LA-UR-17-27109
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Title: Image Statistics

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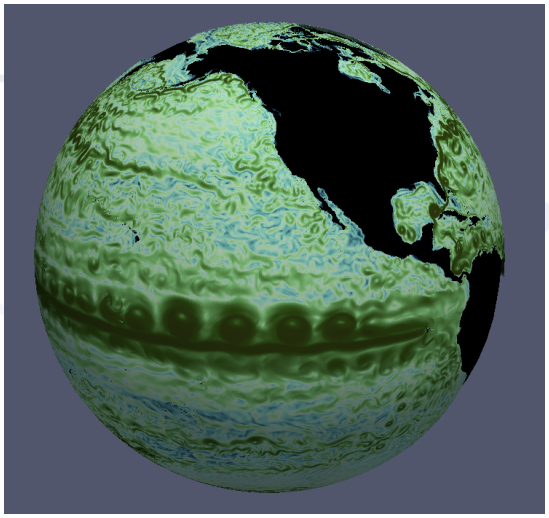
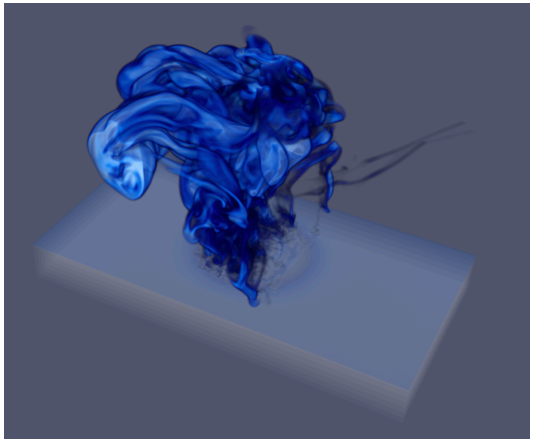
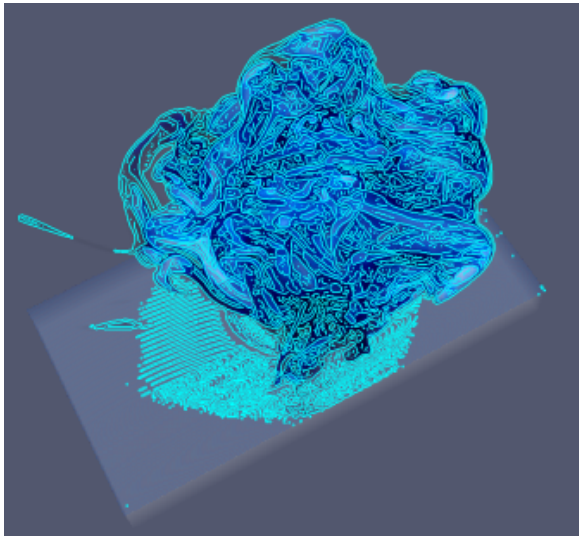




Los Alamos
NATIONAL LABORATORY
EST.1943

Image Statistics



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Summer 2017

NNSA
National Nuclear Security Administration

Overview

- Background
- Data
- Obtain Image Statistics
- Image Selection
- Change Detection
- Visualization

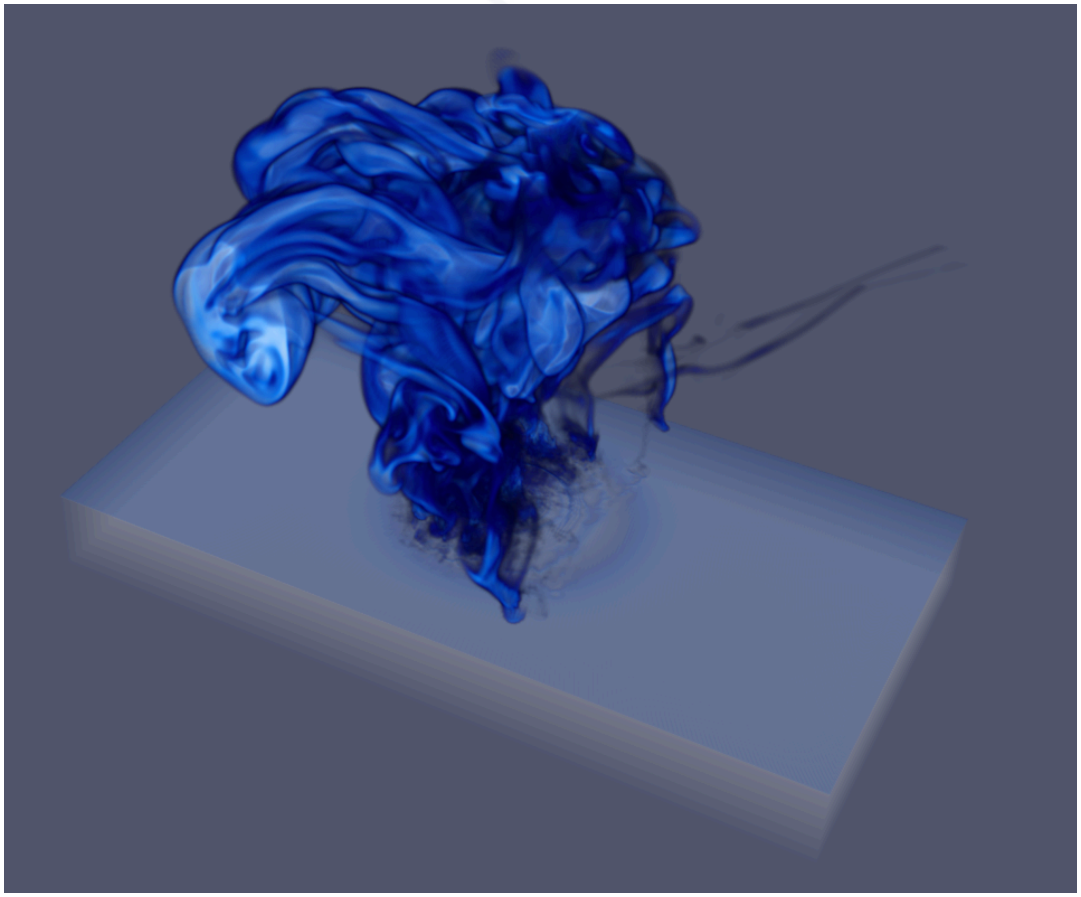
Background

- Problem: In large datasets, it is time consuming or even impossible to pick out interesting images
- Proposed solution: Find statistics to quantify the information in each image and use those to identify and pick out images of interest
- Applications in:
  - Post-processing image selection
  - In situ change detection

Data

Asteroid Impact

- XRAGE simulation
- 45,696 images
- Time: 0 to 475
- Various theta and phi values define the direction the simulation is viewed from



Data

Ocean

- MPAS simulation
- 3,600 images
- Time: 1 to 9
- Various theta and phi values define the direction the simulation is viewed from

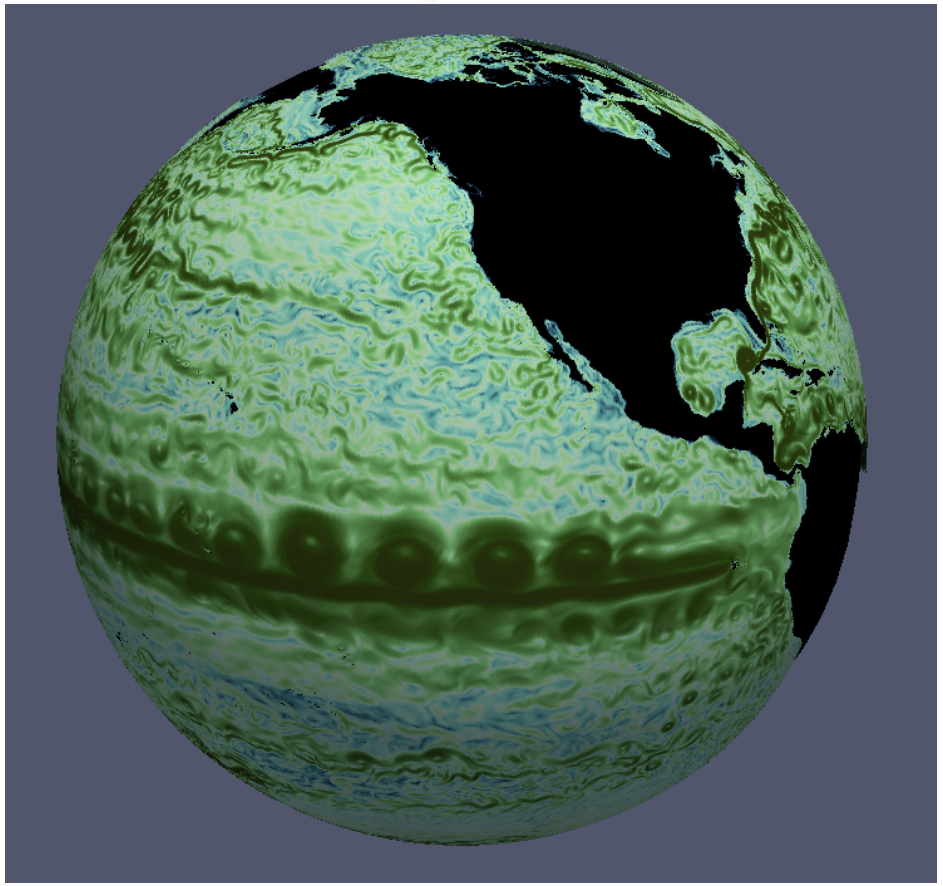


Image Statistics

$$Luminance = 0.2125R + 0.7154G + 0.0721B$$

- Mean
- Standard Deviation
- # Unique Pixels
- Edge Length
- Center of Luminance (X)
- Center of Luminance (Y)
- Lower Quartile
- Median
- Upper Quartile

Center of Luminance

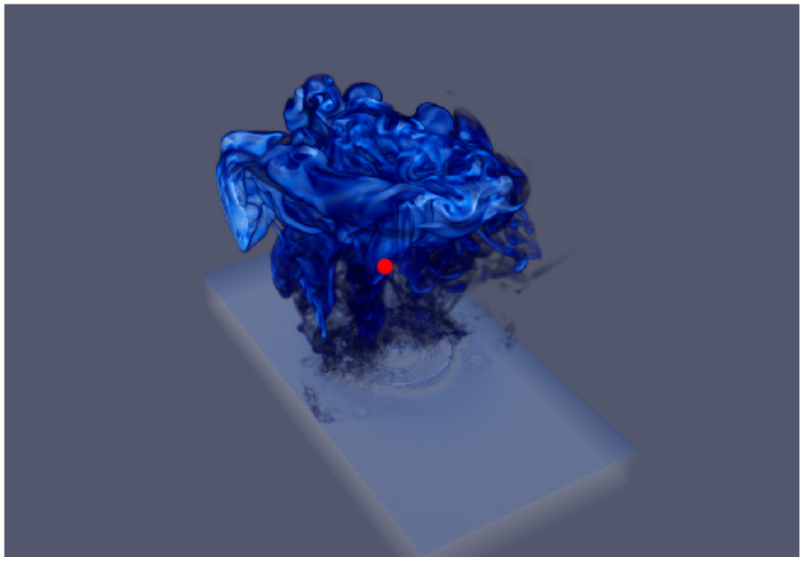
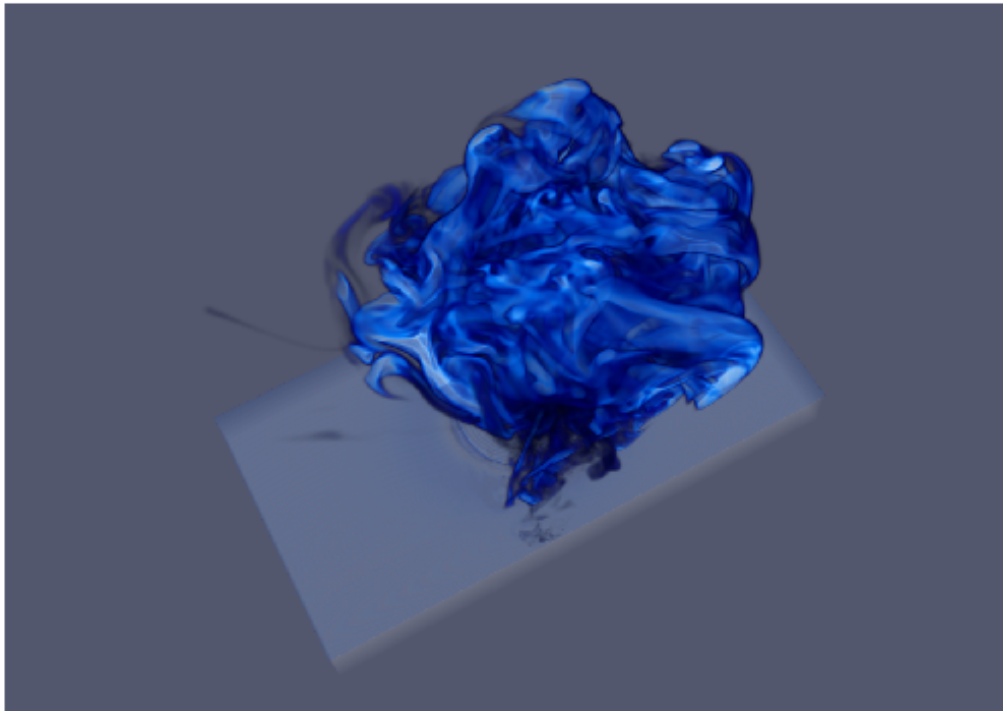


Image Statistics – Canny Edge Detection



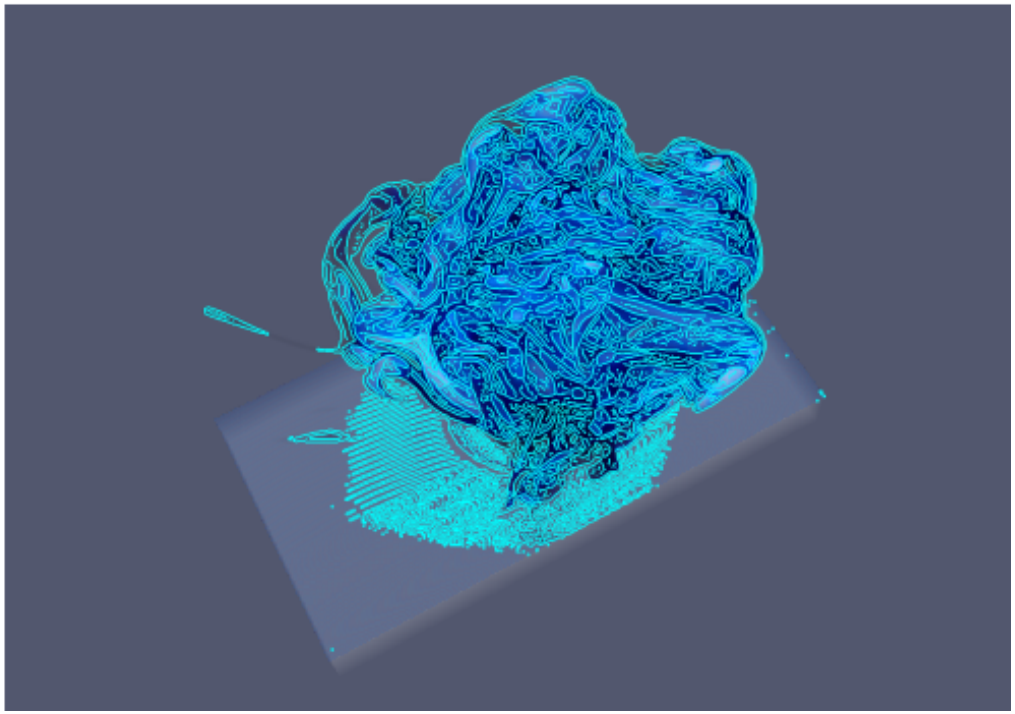
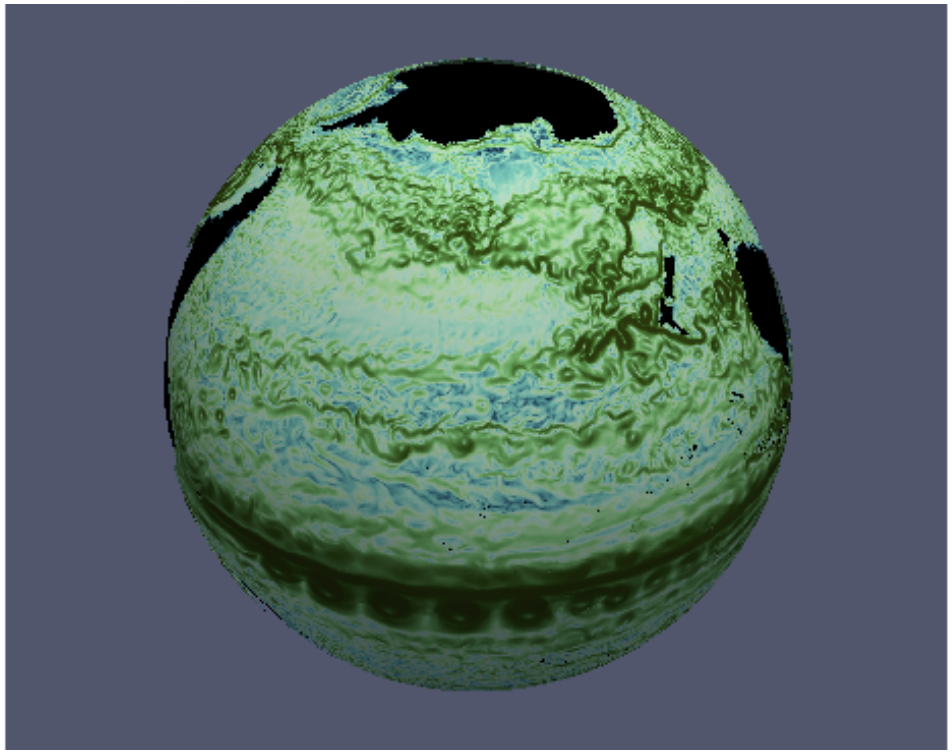


Image Statistics – Canny Edge Detection



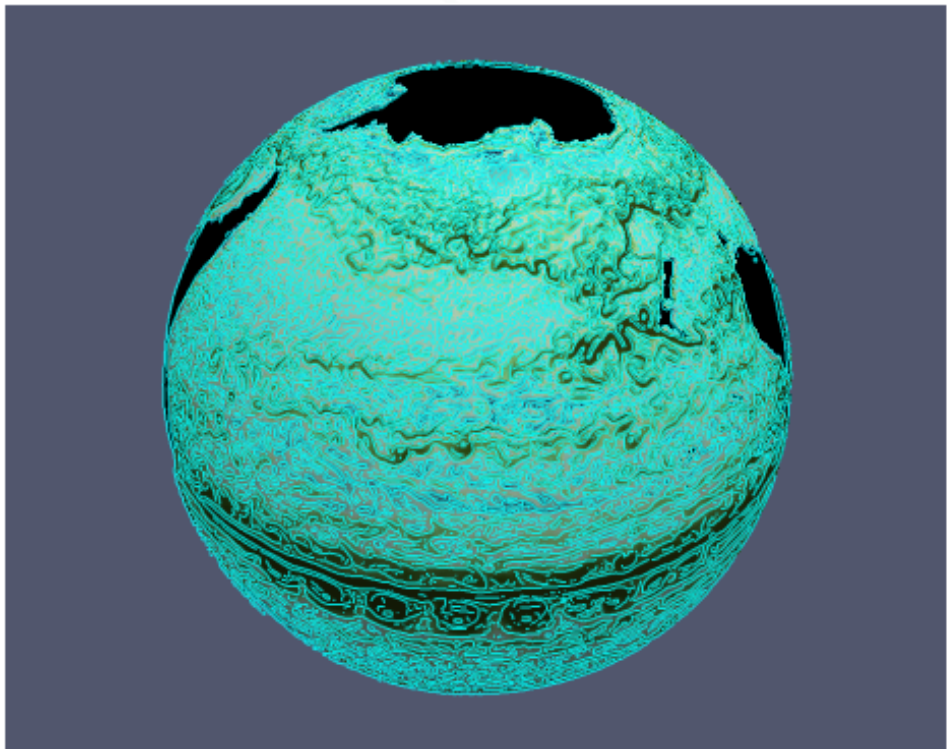
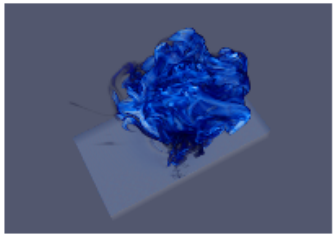


Image Selection

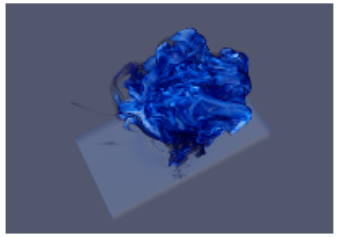
- Identify top n images for a statistic

Edge Length (maximized)

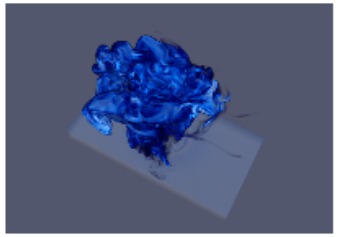
35224.png
theta: 63 phi: -150 time: 475



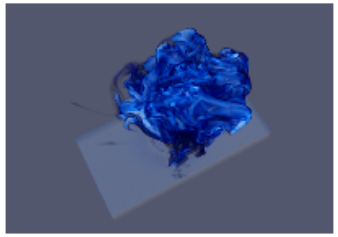
35223.png
theta: 63 phi: -150 time: 474



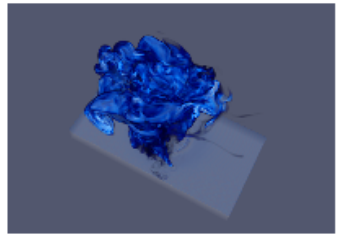
37128.png
theta: 63 phi: -30 time: 475



35222.png
theta: 63 phi: -150 time: 473



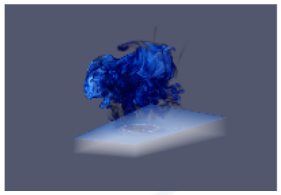
37127.png
theta: 63 phi: -30 time: 474



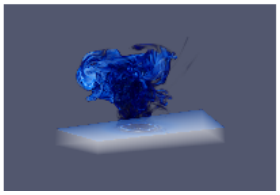
- Identify top n images for a statistic without repeating the set of parameters

Mean Pixel Intensity (maximized)

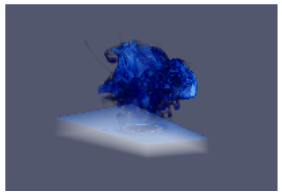
19516.png
theta: -12 phi: -60 time: 475



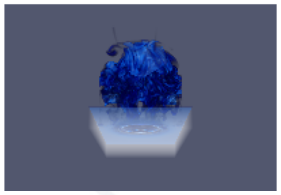
19992.png
theta: -12 phi: -30 time: 475



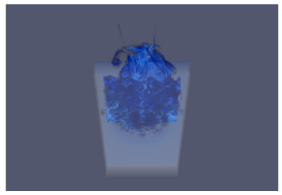
18564.png
theta: -12 phi: -120 time: 475



19040.png
theta: -12 phi: -90 time: 475

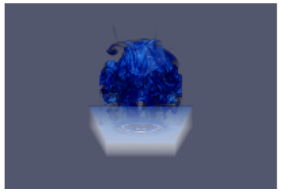


13328.png
theta: -38 phi: -90 time: 475

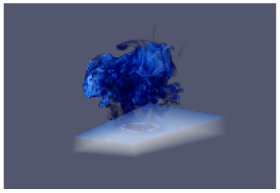


Pixel Intensity Standard Deviation (maximized)

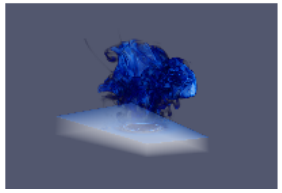
19040.png
theta: -12 phi: -90 time: 475



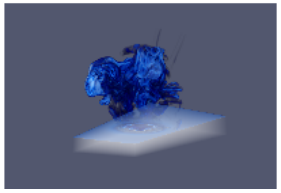
19516.png
theta: -12 phi: -60 time: 475



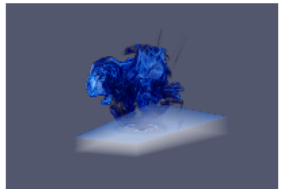
18564.png
theta: -12 phi: -120 time: 475



19460.png
theta: -12 phi: -60 time: 419

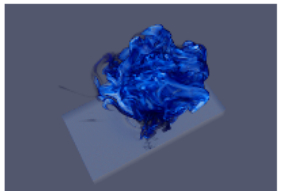


19461.png
theta: -12 phi: -60 time: 420

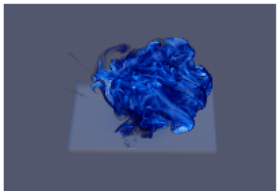


Number of Unique Color Pixels (maximized)

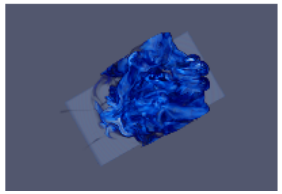
35224.png
theta: 63 phi: -150 time: 475



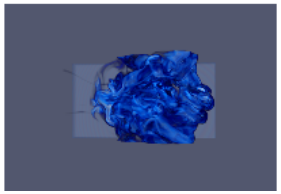
34748.png
theta: 63 phi: -180 time: 475



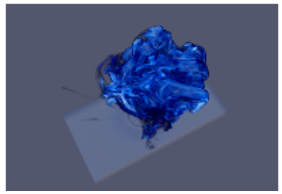
40936.png
theta: 88 phi: -150 time: 475



40460.png
theta: 88 phi: -180 time: 475

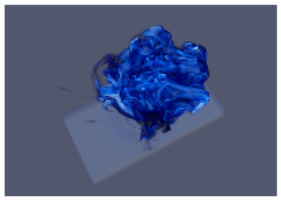


35208.png
theta: 63 phi: -150 time: 459

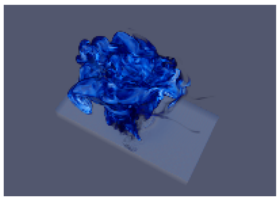


Edge Length (maximized)

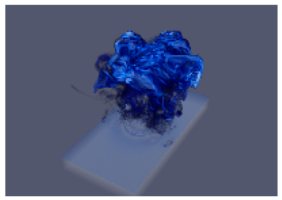
35224.png
theta: 63 phi: -150 time: 475



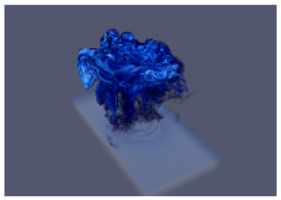
37128.png
theta: 63 phi: -30 time: 475



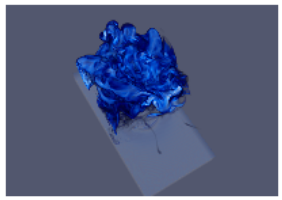
29988.png
theta: 38 phi: -120 time: 475



30940.png
theta: 38 phi: -60 time: 475

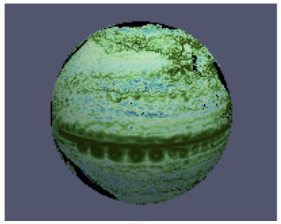


36652.png
theta: 63 phi: -60 time: 475

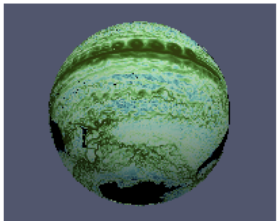


Mean Pixel Intensity (maximized)

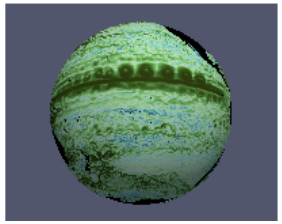
349.png
theta: -162 phi: 144 time: 7



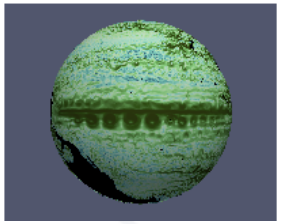
1521.png
theta: -36 phi: -36 time: 9



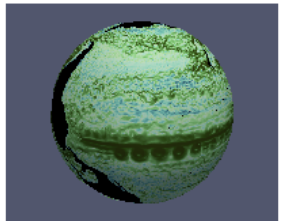
1699.png
theta: -18 phi: -36 time: 7



168.png
theta: -180 phi: 144 time: 6

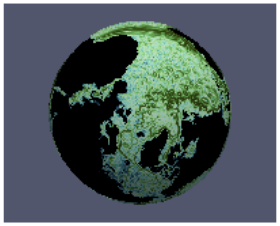


342.png
theta: -162 phi: 126 time: 9

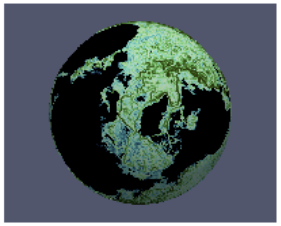


Pixel Intensity Standard Deviation (maximized)

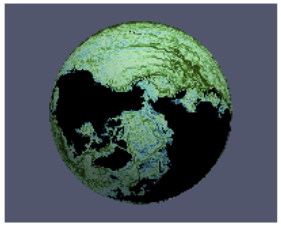
3164.png
theta: 126 phi: 18 time: 5



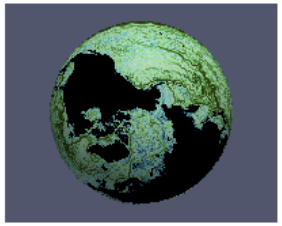
2982.png
theta: 108 phi: 18 time: 3



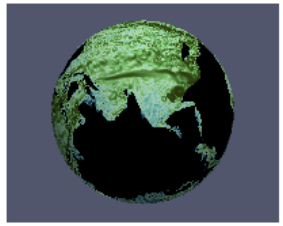
3060.png
theta: 108 phi: 162 time: 9



3050.png
theta: 108 phi: 144 time: 8

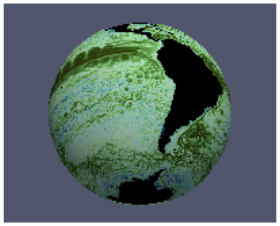


3481.png
theta: 162 phi: -72 time: 7

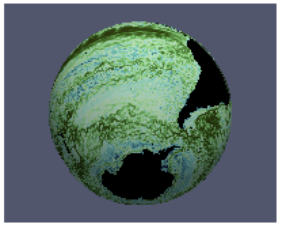


Number of Unique Color Pixels (maximized)

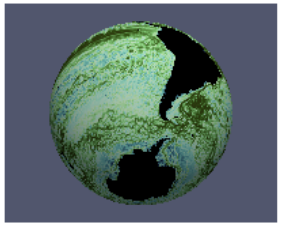
1490.png
theta: -36 phi: -90 time: 5



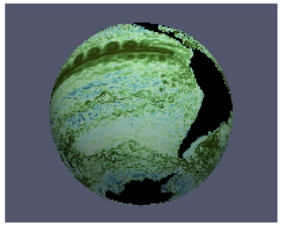
1319.png
theta: -54 phi: -72 time: 5



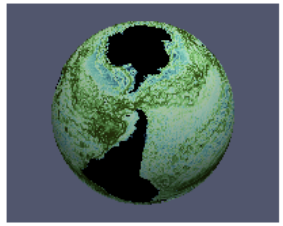
1310.png
theta: -54 phi: -90 time: 5



1498.png
theta: -36 phi: -72 time: 4

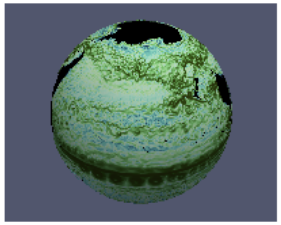


674.png
theta: -126 phi: 72 time: 8

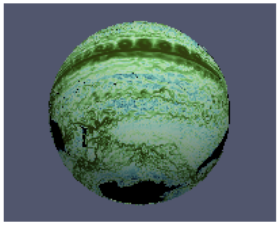


Edge Length (maximized)

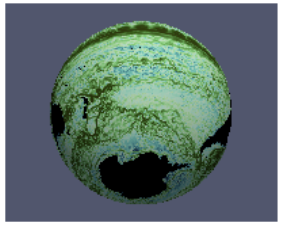
529.png
theta: -144 phi: 144 time: 7



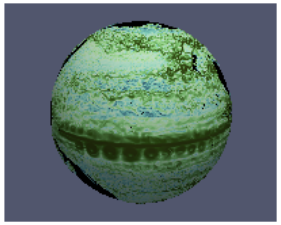
1519.png
theta: -36 phi: -36 time: 7



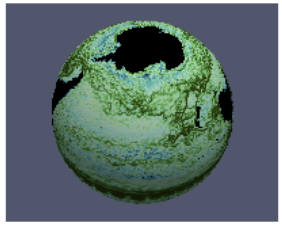
1340.png
theta: -54 phi: -36 time: 8



343.png
theta: -162 phi: 144 time: 1



704.png
theta: -126 phi: 144 time: 2

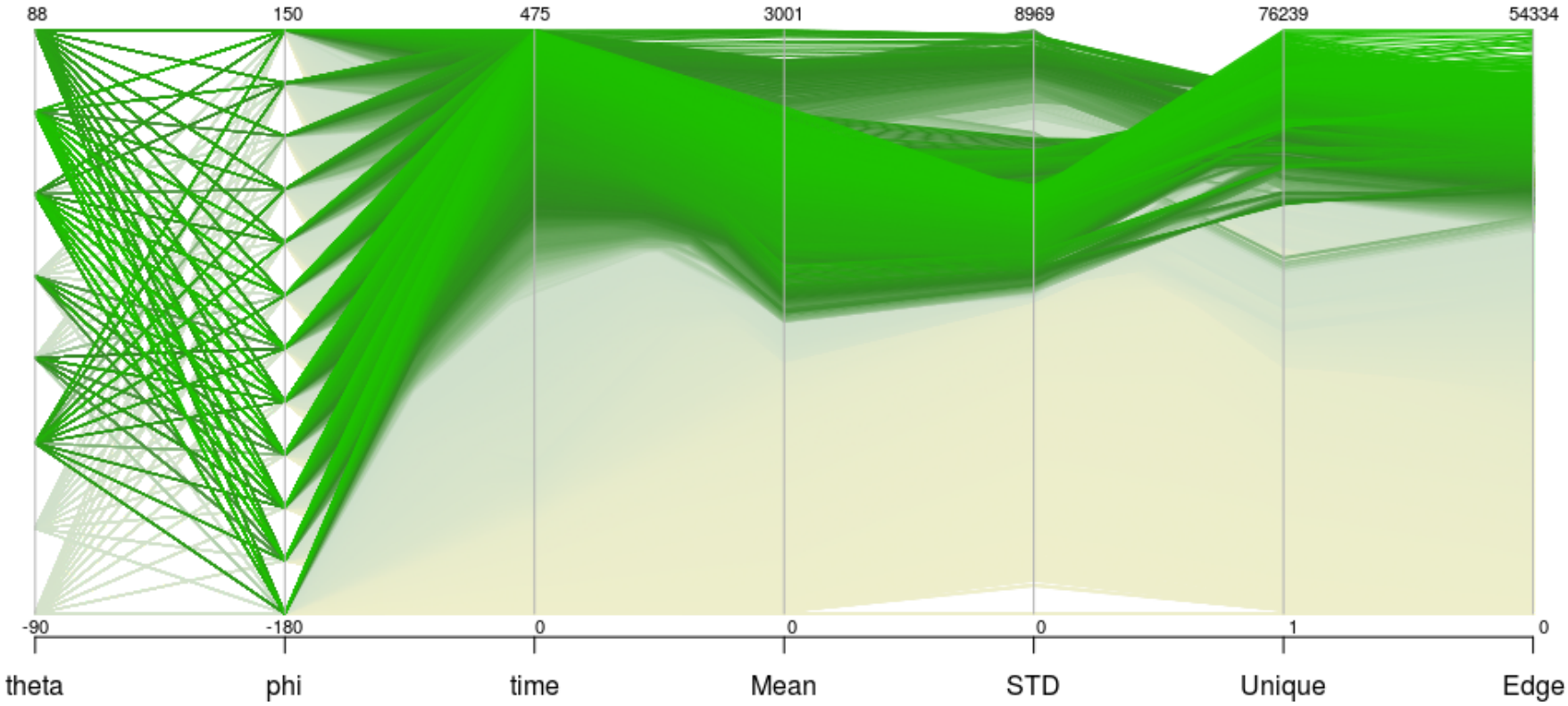


Change Detection

- In Situ Analysis
  - Save only important time steps
  - Piecewise running linear fit
    - 474 time steps
    - 35 partitions

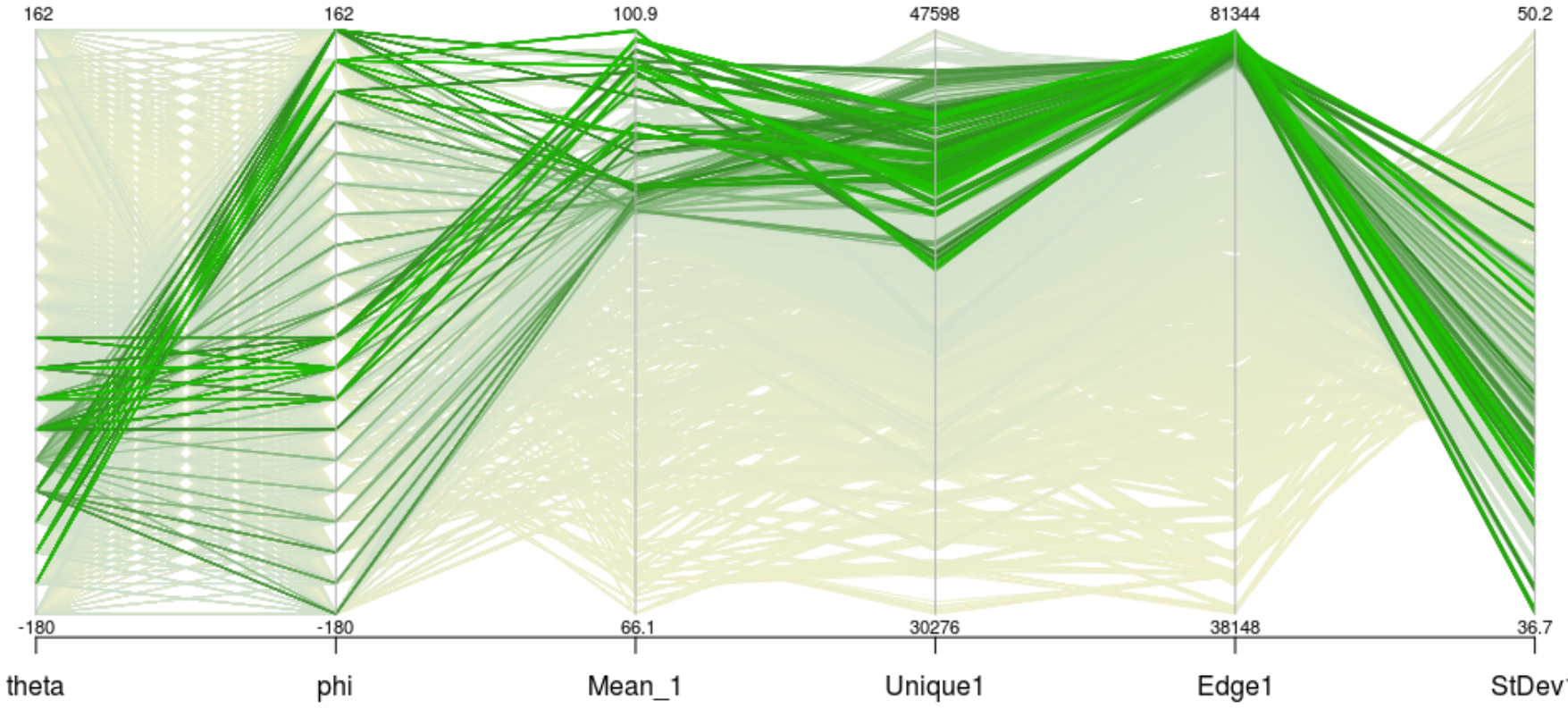
Visualization

Asteroid Impact Parallel Coordinates



Visualization

Ocean Parallel Coordinates



Future work

- Spatial statistics
- Linear combinations of existing statistics
- Compare human perception to statistical selection with experiment

Questions?