Unifying Verification with MET+ An Update

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NCAR/RAL and DTC

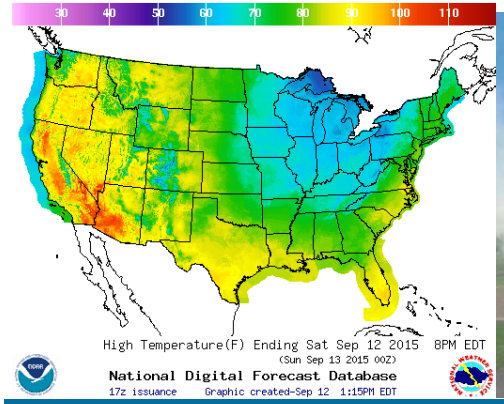
9th NOAA Testbed and Proving Ground Workshop

10-11 April 2018

Kansas City, MO

Why Unified Verification?

Forecasters



Operational Centers

Universities and National Laboratories

Comprehensive and unified verification tool - Make R2O more efficient - Provide consistent set of metrics

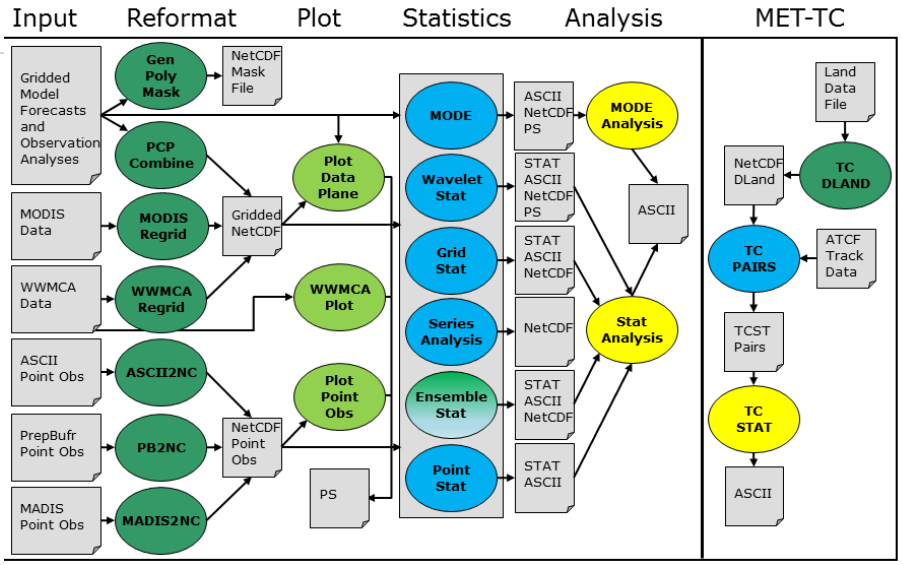
Allows researchers and operational scientists to speak a "common verification" language

MET
Model Evaluation Tools

User support of unified package provides greater opportunity to train all on verification best practices

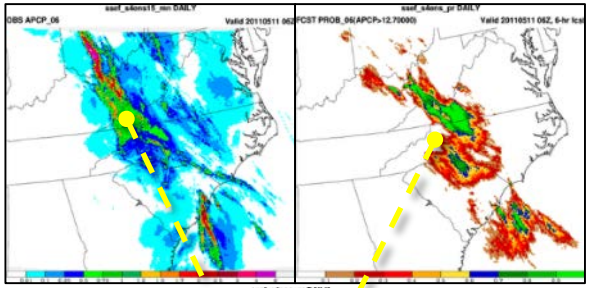
A Verification Toolkit Designed for Flexible Yet Systematic Evaluation

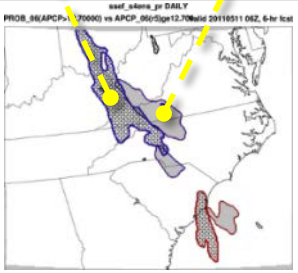
(supported to the community via the DTC)



- Originally developed to replicated the EMC mesoscale verification system
- **Over 85 traditional statistics** using both point and gridded datasets
- 15 interpolation methods
- Computation of confidence intervals
- Able to read in GRIB1, GRIB2 and CF-compliant NetCDF
- Applied to many spatial and temporal scales
- 3500+ users, both US & Int'l

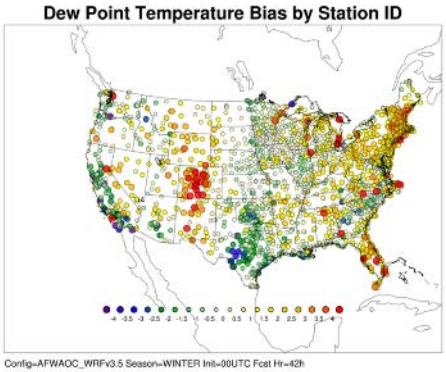
Object Based and Spatial Methods



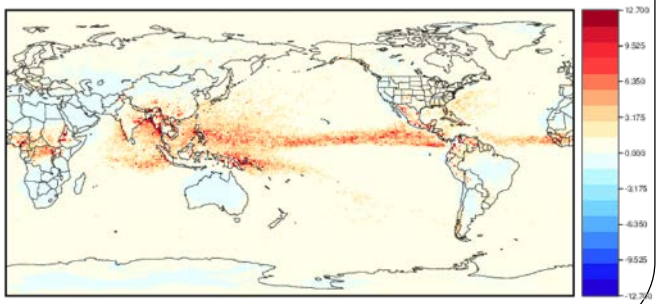


Bad forecast or Good forecast with displacement error?

Geographical Representation of Errors



90th Percentile of difference between two models



METViewer Database and Display

Database: mv_det_sref_2013 | Generate Plot | Reload databases | Load XML

Series | Box | Bar | Rhist | Phist | Roc | Rely | Ens_ss

Plot Data: Stat | Plot statistic: Median

Y1 Axis variables | Y2 Axis variables

Y1 Dependent (Forecast) Variables:

TMP | ME

Variable

Y1 Series Variables:

MODEL | ens-16km-mp, ens-16km-std, ens-9km-std | Group_y1_1

Series Variable

Fixed Values:

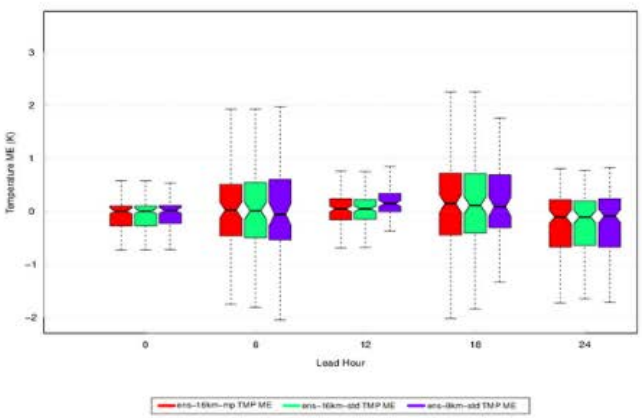
FCST_INIT_BEG | 2013-05-01 00:00:00, 2013-05-02 00:00:00, 2013-05-03 00:00:00, 2013-05-04 00:00:00, 2013-05-05 00:00:00, 2013-05-06 00:00:00, 2013-05-07 00:00:00, 2013-05-08 00:00:00, 2013-05-09 00:00:00, 2013-05-10 00:00:00, 2013-05-11 00:00:00, 2013-05-12 00:00:00, 2013-05-13 00:00:00, 2013-05-14 00:00:00, 2013-05-15 00:00:00, 2013-05-16 00:00:00, 2013-05-17 00:00:00, 2013-05-18 00:00:00, 2013-05-19 00:00:00, 2013-05-20 00:00:00

Fixed Value

Plot Cond

20140722_151502

Plot | XML | Log | R script | R data | SQL



Titles & Labels | Common | Formatting | X1 | X2 | Y1 | Y2 | Legend & Caption

Title	Example for METViewer Interface
X label	Lead Hour
Y1 label	Temperature ME (K)
Y2 label	
Caption	

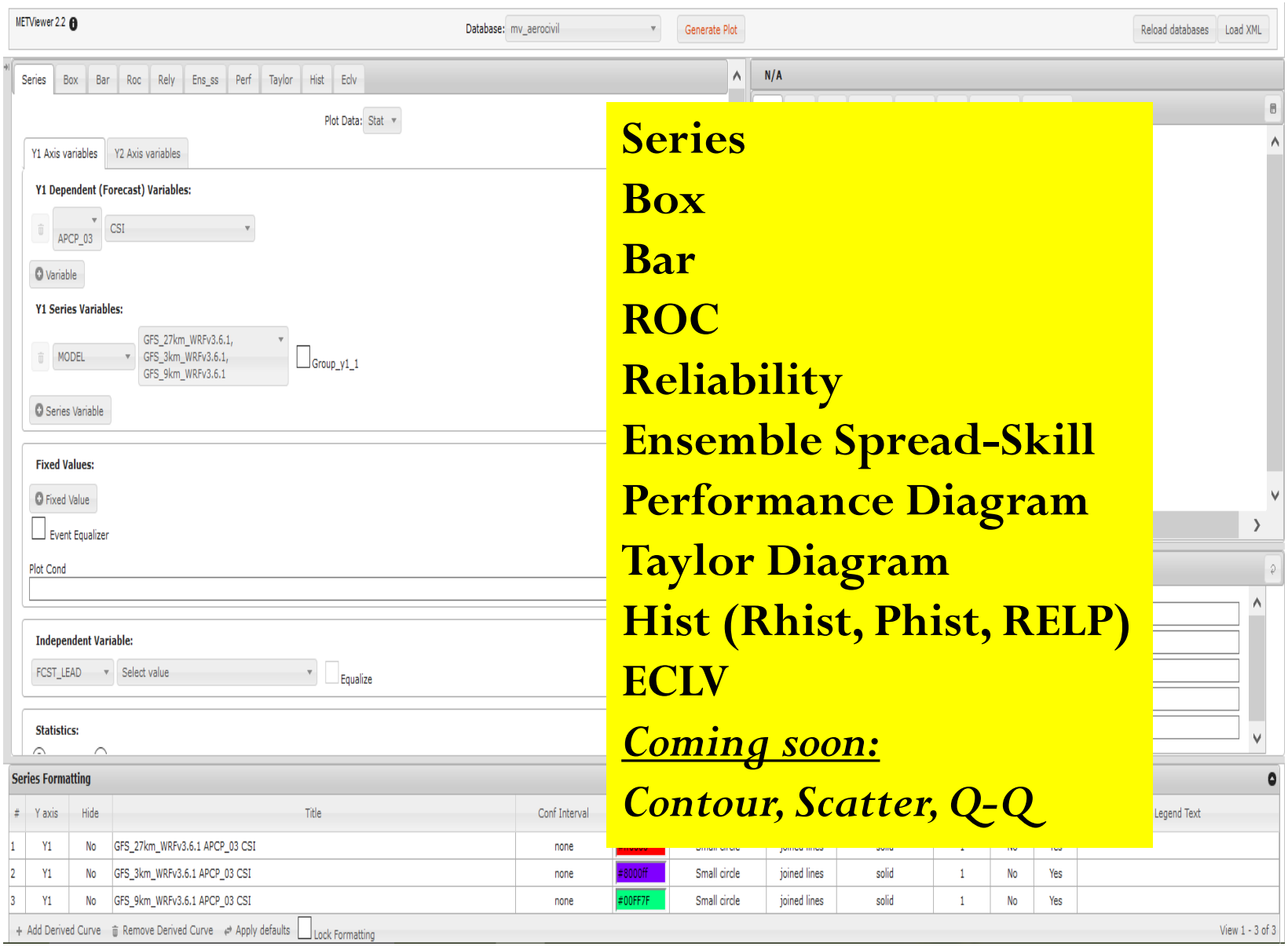
Series Formatting

#	Y axis	Hide	Title	Conf Interval	Line Color	Point Symbol	Series Line Type	Line Type	Line Width	Show Signifi	Conne Acros NA	Legend Text
1	Y1	No	ens-16km-mp TMP ME	none	#FF000	Small circle	joined lines	solid	1	No	Yes	
2	Y1	No	ens-16km-std TMP ME	none	#00FF7F	Small circle	joined lines	solid	1	No	Yes	
3	Y1	No	ens-9km-std TMP ME	none	#8000FF	Small circle	joined lines	solid	1	No	Yes	

Lock Formatting

View 1 - 3 of 3

METViewer Plot Templates



Series

Box

Bar

ROC

Reliability

Ensemble Spread-Skill

Performance Diagram

Taylor Diagram

Hist (Rhist, Phist, RELP)

ECLV

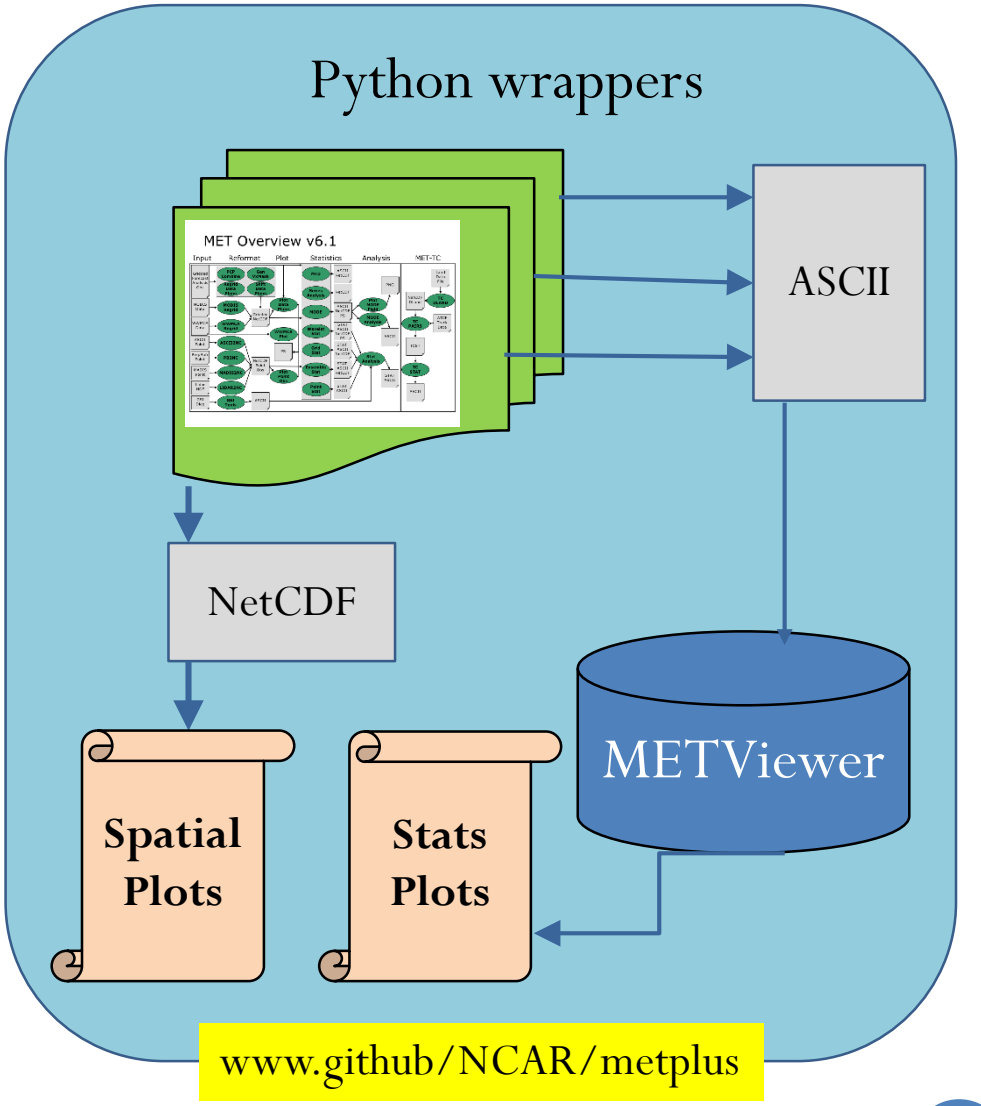
<u>Coming soon:</u>

Contour, Scatter, Q-Q

MET+

Python wrappers around:

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



<u>Near Term:</u> After Global - CAM, Ensembles and Aerosols/Air Qual
<u>Longer Term:</u> Earth System "Components"

MET Use-Case Example

Aeronet 1-min AOD Data

ASCII 2NC

Aeronet AOD

6-hr mean, max, stdev, range

MODE

MODE-TD

Wavelet Stat

Grid Stat

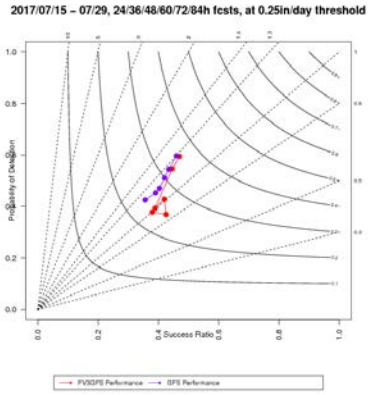
Series Analysis

Ensemble Stat

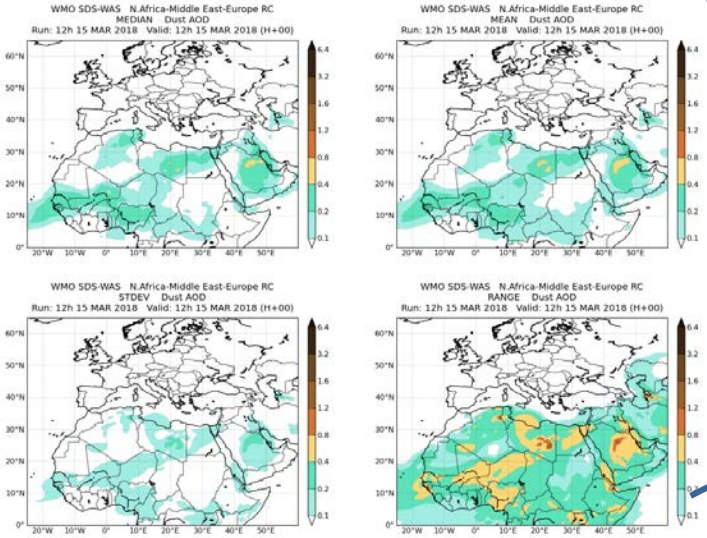
Point Stat

METViewer Database and Display

Multiple runs over time



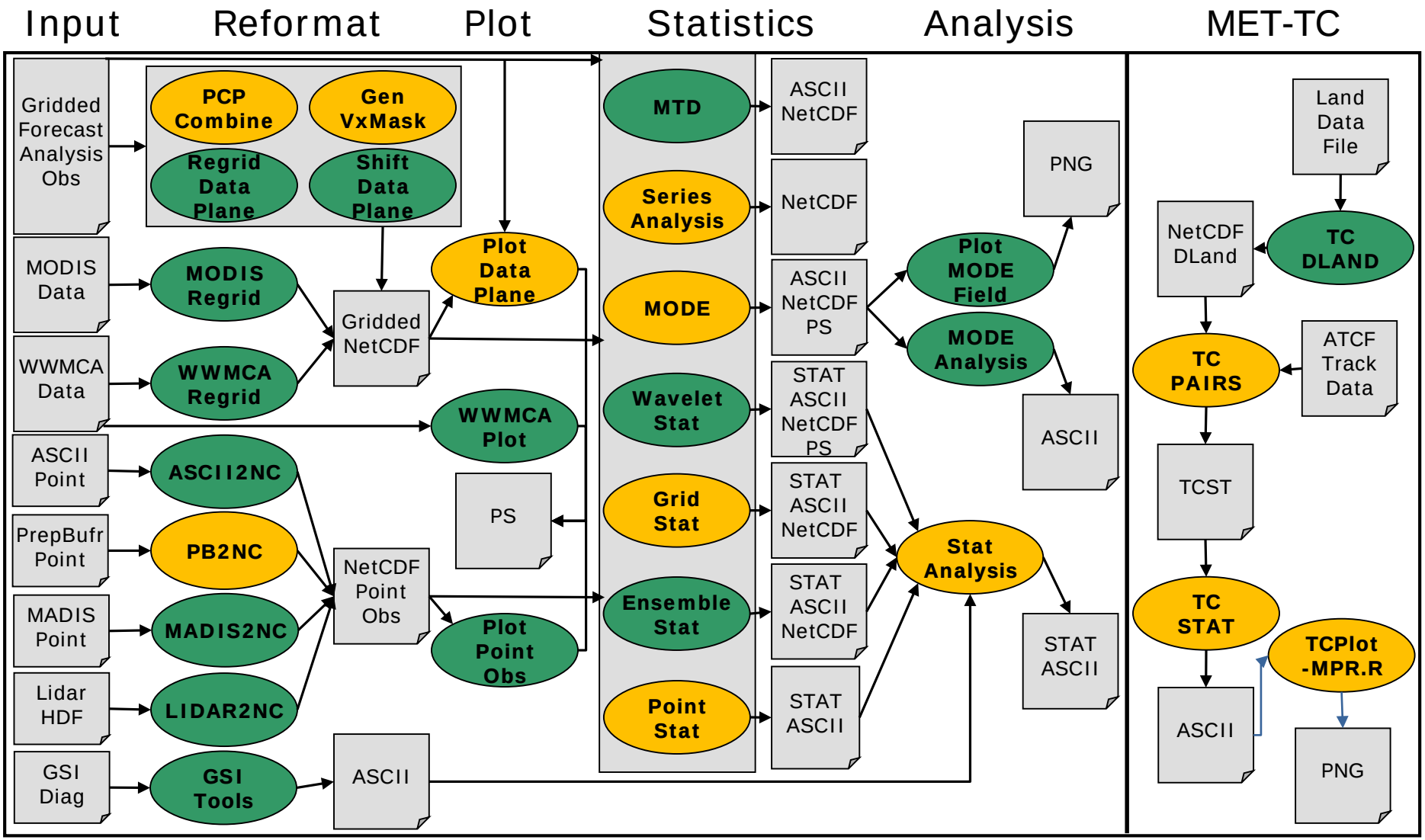
ICAP MME forecasts



Use-case includes

- MET+ .conf file
- MET config files
- Python scripts to:
  - Call Ascii2NC
  - Call Point-Stat
  - Load METViewer
  - Make stat plot
  - Make plot of fields

What is Wrapped by Python Right Now



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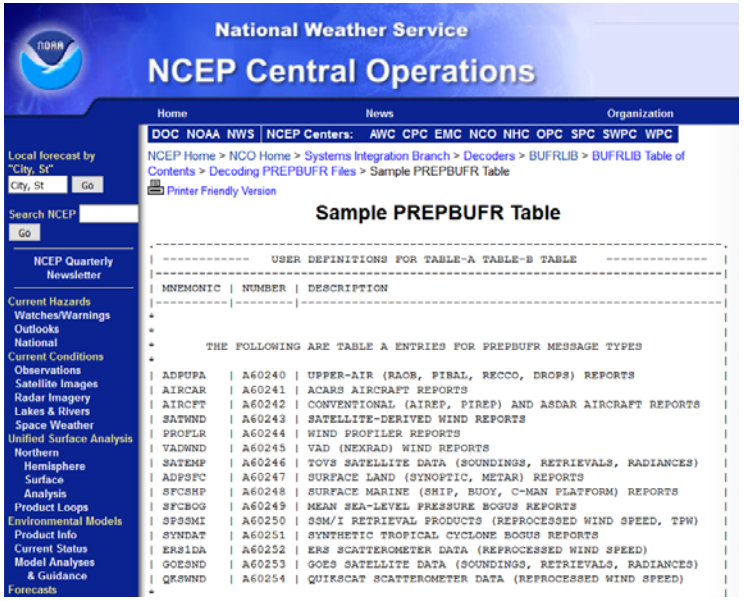
Recent Additions

Gridded Statistics

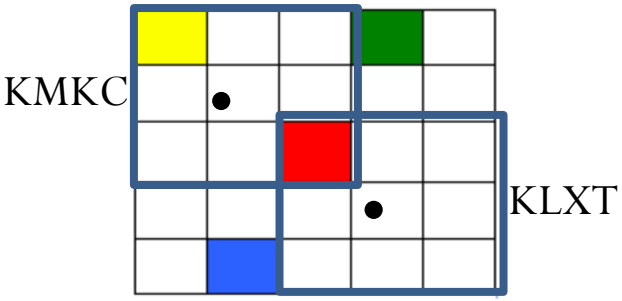
- S1 score
- Vector Winds
- Custom Daily Means

- Variable names no longer tied to Grib code
- Derive additional fields
- Rename obs field to match forecast

Read most PREPBUFRc and BUFR obs

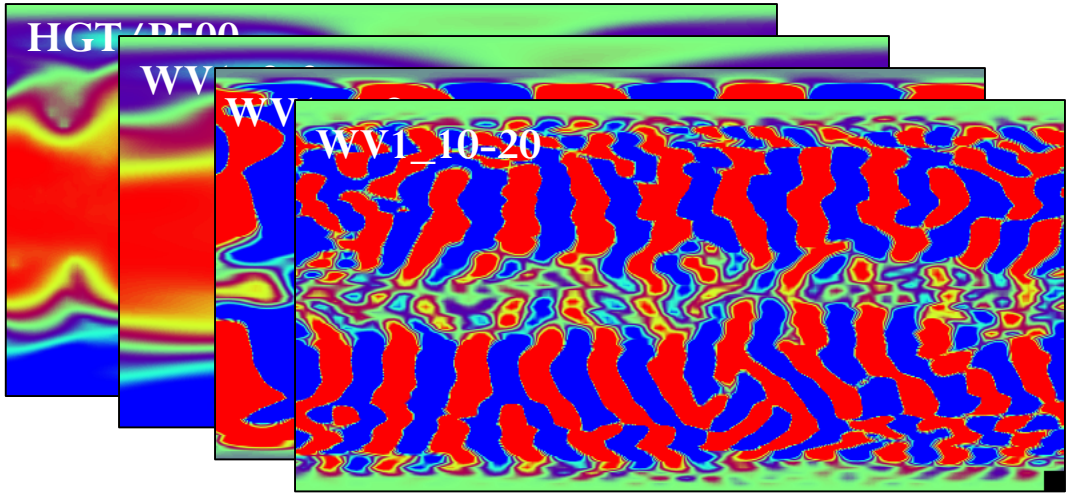


High Resolution Assessment (HIRA)



Neighborhood method when using point observations. Allows for temporal and spatial uncertainty

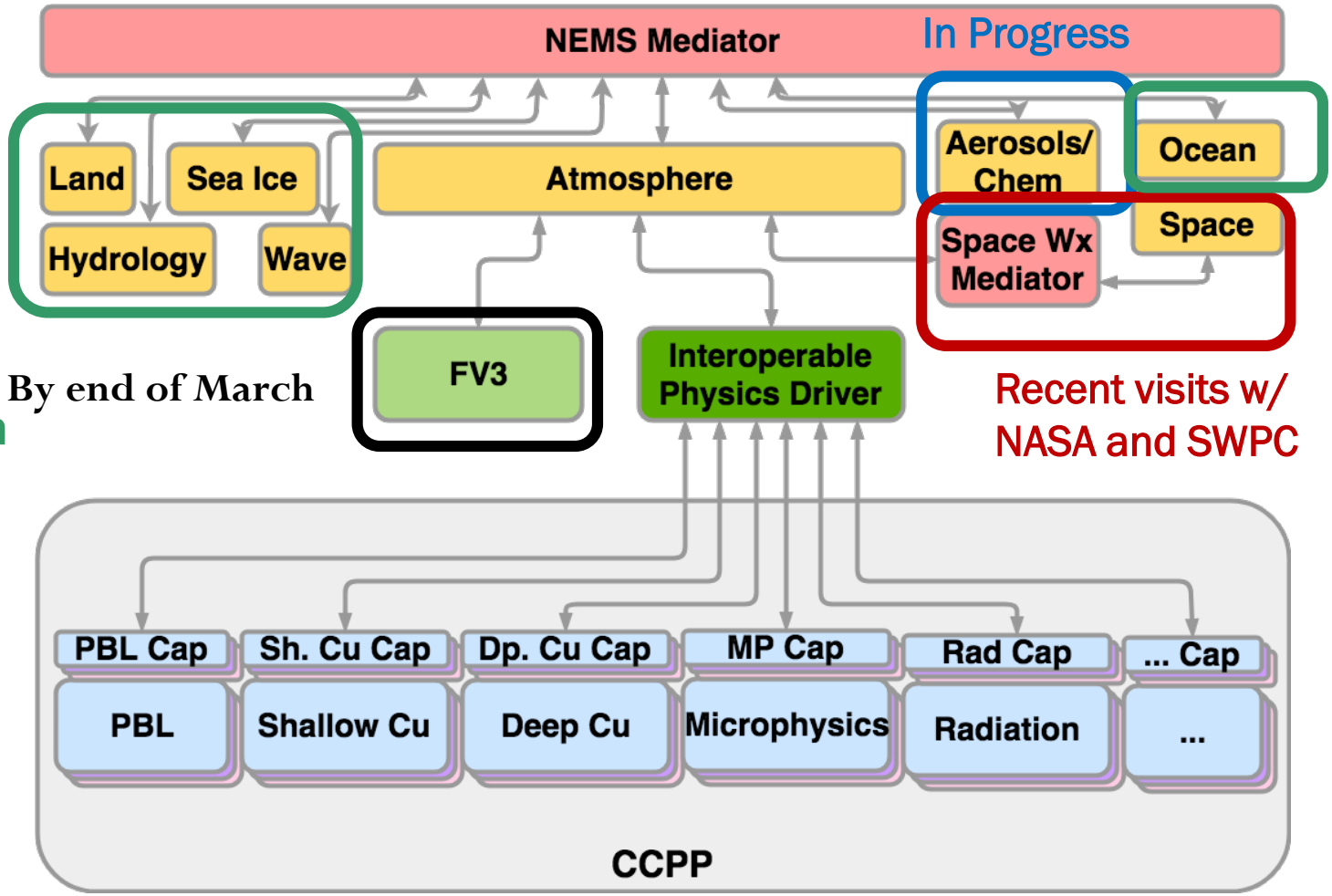
Fourier Decomposition



Moving toward NGGPS UFS Evaluation

- MET+ being integrated into FV3GFS parallel and retrospective workflows at EMC
  - Grid-to-Grid evaluation of global state parameters and precipitation
  - Grid-to-Obs evaluation using surface and upper air observations and precipitation
  - TC track and intensity errors
  - Gridded Errors
- Starting to work on interface between C++ (MET) and MET+ python wrappers
- Documenting and user needs for components of the coupled UFS (see next slide)
- Moving all components to GitHub

NGGPS Verification and Validation WG
Adding Additional Capability



Already have pre-existing packages which we will link in

By end of March

Recent visits w/ NASA and SWPC

Image courtesy of GMTB

Next year hoping to add more process-oriented diagnostics to aid in GMTB CCPP development

NGGPS V&V Areas of Focus

- Scheduled
- NGGPS Proposals
- Need Requirements
- Available in MET+

- Treatment of uncertainty

✓ Scorecard and weighted performance indices

✓ Ensemble and probability verification metrics

- Diagnostic tools and S2S (scales at which errors occur, energy spectra)
- Physics-oriented metrics (radiation, fluxes, cloud verification)
- Forecast consistency – extreme weather

✓ Object-oriented metrics

- Coupled model component performance
- Validation – during development process

METViewer Scorecard

Specify the Statistic
CNT, CTS, Prob

Specify the Field
& Level

Specify the regions

Specify the aggregations

Specify whether you have
symbol, values, pairwise difference

METViewer Scorecard
for PR4RN_1405 and GFS2016

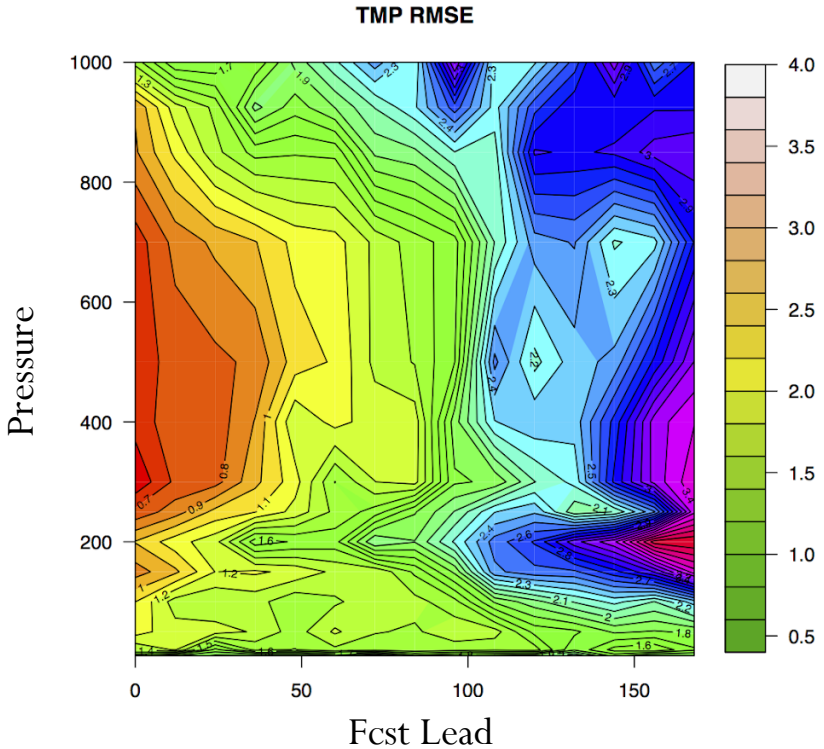
2014-05-20 00:00:00 - 2014-07-30 00:00:00

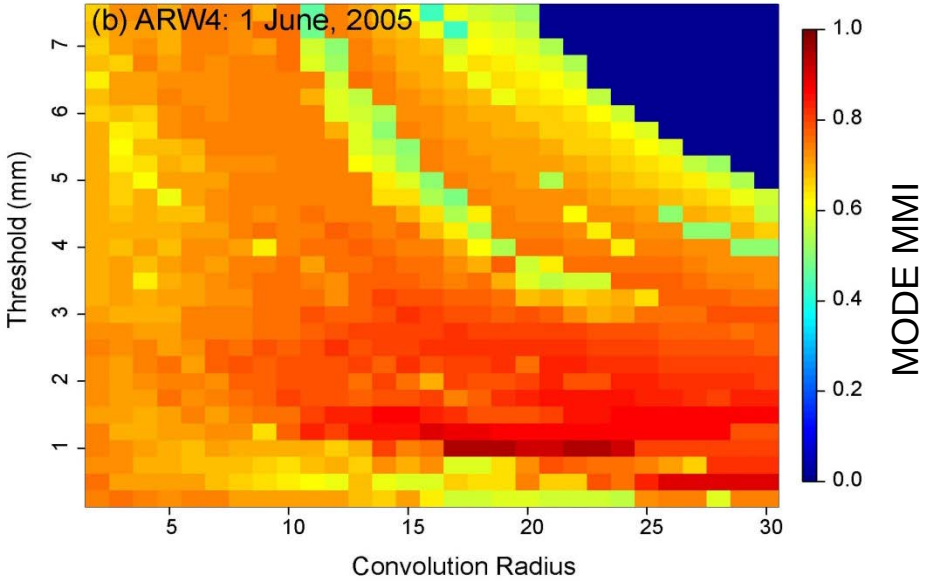
			N.American						N.Hemisphere						S.Hemisphere						Tropics					
			Day 1	Day 3	Day 5	Day 6	Day 8	Day 10	Day 1	Day 3	Day 5	Day 6	Day 8	Day 10	Day 1	Day 3	Day 5	Day 6	Day 8	Day 10	Day 1	Day 3	Day 5	Day 6	Day 8	Day 10
Anom Corr	Heights	P250	▲				▲		▲				▲													
		P500	▲																		▼		▲			
		P700							▼												▼		▲			
		P1000							▼						▼						▼					
Anom Corr	Vector Wind	P250																			▼					
		P500							▼												▼	▼				
		P850							▼				▲								▼	▼				
Anom Corr	Temp	P250					▲														▼		▲	▲	▲	▲
		P500					▲						▲		▼						▼					
		P850			▲	▲	▲		▲	▲			▲								▼	▼				
Anom Corr	MSLP	MSL							▼						▼						▼					
RMSE	Heights	P10	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲					▲	▲	▲	▲	▲	▲
		P20	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲						▼	▲	▲	▲	▲	▲
		P50	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲					▼	▲	▲	▲	▲	▲
		P100	▲	▲	▲				▲						▲	▲						▲	▲	▲	▲	▲
		P200	▲							▼	▼				▲							▲	▲	▲	▲	▲
		P500	▲							▼					▲						▼	▲	▲	▲	▲	
		P700	▲						▼												▼		▲			
		P850	▲						▼						▼						▼					
		P1000	▲						▼						▼						▼					

Coming soon: Customize color preferences and significance levels

Submit to batch engine of METViewer

Coming Soon: Additional METViewer Enhancements



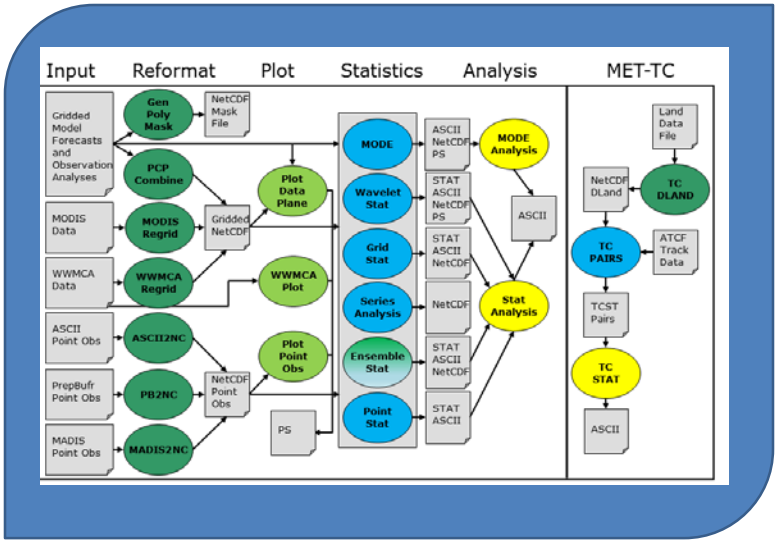


Contour Plots
&
Quilt Plots/Heat Diagrams

Docker MET and METViewer

<u>Docker</u> (Amazon Web Services):

- Open-source technology to build and deploy applications inside software containers
- Packages software containing: code, runtime, system tools, system
- libraries, etc.
- Enables you to quickly, reliably, and consistently deploy applications

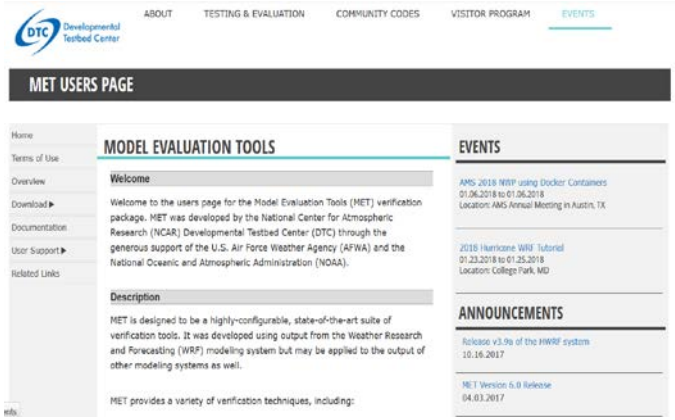


MET and METViewer compiled in a Docker Container

1) Set up to work with a suite of test-cases for NWP innovation testing (MMET/MERIT)
2) Bundled with MET online tutorial data

http://www.dtcenter.org/met/users/downloads/docker_container.php

Thank You



Email: jensen@ucar.edu

- GitHub Instructions at Release link
  - https://github.com/NCAR/METplus/releases
  - https://github.com/NCAR/METViewer
  - https://github.com/NCAR/MET coming soon
- MET Users Page: https://dtcenter.org/met/users
- Contact met_help@ucar.edu

DTC Workshop on Testplans and Metrics
July 30-Aug 1, 2018
NCWCS, College Park

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DTC Developmental Testbed Center

as well as NGGPS and USWRP projects