Project 5 - Scientific Visualization using ParaView

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1 The Data

1.1 Data Set 1: NOAA 3D Ocean Model

This set of data comes from NOAA's AEC Model Climatology 3D. It is a set of oceanographic data. It allows the user to specify bounds in time, latitude, longitude, and ocean depth. For each point in time, latitude, longitude, and depth, the user can also request water temperature, eastward seawater velocity, western sea water velocity, salinity, small phytoplankton, diatoms, mesozooplankton, and microzooplankton.

The data can be downloaded in a number of forms, including forms common for data work like CSV and JSON. Depending on the size of the bounds set, the data-sets can be very large. To keep downloads to reasonable sizes, it is recommended to keep the bounds tight. For example, one degree of latitude and longitude, and depths from 0 to -50m will give several thousand points. To keep things relatively simple to work with (and ParaView running quickly) I selected a small sample of a 50m, in the bounds of latitude 18.4 to 19.0, and longitude -77.06 to -77.36.

1.2 Data Set 2: Visible Human

This set of data comes from the Visible Human male head CT data-set. Emmet Murphy posted a link to this data-set in the module 12 discussion. The Visible Human Project is, according to its homepage, a "publicly-available complete, anatomically detailed, three-dimensional representations of a human male body and a human female body."

For the purpose of this project, I have downloaded a subset of this data, specifically the head regional tar file. This subset of data for the head is 245 DICOM files, each file being 512x512. ParaView can load DICOM files with its built-in DICOM reader for both files and directories of DICOM files.

2 The Visualizations

2.1 NOAA 3D Ocean Model

2.1.1 Visualization 1: Ocean Eastward Velocity

In figure 1, a volume was used to represent the state of the ocean column sampled. Between the points that lie in 3D space, ParaView uses Gouraud interpolation to estimate the values.

2.1.2 Visualization 2: Ocean Water Temperature

In figure 2, the style of visualization is the same, but for a different parameter: water temperature. Water temperature was chosen to demonstrate that in this particular case, there is very little change in the water column over depth. Only one small section near the surface is a bit warmer than the surrounding areas.

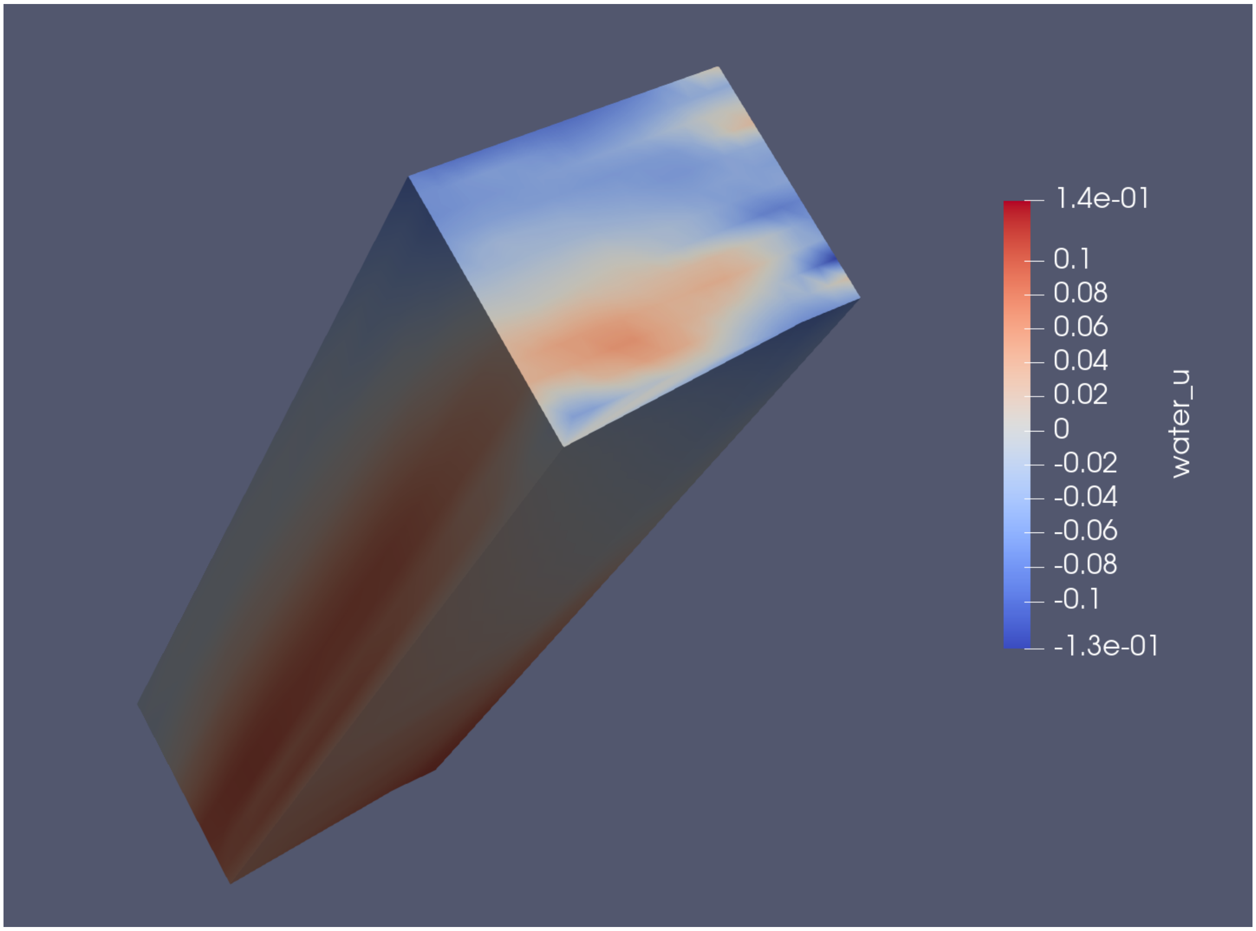

Figure 1: Ocean Eastward Velocity

2.1.3 Visualization 3: Ocean Salinity

In figure 3, we introduce a new kind of visualization. A volume was created, like in the previous examples, but then sliced at various heights to show how the value changes with depth. In this case, that value is salinity. An interesting trend can be noted as the depth decreases: a particularly low salinity value gradually turns to one much higher than its surrounding the further down the water column we travel.

2.2 Visible Human

2.2.1 Visualization 1: Head Volume

In the first dataset, we loaded a CSV and manually created volumes and further visualizations. In figure 4, we are examining a different kind of dataset entirely: one that ParaView can automatically create a volume for. Figure 4 is the default representation upon reading in the directory of DICOM files for the Visual Human Project. In an individual DICOM file, each pixel has a scalar value. When stacking multiple DICOM files, ParaView interprets that value as the opacity. This leads to the easily visible skull bone surrounding the eyes.

2.2.2 Visualization 2: Head Contour

In figure 5, we look at the places with the greatest changes in value creating contour maps of each slice, and putting them together into a new volume. The end effect of this is that the bone is pretty well shown. The bone in particular is picked out because the value change from tissue to bone is relatively large.

2.2.3 Visualization 3: Head Slices

In figure 6, we examine the volume of the head, taken as a series of individual slices. Something I struggled with in this example, but not with the ocean data, was getting the slices at good intervals. Too close and very little can be seen of each slice, and too far apart, and very little of the total volume is shown. This was easier with the ocean data because the data was taller than it was wide, so much more of each slice could be seen from a given vantage point.

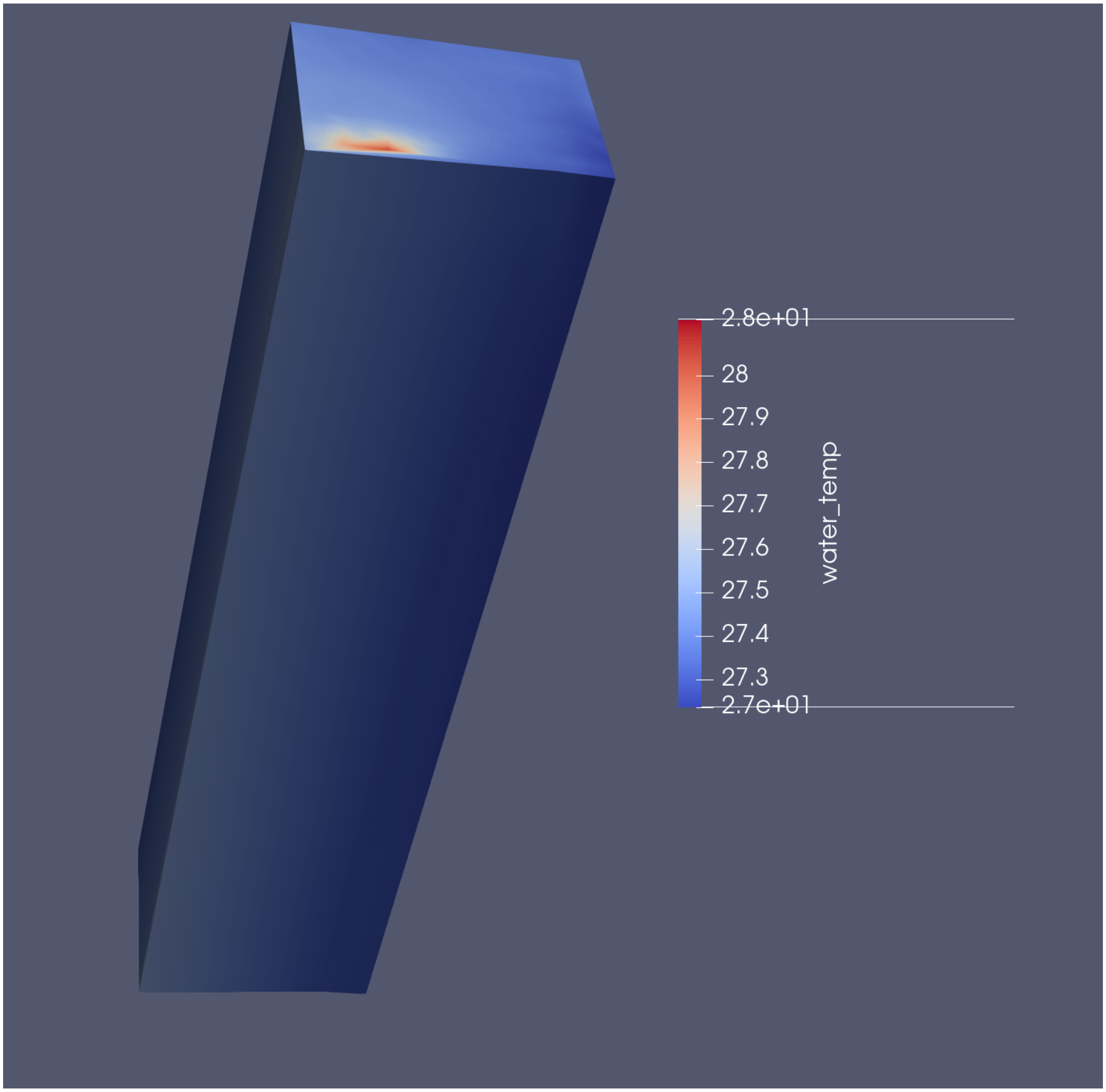

Figure 2: Ocean Water Temperature

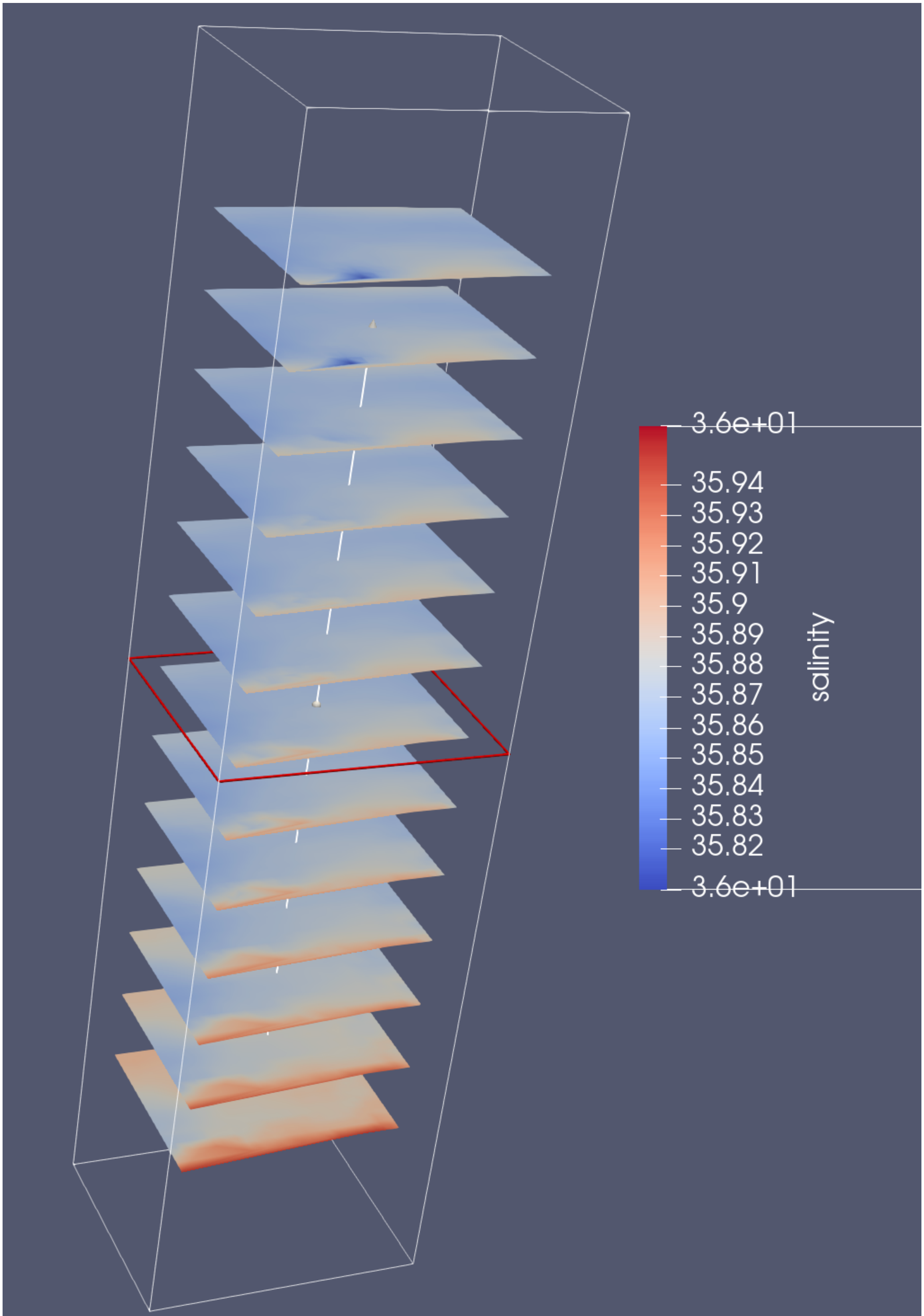

Figure 3: Ocean Salinity

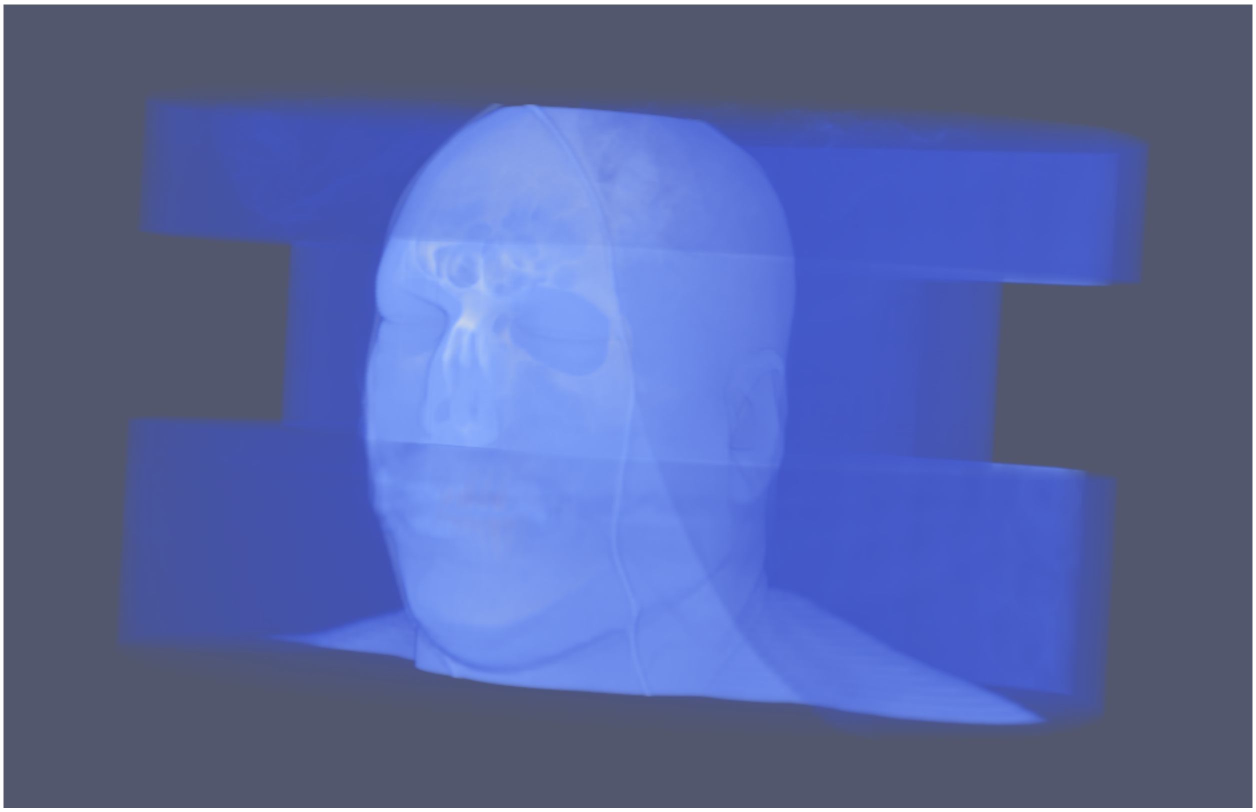

Figure 4: Head Volume

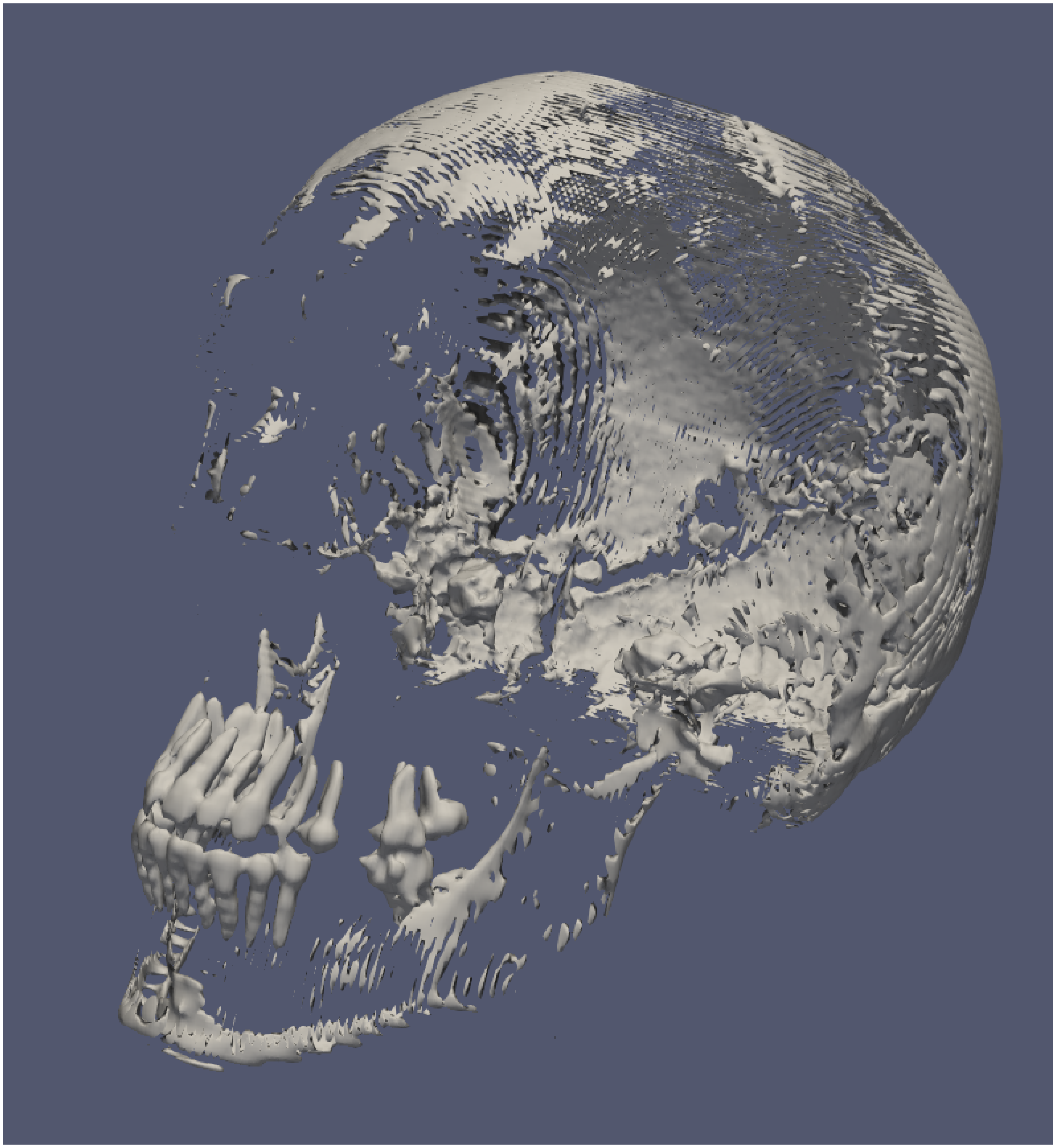

Figure 5: Head Contour

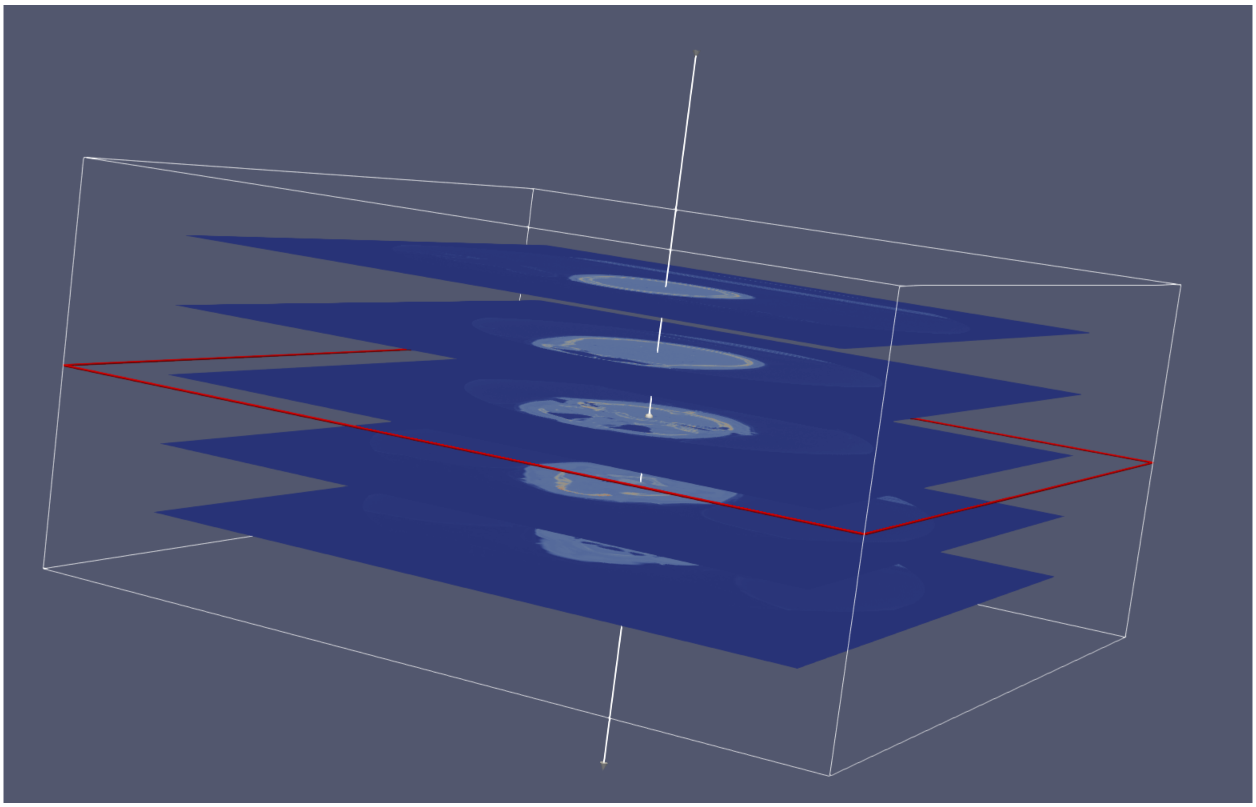

Figure 6: Head Slices