



Streams

Version 3.03

User's Guide:
Field Objects

by Dr. Roger Nokes

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User's Guide: Field objects



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February 2021

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I	Introduction.....	1
1.1	Description.....	2
1.2	Naming of fields	3
1.3	Views	3
1.4	Visualisation in 3 dimensions	6
1.5	Tablets.....	7
1.6	Field registry	7
1.7	Greek and Latin symbols.....	7
1.8	Summary.....	7
2	Cameras in 3D visualisation	9
2.1	Description.....	9
2.1.1	Camera definition	9
2.1.2	Camera transformations	10
2.2	Camera manager view.....	12
2.3	Views.....	12
2.3.1	Details view	13
2.3.2	Controller view	13
2.4	Popup menu.....	14
3	Lighting in 3D visualisation.....	15
3.1	Description.....	15
3.2	Lighting manager view	15
3.3	Light types	16
3.3.1	Ambient light.....	16
3.3.2	Directional light.....	18
3.3.3	Point light	19
3.3.4	Spot light	20
4	Curve Fitting.....	23
4.1	Description.....	23

- 4.2 Curve fit manager view 23
- 4.3 Views 24
 - 4.3.1 Linear fit details view 24
 - 4.3.2 Polynomial fit details view 25
 - 4.3.3 Gaussian fit details view 25
 - 4.3.4 Power fit details view 25
- 4.4 Popup menu 25
- 5 Adornments in 2D 27**
 - 5.1 Description 27
 - 5.2 Adornment 2D manager view 27
 - 5.3 Views 29
 - 5.3.1 Generic adornment parameters 30
 - 5.3.2 Line adornment parameters 31
 - 5.3.3 Text adornment parameters 31
 - 5.3.4 Line adornment details view 32
 - 5.3.5 Arrow adornment details view 32
 - 5.3.6 Circle adornment details view 32
 - 5.3.7 Formula adornment details view 33
 - 5.3.8 Oval adornment details view 33
 - 5.3.9 Rectangle adornment details view 34
 - 5.3.10 Polygon adornment details view 34
 - 5.3.11 Text adornment details view 35
 - 5.3.12 Text in box adornment details view 35
 - 5.4 Popup menu 36
- 6 Adornments in 3D 37**
 - 6.1 Description 37
 - 6.2 Adornment 3D manager view 37
 - 6.3 Views 39
 - 6.3.1 Generic adornment parameters 39
 - 6.3.2 Cylinder adornment details view 40
 - 6.3.3 Cone adornment details view 40
 - 6.3.4 Sphere adornment details view 41
 - 6.3.5 Rectangular prism adornment details view 41
 - 6.3.6 General rectangular prism adornment details view 41

6.4	Popup menu.....	42
7	Adornment animators in 2D	43
7.1	Description.....	43
7.2	Adornment 2D animator manager view	44
7.3	Adornment 2D animator details view.....	45
7.4	Popup menu.....	46
8	Adornment animators in 3D	47
8.1	Description.....	47
8.2	Adornment 3D animator manager view	47
8.3	Adornment 3D animator details view.....	48
8.4	Popup menu.....	49
9	Particle seeders in 2D	51
9.1	Description.....	51
9.2	Seeder manager view	51
9.3	Views.....	52
9.3.1	Details view	52
9.4	Popup menu.....	54
10	Particle seeders in 3D	55
10.1	Description.....	55
10.2	Seeder manager view	55
10.3	Views.....	56
10.3.1	Details view	56
10.4	Popup menu.....	58
11	Creating images from field views	59
11.1	Description.....	59
11.2	Images.....	59

- 11.2.1 Layout 59
 - 11.2.2 Tiff quality..... 60
 - 11.2.3 File 60
- 11.3 Image sequences 60
- 12 Scalar field 0D..... 61**
 - 12.1 Description..... 61
 - 12.2 Views 61
 - 12.2.1 Details view 61
 - 12.2.2 Table view 61
 - 12.3 Popup menu..... 62
- 13 Scalar field 1D..... 63**
 - 13.1 Description..... 63
 - 13.2 Views 63
 - 13.2.1 Details view 63
 - 13.2.2 Table view 63
 - 13.2.3 Graph view 64
 - 13.2.4 PDF view 71
 - 13.2.5 Spectral view 75
 - 13.3 Popup menu..... 80
- 14 Scalar field 2D..... 81**
 - 14.1 Description..... 81
 - 14.2 Views 81
 - 14.2.1 Details view 81
 - 14.2.2 Table view 81
 - 14.2.3 Contour view 82
 - 14.2.4 Animated graph view 93
 - 14.2.5 Multi graph view 98
 - 14.2.6 Offset graph view..... 103
 - 14.2.7 PDF view 110
 - 14.2.8 Surface view 115
 - 14.2.9 Multi spectral view..... 121
 - 14.3 Popup menu..... 125

15 Scalar field 3D.....	127
15.1 Description.....	127
15.2 Views.....	127
15.2.1 Details view.....	127
15.2.2 Contour view.....	127
15.2.3 Animated contour view.....	133
15.2.4 Animated surface view.....	140
15.2.5 Contour layers view.....	147
15.3 Popup menu.....	152
16 Vector 2D field 0D.....	155
16.1 Description.....	155
16.2 Views.....	155
16.2.1 Details view.....	155
16.2.2 Table view.....	155
16.3 Popup menu.....	156
17 Vector 2D field 1D.....	157
17.1 Description.....	157
17.2 Views.....	157
17.2.1 Details view.....	157
17.2.2 Table view.....	157
17.2.3 Graph view.....	158
17.2.4 Vector view.....	162
17.3 Popup menu.....	166
18 Vector 2D field 2D.....	169
18.1 Description.....	169
18.2 Views.....	169
18.2.1 Details view.....	169
18.2.2 Table view.....	169
18.2.3 Vector view.....	170
18.2.4 Animated graph view.....	177
18.2.5 Particle track view.....	182

- 18.3 Popup menu..... 192
- 19 Vector 2D field 3D..... 193**
 - 19.1 Description..... 193
 - 19.2 Views 193
 - 19.2.1 Details view 193
 - 19.2.2 Animated vector view..... 193
 - 19.2.3 Particle track view 199
 - 19.2.4 3D vector view..... 206
 - 19.3 Popup menu..... 212
- 20 Vector 3D field 0D..... 213**
 - 20.1 Description..... 213
 - 20.2 Views 213
 - 20.2.1 Details view 213
 - 20.2.2 Table view 213
 - 20.3 Popup menu..... 214
- 21 Vector 3D field 1D..... 215**
 - 21.1 Description..... 215
 - 21.2 Views 215
 - 21.2.1 Details view 215
 - 21.2.2 Table view 215
 - 21.2.3 Graph view 216
 - 21.3 Popup menu..... 221
- 22 Vector 3D field 2D..... 223**
 - 22.1 Description..... 223
 - 22.2 Views 223
 - 22.2.1 Details view 223
 - 22.2.2 Table view 223
 - 22.2.3 Vector view 224
 - 22.2.4 Animated graph view 229
 - 22.3 Popup menu..... 235

23 Vector 3D field 3D..... 237

23.1 Description..... 237

23.2 Views 237

23.2.1 Details view 237

23.2.2 Vector view 237

23.2.3 Animated 2D vector view 242

23.3 Popup menu..... 248

24 Vector 3D field 4D..... 251

24.1 Description..... 251

24.2 Views 251

24.2.1 Details view 251

24.2.2 Animated vector view 251

24.2.3 Particle track view 258

24.3 Popup menu..... 264

I Introduction

Streams is an image processing system designed and implemented at the University of Canterbury. The system has been designed specifically to provide a user interface that is both friendly and powerful so that relative novices can rapidly gain familiarity with its capabilities. Both postgraduate and undergraduate research students have used the system effectively within our laboratory.

Four documents describing *Streams* are available. The first, the **Streams 3.03 – System Theory and Design** Manual, provides a general introduction to image processing in the context of laboratory-based fluid dynamics experiments and describes in detail the theory underpinning the *Streams* system. The second manual, the **Streams 3.03 – User's Guide: Core Objects** describes all objects within the *Streams* environment excluding the field and tablet objects. Tablets are discussed in the **Streams 3.03 – User's Guide: Tablets**, while fields are detailed here in the **Streams 3.03 – User's Guide: Field Objects**.

Streams is designed according to the object model of software development. Both the underlying code and the user interface are consistent with this model. While the code is of little concern to the user, the structure of the interface is. This manual covers the very important topic of fields within the *Streams* system and describes the interface provided to the user to interact with these objects. These fields are normally the end product of an analysis that will probably have started with the manipulation of a sequence of images. Fields represent everything from density or concentration to velocity or strain fields.

This manual

- provides the user with detailed information about the various field objects present in *Streams*,
- explains the available field views, the information they display and the menu options each provides,
- explains the interaction mechanisms through popup menus and dialog boxes, and
- explains the use of tablets in manipulating and storing fields.

I.1 Description

Streams aims to provide a software ecosystem where scalar and vector field data, obtained from experiment, can be manipulated, analysed and visualised. The underlying objects that support this aim are the field objects that represent scalar and vector fields calculated on a rectangular grid of some sort. These fields are typically created by calculators operating on Eulerian or Lagrangian fields (see System Theory and Design manual) and stored and manipulated in tablets.

A broad range of field objects is supported. Eulerian fields generated from 2D particle tracking may be scalar or 2D vector fields defined as functions of two spatial coordinates (x and y) and time while fields generated from 3D particle tracking may be scalar or 3D vector fields defined as functions of 3 spatial coordinates (x, y and z) and time. In contrast Lagrangian fields generated via 2D or 3D particle tracking will generate fields that are functions of path number and time.

These fields are treated generically with the result that thirteen different field types are provided. These are

- scalar field 0D (a single scalar)
- scalar field 1D
- scalar field 2D
- scalar field 3D
- vector 2D field 0D (a single 2D vector)
- vector 2D field 1D
- vector 2D field 2D
- vector 2D field 3D
- vector 3D field 0D (a single 3D vector)
- vector 3D field 1D
- vector 3D field 2D
- vector 3D field 3D
- vector 3D field 4D

It is important to note that the last dimension in this list corresponds to the number of independent variables (including space and time coordinates) while the initial 2D and 3D for vector fields refers to the number of components present in the dependent vector field.

1.2 Naming of fields

All fields possess two names. The first name is a short name that corresponds to that of the calculator that created the field and indicates the data stored within the field. For example the fluid velocity in the x direction is normally given the symbol u , the turbulent kinetic energy is given the name tke and so on. The second, full, name includes information about the domain from which the field was created. This name is given to the field at the time that it is created by a calculator operating on an Eulerian or Lagrangian field, and its form is described in section 7.4.1 of the User's Guide: Core objects.

All fields store text information referred to as the description. The user is at liberty to include whatever information seems appropriate in the description. The two field names and description are accessible through the details view of the field.

1.3 Views

All fields provide the user with a range of different views, and each view provides the user with some degree of control over how the view is displayed. One group of view settings is unique to the displayed view and when that view is closed these settings are lost. A second group of settings are associated with all views of a particular type – for example a scalar field 1D graph view. This group of settings is manipulated in a consistent way for all views, through a Set Layout dialog box. Even when a particular view is closed these settings remain in place and all views of this type will utilize these settings.

A comment about the use of variable names is worth mentioning here. Variables within a view are referred to by their actual names e.g. x , y , t and the various field names such as tke etc. In the documentation below we will refer to generic names such as field for the field variables, x for the independent variable in a one-dimensional field etc. Be aware that these generic names are replaced by the actual names themselves in the views, and in fact, the user can generally change the names of these variables to suit their requirements, including using Greek symbols if desired (see section 1.7).

The functionality and interfaces provided by the graphical views (all views other than the table and details views) have much in common. A brief overview of this commonality is given here before the views are considered in more detail in the later chapters.

All graphical views, together with the settings associated with those views, can be saved for later use. Such views are referred to as **persistent views**, and each field object retains a list of its persistent views that is easily accessed by the user through its popup menu. When a persistent view is opened all of the previously chosen settings for the view, including those common to all views of that type, are reinstated. Thus the view appears exactly as it was when it was saved. When a field object is saved to a file all of its persistent views are saved with it.

The settings common to all views of the same type can also be saved to file and reinstated when required. This enables rapid reconstruction of certain view layout choices.

The functionality provided by each graphical view is available to the user in a number of locations. Firstly the menu bar at the top of the view window provides a number of menus that directly control the view. Every view has at least 4 menus. These are the File, View, Adornment and Zoom menus. Secondly, below the menu bar is a group of toolbars that provide the user with easy access to some of the functionality available in the menu bar, as well as some additional information. For example, most views display the current cursor location and perhaps the value of the displayed field at the cursor location. A third way to access the functionality of the view is through a popup menu that is displayed when the right mouse button is clicked anywhere inside the graphical display area. Generally this popup menu does not provide the full list of menu options available in the main menu bar. The popup menu is designed to provide the user with easy access to some of the common view functions.

Below the toolbars lies the display area in which the view presents its graphical display of the field data. When the display is resized the toolbars can take up a significant proportion of the view space, and all views allow these controls to be hidden through menu options or through holding the ALT key and double clicking within the view area.

For some graphical views the display area maintains a preferred aspect ratio because of the data it represents – for example a contour plot of a scalar field 2D will wish to keep a fixed aspect ratio so that the physical coordinates corresponding to the x and y axes keep the same scale. When these views are first opened the system sizes the window so that there is no waste space. If the user resizes the view at any stage they can return to the optimal window layout by double clicking in the blank space between the toolbars or choosing Adjust view size from the View menu.

Management of field views, when many are displayed simultaneously, is quite challenging with limited display space. A graphical view can be shrunk to one quarter of the display area and relocated into the bottom right corner of the display by double clicking anywhere in the graphical display area. Double clicking again will return the view to its previous size and location. Menu and toolbar options in the main application window enable all graphical field views, currently displayed, to be shrunk and expanded simultaneously. Other options enable the user to cycle through the displayed views, forwards or backwards, bringing each view to the front in sequence.

In addition the main application window provides the user with a number of commands that operate on all open field views. For example all views can be minimized, tiled, stacked or closed. When the views are manipulated in this way the system remembers all views settings selected by the user and will reinstate these settings when the views are redisplayed. For example the user may have chosen to display only a subset of the data in a view or changed the number of decimal places used to display the field values. These settings are retained even if the views are minimized, stacked or tiled. Of course if the views are closed default settings are used if they are reopened.

All graphical views provide the user with the ability to create and display **adornments**. An adornment is simply a geometric object, curve or text string that can be used to enhance the view. Both two-dimensional and three-dimensional adornments are available depending on the view. Two-dimensional adornments are described in chapter 5 while three-dimensional adornments are presented in chapter 6. The user can define many of the characteristics of these adornments including their colour, location, size, font (if the adornment includes text), line width and style (if the adornment includes drawn lines) and so on. Adornments can be stored to disk so that they can be readily retrieved when a view is redisplayed, and they can be hidden, or shown, as required by the user.

In addition to static adornments all graphical views that support animation also provide **adornment animators**. Animated graphical views include a simple video player interface that enables the user to play through a sequence of frames containing one-, two- or three-dimensional scalar or vector fields. Adornment animators comprise a list of adornments whose location on screen are changed from frame to frame based on displacement formulae provided by the user.

All graphical views provide a zoom capability that allows the user to enlarge a certain portion of the displayed data. The zoom region is

defined by a rectangle region (see User's Guide: Core Objects) drawn in the standard way on the display area. For most views the only region that can be drawn is a rectangle so no drawing tool selection is provided. In addition, for these views the zoom rectangle cannot be resized or moved. Instead it must be redrawn. In some views a change in viewing region can be achieved by setting the upper and lower limits of the two or three axes in four or six text boxes displayed in the view's toolbars. Whatever method is chosen to change the portion of the data that is displayed on screen, the unzoom option restores the default viewing region.

The majority of views allow the user to display only a subset of the data available within the field. This feature is most helpful when the field contains such a large amount of data that rendering of the view is slow, or where rendering the full dataset will result in a very cluttered graph. For example, a one-dimensional scalar field with one million data points takes some time to render in its graph view. When a view is first opened it checks to see if the size of the dataset is such that rendering will be slow or result in excessive clutter. If so the view will automatically reduce the number of data points displayed. The user is at liberty to reinstate the original dataset or choose some other subset of the dataset.

I.4 Visualisation in 3 dimensions

Streams 3.00 introduced rendering of data in three dimensions in order to support the visualization of 3D fields – both scalar and vector. All three-dimensional views provide a rather more sophisticated viewing experience than simple two-dimensional views. The three-dimensional scene can be lit with a range of lighting options (see chapter 3) and viewed by a variety of cameras (see chapter 2) that the user is at liberty to move, rotate and zoom in and out relative to the data being inspected.

It should be recognized that the three-dimensional display of large datasets, through ray casting methods, is computationally very demanding. While the code for displaying three-dimensional fields has been optimized somewhat no use has been explicitly made of the GPU and thus rendering speeds can be slow. There are a number of mechanisms that enable the rendering speed to be improved, including displaying only portions of the data and viewing “from afar” so fewer pixels are involved in the rendering. The user will quickly learn the best way to manipulate and view their data through experimenting with the various options available in each of the views but sometimes patience is required.

I.5 Tablets

Tablets were a new addition to *Streams 3.00*. They provide a convenient tool for manipulating field data in a similar manner to MATLAB[®]. The user has access to a range of functions and operators that enable simple and more complex computations to be performed on scalar and vector fields. The results from these computations are all stored within the tablet and thus the tablet also becomes a convenient storage mechanism for associated fields. Tablets are described in a separate manual - **Streams 3.03 – User's Guide: Tablets**.

I.6 Field registry

Fields arise in a number of locations in *Streams*. They may reside in a variety of Eulerian or Lagrangian calculators, they may have been loaded into *Streams* from disk, or be contained within a tablet. To enable access to all of these fields in a simple way all fields, when they first appear in *Streams*, are registered with the system in what is termed the Field Registry. The user can easily see the contents of the registry through the main application menu – see the User's guide: Core objects.

I.7 Greek and Latin symbols

All text is initially rendered using Latin characters. However in graphical views the user can choose to use Greek symbols for axis names etc. The change of alphabet is achieved by selecting the text and right clicking for a popup menu that provides the two options Latin and Greek.

I.8 Summary

This chapter has provided a brief introduction to fields and their views. In later chapters the different fields and their views and popup menus will be described in detail. However the next few chapters discuss elements of fields and their views that are used across a range of views. Finally before the fields are discussed tablets are introduced.

2 Cameras in 3D visualisation

2.1 Description

Streams provides a range of views for three-dimensional data that render the data in three-dimensional space. Such views have visual complexity not possessed by simple two-dimensional views. In particular in these views the user requires the capability to change their viewing location in order to be able to inspect all aspects of the data. These three-dimensional views support this requirement through the use of cameras. Whenever the user is viewing three-dimensional data they are doing so through a **virtual camera**. The user can define as many of these virtual cameras as they wish and move between them to gain different views of the data, or they can use a single camera and shift, rotate and zoom that camera to experience different perspectives of the data.

A camera can be saved to a file and reloaded at a later time in order to reproduce exactly the same viewing location as previously defined.

The management of cameras associated with a view is achieved through the camera management view. This view is accessed through the Cameras menu and is discussed in section 2.2.

2.1.1 Camera definition

Cameras possess a number of parameters that determine exactly what the user sees through the camera. These parameters include the location and orientation of the camera in space as well as camera specific parameters.

These parameters are as follows:

- *Location* – this is a 3D point in space at which the camera, regarded as a point, is located.
- *Projection direction* – this 3D vector points from the camera location in the direction towards which the camera looks. It is a unit vector although if the user chooses to change this direction manually then they need not enter it as a unit vector – the view will convert this automatically.
- *Up direction* – this 3D vector points upward through the camera location and is orthogonal to the projection direction. It defines the direction that the viewer will see as vertically upwards. It is a unit vector although if the user chooses to change this direction manually then they need not enter it as a unit vector – the view will convert this automatically.

- *Focal distance* – the distance from the camera, in the projection direction, to the focal point. The plane that passes through the focal point and has the projection direction as its normal is known as the focal plane. There is no sense that data in the view is out of focus – in photographic terminology all virtual cameras have an infinite f number, i.e. they view through a pinhole. The importance of the focal point will become clear when transformations of the camera are discussed.
- *Horizontal zoom angle* – this internal camera setting specifies the horizontal angle – where horizontal is defined as the direction normal to both the projection and up directions – that defines what is visible through the camera. The smaller this parameter the smaller the extent of the data that the user will see and thus the viewer will feel closer to the data. A wider angle has the opposite effect.

All of these camera parameters can be changed, either through camera views described in section 2.3, or through camera transformations described in section 2.1.2.

When a three-dimensional view is first created a default camera is created. The projection direction is the negative z direction and the up direction is the y direction. The camera is located in the middle of the x and y ranges and at a distance, and with a zoom angle, such that the entire dataset is visible.

2.1.2 Camera transformations

The simplest technique for changing the camera settings, and hence the view of the data seen by the user, is to transform the camera. Such transformations include moving, rotating and zooming. These transformations can be executed either using keyboard commands in the view itself, or through the controller view of the camera (see section 2.3.2).

The full set of transformations is described below. It should be noted that two of the transformations, changing the pitch and changing the yaw, are not supported with keyboard commands.

The most common method for transforming the camera is through keystrokes in the three-dimensional view. In order for the keystrokes to register with the view the display area must have the keyboard focus. As is standard across the *Streams* environment this is gained by clicking the mouse on the display area and this action is confirmed by the display of a small green rectangle in the bottom right hand corner of the view.

The transformations and their associated keyboard commands are as follows:

- *Move left/right* – this transformation moves the camera to the left or right without changing any other parameters. The direction of movement is normal to the up and projection directions. The result is that the focal point will move within the focal plane. The key commands are SHIFT + LEFT ARROW and SHIFT + RIGHT ARROW. Note that this transformation acts on the camera and thus the data displayed will move in the opposite direction to that chosen.
- *Move up/down* – this transformation moves the camera up or down without changing any other parameters. The direction of movement is parallel to the up direction. The result is that the focal point will move within the focal plane. The key commands are SHIFT + UP ARROW and SHIFT + DOWN ARROW. Note that this transformation acts on the camera and thus the data displayed will move in the opposite direction.
- *Move in/out* – this transformation moves the camera in or out without changing any other parameters. The direction of movement is parallel to the projection direction and this transformation has no effect on the focal point or plane but does change the focal distance. The key commands are ALT + RIGHT ARROW (in) and ALT + LEFT ARROW (out).
- *Zoom in/out* – this transformation changes the horizontal zoom angle without changing any other parameters. The transformation has no effect on the focal point or plane. The key commands are ALT + UP ARROW (zoom in) and ALT + DOWN ARROW (zoom out).
- *Roll* – this transformation changes the up direction without changing any other parameters. The effect of the transformation is to rotate the camera about the projection direction. The key commands are SHIFT + CONTROL + LEFT ARROW (rotates anticlockwise) and SHIFT + CONTROL + RIGHT ARROW (rotate clockwise).
- *Change elevation* – this transformation rotates the camera about the focal point in the up or down direction. The transformation has no effect on the zoom, focal point or focal distance but all other camera parameters are affected. The key commands are CONTROL + UP ARROW (rotate in the up direction) and CONTROL + DOWN ARROW (rotate in the down direction).
- *Change azimuth* – this transformation rotates the camera about the focal point in the left or right directions. The transformation has no effect on the up direction, zoom, focal point or focal distance but all other camera parameters are changed. The key commands are CONTROL + LEFT ARROW (rotate in the left direction) and CONTROL + RIGHT ARROW (rotate in the right direction).
- *Change pitch* – this transformation rotates the camera about the camera's location in the up or down directions. The transformation has no effect on the focal distance, camera location or zoom, but all other camera parameters are affected. There is no keyboard equivalent.
- *Change yaw* – this transformation rotates the camera about the camera's location in the left or right directions. The transformation has no effect

on the focal distance, camera's location or but all other camera parameters are affected. There is no keyboard equivalent.

One other keyboard command is useful. By pressing the ESCAPE key the user can reset the camera parameters to their values when the camera was first created. The user is asked to confirm this decision.

2.2 Camera manager view

Description

The camera manager view provides the user with direct access to the currently defined cameras for a view. These cameras are displayed in a list. Each camera has a name that can be specified by the user. One camera in the list is active at any one time and it is this camera that is used to render the view of the data. The active camera has a tick next to its name.

The five buttons at the bottom of the camera manager view provide the following options for manipulating the list of cameras.

- *Select* – if this button is pressed the selected camera in the list becomes the current camera and a tick is displayed next to its name. The three-dimensional view will automatically update to change the view of the data based on the new camera.
- *New* – creates a new camera with default name and parameters and adds it to the list of cameras.
- *Load* – allows the user to load a camera from file and adds it to the list of cameras. The camera is stored in a file with a .cam3d extension.
- *Delete* – deletes the selected camera in the list. The user will be prompted to confirm this action.
- *Clear* – deletes all cameras from the list except the default camera. The user will be prompted to confirm this action.

Access

The camera manager view of a three-dimensional field view can be accessed through the Cameras menu.

2.3 Views

A camera has two views.

- *Details view.*
- *Controller view.*

2.3.1 Details view

Description

The details view of a camera allows the user to change the camera name and the camera parameters as discussed in section 2.1.1.

The three buttons at the bottom of the view perform the following actions:

- *Update* – when this button is pressed the camera settings are updated based on changes made by the user but the details view remains open. The three dimensional field view will automatically update.
- *Save and close* – this button performs the same action as the update button except the details view is closed.
- *Cancel* – if pressed the details view is closed and any parameter changes made are discarded.

Access

The details view of a camera can be accessed through the popup menu of the camera object.

2.3.2 Controller view

Description

In many ways the controller view provides another mechanism for changing the camera parameters, but it does so typically through camera transformations. Changing camera parameters manually is laborious and probably unlikely to yield the view of the data one expected. Thus the transformations, which have a more intuitive feel, are the typical mechanism for changing the view of a three dimensional dataset.

The controller view allows manual changes to the camera parameters to be made (and even displays the position of the focal point although this cannot be changed directly). It also provides the full range of transformations. These transformations are self-explanatory with buttons provided to execute each transformation. For example the Shift left/right transformation has two buttons labeled Left and Right to execute the transformation.

Each transformation has an associated step. For example when a shift left transformation is executed the distance moved is specified by the associated step. When the camera is first created sensible steps for each of the transformations are set by the view. These steps are displayed in

the controller view and can be changed in this view. These steps are used both by the controller view when executing the transformations and the equivalent keyboard commands.

The two buttons at the bottom of the view perform the following actions:

- *Update* – when this button is pressed the camera settings are updated based on changes made by the user but the view remains open. The three-dimensional view is automatically updated.
- *Reset camera* – this button resets all of the camera parameters to their initial settings. The user is asked to confirm this action. This is equivalent to the keyboard command generated by the ESCAPE key.

Access

The controller view is the default view for a camera and can be accessed by double clicking the camera object or through the popup menu of the camera object. In addition, as quick access to this view is often desirable if the user wishes to change any of the transformation steps, the user can also access this view through the Cameras menu of the three-dimensional view by selecting the Open current controller option. In addition the controller view of the current camera is also opened by double clicking on the display area of the three dimensional view while holding down the SHIFT and ALT keys.

2.4 Popup menu

The camera provides the following options in its popup menu.

- *Save as...* – saves the camera to a disk file. The file has a *.cam3d* extension.
- *Open controller view...* – opens the controller view.
- *Open details view...* – opens the details view.

3 Lighting in 3D visualisation

3.1 Description

The effective rendering of 3D data onto a 2D surface (the computer screen) needs to convince the user that they are indeed viewing three dimensional surfaces and objects. This is achieved through the use of lighting. Light generated from the light sources reflects from the surface of the three-dimensional objects and these reflections provide that sense of three-dimensionality to the user.

Streams provides four different types of light sources and the user is at liberty to adopt as many of these lights as they wish to enhance their visualization of the data.

The four different light types supported are:

- *Ambient light*
- *Directional light*
- *Point light*
- *Spot light*

The different light types are described in section 3.3.

These lights are manipulated through the lighting manager view that all three-dimensional views possess. The manage view is accessed through the Lighting menu.

3.2 Lighting manager view

Description

The lighting manager view provides the user with direct access to the currently defined lights all of which are listed in the manager view.

Each light has a user-defined name, which is displayed in the list. The lights that are currently turned on have ticks next to their names. Many lights can be on simultaneously.

The three buttons at the bottom of the lighting manager view provide the following options for manipulating the list of lights.

- *Load* – allows the user to load a light from a disk file and add it to the list. The file has a .lit3D extension.
- *Delete* – deletes the currently selected light in the list. The user will be prompted to confirm this action.
- *Clear* – deletes all lights in the list. The user will be prompted to confirm this action.

Access

The lighting manager view of a three dimensional view can be accessed through the Lighting menu of the view.

Menus

Light menu

- *Create ambient light...* – creates a new ambient light and adds it to the list. The details view of the light is automatically opened on creation to allow the user to set its parameters.
- *Create directional light...* – creates a new directional light and adds it to the list. The details view of the light is automatically opened on creation to allow the user to set its parameters.
- *Create point light...* – creates a new point light and adds it to the list. The details view of the light is automatically opened on creation to allow the user to set its parameters.
- *Create spot light...* – creates a new spot light and adds it to the list. The details view of the light is automatically opened on creation to allow the user to change its parameters.

3.3 Light types

Each of the light types provides a different lighting effect. When a view is first opened two light sources are created automatically – an ambient light source and a directional light source. For many applications these default lights will be sufficient for the user's needs.

3.3.1 Ambient light

An ambient light has no preferred direction - light of a single colour comes from all directions. A surface lit with an ambient light source will look flat and will not provide a sense of the three dimensionality of the objects being viewed.

The only adjustable parameter, other than the name of the light and whether it is on or off, is the colour of the light. It is important to note

that when many lights are on simultaneously their colours superimpose. Thus if a number of lights are on and they are all white it is likely that portions of the three dimensional surfaces will saturate – in other words while there should be variations in colour due to different levels of reflection these variations are washed out in the same way as an over exposed photograph. For example the colours of the two default lights are both gray such that if the two colours perfectly superimposed the colour would be pure white. In this way no saturation will occur.

3.3.1.1 *Details view*

The details view has two tabs General and Parameters:

General

- Light name... – the name of the light. The default name is the light type.
- On – this check box specifies whether the light is on. It can be set here or through the popup menu.

Parameters

- Colour: red... – a real number between 0 and 1 that specifies the level of red in the light. 0 corresponds to no red and 1 corresponds to maximum red.
- Green – a real number between 0 and 1 that specifies the level of green in the light.
- Blue – a real number between 0 and 1 that specifies the level of blue in the light.
- Choose colour... – pressing this button will bring up a colour chooser. This is often the easiest way to select a light colour. The three red, green and blue text boxes will be updated when a colour is selected.

The two buttons at the bottom of the view do the following:

- OK – saves the changes to the settings and closes the view.
- Cancel – discards the changes to the settings and closes the view.

3.3.1.2 *Popup menu*

All ambient lights have a popup menu with the following options.

- Save as... – saves the light to a disk file. The file has a .lit3D extension.
- Turn on/off... – turns the light on or off.
- Open details view – opens the light's details view.

3.3.2 Directional light

A directional light has a preferred direction - light of a single colour comes from this direction in parallel rays. It mimics the light coming from a distant source such as the sun. This directional light is very effective at providing a sense of the three dimensionality of objects as parts of objects may be hidden from the directional light by other objects and thus they will appear to be in shadow.

While a directional light is useful in visualizing the three dimensionality of an object generally it is not sufficient by itself. If a portion of an object does not receive light from the source then it will appear black, like a crescent moon, and variations in colour will be lost. Thus it is useful to partner a directional light source with an ambient light source. In this way no part of any surface will appear black unless it is actually coloured black.

3.3.2.1 Details view

The details view has two tabs General and Parameters:

General

- Light name... – the name of the light. The default name is the light type.
- On – this check box specifies whether the light is on. It can be set here or through the popup menu.

Parameters

- Colour: red... – a real number between 0 and 1 that specifies the level of red in the light. 0 corresponds to no red and 1 corresponds to maximum red.
- Green – a real number between 0 and 1 that specifies the level of green in the light.
- Blue – a real number between 0 and 1 that specifies the level of blue in the light.
- Choose colour... – pressing this button will bring up a colour chooser. This is often the easiest way to select a light colour. The three red, green and blue text boxes will be updated when a colour is selected.
- Direction: x... – the x component of the vector specifying the light direction. This vector is a unit vector but the user can choose not to enter it as a unit vector as the view will automatically convert it.
- y – the y component of the vector specifying the light direction.
- z – the z component of the vector specifying the light direction.

The two buttons at the bottom of the view do the following:

- *OK* – saves the changes to the settings and closes the view.
- *Cancel* – discards the changes to the settings and closes the view.

3.3.2.2 *Popup menu*

All directional lights have a popup menu with the following options.

- *Save as...* – saves the light to a disk file. The file has a .lit3D extension.
- *Turn on/off...* – turns the light on or off.
- *Open details view* – opens the light's details view.

3.3.3 **Point light**

A point light source corresponds to light emanating from a single point in all directions. The unique parameters for this type of light source is the location of the light and information about the attenuation of the light as a function of distance. The attenuation factor is the inverse of a quadratic polynomial of distance and the user can specify the coefficients for the 3 powers of distance that appear in the quadratic.

3.3.3.1 *Details view*

The details view has two tabs General and Parameters:

General

- *Light name...* – the name of the light. The default name is the light type.
- *On* – this check box specifies whether the light is on. It can be set here or through the popup menu.

Parameters

- *Colour: red...* – a real number between 0 and 1 that specifies the level of red in the light. 0 corresponds to no red and 1 corresponds to maximum red.
- *Green* – a real number between 0 and 1 that specifies the level of green in the light.
- *Blue* – a real number between 0 and 1 that specifies the level of blue in the light.

- *Choose colour...* – pressing this button will bring up a colour chooser. This is often the easiest way to select a light colour. The three red, green and blue text boxes will be updated when a colour is selected.
- *Location: x...* – the x component of the point specifying the light location.
- *y* – the y component of the point specifying the light location.
- *z* – the z component of the point specifying the light location.
- *Attenuation: c1...* – the constant in the quadratic specifying the attenuation function.
- *c2* – the coefficient of the linear term in quadratic specifying the attenuation function.
- *c3* – the coefficient of the squared term in quadratic specifying the attenuation function.

The two buttons at the bottom of the view do the following:

- *OK* – saves the changes to the settings and closes the view.
- *Cancel* – discards the changes to the settings and closes the view.

3.3.3.2 *Popup menu*

All point lights have a popup menu with the following options.

- *Save as...* – saves the light to a disk file. The file has a .lit3D extension.
- *Turn on/off...* – turns the light on or off.
- *Open details view* – opens the light's details view.

3.3.4 **Spot light**

A spotlight provides a light source located at a single point, but unlike the point light it does not emit light in all directions. Instead the light is effectively constrained to a cone emanating from the point and the intensity of the light across the cone varies with distance from the axis of the cone. Like the point light an attenuation function is also specified.

The variation of the light across the cone is computed as the cosine of the angle between the light direction and the cone axis to the power of a focus exponent.

3.3.4.1 *Details view*

The details view has two tabs General and Parameters:

General

- *Light name...* – the name of the light. The default name is the light type.
- *On* – this check box specifies whether the light is on. It can be set here or through the popup menu.

Parameters

- *Colour: red...* – a real number between 0 and 1 that specifies the level of red in the light. 0 corresponds to no red and 1 corresponds to maximum red.
- *Green* – a real number between 0 and 1 that specifies the level of green in the light.
- *Blue* – a real number between 0 and 1 that specifies the level of blue in the light.
- *Choose colour...* – pressing this button will bring up a colour chooser. This is often the easiest way to select a light colour. The three red, green and blue text boxes will be updated when a colour is selected.
- *Location: x...* – the x component of the point specifying the light location.
- *y* – the y component of the point specifying the light location.
- *z* – the z component of the point specifying the light location.
- *Direction: x...* – the x component of the vector specifying the axis of the cone. This vector is a unit vector but the user can choose not to enter it as a unit vector as the view will automatically convert it.
- *y* – the y component of the vector specifying the axis of the cone.
- *z* – the z component of the vector specifying the axis of the cone.
- *Attenuation: c1...* – the constant in the quadratic specifying the attenuation function.
- *c2* – the coefficient of the linear term in quadratic specifying the attenuation function.
- *c3* – the coefficient of the squared term in quadratic specifying the attenuation function.
- *Focus exponent* – the power that determines how rapidly the light intensity decreases across the cone of the spotlight.

The two buttons at the bottom of the view do the following:

- *OK* – saves the changes to the settings and closes the view.
- *Cancel* – discards the changes to the settings and closes the view.

3.3.4.2 *Lighting*

All spot lights have a popup menu with the following options.

- *Save as...* – saves the light to a disk file. The file has a .lit3D extension.
- *Turn on/off...* – turns the light on or off.
- *Open details view* – opens the light's details view.

4 Curve Fitting

4.1 Description

A number of field views that display simple curves provide the user with the option of doing least squares based curve fits to these curves or subsets of them.

In total four different curve fits are supported. These are:

- *Linear*
- *Polynomial*
- *Gaussian*
- *Power*

The creation and manipulation of curve fits is consistent across all views that support them. Each view has a Curve fitting menu that enables the user to open the curve fitting management view. In this view the user can create new curve fits, delete curve fits and choose which curve fit to display on the graph.

Individual curve fits are described in section 4.3.

4.2 Curve fit manager view

Description

The curve fit manager view provides the user with direct access to the currently defined curve fits, and the ability to create new curve fits.

The view includes a list of the current curve fits. Each curve fit has a name that can be specified by the user, and this is displayed in the list. The currently selected, and hence displayed, curve fit is designated by a tick following the curve fit name.

The three buttons at the bottom of the curve fit manager view provide the following options for manipulating the list of curve fits.

- *Select* – if this button is pressed the selected curve fit in the list is displayed and a tick is displayed next to its name. When many curve fits have been computed this provides the user with a simple method for comparing the fits to the data.

- *Delete...* – pressing this button will delete the selected curve fit from the list. The user will be prompted to confirm this action.
- *Clear...* – pressing this button will clear all curve fits from the list. The user will be prompted to confirm this action.

Access

The curve fit manager view of a field view can be accessed through the Curve fitting menu of the field view.

Menus

Curve fit menu

- *Create linear fit...* – creates a new linear curve fit. Initially a dialog box is displayed that enables the user to specify two things. Firstly, the name of the curve fit and secondly, the data range to be used in fitting the data. The latter is designated by choosing the minimum and maximum independent variable values for this range.
- *Create polynomial fit...* – creates a new polynomial curve fit. Initially a dialog box is displayed that enables the user to specify three things. Firstly, the name of the curve fit, secondly, the data range to be used in fitting the data and thirdly the order of the polynomial. The data range is designated by choosing the minimum and maximum independent variable values for this range.
- *Create Gaussian fit...* – creates a new Gaussian curve fit. Initially a dialog box is displayed that enables the user to specify two things. Firstly, the name of the curve fit and secondly, the data range to be used in fitting the data. The latter is designated by choosing the minimum and maximum independent variable values for this range. Note that this curve fit will fail if the dependent variable takes non-positive values in the selected data range.
- *Create power fit...* – creates a new power curve fit. Initially a dialog box is displayed that enables the user to specify two things. Firstly, the name of the curve fit and secondly, the data range to be used in fitting the data. The latter is designated by choosing the minimum and maximum independent variable values for this range. Note that this curve fit will fail if the dependent variable takes non-positive values in the selected data range.

4.3 Views

All curve fits have a single view, a details view. This view gives the user access to the fitting parameters and RMS error of the fit.

4.3.1 Linear fit details view

The following fit parameters are displayed but are not editable:

- *Slope* – the slope of the linear fit.
- *Intercept* – the intercept (the value at $x = 0$) of the fit.
- *RMS error* – the root mean square error of the fit.

4.3.2 Polynomial fit details view

This view displays a list of the fit parameters. The number of parameters will be determined by the order of the polynomial chosen when doing the fit. The list contains the following:

- *Power xx coeff* – the list will include $n+1$ entries of this type where xx will take values from 0 to n , the order of the polynomial.
- *RMS fit error* – the root mean square error of the fit.

4.3.3 Gaussian fit details view

The following fit parameters are displayed but are not editable:

- *Centre* – the x location of the Gaussian centre.
- *Maximum* – the value of the fit at the location of the centre.
- *Standard dev* – the standard deviation of the Gaussian.
- *RMS error* – the root mean square error of the fit.

4.3.4 Power fit details view

The following fit parameters are displayed but are not editable:

- *Amplitude* – the multiplying factor in the power fit.
- *Power* – the power in the power fit.
- *RMS error* – the root mean square error of the fit.

4.4 Popup menu

All curve fits have the same popup menu with the following options.

- *Open details view* – opens the details view of the curve fit.

5 Adornments in 2D

5.1 Description

All 2D graphical views for fields support the creation and display of **2D adornments**. Adornments are graphical elements that are drawn on top of the field data, and that are used to enhance the information provided by the view itself. The user is free to use them as they see fit. Examples of adornment use are in the annotation of characteristics of the field and the definition and illustration of domain boundaries.

In total nine different adornments are supported. These are:

- *Lines*
- *Arrows*
- *Circles*
- *Formula-based curves*
- *Ovals*
- *Rectangles*
- *Polygons*
- *Text*
- *Text in rectangular boxes*

The creation and manipulation of adornments is consistent across all 2D views. Each view has an Adornment management view. In this view the user can load adornments from a file (with .ado or .ado2 extensions), save the currently defined adornments to a file, show and hide the currently defined adornments and delete the adornments. This view is described in detail in section 5.2.

Individual adornments and their parameters are described in section 5.3.

5.2 Adornment 2D manager view

Description

The adornment 2D manager view provides the user with direct access to the currently defined adornments, and the ability to create new adornments.

The view includes a list of the current adornments. Each adornment has a name that can be specified by the user, and this is displayed in the list. This name is followed by a tick if the adornment is currently visible. The order of the adornments in the list is important as it determines the order in which the adornments are drawn. The adornment at the top of the list is the first to be drawn, so if adornments within the list overlap when drawn on the field view, an adornment lower in the list will be drawn on top of adornments that appear higher in the list.

The list of adornments supports drag and drop. Thus any 2D adornment listed in an adornment manager window can be dragged to another view's adornment manager window. The result is a copy of the dragged adornment is added to the destination view.

The six buttons at the bottom of the adornment manager view provide the following options for manipulating the list of adornments.

- *Move up* – if this button is pressed the selected adornments in the list are moved upwards. If multiple adornments are selected the first selected adornment is moved up one place in the list and all other selected adornments are moved to lie directly below the first. If the first adornment in the list is included in the selection then this button will have no effect.
- *Move down* – if this button is pressed the selected adornments in the list are moved downwards. If multiple adornments are selected the Move down button shifts the last selected adornment down one place and all other selected adornments are moved to lie directly above this one. If the last adornment in the list is included in the selection then this button will have no effect.
- *Load...* – this button enables the user to load previously saved adornments from disk. These are stored in a file with a *.ado* or *.ado2* extension. The loaded adornments are added to the end of the current list.
- *Save...* – this button saves the currently defined adornments in a file with a *.ado2* extension.
- *Delete...* – pressing this button will delete the selected adornments from the list. The user will be prompted to confirm this action.
- *Clear...* – pressing this button will clear all adornments from the list. The user will be prompted to confirm this action.

Access

The adornment manager view of a field view can be accessed through the Adornments menu of the field view.

Menus

Adornment menu

- *Create line* – creates a new line adornment, with default parameter values, and adds it to the list of current adornments. The details view of the line is displayed automatically to allow the user to edit its properties.
- *Create arrow* – creates a new arrow adornment, with default parameter values, and adds it to the list of current adornments. The details view of the arrow is displayed automatically to allow the user to edit its properties.
- *Create circle* – creates a new circle adornment, with default parameter values, and adds it to the list of current adornments. The details view of the circle is displayed automatically to allow the user to edit its properties.
- *Create formula* – creates a new formula-based curve adornment, with default parameter values, and adds it to the list of current adornments. The details view of the adornment is displayed automatically to allow the user to edit its properties.
- *Create oval* – creates a new oval adornment, with default parameter values, and adds it to the list of current adornments. The details view of the oval is displayed automatically to allow the user to edit its properties.
- *Create rectangle* – creates a new rectangle adornment, with default parameter values, and adds it to the list of current adornments. The details view of the rectangle is displayed automatically to allow the user to edit its properties.
- *Create polygon* – creates a new polygon adornment, with default parameter values, and adds it to the list of current adornments. The details view of the polygon is displayed automatically to allow the user to edit its properties.
- *Create text* – creates a new text adornment, with default parameter values, and adds it to the list of current adornments. The details view of the text is displayed automatically to allow the user to edit its properties.
- *Create text in box* – creates a new text in box adornment, with default parameter values and adds it to the list of current adornments. The details view of the text in box is displayed automatically to allow the user to edit its properties.

5.3 Views

All adornments have a single view, a details view. This view gives the user access to the adornment's defining parameters such as its name, whether it is visible in the view, its colour, its location and so on.

Each details view has a tab that gives access to parameters that are common to all adornments. This is described in section 5.3.1.

Many adornments are geometric figures that are defined by a line width and a line type. These adornments have a tab in their details view where these parameters are set – see section 5.3.2.

Other adornments incorporate text which requires a font and font size to complete their definition. These adornments have a tab in their details view where these parameters are set – see section 5.3.3.

The adornment specific parameters, defined in their individual details views, are described in sections 5.3.4 – 5.3.12. In all cases the user can specify the location of the adornment in the field view and, perhaps, specify its size. The units for the location and size are dependent on the view and in most cases correspond to the units that appear on the axes in the field view. The units for the x and y axes may well be different. For example, for a 1D scalar field displayed in its PDF view the x axis will have units associated with the field itself while the y axis will have units corresponding to a probability. The exception to this rule occurs in any of the spectral views when the axes are displayed using logarithmic scales. In this case the units for both axes correspond to the logarithm base 10 of the axis units. For example if the x axis ranges from 10^{-3} to 10^2 , then the units used to define the adornment in the x direction will range from -3 to 2.

At the bottom of each details view are three buttons. Their functionality is as follows.

- *Save* – if this button is pressed the parameters specified in the details view are saved and the adornment, if displayed in the field view, is redrawn.
- *Save and close* – if this button is pressed the parameters specified in the details view are saved, the view is closed, and the adornment, if displayed in the field view, is redrawn.
- *Cancel* – if this button is pressed changes made to the adornment's parameters are discarded and the view is closed.

5.3.1 Generic adornment parameters

The first tab in all details views is labelled Generic. The parameters set in this tab are common to all adornments.

The following parameters are set on this tab:

- *Name* – the user can choose a name for the adornment that will identify it in the list of adornments displayed in the adornment manager view.

The default name provided when the adornment is first created corresponds to the type of the adornment.

- *Visible* – this checkbox allows the user to select whether an individual adornment is visible in the associated field view. If the user chooses to hide all adornments in the field view this checkbox is unselected for all adornments.
- *Clipped* – this checkbox allows the user to select whether an adornment will be drawn beyond the borders of the view. If selected the adornment will be clipped if it extends beyond of the view display area.
- *Colour* – this field shows the current colour used for drawing the adornment. The Choose colour button allows the user to select a new colour.

5.3.2 Line adornment parameters

For each adornment that is drawn as a graphical figure there is a tab in the details view labelled Line.

The following parameters are set on this tab:

- *Line width* – this field allows the user to specify the width (in pixels) of the lines drawn as part of this adornment. For example a line adornment has its line width specified here. The minimum value that can be specified is 1.0. It should be noted that the adornment line width will always be the specified width even if the user zooms in on a region containing the adornment.
- *Line type* – this combo box enables the user to select a line type. Four different line types, solid, dotted, dashed and dot-dash, are provided.

5.3.3 Text adornment parameters

For each adornment that includes text there is a tab in the details view labelled Font.

The following parameters are set here:

- *Font* – the current font is specified in the text field labelled Font name. Note that the name includes both the font name and also whether it is bold, italic etc. A new font can be selected from the combo box at the bottom of the tab labelled Available fonts. The first time a details view of a text based adornment is displayed there is normally a slight delay while the Available fonts box is populated.
- *Font size (pt)* – this field allows the user to specify the size of the font in point units. It should be noted that the adornment text will always appear in this font size even if the user zooms in on a region containing the text string.

5.3.4 Line adornment details view

The details view of a line adornment has a tab labelled Parameters.

The following parameters are set here:

- *Start x* – the x coordinate of the beginning of the line.
- *Start y* – the y coordinate of the beginning of the line.
- *End x* – the x coordinate of the end of the line.
- *End y* – the y coordinate of the end of the line.

5.3.5 Arrow adornment details view

The details view of an arrow adornment has a tab labelled Parameters.

The following parameters are set here:

- *Start x* – the x coordinate of the beginning of the line.
- *Start y* – the y coordinate of the beginning of the line.
- *End x* – the x coordinate of the end of the line.
- *End y* – the y coordinate of the end of the line.
- *Head at start* – if this box is checked the arrow will have a head at its start.
- *Head at end* – if this box is checked the arrow will have a head at its end. An arrow can have heads at both ends.
- *Head length (pix)* – the user can specify the length of each “barb” in the arrow head in pixels.

5.3.6 Circle adornment details view

The details view of a circle adornment has a tab labelled Parameters.

The following parameters are set here:

- *Centre x* – the x coordinate of the centre of the circle.
- *Centre y* – the y coordinate of the centre of the circle.
- *Radius* – the circle radius. For some 2D scalar and vector fields the x and y axes are initially drawn so that the aspect ratio of the graph is such that one unit in each direction corresponds to the same number of pixels on screen. In this case the radius specification is unambiguous. However, if the user chooses to expand the graph to fill the view these scales are no longer equivalent, and for most other views this is the case in the first place. For example the graph view of a 1D scalar field will invariably have different scales for the two axes. A circle adornment will always be

drawn as a circle. The radius of the circle using each of the axis scales is computed, and the radius which leads to the smallest circle on screen is chosen.

- *Filled* – when selected the circle is filled with its colour. If it is not selected the circle is hollow and is drawn using the line characteristics specified on the Line tab.

5.3.7 Formula adornment details view

The formula adornment draws a curve on the view using two parametric equations for the x and y coordinates. These parametric equations are standard mathematical formulae that can include the normal set of unary and binary operators, brackets and mathematical functions. The parameter is designated *s*.

The details view of a formula adornment has two tabs labelled *Parameters* and *Formulae*.

The following parameters are set on the Parameters tab:

- *Initial s* – the curve corresponding to this adornment is constructed using the two formulae specified on the Formulae tab. These formulae are functions of the parameter *s* and the range of *s* values used to generate the curve are specified here. Initial *s* is the first value of *s* used.
- *Final s* – this is the final value of *s* used in generating the curve.
- *ns* – this specifies the number of line segments used to construct the curve. A value of 1 means the formulae are evaluated at the initial *s* value and the final *s* value and a straight line is drawn between these two points. Generally a much larger value will be chosen to ensure a smooth curve.

The following parameters are set on the Formulae tab:

- *x(s) formula* – the mathematical formula for the x coordinates of the curve in the view. This formula is checked for correct format before being accepted. A popup menu provides the user with the list of all of the available brackets, operators, functions etc. The parameter used in the formula is *s*.
- *y(s) formula* – the mathematical formula for the y coordinates of the curve in the view.

5.3.8 Oval adornment details view

The details view of an oval adornment has a tab labelled Parameters.

The following parameters are set here:

- *Centre x* – the x coordinate of the centre of the oval.
- *Centre y* – the y coordinate of the centre of the oval.
- *x semi axis* – the dimension of the oval's semi axis in the x direction.
- *y semi axis* – the dimension of the oval's semi axis in the y direction. The choice of semi axes in the x and y directions will depend on the scales on these axes and commonly these will be different. Unlike a circle adornment, that always has the same shape, an oval adornment will stretch and shrink in the x and y directions if the user resizes the view.
- *Filled* – when selected the oval is filled with its colour. If it is not selected the oval is hollow, and is drawn using the line characteristics specified on the Line tab.

5.3.9 Rectangle adornment details view

The details view of a rectangle adornment has a tab labelled Parameters.

The following parameters are set here:

- *Left x* – the x coordinate of the left of the rectangle.
- *Right x* – the x coordinate of the right of the rectangle.
- *Bottom y* – the y coordinate of the bottom of the rectangle.
- *Top y* – the y coordinate of the top of the rectangle.
- *Filled* – when selected the rectangle is filled with its colour. If it is not selected the rectangle is hollow, and is drawn using the line characteristics specified on the Line tab.

5.3.10 Polygon adornment details view

The details view of a polygon adornment has a tab labelled Parameters.

At the top of this tab is a list of the vertices that currently define the polygon. The order of vertices in the list is important as the polygon is drawn beginning at the first vertex and finishing at the last in the list. The buttons and fields below the list provide the following functionality.

- *Move up* – if this button is pressed the selected vertices in the list are moved upwards. If multiple vertices are selected the first selected vertex is moved up one place in the list and all other selected vertices are moved to lie directly below the first. If the first vertex in the list is included in the selection then this button will have no effect.
- *Move down* – if this button is pressed the selected vertices in the list are moved downwards. If multiple vertices are selected the Move down button shifts the last selected vertex down one place and all other selected vertices are moved to lie directly above this one. If the last

vertex in the list is included in the selection then this button will have no effect.

- *Delete vertices* – this button enables the user to delete the selected vertices from the list. The user is prompted to confirm this action.
- *New vertex x* – the x coordinate of the new vertex.
- *New vertex y* – the y coordinate of the new vertex.
- *Add vertex* – pressing this button creates a new vertex with the coordinates specified in the New vertex x and New vertex y fields and adds it to the end of the list of vertices.
- *Insert vertex* – pressing this button creates a new vertex with the coordinates specified in the New vertex x and New vertex y fields and inserts it before the first selected vertex in the list. If no vertex in the list is selected then the new vertex is added to the end of the list
- *Filled* – is this box is selected then the polygon is filled with its colour. If it is not selected the polygon is hollow and drawn using the line characteristics given in the Line tab.

5.3.11 Text adornment details view

The details view of a text adornment has a tab labelled Parameters.

The following parameters are set here:

- *Text* – this field defines the text that is displayed on the field view. It should not be confused with the adornment name which is simply the name that appears in the adornment list within the adornment manager view. Of course these two text strings might be the same.
- *Location x* – the x coordinate of the left bottom edge of the text.
- *Location y* – the y coordinate of the left bottom edge of the text.

5.3.12 Text in box adornment details view

The details view of a text in box adornment has a tab labelled Parameters.

A text in box adornment displays a text string centred inside a filled rectangle with rounded corners.

The following parameters are set on this tab:

- *Text* – this field defines the text that is displayed on the field view. It should not be confused with the adornment name which is simply the name that appears in the adornment list within the adornment manager view. Of course these two text strings might be the same.
- *Location x* – the x coordinate of the left bottom edge of the text.

- *Location y* – the y coordinate of the left bottom edge of the text.
- *Rectangle width* – the width of the background rectangle based on the x axis scale.
- *Rectangle height* – the height of the background rectangle based on the y axis scale.
- *Rectangle colour* – the colour of the background rectangle is displayed in this field. It can be changed using the Choose colour button. Note that the colour of the text is set on the Generic tab.

5.4 Popup menu

All adornments have the same popup menu with the following options.

- *Save as...* – enables the user to save this individual adornment in a file with a .ado2 extension. The adornment can be loaded through the adornment 2D manager view.
- *Open details view* – opens the details view of the adornment.
- *Toggle visibility* – enables the user to change the visibility of the adornment. If currently visible (i.e. the adornment is ticked) this menu item will remove the tick and hide the adornment.

6 Adornments in 3D

6.1 Description

All 3D graphical field views support the creation and display of **3D adornments**. Adornments are graphical elements that are drawn amidst the field data, and that are used to enhance the information provided by the view itself in much the same way as 2D adornments in 2D graphical views.

In total five different adornments are supported. These are:

- *Cylinder*
- *Cone*
- *Sphere*
- *Rectangular prism*
- *General rectangular prism*

The creation and manipulation of adornments is consistent across all field views. Each view has an Adornments management view. In this view the user can load adornments from a file (with .ado3 extension), save the currently defined adornments to a file, show and hide the currently defined adornments and delete the adornments. This view is described in detail in section 6.2.

Individual adornments and their parameters are described in section 6.3.

6.2 Adornment 3D manager view

Description

The adornment 3D manager view provides the user with direct access to the currently defined adornments, and the ability to create new adornments.

The view includes a list of the current adornments. Each adornment has a name that can be specified by the user, and this is displayed in the list. This name is followed by a tick if the adornment is currently visible. Unlike 2D adornments the order of display is not important as the adornments are uniquely defined in 3D space. All adornments are opaque when drawn.

The four buttons at the bottom of the adornment manager view provide the following options for manipulating the list of adornments.

- *Load...* – this button enables the user to load previously saved adornments from disk. These are stored in a file with a *.ado3* extension. The loaded adornments are added to the end of the current list.
- *Save...* – this button saves the currently defined adornments in a file with a *.ado3* extension.
- *Delete...* – pressing this button will delete the selected adornments from the list. The user will be prompted to confirm this action.
- *Clear...* – pressing this button will delete the all adornments from the list. The user will be prompted to confirm this action.

Access

The adornment manager view of a field view can be accessed through the Adornments menu of the field view.

Menus

Adornment menu

- *Create cylinder* – creates a new cylinder adornment, with default parameter values, and adds it to the list of current adornments. The details view of the cylinder is displayed automatically to allow the user to edit its properties.
- *Create cone* – creates a new cone adornment, with default parameter values, and adds it to the list of current adornments. The details view of the cone is displayed automatically to allow the user to edit its properties.
- *Create sphere* – creates a new sphere adornment, with default parameter values, and adds it to the list of current adornments. The details view of the sphere is displayed automatically to allow the user to edit its properties.
- *Create rectangular prism* – creates a new rectangular prism adornment, with default parameter values, and adds it to the list of current adornments. The details view of the adornment is displayed automatically to allow the user to edit its properties. Rectangular prisms have their faces aligned with the coordinate axes.
- *Create general rectangular prism* – creates a new general rectangular prism adornment, with default parameter values, and adds it to the list of current adornments. The details view of the adornment is displayed automatically to allow the user to edit its properties. General rectangular prisms can possess arbitrary orientations.

6.3 Views

All adornments have a single view, a details view. This view gives the user access to the adornment's defining parameters such as its name, whether it is visible in the view, its colour, its location and so on.

Each details view has a tab that gives access to parameters that are common to all adornments. This is described in section 6.3.1.

The adornment specific parameters, defined in their individual details views, are described in sections 6.3.2 – 6.3.6. In all cases the user can specify the location of the adornment and its geometric parameters. The units for the location and geometric parameters are dependent on the view and in most cases correspond to the units that appear on the axes in the field view. The units for the x, y and z axes may well be different, for example when the z axis corresponds to time.

At the bottom of each details view are three buttons. Their functionality is as follows.

- *Save* – if this button is pressed the parameters specified in the details view are saved and the adornment, if displayed in the field view, is redrawn.
- *Save and close* – if this button is pressed the parameters specified in the details view are saved, the view is closed, and the adornment, if displayed in the field view, is redrawn.
- *Cancel* – if this button is pressed changes made to the adornment's parameters are discarded and the view is closed.

6.3.1 Generic adornment parameters

The first tab in all details views is labelled Generic. The parameters set in this tab are common to all adornments.

The following parameters are set on this tab:

- *Name* – the user can choose a name for the adornment that will identify it in the list of adornments displayed in the adornment manager view. The default name provided when the adornment is first created corresponds to the type of the adornment.
- *Visible* – this checkbox allows the user to select whether an individual adornment is visible in the associated field view. If the user chooses to hide all adornments in the field view this checkbox is unselected for all adornments.

- **Colour** – this field shows the current colour used for drawing the adornment. The Choose colour button allows the user to select a new colour.

6.3.2 Cylinder adornment details view

A cylinder is described by a point in the centre of its base, a vector specifying the axis of the cylinder directed from the centre of the base through the centre of the top of the cylinder (this is a unit vector), the radius of the cylinder and its length. Note that the user need not enter the axis as a unit vector as *Streams* will convert it automatically.

The details view of a cylinder adornment has a tab labelled Parameters.

The following parameters are set here:

- **Base centre x** – the x coordinate of the centre of the base.
- **Base centre y** – the y coordinate of the centre of the base.
- **Base centre z** – the z coordinate of the centre of the base.
- **Axis x** – the x component of the cylinder axis vector.
- **Axis y** – the y coordinate of the cylinder axis vector.
- **Axis z** – the z coordinate of the cylinder axis vector.
- **Radius** – the radius of the cylinder.
- **Length** – the length of the cylinder.

6.3.3 Cone adornment details view

A cone is described by a point at its tip, a vector specifying the axis of the cone directed from the tip through the centre of its base (this is a unit vector), the radius of the base and the cone's length. Note that the user need not enter the axis as a unit vector as *Streams* will convert it automatically.

The details view of a cone adornment has a tab labelled Parameters.

The following parameters are set here:

- **Tip x** – the x coordinate of the tip.
- **Tip y** – the y coordinate of the tip.
- **Tip z** – the z coordinate of the tip.
- **Axis x** – the x component of the cone axis vector.
- **Axis y** – the y coordinate of the cone axis vector.
- **Axis z** – the z coordinate of the cone axis vector.

- *Radius* – the radius of the cone base.
- *Length* – the length of the cone.

6.3.4 Sphere adornment details view

A sphere is described by a point at its centre and its radius.

The details view of a sphere adornment has a tab labelled Parameters.

The following parameters are set here:

- *Centre x* – the x coordinate of the centre of the sphere.
- *Centre y* – the y coordinate of the centre of the sphere.
- *Centre z* – the z coordinate of the centre of the sphere.
- *Radius* – the radius of the sphere.

6.3.5 Rectangular prism adornment details view

A rectangular prism is described by minimum and maximum coordinate values.

The details view of a rectangular prism adornment has a tab labelled Parameters.

The following parameters are set here:

- *Left x* – the x coordinate of the left of the prism.
- *Right x* – the x coordinate of the right of the prism.
- *Bottom y* – the y coordinate of the bottom of the prism.
- *Top y* – the y coordinate of the top of the prism.
- *Back z* – the z coordinate of the back of the prism.
- *Front z* – the z coordinate of the front of the prism.

6.3.6 General rectangular prism adornment details view

A general rectangular prism can possess any orientation in space and therefore requires more parameters in its description than a rectangular prism. It is described by a point at its centre, two mutually orthogonal unit vectors specifying the width and height directions, its width, its height and its depth. The depth direction is computed by the cross-

product of the width and height directions. The user need not enter the direction vectors as unit vectors as *Streams* will automatically convert them.

The details view of a general rectangular prism adornment has a tab labelled Parameters.

The following parameters are set here:

- *Centre x* – the x coordinate of the centre of the prism.
- *Centre y* – the y coordinate of the centre of the prism.
- *Centre z* – the z coordinate of the centre of the prism.
- *Width axis x* – the x component of the width axis vector.
- *Width axis y* – the y component of the width axis vector.
- *Width axis z* – the z component of the width axis vector.
- *Height axis x* – the x component of the height axis vector.
- *Height axis y* – the y component of the height axis vector.
- *Height axis z* – the z component of the height axis vector.
- *Width* – the width of the prism.
- *Height* – the height of the prism.
- *Depth* – the depth of the prism.

6.4 Popup menu

All adornments have the same popup menu with the following option.

- *Save as...* – enables the user to save this individual adornment in a file with a .ado3 extension. The adornment can be loaded through the adornment 3D manager view.
- *Open details view* – opens the details view of the adornment.
- *Toggle visibility* – enables the user to change the visibility of the adornment. If currently visible (i.e. the adornment is ticked) this menu item will remove the tick and hide the adornment.

7 Adornment animators in 2D

7.1 Description

The 2D adornments described in chapter 5 are static in nature. They are displayed as fixed graphical elements in a view. As an example, an adornment may be created to represent a fixed boundary in a fluid flow – a circular cylinder that is placed in a uniform flow perhaps. In views that support animation, in other words views that enable the time dependency of a flow to be visualized in a movie-like format, there may be circumstances where the boundaries of the flow are not stationary. The camera in the circular cylinder experiment referred to above may have been fixed in place and the cylinder moved past it. In this case the boundary needs to be animated together with the flow itself. Adornment animators provide this capability for all views that support the animation of their underlying field objects.

Adornment animators are comprised of two key elements, the adornments that are moved as part of the animation, and the formulae that specify how these adornments should be moved during the animation. An adornment animator can have any number of adornments of any type. Each of these adornments has a specified location. The formulae provided by the user determine how far, in the x and y directions, each adornment is displaced from this location during the animation. The two formulae, one for x and one for y , are functions of the parameter t , which nominally represents time. As mentioned in the chapters that discuss the various field objects, the animation views, while normally used to display one and two-dimensional fields as they change with time, can in fact use spatial coordinates as their animation variables. For example a two-dimensional field whose independent variables are x and y might display its data in an animated graph view where x or y plays the role of time. In this case t is still used as the animating parameter in the formulae.

The creation and manipulation of adornment animators is consistent across all field views that support animation. Each view has an Adornments menu. In this menu the user can open the Adornment 2D Animator Manager View. This view provides management of the animators for the field view and is described in detail in section 7.2.

7.2 Adornment 2D animator manager view

Description

The adornment 2D animator manager view provides the user with direct access to the currently defined animators and provides the option to create new animators.

The view includes a list of the current animators. Each animator has a name that can be specified by the user, and this is displayed in the list. If the animator is currently visible the name is followed by a tick. The order of the animators in the list is important as it determines the order in which the animators are drawn. The animator at the top of the list is the first to be drawn, so if animators within the list overlap when drawn on the field view, an animator lower in the list will be drawn on top of animators that appear higher in the list.

The five buttons at the bottom of the adornment animator manager view provide the following options for manipulating the list of adornments.

- *Move up* – if this button is pressed the selected animators in the list are moved upwards. If multiple animators are selected the first selected animator is moved up one place in the list and all other selected animators are moved to lie directly below the first. If the first animator in the list is included in the selection then this button will have no effect.
- *Move down* – if this button is pressed the selected animators in the list are moved downwards. If multiple animators are selected the Move down button shifts the last selected animator down one place and all other selected animators are moved to lie directly above this one. If the last animator in the list is included in the selection then this button will have no effect.
- *Load...* – this button loads a previously saved animator from disk. Animators are stored in a file with a *.amr2* or *.amr* extension. The loaded animator is added to the end of the current list.
- *Delete...* – pressing this button will delete the selected animators from the list. The user will be prompted to confirm this action.
- *Clear...* – pressing this button will delete all of the animators from the list. The user will be prompted to confirm this action.

Access

The adornment 2D animator manager view of a field view can be accessed through the Adornments menu of the field view.

Menus

Animator menu

- *New animator...* – creates a new animator, with default parameter values, and adds it to the list of current adornments. The details view of the animator is displayed automatically to allow the user to edit its properties.

7.3 Adornment 2D animator details view

Adornment 2D animators have a single view, the details view. This view has three tabs, Name, Adornments, and Formulae, that provide the following information:

Name

- *Animator name* – the name used to identify the animator in the manager view.
- *Visible* – this specifies whether the animator is currently visible on the view. When the user chooses to hide all animators through the Adornment menu of the view, this parameter is set to false for all animators. However, the user is at liberty to set this parameter on animators individually through their details view.

Adornment

In the Adornment tab the user is able to create adornments for this animator and to manipulate the currently defined adornments. The Adornment menu on the menubar of the view provides access to the creation of new adornments in the same way as in the Adornment manager view. The three buttons at the bottom of the tab provide the following options:

- *Load adornments* – this button enables the user to load previously saved adornments from disk. These are stored in a file with a *.ado2* or *.ado* extension. The loaded adornments are added to the end of the current list.
- *Save adornments* – this button saves the currently defined adornments in a file with a *.ado2* extension.
- *Delete adornments* – pressing this button will delete the selected adornments from the list. The user will be prompted to confirm this action.

Formulae

The following parameters are set on the Formulae tab:

- *x(t) displacement formula* – the mathematical formula for the x displacement of the adornments as a function of time. This formula is checked for correct format before being accepted. A popup menu provides the user with the list of all available brackets, operators, and functions etc. The parameter used in the formula is t.
- *y(t) displacement formula* – the mathematical formula for the y displacement as a function of time.

The three buttons at the bottom of the view provide the following options:

- *Save* – if this button is pressed the parameters specified in the details view are saved and the animator, if displayed in the field view, is redrawn.
- *Save and close* – if this button is pressed the parameters specified in the details view are saved, the view is closed, and the animator, if displayed in the field view, is redrawn.
- *Cancel* – if this button is pressed changes made to the animator 's parameters are discarded and the view is closed.

Access

The adornment 2D animator details view of an animator can be accessed by double clicking on the animator in the Adornment 2D Animator Manager View or through its popup menu.

7.4 Popup menu

All adornment animators have a popup menu with the following options:

- *Save as...* – enables the user to save this individual animator in a file with a .amr2 extension. The animator can be loaded through the animator 2D adornment manager view.
- *Open details view* – opens the details view of the animator.
- *Toggle visibility* – enables the user to change the visibility of the animator. If currently visible (i.e. the animator is ticked) this menu item will remove the tick and hide the animator.

8 Adornment animators in 3D

8.1 Description

The 3D adornments described in chapter 6 are static in nature. They are displayed as fixed graphical elements in a view. In views that support animation, in other words views that enable the time dependency of a flow to be visualized in a movie-like format, it may be desirable for adornments to move with the flow. Adornment animators provide this capability for all 3D views that support the animation of their underlying field objects.

Adornment animators are comprised of two key elements, the adornments that are moved as part of the animation, and the formulae that specify how these adornments should be moved during the animation. An adornment animator can have any number of adornments of any type. Each of these adornments has a specified location. The formulae provided by the user determine how far, in the x, y and z directions, each adornment is displaced from this location during the animation. The three formulae, one for x, one for y, and one for z are functions of the parameter t , which represents time.

The creation and manipulation of adornment animators is consistent across all 3D field views that support animation. Each view has an Adornments menu. In this menu the user can open the Adornment 3D Animator Manager View. This view provides management of the animators for the field view and is described in detail in section 8.2.

8.2 Adornment 3D animator manager view

Description

The adornment 3D animator manager view provides the user with direct access to the currently defined animators and provides the option to create new animators.

The view includes a list of the current animators. Each animator has a name that can be specified by the user, and this is displayed in the list. If the animator is currently visible the name is followed by a tick.

The three buttons at the bottom of the adornment 3D animator manager view provide the following options for manipulating the list of adornments.

- *Load...* – this button loads a previously saved animator from disk. Animators are stored in a file with a *.amr3* extension. The loaded animator is added to the end of the current list.
- *Delete...* – pressing this button will delete the selected animators from the list. The user will be prompted to confirm this action.
- *Clear...* – pressing this button will delete all of the animators from the list. The user will be prompted to confirm this action.

Access

The adornment 3D animator manager view of a field view can be accessed through the Adornments menu of the field view.

Menus

Animator menu

- *New animator...* – creates a new animator, with default parameter values, and adds it to the list of current adornments. The details view of the animator is displayed automatically to allow the user to edit its properties.

8.3 Adornment 3D animator details view

Adornment 3D animators have a single view, the details view. This view has three tabs, Name, Adornments, and Formulae, that provide the following information:

Name

- *Animator name* – the name used to identify the animator in the manager view.
- *Visible* – this specifies whether the animator is currently visible on the view. When the user chooses to hide all animators through the Adornment menu of the view, this parameter is set to false for all animators. However, the user is at liberty to set this parameter on animators individually through their details view.

Adornment

In the Adornment tab the user is able to create adornments for this animator and to manipulate the currently defined adornments. The

Adornment menu on the menubar of the view provides access to the creation of new adornments in the same way as in the Adornment manager view. The three buttons at the bottom of the tab provide the following options:

- *Load adornments* – this button enables the user to load previously saved adornments from disk. These are stored in a file with a *.ado3* extension. The loaded adornments are added to the end of the current list.
- *Save adornments* – this button saves the currently defined adornments in a file with a *.ado3* extension.
- *Delete adornments* – pressing this button will delete the selected adornments from the list. The user will be prompted to confirm this action.

Formulae

The following parameters are set on the Formulae tab:

- *x(t) displacement formula* – the mathematical formula for the x displacement of the adornments as a function of time. This formula is checked for correct format before being accepted. A popup menu provides the user with the list of all available brackets, operators, and functions etc. The parameter used in the formula is t.
- *y(t) displacement formula* – the mathematical formula for the y displacement as a function of time.
- *z(t) displacement formula* – the mathematical formula for the z displacement as a function of time.

The three buttons at the bottom of the view provide the following options:

- *Save* – if this button is pressed the parameters specified in the details view are saved and the animator, if displayed in the field view, is redrawn.
- *Save and close* – if this button is pressed the parameters specified in the details view are saved, the view is closed, and the animator, if displayed in the field view, is redrawn.
- *Cancel* – if this button is pressed changes made to the animator's parameters are discarded and the view is closed.

Access

The adornment 3D animator details view of an animator can be accessed by double clicking on the animator in the Adornment 3D Animator Manager View or through its popup menu.

8.4 Popup menu

All adornment animators have a popup menu with the following options:

- *Save as...* – enables the user to save this individual animator in a file with a .amr3 extension. The animator can be loaded through the animator 3D adornment manager view.
- *Open details view* – opens the details view of the animator.
- *Toggle visibility* – enables the user to change the visibility of the animator. If currently visible (i.e. the animator is ticked) this menu item will remove the tick and hide the animator.

9 Particle seeders in 2D

9.1 Description

Particle seeders are support objects employed in the 2D vector 2D field and 3D vector 2D field particle tracking views (see sections 20.2.5 and 21.2.3).

A particle seeder has a simple job to perform. It is to introduce particles into a vector field (interpreted as a velocity field by the particle seeder) and then produce tracks for these particles by determining the position of each particle in the flow at each time step, using the defined velocity field. If a particle leaves the flow domain, or encounters a region in which the velocity is undefined, during its motion, then that particle track terminates at that point.

Particle seeders employ user defined regions (drawn in one of the particle tracking views) to specify the locations in the flow at which the particles are to be introduced. These regions can be single points, lines, or any of the other internal/external regions supported by the *Streams* system. Particles can be introduced at one time and tracked from that point, or they may be introduced at a number of times. The particles can be distributed uniformly or randomly in the regions in which they appear and the user has a number of choices on how the velocity field at each particle's location is to be evaluated.

Particle seeders (both for 2D and 3D vector fields) can be saved to disk in files with a .pts extension and reloaded at a later time. However, 3D particle seeders and 2D particle seeders cannot be mixed and must be used with the appropriate field. Thus careful naming of the seeder files is important.

9.2 Seeder manager view

Description

The seeder manager view provides the user with direct access to the current particle seeders and provides facilities to create new seeders, delete seeders and manipulate the tracks they produce.

The view includes a list of the seeders. Each seeder has a name that can be specified by the user, and this is displayed in the list.

The seven buttons at the bottom of the seeder manager view provide the following options for manipulating the seeders and their tracks.

- *New seeder...* – this button creates a new seeder and displays it in the list. The seeder will have default settings and the user should open the seeder's details view to change its parameters (see section 9.3.1).
- *Load seeder...* – this option allows the user to load a seeder from file. Once loaded it will be displayed in the seeder list.
- *Delete seeder* – deletes the currently selected seeders in the list. The user is asked to confirm this decision.
- *Clear seeders* – deletes all seeders currently defined for this view.
- *Generate tracks* – pressing this button will cause all seeders to generate their particle tracks. This process, depending on the number of seeders and the number of particles they are tracking can take quite some time.
- *Delete tracks* – deletes all tracks currently defined.
- *Save tracks...* – this button allows the user to save all of the currently defined tracks to a comma delimited text file (.txt or .csv). The user is presented with a dialog box in which they can choose the number of decimal places to be used for saving the spatial and temporal coordinates as well as the file name. The name of the vector field is stored first, followed by the time step. Then the text "x" is stored followed by the x coordinates of the track of the first particle, and the text "y" and the list of y coordinates for the first particle. This is repeated for all particles.

Access

The seeder manager view of a field view can be accessed through the Seeder menu of the field view.

9.3 Views

The particle seeder object has a details view.

9.3.1 Details view

Description

The details view displays the parameter settings for the particle seeder object and allows the user to change them. Three tabs are used to organise the data. These tabs specify information in 3 general areas, and are discussed in the following sections.

Name

The Name tab allows the user to enter a name for this particle seeder that will identify it amongst other particle seeders. The user enters the chosen name into the name text field.

Seeding parameters

These parameters govern the manner in which the particles are seeded into the flow and how their paths are determined.

The following parameters are set here:

- *Start seeding at* – this combo box specifies the first frame (time) in the simulation at which seeding occurs.
- *Finish seeding at* – this combo box specifies the last frame (time) in which seeding occurs.
- *Seed every* – this field specifies how often particles are introduced into the flow between the start and finish frames. If this parameter is set to 1, then particles are introduced at every time step between the start and finish frames.
- *Particles per seeding* – this parameter specifies how many particles are introduced into each seeding region at each seeding. When particles are uniformly distributed within the regions Streams overlays a rectangular mesh of particles over each region where the spacing between particles in the x and y directions are as close to each other as possible. For non-rectangular regions some of these particles do not lie over the region and so the total number of particles will be less than specified. Even for a rectangular region the number of particles may not perfectly match that specified by the user due to the required regular spacing. For randomly distributed particles the number of particles in each region will match the number specified by the user. If the user wishes to use different numbers of particles for each region then separate seeders should be created for each region. It is important to recognise that seeding a large number of particles often into a flow with many frames will require substantial memory and processing time.
- *Direction* – this parameter specifies the direction, in time, used to generate the particle tracks. This can be either Forward, Backward, or Forward and Backward.
- *Particle distribution* – the user can choose to seed the particles randomly or uniformly within the seeding regions.
- *Cell interpolation* – this parameter specifies how the velocity at a particle location is calculated. The grid cell in which the particle resides is identified and a velocity estimate is available provided the velocity at all corners of the cell is defined. The estimated velocity can be obtained by averaging the four corner velocities, or by doing a bi-linear fit to the velocity field and interpolating the velocity at the particle location. The bilinear fit is the default setting.
- *Velocity estimate* – the displacement of the particle can be based on the velocity field at the current time step (forward), the velocity field at the next time step (backward), or a combination of the two (central). The central estimate is the default setting.
- *Particle size (pix)* – the size of the particles in pixels can be specified in this text box. The size is nominally the diameter of the particles.

Warning: On some computers we have found that particles with a size of 1 pixel are not visible on the screen. The particles and tracks are

created but the particles are not displayed. Choosing a size of 2 will rectify this problem.

- *Particle colour* – the colour used to render the particles generated by this particle seeder is painted in the rectangular box. The colour can be changed by clicking the *Change colour* button below.

Seeding regions

The regions in which the particles are introduced can be selected in this tab. The currently defined regions for the field view that is to be seeded with particles are listed in the top list box. The regions used by the seeder are listed in the bottom list box. Regions can be selected in the top list box and added to the seeding region list, and regions selected in the seeding region list can be deleted. There is no limit on the number of regions used for seeding.

Access

Each field view that utilizes particle seeders provides a view listing all of the currently defined particle seeders. The particle seeder details view can be accessed by double clicking a particle seeder object displayed in this list box, or through its popup menu.

9.4 Popup menu

The particle seeder provides the following options in its popup menu.

- *Save as...* – saves the particle seeder object in a disk file. All particle seeder files have the extension *.pts*.
- *Change name...* – this option allows the user to change the name of the seeder.
- *Open details view* – opens the object's details view.
- *Close all views* – closes all views for this object which are currently open.

10 Particle seeders in 3D

10.1 Description

Particle seeders can also be used to visualize the velocity fields with three vector components. The concepts are identical to those described in chapter 9 – see section 9.1 for a description. The seeders described in this chapter are employed in the particle tracking view for 4D vector 3D fields (see section 25.2.3).

10.2 Seeder manager view

Description

The seeder manager view provides the user with direct access to the current particle seeders and provides facilities to create new seeders, delete seeders and manipulate the tracks they produce.

The view includes a list of the seeders. Each seeder has a name that can be specified by the user, and this is displayed in the list.

The seven buttons at the bottom of the seeder manager view provide the following options for manipulating the seeders and their tracks.

- *New seeder...* – this button creates a new seeder and displays it in the list. The seeder will have default settings and the user should open the seeder's details view to change its parameters (see section 10.3.1).
- *Load seeder...* – this option allows the user to load a seeder with a .pts extension from file. Once loaded it will be displayed in the seeder list.
- *Delete seeder* – deletes the currently selected seeders in the list. The user is asked to confirm this decision.
- *Clear seeders* – deletes all seeders currently defined for this view.
- *Generate tracks* – pressing this button will cause all seeders to generate their particle tracks. This process, depending on the number of seeders and the number of particles they are tracking can take quite some time.
- *Delete tracks* – deletes all tracks currently defined.
- *Save tracks...* – this button allows the user to save all of the currently defined tracks to a comma delimited text file (.txt or .csv). The user is presented with a dialog box in which they can choose the number of decimal places to be used for saving the spatial and temporal coordinates as well as the file name. The name of the vector field is stored first, followed by the time step. Then the text “x” is stored followed by the x coordinates of the track of the first particle, the text “y” and the list of y

coordinates for the first particle, and then the text “z” and the list of z coordinates for the first particle. This is repeated for all particles.

Access

The seeder manager view of a field view can be accessed through the Seeder menu of the field view.

10.3 Views

The particle seeder object has a details view.

10.3.1 Details view

Description

The details view displays the parameter settings for the particle seeder object and allows the user to change them. Three tabs are used to organise the data. These tabs specify information in 3 general areas, and are discussed in the following sections.

Name

The Name tab allows the user to enter a name for this particle seeder that will identify it amongst other particle seeders. The user enters the chosen name into the name text field.

Seeding parameters

These parameters govern the manner in which the particles are seeded into the flow and how their paths are determined.

The following parameters are set here:

- *Start seeding at* – this combo box specifies the first frame (time) in the simulation at which seeding occurs.
- *Finish seeding at* – this combo box specifies the last frame (time) in which seeding occurs.
- *Seed every* – this field specifies how often particles are introduced into the flow between the start and finish frames. If this parameter is set to 1, then particles are introduced at every time step between the start and finish frames.
- *Particles per seeding* – this parameter specifies how many particles are introduced into each seeding region at each seeding. When particles are uniformly distributed within the regions Streams overlays a rectangular mesh of particles over each region where the spacing between particles in the x and y directions are as close to each other as possible. For non-

rectangular regions some of these particles do not lie over the region and so the total number of particles will be less than specified. Even for a rectangular region the number of particles may not perfectly match that specified by the user due to the required regular spacing. For randomly distributed particles the number of particles in each region will match the number specified by the user. If the user wishes to use different numbers of particles for each region then separate seeders should be created for each region. It is important to recognise that seeding a large number of particles often into a flow with many frames will require substantial memory and processing time.

- *Direction* – this parameter specifies the direction, in time, used to generate the particle tracks. This can be either Forward, Backward, or Forward and Backward.
- *Particle distribution* – the user can choose to seed the particles randomly or uniformly within the seeding regions.
- *Cell interpolation* – this parameter specifies how the velocity at a particle location is calculated. The grid cell in which the particle resides is identified and a velocity estimate is available provided the velocity at all corners of the cell is defined. The estimated velocity can be obtained by averaging the four corner velocities, or by doing a bi-linear fit to the velocity field and interpolating the velocity at the particle location. The bilinear fit is the default setting.
- *Velocity estimate* – the displacement of the particle can be based on the velocity field at the current time step (forward), the velocity field at the next time step (backward), or a combination of the two (central). The central estimate is the default setting.
- *Particle type* – the user has the choice of displaying the particles in the view as points or spheres with the specified radius. The rendering of spheres is computationally more demanding but the visual effect is more attractive.
- *Particle radius* – the radius of the particles for when spherical particles are displayed.
- *Particle colour* – the colour used to render the particles generated by this particle seeder is painted in the rectangular box. The colour can be changed by clicking the *Change colour* button below.

Seeding regions

The regions in which the particles are introduced can be selected in this tab. The currently defined regions for the field view that is to be seeded with particles are listed in the top list box. The regions used by the seeder are listed in the bottom list box. Regions can be selected in the top list box and added to the seeding region list, and regions selected in the seeding region list can be deleted. There is no limit on the number of regions used for seeding.

Access

Each field view that utilizes particle seeders provides a view listing all of the currently defined particle seeders. The particle seeder details view can be accessed by double clicking a particle seeder object displayed in this list box, or through its popup menu.

10.4 Popup menu

The particle seeder provides the following options in its popup menu.

- *Save as...* – saves the particle seeder object in a disk file. All particle seeder files have the extension *.pts*.
- *Change name...* – this option allows the user to change the name of the seeder.
- *Open details view* – opens the object's details view.
- *Close all views* – closes all views for this object that are currently open.

11 Creating images from field views

11.1 Description

Many of the field views, along with the particle record particle view and Lagrangian path field path view, provide graphical representations of the objects that they display. These views are often useful for inclusion in reports or presentations and all of these views, under the File menu, provide the option of saving the graph to an image file. For some of these views, which support animation of the data being displayed, the user also has the option of saving the view as a sequence of images corresponding to the changing view in the animation. This chapter explains the parameters available for these options.

11.2 Images

The image file can be in a number of standard formats including PNG, JPG, BMP and TIFF. However, for reproduction in printed form the TIFF format is generally preferred and it is only in this format that the user can select a quality (dpi) setting.

Control over the image formatting is provided through a dialog box entitled Image layout parameters that is displayed when the user selects the Save as image... from the appropriate File menu. Once appropriate format settings (see sections 11.2.1 – 11.2.3) have been selected the user can see how the actual image will look by clicking on the Preview button at the bottom of the dialog box. All view settings on screen are used in the creation of the image – for example border size, line width etc.

The three buttons at the bottom of the dialog box do the following:

- *Preview* – opens a dialog box that shows the image that will be produced.
- *OK* – creates the image and stores it in the specified file.
- *Cancel* – closes the dialog box without creating and saving the image.

11.2.1 Layout

- *Width (pix)* – specifies the number of pixels to be used for the width of the image.

- *Height (pix)* – specifies the number of pixels to be used for the height of the image.
- *Transparent border* – if this check box is selected (and this is the default), then the border around the graph is transparent. The result is that the axis labels and scales will appear separate from the graph itself and the border will take the colour of whatever lies beneath it in a document or a slideshow. Otherwise the border is drawn with the background colour. Note that not all image formats support transparency and if a format that does not support transparency is selected for the output file the background colour is used. It is recommended that PNG format is used when transparency is required.

11.2.2 Tiff quality

- *Resolution(dpi)* – this field allows the user to specify the image quality (resolution in dots/pixels per inch) when a TIFF image format has been chosen. Resolutions of 600 dpi or more are suitable for high quality printed reproduction.
- *Compression* – select this checkbox if the TIFF file is to be compressed.

11.2.3 File

The user can browse the file system and select the appropriate file for storing the image. If no extension is provided a TIFF format is assumed.

11.3 Image sequences

For views that support animation the File menu also provides a Save as image sequence... option. The same dialog box is displayed as for a single image. The only difference in behaviour is that a sequential 5 digit number is added to the specified file name when each image is saved to disk.

12 Scalar field 0D

12.1 Description

A scalar field 0D is a single scalar quantity, computed from a Eulerian or Lagrangian field.

12.2 Views

A scalar field 0D has two views.

- *Details view.*
- *Table view.*

12.2.1 Details view

Description

The details view of a scalar field 0D displays the name of the field, its full name and its description.

Access

The details view of a scalar field 0D can be accessed through the popup menu of the field object.

12.2.2 Table view

Description

The table view of a scalar field 0D simply displays the field value and details of the independent variables. For example if the field had been computed from a scalar field 3D by fixing the values of x and y and averaging over t then the values of x and y and the range involved in the t averaging would be displayed. It is the default view.

Access

The table view of a scalar field 0D can be accessed by double clicking the field or through the popup menu of the field object.

Menus

View menu

- *Change field decimal places...* – allows the user to select the number of decimal places used to display the field value.

I 2.3 Popup menu

The scalar field 0D provides the following options in its popup menu.

- *Save as...* – saves the field to a disk file. The file has a *.s0d* extension.
- *Save* – saves the field to a disk file with the current name.
- *Save as text file...* – saves the field in a comma (,) delimited text file. Either a *.txt* or *.csv* extension can be specified. The user will be prompted to specify the number of decimal places used to store the field value.
- *Open details view...* – opens the details view.
- *Open table view...* – opens the table view.
- *Close all views* – closes all open views of this field.
- *Close* – this option removes the field from its enclosing container. The user will be prompted to confirm the choice and to save the field if desired.

13 Scalar field 1D

13.1 Description

A scalar field 1D is a scalar quantity that is a function of one variable, x , y , z or t .

13.2 Views

A scalar field 1D has five views.

- *Details view.*
- *Table view.*
- *Graph view.*
- *PDF view.*
- *Spectral view.*

13.2.1 Details view

Description

The details view of a scalar field 1D displays the name of the field, its full name and its description.

Access

The details view of a scalar field 1D can be accessed through the popup menu of the field object.

13.2.2 Table view

Description

The table view of a scalar field 1D provides a table of the independent variable and its corresponding field value. Details of the other variables, whether they were averaged or fixed are displayed at the top of the view.

Access

The table view of a scalar field 1D can be accessed through the popup menu of the field object.

Menus

View menu

- *Change variable decimal places...* – this displays a dialog box in which the user can select the number of decimal places used to display the independent and field variables.
- *Select data to display...* – allows the user to select a subset of the data to display via a dialog box. This subset is produced by only displaying I in N field values where N is specified by the user.

13.2.3 Graph view

Description

The graph view of a scalar field 1D provides a conventional plot of the scalar field. It is the default view for a scalar field 1D object.

The user has considerable control over the form of the display, and additional functionality, such as curve fitting, is provided.

This view has the ability to overlay and display other scalar fields 1D. This can be achieved in two ways. Firstly the user can simply drag another scalar field 1D onto the drawing area of the view from any list box that supports drag and drop. The view allocates a default colour for the overlay curve but does not adjust the axes limits. A menu option can be used to recalculate the limits of the graph after a number of overlays have been added. Secondly the user can access the overlay manager view through the Overlays menu. The overlay manager view provides more control for the user and is described in detail in section 14.2.3.2.

Three toolbars are provided at the top of the view.

Display toolbar

- *Points* – if this check box is selected the field data points are shown on the graph.
- *Lines* – if this check box is selected lines are drawn between the data points on the graph.
- *Divisions* – if this check box is selected the divisions on each axis are drawn on the graph. The user can specify the number of divisions in the set layout dialog box.
- *Curve fit* – if this check box is selected the current curve fit to the data is shown on the graph.

- **Swap axes** – if this check box is selected the axes are swapped on the graph.

x axis toolbar

- **x axis min** – sets the minimum x value displayed.
- **x axis max** – sets the maximum x value displayed.
- **x** – displays the x value of the cursor as it moves over the graph.

y axis toolbar

- **y axis min** – sets the minimum y value displayed.
- **y axis max** – sets the maximum y value displayed.
- **y** – displays the y value of the cursor as it moves over the graph.

Access

The graph view of a scalar field 1D can be accessed by double clicking the field, or through the popup menu of the field object.

Menus

File menu

- **Save view settings...** – this allows the user to save the current view settings. These are common to all views of this type and are described in section 13.2.3.1. The settings are saved in a file with extension `.sl dgraphset`.
- **Restore view settings...** – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of `.sl dgraphset`.
- **Add to persistent views...** – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- **Save as image...** – enables the user to save the graph as an image file. See chapter 11 for details.

View menu

- *Set layout...* – this option displays the set layout dialog in which the user can change the settings common for all views of this type. This includes line width, font size, colours, borders and so on. The details are provided in section 13.2.3.1.
- *Show field* – when selected the field data are displayed. Overlaid fields are not affected.
- *Show overlays* – when selected overlay fields are displayed.
- *Show points* – when selected the data points are displayed. This applies to the field and all overlays.
- *Show lines* – when selected the lines connecting the data points are displayed. This applies to the field and all overlays.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected info text at the bottom of the view is displayed.
- *Show frame* – when selected the outline box of the graph is displayed.
- *Show divisions* – when selected the divisions on each axis are displayed.
- *Show curve fit* – when selected the current curve fit is displayed.
- *Show adornments* – when selected all adornments are displayed are displayed.
- *Swap axes* – when selected the axes are swapped.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes. Greek symbols can be used as described in chapter 1.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Compute new limits* – this command computes new ranges for the x and y axes so that field and all overlays are visible. This is not done automatically when new overlays are added so that the user can choose to use fixed axis ranges.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Hide toolbars* – when selected the toolbars are hidden.

Overlays menu

- *Manage overlay fields...* – displays a view in which the user can manage overlay fields. See section 13.2.3.2.

Curve fitting menu

- *Manage curve fits...* – displays the manage curve fitting view in which the user can manage the curve fits. See chapter 4.

Adornments menu

- *Manage adornments...* – displays the adornments 2D manager view in which the user can manage the adornments. See chapter 5.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Show field* – see View menu.
- *Show overlays* – see View menu.
- *Show points* – see View menu.
- *Show lines* – see View menu.
- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show frame* – see View menu.
- *Show divisions* – see View menu.
- *Show curve fit* – see View menu.
- *Show adornments* – see Adornments menu.
- *Swap axes* – see View menu.
- *Zoom* – see Zoom menu.
- *Unzoom* – see Zoom menu.
- *Clear zoom rectangle* – see Zoom menu.

13.2.3.1 Set layout dialog

The user has considerable control over the appearance of this view. The set layout dialog can be opened through the View menu or the popup menu. It is important to note that the parameters set in this dialog box apply to all graph views for scalar fields 1D so that when other views are opened they will possess the same settings. The three buttons at the bottom of the dialog are:

- **Reset...** – resets all of the layout settings to their defaults.
- **OK** – confirms the changes made and applies them to the view.
- **Cancel...** – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Rotate y label* – when selected the y axis label is rotated so that the text is vertical.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Axes colour* – the colour of axes. It can be changed by clicking on the **Select...** button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the **Select...** button.

- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.
- *Curve fit colour* – the colour used for drawing curve fits. It can be changed by clicking on the Select... button.

13.2.3.2 Manage overlay fields view

The user can display a number of additional scalar fields 1D in this graph view and the manage overlay fields view gives the user control over these fields. The overlay fields can be loaded from disk, selected from the field registry, dragged onto the overlay list in this view, or dragged onto the view itself.

The view has two tabs and five buttons. The buttons are as follows:

- *Load* – enables the user to load a scalar field from disk.
- *Select* – enables the user to select a scalar field from the field registry.
- *Delete* – deletes any fields currently selected in the field list – see Overlays tab description below.
- *Clear* – deletes all of the overlay fields.
- *Refresh* – refreshes the view.

The dialog includes 2 tabs – Overlays and Legend

Overlays

- *Overlay fields* – this list box lists all current overlay fields, including at the top of the list the field for which the view was opened. All fields listed are treated in the same way. Three key parameters that can be manipulated in this view - their name, colour and display setting – can be changed using the popup menu for each field. The field name is the field's short name by default. The name is used in the legend, if displayed, and therefore the user may wish to change the name. The colour used to display each of the overlay fields is set through their popup menus and the name of the field is displayed in this colour in the list box. Note the initial colour is randomly allocated by the view and both the points and line used to render the field on the graph use the same colour. Finally each of the fields can be shown or hidden through their display setting. If a field is shown its name will be followed by a tick in the list box. In addition the popup menu of an overlay field allows the user access to the details view of the overlay. The details view can be used to change the three parameters discussed above as well as the size of the points and the line width and type used to render the overlay field.

Legend

- *Display legend* – if selected a legend will be displayed on the view that will include the field itself as well as all visible overlay fields. The names and colours specified in the Layout tab are used in the legend.
- *Display border* – if selected the legend will possess a border.
- *Black text* – if selected the text in the legend will be displayed in black. If not selected the colour of each curve is used for the text.
- *Legend location* – this drop down box provides the user with 4 possible locations for the legend – top right, top left, bottom right and bottom left. Which is appropriate will depend on the region of the graph covered by the curves.
- *Legend offset x* – this allows the user to offset the legend the specified number of pixels from the chosen location in the x direction. The larger the number the closer the legend will move away from its location. Changes to this and the other settings will automatically appear on the graph.
- *Legend offset y* – this allows the user to offset the legend the specified number of pixels from the chosen location in the y direction. The larger the number the closer the legend will move away from its location. Changes to this and the other settings will automatically appear on the graph.

Menus

Legend menu

- *View preset legend labels...* – it is common for a set of legend labels (for each of the overlay curves) to be used in multiple views of the same sort. For example when comparing the results from a number of experiments the user may wish to produce a number of different graphs corresponding to different flow variables. In each case the results from the same set of experiments will appear in each graph. Preset legend labels enable the user to have a standard set of legend labels that can be used and reused in views of the same sort. This menu option displays these preset legend labels. The dialog box that is displayed enables the user to add or insert new legend labels, delete them and edit them.
- *Save preset legend labels* – this command will use the current legend labels (overlay names) as the preset labels. The user is prompted to confirm this action.
- *Use preset legend labels* – this command replaces the current overlay names (legend labels) with the preset labels. If there are more presets than required the unused preset labels are ignored. If there are more overlays than preset labels the additional overlays, for which no preset label exists, will retain their current name/label. The user is prompted to confirm this action.

13.2.4 PDF view

Description

The PDF view of a scalar field 1D displays either the probability density function (PDF) or cumulative probability density function (cumulative PDF) of the field. The range of the field values is divided into a number of equally sized bins (20 is the default number of bins) and the number of occurrences of field values lying within each bin is determined. When these numbers are normalized by the total number of field values the PDF of the field is obtained. If the numbers in the bins are summed from the smallest value of the independent variable to the largest (i.e. the left most bin to the right most bin) the cumulative PDF is obtained. The cumulative PDF ranges from 0 to 1.

The PDF or cumulative PDF can be displayed using points and lines, and/or bars.

Three toolbars are provided at the top of the view.

Display toolbar

- *Cumulative PDF* – if this check box is selected the cumulative PDF is displayed on the graph. Otherwise the PDF is displayed.
- *Points* – if this check box is selected the data points (PDF or cumulative PDF) are shown on the graph.
- *Lines* – if this check box is selected lines are drawn between the data points on the graph.
- *Bars* – if this check box is selected the data is plotted as bars, where each bar has a width equal to the width of one of the bins.
- *Curve fit* – if this check box is selected any curve fit to the data is shown on the graph.

x axis toolbar

- *x axis min* – sets the minimum x value displayed.
- *x axis max* – sets the maximum x value displayed.
- *x* – displays the x value of the cursor as it moves over the graph.

y axis toolbar

- *y axis min* – sets the minimum y value displayed.
- *y axis max* – sets the maximum y value displayed.
- *y* – displays the y value of the cursor as it moves over the graph.

Access

The PDF view of a scalar field 1D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 13.2.4.1. The settings are saved in a file with extension `.slpdfset`.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of `.slpdfset`.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.
- *Save to text file...* – enables the user to save the data displayed in a comma (,) delimited text file (`.txt` or `.csv`).

View menu

- *Set layout...* – displays the set layout dialog box described in section 13.2.4.1.
- *Show cumulative PDF* – when selected the cumulative PDF is displayed. Otherwise the PDF is displayed.
- *Show points* – when selected the data points are displayed.
- *Show lines* – when selected the lines connecting the data points are displayed.
- *Show bars* – when selected the data is represented by bars.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected the info text at the bottom of the view is displayed.
- *Show frame* – when selected the rectangular border around the graph is displayed.

- *Show divisions* – when selected the x and y axis divisions are drawn as dashed lines.
- *Show curve fit* – when selected the current curve fit is displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Set number of bins...* – displays a dialog box that allows the user to specify the number of bins used in computing the PDF for the field.
- *Set range...* – displays a dialog box that prompts the user for the range of field values to be used in computing the PDF. This enables the user to focus on a subset of the field values or to adopt a more intuitive range.
- *Reset range* – the range used for the PDF is reset to the default value based on the range of values present in the field. For example if all field values lie between Min and Max the range will be reset to Min and Max.
- *Hide toolbars* – when selected the toolbars are hidden.

Curve fitting menu

- *Manage curve fits...* – opens the manage curve fits view. See chapter 4.

Adornments menu

- *Manage adornments...* – opens the adornments 2D manager view. See chapter 5.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Show cumulative PDF* – see View menu.
- *Show points* – see View menu.
- *Show lines* – see View menu.
- *Show bars* – see View menu.
- *Show x label* – see View menu.

- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show frame* – see View menu.
- *Show divisions* – see View menu.
- *Show curve fit* – see View menu.
- *Show adornments* – see Adornments menu.
- *Zoom* – see Zoom menu.
- *Unzoom* – see Zoom menu.
- *Clear zoom rectangle* – see Zoom menu.

13.2.4.1 *Set layout dialog*

The user has considerable control over the appearance of this view. The set layout dialog can be opened through the View menu or a popup menu. It is important to note that the parameters set in this dialog box apply to all PDF views for scalar fields 1D so that when other views are opened they will possess the same settings. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Rotate y label* – when selected the y axis label is rotated so that the text is vertical.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left

hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.

- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width*– sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Points colour* – the colour of the points displayed for the field. It can be changed by clicking on the Select... button.
- *Line colour* – the colour of the lines used to plot the field. It can be changed by clicking on the Select... button.
- *Bars colour* – the colour of the bars used to plot the field. It can be changed by clicking on the Select... button.
- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.
- *Curve fit colour* – the colour used for drawing curve fits. It can be changed by clicking on the Select... button.

13.2.5 Spectral view

Description

The spectral view of a scalar field 1D provides a plot of the power spectral density (PSD) of the scalar field. The graph is plotted using logarithmic axis scales.

The PSD is calculated using a fast Fourier Transform (FFT) that includes a number of windowing algorithms, segmentation (and averaging of the PSD) and the use of overlapping segments. FFTs are computationally most efficient when the number of data points in the series equals an integer power of 2. Most fields do not conform to this requirement, and the FFT used in this view provides the user with 2 options. The first is to truncate the data series, starting from the beginning, so that its length equals the highest power of two less than its original length. The second option is to pad the complete series with zeros so that its length equals

the lowest power of 2 greater than the original series length. All of these FFT settings can be changed using the FFT menu.

Three toolbars are provided at the top of the view.

Display toolbar

- *Points* – if this check box is selected the field data points are shown on the graph.
- *Lines* – if this check box is selected lines are drawn between the data points on the graph.
- *Curve fit* – if this check box is selected any curve fit to the data is shown on the graph.

freq axis toolbar

- *freq axis min* – sets the minimum freq value displayed.
- *freq axis max* – sets the maximum freq value displayed.
- *freq* – displays the freq value of the cursor as it moves over the graph.

power axis toolbar

- *power axis min* – sets the minimum power value displayed.
- *power axis max* – sets the maximum power value displayed.
- *power* – displays the power value of the cursor as it moves over the graph.

Access

The spectral view of a 1D scalar field can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 13.2.5.1. The settings are saved in a file with extension .sl dspectset.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .sl dspectset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the

view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.

- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.
- *Save to text file...* – enables the user to save the PSD as to a comma (,) delimited text file. The user can select the number of significant figures used to save the data.

View menu

- *Set layout...* – displays the set layout dialog box described in section 14.2.5.1.
- *Show points* – when selected the data points are displayed.
- *Show lines* – when selected the lines connecting the data points are displayed.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected the info text at the bottom of the view is displayed.
- *Show frame* – when selected the rectangular border around the graph is displayed.
- *Show divisions* – when selected the x and y axis divisions are drawn as dashed lines.
- *Show curve fit* – when selected the current curve fit is displayed.
- *Use log scales* – when selected log scales are used for both axes.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Hide toolbars* – when selected the toolbars are hidden.

FFT menu

- *Set FFT parameters...* – this menu item displays a dialog box in which the user can change the parameters governing the FFT used by the view. Parameters include: whether the series should be truncated or padded with zeros (a non-editable text box at the top of the dialog box indicates the number of data points that will be used in the FFT given the current

settings); which windowing algorithm should be employed (the user can select from a number of standard windowing algorithms including Hann, Hamming, Gaussian etc); the alpha parameter which is used in the Kaiser and Gaussian windowing algorithms; the number of segments that the series should be broken into (the default is 1, ie the whole series is used to calculate the PSD); and whether overlapping of segments (by half the segment length) should be used when the series is segmented.

Curve fitting menu

- *Manage curve fits...* – opens the manage curve fits view. See section chapter 4.

Adornments menu

- *Manage adornments...* – opens the adornments 2D manager view. See chapter 5.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Show points* – see View menu.
- *Show lines* – see View menu.
- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show frame* – see View menu.
- *Show divisions* – see View menu.
- *Show curve fit* – see View menu.
- *Use log scales* – see View menu.
- *Zoom* – see Zoom menu.
- *Unzoom* – see Zoom menu.
- *Clear zoom rectangle* – see Zoom menu.

13.2.5.1 *Set layout dialog*

The user has considerable control over the appearance of this view. The set layout dialog can be opened through the View menu or a popup menu. It is important to note that the parameters set in this dialog box apply to all spectral views for scalar fields 1D so that when other views are opened they will possess the same settings. The three buttons at the bottom of the dialog are:

- **Reset...** – resets all of the layout settings to their defaults.
- **OK** – confirms the changes made and applies them to the view.
- **Cancel...** – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- **Number of x divisions** – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- **Number of y divisions** – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- **Line width** – the line width for the view is specified here. The default is 1.5.
- **Font size** – sets the font size. The default is 14.
- **Rotate y label** – when selected the y axis label is rotated so that the text is vertical.

Borders

- **Left border width** – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- **Right border width** – sets the size, in pixels, of the right hand border.
- **Bottom Border width** – sets the size of the bottom border in pixels.
- **Top border width** – sets the size of the top border in pixels.

Colour

- **Points colour** – the colour of the points displayed for the field. It can be changed by clicking on the Select... button.
- **Line colour** – the colour of the lines used to plot the field. It can be changed by clicking on the Select... button.

- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.
- *Curve fit colour* – the colour used for drawing curve fits. It can be changed by clicking on the Select... button.

13.3 Popup menu

The scalar field 1D provides the following options in its popup menu.

- *Save as...* – saves the field to a disk file. The file has a *.sld* extension.
- *Save* – saves the field to a disk file with the current name.
- *Save as text file...* – saves the field in a comma (,) delimited text file. Either a *.txt* or *.csv* extension can be specified. The user can choose the save the data with headers (which means header information is included) or without headers (just raw field data is stored). The user will be prompted to specify the number of decimal places used to store the independent and field values.
- *Open details view...* – opens the details view.
- *Open graph view...* – opens the graph view.
- *Open PDF view...* – opens the PDF view.
- *Open spectral view...* – opens the spectral view.
- *Open table view...* – opens the table view.
- *Open persistent view manager view...* – opens the view that manages all of the persistent views saved for this field. The persistent views appear in a list box that displays the names given to the views by the user when they were saved. A persistent view can be opened by double clicking on its name.
- *Close all views* – closes all open views of this field.
- *Close* – this option removes the field from its enclosing container. The user will be prompted to confirm the choice and to save the field if desired.

I4 Scalar field 2D

I4.1 Description

A scalar field 2D is a scalar field that is a function of two variables.

I4.2 Views

A 2D scalar field has nine views.

- *Details view.*
- *Table view.*
- *Contour view.*
- *Animated graph view.*
- *Offset graph view.*
- *Multi graph view.*
- *PDF view.*
- *Surface view.*
- *Multi spectral view.*

I4.2.1 Details view

Description

The details view of a scalar field 2D displays the name of the field, its full name and its description.

Access

The details view of a scalar field 2D can be accessed through the popup menu of the field object.

I4.2.2 Table view

Description

The table view of the scalar field 2D displays the field values in tabular form – x axis values label the columns, and y axis values label the rows.

The data from the table can be easily selected and copied and pasted into a spreadsheet.

Access

The table view of a scalar field 2D can be accessed through the popup menu of the field object.

Menus

View menu

- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.

14.2.3 Contour view

Description

The contour view of the scalar field 2D provides a false colour contour plot of the field. It is also possible to overlay a number of vector 2D fields 2D onto the contour plot and/or scalar 1D fields. This can be achieved through dragging and dropping the overlay field object onto the display area of the view or through the vector 2D field overlay manager view (see section 14.2.3.2) or the scalar 1D field overlay manager view (see section 14.2.3.3).

This view provides the user access to a rudimentary edge/contour detection algorithm. The user can choose a contour value of the plotted field and the location of this contour is then determined either as a function of the horizontal (or vertical) coordinate. The algorithm simply scans vertical (or horizontal) lines in search of the chosen contour value. The search can start from the top or bottom (or left or right) of the field and stops once the first occurrence of the contour value is detected. Generally the contour value lies between two grid points and a linear interpolation is used to find the actual contour location. The result of this edge/contour detection is a scalar 1D field where the vertical (horizontal) position of the contour is given as a function of the horizontal (vertical) coordinate. This scalar field is available in a separate view that is accessed from the Edge menu. When the contour view is closed the edge fields are saved in the field registry.

This is the default view of scalar field 2D object.

There are three toolbars at the top of the view. These are:

Display toolbar

- *Colour cells* – if this check box is selected then the data is displayed using colour cells to indicate the field value on the two-dimensional domain.
- *Contour lines* – if this check box is selected colour contour lines are drawn on the graph.
- *Swap axes* – if this check box is selected the axes are swapped.
- *Fill view* – if this check box is selected the aspect ratio of the data is ignored and the graph is expanded to fill the entire view.

x axis toolbar

- *x axis min* – sets the minimum x value displayed.
- *x axis max* – sets the maximum x value displayed.
- *x* – displays the x value of the cursor as it moves over the graph.

y axis toolbar

- *y axis min* – sets the minimum y value displayed.
- *y axis max* – sets the maximum y value displayed.
- *y* – displays the x value of the cursor as it moves over the graph.

Field toolbar

- *Field min* – this is the field value corresponding to the colour at the bottom of the legend. Initially this is set to be the smallest field value on the grid. However, the user may choose to change this value. If grid values smaller than the value specified exist, then these will be coloured white.
- *Field max* – this is the field value corresponding to the colour at the top of the legend. Initially this is set to be the largest field value on the grid. However, the user may choose to change this value. If grid values larger than the value specified exist, then these will be coloured white.
- *field* – displays the field value of the cursor as it moves over the graph.

It is possible that the field is undefined in some regions of the grid, due to the fact that there is no data in this region and hence the field is undefined. In this case the cell colour will be black.

Access

The contour view of a scalar field 2D can be accessed by double clicking the field or through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 14.2.3.1. The settings are saved in a file with extension .s2dcontset.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .s2dcontset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.

View menu

- *Set layout* – opens the set layout dialog box in which the user can change the settings common to all views of this type. This includes colours, borders and so on. The details are provided in section 14.2.3.1.
- *Show colour cells* – when selected the data points are displayed.
- *Show contours* – when selected the lines connecting the data points are displayed.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected the info text at the bottom of the view is displayed.
- *Show legend* – when selected the legend on the right of the view is displayed.
- *Show frame* – when selected the rectangular border around the graph is displayed.
- *Show divisions* – when selected the x and y axis divisions are drawn as dashed lines.

- *Show grid* – when selected the grid is displayed.
- *Show overlay vector 2D fields* – when selected the chosen overlay vector 2D fields are displayed. See section 14.2.3.2.
- *Show overlay scalar 1D fields* – when selected the chosen overlay scalar 1D fields are displayed. See section 14.2.3.3.
- *Show adornments* – when selected the adornments are displayed.
- *Swap axes* – when selected the axes are swapped.
- *Fill view* – if selected the aspect ratio of the graph is ignored and the figure is expanded to fill the entire view.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Set field min and max values to default* – resets the minimum and maximum values to the default values.
- *Set field min and max values using contour values* – if the user changes the contour values to be displayed in the figure this option will set the minimum and maximum values to the minimum and maximum contour values and hence will update the legend to correspond to this new range.
- *Redraw during resize* – if set, the view redraws during a resize operation. For a fine grid this might cause a lack of responsiveness. If not set redrawing does not occur and the user needs to perform some manual operation after the resize in order to force a redraw.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Hide toolbars* – when selected the toolbars are hidden.
- *Adjust view size* – resets the view window size to eliminate unnecessary waste space. This has the same effect as double clicking in the blank space in the toolbars at the top of the view.

Contour menu

- *Change contour values...* – allows the user to select the values of the contours displayed on the plot. Default values are chosen by the system when the view is first opened. These are based on the maximum and minimum scalar values displayed in the view. The user can add and remove contour values as they wish.
- *Set contour values using field min and max* – the min and max field values specified in the scale toolbar are used to construct a new set of contour values.

Overlay menu

- *Manage vector 2D overlay fields...* – this option opens the manage overlay fields view. See section 14.2.3.2.

- *Manage scalar 1D overlay fields...* – this option opens the manage overlay fields view. See section 14.2.3.3.

Edge menu

- *Manage edge fields...* – this opens the manage edge field view. See section 14.2.3.4.

Adornments menu

- *Manage adornments* – opens the adornments 2D manager view. See chapter 5.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Show colour cells* – see View menu.
- *Show contours* – see View menu.
- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show legend* – see View menu.
- *Show frame* – see View menu.
- *Show divisions* – see View menu.
- *Show grid* – see View menu.
- *Show overlay vector 2D field* – see View menu.
- *Show overlay scalar 1D field* – see View menu.
- *Show adornments* – see Adornments menu.
- *Swap axes* – see View menu.
- *Fill view* – see View menu.
- *Zoom* – see Zoom menu.
- *Unzoom* – see Zoom menu.

- Clear zoom rectangle – see Zoom menu.

14.2.3.1 Set layout dialog

The user has considerable control over the appearance of this view. The set layout dialog can be opened through the View menu or a popup menu. It is important to note that the parameters set in this dialog box apply to all contour views for scalar fields 2D so that when other views are opened they will possess the same settings. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Grid refinement factor* – this option allows the user to refine the grid on which the contour and colour cell data is plotted. The field values on the refined grid are linearly interpolated. Using a value larger than 1 can provide a smoother looking graph.
- *Vector scale factor* – vectors in an overlay vector field have arbitrary length. This factor allows the user to control the length of the vectors by scaling all their lengths by this value.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Rotate y label* – when selected the y axis label is rotated so that the text is vertical.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.

- *Top border width* – sets the size of the top border in pixels.

Colour

- *Contours colour* – the range of colours used to present the data. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range or return to the defaults provided. The user can also save and reload their colour choices.
- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Grid colour* – the colour of the grid lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Vectors colour* – the colour used to display the overlay vectors. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.
- *Use black contours* – if selected all contours will be displayed in black. This can be helpful if both the colour cells and contours are displayed simultaneously.
- *Colour format* – the colour coding of the cells in the plot can be done in two ways. If the continuous button is selected then a continuous range of colours is used based on the colour palette selected. If the binned button is selected the field value is binned into one of x discrete bins – where x is set in the number of bins field. In this case all field values in the same bin have the same colour based on the same colour palette. The result is a plot with clear demarcation between field values from different bins.
- *Number of bins* – if colour binning is used this field sets the number of bins.

14.2.3.2 Manage overlay vector 2D fields view

The user can overlay a number of vector 2D fields 2D on this view. The user can overlay fields by loading them from file, selecting them from the field registry, dragging them onto the list box of overlay fields in this view, or dragging the fields directly onto the contour view itself.

The view has five buttons. The buttons are as follows:

- **Load** – enables the user to load a vector 2D field 2D from disk.

- *Select* – enables the user to select a vector field from the field registry.
- *Delete* – deletes any fields currently selected in the field list.
- *Clear* – deletes all selected fields.
- *Refresh* – refreshes the view.

The dialog includes 2 tabs – Overlays and Legend

Overlays

- *Overlay fields* – this list box lists all current overlay vector fields. Three key parameters that can be manipulated in this view - their name, colour and display setting – can be changed using the popup menu for each field. The field name is the field's short name by default. The name is used in the legend, if displayed, and therefore the user may wish to change the name. The colour used to display each of the overlay fields is set through their popup menus and the name of the field is displayed in this colour in the list box. Note the initial colour is randomly allocated by the view and both the points and line used to render the field on the graph use the same colour. Finally each of the fields can be shown or hidden through their display setting. If a field is shown its name will be followed by a tick in the list box. In addition the popup menu of an overlay field allows the user access to the details view of the overlay. The details view can be used to change the three parameters discussed above as well as the line width used to render the overlay vectors.

Legend

- *Display legend* – if selected a legend will be displayed on the view that will include all visible overlay vector fields. The names and colours specified in the Layout tab are used in the legend.
- *Display border* – is selected the legend will possess a border.
- *Black text* – if selected the text in the legend will be displayed in black. If not selected the colour of each vector field is used for the text.
- *Legend location* – this drop down box provides the user with 4 possible locations for the legend – top right, top left, bottom right and bottom left. Which is appropriate will depend on the region of the graph covered by the curves.
- *Legend offset x* – this allows the user to offset the legend the specified number of pixels from the chosen location in the x direction. The larger the number the closer the legend will move away from its location. Changes to this and the other settings will automatically appear on the graph.
- *Legend offset y* – this allows the user to offset the legend the specified number of pixels from the chosen location in the y direction. The larger the number the closer the legend will move away from its location. Changes to this and the other settings will automatically appear on the graph.

Menus

Legend menu

- *View preset legend labels...* – it is common for a set of legend labels (for each of the overlay vector fields) to be used in multiple views of the same sort. Preset legend labels enable the user to have a standard set of legend labels that can be used and reused in views of the same sort. This menu option displays these preset legend labels. The dialog box that is displayed enables the user to add or insert new legend labels, delete them and edit them.
- *Save preset legend labels* – this command will use the current legend labels (overlay names) as the preset labels. The user is prompted to confirm this action.
- *Use preset legend labels* – this command replaces the current overlay names (legend labels) with the preset labels. If there are more presets than required the unused preset labels are ignored. If there are more overlays than preset labels the additional overlays, for which to preset label exists, will retain their current name/label. The user is prompted to confirm this action.

14.2.3.3 Manage overlay scalar 1D fields view

The user can overlay a number of scalar 1D fields on this view. The user can overlay fields by loading them from file, selecting them from the field registry, dragging them onto the list box of overlay fields in this view, or dragging the fields directly onto the contour view itself.

The view has five buttons. The buttons are as follows:

- *Load* – enables the user to load a scalar 1D field from disk.
- *Select* – enables the user to select a scalar 1D field from the field registry.
- *Delete* – deletes any fields currently selected in the field list.
- *Clear* – deletes all selected fields.
- *Refresh* – refreshes the view.

The dialog includes 2 tabs – Overlays and Legend

Overlays

- *Overlay fields* – this list box lists all current overlay scalar fields. Three key parameters that can be manipulated in this view - their name, colour and display setting – can be changed using the popup menu for each field. The field name is the field's short name by default. The name is used in the legend, if displayed, and therefore the user may wish to change the name. The colour used to display each of the overlay fields is set through their

popup menus and the name of the field is displayed in this colour in the list box. Note the initial colour is randomly allocated by the view and both the points and line used to render the field on the graph use the same colour. Finally each of the fields can be shown or hidden through their display setting. If a field is shown its name will be followed by a tick in the list box. In addition the popup menu of an overlay field allows the user access to the details view of the overlay. The details view can be used to change the three parameters discussed above as well as the line width and type used to render the curve. The option to set the size of the points is unused in this context.

Legend

- *Display legend* – if selected a legend will be displayed on the view that will include all visible overlay scalar fields. The names and colours specified in the Layout tab are used in the legend.
- *Display border* – is selected the legend will possess a border.
- *Black text* – if selected the text in the legend will be displayed in black. If not selected the colour of each curve is used for the text.
- *Legend location* – this drop down box provides the user with 4 possible locations for the legend – top right, top left, bottom right and bottom left. Which is appropriate will depend on the region of the graph covered by the curves.
- *Legend offset x* – this allows the user to offset the legend the specified number of pixels from the chosen location in the x direction. The larger the number the closer the legend will move away from its location. Changes to this and the other settings will automatically appear on the graph.
- *Legend offset y* – this allows the user to offset the legend the specified number of pixels from the chosen location in the y direction. The larger the number the closer the legend will move away from its location. Changes to this and the other settings will automatically appear on the graph.

Menus

Legend menu

- *View preset legend labels...* – it is common for a set of legend labels (for each of the overlay scalar fields) to be used in multiple views of the same sort. Preset legend labels enable the user to have a standard set of legend labels that can be used and reused in views of the same sort. This menu option displays these preset legend labels. The dialog box that is displayed enables the user to add or insert new legend labels, delete them and edit them.
- *Save preset legend labels* – this command will use the current legend labels (overlay names) as the preset labels. The user is prompted to confirm this action.

- *Use preset legend labels* – this command replaces the current overlay names (legend labels) with the preset labels. If there are more presets than required the unused preset labels are ignored. If there are more overlays than preset labels the additional overlays, for which no preset label exists, will retain their current name/label. The user is prompted to confirm this action.

14.2.3.4 *Manage edge fields view*

As described at the beginning of this section the user can create simple edge fields. This view manages those fields.

The two buttons at the bottom of the dialog are:

- *Delete edge fields* – deletes all currently selected edge fields in the list box.
- *Clear edge fields* – deletes all edge fields in the list box.

There are two tabs, Edge fields and Parameters.

Edge fields

- *Current edge fields* – this list box lists all of the edge fields that have been created through this view. As these are scalar fields ID they can be manipulated using their popup menus.

Parameters

- *Edge value* – the value of the field that is being used in the edge field calculation.
- *Independent variable* – this option allows the user to choose whether the location of the edge field will be a function of x or y. The search is done in the perpendicular direction to this. Thus if x is chosen as the independent variable the edge value will be searched for in the y direction.
- *Interpolation order* – currently only linear interpolation between grid points is supported in computing the location of the field value.
- *Search direction* – specifies whether the search for the field value will be in the direction of increasing or decreasing y (when x is the independent variable or vice versa) direction.
- *Compute edge field* – once all search parameters have been specified the user presses this button to generate the edge field. The new field will appear in the list box in the Edge fields tab.

14.2.4 Animated graph view

Description

The animated graph view of a scalar field 2D provides a plot of a one dimensional slice of the field, similar to the scalar field 1D graph view. However, because of the extra dimension, which for convenience is assumed to be associated with time, this 1D view varies in time. Thus this view allows the user to animate the one dimensional plot. If, for example, the field corresponded to the free surface elevation of a wave field as a function of time and space, this view would provide an animated view of the wave motion.

However, the view is not limited to a display of time-varying data. Suppose the field being viewed is a function of two spatial dimensions, x and y . In this case the view is a one dimensional slice through this field in, say, the x direction, and the animation will display the slice for different values of y . The user is at liberty to change the axis that is interpreted as the time, or animation, variable.

Four toolbars are provided at the top of the view.

Animation toolbar

The animation toolbar provides a number of animation controls which allow the user to control the animation. Most of these controls are represented with icons which have a clear meaning. They are from left to right

- *Current time* – this combo box displays the current value of the animating variable. This variable originally corresponds to the “ x ” axis of the field, but may be changed (see View menu). The user can select any value in this box to move to a different position in the field.
- *Go to next time* – steps the display forward one frame.
- *Go to previous time* – steps the display back one frame.
- *Play* – starts the animation forward in time.
- *Play in reverse* – starts the animation backward in time.
- *Pause* – pauses the animation.
- *Go to start* – resets the display to the first frame.
- *Go to end* – resets the display to the last frame.
- *Animation timing delay (ms)* – this text box allows the user to change the speed of the animation. The displayed timing delay is the minimum time between frames. The actual delay may be longer if the drawing overhead is high.

Display toolbar

- *Points* – if this check box is selected the field data points are shown on the graph. Their default colour is green. This can be changed in the *Colour* menu.
- *Lines* – if this check box is selected lines are drawn between the data points on the graph. Their default colour is red. This can be changed in the *Colour* menu.
- *Swap axes* – if this check box is selected the axes are swapped on the graph.

x axis toolbar

- *x axis min* – sets the minimum x value displayed.
- *x axis max* – sets the maximum x value displayed.
- *x* – displays the x value of the cursor as it moves over the graph.

y axis toolbar

- *y axis min* – sets the minimum y value displayed.
- *y axis max* – sets the maximum y value displayed.
- *y* – displays the y value of the cursor as it moves over the graph.

Access

The animated graph view of a scalar field 2D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 14.2.4.1. The settings are saved in a file with extension *.s2danigrset*.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of *.s2danigrset*.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the

object when it is saved to file and hence can be accessed again at a later time.

- *Save as image...* – enables the user to save the graph as an image file. See chapter 11 for details.
- *Save as image sequence...* – enables the user to save each graph as an image in an image sequence. Image file types supported are JPEG, PNG and BMP format. The user can select the resolution of the images. The name, specified by the user, has the number of the frame added as a suffix. It is recommended that the base name ends in an underscore (_) in order to separate the file name from the frame numbering.

View menu

- *Set layout* – opens the set layout dialog box in which the user can change the settings common to all views of this type. This includes colours, borders and so on. The details are provided in section 14.2.4.1.
- *Show points* – when selected the data points are displayed.
- *Show lines* – when selected the lines connecting the data points are displayed.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected info text at the bottom of the view is displayed.
- *Show frame* – when selected the outline box of the graph is displayed.
- *Show divisions* – when selected the divisions on each axis are displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Show animators* – when selected the animators are displayed.
- *Swap axes* – when selected the axes are swapped.
- *Swap animation axis* – this option allows the user to select which of the two independent variables will be treated as the animation variable. The default setting is for the x axis to be treated as time, so the field is plotted against the y variable. Selecting this menu item will cause the x and y variables to swap roles.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Hide toolbars* – when selected the toolbars are hidden.

Animation menu

- *Go to next time* – steps the display forward one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to previous time*– steps the display back one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Play* – starts the animation forward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Play in reverse* – starts the animation backward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Pause* – pauses the animation. This has the same effect as the equivalent button in the animation toolbar.
- *Go to start* – resets the display to the first frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to end* – resets the display to the last frame. This has the same effect as the equivalent button in the animation toolbar.

Adornments menu

- *Manage adornments...* – opens the adornments 2D manager view for this field view. See chapter 5.
- *Manage animators...* – opens the animators 2D manager view for this field view. See chapter 7.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Go to next time* – see Animation menu.
- *Go to previous time*– see Animation menu.
- *Play*– see Animation menu.
- *Play in reverse* – see Animation menu.
- *Pause* – see Animation menu.
- *Go to start* – see Animation menu.
- *Go to end* – see Animation menu.
- *Swap animation axis* – see Animation menu.
- *Show points* – see View menu.
- *Show lines* – see View menu.

- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show frame* – see View menu.
- *Show divisions* – see View menu.
- *Show adornments* – see Adornments menu.
- *Show animators* – see Adornments menu.
- *Swap axes* – see View menu.
- *Swap animation axis* – see View menu.
- *Zoom* – see Zoom menu.
- *Unzoom* – see Zoom menu.
- *Clear zoom rectangle* – see Zoom menu.

14.2.4.1 Set layout dialog

The set layout dialog can be opened through the View menu or a popup menu and allows the user to change settings for all views of this type.

The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Rotate y label* – when selected the y axis label is rotated so that the text is vertical.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left

hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.

- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width*– sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Points colour* – the colour of the points displayed for the field. It can be changed by clicking on the Select... button.
- *Lines colour* – the colour of the lines used to plot the field. It can be changed by clicking on the Select... button.
- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

14.2.5 Multi graph view

Description

The multi graph view of a scalar field 2D provides multiple overlaid plots of one dimensional slices of the field, similar to the scalar field 1D graph view. Thus if the two independent variables are x and t the user can view the spatial dependence of the field for each time, or alternatively he or she can view the temporal dependence of the field at each position in space.

Each graph is displayed in a different colour based on the colour legend displayed to the right of the plot. The range of colours employed for this purpose can be changed by the user.

Three toolbars are provided at the top of the view.

Display toolbar

- *Points* – if this check box is selected the field data points are shown on the graph. Each curve is displayed in a different colour and the lines and points are displayed with this colour.

- *Lines* – if this check box is selected lines are drawn between the data points for each graph displayed.
- *Mean points* – if this check box is selected the average field data points are shown on the graph. The points are displayed in white.
- *Mean lines* – if this check box is selected lines are drawn between the data points for the mean field. Each curve is drawn in white.
- *Divisions* – if this check box is selected the axis divisions are drawn as dashed lines on the graph.
- *Curve fit* – if this check box is selected the current curve fit to the mean field is displayed.
- *Swap axes* – if this check box is selected the axes are swapped on the graph.

x axis toolbar

- *x axis min* – sets the minimum x value displayed.
- *x axis max* – sets the maximum x value displayed.
- *x* – displays the x value of the cursor as it moves over the graph.

y axis toolbar

- *y axis min* – sets the minimum y value displayed.
- *y axis max* – sets the maximum y value displayed.
- *y* – displays the y value of the cursor as it moves over the graph.

Access

The multi graph view of a scalar field 2D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 14.2.5.1. The settings are saved in a file with extension .s2dmulgrset.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .s2dmulgrset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated

to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.

- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.
- *Save mean to text file...* – enables the user to save the mean field to a text file.

View menu

- *Set layout* – opens the set layout dialog box in which the user can change the settings common to all views of this type. This includes colours, borders and so on. The details are provided in section 14.2.5.1.
- *Show points* – when selected the data points are displayed.
- *Show lines* – when selected the lines connecting the data points are displayed.
- *Show mean points* – when selected the data points for the mean field are displayed.
- *Show mean lines* – when selected the lines connecting the data points for the mean field are displayed.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected info text at the bottom of the view is displayed.
- *Show legend* – when selected the legend on the right of the view is displayed.
- *Show frame* – when selected the outline box of the graph is displayed.
- *Show divisions* – when selected the divisions on each axis are displayed.
- *Show curve fit* – when selected the current curve fit of the mean field is displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Swap axes* – when selected the axes are swapped.
- *Swap independent variable...* – allows the user to change the independent variable plotted on the x axis. The default setting is the x variable. Thus the y variable acts as the label for each curve.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.

- *Set curves details...* – when the view is first opened a curve for each value of *y* is plotted. This menu option displays a dialog box which allows the user to select the *y* values for which curves are to be plotted. The first *y* value, the number of *y* values and the increment between them can be specified.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Hide toolbars* – when selected the toolbars are hidden.

Curve fitting menu

- *Manage x curve fits...* – this opens the manage x curve fits view. See chapter 4.
- *Manage y curve fits...* this opens the manage y curve fits view. See chapter 4.

Adornments menu

- *Manage adornments...* – opens the adornments 2D manager view for this field view. See chapter 5.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Show points* – see View menu.
- *Show lines* – see View menu.
- *Show mean points* – see View menu.
- *Show mean lines* – see View menu.
- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show legend* – see View menu.
- *Show frame* – see View menu.
- *Show divisions* – see View menu.

- *Show curve fit* – see View menu.
- *Show adornments* – see Adornments menu.
- *Swap axes* – see View menu.
- *Swap independent variable* – see View menu.
- *Zoom* – see Zoom menu.
- *Unzoom* – see Zoom menu.
- *Clear zoom rectangle* – see Zoom menu.

14.2.5.1 Set layout dialog

This dialog allows the user to adjust display settings for all views of this type. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Rotate y label* – when selected the y axis label is rotated so that the text is vertical.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Curve colours* – the user can choose the range of colours used to display the various curves. See the description given in section 14.2.3.1.
- *Mean points colour* – the colour of the mean point. It can be changed by clicking on the Select... button.
- *Mean lines colour* – the colour of lines corresponding to the mean. It can be changed by clicking on the Select... button.
- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.
- *Mean curve fit colour* – the colour used for drawing the mean curve fit. It can be changed by clicking on the Select... button.

14.2.6 Offset graph view

Description

The offset graph view of a scalar field 2D is similar to the multi graph view in that multiple slices through the field are displayed as separate curves. However in this case, instead of the curves being overlaid on the same graph and a colour based legend used to determine which slice corresponds to which value of one of the independent variables, the slices are offset with respect to one another and their location on the plot indicates where they lie in the field itself. The slices are always vertical slices of plotted at the x location at which they occur. The result is a series of offset graphs that are often more informative and less confusing than the overlaid graphs in the multi graph view.

The x-y axes correspond to the domain of the field. Above the graph (or to the right if the axes are swapped) small scales are provided above each of the plotted profiles that correspond to the scale of the dependent variable. The user has control over the number of slices they wish to display and how they are displayed.

The view supports overlays of both scalar 2D fields and scalar 1D fields.

Four toolbars are provided at the top of the view.

Display toolbar

- *Points* – if this check box is selected the field data points are shown on the graph.
- *Lines* – if this check box is selected lines are drawn between the data points for each graph displayed.
- *Divisions* – if this check box is selected the axis divisions are drawn as dashed lines on the graph.
- *Swap profile axis* – if this check box is selected the axes are swapped on the graph. The profiles are always vertical slices so this setting simply draws the slices horizontally and swaps the x and y axes.

x axis toolbar

- *x axis min* – sets the minimum x value displayed.
- *x axis max* – sets the maximum x value displayed.

y axis toolbar

- *y axis min* – sets the minimum y value displayed.
- *y axis max* – sets the maximum y value displayed.

cursor toolbar

- *x* – displays the x value of the cursor as it moves over the graph.
- *y* – displays the y value of the cursor as it moves over the graph.
- *y* – displays the y value of the cursor as it moves over the graph.

Access

The multi graph view of a scalar field 2D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 14.2.6.1. The settings are saved in a file with extension .s2doffgrset.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .s2doffgrset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an

identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.

- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.

View menu

- *Set layout* – opens the set layout dialog box in which the user can change the settings common to all views of this type. This includes colours, borders and so on. The details are provided in section 14.2.5.1.
- *Show field* – when selected the field data is displayed.
- *Show overlay scalar 2D fields* – when selected the overlaid scalar 2D fields are displayed.
- *Show overlay scalar 1D fields* – when selected the overlaid scalar 1D fields are displayed.
- *Show points* – when selected the data points are displayed.
- *Show lines* – when selected the lines connecting the data points are displayed.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected info text at the bottom of the view is displayed.
- *Show frame* – when selected the outline box of the graph is displayed.
- *Show divisions* – when selected the divisions on each axis are displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Swap profile axis* – when selected the profiles are displayed horizontally instead of vertically.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Set number of profiles...* – displays a dialog box in which the user can specify the number of profiles to be displayed.
- *Set profile scale factor...* – displays a dialog box that enables the user to change the scale factor for the profiles. This scale factor determines the physical size of the dependent variable scale displayed at the top (or right) of the plot. The default value is 0.5 and this ensures that the

maximum field value lies halfway between profiles. The factor can be no larger than 1. The larger the factor the more likely the profiles will overlap with one another.

- *Hide toolbars* – when selected the toolbars are hidden.

Overlay menu

- *Manage scalar 2D overlay fields...* – this option opens the manage overlay fields view. See section 14.2.6.2.
- *Manage scalar 1D overlay fields...* – this option opens the manage overlay fields view. See section 14.2.6.3.

Adornments menu

- *Manage adornments...* – opens the adornments 2D manager view for this field view. See chapter 5.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Show field* – see View menu.
- *Show overlay scalar 2D fields* – see View menu.
- *Show overlay scalar 1D fields* – see View menu.
- *Show points* – see View menu.
- *Show lines* – see View menu.
- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show frame* – see View menu.
- *Show divisions* – see View menu.
- *Show adornments* – see Adornments menu.
- *Swap profile axis* – see View menu.
- *Zoom* – see Zoom menu.

- *Unzoom* – see Zoom menu.
- *Clear zoom rectangle* – see Zoom menu.

14.2.6.1 Set layout dialog

This dialog allows the user to adjust display settings for all views of this type. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Rotate y label* – when selected the y axis label is rotated so that the text is vertical.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Axes colour* – the colour of axes. It can be changed by clicking on the *Select...* button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the *Select...* button.

- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

14.2.6.2 *Manage overlay scalar 2D fields view*

The user can overlay a number of scalar 2D fields on this view. The user can overlay fields by loading them from file, selecting them from the field registry, dragging them onto the list box of overlay fields in this view, or dragging the fields directly onto the offset view itself.

The view has five buttons. The buttons are as follows:

- *Load* – enables the user to load a scalar 2D field from disk.
- *Select* – enables the user to select a scalar 2D field from the field registry.
- *Delete* – deletes any fields currently selected in the field list.
- *Clear* – deletes all selected fields.
- *Refresh* – refreshes the view.

The dialog includes 2 tabs – Overlays and Legend

Overlays

- *Overlay fields* – this list box lists all current overlay scalar 2D fields. Three key parameters that can be manipulated in this view - their name, colour and display setting – can be changed using the popup menu for each field. The field name is the field's short name by default. The name is used in the legend, if displayed, and therefore the user may wish to change the name. The colour used to display each of the overlay fields is set through their popup menus and the name of the field is displayed in this colour in the list box. Note the initial colour is randomly allocated by the view and both the points and line used to render the field on the graph use the same colour. Finally each of the fields can be shown or hidden through their display setting. If a field is shown its name will be followed by a tick in the list box. In addition the popup menu of an overlay field allows the user access to the details view of the overlay. The details view can be used to change the three parameters discussed above as well as the line width and type used to render the curve. The option to set the size of the points is unused in this context.

Legend

- *Display legend* – if selected a legend will be displayed on the view that will include all visible overlay scalar fields. The names and colours specified in the Layout tab are used in the legend.
- *Display border* – is selected the legend will possess a border.
- *Black text* – if selected the text in the legend will be displayed in black. If not selected the colour of each curve is used for the text.
- *Legend location* – this drop down box provides the user with 4 possible locations for the legend – top right, top left, bottom right and bottom left. Which is appropriate will depend on the region of the graph covered by the curves.
- *Legend offset x* – this allows the user to offset the legend the specified number of pixels from the chosen location in the x direction. The larger the number the closer the legend will move away from its location. Changes to this and the other settings will automatically appear on the graph.
- *Legend offset y* – this allows the user to offset the legend the specified number of pixels from the chosen location in the y direction. The larger the number the closer the legend will move away from its location. Changes to this and the other settings will automatically appear on the graph.

14.2.6.3 Manage overlay scalar 1D fields view

The user can overlay a number of scalar 1D fields on this view. The user can overlay fields by loading them from file, selecting them from the field registry, dragging them onto the list box of overlay fields in this view, or dragging the fields directly onto the offset view itself.

The view has five buttons. The buttons are as follows:

- *Load* – enables the user to load a scalar 1D field from disk.
- *Select* – enables the user to select a scalar 1D field from the field registry.
- *Delete* – deletes any fields currently selected in the field list.
- *Clear* – deletes all selected fields.
- *Refresh* – refreshes the view.

The dialog includes 2 tabs – Overlays and Legend

Overlays

- *Overlay fields* – this list box lists all current overlay scalar fields. Three key parameters that can be manipulated in this view - their name, colour and display setting – can be changed using the popup menu for each field. The

field name is the field's short name by default. The name is used in the legend, if displayed, and therefore the user may wish to change the name. The colour used to display each of the overlay fields is set through their popup menus and the name of the field is displayed in this colour in the list box. Note the initial colour is randomly allocated by the view and both the points and line used to render the field on the graph use the same colour. Finally each of the fields can be shown or hidden through their display setting. If a field is shown its name will be followed by a tick in the list box. In addition the popup menu of an overlay field allows the user access to the details view of the overlay. The details view can be used to change the three parameters discussed above as well as the line width and type used to render the curve. The option to set the size of the points is unused in this context.

Legend

- *Display legend* – if selected a legend will be displayed on the view that will include all visible overlay scalar fields. The names and colours specified in the Layout tab are used in the legend.
- *Display border* – is selected the legend will possess a border.
- *Black text* – if selected the text in the legend will be displayed in black. If not selected the colour of each curve is used for the text.
- *Legend location* – this drop down box provides the user with 4 possible locations for the legend – top right, top left, bottom right and bottom left. Which is appropriate will depend on the region of the graph covered by the curves.
- *Legend offset x* – this allows the user to offset the legend the specified number of pixels from the chosen location in the x direction. The larger the number the closer the legend will move away from its location. Changes to this and the other settings will automatically appear on the graph.
- *Legend offset y* – this allows the user to offset the legend the specified number of pixels from the chosen location in the y direction. The larger the number the closer the legend will move away from its location. Changes to this and the other settings will automatically appear on the graph.

14.2.7 PDF view

Description

The PDF view of a scalar field 2D displays either the probability density function (PDF) or cumulative probability density function (cumulative PDF) of the field. The range of the field values is divided into a number of equally sized bins (20 is the default number of bins) and the number of occurrences of field values lying within each bin is determined. When these numbers are normalized by the total number of field values the PDF of the field is obtained. If the numbers in the bins are summed from

the smallest value of the independent variable to the largest (i.e. the left most bin to the right most bin) the cumulative PDF is obtained. The cumulative PDF ranges from 0 to 1.

The PDF or cumulative PDF can be displayed using points and lines, and/or bars.

Three toolbars are provided at the top of the view.

Display toolbar

- *Cumulative PDF* – if this check box is selected the cumulative PDF is displayed on the graph. Otherwise the PDF is displayed.
- *Points* – if this check box is selected the data points (PDF or cumulative PDF) are shown on the graph.
- *Lines* – if this check box is selected lines are drawn between the data points on the graph.
- *Bars* – if this check box is selected the data is plotted as bars, where each bar has a width equal to the width of one of the bins.
- *Curve fit* – if this check box is selected any curve fit to the data is shown on the graph.

x axis toolbar

- *x axis min* – sets the minimum x value displayed.
- *x axis max* – sets the maximum x value displayed.
- *x* – displays the x value of the cursor as it moves over the graph.

y axis toolbar

- *y axis min* – sets the minimum y value displayed.
- *y axis max* – sets the maximum y value displayed.
- *y* – displays the y value of the cursor as it moves over the graph.

Access

The PDF view of a scalar field 2D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 14.2.7.1. The settings are saved in a file with extension .s2dpdfset.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .s2dpdfset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.
- *Save to text file...* – enables the user to save the data displayed in a comma (,) delimited text file (.txt or .csv).

View menu

- *Set layout...* – displays the set layout dialog box described in section 14.2.7.1.
- *Show cumulative PDF* – when selected the cumulative PDF is displayed. Otherwise the PDF is displayed.
- *Show points* – when selected the data points are displayed.
- *Show lines* – when selected the lines connecting the data points are displayed.
- *Show bars* – when selected the data is represented by bars.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected the info text at the bottom of the view is displayed.
- *Show frame* – when selected the rectangular border around the graph is displayed.
- *Show divisions* – when selected the x and y axis divisions are drawn as dashed lines.
- *Show curve fit* – when selected the current curve fit is displayed.
- *Show adornments* – when selected the adornments are displayed.

- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Set number of bins...* – displays a dialog box that allows the user to specify the number of bins used in computing the PDF for the field.
- *Set range...* – displays a dialog box that prompts the user for the range of field values to be used in computing the PDF. This enables the user to focus on a subset of the field values or to adopt a more intuitive range.
- *Reset range* – the range used for the PDF is reset to the default value based on the range of values present in the field. For example if all field values lie between Min and Max the range will be reset to Min and Max.
- *Hide toolbars* – when selected the toolbars are hidden.

Curve fitting menu

- *Manage curve fits...* – opens the manage curve fits view. See chapter 4.

Adornments menu

- *Manage adornments...* – opens the adornments 2D manager view. See chapter 5.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Show cumulative PDF* – see View menu.
- *Show points* – see View menu.
- *Show lines* – see View menu.
- *Show bars* – see View menu.
- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.

- Show frame – see View menu.
- Show divisions – see View menu.
- Show curve fit – see View menu.
- Show adornments – see Adornments menu.
- Zoom – see Zoom menu.
- Unzoom – see Zoom menu.
- Clear zoom rectangle – see Zoom menu.

14.2.7.1 Set layout dialog

The user has considerable control over the appearance of this view. The set layout dialog can be opened through the View menu or a popup menu. It is important to note that the parameters set in this dialog box apply to all PDF views for scalar fields 2D so that when other views are opened they will possess the same settings. The three buttons at the bottom of the dialog are:

- Reset... – resets all of the layout settings to their defaults.
- OK – confirms the changes made and applies them to the view.
- Cancel... – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Rotate y label* – when selected the y axis label is rotated so that the text is vertical.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.

- *Top border width* – sets the size of the top border in pixels.

Colour

- *Points colour* – the colour of the points displayed for the field. It can be changed by clicking on the Select... button.
- *Line colour* – the colour of the lines used to plot the field. It can be changed by clicking on the Select... button.
- *Bars colour* – the colour of the bars used to plot the field. It can be changed by clicking on the Select... button.
- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.
- *Curve fit colour* – the colour used for drawing curve fits. It can be changed by clicking on the Select... button.

14.2.8 Surface view

Description

The surface view of the scalar field 2D provides a false colour surface plot of the field using the field values as a measure of elevation above the x-y plane. Effectively this view is a three-dimensional representation of the contour view.

As an alternative the user may choose a different scalar field 2D to be used as the colour map on the surface. For example the surface elevation may correspond to the longitudinal velocity component, while the colour displayed on the surface could be the vorticity field.

There are three toolbars at the top of the view. These are:

x axis toolbar

- *x axis min* – sets the minimum x value displayed.
- *x axis max* – sets the maximum x value displayed.
- *x offset* – sets which portion of the data set is displayed. The figure displayed is N where 1 data point in N is used to construct the surface. When the grid contains a large number of points Streams chooses only

to display a coarse approximation to the surface to attempt to improve rendering speeds.

- *Focal x* – displays the value of *x* at the cursor location in the focal plane. This value cannot be edited.

y axis toolbar

- *y axis min* – sets the minimum *y* value displayed.
- *y axis max* – sets the maximum *y* value displayed.
- *y offset* – sets which portion of the data set is displayed. The figure displayed is *N* where 1 data point in *N* is used to construct the surface. When the grid contains a large number of points Streams chooses only to display a coarse approximation to the surface to attempt to improve rendering speeds.
- *Focal y* – displays the value of *y* at the cursor location in the focal plane. This value cannot be edited.

Field toolbar

- *Field min* – this is the field value corresponding to the colour at the bottom of the legend. Initially this is set to be the smallest field value on the grid. However, the user may choose to change this value. If grid values smaller than the value specified exist, then these will be coloured white.
- *Field max* – this is the field value corresponding to the colour at the top of the legend. Initially this is set to be the largest field value on the grid. However, the user may choose to change this value. If grid values larger than the value specified exist, then these will be coloured white.

It is possible that the field is undefined in some regions of the grid, due to the fact that there is no data in this region and hence the field is undefined. In this case surface will be missing.

Access

The surface view of a scalar field 2D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 14.2.8.1. The settings are saved in a file with extension *.s2dsurset*.

- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .s2dsurset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.

View menu

- *Set layout* – opens the set layout dialog box in which the user can change the settings common to all views of this type. This includes colours, borders and so on. The details are provided in section 14.2.8.1.
- *Show surface* – when selected the field data is displayed as a continuous surface.
- *Show wire mesh* – when selected the field data is displayed as a wire mesh. The rendering of the wire mesh is likely to be more rapid than a solid surface.
- *Show frame* – when selected the rectangular border around the graph is displayed.
- *Show scales* – when selected the axis scales are displayed.
- *Show info* – when selected the info text at the bottom of the view is displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Swap axes* – when selected the axes are swapped. The default display places the x-y plane in the horizontal plane with the field values vertical. When the axes are swapped the x-y plane is a vertical plane with the field values plotted out of the plane.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Change axes scaling...* – the scaling of the field axis is arbitrary in this view. By default the field axis is scaled so its length is the comparable to that of the longer of the x and y axes. The user can change this scaling through a dialog box that is displayed when this menu option is selected..
- *Redraw during resize* – if set, the view redraws during a resize operation. For a fine grid this might cause a lack of responsiveness. If not set redrawing does not occur and the user needs to perform some manual operation after the resize in order to force a redraw.

- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Reset x/z axes to default limits* – resets the independent variable axes (nominally x and z) to their default sizes. If the user chooses to change the data displayed by setting the x min and x max values in top toolbar or y min and y max values in the second toolbar this menu option allows the user to restate the original limits.
- *Reset field range to default* – resets the field axis limits to the default values. The user may have changed these through the field min and field max values in the third toolbar.
- *Change colour range...* – this option displays a dialog box in which the user can change the fields values that correspond to the lower and upper end of the colour range. If field values lie outside these limits then the surface or wire mesh will be coloured white.
- *Reset colour range to defaults* – this option resets the field values corresponding to the lower and upper ends of the colour range to the default values.
- *Hide toolbars* – when selected the toolbars are hidden.

Colour maps menu

- *Manage colour map fields...* – opens a window for managing the colour maps used to display the field. The chosen colour map provides the colours for the displayed surface while the original field provides the surface elevations. By default the original field is the colour map. The dialog box displays a list of the current scalar fields 2D registered with the view. These can be loaded from file (the Load button) or selected from the field registry (the Select button). The user selects the field that is to be used as the colour map and presses the Choose button. This field will be marked with a tick and the view will be updated with the new colour map.

Cameras menu

- *Manage cameras...* – opens the camera management view. See chapter 2.
- *Open current controller* – this opens the controller view of the currently selected camera so the user can make adjustments to the camera settings. These changes are often most easily achieved using keyboard commands (see chapter 2). The camera controller view is also opened by double clicking the mouse on the display area with SHIFT and ALT keys held down.

Lighting menu

- *Manage lighting...* – this option opens the manage lighting view. See chapter 3.

Adornments menu

- *Manage adornments* – opens the adornments 3D manager view. See chapter 6.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped. Note the zoom rectangle is interpreted as being located in the focal plane of the camera. The zoom can also be achieved by double clicking the mouse within the rectangle while holding the SHIFT key.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain. The unzoom can also be achieved by double clicking the mouse within the rectangle while holding the SHIFT key.
- *Clear zoom rectangle* – clears the zoom rectangle..

Popup menu

- *Set layout...* – see View menu.
- *Show surface* – see View menu.
- *Show wire mesh* – see View menu.
- *Show frame* – see View menu.
- *Show scales* – see View menu.
- *Show info* – see View menu.
- *Show adornments* – see Adornments menu.
- *Swap axes* – see View menu.
- *Select data to display...* – see View menu.

14.2.8.1 Set layout dialog

The user has considerable control over the appearance of this view. The set layout dialog can be opened through the View menu or a popup menu. It is important to note that the parameters set in this dialog box apply to all surface views for scalar fields 2D so that when other views are opened they will possess the same settings. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. This determines the number of scale values that are displayed.
- *Number of y divisions* – the divisions that divide the y axis. This determines the number of scale values that are displayed.
- *Number of z divisions* – the divisions that divide the z axis. This determines the number of scale values that are displayed.
- *Geometric scale factor* – this option allows the user to globally change the “size” of objects such as the axes thickness.
- *Font size* – sets the font size. The default is 14.
- *Draw axes at origin* – the default setting is to draw the axes to the left, bottom and back of the figure. By selecting this checkbox the axes are relocated so they pass through the origin.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Contours colour* – the range of colours used to present the data. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range or return to the defaults provided. The user can also save and reload their colour choices.
- *Axes colour* – the colour of axes and frame. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

14.2.9 Multi spectral view

Description

The multi spectral view of a scalar field 2D provides a plot of the power spectral density (PSD) of the scalar field using one of the two independent variables as the independent variable for the spectral analysis. The user can choose which of the independent variables should be used for this. The graph is plotted on logarithmic axes.

The PSD is calculated using a fast Fourier Transform (FFT) that includes a number of windowing algorithms, segmentation (and averaging of the PSD) and the use of overlapping segments. FFTs are computationally most efficient when the number of data points in the series equals an integer power of 2. Most fields do not conform to this requirement, and the FFT used in this view provides the user with 2 options. The first is to truncate the data series, starting from the beginning, so that its length equals the highest power of two less than its original length. The second option is to pad the complete series with zeros so that its length equals the lowest power of 2 greater than the original series length. All of these FFT settings can be changed using the FFT menu.

Curve fitting is available for the average PSD in this view.

Three toolbars are provided at the top of the view.

Display toolbar

- *Points* – if this check box is selected the field data points are shown on the graph.
- *Lines* – if this check box is selected lines are drawn between the data points on the graph.
- *Mean points* – if this check box is selected the average PSD data points are shown on the graph.
- *Mean lines* – if this check box is selected lines are drawn between the data points for the mean PSD.
- *Curve fit* – if this check box is selected any curve fit to the data is shown on the graph.

freq axis toolbar

- *freq min* – sets the minimum freq value displayed.
- *freq max* – sets the maximum freq value displayed.
- *freq* – displays the freq value of the cursor as it moves over the graph.

power axis toolbar

- *power min* – sets the minimum power value displayed.
- *power max* – sets the maximum power value displayed.
- *power* – displays the power value of the cursor as it moves over the graph.

Access

The spectral view of a scalar field 2D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 14.2.9.1. The settings are saved in a file with extension .s2dspectset.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .s2dspectset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.
- *Save mean to text file...* – enables the user to save the mean PSD as to a comma (,) delimited text file. The user can select the number of significant figures used to save the data.

View menu

- *Set layout* – opens the set layout dialog box in which the user can change the settings common to all views of this type. This includes colours, borders and so on. The details are provided in section 14.2.9.1.
- *Show points* – when selected the data points are displayed.
- *Show lines* – when selected the lines connecting the data points are displayed.

- *Show mean points* – when selected the data points for the mean PSD are displayed.
- *Show mean lines* – when selected the lines connecting the data points for the mean PSD are displayed.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected info text at the bottom of the view is displayed.
- *Show frame* – when selected the outline box of the graph is displayed.
- *Show divisions* – when selected the divisions on each axis are displayed.
- *Show curve fit* – when selected the current curve fit of the mean PSD is displayed.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Set curves details...* – when the view is first opened a curve for each value of y is plotted. This menu option displays a dialog box which allows the user to select the y values for which curves are to be plotted. The first y value, the number of y values and the increment between them can be specified.
- *Swap independent variable...* – allows the user to change the independent variable used in the spectral analysis.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Hide toolbars* – when selected the toolbars are hidden.

FFT menu

- *Set FFT parameters...* – this menu item displays a dialog box in which the user can change the parameters governing the FFT used by the view. Parameters include: whether the series should be truncated or padded with zeros (an non-editable text box at the top of the dialog box indicates the number of data points that will be used in the FFT given the current settings); which windowing algorithm should be employed (the user can select from a number of standard windowing algorithms including Hann, Hamming, Gaussian etc); the alpha parameter which is used in the Kaiser and Gaussian windowing algorithms; the number of segments that the series should be broken into (the default is 1, ie the whole series is used to calculate the PSD); and whether overlapping of segments (by half the segment length) should be used when the series is segmented.

Curve fitting menu

- *Manage curve fits...* – opens the manage curve fits view. See section chapter 4.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Show points* – see View menu.
- *Show lines* – see View menu.
- *Show mean points* – see View menu.
- *Show mean lines* – see View menu.
- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show frame* – see View menu.
- *Show divisions* – see View menu.
- *Show curve fit* – see View menu.
- *Swap independent variable* – see View menu.
- *Zoom* – see Zoom menu.
- *Unzoom* – see Zoom menu.
- *Clear zoom rectangle* – see Zoom menu.

14.2.9.1 *Set layout dialog*

This dialog allows the user to set a range of display settings that are common to all views of this type. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Rotate y label* – when selected the y axis label is rotated so that the text is vertical.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Points colour* – the colour of the points displayed for the field. It can be changed by clicking on the Select... button.
- *Lines colour* – the colour of the lines used to plot the field. It can be changed by clicking on the Select... button.
- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

14.3 Popup menu

The scalar field 2D provides the following options in its popup menu.

- *Save as...* – saves the field to a disk file. The file has a *.s2d* extension.
- *Save* – saves the field to a disk file with the current name.
- *Save as text file...* – saves the field in a comma delimited text file. Either a *.txt* or *.csv* extension can be specified. The user can choose the save the data with headers (which means header information is included) or without headers (just raw field data is stored). They can also choose whether they wish to have data stored so that the y axis is downwards or the x axis is downwards (swap axes). This latter feature can be important when trying to read a field file into a spreadsheet that has a limit on the number of columns available. The user will be prompted to specify the number of decimal places used to store the independent and field values.
- *Open details view...* – opens the details view.
- *Open contour view...* – opens the contour view.
- *Open animated graph view...* – opens the animated graph view.
- *Open multi graph view...* – opens the multi graph view.
- *Open offset graph view...* – opens the offset graph view.
- *Open surface view...* – opens the surface view.
- *Open multi spectral view...* – opens the multi spectral view.
- *Open table view...* – opens the table view.
- *Open persistent view manager view...* – opens the view that manages all of the persistent views saved for this field. The persistent views appear in a list box that displays the names given to the views by the user when they were saved. A persistent view can be opened by double clicking on its name.
- *Close all views* – closes all open views of this field.
- *Close* – this option removes the field from its enclosing container. The user will be prompted to confirm the choice and to save the field if desired.

15 Scalar field 3D

15.1 Description

A scalar field 3D is a scalar field that is a function of three variables.

15.2 Views

A scalar field 3D has five views.

- *Details view*
- *Contour view*
- *Animated contour view*
- *Animated surface view*
- *Contour layers view*

15.2.1 Details view

Description

The details view of a scalar field 3D displays the name of the field, its full name and its description.

Access

The details view of a scalar field 3D can be accessed through the popup menu of the field object.

15.2.2 Contour view

Description

The contour view of the scalar field 3D provides a 3D plot of colour coded contour surfaces. A legend on the right of the figure indicates the colour equivalence for the range of contour values.

There are four toolbars at the top of the view. These are:

x axis toolbar

- *x axis min* – sets the minimum x value displayed.

- *x axis max* – sets the maximum x value displayed.
- *x offset* – sets which portion of the data set is displayed. The figure displayed is N where 1 data point in N is used to construct the surface. When the grid contains a large number of points Streams chooses only to display a coarse approximation to the surfaces to attempt to improve rendering speeds.
- *Focal x* – displays the value of x at the cursor location in the focal plane. This value cannot be edited.

y axis toolbar

- *y axis min* – sets the minimum y value displayed.
- *y axis max* – sets the maximum y value displayed.
- *y offset* – sets which portion of the data set is displayed. The figure displayed is N where 1 data point in N is used to construct the surface. When the grid contains a large number of points Streams chooses only to display a coarse approximation to the surfaces to attempt to improve rendering speeds.
- *Focal y* – displays the value of y at the cursor location in the focal plane. This value cannot be edited.

z axis toolbar

- *z axis min* – sets the minimum z value displayed.
- *z axis max* – sets the maximum z value displayed.
- *z offset* – sets which portion of the data set is displayed. The figure displayed is N where 1 data point in N is used to construct the surface. When the grid contains a large number of points Streams chooses only to display a coarse approximation to the surfaces to attempt to improve rendering speeds.
- *Focal z* – displays the value of z at the cursor location in the focal plane. This value cannot be edited.

Field toolbar

- *Field min* – this is the field value corresponding to the colour at the bottom of the legend. Initially this is set to be the smallest field value on the grid. However, the user may choose to change this value. If grid values smaller than the value specified exist, then these will be coloured white.
- *Field max* – this is the field value corresponding to the colour at the top of the legend. Initially this is set to be the largest field value on the grid. However, the user may choose to change this value. If grid values larger than the value specified exist, then these will be coloured white.

It is possible that the field is undefined in some regions of the grid, due to the fact that there is no data in this region and hence the field is undefined. In this case surface will be missing.

Access

The contour view of a scalar field 3D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 15.2.2.1. The settings are saved in a file with extension .s3dconset.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .s3dconset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.

View menu

- *Set layout* – opens the set layout dialog box in which the user can change the settings common to all views of this type. This includes colours, borders and so on. The details are provided in section 15.2.2.1.
- *Show contours* – when selected the field data is displayed as a set of contour surfaces.
- *Show frame* – when selected the rectangular border around the graph is displayed.
- *Show scales* – when selected the axis scales are displayed.
- *Show info* – when selected the info text at the bottom of the view is displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x, y and z axes.

- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Change t axis scaling...* – if the z axis corresponds to time then the scaling of this axis is arbitrary. By default the field axis is scaled so its length is the comparable to that of the longer of the x and y axes. The user can change this scaling through a dialog box that is displayed when this menu option is selected.
- *Redraw during resize* – if set, the view redraws during a resize operation. For a fine grid this might cause a lack of responsiveness. If not set redrawing does not occur and the user needs to perform some manual operation after the resize in order to force a redraw.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Reset min/max to default limits* – resets the independent variable axes to their default sizes. If the user chooses to change the data displayed by setting the min and max values in top three toolbars this menu option allows the user to restate the original limits.
- *Hide toolbars* – when selected the toolbars are hidden.

Contour menu

- *Change contour values...* – opens a dialog box in which the user can edit the contour values displayed.
- *Reset field range* – this resets the range of field values, indicated in the third toolbar, to the initial default values. Note that this does not reset the contour values specified in the legend.
- *Set contour values to default* – this resets the range of contour values to those based on the original default range of the field.
- *Set contour values using u min and max* – this option will change the contour range to match the currently selected min/max range for the field specified in the bottom toolbar. Eleven contour values, equally spaced between the max and min values, are used.
- *Set u min and max values using the contour values* – if the user has chosen to change the range of contour values for the view this option enables the user to set the min and max field values to match the min and max contour values.

Cameras menu

- *Manage cameras...* – opens the camera management view. See chapter 2.
- *Open current camera controller* – this opens the controller view of the currently selected camera so the user can make adjustments to the camera settings. These changes are often most easily achieved using keyboard commands (see chapter) 2. The camera controller is also opened by holding the ALT and SHIFT keys and double clicking the mouse on the display area with no control keys held.

Lighting menu

- *Manage lighting...* – this option opens the manage lighting view. See chapter 3.

Adornments menu

- *Manage adornments* – opens the adornments 3D manager view. See chapter 6.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped. Note the zoom rectangle is interpreted as being located in the focal plane of the camera. The zoom can also be achieved by double clicking the mouse within the rectangle while holding the SHIFT key.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain. The unzoom can also be achieved by double clicking the mouse within the rectangle while holding the SHIFT key.
- *Clear zoom rectangle* – clears the zoom rectangle..

Popup menu

- *Set layout...* – see View menu.
- *Show contours* – see View menu.
- *Show frame* – see View menu.
- *Show scales* – see View menu.
- *Show info* – see View menu.
- *Show adornments* – see Adornments menu.
- *Select data to display...* – see View menu.

15.2.2.1 Set layout dialog

The user has considerable control over the appearance of this view. The set layout dialog can be opened through the View menu or a popup menu. It is important to note that the parameters set in this dialog box apply to all contour views for scalar fields 3D so that when other views are opened they will possess the same settings. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.

- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. This determines the number of scale values that are displayed.
- *Number of y divisions* – the divisions that divide the y axis. This determines the number of scale values that are displayed.
- *Number of z divisions* – the divisions that divide the z axis. This determines the number of scale values that are displayed.
- *Geometric scale factor* – this option allows the user to globally change the “size” of objects such as the axes thickness.
- *Font size* – sets the font size. The default is 14.
- *Draw axes at origin* – the default setting is to draw the axes to the left, bottom and back of the figure. By selecting this checkbox the axes are relocated so they pass through the origin.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Contours colour* – the range of colours used to present the data. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range or return to the defaults provided. The user can also save and reload their colour choices.
- *Axes colour* – the colour of axes and frame. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

15.2.3 Animated contour view

Description

The animated contour view of the scalar field 3D assumes that the third dimension corresponds to time and thus provides a two-dimensional contour plot of the field for each time step in the series. It has much in common with the contour plot for a scalar field 2D, but with an animation capability. The assumption of time as the third axis is not restrictive and the user can still view three-dimensional spatial data with this view – in which case the animation is based on the values of the z axis.

This view provides the user access to a rudimentary edge/contour detection algorithm. The user can choose a contour value of the plotted field. The location of this contour is then determined either as a function of the horizontal (or vertical) coordinate. The algorithm simply scans vertical (or horizontal) lines in search of the chosen contour value. The search can start from the top or bottom (or left or right) of the field and stops once the first occurrence of the contour value is detected. Generally the contour value lies between two grid points and a linear interpolation is used to find the actual contour location. The result of this edge/contour detection is a two dimensional scalar field where the vertical (horizontal) position of the contour is given as a function of the horizontal (vertical) coordinate, or vice versa, and as a function of time. This scalar field is available in a separate view that is accessed from the Edge menu – see section 15.2.3.2. When the view is closed all edge fields are automatically saved to the field registry.

This is the default view of scalar field 3D object.

There are five toolbars at the top of the view. These are:

Animation toolbar

- *Current time* – this combo box displays the current value of time. The user can select any value in this box to move to a different position in the field.
- *Go to next time* – steps the display forward one frame. If the display region of the view has the keyboard focus pressing the right arrow key causes the same action.
- *Go to previous time...* – steps the display back one frame. If the display region of the view has the keyboard focus pressing the left arrow key causes the same action.
- *Play* – starts the animation forward in time.

- *Play in reverse* – starts the animation backward in time.
- *Pause* – pauses the animation.
- *Go to start* – resets the display to the first frame.
- *Go to end* – resets the display to the last frame.
- *Animation timing delay (ms)* – this text box allows the user to change the speed of the animation. The displayed timing delay is the minimum time between frames. The actual delay may be longer if the drawing overhead is high.

Display toolbar

- *Colour cells* – if this check box is selected then the data is displayed using colour cells to indicate the field value on the two-dimensional domain.
- *Contour lines* – if this check box is selected colour contour lines are drawn on the graph.
- *Swap axes* – if this check box the axes are swapped.
- *Fill view* – if this check box is selected the aspect ratio of the data is ignored and the graph is expanded to fill the entire view.

x axis toolbar

- *x axis min* – sets the minimum x value displayed.
- *x axis max* – sets the maximum x value displayed.
- *x* – displays the x value of the cursor as it moves over the graph.

y axis toolbar

- *y axis min* – sets the minimum y value displayed.
- *y axis max* – sets the maximum y value displayed.
- *y* – displays the x value of the cursor as it moves over the graph.

Field toolbar

- *Field min* – this is the field value corresponding to the colour at the bottom of the legend. Initially this is set to be the smallest field value on the grid for all time. However, the user may choose to change this value. If grid values smaller than the value specified exist, then these will be coloured white.
- *Field max* – this is the field value corresponding to the colour at the top of the legend. Initially this is set to be the largest field value on the grid for all time. However, the user may choose to change this value. If grid values larger than the value specified exist, then these will be coloured white.
- *Field* – displays the field value at the cursor location.

It is possible that the field is undefined in some regions of the grid, due to the fact that there is no data in this region and hence the field is undefined. In this case the cell colour will be black.

Access

The animated contour view of a scalar field 3D can be accessed by double clicking the field or through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 15.2.3.1. The settings are saved in a file with extension .s3daniconset.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .s3daniconset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time. *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.
- *Save to image sequence...* – enables the user to save each 2D contour plot as an image in an image sequence. Image file types supported are JPEG, PNG and BMP format. The user can select the resolution of the images. The name, specified by the user, has the number of the frame added as a suffix. It is recommended that the base name ends in an underscore (_) in order to separate the file name from the frame numbering.

View menu

- *Set layout...* opens the set layout dialog. See section 15.2.3.1.
- *Show colour cells* – when selected the data points are displayed.
- *Show contours* – when selected the lines connecting the data points are displayed.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.

- *Show info* – when selected info text at the bottom of the view is displayed.
- *Show legend* – when selected the legend on the right of the view is displayed.
- *Show frame* – when selected the outline box of the graph is displayed.
- *Show divisions* – when selected the divisions on each axis are displayed.
- *Show grid* – when selected the grid is displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Show animators* – when selected the animators are displayed.
- *Swap axes* – when selected the axes are swapped.
- *Fill view* – allows the user to change the number of grid lines.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes. Greek or Latin symbols can be used.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Set field min and max values to default* – resets the minimum and maximum values to the default values.
- *Set field min and max values using contour values* – if the user changes the contour values to be displayed in the figure this option will set the minimum and maximum values to the minimum and maximum contour values and hence will update the legend to correspond to this new range.
- *Redraw during resize* – if set, the view redraws during a resize operation. For a fine grid this might cause a lack of responsiveness. If not set redrawing does not occur and the user needs to perform some manual operation after the resize in order to force a redraw.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Hide toolbars* – when selected the toolbars are hidden.
- *Adjust view size* – resets the view window size to eliminate unnecessary waste space. This has the same effect as double clicking in the blank space in the toolbars at the top of the view.

Animation menu

- *Go to next time* – steps the display forward one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to previous time* – steps the display back one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Play* – starts the animation forward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Play in reverse* – starts the animation backward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Pause* – pauses the animation. This has the same effect as the equivalent button in the animation toolbar.

- *Go to start* – resets the display to the first frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to end* – resets the display to the last frame. This has the same effect as the equivalent button in the animation toolbar.

Edge menu

- *Manage edge fields...* – this opens the manage edge field view. See section 15.2.3.2.

Adornments menu

- *Manage adornments* – opens the adornments manager view for this field view. See chapter 5.
- *Manage animators...* – opens the adornments manager view for this field view. See chapter 7.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Go to next time* – see Animation menu.
- *Go to previous time* – see Animation menu.
- *Play* – see Animation menu.
- *Play in reverse* – see Animation menu.
- *Pause* – see Animation menu.
- *Go to start* – see Animation menu.
- *Go to end* – see Animation menu.
- *Show colour cells* – see View menu.
- *Show contours* – see View menu.
- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show legend* – see View menu.
- *Show frame* – see View menu.

- Show divisions – see View menu.
- Show grid – see View menu.
- Show adornments – see Adornments menu.
- Show animators – see Adornments menu.
- Swap axes – see View menu.
- Fill view – see View menu.
- Zoom – see Zoom menu.
- Unzoom – see Zoom menu.
- Clear zoom rectangle – see Zoom menu.

15.2.3.1 Set layout dialog

The set layout dialog controls the display settings for all views of this type. The three buttons at the bottom of the dialog are:

- Reset... – resets all of the layout settings to their defaults.
- OK – confirms the changes made and applies them to the view.
- Cancel... – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- Number of *x* divisions – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- Number of *y* divisions – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- Grid refinement factor – this option allows the user to refine the grid on which the contour and colour cell data is plotted. The field values on the refined grid are linearly interpolated. Using a value larger than 1 can provide a smoother looking graph.
- Line width – the line width for the view is specified here. The default is 1.5.
- Font size – sets the font size. The default is 14.
- Rotate *y* label – when selected the y axis label is rotated so that the text is vertical.

Borders

- Left border width – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.

- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width*– sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Contours colour* – the range of colours used to present the data. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range or return to the defaults provided. The user can also save and reload their colour choices.
- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Grid colour* – the colour of the grid lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.
- *Use black contours* – if selected all contours will be displayed in black. This can be helpful if both the colour cells and contours are displayed simultaneously.
- *Colour format* – the colour coding of the cells in the plot can be done in two ways. If the continuous button is selected then a continuous range of colours is used based on the colour pallette selected. If the binned button is selected the field value is binned into one of x discrete bins – where x is set in the number of bins field. In this case all field values in the same bin have the same colour based on the same colour pallette. The result is a plot with clear demarcation between field values from different bins.

15.2.3.2 Manage edge fields view

As described at the beginning of this section the user can create simple edge fields. This view manages those fields.

The two buttons at the bottom of the dialog are:

- *Delete edge fields* – deletes all currently selected edge fields in the list box.
- *Clear edge fields* – deletes all edge fields in the list box.

There are two tabs, Edge fields and Parameters.

Edge fields

- *Current edge fields* – this list box lists all of the edge fields that have been created through this view. As these are scalar fields 2D they can be manipulated using their popup menus.

Parameters

- *Edge value* – the value of the field that is being used in the edge field calculation.
- *Independent variable* – this option allows the user to choose whether the location of the edge field will be a function of x or y. The search is done in the perpendicular direction to this. Thus if x is chosen as the independent variable the edge value will be searched for in the y direction.
- *Interpolation order* – currently only linear interpolation between grid points is supported in computing the location of the field value.
- *Search direction* – specifies whether the search for the field value will be in the direction of increasing or decreasing y (when x is the independent variable or vice versa) direction.
- *Compute edge field* – once all search parameters have been specified the user presses this button to generate the edge field. The new field will appear in the list box in the Edge fields tab.

15.2.4 Animated surface view

Description

The animated surface view of the scalar field 3D resembles the surface view of the scalar field 2D. The additional dimension is taken to be time and thus the view enables the animation of a surface field.

There are four toolbars at the top of the view. These are:

Animation toolbar

- *Current time* – this combo box displays the current value of time. The user can select any value in this box to move to a different position in the field.
- *Go to next time* – steps the display forward one frame. If the display region of the view has the keyboard focus pressing the right arrow key causes the same action.
- *Go to previous time...* – steps the display back one frame. If the display region of the view has the keyboard focus pressing the left arrow key causes the same action.
- *Play* – starts the animation forward in time.
- *Play in reverse* – starts the animation backward in time.

- *Pause* – pauses the animation.
- *Go to start* – resets the display to the first frame.
- *Go to end* – resets the display to the last frame.
- *Animation timing delay (ms)* – this text box allows the user to change the speed of the animation. The displayed timing delay is the minimum time between frames. The actual delay may be longer if the drawing overhead is high.

x axis toolbar

- *x axis min* – sets the minimum x value displayed.
- *x axis max* – sets the maximum x value displayed.
- *x offset* – sets which portion of the data set is displayed. The figure displayed is N where 1 data point in N is used to construct the surface. When the grid contains a large number of points Streams chooses only to display a coarse approximation to the surface to attempt to improve rendering speeds.
- *Focal x* – displays the value of x at the cursor location in the focal plane. This value cannot be edited.

y axis toolbar

- *y axis min* – sets the minimum y value displayed.
- *y axis max* – sets the maximum y value displayed.
- *y offset* – sets which portion of the data set is displayed. The figure displayed is N where 1 data point in N is used to construct the surface. When the grid contains a large number of points Streams chooses only to display a coarse approximation to the surface to attempt to improve rendering speeds.
- *Focal y* – displays the value of y at the cursor location in the focal plane. This value cannot be edited.

Field toolbar

- *Field min* – this is the field value corresponding to the colour at the bottom of the legend. Initially this is set to be the smallest field value on the grid. However, the user may choose to change this value. If grid values smaller than the value specified exist, then these will be coloured white.
- *Field max* – this is the field value corresponding to the colour at the top of the legend. Initially this is set to be the largest field value on the grid. However, the user may choose to change this value. If grid values larger than the value specified exist, then these will be coloured white.

It is possible that the field is undefined in some regions of the grid, due to the fact that there is no data in this region and hence the field is undefined. In this case surface will be missing.

Access

The surface view of a scalar field 3D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 15.2.4.1. The settings are saved in a file with extension .s3danisurset.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .s3danisurset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.

View menu

- *Set layout* – opens the set layout dialog box in which the user can change the settings common to all views of this type. This includes colours, borders and so on. The details are provided in section 15.2.4.1.
- *Show surface* – when selected the field data is displayed as a continuous surface.
- *Show wire mesh* – when selected the field data is displayed as a wire mesh. The rendering of the wire mesh is likely to be more rapid than a solid surface.
- *Show frame* – when selected the rectangular border around the graph is displayed.
- *Show scales* – when selected the axis scales are displayed.
- *Show info* – when selected the info text at the bottom of the view is displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Show animators* – when selected the animators are displayed.
- *Swap axes* – when selected the axes are swapped. The default display places the x-y plane in the horizontal plane with the field values vertical. When the axes are swapped the x-y plane is a vertical plane with the field values plotted out of the plane.

- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Change axes scaling...* – the scaling of the field axis is arbitrary in this view. By default the field axis is scaled so its length is the comparable to that of the longer of the x and y axes. The user can change this scaling through a dialog box that is displayed when this menu option is selected..
- *Redraw during resize* – if set, the view redraws during a resize operation. For a fine grid this might cause a lack of responsiveness. If not set redrawing does not occur and the user needs to perform some manual operation after the resize in order to force a redraw.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Reset x/z axes to default limits* – resets the independent variable axes (nominally x and z) to their default sizes. If the user chooses to change the data displayed by setting the x min and x max values in top toolbar or y min and y max values in the second toolbar this menu option allows the user to restate the original limits.
- *Reset field range to default* – resets the field axis limits to the default values. The user may have changed these through the field min and field max values in the third toolbar.
- *Change colour range...* – this option displays a dialog box in which the user can change the fields values that correspond to the lower and upper end of the colour range. If field values lie outside these limits then the surface or wire mesh will be coloured white.
- *Reset colour range to defaults* – this option resets the field values corresponding to the lower and upper ends of the colour range to the default values.
- *Hide toolbars* – when selected the toolbars are hidden.

Colour maps menu

- *Manage colour map fields...* – opens a window for managing the colour maps used to display the field. The chosen colour map provides the colours for the displayed surface while the original field provides the surface elevations. By default the original field is the colour map. The dialog box displays a list of the current scalar fields 3D registered with the view. These can be loaded from file (the Load button) or selected from the field registry (the Select button). The user selects the field that is to be used as the colour map and presses the Choose button. This field will be marked with a tick and the view will be updated with the new colour map.

Animation menu

- *Go to next time* – steps the display forward one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to previous time* – steps the display back one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Play* – starts the animation forward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Play in reverse* – starts the animation backward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Pause* – pauses the animation. This has the same effect as the equivalent button in the animation toolbar.
- *Go to start* – resets the display to the first frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to end* – resets the display to the last frame. This has the same effect as the equivalent button in the animation toolbar.

Cameras menu

- *Manage cameras...* – opens the camera management view. See chapter 2.
- *Open current controller* – this opens the controller view of the currently selected camera so the user can make adjustments to the camera settings. These changes are often most easily achieved using keyboard commands (see chapter 2). The camera controller view is also opened by double clicking the mouse on the display area with SHIFT and ALT keys held down.

Lighting menu

- *Manage lighting...* – this option opens the manage lighting view. See chapter 3.

Adornments menu

- *Manage adornments* – opens the adornments 3D manager view. See chapter 6.
- *Manage animators* – opens the animators 3D manager view. See chapter 8.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped. Note the zoom rectangle is interpreted as being located in the focal plane of the camera. The zoom can also be achieved by double clicking the mouse within the rectangle while holding the SHIFT key.

- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain. The unzoom can also be achieved by double clicking the mouse within the rectangle while holding the SHIFT key.
- *Clear zoom rectangle* – clears the zoom rectangle..

Popup menu

- *Set layout...* – see View menu.
- *Go to next time* – see Animation menu.
- *Go to previous time* – see Animation menu.
- *Play* – see Animation menu.
- *Play in reverse* – see Animation menu.
- *Pause* – see Animation menu.
- *Go to start* – see Animation menu.
- *Go to end* – see Animation menu.
- *Show surface* – see View menu.
- *Show wire mesh* – see View menu.
- *Show frame* – see View menu.
- *Show scales* – see View menu.
- *Show info* – see View menu.
- *Show adornments* – see Adornments menu.
- *Show animators* – see Adornments menu.
- *Swap axes* – see View menu.
- *Select data to display...* – see View menu.

15.2.4.1 Set layout dialog

The user has considerable control over the appearance of this view. The set layout dialog can be opened through the View menu or a popup menu. It is important to note that the parameters set in this dialog box apply to all animated surface views for scalar fields 3D so that when other views are opened they will possess the same settings. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. This determines the number of scale values that are displayed.
- *Number of y divisions* – the divisions that divide the y axis. This determines the number of scale values that are displayed.
- *Number of z divisions* – the divisions that divide the z axis. This determines the number of scale values that are displayed.
- *Geometric scale factor* – this option allows the user to globally change the “size” of objects such as the axes thickness.
- *Font size* – sets the font size. The default is 14.
- *Draw axes at origin* – the default setting is to draw the axes to the left, bottom and back of the figure. By selecting this checkbox the axes are relocated so they pass through the origin.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Contours colour* – the range of colours used to present the data. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range or return to the defaults provided. The user can also save and reload their colour choices.
- *Axes colour* – the colour of axes and frame. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

15.2.5 Contour layers view

Description

The contour layers view of the scalar field 3D provides a 3D plot that comprises a set 2D contour surfaces generated by slices through the three dimensional field. By default the slices are horizontal planes – i.e. the normal to the slices is the y axis. The orientation, separation and number of the slices is at the user's discretion.

A legend on the right of the figure indicates the colour equivalence for the range of contour values.

There are four toolbars at the top of the view. These are:

x axis toolbar

- *x axis min* – sets the minimum x value displayed.
- *x axis max* – sets the maximum x value displayed.
- *x offset* – sets which portion of the data set is displayed. The figure displayed is N where 1 data point in N is used to construct the surface. When the grid contains a large number of points Streams chooses only to display a coarse approximation to the surfaces to attempt to improve rendering speeds.
- *Focal x* – displays the value of x at the cursor location in the focal plane. This value cannot be edited.

y axis toolbar

- *y axis min* – sets the minimum y value displayed.
- *y axis max* – sets the maximum y value displayed.
- *y offset* – sets which portion of the data set is displayed. The figure displayed is N where 1 data point in N is used to construct the surface. When the grid contains a large number of points Streams chooses only to display a coarse approximation to the surfaces to attempt to improve rendering speeds.
- *Focal y* – displays the value of y at the cursor location in the focal plane. This value cannot be edited.

z axis toolbar

- *z axis min* – sets the minimum z value displayed.
- *z axis max* – sets the maximum z value displayed.
- *z offset* – sets which portion of the data set is displayed. The figure displayed is N where 1 data point in N is used to construct the surface. When the grid contains a large number of points Streams chooses only

to display a coarse approximation to the surfaces to attempt to improve rendering speeds.

- *Focal z* – displays the value of *z* at the cursor location in the focal plane. This value cannot be edited.

Field toolbar

- *Field min* – this is the field value corresponding to the colour at the bottom of the legend. Initially this is set to be the smallest field value on the grid. However, the user may choose to change this value. If grid values smaller than the value specified exist, then these will be coloured white.
- *Field max* – this is the field value corresponding to the colour at the top of the legend. Initially this is set to be the largest field value on the grid. However, the user may choose to change this value. If grid values larger than the value specified exist, then these will be coloured white.

It is possible that the field is undefined in some regions of the grid, due to the fact that there is no data in this region and hence the field is undefined. In this case surface will be missing.

Access

The contour layers view of a scalar field 3D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 15.2.2.1. The settings are saved in a file with extension *.s3dconlayset*.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of *.s3dconlayset*.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time. *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.

View menu

- *Set layout* – opens the set layout dialog box in which the user can change the settings common to all views of this type. This includes colours, borders and so on. The details are provided in section 15.2.4.1.
- *Show layers* – when selected the field data is displayed as a set of layered contour surfaces.
- *Show frame* – when selected the rectangular border around the graph is displayed.
- *Show scales* – when selected the axis scales are displayed.
- *Show info* – when selected the info text at the bottom of the view is displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Reset field range* – resets the default min and max values for the field displayed in the bottom toolbar.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x, y and z axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Change t axis scaling...* – if the z axis corresponds to time then the scaling of this axis is arbitrary. By default the field axis is scaled so its length is comparable to that of the longer of the x and y axes. The user can change this scaling through a dialog box that is displayed when this menu option is selected.
- *Redraw during resize* – if set, the view redraws during a resize operation. For a fine grid this might cause a lack of responsiveness. If not set redrawing does not occur and the user needs to perform some manual operation after the resize in order to force a redraw.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Reset min/max to default limits* – resets the independent variable axes to their default sizes. If the user chooses to change the data displayed by setting the min and max values in top three toolbars this menu option allows the user to restate the original limits.
- *Hide toolbars* – when selected the toolbars are hidden.

Layer menu

- *Change layer values...* – opens a dialog box in which the user can edit the layer values used. The dialog matches that used for changing contour values. The surfaces used are defined by their normal (see below) and their values. The values are computed by taking a dot product of the unit normal to the surface and the vector from the coordinate origin to a point on the layer surface. Thus if the normal is in the y direction the layer values will simply correspond to the y values of the slices through the data.

- *Set layer values to defaults* – this resets the layer values to their original values. To achieve the original set of layers the normal must also be set to (0,1,0).
- *Generate number of layer values...* – this option will generate a specified number of layers.
- *Set normal...* – this option enables the user to edit the normal. The vector will be converted to have unit length but this is not required of the user when they enter the normal components.
- *Manage transparency ranges...* – one of the limitations of this view is the obscuring of each slice by those above it. To manage this somewhat the user can define ranges of field values that become transparent (i.e. are not drawn). Thus the user has the capability of looking “through” layers. This menu option displays a dialog box in which the user can manage these transparency ranges. Lower and upper bounds are set for each range and a number of different ranges can be defined.

Cameras menu

- *Manage cameras...* – opens the camera management view. See chapter 2.
- *Open current camera controller* – this opens the controller view of the currently selected camera so the user can make adjustments to the camera settings. These changes are often most easily achieved using keyboard commands (see chapter) 2. The camera controller is also opened by holding the ALT and SHIFT keys and double clicking the mouse on the display area with no control keys held.

Lighting menu

- *Manage lighting...* – this option opens the manage lighting view. See chapter 3.

Adornments menu

- *Manage adornments* – opens the adornments 3D manager view. See chapter 6.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped. Note the zoom rectangle is interpreted as being located in the focal plane of the camera. The zoom can also be achieved by double clicking the mouse within the rectangle while holding the SHIFT key.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain. The unzoom can also be achieved by double clicking the mouse within the rectangle while holding the SHIFT key.

- *Clear zoom rectangle* – clears the zoom rectangle..

Popup menu

- *Set layout...* – see View menu.
- *Show layers* – see View menu.
- *Show frame* – see View menu.
- *Show scales* – see View menu.
- *Show info* – see View menu.
- *Show adornments* – see Adornments menu.
- *Select data to display...* – see View menu.

15.2.5.1 Set layout dialog

The user has considerable control over the appearance of this view. The set layout dialog can be opened through the View menu or a popup menu. It is important to note that the parameters set in this dialog box apply to all contour layer views for scalar fields 3D so that when other views are opened they will possess the same settings. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. This determines the number of scale values that are displayed.
- *Number of y divisions* – the divisions that divide the y axis. This determines the number of scale values that are displayed.
- *Number of z divisions* – the divisions that divide the z axis. This determines the number of scale values that are displayed.
- *Geometric scale factor* – this option allows the user to globally change the “size” of objects such as the axes thickness.
- *Font size* – sets the font size. The default is 14.
- *Draw axes at origin* – the default setting is to draw the axes to the left, bottom and back of the figure. By selecting this checkbox the axes are relocated so they pass through the origin.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width*– sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Contours colour* – the range of colours used to present the data. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range or return to the defaults provided. The user can also save and reload their colour choices.
- *Axes colour* – the colour of axes and frame. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

15.3 Popup menu

The scalar field 3D provides the following options in its popup menu.

- *Save as...* – saves the field to a disk file. The file has a .s3d extension.
- *Save* – saves the field to a disk file with the current name.
- *Save as text file...* – saves the field in a comma delimited.txt or.csv file. The user can choose the save the data with headers (which means header information is included) or without headers (just raw field data is stored). In the latter case the user can choose to store only a subset of the 2D fields (each 2D field corresponds to a different time) in the text file and thus a number of sequentially numbered files are used to store the entire 3D field. The user can also choose whether they wish to have data stored so that the y axis is downwards or the x axis is downwards (swap axes). This latter feature can be important when trying to read a field file into a spreadsheet that has a limit on the number of columns available. The 2D fields are stored sequentially in the (each) file. The user will be prompted to specify the number of decimal places used to store the independent and field values.

- *Open details view...* – opens the details view.
- *Open contour view...* – opens the contour view.
- *Open animated contour view...* – opens the animated contour view.
- *Open contour layers view...* – opens the contour layers view.
- *Open persistent view manager view...* – opens the view that manages all of the persistent views saved for this field. The persistent views appear in a list box that displays the names given to the views by the user when they were saved. A persistent view can be opened by double clicking on its name.
- *Close all views* – closes all open views of this field.
- *Close* – this option removes the field from its enclosing container. The user will be prompted to confirm the choice and to save the field if desired.

16 Vector 2D field 0D

16.1 Description

A vector 2D field in 0D, or a vector 2D field 0D, is a single constant vector quantity with two components.

16.2 Views

A vector 2D field 0D has two views.

- *Details view*
- *Table view*

16.2.1 Details view

Description

The details view of a vector 2D field 0D displays the name of the field, its full name and its description.

Access

The details view can be accessed through the popup menu of the field object.

16.2.2 Table view

Description

The vector 2D field 0D table view displays the vector components, and details of the three coordinates, x, y and t. The table view is the default view of a vector 2D field 0D.

Access

The table view of a vector 2D field 0D can be accessed by double clicking the field or through the popup menu of the field object.

Menus

View menu

- *Change field decimal places...* – allows the user to select the number of decimal places used to display the field value.

16.3 Popup menu

The vector 2D field 0D provides the following options in its popup menu.

- *Save as...* – saves the field to a disk file. The file has a *.v2d0d* extension.
- *Save* – saves the field to a disk file with the current name.
- *Save as text file...* – saves the field in a comma delimited text file. Either a *.txt* or *.csv* extension can be specified. The user will be prompted to specify the number of decimal places used to store the field value.
- *Open details view...* – opens the details view.
- *Open table view...* – opens the table view.
- *Close all views* – closes all open views of this field.
- *Close* – this option removes the field from its enclosing container. The user will be prompted to confirm the choice and to save the field if desired.

17 Vector 2D field 1D

17.1 Description

A 2D vector field in 1D, or vector 2D field 1D, is a vector field that is a function of a single variable.

17.2 Views

A vector 2D field 1D has four views.

- *Details view*
- *Table view*
- *Graph view*
- *Vector view*

17.2.1 Details view

Description

The details view of a vector 2D field 1D displays the name of the field, its full name and its description.

Access

The details view of a vector 2D field 1D can be accessed through the popup menu of the field object.

17.2.2 Table view

Description

The vector 2D field 1D table view tabulates the independent field values together with the vector field at those points. Details of the remaining two independent coordinates are given above the table.

Access

The table view of a vector 2D field 1D can be accessed through the popup menu of the field object.

Menus

View menu

- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.

17.2.3 Graph view

Description

The graph view of a vector 2D field 1D provides a conventional plot of the two field components (denoted u and v for the x and y components respectively), and has much in common with the graph view of a scalar field 1D. It is the default view for a vector 2D field 1D object.

Three toolbars are provided at the top of the view.

Display toolbar

- *u points* – if this check box is selected the u field data points are shown on the graph.
- *u lines* – if this check box is selected lines are drawn between the u data points on the graph.
- *v points* – if this check box is selected the v field data points are shown on the graph.
- *v lines* – if this check box is selected lines are drawn between the v data points on the graph.
- *Swap axes* – if this check box is selected the axes are swapped on the graph.

x axis toolbar

- *x axis min* – sets the minimum x value displayed.
- *x axis max* – sets the maximum x value displayed.
- *x* – displays the x value of the cursor as it moves over the graph.

y axis toolbar

- *y axis min* – sets the minimum y value displayed.
- *y axis max* – sets the maximum y value displayed.

- y – displays the y value of the cursor as it moves over the graph.

Access

The graph view of a vector 2D field 1D can be accessed by double clicking the field or through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 17.2.3.1. The settings are saved in a file with extension `.v2d1dgrset`.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of `.v2d1dgrset`.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.

View menu

- *Set layout...* – opens the set layout dialog. See section 17.2.3.1.
- *Show u points* – when selected the u data points are displayed.
- *Show u lines* – when selected the lines connecting the u data points are displayed.
- *Show v points* – when selected the v data points are displayed.
- *Show v lines* – when selected the lines connecting the v data points are displayed.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected info text at the bottom of the view is displayed.

- *Show frame* – when selected the outline box of the graph is displayed.
- *Show divisions* – when selected the divisions on each axis are displayed.
- *Show u curve fit* – when selected the current curve fit for the u data is displayed.
- *Show v curve fit* – when selected the current curve fit for the v data is displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Swap axes* – when selected the axes are swapped.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Hide toolbars* – when selected the toolbars are hidden.

Curve fitting menu

- *Manage u curve fits...* – opens the manage u curve fits view. See chapter 4 for more information.
- *Manage v curve fits ...* – opens the manage v curve fits view. See chapter 4 for more information.

Adornments menu

- *Manage adornments...* – opens the adornments manager view for this field view. See chapter 5.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout* – see View menu.
- *Show u points* – see View menu.
- *Show u lines* – see View menu.
- *Show v points* – see View menu.
- *Show v lines* – see View menu.

- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show frame* – see View menu.
- *Show divisions* – see View menu.
- *Show u curve fit* – see View menu.
- *Show v curve fit* – see View menu.
- *Swap axes* – see View menu.
- *Zoom* – see Zoom menu.
- *Unzoom* – see Zoom menu.
- *Clear zoom rectangle* – see Zoom menu.

17.2.3.1 Set layout dialog

The set layout dialog controls the display settings for all views of this type. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Rotate y label* – when selected the y axis label is rotated so that the text is vertical.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to

change when producing an image of this view depending on the resolution chosen for the image.

- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width*– sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *u points colour* – the colour for the u component points. It can be changed by clicking on the Select... button.
- *v points colour* – the colour for the v component points. It can be changed by clicking on the Select... button.
- *u lines colour* – the colour for the u component lines. It can be changed by clicking on the Select... button.
- *v lines colour* – the colour for the v component lines. It can be changed by clicking on the Select... button.
- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Grid colour* – the colour of the grid lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.
- *u curve fit colour* – the colour of the curve fit drawn through the u data. It can be changed by clicking on the Select... button.
- *v curve fit colour* – the colour of the curve fit drawn through the v data. It can be changed by clicking on the Select... button.

17.2.4 Vector view

Description

The vector 2D field 1D vector view provides a visual representation of the vector field as a function of the independent variable. This variable is plotted on the x, or y, axis, and at each grid point the corresponding field vector is drawn. The other axis is given a scale that corresponds to the length of vectors. The default scale for this axis is chosen so the maximum value is 4 times the size of the longest vector. The scales for both axes are readily changed using the text boxes in the axes toolbar. A colour legend, based on vector length, is displayed to the right of the graph.

There are three toolbars at the top of the view.

Display toolbar

- *Vectors* – if this check box is selected the field vectors are displayed. The colour of the vectors can be changed under the *Colour* menu.
- *Clip* – if this box is checked any vectors drawn outside the displayed region will be clipped. This is particularly useful if the view has been zoomed.
- *Swap axes* – if this box is checked the vectors are drawn on the other axis.

x axis toolbar

- *x axis min* – sets the minimum x value displayed.
- *x axis max* – sets the maximum x value displayed.
- *x* – displays the x value of the cursor as it moves over the graph.

Field axis toolbar

- *field min* – sets the minimum field value displayed.
- *field max* – sets the maximum field value displayed.
- *field* – displays the vector value of the cursor as it moves over the graph.

Access

The vector view of a vector 2D field 1D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 17.2.4.1. The settings are saved in a file with extension .v2d1dvecset.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .v2d1dvecset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent

views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.

- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.

View menu

- *Set layout* – opens the set layout dialog. See section 17.2.4.1.
- *Show vectors* – when selected the vectors are displayed. The colour of the vectors can be changed under the *Colour* menu.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected info text at the bottom of the view is displayed.
- *Show frame* – when selected the outline box of the graph is displayed.
- *Show divisions* – when selected the divisions on each axis are displayed.
- *Clip vectors* – when selected vectors drawn outside the display region will be clipped.
- *Swap axes...* – when selected the axes are swapped.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Hide toolbars* – when selected the toolbars are hidden.

Adornments menu

- *Manage adornments* – opens the adornments manager view for this field view. See chapter 5.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – opens the set layout dialog. See section 17.2.4.1.
- *Show vectors* – see View menu.
- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show frame* – see View menu.
- *Show divisions* – see View menu.
- *Show adornments* – see Adornments menu.
- *Clip vectors* – see View menu.
- *Swap axes* – see View menu.
- *Zoom* – see Zoom menu.
- *Unzoom* – see Zoom menu.
- *Clear zoom rectangle* – see Zoom menu.

17.2.4.1 Set layout dialog

The set layout dialog controls the display settings for all views of this type. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Rotate y label* – when selected the y axis label is rotated so that the text is vertical.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width*– sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Vectors colour* – the range of colours used to present the data. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range or return to the defaults provided. The user can also save and reload their colour choices.
- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

17.3 Popup menu

The vector 2D field 1D provides the following options in its popup menu.

- *Save as...* – saves the field to a disk file. The file has a *.v2d1d* extension.
- *Save* – saves the field to a disk file with the current name.
- *Save* – saves the field to a disk file with the current name *Save as text file...* – saves the field in a comma delimited text file. Either a *.txt* or *.csv* extension can be specified. The user can choose the save the data with headers (which means header information is included) or without headers (just raw field data is stored). The user will be prompted to specify the number of decimal places used to store the independent and field values.
- *Open details view...* – opens the details view.
- *Open graph view...* – opens the graph view.
- *Open vector view...* – opens the vector view.

- *Open table view...* – opens the table view.
- *Open persistent view manager view...* – opens the view that manages all of the persistent views saved for this field. The persistent views appear in a list box that displays the names given to the views by the user when they were saved. A persistent view can be opened by double clicking on its name.
- *Close all views* – closes all open views of this field.
- *Close* – this option removes the field from its enclosing container. The user will be prompted to confirm the choice and to save the field if desired.

18 Vector 2D field 2D

18.1 Description

A vector 2D field 2D is a vector field that is a function of two variables.

18.2 Views

A 2D vector 2D field has five views.

- *Details view.*
- *Table view.*
- *Vector view.*
- *Animated graph view.*
- *Particle track view.*

18.2.1 Details view

Description

The details view of a vector 2D field 2D displays the name of the field, its full name and its description.

Access

The details view of a vector 2D field 2D can be accessed through the popup menu of the field object.

18.2.2 Table view

Description

The vector 2D field 2D table view displays the two-dimensional vector field in a scrollable table. The horizontal coordinate is used to label the columns of the table, and the vertical coordinate the rows. Information about the third variable is given in the view header.

Access

The table view of a vector 2D field 2D can be accessed through the popup menu of the field object.

Menus

View menu

- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.

18.2.3 Vector view

Description

The vector 2D field 2D vector view provides a visual representation of the vector field by drawing the field vectors at the given grid points. A colour legend, based on vector length, is displayed to the right of the graph.

The view supports overlays of scalar 1D fields.

This is the default view for the vector 2D field 2D.

There are four toolbars at the top of the view. These are:

Display toolbar

- *Vectors* – if this is selected the field vectors are displayed. The colours of the vectors can be changed under the *Colour* menu.
- *Tangents* – if this is selected curves tangent to the vector field are drawn. If the vector field is a velocity field then these curves are streamlines, based on a streamfunction. The streamfunction is calculated using an iterative technique where a new value for ψ at a grid point is obtained from the velocities at the four neighbouring grid points. The tolerance used in this iterative scheme, and the maximum number of iterations allowed, are set in the *View* menu. If the flow is essentially two-dimensional, so that the divergence is everywhere close to zero, the streamfunction is accurate. If there is a gain or loss of mass in regions within the flow the streamfunction will give spurious results.
- *Fill view* – if this check box is selected the aspect ratio of the grid is ignored and the graph is expanded to fill the view.

x axis toolbar

- *x axis min* – sets the minimum x value displayed.

- *x axis max* – sets the maximum x value displayed.
- *x* – displays the x value of the cursor as it moves over the graph.

y axis toolbar

- *y axis min* – sets the minimum y value displayed.
- *y axis max* – sets the maximum y value displayed.
- *y* – displays the y value of the cursor as it moves over the

Field toolbar

- *|field| min* – the field value corresponding to the colour at the bottom of the legend. Initially this is set to be the magnitude of the shortest vector on the grid. However, the user may choose to change this value. If vectors shorter than the value specified exist, then these will be coloured white.
- *|field| max* – the field value corresponding to the colour at the top of the legend. Initially this is set to be the magnitude of the longest vector on the grid. However, the user may choose to change this value. If vectors longer than the value specified exist, then these will be coloured white.
- *field* – the vector field value at the location of the cursor.
- *psi* – displays the value of the streamfunction at the location of the cursor as it moves over the graph.

Access

The vector view of a vector 2D field 2D can be accessed by double clicking the field or through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 18.2.3.1. The settings are saved in a file with extension *.v2d2dvecset*.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of *.v2d2dvecset*.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent

views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.

- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.

View menu

- *Set layout* – opens a dialog box that enables a range of layout parameters to be set for all views of this type. See section 18.2.3.1.
- *Show vectors* – when selected the vectors are displayed. The colour of the particles can be changed in the layout dialog.
- *Show tangents* – when selected the tangent field is displayed.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected the information field is displayed.
- *Show legend* – when selected the legend on the right of the view is displayed.
- *Show frame* – when selected the frame around the graph is displayed.
- *Show divisions* – when selected the divisions (corresponding to the tick marks along each axis) are displayed.
- *Show grid* – when selected the grid is displayed.
- *Show overlay scalar ID fields* – when selected the overlay scalar ID fields are displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Fill view* – when selected the graph is expanded to fill the entire view.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Redraw during resize* – if set, the view redraws during a resize operation. For a fine grid this might cause a lack of responsiveness. If not set redrawing does not occur and the user needs to perform some manual operation after the resize in order to force a redraw.
- *Set [field] min and max values to default* – returns the min and max values in the field toolbar to their default values.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Hide toolbars* – when selected the toolbars are hidden.
- *Adjust view size* – resets the view window size to eliminate unnecessary waste space. This has the same effect as double clicking in the blank space in the toolbars at the top of the view.

Tangent menu

- *Change tangent values...* – allows the user to change the values of the streamfunction used to draw the tangents.
- *Set tangent values to default...* – sets the streamfunction values, used for drawing the tangent lines, back to their default values.
- *Set tangent line accuracy...* – sets the accuracy to within which the streamfunction should be calculated when determining the tangent lines.
- *Set tangent line iteration limit...* – sets the maximum number of iterations used to determine streamfunction. This limit is needed because convergence may not occur for data that is not two-dimensional, or nearly two-dimensional.

Overlay menu

- *Manage scalar 1D overlay fields...* – this option opens the manage overlay fields view. See section 18.2.3.2.

Adornments menu

- *Manage adornments...* – opens the adornments manager view for this field view. The adornments manager view allows the user to create and manipulate adornments (see chapter 12 for full information).

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Show vectors* – see View menu.
- *Show tangents* – see View menu.
- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show legend* – see View menu.
- *Show frame* – see View menu.

- Show divisions – see View menu.
- Show grid – see View menu.
- Show overlay scalar ID fields – see View menu.
- Show adornments – see Adornments menu.
- Fill view – see View menu.
- Zoom – see Zoom menu.
- Unzoom – see Zoom menu.
- Clear zoom rectangle – see Zoom menu.

18.2.3.1 Set layout dialog

The set layout dialog controls the display settings for all views of this type. The three buttons at the bottom of the dialog are:

- Reset... – resets all of the layout settings to their defaults.
- OK – confirms the changes made and applies them to the view.
- Cancel... – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- Number of x divisions – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- Number of y divisions – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- Vector scale factor – the vectors drawn in this view are drawn with an arbitrary length scale. This option enables the user to scale the vectors lengths to a more convenient size.
- Line width – the line width for the view is specified here. The default is 1.5.
- Font size – sets the font size. The default is 14.
- Rotate y label – when selected the y axis label is rotated so that the text is vertical.
- Clip vectors – when selected vectors are clipped at the edges of the graph area.

Borders

- Left border width – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.

- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width*– sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Vector colours* – the range of colours used to present the vectors. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range or return to the defaults provided. The user can also save and reload their colour choices.
- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Grid colour* – the colour of the grid lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Tangent colour* – the tangent colour. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

18.2.3.2 Manage overlay scalar 1D fields view

The user can overlay a number of scalar 1D fields on this view. The user can overlay fields by loading them from file, selecting them from the field registry, dragging them onto the list box of overlay fields in this view, or dragging the fields directly onto the contour view itself.

The view has five buttons. The buttons are as follows:

- *Load* – enables the user to load a scalar 1D field from disk.
- *Select* – enables the user to select a scalar 1D field from the field registry.
- *Delete* – deletes any fields currently selected in the field list.
- *Clear* – deletes all selected fields.
- *Refresh* – refreshes the view.

The dialog includes 2 tabs – Overlays and Legend

Overlays

- *Overlay fields* – this list box lists all current overlay scalar fields. Three key parameters that can be manipulated in this view - their name, colour and display setting – can be changed using the popup menu for each field. The field name is the field's short name by default. The name is used in the legend, if displayed, and therefore the user may wish to change the name. The colour used to display each of the overlay fields is set through their popup menus and the name of the field is displayed in this colour in the list box. Note the initial colour is randomly allocated by the view and both the points and line used to render the field on the graph use the same colour. Finally each of the fields can be shown or hidden through their display setting. If a field is shown its name will be followed by a tick in the list box. In addition the popup menu of an overlay field allows the user access to the details view of the overlay. The details view can be used to change the three parameters discussed above as well as the line width and type used to render the curve. The option to set the size of the points is unused in this context.

Legend

- *Display legend* – if selected a legend will be displayed on the view that will include all visible overlay scalar fields. The names and colours specified in the Layout tab are used in the legend.
- *Display border* – if selected the legend will possess a border.
- *Black text* – if selected the text in the legend will be displayed in black. If not selected the colour of each curve is used for the text.
- *Legend location* – this drop down box provides the user with 4 possible locations for the legend – top right, top left, bottom right and bottom left. Which is appropriate will depend on the region of the graph covered by the curves.
- *Legend offset x* – this allows the user to offset the legend the specified number of pixels from the chosen location in the x direction. The larger the number the closer the legend will move away from its location. Changes to this and the other settings will automatically appear on the graph.
- *Legend offset y* – this allows the user to offset the legend the specified number of pixels from the chosen location in the y direction. The larger the number the closer the legend will move away from its location. Changes to this and the other settings will automatically appear on the graph.

Menus

Legend menu

- *View preset legend labels...* – it is common for a set of legend labels (for each of the overlay scalar fields) to be used in multiple views of the same sort. Preset legend labels enable the user to have a standard set of legend labels that can be used and reused in views of the same sort. This menu

option displays these preset legend labels. The dialog box that is displayed enables the user to add or insert new legend labels, delete them and edit them.

- *Save preset legend labels* – this command will use the current legend labels (overlay names) as the preset labels. The user is prompted to confirm this action.
- *Use preset legend labels* – this command replaces the current overlay names (legend labels) with the preset labels. If there are more presets than required the unused preset labels are ignored. If there are more overlays than preset labels the additional overlays, for which no preset label exists, will retain their current name/label. The user is prompted to confirm this action.

18.2.4 Animated graph view

Description

The animated graph view of the vector 2D field 2D is similar to the animated graph view of a scalar field 2D, except now both vector components are plotted.

The view has four toolbars at the top of the view.

Animation toolbar

- *Current time* – this combo box displays the current value of the animating variable. This variable originally corresponds to the “x” axis of the field, but may be changed (see View menu). The user can select any value in this box to move to a different position in the field.
- *Go to next time* – steps the display forward one frame.
- *Go to previous time* – steps the display back one frame.
- *Play* – starts the animation forward in time.
- *Play in reverse* – starts the animation backward in time.
- *Pause* – pauses the animation.
- *Go to start* – resets the display to the first frame.
- *Go to end* – resets the display to the last frame.
- *Animation timing delay (ms)* – this text box allows the user to change the speed of the animation. The displayed timing delay is the minimum time between frames. The actual delay may be longer if the drawing overhead is high.

Display toolbar

- *u points* – if this check box is selected the u field data points are shown on the graph. The colour of the particles can be changed in the layout dialog.

- *u lines* – if this check box is selected lines are drawn between the *u* data points on the graph. The colour of the particles can be changed in the layout dialog.
- *v points* – if this check box is selected the *v* field data points are shown on the graph. The colour of the particles can be changed in the layout dialog.
- *v lines* – if this check box is selected lines are drawn between the *v* data points on the graph. The colour of the particles can be changed in the layout dialog.
- *Swap axes* – if this check box is selected the axes are swapped on the graph.

x axis toolbar

- *x axis min* – sets the minimum *x* value displayed.
- *x axis max* – sets the maximum *x* value displayed.
- *x* – displays the *x* value of the cursor as it moves over the graph.

y axis toolbar

- *y min* – sets the minimum *y* value displayed.
- *y max* – sets the maximum *y* value displayed.
- *y* – displays the *y* value of the cursor as it moves over the graph.

Access

The animated graph view of a vector 2D field 2D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 18.2.4.1. The settings are saved in a file with extension *.v2d2danigrset*.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of *.v2d2danigrset*.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent

views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.

- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.
- *Save to image sequence...* – enables the user to save each 2D contour plot as an image in an image sequence. Image file types supported are JPEG, PNG and BMP format. The user can select the resolution of the images. The name, specified by the user, has the number of the frame added as a suffix. It is recommended that the base name ends in an underscore (`_`) in order to separate the file name from the frame numbering.

View menu

- *Set layout* – opens a dialog box that enables a range of layout parameters to be set for all views of this type. See section 18.2.4.1.
- *Show u points* – when selected the u data points are displayed.
- *Show u lines* – when selected the lines connecting the u data points are displayed.
- *Show v points* – when selected the v data points are displayed.
- *Show v lines* – when selected the lines connecting the v data points are displayed.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected the information field is displayed.
- *Show frame* – when selected the frame around the graph is displayed.
- *Show divisions* – when selected the divisions (corresponding to the tick marks along each axis) are displayed.
- *Show adornments* – when selected all adornments are displayed.
- *Swap axes* – when selected the axes are swapped.
- *Swap animation axis* – this option allows the user to select which of the two independent variables will be treated as the animation variable. The default setting is for the x axis to be treated as time, so the field is plotted against the y variable. Selecting this menu item will cause the x and y variables to swap roles.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Hide toolbars* – when selected the toolbars are hidden.

Animation menu

- *Go to next time* – steps the display forward one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to previous time*– steps the display back one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Play* – starts the animation forward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Play in reverse* – starts the animation backward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Pause* – pauses the animation. This has the same effect as the equivalent button in the animation toolbar.
- *Go to start* – resets the display to the first frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to end* – resets the display to the last frame. This has the same effect as the equivalent button in the animation toolbar.

Adornments menu

- *Manage adornments...* – opens the adornments manager view for this field view. The adornments manager view allows the user to create and manipulate adornments. See chapter 5.
- *Manage animators...* – opens the animators manager view. This enables animators to be created and manipulated. See chapter 7 for full information.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Go to next time* – see Animation menu.
- *Go to previous time*– see Animation menu.
- *Play*– see Animation menu.
- *Play in reverse* – see Animation menu.
- *Pause* – see Animation menu.
- *Go to start* – see Animation menu.
- *Go to end* – see Animation menu.

- *Show u points* – see View menu.
- *Show u lines* – see View menu.
- *Show v points* – see View menu.
- *Show v lines* – see View menu.
- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show frame* – see View menu.
- *Show divisions* – see View menu.
- *Show adornments* – see Adornments menu.
- *Show animators* – see Adornments menu.
- *Swap axes* – see View menu.
- *Swap animation axis* – see Animation menu.
- *Zoom* – see Zoom menu.
- *Unzoom* – see Zoom menu.
- *Clear zoom rectangle* – see Zoom menu.

18.2.4.1 Set layout dialog

The set layout dialog controls the display settings for all views of this type. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Rotate y label* – when selected the y axis label is rotated so that the text is vertical.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width*– sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *u points colour* – the colour of the u points. It can be changed by clicking on the Select... button.
- *v points colour* – the colour of v points. It can be changed by clicking on the Select... button.
- *u lines colour* – the colour of u lines. It can be changed by clicking on the Select... button.
- *v lines colour* – the colour of v lines. It can be changed by clicking on the Select... button.
- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

18.2.5 Particle track view

Description

The particle track view of the vector 2D field 2D is primarily suited to vector fields corresponding to fluid velocity fields. It is designed to enable the user to view the fluid motion by seeding the flow with particles and tracking their trajectories. The flow is assumed steady, so that the velocity field is invariant in time at each point in the flow. This seeding process is achieved with an object known as a **particle seeder** – see chapter 9. As the field does not possess any variation in time a simulation time is defined by the user. This includes a time step between frames and the number of frames in the simulation. These two parameters are set to 0.04 and 500 by default.

The underlying display in this view is almost identical to the vector field 2D vector 2D view. One important difference worth noting is that this view allows the user to create a full suite of regions. These are important in defining the zones in which the particle seeders introduce the particles to the flow. Therefore the zooming capability of this view is somewhat different to the majority of the other views. It follows the same rules as used in the particle 2D record particle view. Only internal rectangles can be used for zooming. If the zoom command is executed and only one internal rectangle is defined, then this rectangle is used as the zoom rectangle. If more than one is defined then the user is presented with a dialog box from which they can choose the zoom rectangle. Another approach is to double click the left mouse button, while holding down the SHIFT key, inside the rectangle that is to be used as the zoom rectangle.

The view supports the overlay of scalar 1D fields.

There are five toolbars at the top of the view. These are:

Animation toolbar

- *Current time* – this combo box displays the current value of time. The user can select any value in this box to move to a different time.
- *Go to next time* – steps the display forward one frame.
- *Go to previous time* – steps the display back one frame.
- *Play* – starts the animation forward in time.
- *Play in reverse* – starts the animation backward in time.
- *Pause* – pauses the animation.
- *Go to start* – resets the display to the first frame.
- *Go to end* – resets the display to the last frame.
- *Animation timing delay (ms)* – this text box allows the user to change the speed of the animation. The displayed timing delay is the minimum time between frames. The actual delay may be longer if the drawing overhead is high.

Display toolbar

- *Particles* – if this is selected the seeded particles are displayed. The colour of the particles can be changed in the layout dialog.
- *Vectors* – if this is selected the field vectors are displayed. The colour of the particles can be changed in the layout dialog.
- *Fill view* – if this check box is selected the aspect ratio of the grid is ignored and the graph is expanded to fill the view.

- *Dimmer* – this slide control allows the user dim or brighten the vector field which acts as a backdrop to this view. When the vector field is displayed at full brightness it can be difficult to see the motion of the particles, and hence dimming the field can be useful.

x axis toolbar

- *x axis min* – sets the minimum x value displayed.
- *x axis max* – sets the maximum x value displayed.
- *x* – displays the x value of the cursor as it moves over the graph.

y axis toolbar

- *y axis min* – sets the minimum y value displayed.
- *y axis max* – sets the maximum y value displayed.
- *y* – displays the y value of the cursor as it moves over the

Field toolbar

- *[field] min* – the field value corresponding to the colour at the bottom of the legend. Initially this is set to be the magnitude of the shortest vector on the grid. However, the user may choose to change this value. If vectors shorter than the value specified exist, then these will be coloured white.
- *[field] max* – the field value corresponding to the colour at the top of the legend. Initially this is set to be the magnitude of the longest vector on the grid. However, the user may choose to change this value. If vectors longer than the value specified exist, then these will be coloured white.
- *field* – the vector field value at the location of the cursor.

Access

The particle track view of a vector 2D field 2D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 18.2.5.1. The settings are saved in a file with extension `.v2d2dparterset`.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of `.v2d2dparterset`.

- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time. *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.
- *Save to image sequence...* – enables the user to save each 2D contour plot as an image in an image sequence. Image file types supported are JPEG, PNG and BMP format. The user can select the resolution of the images. The name, specified by the user, has the number of the frame added as a suffix. It is recommended that the base name ends in an underscore (`_`) in order to separate the file name from the frame numbering.

View menu

- *Set layout* – opens a dialog box that enables a range of layout parameters to be set for all views of this type. See section 18.2.5.1.
- *Show particles* – when selected the particles are displayed. The colour of the particles can be changed in the layout dialog.
- *Show vectors* – when selected the vectors are displayed. The colour of the particles can be changed in the layout dialog.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected the information field is displayed.
- *Show legend* – when selected the legend on the right of the view is displayed.
- *Show frame* – when selected the frame around the graph is displayed.
- *Show divisions* – when selected the divisions (corresponding to the tick marks along each axis) are displayed.
- *Show grid* – when selected the grid is displayed.
- *Show overlay scalar 1D fields* – when selected the overlaid scalar 1D fields are displayed.
- *Show particle tracks* – when selected the particles tracks are displayed.
- *Show regions* – when selected the regions are displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Show animators* – when selected the animators are displayed.
- *Fill view* – when selected the graph is expanded to fill the entire view.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.

- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Redraw during resize* – if set, the view redraws during a resize operation. For a fine grid this might cause a lack of responsiveness. If not set redrawing does not occur and the user needs to perform some manual operation after the resize in order to force a redraw.
- *Set |field| min and max values to default* – returns the min and max values in the field toolbar to their default values.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Hide toolbars* – when selected the toolbars are hidden.
- *Adjust view size* – resets the view window size to eliminate unnecessary waste space. This has the same effect as double clicking in the blank space in the toolbars at the top of the view.

Overlay menu

- *Manage scalar ID overlay fields...* – this option opens the manage overlay fields view. See section 18.2.5.2.

Animation menu

- *Set time step...* – as the field used in this particle tracking simulation is a single two dimensional field, the user is required to specify the time step between frames in the simulation and the number of frames in the simulation. This menu item allows the user to set the time step. The default is 0.04s.
- *Set number of frames...* – this item allows the user to specify the total number of frames used in the simulation. The default is 500.
- *Go to next time* – steps the display forward one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to previous time* – steps the display back one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Play* – starts the animation forward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Play in reverse* – starts the animation backward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Pause* – pauses the animation. This has the same effect as the equivalent button in the animation toolbar.
- *Go to start* – resets the display to the first frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to end* – resets the display to the last frame. This has the same effect as the equivalent button in the animation toolbar.

Seeder Menu

- *Manage seeders...* – opens the seeder manager view. See chapter 9.

Region Menu

- *Display regions...* – displays all of the currently defined regions in a list box.
- *Load regions...* – previously stored regions are loaded from a disk file and added to the currently defined regions. Regions are stored in a file with a .rgn or .rgn2 extension.
- *Save regions as...* – saves all of the currently defined regions in a .rgn2 disk file.
- *Delete all regions* – deletes all currently defined regions. The user is prompted to confirm this option.
- *Delete selected regions* – deletes all selected regions.
- *Select all regions* – selects all regions.
- *Select <-> unselect* – makes all selected regions unselected and vice versa.
- *Invert selected regions* – converts all selected regions that are interior regions into exterior regions and vice versa.
- *Invert all regions* – converts all regions that are interior regions into exterior regions and vice versa.
- *Draw point* – sets the current drawing tool to a point.
- *Draw line* – sets the current drawing tool to a line.
- *Draw internal rectangle* – sets the current drawing tool to an internal rectangle. This is the default.
- *Draw internal circle* – sets the current drawing tool to an internal circle.
- *Draw internal polygon* – sets the current drawing tool to an internal polygon.
- *Draw internal freehand* – sets the current drawing tool to an internal freehand.
- *Draw external rectangle* – sets the current drawing tool to an external rectangle.
- *Draw external circle* – sets the current drawing tool to an external circle.
- *Draw external polygon* – sets the current drawing tool to an external polygon.
- *Draw external freehand* – sets the current drawing tool to an external freehand.

Adornments menu

- *Manage adornments...* – opens the adornments manager view for this field view. The adornments manager view allows the user to create and manipulate adornments. See chapter 5.

- *Manage animators...* – opens the animators manager view. This enables animators to be created and manipulated. See chapter 7.

Zoom Menu

- *Zoom...* – causes the view to be zoomed. If only one internal rectangle is currently defined then it is used as the zoom rectangle. If more than one internal rectangle exists then a dialog box is presented to the user, listing all internal rectangles currently defined. The user can select a zoom rectangle from the list.
- *Unzoom...* – this undoes any zoom operation by redisplaying the entire field.

Popup menu

- *Set layout...* – see View menu.
- *Go to next time* – see Animation menu.
- *Go to previous time* – see Animation menu.
- *Play* – see Animation menu.
- *Play in reverse* – see Animation menu.
- *Pause* – see Animation menu.
- *Go to start* – see Animation menu.
- *Go to end* – see Animation menu.
- *Show particles* – see View menu.
- *Show vectors* – see View menu.
- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show legend* – see View menu.
- *Show frame* – see View menu.
- *Show divisions* – see View menu.
- *Show grid* – see View menu.
- *Show overlay scalar ID fields* – see View menu.
- *Show particle tracks* – see View menu.
- *Show regions* – see View menu.
- *Show adornments* – see Adornments menu.
- *Show animators* – see Adornments menu.
- *Fill view* – see View menu.
- *Zoom* – see Zoom menu.
- *Unzoom* – see Zoom menu.

18.2.5.1 Set layout dialog

The set layout dialog controls the display settings for all views of this type. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Vector scale factor* – the vectors drawn in this view are drawn with an arbitrary length scale. This option enables the user to scale the vectors lengths to a more convenient size.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Rotate y label* – when selected the y axis label is rotated so that the text is vertical.
- *Clip vectors* – when selected vectors are clipped at the edges of the graph area.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Vector colours* – the range of colours used to present the vectors. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range

or return to the defaults provided. The user can also save and reload their colour choices.

- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Grid colour* – the colour of the grid lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

18.5.3.2 *Manage overlay scalar 1D fields view*

The user can overlay a number of scalar 1D fields on this view. The user can overlay fields by loading them from file, selecting them from the field registry, dragging them onto the list box of overlay fields in this view, or dragging the fields directly onto the contour view itself.

The view has five buttons. The buttons are as follows:

- *Load* – enables the user to load a scalar 1D field from disk.
- *Select* – enables the user to select a scalar 1D field from the field registry.
- *Delete* – deletes any fields currently selected in the field list.
- *Clear* – deletes all selected fields.
- *Refresh* – refreshes the view.

The dialog includes 2 tabs – Overlays and Legend

Overlays

- *Overlay fields* – this list box lists all current overlay scalar fields. Three key parameters that can be manipulated in this view - their name, colour and display setting – can be changed using the popup menu for each field. The field name is the field's short name by default. The name is used in the legend, if displayed, and therefore the user may wish to change the name. The colour used to display each of the overlay fields is set through their popup menus and the name of the field is displayed in this colour in the list box. Note the initial colour is randomly allocated by the view and both the points and line used to render the field on the graph use the same colour. Finally each of the fields can be shown or hidden through their display setting. If a field is shown its name will be followed by a tick in the list box. In addition the popup menu of an overlay field allows the user access to the details view of the overlay. The details view can be

used to change the three parameters discussed above as well as the line width and type used to render the curve. The option to set the size of the points is unused in this context.

Legend

- *Display legend* – if selected a legend will be displayed on the view that will include all visible overlay scalar fields. The names and colours specified in the Layout tab are used in the legend.
- *Display border* – is selected the legend will possess a border.
- *Black text* – if selected the text in the legend will be displayed in black. If not selected the colour of each curve is used for the text.
- *Legend location* – this drop down box provides the user with 4 possible locations for the legend – top right, top left, bottom right and bottom left. Which is appropriate will depend on the region of the graph covered by the curves.
- *Legend offset x* – this allows the user to offset the legend the specified number of pixels from the chosen location in the x direction. The larger the number the closer the legend will move away from its location. Changes to this and the other settings will automatically appear on the graph.
- *Legend offset y* – this allows the user to offset the legend the specified number of pixels from the chosen location in the y direction. The larger the number the closer the legend will move away from its location. Changes to this and the other settings will automatically appear on the graph.

Menus

Legend menu

- *View preset legend labels...* – it is common for a set of legend labels (for each of the overlay scalar fields) to be used in multiple views of the same sort. Preset legend labels enable the user to have a standard set of legend labels that can be used and reused in views of the same sort. This menu option displays these preset legend labels. The dialog box that is displayed enables the user to add or insert new legend labels, delete them and edit them.
- *Save preset legend labels* – this command will use the current legend labels (overlay names) as the preset labels. The user is prompted to confirm this action.
- *Use preset legend labels* – this command replaces the current overlay names (legend labels) with the preset labels. If there are more presets than required the unused preset labels are ignored. If there are more overlays than preset labels the additional overlays, for which no preset label exists, will retain their current name/label. The user is prompted to confirm this action.

18.3 Popup menu

The vector 2D field 2D provides the following options in its popup menu.

- *Save as...* – saves the field to a disk file. The file has a *.v2d2d* extension.
- *Save* – saves the field to a disk file with the current name.
- *Save as text file...* – saves the field in a comma delimited text file. Either a *.txt* or *.csv* extension can be specified. The user can choose the save the data with headers (which means header information is included) or without headers (just raw field data is stored). They can also choose whether they wish to have data stored so that the y axis is downwards or the x axis is downwards (swap axes). This latter feature can be important when trying to read a field file into a spreadsheet that has a limit on the number of columns available. The user will be prompted to specify the number of decimal places used to store the independent and field values.
- *Open details view...* – opens the details view.
- *Open animated graph view...* – opens the animated graph view.
- *Open vector view...* – opens the vector view.
- *Open particle track view...* – opens the particle track view.
- *Open table view...* – opens the table view.
- *Open persistent view manager view...* – opens the view that manages all of the persistent views saved for this field. The persistent views appear in a list box that displays the names given to the views by the user when they were saved. A persistent view can be opened by double clicking on its name.
- *Close all views* – closes all open views of this field.
- *Close* – this option removes the field from its enclosing container. The user will be prompted to confirm the choice and to save the field if desired.

19 Vector 2D field 3D

19.1 Description

A vector 2D field 3D is a 2D vector field that is a function of three variables.

19.2 Views

A vector 2D field 3D has four views.

- *Details view.*
- *Animated vector view.*
- *Particle track view.*
- *3D vector view.*

19.2.1 Details view

Description

The details view of a vector 2D field 3D displays the name of the field, its full name and its description.

Access

The details view of a vector 2D field 3D can be accessed through the popup menu of the field object.

19.2.2 Animated vector view

Description

The animated vector view of the vector 2D field 3D provides a vector plot of the field for each time step in the series. It has much in common with the vector view of a vector 2D field 2D.

This is the default view for the vector 2D field 3D.

There are five toolbars at the top of the view. These are:

Animation toolbar

- *Current time* – this combo box displays the current value of time. The user can select any value in this box to move to a different time.
- *Go to next time* – steps the display forward one frame. If the display area of the graph has the keyboard focus pressing the right arrow key has the same effect.
- *Go to previous time*– steps the display back one frame. If the display area of the graph has the keyboard focus pressing the left arrow key has the same effect.
- *Play*– starts the animation forward in time.
- *Play in reverse* – starts the animation backward in time.
- *Pause* – pauses the animation.
- *Go to start* – resets the display to the first frame.
- *Go to end* – resets the display to the last frame.
- *Animation timing delay (ms)* – this text box allows the user to change the speed of the animation. The displayed timing delay is the minimum time between frames. The actual delay may be longer if the drawing overhead is high.

Display toolbar

- *Vectors* – if this is selected the field vectors are displayed. The colours of the vectors can be changed under the *Colour* menu.
- *Fill view* – if this check box is selected the aspect ratio of the grid is ignored and the graph is expanded to fill the view.

x axis toolbar

- *x axis min* – sets the minimum x value displayed.
- *x axis max* – sets the maximum x value displayed.
- *x* – displays the x value of the cursor as it moves over the graph.

y axis toolbar

- *y axis min* – sets the minimum y value displayed.
- *y axis max* – sets the maximum y value displayed.
- *y* – displays the y value of the cursor as it moves over the

Field toolbar

- *[field] min* – the field value corresponding to the colour at the bottom of the legend. Initially this is set to be the magnitude of the shortest vector on the grid. However, the user may choose to change this value. If vectors shorter than the value specified exist, then these will be coloured white.

- *[field] max* – the field value corresponding to the colour at the top of the legend. Initially this is set to be the magnitude of the longest vector on the grid. However, the user may choose to change this value. If vectors longer than the value specified exist, then these will be coloured white.
- *field* – the vector field value at the location of the cursor.

Access

The animated vector view of a vector 2D field 3D can be accessed by double clicking the field or through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 19.2.2.1. The settings are saved in a file with extension .v2d3danivcset.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .v2d3danivcset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.
- *Save to image sequence...* – enables the user to save each 2D contour plot as an image in an image sequence. Image file types supported are JPEG, PNG and BMP format. The user can select the resolution of the images. The name, specified by the user, has the number of the frame added as a suffix. It is recommended that the base name ends in an underscore (_) in order to separate the file name from the frame numbering.

View menu

- *Set layout* – opens a dialog box that enables a range of layout parameters to be set for all views of this type. See section 19.2.2.1.
- *Show vectors* – when selected the vectors are displayed. The colour of the particles can be changed in the layout dialog.
- *Show x label* – when selected the x axis label is displayed.

- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected the information field is displayed.
- *Show frame* – when selected the frame around the graph is displayed.
- *Show divisions* – when selected the divisions (corresponding to the tick marks along each axis) are displayed.
- *Show grid* – when selected the grid is displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Show animators* – when selected the animators are displayed.
- *Fill view* – when selected the graph is expanded to fill the entire view.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Redraw during resize* – if set, the view redraws during a resize operation. For a fine grid this might cause a lack of responsiveness. If not set redrawing does not occur and the user needs to perform some manual operation after the resize in order to force a redraw.
- *Set |field| min and max values to default* – returns the min and max values in the field toolbar to their default values.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Hide toolbars* – when selected the toolbars are hidden.
- *Adjust view size* – resets the view window size to eliminate unnecessary waste space. This has the same effect as double clicking in the blank space in the toolbars at the top of the view.

Animation menu

- *Go to next time* – steps the display forward one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to previous time* – steps the display back one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Play* – starts the animation forward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Play in reverse* – starts the animation backward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Pause* – pauses the animation. This has the same effect as the equivalent button in the animation toolbar.
- *Go to start* – resets the display to the first frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to end* – resets the display to the last frame. This has the same effect as the equivalent button in the animation toolbar.

Adornments menu

- *Manage adornments...* – opens the adornments manager view for this field view. The adornments manager view allows the user to create and manipulate adornments. See chapter 5.
- *Manage animators...* – opens the animators manager view. This enables animators to be created and manipulated. See chapter 7.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Go to next time* – see Animation menu.
- *Go to previous time* – see Animation menu.
- *Play* – see Animation menu.
- *Play in reverse* – see Animation menu.
- *Pause* – see Animation menu.
- *Go to start* – see Animation menu.
- *Go to end* – see Animation menu.
- *Show vectors* – see View menu.
- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show frame* – see View menu.
- *Show divisions* – see View menu.
- *Show grid* – see View menu.
- *Show adornments* – see Adornments menu.
- *Show animators* – see Adornments menu.
- *Fill view* – see View menu.
- *Zoom* – see Zoom menu.
- *Unzoom* – see Zoom menu.
- *Clear zoom rectangle* – see Zoom menu.

19.2.2.1 Set layout dialog

The set layout dialog controls the display settings for all views of this type. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Vector scale factor* – the vectors drawn in this view are drawn with an arbitrary length scale. This option enables the user to scale the vectors lengths to a more convenient size.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Rotate y label* – when selected the y axis label is rotated so that the text is vertical.
- *Clip vectors* – when selected vectors are clipped at the edges of the graph area.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Vector colours* – the range of colours used to present the vectors. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range

or return to the defaults provided. The user can also save and reload their colour choices.

- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Grid colour* – the colour of the grid lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

19.2.3 Particle track view

Description

The particle track view of the vector 2D field 3D is primarily suited to vector fields corresponding to fluid velocity fields and is very similar to the particle track view of a vector 2D field 2D. The key difference is that the vector field is now time dependent, with a specified time step and number of frames. The particle motion is now determined by the time varying velocity field.

There are five toolbars at the top of the view. These are:

Animation toolbar

- *Current time* – this combo box displays the current value of time. The user can select any value in this box to move to a different time.
- *Go to next time* – steps the display forward one frame.
- *Go to previous time* – steps the display back one frame.
- *Play* – starts the animation forward in time.
- *Play in reverse* – starts the animation backward in time.
- *Pause* – pauses the animation.
- *Go to start* – resets the display to the first frame.
- *Go to end* – resets the display to the last frame.
- *Animation timing delay (ms)* – this text box allows the user to change the speed of the animation. The displayed timing delay is the minimum time between frames. The actual delay may be longer if the drawing overhead is high.

Display toolbar

- *Particles* – if this is selected the seeded particles are displayed. The colour of the particles can be changed under the *Colour* menu.
- *Vectors* – if this is selected the field vectors are displayed. The colours of the vectors can be changed under the *Colour* menu.
- *Fill view* – if this check box is selected the aspect ratio of the grid is ignored and the graph is expanded to fill the view.
- *Dimmer* – this slide control allows the user dim or brighten the vector field which acts as a backdrop to this view. When the vector field is displayed at full brightness it can be difficult to clearly see the motion of the particles, and hence dimming the field can be useful.

x axis toolbar

- *x axis min* – sets the minimum x value displayed.
- *x axis max* – sets the maximum x value displayed.
- *x* – displays the x value of the cursor as it moves over the graph.

y axis toolbar

- *y axis min* – sets the minimum y value displayed.
- *y axis max* – sets the maximum y value displayed.
- *y* – displays the y value of the cursor as it moves over the

Field toolbar

- *[field] min* – the field value corresponding to the colour at the bottom of the legend. Initially this is set to be the magnitude of the shortest vector on the grid. However, the user may choose to change this value. If vectors shorter than the value specified exist, then these will be coloured white.
- *[field] max* – the field value corresponding to the colour at the top of the legend. Initially this is set to be the magnitude of the longest vector on the grid. However, the user may choose to change this value. If vectors longer than the value specified exist, then these will be coloured white.
- *field* – the vector field value at the location of the cursor.

Access

The particle track view of a vector 2D field 3D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 19.2.3.1. The settings are saved in a file with extension .v2d3dpartset.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .v2d3dpartset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.
- *Save to image sequence...* – enables the user to save each 2D contour plot as an image in an image sequence. Image file types supported are JPEG, PNG and BMP format. The user can select the resolution of the images. The name, specified by the user, has the number of the frame added as a suffix. It is recommended that the base name ends in an underscore (_) in order to separate the file name from the frame numbering.

View menu

- *Set layout* – opens a dialog box that enables a range of layout parameters to be set for all views of this type. See section 19.2.3.1.
- *Show particles* – when selected the particles are displayed. The colour of the particles can be changed in the layout dialog.
- *Show vectors* – when selected the vectors are displayed. The colour of the particles can be changed in the layout dialog.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected the information field is displayed.
- *Show legend* – when selected the legend on the right of the view is displayed.
- *Show frame* – when selected the frame around the graph is displayed.

- *Show divisions* – when selected the divisions (corresponding to the tick marks along each axis) are displayed.
- *Show grid* – when selected the grid is displayed.
- *Show particle tracks* – when selected the particles tracks are displayed.
- *Show regions* – when selected the regions are displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Show animators* – when selected the animators are displayed.
- *Fill view* – when selected the graph is expanded to fill the entire view.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Redraw during resize* – if set, the view redraws during a resize operation. For a fine grid this might cause a lack of responsiveness. If not set redrawing does not occur and the user needs to perform some manual operation after the resize in order to force a redraw.
- *Set |field| min and max values to default* – returns the min and max values in the field toolbar to their default values.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Hide toolbars* – when selected the toolbars are hidden.
- *Adjust view size* – resets the view window size to eliminate unnecessary waste space. This has the same effect as double clicking in the blank space in the toolbars at the top of the view.

Animation menu

- *Go to next time* – steps the display forward one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to previous time* – steps the display back one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Play* – starts the animation forward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Play in reverse* – starts the animation backward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Pause* – pauses the animation. This has the same effect as the equivalent button in the animation toolbar.
- *Go to start* – resets the display to the first frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to end* – resets the display to the last frame. This has the same effect as the equivalent button in the animation toolbar.

Seeder Menu

- *Manage seeders...* – opens the seeder manager view. This view allows the user to create and manage seeders. See chapter 9 for complete information relating to seeders.

Region Menu

- *Manage regions...* – opens the region manager view.
- *Load regions...* – previously stored regions are loaded from a disk file and added to the currently defined regions. Regions are stored in a file with a *.rgn* or *.rgn2* extension.
- *Save regions as...* – saves all of the currently defined regions in a *.rgn2* disk file.
- *Delete all regions* – deletes all currently defined regions. The user is prompted to confirm this option.
- *Delete selected regions* – deletes all selected regions.
- *Select all regions* – selects all regions.
- *Select <-> unselect* – makes all selected regions unselected and vice versa.
- *Invert selected regions* – converts all selected regions that are interior regions into exterior regions and vice versa.
- *Invert all regions* – converts all regions that are interior regions into exterior regions and vice versa.
- *Draw point* – sets the current drawing tool to a point.
- *Draw line* – sets the current drawing tool to a line.
- *Draw internal rectangle* – sets the current drawing tool to an internal rectangle. This is the default.
- *Draw internal circle* – sets the current drawing tool to an internal circle.
- *Draw internal polygon* – sets the current drawing tool to an internal polygon.
- *Draw internal freehand* – sets the current drawing tool to an internal freehand.
- *Draw external rectangle* – sets the current drawing tool to an external rectangle.
- *Draw external circle* – sets the current drawing tool to an external circle.
- *Draw external polygon* – sets the current drawing tool to an external polygon.
- *Draw external freehand* – sets the current drawing tool to an external freehand.

Adornments menu

- *Manage adornments...* – opens the adornments manager view for this field view. The adornments manager view allows the user to create and manipulate adornments. See chapter 5.
- *Manage animators...* – opens the animators manager view. This enables animators to be created and manipulated. See chapter 7.

Zoom Menu

- *Zoom...* – causes the view to be zoomed. If only one internal rectangle is currently defined then it is used as the zoom rectangle. If more than one internal rectangle exists then a dialog box is presented to the user, listing all internal rectangles currently defined. The user can select a zoom rectangle from the list.
- *Unzoom...* – this undoes any zoom operation by redisplaying the entire field.

Popup menu

- *Set layout...* – see View menu.
- *Go to next time* – see Animation menu.
- *Go to previous time* – see Animation menu.
- *Play* – see Animation menu.
- *Play in reverse* – see Animation menu.
- *Pause* – see Animation menu.
- *Go to start* – see Animation menu.
- *Go to end* – see Animation menu.
- *Show particles* – see View menu.
- *Show vectors* – see View menu.
- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show legend* – see View menu.
- *Show frame* – see View menu.
- *Show divisions* – see View menu.
- *Show grid* – see View menu.
- *Show particle tracks* – see View menu.
- *Show regions* – see View menu.
- *Show adornments* – see Adornments menu.
- *Show animators* – see Adornments menu.
- *Fill view* – see View menu.
- *Zoom* – see Zoom menu.
- *Unzoom* – see Zoom menu.

19.2.3.1 *Set layout dialog*

The set layout dialog controls the display settings for all views of this type. The three buttons at the bottom of the dialog are:

- **Reset...** – resets all of the layout settings to their defaults.
- **OK** – confirms the changes made and applies them to the view.
- **Cancel...** – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Vector scale factor* – the vectors drawn in this view are drawn with an arbitrary length scale. This option enables the user to scale the vectors lengths to a more convenient size.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Rotate y label* – when selected the y axis label is rotated so that the text is vertical.
- *Clip vectors* – when selected vectors are clipped at the edges of the graph area.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Vector colours* – the range of colours used to present the vectors. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range or return to the defaults provided. The user can also save and reload their colour choices.
- *Axes colour* – the colour of axes. It can be changed by clicking on the **Select...** button.

- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Grid colour* – the colour of the grid lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

19.2.4 3D vector view

Description

The 3D vector view displays the field in three dimensional space, where the third space dimension (z) corresponds to time. Thus this view displays all of the vectors in the field simultaneously. As this is a three dimensional view it supports the full set of 3D visualization tools such as multiple virtual cameras and multiple light sources.

Due to the fact that all of the data is displayed simultaneously this view can easily become over populated with vectors so that it is difficult to differentiate between them. Therefore *Streams* will display only a subset of the data when the view is first opened. This is common for all 3D views as it can reduce rendering times as well as address the issue of information overload referred to above. The user has total control over the amount of data displayed and can make changes once the view is open.

There is a further issue that the user needs to be aware of in using this view. As one of the dimensions displayed does not correspond to a spatial dimension (as described above the z axis corresponds to time) the scaling of this axis can be problematic in ensuring that the view is “pleasant” to look at. The most easily viewed data lies in a 3D region that is roughly cubic. Often the time axis scale is such that its length is quite different to the two spatial dimensions – for example imagine an experiment that covers approximately 500mm x 500mm in space and runs for 10 seconds. Therefore to adjust for this disparity in these scales *Streams* arbitrarily scales the z (time) axis so that it has a length that is a similar size to the largest of the x and y axes. The labeling of the scale displayed for the z axis will be correct (i.e. it will be the actual time scale) but it will be noticed that this axis seems to be stretched or compressed when compared with the x and y axes. One ramification of this scaling of the z axis is that all cameras associated with the view will

use scaled coordinates for all parameters associated with the z axis. Thus the z coordinate of the camera location will be the scaled value, not the actual value of z (time). In most cases the user will not need to concern themselves with these details when exploiting this is. The information is included here for completeness.

To the right of the view is a colour legend that maps colour to vector magnitude.

There are 4 toolbars at the top of the view. These are:

x axis toolbar

- *x axis min* – sets the minimum x value displayed.
- *x axis max* – sets the maximum x value displayed.
- *x axis offset* – this displays the offset between grid points displayed in the x direction. When every vector is displayed this will be 1, but when the user chooses to display a subset of the data, say only 1 in every 3 vectors is to be displayed in the x direction, then this box displays the offset between vectors, in the case just described that would be 3. When the view is first opened for large datasets this value will not be 1.
- *x* – displays the x value of the cursor, taken in the focal plane, as it moves over the graph.

y axis toolbar

- *y axis min* – sets the minimum y value displayed.
- *y axis max* – sets the maximum y value displayed.
- *y axis offset* – this displays the offset between grid points displayed in the y direction. When every vector is displayed this will be 1, but when the user chooses to display a subset of the data, say only 1 in every 3 vectors is to be displayed in the y direction, then this box displays the offset between vectors, in the case just described that would be 3. When the view is first opened for large datasets this value will not be 1.
- *y* – displays the y value of the cursor, taken in the focal plane, as it moves over the graph.

t axis toolbar

- *t axis min* – sets the minimum t value displayed.
- *t axis max* – sets the maximum t value displayed.
- *t axis offset* – this displays the offset between grid points displayed in the t direction. When every vector is displayed this will be 1, but when the user chooses to display a subset of the data, say only 1 in every 3 vectors is to be displayed in the t direction, then this box displays the offset

between vectors, in the case just described that would be 3. When the view is first opened for large datasets this value will not be 1.

- t – displays the t value of the cursor, taken in the focal plane, as it moves over the graph.

Field toolbar

- *[field] min* – the field value corresponding to the colour at the bottom of the legend. Initially this is set to be the magnitude of the shortest vector on the grid. However, the user may choose to change this value. If vectors shorter than the value specified exist, then these will be coloured white.
- *[field] max* – the field value corresponding to the colour at the top of the legend. Initially this is set to be the magnitude of the longest vector on the grid. However, the user may choose to change this value. If vectors longer than the value specified exist, then these will be coloured white unless the user chooses not to display them – see View menu.

Access

The 3D vector view of a vector 2D field 3D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 19.2.4.1. The settings are saved in a file with extension `.v2d3dvecset`.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of `.v2d3dvecset`.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.

View menu

- *Set layout* – opens a dialog box that enables a range of layout parameters to be set for all views of this type. See section 19.2.4.1.
- *Draw line vectors* – when selected the vectors are drawn as simple arrows.
- *Draw 3D vectors* – when selected the vectors are drawn as three dimensional vectors. The rendering will be slower than for line vectors but visually the vectors are clearer.
- *Use sorted rendering* – when selected the vectors are drawn as lines the order in which the vectors are drawn determines which appear on top and hence look closer to the camera. This option renders the vectors so that the closest vectors are drawn on top. When the vectors are drawn as 3D shapes this option has no effect as these shapes are rendered correctly.
- *Show vectors* – when selected the vectors are displayed. The colour of the particles can be changed in the layout dialog.
- *Show vectors out of range* – when selected the vectors are drawn even if they outside the min/max range set by the user. If not selected then out of range vectors, that would normally be drawn white will not be drawn at all.
- *Show frame* – when selected the frame around the graph is displayed. This is a 3D box determined by the specified ranges of the x, y and z axes.
- *Show scales* – when selected the scales are displayed.
- *Show info* – when selected the information field is displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Reset field range* – resets the range of the vector magnitudes to the defaults. This also includes resetting the colour range in the legend.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Redraw during resize* – if set, the view redraws during a resize operation. For a fine grid this might cause a lack of responsiveness. If not set redrawing does not occur and the user needs to perform some manual operation after the resize in order to force a redraw.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Reset min and max values to default* – returns the min and max values for all axes and the field magnitude to their default values.
- *Hide toolbars* – when selected the toolbars are hidden. This can also be achieved using the keyboard equivalent – double clicking the mouse while holding the ALT key down. Redisplaying the toolbars uses the same keyboard command.

Camera menu

- *Manage cameras...* – opens the camera management view – see chapter 2.
- *Open current controller...* opens the controller view of the currently active camera – see chapter 2. This option can also be initiated using the keyboard equivalent – double-clicking with the SHIFT and ALT keys held down.

Lighting Menu

- *Manage lighting...* – opens the lighting manager view - see chapter 3.

Adornments menu

- *Manage adornments...* – opens the adornments manager view for this field view. The adornments manager view allows the user to create and manipulate adornments. See chapter 6.

Zoom Menu

- *Zoom...* – causes the view to be zoomed. For a 3D view the zoom rectangle is assumed to lie in the focal plane of the currently active camera. This can also be achieved using the keyboard equivalent – double clicking the mouse while holding the SHIFT key down.
- *Unzoom...* – this undoes any zoom operation by redisplaying the entire field.

Popup menu

- *Set layout...* – see View menu.
- *Show vectors* – see View menu.
- *Show vectors out of range* – see View menu.
- *Show frame* – see View menu.
- *Show scales* – see View menu.
- *Show info* – see View menu.
- *Show adornments* – see Adornments menu.
- *Select data to display...* – see Zoom menu.

19.2.4.1 Set layout dialog

The set layout dialog controls the display settings for all views of this type. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.

- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. This specifies the number of axis labels displayed.
- *Number of y divisions* – the divisions that divide the y axis. This specifies the number of axis labels displayed.
- *Number of z divisions* – the divisions that divide the z axis. This specifies the number of axis labels displayed.
- *Vector scale factor* – the vectors drawn in this view are drawn with an arbitrary length scale. This option enables the user to scale the vectors lengths to a more convenient size.
- *Geometric scale factor* – this scale factor is applied to all geometric entities in the view such as the vectors, the axes and the frame. If the user zooms far from the view some of these objects may be hard to see and so this setting allows a global increase (or decrease if the user is zoomed in) in the scale of the drawn objects.
- *Font size* – sets the font size. The default is 14.
- *Draw axes at origin* – by default the axes in 3D space are drawn at the minimum values for each of the three coordinate axes. Thus they lie at the left, bottom and back of the 3D box that encapsulates the dataset. If this option is selected the axes are drawn through the origin. This may result in the axes appearing within the dataset.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Vector colours* – the range of colours used to present the vectors. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range or return to the defaults provided. The user can also save and reload their colour choices.

- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

19.3 Popup menu

The vector 2D field 3D provides the following options in its popup menu.

- *Save as...* – saves the field to a disk file. The file has a *.v2d3d* extension.
- *Save* – saves the field to a disk file with the current name.
- *Save as text file...* – saves the field in a comma delimited text file. Either a *.txt* or *.csv* extension can be specified. The user can choose the save the data with headers (which means header information is included) or without headers (just raw field data is stored).). In the latter case the user can choose to store only a subset of the 2D fields (each 2D field corresponds to a different time) in the text file and thus a number of sequentially numbered files are used to store the entire 3D field. In all cases the x component of the vector field is stored in the file (for all times) followed by the y component of the field. The user can also choose whether they wish to have data stored so that the y axis is downwards or the x axis is downwards (swap axes). This latter feature can be important when trying to read a field file into a spreadsheet that has a limit on the number of columns available. The 2D fields are stored sequentially in the (each) file. The user will be prompted to specify the number of decimal places used to store the independent and field values.
- *Open details view...* – opens the details view.
- *Open animated vector view...* – opens the animated vector view.
- *Open particle track view...* – opens the particle track view.
- *Open 3D vector view...* – opens the 3D vector view.
- *Open persistent view manager view...* – opens the view that manages all of the persistent views saved for this field. The persistent views appear in a list box that displays the names given to the views by the user when they were saved. A persistent view can be opened by double clicking on its name.
- *Close all views* – closes all open views of this field.
- *Close* – this option removes the field from its enclosing container. The user will be prompted to confirm the choice and to save the field if desired.

20 Vector 3D field 0D

20.1 Description

A vector 3D field 0D is a single constant vector quantity.

20.2 Views

A vector 3D field 0D has two views.

- *Details view*
- *Table view*

20.2.1 Details view

Description

The details view of a vector 3D field 0D displays the name of the field, its full name and its description.

Access

The details view of a vector 3D field 0D can be accessed through the popup menu of the field object.

20.2.2 Table view

Description

The vector 3D field 0D table view displays the vector components, and details of the three coordinates, x, y, z and t. The table view is the default view of a vector 3D field 0D.

Access

The table view of a vector 3D field 0D can be accessed by double clicking the field or through the popup menu of the field object.

Menus

View menu

- *Change field decimal places...* – allows the user to select the number of decimal places used to display the field value.

20.3 Popup menu

The vector 3D field 0D provides the following options in its popup menu.

- *Save as...* – saves the field to a disk file. The file has a *.v3d0d* extension.
- *Save* – saves the field to a disk file with the current name.
- *Save as text file...* – saves the field in a comma delimited text file. Either a *.txt* or *.csv* extension can be specified. The user will be prompted to specify the number of decimal places used to store the field value.
- *Open details view...* – opens the details view.
- *Open table view...* – opens the table view.
- *Close all views* – closes all open views of this field.
- *Close* – this option removes the field from its enclosing container. The user will be prompted to confirm the choice and to save the field if desired.

21 Vector 3D field 1D

21.1 Description

A vector 3D field 1D is a vector field that is a function of a single variable.

21.2 Views

A vector 3D field 1D has three views.

- *Details view*
- *Table view*
- *Graph view*

21.2.1 Details view

Description

The details view of a vector3D field 1D displays the name of the field, its full name and its description.

Access

The details view of a vector 3D field 1D can be accessed through the popup menu of the field object.

21.2.2 Table view

Description

The vector 3D field 1D table view tabulates the independent field values together with the vector field at those points. Details of the remaining two independent coordinates are given above the table.

Access

The table view of a vector 3D field 1D can be accessed through the popup menu of the field object.

Menus

View menu

- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.

21.2.3 Graph view

Description

The graph view of a vector 3D field 1D provides a conventional plot of the three field components (denoted u , v and w for the x , y and z components respectively), and has much in common with the graph view of a scalar field 1D. It is the default view for a vector 3D field 1D object.

Three toolbars are provided at the top of the view.

Display toolbar

- *u points* – if this check box is selected the u field data points are shown on the graph.
- *u lines* – if this check box is selected lines are drawn between the u data points on the graph.
- *v points* – if this check box is selected the v field data points are shown on the graph.
- *v lines* – if this check box is selected lines are drawn between the v data points on the graph.
- *w points* – if this check box is selected the w field data points are shown on the graph.
- *w lines* – if this check box is selected lines are drawn between the w data points on the graph.
- *Swap axes* – if this check box is selected the axes are swapped on the graph.

Independent variable axis toolbar

- *x axis min* – sets the minimum x (the independent variable) value displayed.
- *x axis max* – sets the maximum x value displayed.
- *x* – displays the x value of the cursor as it moves over the graph.

Field axis toolbar

- *y axis min* – sets the minimum *y* (the field variable) value displayed.
- *y axis max* – sets the maximum *y* value displayed.
- *y* – displays the *y* value of the cursor as it moves over the graph.

Access

The graph view of a vector 3D field 1D can be accessed by double clicking the field or through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 21.2.3.1. The settings are saved in a file with extension *.v3dldgraphset*.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of *.v3dldgraphset*.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.

View menu

- *Set layout...* – opens the set layout dialog. See section 21.2.3.1.
- *Show u points* – when selected the *u* data points are displayed.
- *Show u lines* – when selected the lines connecting the *u* data points are displayed.
- *Show v points* – when selected the *v* data points are displayed.
- *Show v lines* – when selected the lines connecting the *v* data points are displayed.
- *Show w points* – when selected the *w* data points are displayed.
- *Show w lines* – when selected the lines connecting the *w* data points are displayed.

- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected info text at the bottom of the view is displayed.
- *Show frame* – when selected the outline box of the graph is displayed.
- *Show divisions* – when selected the divisions on each axis are displayed.
- *Show u curve fit* – when selected the current curve fit for the u data is displayed.
- *Show v curve fit* – when selected the current curve fit for the v data is displayed.
- *Show w curve fit* – when selected the current curve fit for the w data is displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Swap axes* – when selected the axes are swapped.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Hide toolbars* – when selected the toolbars are hidden.

Curve fitting menu

- *Manage u curve fits...* – opens the manage u curve fits view. See chapter 4.
- *Manage v curve fits ...* – opens the manage v curve fits view. See chapter 4.
- *Manage w curve fits ...* – opens the manage w curve fits view. See chapter 4.

Adornments menu

- *Manage adornments...* – opens the adornments manager view for this field view. See chapter 5.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.

- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Show u points* – see View menu.
- *Show u lines* – see View menu.
- *Show v points* – see View menu.
- *Show v lines* – see View menu.
- *Show w points* – see View menu.
- *Show w lines* – see View menu.
- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show frame* – see View menu.
- *Show divisions* – see View menu.
- *Show u curve fit* – see View menu.
- *Show v curve fit* – see View menu.
- *Show w curve fit* – see View menu.
- *Swap axes* – see View menu.
- *Zoom* – see Zoom menu.
- *Unzoom* – see Zoom menu.
- *Clear zoom rectangle* – see Zoom menu.

21.2.3.1 Set layout dialog

The set layout dialog controls the display settings for all views of this type. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.

- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Rotate y label* – when selected the y axis label is rotated so that the text is vertical.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *u points colour* – the colour for the u component points. It can be changed by clicking on the Select... button.
- *v points colour* – the colour for the v component points. It can be changed by clicking on the Select... button.
- *w points colour* – the colour for the w component points. It can be changed by clicking on the Select... button.
- *u lines colour* – the colour for the u component lines. It can be changed by clicking on the Select... button.
- *v lines colour* – the colour for the v component lines. It can be changed by clicking on the Select... button.
- *w lines colour* – the colour for the w component lines. It can be changed by clicking on the Select... button.
- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Grid colour* – the colour of the grid lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

- *u curve fit colour* – the colour of the curve fit drawn through the *u* data. It can be changed by clicking on the Select... button.
- *v curve fit colour* – the colour of the curve fit drawn through the *v* data. It can be changed by clicking on the Select... button.
- *w curve fit colour* – the colour of the curve fit drawn through the *w* data. It can be changed by clicking on the Select... button.

21.3 Popup menu

The vector 3D field 1D provides the following options in its popup menu.

- *Save as...* – saves the field to a disk file. The file has a *.v3d1d* extension.
- *Save* – saves the field to a disk file with the current name.
- *Save* – saves the field to a disk file with the current name *Save as text file...* – saves the field in a comma delimited text file. Either a *.txt* or *.csv* extension can be specified. The user can choose the save the data with headers (which means header information is included) or without headers (just raw field data is stored). The user will be prompted to specify the number of decimal places used to store the independent and field values.
- *Open details view...* – opens the details view.
- *Open graph view...* – opens the graph view.
- *Open table view...* – opens the table view.
- *Open persistent view manager view...* – opens the view that manages all of the persistent views saved for this field. The persistent views appear in a list box that displays the names given to the views by the user when they were saved. A persistent view can be opened by double clicking on its name.
- *Close all views* – closes all open views of this field.
- *Close* – this option removes the field from its enclosing container. The user will be prompted to confirm the choice and to save the field if desired.

22 Vector 3D field 2D

22.1 Description

A vector 3D field 2D is a vector field that is a function of two variables.

22.2 Views

A vector 3D field 2D has four views.

- *Details view.*
- *Table view.*
- *Vector view.*
- *Animated graph view.*

22.2.1 Details view

Description

The details view of a vector 3D field 2D displays the name of the field, its full name and its description.

Access

The details view of a vector 3D field 2D can be accessed through the popup menu of the field object.

22.2.2 Table view

Description

The vector 3D field 2D table view displays the two-dimensional vector field in a scrollable table. The horizontal coordinate is used to label the columns of the table, and the vertical coordinate the rows. Information about the third variable is given in the view header.

Access

The table view of a vector 3D field 2D can be accessed through the popup menu of the field object.

Menus

View menu

- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.

22.2.3 Vector view

Description

The vector 3D field 2D vector view provides a visual representation of the vector field by drawing the field vectors at the given grid points. These vectors are displayed in three-dimensional space so this view supports all of the visualization components for such views – see chapters 2 and 3. These vectors are only defined on a two-dimensional mesh but the third dimension is required in order to see all three vector components. However this means that the z axis in this view is a dummy axis as it does not correspond to an actual independent coordinate. It is arbitrarily given a length half that of the x axis. A colour legend, based on vector length, is displayed to the right of the graph.

This is the default view for the vector 3D field 2D.

There are three toolbars at the top of the view. These are:

x axis toolbar

- *x min* – sets the minimum x value displayed.
- *x max* – sets the maximum x value displayed.
- *x offset* – this specifies the data displayed in the figure. If every vector in the x direction is displayed the offset is 1. If only every second vector is displayed the offset set is 2 and so on.

y axis toolbar

- *y min* – sets the minimum y value displayed.
- *y max* – sets the maximum y value displayed.
- *y offset* – this specifies the data displayed in the figure. If every vector in the y direction is displayed the offset is 1. If only every second vector is displayed the offset set is 2 and so on.

Field toolbar

- *[field] min* – the field value corresponding to the colour at the bottom of the legend. Initially this is set to be the magnitude of the shortest vector on the grid. However, the user may choose to change this value. If vectors shorter than the value specified exist, then these will be coloured white.
- *[field] max* – the field value corresponding to the colour at the top of the legend. Initially this is set to be the magnitude of the longest vector on the grid. However, the user may choose to change this value. If vectors longer than the value specified exist, then these will be coloured white.

Access

The vector view of a vector 3D field 2D can be accessed by double clicking the field or through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 22.2.3.1. The settings are saved in a file with extension .v3d2dvecset.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .v3d2dvecset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.

View menu

- *Set layout* – opens a dialog box that enables a range of layout parameters to be set for all views of this type. See section 22.2.3.1.
- *Draw line vectors* – when selected the vectors are drawn as simple arrows.

- *Draw 3D vectors* – when selected the vectors are drawn as three dimensional vectors. The rendering will be slower than for line vectors but visually the vectors are clearer.
- *Use sorted rendering* – when selected the vectors are drawn as lines the order in which the vectors are drawn determines which appear on top and hence look closer to the camera. This option renders the vectors so that the closest vectors are drawn on top. When the vectors are drawn as 3D shapes this option has no effect as these shapes are rendered correctly.
- *Show vectors* – when selected the vectors are displayed. The colour of the particles can be changed in the layout dialog.
- *Show vectors out of range* – when selected the vectors are drawn even if they outside the min/max range set by the user. If not selected then out of range vectors, that would normally be drawn white will not be drawn at all.
- *Show frame* – when selected the frame around the graph is displayed. This is a 3D box determined by the specified ranges of the x, y and x axes.
- *Show scales* – when selected the scales are displayed.
- *Show info* – when selected the information field is displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Reset field range* – resets the range of the vector magnitudes to the defaults. This also includes resetting the colour range in the legend.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Change t axis scaling...* – if the y axis corresponds to time then the scaling of this axis is arbitrary. By default the y axis is scaled so its length is the comparable to that of the longer of the x axis. The user can change this scaling through a dialog box that is displayed when this menu option is selected.
- *Redraw during resize* – if set, the view redraws during a resize operation. For a fine grid this might cause a lack of responsiveness. If not set redrawing does not occur and the user needs to perform some manual operation after the resize in order to force a redraw.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Reset min and max values to default* – returns the min and max values for all axes and the field magnitude to their default values.
- *Hide toolbars* – when selected the toolbars are hidden. This can also be achieved using the keyboard equivalent – double clicking the mouse while holding the ALT key down. Redisplaying the toolbars uses the same keyboard command.

Camera menu

- *Manage cameras...* – opens the camera management view – see chapter 2.
- *Open current controller...* opens the controller view of the currently active camera – see chapter 2. This option can also be initiated using the keyboard equivalent – double-clicking with the SHIFT and ALT keys held down.

Lighting Menu

- *Manage lighting...* – opens the lighting manager view - see chapter 3.

Adornments menu

- *Manage adornments...* – opens the adornments manager view for this field view. The adornments manager view allows the user to create and manipulate adornments. See chapter 6.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Show vectors* – see View menu.
- *Show out of range* – see View menu.
- *Show frame* – see View menu.
- *Show scales* – see View menu.
- *Show info* – see View menu.
- *Show adornments* – see Adornments menu.
- *Select data to display...* – see view menu.

22.2.3.1 Set layout dialog

The set layout dialog controls the display settings for all views of this type. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.

- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. This determines the number of scale values that are displayed.
- *Number of y divisions* – the divisions that divide the y axis. This determines the number of scale values that are displayed.
- *Number of z divisions* – the divisions that divide the z axis. This determines the number of scale values that are displayed.
- *Vector scale factor* – the vectors drawn in this view are drawn with an arbitrary length scale. This option enables the user to scale the vectors lengths to a more convenient size.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Draw axes at origin* – by default the axes in 3D space are drawn at the minimum values for each of the three coordinate axes. Thus they lie at the left, bottom and back of the 3D box that encapsulates the dataset. If this option is selected the axes are drawn through the origin. This may result in the axes appearing within the dataset.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Vector colours* – the range of colours used to present the vectors. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range or return to the defaults provided. The user can also save and reload their colour choices.
- *Axes colour* – the colour of axes. It can be changed by clicking on the *Select...* button.

- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

22.2.4 Animated graph view

Description

The animated graph view of the vector 3D field 2D is similar to the animated graph view of a scalar field 2D, except here all three vector components are plotted.

The view has four toolbars at the top of the view.

Animation toolbar

- *Current time* – this combo box displays the current value of the animating variable. This variable originally corresponds to the “x” axis of the field, but may be changed (see View menu). The user can select any value in this box to move to a different position in the field.
- *Go to next time* – steps the display forward one frame.
- *Go to previous time* – steps the display back one frame.
- *Play* – starts the animation forward in time.
- *Play in reverse* – starts the animation backward in time.
- *Pause* – pauses the animation.
- *Go to start* – resets the display to the first frame.
- *Go to end* – resets the display to the last frame.
- *Animation timing delay (ms)* – this text box allows the user to change the speed of the animation. The displayed timing delay is the minimum time between frames. The actual delay may be longer if the drawing overhead is high.

Display toolbar

- *u points* – if this check box is selected the u field data points are shown on the graph. The colour of the particles can be changed in the layout dialog.
- *u lines* – if this check box is selected lines are drawn between the u data points on the graph. The colour of the particles can be changed in the layout dialog.
- *v points* – if this check box is selected the v field data points are shown on the graph. The colour of the particles can be changed in the layout dialog.

- *v lines* – if this check box is selected lines are drawn between the *v* data points on the graph. The colour of the particles can be changed in the layout dialog.
- *w points* – if this check box is selected the *w* field data points are shown on the graph. The colour of the particles can be changed in the layout dialog.
- *w lines* – if this check box is selected lines are drawn between the *w* data points on the graph. The colour of the particles can be changed in the layout dialog.
- *Swap axes* – if this check box is selected the axes are swapped on the graph.

x axis toolbar

- *x axis min* – sets the minimum *x* value displayed.
- *x axis max* – sets the maximum *x* value displayed.
- *x* – displays the *x* value of the cursor as it moves over the graph.

Field axis toolbar

- *field magnitude min* – sets the minimum value of the field magnitude displayed.
- *field magnitude max* – sets the maximum value of the field magnitude displayed.
- *field* – displays the field value of the cursor as it moves over the graph.

Access

The animated graph view of a vector 3D field 2D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 22.2.4.1. The settings are saved in a file with extension *.v3d2danigrset*.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of *.v3d2danigrset*.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated

to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.

- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.
- *Save to image sequence...* – enables the user to save each 2D contour plot as an image in an image sequence. Image file types supported are JPEG, PNG and BMP format. The user can select the resolution of the images. The name, specified by the user, has the number of the frame added as a suffix. It is recommended that the base name ends in an underscore (_) in order to separate the file name from the frame numbering.

View menu

- *Set layout* – opens a dialog box that enables a range of layout parameters to be set for all views of this type. See section 22.2.4.1.
- *Show u points* – when selected the u data points are displayed.
- *Show u lines* – when selected the lines connecting the u data points are displayed.
- *Show v points* – when selected the v data points are displayed.
- *Show v lines* – when selected the lines connecting the v data points are displayed.
- *Show w points* – when selected the w data points are displayed.
- *Show w lines* – when selected the lines connecting the w data points are displayed.
- *Show x label* – when selected the x axis label is displayed.
- *Show y label* – when selected the y axis label is displayed.
- *Show x scale* – when selected the x axis scale is displayed.
- *Show y scale* – when selected the y axis scale is displayed.
- *Show info* – when selected the information field is displayed.
- *Show frame* – when selected the frame around the graph is displayed.
- *Show divisions* – when selected the divisions (corresponding to the tick marks along each axis) are displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Show animators* – when selected the animators are displayed.
- *Swap axes* – when selected the axes are swapped.
- *Swap animation axis* – this option allows the user to select which of the two independent variables will be treated as the animation variable. The default setting is for the x axis to be treated as time, so the field is plotted against the y variable. Selecting this menu item will cause the x and y variables to swap roles.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.

- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Hide toolbars* – when selected the toolbars are hidden.

Animation menu

- *Go to next time* – steps the display forward one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to previous time* – steps the display back one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Play* – starts the animation forward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Play in reverse* – starts the animation backward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Pause* – pauses the animation. This has the same effect as the equivalent button in the animation toolbar.
- *Go to start* – resets the display to the first frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to end* – resets the display to the last frame. This has the same effect as the equivalent button in the animation toolbar.

Adornments menu

- *Manage adornments...* – opens the adornments manager view for this field view. See chapter 6.
- *Manage animators...* – opens the animators manager view. See chapter 8.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Go to next time* – see Animation menu.
- *Go to previous time* – see Animation menu.
- *Play* – see Animation menu.

- *Play in reverse* – see Animation menu.
- *Pause* – see Animation menu.
- *Go to start* – see Animation menu.
- *Go to end* – see Animation menu.
- *Show u points* – see View menu.
- *Show u lines* – see View menu.
- *Show v points* – see View menu.
- *Show v lines* – see View menu.
- *Show w points* – see View menu.
- *Show w lines* – see View menu.
- *Show x label* – see View menu.
- *Show y label* – see View menu.
- *Show x scale* – see View menu.
- *Show y scale* – see View menu.
- *Show info* – see View menu.
- *Show frame* – see View menu.
- *Show divisions* – see View menu.
- *Show adornments* – see Adornments menu.
- *Show animators* – see Adornments menu.
- *Swap axes* – see View menu.
- *Swap animation axis* – see Animation menu.
- *oom* – see Zoom menu.
- *Unzoom* – see Zoom menu.
- *Clear zoom rectangle* – see Zoom menu.

22.2.4.1 *Set layout dialog*

The set layout dialog controls the display settings for all views of this type. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.

- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Rotate y label* – when selected the y axis label is rotated so that the text is vertical.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *u points colour* – the colour of the u points. It can be changed by clicking on the Select... button.
- *v points colour* – the colour of v points. It can be changed by clicking on the Select... button.
- *w points colour* – the colour of w points. It can be changed by clicking on the Select... button.
- *u lines colour* – the colour of u lines. It can be changed by clicking on the Select... button.
- *v lines colour* – the colour of v lines. It can be changed by clicking on the Select... button.
- *w lines colour* – the colour of w lines. It can be changed by clicking on the Select... button.
- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Divisions colour* – the colour of the dashed division lines. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

22.3 Popup menu

The vector 3D field 2D provides the following options in its popup menu.

- *Save as...* – saves the field to a disk file. The file has a *.v3d2d* extension.
- *Save* – saves the field to a disk file with the current name.
- *Save as text file...* – saves the field in a comma delimited text file. Either a *.txt* or *.csv* extension can be specified. The user can choose to save the data with headers (which means header information is included) or without headers (just raw field data is stored). They can also choose whether they wish to have data stored so that the y axis is downwards or the x axis is downwards (swap axes). This latter feature can be important when trying to read a field file into a spreadsheet that has a limit on the number of columns available. The user will be prompted to specify the number of decimal places used to store the independent and field values.
- *Open details view...* – opens the details view.
- *Open animated graph view...* – opens the animated graph view.
- *Open vector view...* – opens the vector view.
- *Open table view...* – opens the table view.
- *Open persistent view manager view...* – opens the view that manages all of the persistent views saved for this field. The persistent views appear in a list box that displays the names given to the views by the user when they were saved. A persistent view can be opened by double clicking on its name.
- *Close all views* – closes all open views of this field.
- *Close* – this option removes the field from its enclosing container. The user will be prompted to confirm the choice and to save the field if desired.

23 Vector 3D field 3D

23.1 Description

A vector 3D field 3D is a vector field that is a function of three variables.

23.2 Views

A vector 3D field 3D has three views.

- *Details view.*
- *Vector view.*
- *Animated 2D vector view.*

23.2.1 Details view

Description

The details view of a vector 3D field 3D displays the name of the field, its full name and its description.

Access

The details view of a vector 3D field 3D can be accessed through the popup menu of the field object.

23.2.2 Vector view

Description

The vector 3D field 3D vector view provides a 3D visual representation of the vector field by drawing the field vectors on the field's grid. This is a three-dimensional space so this view supports all of the visualization components for such views – see chapters 2 and 3. A colour legend, based on vector length, is displayed to the right of the graph.

This is the default view for the vector 3D field 3D.

There are four toolbars at the top of the view. These are:

x axis toolbar

- *x min* – sets the minimum x value displayed.
- *x max* – sets the maximum x value displayed.
- *x offset* – this specifies the data displayed in the figure. If every vector in the x direction is displayed the offset is 1. If only every second vector is displayed the offset set is 2 and so on.
- *Focal x* – this displays the value of x in the focal plane at the cursor location.

y axis toolbar

- *y min* – sets the minimum y value displayed.
- *y max* – sets the maximum y value displayed.
- *y offset* – this specifies the data displayed in the figure. If every vector in the y direction is displayed the offset is 1. If only every second vector is displayed the offset set is 2 and so on.
- *Focal y* – this displays the value of y in the focal plane at the cursor location.

z axis toolbar

- *z min* – sets the minimum z value displayed.
- *z max* – sets the maximum z value displayed.
- *z offset* – this specifies the data displayed in the figure. If every vector in the z direction is displayed the offset is 1. If only every second vector is displayed the offset set is 2 and so on.
- *Focal z* – this displays the value of z in the focal plane at the cursor location.

Field toolbar

- *|field| min* – the field value corresponding to the colour at the bottom of the legend. Initially this is set to be the magnitude of the shortest vector on the grid. However, the user may choose to change this value. If vectors shorter than the value specified exist, then these will be coloured white.
- *|field| max* – the field value corresponding to the colour at the top of the legend. Initially this is set to be the magnitude of the longest vector on the grid. However, the user may choose to change this value. If vectors longer than the value specified exist, then these will be coloured white.

Access

The vector view of a vector 3D field 3D can be accessed by double clicking the field or through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 23.2.2.1. The settings are saved in a file with extension .v3d3dvecset.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .v3d3dvecset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.

View menu

- *Set layout* – opens a dialog box that enables a range of layout parameters to be set for all views of this type. See section 23.2.2.1.
- *Draw line vectors* – when selected the vectors are drawn as simple arrows.
- *Draw 3D vectors* – when selected the vectors are drawn as three dimensional vectors. The rendering will be slower than for line vectors but visually the vectors are clearer.
- *Use sorted rendering* – when selected the vectors are drawn as lines the order in which the vectors are drawn determines which appear on top and hence look closer to the camera. This option renders the vectors so that the closest vectors are drawn on top. When the vectors are drawn as 3D shapes this option has no effect as these shapes are rendered correctly.
- *Show vectors* – when selected the vectors are displayed. The colour of the particles can be changed in the layout dialog.
- *Show vectors out of range* – when selected the vectors are drawn even if they outside the min/max range set by the user. If not selected then out of range vectors, that would normally be drawn white will not be drawn at all.
- *Show frame* – when selected the frame around the graph is displayed. This is a 3D box determined by the specified ranges of the x, y and x axes.

- *Show scales* – when selected the scales are displayed.
- *Show info* – when selected the information field is displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Reset field range* – resets the range of the vector magnitudes to the defaults. This also includes resetting the colour range in the legend.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Change t axis scaling...* – if the y axis corresponds to time then the scaling of this axis is arbitrary. By default the y axis is scaled so its length is the comparable to that of the longer of the x axis. The user can change this scaling through a dialog box that is displayed when this menu option is selected.
- *Redraw during resize* – if set, the view redraws during a resize operation. For a fine grid this might cause a lack of responsiveness. If not set redrawing does not occur and the user needs to perform some manual operation after the resize in order to force a redraw.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Reset min and max values to default* – returns the min and max values for all axes and the field magnitude to their default values.
- *Hide toolbars* – when selected the toolbars are hidden. This can also be achieved using the keyboard equivalent – double clicking the mouse while holding the ALT key down. Redisplaying the toolbars uses the same keyboard command.

Camera menu

- *Manage cameras...* – opens the camera management view – see chapter 2.
- *Open current controller...* opens the controller view of the currently active camera – see chapter 2. This option can also be initiated using the keyboard equivalent – double-clicking with the SHIFT and ALT keys held down.

Lighting Menu

- *Manage lighting...* – opens the lighting manager view - see chapter 3.

Adornments menu

- *Manage adornments...* – opens the adornments manager view for this field view. The adornments manager view allows the user to create and manipulate adornments. See chapter 6.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Show vectors* – see View menu.
- *Show out of range* – see View menu.
- *Show frame* – see View menu.
- *Show scales* – see View menu.
- *Show info* – see View menu.
- *Show adornments* – see Adornments menu.
- *Select data to display...* – see view menu.

23.2.3.1 Set layout dialog

The set layout dialog controls the display settings for all views of this type. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. This specifies the number of axis labels displayed.
- *Number of y divisions* – the divisions that divide the y axis. This specifies the number of axis labels displayed.
- *Number of z divisions* – the divisions that divide the z axis. This specifies the number of axis labels displayed.
- *Vector scale factor* – the vectors drawn in this view are drawn with an arbitrary length scale. This option enables the user to scale the vectors lengths to a more convenient size.
- *Geometric scale factor* – this scale factor is applied to all geometric entities in the view such as the vectors, the axes and the frame. If the user zooms far from the view some of these objects may be hard to see and

so this setting allows a global increase (or decrease if the user is zoomed in) in the scale of the drawn objects.

- *Font size* – sets the font size. The default is 14.
- *Draw axes at origin* – by default the axes in 3D space are drawn at the minimum values for each of the three coordinate axes. Thus they lie at the left, bottom and back of the 3D box that encapsulates the dataset. If this option is selected the axes are drawn through the origin. This may result in the axes appearing within the dataset.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Vector colours* – the range of colours used to present the vectors. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range or return to the defaults provided. The user can also save and reload their colour choices.
- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

23.2.3 Animated 2D vector view

Description

The vector 3D field 3D animated 2D vector view is identical to the 3D vector view of the vector 3D field 2D with the addition that the vector field can now be animated (using the third dimension). This view will most often be used when the third independent variable is time. In that case the vector field at one time is displayed and as the animation

proceeds the development of the vector field in time can be observed. Again the third space dimension in this view is a dummy dimension included simply so that the three dimensionality of the vector field can be observed. It is arbitrarily given a length half that of the x axis. A colour legend, based on vector length, is displayed to the right of the graph.

There are four toolbars at the top of the view. These are:

Animation toolbar

- *Current time* – this combo box displays the current value of time. The user can select any value in this box to move to a different time.
- *Go to next time* – steps the display forward one frame.
- *Go to previous time* – steps the display back one frame.
- *Play* – starts the animation forward in time.
- *Play in reverse* – starts the animation backward in time.
- *Pause* – pauses the animation.
- *Go to start* – resets the display to the first frame.
- *Go to end* – resets the display to the last frame.
- *Animation timing delay (ms)* – this text box allows the user to change the speed of the animation. The displayed timing delay is the minimum time between frames. The actual delay may be longer if the drawing overhead is high.

x axis toolbar

- *x min* – sets the minimum x value displayed.
- *x max* – sets the maximum x value displayed.
- *x offset* – this specifies the data displayed in the figure. If every vector in the x direction is displayed the offset is 1. If only every second vector is displayed the offset set is 2 and so on.

y axis toolbar

- *y min* – sets the minimum y value displayed.
- *y max* – sets the maximum y value displayed.
- *y offset* – this specifies the data displayed in the figure. If every vector in the y direction is displayed the offset is 1. If only every second vector is displayed the offset set is 2 and so on.

Field toolbar

- *|field| min* – the field value corresponding to the colour at the bottom of the legend. Initially this is set to be the magnitude of the shortest vector

on the grid. However, the user may choose to change this value. If vectors shorter than the value specified exist, then these will be coloured white.

- *[field] max* – the field value corresponding to the colour at the top of the legend. Initially this is set to be the magnitude of the longest vector on the grid. However, the user may choose to change this value. If vectors longer than the value specified exist, then these will be coloured white.

Access

The animated 2D vector view of a vector 3D field 3D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 23.2.3.1. The settings are saved in a file with extension .v3d3danivecset.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .v3d3danivecset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.
- *Save to image sequence...* – enables the user to save each 2D vector field as an image in an image sequence. Image file types supported are JPEG, PNG and BMP format. The user can select the resolution of the images. The name, specified by the user, has the number of the frame added as a suffix. It is recommended that the base name ends in an underscore (_) in order to separate the file name from the frame numbering.

View menu

- *Set layout* – opens a dialog box that enables a range of layout parameters to be set for all views of this type. See section 23.2.3.1.

- *Draw line vectors* – when selected the vectors are drawn as simple arrows.
- *Draw 3D vectors* – when selected the vectors are drawn as three dimensional vectors. The rendering will be slower than for line vectors but visually the vectors are clearer.
- *Use sorted rendering* – when selected the vectors are drawn as lines the order in which the vectors are drawn determines which appear on top and hence look closer to the camera. This option renders the vectors so that the closest vectors are drawn on top. When the vectors are drawn as 3D shapes this option has no effect as these shapes are rendered correctly.
- *Show vectors* – when selected the vectors are displayed. The colour of the particles can be changed in the layout dialog.
- *Show vectors out of range* – when selected the vectors are drawn even if they outside the min/max range set by the user. If not selected then out of range vectors, that would normally be drawn white will not be drawn at all.
- *Show frame* – when selected the frame around the graph is displayed. This is a 3D box determined by the specified ranges of the x, y and x axes.
- *Show scales* – when selected the scales are displayed.
- *Show info* – when selected the information field is displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Reset field range* – resets the range of the vector magnitudes to the defaults. This also includes resetting the colour range in the legend.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Redraw during resize* – if set, the view redraws during a resize operation. For a fine grid this might cause a lack of responsiveness. If not set redrawing does not occur and the user needs to perform some manual operation after the resize in order to force a redraw.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Reset min and max values to default* – returns the min and max values for all axes and the field magnitude to their default values.
- *Hide toolbars* – when selected the toolbars are hidden. This can also be achieved using the keyboard equivalent – double clicking the mouse while holding the ALT key down. Redisplaying the toolbars uses the same keyboard command.

Animation menu

- *Go to next time* – steps the display forward one frame. This has the same effect as the equivalent button in the animation toolbar.

- *Go to previous time*– steps the display back one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Play* – starts the animation forward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Play in reverse* – starts the animation backward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Pause* – pauses the animation. This has the same effect as the equivalent button in the animation toolbar.
- *Go to start* – resets the display to the first frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to end* – resets the display to the last frame. This has the same effect as the equivalent button in the animation toolbar.

Camera menu

- *Manage cameras...* – opens the camera management view – see chapter 2.
- *Open current controller...* opens the controller view of the currently active camera – see chapter 2. This option can also be initiated using the keyboard equivalent – double-clicking with the SHIFT and ALT keys held down.

Lighting Menu

- *Manage lighting...* – opens the lighting manager view - see chapter 3.

Adornments menu

- *Manage adornments...* – opens the adornments manager view for this field view. The adornments manager view allows the user to create and manipulate adornments. See chapter 6.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Show vectors* – see View menu.
- *Show out of range* – see View menu.

- Show frame – see View menu.
- Show scales – see View menu.
- Show info – see View menu.
- Show adornments – see Adornments menu.
- Select data to display... – see view menu.

23.2.3.1 *Set layout dialog*

The set layout dialog controls the display settings for all views of this type. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. Vertical dashed lines are drawn on the graph if the divisions are displayed.
- *Number of y divisions* – the divisions that divide the y axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Number of z divisions* – the divisions that divide the z axis. Horizontal dashed lines are drawn on the graph if the divisions are displayed.
- *Vector scale factor* – the vectors drawn in this view are drawn with an arbitrary length scale. This option enables the user to scale the vectors lengths to a more convenient size.
- *Line width* – the line width for the view is specified here. The default is 1.5.
- *Font size* – sets the font size. The default is 14.
- *Draw axes at origin* – by default the axes in 3D space are drawn at the minimum values for each of the three coordinate axes. Thus they lie at the left, bottom and back of the 3D box that encapsulates the dataset. If this option is selected the axes are drawn through the origin. This may result in the axes appearing within the dataset.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.

- *Bottom Border width*— sets the size of the bottom border in pixels.
- *Top border width* — sets the size of the top border in pixels.

Colour

- *Vector colours* — the range of colours used to present the vectors. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range or return to the defaults provided. The user can also save and reload their colour choices.
- *Axes colour* — the colour of axes. It can be changed by clicking on the Select... button.
- *Labels colour* — the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* — the background colour. It can be changed by clicking on the Select... button.

23.3 Popup menu

The vector 3D field 3D provides the following options in its popup menu.

- *Save as...* — saves the field to a disk file. The file has a *.v3d3d* extension.
- *Save* — saves the field to a disk file with the current name.
- *Save as text file...* — saves the field in a comma delimited text file. Either a *.txt* or *.csv* extension can be specified. The user can choose the save the data with headers (which means header information is included) or without headers (just raw field data is stored).). In the latter case the user can choose to store only a subset of the 2D fields (each 2D field corresponds to a different time) in the text file and thus a number of sequentially numbered files are used to store the entire 3D field. In all cases the x component of the vector field is stored in the file (for all times) followed by the y component of the field. The user can also choose whether they wish to have data stored so that the y axis is downwards or the x axis is downwards (swap axes). This latter feature can be important when trying to read a field file into a spreadsheet that has a limit on the number of columns available. The 2D fields are stored sequentially in the (each) file. The user will be prompted to specify the number of decimal places used to store the independent and field values.
- *Open details view...* — opens the details view.
- *Open vector view...* — opens the vector view.
- *Open animated 2D vector view...* — opens the animated 2D vector view.
- *Open persistent view manager view...* — opens the view that manages all of the persistent views saved for this field. The persistent views appear in a list box that displays the names given to the views by the user when they

were saved. A persistent view can be opened by double clicking on its name.

- *Close all views* – closes all open views of this field.
- *Close* – this option removes the field from its enclosing container. The user will be prompted to confirm the choice and to save the field if desired.

24 Vector 3D field 4D

24.1 Description

A vector 3D field 4D is a vector field that is a function of four variables.

24.2 Views

A vector 3D field 4D has three views.

- *Details view.*
- *Animated vector view.*
- *Particle track view.*

24.2.1 Details view

Description

The details view of a vector 3D field 4D displays the name of the field, its full name and its description.

Access

The details view of a vector 3D field 4D can be accessed through the popup menu of the field object.

24.2.2 Animated vector view

Description

The animated vector view of the vector 3D field 4D provides a vector plot of the field for each time step. It has much in common with the vector plot for a vector 3D field 3D except with the addition of animation.

This is the default view for the vector 3D field 4D.

There are five toolbars at the top of the view. These are:

Animation toolbar

- *Current time* – this combo box displays the current value of time. The user can select any value in this box to move to a different time.
- *Go to next time* – steps the display forward one frame. If the display area of the graph has the keyboard focus pressing the right arrow key has the same effect.
- *Go to previous time*– steps the display back one frame. If the display area of the graph has the keyboard focus pressing the left arrow key has the same effect.
- *Play*– starts the animation forward in time.
- *Play in reverse* – starts the animation backward in time.
- *Pause* – pauses the animation.
- *Go to start* – resets the display to the first frame.
- *Go to end* – resets the display to the last frame.
- *Animation timing delay (ms)* – this text box allows the user to change the speed of the animation. The displayed timing delay is the minimum time between frames. The actual delay may be longer if the drawing overhead is high.

x axis toolbar

- *x min* – sets the minimum x value displayed.
- *x max* – sets the maximum x value displayed.
- *x offset* – this specifies the data displayed in the figure. If every vector in the x direction is displayed the offset is 1. If only every second vector is displayed the offset set is 2 and so on.
- *Focal x* – this displays the value of x in the focal plane at the cursor location.

y axis toolbar

- *y min* – sets the minimum y value displayed.
- *y max* – sets the maximum y value displayed.
- *y offset* – this specifies the data displayed in the figure. If every vector in the y direction is displayed the offset is 1. If only every second vector is displayed the offset set is 2 and so on.
- *Focal y* – this displays the value of y in the focal plane at the cursor location.

z axis toolbar

- *z min* – sets the minimum z value displayed.
- *z max* – sets the maximum z value displayed.

z offset – this specifies the data displayed in the figure. If every vector in the z direction is displayed the offset is 1. If only every second vector is displayed the offset set is 2 and so on.

- Focal z – this displays the value of z in the focal plane at the cursor location.

Field toolbar

- *|field| min* – the field value corresponding to the colour at the bottom of the legend. Initially this is set to be the magnitude of the shortest vector on the grid. However, the user may choose to change this value. If vectors shorter than the value specified exist, then these will be coloured white.
- *|field| max* – the field value corresponding to the colour at the top of the legend. Initially this is set to be the magnitude of the longest vector on the grid. However, the user may choose to change this value. If vectors longer than the value specified exist, then these will be coloured white.

Access

The animated vector view of a vector 3D field 4D can be accessed by double clicking the field or through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 24.2.2.1. The settings are saved in a file with extension .v3d4danivcset.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of .v3d4danivcset.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.
- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.
- *Save to image sequence...* – enables the user to save each 3D vector plot as an image in an image sequence. Image file types supported are JPEG, PNG and BMP

format. The user can select the resolution of the images. The name, specified by the user, has the number of the frame added as a suffix. It is recommended that the base name ends in an underscore (_) in order to separate the file name from the frame numbering.

View menu

- *Set layout* – opens a dialog box that enables a range of layout parameters to be set for all views of this type. See section 24.2.2.1.
- *Draw line vectors* – when selected the vectors are drawn as simple arrows.
- *Draw 3D vectors* – when selected the vectors are drawn as three dimensional vectors. The rendering will be slower than for line vectors but visually the vectors are clearer.
- *Use sorted rendering* – when selected the vectors are drawn as lines the order in which the vectors are drawn determines which appear on top and hence look closer to the camera. This option renders the vectors so that the closest vectors are drawn on top. When the vectors are drawn as 3D shapes this option has no effect as these shapes are rendered correctly.
- *Show vectors* – when selected the vectors are displayed. The colour of the particles can be changed in the layout dialog.
- *Show vectors out of range* – when selected the vectors are drawn even if they outside the min/max range set by the user. If not selected then out of range vectors, that would normally be drawn white will not be drawn at all.
- *Show frame* – when selected the frame around the graph is displayed. This is a 3D box determined by the specified ranges of the x, y and z axes.
- *Show scales* – when selected the scales are displayed.
- *Show info* – when selected the information field is displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Show animators* – when selected the animators are displayed.
- *Reset field range* – resets the range of the vector magnitudes to the defaults. This also includes resetting the colour range in the legend.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Redraw during resize* – if set, the view redraws during a resize operation. For a fine grid this might cause a lack of responsiveness. If not set redrawing does not occur and the user needs to perform some manual operation after the resize in order to force a redraw.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.

- *Reset min and max values to default* – returns the min and max values for all axes and the field magnitude to their default values.
- *Hide toolbars*– when selected the toolbars are hidden. This can also be achieved using the keyboard equivalent – double clicking the mouse while holding the ALT key down. Redisplaying the toolbars uses the same keyboard command.

Animation menu

- *Go to next time* – steps the display forward one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to previous time*– steps the display back one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Play* – starts the animation forward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Play in reverse* – starts the animation backward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Pause* – pauses the animation. This has the same effect as the equivalent button in the animation toolbar.
- *Go to start* – resets the display to the first frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to end* – resets the display to the last frame. This has the same effect as the equivalent button in the animation toolbar.

Camera menu

- *Manage cameras...* – opens the camera management view – see chapter 2.
- *Open current controller...* opens the controller view of the currently active camera – see chapter 2. This option can also be initiated using the keyboard equivalent – double-clicking with the SHIFT and ALT keys held down.

Lighting Menu

- *Manage lighting...* – opens the lighting manager view - see chapter 3.

Adornments menu

- *Manage adornments...* – opens the adornments manager view for this field view. The adornments manager view allows the user to create and manipulate adornments. See chapter 6.
- *Manage animators...* – opens the animators manager view. This enables animators to be created and manipulated. See chapter 8 for full information.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Go to next time* – see Animation menu.
- *Go to previous time*– see Animation menu.
- *Play*– see Animation menu.
- *Play in reverse* – see Animation menu.
- *Pause* – see Animation menu.
- *Go to start* – see Animation menu.
- *Go to end* – see Animation menu.
- *Show vectors* – see View menu.
- *Show out of range* – see View menu.
- *Show frame* – see View menu.
- *Show scales* – see View menu.
- *Show info* – see View menu.
- *Show adornments* – see Adornments menu.
- *Show animators* – see Adornments menu.
- *Select data to display...* – see view menu.

24.2.2.1 Set layout dialog

The set layout dialog controls the display settings for all views of this type. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...*– cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. This determines the number of scale values that are displayed.

- *Number of y divisions* – the divisions that divide the y axis. This determines the number of scale values that are displayed.
- *Number of z divisions* – the divisions that divide the z axis. This determines the number of scale values that are displayed.
- *Vector scale factor* – the vectors drawn in this view are drawn with an arbitrary length scale. This option enables the user to scale the vectors lengths to a more convenient size.
- *Geometric scale factor* – this scale factor is applied to all geometric entities in the view such as the vectors, the axes and the frame. If the user zooms far from the view some of these objects may be hard to see and so this setting allows a global increase (or decrease if the user is zoomed in) in the scale of the drawn objects.
- *Font size* – sets the font size. The default is 14.
- *Draw axes at origin* – by default the axes in 3D space are drawn at the minimum values for each of the three coordinate axes. Thus they lie at the left, bottom and back of the 3D box that encapsulates the dataset. If this option is selected the axes are drawn through the origin. This may result in the axes appearing within the dataset.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Vector colours* – the range of colours used to present the vectors. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range or return to the defaults provided. The user can also save and reload their colour choices.
- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

24.2.3 Particle track view

Description

The particle track view of the vector 3D field 4D is primarily suited to vector fields corresponding to fluid velocity fields and is very similar to the particle track view of a vector 2D field 3D. The key difference is that the vector field is now displayed in three-dimensional space.

There are five toolbars at the top of the view. These are:

Animation toolbar

- *Current time* – this combo box displays the current value of time. The user can select any value in this box to move to a different time.
- *Go to next time* – steps the display forward one frame.
- *Go to previous time* – steps the display back one frame.
- *Play* – starts the animation forward in time.
- *Play in reverse* – starts the animation backward in time.
- *Pause* – pauses the animation.
- *Go to start* – resets the display to the first frame.
- *Go to end* – resets the display to the last frame.
- *Animation timing delay (ms)* – this text box allows the user to change the speed of the animation. The displayed timing delay is the minimum time between frames. The actual delay may be longer if the drawing overhead is high.
- *Dimmer* – this slide control allows the user dim or brighten the vector field which acts as a backdrop to this view. When the vector field is displayed at full brightness it can be difficult to clearly see the motion of the particles, and hence dimming the field can be useful.

x axis toolbar

- *x min* – sets the minimum x value displayed.
- *x max* – sets the maximum x value displayed.
- *x offset* – this specifies the data displayed in the figure. If every vector in the x direction is displayed the offset is 1. If only every second vector is displayed the offset set is 2 and so on.
- *Focal x* – this displays the value of x in the focal plane at the cursor location.

y axis toolbar

- *y min* – sets the minimum y value displayed.
- *y max* – sets the maximum y value displayed.

- *y offset* – this specifies the data displayed in the figure. If every vector in the *y* direction is displayed the offset is 1. If only every second vector is displayed the offset set is 2 and so on.
- *Focal y* – this displays the value of *y* in the focal plane at the cursor location.

z axis toolbar

- *z min* – sets the minimum *z* value displayed.
- *z max* – sets the maximum *z* value displayed.
- *z offset* – this specifies the data displayed in the figure. If every vector in the *z* direction is displayed the offset is 1. If only every second vector is displayed the offset set is 2 and so on.
- *Focal z* – this displays the value of *z* in the focal plane at the cursor location.

Field toolbar

- *[field] min* – the field value corresponding to the colour at the bottom of the legend. Initially this is set to be the magnitude of the shortest vector on the grid. However, the user may choose to change this value. If vectors shorter than the value specified exist, then these will be coloured white.
- *[field] max* – the field value corresponding to the colour at the top of the legend. Initially this is set to be the magnitude of the longest vector on the grid. However, the user may choose to change this value. If vectors longer than the value specified exist, then these will be coloured white.

Access

The particle track view of a vector 3D field 4D can be accessed through the popup menu of the field object.

Menus

File menu

- *Save view settings...* – this allows the user to save the current view settings. These are common to all views of this type and are described in section 24.2.3.1. The settings are saved in a file with extension *.v3d4dpartset*.
- *Restore view settings...* – enables the user to reinstate the view settings from file. All views of this type will inherit these settings. The file has an extension of *.v3d4dpartset*.
- *Add to persistent views...* – this adds the view to the list of persistent views for this field object. The user is prompted to provide an identifying name for the saved view. Normally when a view is closed the view settings, both those common to all views of this type as well as local settings for only this view, are lost. A persistent view can be reinstated

to the exact same state as when it was saved. Note however that changes made to a view after it has been added to the list of persistent views do not affect the saved view. Persistent views are saved with the object when it is saved to file and hence can be accessed again at a later time.

- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.
- *Save to image sequence...* – enables the user to save each 2D contour plot as an image in an image sequence. Image file types supported are JPEG, PNG and BMP format. The user can select the resolution of the images. The name, specified by the user, has the number of the frame added as a suffix. It is recommended that the base name ends in an underscore (_) in order to separate the file name from the frame numbering.

File menu

- *Save to image...* – enables the user to save the graph as an image file. See chapter 11 for details.
- *Save to image sequence...* – enables the user to save each 3D vector plot as an image in an image sequence. Image file types supported are JPEG, PNG and BMP format. The user can select the resolution of the images. The name, specified by the user, has the number of the frame added as a suffix. It is recommended that the base name ends in an underscore (_) in order to separate the file name from the frame numbering.

View menu

- *Set layout* – opens a dialog box that enables a range of layout parameters to be set for all views of this type. See section 24.2.3.1.
- *Draw line vectors* – when selected the vectors are drawn as simple arrows.
- *Draw 3D vectors* – when selected the vectors are drawn as three dimensional vectors. The rendering will be slower than for line vectors but visually the vectors are clearer.
- *Use sorted rendering* – when selected the vectors are drawn as lines the order in which the vectors are drawn determines which appear on top and hence look closer to the camera. This option renders the vectors so that the closest vectors are drawn on top. When the vectors are drawn as 3D shapes this option has no effect as these shapes are rendered correctly.
- *Show vectors* – when selected the vectors are displayed. The colour of the particles can be changed in the layout dialog.
- *Show vectors out of range* – when selected the vectors are drawn even if they outside the min/max range set by the user. If not selected then out of range vectors, that would normally be drawn white will not be drawn at all.
- *Show frame* – when selected the frame around the graph is displayed. This is a 3D box determined by the specified ranges of the x, y and x axes.

- *Show scales* – when selected the scales are displayed.
- *Show info* – when selected the information field is displayed.
- *Show particle tracks* – when selected the currently defined particle tracks are displayed.
- *Show regions* – when selected the regions are displayed.
- *Show adornments* – when selected the adornments are displayed.
- *Show animators* – when selected the animators are displayed.
- *Reset field range* – resets the range of the vector magnitudes to the defaults. This also includes resetting the colour range in the legend.
- *Change variable labels* – displays a dialog box that prompts the user for new labels for the x and y axes.
- *Change variable decimal places...* – displays a dialog box in which the user can select the number of decimal places to be used for displaying the independent and field variables.
- *Redraw during resize* – if set, the view redraws during a resize operation. For a fine grid this might cause a lack of responsiveness. If not set redrawing does not occur and the user needs to perform some manual operation after the resize in order to force a redraw.
- *Select data to display...* – allows the user to select the subset of the data to display via a dialog box.
- *Reset min and max values to default* – returns the min and max values for all axes and the field magnitude to their default values.
- *Hide toolbars* – when selected the toolbars are hidden. This can also be achieved using the keyboard equivalent – double clicking the mouse while holding the ALT key down. Redisplaying the toolbars uses the same keyboard command.

Animation menu

- *Go to next time* – steps the display forward one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to previous time* – steps the display back one frame. This has the same effect as the equivalent button in the animation toolbar.
- *Play* – starts the animation forward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Play in reverse* – starts the animation backward in time. This has the same effect as the equivalent button in the animation toolbar.
- *Pause* – pauses the animation. This has the same effect as the equivalent button in the animation toolbar.
- *Go to start* – resets the display to the first frame. This has the same effect as the equivalent button in the animation toolbar.
- *Go to end* – resets the display to the last frame. This has the same effect as the equivalent button in the animation toolbar.

Camera menu

- *Manage cameras...* – opens the camera management view – see chapter 2.
- *Open current controller...* opens the controller view of the currently active camera – see chapter 2. This option can also be initiated using the keyboard equivalent – double-clicking with the SHIFT and ALT keys held down.

Lighting Menu

- *Manage lighting...* – opens the lighting manager view - see chapter 3.

Seeder Menu

- *Manage seeders...* – opens the seeder manager view. This view allows the user to create and manage seeders. See chapter 10 for complete information relating to seeders.

Region Menu

- *Manage regions...* – regions 3D manager view, allowing the user to create regions for use in the particle seeders.

Adornments menu

- *Manage adornments...* – opens the adornments manager view for this field view. The adornments manager view allows the user to create and manipulate adornments. See chapter 6.
- *Manage animators...* – opens the animators manager view. This enables animators to be created and manipulated. See chapter 8 for full information.

Zoom menu

- *Zoom* – if a zoom rectangle has been defined (drawn on the view) this command will cause this region to fill the entire display. Data outside this rectangle will be clipped.
- *Unzoom* – reverses any changes to the limits of the display region and restores the full field domain.
- *Clear zoom rectangle* – clears the zoom rectangle.

Popup menu

- *Set layout...* – see View menu.
- *Go to next time* – see Animation menu.
- *Go to previous time* – see Animation menu.

- *Play* – see Animation menu.
- *Play in reverse* – see Animation menu.
- *Pause* – see Animation menu.
- *Go to start* – see Animation menu.
- *Go to end* – see Animation menu.
- *Show vectors* – see View menu.
- *Show out of range* – see View menu.
- *Show frame* – see View menu.
- *Show scales* – see View menu.
- *Show info* – see View menu.
- *Show particle tracks* – see View menu.
- *Show regions* – see View menu.
- *Show adornments* – see Adornments menu.
- *Show animators* – see Adornments menu.
- *Select data to display...* – see view menu.

24.2.3.1 *Set layout dialog*

The set layout dialog controls the display settings for all views of this type. The three buttons at the bottom of the dialog are:

- *Reset...* – resets all of the layout settings to their defaults.
- *OK* – confirms the changes made and applies them to the view.
- *Cancel...* – cancels the changes and closes the dialog box.

The dialog includes 3 tabs – General, Borders and Colour.

General

- *Number of x divisions* – the divisions that divide the x axis. This determines the number of scale values that are displayed.
- *Number of y divisions* – the divisions that divide the y axis. This determines the number of scale values that are displayed.
- *Number of z divisions* – the divisions that divide the z axis. This determines the number of scale values that are displayed.
- *Vector scale factor* – the vectors drawn in this view are drawn with an arbitrary length scale. This option enables the user to scale the vectors lengths to a more convenient size.
- *Geometric scale factor* – this scale factor is applied to all geometric entities in the view such as the vectors, the axes and the frame. If the user zooms far from the view some of these objects may be hard to see and so this setting allows a global increase (or decrease if the user is zoomed in) in the scale of the drawn objects.
- *Font size* – sets the font size. The default is 14.

- *Draw axes at origin* – by default the axes in 3D space are drawn at the minimum values for each of the three coordinate axes. Thus they lie at the left, bottom and back of the 3D box that encapsulates the dataset. If this option is selected the axes are drawn through the origin. This may result in the axes appearing within the dataset.

Borders

- *Left border width* – the view includes a viewable region surrounded by borders in which the axis labels and scales appear as well the info label in the centre at the bottom. This setting is for the size, in pixels, of the left hand border. It is worth noting that the size of the borders may need to change when producing an image of this view depending on the resolution chosen for the image.
- *Right border width* – sets the size, in pixels, of the right hand border.
- *Bottom Border width* – sets the size of the bottom border in pixels.
- *Top border width* – sets the size of the top border in pixels.

Colour

- *Vector colours* – the range of colours used to present the vectors. The dialog box that is presented provides the user with a range of options. The colour scale is defined by 6 fixed points with colours between these interpolated linearly across the red, green and blue guns. Each can be changed independently. The user may choose to use a gray scale range or return to the defaults provided. The user can also save and reload their colour choices.
- *Axes colour* – the colour of axes. It can be changed by clicking on the Select... button.
- *Labels colour* – the colour of all labels, including the scales, axis names and the info text at the bottom of the view. It can be changed by clicking on the Select... button.
- *Background colour* – the background colour. It can be changed by clicking on the Select... button.

24.3 Popup menu

The vector field 3D provides the following options in its popup menu.

- *Save as...* – saves the field to a disk file. The file has a *.v3d4d* extension.
- *Save* – saves the field to a disk file with the current name.
- *Save as text file...* – saves the field in a comma delimited text file. Either a *.txt* or *.csv* extension can be specified. The user can choose to save the data with headers (which means header information is included) or without headers (just raw field data is stored).). In the latter case the user can choose to store only a subset of the 2D fields (each 2D field corresponds to a different time) in the text file and thus a number of sequentially numbered files are used to store the entire 3D field.

In all cases the x component of the vector field is stored in the file (for all times) followed by the y component of the field. The user can also choose whether they wish to have data stored so that the y axis is downwards or the x axis is downwards (swap axes). This latter feature can be important when trying to read a field file into a spreadsheet that has a limit on the number of columns available. The 2D fields are stored sequentially in the (each) file. The user will be prompted to specify the number of decimal places used to store the independent and field values.

- *Open details view...* – opens the details view.
- *Open animated vector view...* – opens the animated vector view.
- *Open particle track view...* – opens the particle track view.
- *Open persistent view manager view...* – opens the view that manages all of the persistent views saved for this field. The persistent views appear in a list box that displays the names given to the views by the user when they were saved. A persistent view can be opened by double clicking on its name.
- *Close all views* – closes all open views of this field.
- *Close* – this option removes the field from its enclosing container. The user will be prompted to confirm the choice and to save the field if desired.