Diagnostics Package for the E3SM MODEL

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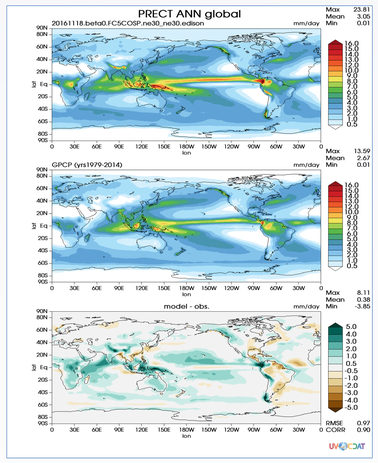
Objective

A comprehensive diagnostics package that:

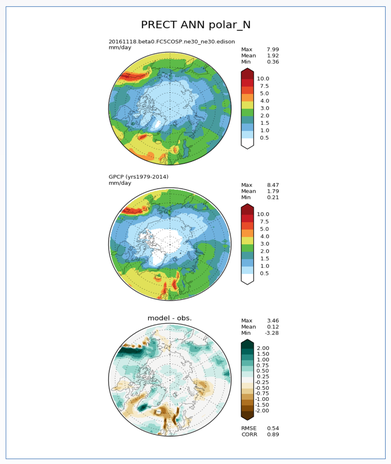
- **Developed in Python**
- **Fully implements** the functionality of AMWG diagnostics package
- Delivers **valuable diagnostics** developed from E3SM to the community
- Maintains repo for most **updated observational datasets**, including remote sensing, reanalysis and in-situ datasets
- Is **flexible** for adding user-specified diagnostics
- Interacts effectively with the **PCMDI**'s metrics package PMP and the **ARM** diagnostics package through a unified framework: **Community Diagnostics Package (CDP)**.

Current Diagnostics Sets

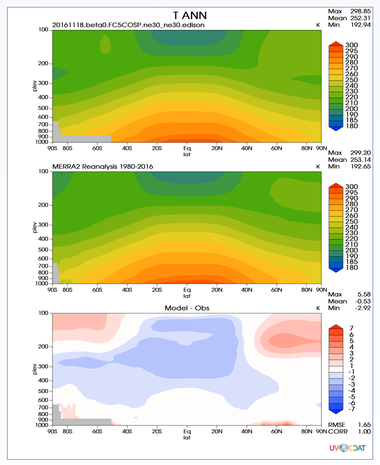
Latitude-Longitude Map



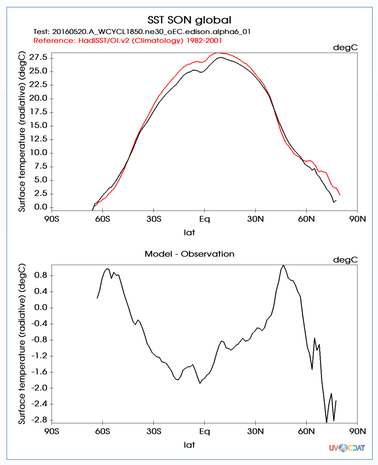
Polar Projection



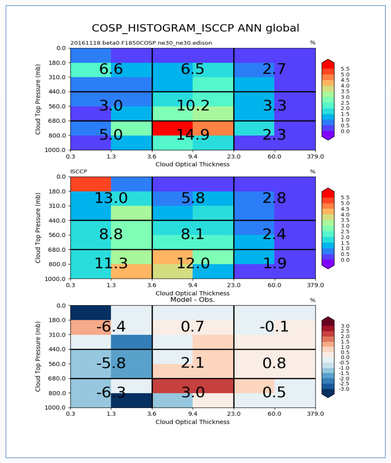
Zonal Mean Contour



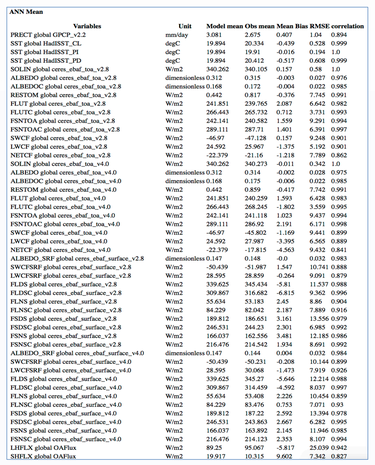
Zonal Mean Line



CloudTopHeight vs tau



Summary Table



ANN Mean

Variables	Unit	Model mean	Obs mean	Mean Bias	RMSE	correlation
PRECT global GPCP_v2.2	mm/day	3.081	2.675	0.407	1.04	0.894
SST global HadISST_CL	degC	19.894	20.334	-0.439	0.528	0.999
SST global HadISST_PI	degC	19.894	19.91	-0.016	0.194	1.0
SST global HadISST_PD	degC	19.894	20.412	-0.517	0.608	0.999
SOLIN global ceres_ebaf_toa_v2.8	W/m2	340.262	340.105	0.157	0.58	1.0
ALBEDO global ceres_ebaf_toa_v2.8	dimensionless	0.312	0.315	-0.003	0.027	0.976
ALBEDOC global ceres_ebaf_toa_v2.8	dimensionless	0.168	0.172	-0.004	0.022	0.985
RESTOM global ceres_ebaf_toa_v2.8	W/m2	0.442	0.817	-0.376	7.745	0.991
FLUT global ceres_ebaf_toa_v2.8	W/m2	241.851	239.765	2.087	6.642	0.982
FLUTC global ceres_ebaf_toa_v2.8	W/m2	266.443	265.732	0.712	3.731	0.993
FSNTOA global ceres_ebaf_toa_v2.8	W/m2	242.141	240.582	1.559	9.291	0.994
FSNTOAC global ceres_ebaf_toa_v2.8	W/m2	289.111	287.71	1.401	6.391	0.997
SWCF global ceres_ebaf_toa_v2.8	W/m2	-46.97	-47.128	0.157	9.248	0.901
LWCF global ceres_ebaf_toa_v2.8	W/m2	24.592	25.967	-1.375	5.192	0.901
NETCF global ceres_ebaf_toa_v2.8	W/m2	-22.379	-21.16	-1.218	7.789	0.862
SOLIN global ceres_ebaf_toa_v4.0	W/m2	340.262	340.273	-0.011	0.342	1.0
ALBEDO global ceres_ebaf_toa_v4.0	dimensionless	0.312	0.314	-0.002	0.028	0.975
ALBEDOC global ceres_ebaf_toa_v4.0	dimensionless	0.168	0.175	-0.006	0.022	0.985
RESTOM global ceres_ebaf_toa_v4.0	W/m2	0.442	0.859	-0.417	7.742	0.991
FLUT global ceres_ebaf_toa_v4.0	W/m2	241.851	240.259	1.593	6.428	0.983
FLUTC global ceres_ebaf_toa_v4.0	W/m2	266.443	268.245	-1.802	3.559	0.995
FSNTOA global ceres_ebaf_toa_v4.0	W/m2	242.141	241.118	1.023	9.437	0.994
FSNTOAC global ceres_ebaf_toa_v4.0	W/m2	289.111	286.92	2.191	6.171	0.998
SWCF global ceres_ebaf_toa_v4.0	W/m2	-46.97	-45.802	-1.169	9.441	0.899
LWCF global ceres_ebaf_toa_v4.0	W/m2	24.592	27.987	-3.395	6.565	0.889
NETCF global ceres_ebaf_toa_v4.0	W/m2	-22.379	-17.815	-4.563	9.432	0.841
ALBEDO_SRF global ceres_ebaf_surface_v2.8	dimensionless	0.147	0.148	-0.0	0.032	0.983
SWCFSRF global ceres_ebaf_surface_v2.8	W/m2	-50.439	-51.987	1.547	10.741	0.888
LWCFSRF global ceres_ebaf_surface_v2.8	W/m2	28.595	28.859	-0.264	9.091	0.879
FLDS global ceres_ebaf_surface_v2.8	W/m2	339.625	345.434	-5.81	11.537	0.988
FLDSC global ceres_ebaf_surface_v2.8	W/m2	309.867	316.682	-6.815	9.362	0.996
FLNS global ceres_ebaf_surface_v2.8	W/m2	55.634	53.183	2.45	8.86	0.904
FLNSC global ceres_ebaf_surface_v2.8	W/m2	84.229	82.042	2.187	7.889	0.916
FSDS global ceres_ebaf_surface_v2.8	W/m2	189.812	186.651	3.161	13.556	0.979
FSDSC global ceres_ebaf_surface_v2.8	W/m2	246.531	244.23	2.301	6.985	0.992
FSNS global ceres_ebaf_surface_v2.8	W/m2	166.037	162.556	3.481	12.185	0.986
FSNSC global ceres_ebaf_surface_v2.8	W/m2	216.476	214.542	1.934	8.691	0.992
ALBEDO_SRF global ceres_ebaf_surface_v4.0	dimensionless	0.147	0.144	0.004	0.032	0.984
SWCFSRF global ceres_ebaf_surface_v4.0	W/m2	-50.439	-50.231	-0.208	10.144	0.899
LWCFSRF global ceres_ebaf_surface_v4.0	W/m2	28.595	30.068	-1.473	7.919	0.926
FLDS global ceres_ebaf_surface_v4.0	W/m2	339.625	345.27	-5.646	12.214	0.988
FLDSC global ceres_ebaf_surface_v4.0	W/m2	309.867	314.459	-4.592	8.037	0.997
FLNS global ceres_ebaf_surface_v4.0	W/m2	55.634	53.408	2.226	10.454	0.859
FLNSC global ceres_ebaf_surface_v4.0	W/m2	84.229	83.476	0.753	7.071	0.93
FSDS global ceres_ebaf_surface_v4.0	W/m2	189.812	187.22	2.592	13.394	0.978
FSDSC global ceres_ebaf_surface_v4.0	W/m2	246.531	243.863	2.667	6.282	0.995
FSNS global ceres_ebaf_surface_v4.0	W/m2	166.037	163.892	2.145	11.946	0.985
FSNSC global ceres_ebaf_surface_v4.0	W/m2	216.476	214.123	2.353	8.107	0.994
LHFLX global OAFlux	W/m2	89.25	95.067	-5.817	25.039	0.942
SHFLX global OAFlux	W/m2	19.917	10.315	9.602	7.342	0.827

GitHub Our github repo:https://github.com/ACME-Climate/acme_diags

Note: E3SM model is formerly known as ACME

Features

Feature: Clean and simple design

Feature: Flexible configuration.

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

A python script: myparams.py

```
#required settings
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"]
Backend = 'mpl'

# optional settings below
diff_title = 'Model - Obs'
results_dir = 'lat_lon_demo' # name of folder to store
result
seasons = ["ANN", "DJF"]
# Multiprocessing
multiprocessing = True
num_workers = 4
save_netcdf = True     #default to False
```

A cfg/json script: mydiags.cfg

```
[Diags]
#required settings
case_id = "GPCP_v2.2"
variables = ["PRECT"]
ref_name = "GPCP_v2.2"
seasons = ["ANN", "DJF"]
reference_name = "GPCP (yrs1979-2014)"

# optional settings below

regions = ["global"]
test_colormap = "WhiteBlueGreenYellowRed.rgb"
reference_colormap = "WhiteBlueGreenYellowRed.rgb"
diff_colormap = "BrBG"
contour_levels = [0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13,
14, 15, 16]
diff_levels = [-5, -4, -3, -2, -1, -0.5, 0.5, 1, 2, 3, 4, 5]
```

Feature: Flexible for derived variables.

- Derived variables: variable(s) needing preprocessing before calculation. i.e. total precipitation rate [PRECT]
  - PRECT = PRECL + PRECC
  - Unit conversion: into mm/day
  - Name conversion: pr into PRECT
- Built-in derived variables list for E3SM output, adjustable for **CMIP conventions**.
- User expandable in configuration files

Feature: Enhanced color maps and color bar intervals for built-in variables

- https://acme-climate.github.io/acme_diags/docs/html/colormaps.html

User's Guide

Installation and Running:

- Two commands to install:
  - `wget https://raw.githubusercontent.com/ACME-Climate/acme_diags/master/conda/acme_diags_env.yml`
  - `Conda env create -f acme_diags_env.yml`
- Edit scripts for configuration
- Multiple Uses:
  1. Model versus obs, model versus model, obs versus obs
  2. Run single or multiple sets of diagnostics
  3. Run all sets of E3SM diagnostics:
     - `acme_diags_driver.py -p myparam.py`

Documentation website:

https://acme-climate.github.io/acme_diags/docs/html/index.html

Please contact zhang40@llnl.gov or shaheen2@llnl.gov for technical support

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E3SM Energy Exascale Earth System Model

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