OpenFOAM® Basic Training

Appendix D
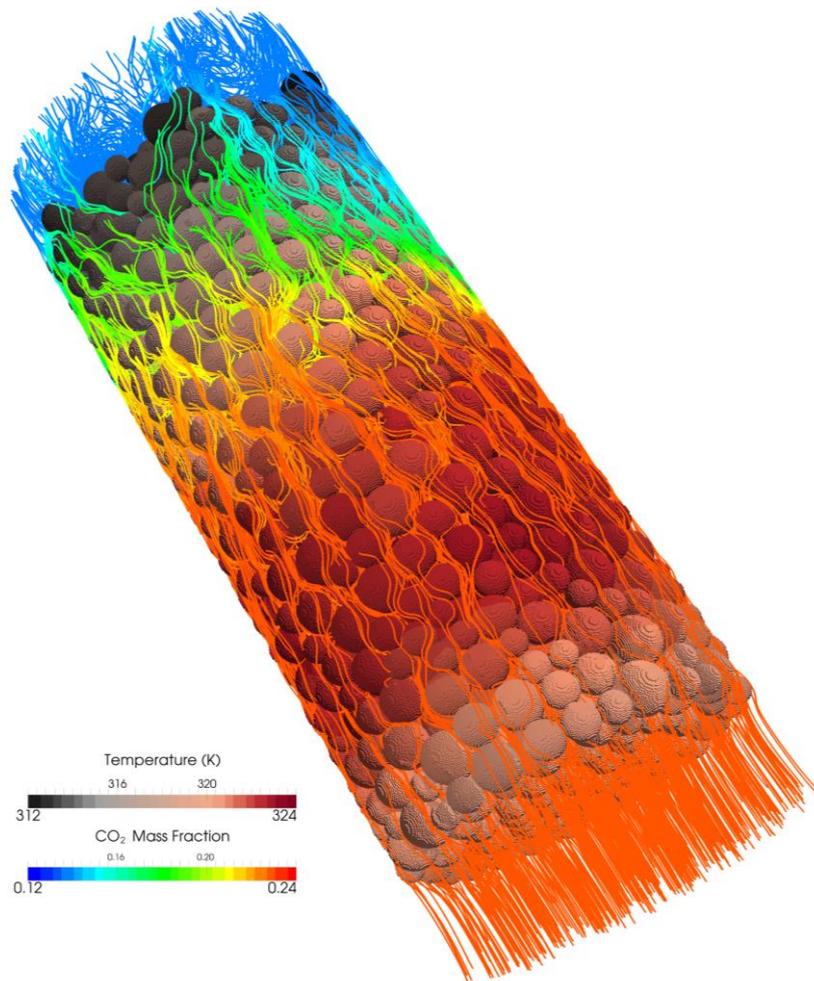
Temperature (K)

CO$_2$ Mass Fraction

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Cover picture from:
- Bahram Haddadi, The image presented on the cover page has been prepared using the Vienna Scientific Cluster (VSC).

Appendix D

ParaView

The visualization application, which is usually used with OpenFOAM® is ParaView (Figure D-1) which is a free, open source program. The OpenFOAM® command foamToVTK converts OpenFOAM® files to readable formats for ParaView.
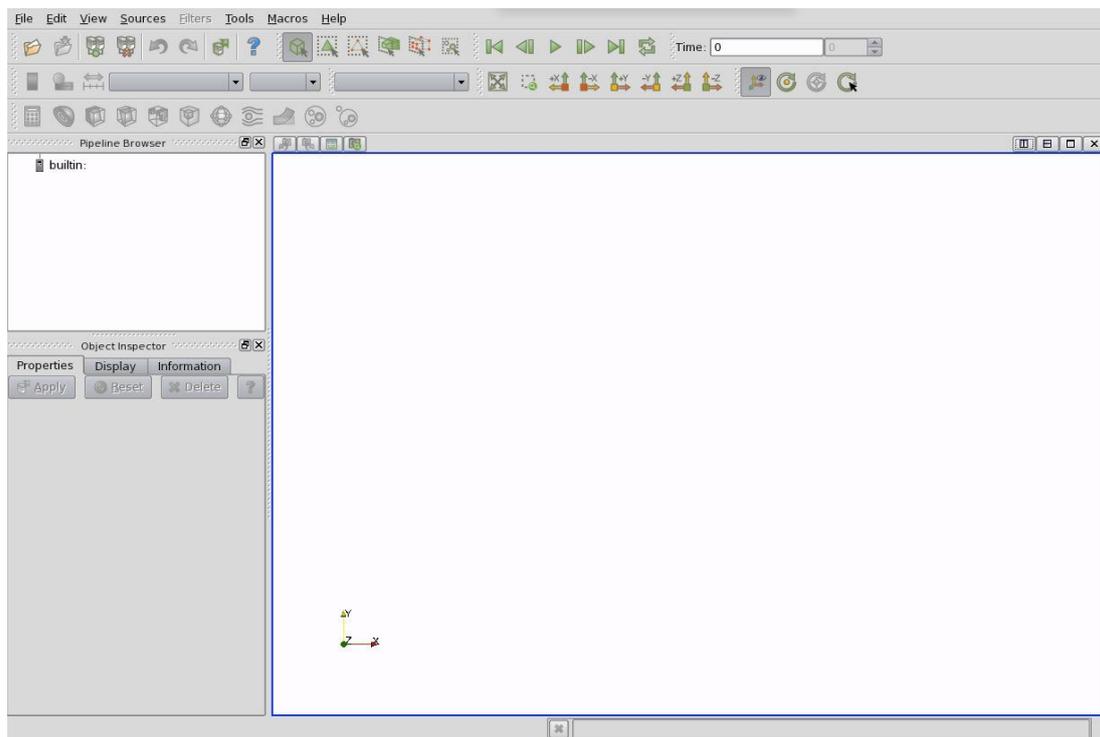
Figure D-1 The paraView window

The tree structure ("pipeline") of ParaView helps the user to easily choose and display suitable sub-models for creating the desired image or animation. Adding a mesh or velocity vectors to a contour plot of pressure is an example of this functionality.

For general operations a selection should be made and then the green *Apply* bottom should be pressed. The reset bottom is used for resetting the window and delete deletes the selected operation.

Properties panel (D-2)

Setting for time step, regions and fields can be done in the Properties panel.
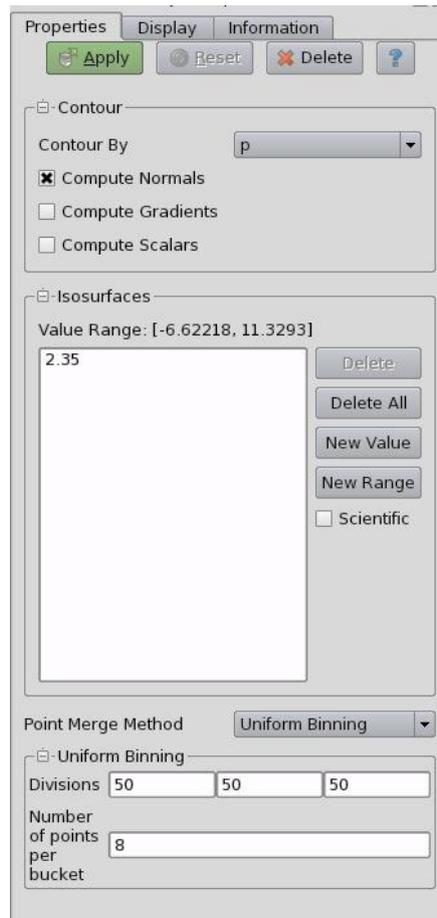
Figure D-2 The Properties panel for contour plots

Display panel (D-3)

For a given case settings for visualizing the data are in the Display panel.

Some important notes:
- The max/min data range might not be updated automatically, so check and if needed, rescale the data range after appropriate intervals (e.g. after loading the case).

- Two panels can be accessed by clicking the Edit Color Map button:
    1. Color Scale panel: scale colors can be chosen, for resetting the color to standard blue to red, click choose preset, and select from opened window, Blue to Red HSV.
    2. Color Legend panel: the legend layout (e.g. the font) can be set in this panel.
- For displaying the mesh select Wireframe from Representation menu of the Style panel.
- Single color can be used for visualizing the geometry, e.g. a mesh (if Wireframe is selected), by selecting Solid Color from the "Color by" menu and specifying the color in the Set Ambient Color window.
- The opacity of the image can be set (1 = solid, 0 = invisible) in the *Opacity* in the Style panel.
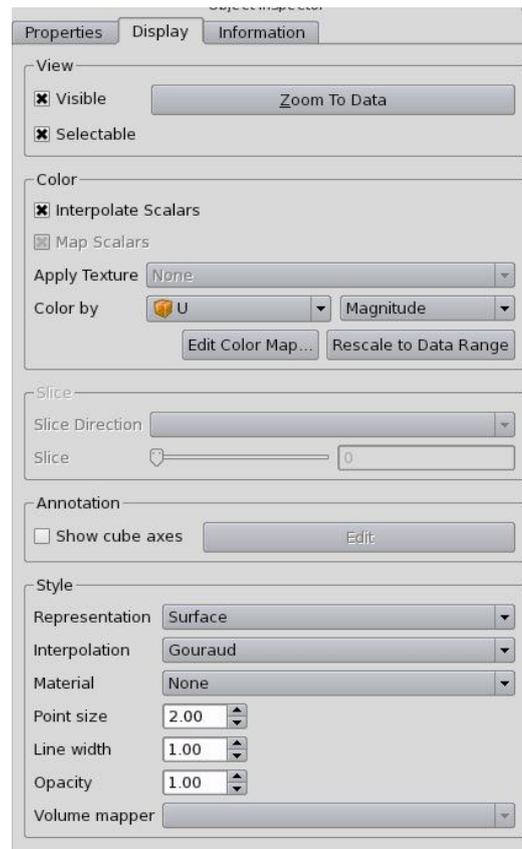
Figure D-3 The Display panel

Button toolbars

Pull-down menus at the top of the main window and the major panels, in the toolbars below the main pull-down menus increase the functionality of ParaView. The function of each button can be easily understood by its icon (Figure D-4), also any button description can be found in the Help menu (keeping the mouse over an icon without clicking on it will also give a short explanation on its functionality).
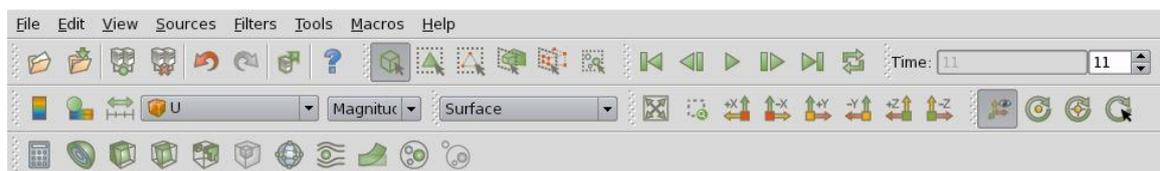
Figure D-4 Toolbars in ParaView

Manipulating the view

View settings

The View menu from Edit menu contains three items: General, Lights and Annotation.

The General panel includes the following items (which are often set at startup):

- The background color, from arrow down Choose Color button.
- Parallel projection is the usual choice for 2D, CFD simulations.

The lighting controls are in Lights panel in the Light Kit panel. For producing images with strong bright colors (e.g. isosurface) Headlight of strength 1 is appropriate.

For including annotations in the image Annotation panel should be used. The Orientation Axes feature controls an axes icon in the image window (e.g. to set the color of the axes labels x, y and z).

General settings

Some default behavior of ParaView can be controlled in the General panel. The Auto Accept button enables accepting the changes without pressing the Apply button (not a very good option for big cases because re-rendering the image after each change takes a long time)

The Render View panel contains three sub-items: General, Camera and Server. The level of detail (LOD) is included in the General panel which controls the rendering of the image while it is being manipulated (e.g. rotated or resized); lower levels allow cases with large numbers of cells to be re-rendered quickly during manipulation.

The Camera panel includes control settings for 3D and 2D movements. The user can edit the rotation, translation and the zoom map to make it suitable for these needs. This can be used by a combination of mouse, Shift and Control keys.

Contour plots

Selecting Contour from the Filter menu at the top menu bar creates a contour plot.

If the case is a 3D case module, the contours will be a set of 2D surfaces that represent a constant value. There is Isosurface list in the Properties panel that the users can edit by New Range window in the most convenient way. The chosen scalar field is selected from a pull down menu.

Introducing a cutting plane

Creating contour plots across a plane is more convenient than isosurfaces. Cutting planes are the tools which can be used for this purpose, to create surfaces. This can be done by Slice filters, using cutting Plane, Box or Sphere options. A cutting plate can be manipulated like other by mouse. In a similar way, the contour lines can also be derived out of planes.

By default ParaView triangulate the cells and shows them as triangles. For disabling this uncheck "triangulate the slice" option in the properties window of slice.

Vector plots

The Glyph filter is used for creating vector plots. Scale Mode menu in the properties panel is used for:

- Setting the length of a vector, weather to be proportional to vector magnitude or not, all with the same length (Vector).

- Controlling the base length of the glyphs (set Scale Factor).

Plotting at cell centers

Vectors at cell centers are more common, for this purpose the Cell Centers filter should be applied before Glyph filter.

Streamlines

Creating tracer lines, using the Stream Tracer filter create streamlines. Tracer points can be along a line or point which are shown in white, and can be choose from Tracer Seed panel. Usually, some trial and error is needed for achieving the desired streamlines, the length of steps tracer takes can be changed in the main Stream Tracer panel, a smaller length increase calculation time but increase smoothness. For having high quality images Tubes filter can be used after tracer lines have been created. There are different types of tubes, not only cylindrical.

Image output

For creating a screenshot of the graphs the easiest way is Save Screenshot from File menu. After selecting it in the opened window the picture resolution can be set, and by locking the aspect ratio, changing image resolution in one direction cause change in its resolution in the other direction respectively. For high quality images a resolution of more than 1000 pixels is a good choice.

Animation output

Some animations can be also created using ParaView in the File menu by choosing animation and setting the resolution, and also frames per time step. You can save your animation by assigning a name and choosing file format, and then the captured pictures are saved with this format:

"<fileRoot>_<imageNo>.<fileExt>"

In the newer versions of ParaView (4.3.1), it is possible to export directly as animation with .ogv or avi format. Do the same as before, except in the saving window select .ogv or .avi for file format.