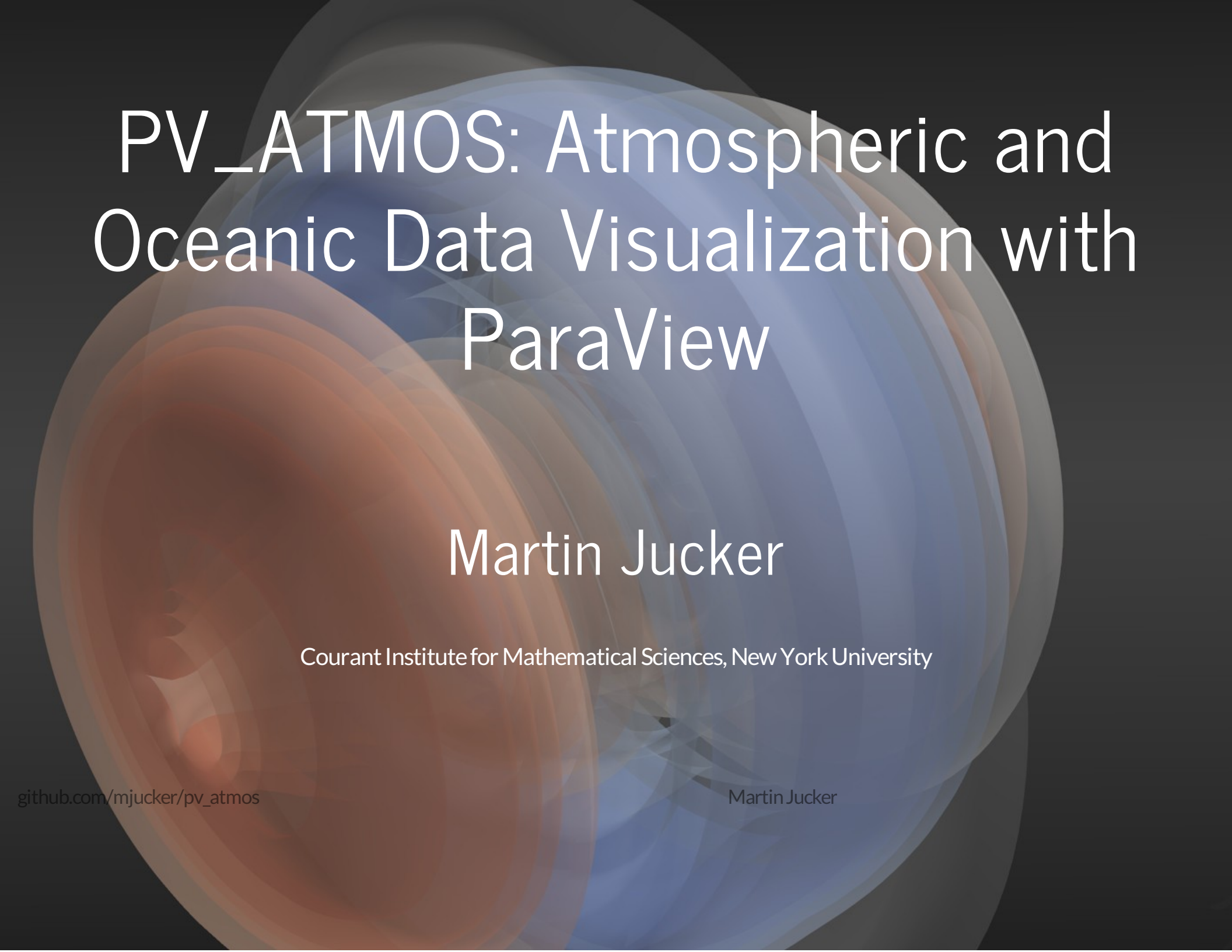
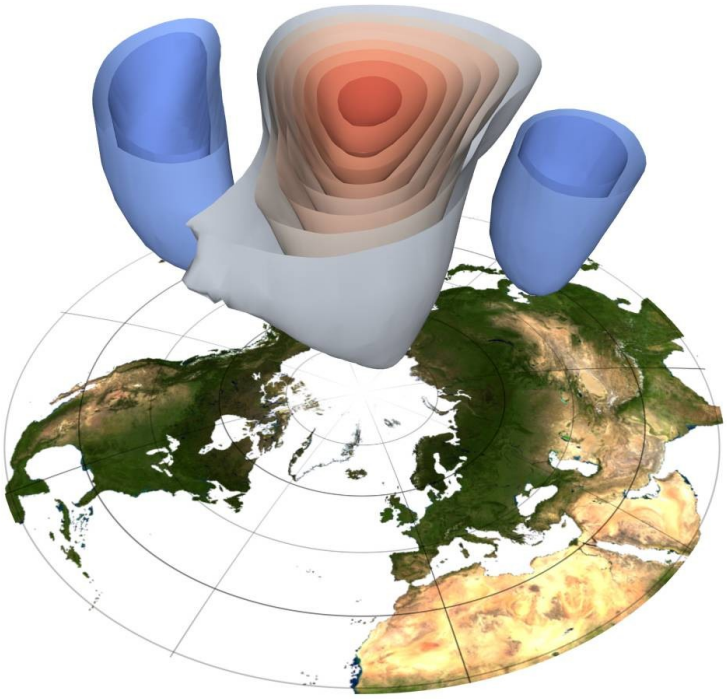


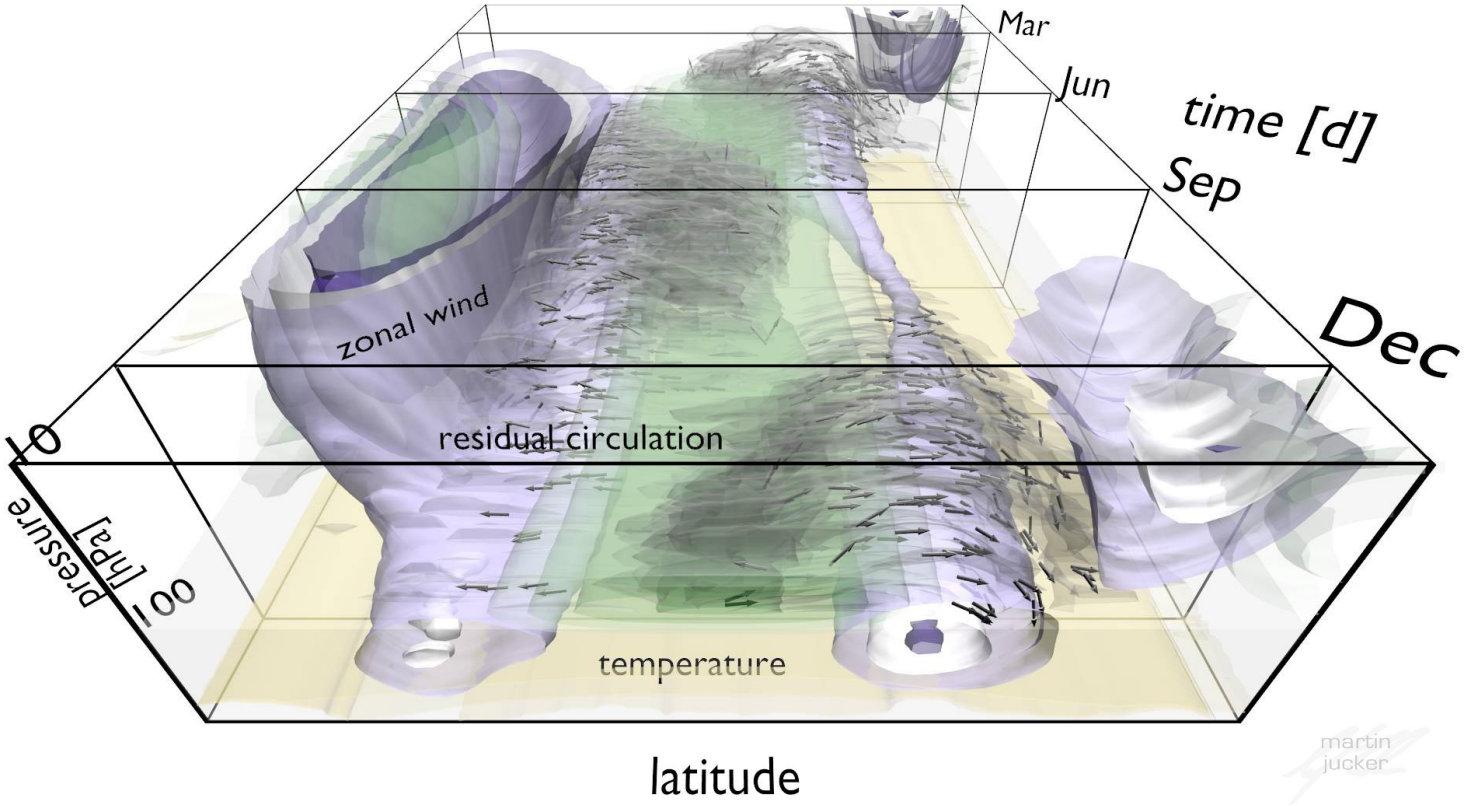
PV_ATMOS: Atmospheric and Oceanic Data Visualization with ParaView

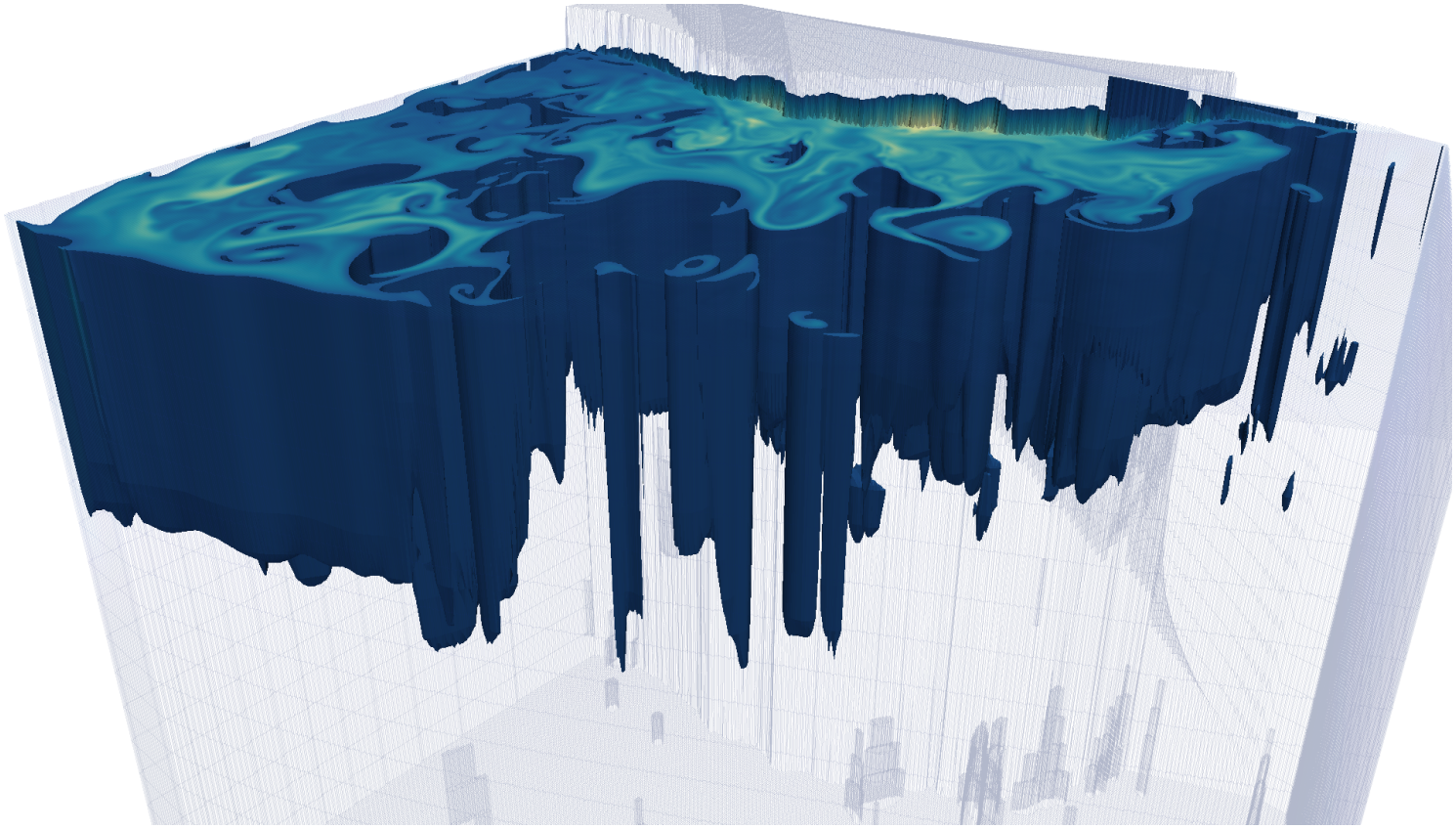
Martin Jucker

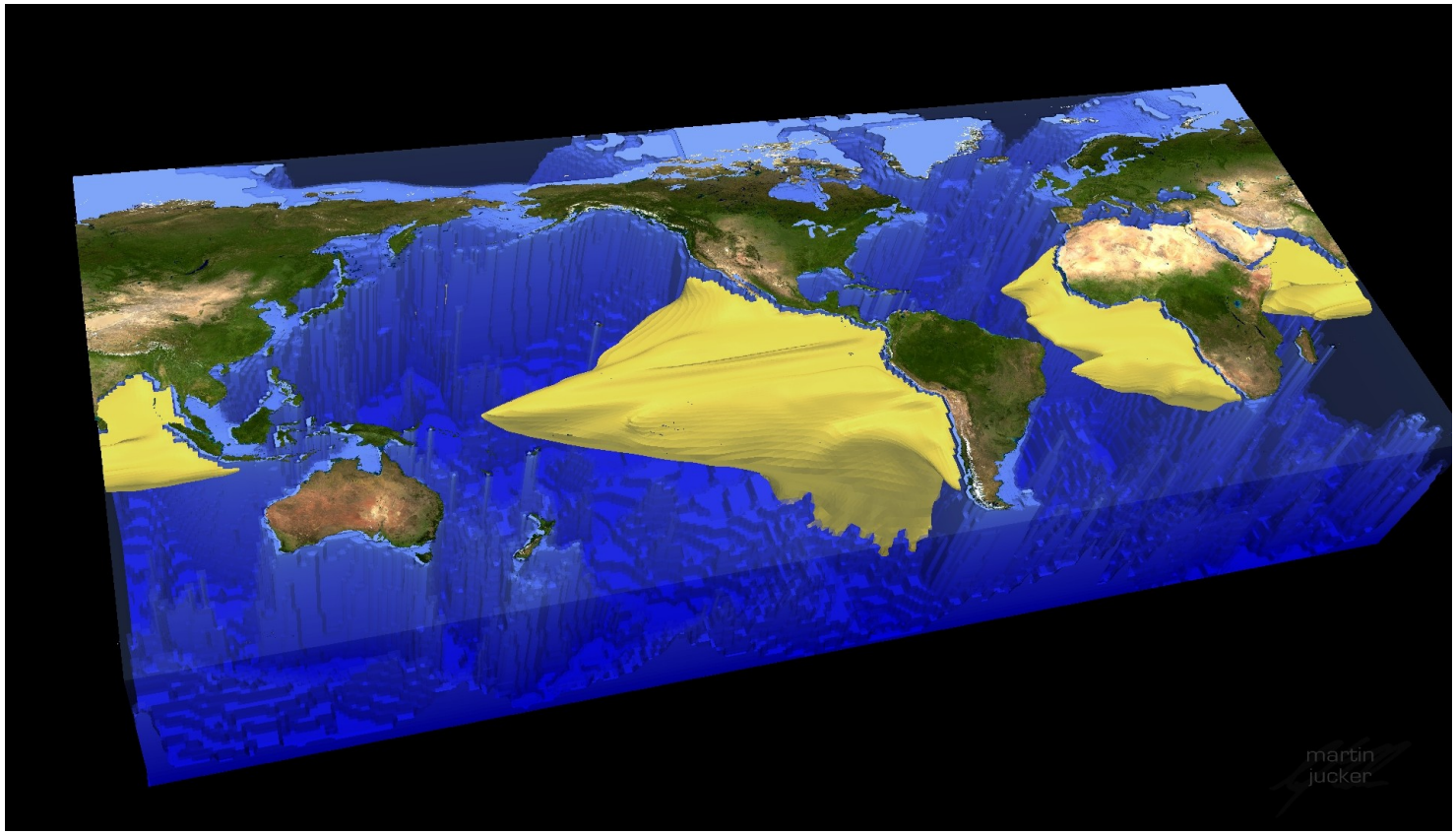
Courant Institute for Mathematical Sciences, New York University

3 in 1: Science, Beauty, Fun




Mar
Jun
time [d]
Sep
Dec
zonal wind
residual circulation
temperature
0
pressure
001 [hPa]
latitude
martin
jucker




martin
jucker

ParaView: Generalities

Installation and geekyness:

- Free, open source software
- Binaries available for any platform
  - No installation required
  - No python required (comes with it)
- Geekyness up to the user
  - No coding, just mouse and GUI, or
  - Pure coding, as python module, or
  - Anything in-between

Why ParaView?

Development and application:

- Very powerful, general viz software, based on VTK and Python
- Active development by Kitware, support from Sandia, LANL, many more
- Used in plasma physics, aerodynamics, medicine, biology, geosciences, particle physics, engineering, ...

ParaView is here to stay!

www.paraview.org

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pv_atmos: specializing PV

pv_atmos.basic: Data manipulation, helper tools

- Load netCDF data
- Convert lat-lon to sphere
- Logarithmic coordinates (→ pressure coordinates)
- Adjust aspect ratio

```
LoadData( fileName, ncDims=['lon','lat','pfull'],
          aspectRatios=[1,1,20], logCoords=[2], basis=[1000] )

Make3D( expandVar, expandDir='z' )

Cart2Spherical()

HideAll(),ShowAll(),DeleteAll()
```

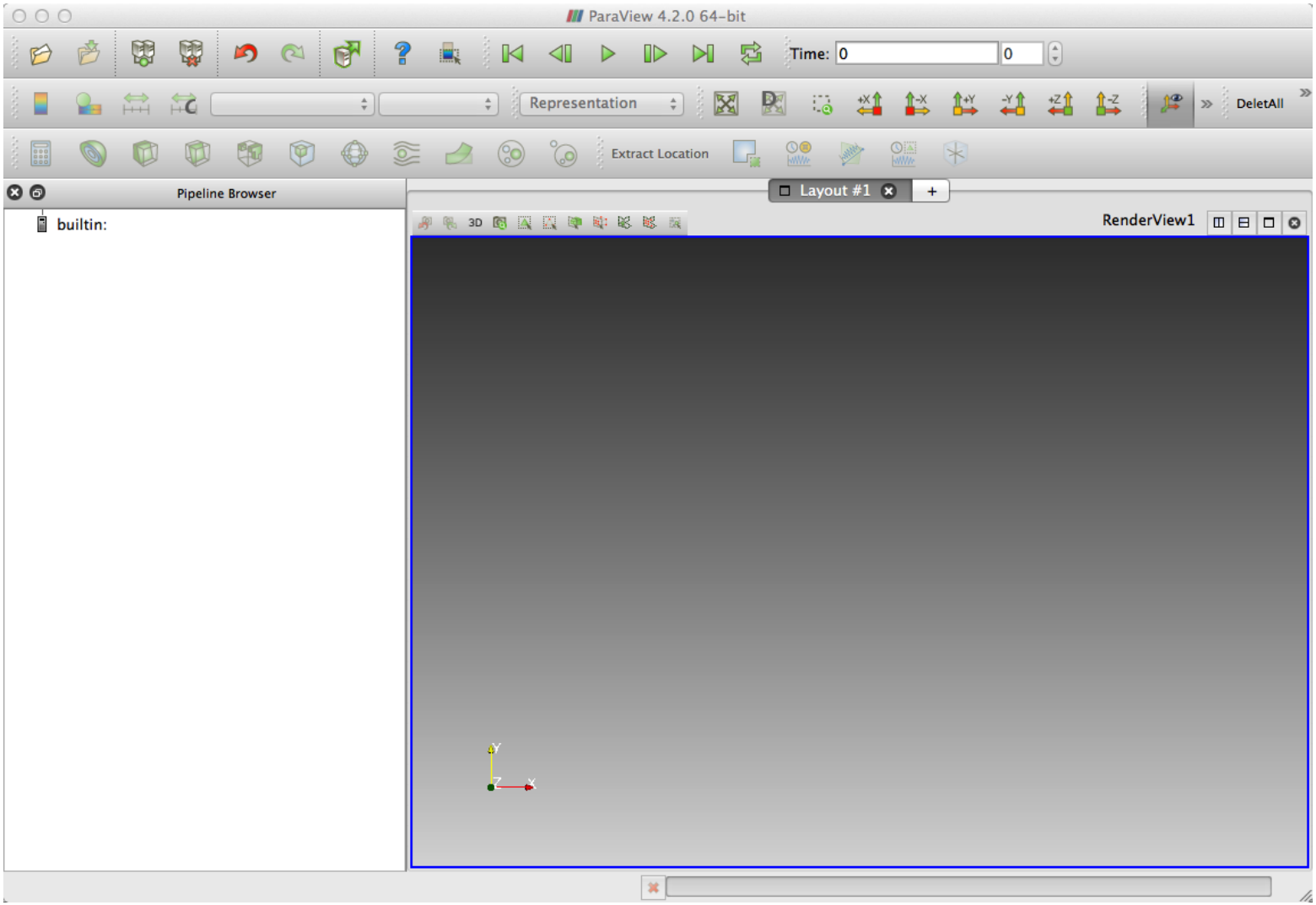
pv_atmos: specializing PV

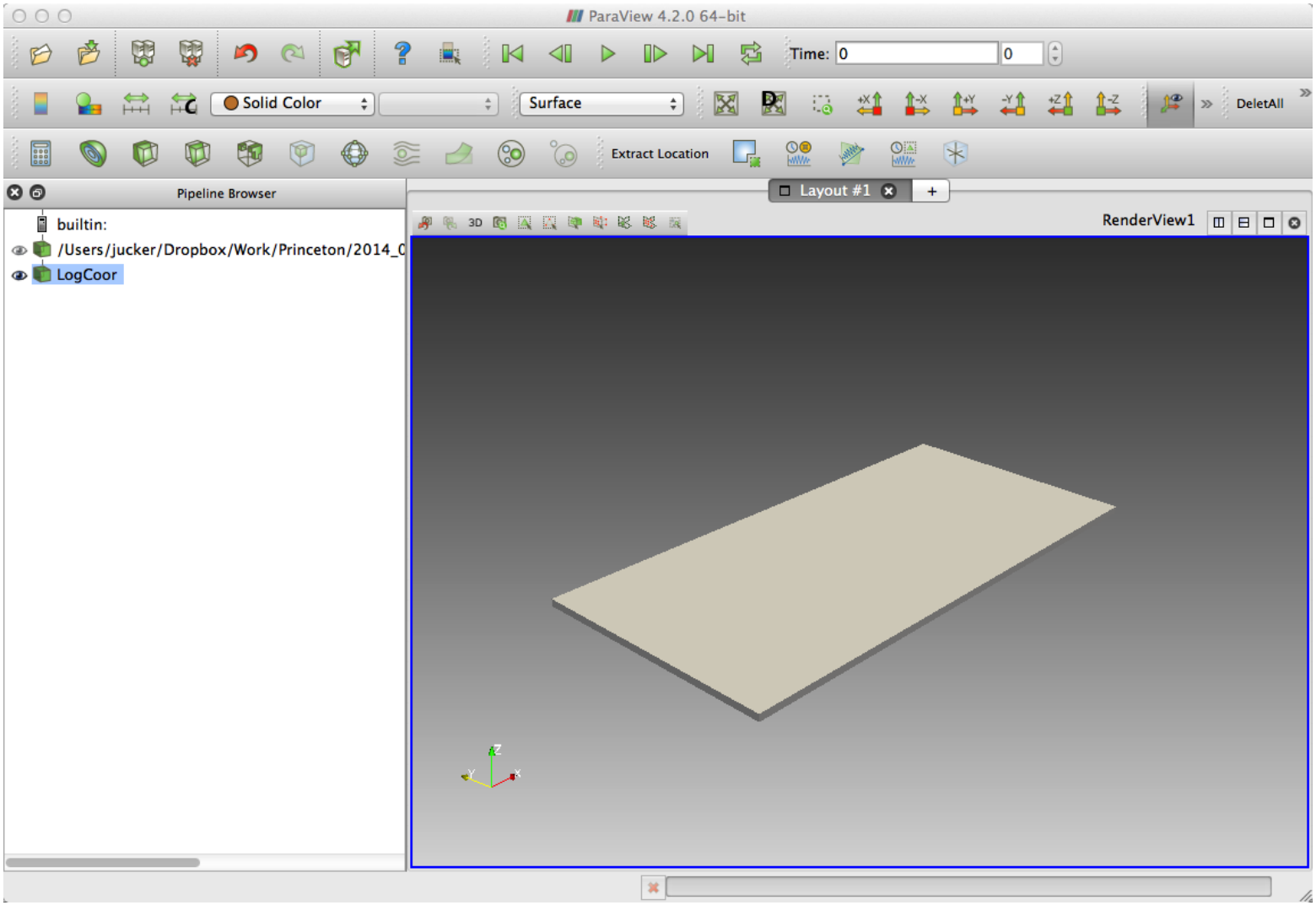
pv_atmos.grids: Axes, Labels, Grids, Slices

- Axes with or without labels
- Labels at specific places
- Grid and/or data planes

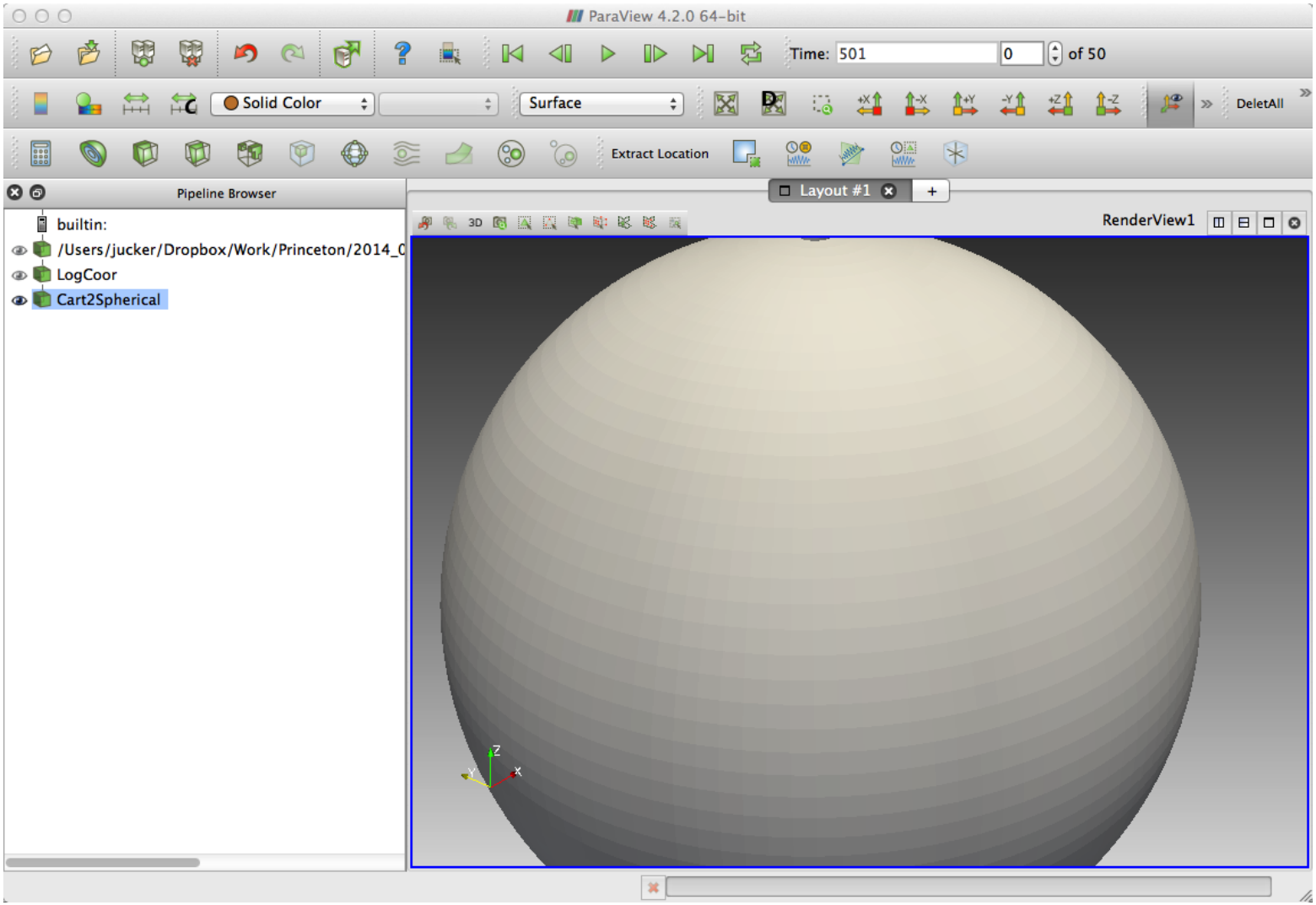
at the correct location in physical space.

```
AddGrid      ( xlevels, ylevels, zlevels,
                 AxisNames=["lon","lat","pressure [hPa]"])

AddGridPlane ( dim, dimVal )

AddGridLabel ( dim, dimVal, LabelSize=5.0 )
```

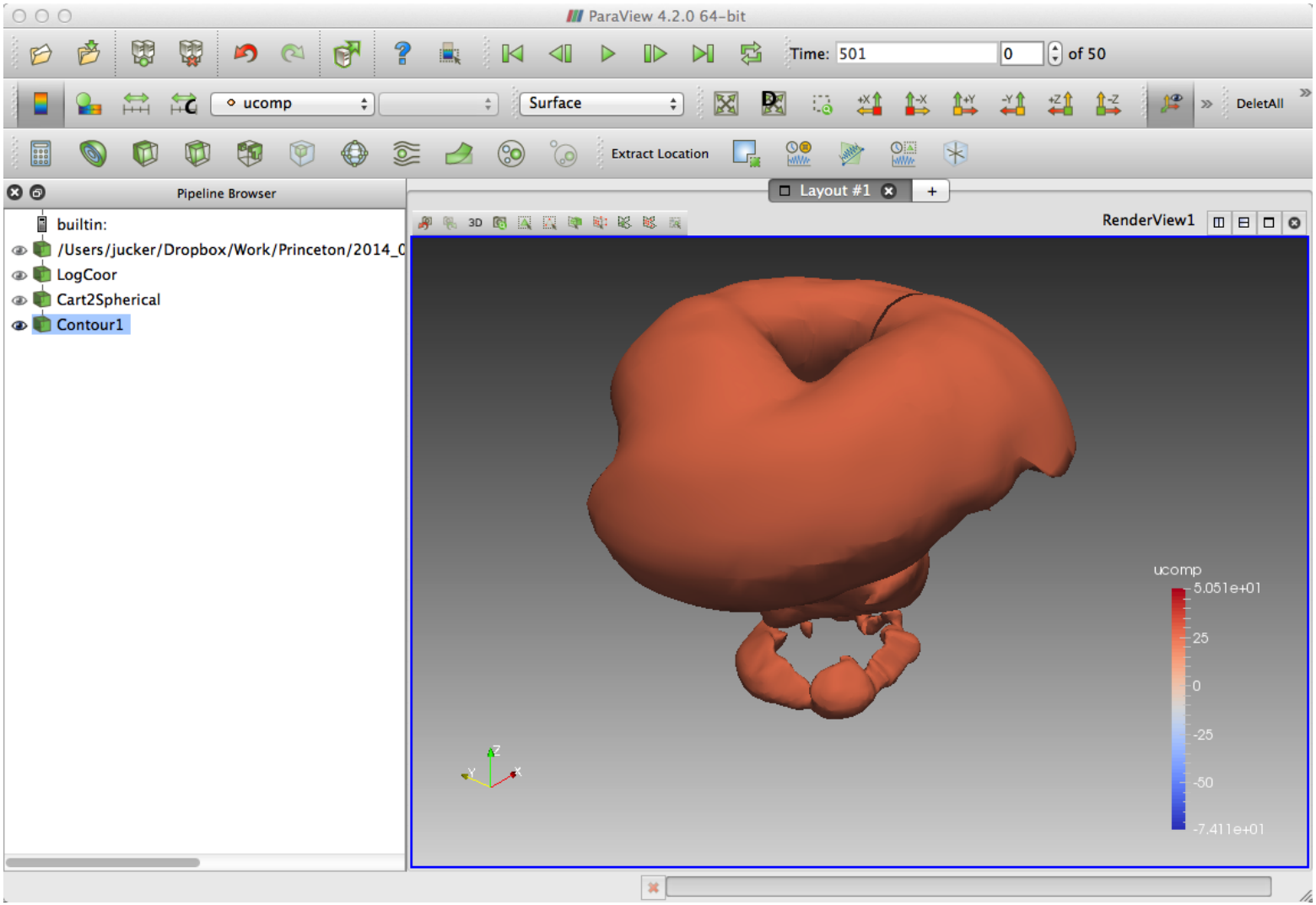

ParaView 4.2.0 64-bit
Time:
0
0
Representation
DeletAll
Extract Location
Pipeline Browser
builtin:
Layout #1
3D
RenderView1



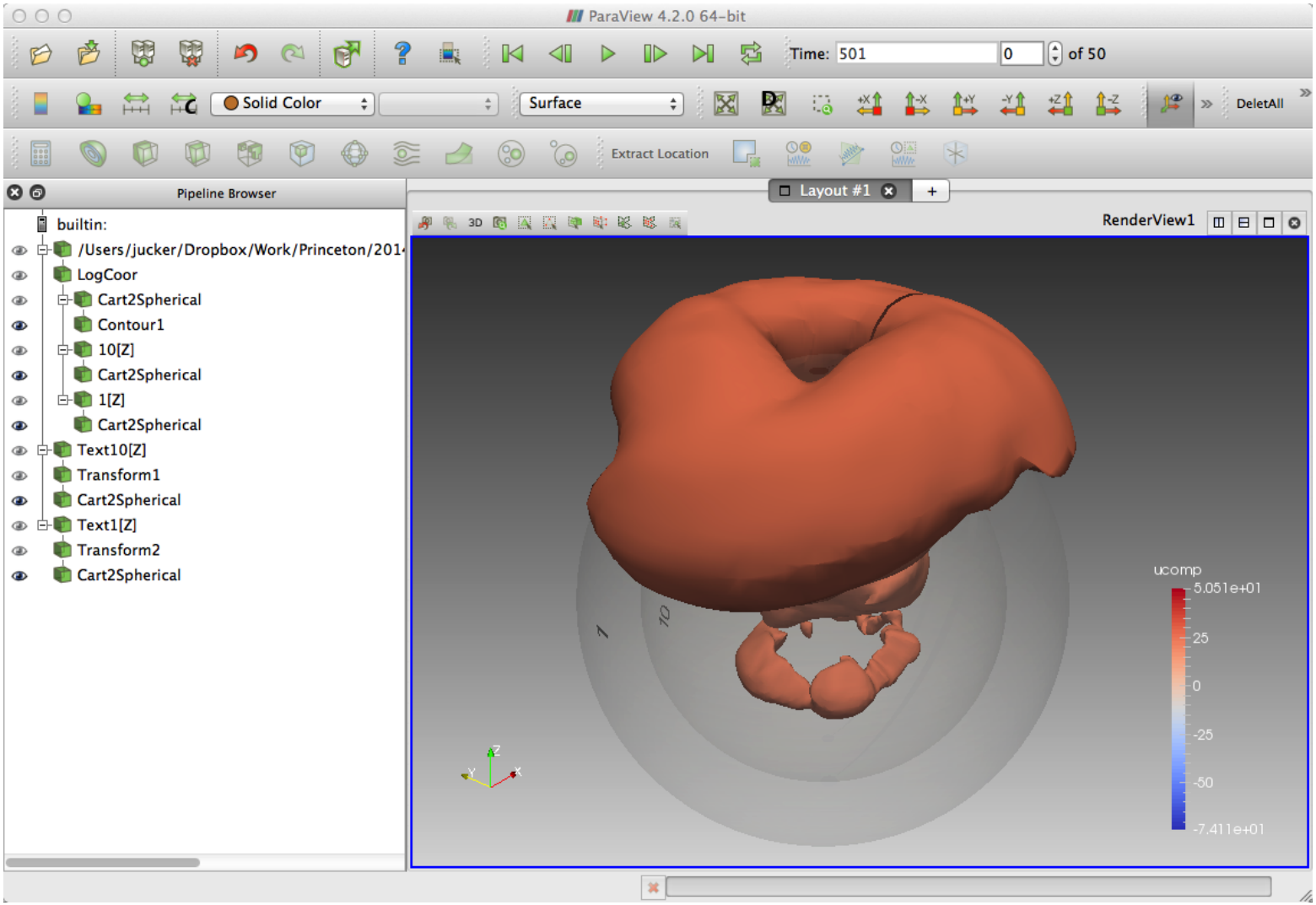

```
(output_nc,Coor) = LoadData( fileName, ncDims=['lon','lat','pfull'] )
```



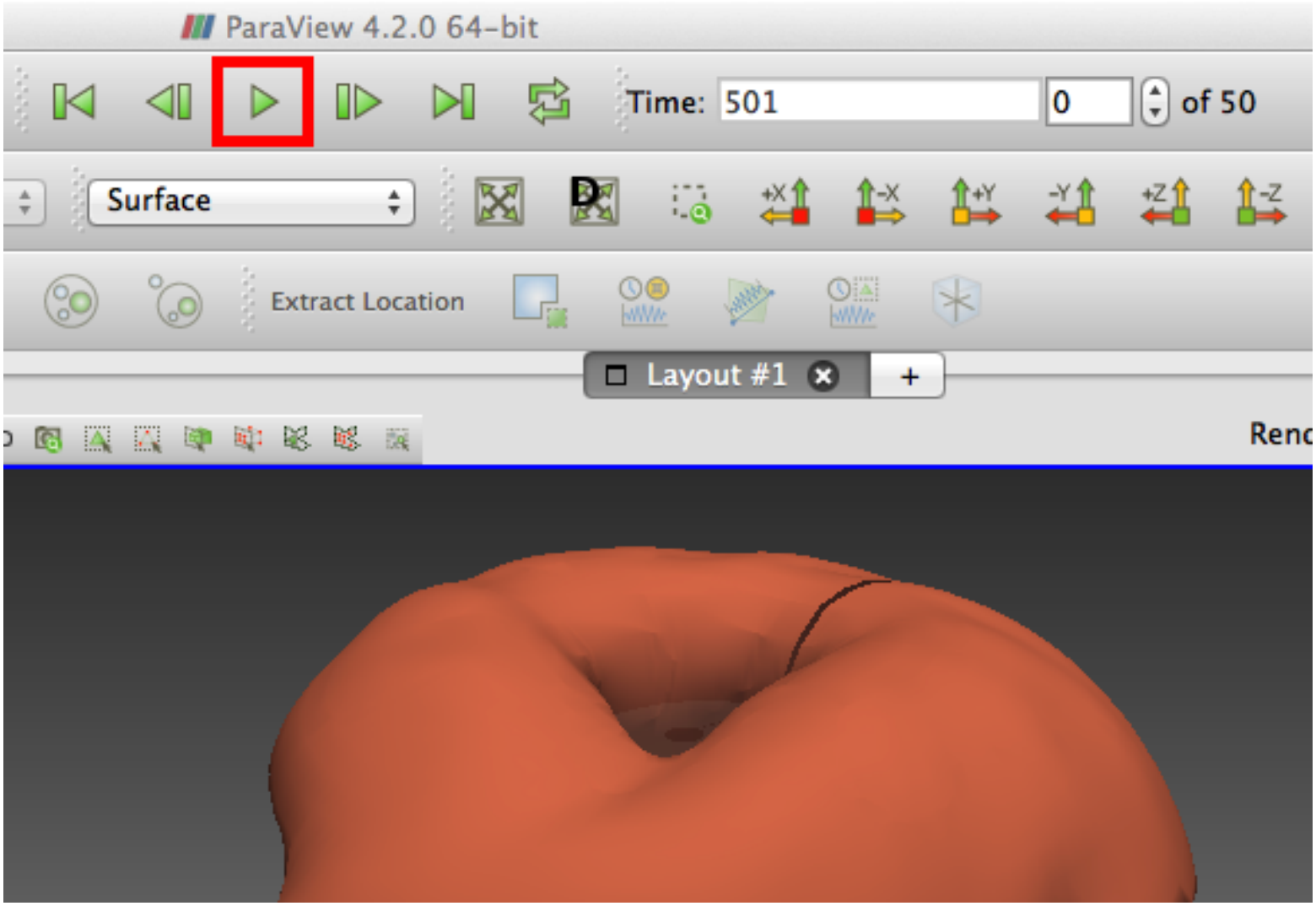

```
(output_nc,Coor) = LoadData( fileName, ncDims=['lon','lat','pfull'] )
Globe = Cart2Spherical(1.0,Coor)
```




```
(output_nc,Coor) = LoadData( fileName, ncDims=['lon','lat','pfull'] )
Globe = Cart2Spherical(1.0,Coor)
Cont = Contour(ContourBy='ucomp',Isosurfaces=[25])
```




```
(output_nc,Coor) = LoadData( fileName, ncDims=['lon','lat','pfull'] )
Globe = Cart2Spherical(1.0,Coor)
Cont = Contour(ContourBy='ucomp',Isosurfaces=[25])
Shells = SphericalShells( radius,src=Coor,shellValues=[10,1] )
```




```
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Shells = SphericalShells( radius,src=Coor,shellValues=[10,1] )
< File -> Save Animation >
```

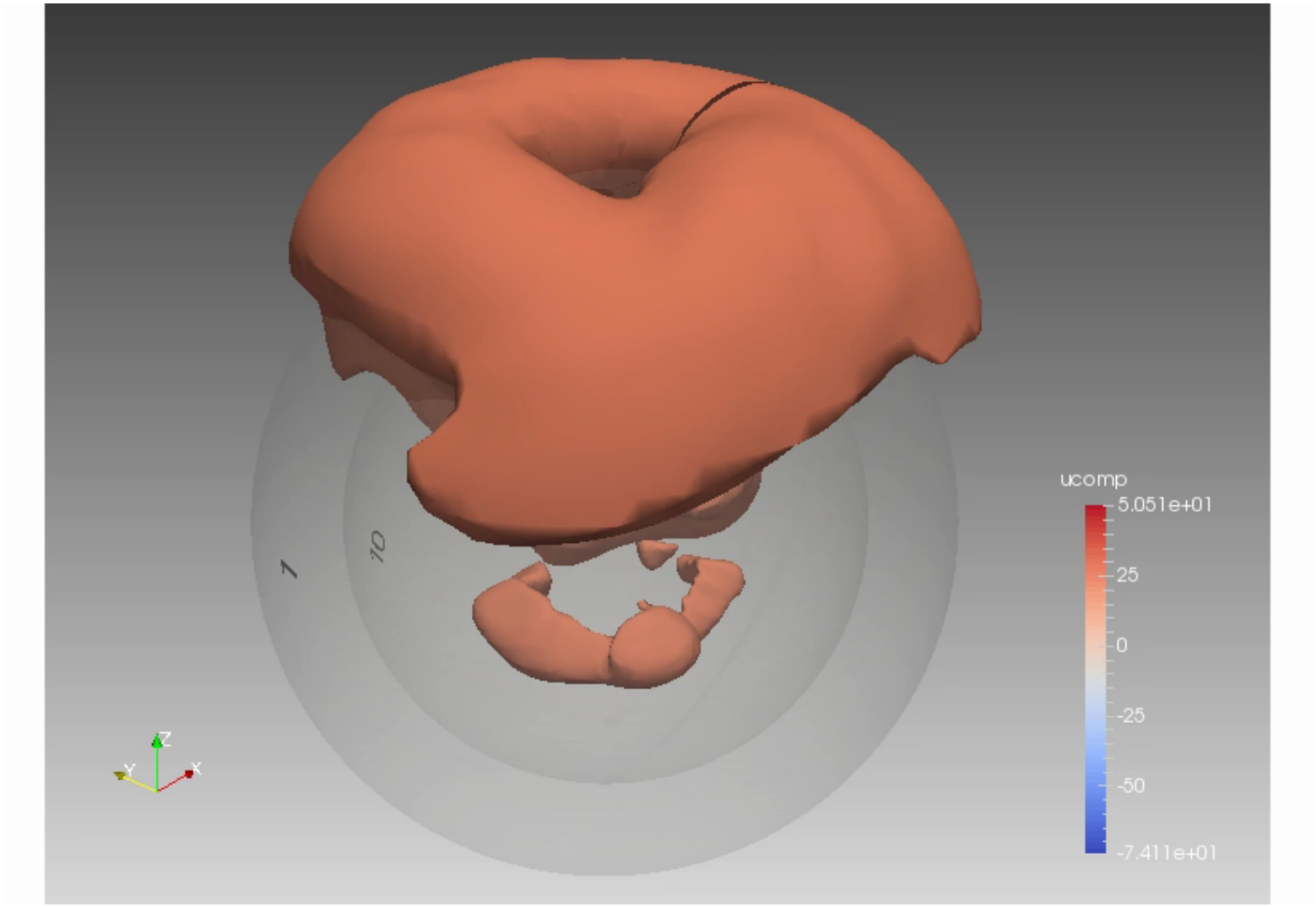


```
(output_nc,Coor) = LoadData( fileName, ncDims=['lon','lat','pfull'] )
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< File -> Save Animation >
```
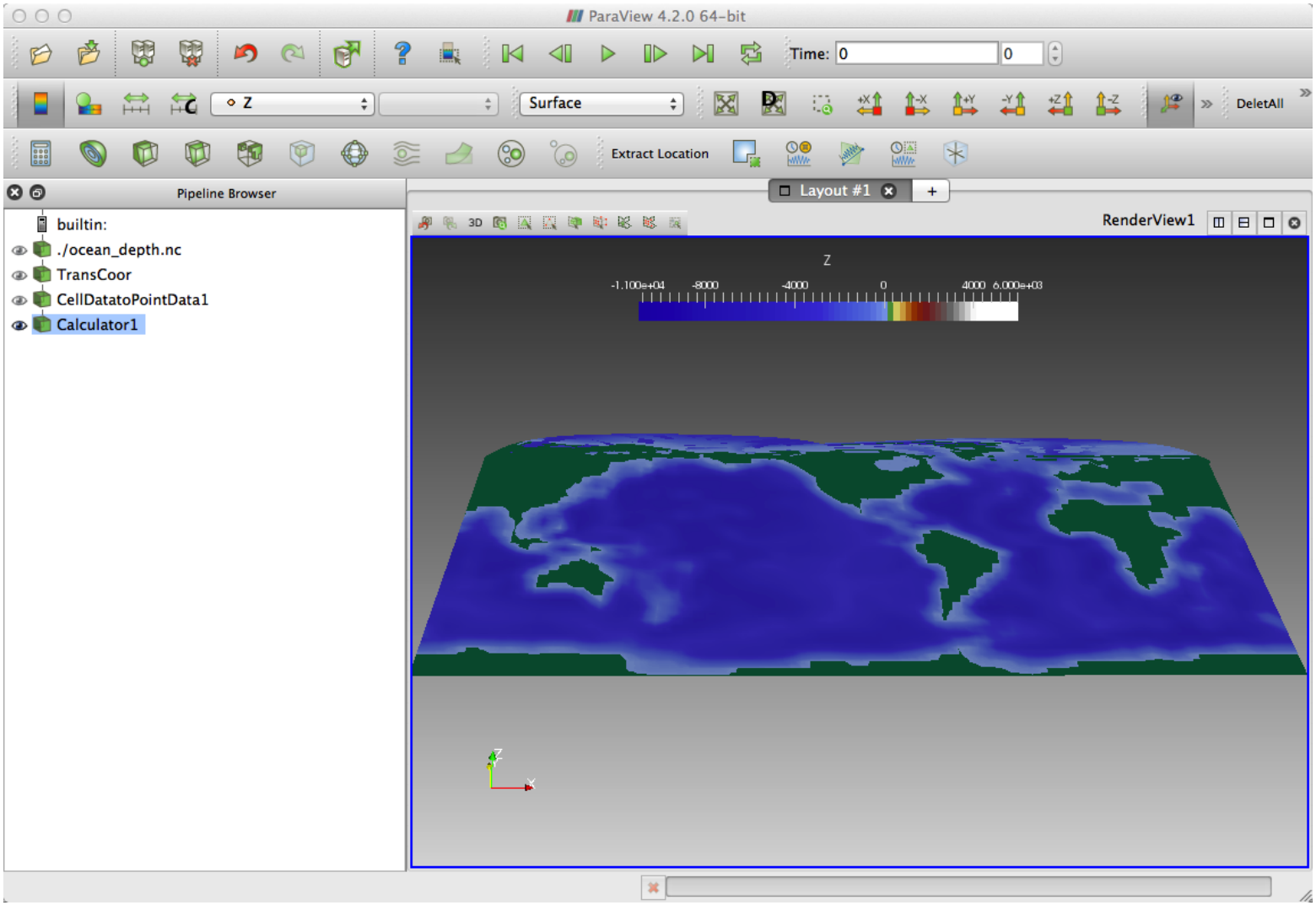
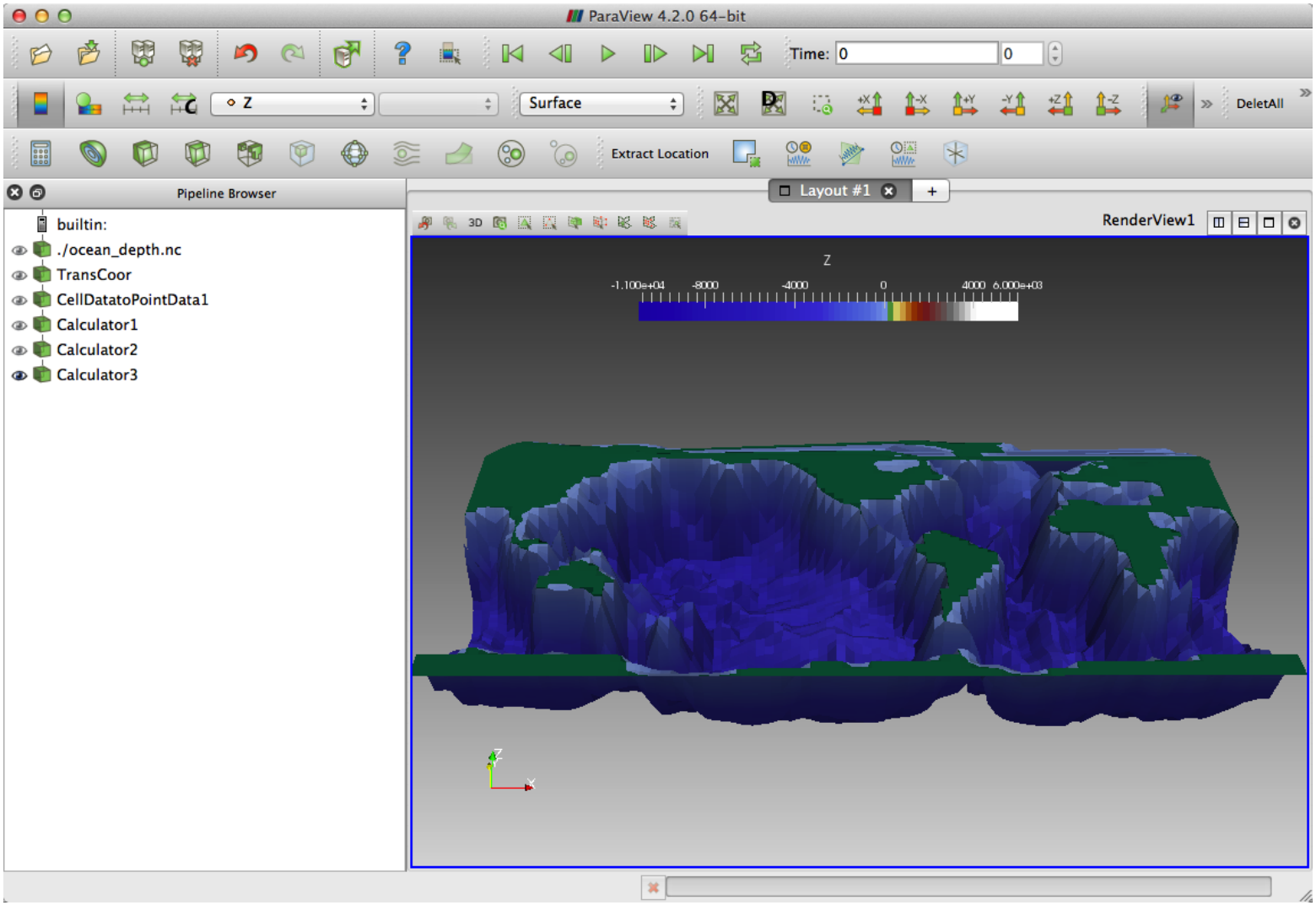
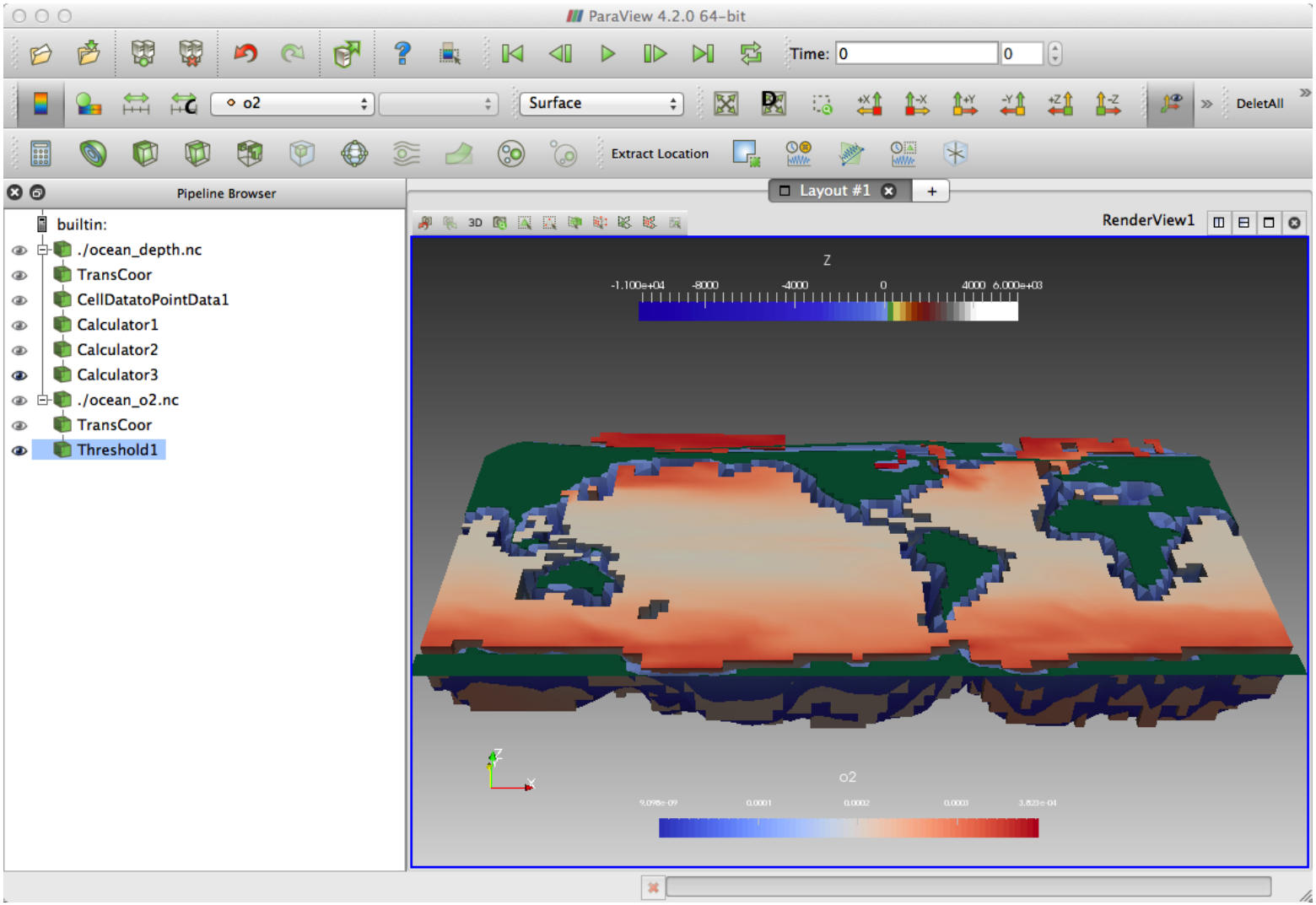



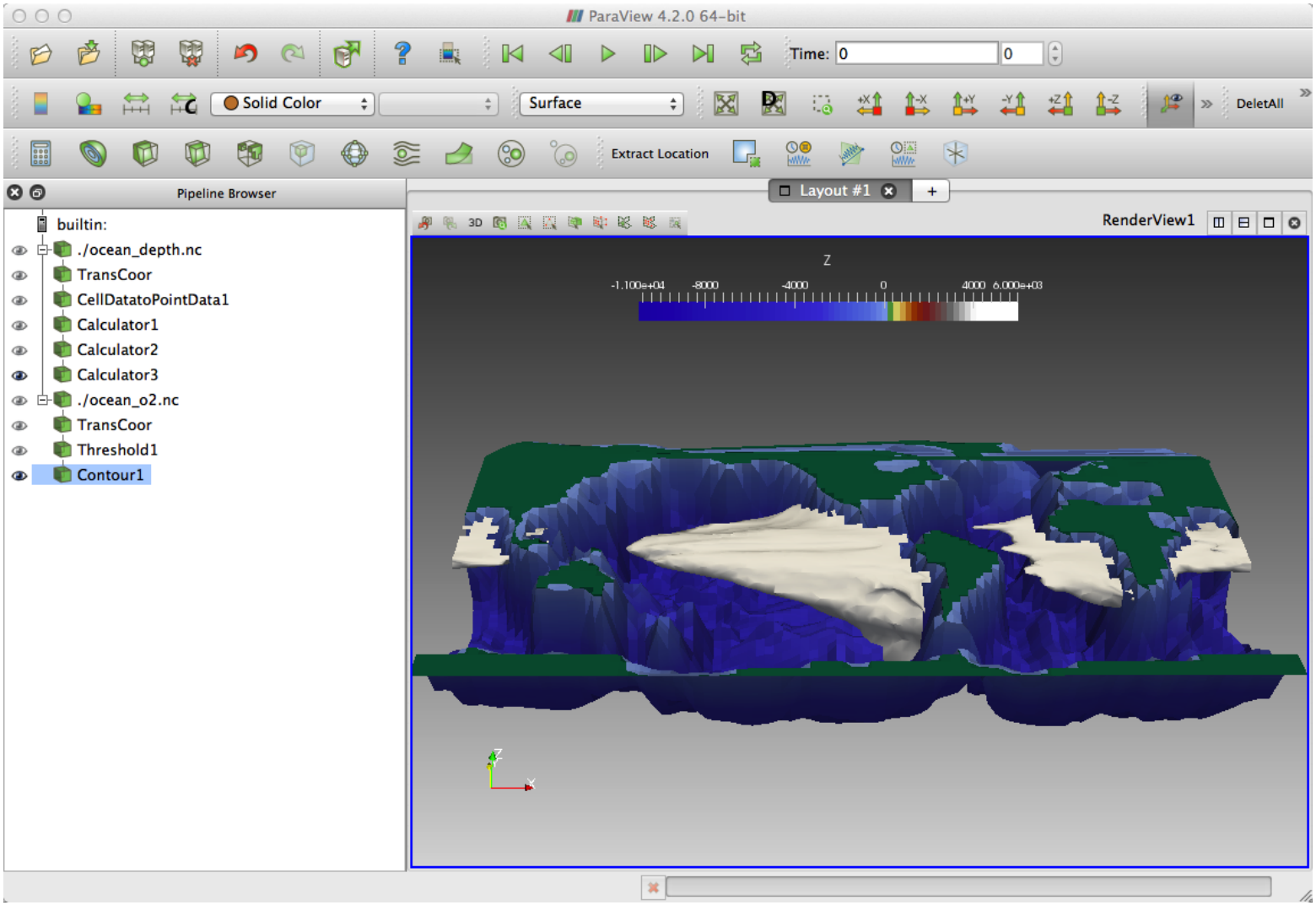

```
(depth_out,depth_coor) = LoadData( fileName, ncDims=['lon','lat'] )
```



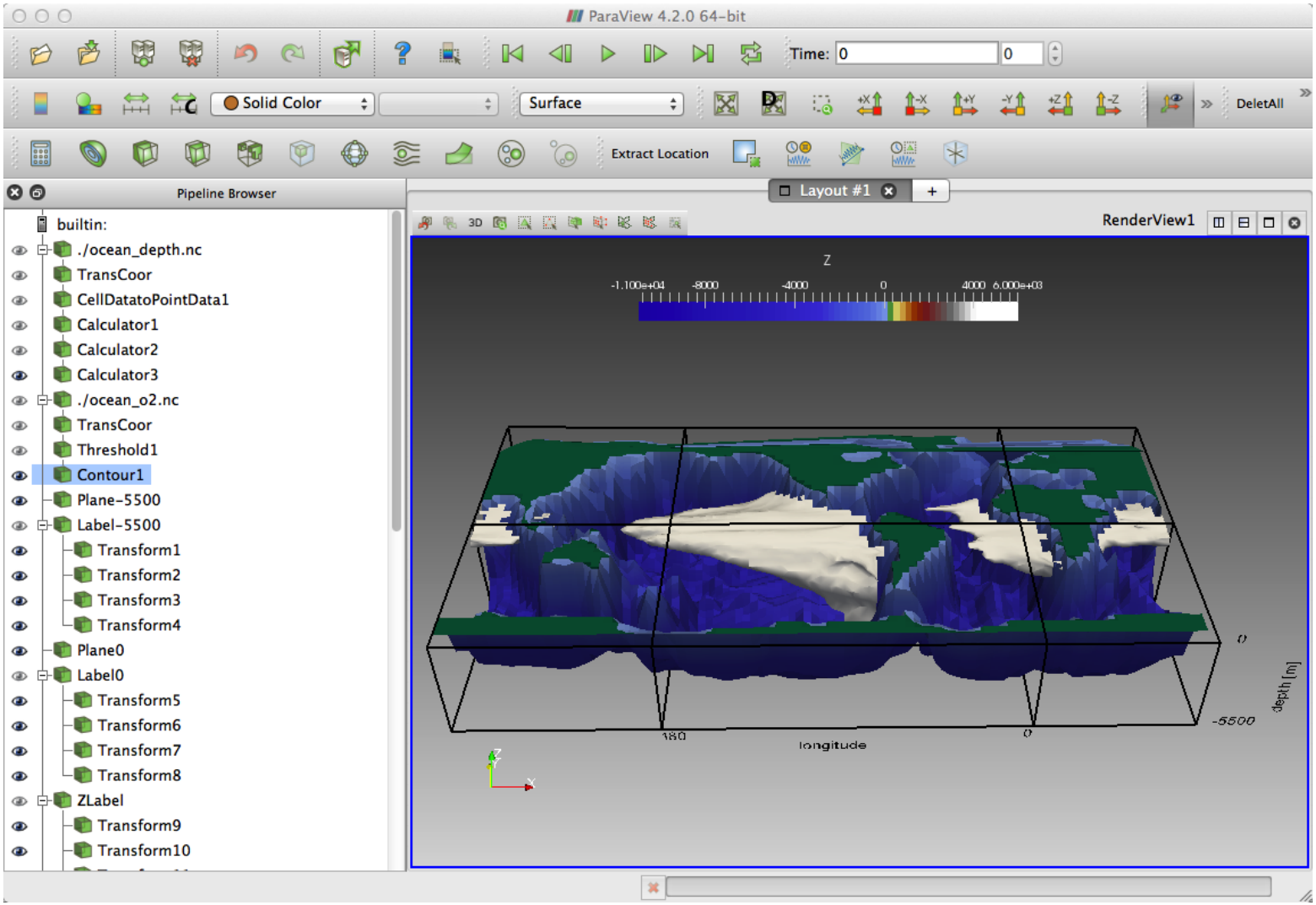

```
(depth_out,depth_coor) = LoadData( fileName, ncDims=['lon','lat'] )
bathy = Make3D( expandVar='Z', expandDir='z', aspRat, logCoords=[] )
```




```
(depth_out,depth_coor) = LoadData( fileName, ncDims=['lon','lat'] )
bathy = Make3D( expandVar='Z', expandDir='z', aspRat, logCoords=[] )
(o2_out,o2_coor) = LoadData( dataFile, ncDims=['x','y','s'], aspRat )
```




```
(depth_out,depth_coor) = LoadData( fileName, ncDims=['lon','lat'] )
bathy = Make3D( expandVar='Z', expandDir='z', aspRat, logCoords=[] )
(o2_out,o2_coor) = LoadData( dataFile, ncDims=['x','y','s'], aspRat )
o2_cont = Contour( o2_coor, ContourBy=['POINTS','o2'], Isosurfaces=[8e-5] )
```



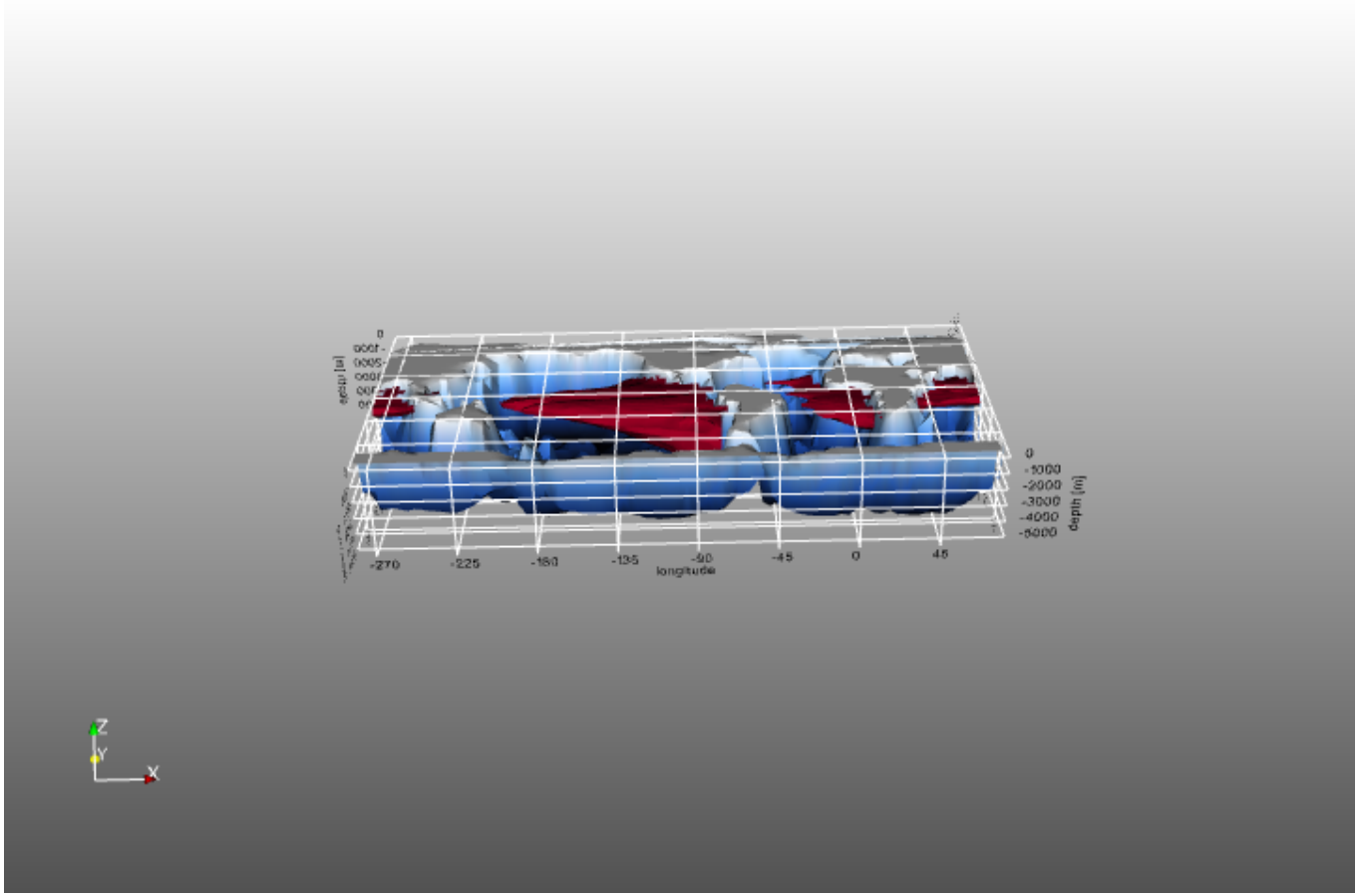

```
(depth_out,depth_coor) = LoadData( fileName, ncDims=['lon','lat'] )
bathy = Make3D( expandVar='Z', expandDir='z', aspRat, logCoords=[] )
(o2_out,o2_coor) = LoadData( dataFile, ncDims=['x','y','s'], aspRat )
o2_cont = Contour( o2_coor, ContourBy=['POINTS','o2'], Isosurfaces=[8e-5] )
AddGrid( xlevels=[-180,0], ylevels=[-90,0,90], zlevels=[-5000,0],
    bounds=[-280,80,-90,90,-5500,0], AxisNames=["longitude","latitude","depth
```

Exporting visualizations

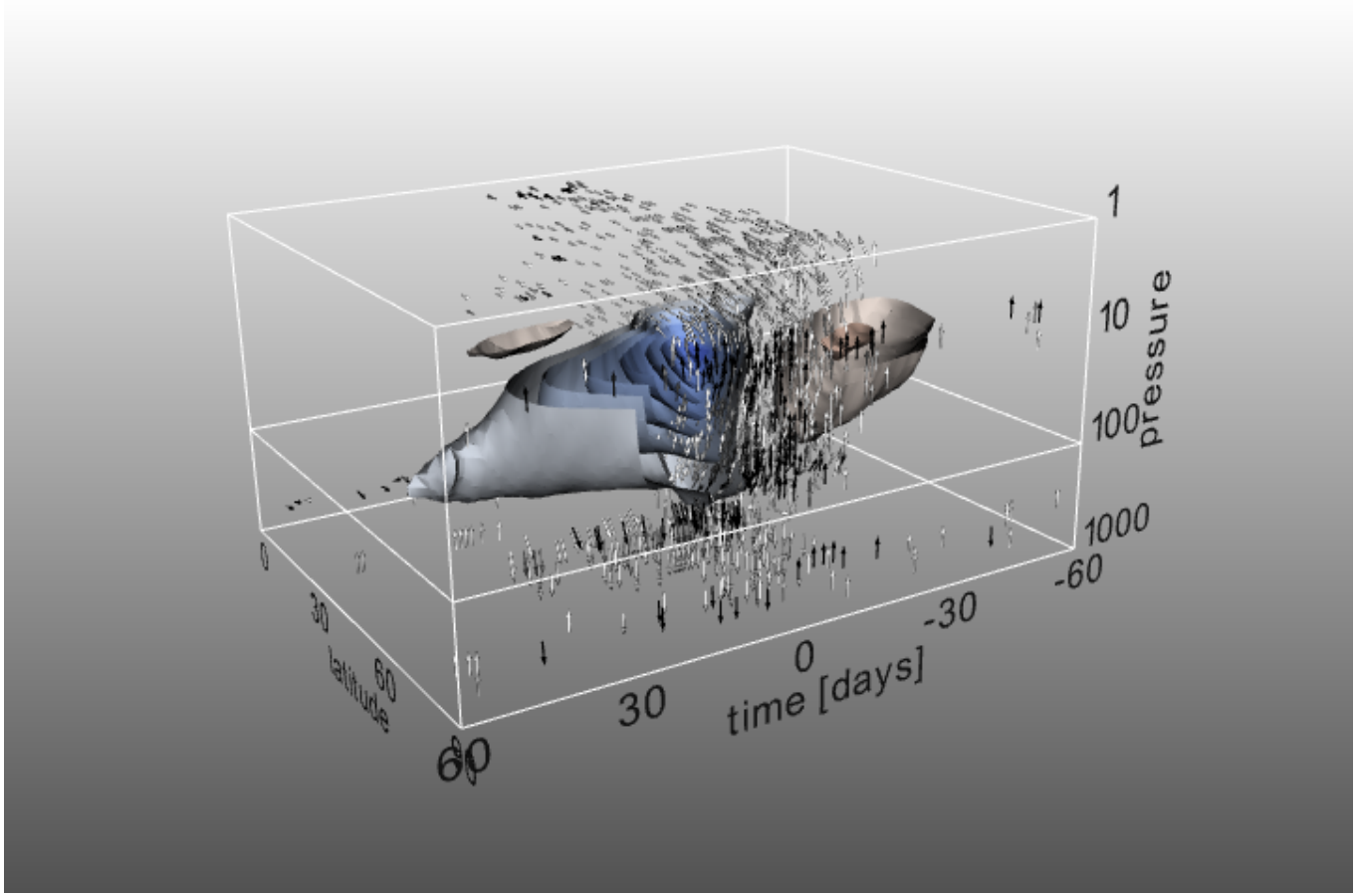
- Images: png,bmp,tiff,ppm,jpg,pdf,eps,ps,svg
- Models: pov,vrml,x3d,x3db,webgl
- Movies: ogv,avi
- Data: CVS,Paraview data file

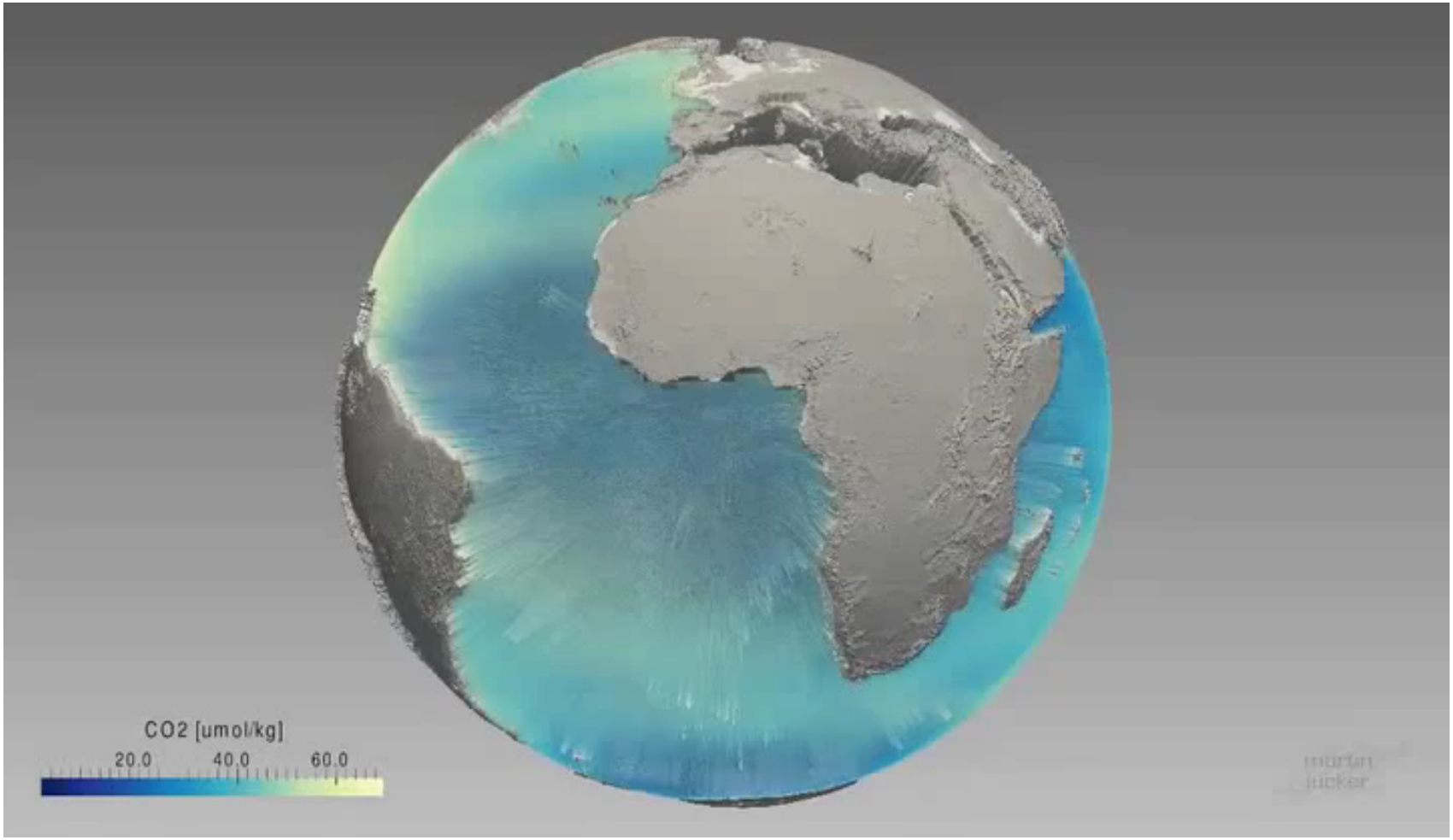
Export images, movies, web, ...

Ex 1: Oceanic oxygen content

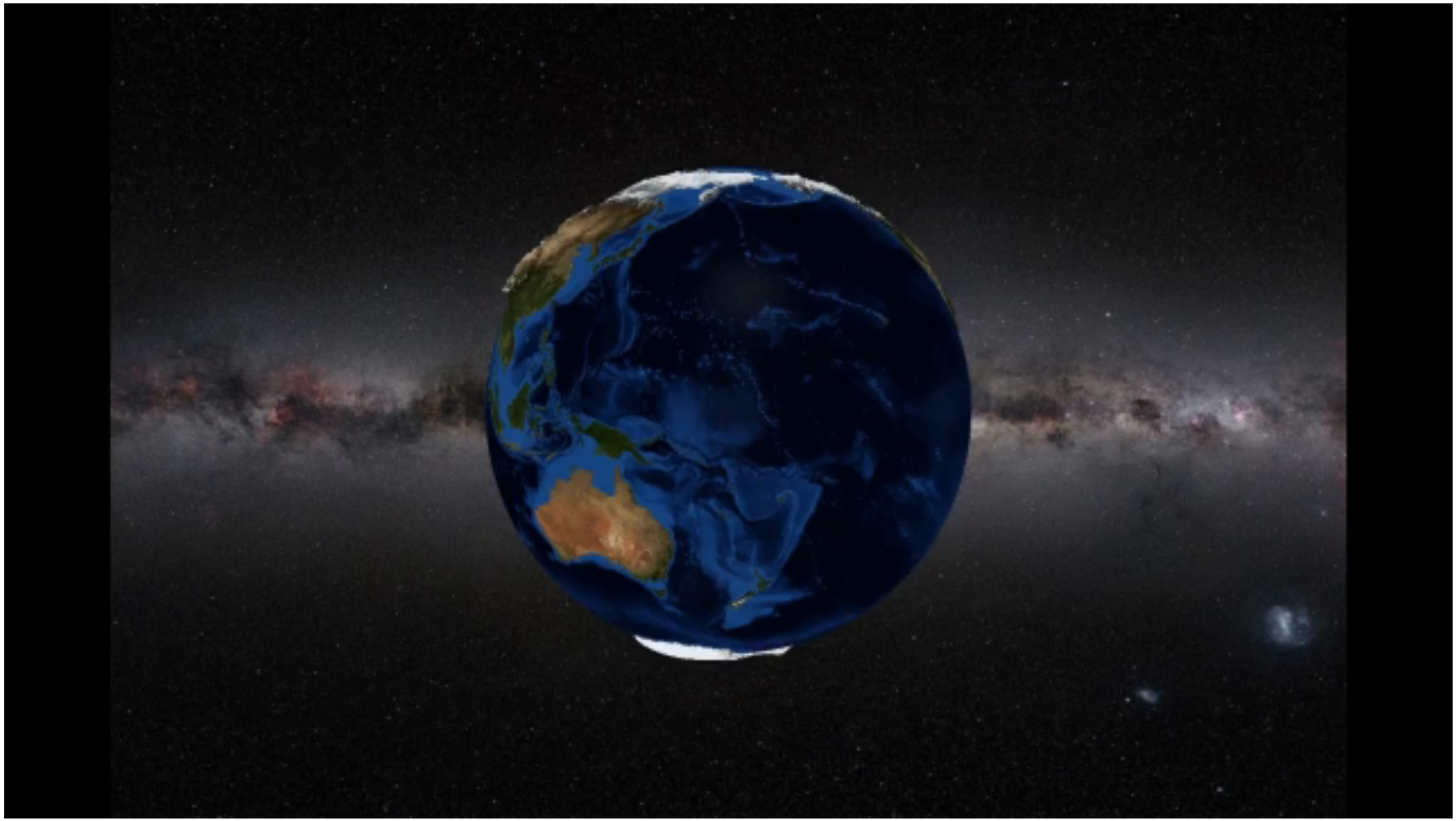


Ex 2: Sudden Stratospheric Warming





"Athropogenic CO2 in the Oceans" by Martin Jucker, cims.nyu.edu/~jucker/media.html



"Antarctic Ozone Hole Animation" by Kane Stone, http://vimeo.com/106151359

Summary and Conclusions

pv_atmos is ...

- a Python module that brings GFD specific functionality to Paraview
- freely available on GitHub or PyPi
- a bunch of scripts, so no installation necessary (but possible)

With Paraview + pv_atmos you can ...

- see 3D data in 3D (+ time)
- "hands-on" understanding
- extract correlations visually (data extraction/coloring)
- make complex things easier to understand for non-experts

Get the code:

- ParaView: www.paraview.org, Open Source BSD license
- pv_atmos: github.com/mjucker/pv_atmos, Open Source MIT license

Get help and cite:

- [see above]
- Jucker, M (2014): *Scientific Visualisation of Atmospheric Data with ParaView*. Journal of Open Research Software 2(1):e4, DOI: http://dx.doi.org/10.5334/jors.al

Thanks for citing above paper when using pv_atmos!