SUPPLEMENTAL DOCUMENTATION

Demonstration

Github link to access instructions to launch a new dashboard: https://github.com/sci-visus/Openvisus-NASA-Dashboard
Dashboard 1: http://chpc3.nationalsciencedatafabric.org:11957/dashboards
Dashboard 2: http://chpc3.nationalsciencedatafabric.org:11857/run

VIDEOS

Overview Video of Dashboards from the Paper

Our interactive dashboard shown running on a local machine, streaming data from SealStorage in the cloud or streaming data with credentials and port forwarding from NAS Supercomputer Pleiades (Figure 1). The petascale climate data shown above across multiple variables and 10,000 time steps with a divergent colormap for the Gulf Stream region of interest that spans across 75° W to 60° W and 30° N to 45° N. On the top left, we have multiple sliders for time steps and longitudinal lines, along with dropdown options for relevant dataset and play speed. The vertical slices are stacked together on the bottom left, and it shows how the ocean temperature (on the bottom) affects the atmospheric variables (on the top). Interactive vertical slicing of the ocean is possible, but it runs on multiple nodes and is run with the help of a visualization researcher. With our framework, a scientist can now explore the data on a web browser and is not limited to playing a video at a time or requiring parallel computing resources. Still, one can pan and zoom in on any region of interest, change the variables, change vertical slices, and adjust precisions while streaming petabytes of cloud data to commodity hardware.

The video also include, an interesting example showing the formation of Agulhas rings at the African southeast coast using the LLC2160 ocean dataset (Figure 7 of the paper). Some of these rings look like domes in a static image, but in the video you can see their rotation. Scientists can focus on any specific regions of their interest and interactively see these natural events streaming from a browser. These features were not available anywhere else before due to data accessibility issues and the lack of real-time analysis capabilities that limited scientific data exploration at this scale on commodity hardware.

Figure 6 Dashboard Demo

Dashboard created for Use Case 1, showing a zoomed-in view of the general water circulation through the Strait of Gibraltar connecting the Mediterranean with the Atlantic Ocean. The low-salinity water enters the Mediterranean Sea from the Atlantic through the Strait of Gibraltar; then the salinity increases, and the water starts to sink as the current moves east. This type of on-the-fly selection of interesting regions from a massive dataset and playing through the time facilitates a deeper understanding of complex climatic phenomena, which was not practically accessible before the implementation of our framework.

HPC Animation

Animation created at NASA Advanced Supercomputing (NAS) facility on the supercomputer Pleides by visualization researchers at NASA Ames Research Center in collaboration with the ocean scientists at JPL/Caltech. Images/Video Copyright NASA and Nina McCurdy, used with permission.

https://data.nas.nasa.gov/viz/vizdata/nmccurdy/patrice/oceT_atmT_QV_EFLUX_HFLUX.mp4

Source Data

The first dataset, DYAMOND, is the simulation output that combines two models to provide high-resolution data on atmospheric and oceanic variables. The first model is a C1440 configuration of the Goddard Earth Observing System (GEOS) atmospheric model, whereas the second model is a LLC2160 configuration of the MITgcm model. There are over 10,000 timesteps in each output, and each of them have multiple scalar fields such as temperature, snow thickness, salinity, east-west velocity, north-south ocean velocity, vertical ocean velocity, and others. The total size of the DYAMOND dataset is approximately 1.8 petabytes. https://data.nas.nasa.gov/geoseccoviz/

The next dataset, LLC4320 Ocean Dataset is the product of a 14-month simulation of ocean circulation and dynamics using MITgcm (MIT General Circulation Model) on a lat-lon-cap grid. This simulation is very similar to the ocean portion of the DYAMOND coupled simulation, but was run with half the horizontal grid spacing (four times the cell count), and with values at the ocean surface boundary that were derived from observations and physical models. Composing extensive scalar data such as temperature, salinity, heat flux, radiation, and velocity, the massive dataset exceeds 2 petabytes. The dataset can potentially improve our understanding of global ocean circulation and its role in Earth's climate system. https://www.ecco-group.org/data.html

Dashboard User Interface Details

Our dashboard framework provides a diverse array of features designed to accommodate both casual explorers and scientific researchers:

- Dataset Selection: Our dashboard includes a drop-down menu for selecting among different datasets. This flexibility allows users to switch seamlessly between variables such as temperature, ocean velocity, and salinity.
- Region of Interests Extraction: Within each dataset, the snipping tool included with the dashboards lets users draw a rectangle within the image. It then shows the detailed view of the selected region while allowing the users to download a NumPy array of the region or a Python script that can be used to download the selected region at a later time.
- Time Slider and Playback: A key component of our dashboard, the time slider, allows users to navigate through time within the dataset. The time slider feature is crucial for observing temporal changes and trends in the data. The dashboard also features a play button, allowing for an automated data play-through.
- Horizontal and Vertical Slices: The dashboard offers tools for taking both horizontal and vertical slices of the data. The flexibility to browse any slice is invaluable for examining specific cross-sections of data models.
- High-Quality Color Palettes: Users can choose from a series of high-quality, perceptually uniform color palettes to visualize data, effectively differentiating data points and enhancing the interpretability of complex datasets.
- Colormap Range: The colormap ranges can be set to either manual (fixed range) or dynamic (based on pixels/voxels in view). Users can manually select the maximum and minimum values for the color ranges.
- Resolution Sliders: Recognizing the need for both overview and detailed analysis, our dashboard includes resolution sliders that enable users to adjust the granularity of the data, from coarser, rapidly loading views to finer, more detailed perspectives that may require more time to render. The sliders are also a critical component of making the data accessible for limited bandwidth connections.
- Time Speed Control: A drop-down menu provides options for controlling the speed of time progression during playback. This feature lets the user choose the pace of variables being changed over time, providing user control for low bandwidth connections.