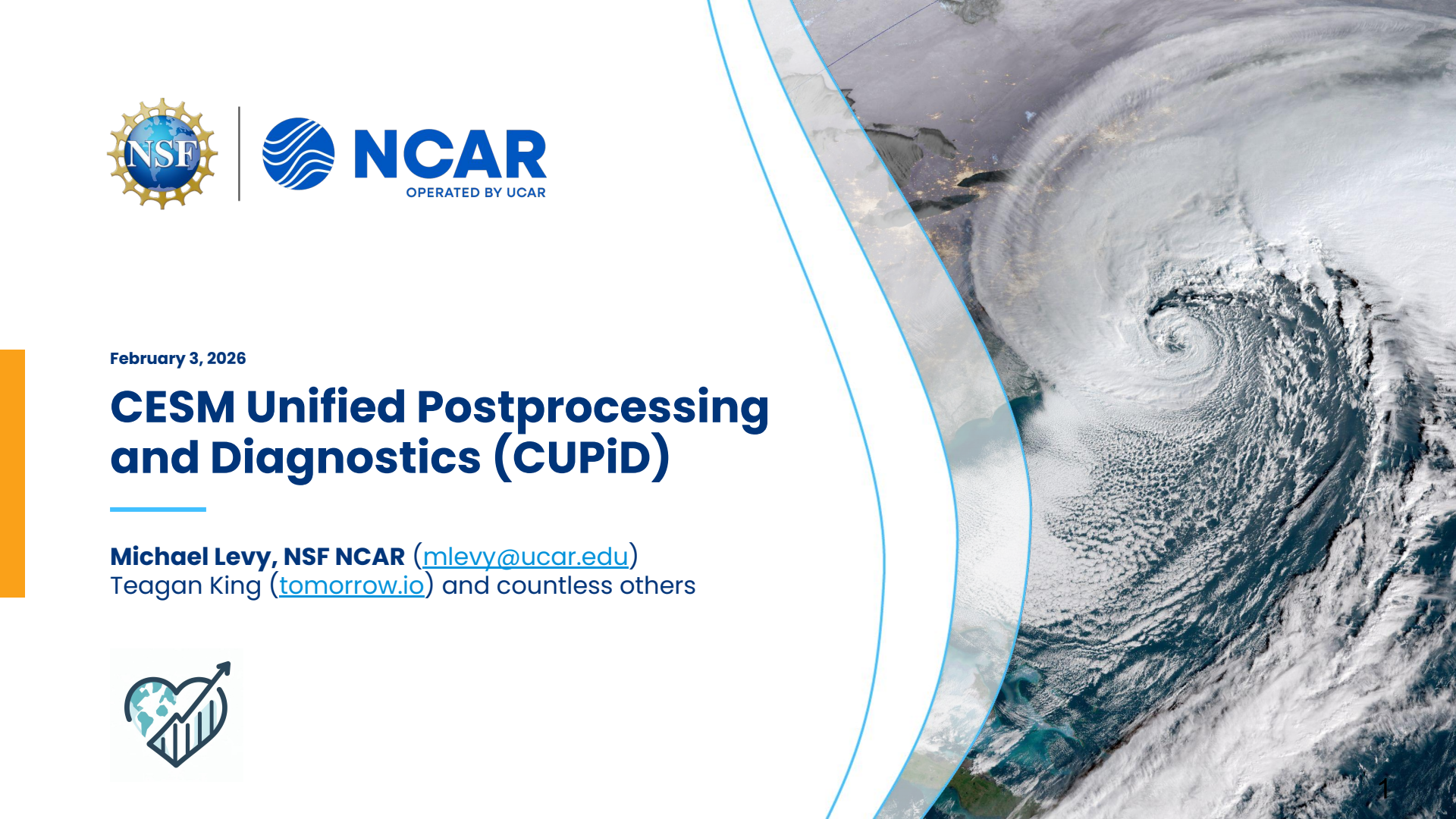


February 3, 2026

CESM Unified Postprocessing and Diagnostics (CUPiD)

Michael Levy, NSF NCAR (mlevy@ucar.edu)
Teagan King (tomorrow.io) and countless others

[Likely Incomplete] List of Collaborators

AMP: Dani Coleman, Cecile Hannay, Christina McCluskey, Brian Medeiros, Jesse Nusbaumer, Justin Richling

CAS: John Fasullo, Adam Phillips, Isla Simpson

CESM: Dave Lawrence, Brian Dobbins

ESDS: Katie Dagon, Teagan King, Mike Levy

ESMF: Bill Sacks

GeoCAT (CISL): Orhan Eroglu, Katelyn FitzGerald, Anissa Zacharias

OS: Anna Deppenmeier, Gustavo Marques, Lev Romashkov

PPC: Dave Bailey, Alice DuVivier, Kate Thayer-Calder, Feng Zhu

TSS: Meg Fowler, Sam Levis, Naoki Mizukami, Sam Rabin, Will Wieder

Students/Interns: Macy Callahan, Ingrid Carlson, Cameron Cummins, Aidan Janney, Shivani Kumar, Hilary Lam, Jasmine Turner

Project Vision

CUPiD is a “one stop shop” that enables and integrates timeseries file generation, data standardization, diagnostics, and metrics from all CESM components.

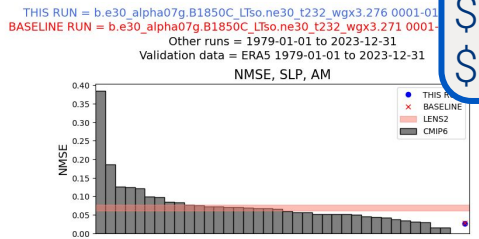
This collaborative effort aims to simplify the user experience of running diagnostics by calling post-processing tools directly from CUPiD, running all component diagnostics from the same tool as either part of the CIME workflow or independently, and sharing python code and a standard conda environment across components.

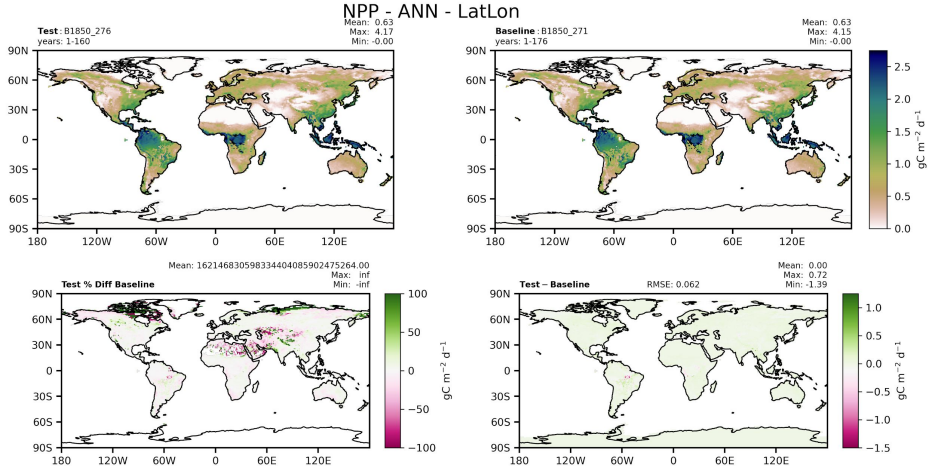
Current Status

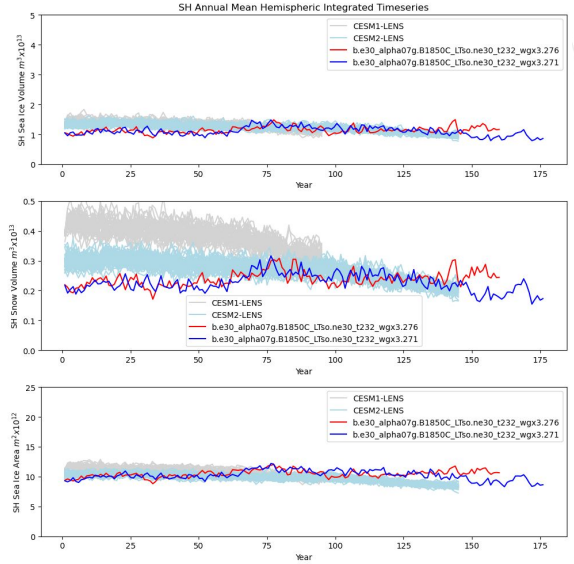
- [x] Key metrics for most components which can run in parallel
- [x] External diagnostic packages
- [x] Command line arguments
- [x] Common environment
- [x] Documentation
- [x] Part of CESM Workflow
- [ ] CMORization of CESM output
- [ ] Support for machines other than Casper / Derecho

How Can I Use CUPiD? (Standalone Example)

```
$ cd CUPiD/examples/key_metrics
$ cupid-diagnostics  # runs notebooks
$ cupid-webpage      # builds website
```

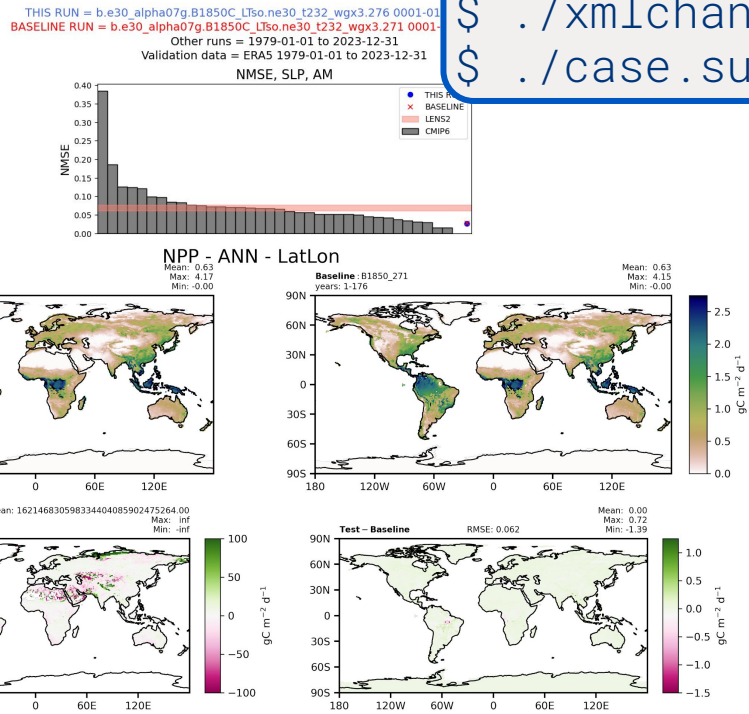






How Can I Use CUPiD? (CESM Workflow)

```
$ ./xmlchange RUN_POSTPROCESSING=TRUE
$ ./xmlchange CUPID_...
$ ./case.submit [--only-job case.cupid]
```



Atmosphere Success Story (NMSE Notebook)

CESM Key Metrics

Search ⌘ + K

Atmosphere

SLP (NMSE)

ADF

CVDP

Land

Land-atmosphere coupling indices & Observational Data Comparison

LDF

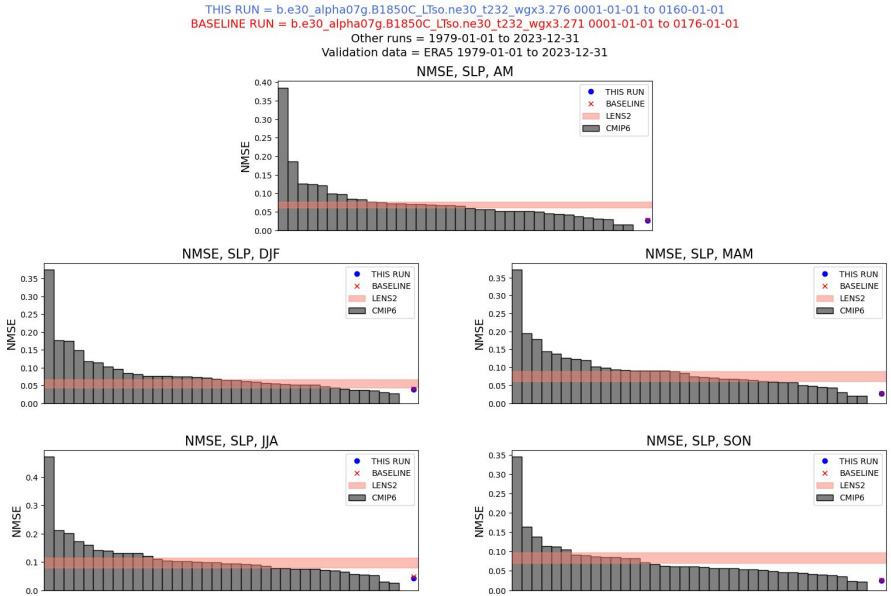
Sea Ice

Sea Ice Diagnostics and LENS comparison

River Runoff

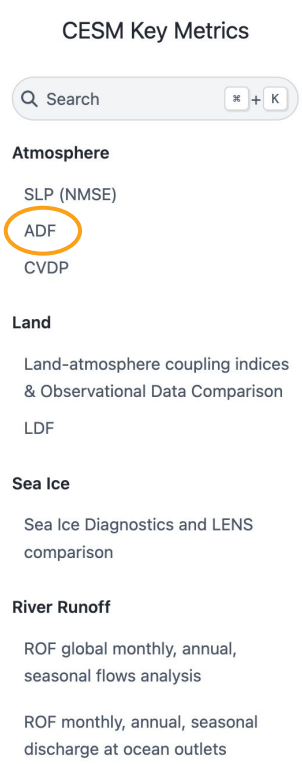
ROF global monthly, annual, seasonal flows analysis

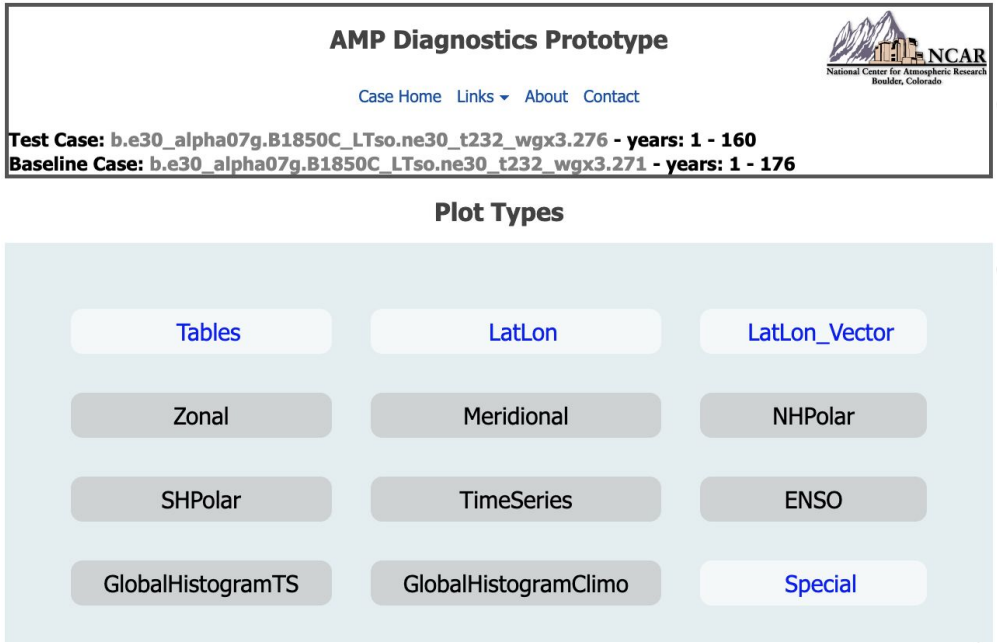
ROF monthly, annual, seasonal discharge at ocean outlets



Isla Simpson gave us a notebook to compute the normalized mean square error of fields

Atmosphere Success Story (ADF)





Justin Richling and Jesse Nusbaumer helped get ADF running through CUPiD

Atmosphere Success Story (ADF)

CESM Key Metrics

Search ⌘ + K

Atmosphere

SLP (NMSE)

ADF

CVDP

Land

Land-atmosphere coupling indices & Observational Data Comparison

LDF

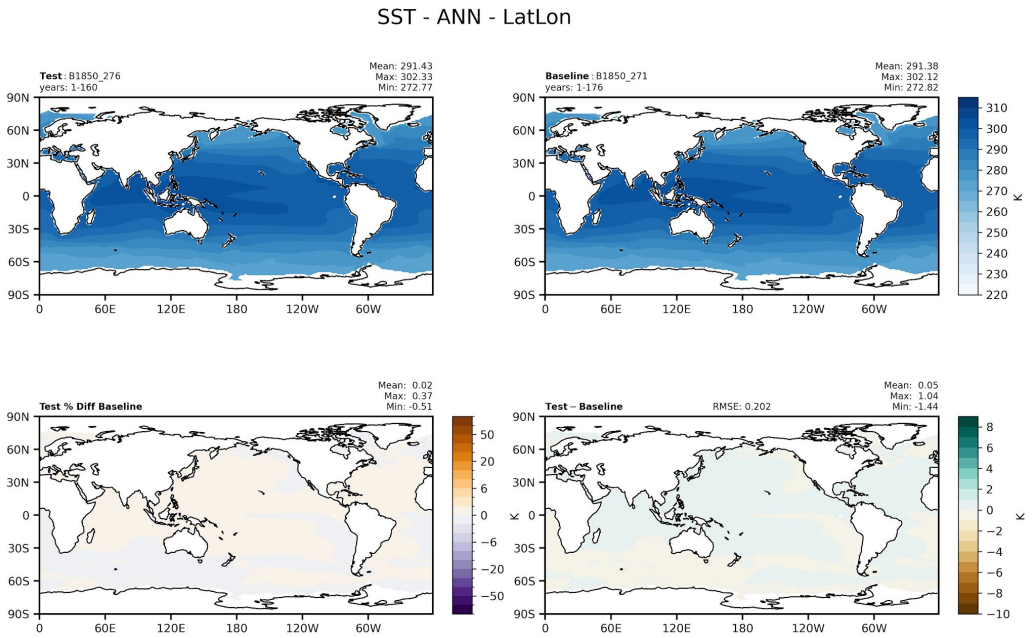
Sea Ice

Sea Ice Diagnostics and LENS comparison

River Runoff

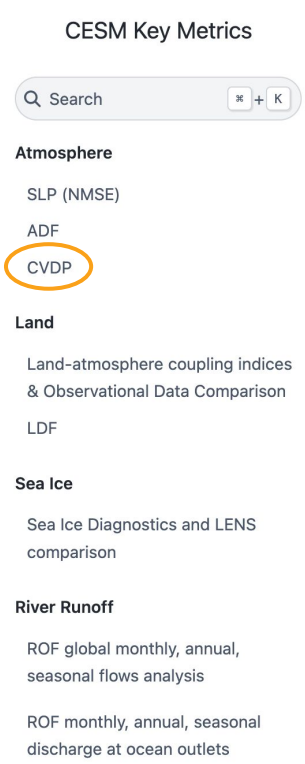
ROF global monthly, annual, seasonal flows analysis

ROF monthly, annual, seasonal discharge at ocean outlets



Justin Richling and Jesse Nusbaumer helped get ADF running through CUPiD

Atmosphere Success Story (CVDP via ADF)



NCAR UCAR | CGD's Climate Analysis Section
Climate Variability Diagnostics Package

Methodology and Definitions
Metrics Tables: Pattern Correlations | RMS
Namelists: Input | Derived
Climatological Period Used: Full
Created: Mon Jan 5 04:23:09 PM MST 2026
CVDP Version 5.2.0

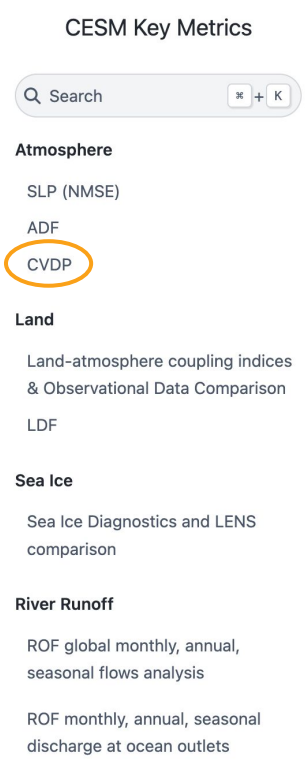
ADF/CVDP Comparison

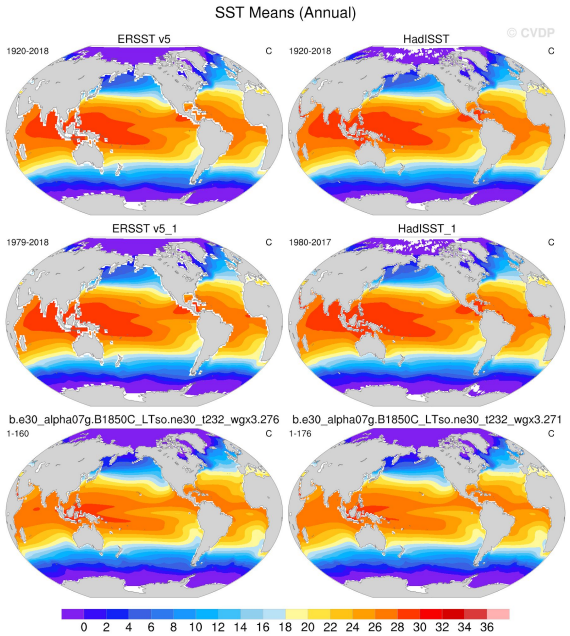
Means

SST	DJF	MAM	JJA	SON	Annual
TAS	DJF	MAM	JJA	SON	Annual
PSL	DJF	MAM	JJA	SON	Annual
PR	DJF	MAM	JJA	SON	Annual
[PR]	DJF	MAM	JJA	SON	Annual
SND	DJF	MAM	JJA	SON	Annual
SIC NH	DJF	MAM	JJA	SON	Annual
SIC SH	DJF	MAM	JJA	SON	Annual

Adam Phillips helped get CVDP running through the ADF (via CUPiD)

Atmosphere Success Story (CVDP via ADF)

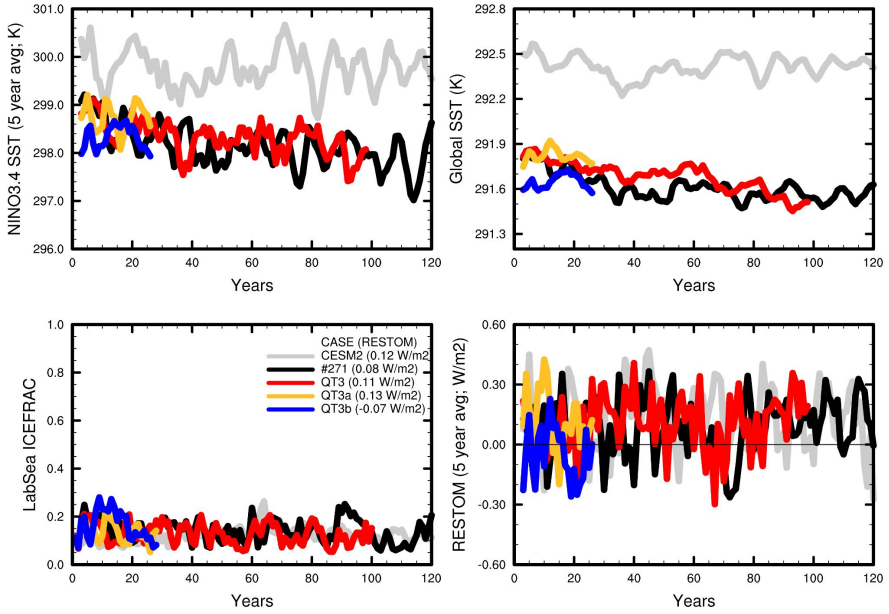




Adam Phillips helped get CVDP running through the ADF (via CUPiD)

Future Atmosphere Success Story

Every week Adam Herrington shares a version of this plot at the CESM Project meeting and I should talk to him about bringing it in to CUPiD

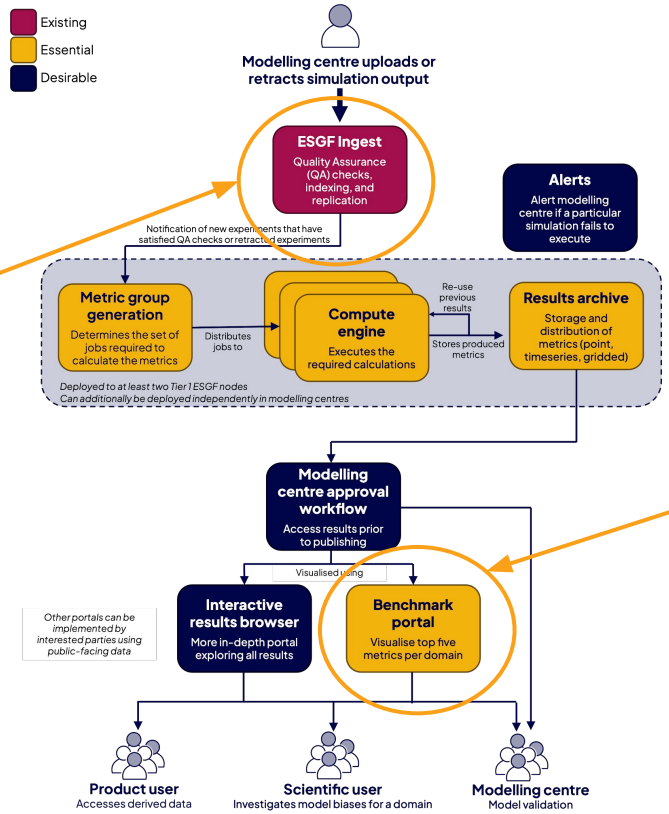


Future Work

- Atmosphere-specific
  - ➢ Notebooks that provide metrics from forcing datasets, not just model output (had some issues with emissions datasets in the past)
  - ➢ CUPiD in stand-alone CAM release?
- General CUPiD features
  - ➢ Support CMIP Rapid Evaluation Framework (REF)
  - ➢ Quick-look functionality: small “top metric” suite that isn’t computationally expensive
- v1.0 release
  - ➢ Better remapping, integration with CMORization, and other features (TBD)

Future Work (CMIP REF)

Data Standardization?



Top Metrics Example?

Summary

- CUPiD is a framework for postprocessing CESM output and generating diagnostic plots / tables
- It can be run as part of the CESM Workflow [not shown in this talk], or launched by hand after a run has been completed
- Can run individual jupyter notebooks or external packages (e.g. ADF and CVDP)
- Contributions are always welcome!
  - ➢ https://github.com/NCAR/CUPiD
  - ➢ https://ncar.github.io/CUPiD/
- Bug reports are also always welcome (it's a work in progress)
  - ➢ SEWG Winter Meeting (March 5/6) is a hackathon, will include CUPiD projects