The Use of the METplus Verification and Diagnostic Capability for Evaluation of Cloud Fields

Tara Jensen
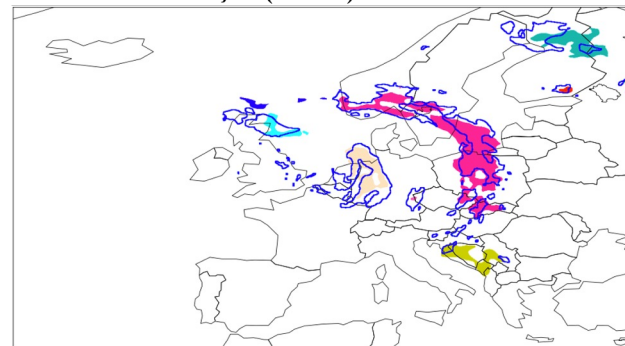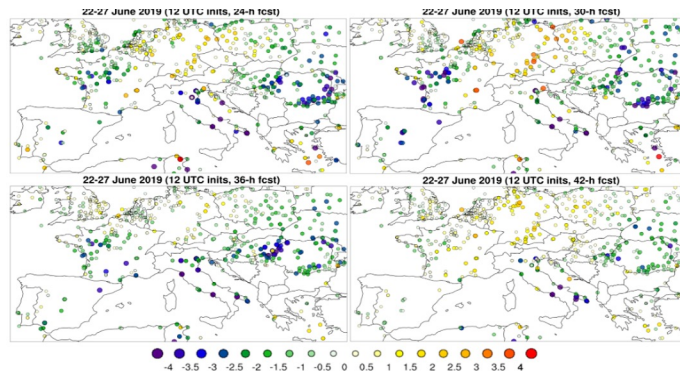
NCAR/RAL/JNT AND DTC

Co-Authors and Examples
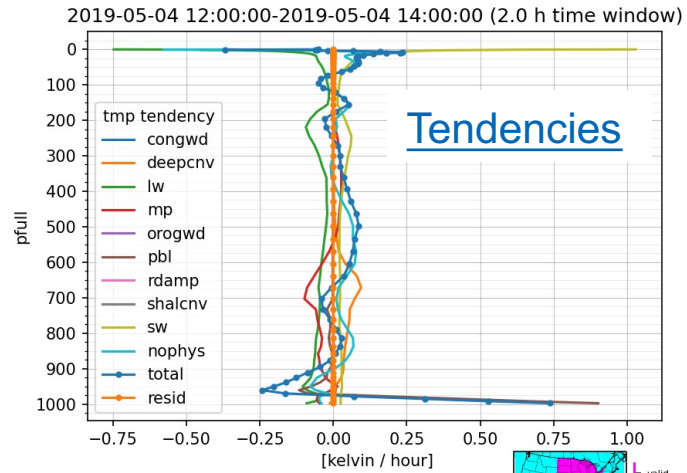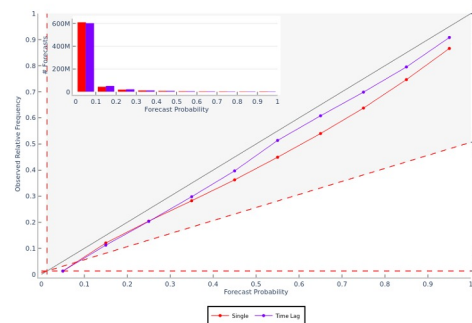
NCAR/RAL AND DTC

John Opatz, Christina Kalb, Daniel Adriaansen, Jonathan Vigh, Mrinal Biswas, Kathryn Newman, Michelle Harrold, and Tracy Hertneky   *NCAR and DTC
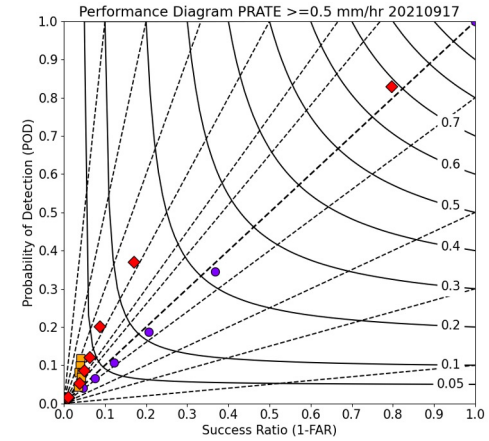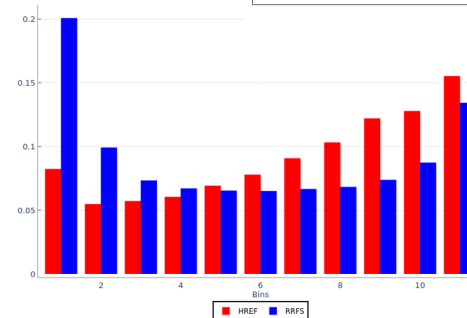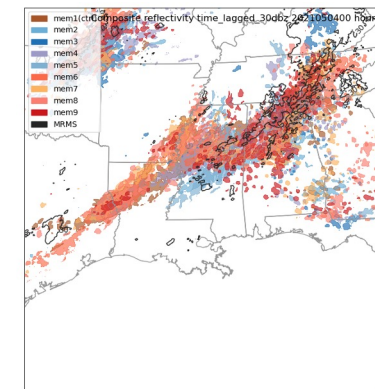
Tendencies

Spatial Representation of Errors
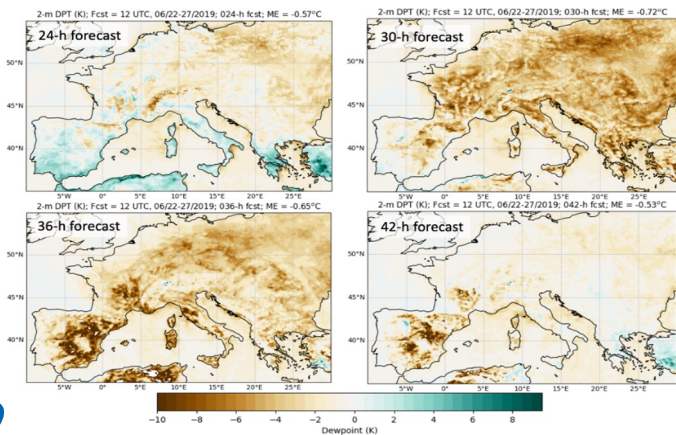
Synthesis Tools

Basic Ensemble Products

Ensemble Measures
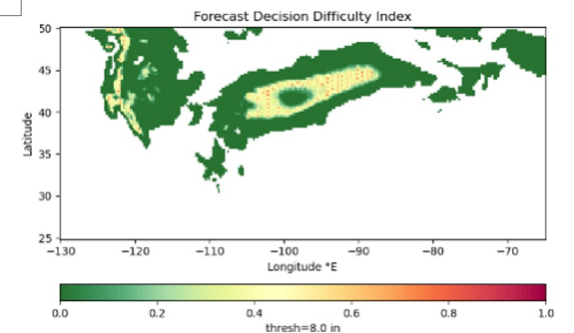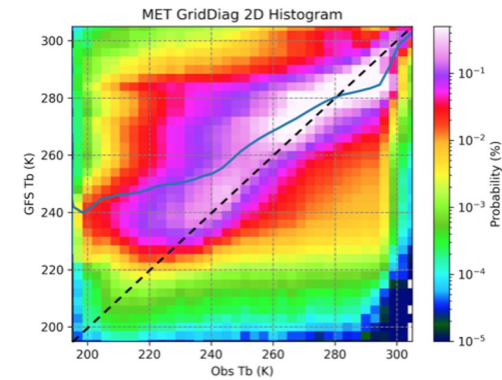
METplus Components

- **Wrappers** - represented by black arrows – low level workflow
- **MET** – suite of statistical and diagnostic tools
- **Analysis Tools** – available for advanced analysis includes
  - METviewer user interface
  - METexpress user interface
  - METdataio, METcalcpy, METplotpy Python components

- Version 5.1 released Aug 1st

Overview

- **Defining "Truth"**
- **Interpolation and Sub-sampling**
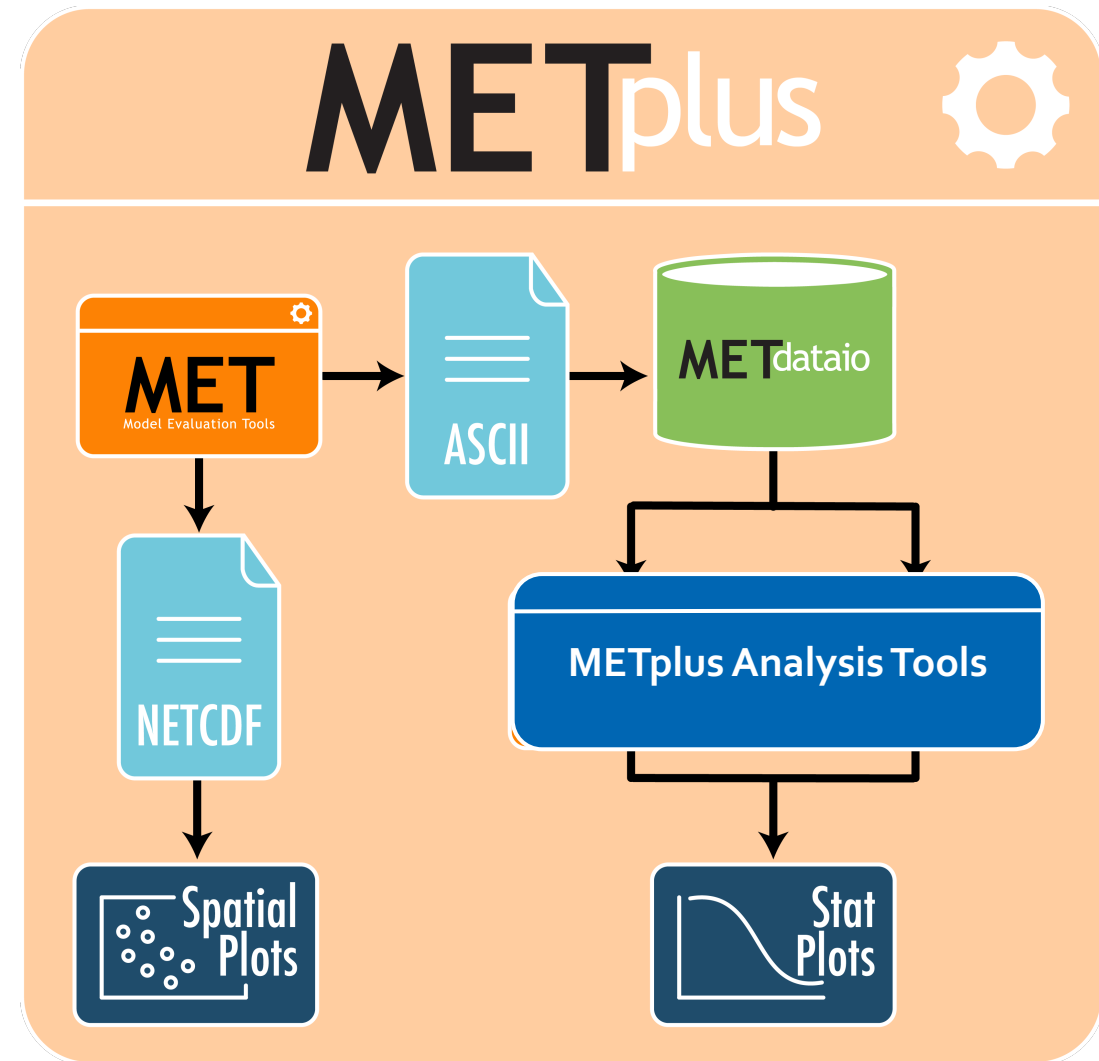- **Continuous Statistics**
- **Categorical Statistics**
- **Spatial Methods**
- **Regional vs. Global**
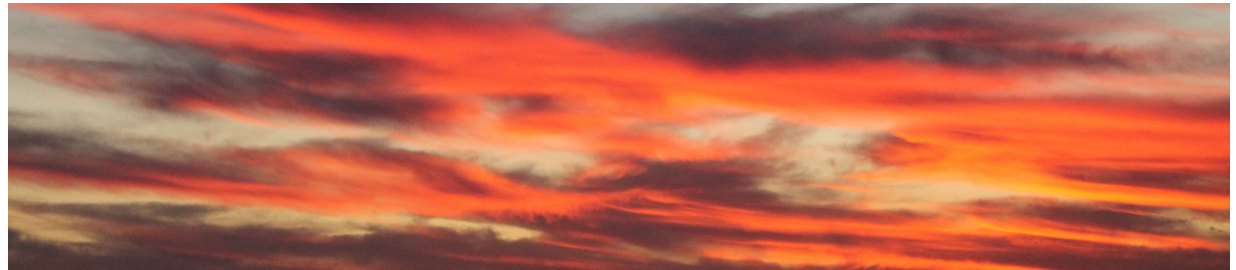
- **Much of this work is based on a project with USAF**
- **Some results from project with NRL**
- **All results from METplus**

Pick Your Truth

Obs
Ceilometer

Satellite-based Cloud Analysis
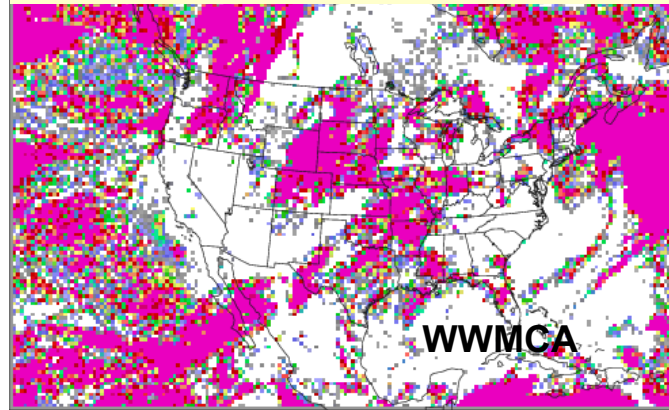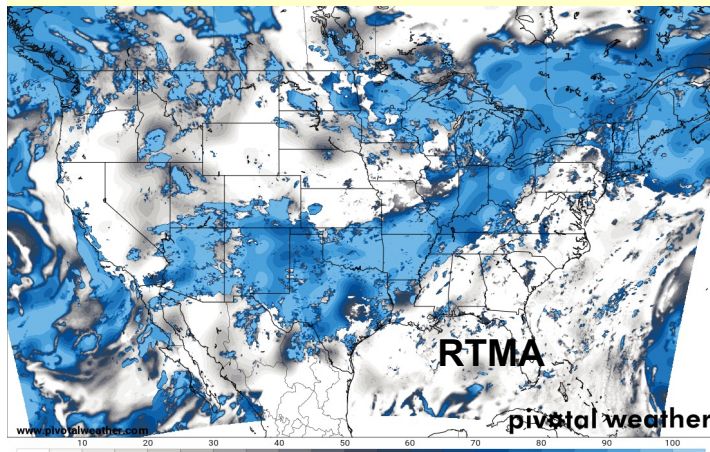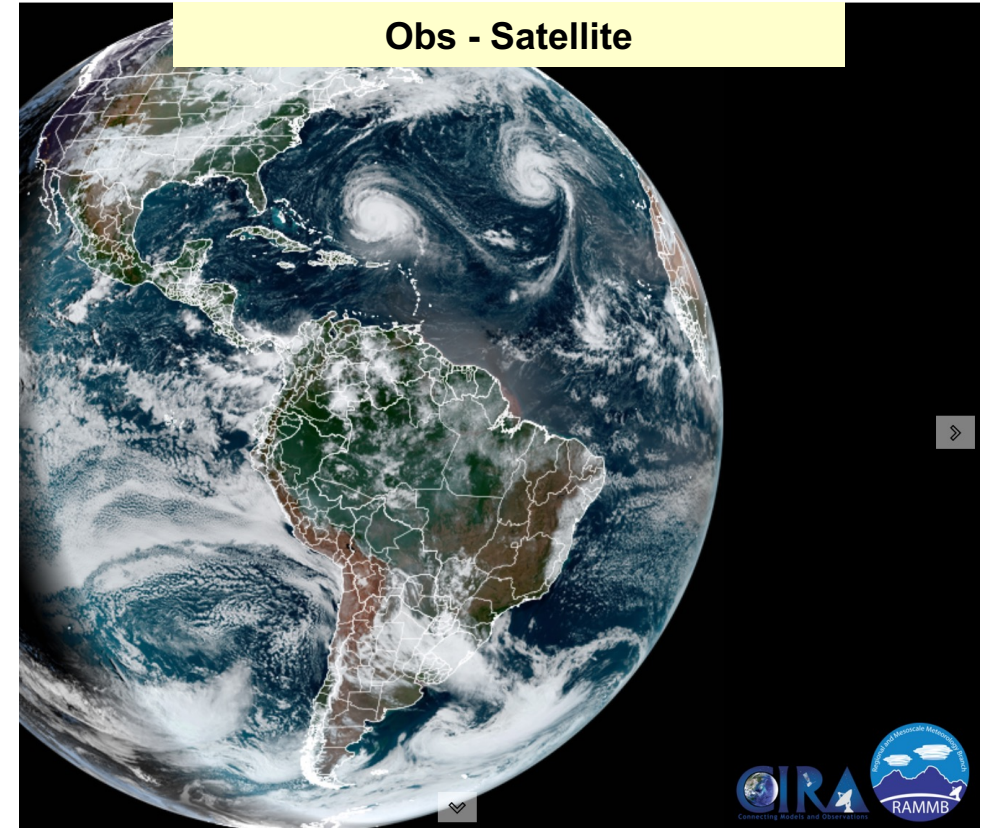
WWMCA

Cloud Cover, Total (%)
F000 Valid: Tue 2023-09-12 14z   Init: Tue 2023-09-12 14z RTMA-RU

Model-based Cloud Analysis

RTMA

pivotal weather

www.pivotalweather.com

Obs - Satellite

Interpolation and Sub-sampling is Key

Obs Ceilometer

Satellite-based Cloud Analysis

WWMCA

Cloud Cover, Total (%)
F000 Valid: Tue 2023-09-12 14z   Init: Tue 2023-09-12 14z RTMA-RU
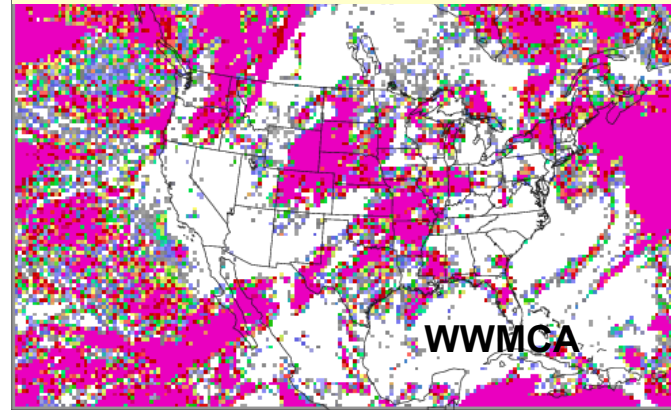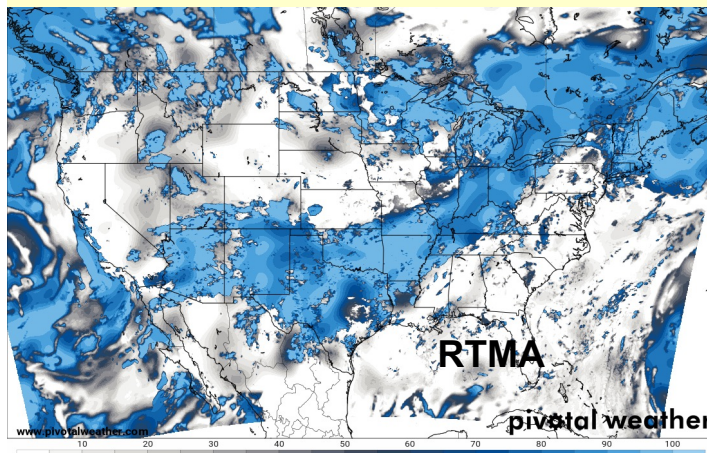
Model-based Cloud Analysis

RTMA

www.pivotalweather.com

pivotal weather

Obs - Satellite
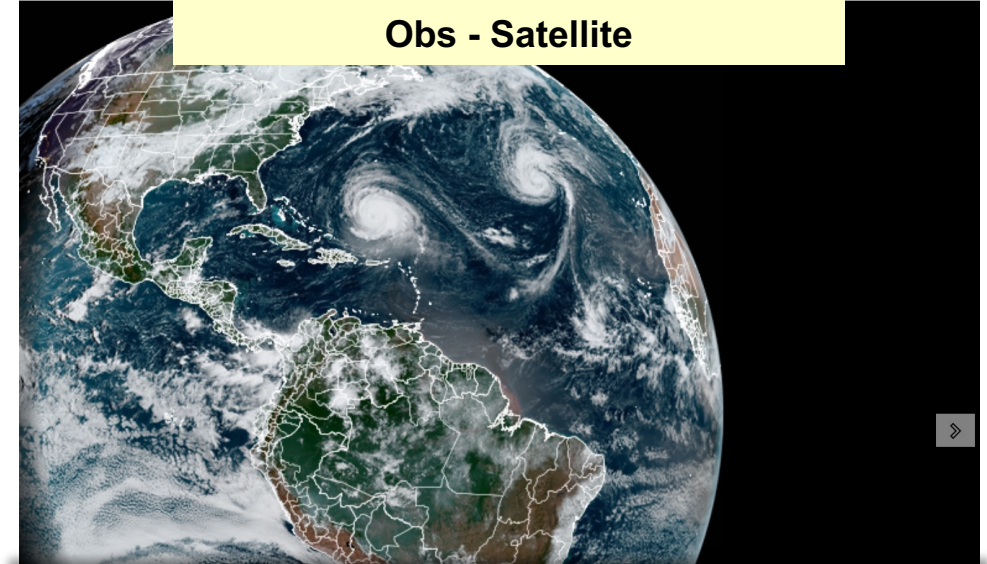
Interpolation Methods in Tools:
Nearest Neighbor, Gaussian, Minimum, Maximum, Distance Weighted, Unweighted, Median, Least-Squares, Bilinear, Upper Left, Upper Right, Lower Left, Lower Right, Best, Geography, Budget (mass conserving)

Shape: Circle or Square

Sub-sampling: ASCII2NC (point observations) and Point2Grid (dense data such as satellite) tool

Be Leary of Continuous Statistics for Clouds

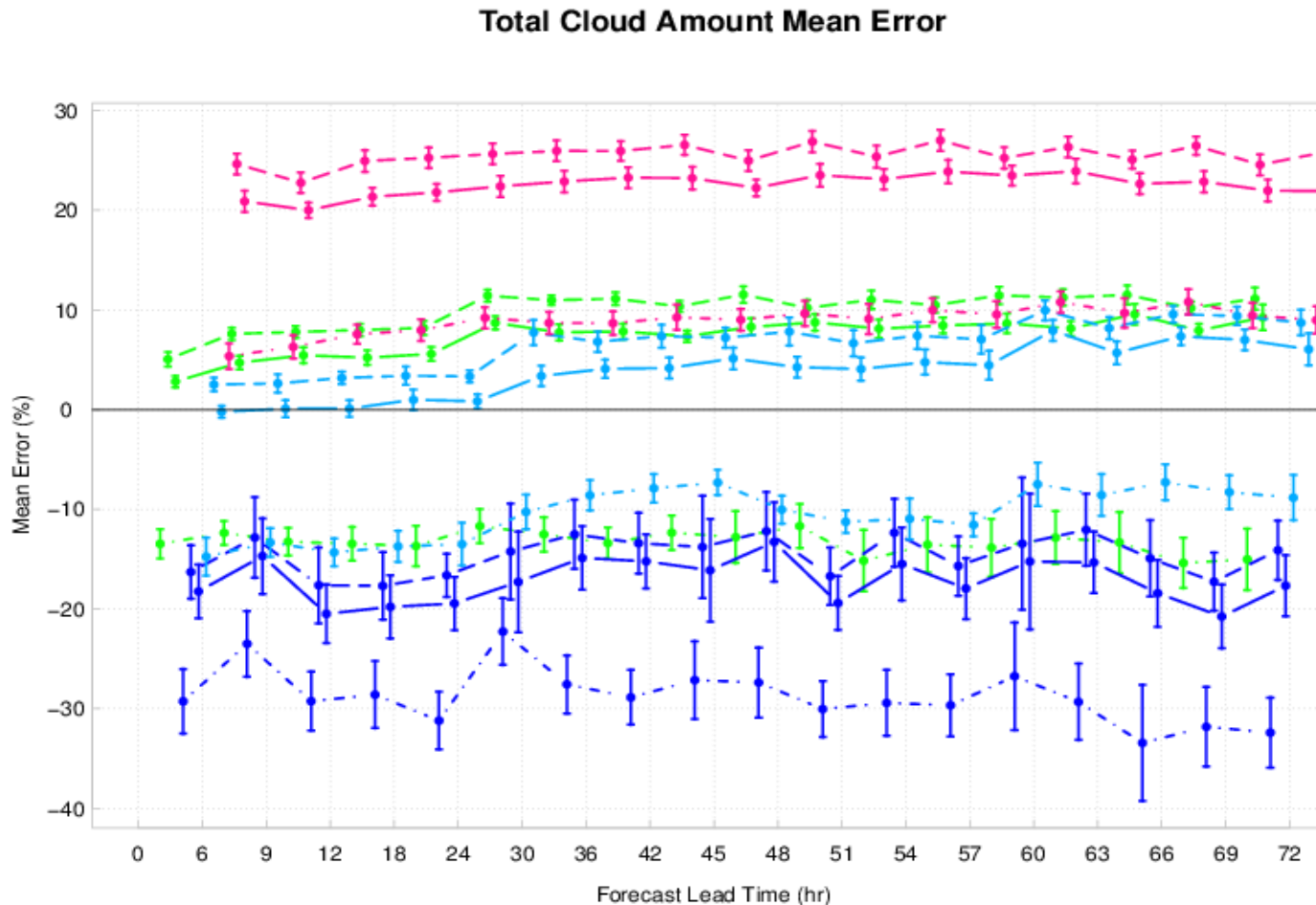Just like precipitation and other fields that have a minimum of zero – Continuous Statistics should be used with caution.

Source of "Truth" will also influence results

Total Cloud Amount Mean Error

Raw Model Fields
Model 1   Model 2

Statistically PP Model Fields
Model 1   Model 2

– – – vs. Obs
– – vs. Analysis 1
——— vs. Analysis 2

Turn Continuous Statistics into Quasi-Categorical
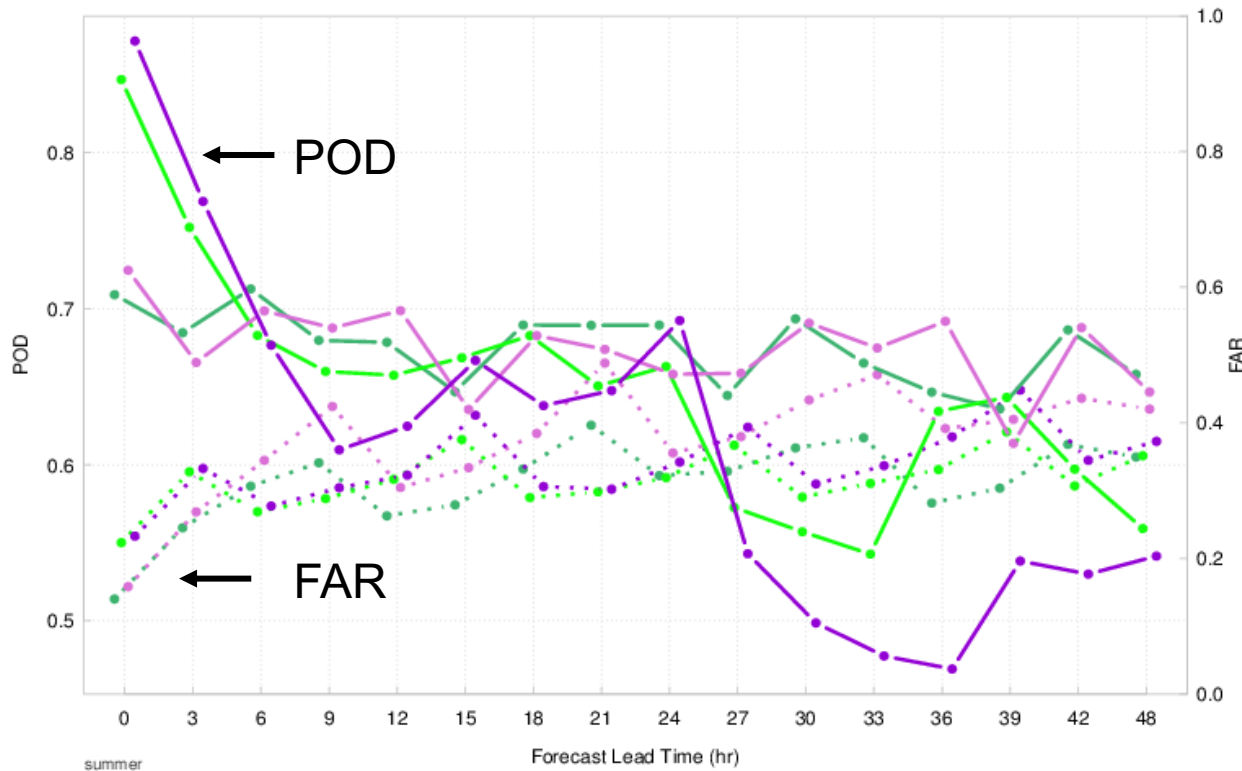
An option would be to use "conditional thresholding" which may be used to represent "categories" that may meet your end-users needs

Total Cloud Amount Mean Error by Threshold

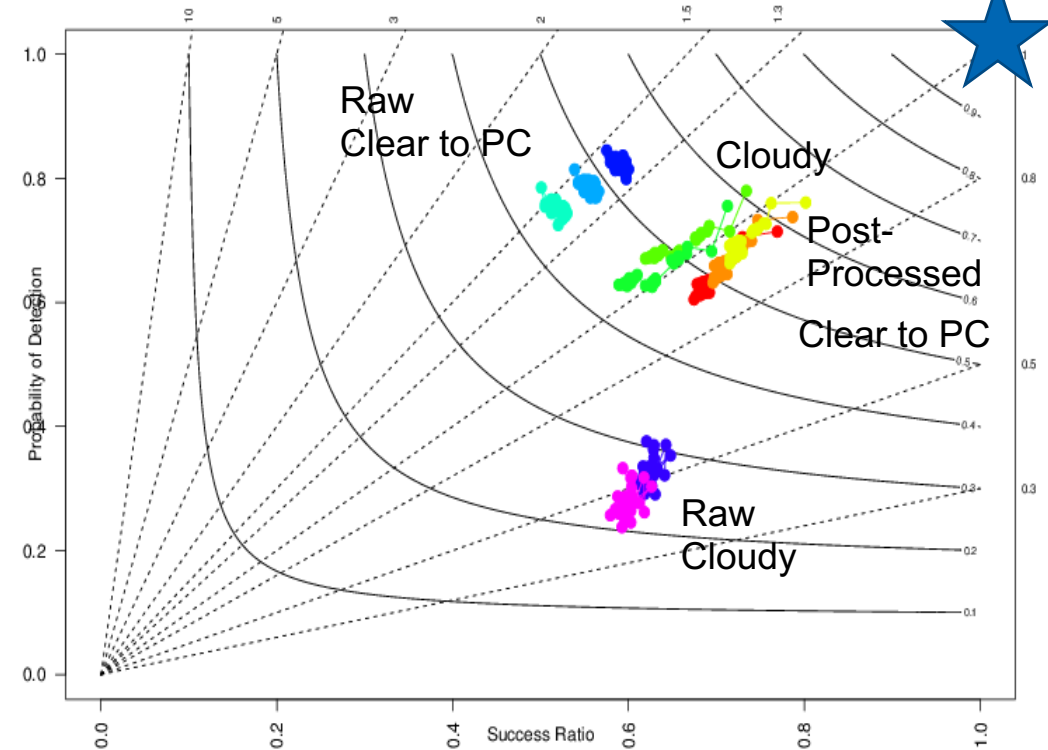<= 22.5
<= 35.0
<= 50.0

>= 60.0
>= 75.0
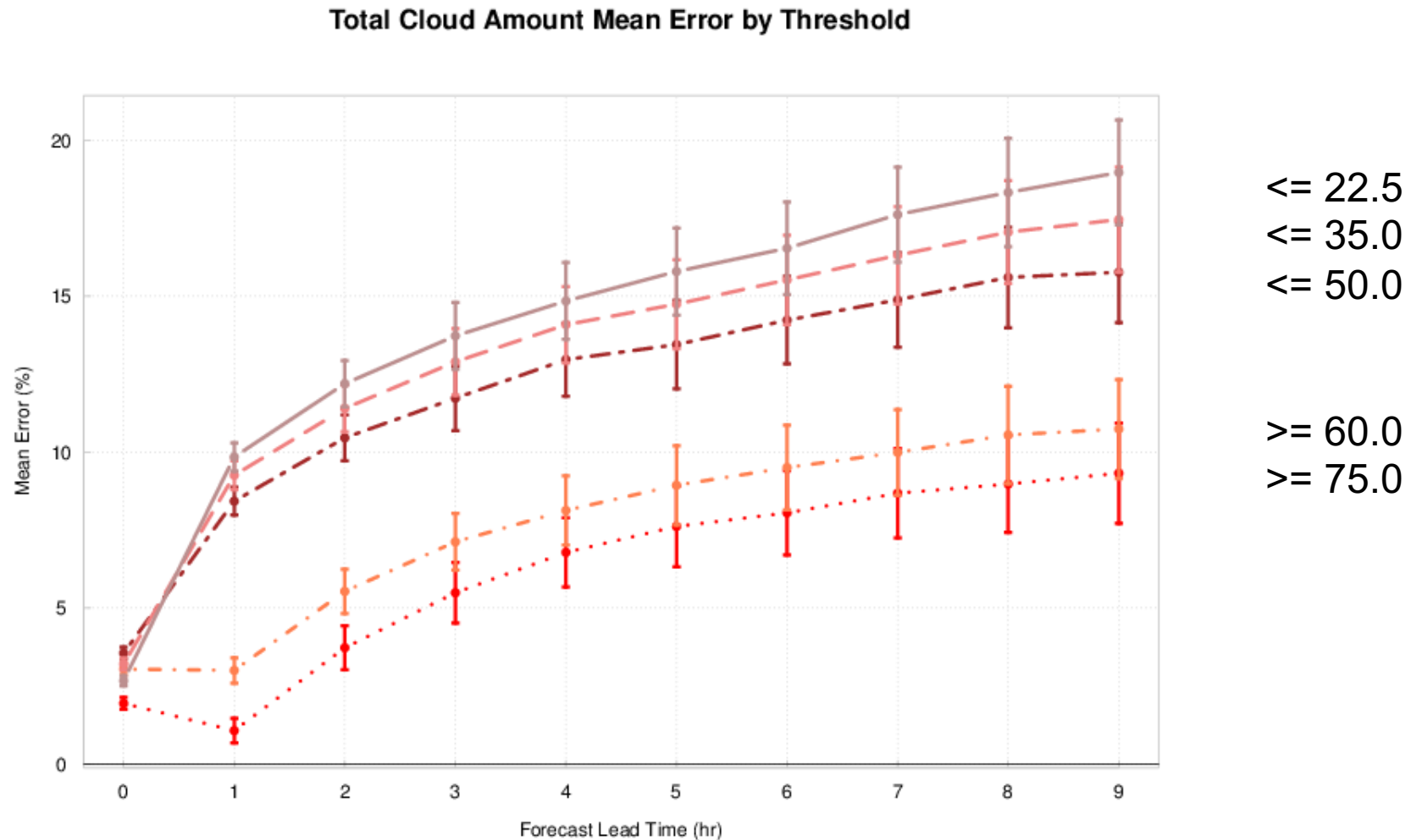
Categorical Statistics or Bust

For Total Cloud Fraction – what is the definition of clear and cloudy? We've found that =0 and =100 does not work well.
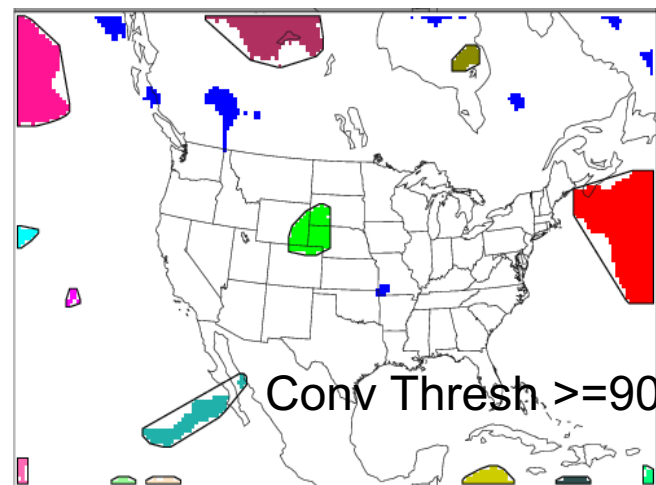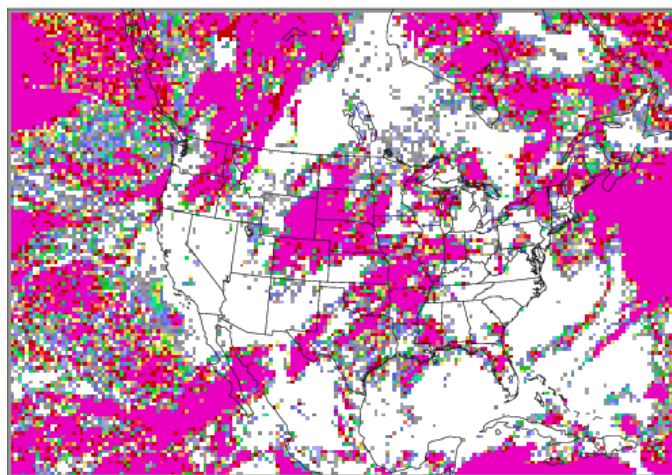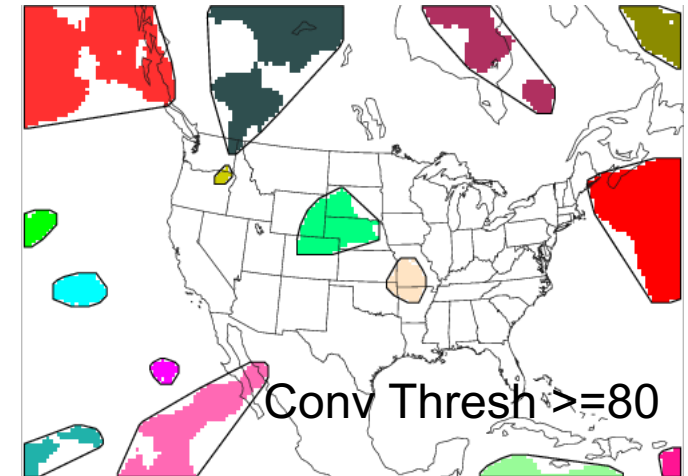

Raw and Post-Processed Stats Similar

Post-Processed Stats More Optimal

Spatial Methods Can Be Useful but Tricky

Conv Thresh >=60

Conv Thresh >=75

Conv Thresh >=80

Conv Thresh >=90
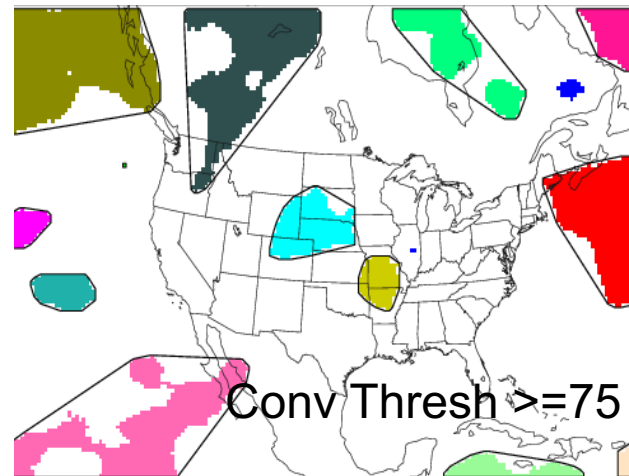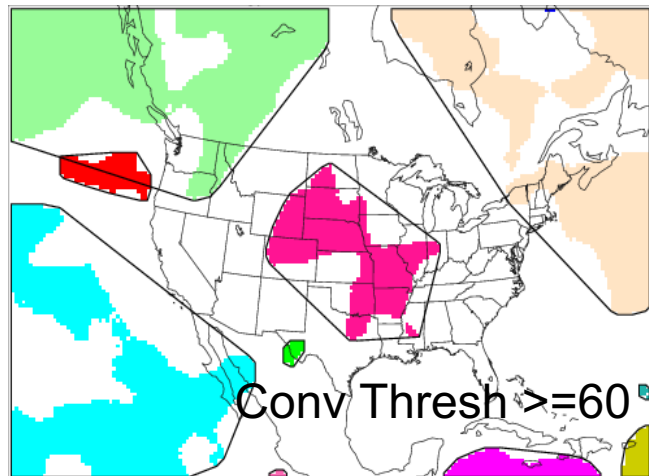
Conv Thresh >=100

MODE Conv Radius 5

Regional vs Global – A Tale of Two Configurations

Forecast Observation Forecast Observation
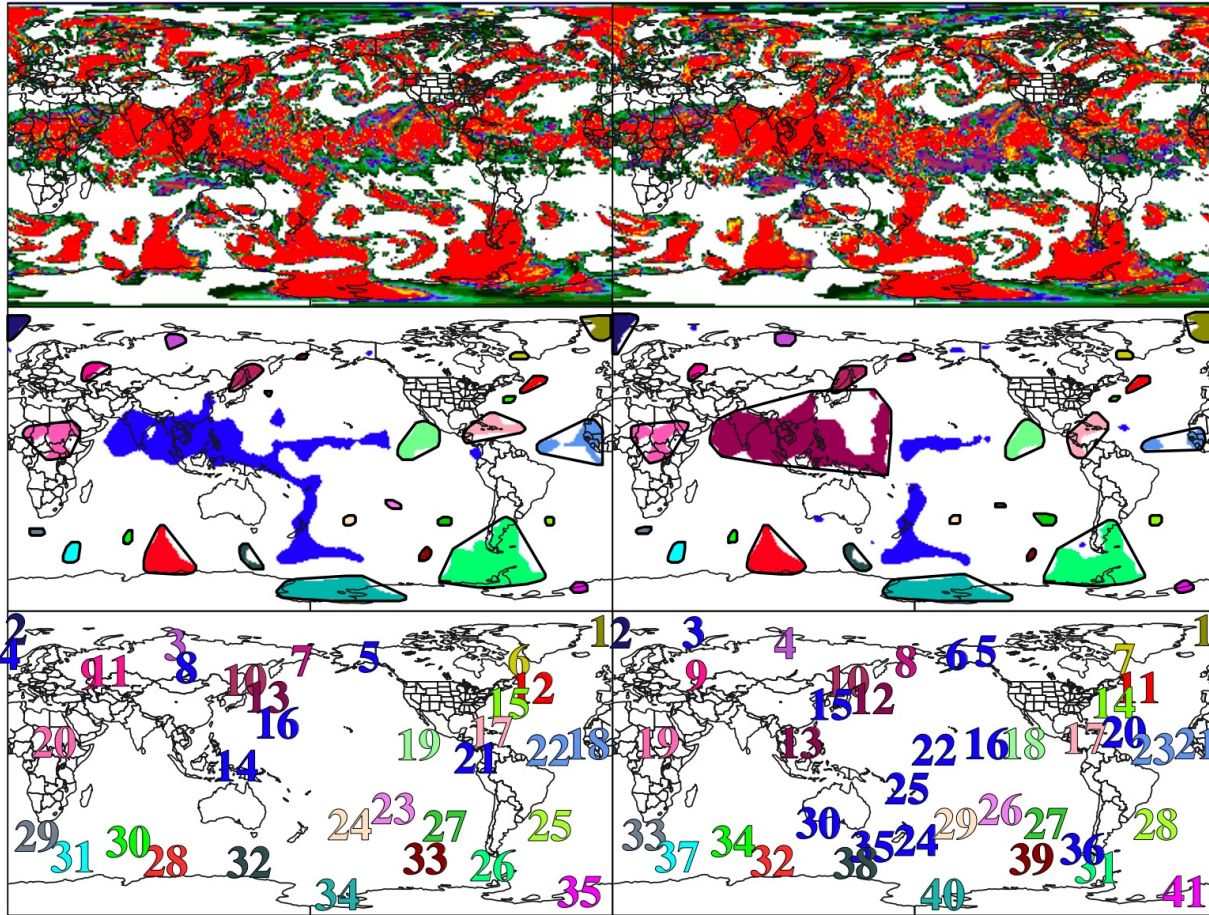
MODE Conv Radius 5; Conv Thresh >=75

MODE Conv Radius 20; Conv Thresh >=75

Somewhere in Between is Probably Better

Using Masking Can Help You Focus But Are Partial Objects Useful?
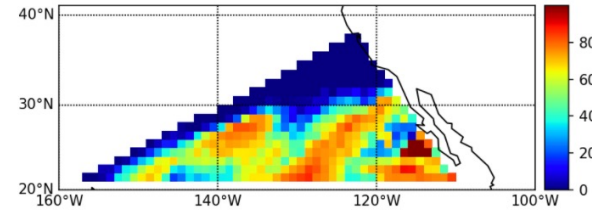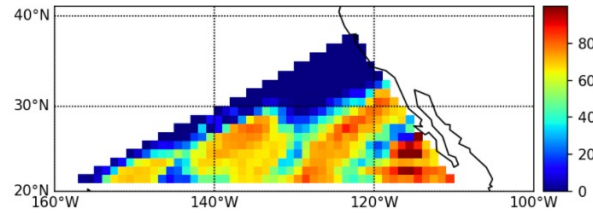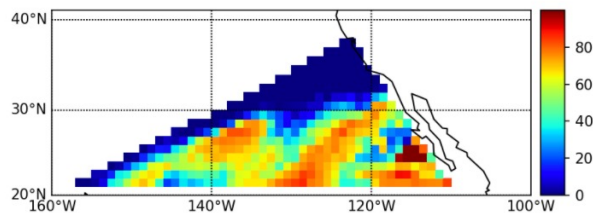
Cloudy

Clear

METplus Use Cases

8. METplus Quick Search for Use Cases

8.1. Use Cases by MET Tool:
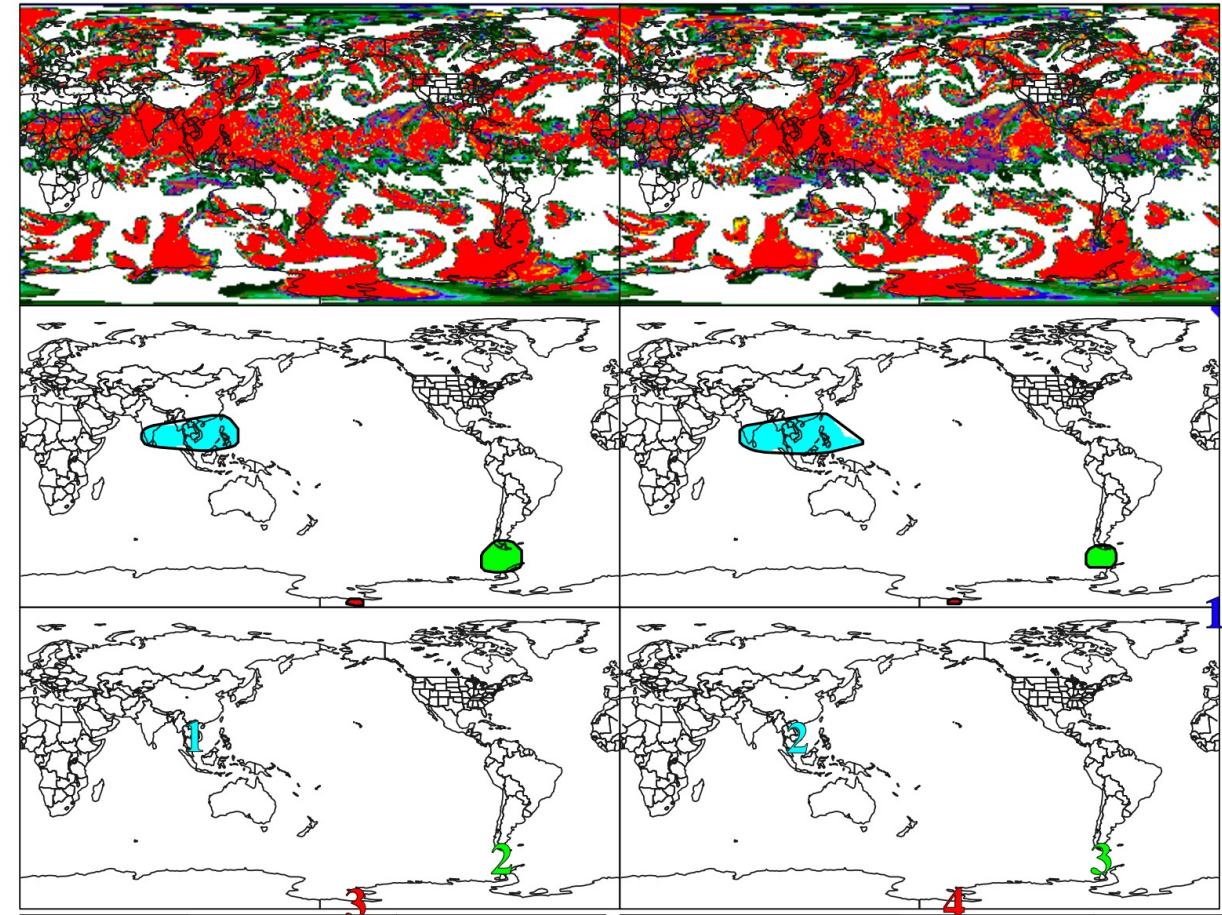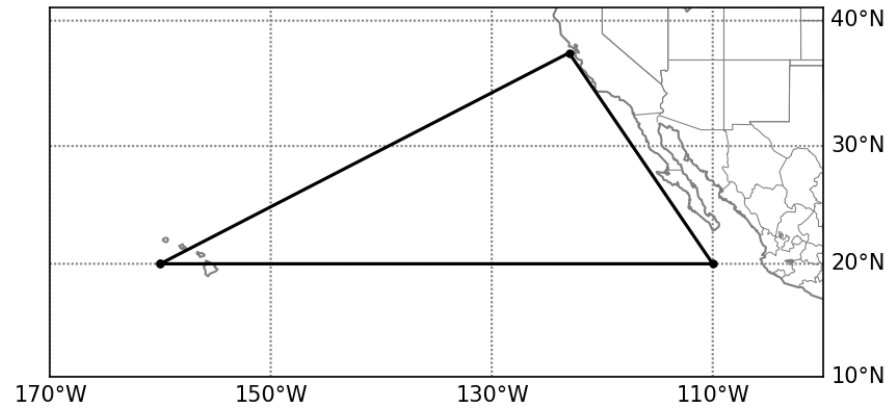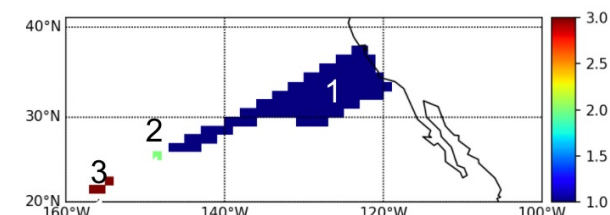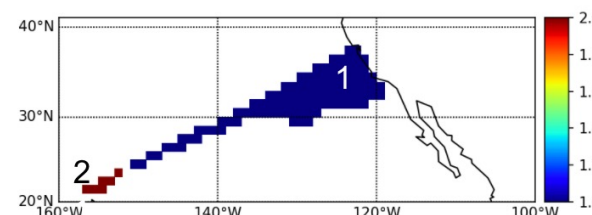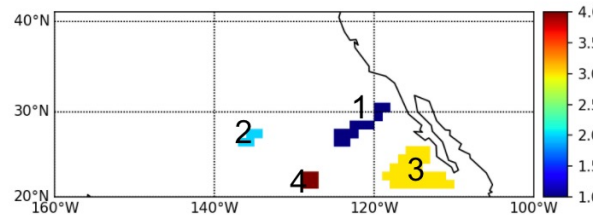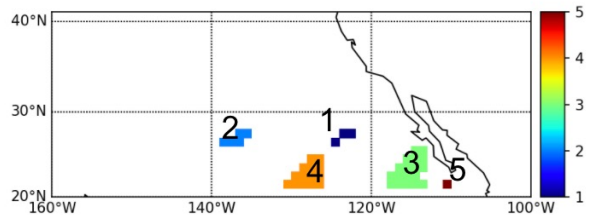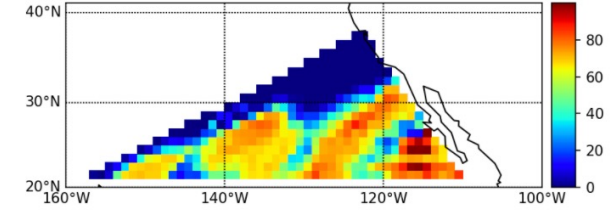
ASCII2NC
CyclonePlotter
EnsembleStat
GenVxMask
GenEnsProd
GridStat
GridDiag
IODA2NC
MODE
MTD
PB2NC
PCPCombine
Point2Grid
PlotDataPlane
PlotPointObs
PointStat
RegridDataPlane
SeriesAnalysis
StatAnalysis
TCDiag
TCMPRPlotter
TCGen
TCPairs
TCRMW
TCStat

Use Cases:
- Sample Data
- Sample Configuration Files
- Documentation

https://metplus.readthedocs.io/en/latest/Users_Guide/usecases.html

8.2. Use Cases by Application:

Air Quality and Composition
Climate
Clouds
Short Range
Data Assimilation
Ensemble
Land Surface
Marine and Cryosphere
Medium Range
PBL
Precipitation
Space Weather
Subseasonal to Seasonal
Subseasonal to Seasonal: Madden-Julian Oscillation
Subseasonal to Seasonal: Mid-Latitude
Tropical Cyclone and Extra-Tropical Cyclone

8.3. Use Cases by Organization:

Developmental Testbed Center (DTC)
National Center for Atmospheric Research (NCAR)
NOAA Weather Prediction Center (WPC)
NOAA Space Weather Prediction Center (SWPC)
NOAA Environmental Modeling Center (EMC)
NOAA Global Systems Laboratory (GSL)
NOAA Hydrometeorology Testbed (HMT)
NOAA Hazardous Weather Testbed (HWT)
State University of New York-Stony Brook University (SUNY-SBU)
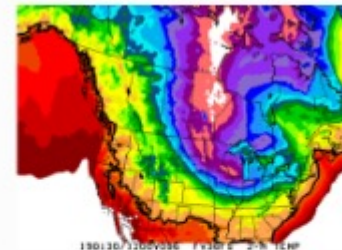
Grid-Stat: Standard Verification of Surface Fields
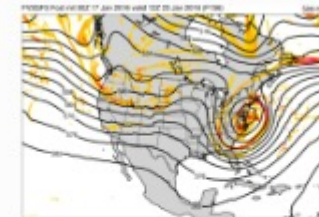
Point-Stat: Standard Verification of Global Upper Air

PyEmbedIngest: Multiple Fields in One File

Exciting Collaborations

- **Met Office** and **NCAR** are collaborating on approaches for sub-sampling high-resolution output for neighborhood methods

- **Air Force** providing mechanisms to make METplus more cyber-secure

- **Bureau of Meteorology** just started contributing directly to METplus – initially enhancing the test suite for CI/CD

- **NCAR**, **Met Office**, **NOAA**, and **NRL** contributing directly to the development of support for evaluation on native grids and use of JEDI libraries

- **NCAR** and **NOAA** working on developing and demonstrating support for S2S, SFS, FireWx, SpaceWx, Land, Marine and Cryo, and AQ/Atm. Comp evaluations

EMC Verification System (EVS)
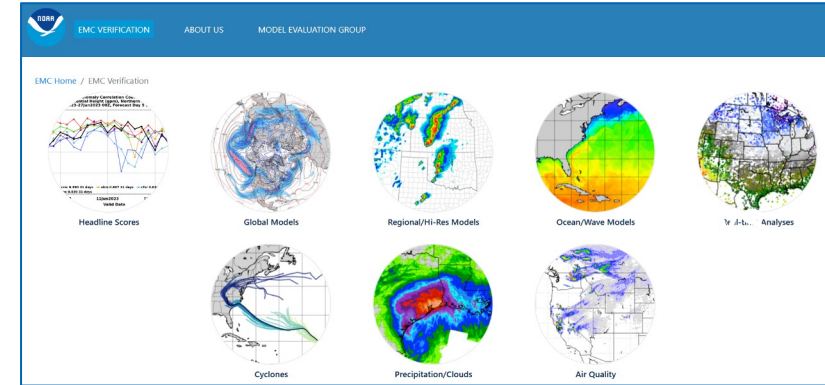
EVS v1 coming by end of CY

Powered by **METplus**

- A new software system for the real-time monitoring of operational NCEP models

- Replaces legacy software

- Unifies the EMC verification effort

- Invokes the results of the 2021 DTC UFS Evaluation Metrics Workshop

- Standardized graphics

- Output will eventually be leveraged to assess performance of model upgrade candidates – DTC working to port to AWS

Resources

METplus <u>website</u>, <u>online tutorial</u>, <u>training series</u>

METplus and MET <u>user support discussion forum</u>

METplus <u>repository</u>, <u>documentation</u>, <u>releases</u>, <u>Docker</u>, <u>v5.1.0 development</u>

MET <u>repository</u>, <u>documentation</u>, <u>releases</u>, <u>Docker</u>, <u>v11.1.0 development</u>

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Questions

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NCAR/RAL/JNT and DTC
jensen@ucar.edu