



CESM Diagnostics Lab

Turning numbers into pictures (and other numbers)

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Lab Goals

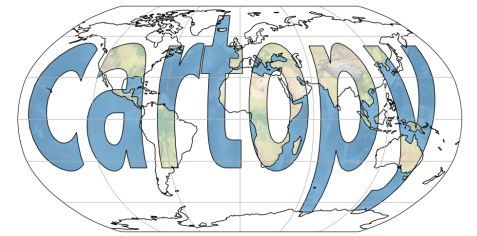
- Learn about (geoscientific) python.
- Successfully run Jupyter notebooks on OnDemand.
- Visualize CESM model output
- Learn about diagnostic software being developed at NCAR, including CUPiD, which will be CESM3's default post-processing and diagnostics package, and UXarray, which is a version of Xarray that can handle unstructured grids.

Python

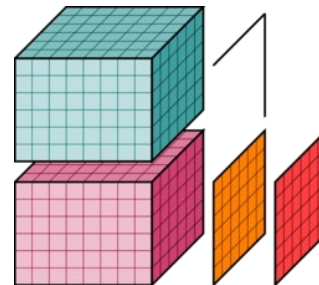
The analysis of CESM output is mostly done in a python ecosystem here at CGD.

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



uxarray

Jupyter and OnDemand

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.

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

Also please note that OnDemand can be used to run other services as well (so feel free to explore). However for this tutorial we are just using Jupyter.



OPEN

 **nDemand**

OnDemand Jupyter login process

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1. Occasionally OnDemand will keep your request in the queue permanently if there is another Jupyter session already running. If that is the case then you might need to end both sessions and try again.

The CESM Unified Postprocessing and Diagnostics (CUPiD) system is a new, push-button diagnostics system which will automatically produce diagnostic output for all CESM3 components for any given CESM3 run.

There is a CUPiD notebook available to try in the official diagnostics exercises. You can also learn more about CUPiD on Github here:

<https://github.com/NCAR/CUPiD.git>



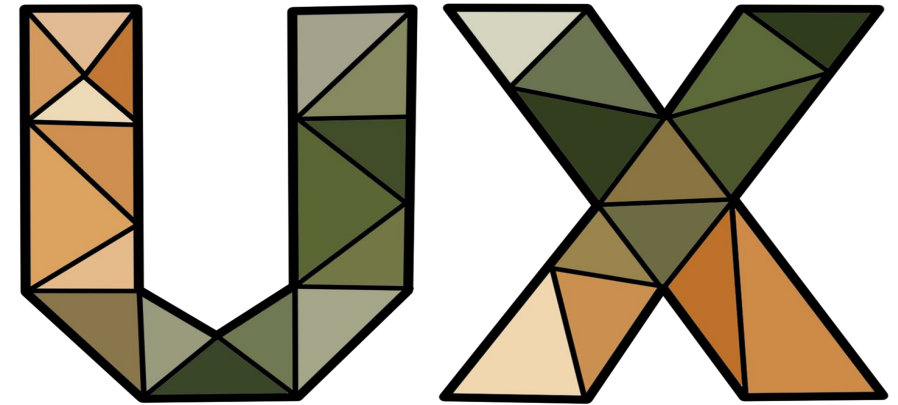
Advanced topics - UXarray

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”. UXarray is also used in the “Basic Land Model plotting” notebook.



Advanced topics - CVDP

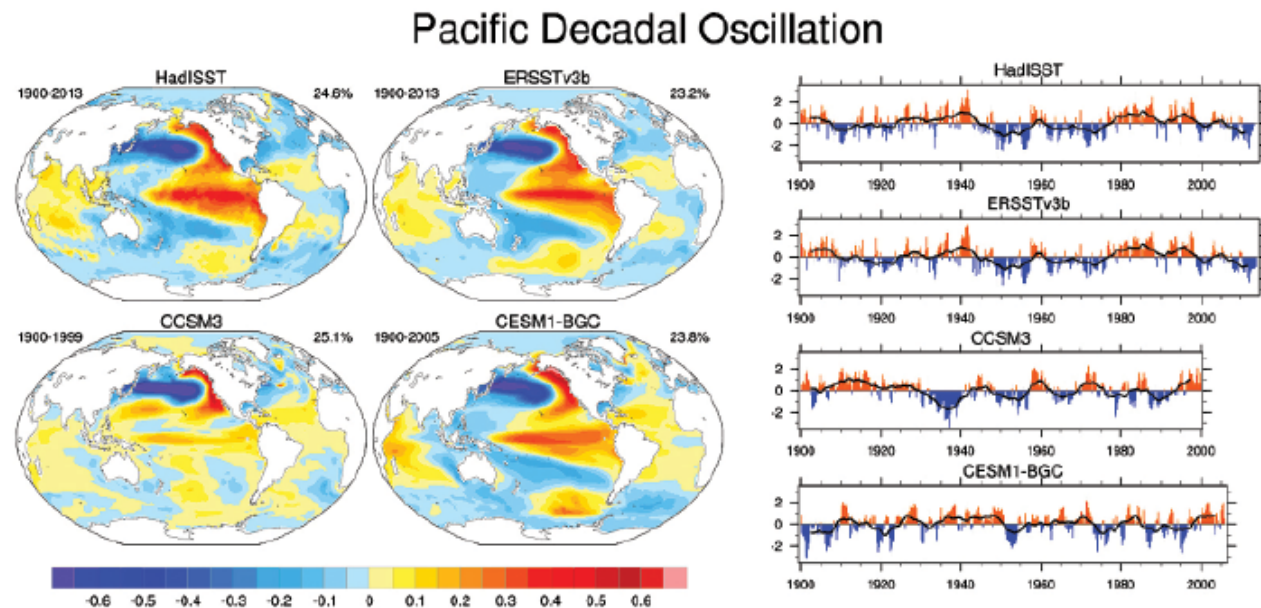
The Climate Variability Diagnostics Package (CVDP) is a diagnostics tool developed in CGD's Climate Analysis Section that is designed to help automatically generate diagnostics related to various modes of variability in a CESM run. There is also a large ensemble version (CVDP-LE) that can do the same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

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?

