2012 AHW Stream 1.5 Retrospective Results

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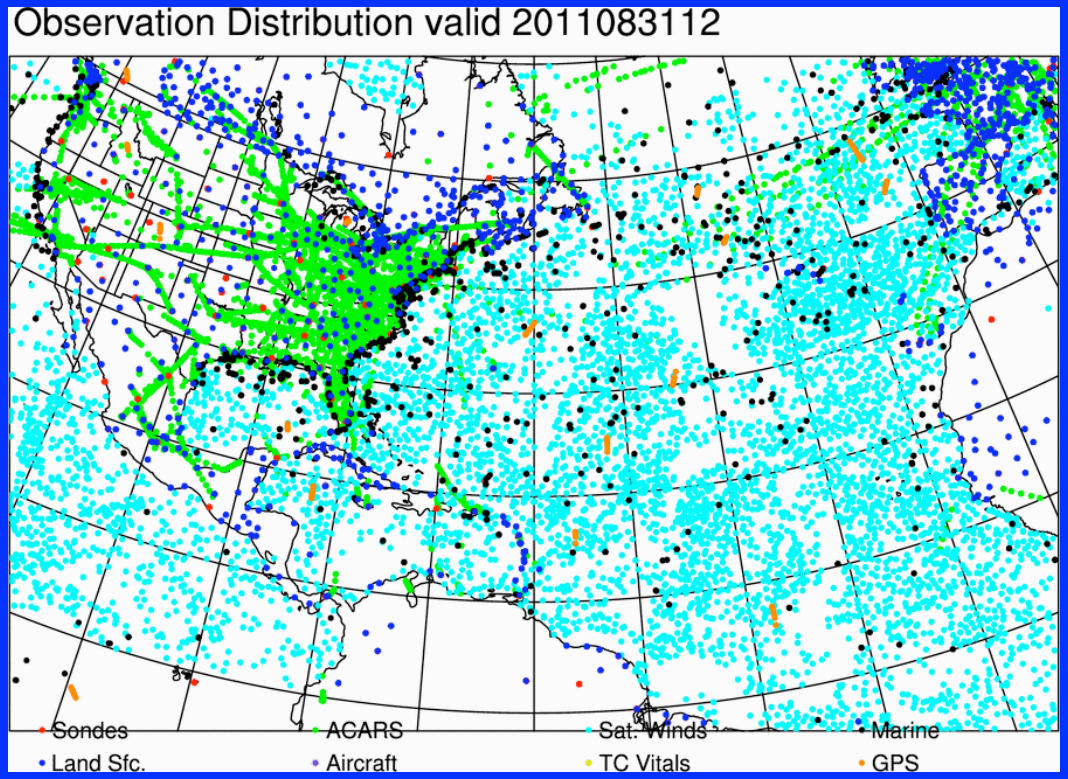
Overview

- Since participation in HFIP HRH test, we have been using cycling EnKF approach to create initial conditions for AHW model
- Wanted initial conditions that:
  - Have a good estimate of environment
  - Have a “decent” estimate of TC structure (wave-0)
  - Does not lead to significant initialization problem
- Since then, we have upgraded the system based on observed flaws in both model and initial conditions
- Stream 1.5 model during both 2010 and 2011

Assimilation System

- WRF ARW (v3.3.1), 36 km horizontal resolution over basin, 96 ensemble members, DART assimilation system.
- Observations assimilated each six hours from surface and marine stations (P_{sfc}), rawinsondes, dropsondes > 100 km from TC, ACARS, sat. winds, TC position, MSLP, GPS RO

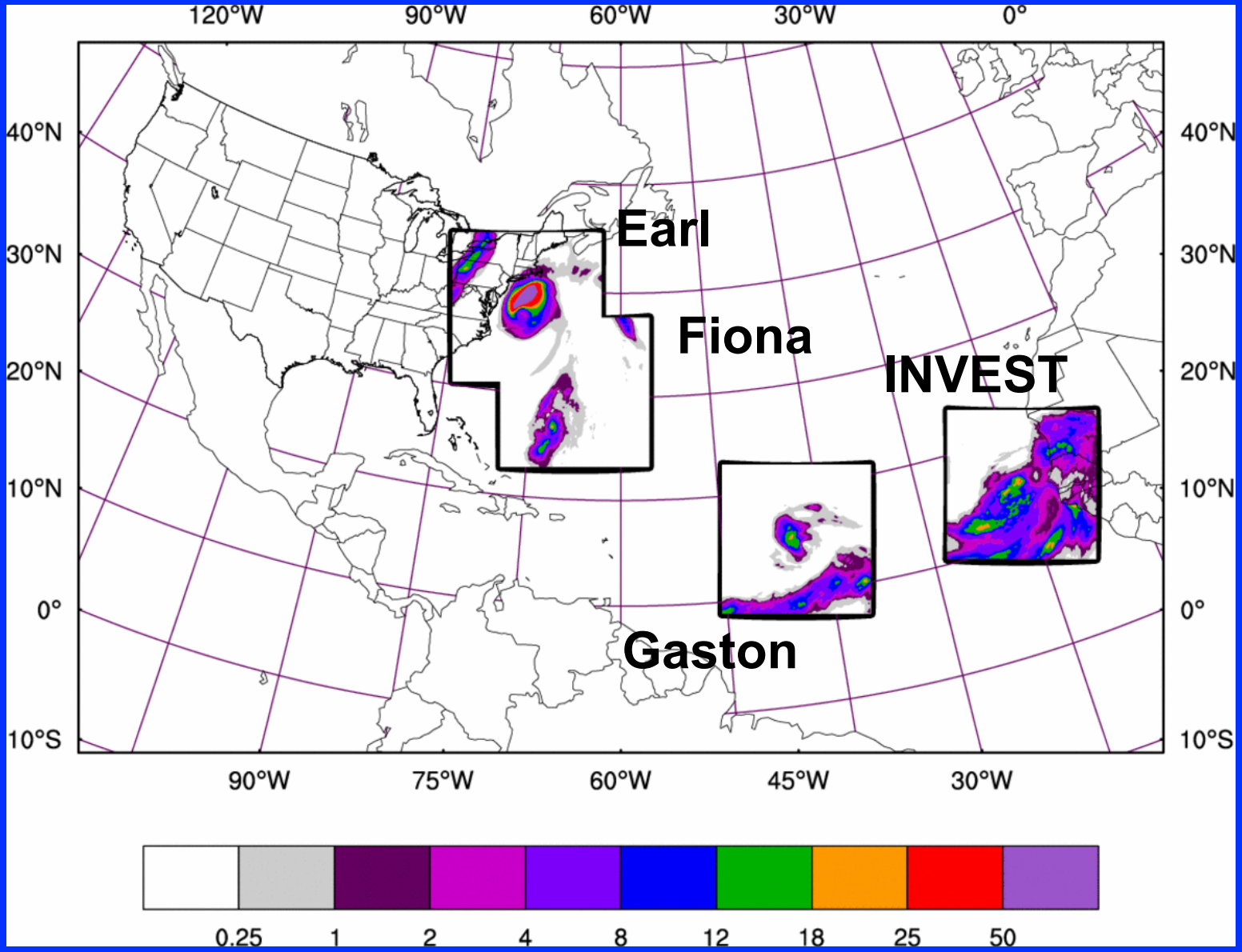
- Initialized system once per season, continuous cycling using GFS LBC
- No vortex bogusing or repositioning, all updates to TC due to observations



Data Assimilation Nesting Strategy

- Each time NHC declares an INVEST area, generate a 12 km resolution two-way interactive nest that moves with the system until NHC stops tracking it (1600 km x 1600 km nest)
- Observations are assimilated on the nested domain each 6 h
- Nest movement determined by extrapolating NHC positions over the previous 6 h
- Works better than vortex-following nests, which have largest covariances associated with differences in land position

Nest Example



AHW Forecast (AHW4)

- For each TC, choose one analysis ensemble member whose TC properties are closest to ensemble mean (see below)
- Remove other 12 km nests, add additional 4 km nest to 12 km domain for that storm (800 km on a side)
- Can produce ensemble forecasts by using other ensemble initial conditions

$$J_s(i) = \left(\frac{Lat_{i,s} - \overline{Lat_s}}{\sigma_{Lat}}\right)^2 + \left(\frac{Lon_{i,s} - \overline{Lon_s}}{\sigma_{Lon}}\right)^2 + 2\left(\frac{MSLP_{i,s} - \overline{MSLP_s}}{\sigma_{MSLP}}\right)^2$$

AHW Physics Setup

- WSM6 Prognostic Microphysics
- Modified Tiedtke cumulus parameterization on 36 and 12 km resolution domains
- YSU PBL Scheme, NOAH LSM
- RRTM LW, Goddard SW Radiation (2011)
- Pollard 1D Column ocean model
- SSTs from NCEP 1/12 degree analysis
- HYCOM Mixed-layer depths

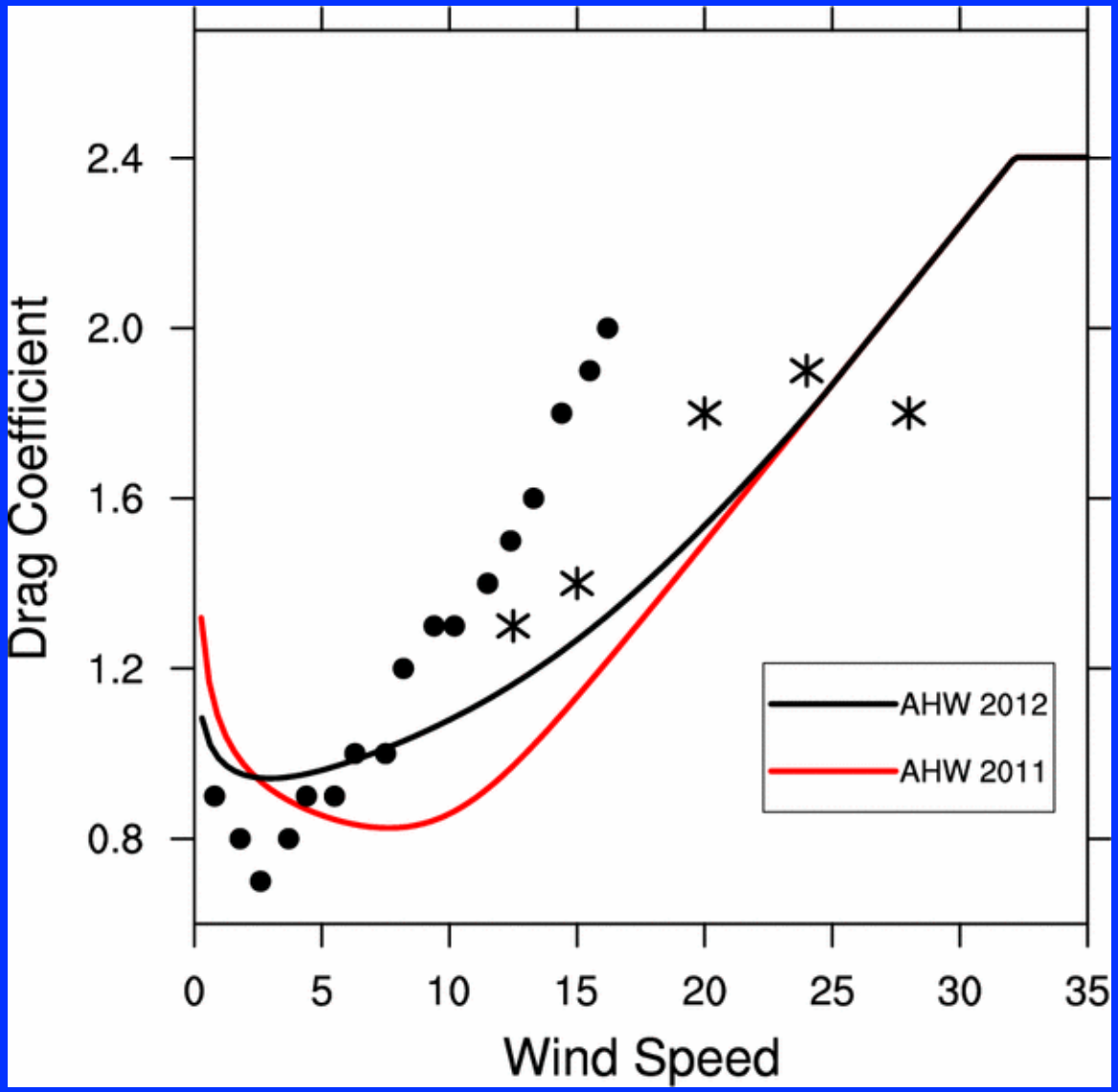
Persistent Biases in 2011 Setup

- TCs move too slow, particularly in the eastern Atlantic basin
- Recurvature happens too soon
- Over-development of TCs being sheared by synoptic-scale systems (e.g., Katia Maria, 2011)
- High bias in midtropospheric moisture
- Surface winds too strong everywhere
- Small TCs, particularly near central America (e.g., Ida, Marco Paula)

Modifications for 2012

- Modified cloud base mass flux for Tiedtke shallow convection (based on vertical flux of MSE, not water vapor; less vigorous)
- Higher shallow convection entrainment
- RRTMG SW+LW radiation, including climatology of aerosol (f(x,y,z,t)) and ozone (f(y,z,t))
- Modified surface drag coefficient which is closer to CBLAST observations (reduction in 10-20 m/s range)

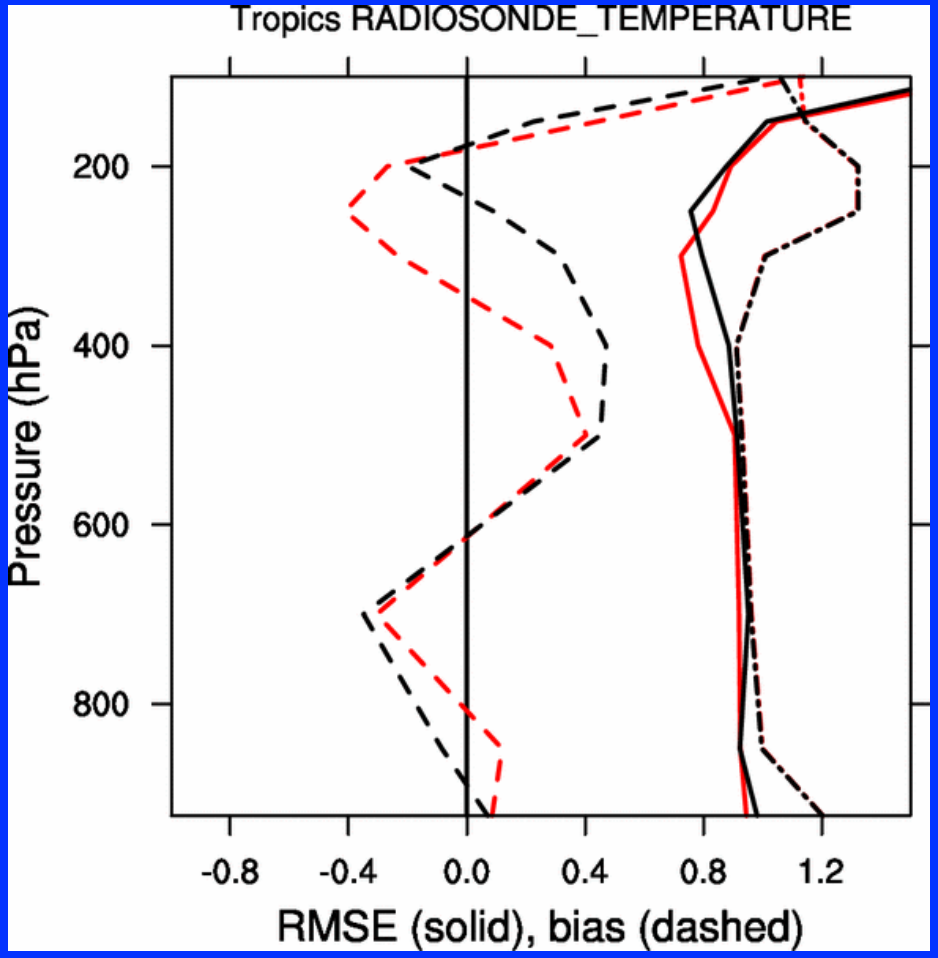
Drag Coefficients

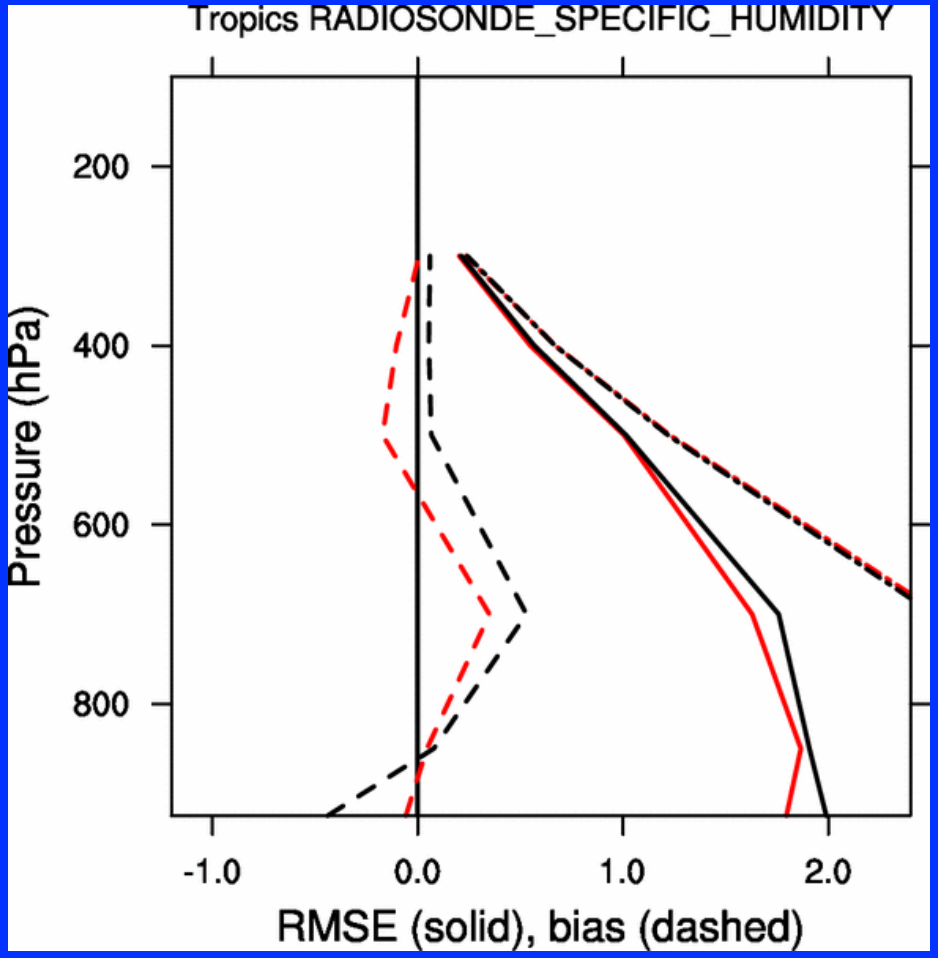


Atlantic Overview

- Cycled the data assimilation system for most Atlantic cases from Aug. – Oct. 2009-2011 (any temporally isolated, short-lived systems were not considered)
- First, consider whether physics improvements are making positive impact on the larger-scale environment

Rawinsonde Verification





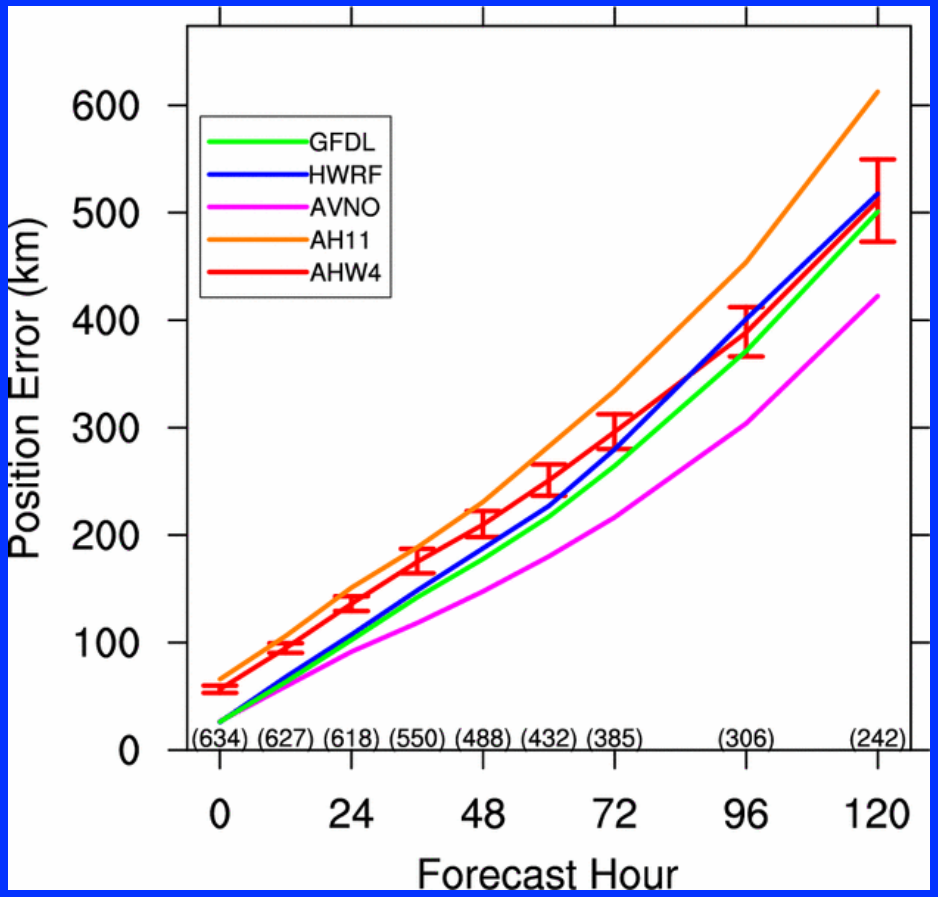
September 2010

2011 Configuration

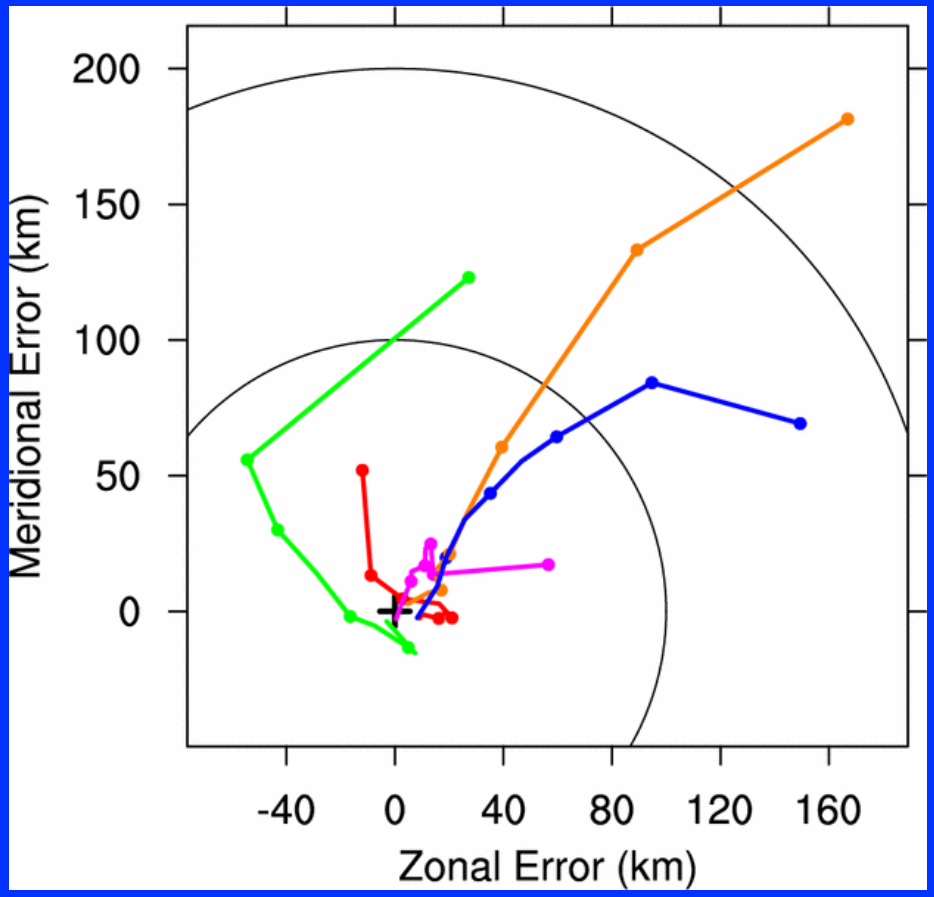
2012 Configuration

Forecast Verification

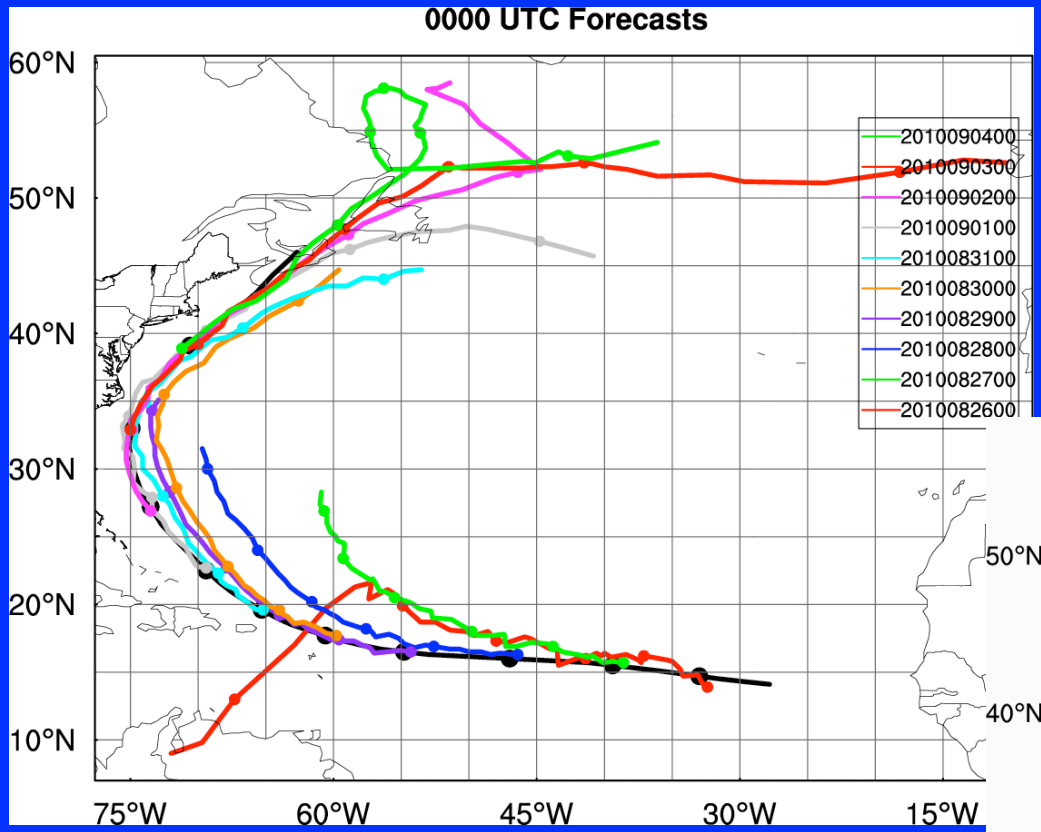
Mean Absolute Error



Bias



Earl Tracks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75°W
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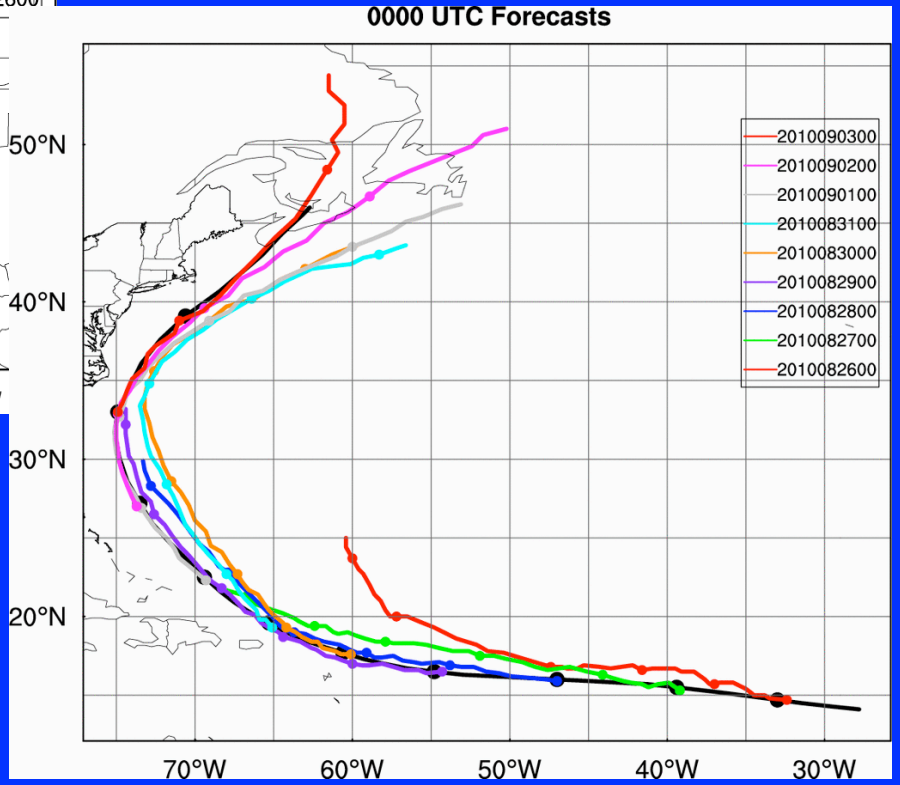
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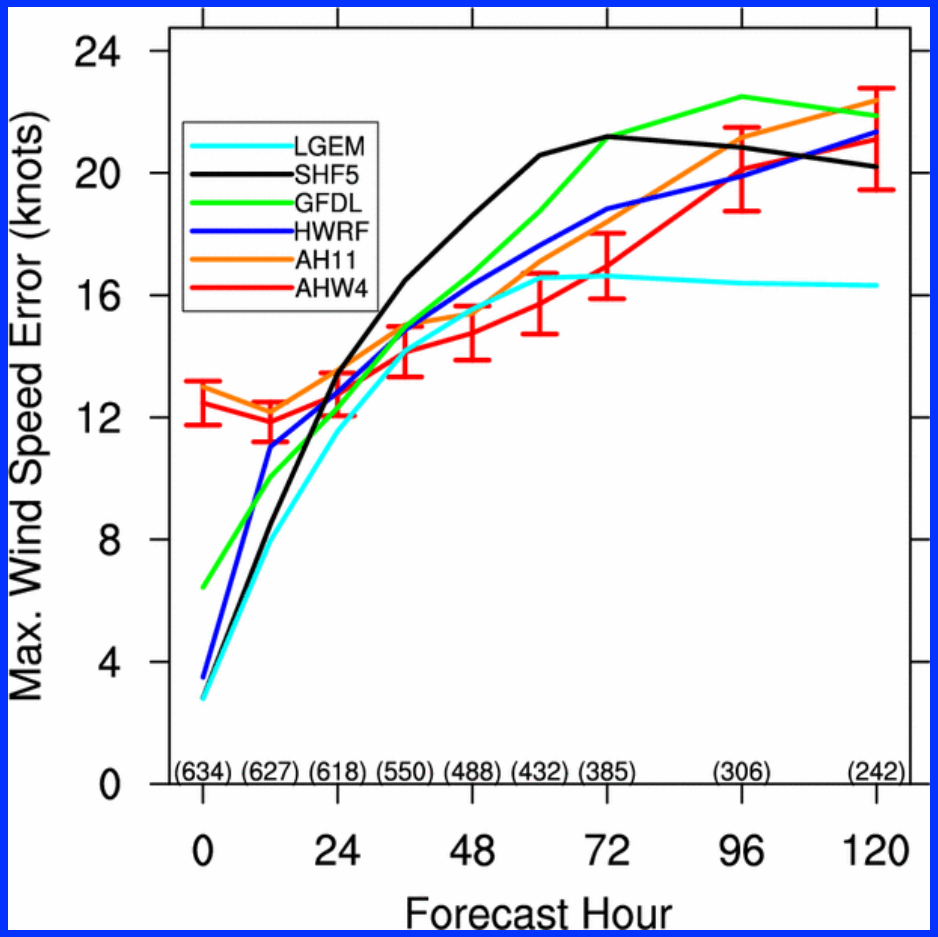
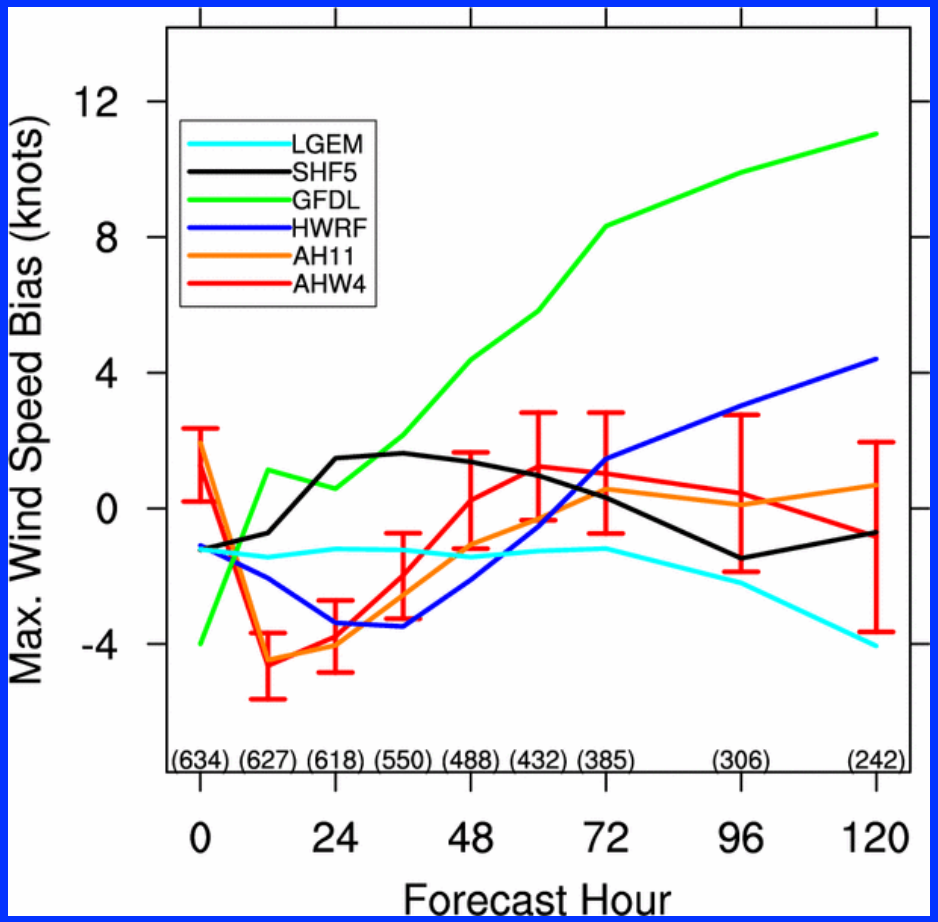
Maximum Wind Speed

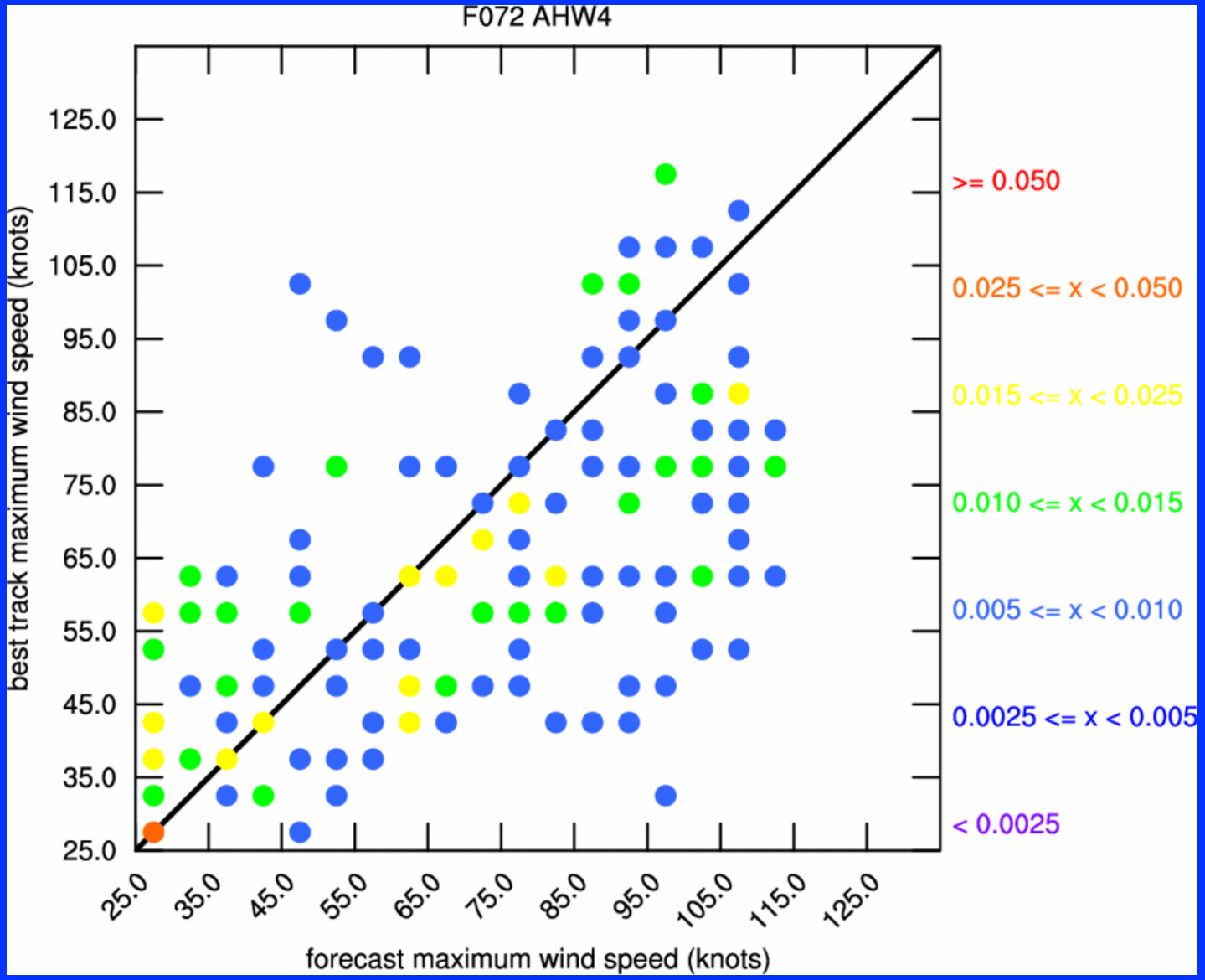
Mean Absolute Error



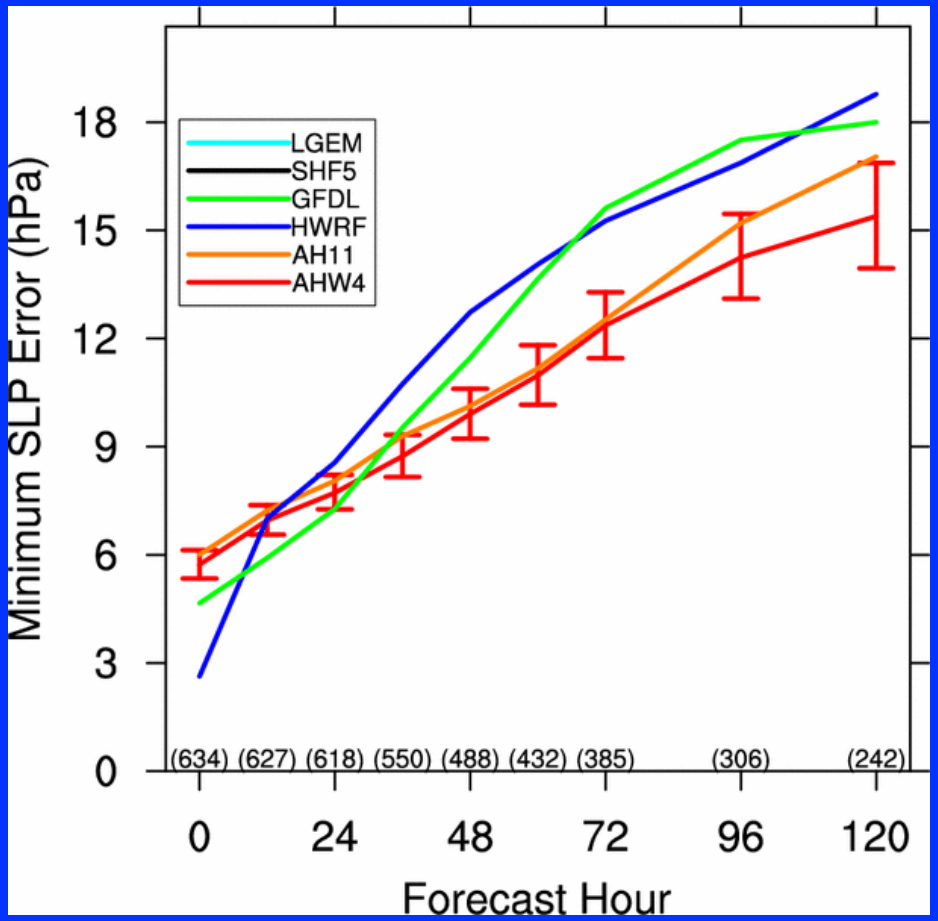
Bias

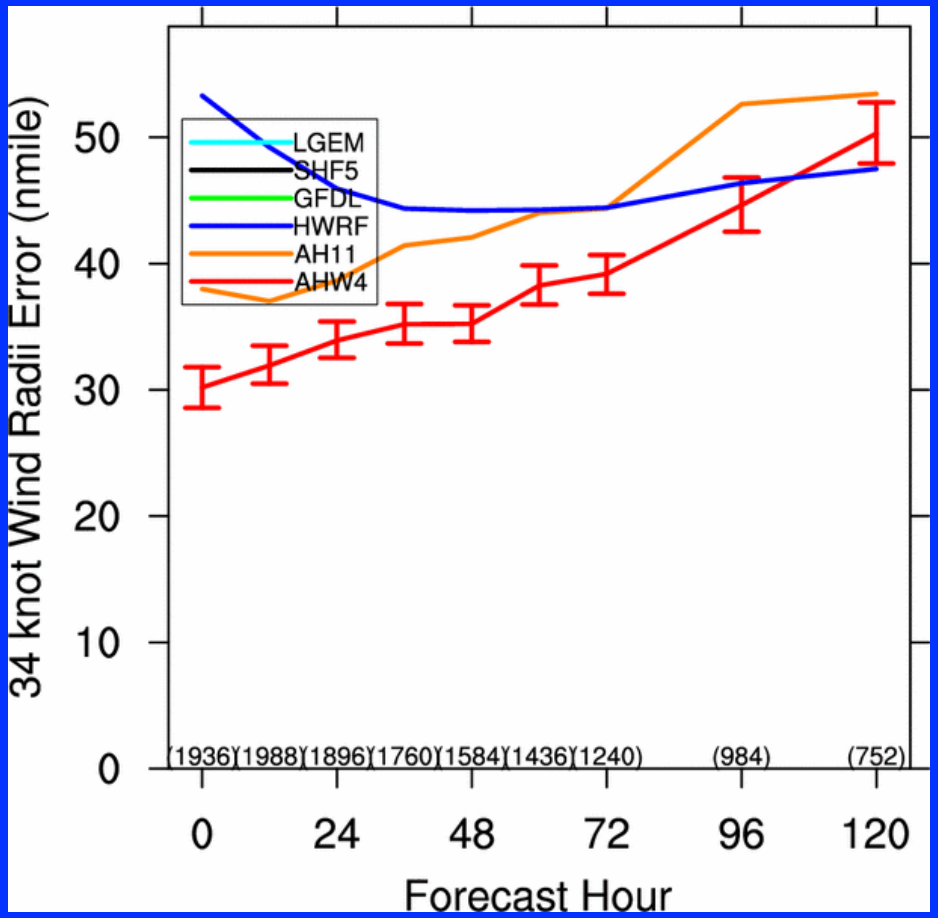


Maximum Wind Errors

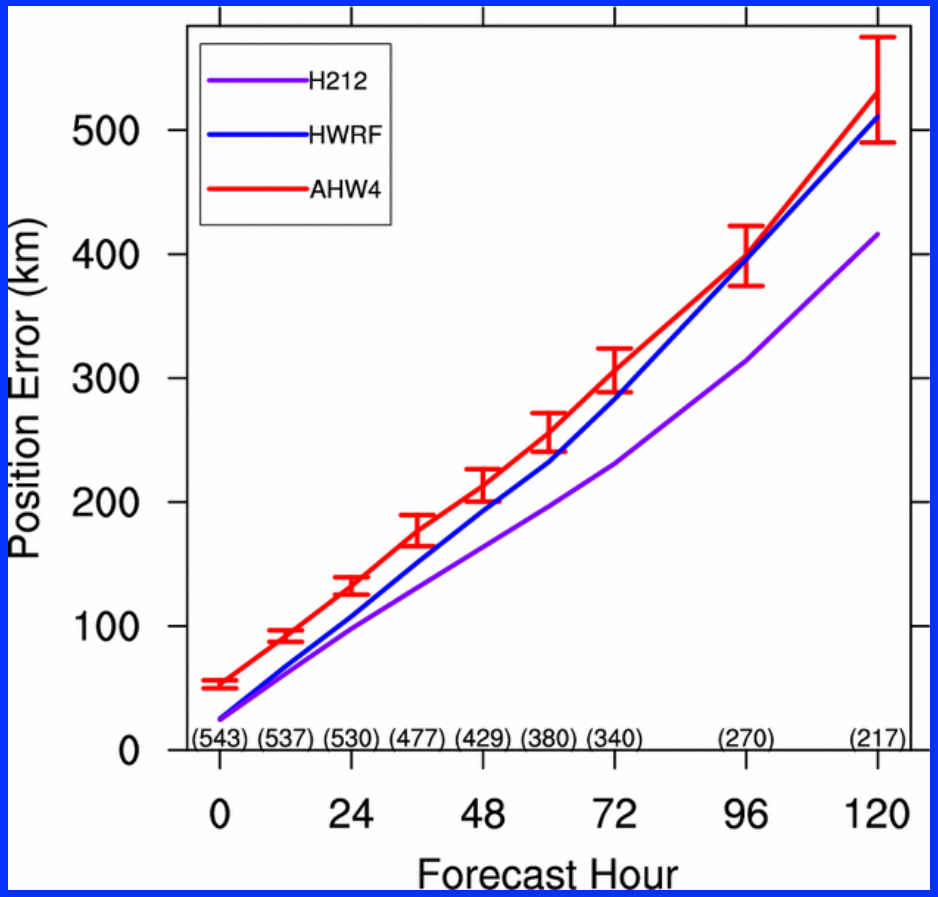


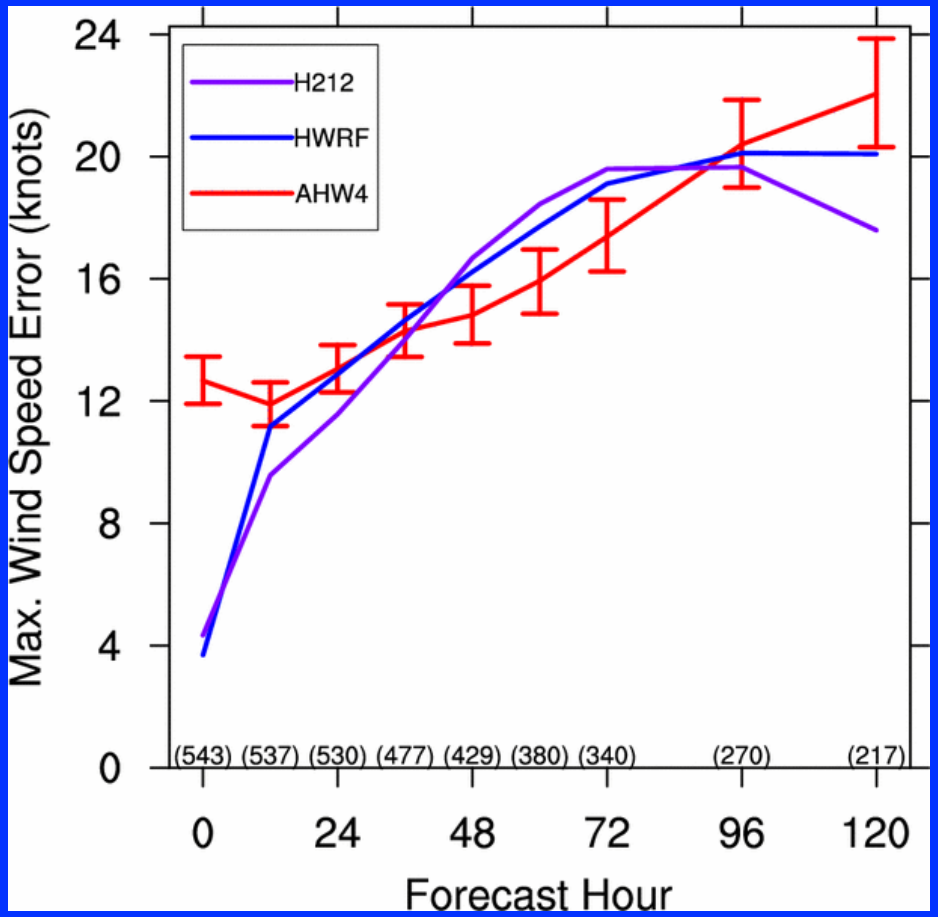
Minimum SLP/34 knot Winds





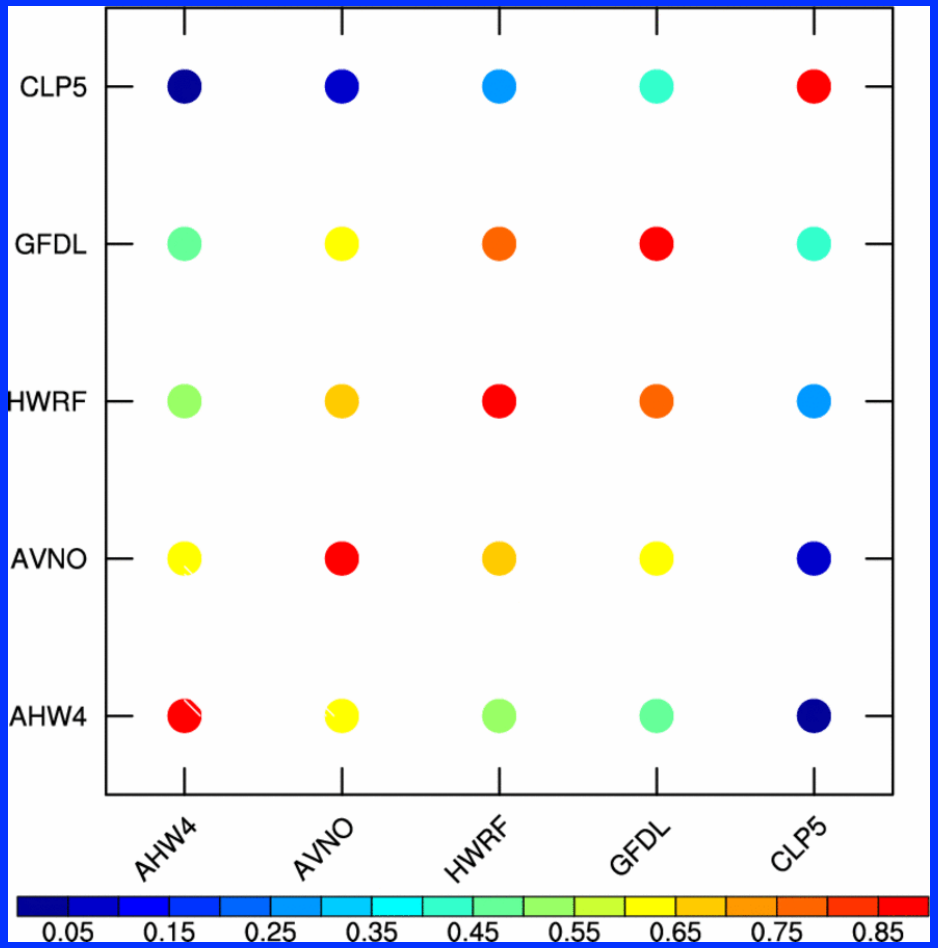
H212 Comparison



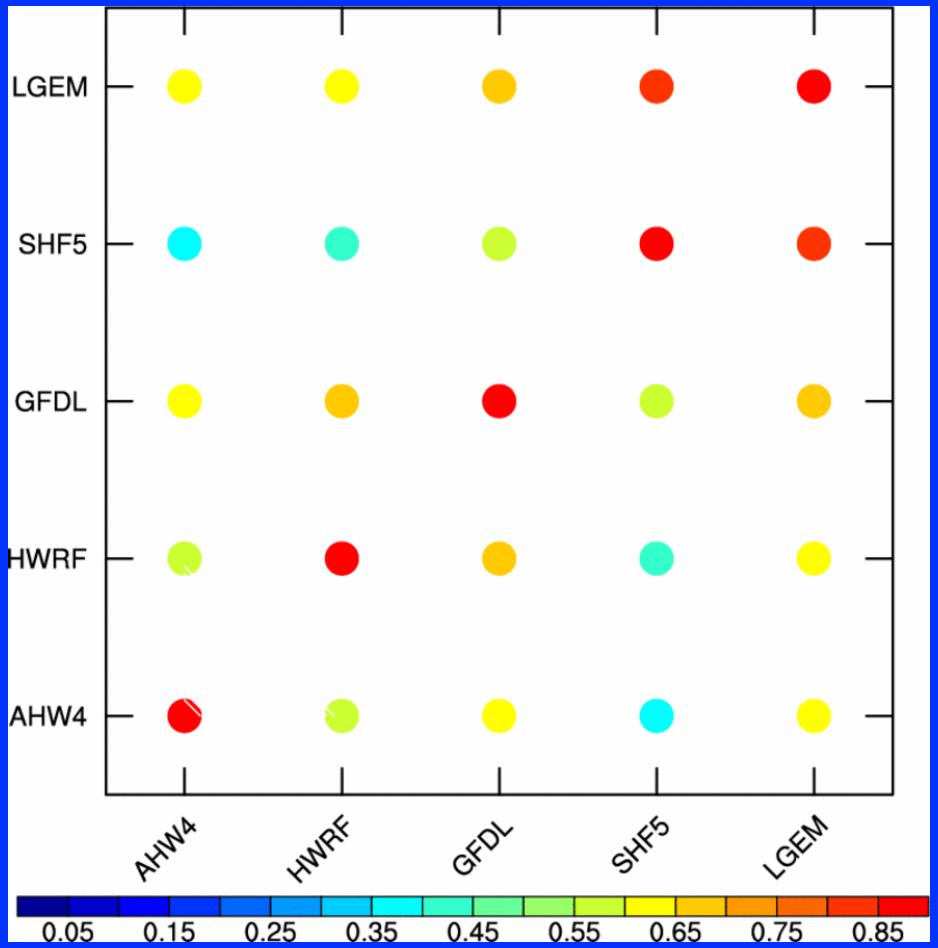


72 h Forecast Error Correlation

Meridional Position

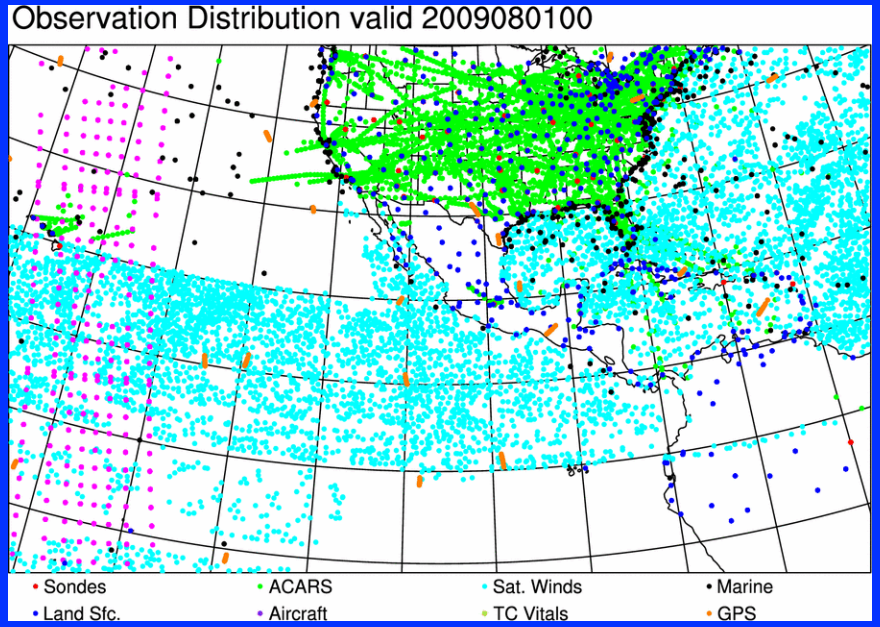


Maximum Wind Speed



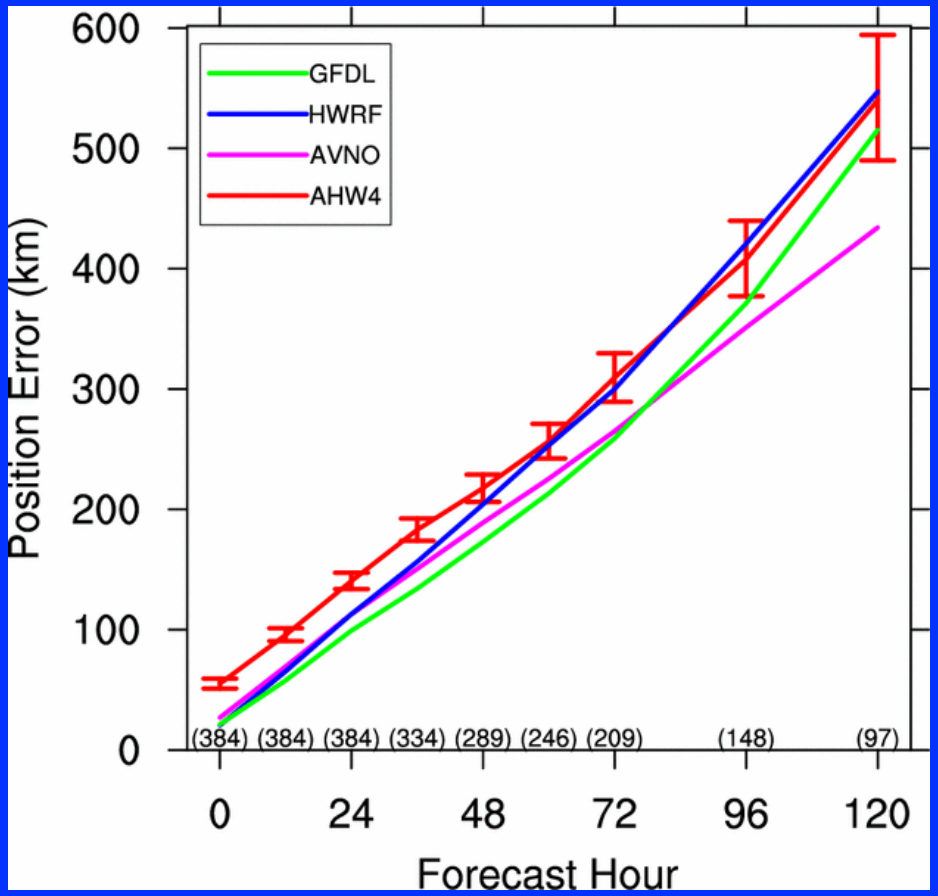
Eastern Pacific

- For the first time, we ported the system to create forecasts of the Eastern Pacific Basin
- Required new domain; however, all other model settings remain the same

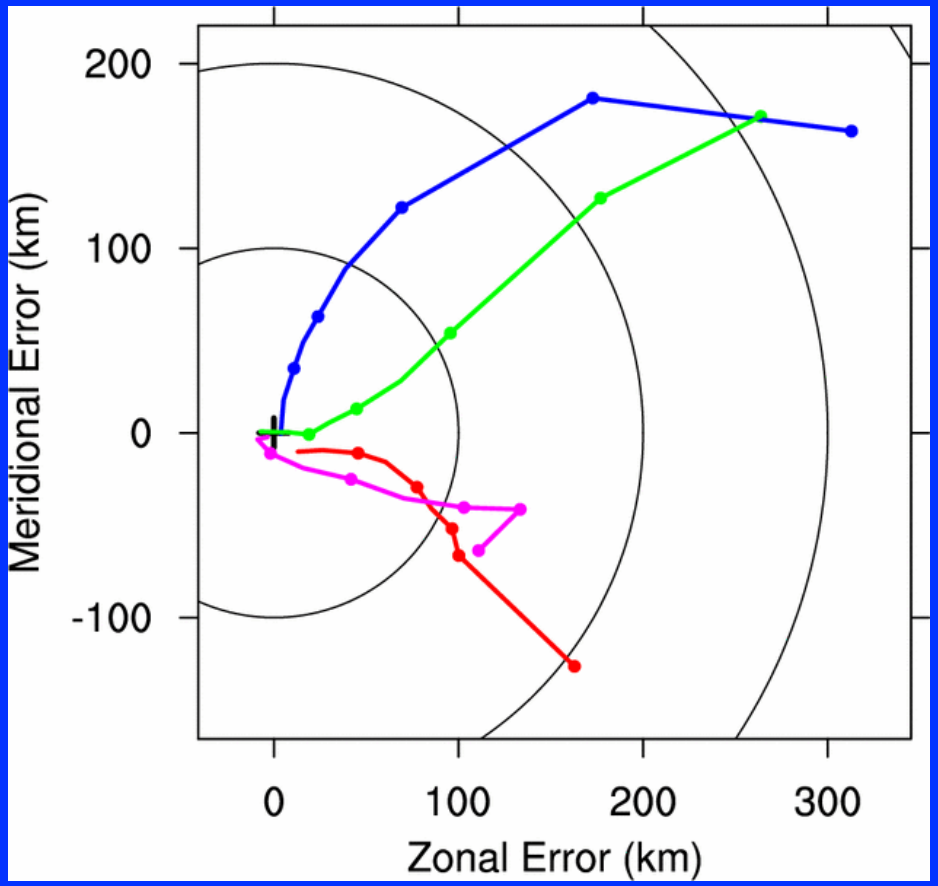


Eastern Pacific

Mean Absolute Error

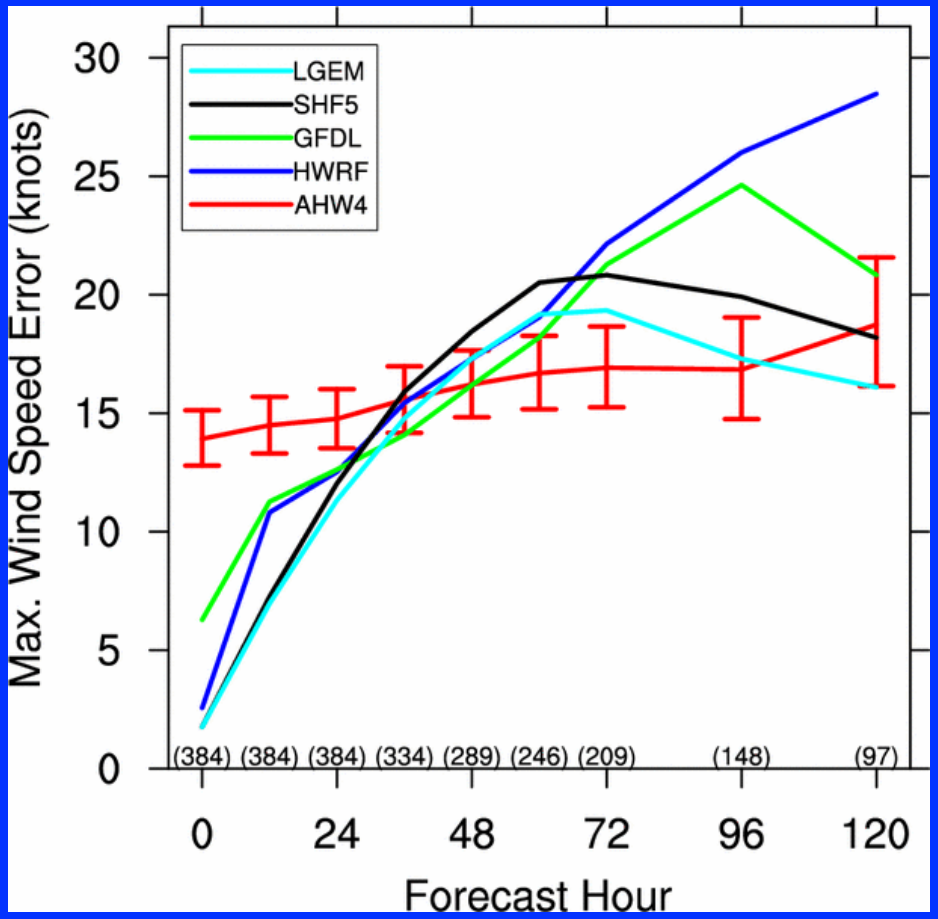


Bias



Eastern Pacific

Mean Absolute Error



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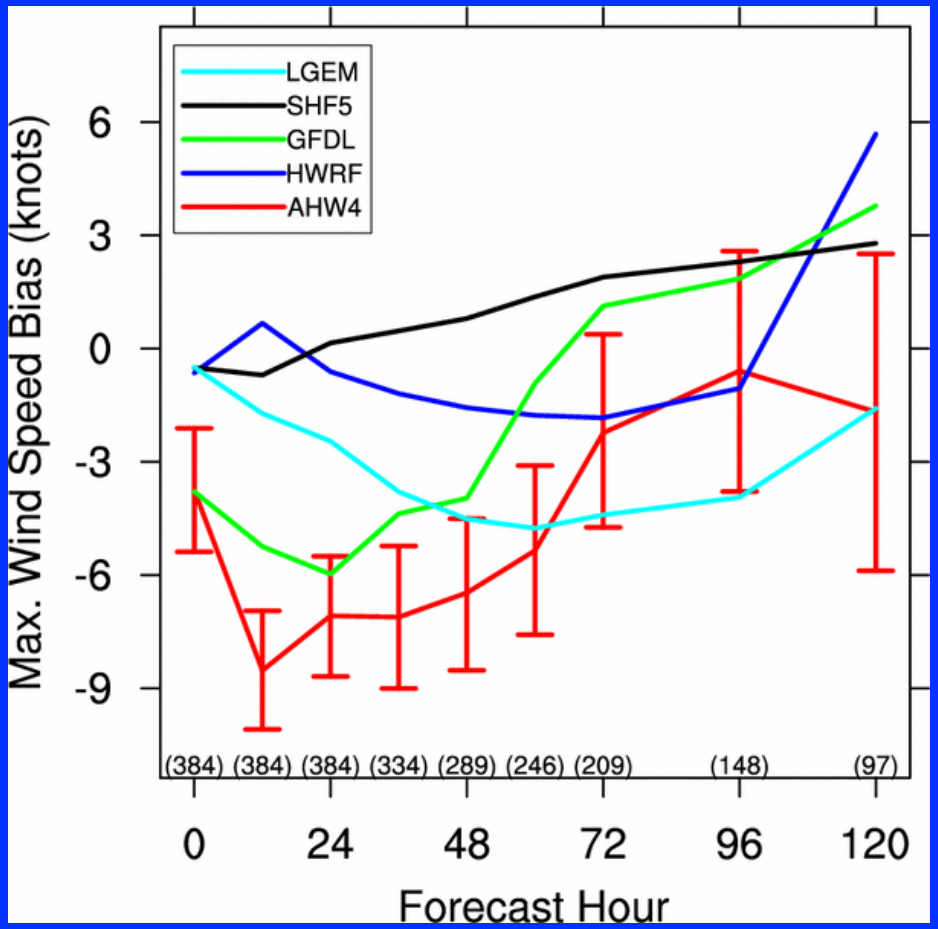
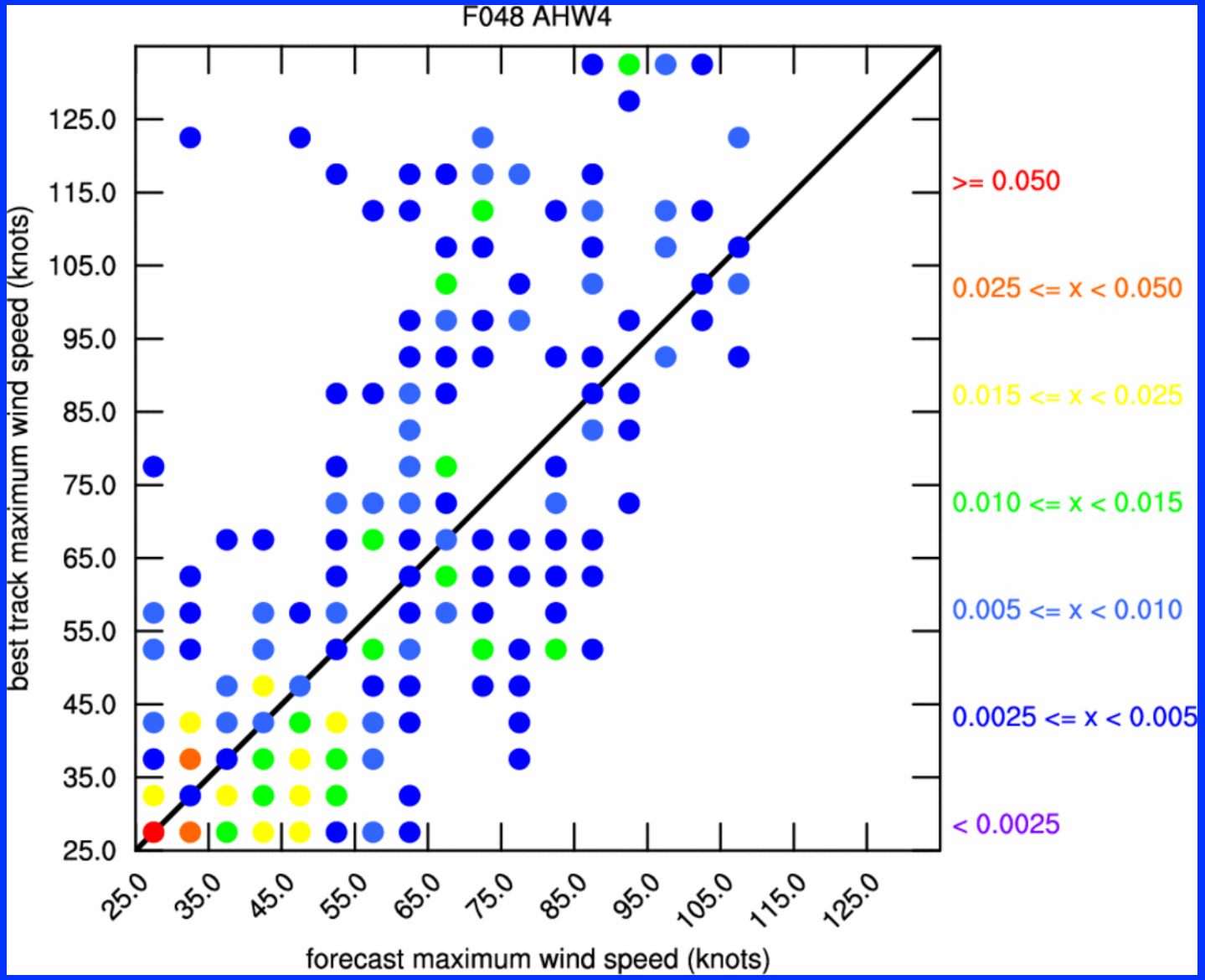
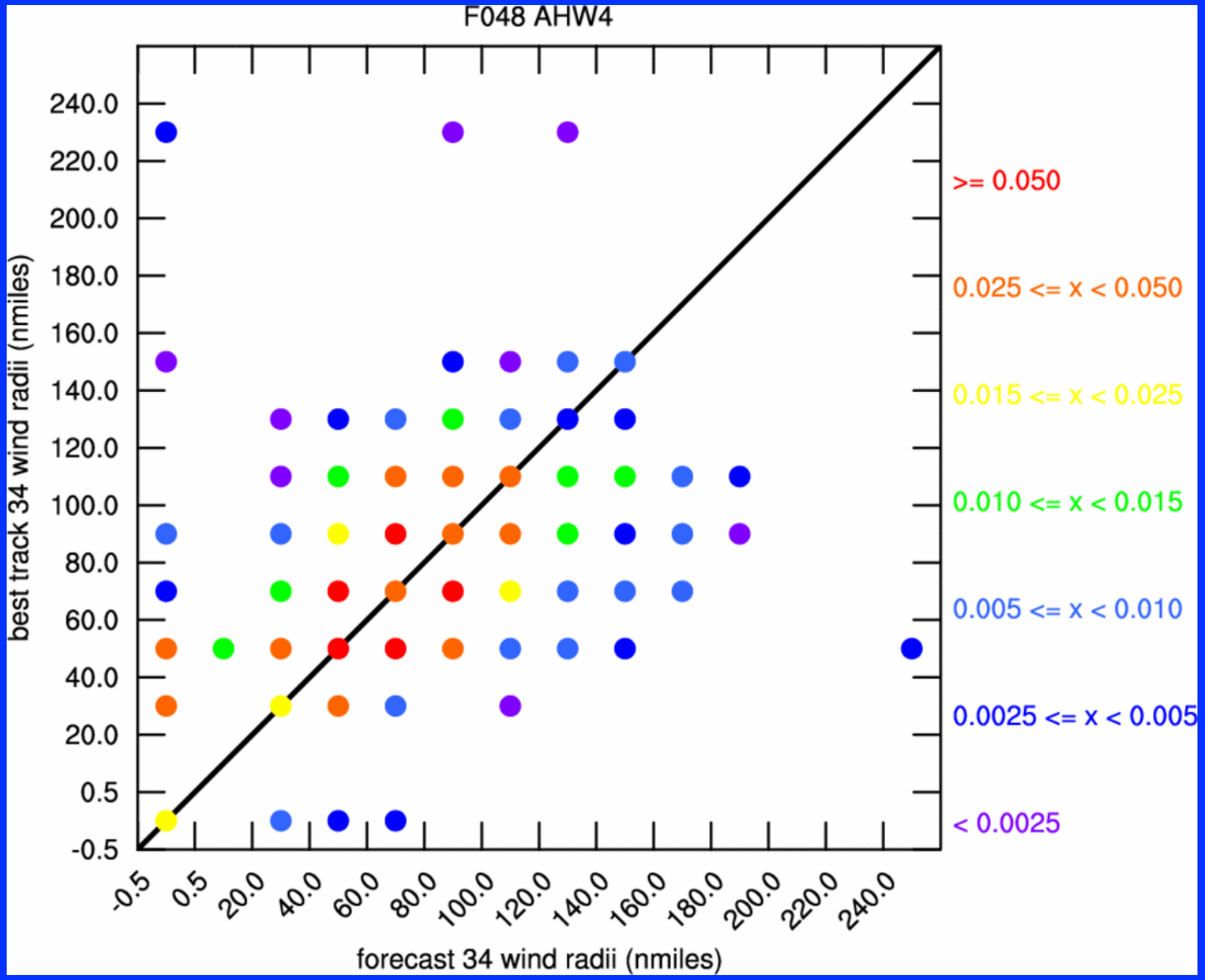


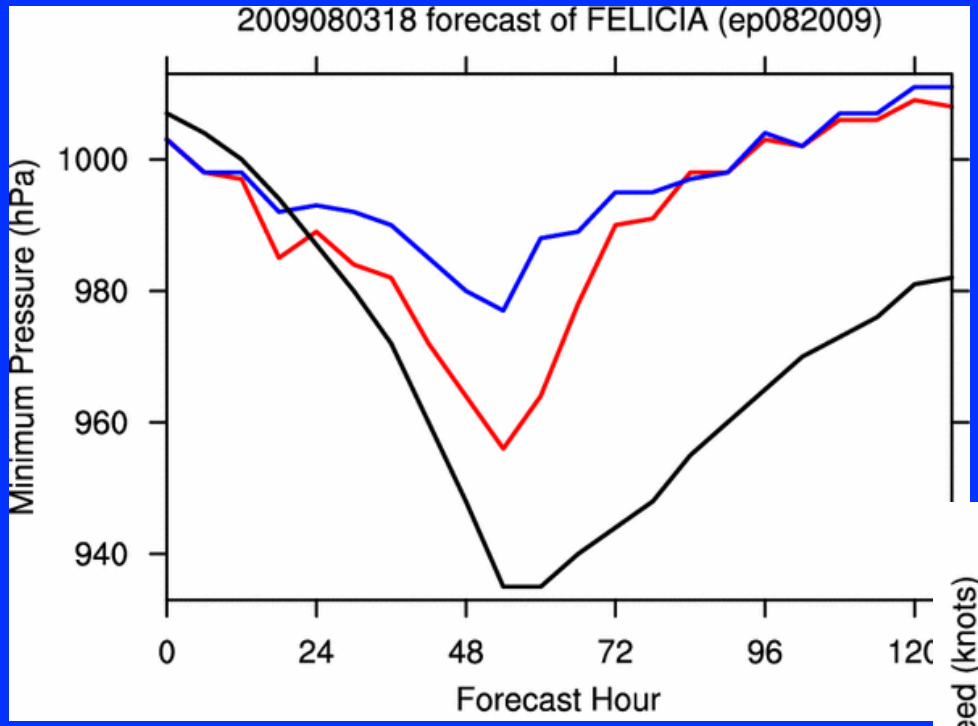
Forecast Verification

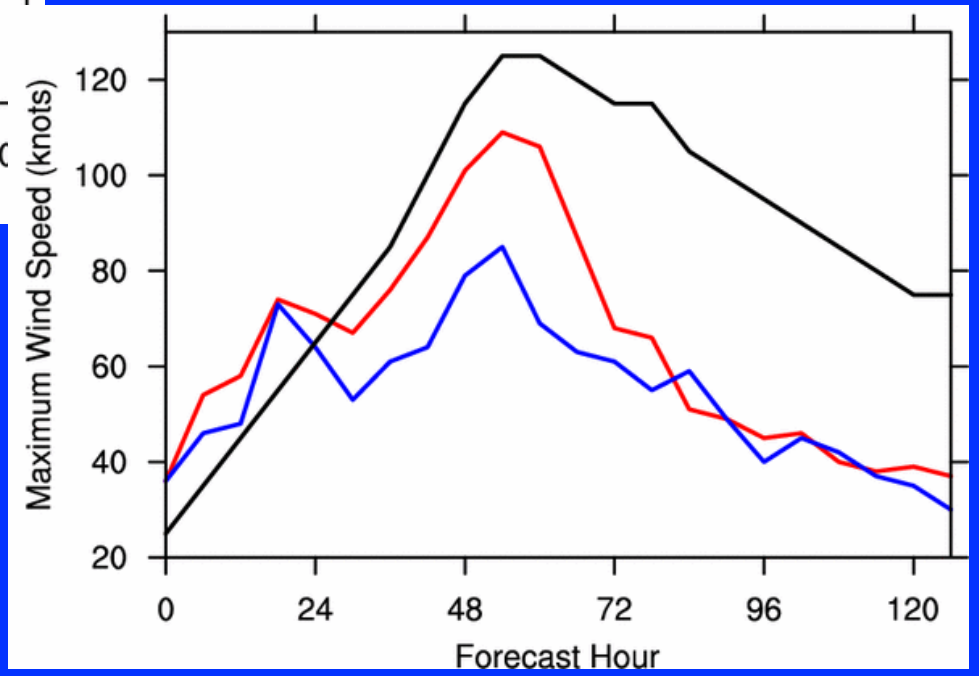


34 knot Verification



Felicia Forecast



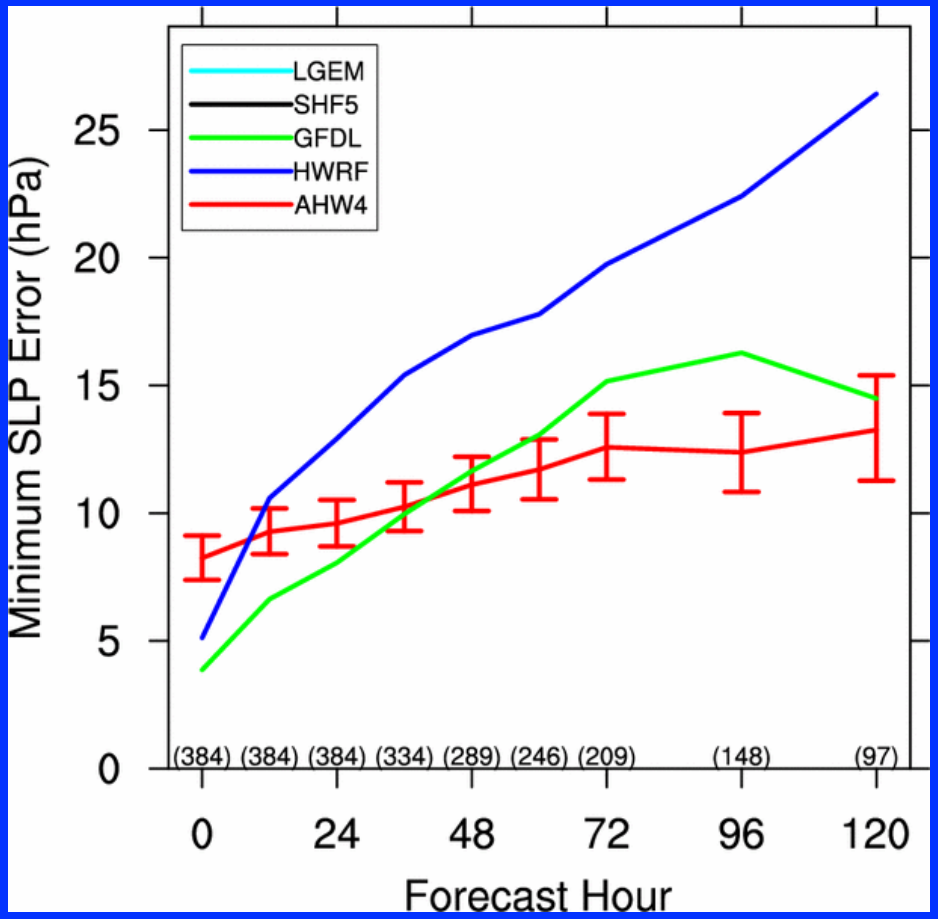


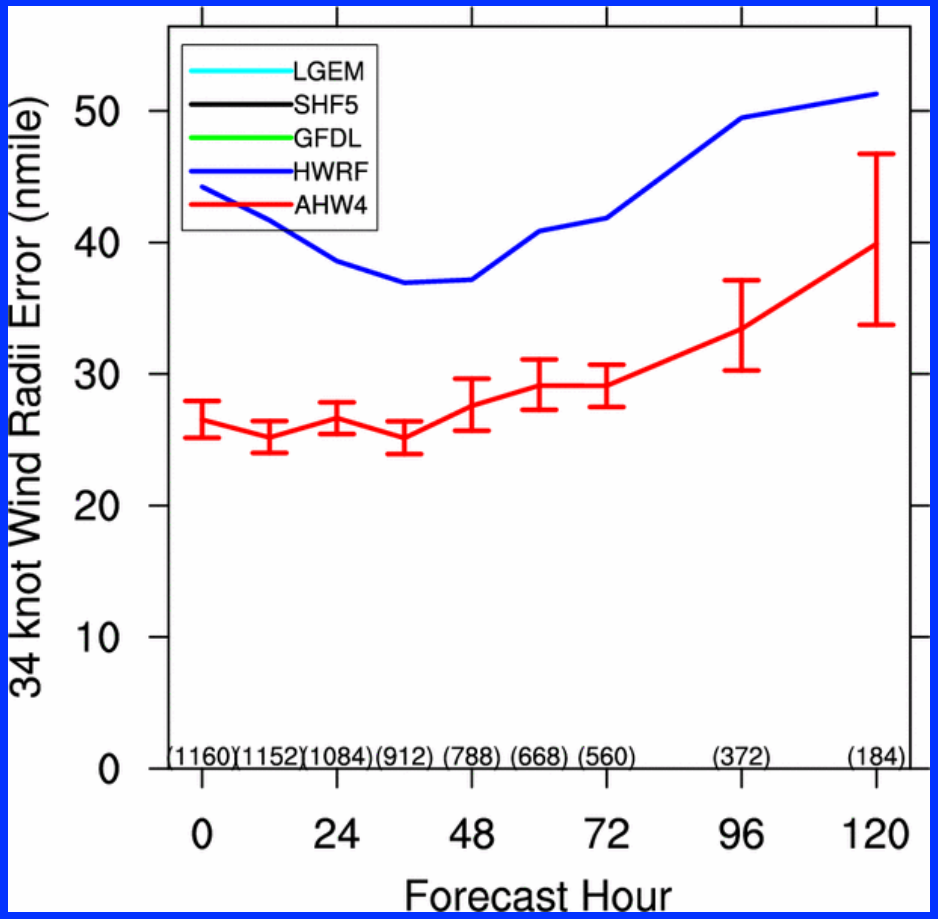
1800 UTC 3 August 2009 Felicia

4 km triple-nested AHW forecast

1.33 km quadruple-nested AHW forecast

Minimum SLP/34 knot Winds





Remaining Issues

- Still have not improved forecast of TCs sheared by synoptic systems (needs evaluation)
- Track errors still relatively large
  - Evaluate sat wind observation errors
  - AIRS retrieval assimilation (large biases)
  - Cumulus parameterization detrainment
- Large position errors at genesis
  - Could assimilate position for INVEST, likely have weak correlations, needs larger observation errrors