

# Visualizing High Performance Computing Data

## Earthquake Simulation of Hayward Fault: SW4

(In 3 minutes or less)

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## What are we modeling?

- ▶ Lawrence Livermore (LLNL) and Lawrence Berkeley (LBNL) National Labs are working on earthquake modeling within the Bay area.
- ▶ United States Geologic Survey (USGS) predicts a 1 in 3 chance of a rupture with  $\geq$  6.7 magnitude in the next 30 years.
- ▶ LLNL and LBNL have created new earthquake modeling sims that are 4-8x more resolved than previous models.
- ▶ Scientists typically look at only 2D slices of data



Figure: Hayward Fault Line (source: Berkeley Seismology Lab)

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- ▶ LLNL and LBNL have created new earthquake modeling sims that are 4-8x more resolved than previous models.
- ▶ Scientists typically look at only 2D slices of data
- ▶ Read more at:  
<https://www.llnl.gov/news/hayward-fault-earthquake-simulations-increase-fidelity-ground-motions>



Figure: Hayward Fault Line (source: Berkeley Seismology Lab)

## In Situ

- ▶ So much data is being generated at once that it is impossible to save all of it and do analysis Post Hoc (after the fact)
- ▶ We need to analyze data as it is being generated, we call this In Situ.
- ▶ Still need to compress data so we can visualize it fast enough.
- ▶ We can use Visit or Ascent
- ▶ Visit is great for post hoc methods
- ▶ Ascent is built for in situ methods and with a small modification of code we can enable in situ techniques.

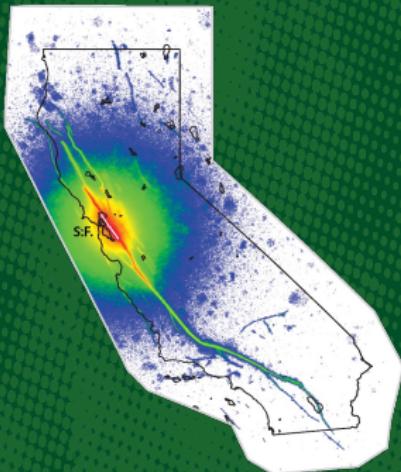


Figure: Aftershocks of M=7.1 Earthquake (source: Temblor)

- Let's open up Visit and plot a single time step

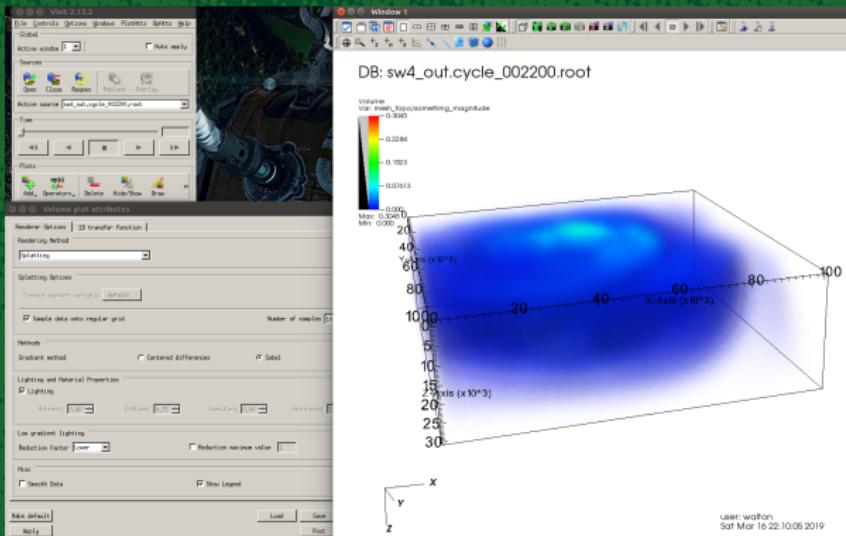
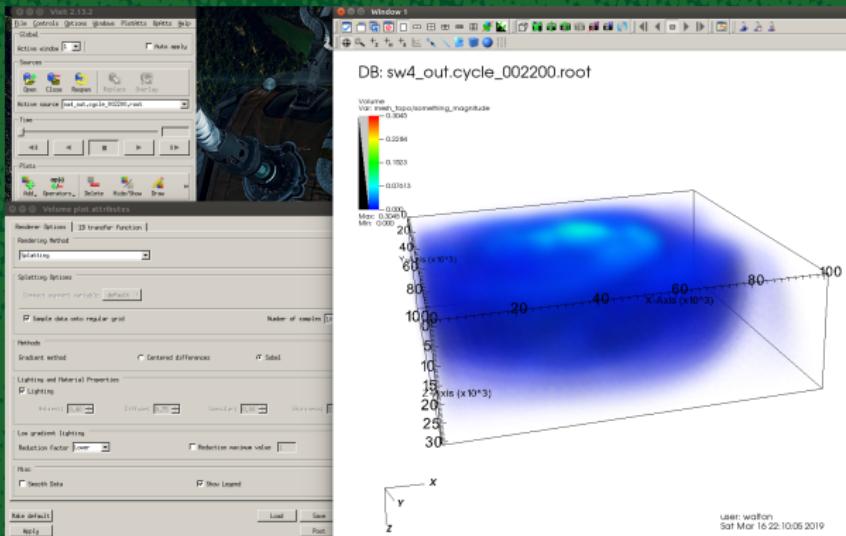


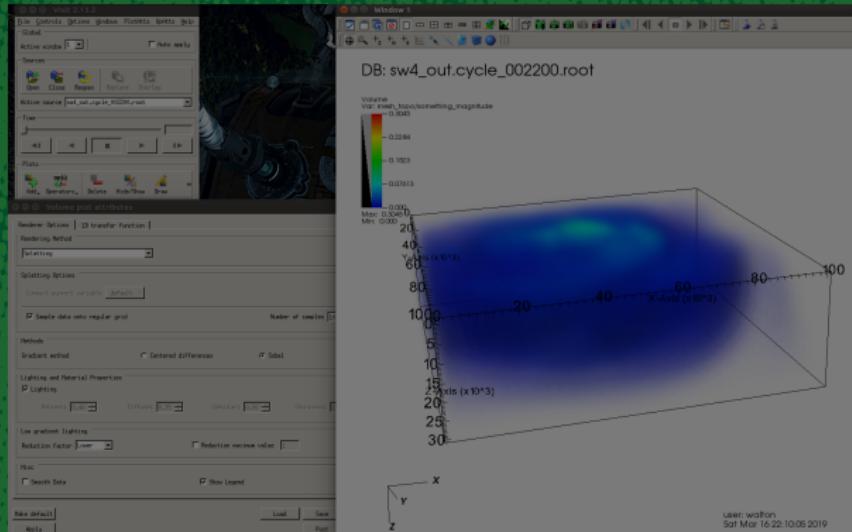
Figure: Visit Setup

- ▶ Let's open up Visit and plot a single time step
  - ▶ Let's try to apply some operators



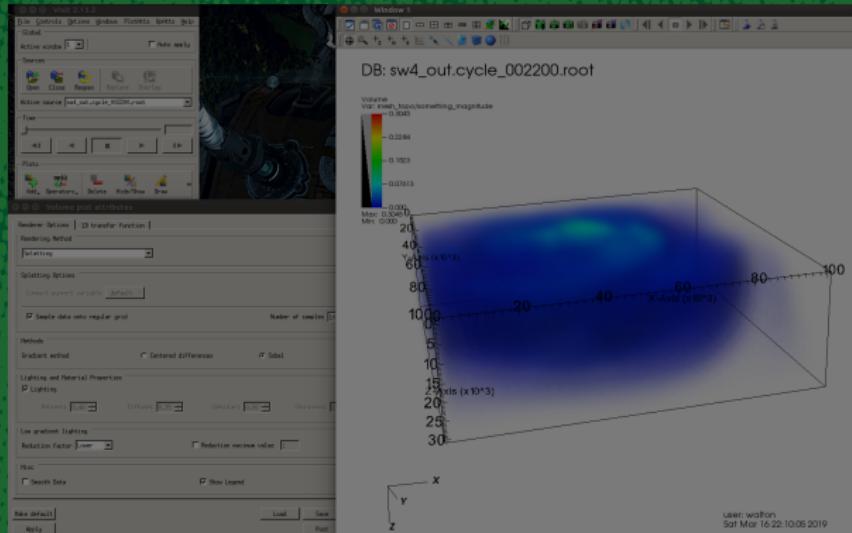
## Figure: Visit Setup

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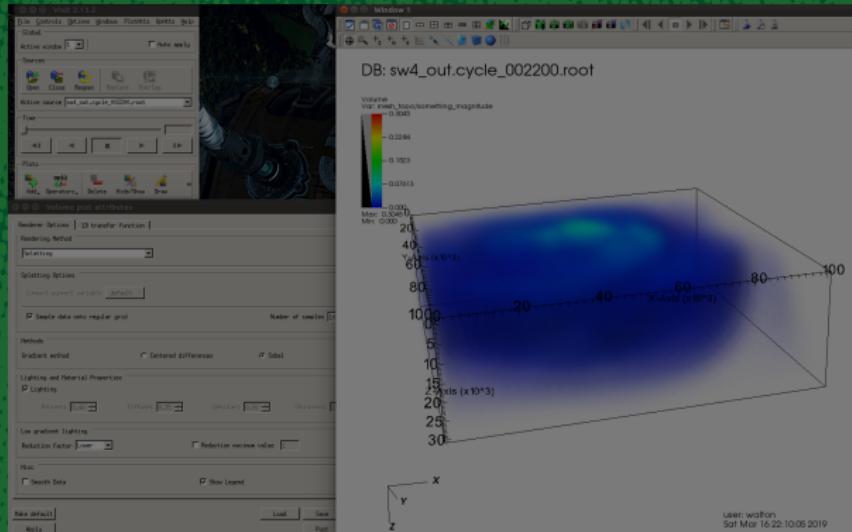
## Figure: Visit Setup

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  - ▶ ... Memory is full



## Figure: Visit Setup

- ▶ Let's open up Visit and plot a single time step
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  - ▶ ... Memory is full
  - ▶ ... Computer crashed



## Figure: Visit Setup

- ▶ Let's open up Visit and plot a single time step
- ▶ Let's try to apply some operators
  - ▶ ... Memory is full
  - ▶ ... Computer crashed
  - ▶ ...

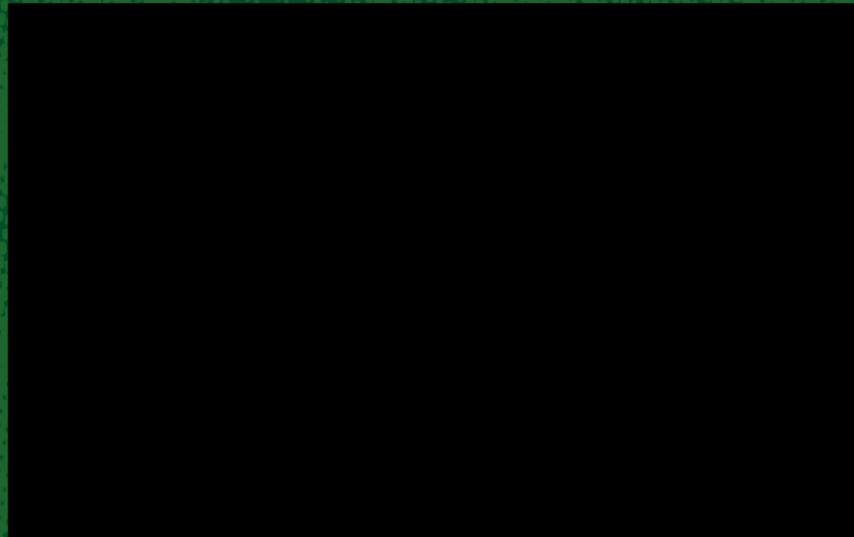


Figure: Visit Setup

- ▶ Let's open up Visit and plot a single time step
- ▶ Let's try to apply some operators
  - ▶ ... Memory is full
  - ▶ ... Computer crashed
  - ▶ ...
  - ▶ ... Let's go to Alaska

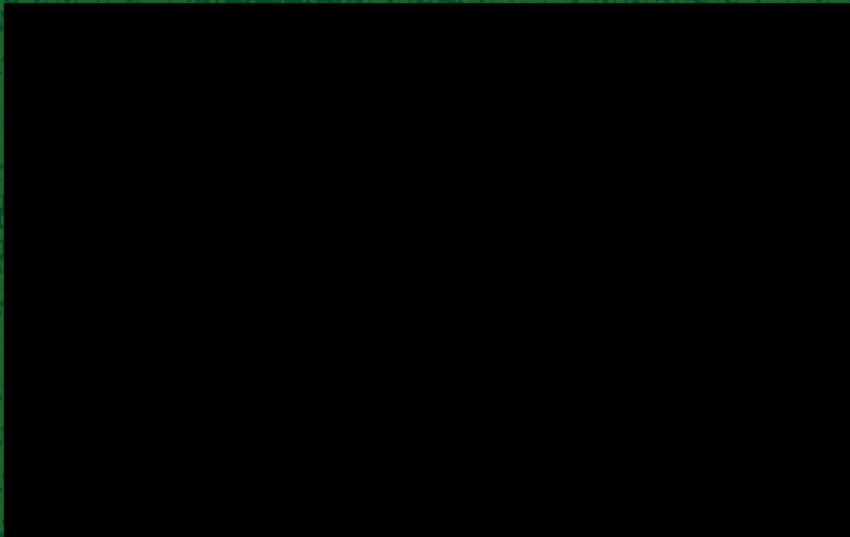


Figure: Visit Setup

So what's it look like?

- ▶ Lots of low frequency data underneath the surface
- ▶ Lots of high frequency data on the surface
- ▶ Can we try to reduce the data size and focus on the important stuff?

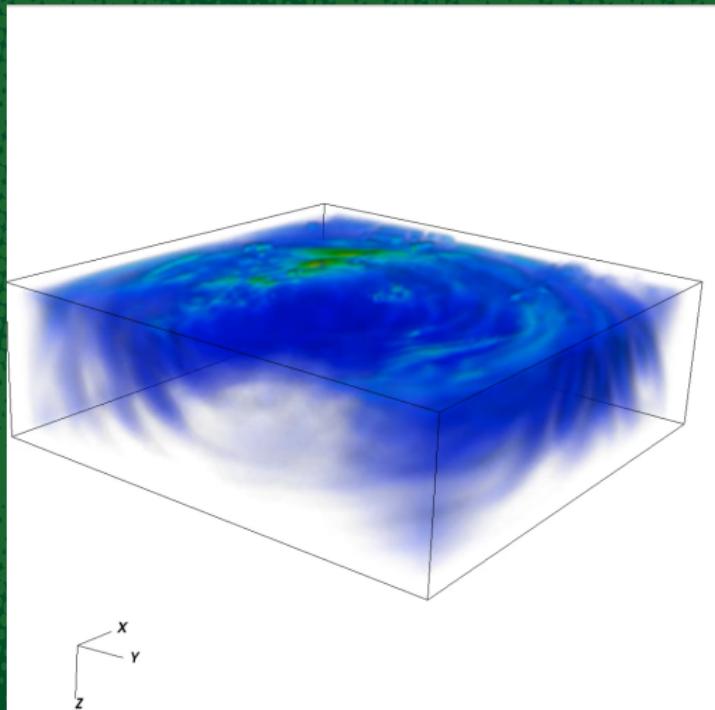


Figure: Raw data plotted

0.01 Threshold

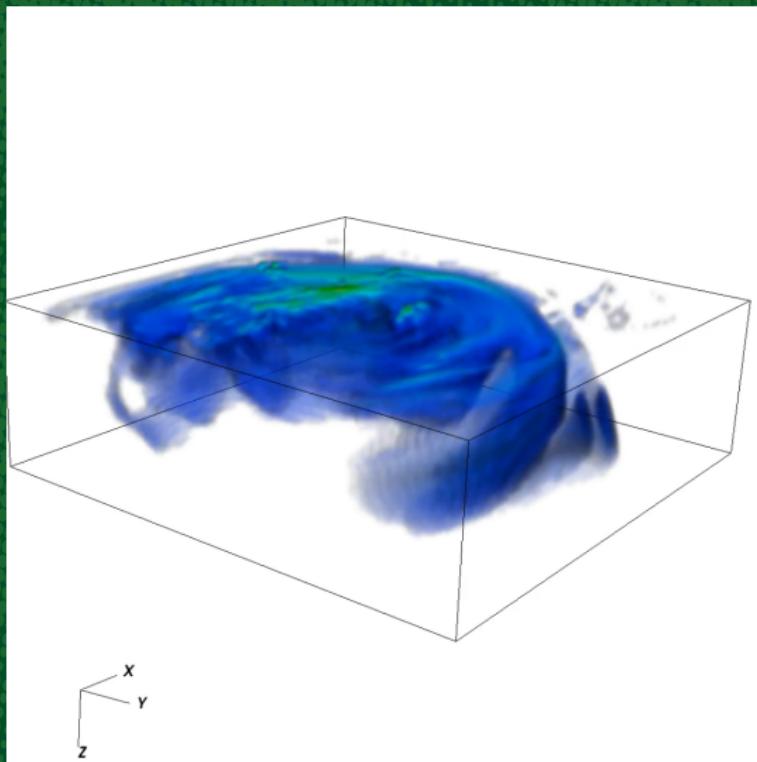


Figure: 0.01 Threshold Applied

0.02 Threshold

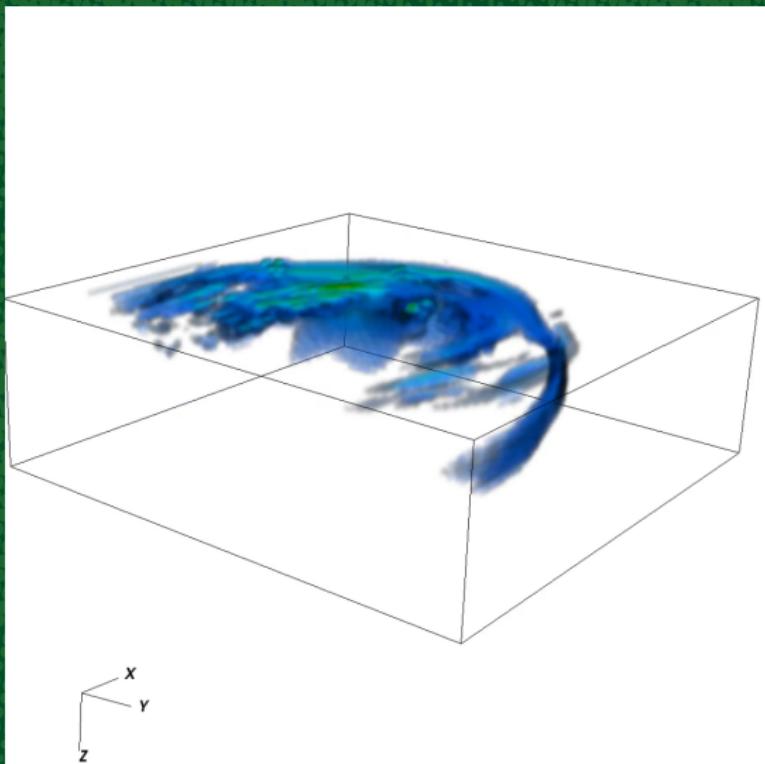


Figure: 0.02 Threshold Applied

What about Ray Tracing the image?

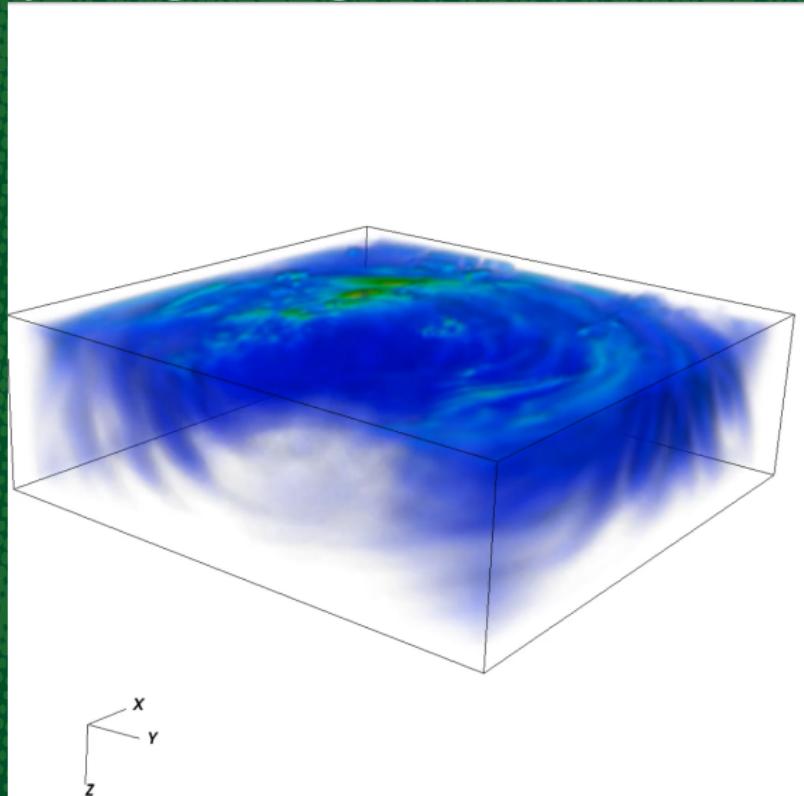


Figure: 0.02 Threshold Ray Tracing

More rays equals more better?

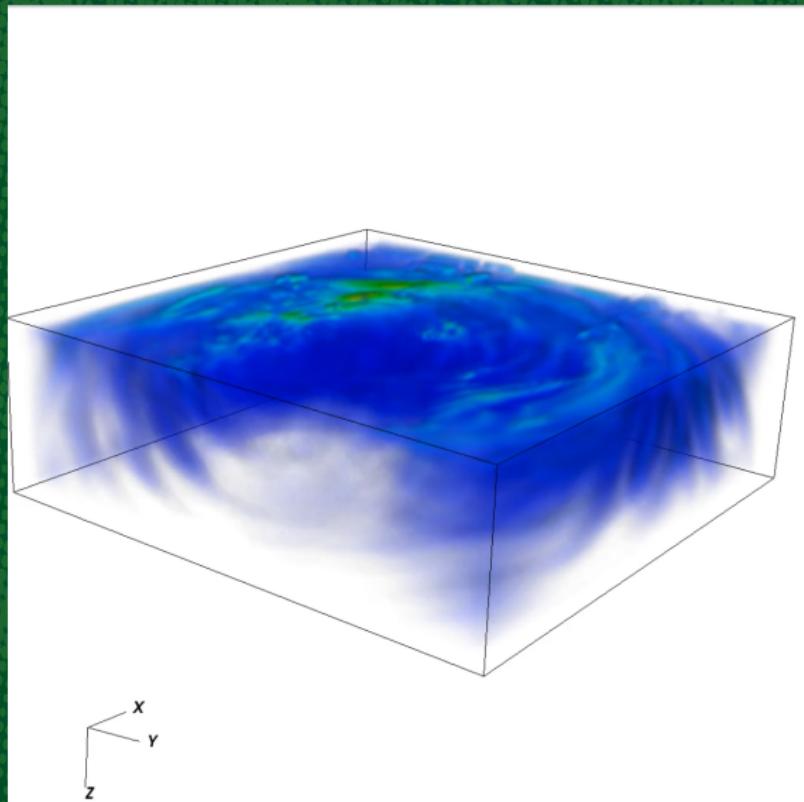


Figure: Failure because of timeout (took over 8hrs to get just this)

More rays equals more better?

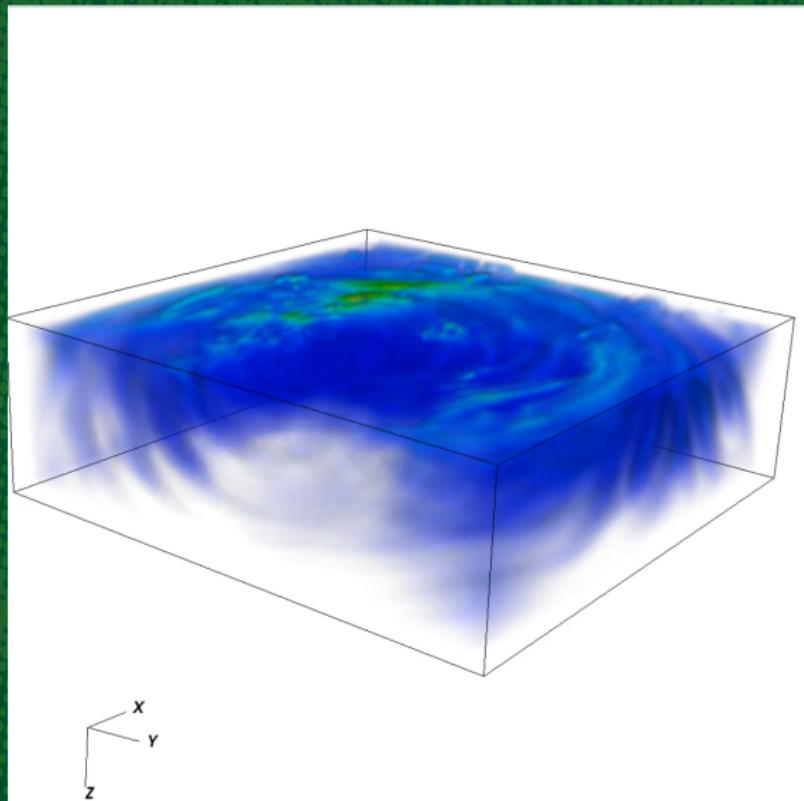


Figure: 0.02 Threshold High Resolution Ray Tracing

## Where to next

- ▶ We need to get this running in Ascent now.
- ▶ Provide an in situ method for performing the same features.
- ▶ Requires restructuring the data so that we can use VTK-h filters.
- ▶ We need to extend features in both VTK-m and VTK-h.
- ▶ Make pretty pictures.
- ▶ Deliver product to scientists and make them happy.