

Evaluation of quantitative precipitation forecasts by HWRF model

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In collaboration with

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Acknowledgment to EMC HWRF Team for providing the HWRF datasets

Introduction

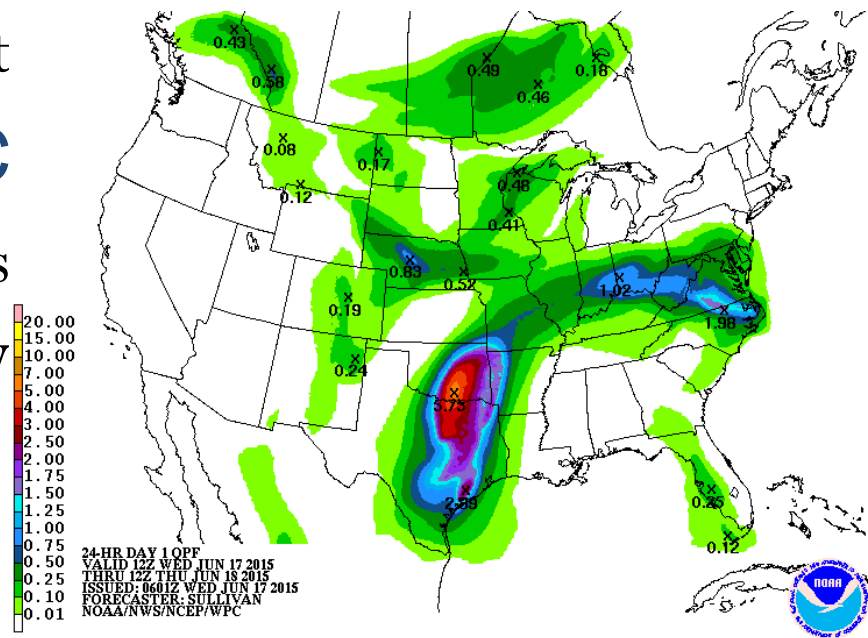
- Rainfall flooding during TCs is the second deadliest cause next to storm surge (Rappaport 2014).

- TC precipitation forecast verification for HWRF has been limited

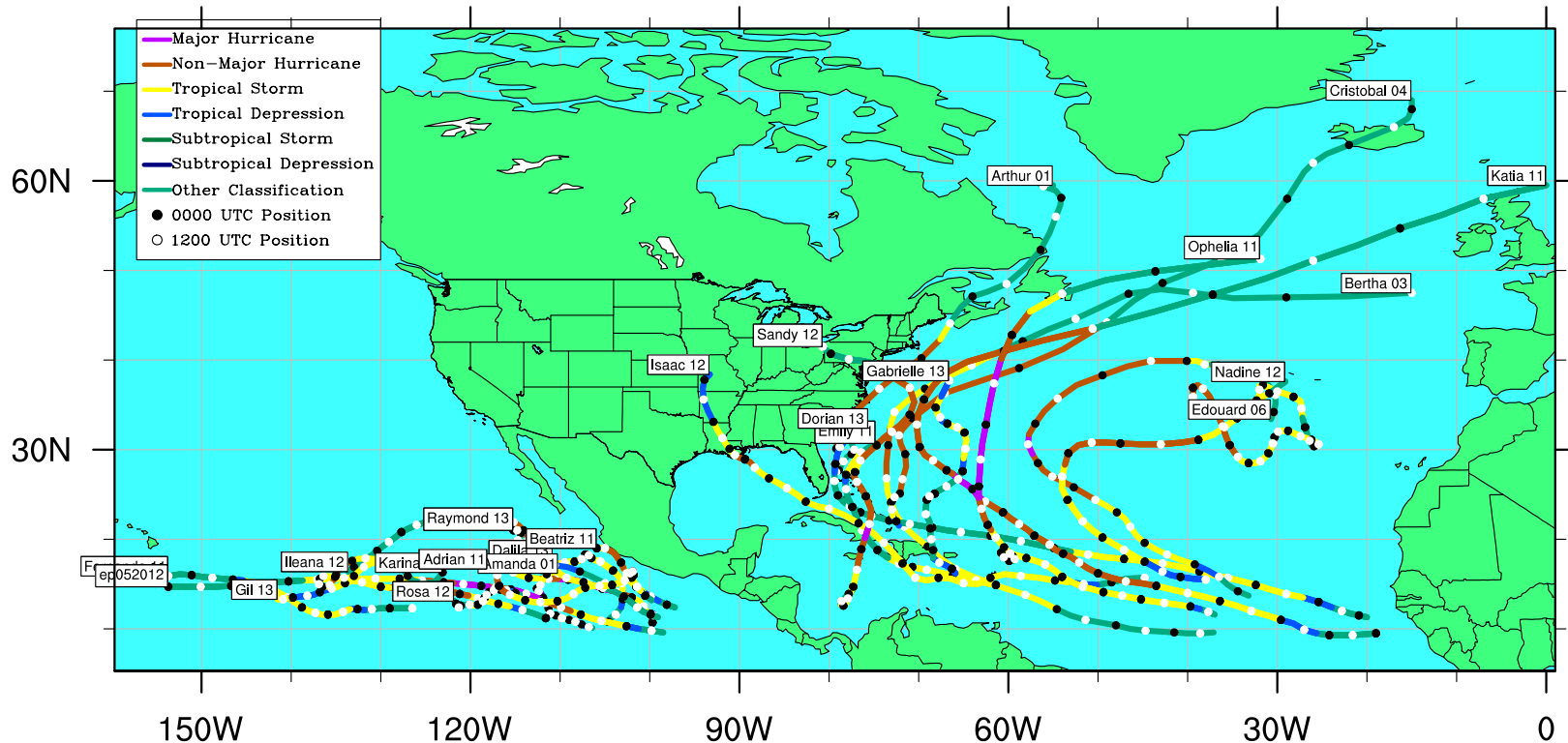
Objectives

- How does
- Does HW

Observations?



Storms for Verification



	EP		AL
2011	Adrian, Beatriz, Fernanda	2011	Emily, Katia, Ophelia
2012	Emilia, Rosa	2012	Isaac, Nadine, Sandy
2013	Dalila, Gil, Raymond	2013	Dorian, Gabrielle,
2014	Amanda, Karina	2014	Arthur, Bertha, Cristobal, Edouard

Data

- **Observations**

- **CMORPH**

- Satellite based precipitation estimate from CPC
 - 3-h on $0.25^\circ \times 0.25^\circ$ grid from 60°S - 60°N

- **NCEP Stage IV**

- Precipitation from rain gauge and radar data
 - 1, 6 and 24-h on 4km grid covering CONUS

- **Model**

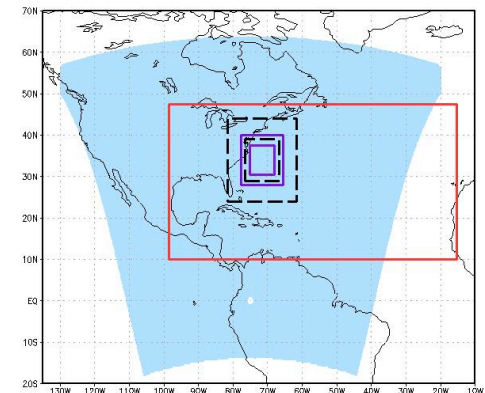
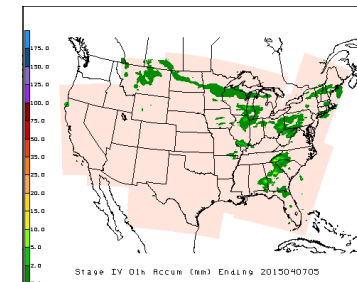
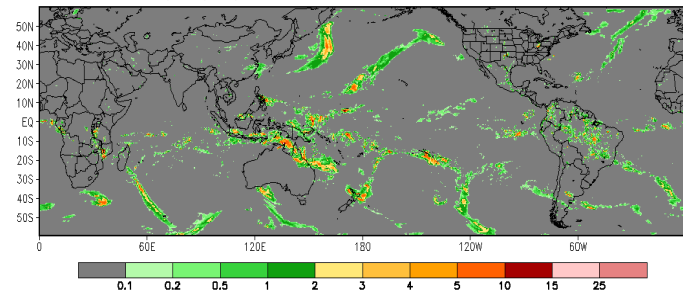
- **HWRF**

- 2014 pre-implementation & realtime 27/9/3 km (EMC)
 - Post processed using UPP from ~ 27 km to 0.25°
 - 0.05° storm total precipitation mostly from d03 domain

- **GFS**

- Operational model output – Mixed model version
 - 0.5° data available to users

NOAA/NCEP/CPC CMORPH satellite estimated precipitation (mm/hr) 00:00 – 03:00 UTC 19 Mar 2012



Large-scale verification

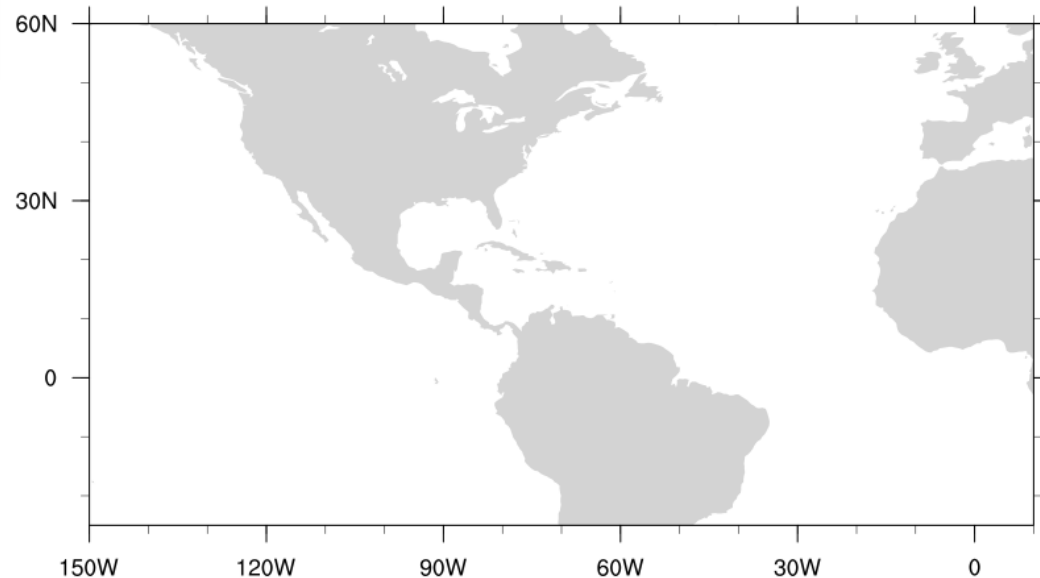
Define “Mega Domain”
(25S-60N, 150W-10E)

Re-gridded model and
obs data to 0.25°

Accumulated 24-h

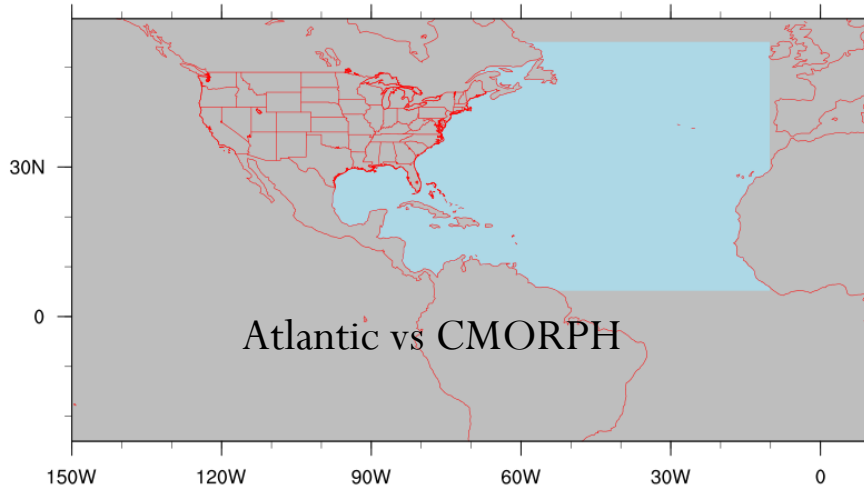
Computed grid-to-grid
statistics using MET

Computed aggregations
for specific regions

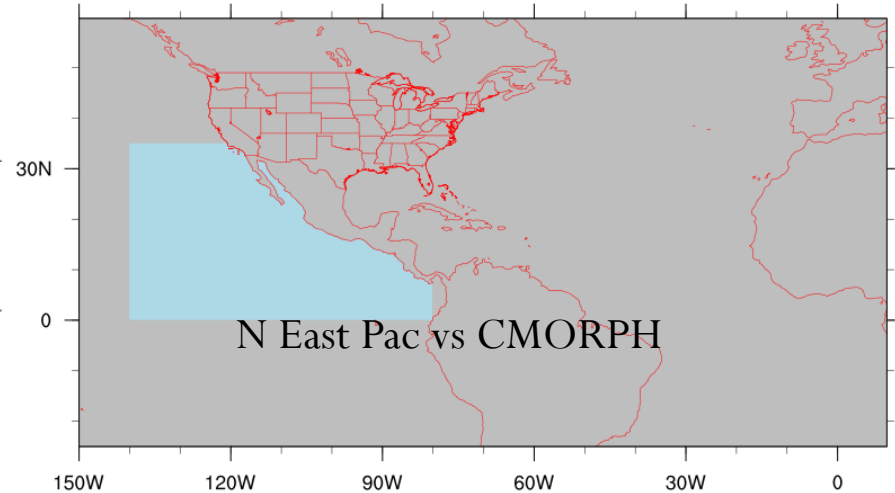


Verification regions

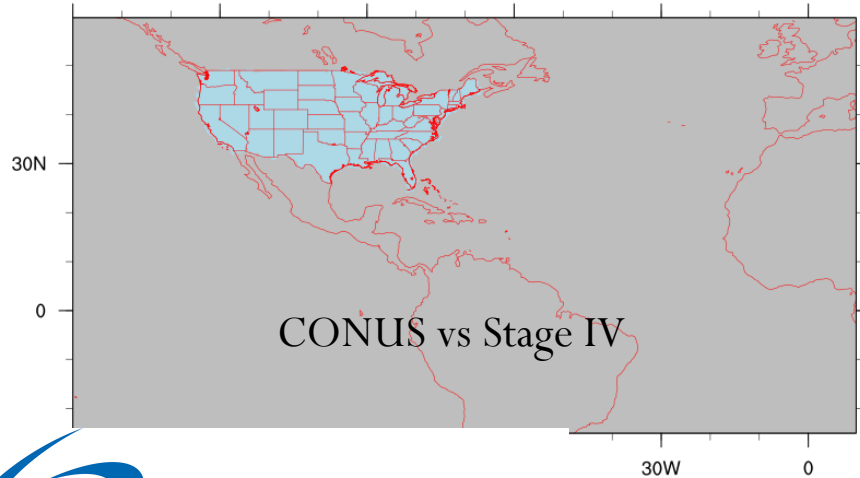
AL masking region



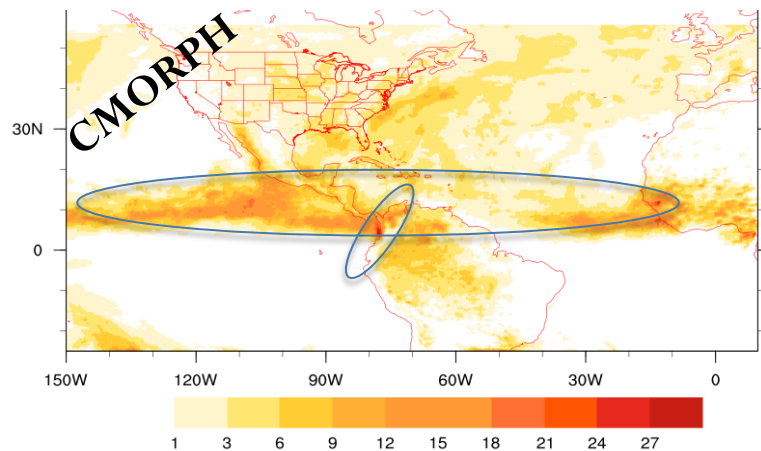
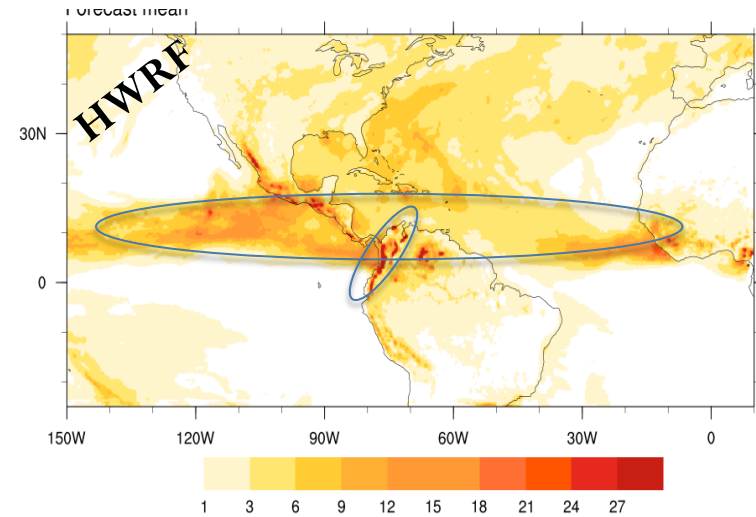
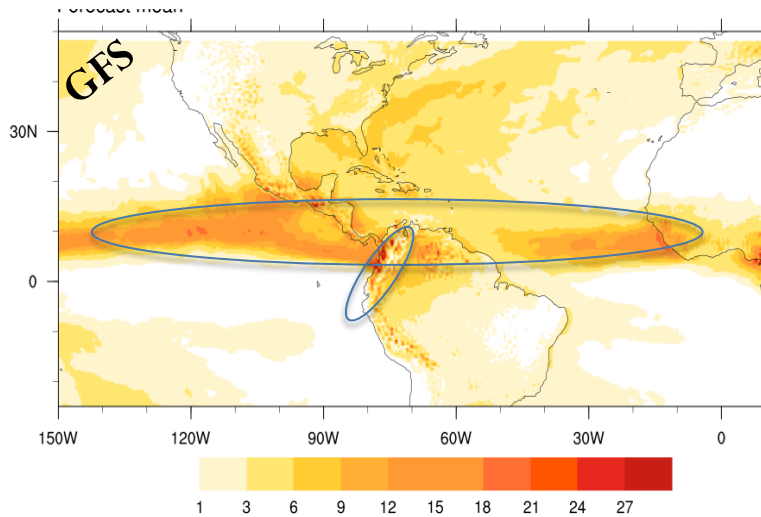
EP masking region



CONUS masking region

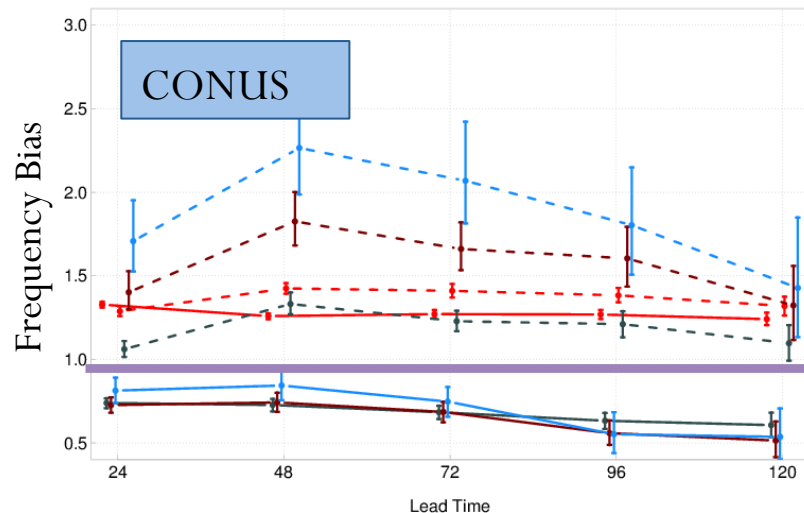
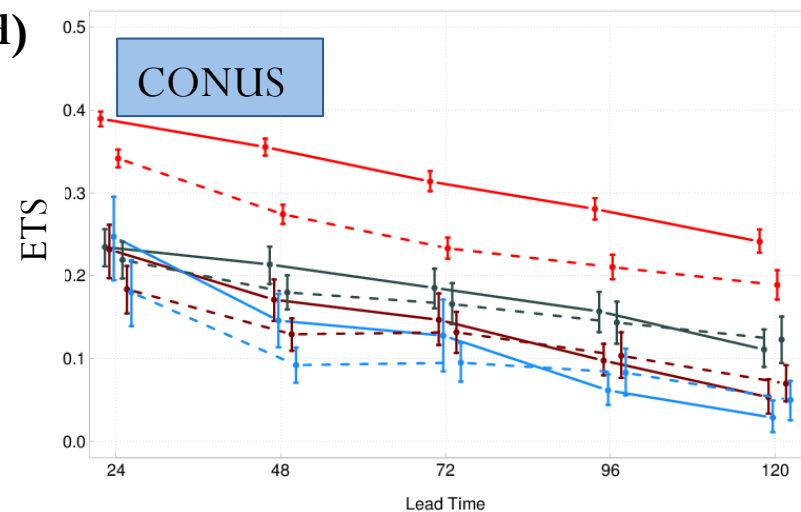
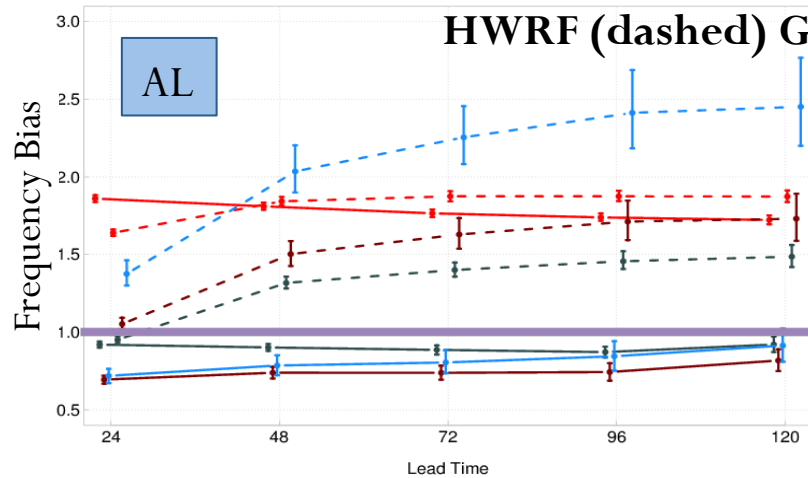


24 h Acc precipitation climatology



Most of the large scale patterns are well captured like ITCZ, orographic rainfall

Frequency Bias/ETS (Thresholds: 0.1", 1", 2", 3")



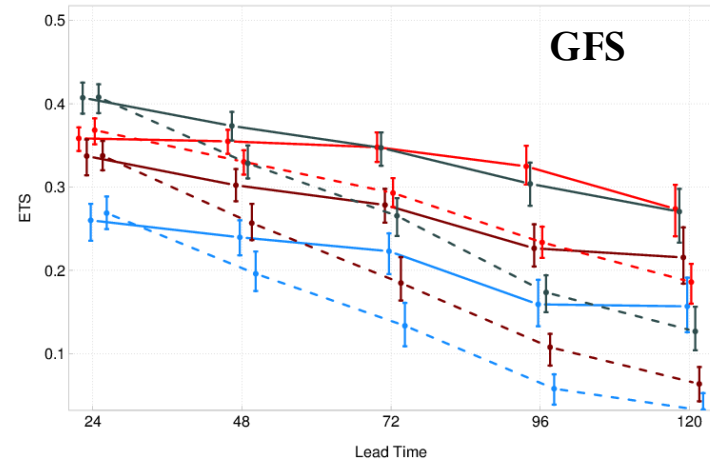
GFS under-estimates precipitation less frequently than observed (except for 0.1")

HWRF over-estimates precipitation more frequently than observed (except for 1", 2" at very short lead times)

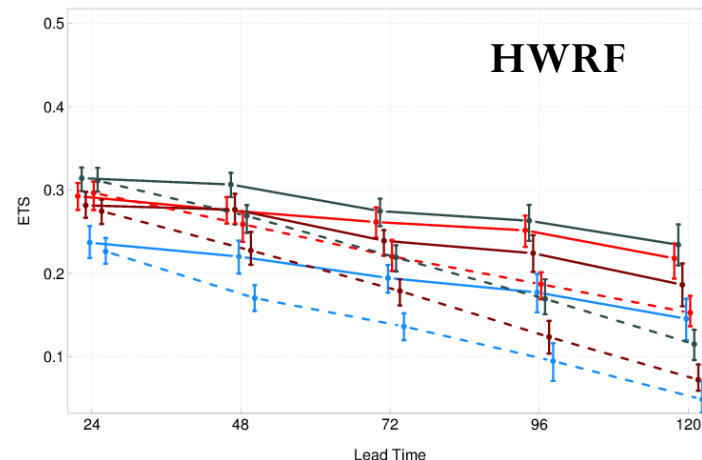
Track errors and impact on QPF

- Track errors increase with lead time – wrong storm position impacts QPF
- Shifted domain based on difference between forecasted & best track location at 24 h acc precip valid time
- Verification over 600 km circle centered on observed storm
- Implemented in MET by DTC verification team

ETS shown before and after shifting



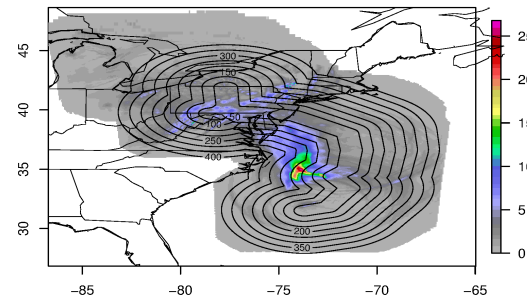
Shifted (solid) No shift (dashed)
Thresholds 0.1", 1", 2", 3"



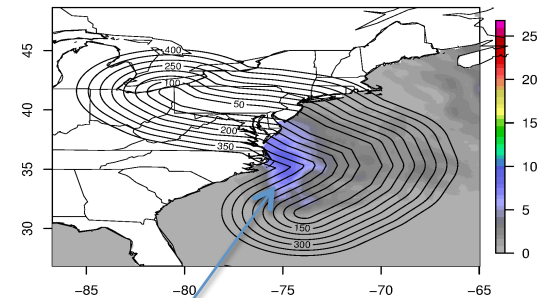
Verification of hi-res HWRF swath

- Re-gridded CMORPH, Stage IV data to 0.05°
- Drew bands of 50 km width around the storm track extending out to 400 km.
- Drawn bands relative to BT for obs and fcst location for HWRF
- Used CMORPH when storm over water and Stage IV when storm over land

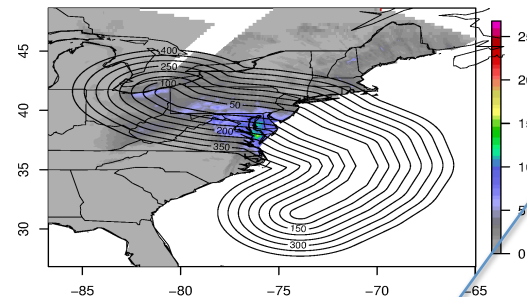
SANDY 2012102806
HWRF Swath Precipitation



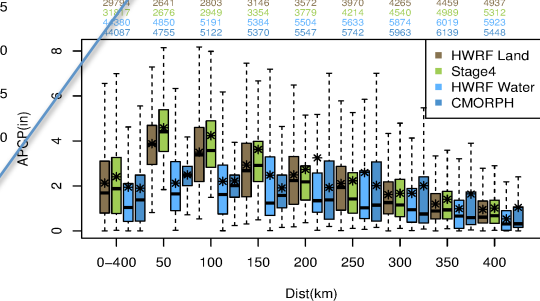
SANDY 2012102806
CMORPH (Water) Best Track Swath Precipitation



SANDY 2012102806
Stage4 (Land) Best Track Swath Precipitation



SANDY 2012102806
Precipitation by Band

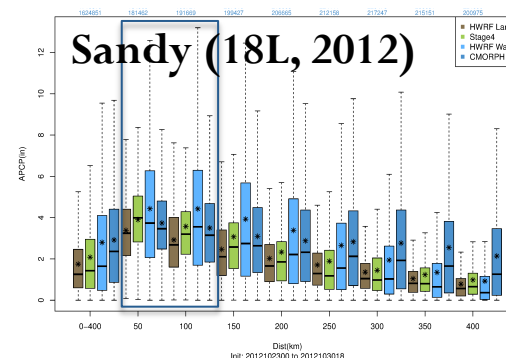
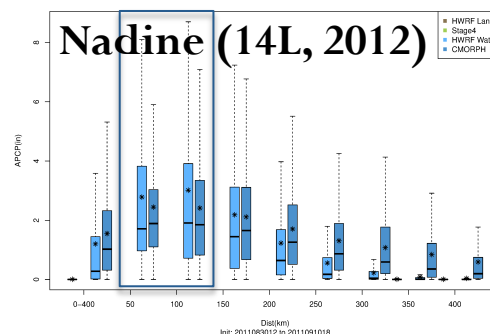
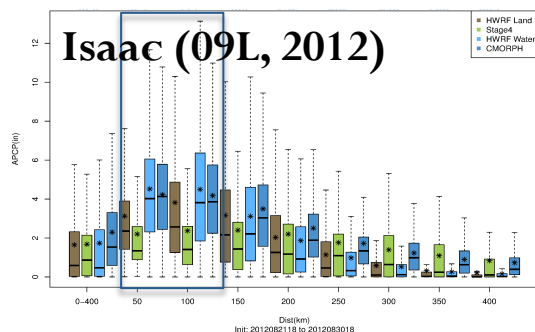
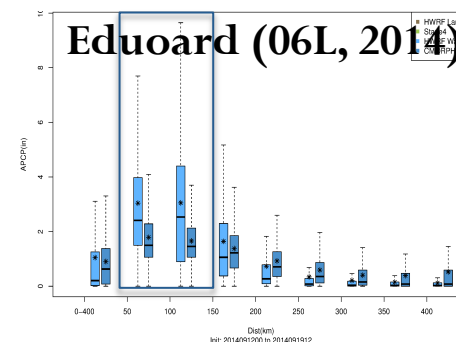
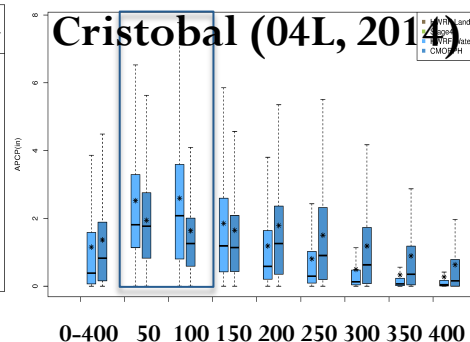
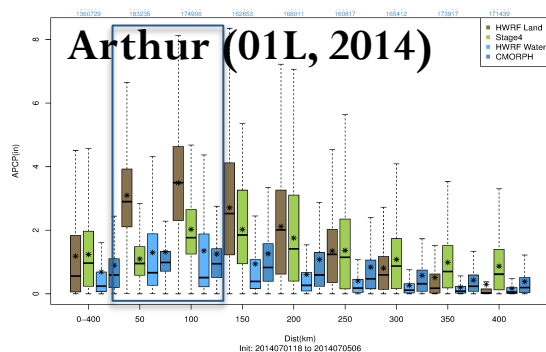


Due to coarse resolution, CMORPH does not truly represent finer scale precipitation

Distribution of acc precip for different bands and 0-400 km

Examples of QPF distributions

- HWRF Land
- Stage4
- HWRF Water
- CMORPH



Most of the HWRF rainfall occurs within 0-100 km

HWRF's precipitation decreases as we move away from the storm center.

Summary

- Both HWRF and GFS capture overall precipitation pattern, e.g. ITCZ, orographic rainfall.
- Generally HWRF QPF over-estimates compared to observations, whereas, GFS QPF under-estimates precipitation.
- At 5-day lead time ETS is reduced substantially due to track error.
- HWRF produces too much rainfall near the storm center, but too little away from it.