IRIS EMC PARAVIEW PLUGINS; GUIDE

IRIS Data Services, Data Products Team, April 2019, V.2019.091

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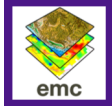
IRIS



CONTACT

Comments or questions?
Please contact:

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IRIS

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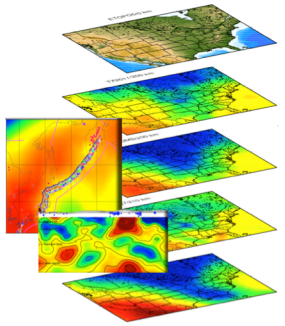
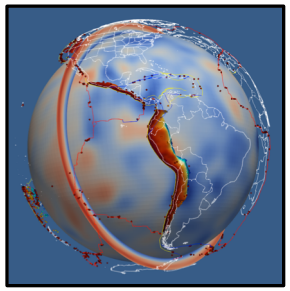
EMC

EMC is a community Earth model repository with the aim of providing the research community with access to various Earth models under a uniform format, visualization tools for model preview and access to the processing software and scripts (http://ds.iris.edu/ds/products/emc/).



- Repository of research Earth models:
  http://ds.iris.edu/ds/products/emc-earthmodels/
- Reference Earth models are also available:
  http://ds.iris.edu/ds/products/emc-referencemodels/
- EMC-Tools - Python tools for the EMC's netCDF Earth model files
  https://github.com/iris-edu/emc-tools
- Web browser-based visualization tools
  http://ds.iris.edu/dms/products/emc/horizontalSlice.html
- ParaView plugins for 3D Visualization supporting both netCDF & GeoCSV formats
  https://github.com/iris-edu/EMC-ParaView



EMC-Tools

EMC's GitHub repository of Python scripts for converting the EMC's netCDF Earth model files (in netCDF 3 format) to and from GeoCSV format:
https://github.com/iris-edu/emc-tools

Formats:

- netCDF 3 (Network Common Data Form)
  https://www.unidata.ucar.edu/software/netcdf/
- GeoCSV (tabular text formatting for geoscience data)
  http://geows.ds.iris.edu/documents/GeoCSV.pdf

Scripts:

- `netCDF_2_GeoCSV_3D.py` - read a 3D netCDF Earth model file and display its header information or convert it to GeoCSV format
- `GeoCSV_2_netCDF_3D.py` - read a 3D GeoCSV Earth model file and display its header information or convert it to netCDF format.
- `netCDF_2_GeoCSV_2D.py` - read a 2D netCDF Earth model file and and display its header information or convert it to GeoCSV format.
- `GeoCSV_2_netCDF_2D.py` - read a 2D GeoCSV Earth model file and display its header information or convert it to netCDF format.

ParaView

Open-source, multi-platform data analysis and visualization application for visualizing 2D/3D data.

- Main site: https://www.paraview.org
- Download page: https://www.paraview.org/download/
- Webinars: https://www.paraview.org/webinars/
- Wiki: https://www.paraview.org/Wiki/ParaView
- Discussion forum: https://discourse.paraview.org/

ParaView currently supports Python 2.7 and offers scripting support. EMC plugins are based on ParaView's support of Python:

- ParaView's Python documentation

  https://kitware.github.io/paraview-docs/latest/python/

- Creating Plugins for ParaView:

  https://www.paraview.org/Wiki/ParaView/Plugin_HowTo

ParaView Getting Started Guide and GUI:

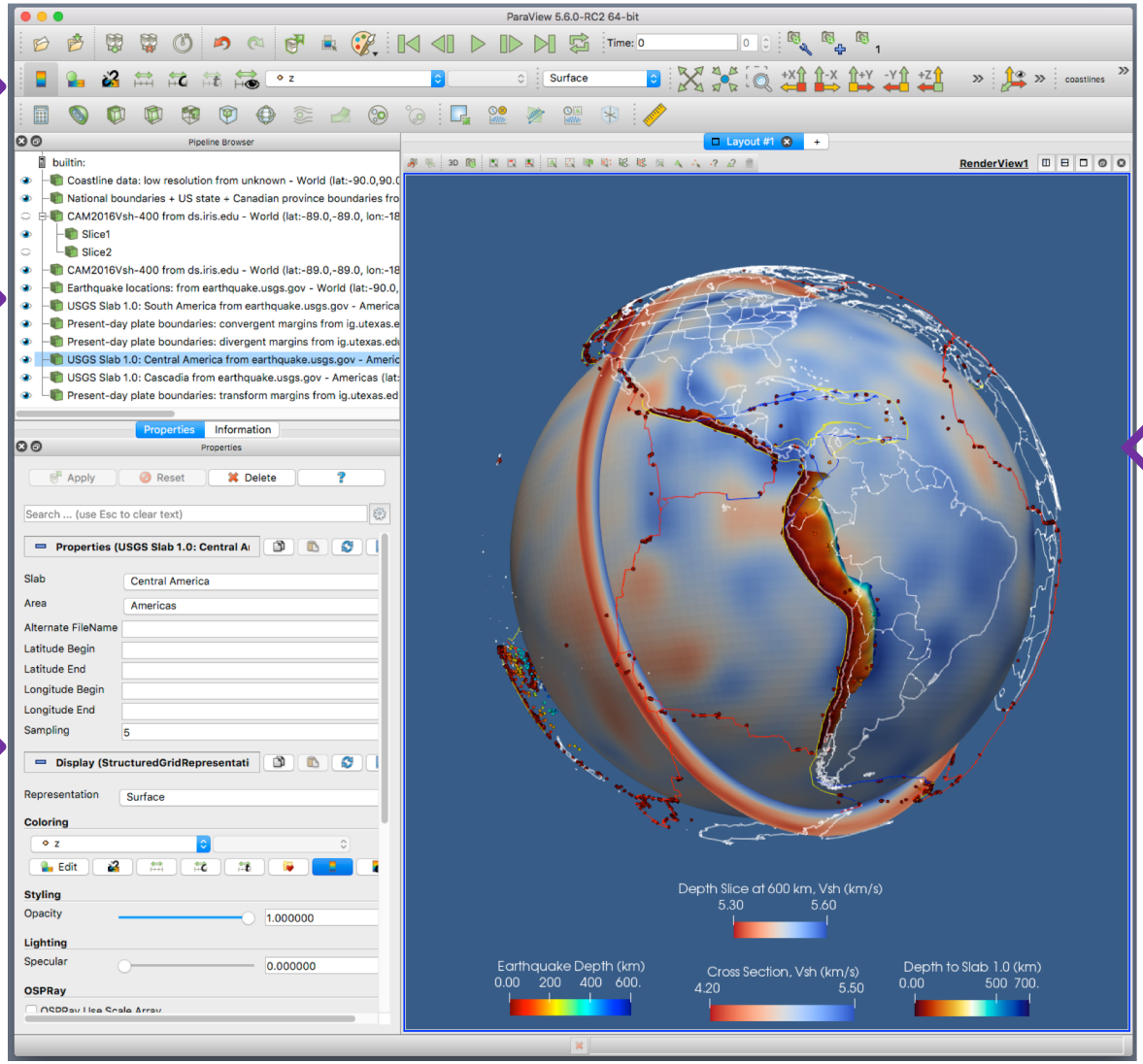
http://www.paraview.org/files/v5.1/ParaViewGettingStarted-5.1.0.pdf

Menu Bars

Tool Bars

Pipeline Browser

Properties & Information Panels



Render View

ParaView GUI

IRIS

ParaView Getting Started Guide:

http://www.paraview.org/files/v5.1/ParaViewGettingStarted-5.1.0.pdf

Menu Bars → For accessing majority of ParaView features, including plugins

Tool Bars → For accessing commonly used features of ParaView

Pipeline Browser → Shows objects in ParaView's pipeline and how they are related. EMC Plugins use the Pipeline Browser to also fully document objects that they create.

Properties & Information Panels →

Properties tab allows you to view and change parameters of the current pipeline object.

Information tab provides a summary of current pipeline object's data.

Where a 3D view of your data is rendered. ← Render View

IRIS

EMC ParaView Plugins

Python programmable filters/sources that allow ParaView display EMC netCDF/GeoCSV Earth models along with other auxiliary Earth data

https://github.com/iris-edu/EMC-ParaView

Installing the Plugins is Easy!

- Make sure you have Python 2.7 installed on your system
- Download the EMC-ParaView GitHub repository and unpack it. This will result in a directory structure like:

```
IRIS_EMC_Paraview  The root directory of the plugins
|
|____plugins  This directory is created and populated during the build and will contain plugings for ParaView
|____xml  This directory contains an XML file for seis color palette
|____macros  This directory is created and populated during the build and will contain macros for ParaView
|____data  This directory and its subdirectories (where your data will be stored) are created during the build
| |____boundaries
| |____models
| |____volcanoes
| |____scratch
| |____slabs
| |____earthquakes
|   |____animation
|____src  This directory and its subdirectories contain the plugin bundle code
  |____filters
  |____IrisEMC_Paraview_Param.py  plugins parameter file
  |____macros
  |____build_plugins_macros.py  Installation script
  |____readers
```

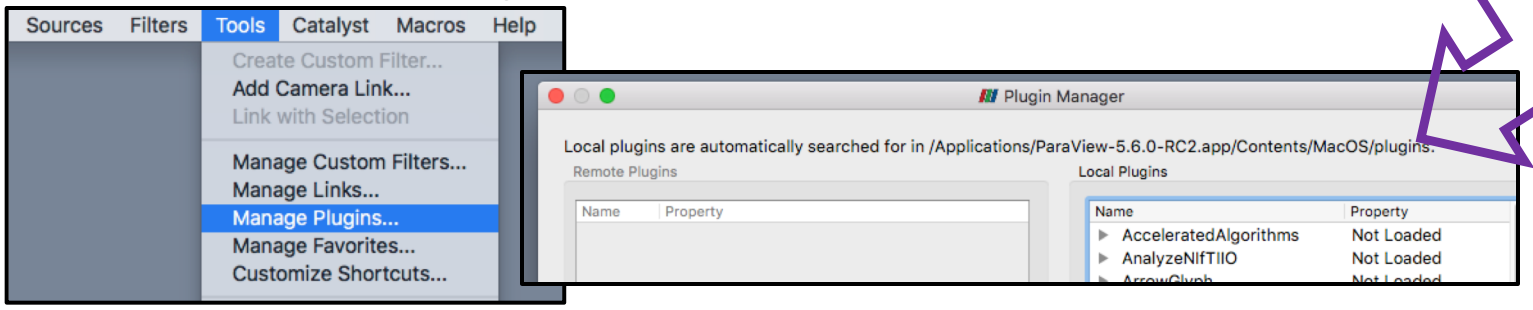
- Read the *INSTALL.txt* file
- Run the *build_plugins_macros.py* script under the *src* directory

Adding Plugins to ParaView

During the build process, the *`plugins`* directory gets populated

```
IRIS_EMC_Paraview  The root directory of the plugins
|
|____plugins
   |____read_boundaries.xml
   |____read_3d_models.xml
   |____read_coordinates_converter.xml
   |____read_earthquakes.xml
   |____read_grids.xml
   |____read_etopo.xml
   |____filter_view_coordinates.xml
   |____read_2d_models.xml
   |____read_volcanoes.xml
   |____read_usgs_slab.xml
```

You need to load the content of the above directory to ParaView.
Where? To find out, go to the `Tools` in ParaView menu

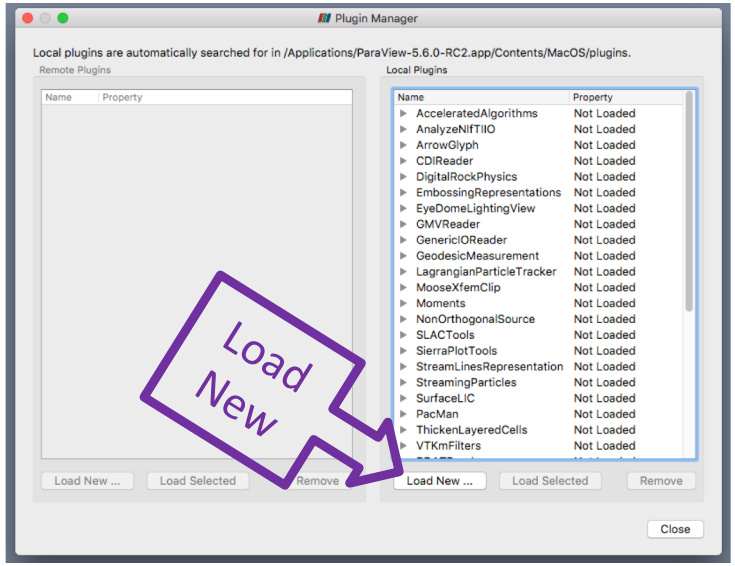


This is where ParaView is looking for them

IRIS

Two options for adding Plugins to ParaView

1. On *`Plugin Manager`* window click on the *`Load New`* button and change the file type to *`xml`* and load plugins from the *`IRIS_EMC_Paraview/plugins`* directory. These plugins will remain active during this ParaView session but you have to reload them after each ParaView restart



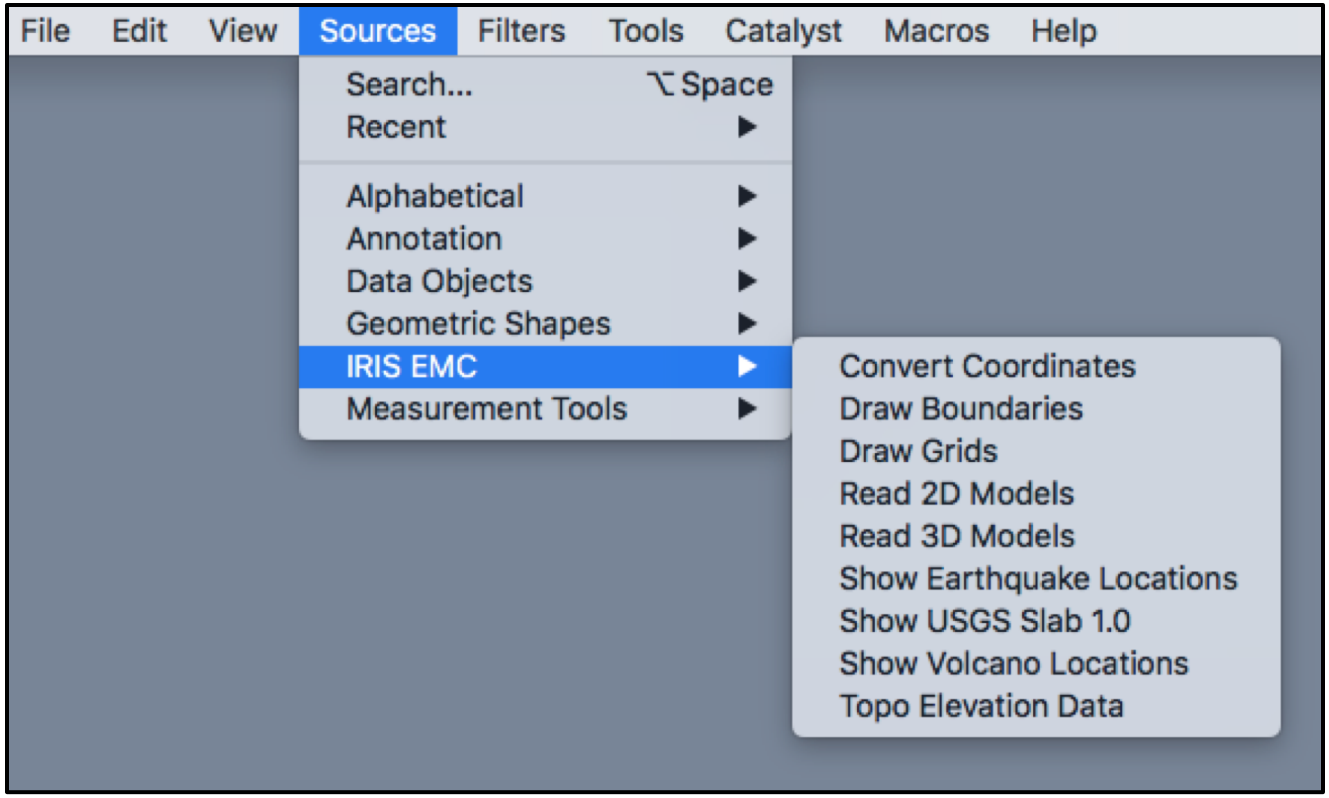
2. Manually copy your plugin files under the designated plugin directory so they would be loaded automatically. A better option would be to assign this directory to the *`EMC_PLUGINS_PATH`* parameter in the plugins parameter file, *`IrisEMC_Paraview_Param.py`*, so every time you rebuild the bundle, plugins get updated. *Warning: this option requires granting full permission to user for accessing this directory.*

   Under Mac and Linux, you can also use symbolic links for this.

   Restart ParaView

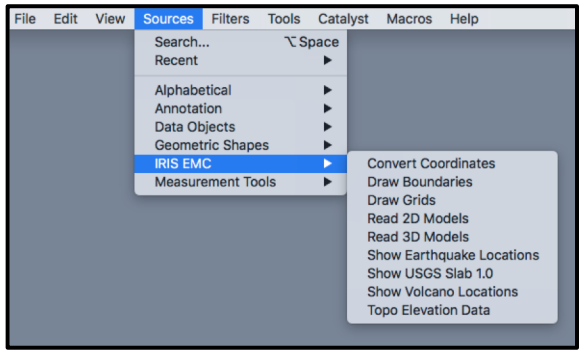
EMC ParaView Plugins

Once the plugins are added to ParaView and ParaView is restarted, EMC plugins will appear under the ParaView menu bar



EMC ParaView Plugins

- Convert Coordinates: Simple tool to convert geographic coordinates to XYZ and vice versa
- Draw Boundaries: Draws coastlines, national, US states and Canadian provinces, present-day plates (divergent, transform or convergent margins) or your own GeoCSV boundary files
- Draw grids: Draw latitude/longitude grid lines
- Read 2D Models: Read and plot 2D Earth model files in netCDF and GeoCSV file format
- Read 3D Models: Read and plot 3D Earth model files in netCDF and GeoCSV file format
- Show Earthquake Locations: plot earthquake locations based on the FDSN event services or your local GeoCSV earthquake location files
- Show USGS Slab 1.0: Display USGS Slab 1.0 models
- Show Volcano Locations: plot location of volcanoes using WOVOdat location data from `ds.iris.edu` or using your own GeoCSV volcano location or other point data files
- Elevation data: Plot surface elevation changes using elevation data files



Data Files

As you use plugins, it is important to know where the data come from:

When you select a dataset to plot, plugin goes through a few checks in the following order to find the data. The first place it finds the data, it will use that data:

1. Checks the corresponding directory under the `data` directory
2. Checks if the file name provided is a full path to the file
3. Checks IRIS EMC's file repository
4. Assumes the file name is a URL to the file you want to download

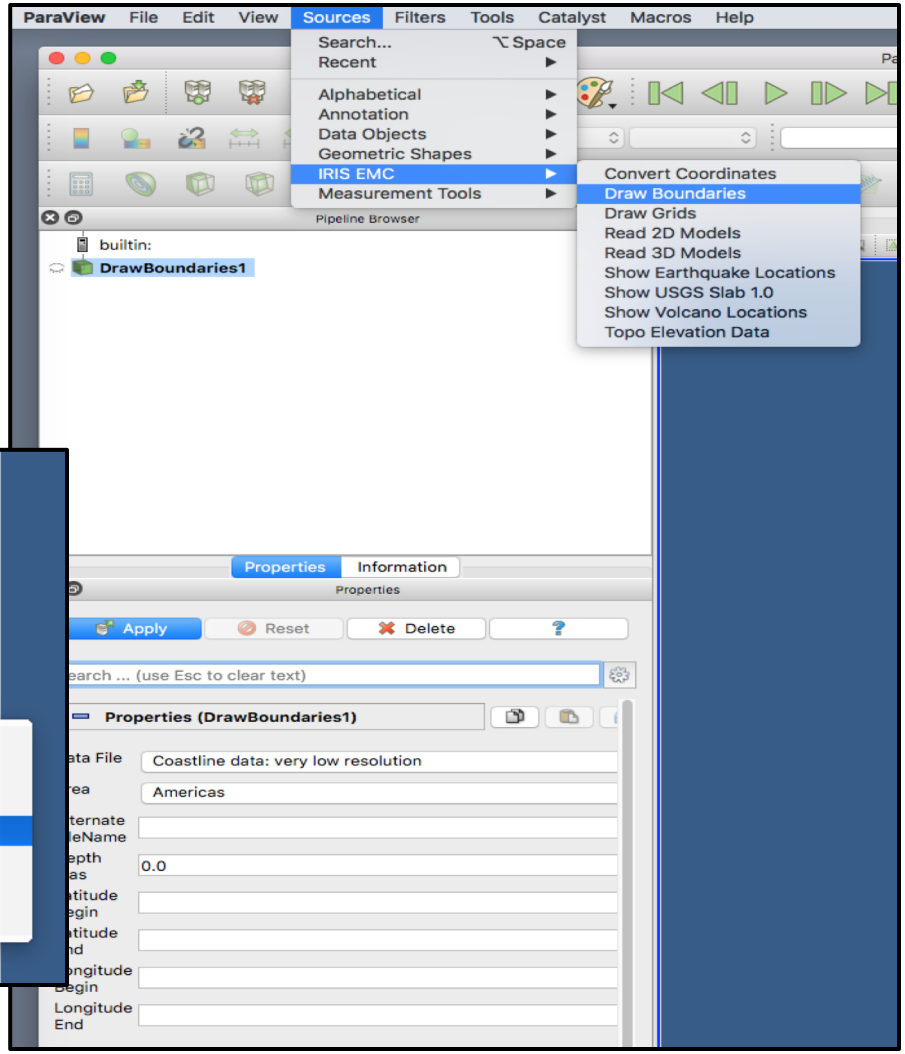
Notes:

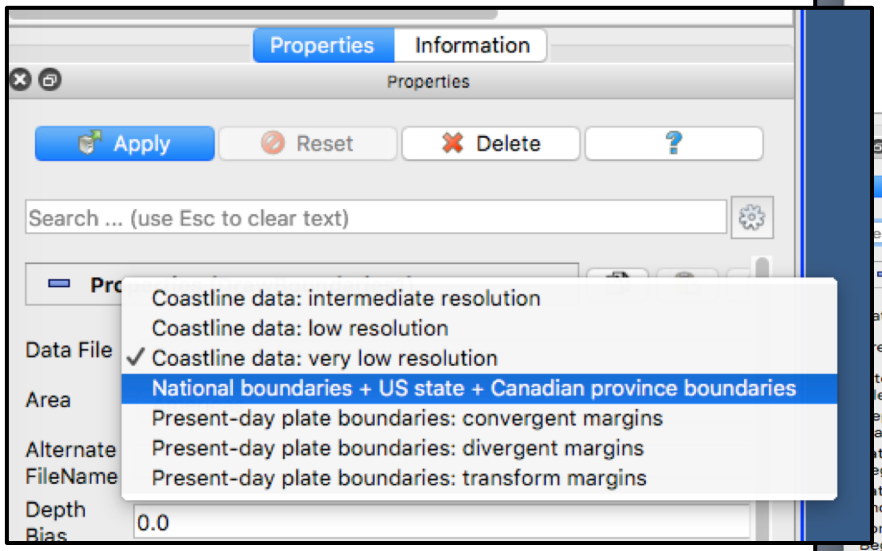
- If the `Alternate File` box is populated in the property panel of the plugin, this alternate file name will override the default file name.
- If file matching your request is found under the data directory that matches your request, it will use it. To force the plugin to download it again, remove the file from the data directory
- If you want to work offline with the plugins, make sure first connect to the Internet and visit all the plugins that you want to use and select the file you want to use (you do not need to go through complete processing sequence, just the first `Apply` should be sufficient). This will ensure that files are available under the data directory when you are offline or connected to a slow Internet.

Draw Boundaries

Allows you to draw boundaries (lines) from IRIS EMC's coastlines, national, US states and Canadian provinces, present-day plates (divergent, transform or convergent margins) boundary files or from your own GeoCSV boundary files:

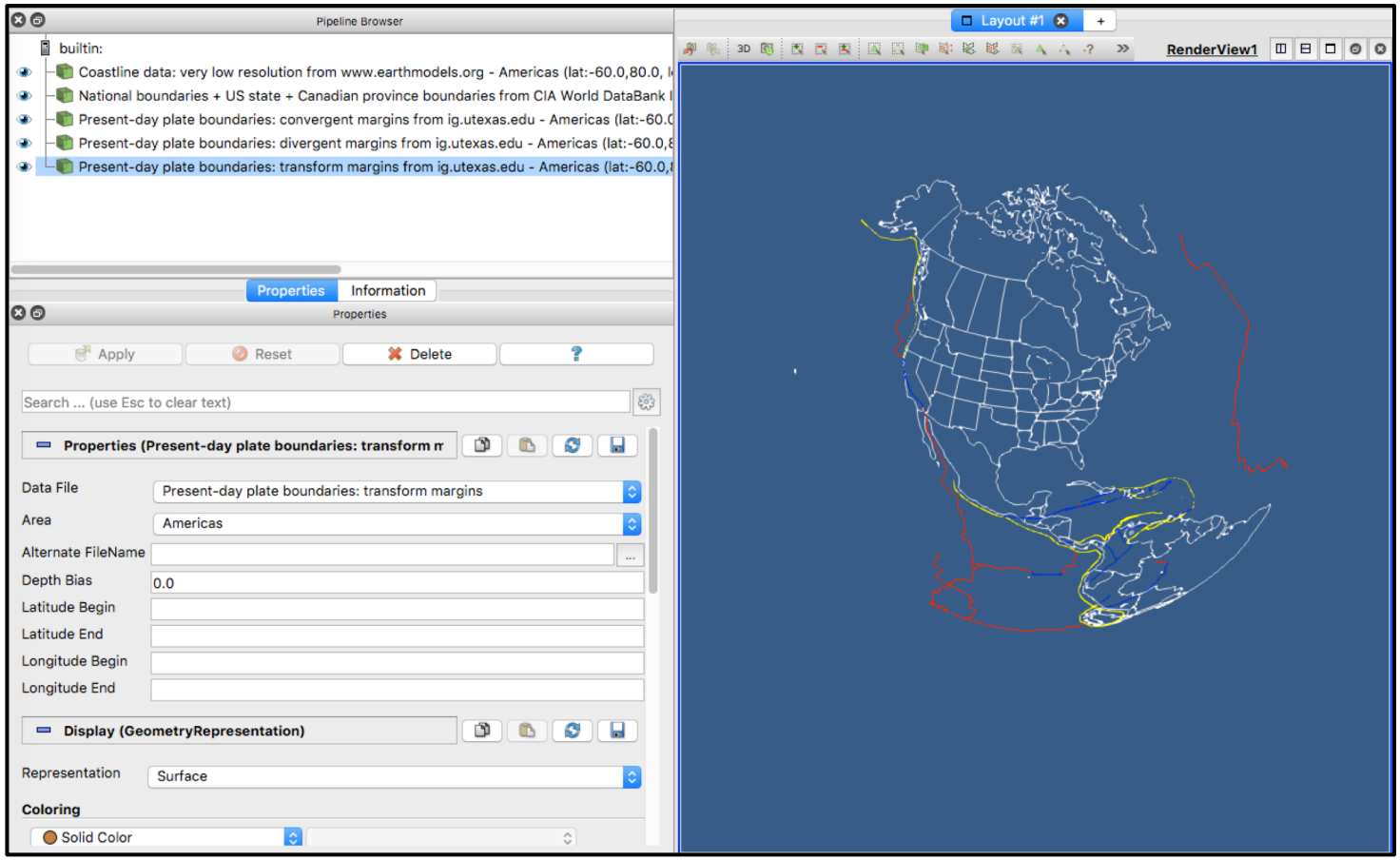
1. Select Draw Boundaries
2. In the properties pane select the type of boundary you want to draw
3. In the properties pane set parameters or simply select the region from the drop-down menu
4. Click `Apply`





Draw Boundaries (Cont'd)

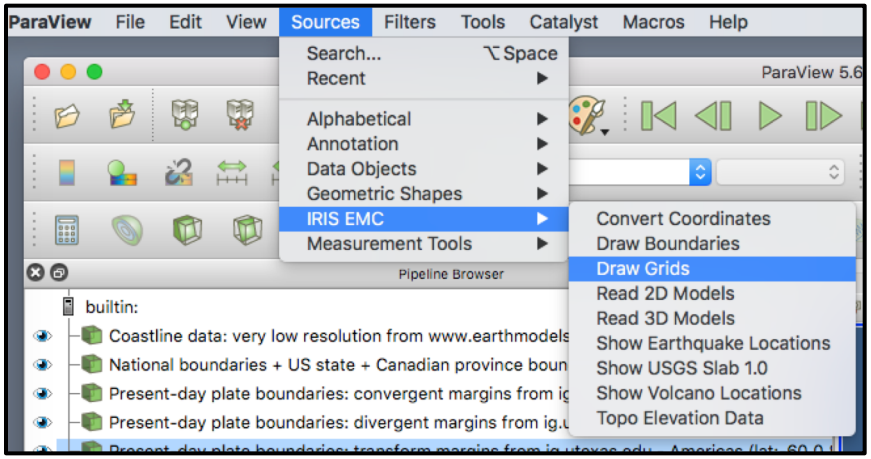
Repeat steps 1 to 4 above for as many boundary lines you want to draw. Each boundary line will appear as an object in the `Pipeline Browser`. You can further tune each boundary line by selecting it from the `Pipeline Browser` and change its properties.

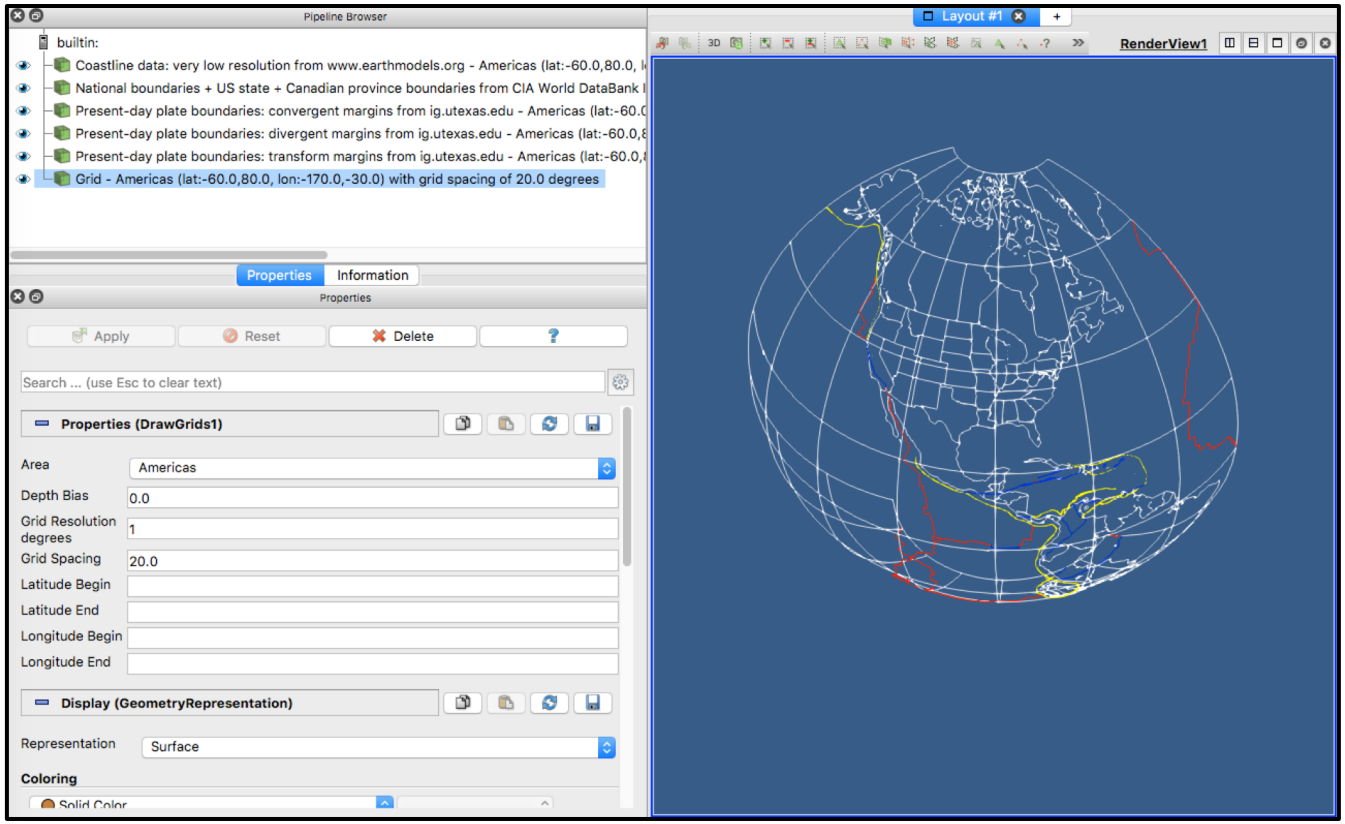


Draw Grids

Draw latitude/longitude grid lines:

1. Select `Draw Grids`
2. In the properties pane set parameters or simply select the region from the drop-down menu
3. Click `Apply`

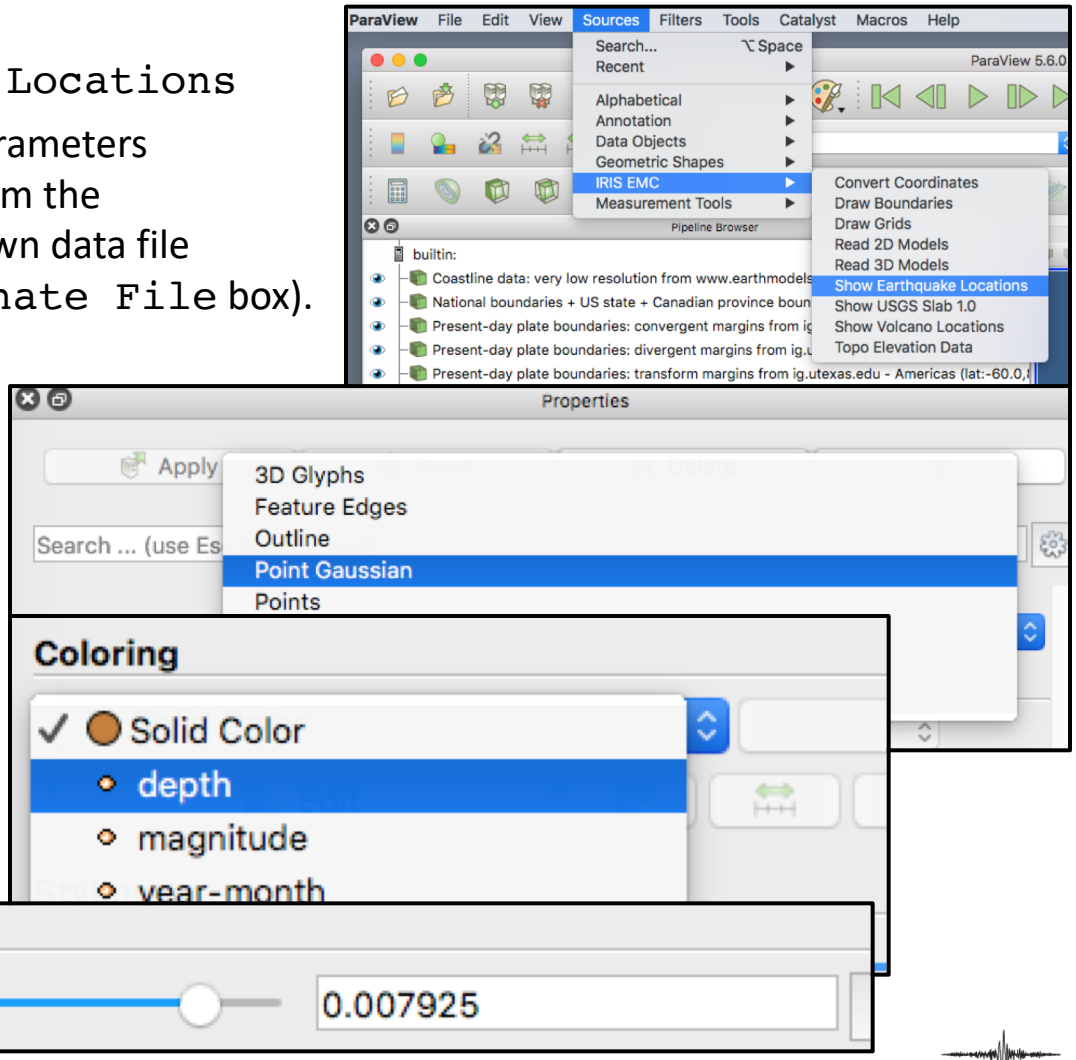




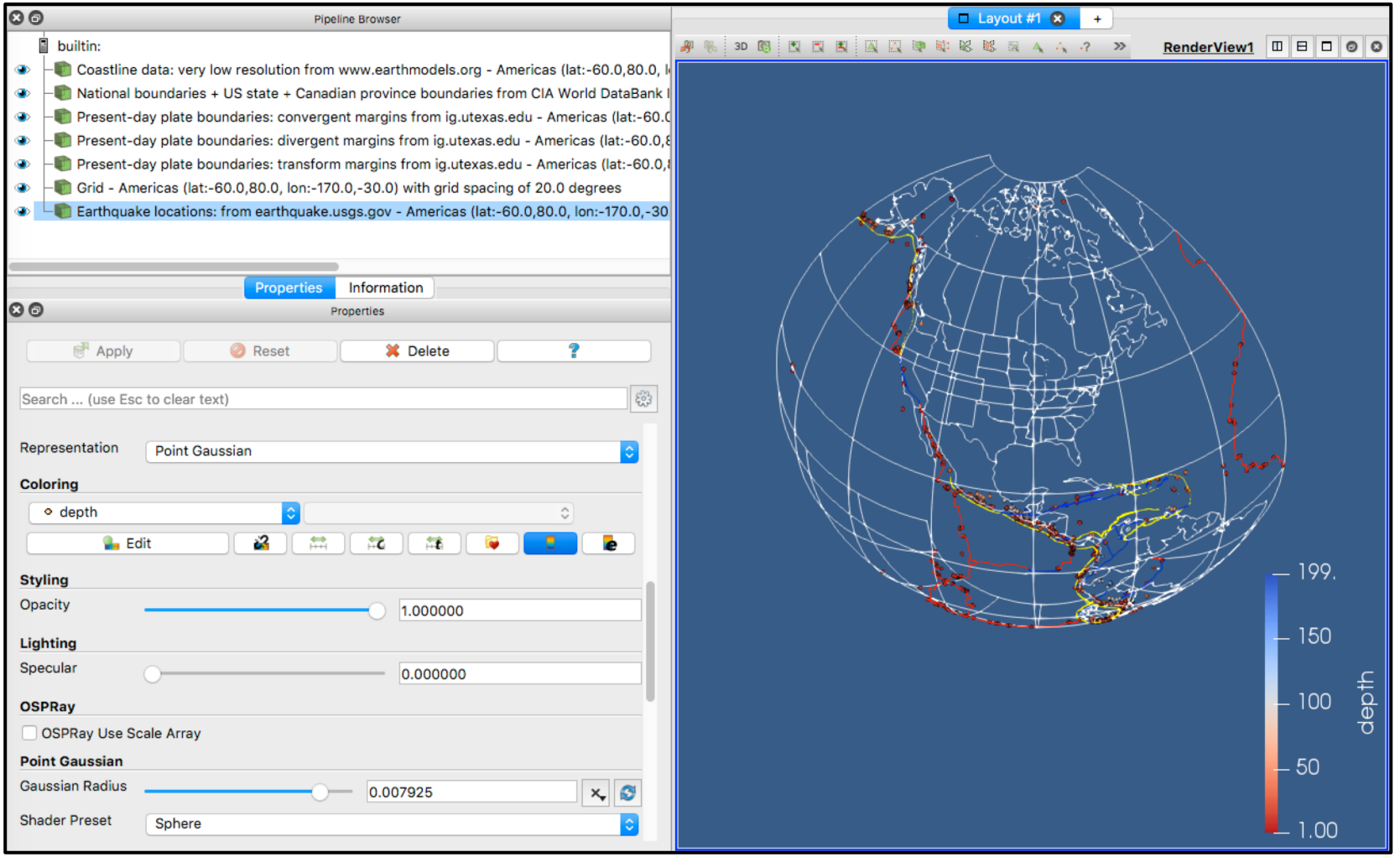
Show Earthquake Locations

Plot earthquake locations based on the FDSN event services or your local GeoCSV earthquake location files

1. Select `Show Earthquake Locations`
2. In the properties pane set parameters or simply select the region from the drop-down menu (use your own data file by specifying it in the `Alternate File` box).
3. Click `Apply`
4. In the properties pane set:
   - `Representation` to `Point Gaussian`
   - Select `Coloring` based on a parameter or leave it as solid
   - Set the marker size via `Gaussian Radius`



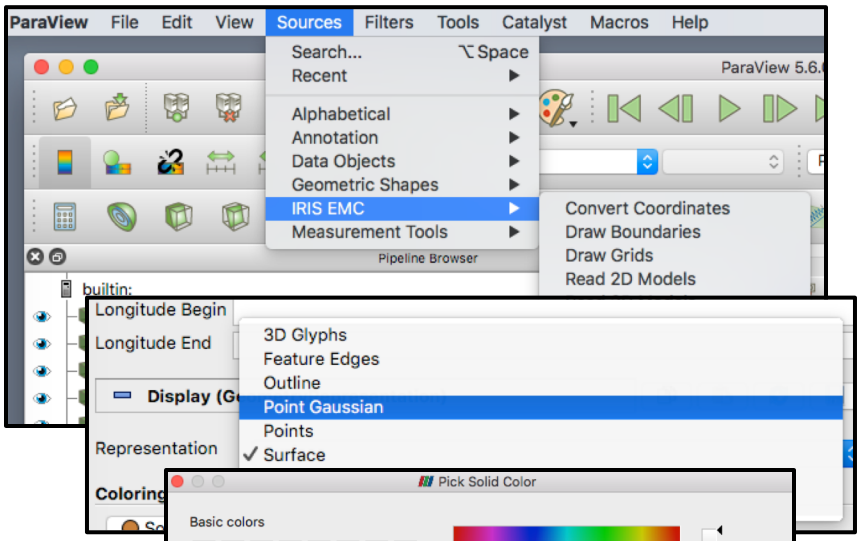
Show Earthquake Locations (Cont'd)

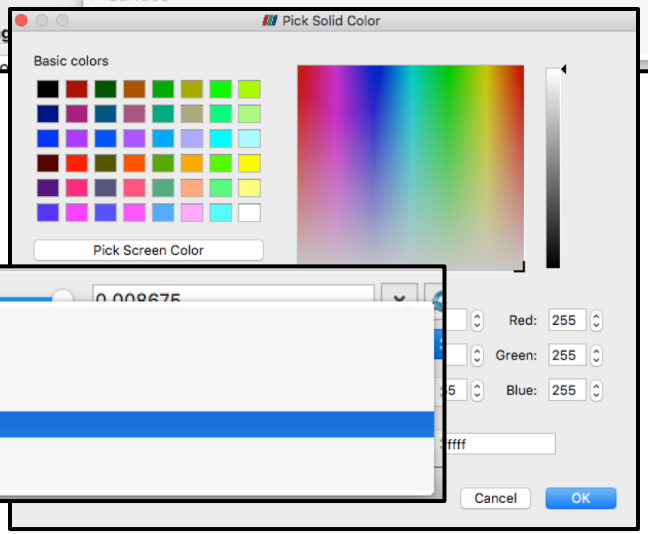


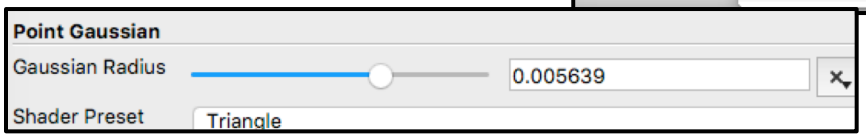
Show Volcano Locations

Plot location of volcanoes using WOVOdat location data (https://wovodat.org/) from `ds.iris.edu` or using your own GeoCSV volcano location or other point data files

1. Select `Show Volcano Locations`
2. In the properties pane set parameters or simply select the region from the drop-down menu (use your own data file by specifying it in the `Alternate File` box).
3. Click `Apply`
4. In the properties pane set:
   - `Representation` to `Point Gaussian`
   - Select `Coloring` using the `Edit` button
   - set marker shape to triangle using `Shader Preset` option
   - Set the marker size via `Gaussian Radius`

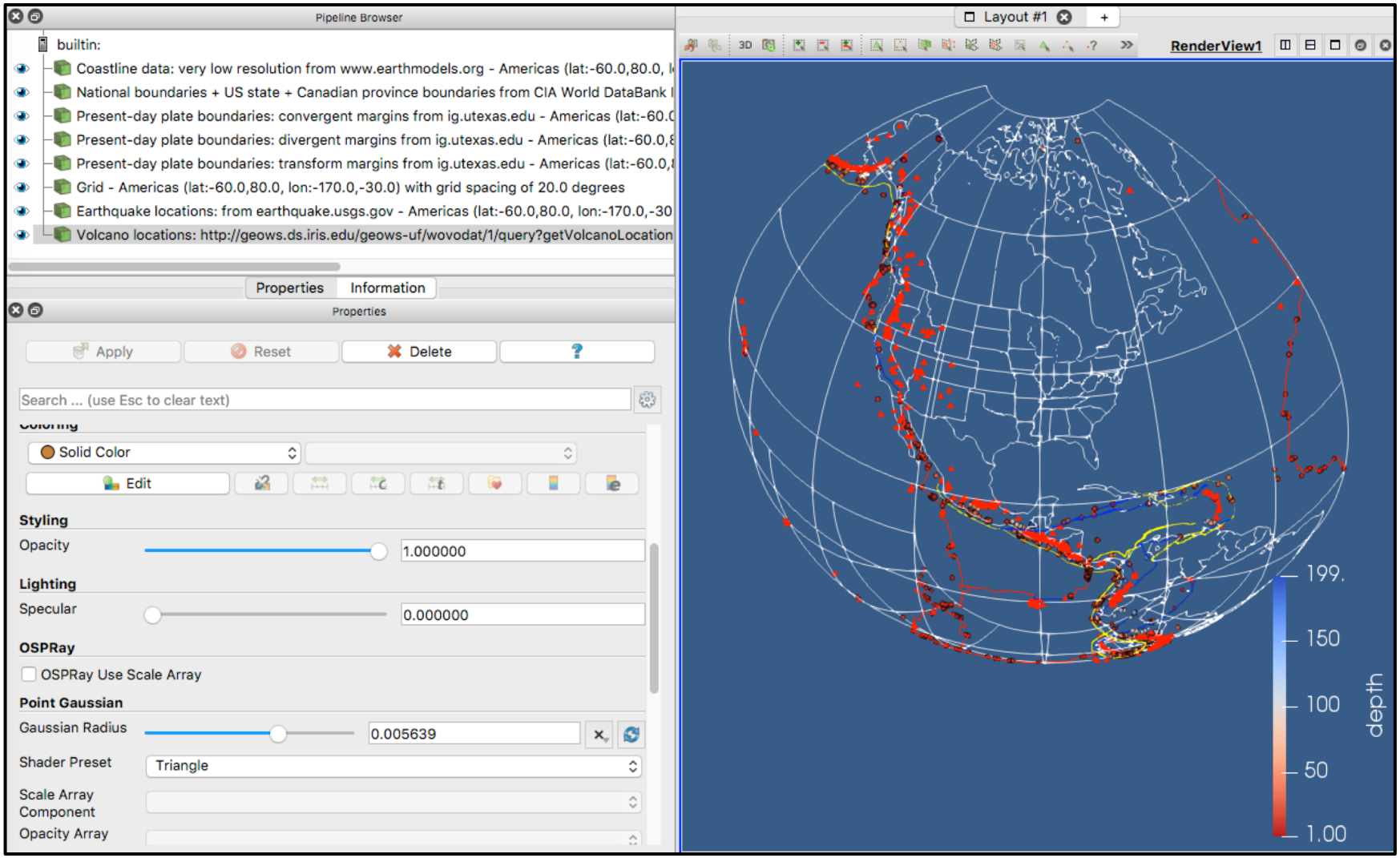






EMC ParaView Plugins – Show Volcano Locations

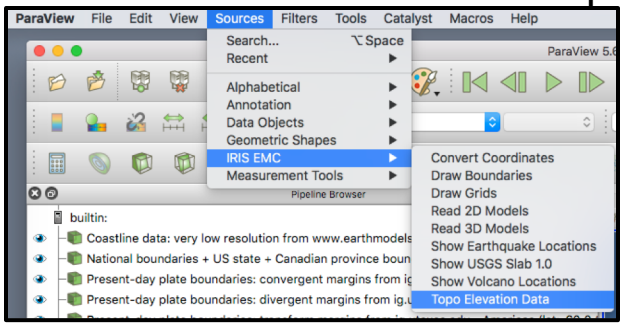
Show Volcano Locations (Cont'd)



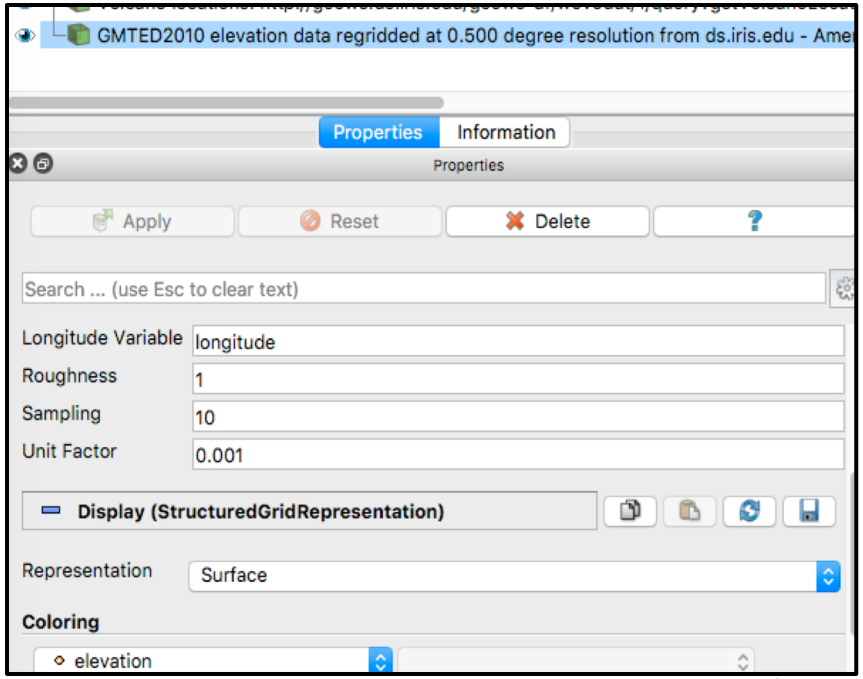
EMC ParaView Plugins – Show Volcano Locations

Topo Elevation Data

Plot surface elevation changes using elevation data files (**NOTE**: Plugins can read netCDF files only under Mac and Linux. Under Windows, plugins automatically try to find the GeoCSV version. You can leave the file extension out to let the plugin choose the format based on your OS).

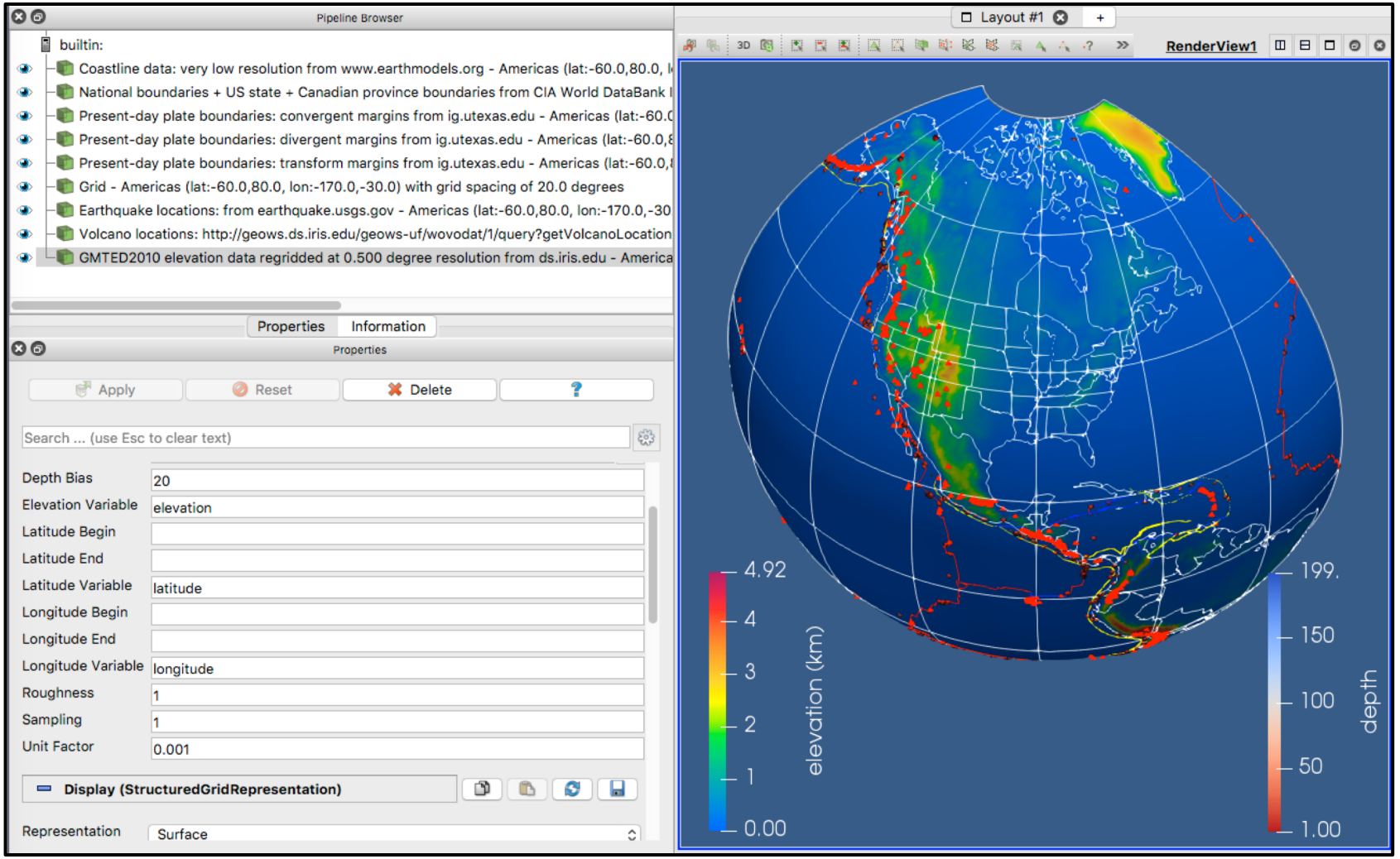


1. Select `Topo Elevation Data` menu (use your own data file by specifying it in the `Alternate File` box).
2. In the properties pane set parameters or simply select the region and topo file from the drop-down menu
3. Click `Apply`
4. In the properties pane set:
   - `Representation` to `Surface`
   - Select `Coloring` as elevation
   - `Unit Factor` to convert elevation unit for example from meter to km
   - `Sampling` to control decimation/ resolution
   - `Roughness` for exaggerating elevation for a 3D effect
   - `Depth Bias` to move depths by a constant value to allow display of other layers below it



Topo Elevation Data

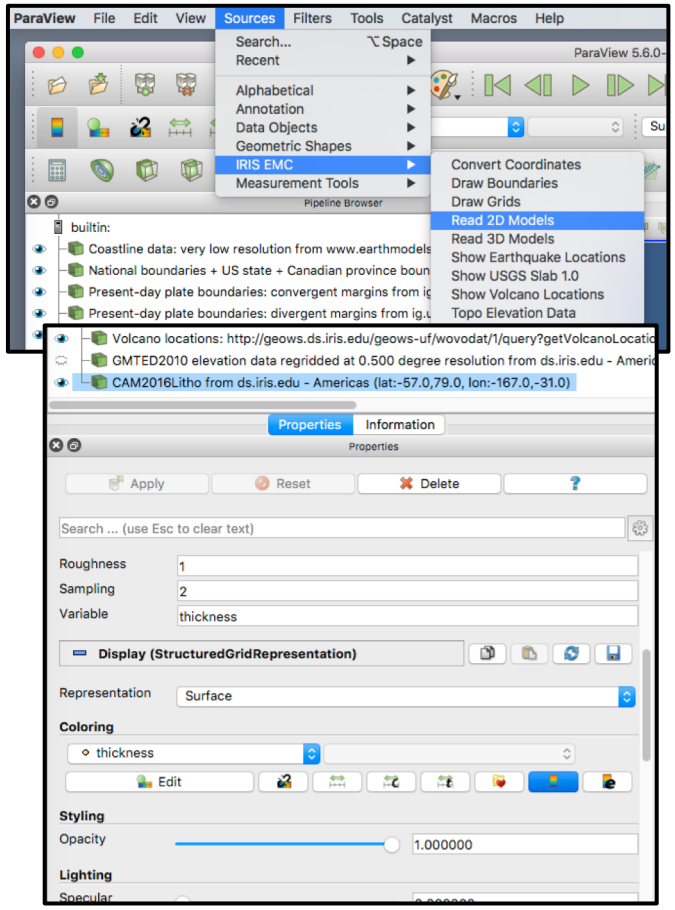
Plot surface elevation changes using elevation data files



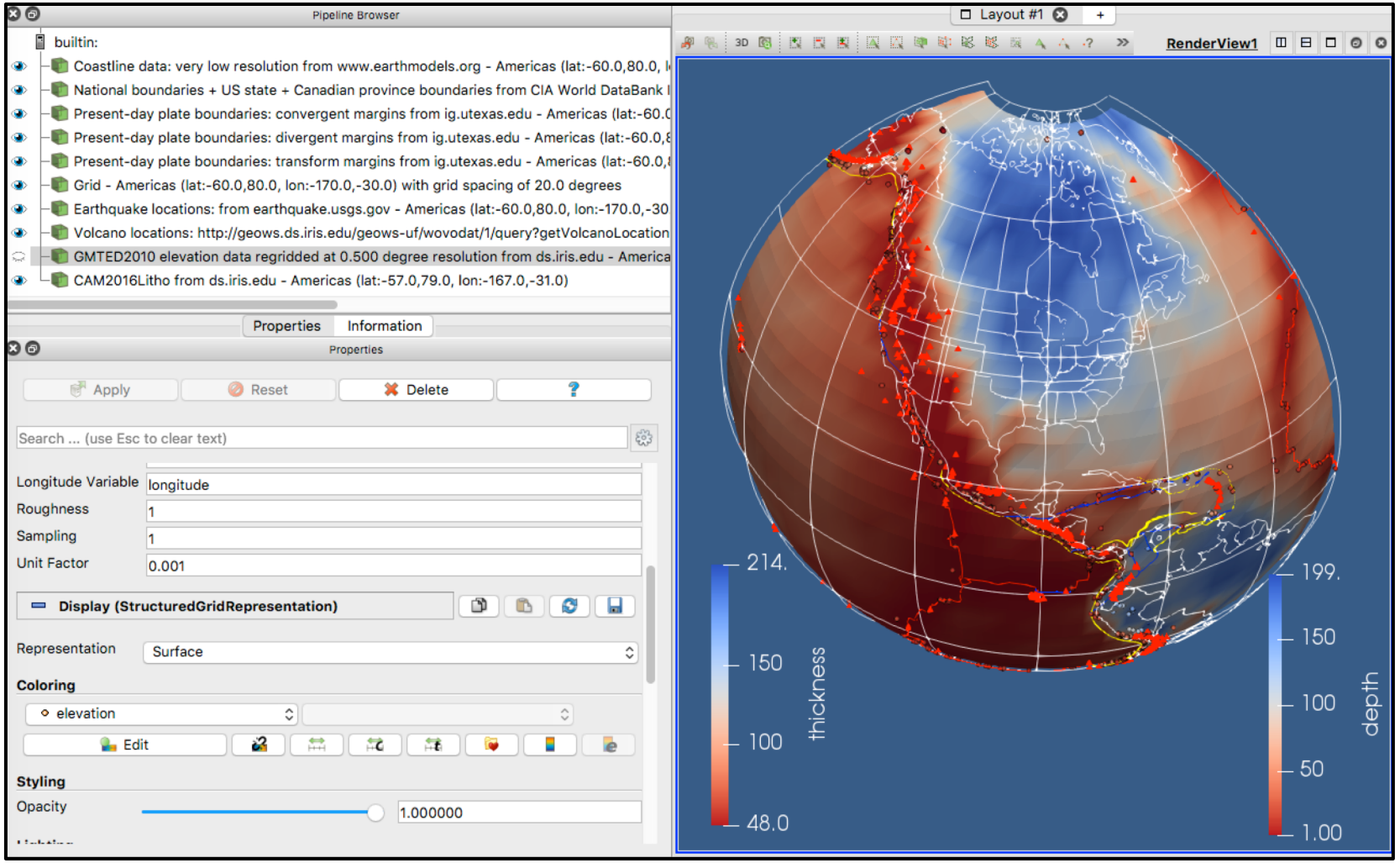
Read 2D Models

Read and plot 2D Earth model files in netCDF and GeoCSV file format (**NOTE**: Plugins can read netCDF files only under Mac and Linux. Under Windows, plugins automatically try to find the GeoCSV version. You can leave the file extension out to let the plugin choose the format based on your OS).

1. Select Read 2D Models
2. In the properties pane set parameters or simply select the region from the drop-down menu and enter a 2D model file name (or use the default model) and click apply. For EMC model repository visit : http://ds.iris.edu/ds/products/emc-earthmodels/
3. In the Pipeline pane, if there are any objects that may block this model, either reduce their opacity in their Properties pane or select the blocking pipeline objects and change their visibility by clicking on the eyeball icon next to them.
4. Click `Apply`
5. In the properties pane set:
   - `Representation` to `Surface`
   - Select `Coloring` variable and set other parameters as desired



Read 2D Models (Cont'd)



Read 3D Models

Read and plot 3D Earth model files in netCDF and GeoCSV file format (**NOTE**: Plugins can read netCDF files only under Mac and Linux. Under Windows, plugins automatically try to find the GeoCSV version. You can leave the file extension out to let the plugin choose the format based on your OS).

1. Select Read 3D Models
2. In the properties pane set parameters or simply select the region from the drop-down menu and enter a 3D model file name (or use the default model) and click apply. For EMC model repository visit : http://ds.iris.edu/ds/products/emc-earthmodels/
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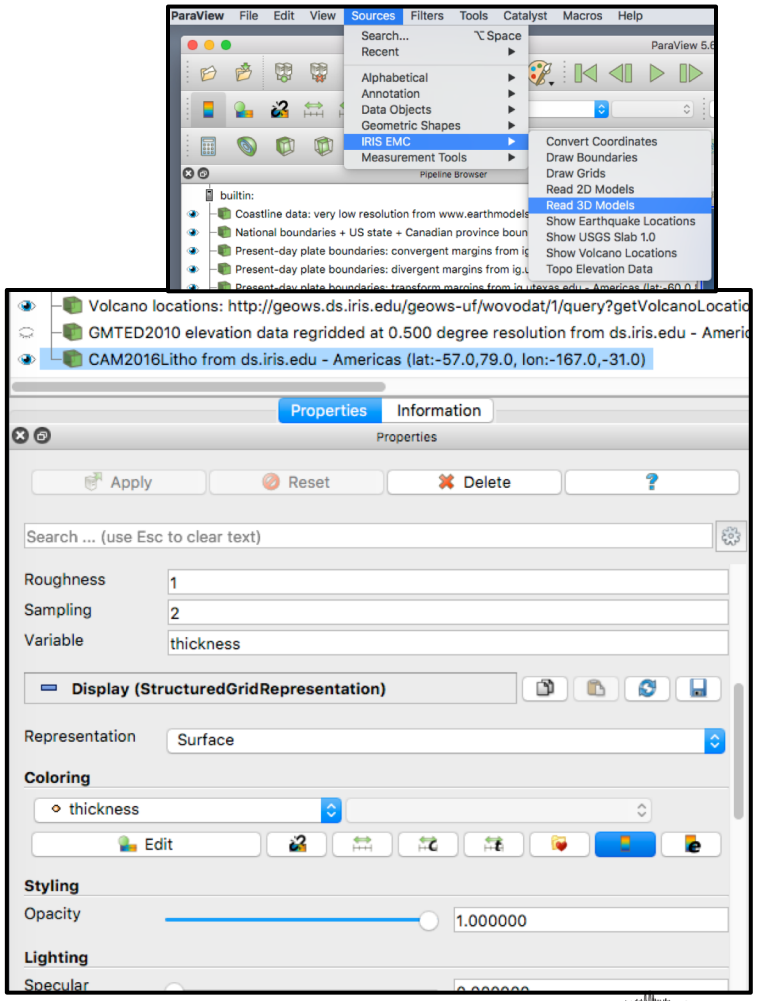
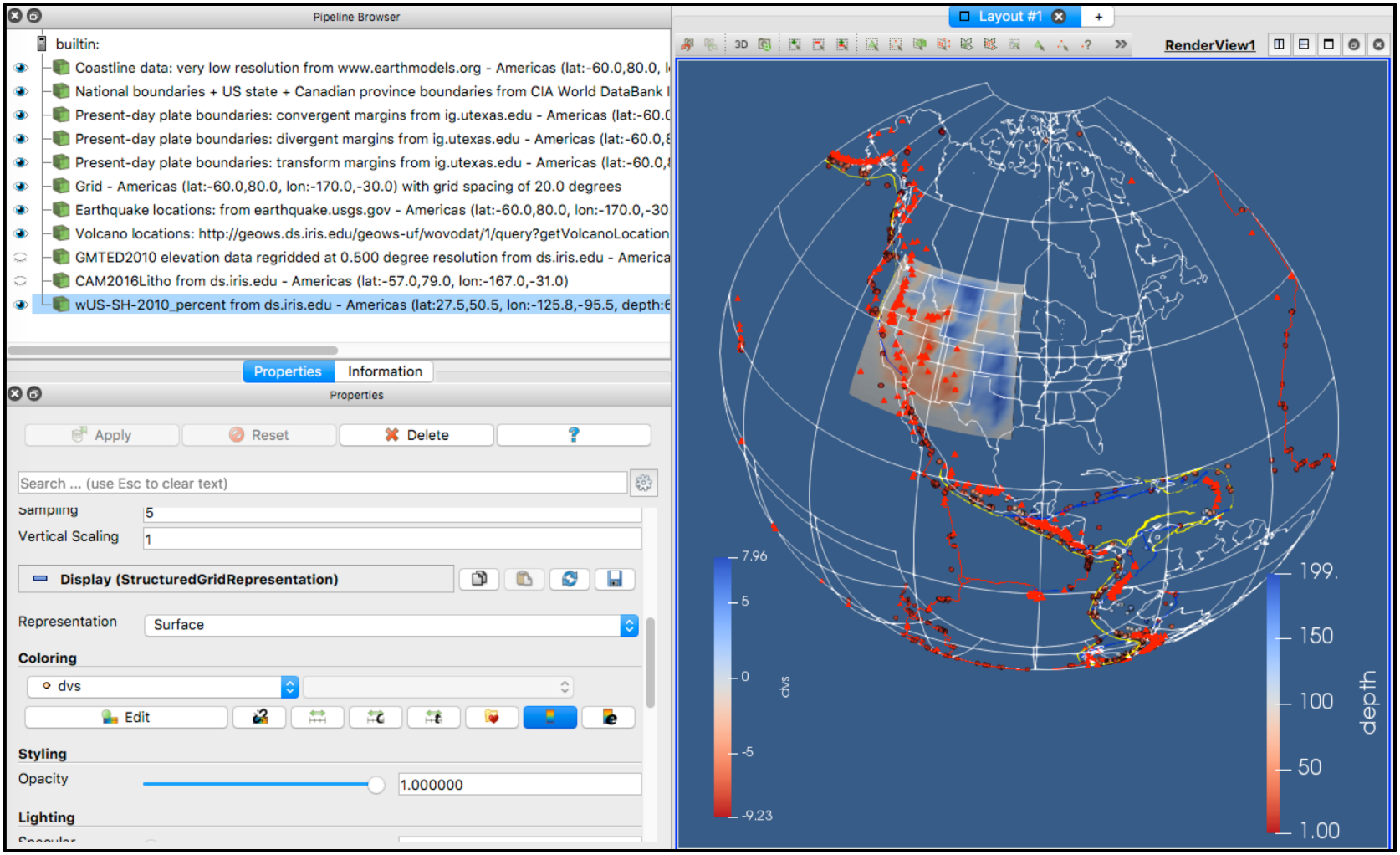
4. Click `Apply`
5. In the properties pane set:
   - `Representation` to `Surface`
   - Select `Coloring` variable and set other parameters as desired

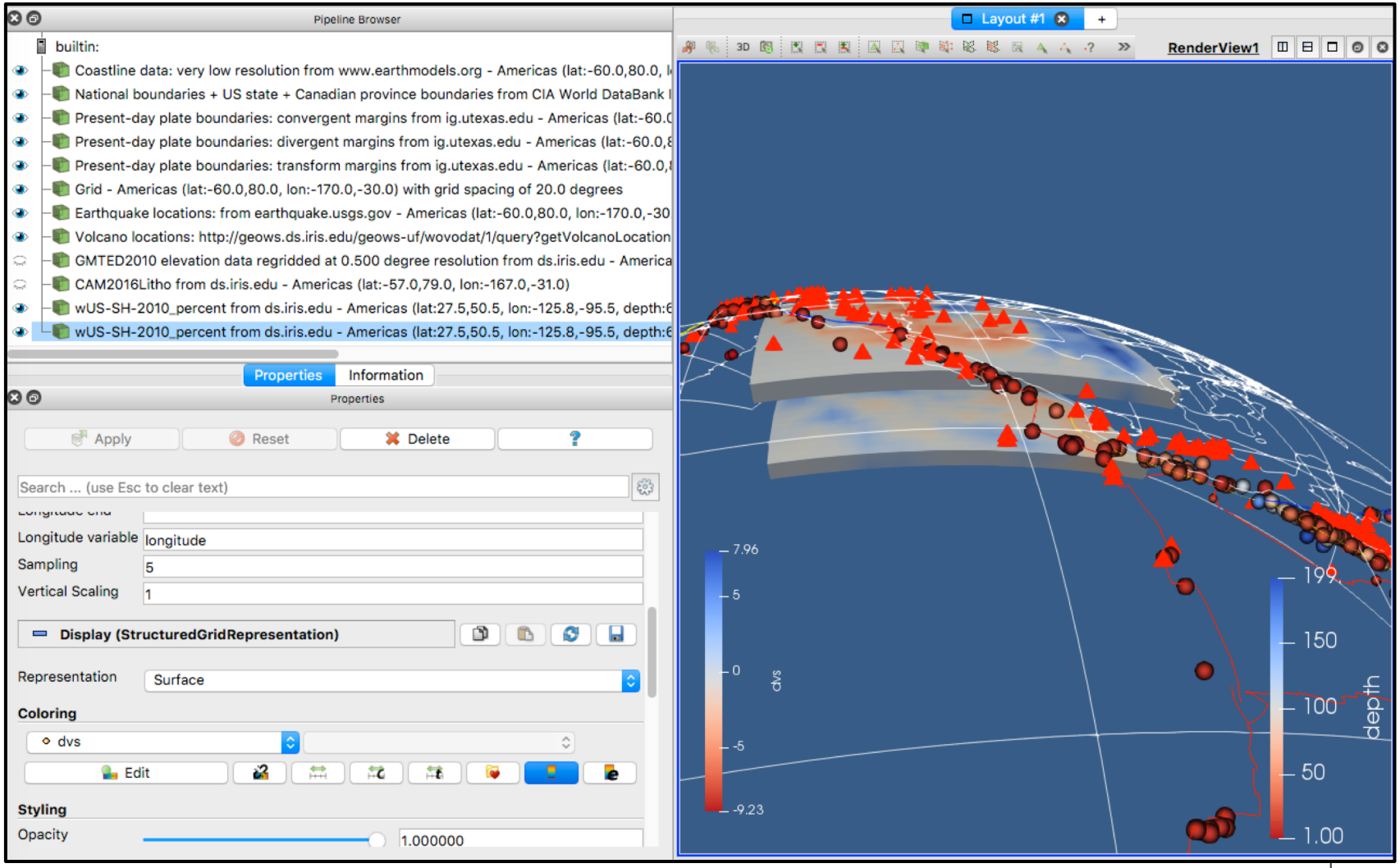


Read 3D Models (Cont'd)



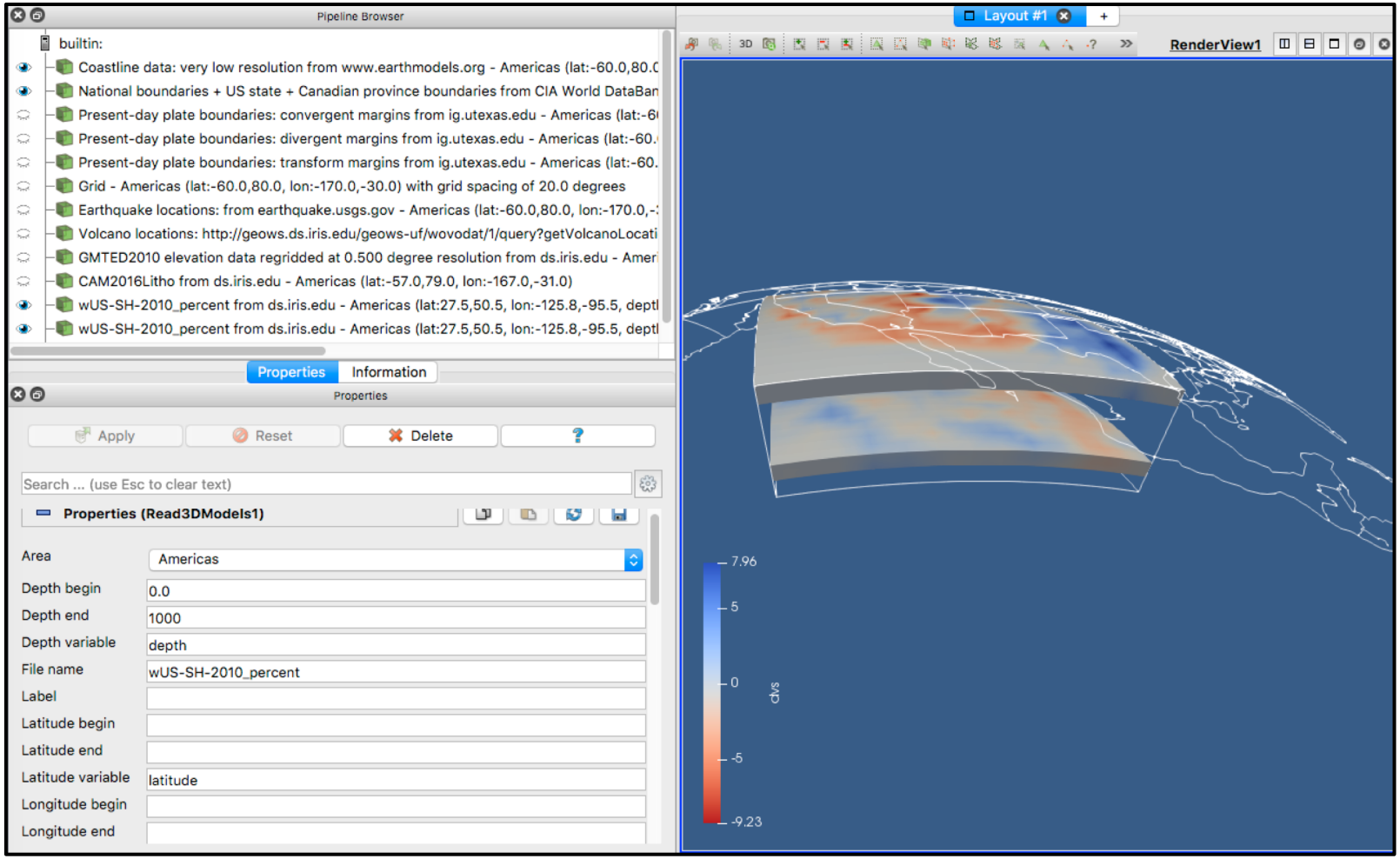
Read 3D Models – Horizontal Slices

Repeat the steps for reading a 3D model but each time use different depth ranges. This will result in a stacked horizontal slice view:



Read 3D Models – Cross-Sections

Again, read the same 3D model but this time set the depth ranges to cover the entire model. You should see outline of the loaded model volume

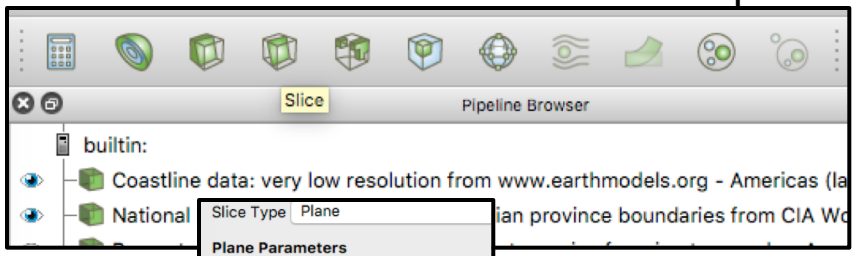


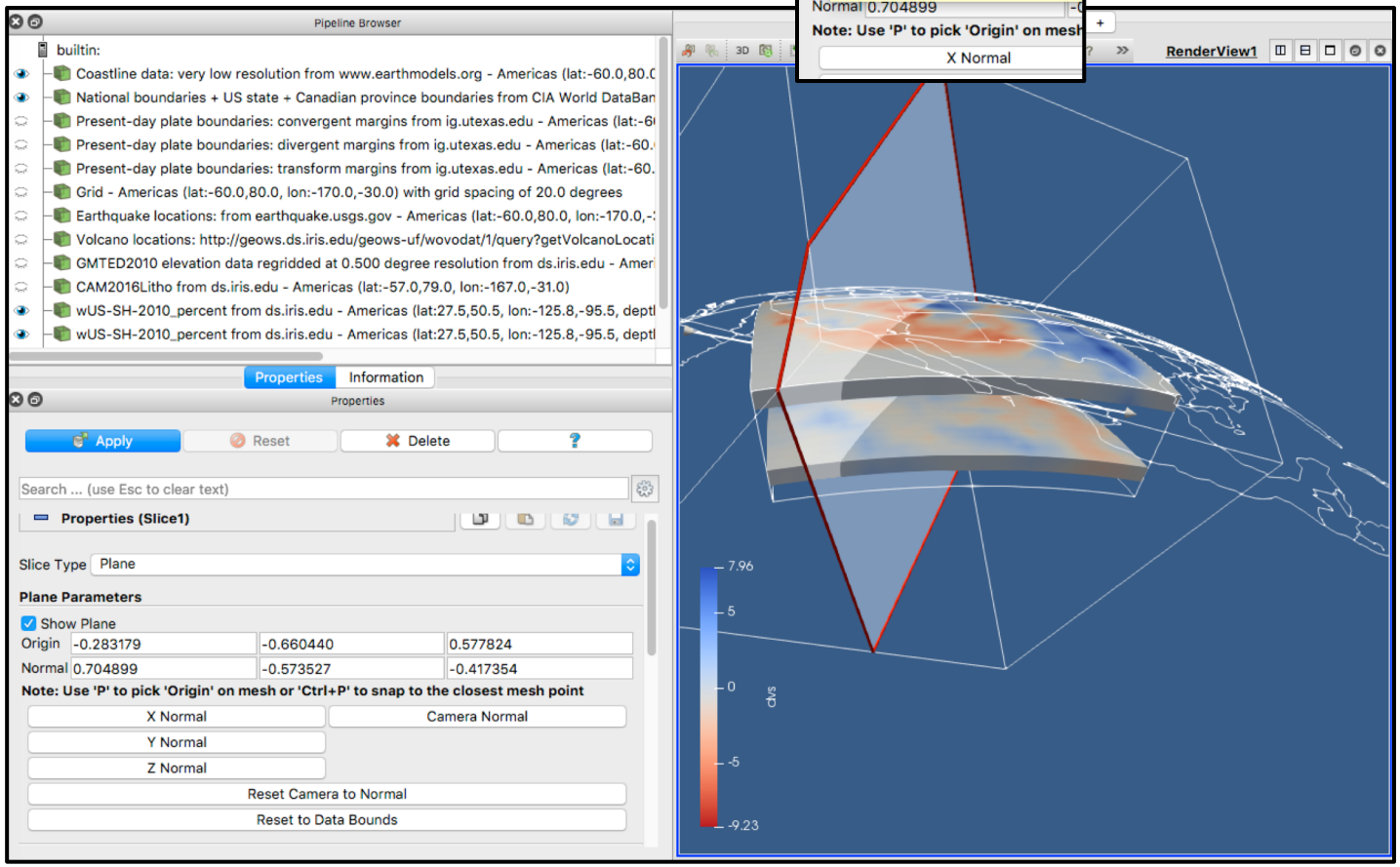
Read 3D Models – cross-sections (Cont'd)

Use ParaView's slice tool to slice the model and use the controls to position it as desired

Once in position:

- Click `Apply`
- Uncheck Show Plane to remove the guides

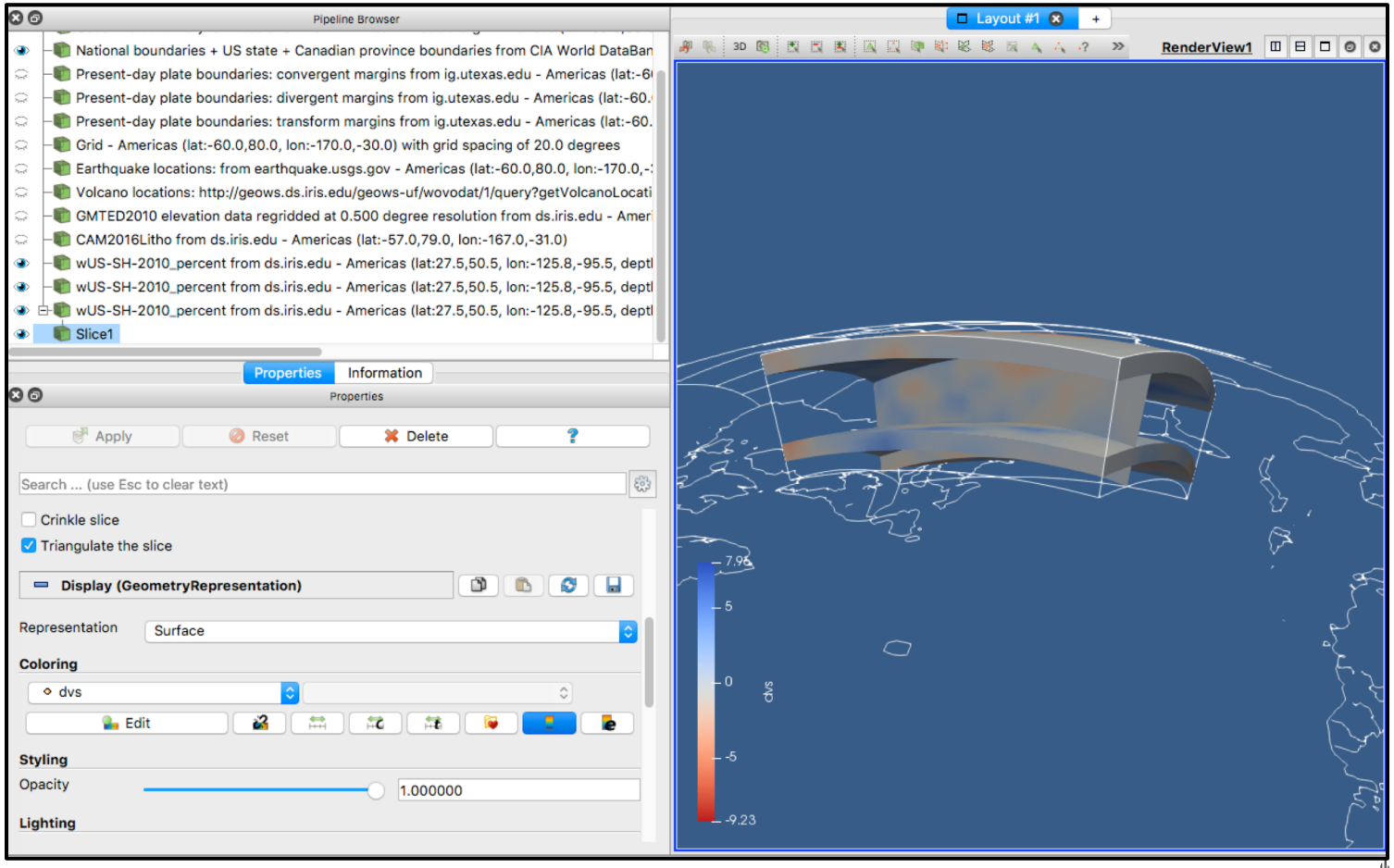




Read 3D Models – cross-sections (Cont'd)

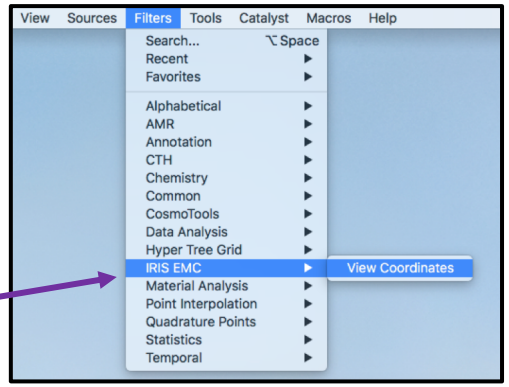
Select surface as the representation and select the variable for coloring. This results in a cross section.

NOTE: Since model volume is already in the pipeline, you can draw as many slices as desired

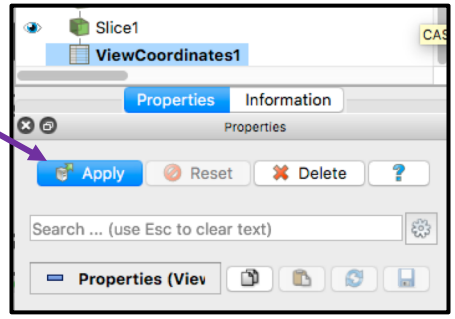


Save Cross-Section Data

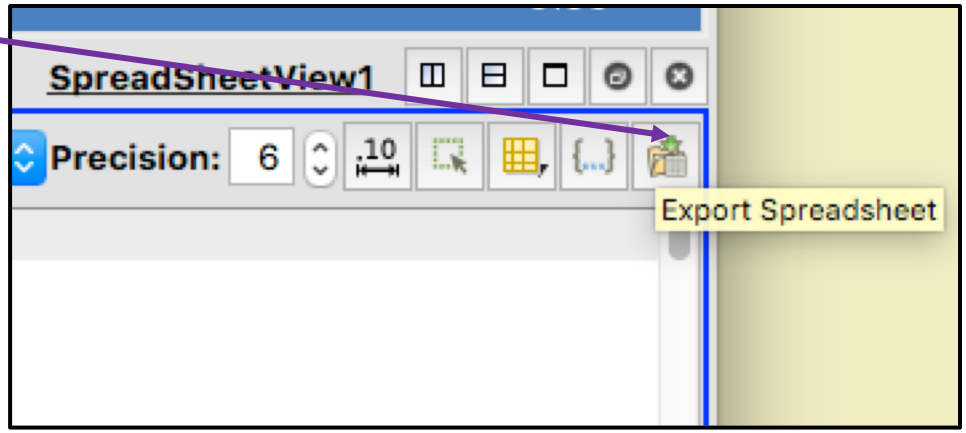
- Data in ParaView are stored as X, Y, Z coordinates. To convert them to latitude-longitude-depth, select the cross-section object in Pipeline, then select the `View Coordinates` Filter:



- Click `Apply`



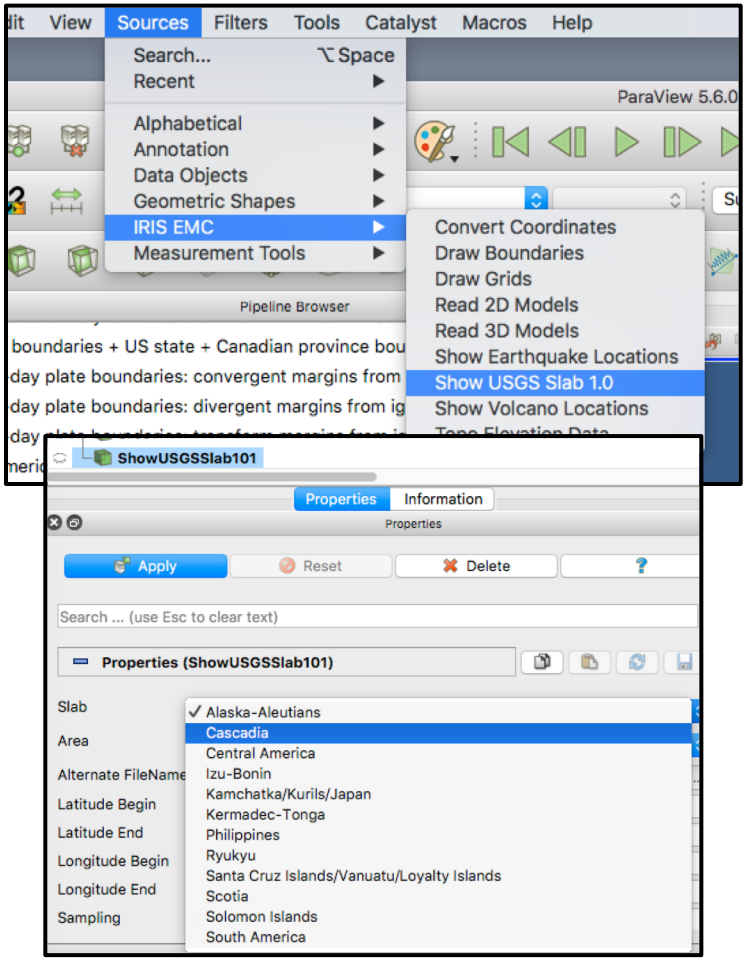
- This will open a `SpreadSheetView` that contains the data for the section.
- Use the `Export Spreadsheet` button on the upper right of the view to export the data



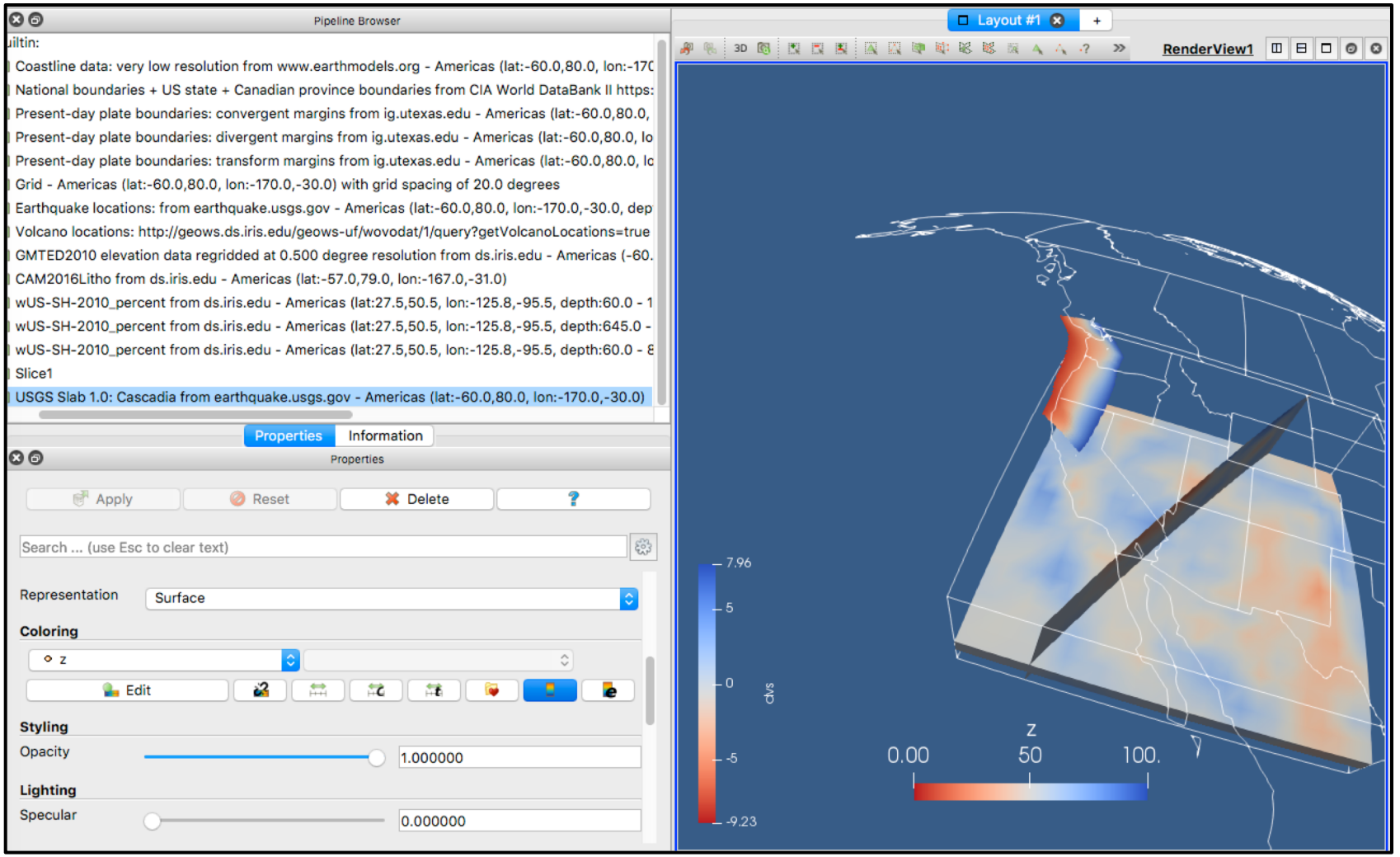
Show USGS Slab 1.0 Model

Display USGS Slab 1.0 models (`https://earthquake.usgs.gov/data/slab/`)

1. Select `Show USGS Slab 1.0`
2. In the properties pane set parameters or simply select the region and slab area from the drop-down menu
3. Click `Apply`
4. In the properties pane set:
   - `Representation` to `Surface`
   - Select `Coloring` as `z` (depth to slab)
   - `Unit Factor` to convert elevation unit for example from meters to km
   - `Sampling` for different resampling/ resolution



Show USGS Slab 1.0 Model (Cont'd)



Show Earthquake Locations (animation)

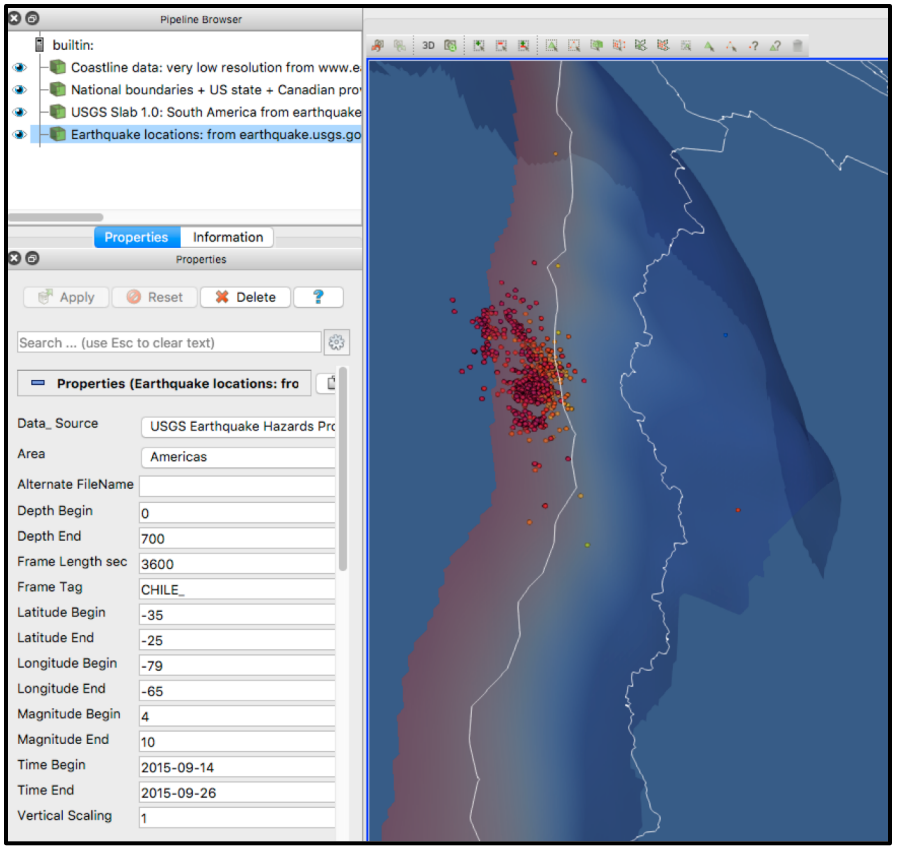
Plot earthquake locations based on the FDSN event services or your local GeoCSV earthquake location files and create timestamped file for animation.

Example:

M 8.3 NEAR COAST OF CENTRAL CHILE, 2015-09-16 22:54:32

We want to look at the aftershocks of this earthquake by creating animation of earthquake locations between 09-14 and 09-26

1. Plot boundaries for South America
2. Plot Slab 1.0 for South America
3. Plot earthquake locations
4. Use the earthquake locations to position your scene
5. Turn off the Earthquake Locations in the Pipeline Browser



NOTE: To create animation files, we have set the `Frame Tag` to CHILE (animation file names will start with CHILE_) and the Frame Length to 3600 (will create hourly animation files starting at Time Begin)

Show Earthquake Locations (animation, Cont'd)

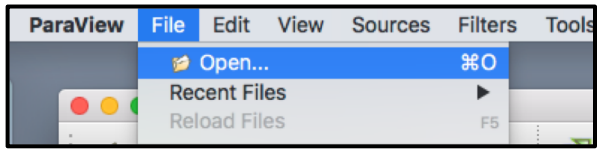
Example: M 8.3 NEAR COAST OF CENTRAL CHILE, 2015-09-16 22:54:32

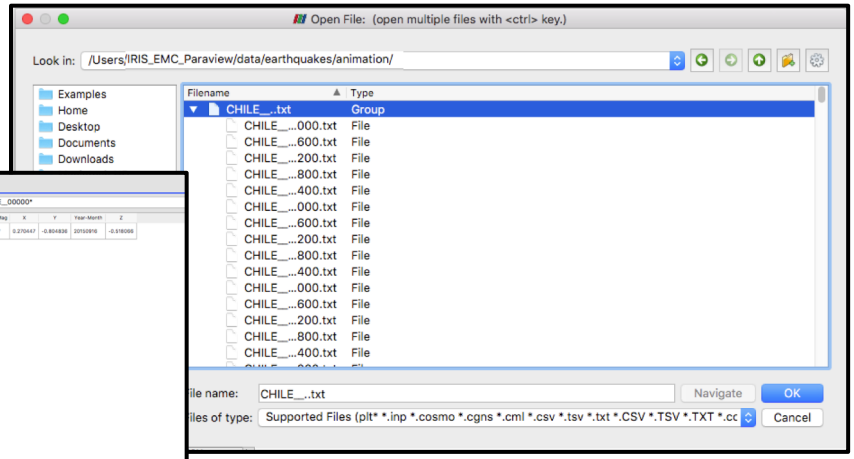
Because we defined `Frame Tag` of CHILE_ and Frame Length of 3600 in the the previous step, animation files are created under `data/earthquakes/animation/` directory with names starting with:

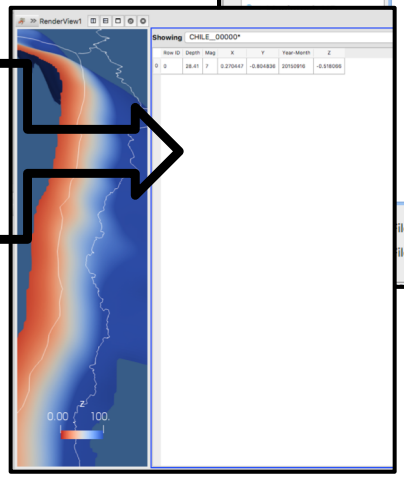
- The CHILE_ files contain events that occurred since Time Begin, including this window
- The CHILE_single_ files contain events that occurred within that 3600 s window

ParaView will recognize these as Group Files

1. Open files of the CHILE_ or CHILE_single_ group
2. Click Apply for the CHILE_... Object created in the pipeline
3. ParaView will import them into a spread sheet. Close the resulting SpreadSheet View







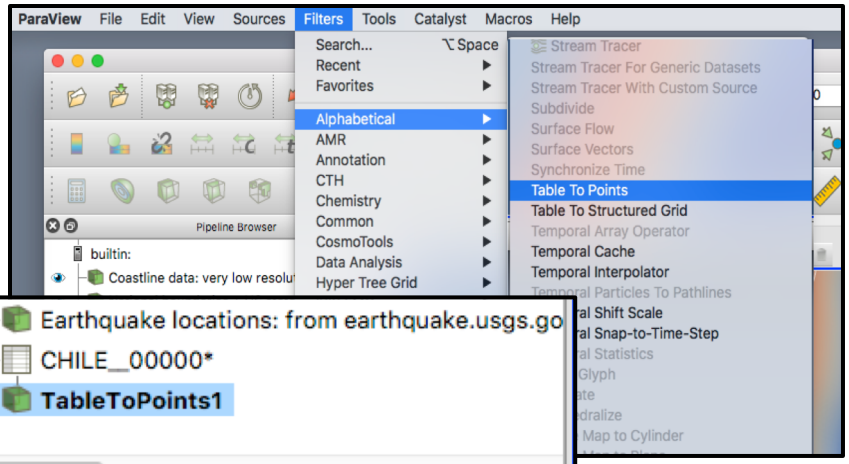
SpredSheet View

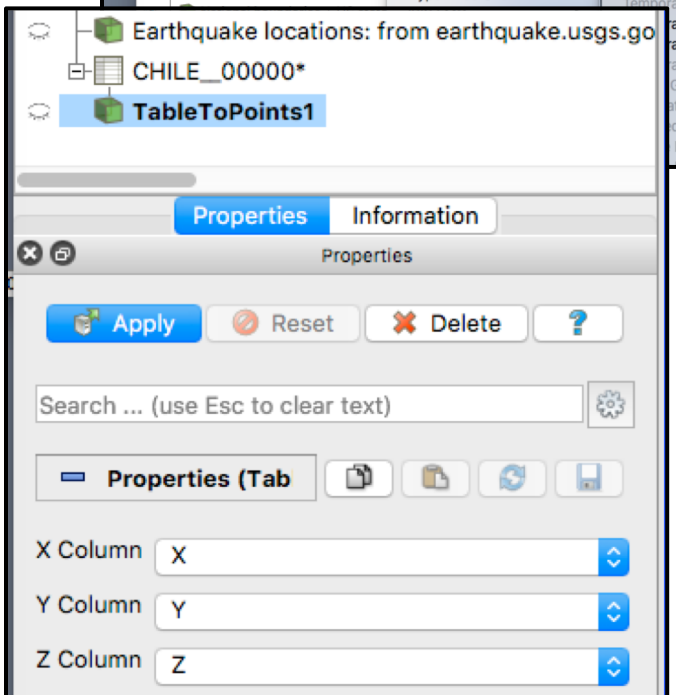
Show Earthquake Locations (animation, Cont'd)

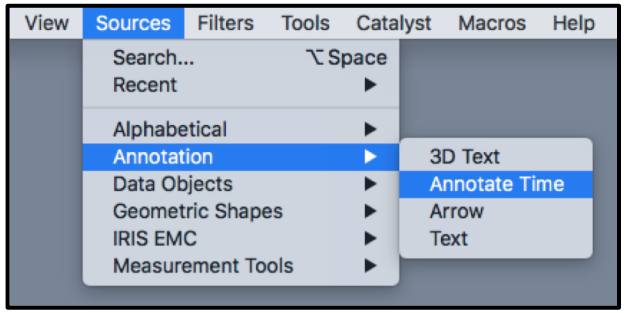
Example: M 8.3 NEAR COAST OF CENTRAL CHILE, 2015-09-16 22:54:32

The previous steps put earthquake data in tables, we now need to convert these data to points for plotting. For this we use ParaView Filters

1. While the CHILE_... Object in the pipeline is selected, go to ParaView's Filter menu and select `Table To Points` filter
2. In the `TableToPoints` filter properties you need to assign columns from table containing X, Y and Z coordinates (they are actuallycalled Z, Y and Z too)
3. Then click Apply
4. We may also want to add a timer to the video to show the elapsed time (in this case 3600 seconds or hours). This can be done via `Annotate Time Source`



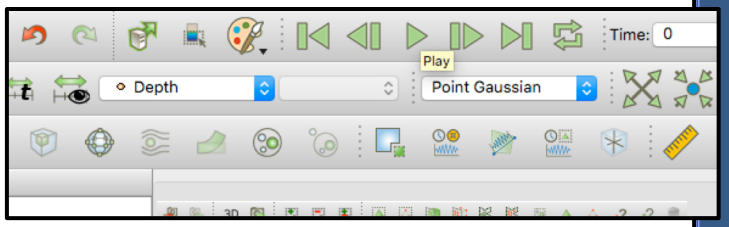




Show Earthquake Locations (animation, Cont'd)

Example: M 8.3 NEAR COAST OF CENTRAL CHILE, 2015-09-16 22:54:32

Use the animation controls to play



We have placed a copy of the animation files for both CHILE_ andCHILE_single_ under the documents directory of this bundle