Enabling Scientific Discovery: Harnessing the Power of the National Science Data Fabric for Large-Scale Data Analysis (Session III & IV)

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Any opinions, findings, conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Prerequisites

Step 0: Access to GitHub

To run this tutorial, you need to have a GitHub account.

➔ You can create one following the instructions here:

https://docs.github.com/en/get-started/start-your-journey/creating-an-account-on-github#

➔ Now you can login into GitHub

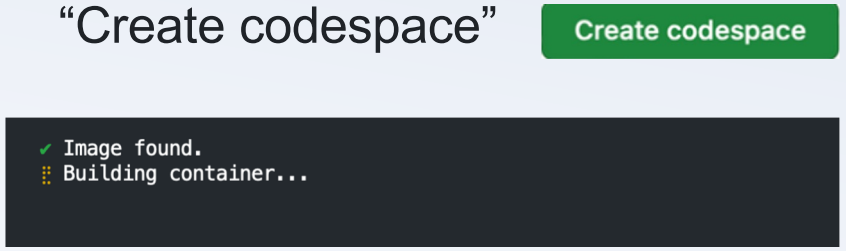
https://github.com/login

Step 1: Create Codespaces

Use your GitHub account to run this tutorial with GitHub codespaces

➔ Access this link:
NSDF Tutorial 2024

➔ Click on green button "Create codespace"



Session III

Tutorial

Step 1: Create Codespaces

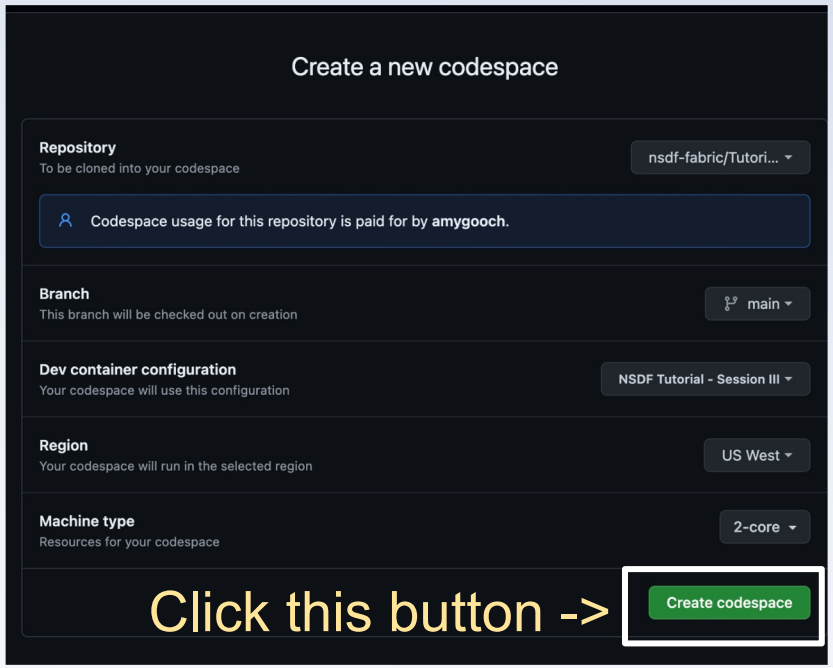
Use your GitHub account to run this tutorial with GitHub codespaces

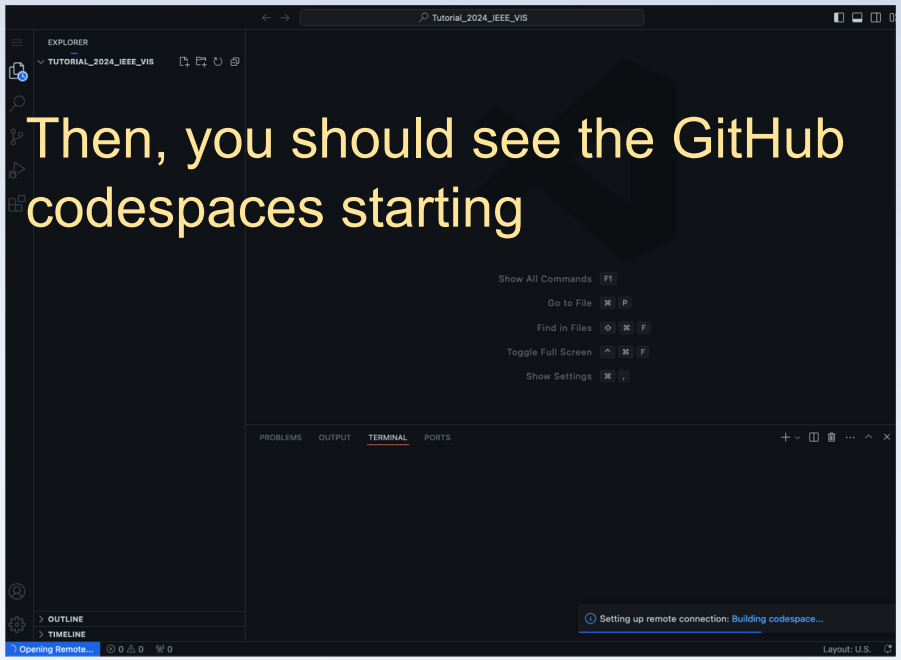
➔ Access this link:
NSDF Tutorial 2024

➔ Click on green button
"Create codespace"

Creating the GitHub Codespace

Tutorial





➔ Let's start:
NSDF Tutorial 2024

Loading GitHub Codespace can take from 1 to 5 minutes

Tutorial Session III Goals

This tutorial demonstrates end-to-end analysis of scientific data through NSDF services

Tutorial Goals

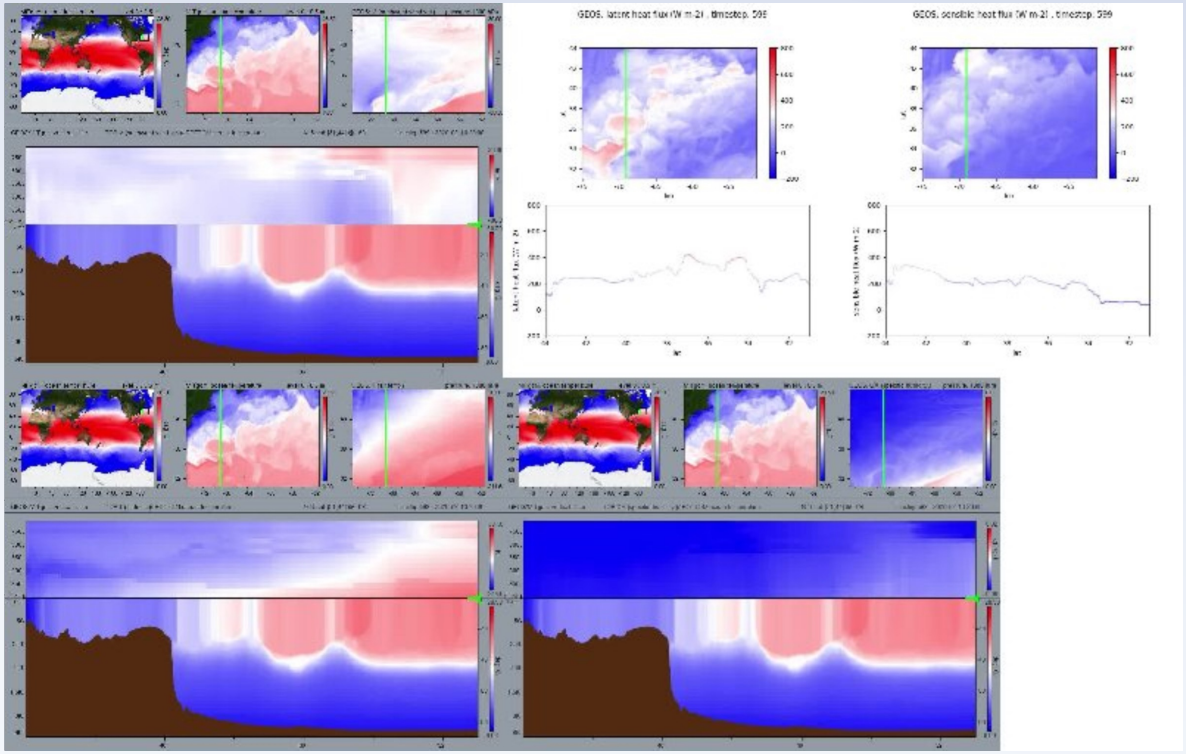
- **Access publicly available petascale datasets**
- **Treat the data as a NumPy array and perform statistical analysis**
- Store your data for large-scale **data access, visualization, analysis, and sharing**

Session III: Petascale Data

NASA makes big datasets available

What does it mean to get to that data?
What do you have to do to see it
As a domain expert, such as a climate scientist, geographer?
As a visualization expert?
As a student?

NASA Scientists and Experts in Vis and Climate



- Difficulty accessing the full data
- Limitations in computational power
- Need real-time processing capabilities

Publicly available NASA Datasets

Datasets :

NASA 1.8 PB DYAMOND dataset[1]:
a global atmospheric model and a global ocean model

LLC4320 2.0 PB Ocean dataset[2]

1) https://gmao.gsfc.nasa.gov/global_mesoscale/dyamond_phaseII/data_access/
2) https://www.ecco-group.org/data.html

How big is a petabyte?

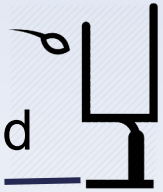
1,000 ^ 5 = 1,000 x 1,000 x 1,000 x 1,000 x 1,000 = 1,000,000,000,000,000 bytes

11,000 4k Movies

over 2.5 years of non-stop binge watching to get

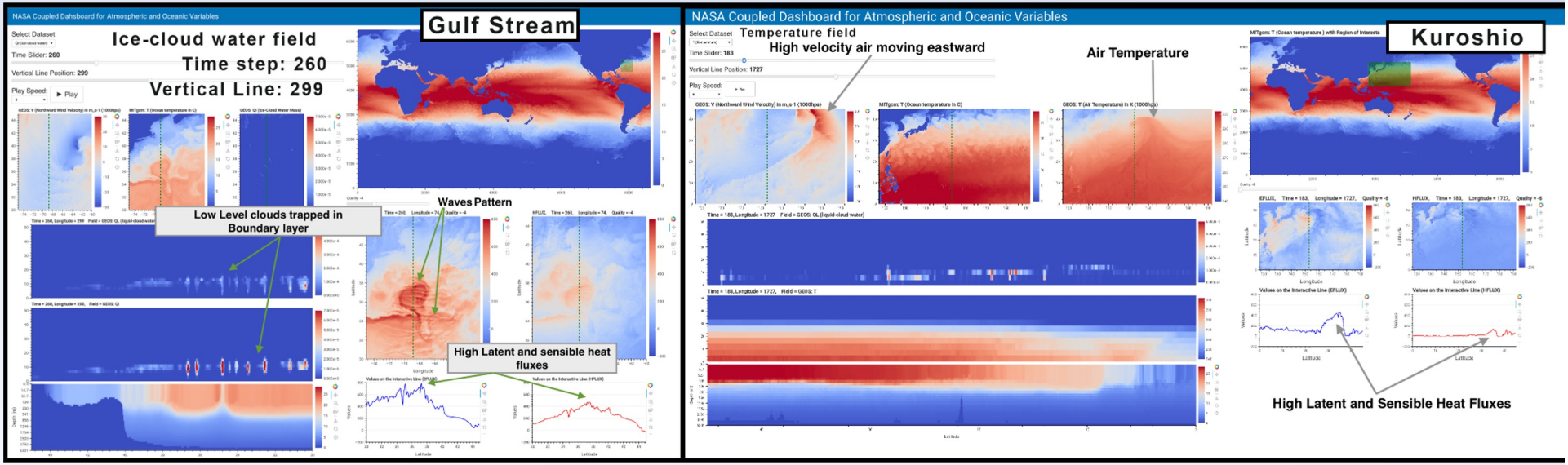
thru a petabyte of 4k movies

92 football fields of 1GB flash drives put end to end



1 PB is equivalent to taking over 4,000 digital photos per day, over your entire life.

Cloud served optimized data with local caching



Aashish Panta, Xuan Huang, Nina McCurdy, David Ellsworth, Amy A. Gooch, Giorgio Scorzelli, Hector Torres, Patrice Klein, Gustavo A. Ovando-Montejo, Valerio Pascucci.

“Web-based Visualization and Analytics of Petascale data: Equity as a Tide that Lifts All Boats”. Best Paper, LDAV 2024

Science of Climate change

The Mediterranean Sea is warming and evaporating more and more with marine heat waves increasing in intensity, duration and frequency

Tracking the changes of the ocean on either side of the Gibraltar Strait is crucial in order to understand the impact of climate change.

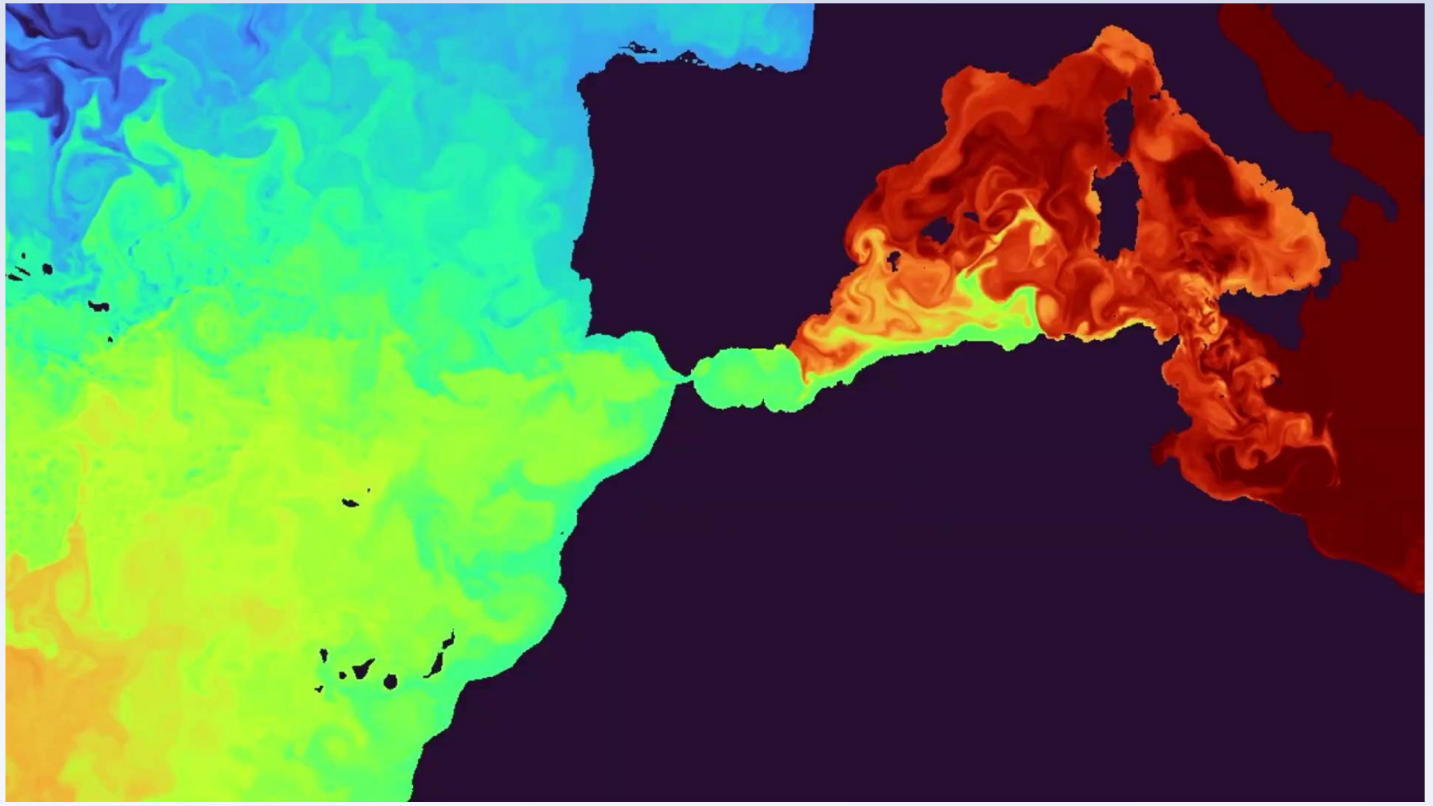
Even today, the Mediterranean is considerably saltier than the North Atlantic.

Now you can Visualize the salient changes in the Strait of Gibraltar

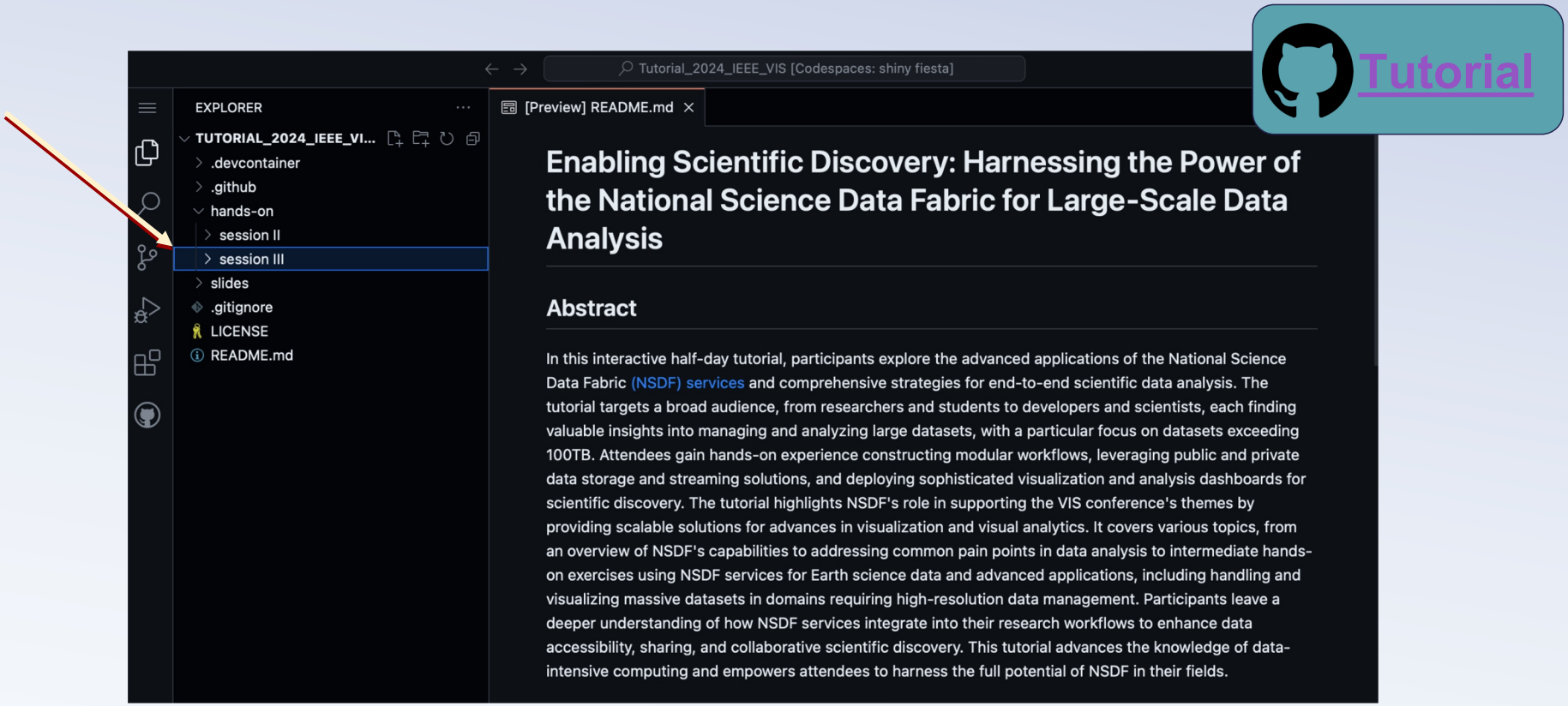
Access petascale NASA data

With OpenViSUS we can treat it as a NumPy array.

Tutorial



Head back to Codespaces

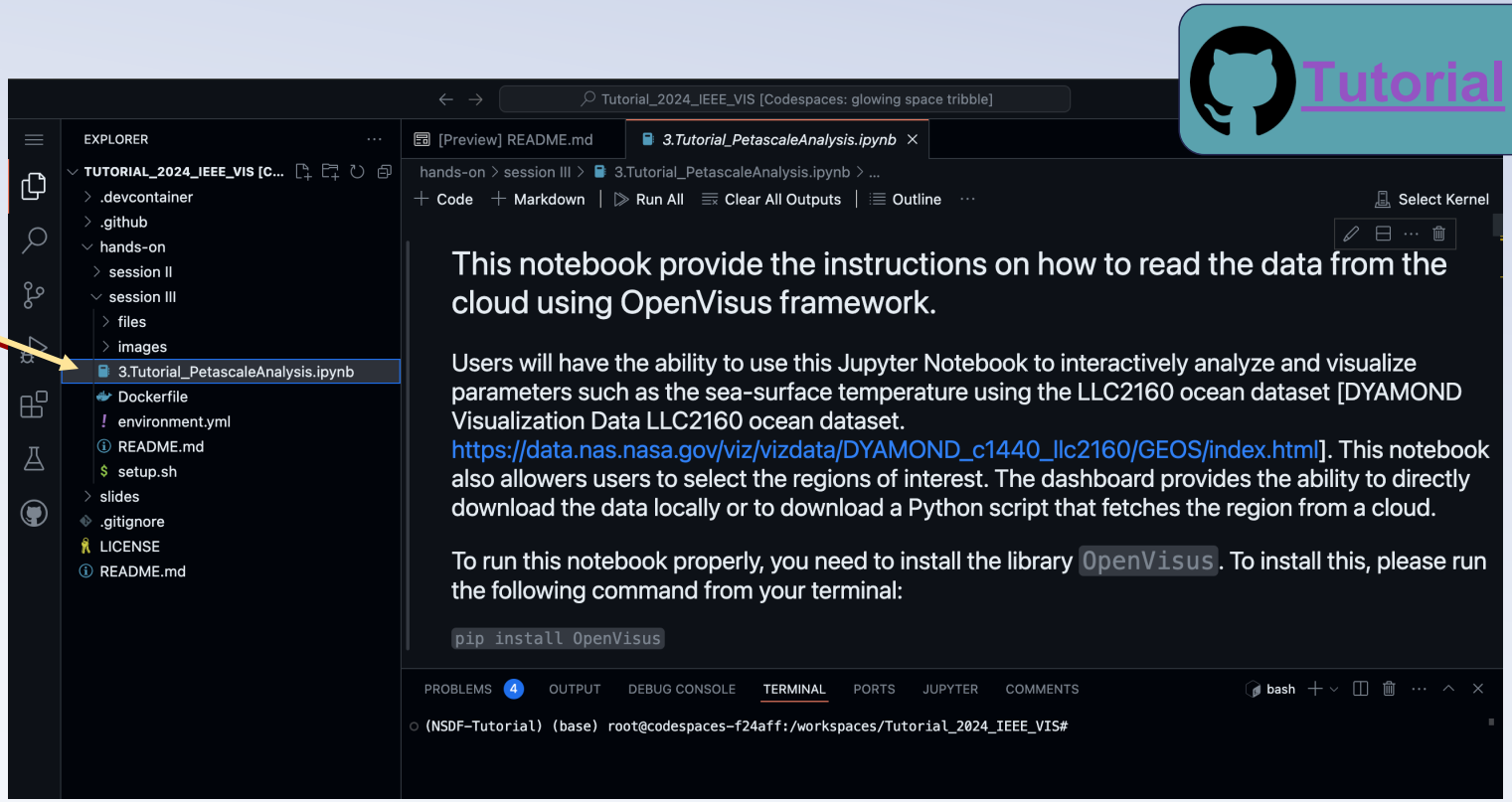


(1)When the codespace is fully loaded, you should see this screen

Select the file

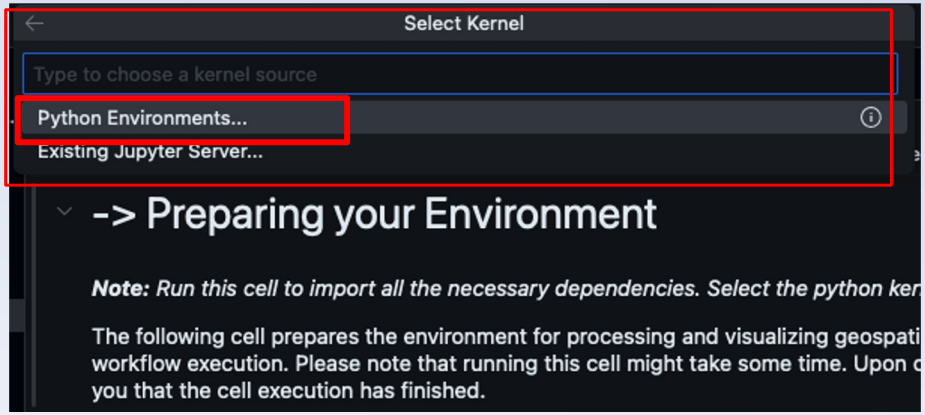
.ipynb

using the side bar

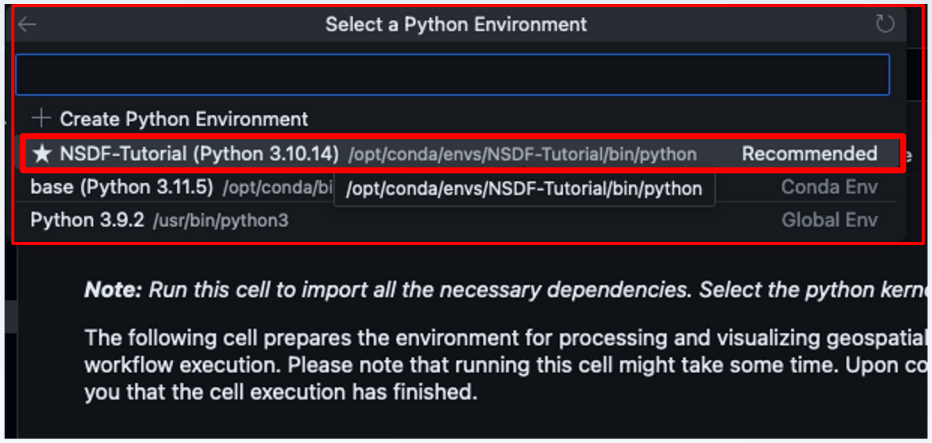


Tutorial

(4) A list to Select Kernel should pop up. Select *Python Environments* …

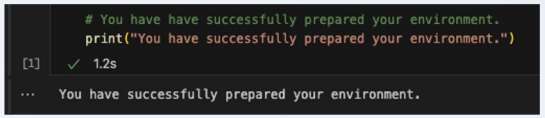


(5) Select the ★*NSDF-Tutorial* option



Tutorial

(6) Finally, after running the *Preparing your Environment* cell, you should see a message saying it was successfully prepared



Click on the triangle to play through the section of Python code

Tutorial

Step 1: Importing the libraries

```
[1]
import numpy as np
import os
os.environ["VISUS_CACHE"]="./visus_cache_can_be_erased"
from OpenVisus import *
import matplotlib.pyplot as plt
import time
start_time = time.time()
```

Hands on..

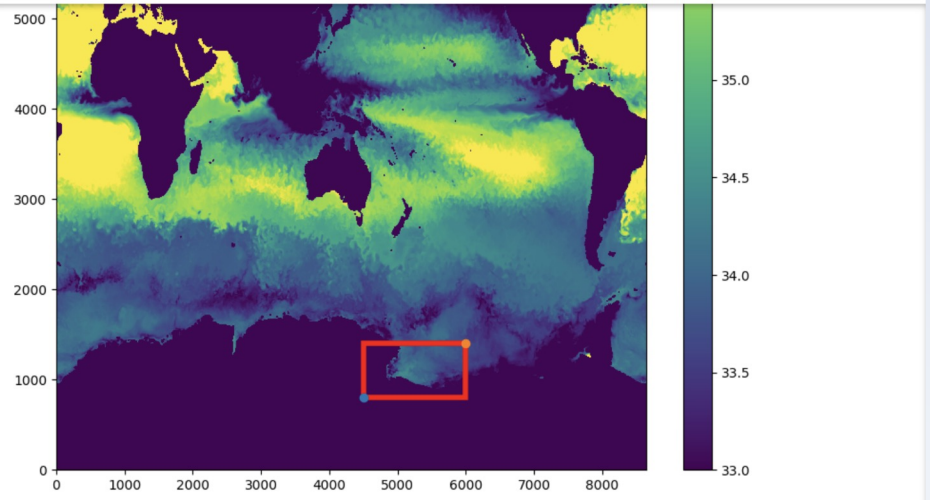
When finished with

3.Tutorial_PetascaleAnalysis.ipynb

You can go to next set of investigations on your own…
(next slide)

Be Curious! Change the Jupyter Notebook:

```
#Step 8a) Test Draw a new region to look at using the unfiltered data:

fig,axes=plt.subplots(1,1,figsize=(10,8))
axes.set_xlim(0,8640)
axes.set_ylim(0,6480)

#Set up a plot of the full data
axp = axes.imshow(data,extent=[0,8640,0,6480], aspect='auto',origin='lower',vmin=33,vmax=36,cmap='viridis')
plt.colorbar(axp,location='right')

#Plot corners of subregion using range of x values (x1,x2) and range of y values (y1,y2)
x1, x2 = [4500,6000]
y1, y2 = [800, 1400]
plt.plot(x1, y1, x2, y2, marker = 'o')

#or you can plot them as a red rectangle
#xy = (top, left)
regionRect =plt.Rectangle(xy=(4500,800), width=1500, height=600, color='r', fill=False, linewidth=4 )
# add the patch to the Axes
axes.add_patch(regionRect)

plt.show()
print('Step 8a done.')
```




```
Step 8a done.
```

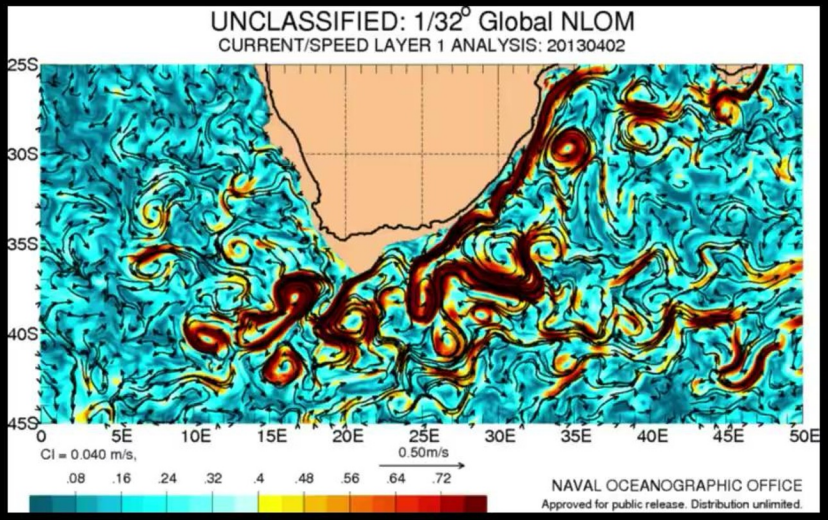
Be Curious! Change the Jupyter Notebook:

Can you visualize the min and max salinity in the Straits of the Gibraltar at a particular time?

HINT: Maybe look at two regions, one on Atlantic side, one in the Mediterranean

What is the min/max over a section of time?

More Domain Science!



Creative Commons Image from http://www7320.nrlssc.navy.mil/global_nlom32/agu.html US Navy NLOM

The Agulhas current is one of the most powerful ocean currents in the world, transporting about 73 billion liters of water per second. A warm water current runs down the east coast of southern Africa, before retroflecting back eastwards into the Indian Ocean.

Dashboard for Figure 7

IEEE Vis Submission: "Web-based Visualization and Analytics of Petascale data: \newline Equity as a Tide to Lift All the Boats"

All Hands Advanced Tutorial Option:

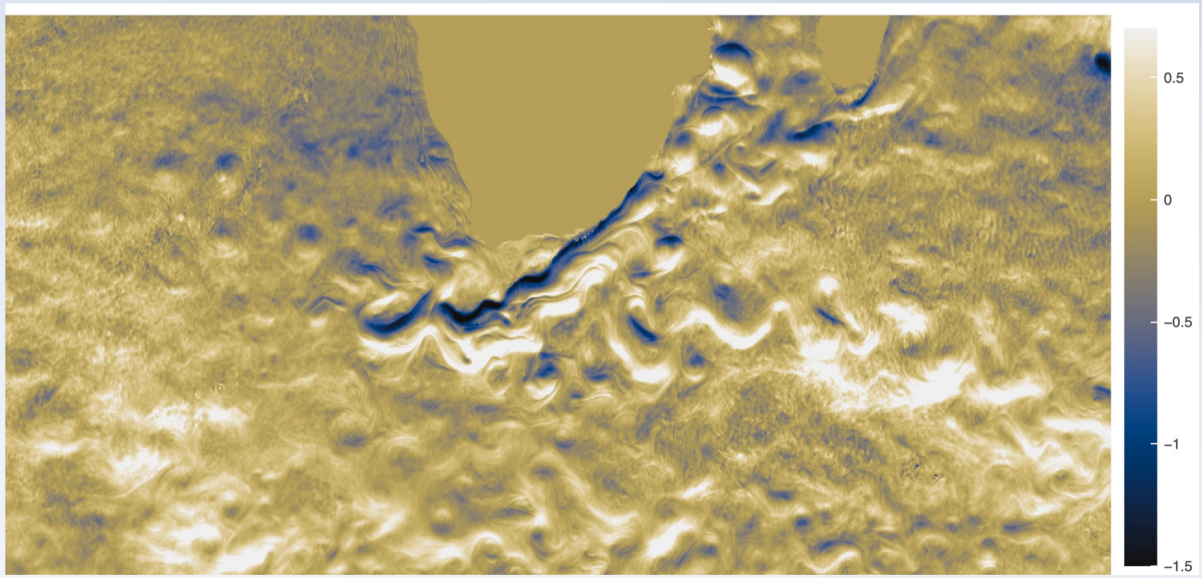
Tutorial

First:

Change the dataset you load in Step 2 to load *eastwest_ocean_velocity_u*

Next:

Change the region of interest in Step 8 to the southern tip of Africa



What is the maximum E-W current of the Aghulas Rings (currents) off the southern tip of South Africa?

Now you have all these datasets

How do you

- organize?
- share?
- view?
- archive?

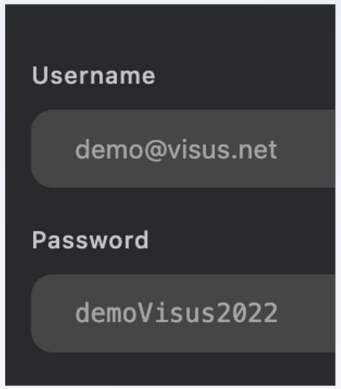
VisSTORE

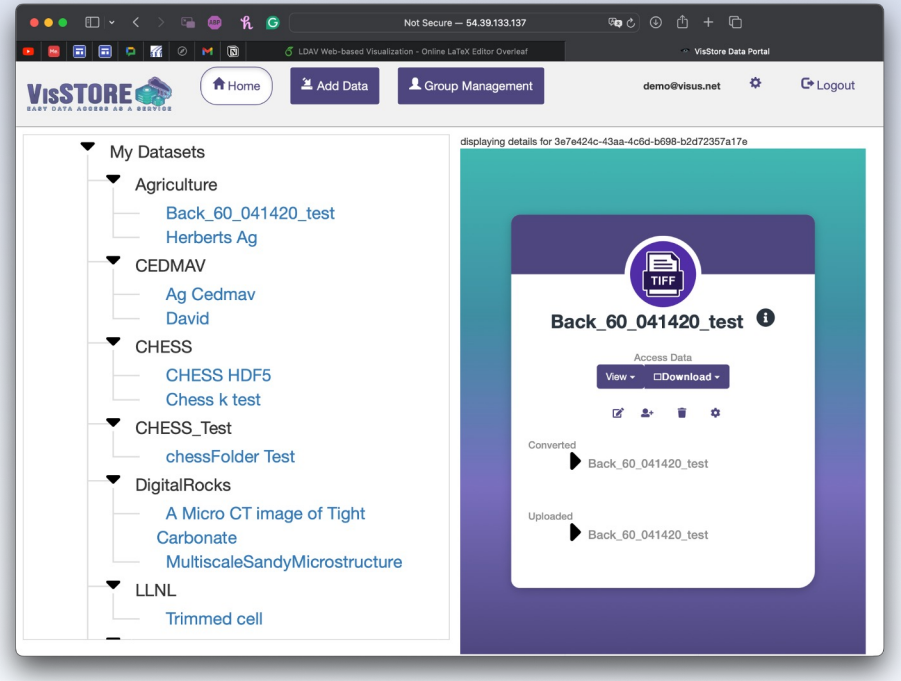
EASY DATA ACCESS AS A SERVICE

Demo: set url in browser to: http://54.39.133.137/

Create your own login to upload your own data

or use:





Session IV: Other Datasets

Democratizing Access and Use of Large-scale Data

Check Out Other NSDF-Dashboards

QR1: NASA Ocean Dataset Use Case

QR2: CHESS Use Case

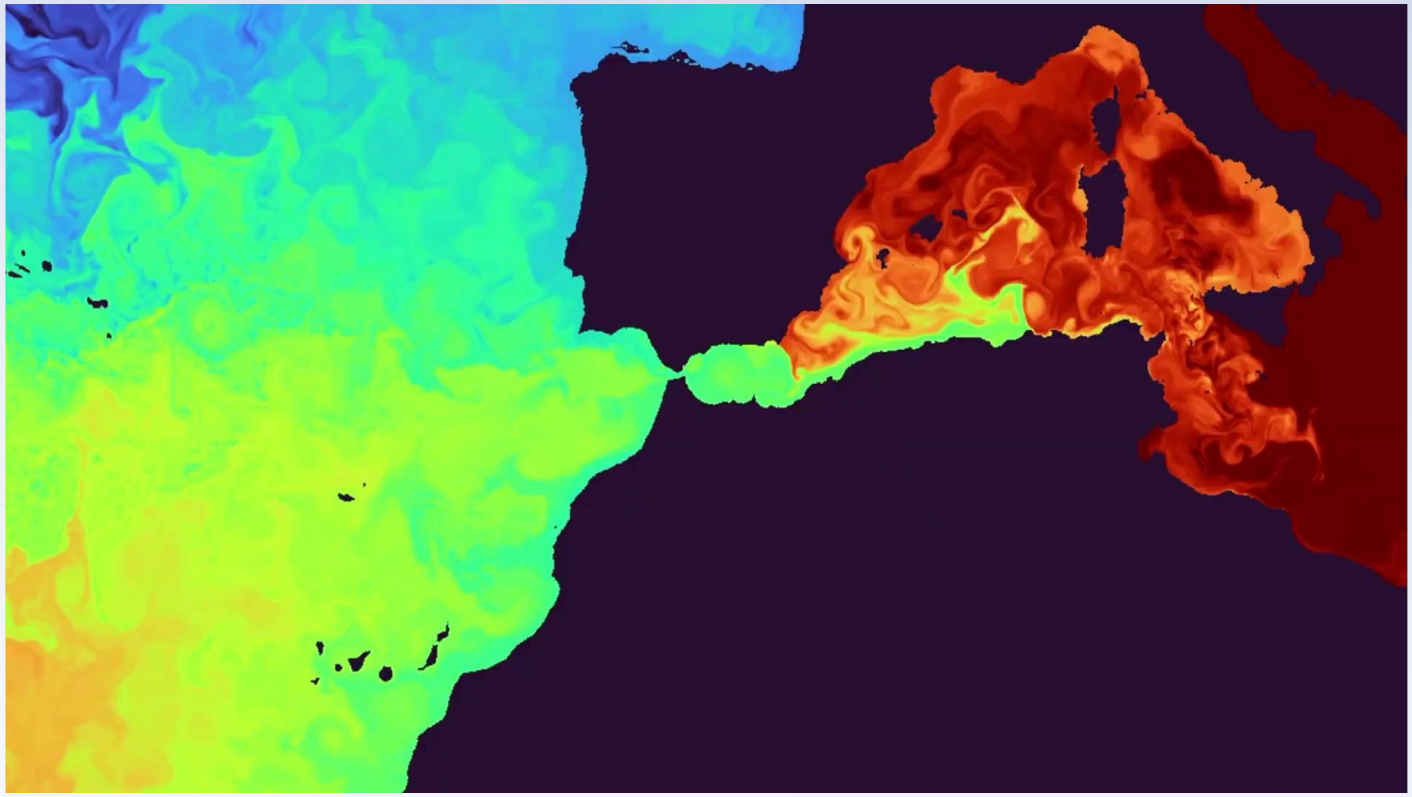
QR3: Material Science Use Case

QR4: Bellows Use Case

Power of Visualization: Water Circulation in the Mediterranean Region

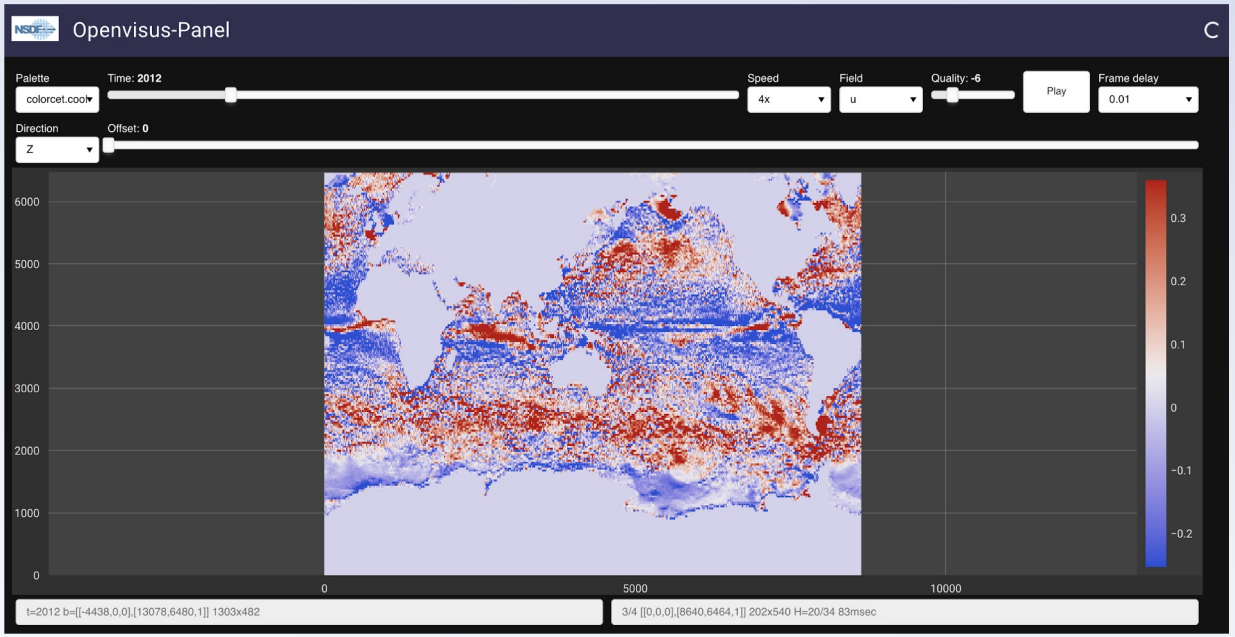
Dashboard 1

Run it yourself



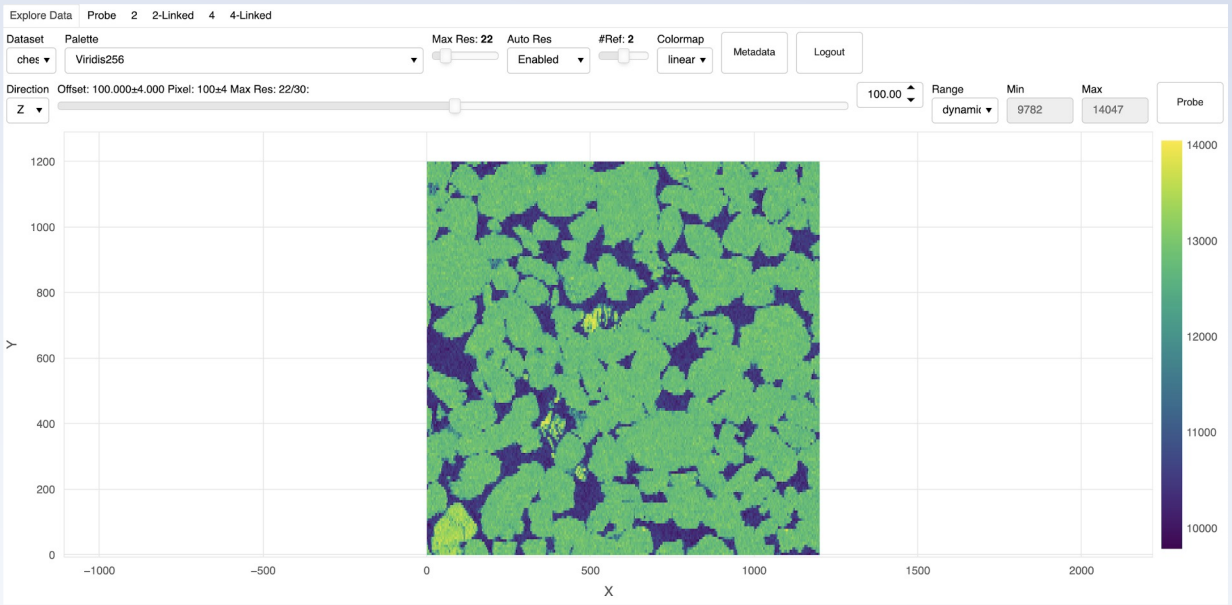
Check Out Other NSDF-Dashboards (I)

[NASA Ocean Dataset Use Case]



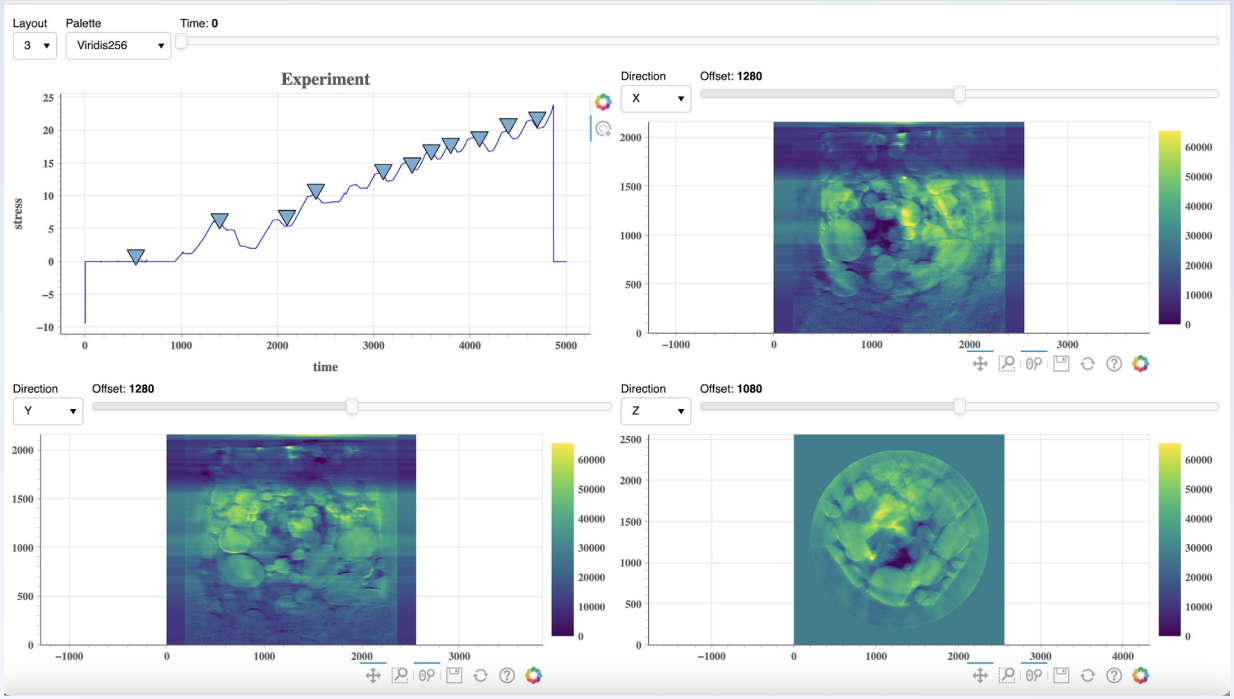
Check Out Other NSDF-Dashboards(II)

CHESS
Use Case



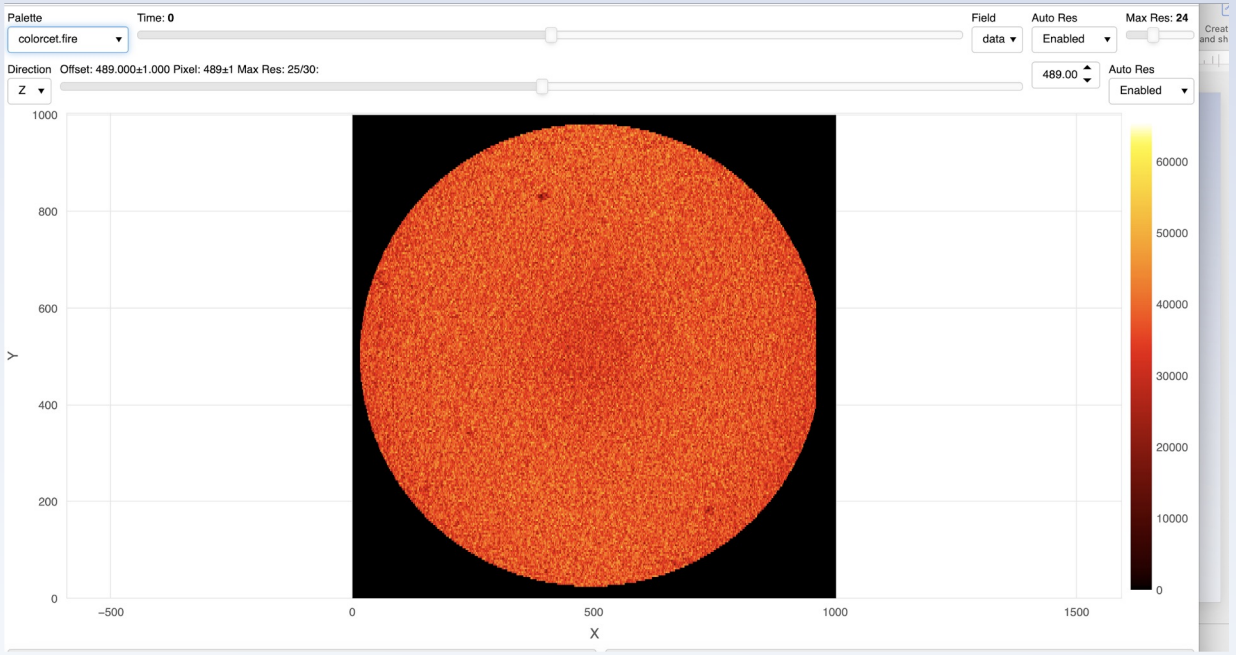
Check Out Other NSDF-Dashboards (III)

[Materials Science Use Case]



Check Out Other NSDF-Dashboards (I)

Bellows
Dataset Use Case



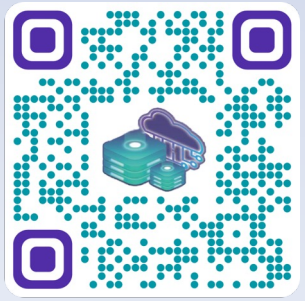
Part IV: Discussion with Tutorial Attendees

Democratizing Access and Use of Large-scale Data

Tutorial Links

NSDF-Tutorial

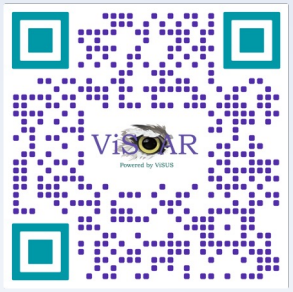
GEOtiled



VisStore

SOMOSPIE

OpenVisus



ViSOAR

Survey

Share your thoughts with us! (3 mins)

https://shorturl.at/qPNP0