IRIS EMC PARAVIEW PLUGINS GUIDE

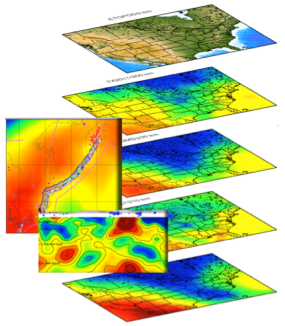
IRIS Data Services, Data Products Team, January 2019

This material is based upon work supported by SAGE which is a major facility fully funded by the National Science Foundation. Award number: EAR-1724509 - SAGE

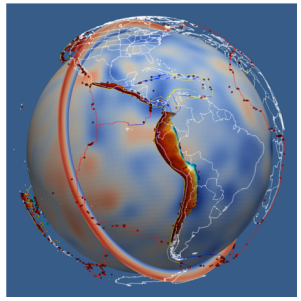
- IRIS EMC
- EMC Tools
- What is ParaView
- ParaView GUI
- EMC ParaView-Plugins
  - Installation
  - Draw Boundaries
  - Draw Grids
  - Show Earthquake Locations
  - Show Volcano Locations
  - Topo Elevation Data
  - Read 2D Models
  - Read 3D Models (horizontal slices & cross-sections)
  - Show USGS Slab 1.0 Model
  - Earthquake Location Animation

EMC is a community Earth model repository:

EMC serves as a repository of Earth models 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 netCDF & GeoCSV formats
  https://github.com/iris-edu/EMC-ParaView



IRIS EMC – EARTH MODEL COLLABORATION

EMC-Tools is 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 convert it to GeoCSV format.

- **GeoCSV_2_netCDF_2D.py** - read a 2D GeoCSV Earth model file and convert it to netCDF format.

ParaView is an 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:

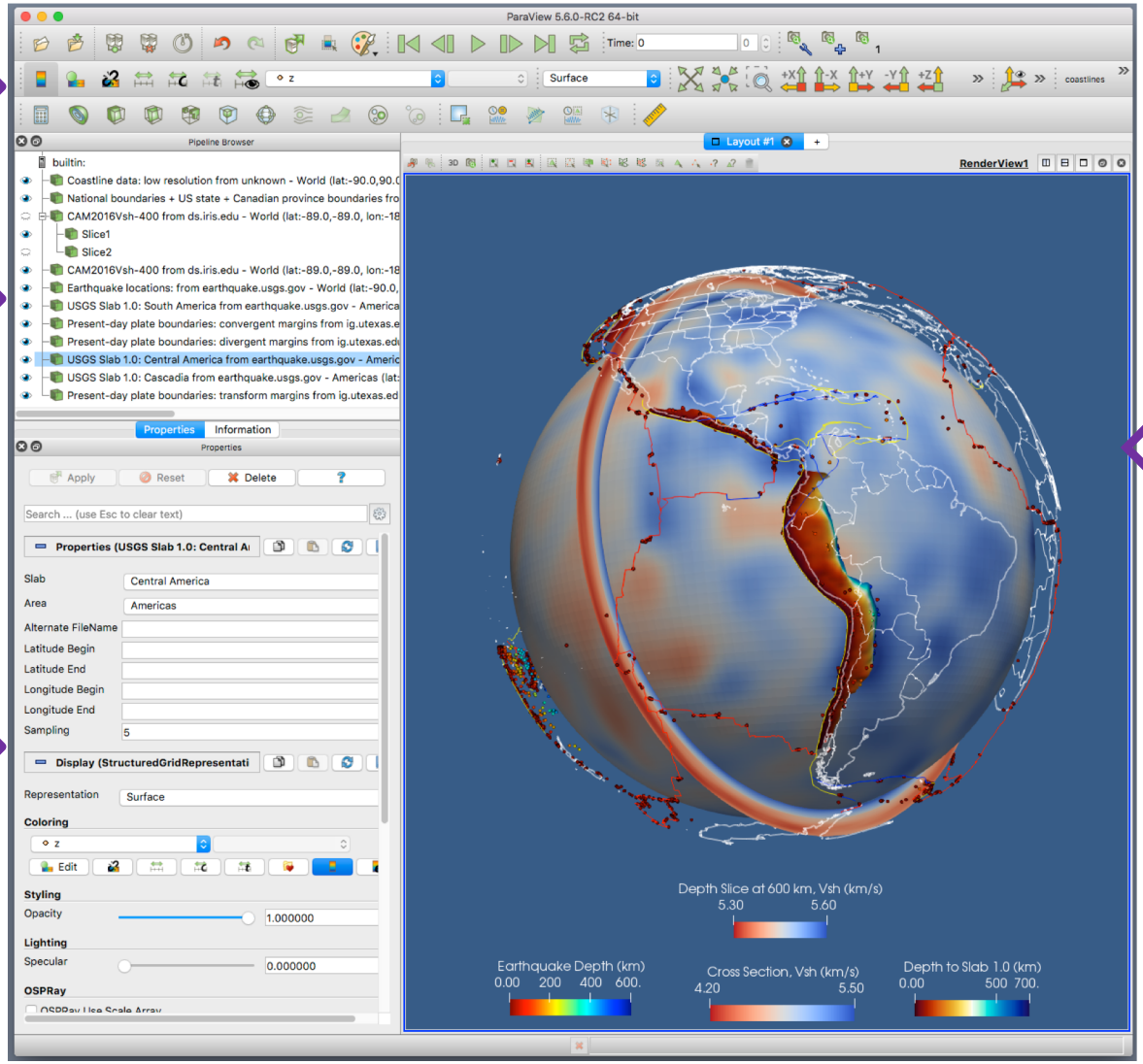
http://www.paraview.org/files/v5.1/ParaViewGettingStarted-5.1.0.pdf

Menu Bars

Tool Bars

Pipeline Browser

Properties & Information Panels



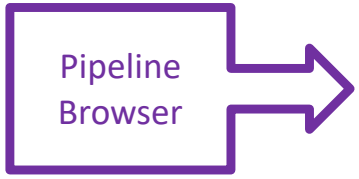
Render View

ParaView Getting Started Guide:

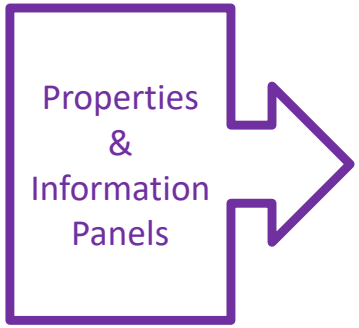
http://www.paraview.org/files/v5.1/ParaViewGettingStarted-5.1.0.pdf

For accessing majority of ParaView features, including plugins

For accessing commonly used features of ParaView



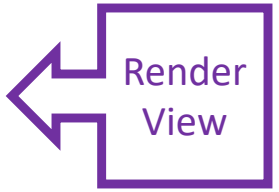
Shows objects in ParaView's pipeline and how they are related. EMC Plugins use the Pipeline Browser to also fully document objects that they create.



Properties 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.



IRIS

EMC ParaView Plugins are 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. 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
```

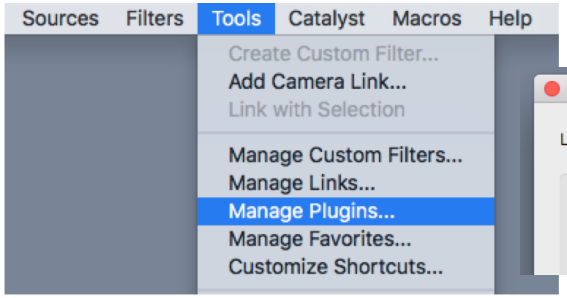
- Read the *INSTALL.txt* file
- Execute the *build_plugins_macros.py* script under the *src* directory

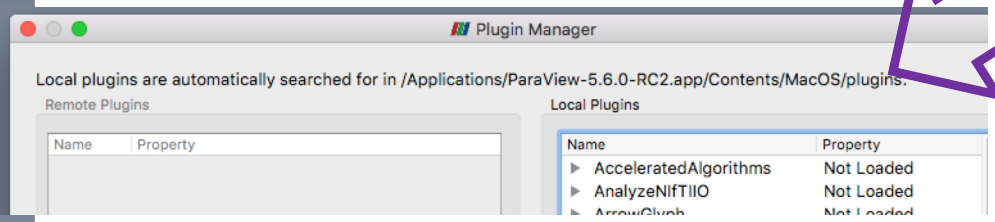
Adding Plugins to ParaView

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





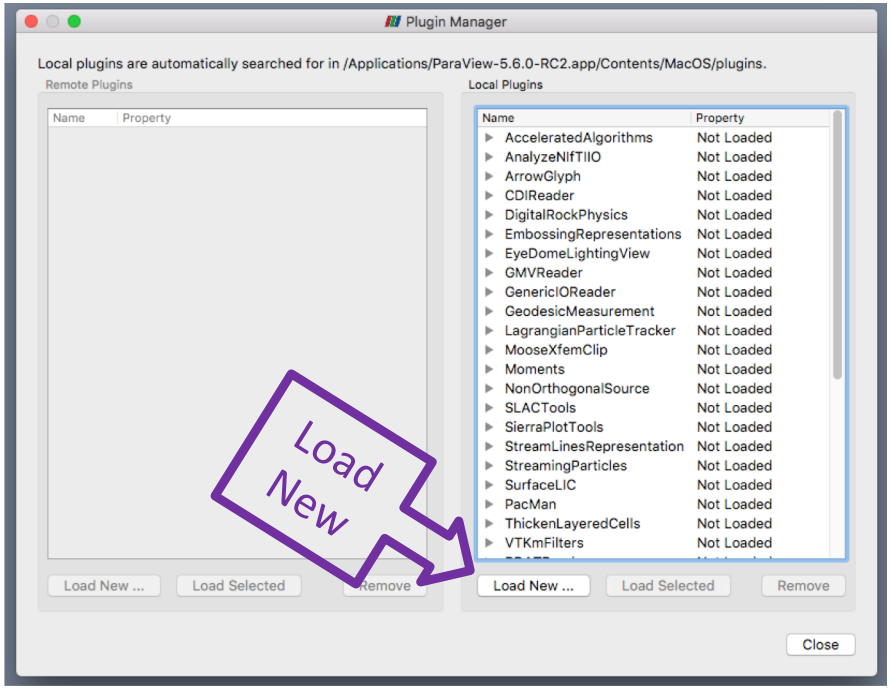
This is where ParaView is looking for them

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.

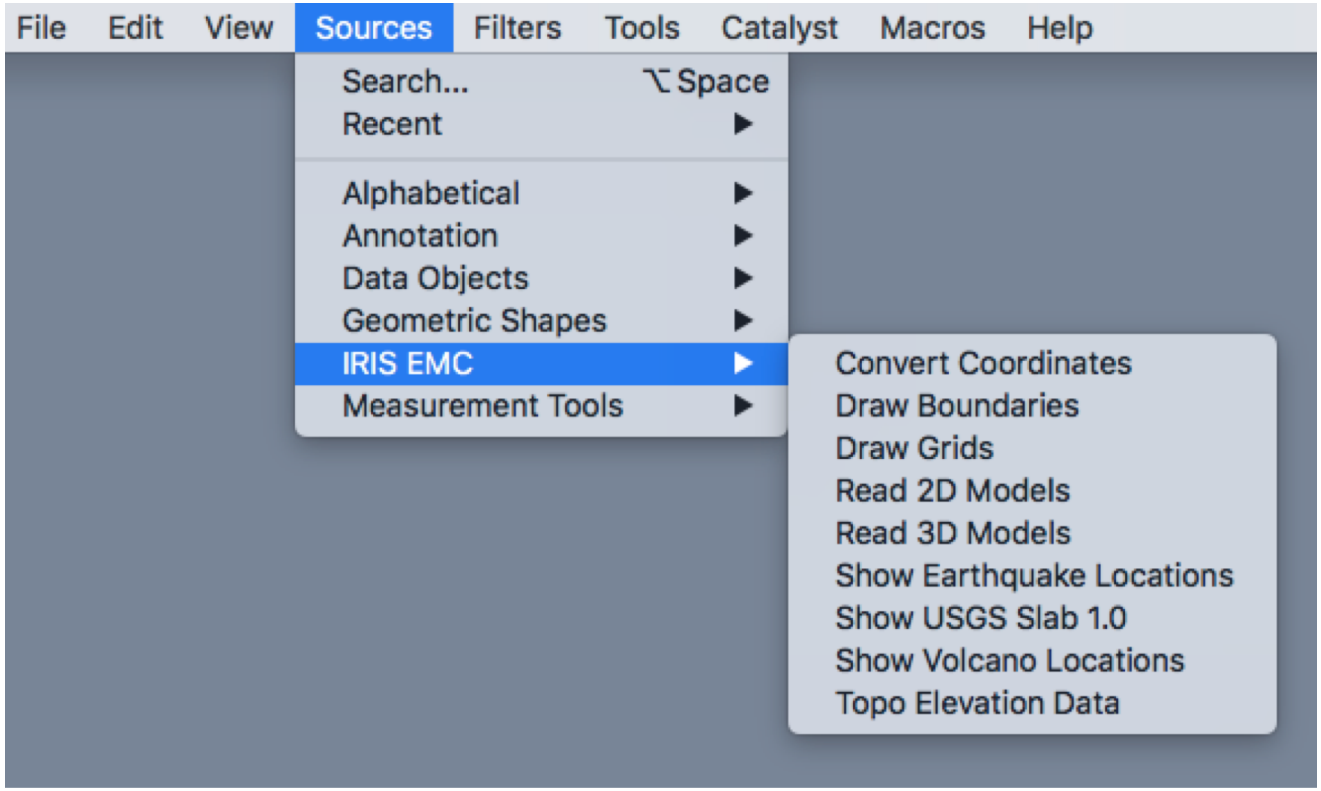


3. **Restart** the ParaView

EMC ParaView Plugins

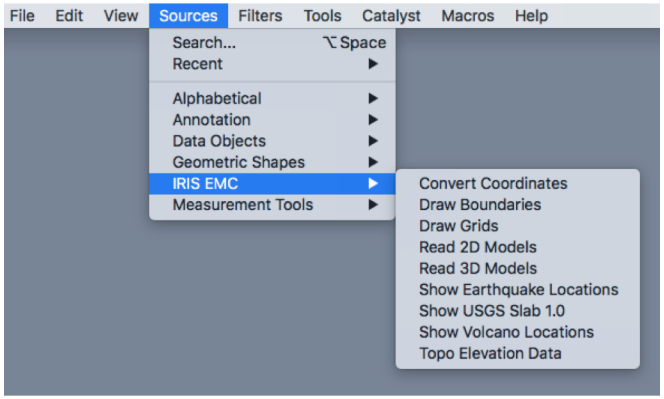
EMC ParaView Plugins

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. Takes the file name provided as a full path to your file
3. Checks IRIS EMC's file repository
4. Assumes the file name is a URL to the file you want to download

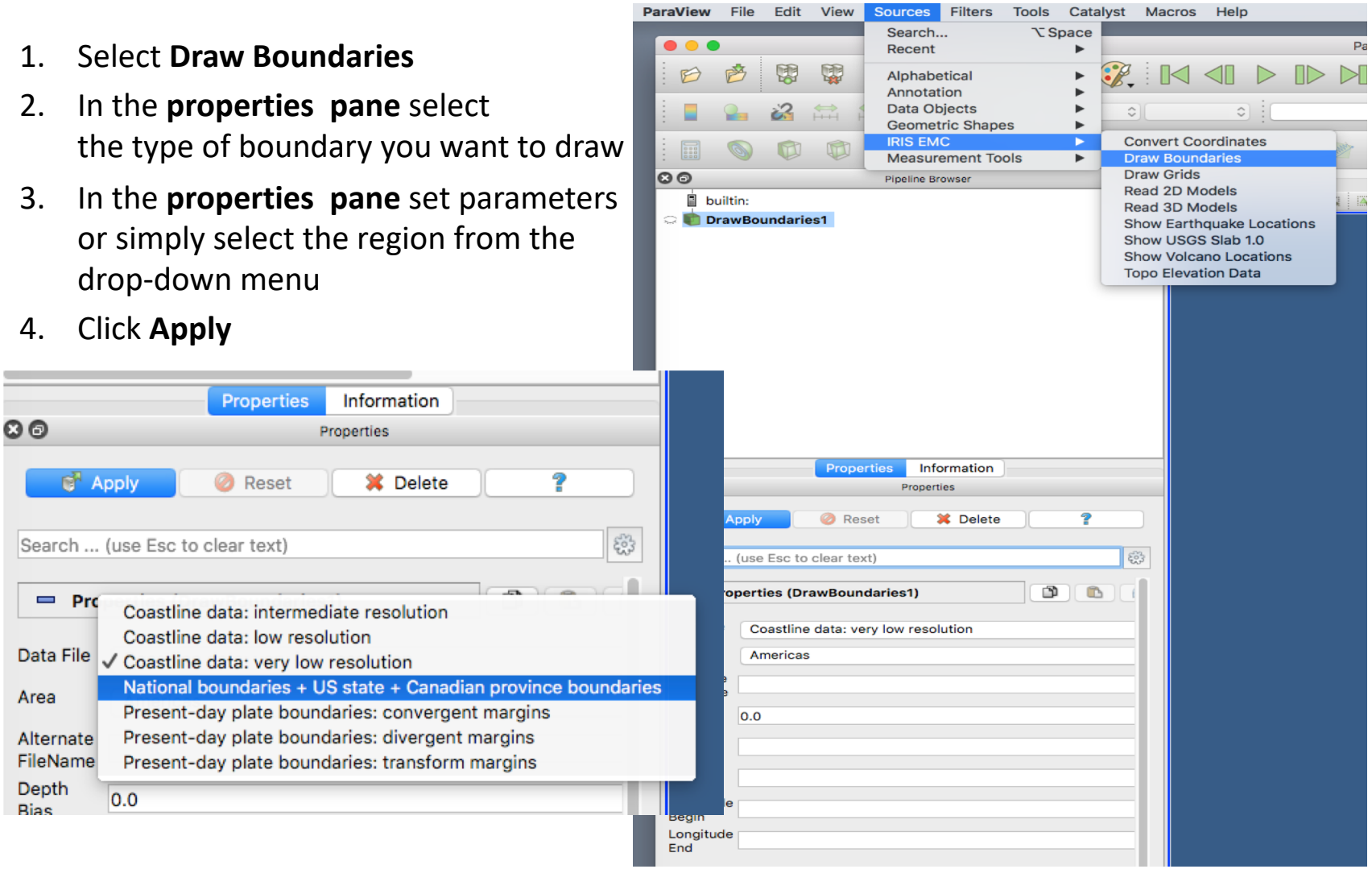
Notes:

- 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 (such as in the field) , make sure first connect to 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

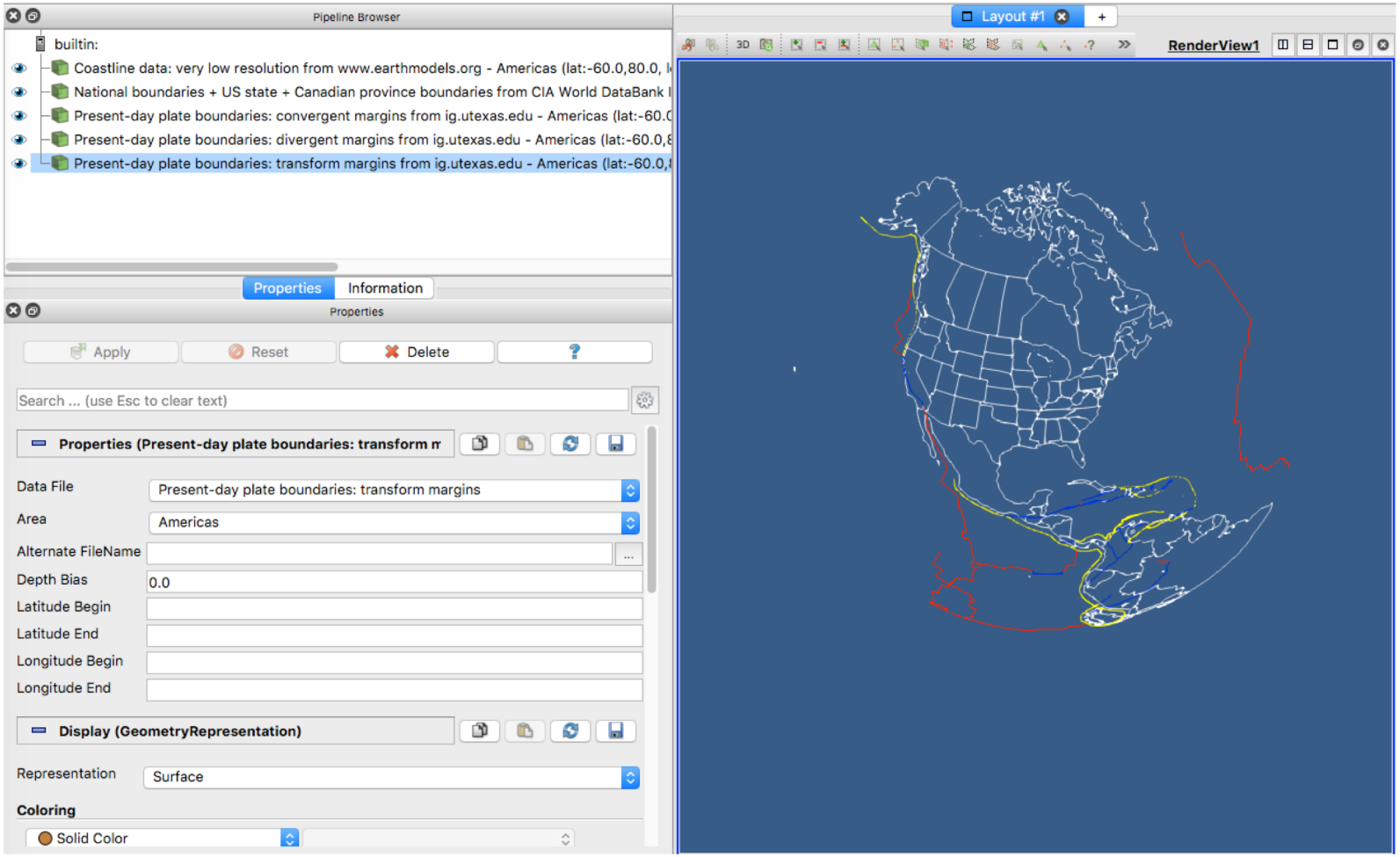
Allows you to draw boundaries (lines) from IRIS EMC's coastlines, national, US states and Canadian provinces, present-day plates (divergent, transform or convergent margins) boundary files or from your own GeoCSV boundary files:

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)

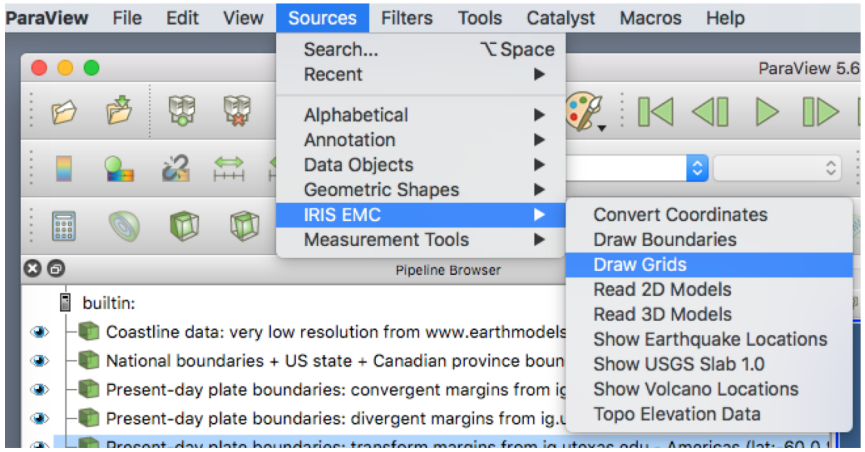
Repeat steps 1 to 4 above for as many boundary lines you want to draw. Each boundary line will appear as an object in the Pipeline Browser. You can further tune each boundary line by selecting it from the Pipeline Browser and changing its properties

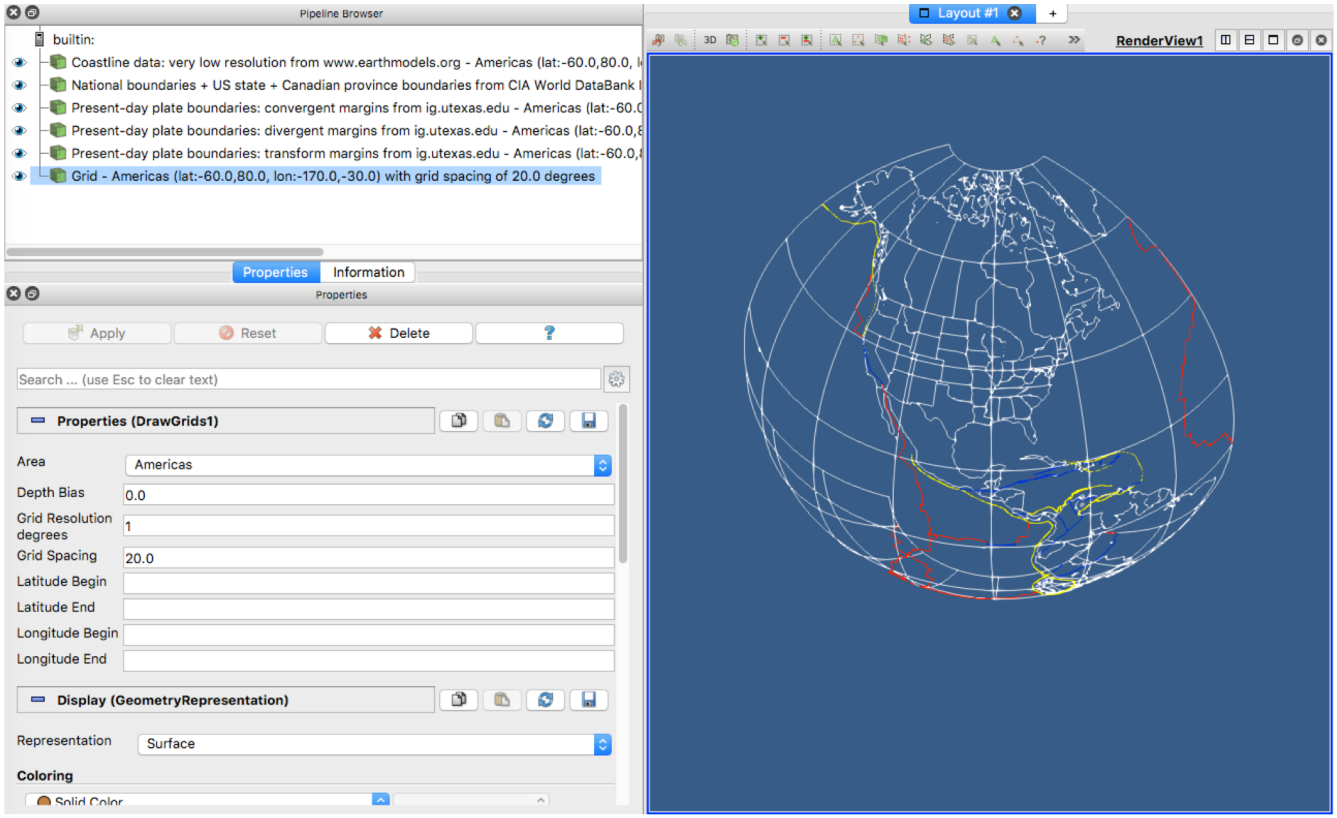


Draw Grids

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**



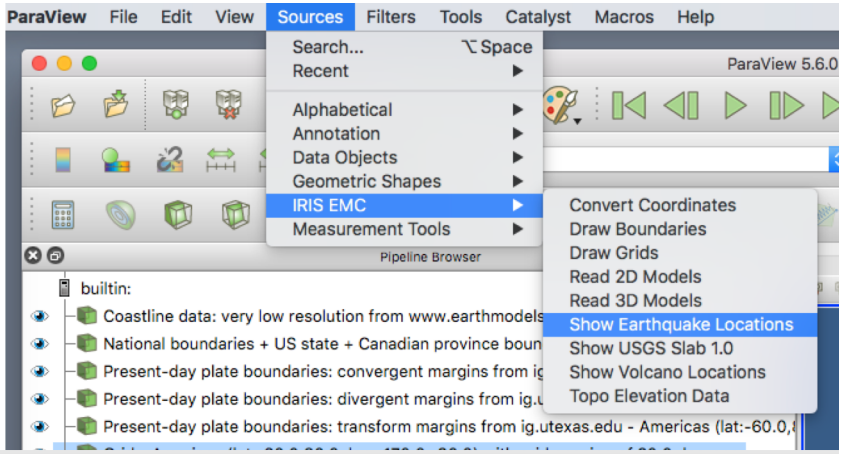


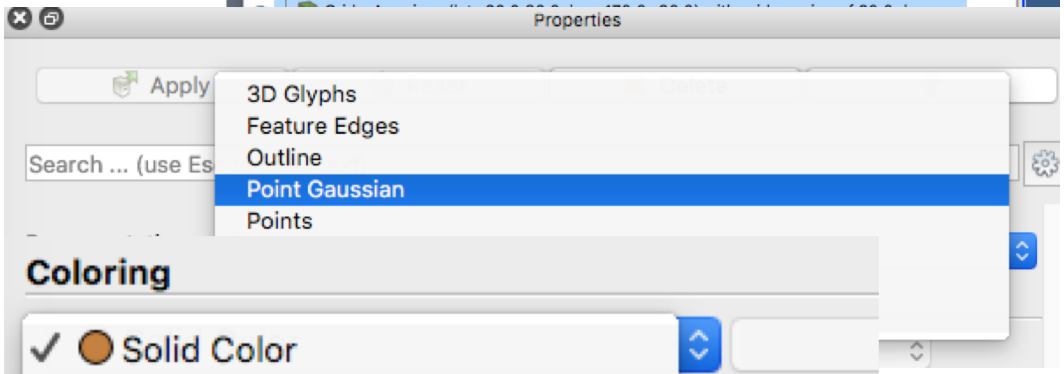
EMC ParaView Plugins – Draw Grids

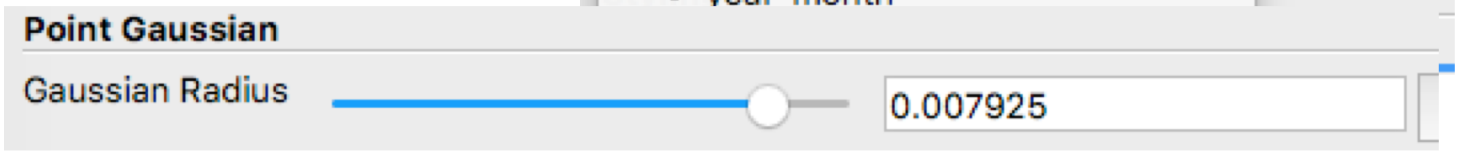
Show Earthquake Locations

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

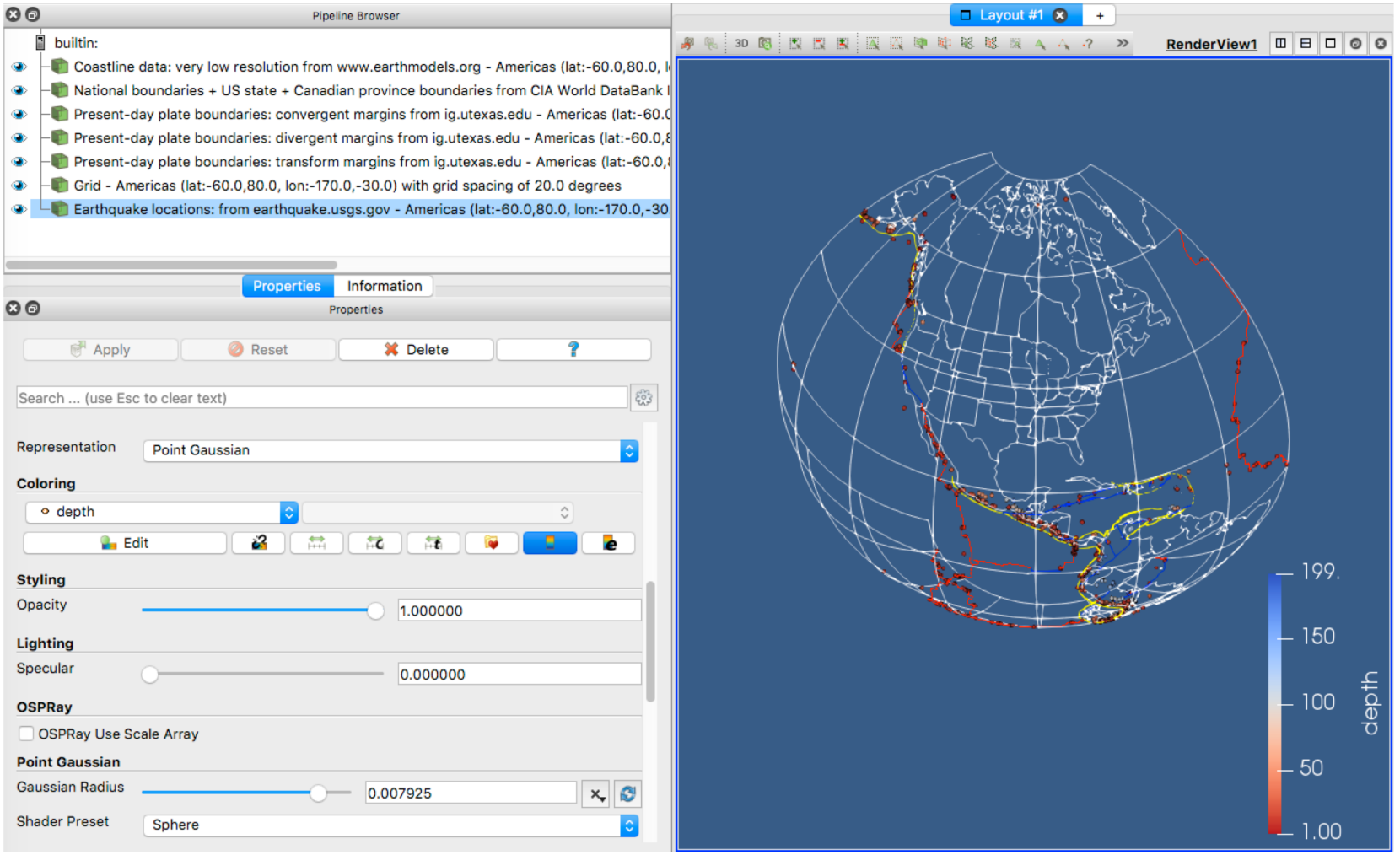
1. Select **Show Earthquake Locations**
2. In the **properties pane** set parameters or simply select the region from the drop-down menu (use your own data file by specifying it in the **Alternate File** box).
3. Click **Apply**
4. In the **properties pane** set:
   - **Representation** to **Point Gaussian**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







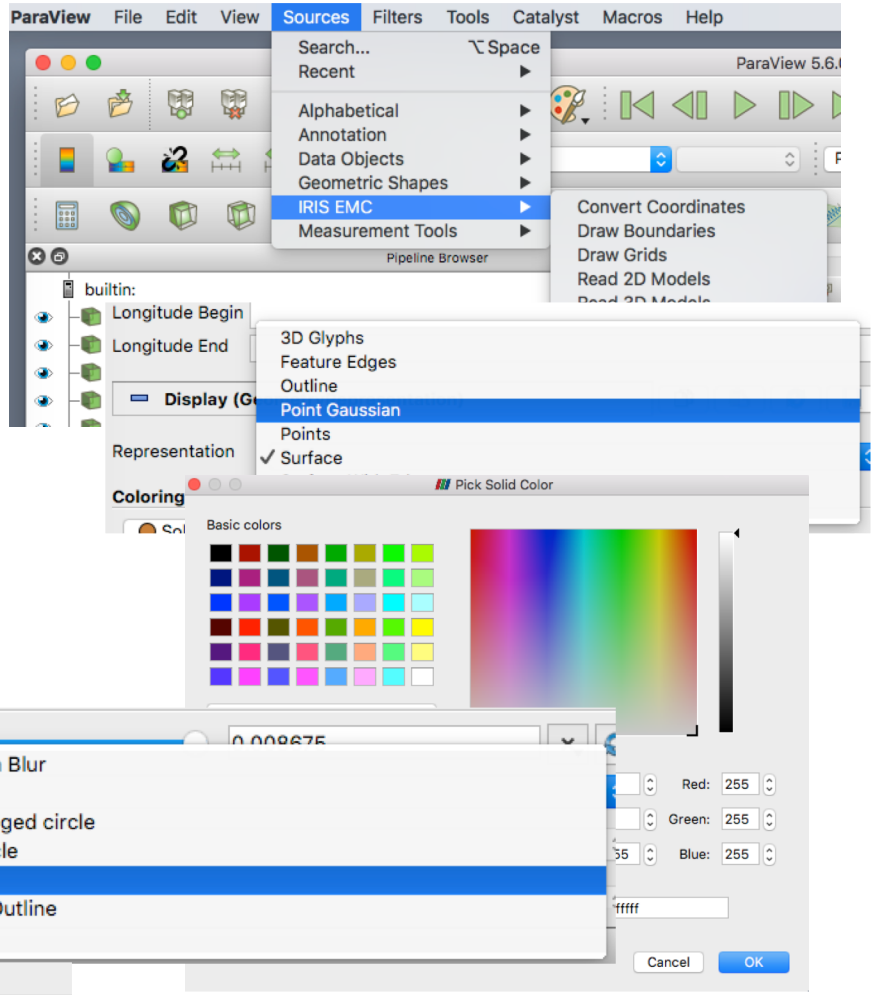
Show Earthquake Locations (Cont'd)



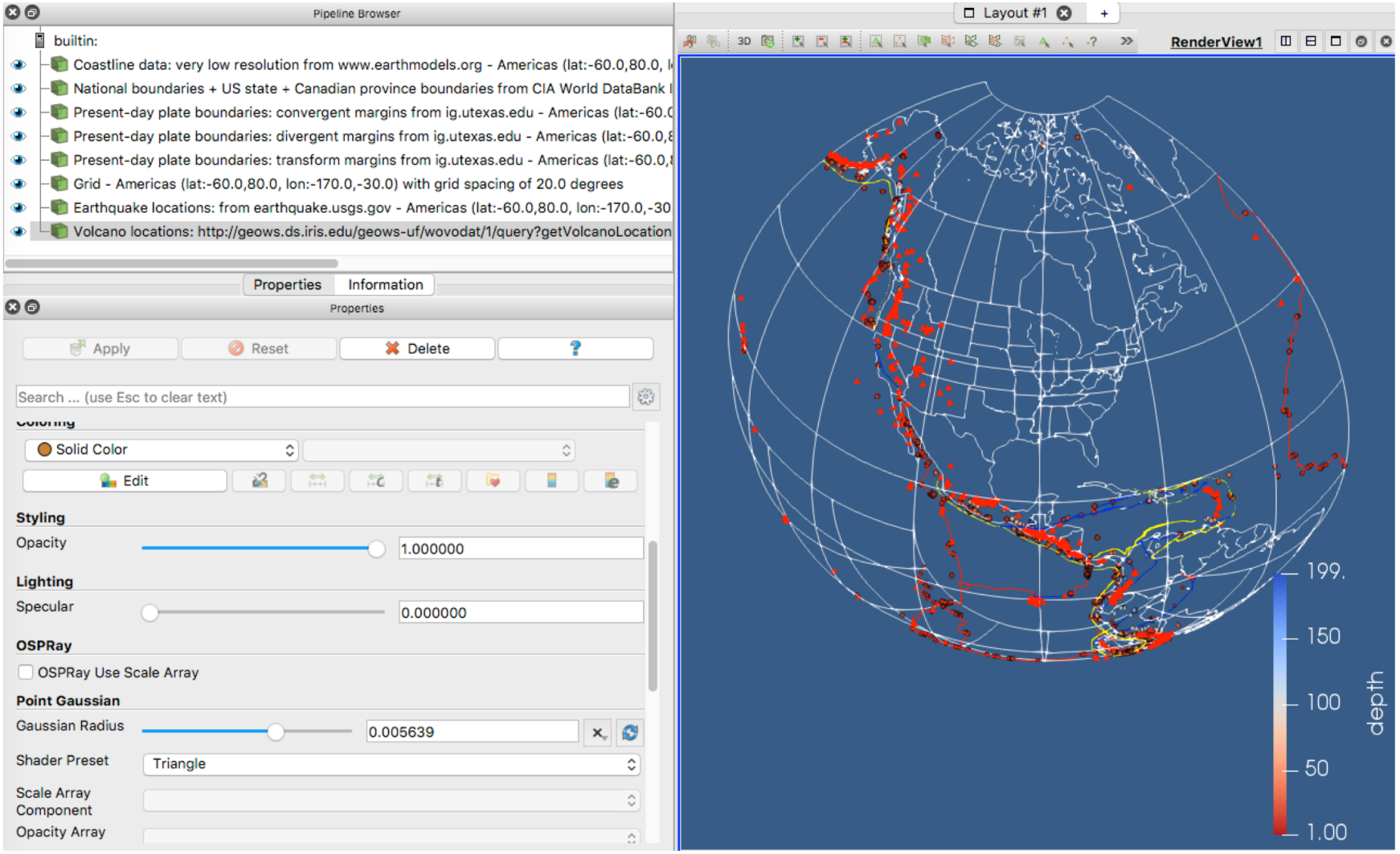
Show Volcano Locations

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**



Show Volcano Locations (Cont'd)

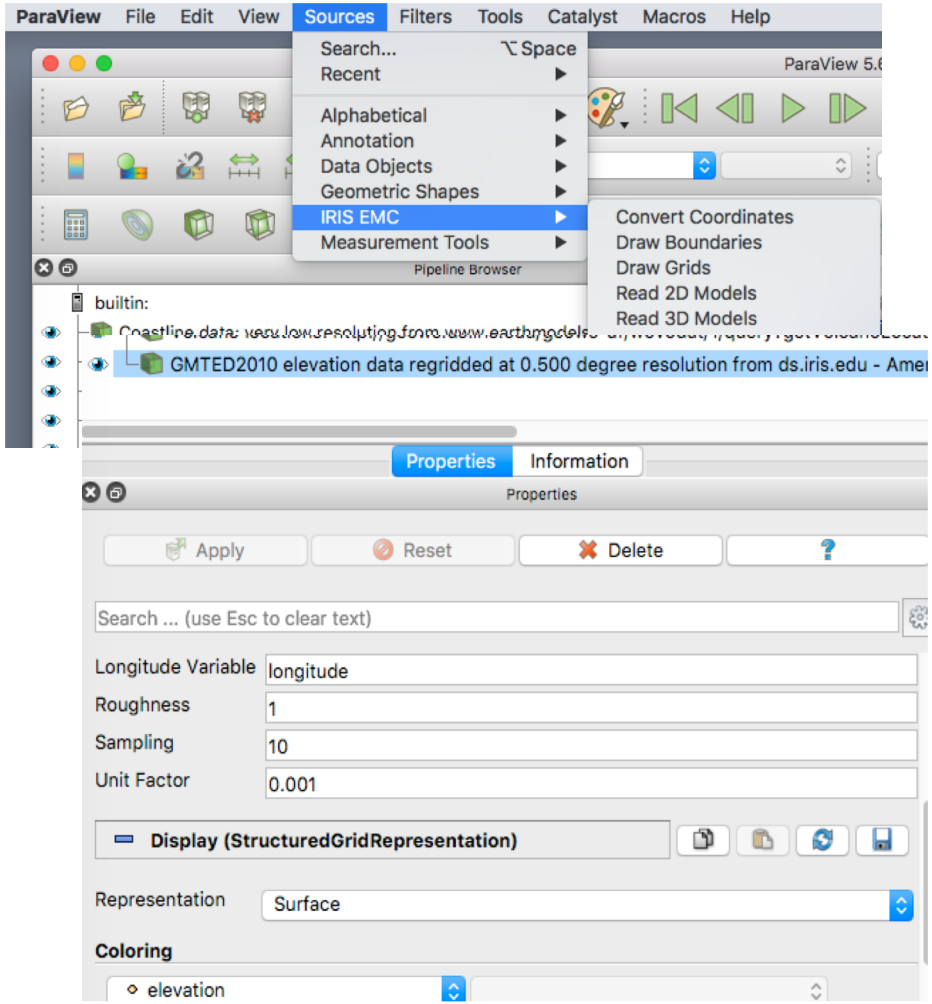


EMC ParaView Plugins – Show Volcano Locations

Topo Elevation Data

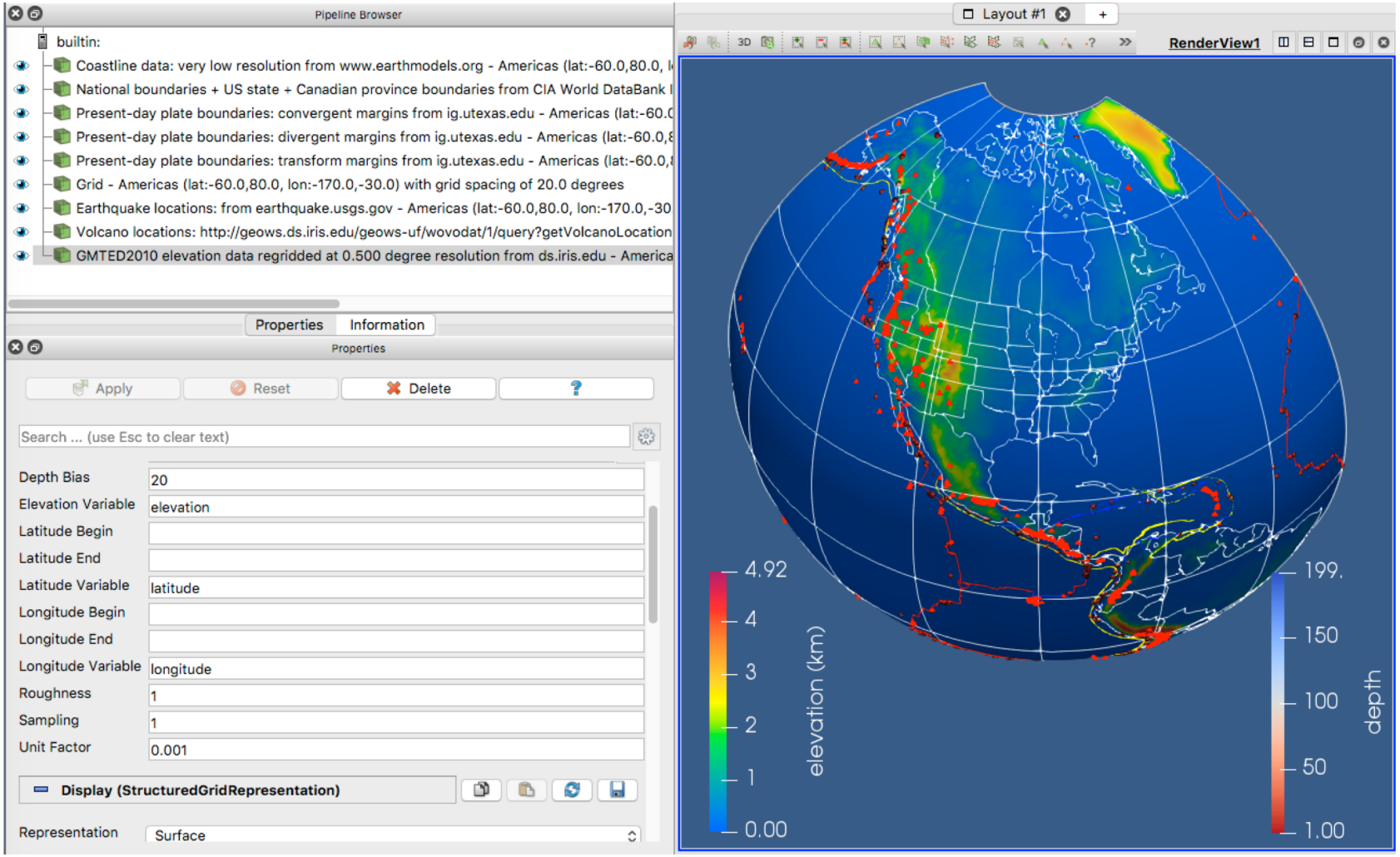
Plot surface elevation changes using elevation data files (**NOTE**: Plugins can read netCDF files only under Mac and Linux. Under Windows, plugins automatically try to find the GeoCSV version. You can leave the file extension out to let the plugin choose the format based on your OS).

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** for different resampling/ 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

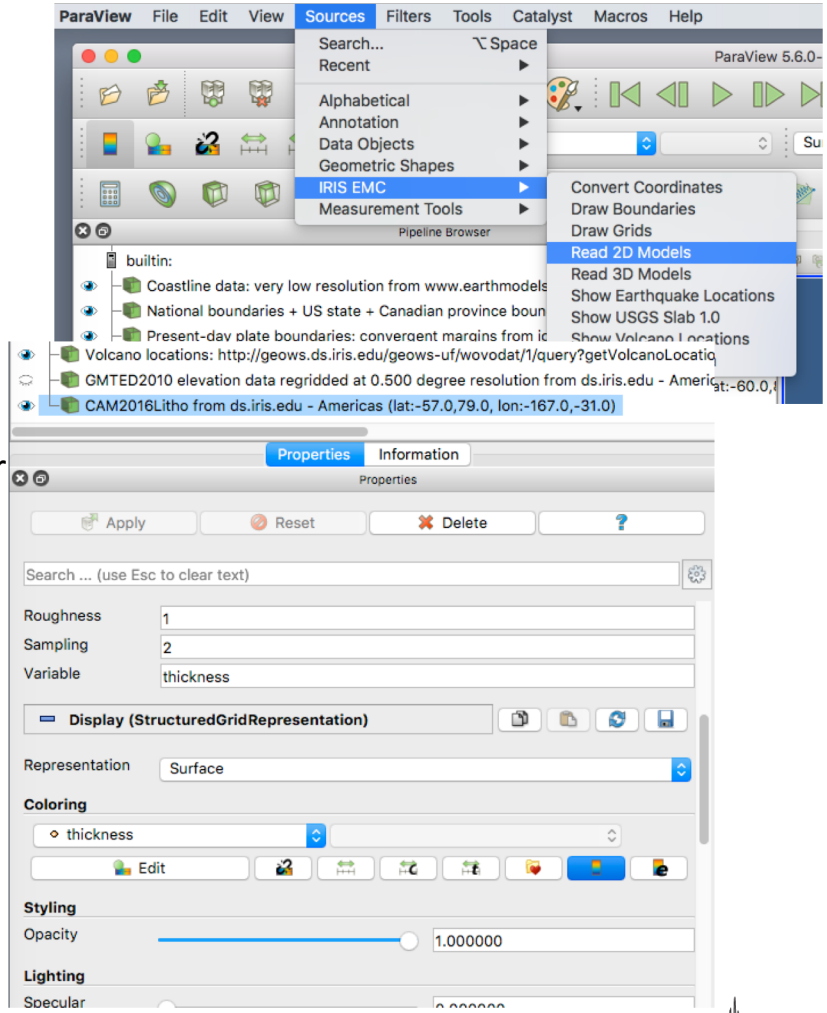
Plot surface elevation changes using elevation data files



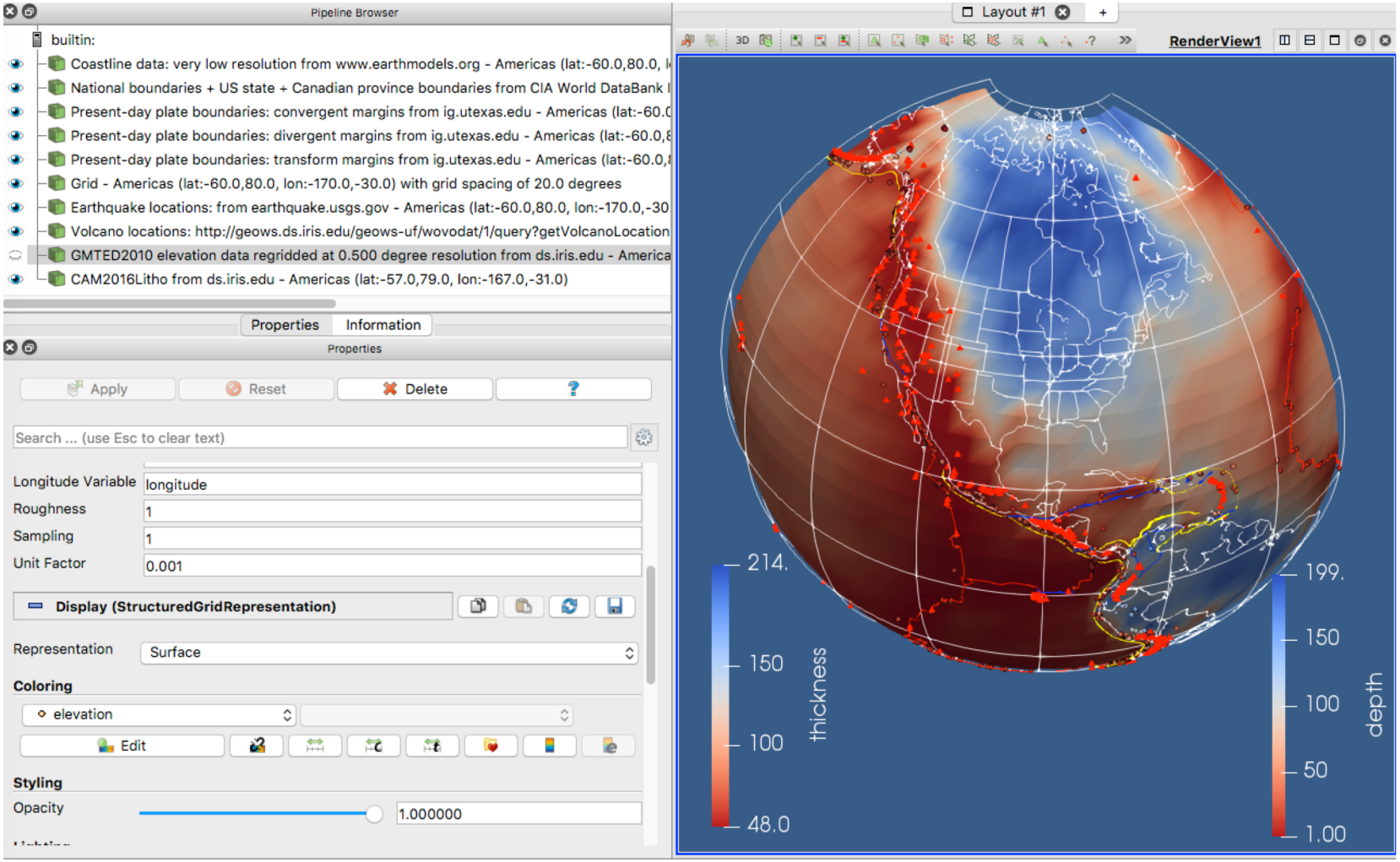
Read 2D Models

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



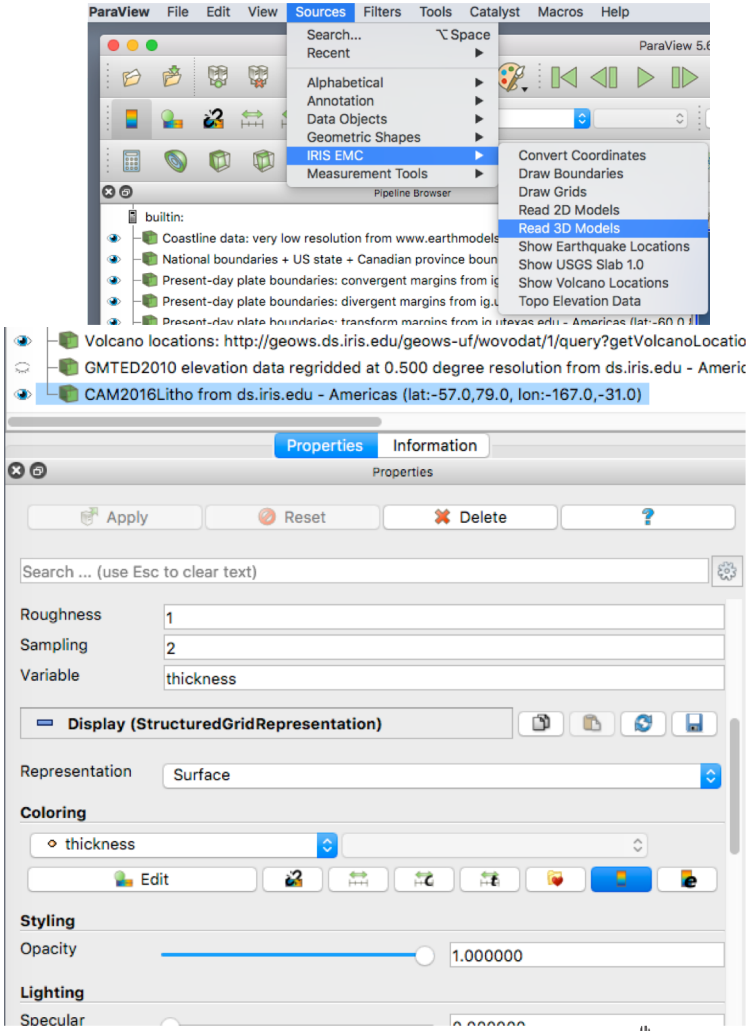
Read 2D Models (Cont'd)



Read 3D Models

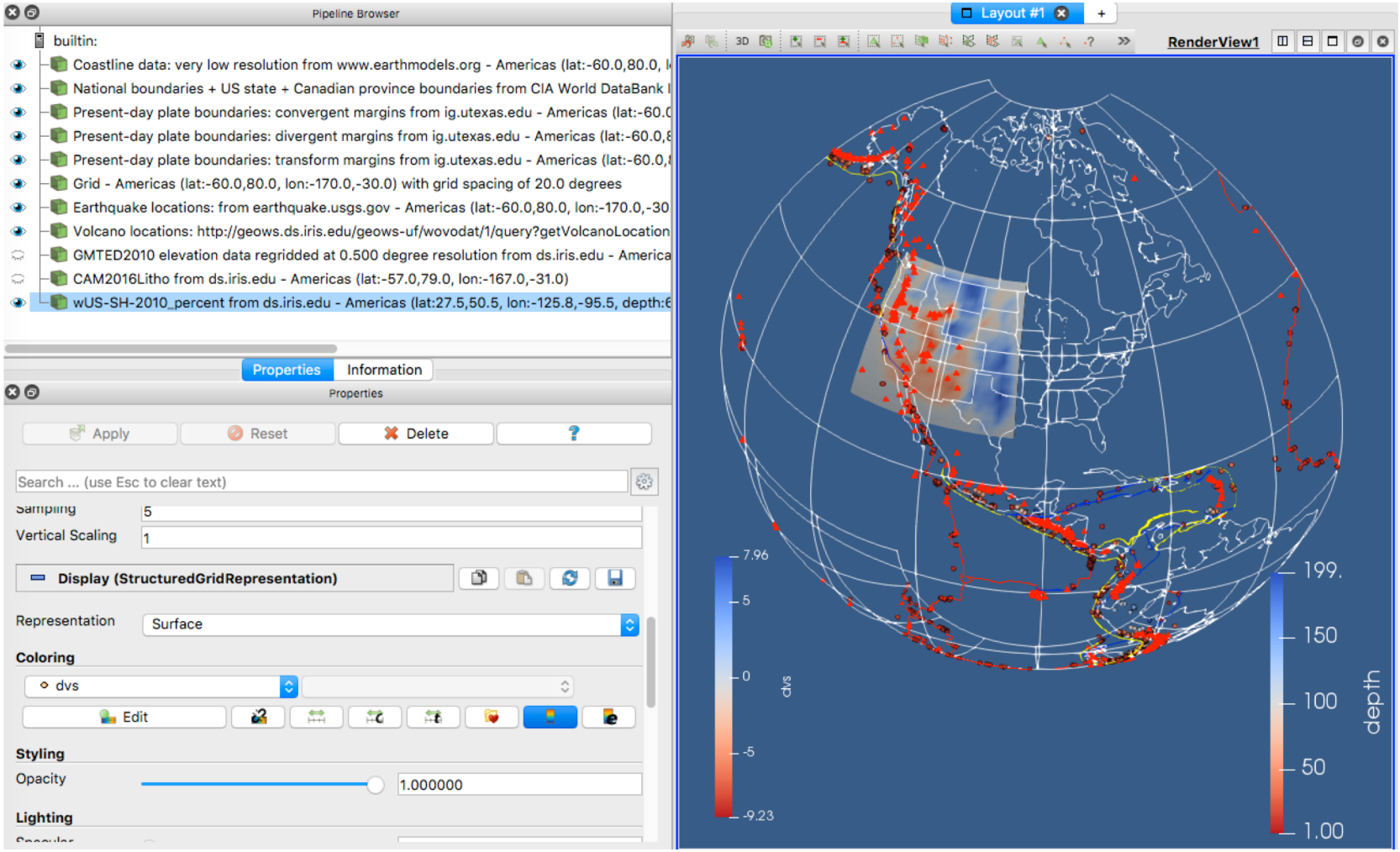
Read and plot 3D Earth model files in netCDF and GeoCSV file format (**NOTE**: Plugins can read netCDF files only under Mac and Linux. Under Windows, plugins automatically try to find the GeoCSV version. You can leave the file extension out to let the plugin choose the format based on your OS).

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/
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



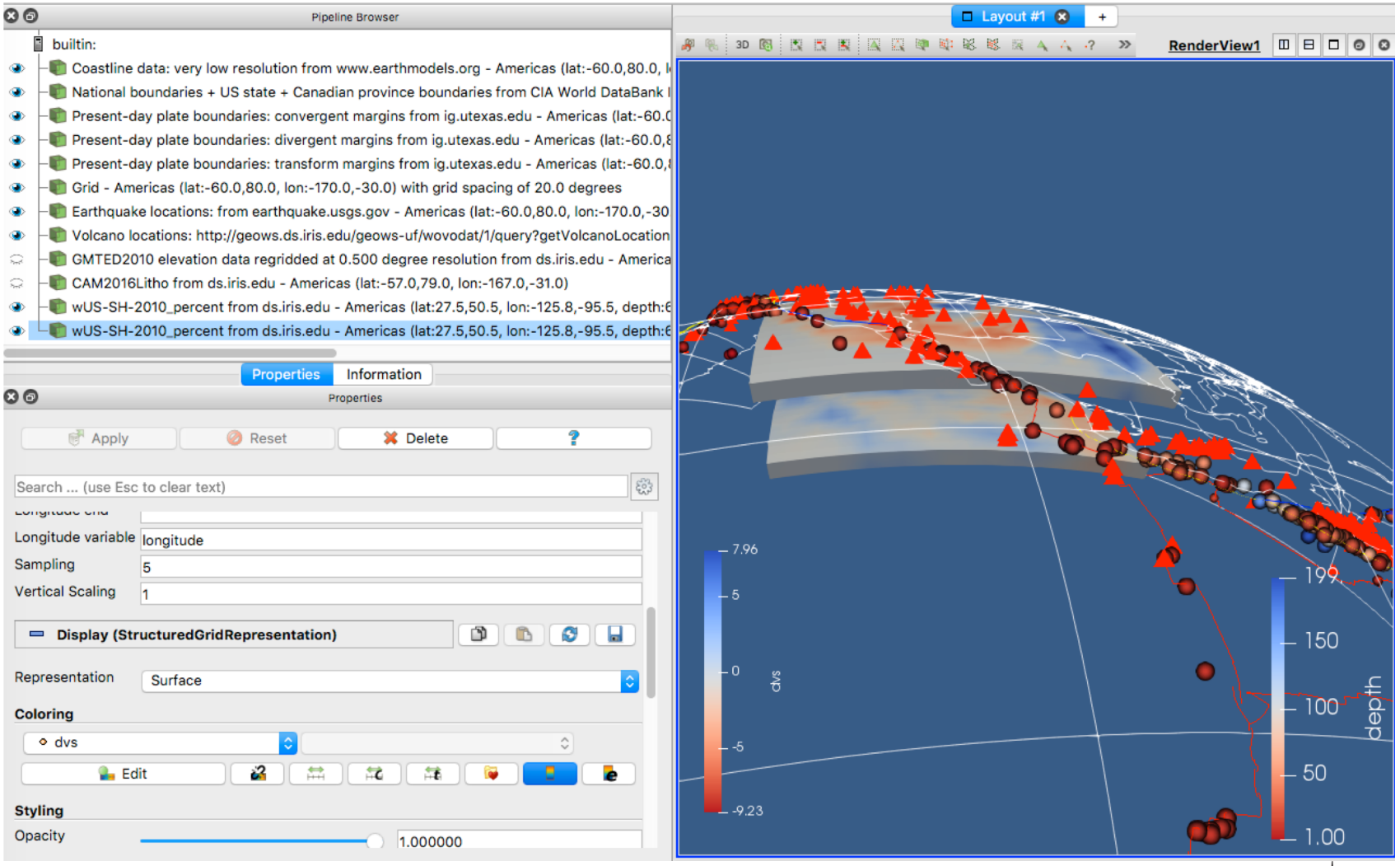
EMC ParaView Plugins – Read 3D Models

Read 3D Models (Cont'd)



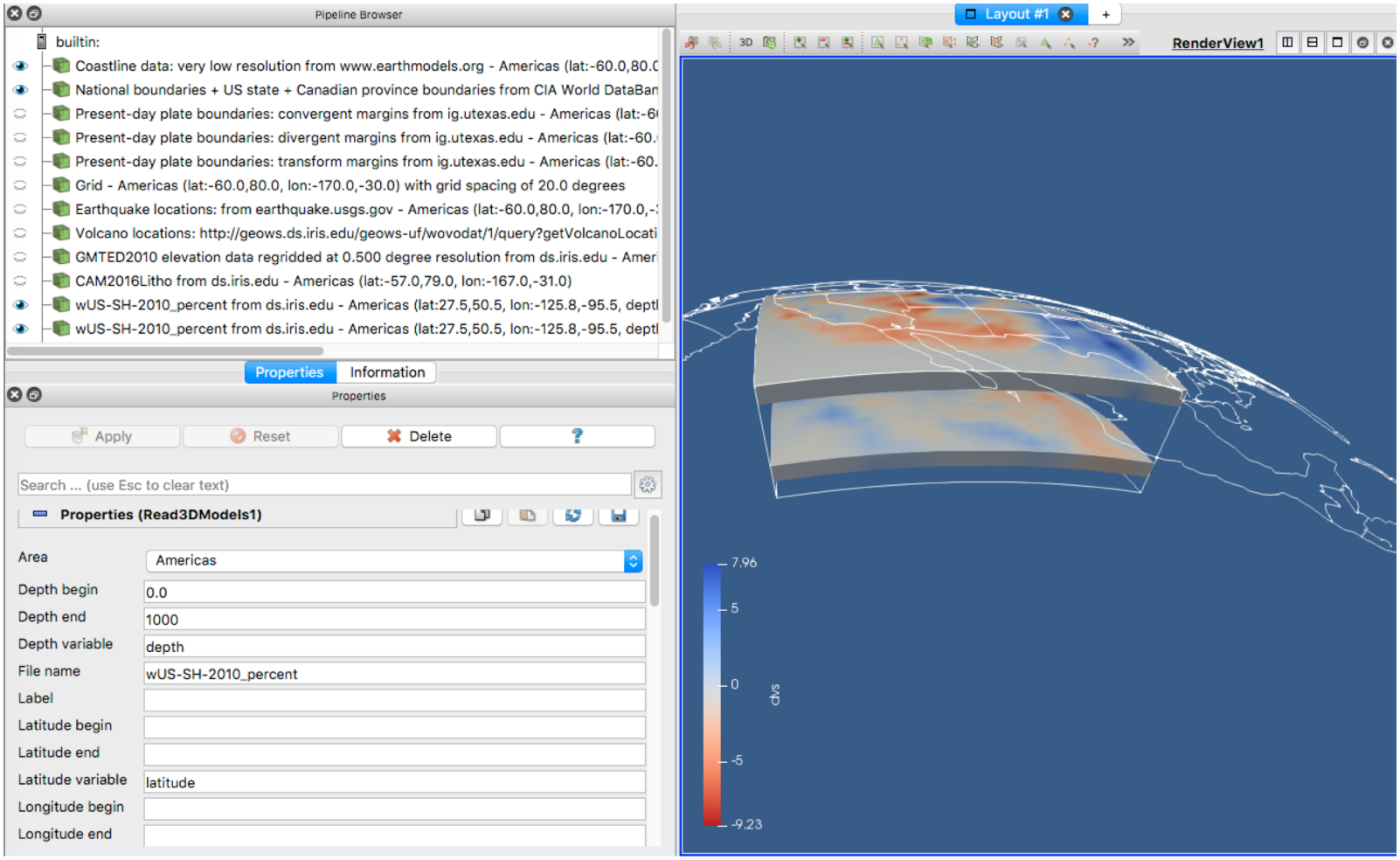
Read 3D Models – horizontal slices

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

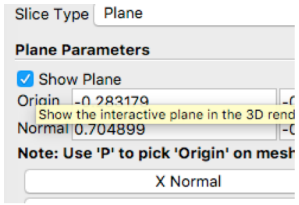


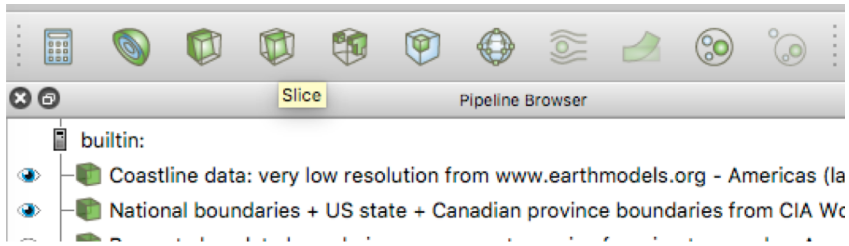
Read 3D Models – cross-sections (Cont'd)

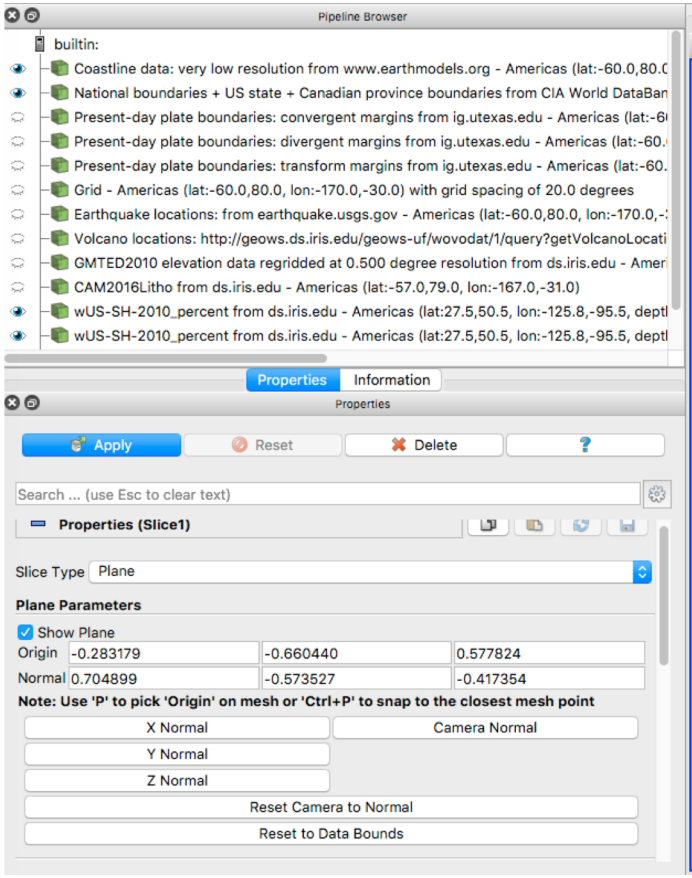
Use ParaView's slice tool to slice the model and use the controls to position it as desired

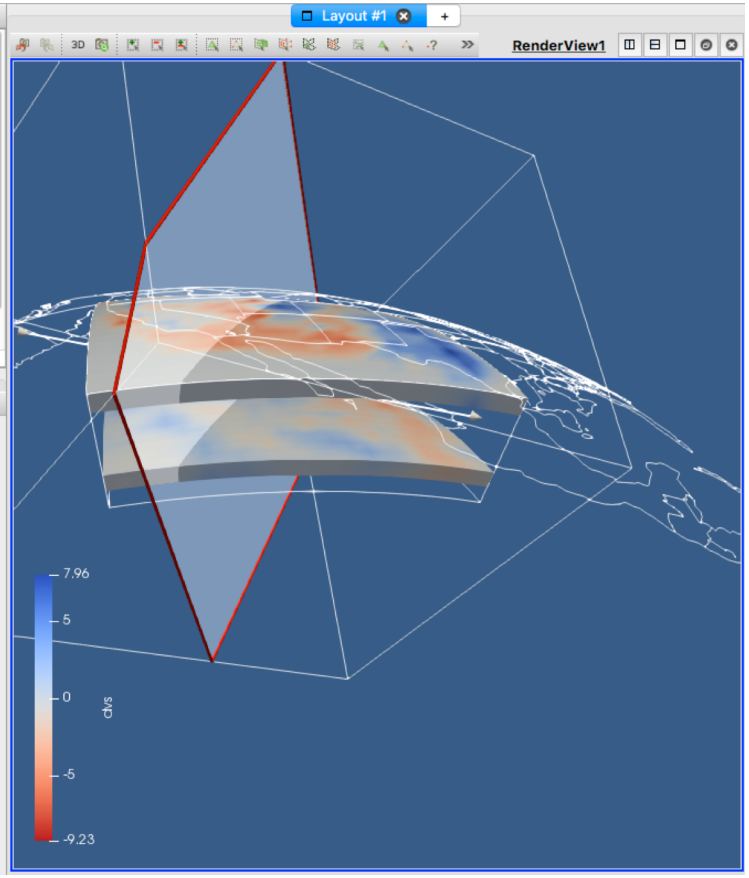
Once in position:

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





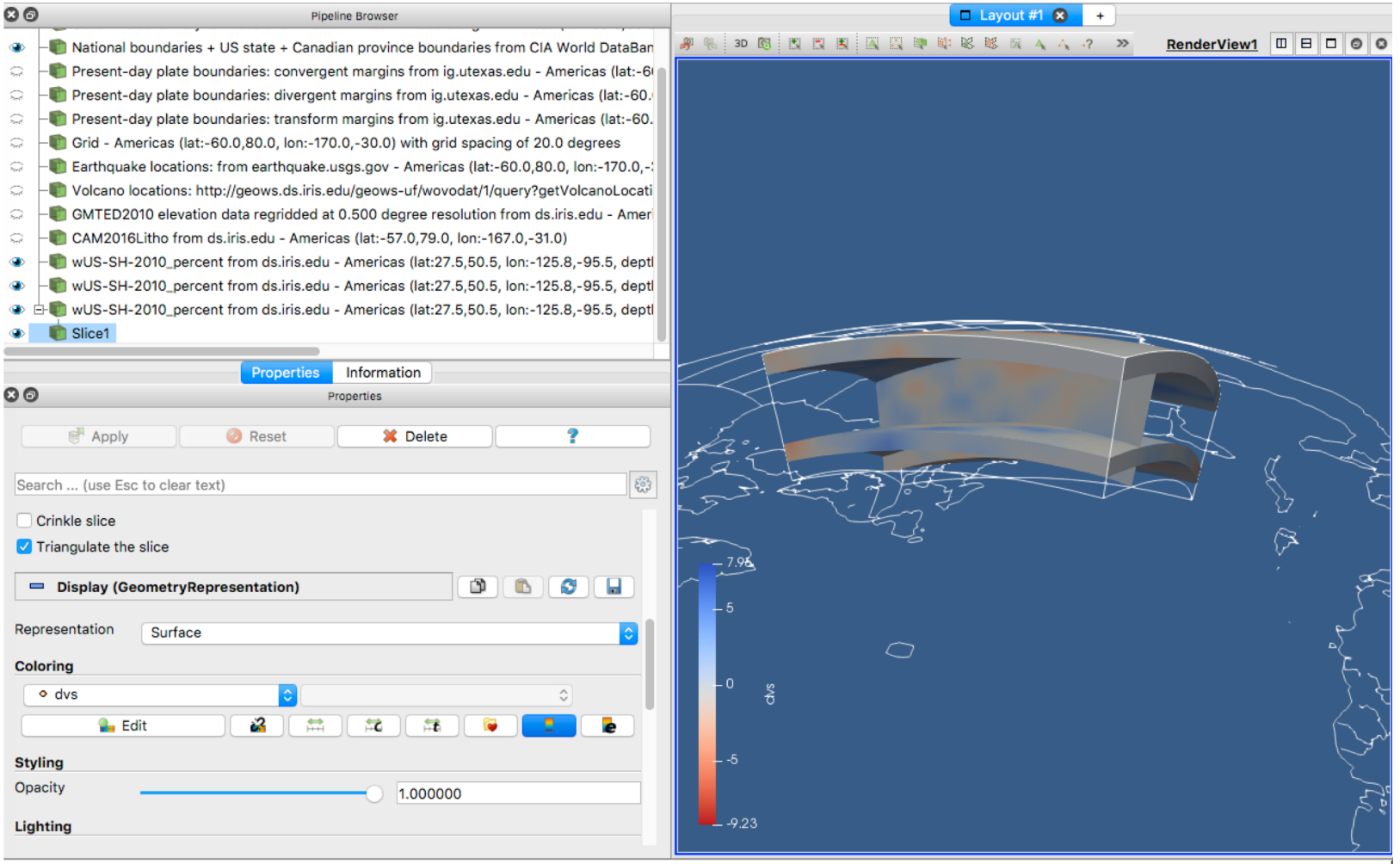




Read 3D Models – cross-sections (Cont'd)

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

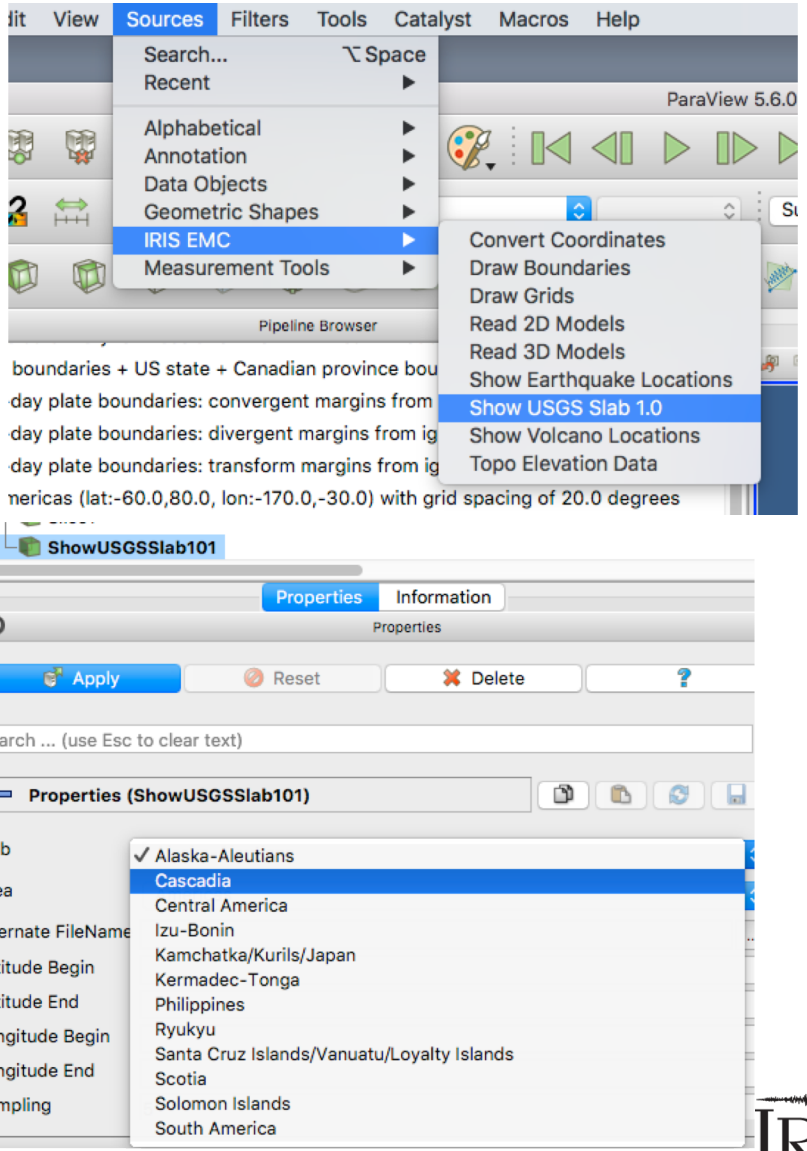
NOTE: Since model volume is already in the pipeline, you can draw as many slices as desired



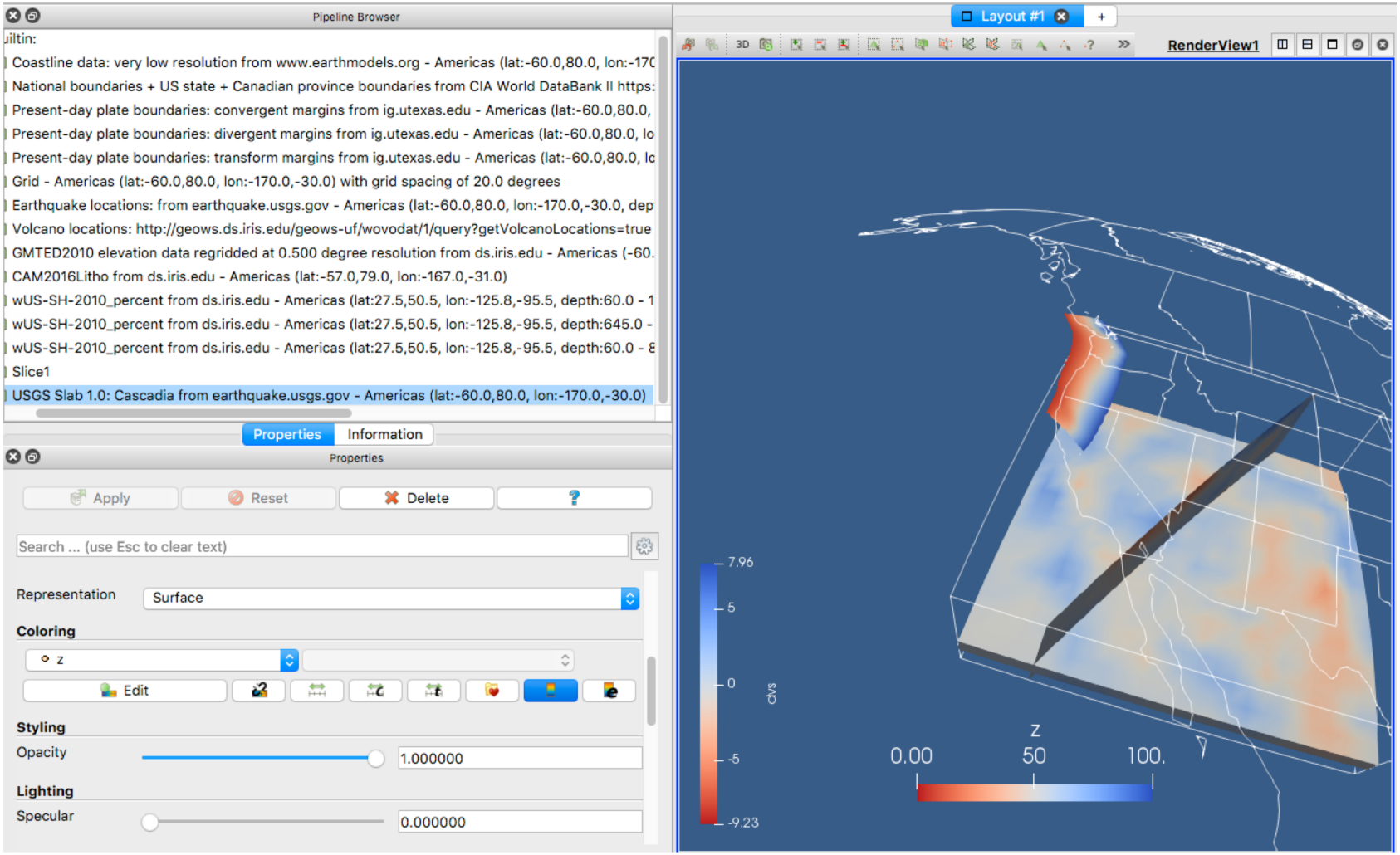
Show USGS Slab 1.0 Model

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

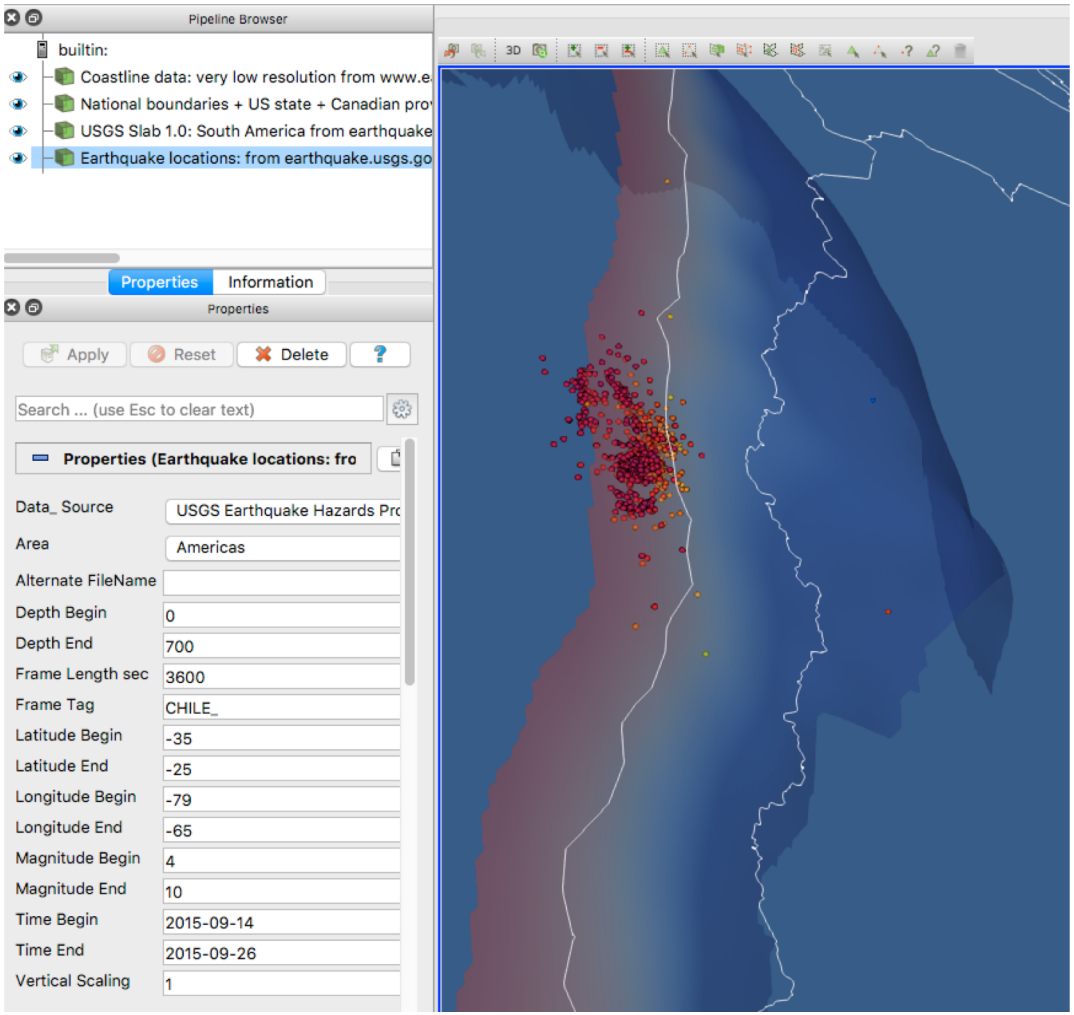


Show USGS Slab 1.0 Model (Cont'd)



Show Earthquake Locations (animation)

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



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

Create 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

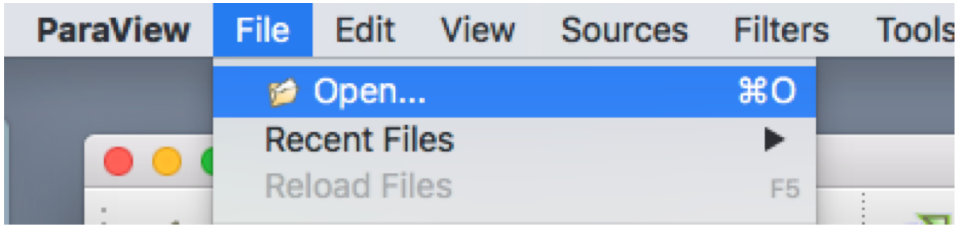
NOTE: For animation we have defined **Frame Tag** of **CHILE_** to tag the animation files and **Frame Length** of 3600 to create hourly animation files

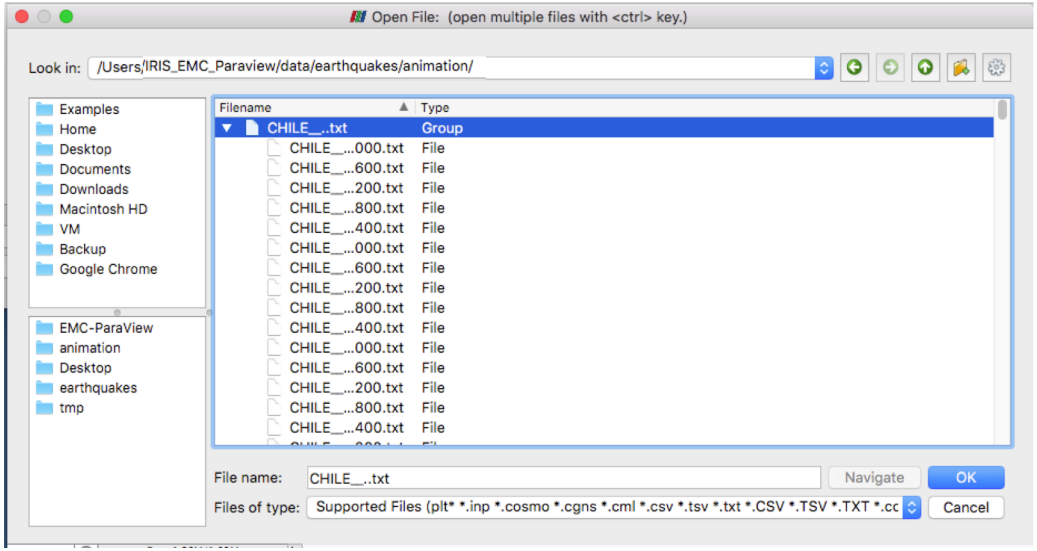
Show Earthquake Locations (animation, Cont'd)

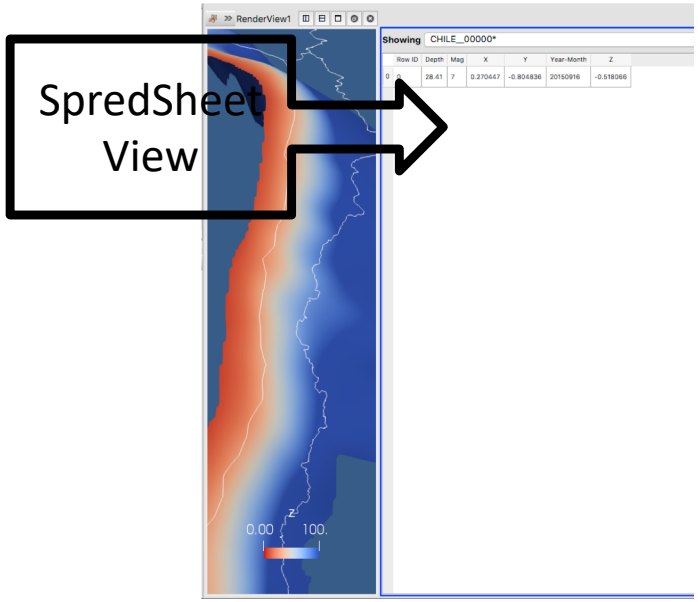
Example: M 8.3 NEAR COAST OF CENTRAL CHILE, 2015-09-16 22:54:32

Because we defined **Frame Tag** of **CHILE_** and **Frame Length** of 3600 in the last step, animation files are created under data/earthquakes/animation/ directory with names starting with **CHILE_** . Each file contains list earthquakes for the past 3600s in addition to the earthquakes of previous steps. **ParaView** will recognize these as **Group Files**

1. Open files of the **CHILE_** group
2. Click **Apply** for the **CHILE_000..** Object created in the pipeline
3. **ParaView** will import them into a spread sheet. **Close** the resulting **SpreadSheet View**





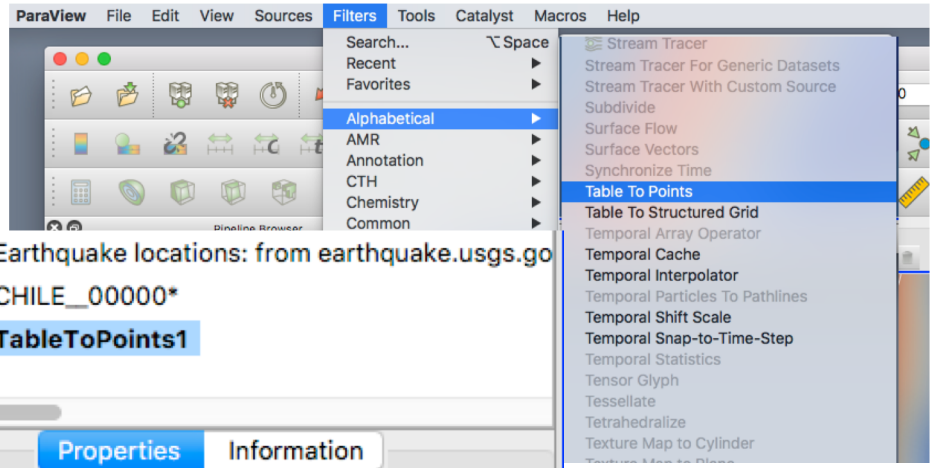


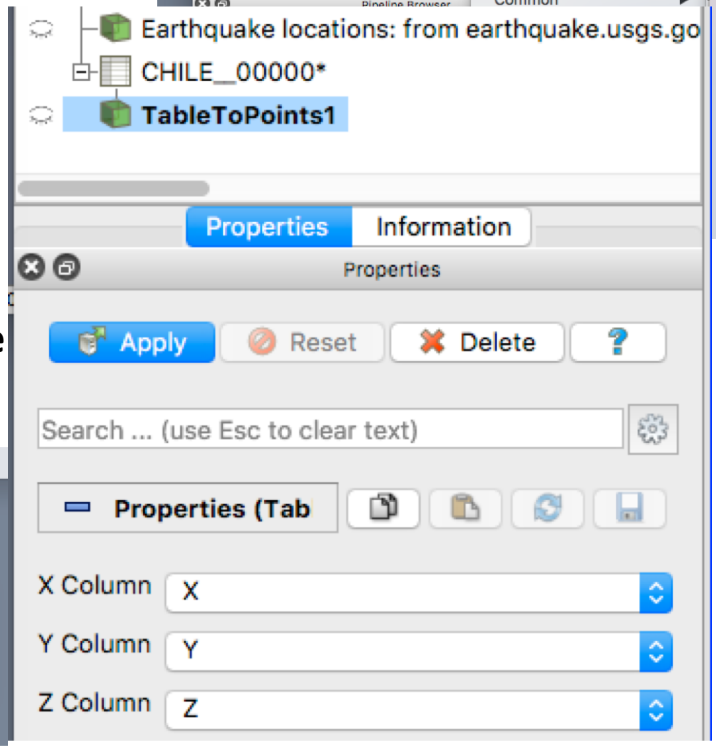
Show Earthquake Locations (animation, Cont'd)

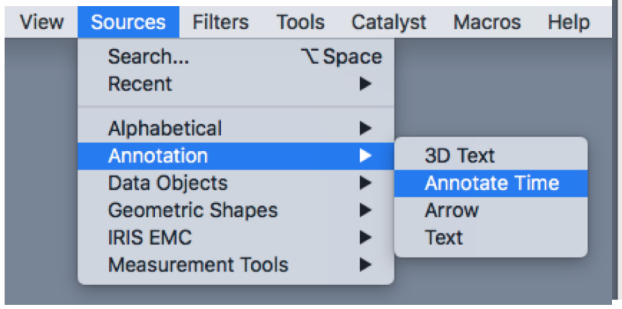
Example: M 8.3 NEAR COAST OF CENTRAL CHILE, 2015-09-16 22:54:32

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_000..** 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 containing X, Y and Z coordinates (they are actually called 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 (hours). This can be done via **Annotate Time Source**



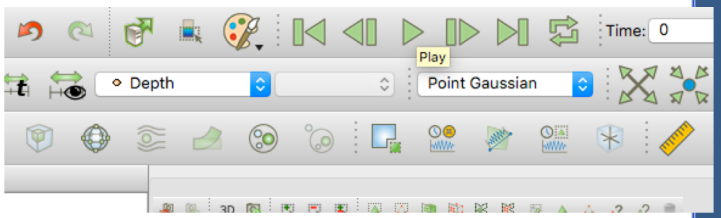




Show Earthquake Locations (animation, Cont'd)

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 file under the documents directory of this bundle