CESM Diagnostics Lab

Turning numbers into pictures

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Lab Goals

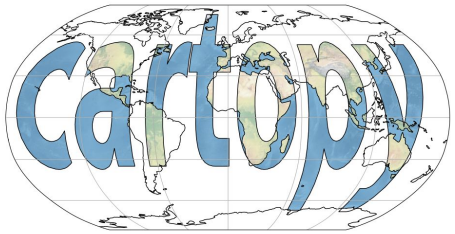
- Learn about (geoscientific) python.
- Successfully run Jupyter notebooks on Jupyterhub.
- Visualize CESM model output.
- Learn about diagnostic software being developed at NCAR, including CUPiD, CVDP, ADF, and UXarray.

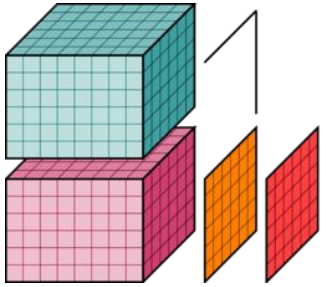
Python

The analysis of CESM output is mostly done in a python ecosystem here at CGD.

Python is an interpreted, multi-paradigm language used for a myriad of purposes (for example the command line tools like “create_newcase” are actually python scripts).

There is “standard” python, and then various libraries and modules which have been developed for specific purposes, like working with scientific datasets and visualizations. Some of the extra libraries we will be using are shown to the right.





xarray

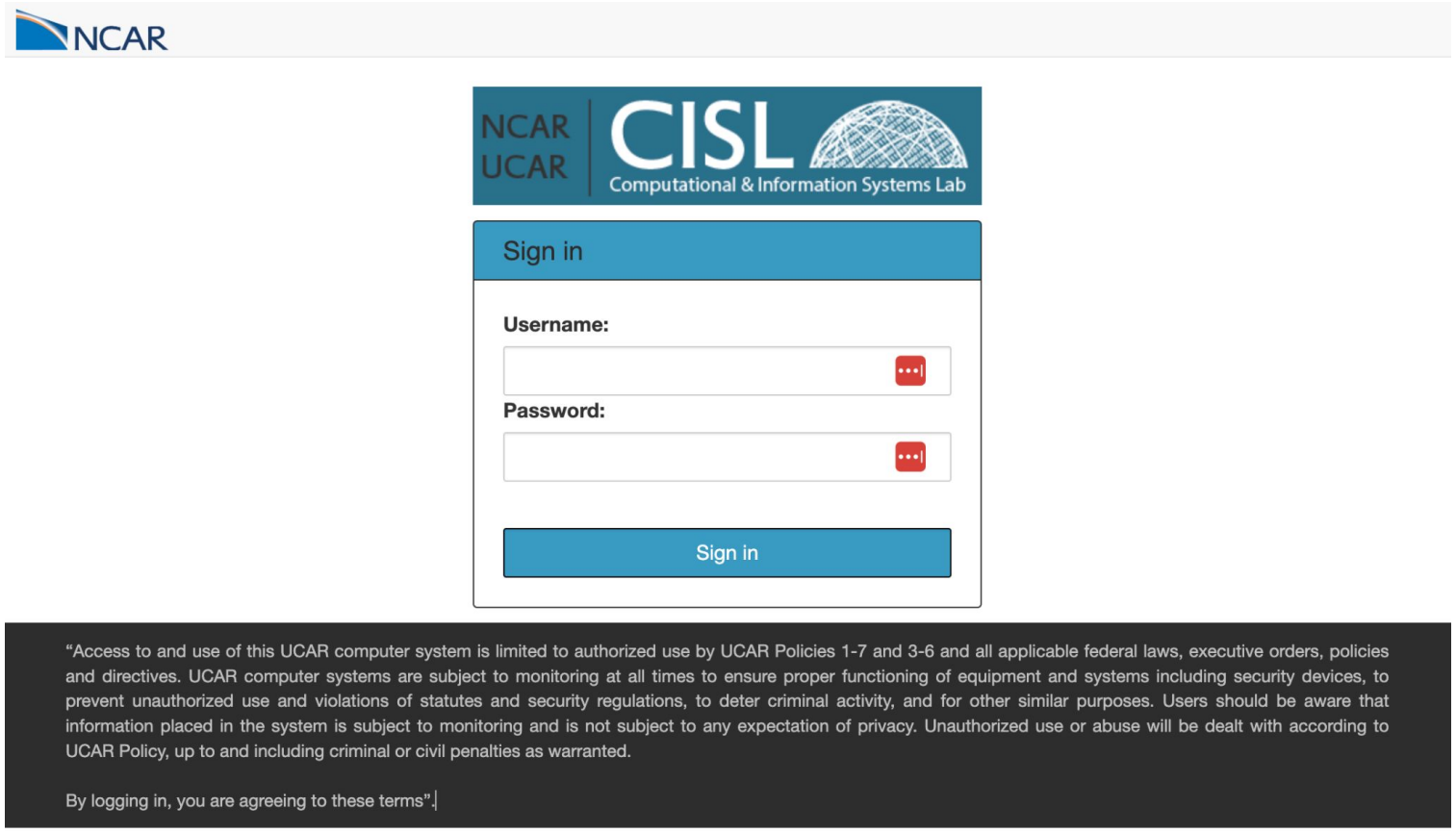
Jupyterhub

Jupyter notebooks are a way to organize text, figures, and cells with executable code. They are increasingly used by scientists here in CGD to develop and share codes and scientific analyses.

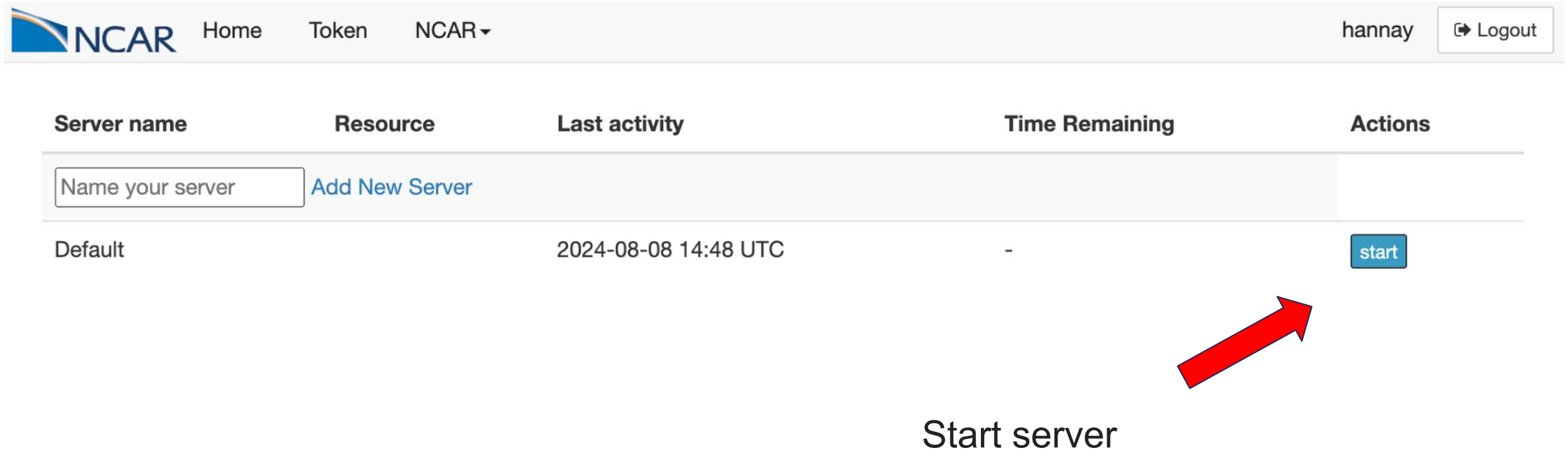
Jupyterhub is a system provided by NCAR CISL to create and run Jupyter notebooks on CISL machines (Casper and Derecho). Anyone with derecho or casper access should also have access to the Jupyterhub system and are free to use it.

Login to the JupyterHub

Login to the JupyterHub website:https://jupyterhub.hpc.ucar.edu/

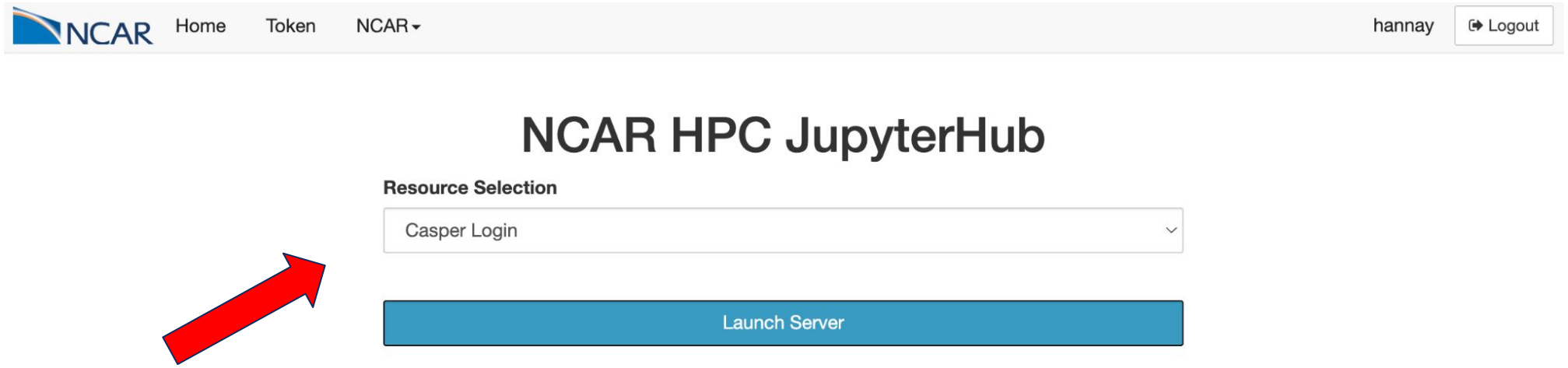


Start server



Start server

Launch server



Change from Casper Login to Casper PBS Batch

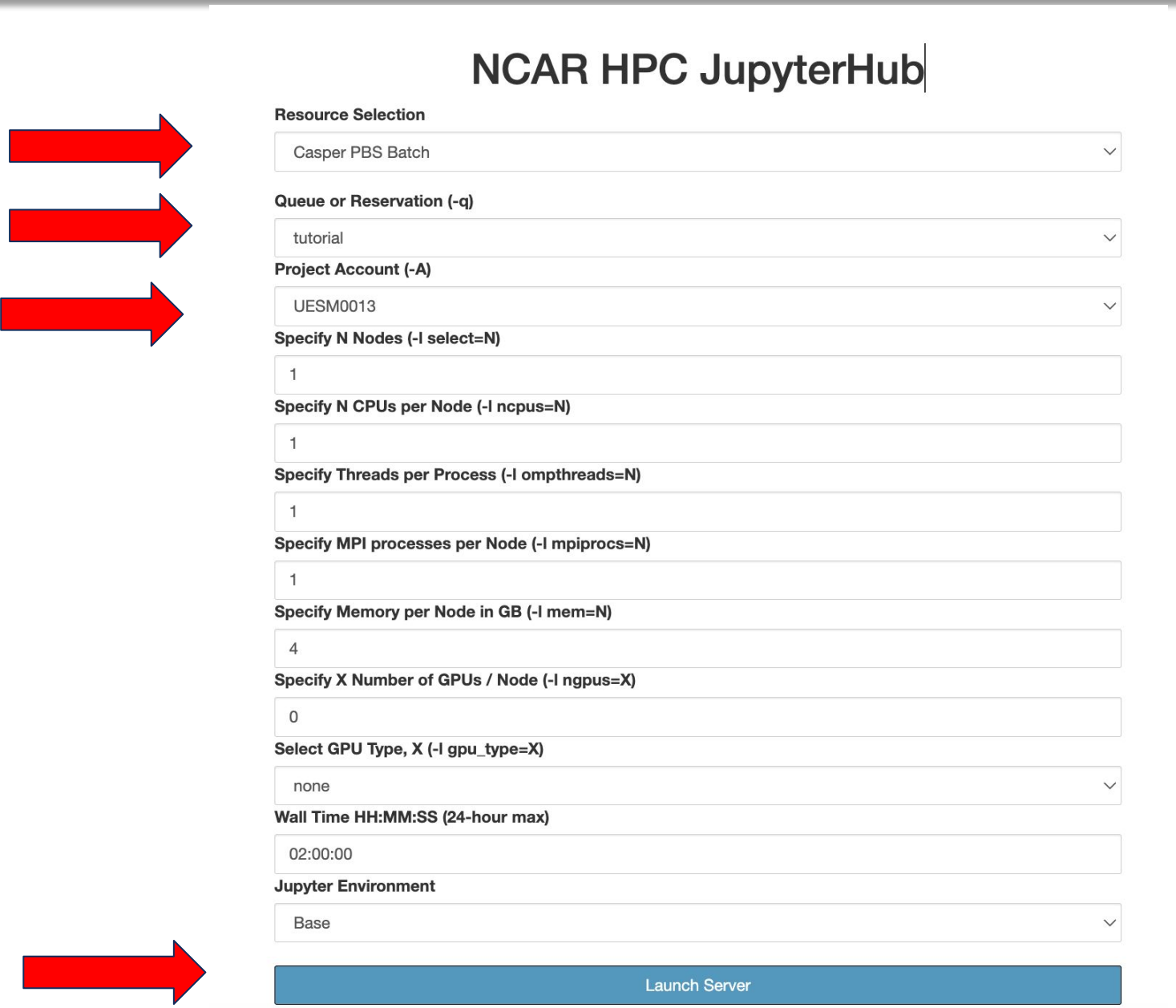
Launch server

Casper PBS Batch

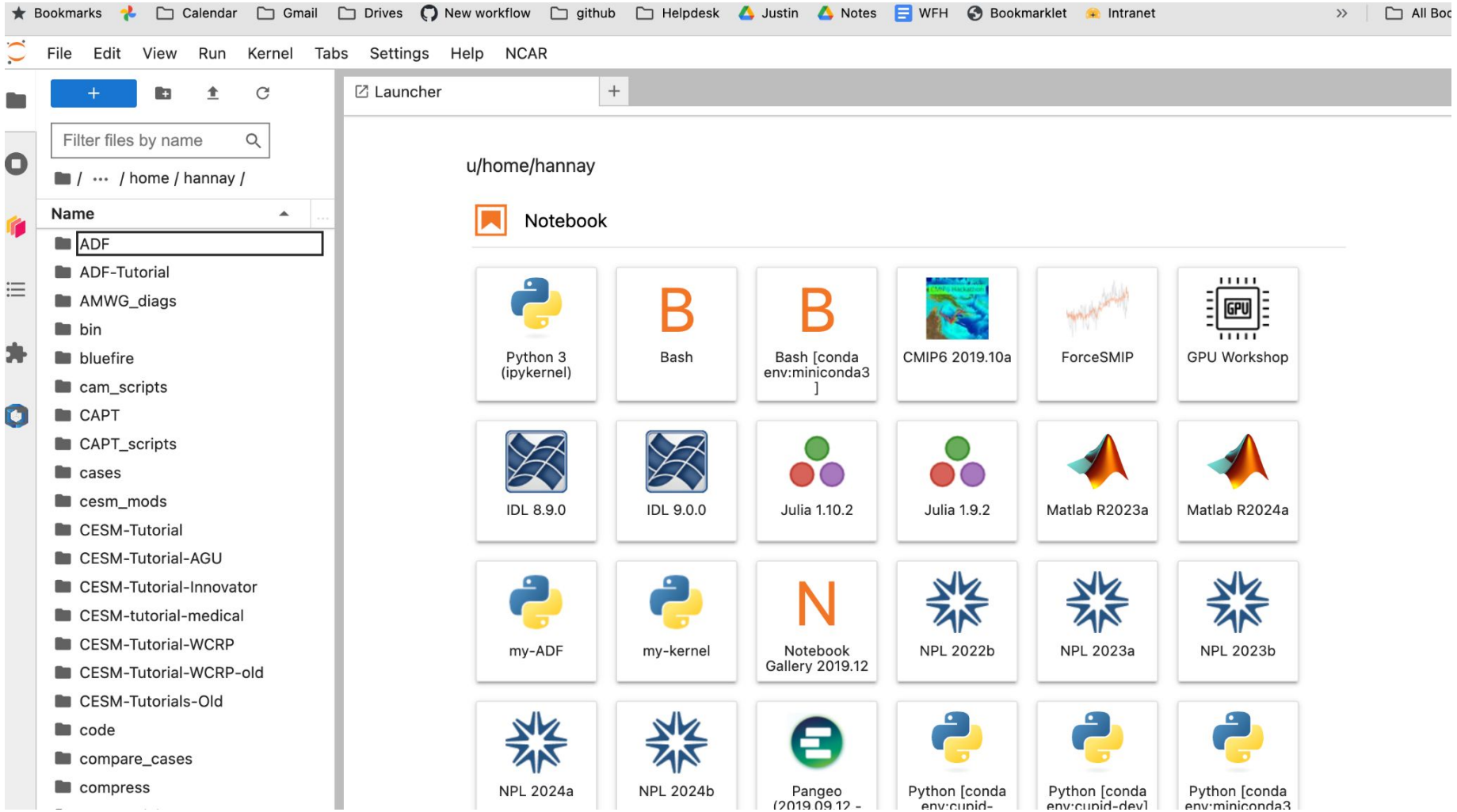
tutorial (or R1903032)

UESM0013

Launch server



Your landing page



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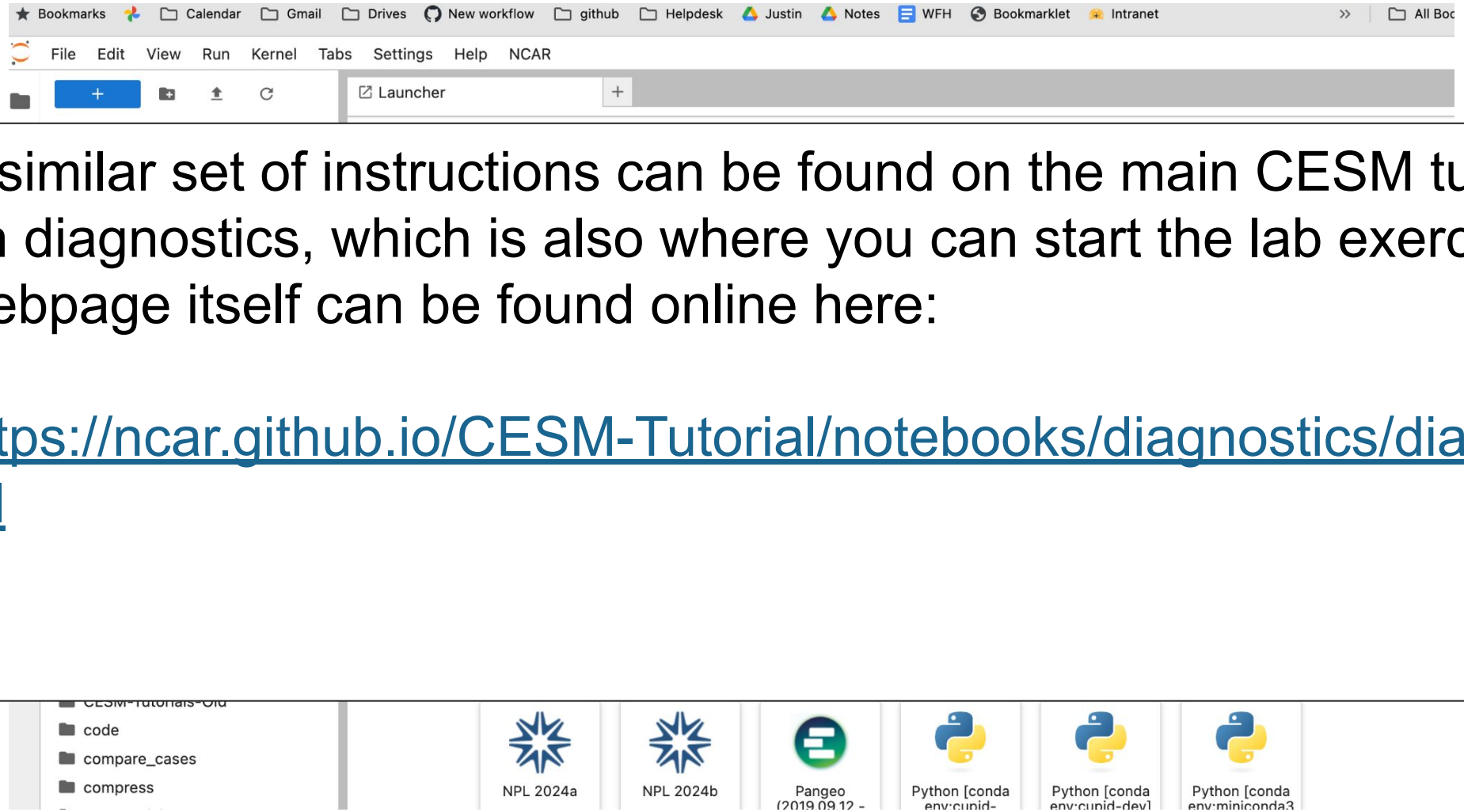


A similar set of instructions can be found on the main CESM tutorial page on diagnostics, which is also where you can start the lab exercises. The webpage itself can be found online here:

https://ncar.github.io/CESM-Tutorial/notebooks/diagnostics/diagnostics.html

Advanced topics - CUPiD

The CESM Unified Postprocessing and Diagnostics (CUPiD) system is an under-development, push-button diagnostics system which will automatically produce diagnostic output for all CESM components for any given CESM run.

Although CUPiD is being targeted for CESM3, it can currently be used to convert standard CESM history output into single variable time series files, which you can do under the “CUPiD” section of the diagnostics tutorial.

You can learn more about CUPiD on Github here:
https://github.com/NCAR/CUPiD.git

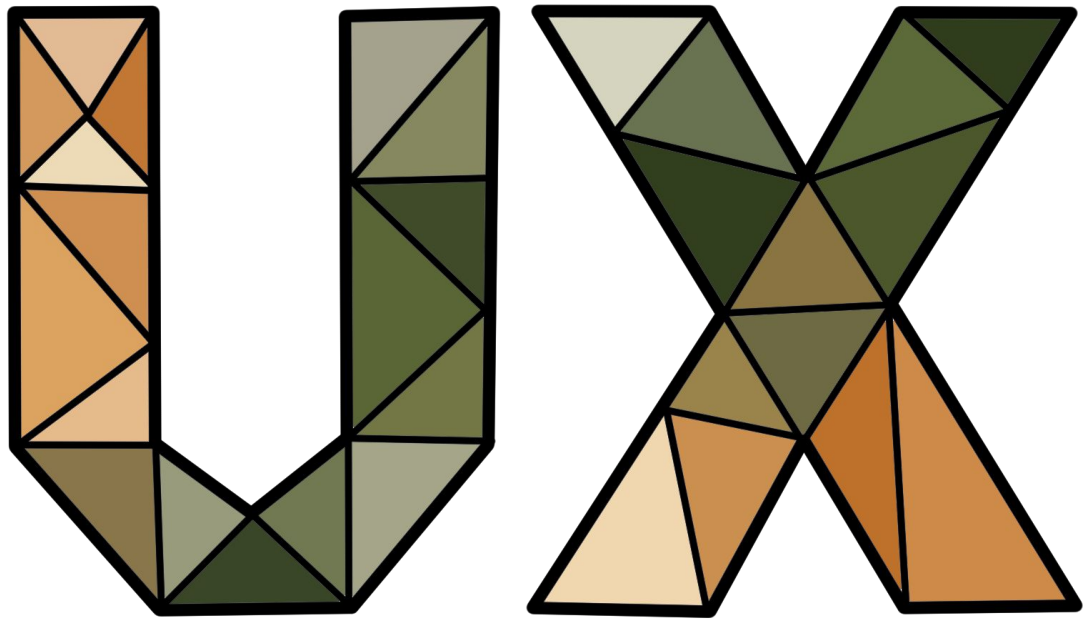
Advanced topics - UXarray

For CESM3 the default grids for the atmosphere and land components will be unstructured, and so having analysis and visualization tools that natively handle or regrid unstructured data will be critical.

One project to help with unstructured data is UXarray. UXarray is a new python package/extension of Xarray that allows one to work with unstructured grids. It is currently under development here at NCAR (via CISL). You can learn more about it online here:

https://uxarray.readthedocs.io/en/latest/

One can try an example workflow with UXarray under the “UXarray” section, which is itself under “Additional Topics”.



Advanced topics - CVDP

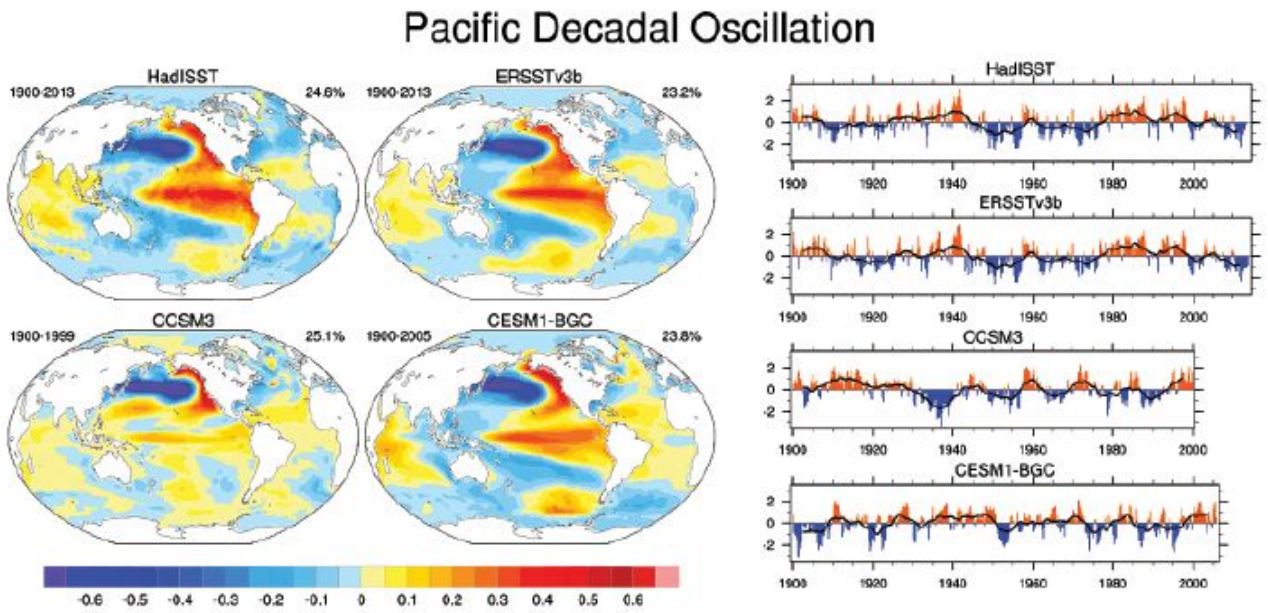
The Climate Variability Diagnostics Package (CVDP) is a diagnostics tool developed in CGD's Climate Analysis Section that is designed to help automatically generate diagnostics related to various modes of variability in a CESM run. There is also a large ensemble version (CVDP-LE) that can do the same for an ensemble of CESM simulations. Both packages are currently written in NCL, but are actively being moved to Python.

Information on the CVDP can be found online here:

https://www.cesm.ucar.edu/projects/cvdp

While information on the CVDP-LE can be found online here:

https://www.cesm.ucar.edu/projects/cvdp-le



Advanced topics - ADF

The AMWG Diagnostics Framework (ADF) is a new python-based diagnostics system designed to replace the older AMWG NCL diagnostics, or in other words to post-process CAM (atm) output and generate a large collection of plots and analyses that are organized into a website for you.

The ADF can also run the CVDP as well, and has been coupled to CUPiD.

Additional information, including examples to try, can be found on the ADF tutorial page online here:

https://justin-richling.github.io/ADF-Tutorial/README.html

Thanks for listening!

Any questions?

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