

An ARM data-oriented metrics and diagnostics package for climate model evaluation

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Introduction

- Facilitate the use of long time, high frequency ARM data in climate model evaluation
- Provide process-oriented diagnostics to help understand model errors and develop improved physical parameterizations for climate models (e.g., ACME)
- Apply archived CMIP simulations as reference



ARM Data-oriented Diagnostics Package

Pre-processed data summary

- ARM data statistical files: Applied stringent QC treating missing data
- CMIP model database

Interface with model to be evaluated

- Read in data to be evaluated
- Process data into required format

Metrics Calculation: Climate Data Analysis Tools (CDAT)

Statistical analysis include:

- Bias, Standard Deviation, Correlation and Root Mean Square Error...
- Fast Fourier Transform

Visualization: Python matplotlib and UV-CDAT

Diagnostic plots include:

- Taylor Diagram
- Line plots of climatology monthly means
- Harmonic Dial plot for diurnal cycles
- Height vs time contour plots of 3d variables (i.e., Cloud fraction)



Standalone package

- **Mobility**

- Can be run on any platforms with standard Python libraries
- Potential to be used as a module of PCMDI Metrics Package
- Fits different diagnostics needs, i.e. CAPT, ACME

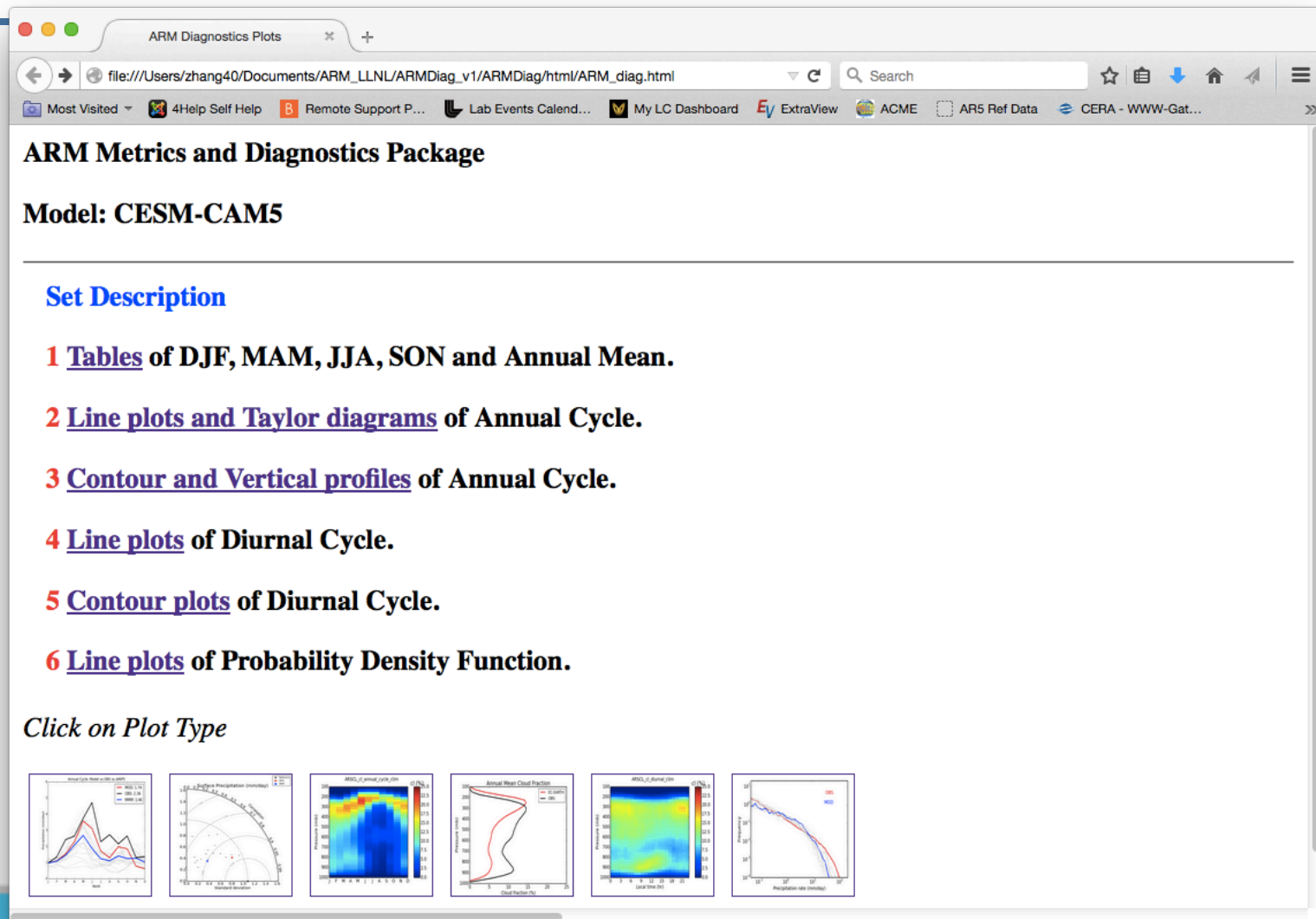


User Guide

- Install
 - Download and unpack
 - Install: `python setup.py install --user`
- Prepare model data
 - Process model data following instruction
 - Save data under: `/model`
- Modify: `ARMDiag_driver.py`
- Run: `python ARMDiag_driver.py`



Main Html Page



ARM Diagnostics Plots

file:///Users/zhang40/Documents/ARM_LLNL/ARMDiag_v1/ARMDiag/html/ARM_diag.html

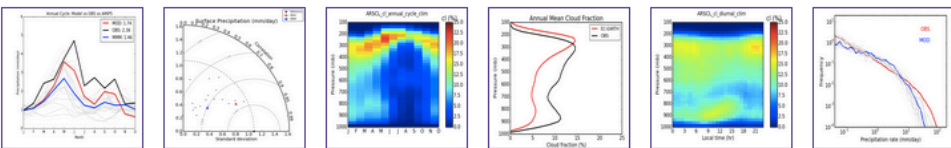
ARM Metrics and Diagnostics Package

Model: CESM-CAM5

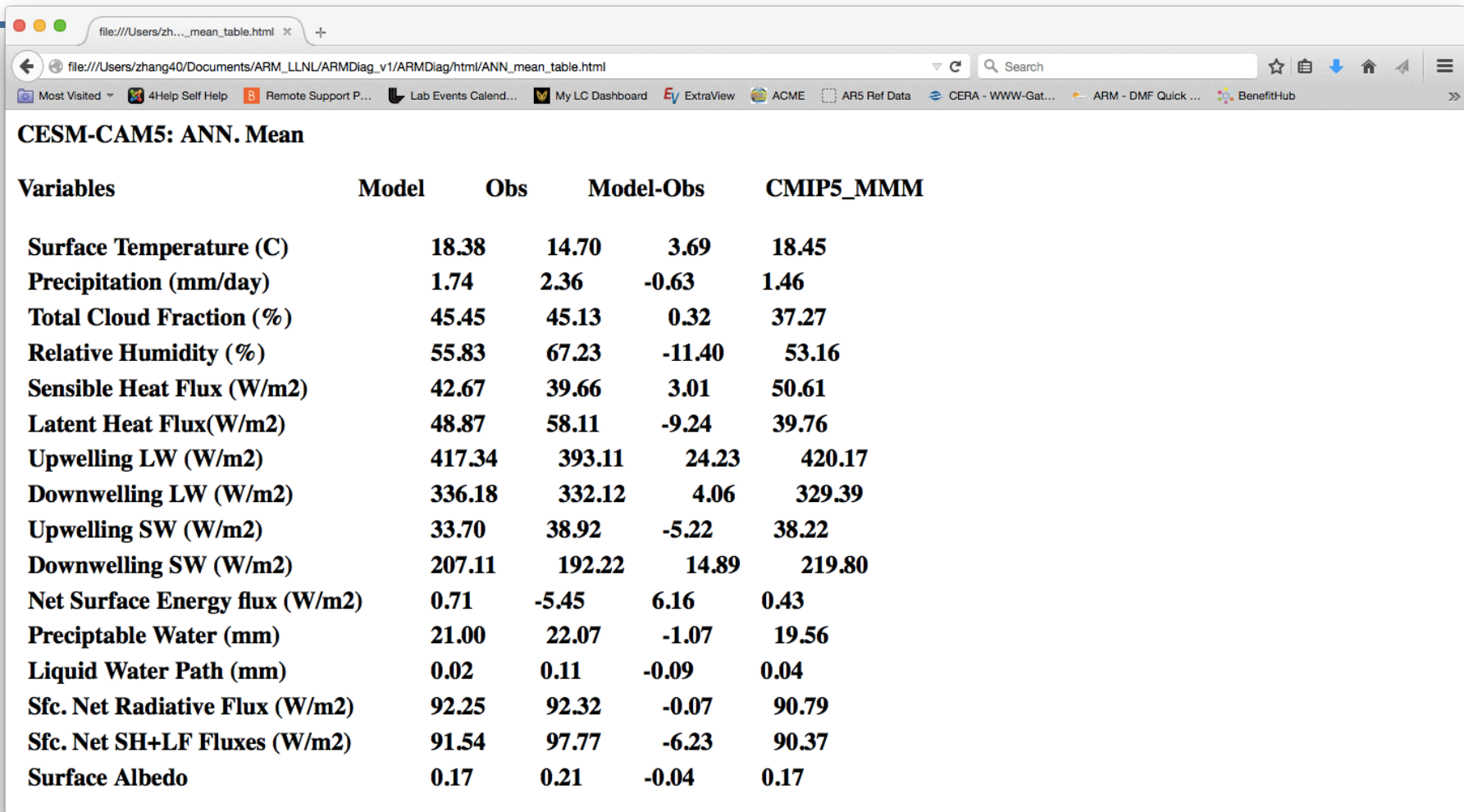
Set Description

- 1 [Tables](#) of DJF, MAM, JJA, SON and Annual Mean.**
- 2 [Line plots and Taylor diagrams](#) of Annual Cycle.**
- 3 [Contour and Vertical profiles](#) of Annual Cycle.**
- 4 [Line plots](#) of Diurnal Cycle.**
- 5 [Contour plots](#) of Diurnal Cycle.**
- 6 [Line plots](#) of Probability Density Function.**

Click on Plot Type



Tables to show statistical summary



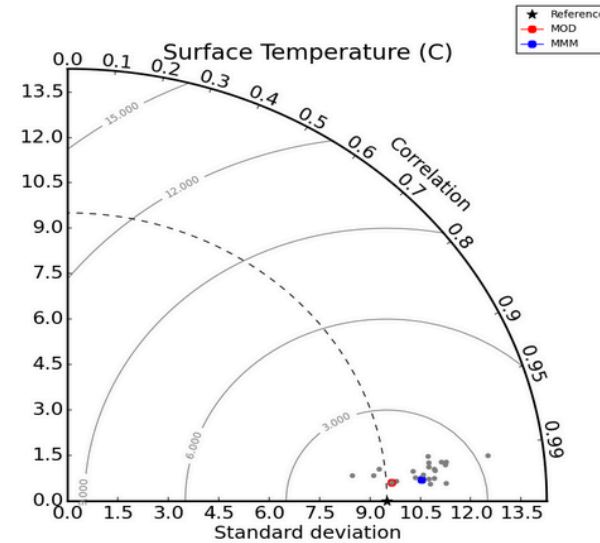
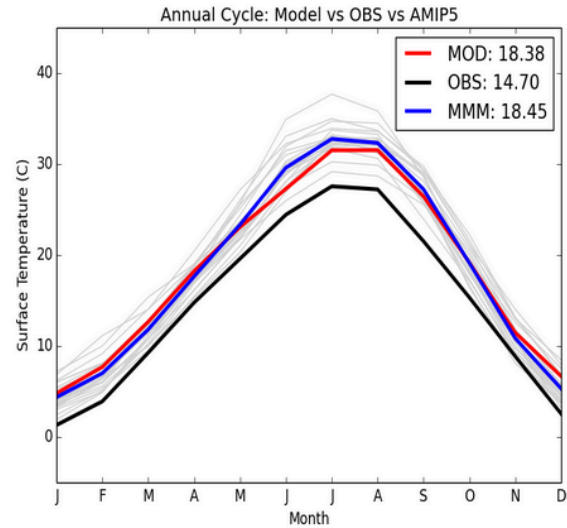
CESM-CAM5: ANN. Mean

Variables	Model	Obs	Model-Obs	CMIP5_MMM
Surface Temperature (C)	18.38	14.70	3.69	18.45
Precipitation (mm/day)	1.74	2.36	-0.63	1.46
Total Cloud Fraction (%)	45.45	45.13	0.32	37.27
Relative Humidity (%)	55.83	67.23	-11.40	53.16
Sensible Heat Flux (W/m2)	42.67	39.66	3.01	50.61
Latent Heat Flux(W/m2)	48.87	58.11	-9.24	39.76
Upwelling LW (W/m2)	417.34	393.11	24.23	420.17
Downwelling LW (W/m2)	336.18	332.12	4.06	329.39
Upwelling SW (W/m2)	33.70	38.92	-5.22	38.22
Downwelling SW (W/m2)	207.11	192.22	14.89	219.80
Net Surface Energy flux (W/m2)	0.71	-5.45	6.16	0.43
Preciptable Water (mm)	21.00	22.07	-1.07	19.56
Liquid Water Path (mm)	0.02	0.11	-0.09	0.04
Sfc. Net Radiative Flux (W/m2)	92.25	92.32	-0.07	90.79
Sfc. Net SH+LF Fluxes (W/m2)	91.54	97.77	-6.23	90.37
Surface Albedo	0.17	0.21	-0.04	0.17

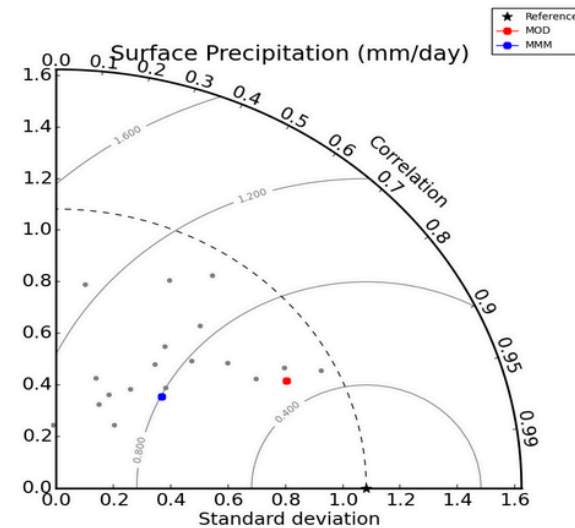
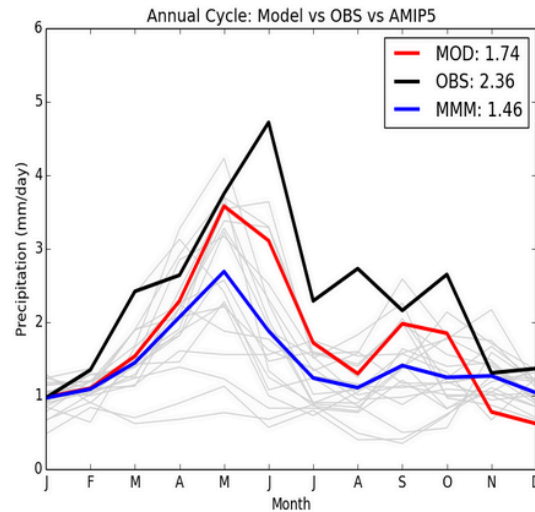


Line plots and Taylor Diagram for annual cycle

Surface T

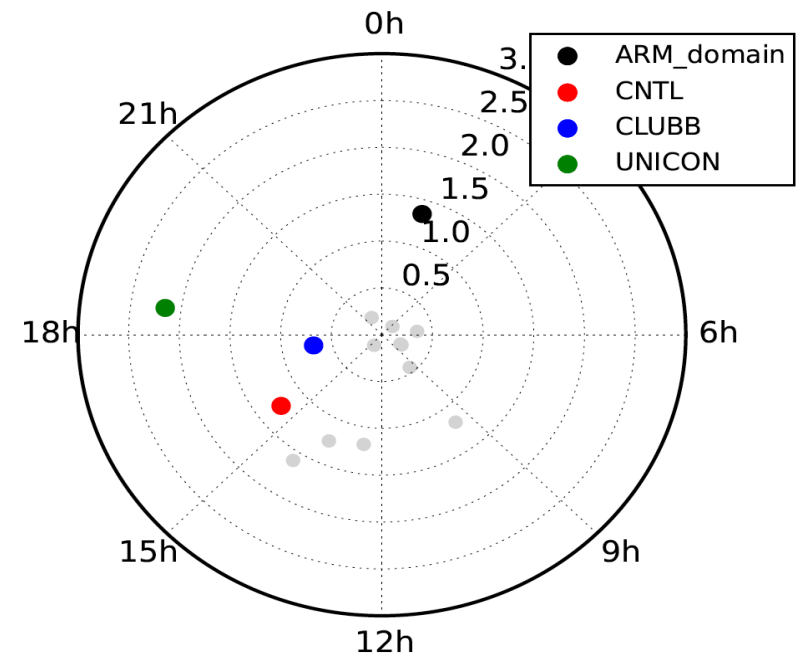
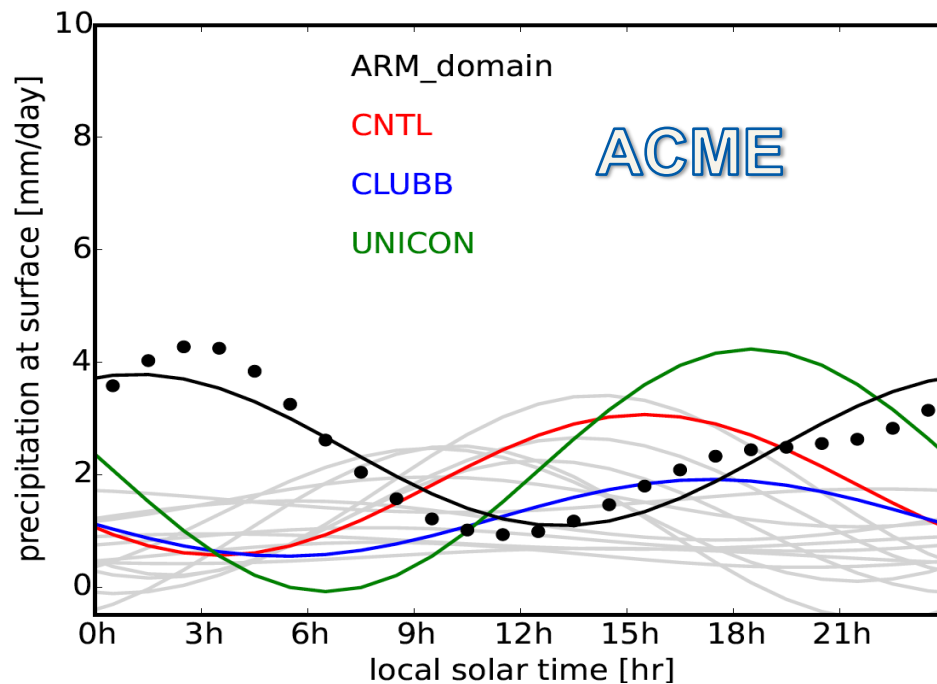


Precipitation



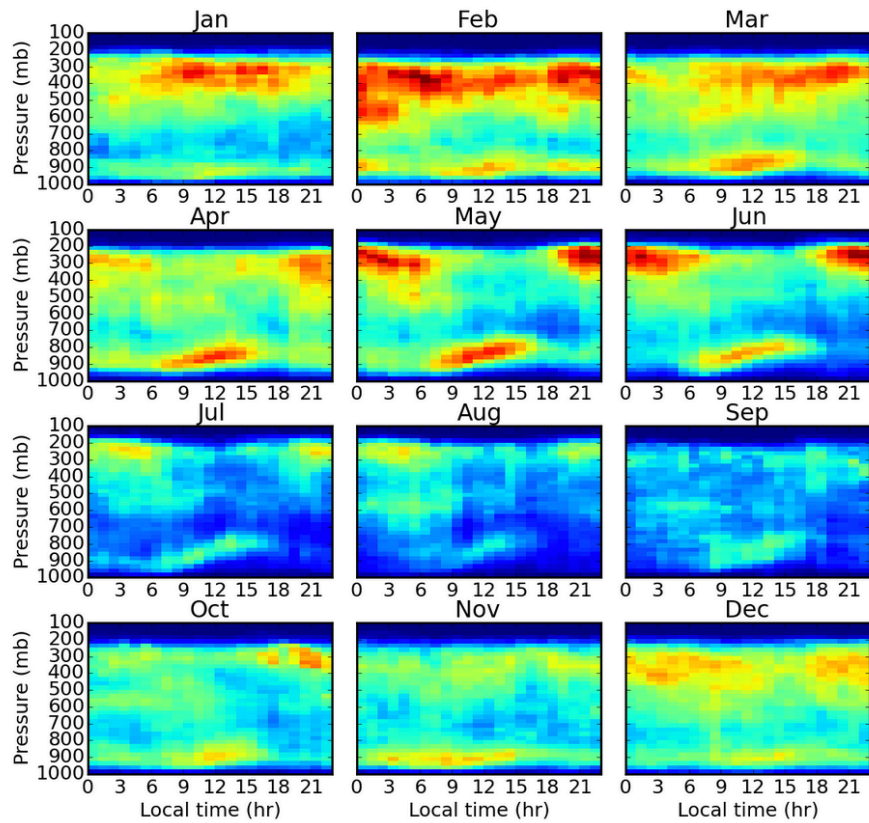
Line plot and harmonic dial for diurnal cycle

Precipitation Diurnal Cycle (July at SGP site)

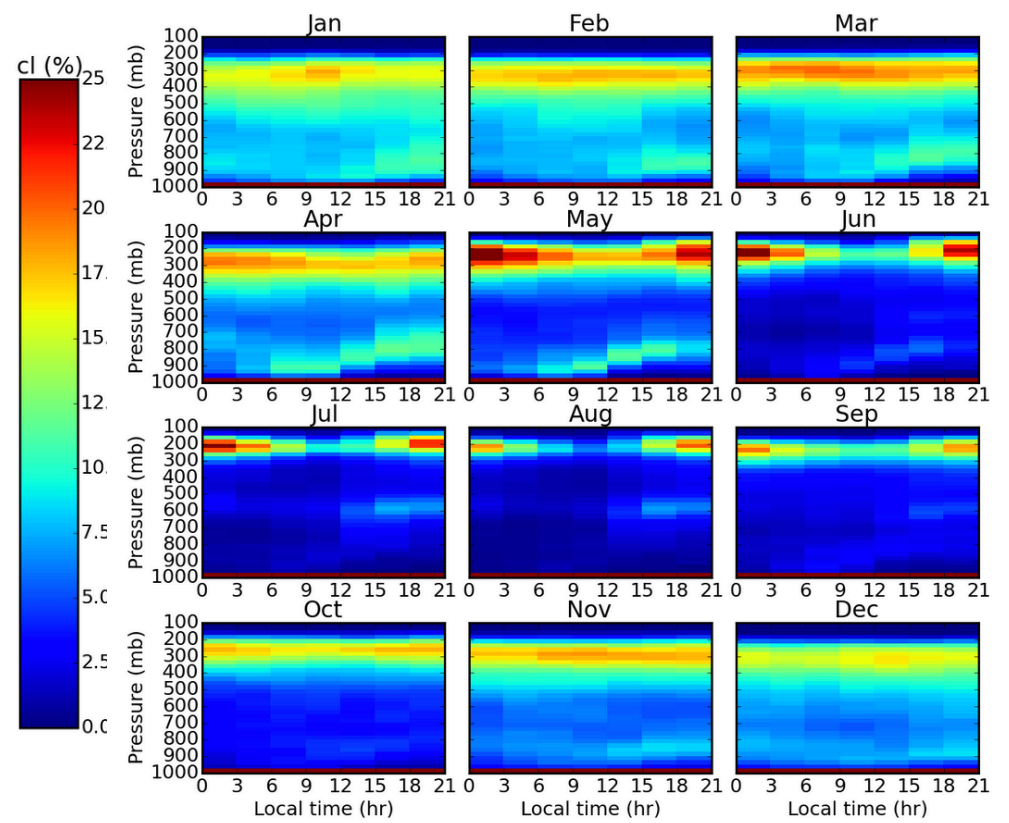


Contour plot for diurnal cycle

OBS: ARSCL Cloud Fraction



One CMIP5 Model



ARM Diag _v0 availability

- Available upon request :

Chengzhu Zhang (zhang40@lnl.gov)

- User guide and help are also available



Future Work

- **Process-oriented diagnostics planned to include:**
 - Frequency of occurrence and intensity probability density function of clouds and precipitation
 - Co-variance analysis: e.g., convection onset and transition statistics, causes of warm bias at central US
 - Cloud regime analysis using ARM radar simulator output
 - Diabatic heating/drying study over various cloud regimes
- **Establishment of a repository for community-contributions to the metrics package**
- **Be fully integrated into the PCMDI metrics package, and also be available independently**
- **With all model and observational and model data and programs published in ARM archive**



Backup slides



Stand-alone package flow chart

Pre-Processing

1. Prepare MODEL data

MODEL: climatology annual, diurnal cycle and Daily mean

Python-based Diagnostics Package

2. Calculate Metrics

Metrics: Mean, RMS, Correlation, Bias

3. Save output

Write metrics results

4. Graphics and Tables hosted by Html

Read metrics results and create tables and plots

Create Html files to host the tables and plots



Available Observational Variables

- **Atmospheric state and surface**

- Atmospheric moisture, pressure and temperature
- Horizontal wind and vertical velocity
- Latent heat flux and sensible heat flux
- Precipitation and soil moisture

- **Cloud and radiation**

- Cloud fraction profiles
- Liquid water path and precipitable water vapor
- TOA radiative fluxes
- Surface radiative fluxes

- **Aerosol and microphysical**

- Aerosol optical depths
- CCN concentration

Detailed information of observational data stream and statistics calculation will be documented.

