

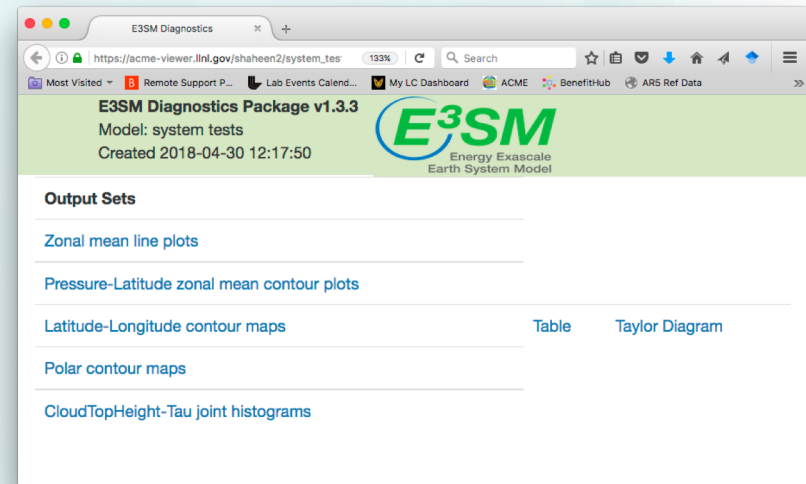


E3SM Diagnostics Package (e3sm_diags) 2018 Tutorial

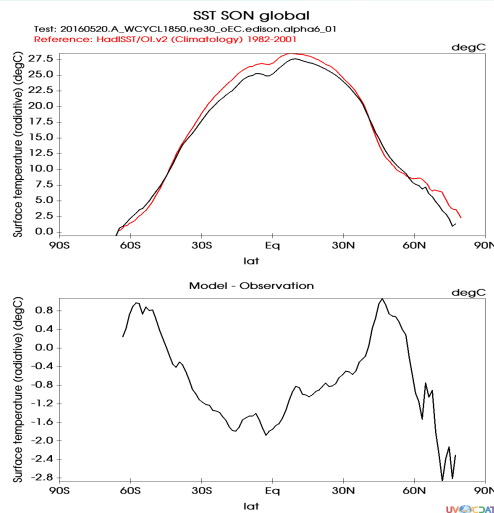
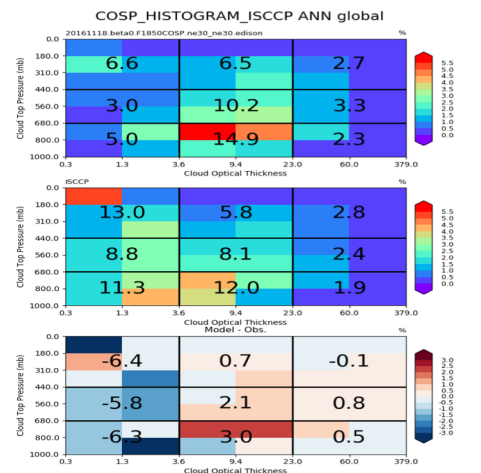
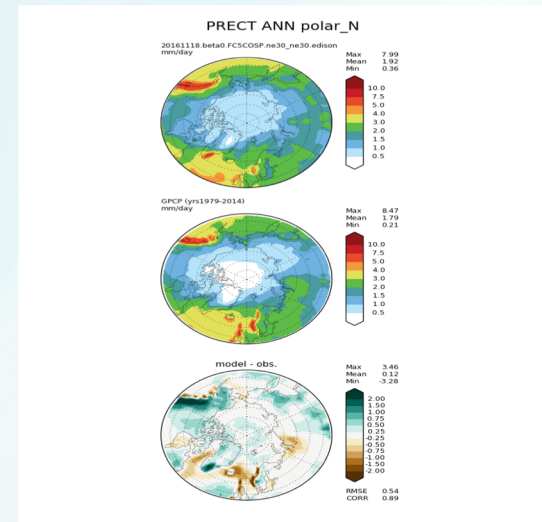
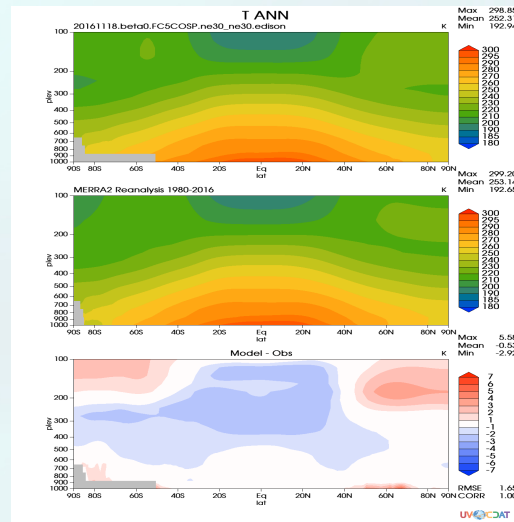
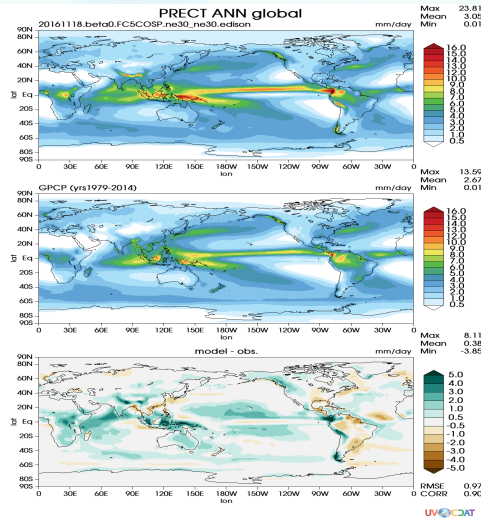
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Introduction

- A **modern, Python-based** diagnostics package for evaluating earth system models.
- Modeled after NCAR's atmosphere diagnostics package with added features:
 - ✓ Flexible to add new observational datasets/diagnostics.
 - ✓ Modifiable figures.
 - ✓ Easier installation, configuration, and execution.
 - ✓ Runs faster using multi-processing .
- Maintain an **updated** observational data repository.
- A **community tool** that accommodates CMIP convention.



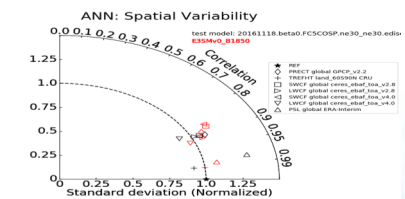
Current Status: Diagnostics Sets



Model Name: 20161118.beta0.FC5COSP.ne30_ne30.edison

ANN Mean

| Variables | Unit | Test | Mean | Ref. | Mean | Bias | STD | Ref. | STD | RMSE | Correlation |
|-----------------------------------|---------------|---------|---------|--------|--------|--------|--------|-------|-----|------|-------------|
| PRECt global GPCP_v2.2 | mm/day | 3.051 | 2.673 | 0.377 | 2.104 | 1.622 | 0.973 | 0.905 | | | |
| TREFFT land_AERONN CPU | degC | 12.953 | 12.859 | 0.095 | 12.105 | 13.089 | 1.892 | 0.992 | | | |
| SST global HadISST_CL | degC | 20.067 | 20.123 | -0.056 | 8.274 | 8.313 | 6.195 | 1.0 | | | |
| SST global HadISST_PI | degC | 20.069 | 19.711 | 0.358 | 8.373 | 8.291 | 0.482 | 0.999 | | | |
| SST global HadISST_PIO | degC | 20.067 | 20.212 | -0.144 | 8.274 | 8.332 | 0.286 | 1.0 | | | |
| SOLAR global cores_ahaf_nu_v2.8 | Wm2 | 340.369 | 340.394 | 0.266 | 72.731 | 72.819 | 0.526 | 1.0 | | | |
| ALBEDO global cores_ahaf_nu_v2.8 | dimensionless | 0.317 | 0.315 | 0.002 | 0.125 | 0.119 | 0.027 | 0.977 | | | |
| ALBEDO global cores_ahaf_nu_v2.8 | dimensionless | 0.169 | 0.172 | -0.004 | 0.12 | 0.124 | 0.02 | 0.988 | | | |
| REISTOM global cores_ahaf_nu_v2.8 | Wm2 | 0.903 | 0.813 | 0.09 | 54.831 | 54.804 | 0.763 | 0.99 | | | |
| FLUT global cores_ahaf_nu_v2.8 | Wm2 | 239.761 | 239.761 | 0.001 | 31.337 | 29.632 | 1.897 | 0.983 | | | |
| FLUT global cores_ahaf_nu_v2.8 | Wm2 | 264.276 | 264.276 | 0.001 | 1.439 | 29.687 | 29.683 | 0.993 | | | |
| PINTAC global cores_ahaf_nu_v2.8 | Wm2 | 240.527 | 240.574 | -0.047 | 81.626 | 79.959 | 0.987 | 0.994 | | | |
| PINTAC global cores_ahaf_nu_v2.8 | Wm2 | 284.884 | 287.709 | -1.175 | 82.841 | 81.94 | 0.606 | 0.998 | | | |
| RWCF global cores_ahaf_nu_v2.8 | Wm2 | -48.387 | -47.136 | -1.251 | 21.497 | 20.338 | 0.386 | 0.902 | | | |
| RWCF global cores_ahaf_nu_v2.8 | Wm2 | 24.484 | 23.974 | 0.51 | 11.374 | 11.057 | 0.201 | 0.9 | | | |
| REISTOM global cores_ahaf_nu_v2.8 | Wm2 | -23.863 | -21.162 | -2.701 | 14.605 | 14.994 | 0.177 | 0.864 | | | |
| ALBEDO global cores_ahaf_nu_v4.0 | dimensionless | 0.317 | 0.314 | 0.003 | 0.125 | 0.12 | 0.027 | 0.976 | | | |
| ALBEDO global cores_ahaf_nu_v4.0 | dimensionless | 0.169 | 0.175 | -0.006 | 0.12 | 0.122 | 0.019 | 0.989 | | | |
| REISTOM global cores_ahaf_nu_v4.0 | Wm2 | 0.903 | 0.852 | 0.051 | 54.831 | 55.966 | 0.717 | 0.991 | | | |
| FLUT global cores_ahaf_nu_v4.0 | Wm2 | 239.761 | 240.226 | -0.475 | 31.337 | 29.73 | 0.844 | 0.983 | | | |
| FLUT global cores_ahaf_nu_v4.0 | Wm2 | 264.276 | 268.248 | -3.973 | 29.647 | 31.239 | 0.187 | 0.993 | | | |
| PINTAC global cores_ahaf_nu_v4.0 | Wm2 | 240.527 | 241.108 | -0.581 | 81.626 | 80.987 | 0.183 | 0.994 | | | |
| PINTAC global cores_ahaf_nu_v4.0 | Wm2 | 284.884 | 286.92 | -1.964 | 82.841 | 82.883 | 0.493 | 0.998 | | | |
| REISTOM global cores_ahaf_nu_v4.0 | Wm2 | -23.863 | -20.612 | -3.252 | 14.605 | 15.235 | 0.235 | 0.874 | | | |



How to Run

Run: `e3sm_diags -p myparams.py [-d mydiags.cfg]`

A Python script: myparams.py

```
reference_data_path = '/space1/obs_data_20140804/'
test_data_path = '/space/golaz1/acme_simulations/'
test_name = '20160520.A_WCYCL1850.ne30_oEC.edison.alpha6_01'
sets = ['lat_lon']
Seasons = ["ANN", "DJF", "JJA"]
multiprocessing = True
num_workers = 6
```

A cfg script: mydiags.cfg

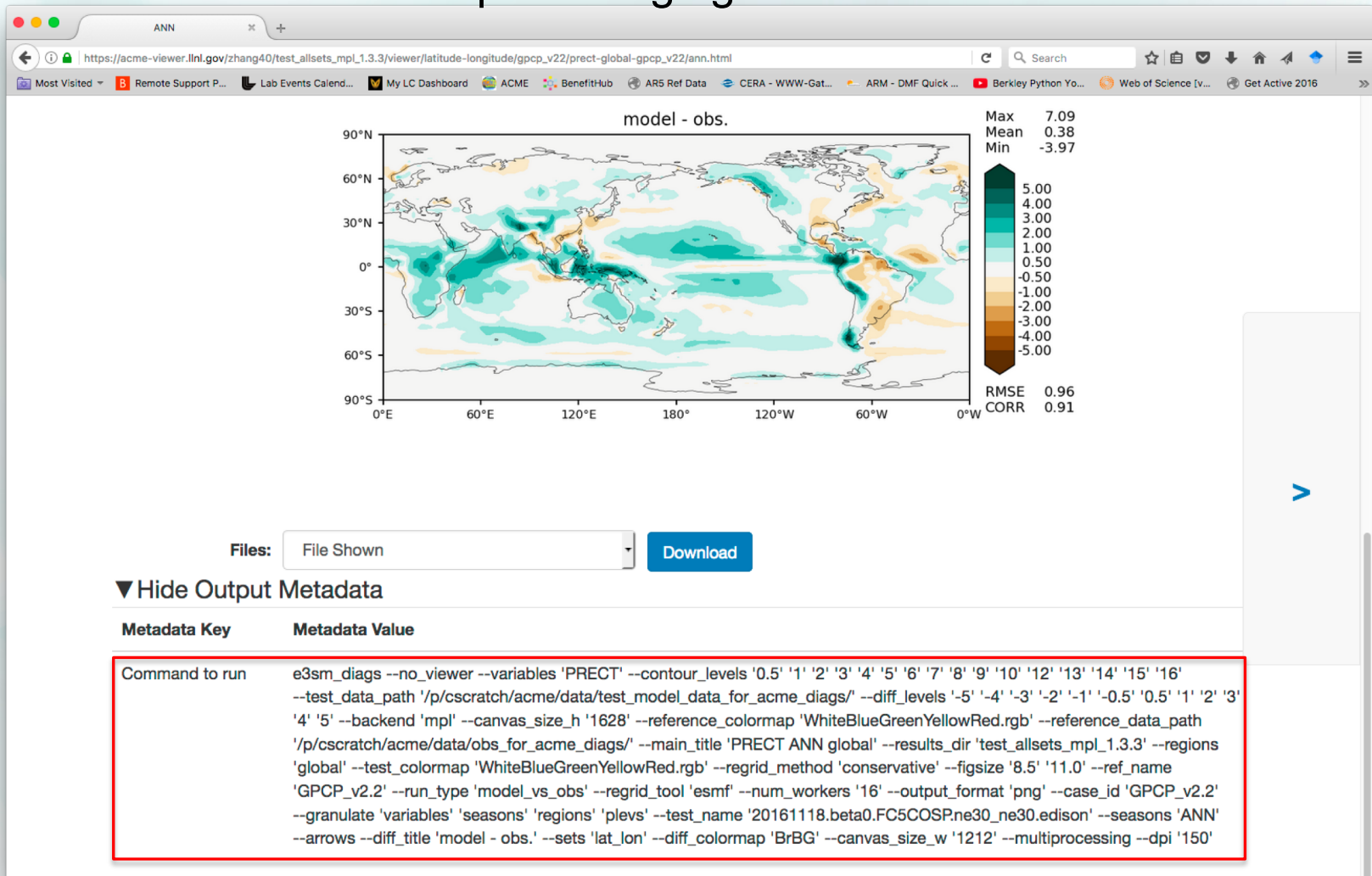
```
[description]
case_id = "GPCP_v2.3"
variables = ["PRECT"]
ref_name = "GPCP_v2.3"
reference_name = "GPCP precipitation"
regions = ["global", "ocean_TROPICS", "TRMM_region"]
diff_colormap = "BrBG"
contour_levels = [0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 16]
diff_levels = [-5, -4, -3, -2, -1, -0.5, 0.5, 1, 2, 3, 4, 5]
```


Useful Parameters

- Main parameters:
 - Sets to run: ['zonal_mean_xy', 'zonal_mean_2d', 'lat_lon', 'polar', 'cosp_histogram']
 - Seasons: ["ANN", "DJF", "MAM", "JJA", "SON"]
 - Regions: ["global", "ocean_TROPICS", "TRMM_region"] # Can add more
 - Pressure levels: [850.0, 200.0]
 - Regrid tool: **'esmf'** ; with Regrid method: 'linear', **'conservative'**
 - Save Netcdf: True, **False**
 - Multi-processing: True, **False**; with Number of Workers: **4**
- Plotting parameters:
 - Backend: vcs, matplotlib
 - Output format: **png**, pdf, svg
 - Colormaps: 'cet_rainbow.rgb'
 - Contour levels: [0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16]
- All available parameters: https://e3sm-project.github.io/acme_diags/docs/html/available-parameters.html

New: More Provenance Saved

- For running the package:
 - Command line for reproducing figures.



New: More Provenance Saved

- For **running the package**:
 - Command line for reproducing figures.
 - Data (optional) and metrics of resulting diagnostics.
 - Environment and configuration files.
- For **analysis datasets**:
 - Original data and processing script for analysis datasets.

New: Containerization (v1.5.0)

- e3sm_diags can now be ran as a container.
- Containerization technology allows a process and its dependencies to run in isolation.
 - Further simplify user's installation process.
 - Avoid unexpected installation failure.
 - Help with distributing the software across various machines.
- Run with a container on **NERSC Edison**:
 - Download the container and auxiliary script.
 - Run using: `e3sm_diags_container.py --shifter -p params.py`
 - Quickstart guide on documentation website.
- Alternative installation: **conda env** and **e3sm_unified**

New: Analysis datasets in time series (v1.6.0, coming soon)

| Data sets | Years Available | Climatology | Time series |
|--------------------------------|-----------------|-------------|-------------|
| GPCP2.3 | 1979 - 2017 | ✓ | ✓ |
| WHOI-OAFlux | 1979 - 2013 | ✓ | ✓ |
| HadISST | 1870 - 2016 | ✓ | ✓ |
| CERES-EBAF TOA 2.8 and 4.0 | 2001 - 2015 | ✓ | ✓ |
| CERES-EBAF Surface 2.8 and 4.0 | 2001 - 2015 | ✓ | ✓ |
| MERRA2 | 1980 - 2016 | ✓ | ✓ |
| ERA-Interim | 1979 - 2016 | ✓ | ✓ |
| AERONET AOD 550nm | N/A | ✓ | x |

* CRU_IPCC, cloud simulators related[COSP], SSMI data are from AMWG package.

New: Support time-series input (v1.6.0, coming soon)

In addition to climo files, time-series as input data, allowing for **user-specified years**:

- Ex: Compare years averaged (2001-2016) and (1850-1865) from the **same model run**.
- Ex: Compare 1980 climatology between **model and obs**.
- Climate variability diagnostics.
- Applicable to monthly time series from any **CMIP** class models data archived on ESGF.

Example Use Cases

Available as Jupyter Notebooks

- **Documentation website** (https://e3sm-project.github.io/e3sm_diags/docs/html/index.html)
- Jupyter notebooks with **climatology file** as input:
 - [Model vs Obs](#)
 - [Model vs Model](#)
- Jupyter notebooks with **time-series files** as input (coming soon):
 - Model vs Model
 - Model vs Obs
- Example output:
 - Documentation Site -> Examples
 - [historical_H1 avg \(2011-2013\) vs historical_H1 avg \(1850-1852\)](#)

Thank you!

- Please try it out and give us your feedback 😊

GitHub: https://github.com/E3SM-Project/e3sm_diags