Validation of Significant Weather Features and Processes in Operational Models Using a Cyclone Relative Approach

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and

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DTC
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Project Goals

- Cyclone tracking, matching, and verification. Compare GEFS, CMC, and EC ensembles for days 0-6.

- Use cyclone relative approach to investigate some of the relevant processes associated with various cyclone biases (moisture, precipitation, surface fluxes, stability, etc...).

- Develop feature-relative verification and diagnostic software within NCAR MET (Model Evaluation Tools).

- Port the feature-relative software in MET to our Operational Center partners and iterate on parameters relevant to operations and Testbeds (e.g., WPC Winter Weather Experiment).

Korfe and Colle (In revision WAF): Percent Best (1ˢᵗ) as well as Percent 2ⁿᵈ-5ᵗʰ rank for Cyclone Intensity and Along-Track for Days 4-6 for mean of EC, NCEP, CMC, NCEP+CMC, and ALL
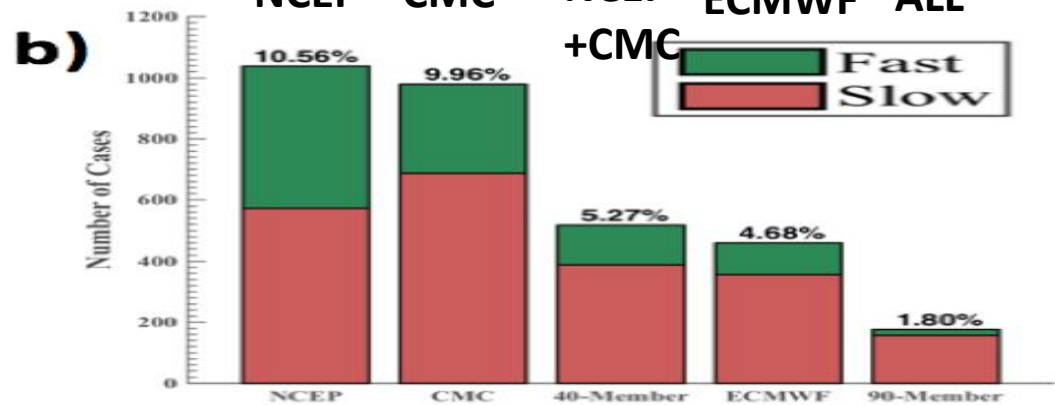
12-72 h

72-144 h

Legend:
- NCEP
- CMC
- NCEP+CMC
- ECMWF
- NCEP+CMC+ECMWF

Cyclone Intensity

Cyclone Intensity

Along-Track
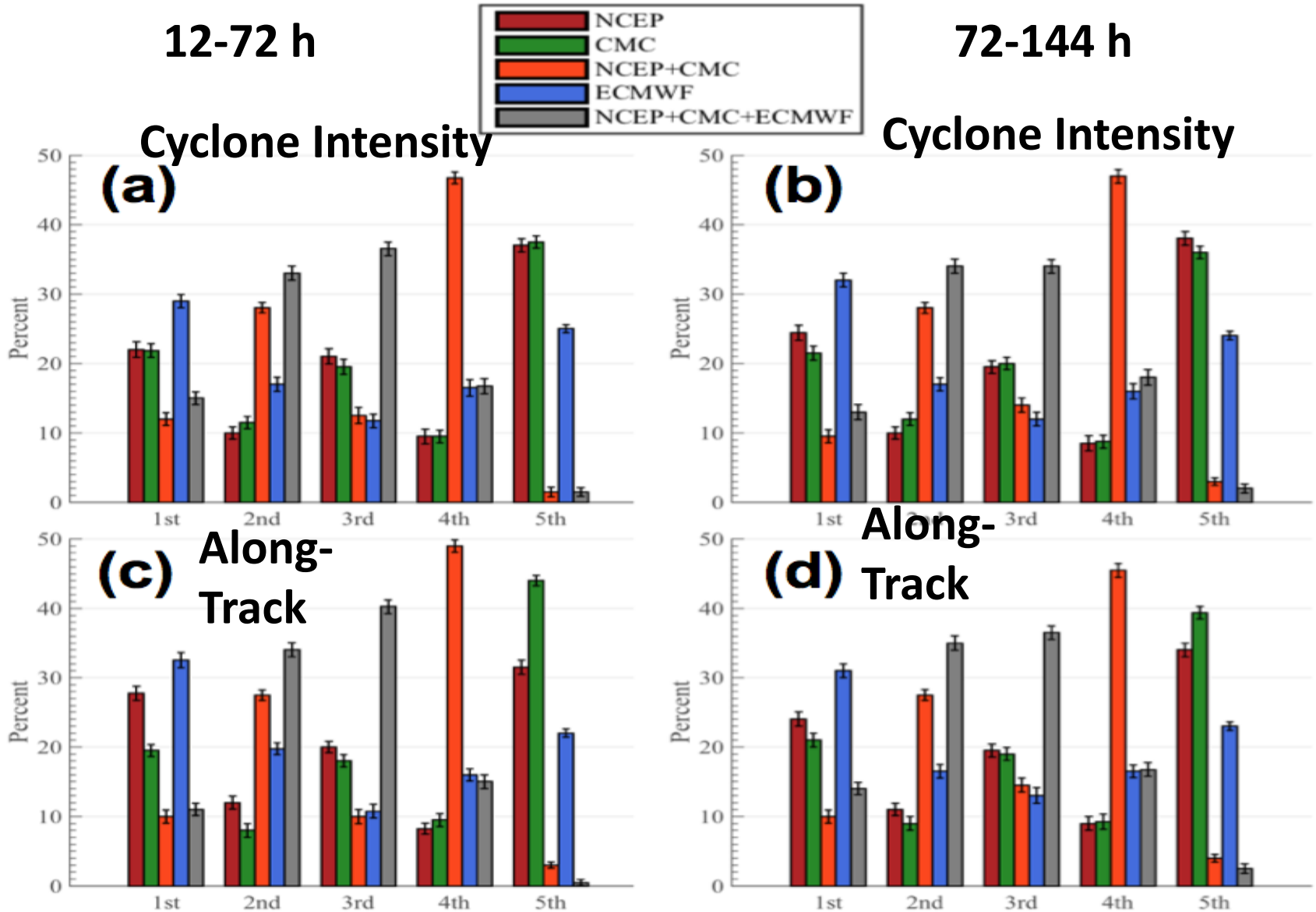
Along-Track

Percent of Cases for Observed Cyclone Outside of Full Ensemble Envelope (hour 120)
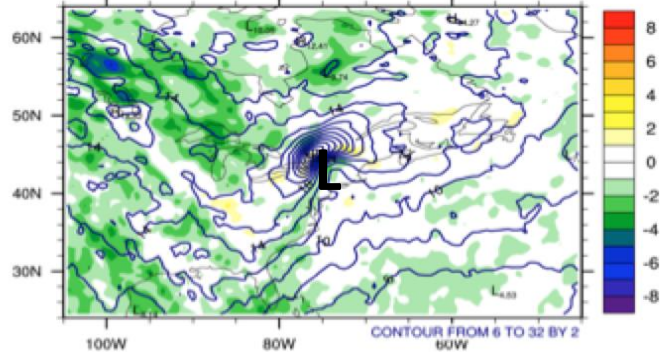
Cyclone Intensity
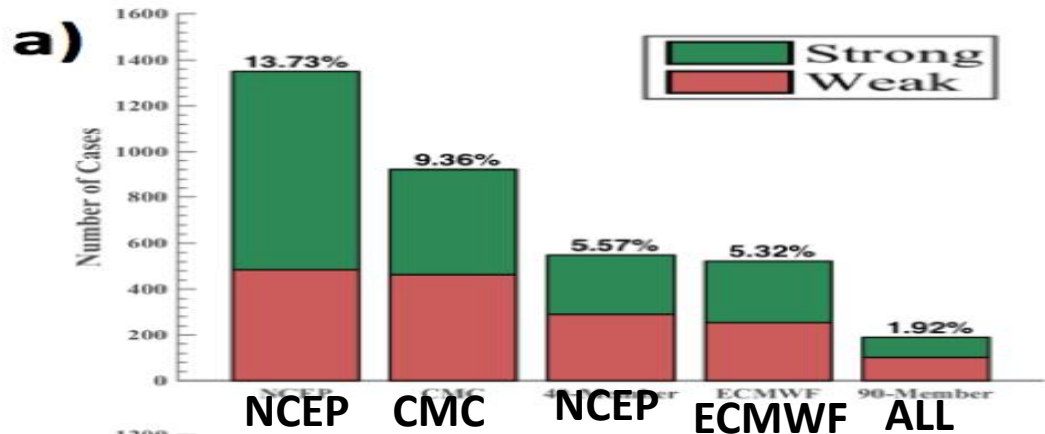
Along-Track

Cross-Track
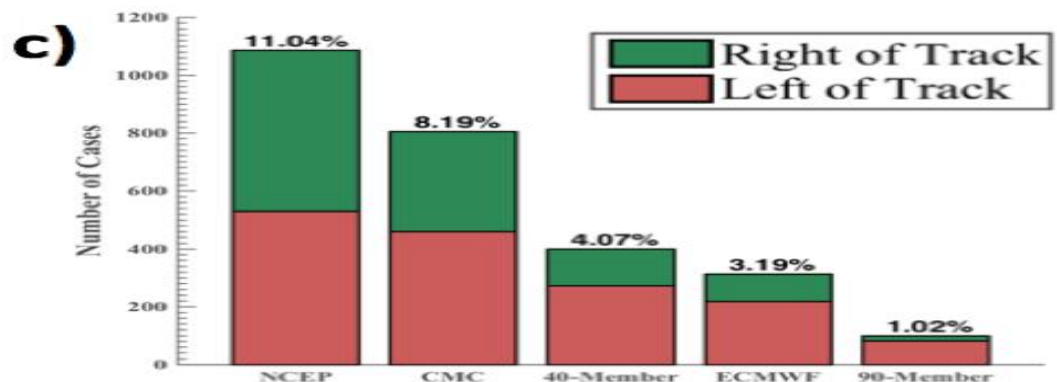
Cyclone Relative Approach – (925 hPa Temp Gradient.. GFS Over vs Under-deepened > 1 stnd dev Cases (hour 120)
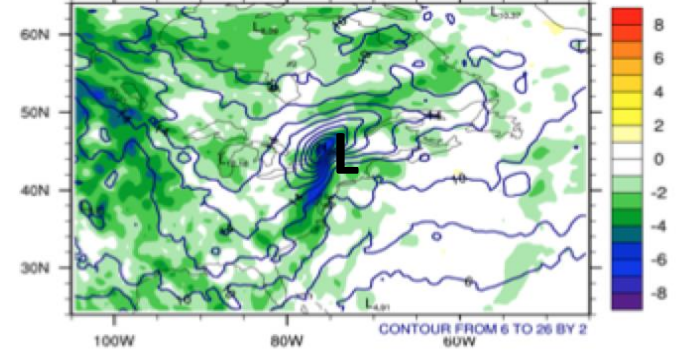
Overdeepened Cases

Underdeepened Cases
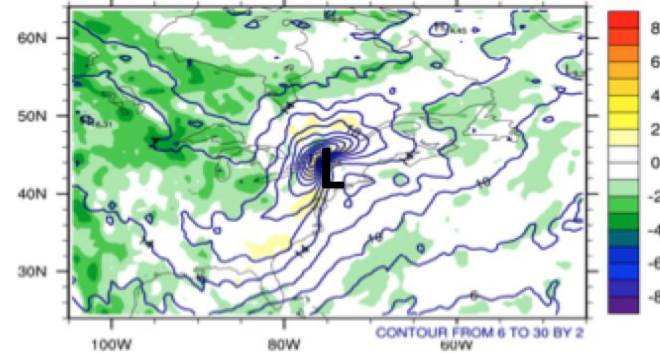
Hour 54-72

925hPa TG error for (-)87 cases h54-72(K/10^3km)
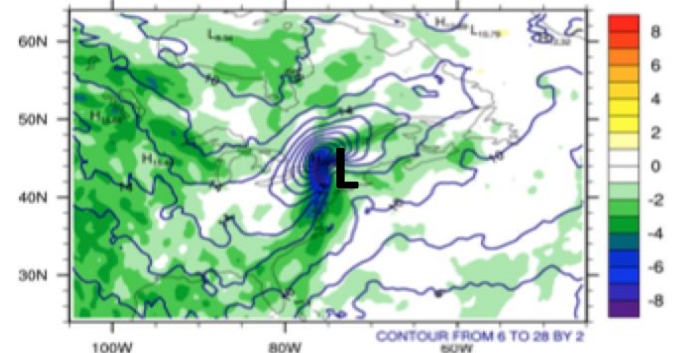
925hPa TG error for (+)89 cases h54-72(K/10^3km)
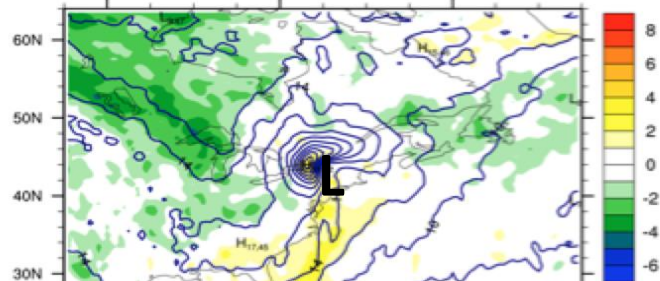
Hour 78-96

925hPa TG error for (-)150 cases h78-96(K/10^3km)
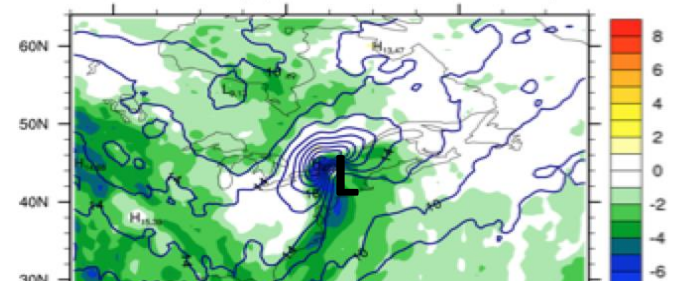
925hPa TG error for (+)166 cases h78-96(K/10^3km)

Hour 102-120

925hPa TG error for (-)167 cases h102-120(K/10^3km)

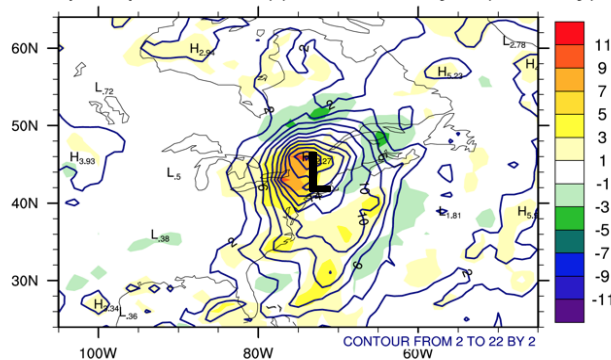925hPa TG error for (+)179 cases h102-120(K/10^3km)

Cyclone Relative Approach – (Precipitation Error using GPCP versus GFS Over vs Under-deepened > 1 stnd dev cases
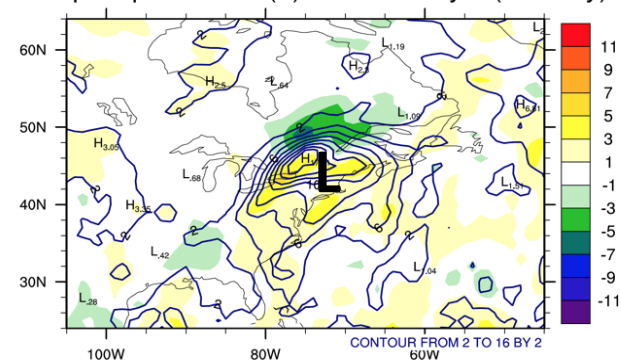

Overdeepened Cases — Underdeepened Cases

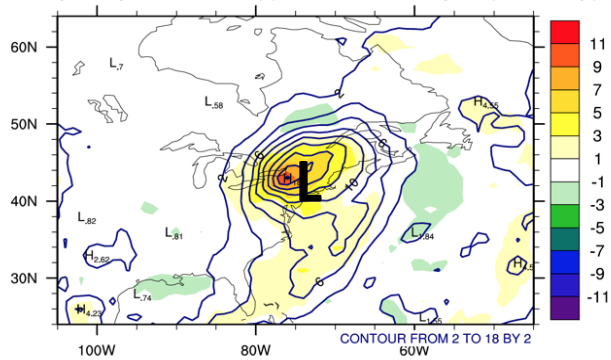Hour 54-72 — Total precipitation for (-)87 cases day 3 (mm/day) — Total precipitation for (+)89 cases day 3 (mm/day)
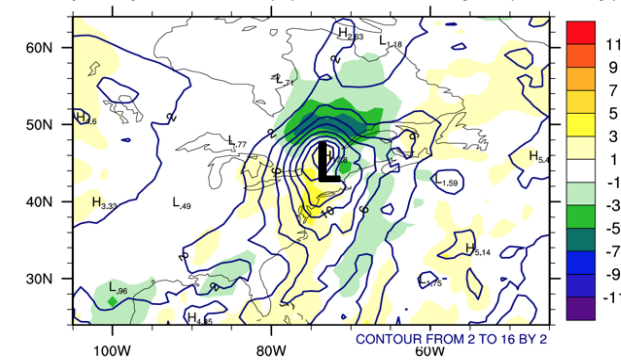
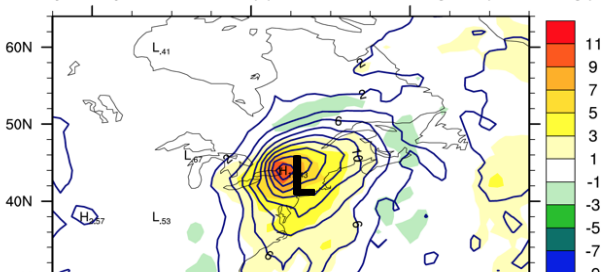Hour 78-96 — Total precipitation for (-)150 cases day 4 (mm/day) — Total precipitation for (+)166 cases day 4 (mm/day)
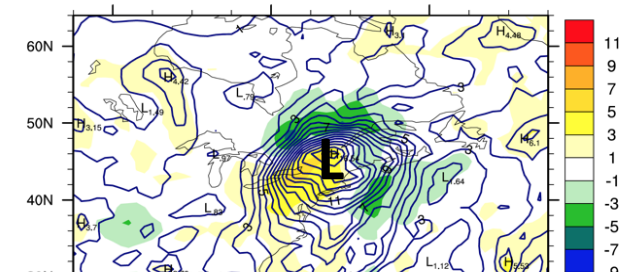
Hour 102-120 — Total precipitation for (-)167 cases day 5 (mm/day) — Total precipitation for (+)179 cases day 5 (mm/day)
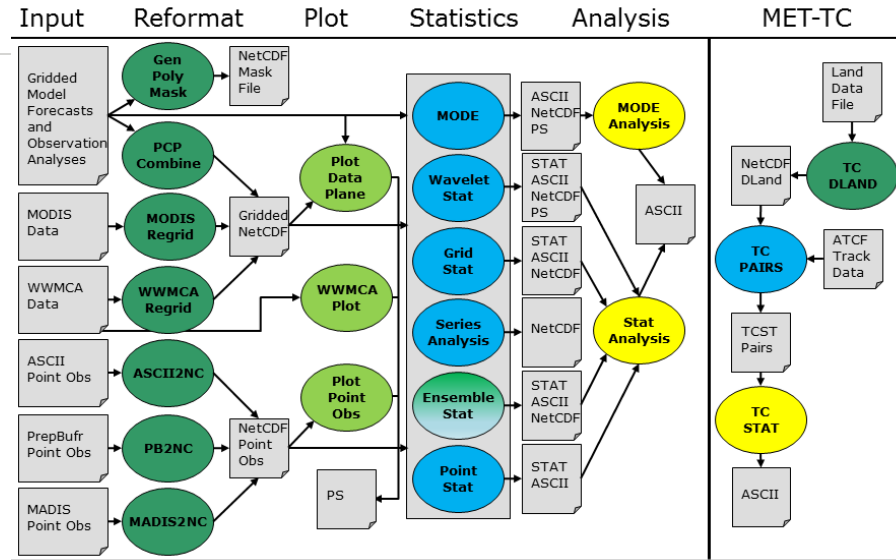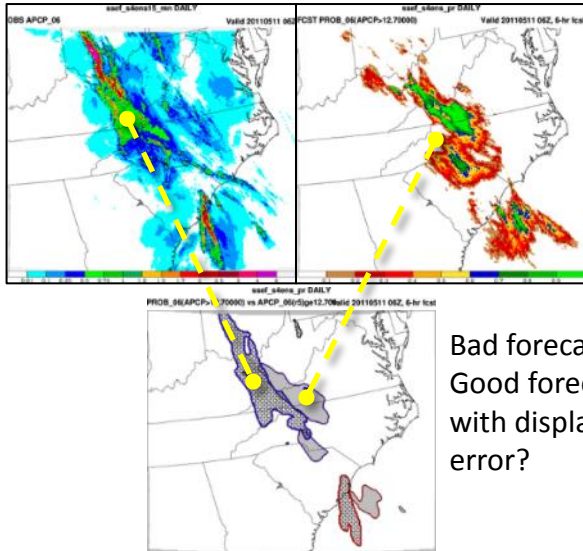
MET

Model Evaluation Tools

A verification toolkit designed for flexible yet systematic evaluation
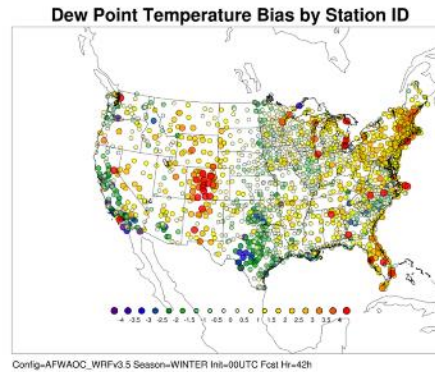## (supported to the community via the DTC)

- **Originally developed to replicate the EMC mesoscale verification system**
- **Over 70 traditional statistics** using both point and gridded datasets
- Multiple interpolation methods
- Computation of confidence intervals
- Able to read in GRIB1, GRIB2 and CF-compliant NetCDF
- Applied to many spatial and temporal scales
- 3300+ users, both US & Int'l
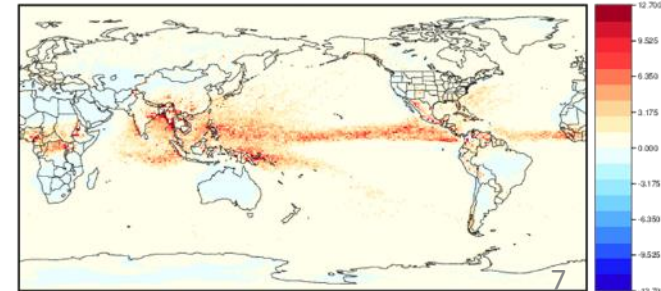

Object Based and Spatial Methods

Bad forecast or Good forecast with displacement error?

Geographical Representation of Errors

Dew Point Temperature Bias by Station ID

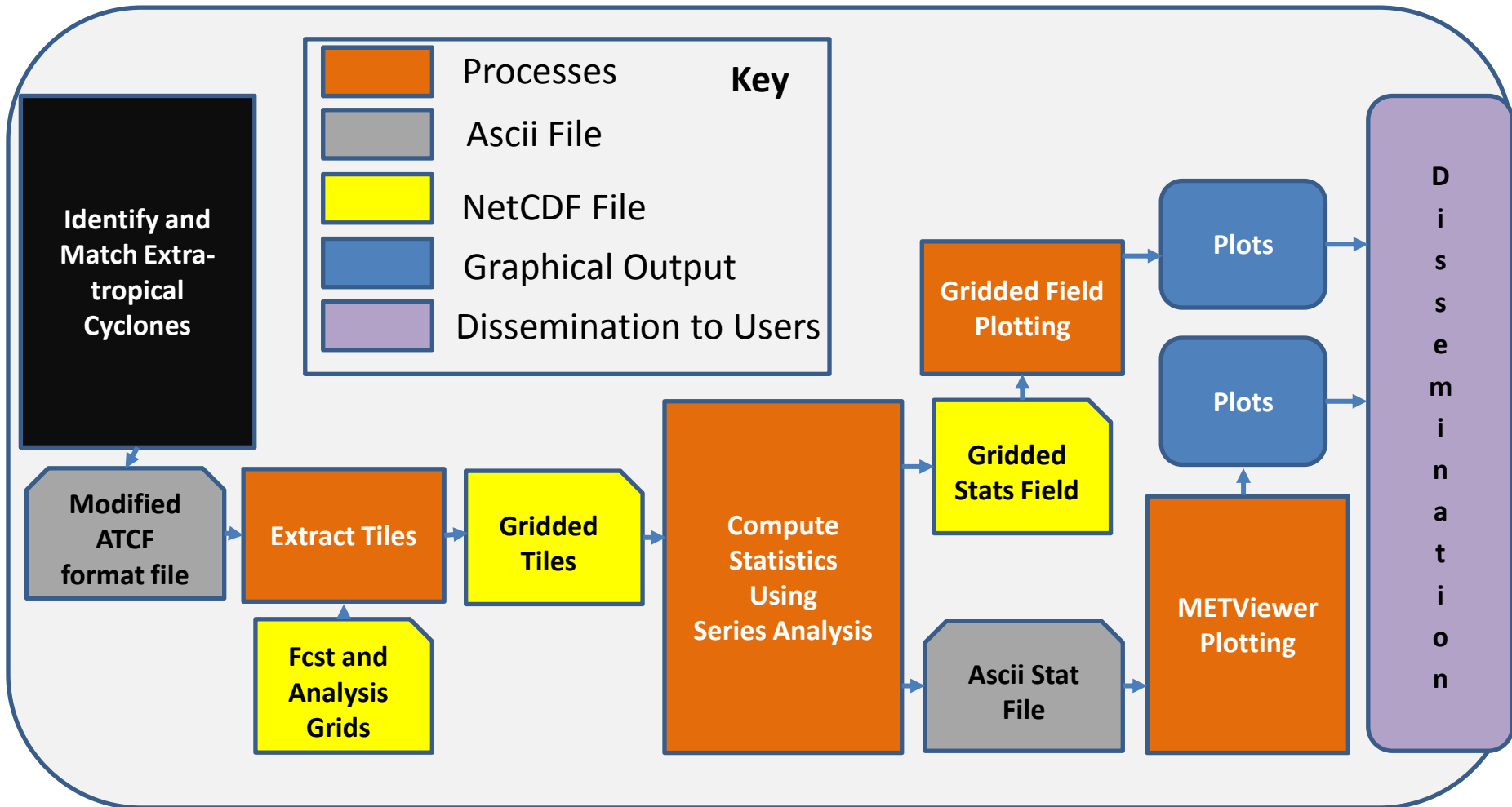Config=AFWAOC_WRFv3.5 Season=WINTER Init=00UTC Fcst Hr=42h
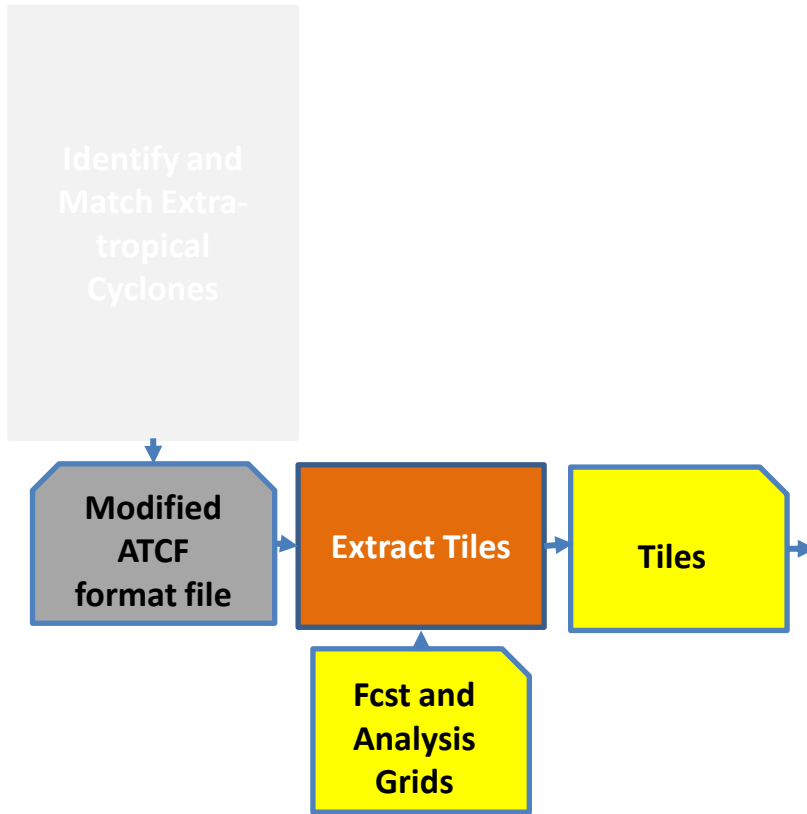
Series Analysis Tool

90th Percentile of difference between two models

Cyclone Relative Evaluation System within Model Evaluation Tools (MET)+

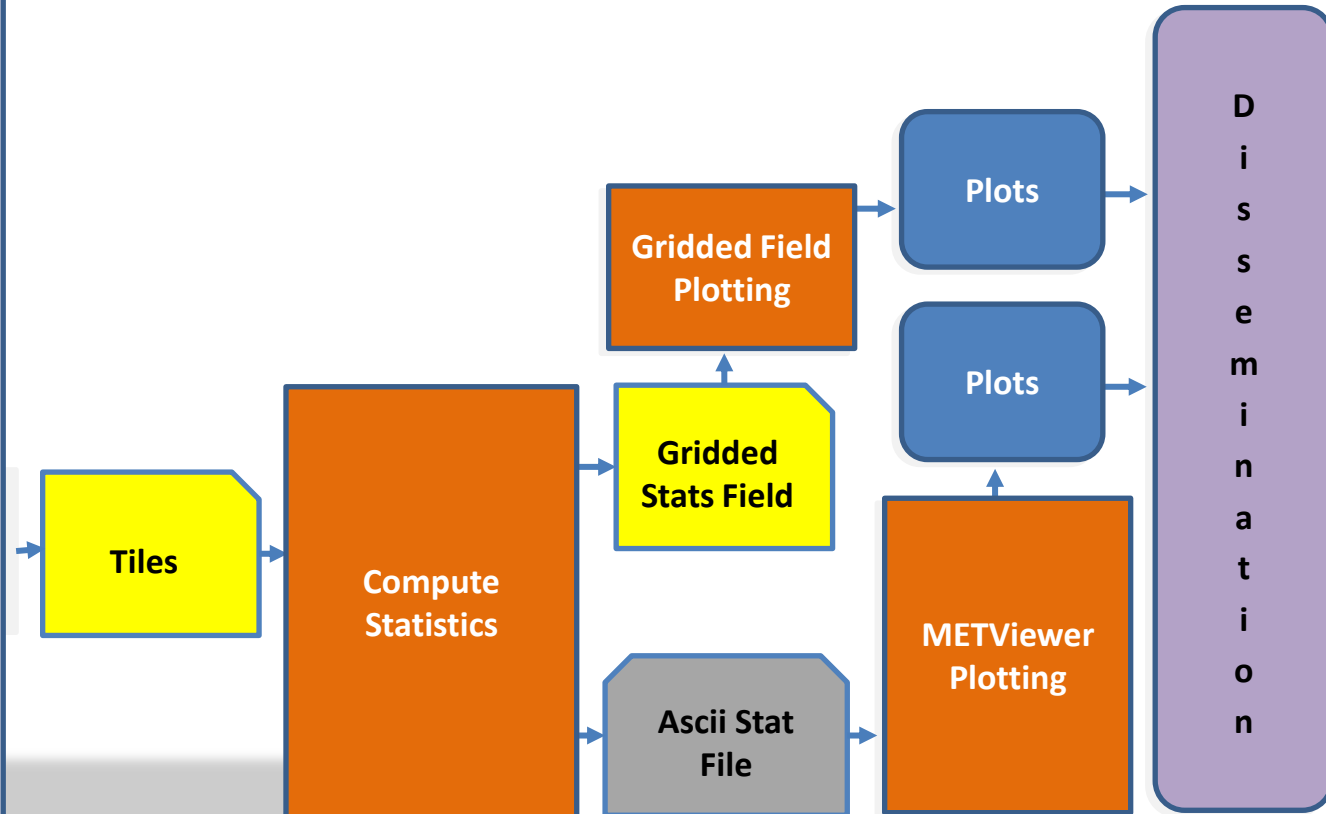# Cyclone Relative Evaluation System

Identify and Match Extra-tropical Cyclones

Modified ATCF format file

Extract Tiles

Tiles

Fcst and Analysis Grids

- **Reformat modified ATCF file** into a format MET can read using scripting
- **Extract pertinent Lat/Lon pairs** from track info
- **Extract Tiles – dimensions user defined**
  - **Option 1 -** extract to a separate file and throw away other data (saves space)
  - **Option 2** - Pass Lat/Lon to MET gen_vx_mask tool mask field on the fly (saves complexity)
- **NOTE:** Any field in the gridded files may be used (e.g. state variables and wind speeds, stability indicies, precipitation)
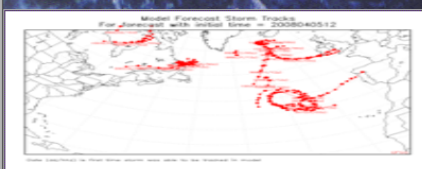
Cyclone Relative Evaluation System

- **Pass a series of tiles or masks into MET** Series_Analysis tool
- **Use new option "-force"** to tell Series_Analysis to disregard displacement errors
- **Compute statistics**
  - **RMSE, Bias, etc...**
  - **CSI, ETS, Freq. Bias etc...**
- **Gridded score fields** and asci output written
- **Scores Plotted** and Disseminated

Tiles → **Compute Statistics** → **Gridded Stats Field** → **Gridded Field Plotting** → **Plots** → **Dissemination**

Compute Statistics → **Ascii Stat File** → **METViewer Plotting** → **Plots** → **Dissemination**

R2O through EMC

Preliminary Results

- Uses TC-Pairs and TC-Stat to identify location of and extract tiles
- "Stack up" tiles by lead or init time to compute systematic errors about "feature" using Series-Analysis
- Plot results using Plot-Data-Plane (quick-look plotting)
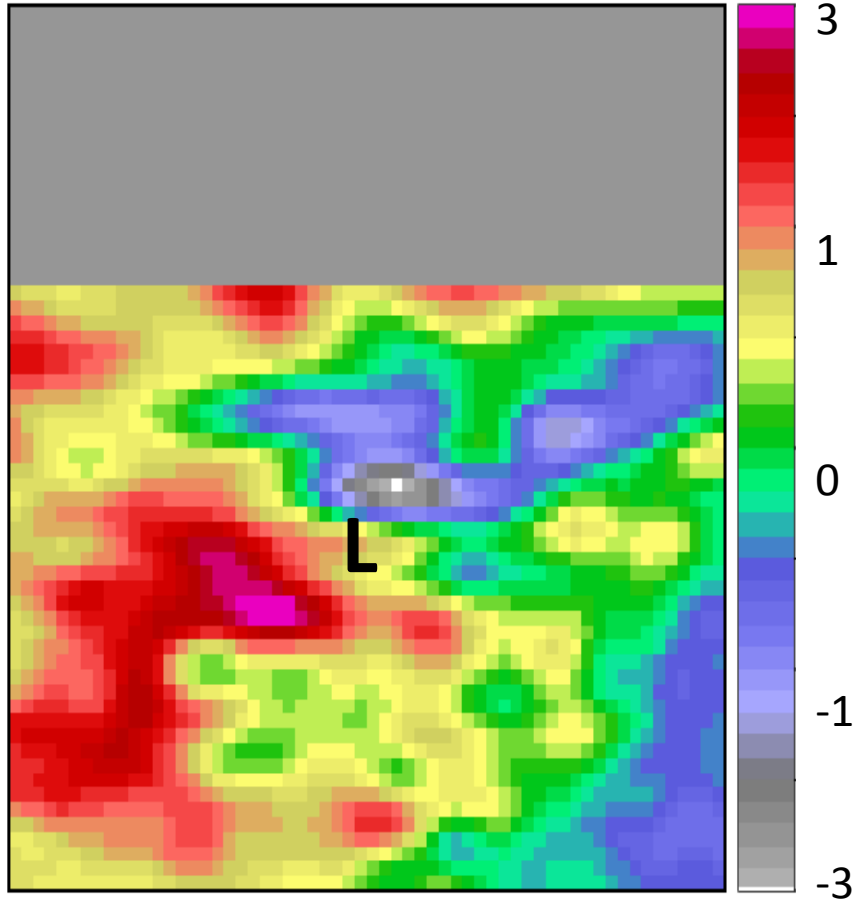
MET+ *alpha* - Python Wrappers

RMSE of MSLP

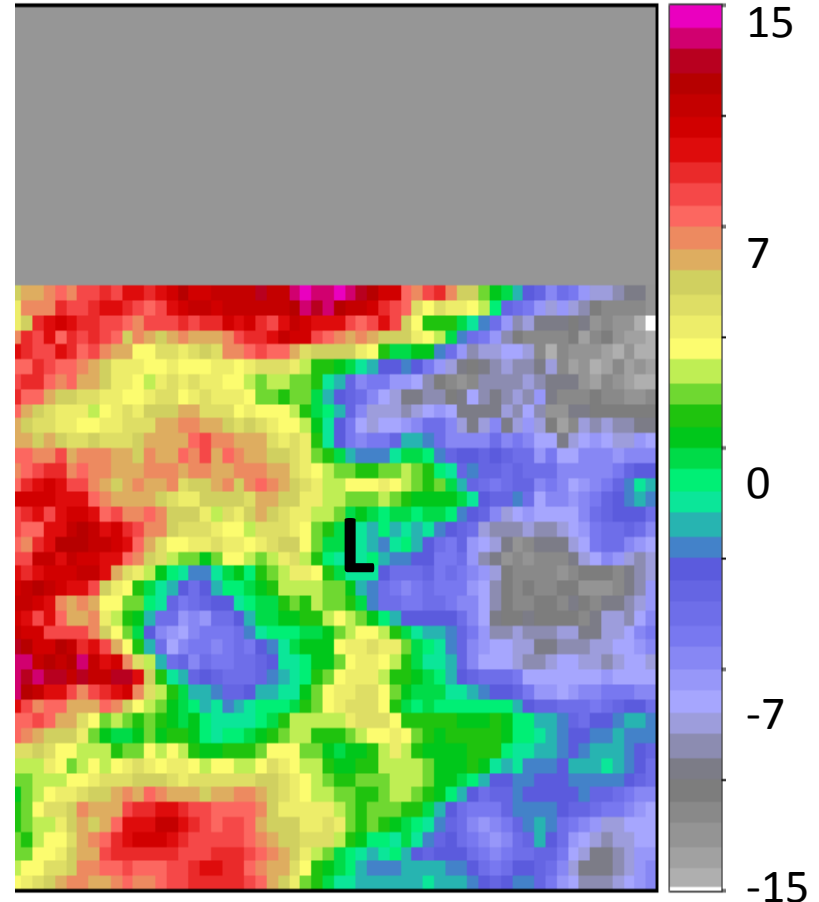Animation over Lead Time

12
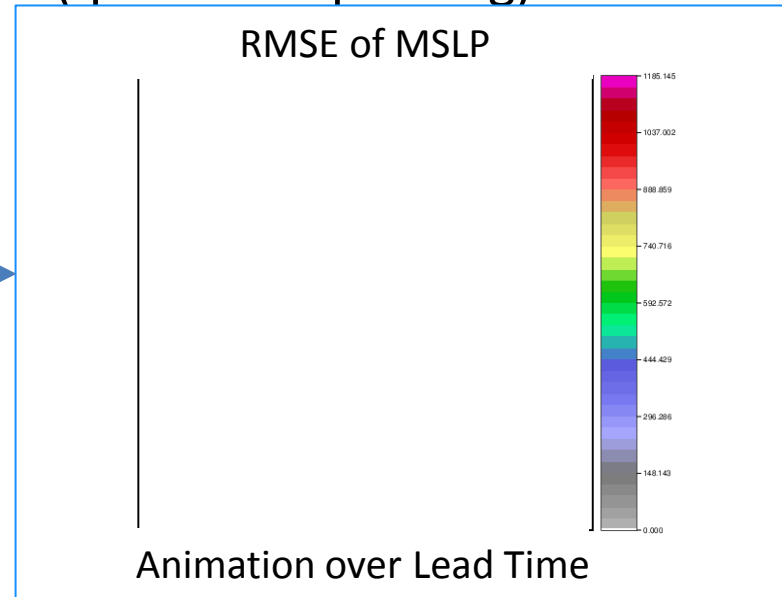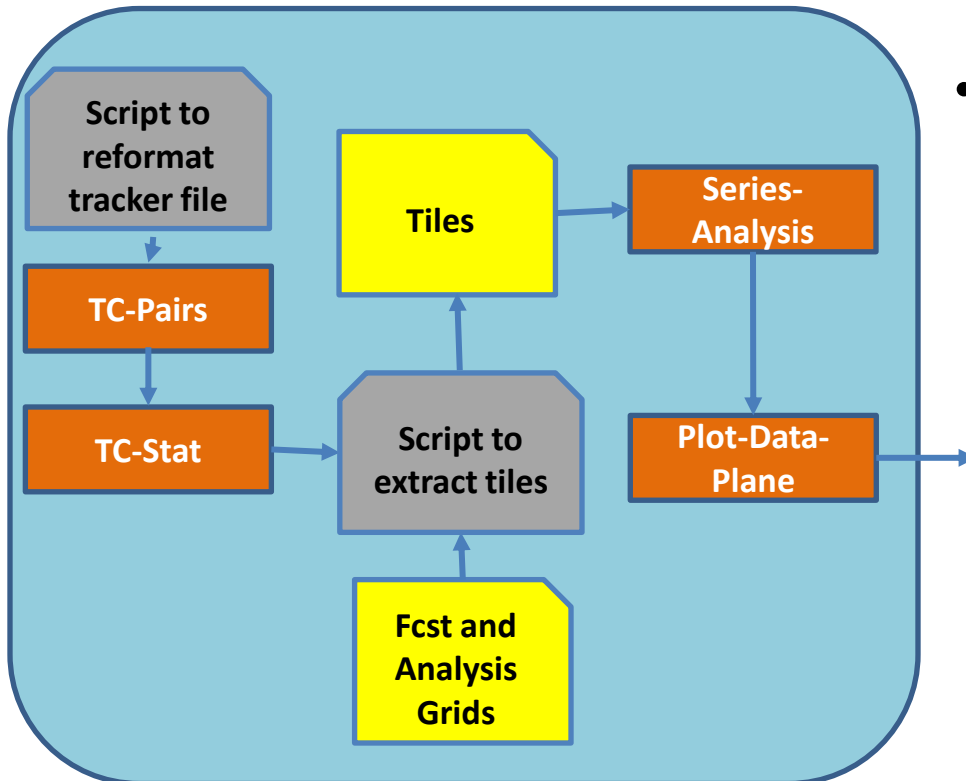
Preliminary Results
Using EMC Cyclone Tracks for GFS (6-12 h forecasts Dec 2016-Feb2017)

Sea-level Pressure Mean Error (hPA)

500 hPa Geo Hght Mean Error (m)
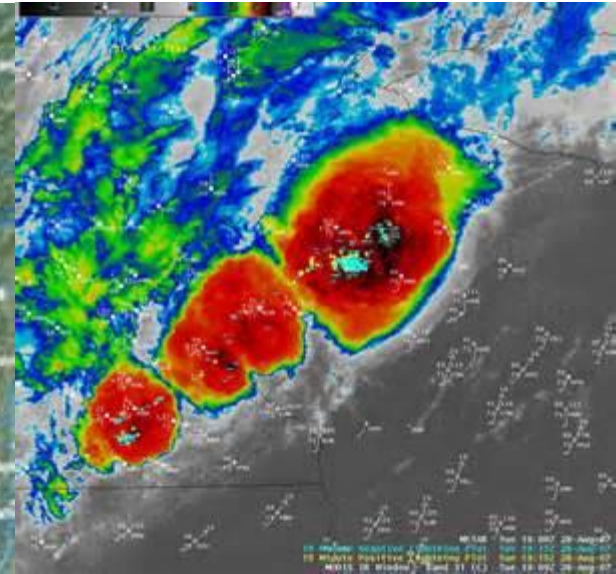

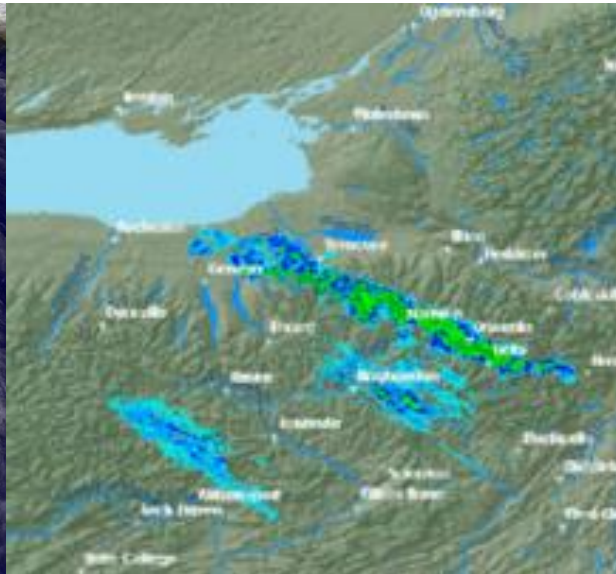series_F000_to_F012_PRMSL_Z0.nc

es_F000_to_F012_HGT_P500.nc

Recent/Future Work: Transition to Feature Relative Evaluation System

Other Applications
- Tropical Cyclones
- Feature centric evaluations such as snowbands, extreme precipitation and turbulence
- Storm centric evaluation of MCSs, Convective Lines and other storms

Cyclone Relative Evaluation System within Model Evaluation Tools (MET)+
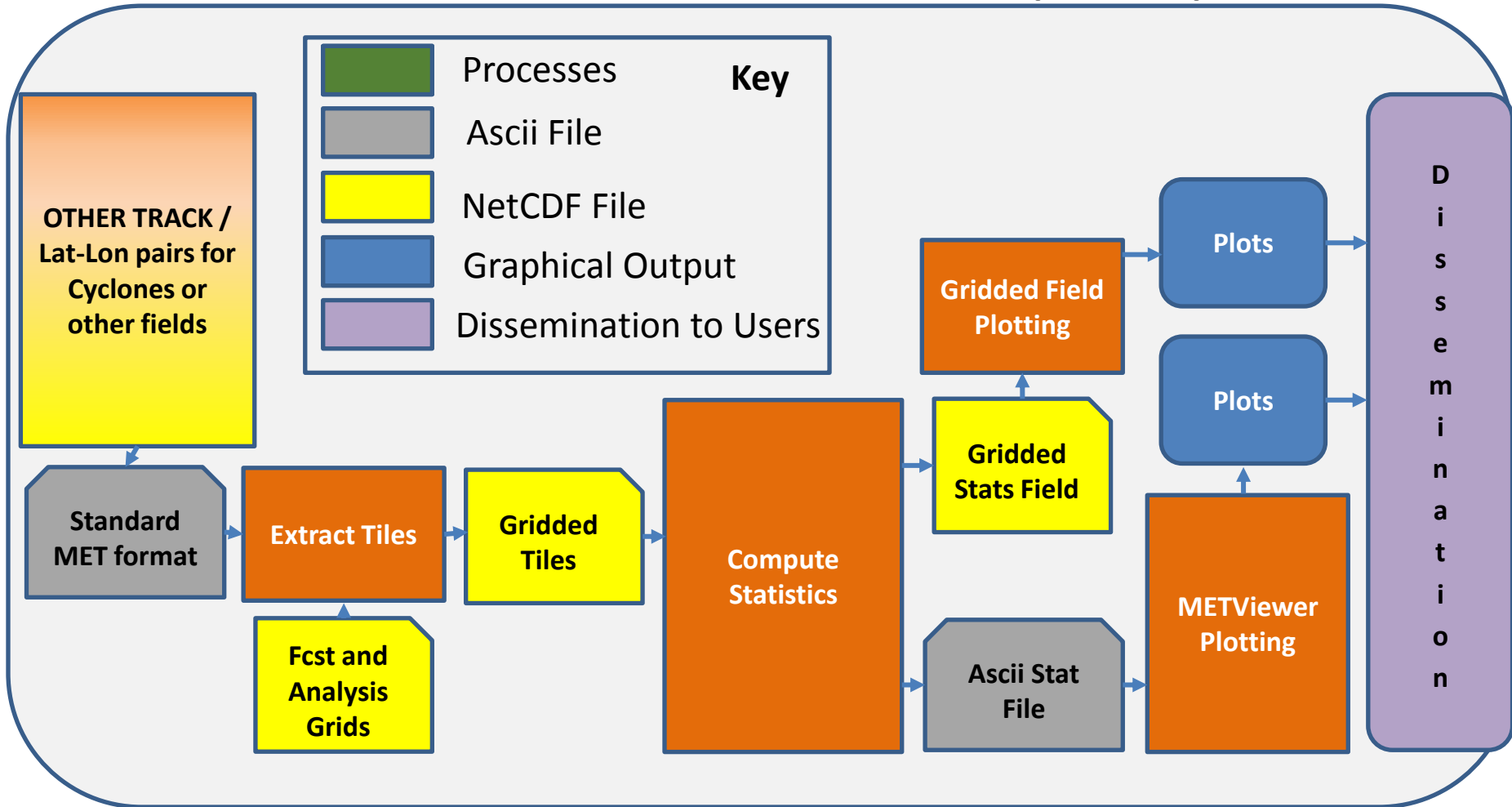
Next Steps

System Next Steps

- Work with WPC and EMC Staff to demonstrate the use of the software for operational evaluation (e.g., ExTC, snow bands, TCs, etc…)

R2O Speed Bumps and Concerns

- Availability of the development side of NOAA WCOSS HPC is sporadic and making it challenging the past few months to transition the MET+ for feature relative verification to developers at EMC;

Research Next Steps

- Complete Analysis to better understand cyclone biases and large error events using MET+ and submit for publication

Thank you and Questions?

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MET Helpdesk: ***met_help@ucar.edu***

http://www.dtcenter.org/met/users/support/met_help.php

Stony Brook University: http://www.somas.stonybrook.edu/