Improved Data Sets and Metrics for Climate Model Evaluation

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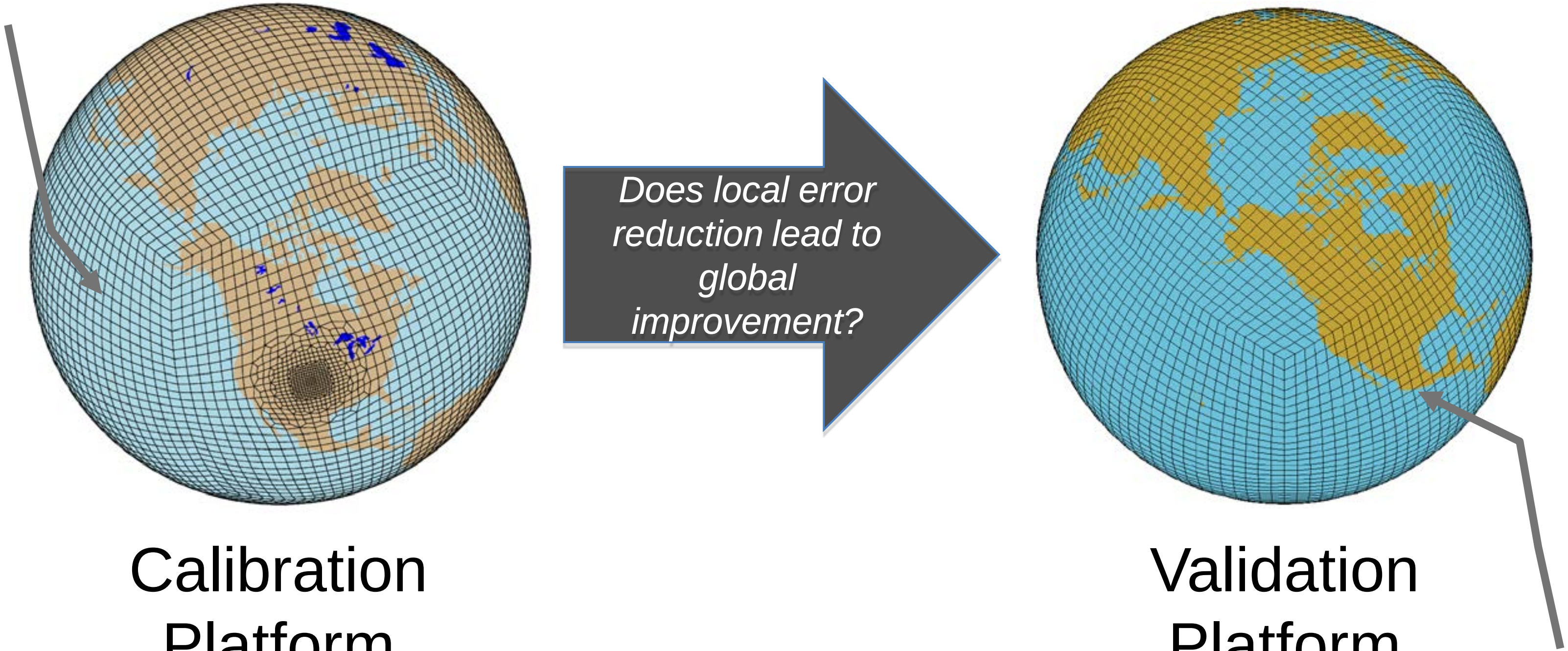
Goal: Develop data sets for use in hydrological cycle testbed of CSSEF

1. Prepare ARM observations for calibrating climate model parameterizations



Calibration Platform

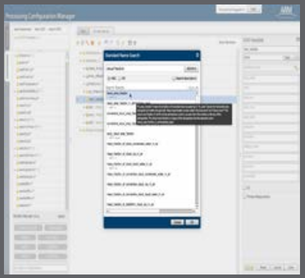
Validation Platform

2. Derive global precipitation statistics from satellite observations for climate model validation

1. ARM Uncertainty Assignment Procedure

Input:
ARM obs., e.g. surface met data

Output:
Version of CMBE dataset with uncertainty estimates



1. Screen Bad Data

*Exclude data that fails quality control tests—**including DQRs!***

2. Assign Uncertainties

Uncertainties based on instrument specifications, operational conditions, spatial variability

3. Fill Missing Data

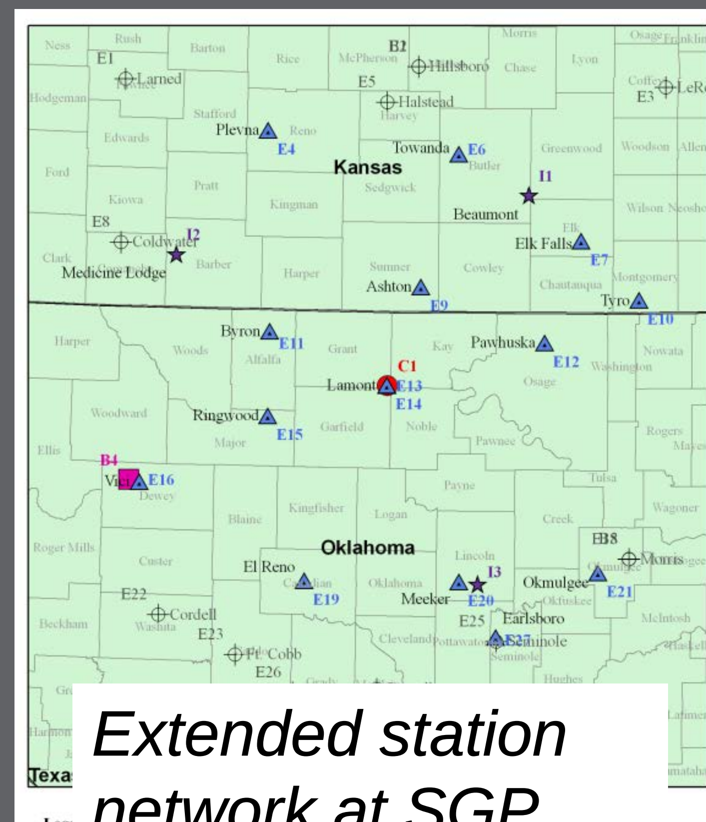
Use statistical methods to fill missing data and estimate uncertainty due to missing data

ARM Input Data Sets

Output:

Input:

e.g., surface meteorological observations



Extended station network at SGP

Data Quality Reports

Input:

ARM ob

e.g. s

me

1. Screen Bad Data

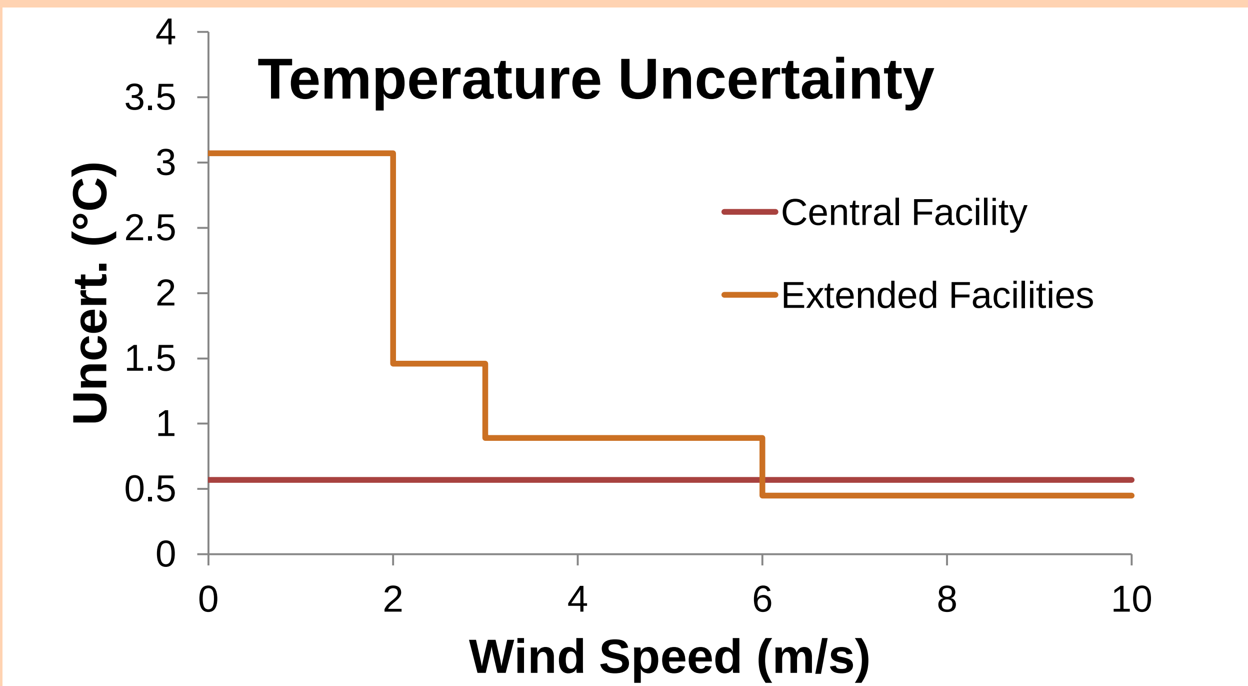
Automate system of excluding bad data based on ARM data quality reports (DQRs), and other qc checks.

D970325.6	Richard Hart	03/25/1997	SGP/SMOS/E13 - T/RH Probe Malfunction	19970226 15:30 - 19970226 21:30	Suspect
D970325.7	Richard Hart	03/25/1997	SGP/SMOS/E13 - T/RH Probe Malfunction	19970227 02:30 - 19970227 16:30	Suspect
D971215.1	Richard Hart	12/15/1997	SGP/SMOS/E13 - Questionable E13 SMOS humidity data APR - NOV 95	19950414 20:38 - 19951101 22:30	Suspect
D991109.11	Richard Hart	11/09/1999	SG/SMOS/E13 - E13 SMOS down for tower replacement	19990414 21:00 - 19990503 20:55	Missing
D991109.20	Richard Hart	11/09/1999	SGP/SMOS/E13 - E13 SMOS lowered to surface to install counterweights	19990924 13:00 - 19990924 13:20	Suspect
D010713.27	Michael Ritsche	07/13/2001	SGP/SMOS/E13 - E13 SMOS Wind speed data incorrect	20010128 17:58 - 20010128 22:01	Incorrect
D010713.28	Michael Ritsche	07/13/2001	SGP/SMOS/E13 - E13 SMOS Daily wind speed data suspect	20010128 00:00 - 20010129 00:01	Suspect
D011217.1	Robin Perez	12/17/2001	SGP/SMOS - Truncated first records in selected sneakernet data files	19981117 00:00 - 19981207 23:59	Incorrect
D020125.10	Michael Ritsche	01/25/2002	SGP/SMOS/E13 - E13 SMOS SNOW DEPTH DATA INCORRECT	20010823 18:35 - 20011101 00:01	Incorrect

Measurement Uncertainty Assignment

2. Assign Uncertainties

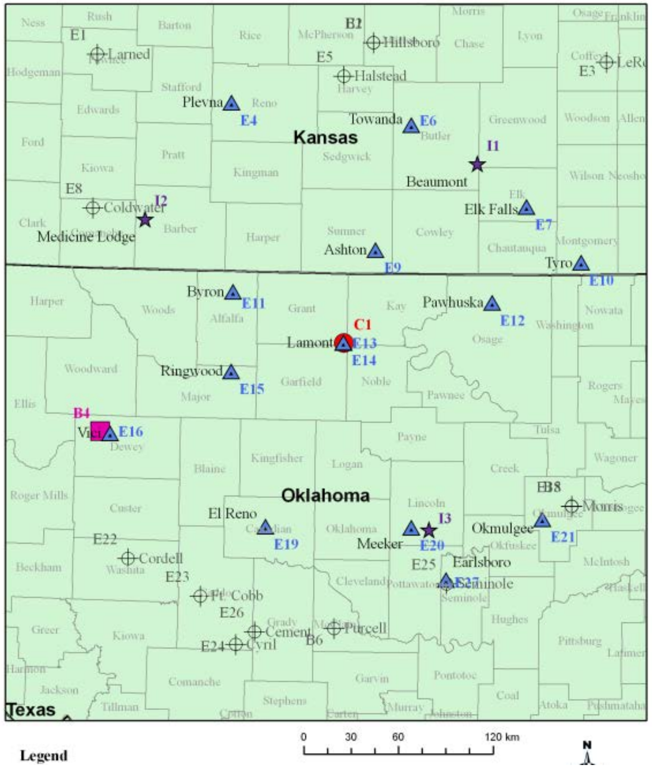
Example: Temperature uncertainties based on manufacturer specifications associated with wind speed.



Point Measurement Issues

2. Assign uncertainties

Use neighboring observations to assess spatial uncertainty of single point data. Produce gridded dataset.

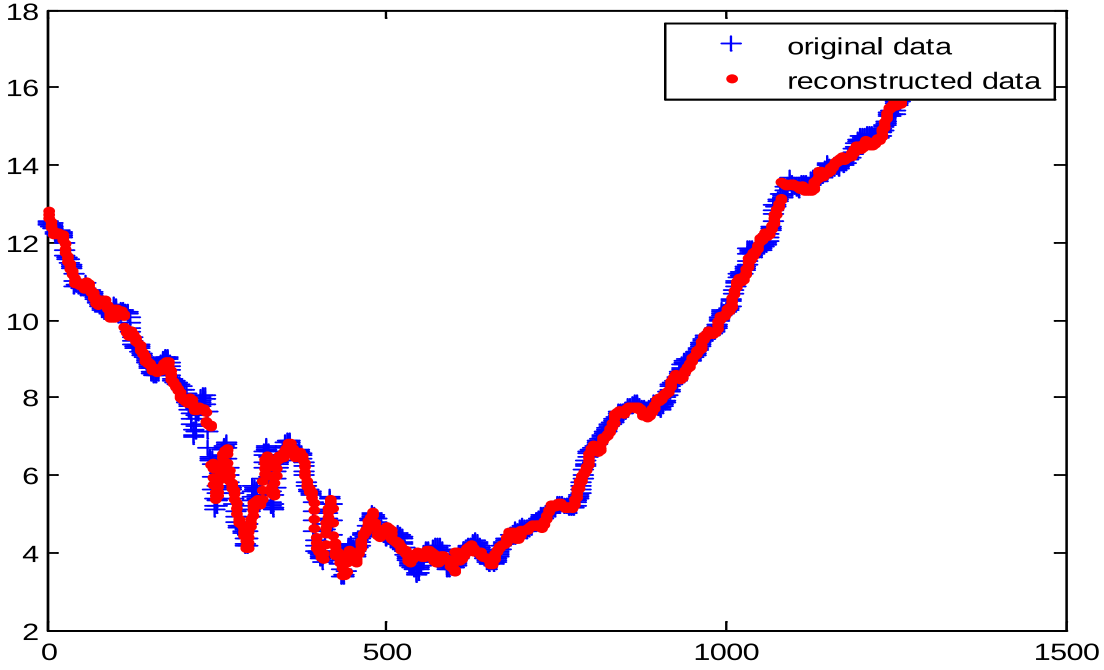


Dealing with Missing Data

3. Fill in Missing Data

Examining the use of Principal Component Analysis to fill missing data and estimate uncertainty due to missing data

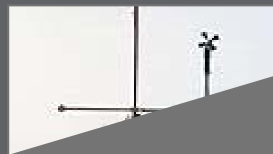
1 Day Temperature Data, 5% missing values



ARM Integrated Software Development Environment

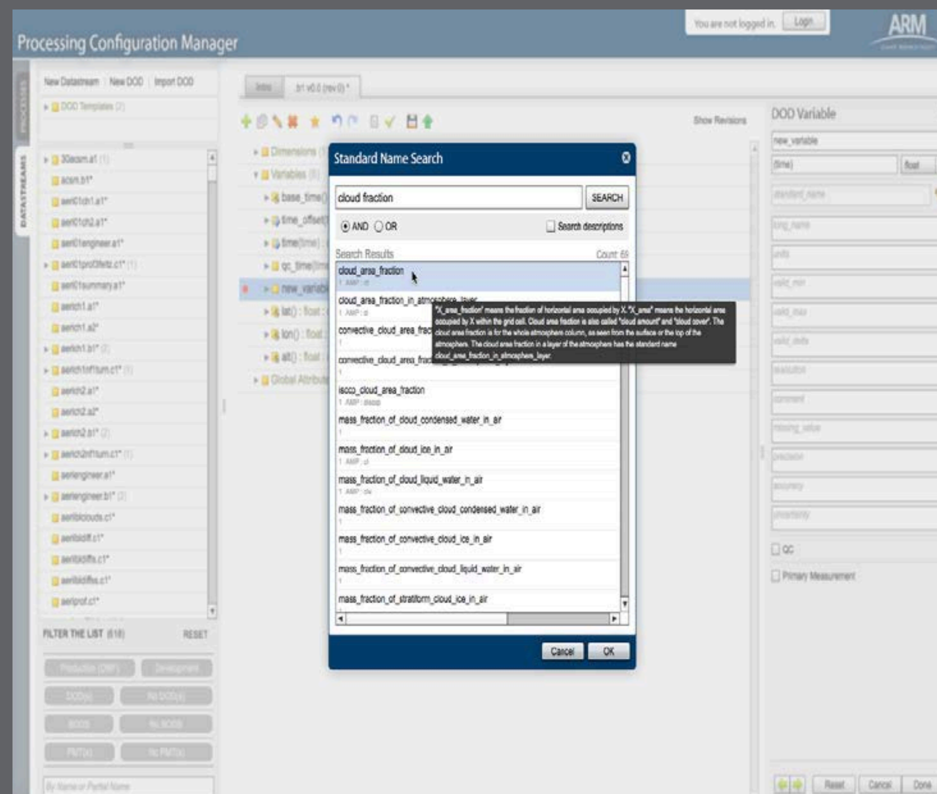
Input:

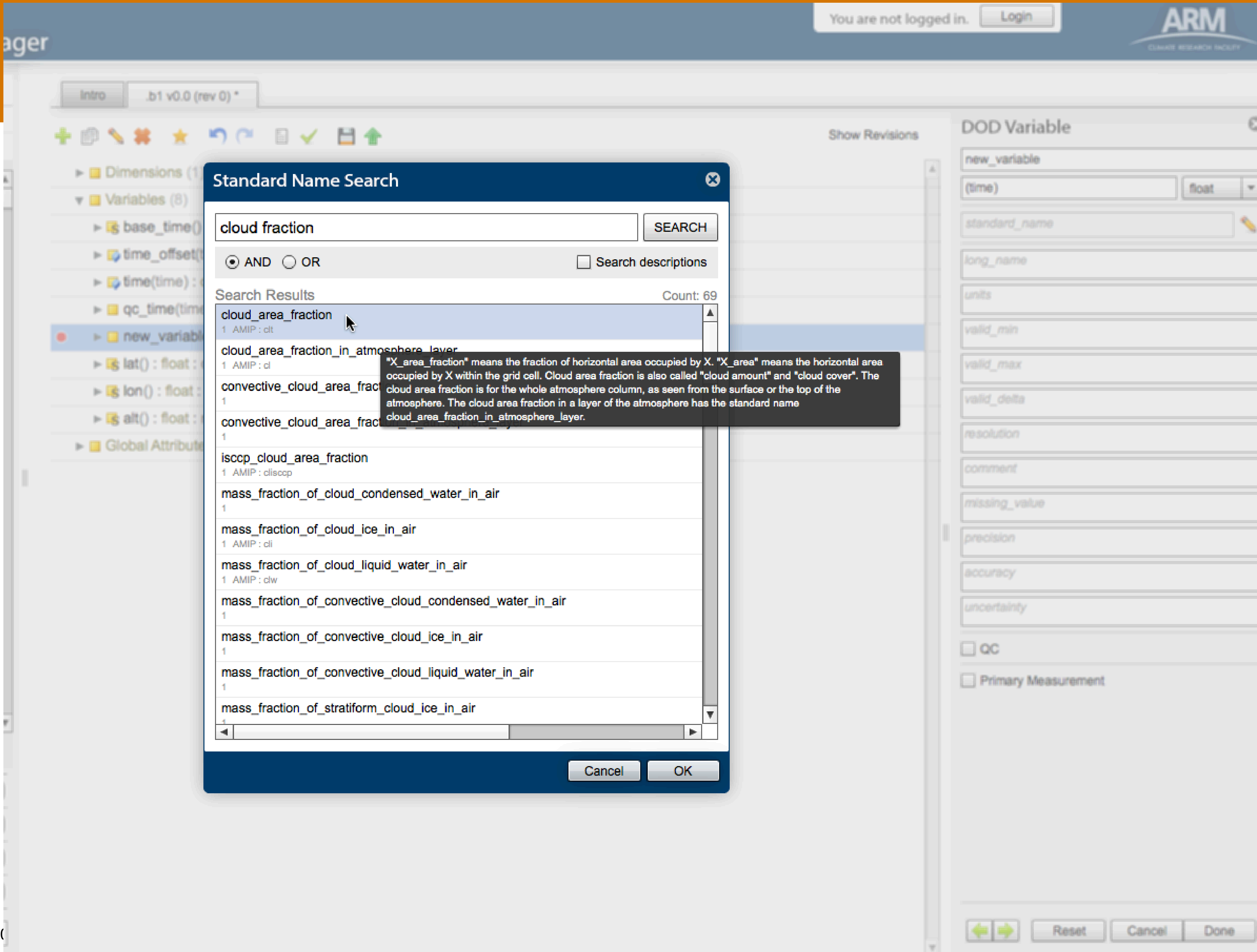
ARM obs.,
e.g. surface
met. s



Output:

Conversion to CF standard names and qc format added to processing capability in Integrated Software Development Environment (ISDE)




ager
You are not logged in.
Login
ARM
Intro
.b1 v0.0 (rev 0) *
Show Revisions
Dimensions (1
Variables (8)
base_time()
time_offset(
time(time) :
qc_time(tim
new_variab
lat() : float :
lon() : float :
alt() : float :
Global Attribut
Standard Name Search
cloud fraction
SEARCH
AND
OR
Search descriptions
Search Results
Count: 69
cloud_area_fraction
1 AMIP : clt
cloud_area_fraction_in_atmosphere_layer
1 AMIP : cl
convective_cloud_area_frac
convective_cloud_area_frac
"X_area_fraction" means the fraction of horizontal area occupied by X. "X_area" means the horizontal area occupied by X within the grid cell. Cloud area fraction is also called "cloud amount" and "cloud cover". The cloud area fraction is for the whole atmosphere column, as seen from the surface or the top of the atmosphere. The cloud area fraction in a layer of the atmosphere has the standard name cloud_area_fraction_in_atmosphere_layer.
isccp_cloud_area_fraction
1 AMIP : cliscсp
mass_fraction_of_cloud_condensed_water_in_air
mass_fraction_of_cloud_ice_in_air
1 AMIP : cli
mass_fraction_of_cloud_liquid_water_in_air
1 AMIP : clw
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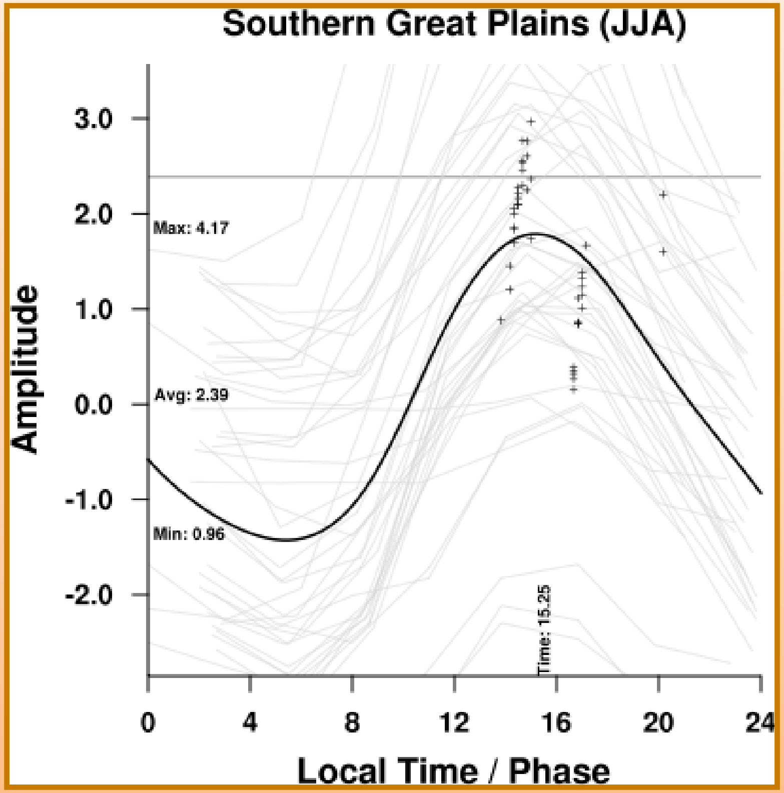
mass_fraction_of_convective_cloud_ice_in_air
mass_fraction_of_convective_cloud_liquid_water_in_air
mass_fraction_of_stratiform_cloud_ice_in_air
Cancel
OK
DOD Variable
new_variable
(time)
float
standard_name
long_name
units
valid_min
valid_max
valid_delta
resolution
comment
missing_value
precision
accuracy
uncertainty
QC
Primary Measurement
Reset
Cancel
Done

2. Development of Precipitation Metrics

- Primary goal of CSSEF is to improve representation of hydrological cycle in CESM
- To calibrate and validate atmosphere component of hydrological cycle requires metrics that move beyond monthly means
- CSSEF Atmosphere team identified key metrics:
  - Probability distribution of precipitation (percentile values of pdf)
  - Harmonics of diurnal cycle
  - Partitioning of total precipitation into stratiform/convective components
- Brian Medeiros (NCAR) has developed initial scripts to calculate quantities from model output – BNL and PNNL teams now working to apply to ARM and satellite data
- Coordination with ESGF for testbed development

Harmonics of the diurnal cycle

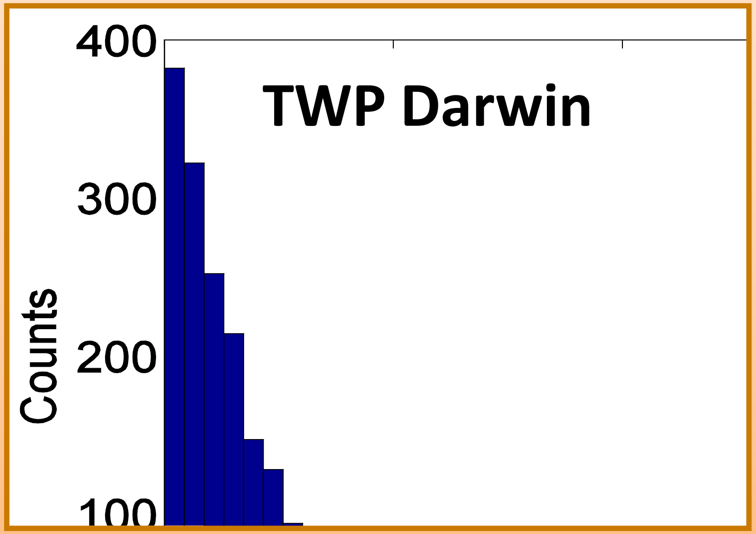
Composite model diurnal cycle calculated by using first two harmonics of FFT. Composite diurnal cycles from region's grid points shown in gray.

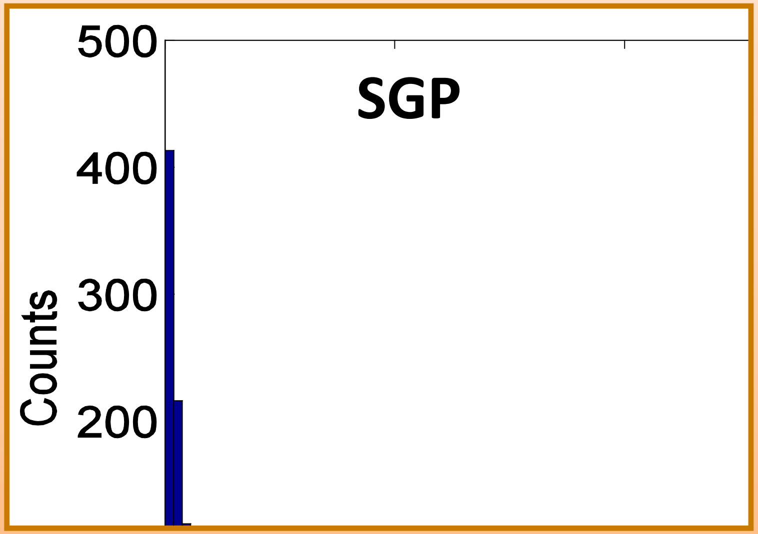


Brian Medeiros & Rich Neale, NCAR

Probability Distribution Functions

Precipitation rate probability distribution functions from 0.25° TRMM grid boxes containing ARM sites.





Stratiform/convective rain distribution

Ratio of convective rain rate to stratiform rain rate from TRMM.

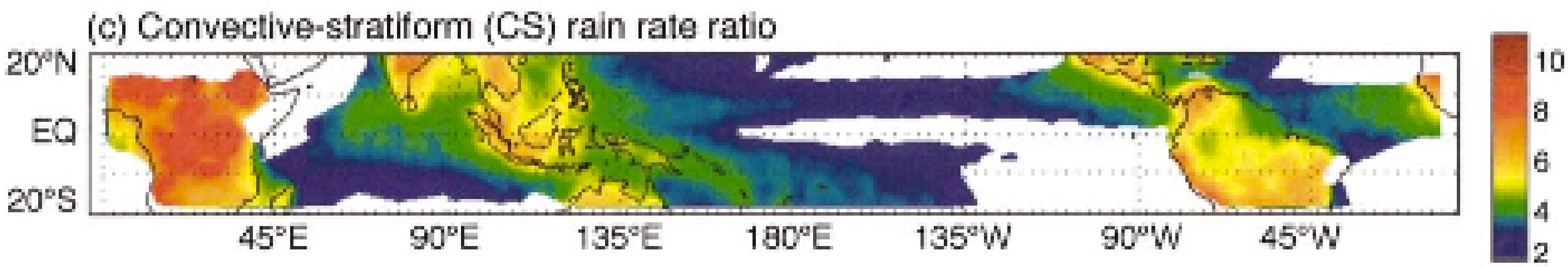


FIG. 4. The PR (a) convective rain rate, (b) stratiform rain rate, and (c) CS rain-rate ratio based on 2.5° grid averages for 1998–2000. Areas with annually averaged rain of less than 0.6 m yr^{-1} were not included.

From Schumacher and Houze, *J. Climate,* 2003.

Summary and Future Work

- Prepare ARM observations for calibration testbed by:
  - Developing automated method for including ARM DQRs
  - Assigning and propagating uncertainties
  - Developing tools for outputting ARM data in CF standard format
  - Developing methods to fill in missing data
  - Examining spatial variability
  - Adding more variables (LWP, PWV, radiation, cloud fraction)
- Develop statistical summaries of satellite data for validating climate models with new metrics:
  - Harmonics of the diurnal cycle
  - Probability distribution functions
  - Stratiform/convective precipitation distinction