



# CESM Diagnostics Lab

Turning numbers into pictures

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# Lab Goals

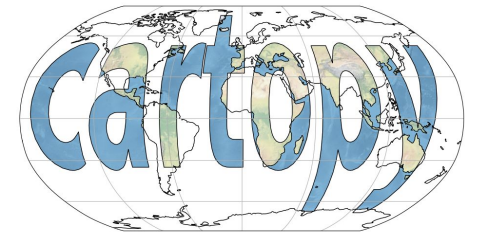
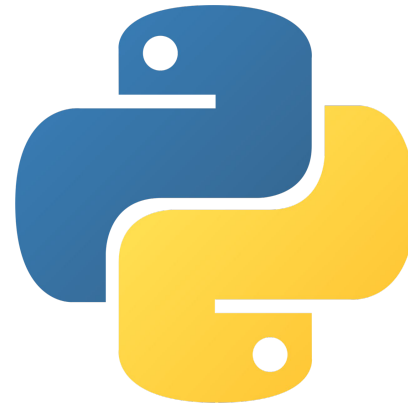
- Learn about (geoscientific) python.
- Successfully run Jupyter notebooks on Jupyterhub.
- Visualize CESM model output.
- Learn about diagnostic software being developed at NCAR, including CUPiD, CVDP, ADF, and UXarray.

# Python

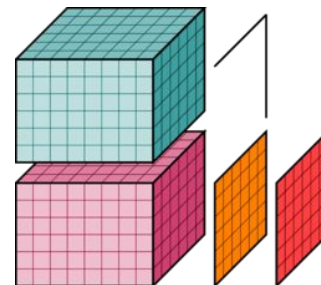
The analysis of CESM output is mostly done in a python ecosystem here at CGD.

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.



**matplotlib**



**xarray**

# Jupyterhub

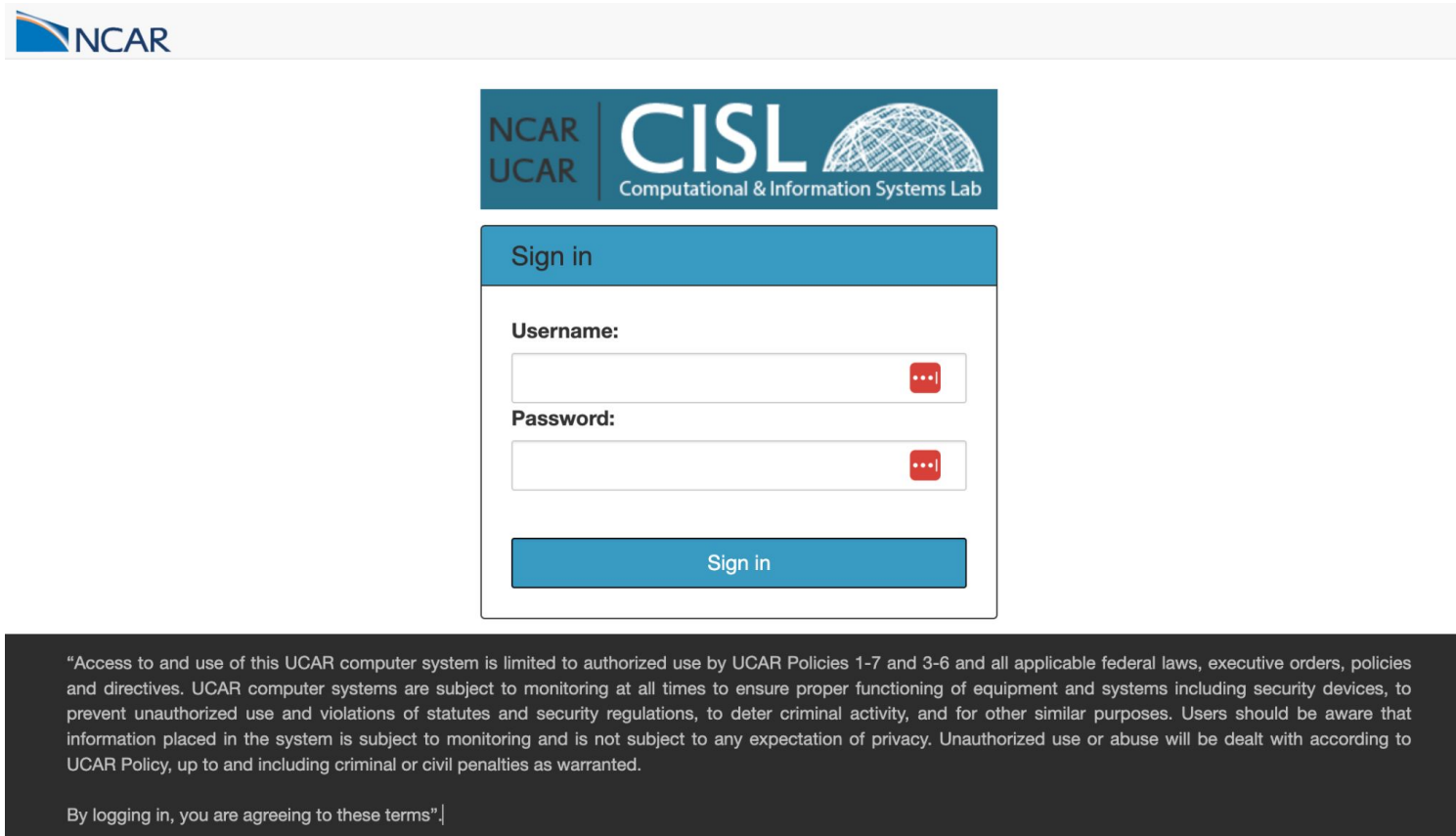
Jupyter notebooks are a way to organize text, figures, and cells with executable code. They are increasingly used by scientists here in CGD to develop and share codes and scientific analyses.

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/>



NCAR

NCAR UCAR CISL  
Computational & Information Systems Lab

Sign in

Username:

Password:

Sign in

"Access to and use of this UCAR computer system is limited to authorized use by UCAR Policies 1-7 and 3-6 and all applicable federal laws, executive orders, policies and directives. UCAR computer systems are subject to monitoring at all times to ensure proper functioning of equipment and systems including security devices, to prevent unauthorized use and violations of statutes and security regulations, to deter criminal activity, and for other similar purposes. Users should be aware that information placed in the system is subject to monitoring and is not subject to any expectation of privacy. Unauthorized use or abuse will be dealt with according to UCAR Policy, up to and including criminal or civil penalties as warranted.

By logging in, you are agreeing to these terms"

# Start server



Home

Token

NCAR ▾

hannay

Logout

Server name

Resource

Last activity

Time Remaining

Actions

Name your server

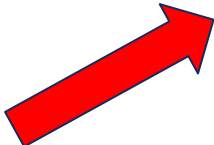
[Add New Server](#)

Default

2024-08-08 14:48 UTC

-

start



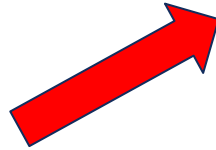
Start server

# Launch server

## NCAR HPC JupyterHub

Resource Selection




Casper Login ▾



Launch Server

Change from Casper Login to Casper PBS Batch

# Launch server

Casper PBS Batch   
tutorial (or R1903032)   
UESM0013 

## NCAR HPC JupyterHub

### Resource Selection

Casper PBS Batch

### Queue or Reservation (-q)

tutorial

### Project Account (-A)

UESM0013

### Specify N Nodes (-l select=N)

1

### Specify N CPUs per Node (-l ncpus=N)

1

### Specify Threads per Process (-l ompthreads=N)

1

### Specify MPI processes per Node (-l mpirprocs=N)

1

### Specify Memory per Node in GB (-l mem=N)

4

### Specify X Number of GPUs / Node (-l ngpus=X)

0

### Select GPU Type, X (-l gpu\_type=X)

none

### Wall Time HH:MM:SS (24-hour max)

02:00:00

### Jupyter Environment

Base

Launch server 

Launch Server



# Your landing page

The image shows a web-based launcher interface. At the top, there is a browser-style address bar with various bookmarks like 'Calendar', 'Gmail', 'Drives', 'New workflow', 'github', 'Helpdesk', 'Justin', 'Notes', 'WFH', 'Bookmarklet', and 'Intranet'. Below this is a menu bar with options: 'File', 'Edit', 'View', 'Run', 'Kernel', 'Tabs', 'Settings', 'Help', and 'NCAR'. The main interface is divided into two panels. The left panel is a file explorer showing a directory tree for 'u/home/hannay'. The right panel is a 'Launcher' window showing a grid of application icons. The path 'u/home/hannay' is displayed at the top of the launcher. A 'Notebook' icon is visible in the top left of the launcher area. The grid of icons includes: Python 3 (ipykernel), Bash, Bash [conda env:miniconda3], CMIP6 2019.10a, ForceSMIP, GPU Workshop, IDL 8.9.0, IDL 9.0.0, Julia 1.10.2, Julia 1.9.2, Matlab R2023a, Matlab R2024a, my-ADF, my-kernel, Notebook Gallery 2019.12, NPL 2022b, NPL 2023a, NPL 2023b, NPL 2024a, NPL 2024b, Pangeo (2019.09.12), Python [conda env:cupid-], Python [conda env:cupid-dev], and Python [conda env:miniconda3].

Bookmarks: Calendar, Gmail, Drives, New workflow, github, Helpdesk, Justin, Notes, WFH, Bookmarklet, Intranet

File Edit View Run Kernel Tabs Settings Help NCAR

Filter files by name

u/home/hannay

Launcher

u/home/hannay

Notebook

Python 3 (ipykernel)

Bash

Bash [conda env:miniconda3]

CMIP6 2019.10a

ForceSMIP

GPU Workshop

IDL 8.9.0

IDL 9.0.0

Julia 1.10.2

Julia 1.9.2

Matlab R2023a

Matlab R2024a

my-ADF

my-kernel

Notebook Gallery 2019.12

NPL 2022b

NPL 2023a

NPL 2023b

NPL 2024a

NPL 2024b

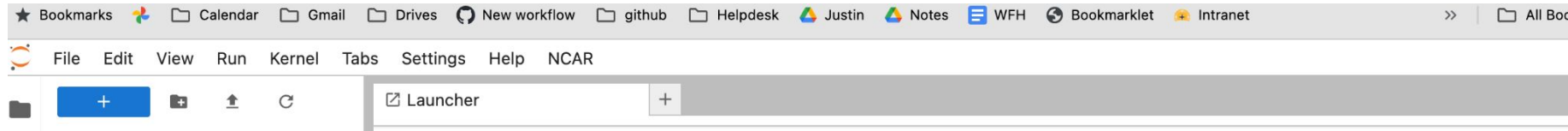
Pangeo (2019.09.12)

Python [conda env:cupid-]

Python [conda env:cupid-dev]

Python [conda env:miniconda3]

# Your landing page



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>



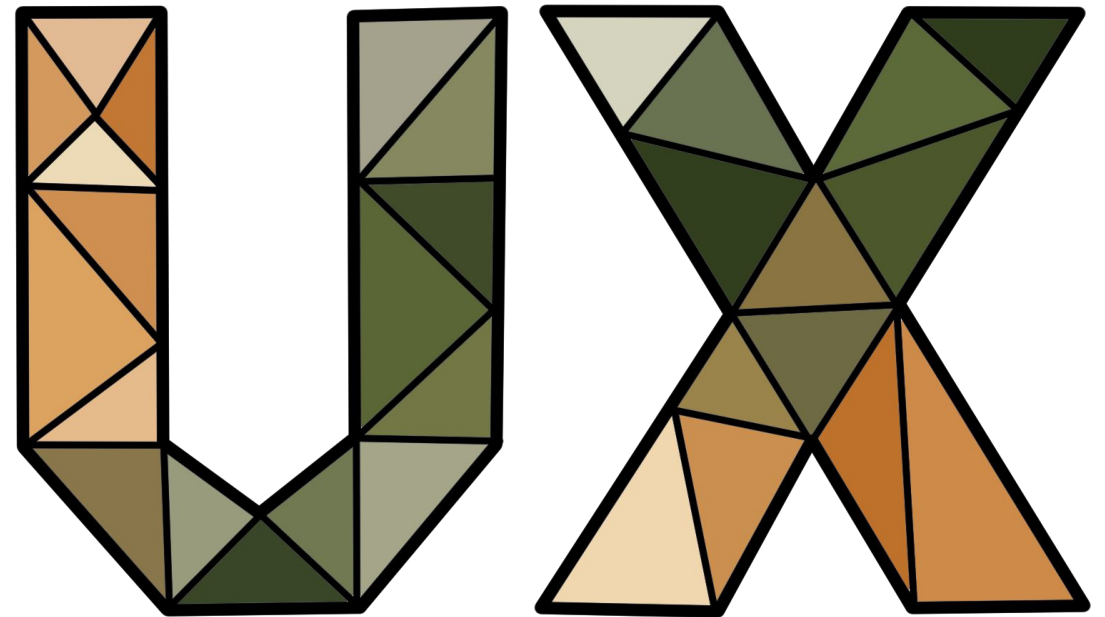
# Advanced topics - UXarray

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

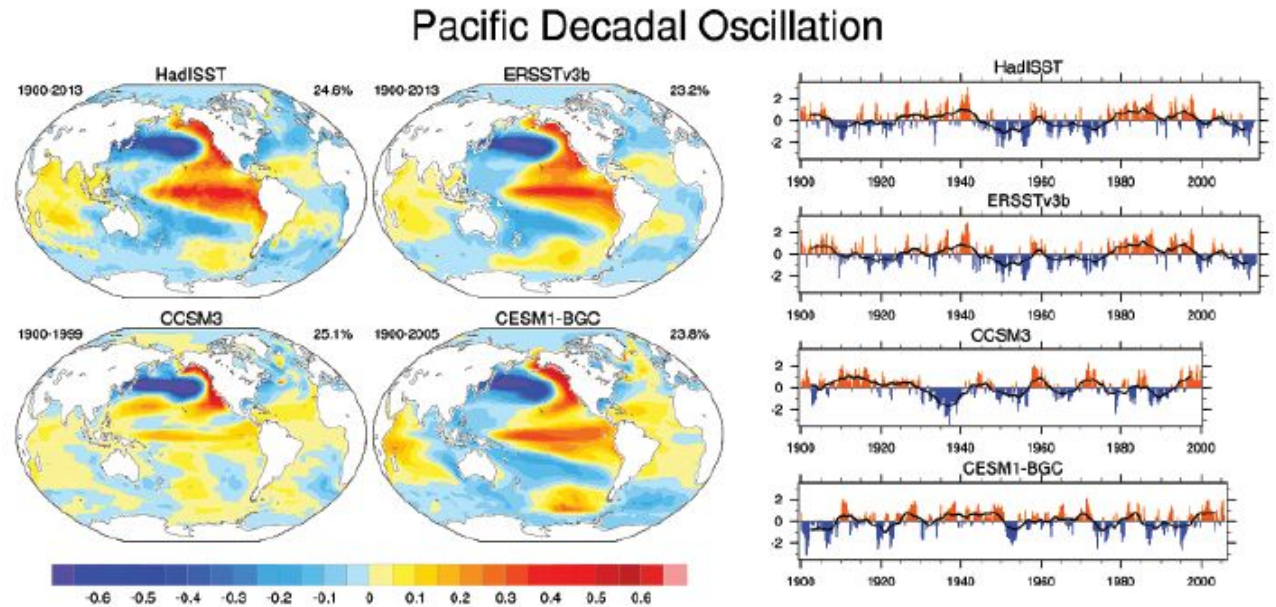
The Climate Variability Diagnostics Package (CVDP) is a diagnostics tool developed in CGD's Climate Analysis Section that is designed to help automatically generate diagnostics related to various modes of variability in a CESM run. There is also a large ensemble version (CVDP-LE) that can do the same 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?**

