# Verifying Weather Scale Applications: Global

DTC Community Unified Forecast System Test Plan and Metrics Workshop

July 31, 2018

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# Current Status

- All model verification now managed by one branch: Verification, Post-processing & Product Generation Branch (VPPGB)

- The current operational verification package for global models is the NCEP-EMC Global NWP Model Verification Package
  - Uses VSDB (Verification Statistics DataBase)

- VPPGB working toward unifying all model verification under DTC's Model Evaluation Tools (MET) and MET+
  - Currently in progress for global model verification
  - WMO required grid-to-grid verification has moved to MET (Thanks Binbin Zhou!)

# NCEP- EMC Global NWP Model Verification Package and VSDB - What is it?

- A collection of shell scripts and Fortran programs, uses GrADS for plotting
- Set up to be easily run by user; a driver script allows user to customize what and how they want to run, and then runs requested verification
- Maintained by Fanglin Yang with code contributions from many others
- Current version number 21 released in July 2017
- Code is on…
  - All Weather & Climate Operational Supercomputing System (WCOSS) machine (Tide, Luna, Mars, Gyre, Surge, Venus)
  - NOAA R&D HPC Systems (RDHPCS) machine Theia
  - FTP website

# NCEP- EMC Global NWP Model Verification Package and VSDB - Who uses it and for what?

- Current Uses:
  - Keep track of the performance history of the GFS
  - Compare the operational GFS with other operational global models (http://www.emc.ncep.noaa.gov/gmb/STATS_vsdb)
  - Evaluate parallel GFS experiments proposed for implementation and compare with the operational GFS (http://www.emc.ncep.noaa.gov/gmb/emc.glopara/vsdb/prfv3rt1)
  - Model developers to evaluate their experiments

# NCEP- EMC Global NWP Model Verification Package and VSDB - What does it do?

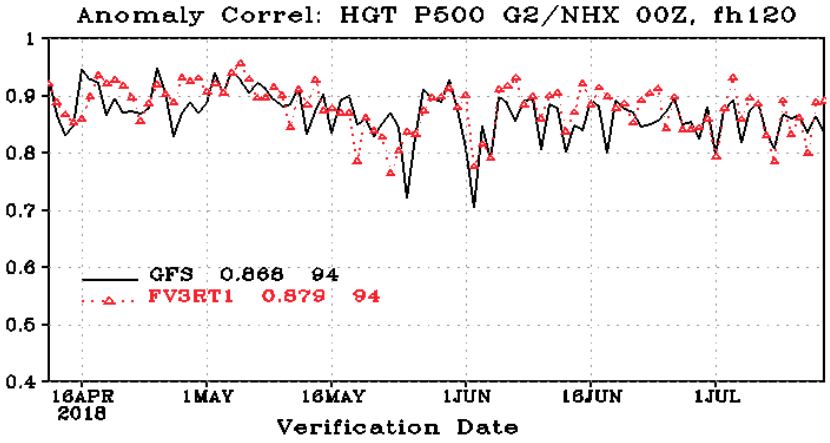
- Built into the parallel GFS workflow, verification statistics computed on the fly, i.e. within the workflow. Can also be run “offline”

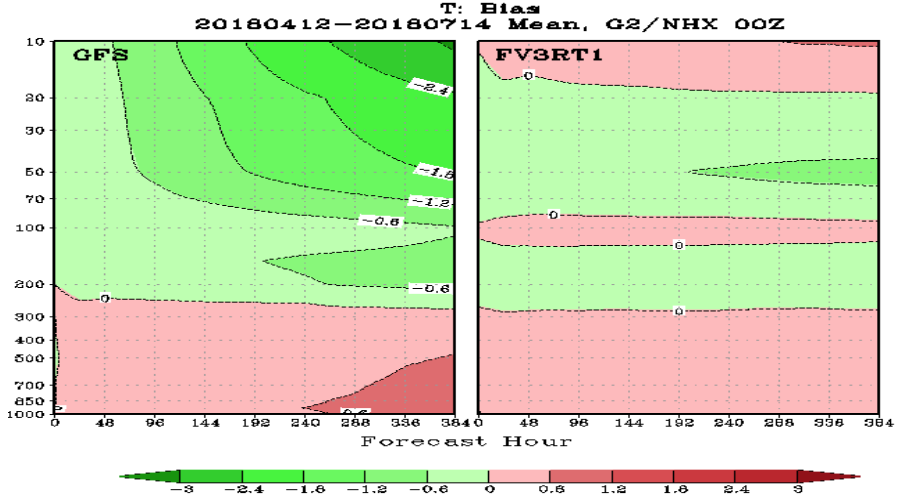
- The package can run various types of verification:
  1. Grid-to-Grid
  2. Scorecard
  3. Grid-to-Obs
  4. Precipitation
  5. 2D (Spatial) Maps
  6. Fit-to-Obs
  7. Tropical Cyclone
  8. Analysis Increment Graphics for Data Assimilation

- Transfers images and a website template to a web server specified by the user for easy display of results

# NCEP- EMC Global NWP Model Verification Package and VSDB - Grid - to - Grid

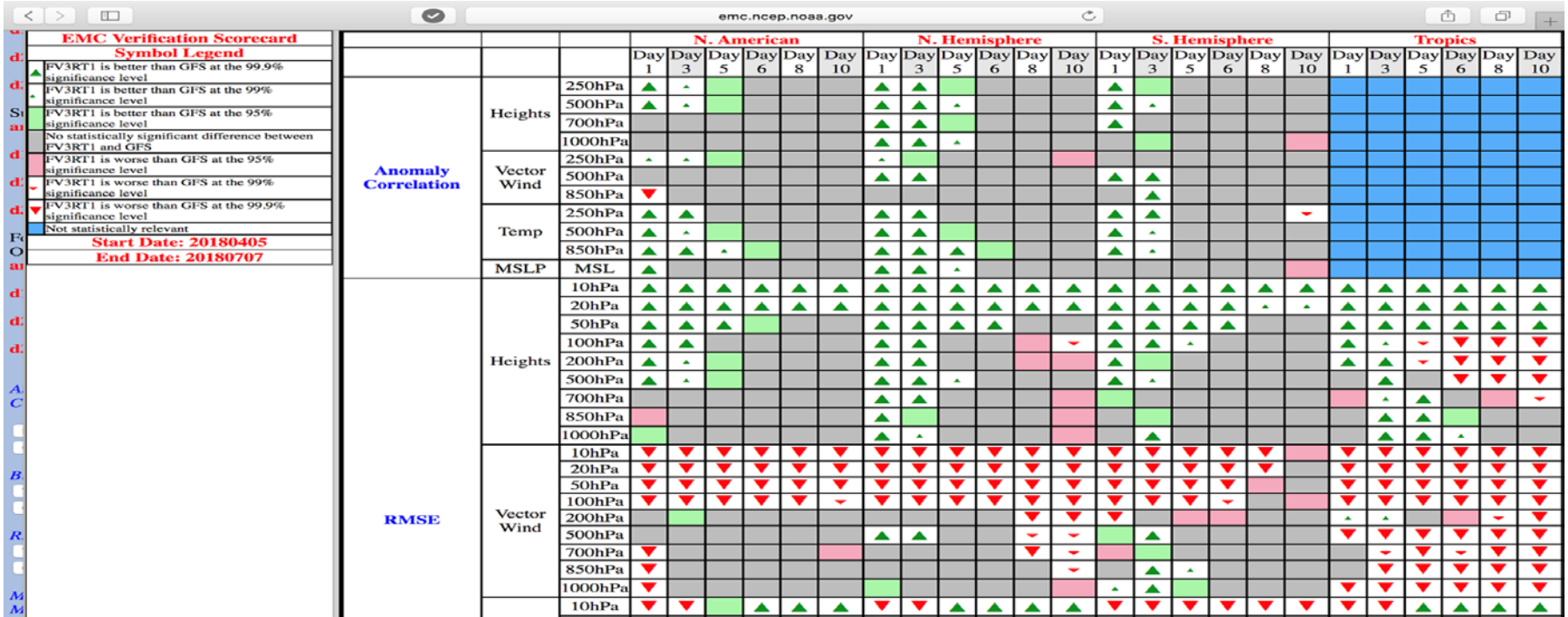
- Step 1 computes regular and anomalous partial sums using the gridded model forecast files and gridded “observation” (model’s own analysis) files (http://www.emc.ncep.noaa.gov/gmb/wx24fy/doc/vsdb_anatomy.txt)
- Step 2 computes various verification metrics and creates plots (http://www.emc.ncep.noaa.gov/gmb/wx24fy/doc/RMSE_decomposition.pdf)



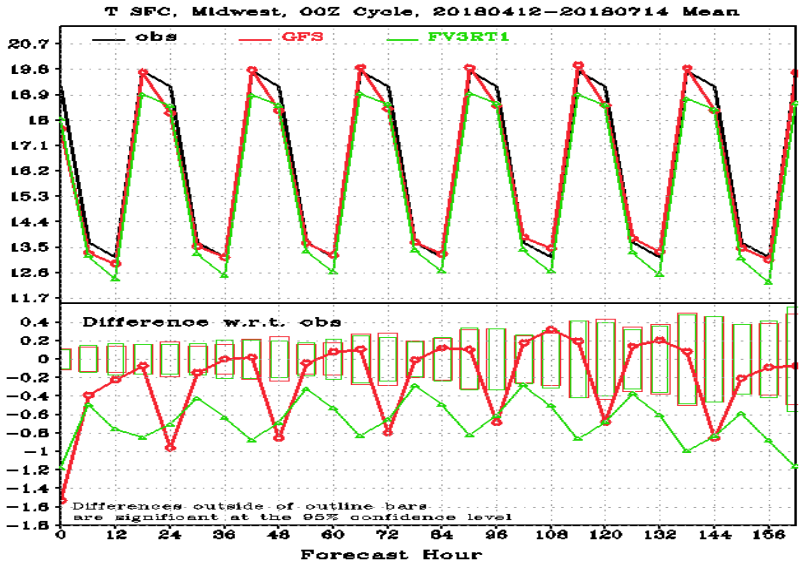
# NCEP- EMC Global NWP Model Verification Package and VSDB - Scorecard

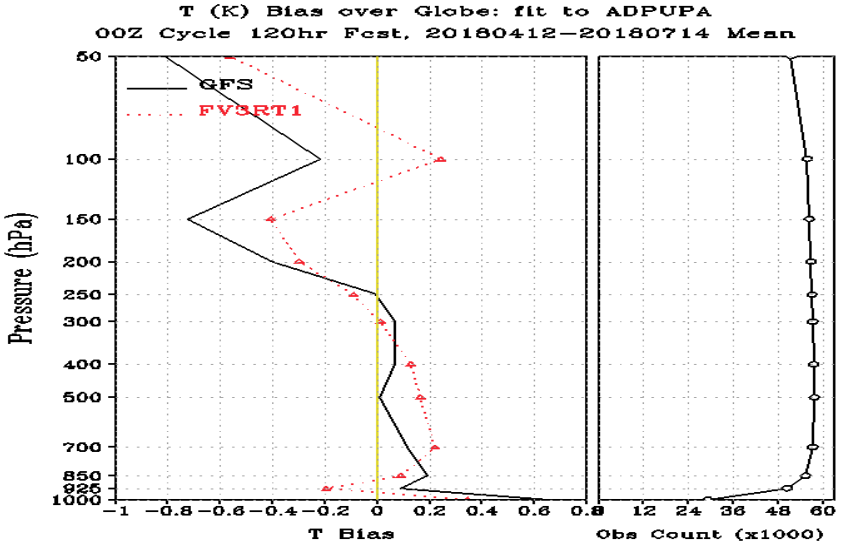
- Uses statistics information from grid-to-grid verification



# NCEP- EMC Global NWP Model Verification Package and VSDB - Grid - to - Obs

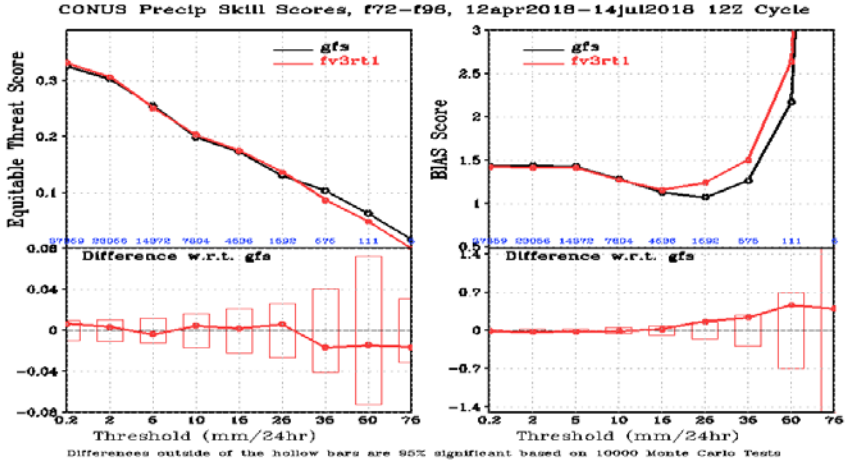
- Step 1 computes regular partial sums interpolating the gridded model forecasts to observations
- Step 2 computes various verification metrics and creates plots

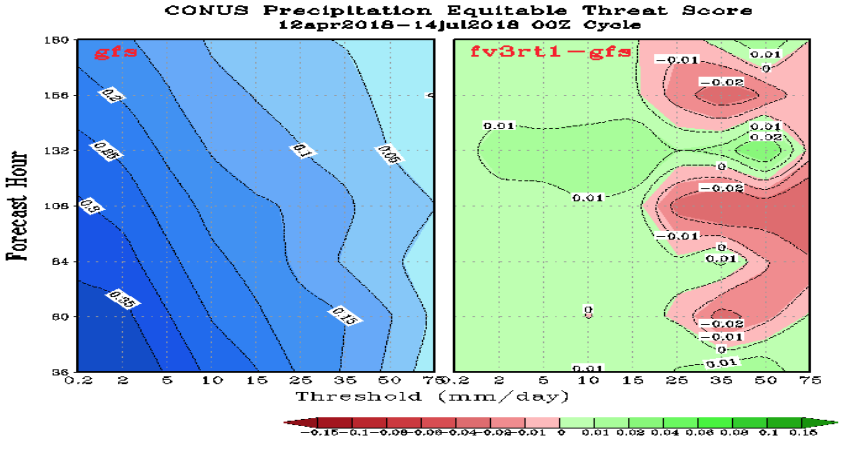


# NCEP- EMC Global NWP Model Verification Package and VSDB - Precipitation

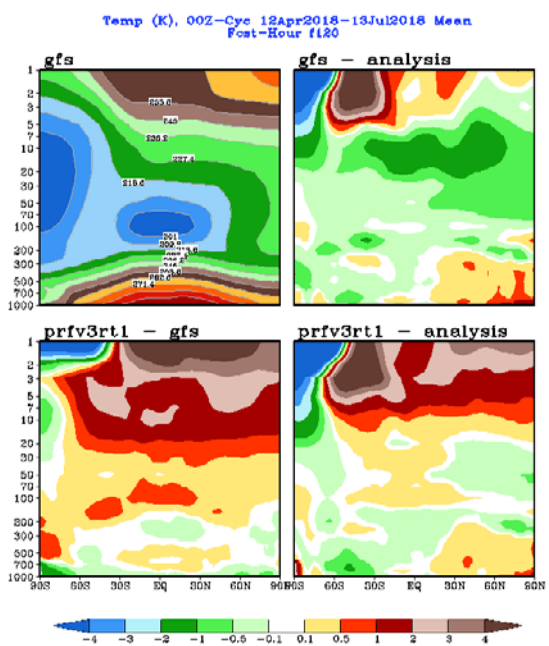
- Step 1 computes contingency table counts for various thresholds using gridded model forecast files and uses CPC rain gauge data as truth.
- Step 2 computes various verification metrics and creates plots
- Ying Lin maintains a grid-to-grid precipitation verification using Climatology Calibrated Precipitation Analysis (CCPA) as observations (http://www.emc.ncep.noaa.gov/mmb/ylin/pcpverif/scores)

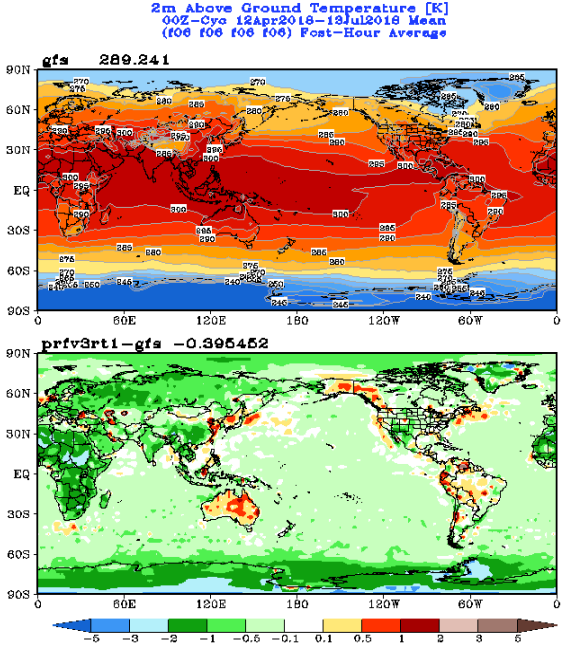


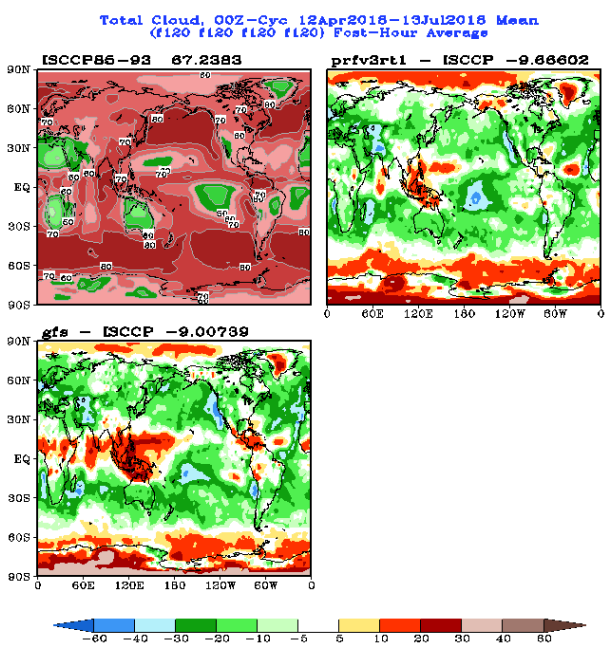



# NCEP- EMC Global NWP Model Verification Package and VSDB - 2D Maps

- Lat-lon and zonal mean vertical cross section plots of forecasts and model analysis, compare model-to-model or model-to-observations

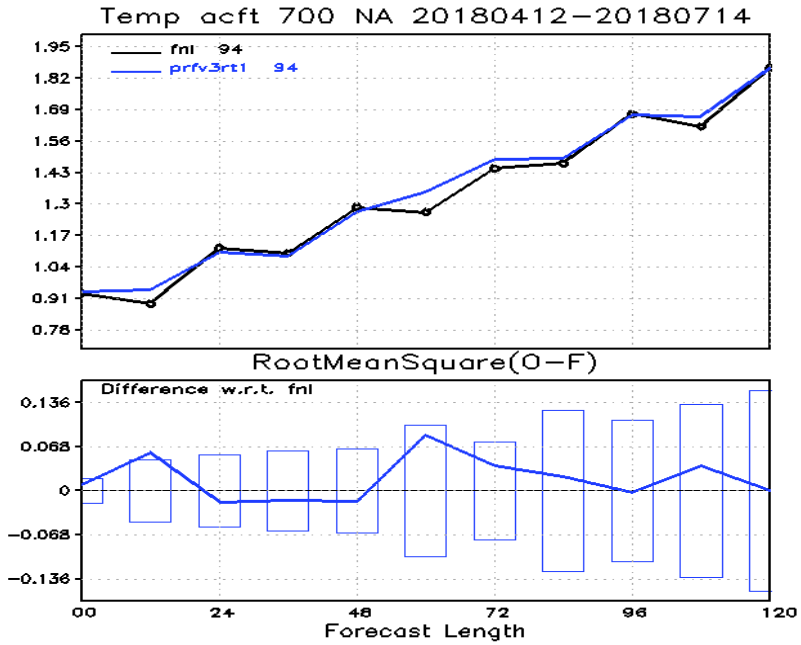


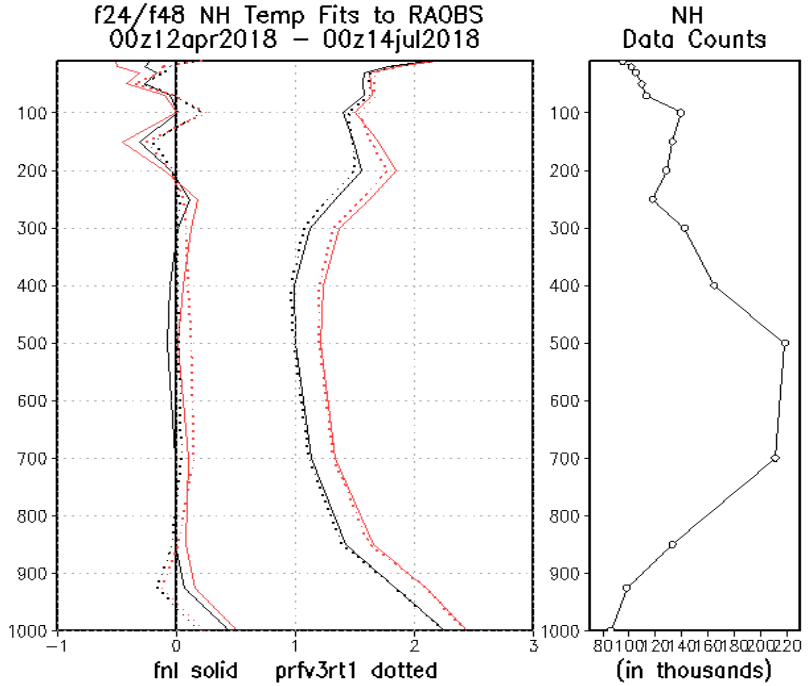



# NCEP- EMC Global NWP Model Verification Package and VSDB - Fit - to - Obs

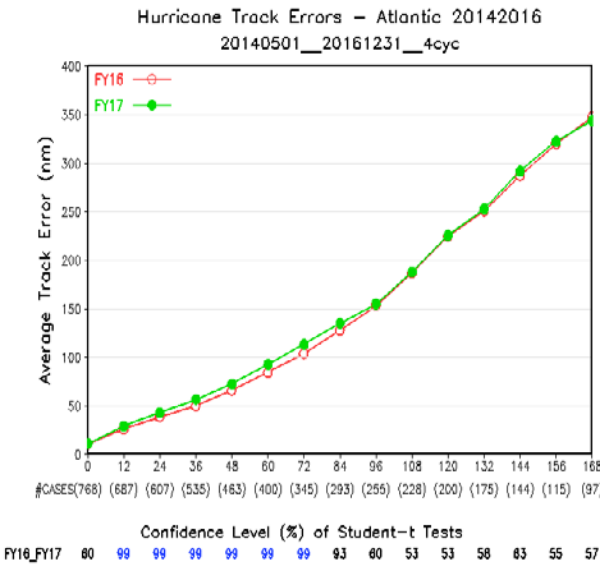
- Compare model forecasts and analysis to RAOBS and aircraft data

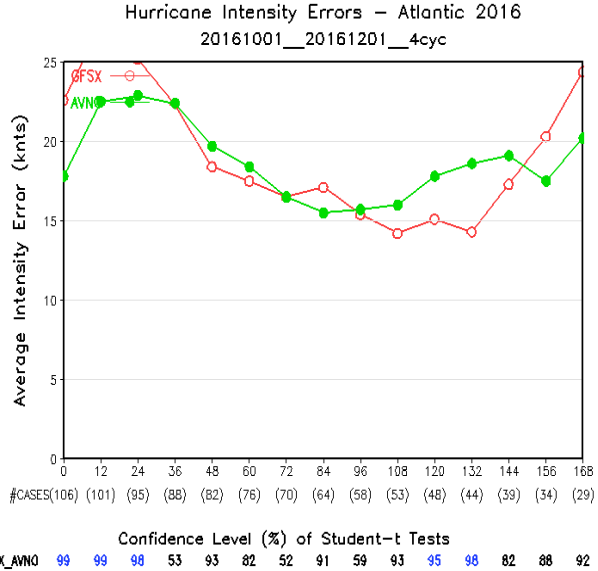


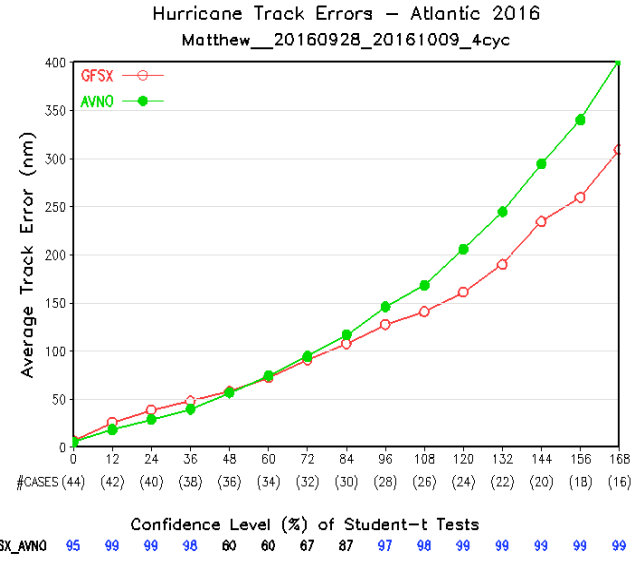



# NCEP- EMC Global NWP Model Verification Package and VSDB - Tropical Cyclone

- Compute tropical cyclone track and intensity error for individual storms and basin mean
- NHC TC best-track used as truth



# Moving to MET+

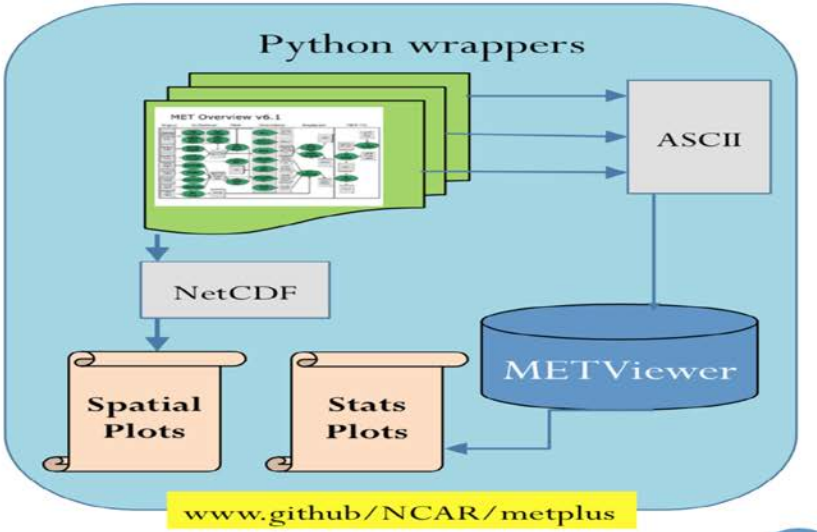
- Under Next Generation Global Prediction System (NGGPS), all verification is unifying under MET+

## MET+

Python wrappers around:

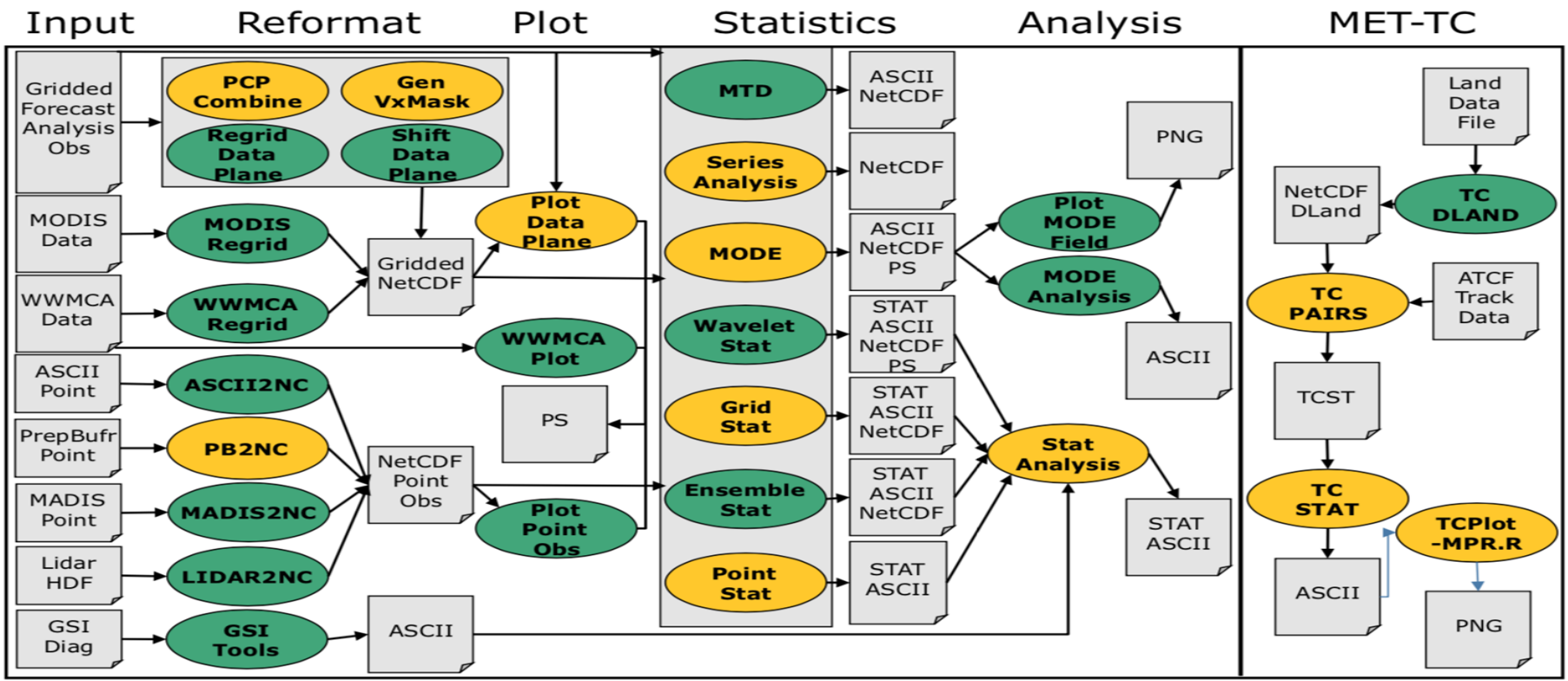
- MET (core)
- METViewer (core)
- Plotting
  - METViewer User Interface
  - METViewer Batch Engine
  - Python plotting scripts
- Communication between MET & python algorithms (Cython)

***Near Term:*** *After Global – CAM, Ensembles and Aerosols/Air Qual*
***Longer Term:*** *Earth System "Components"*




Slide from Tara Jensen

# What is Wrapped by Python Right Now

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Slide from Tara Jensen

# Moving to MET+

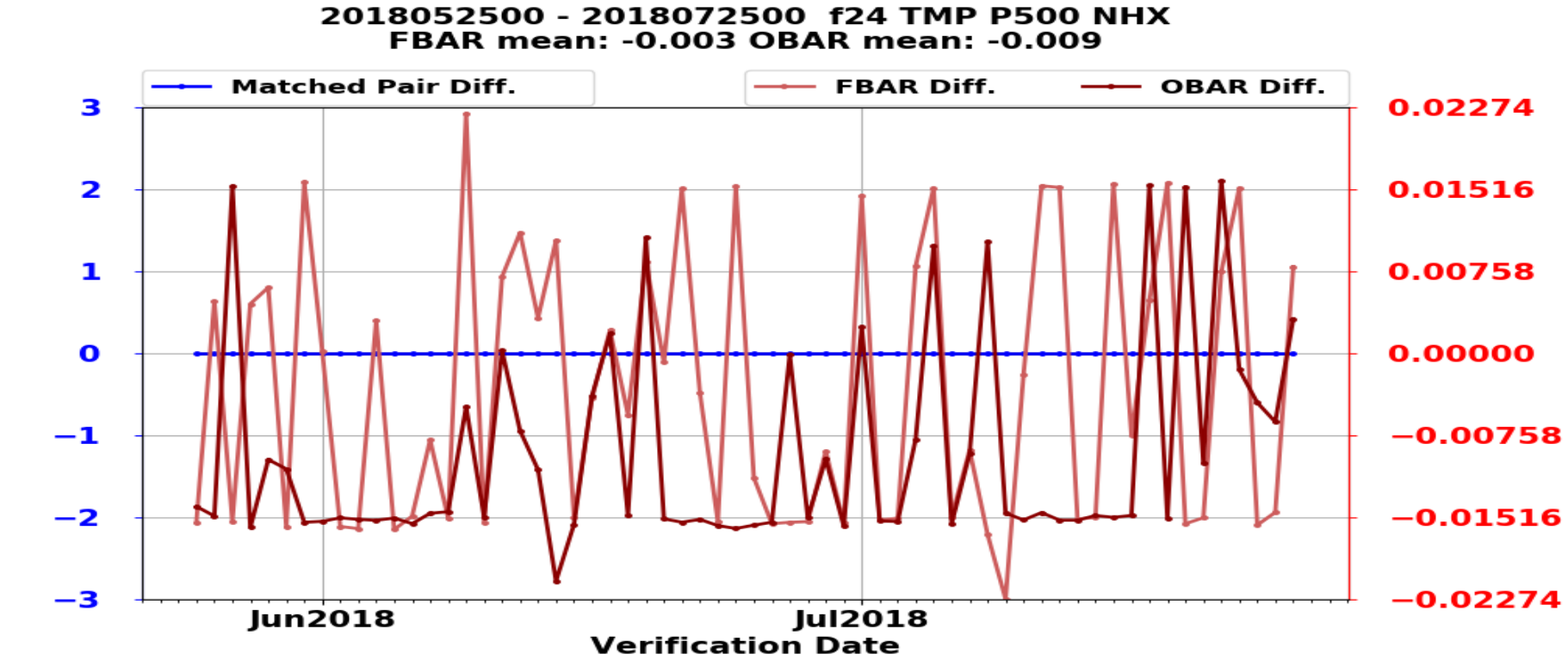
- The base statistical code of MET+, MET, was originally developed to recreate verification capabilities at EMC. Can perform all the types of verification currently done in VSDB.

- Work being done on creating interface to connect MET+ into the parallel GFS workflow

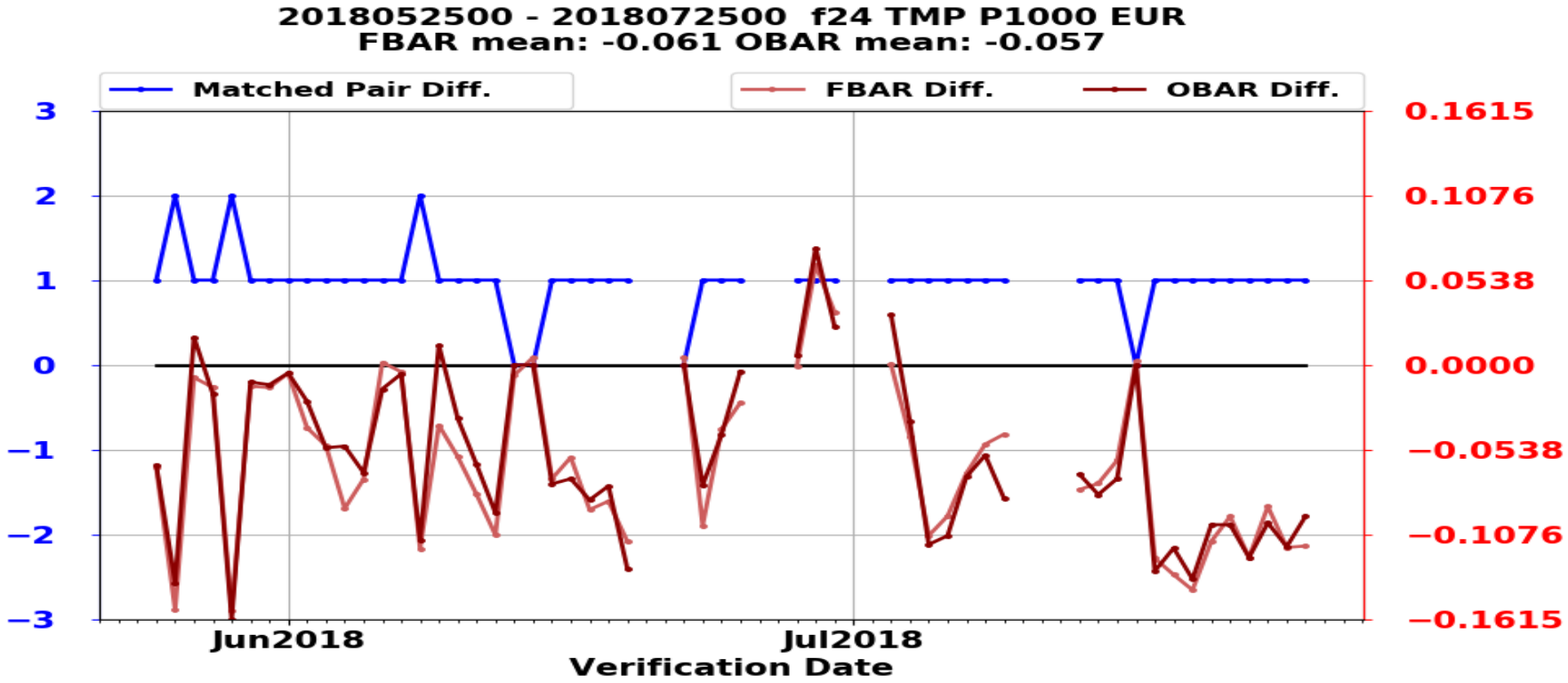
- Current MET+ use cases set up for global model verification

    1. Grid-to-Grid - tested
    2. Grid-to-Obs - tested
    3. Precipitation - needs testing
    4. 2D Maps - needs testing
    5. Tropical Cyclone - being tested by DTC
    6. Scorecard - testing, working with GSD

# How do MET+ and VSDB compare? Grid -to- Grid



# How do MET+ and VSDB compare?
## Grid-to-Obs



# How do MET+ and VSDB compare?
## Scorecard

| EMC Verification Scorecard | |
|---|---|
| **Symbol Legend** | |
| ▲ | FV3RT1 is better than GFS at the 99.9% significance level |
| ▲ | FV3RT1 is better than GFS at the 99% significance level |
| ▲ | FV3RT1 is better than GFS at the 95% significance level |
| | No statistically significant difference between FV3RT1 and GFS |
| | FV3RT1 is worse than GFS at the 95% significance level |
| ▼ | FV3RT1 is worse than GFS at the 99% significance level |
| ▼ | FV3RT1 is worse than GFS at the 99.9% significance level |
| | Not statistically relevant |
| **Start Date: 20180405** | |
| **End Date: 20180707** | |

| | | | N. American | | | | | | N. Hemisphere | | | | | | S. Hemisphere | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Day 1 | Day 3 | Day 5 | Day 6 | Day 8 | Day 10 | Day 1 | Day 3 | Day 5 | Day 6 | Day 8 | Day 10 | Day 1 | Day 3 | Day 5 | Day 6 | Day 8 | Day 10 |
| Anomaly Correlation | Heights | 250hPa | ▲ | ▲ | | | | | ▲ | ▲ | | | | | ▲ | | | | | |
| | | 500hPa | ▲ | ▲ | | | | | ▲ | ▲ | ▲ | | | | ▲ | ▲ | | | | |
| | | 700hPa | | | | | | | ▲ | ▲ | | | | | ▲ | | | | | |
| | | 1000hPa | | | | | | | ▲ | ▲ | ▲ | | | | | | | | | |
| | Vector Wind | 250hPa | ▲ | ▲ | | | | | ▲ | | | | | | | | | | | |
| | | 500hPa | | | | | | | ▲ | ▲ | | | | | ▲ | ▲ | | | | |
| | | 850hPa | ▼ | | | | | | | | | | | | | ▲ | | | | |
| | Temp | 250hPa | ▲ | ▲ | | | | | ▲ | ▲ | | | | | ▲ | ▲ | | | | ▼ |
| | | 500hPa | ▲ | ▲ | | | | | ▲ | ▲ | | | | | ▲ | ▲ | | | | |
| | | 850hPa | ▲ | ▲ | ▲ | | | | ▲ | ▲ | ▲ | | | | ▲ | ▲ | | | | |
| | MSLP | MSL | ▲ | | | | | | ▲ | ▲ | ▲ | | | | | | | | | |

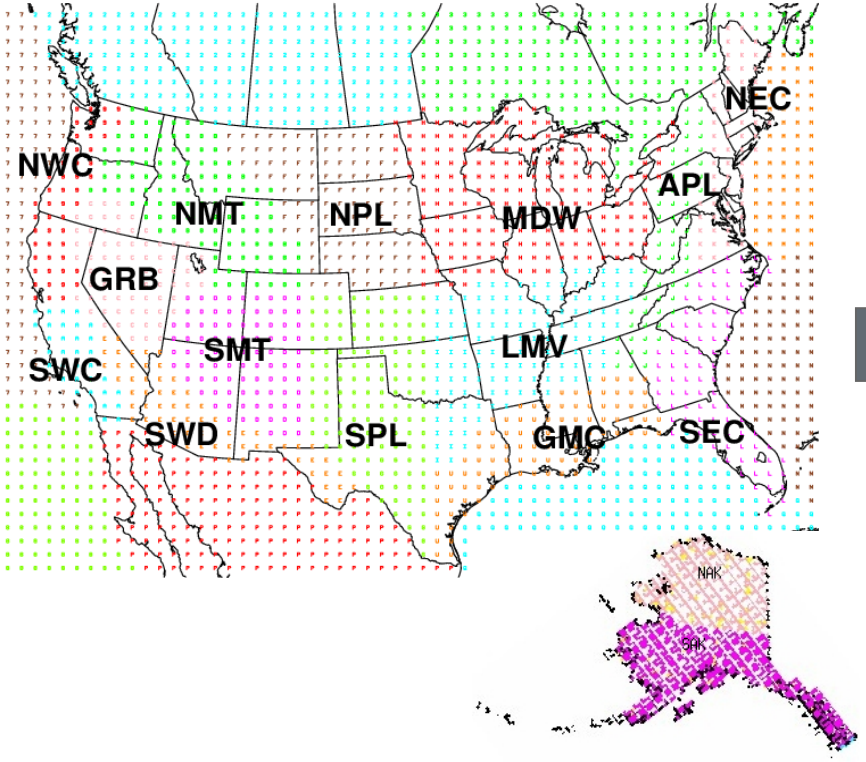
PRFV3RT1 vs GFS -- created 2018_07_11

for PRFV3RT1 and GFS

2018-04-05 00:00:00 - 2018-07-07 00:00:00

| | | | N.American | | | | | | N.Hemisphere | | | | | | S.Hemisphere | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Day 1 | Day 3 | Day 5 | Day 6 | Day 8 | Day 10 | Day 1 | Day 3 | Day 5 | Day 6 | Day 8 | Day 10 | Day 1 | Day 3 | Day 5 | Day 6 | Day 8 | Day 10 |
| Anomaly Correlation | Heights | P250 | | | | | | | | | | | | | | | | | | |
| | | P500 | | | | | | | | | | | | | | | | | | |
| | | P700 | | | | | | | | | | | | | | | | | | |
| | | P1000 | | | | | | | | | | | | | | | | | | |
| | Temp | P250 | | | | | | | | | | | | | | | | | | |
| | | P500 | | | | | | | | | | | | | | | | | | |
| | | P850 | | | | | | | | | | | | | | | | | | |
| | MSLP | MSL | | | | | | | | | | | | | | | | | | |

# Other Work Going on For Global Verification

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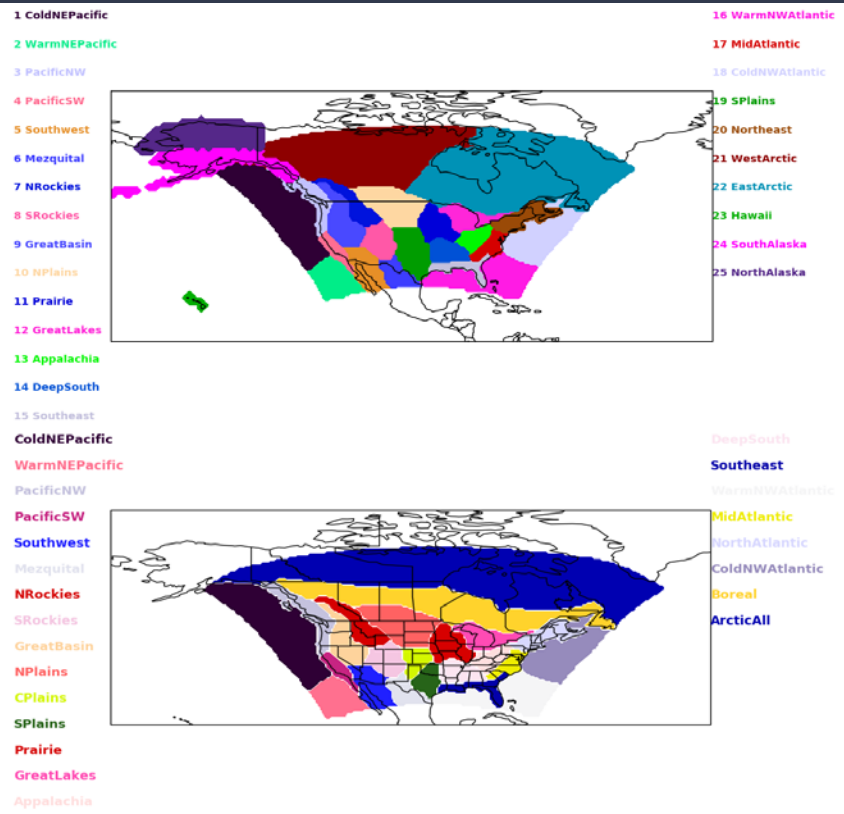

# Looking Forward

- For a complete evaluation for a GFS implementation, there needs to be at least all these aspects of the current verification package.

- What is missing? What can be added?
  - Use more observational datasets
  - Make use and expand on current work using MET's MODE tool (work done by Tracey Dorian, http://www.emc.ncep.noaa.gov/gc_wmb/tdorian/)
  - New plots like Taylor and Roebber diagrams
  - Work more with community, what would they like to see? New statistics added? Variables? Types of plots?