

Impact of Global Hawk on GFS Hurricane Forecasts

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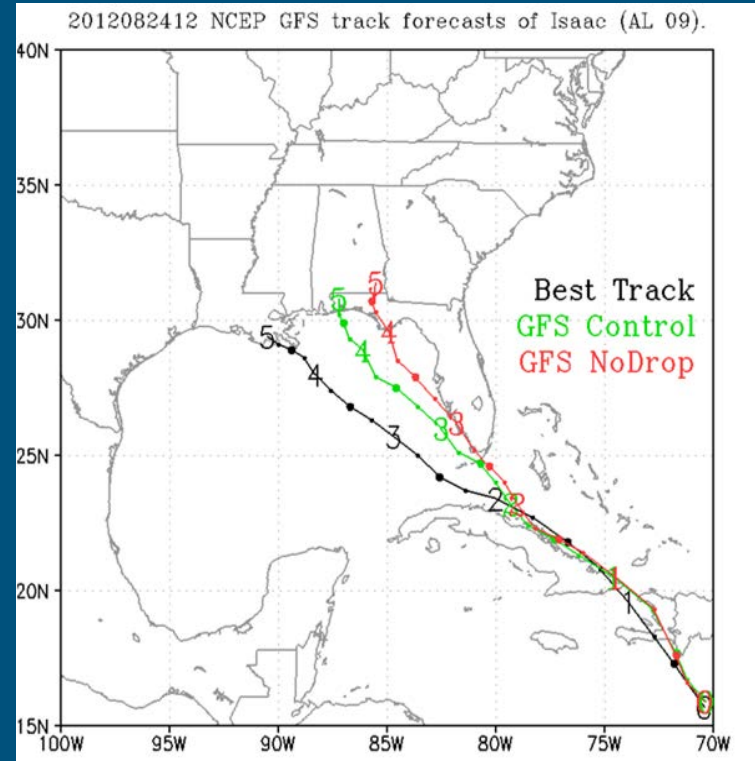
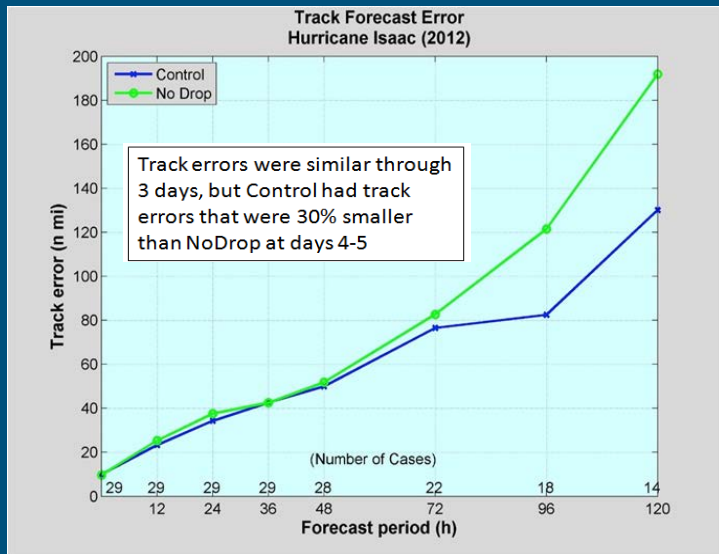
¹ (NOAA NWS NCEP/EMC), ² (NOAA AOML/HRD)

Recent Observing System Experiments (OSE) for Supplemental Observations

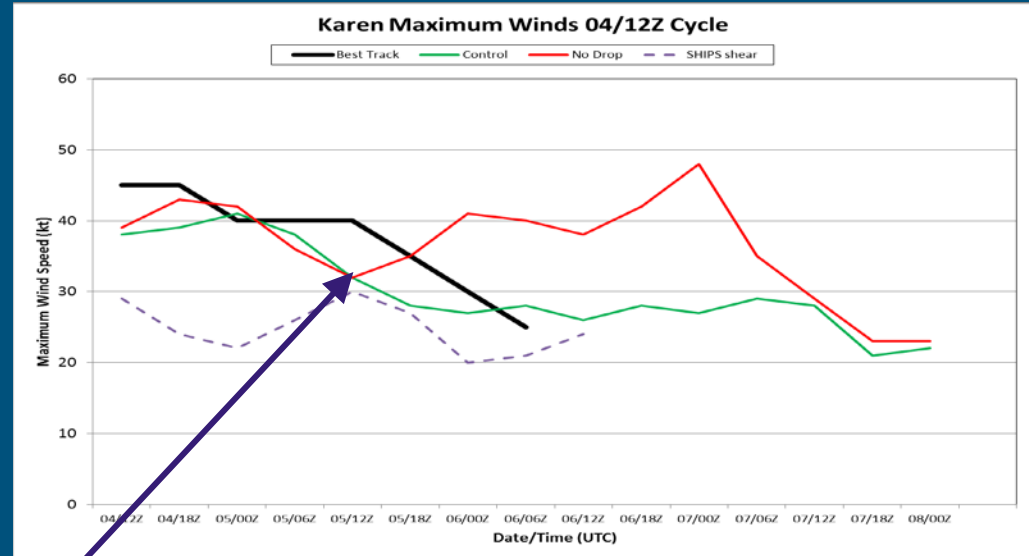
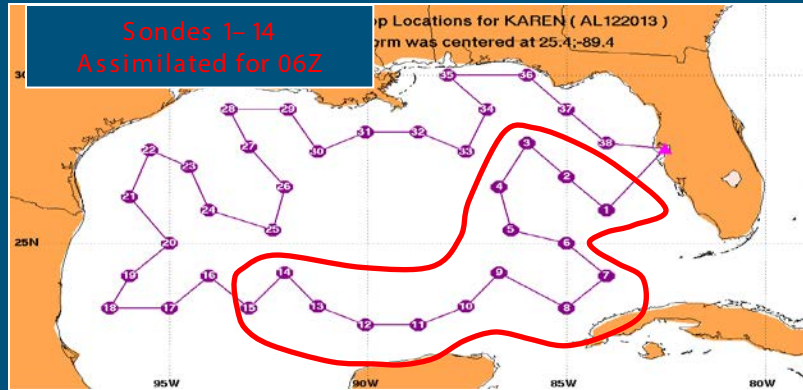
- Experiments run intermittently to evaluate impact of supplemental dropsondes/rawinsondes for TCs in GDAS/GFS.
- The following have been evaluated using Hybrid 3DEnVar
 - Isaac (2012)
 - Sandy (2012)
 - Karen (2013)
 - Joaquin (2015)

Hurricane Isaac (2012)

- Dropwindsondes reduced 4-5 day average track forecast errors by about 30%.
- Drops appear to reduce the cycle-to-cycle variability in track.
- Little change in GFS intensity forecast errors due to the drops.
- Control shows shallower, weaker vortex relative to “no drop”.



Tropical Storm Karen (2013)



As noticed by operational forecasters, assimilation of surveillance sondes resulted in significant change in TC intensity forecast for Karen (no drop resulted in forecast of stronger storm)

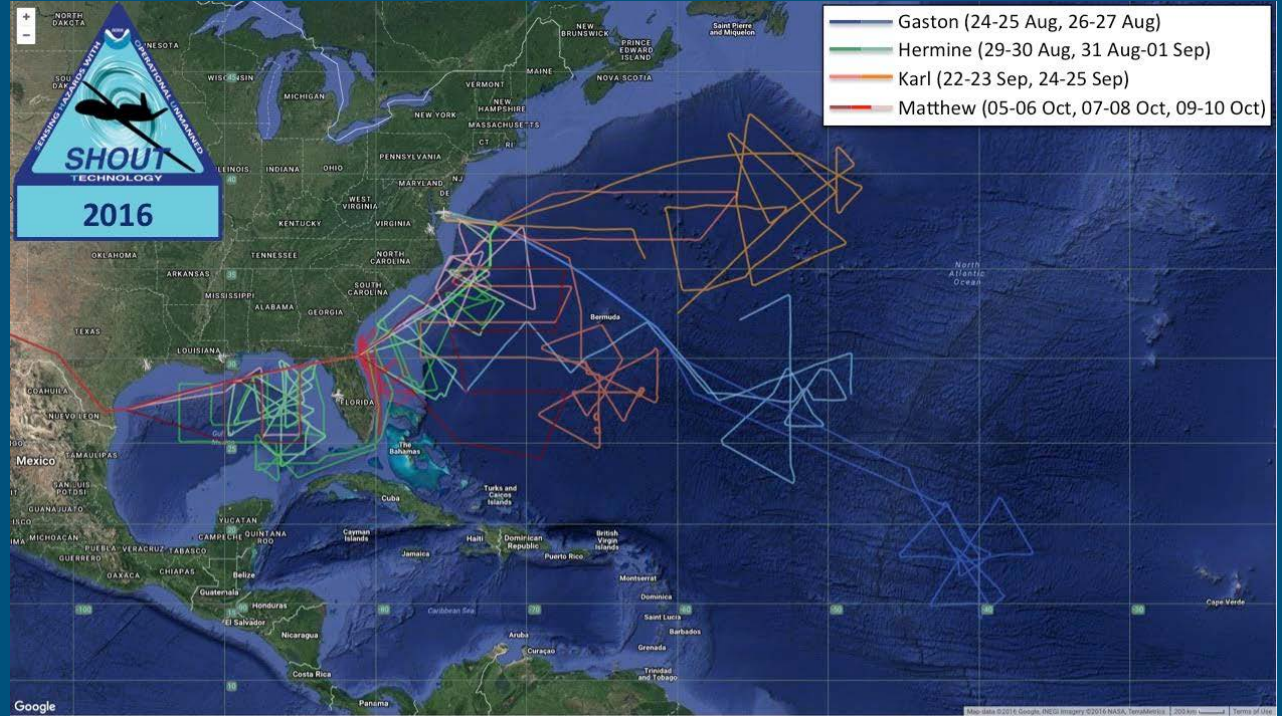
Prior OSE Summary

- Similar to Karen and Isaac case studies, most of the OSEs show varying degrees of small, positive improvements on track forecasts.
- One exception: Experiment with Joaquin (2015) resulted in degradation from dropsondes
 - Caution: This case seems to be extremely sensitive to IC modifications
- **Prior case studies did not evaluate inclusion of Global Hawk observations.**

NOAA SHOUT Flights for 2016 Hurricane Season

Investigate the impact of Global Hawk (GH) dropsonde observations on Global Forecast System (GFS) model hurricane track and intensity forecasts.

Global Hawk data is currently not assimilated in the GFS at NCEP, but positive results from this study would justify their inclusion.



Methodology



Model used: Q3FY17 GFS (planned upgrade)

- T1534L64 (13km) NEMS/GSM
- Hybrid 4DVar Ensemble Kalman Filter (EnKF) Data Assimilation System

Experiments:

- Control run = same as Q3FY17 pre-implementation parallel configuration
- Experimental runs = control plus:
 - Global Hawk observations turned on in GFS by adjusting prepbufr quality marks.
 - Observations within storm radius reflagged for non-use by assimilation.

Targeted 2016 Atlantic storm cases: Gaston, Hermine, Karl, Matthew

Results

PRELIMINARY - FIRST RUNS OF THIS KIND - MORE ANALYSIS TO BE DONE!

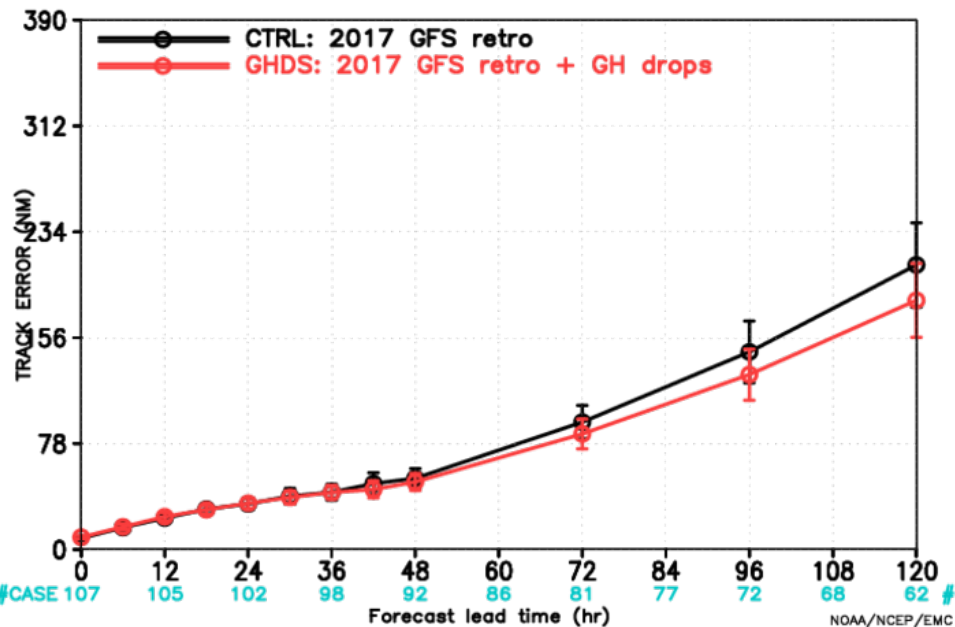
- Track errors
 - Atlantic basin
 - Globally
 - Hurricanes Hermine & Matthew

Track Errors in Atlantic

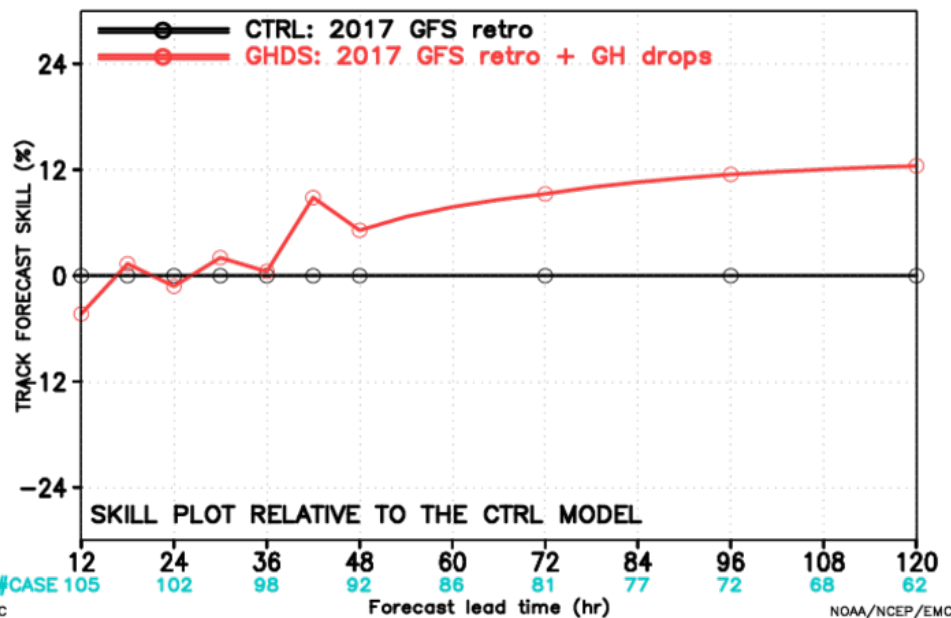
ATLANTIC

GH targeted storms: Gaston, Hermine, Karl, Matthew

TRACK ERROR (NM) STATISTICS
GH drops test



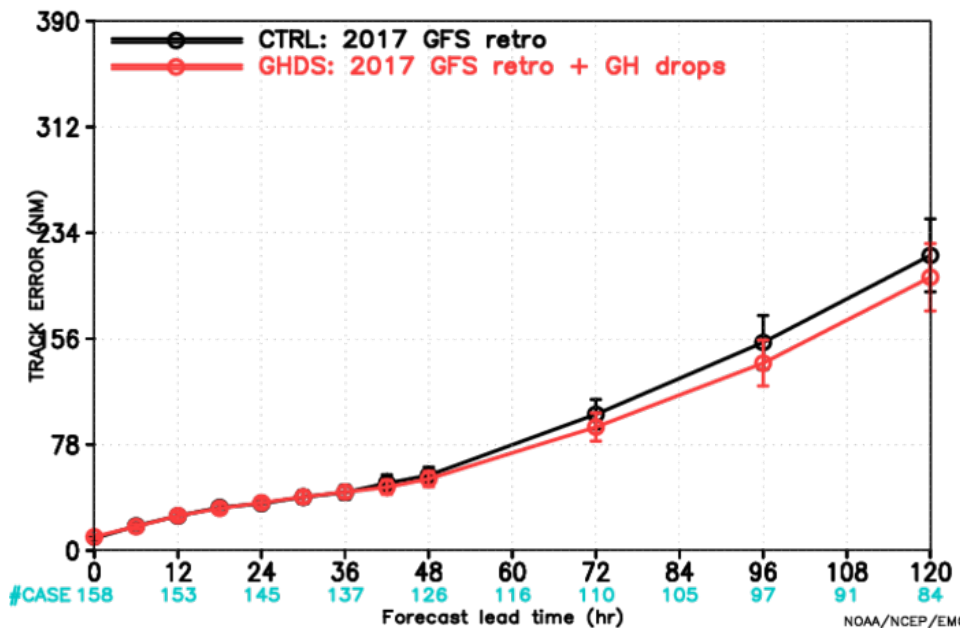
TRACK FORECAST SKILL (%) STATISTICS
GH drops test



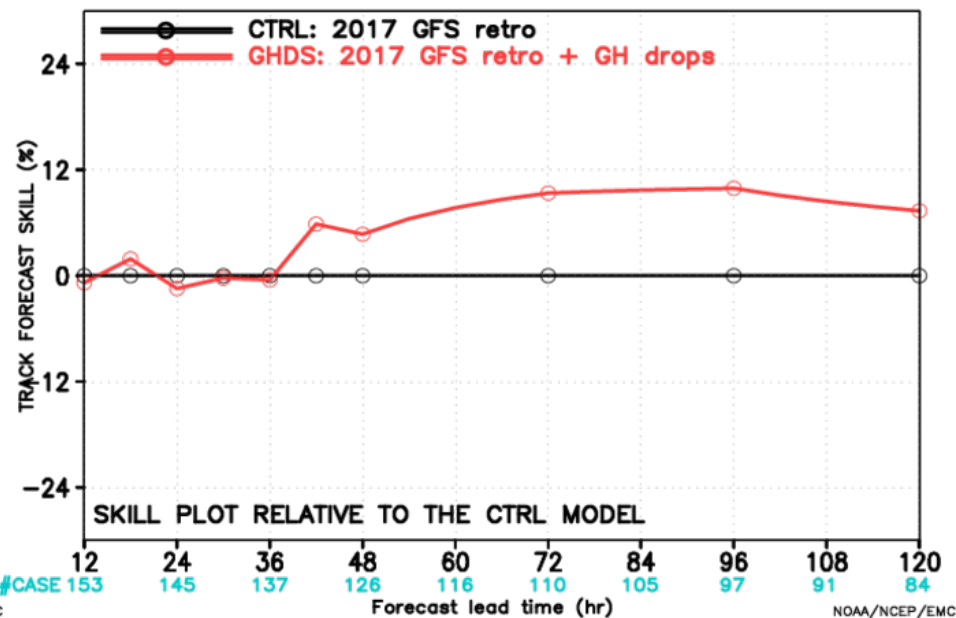
ATLANTIC

all storms in study period

TRACK ERROR (NM) STATISTICS
GH drops test



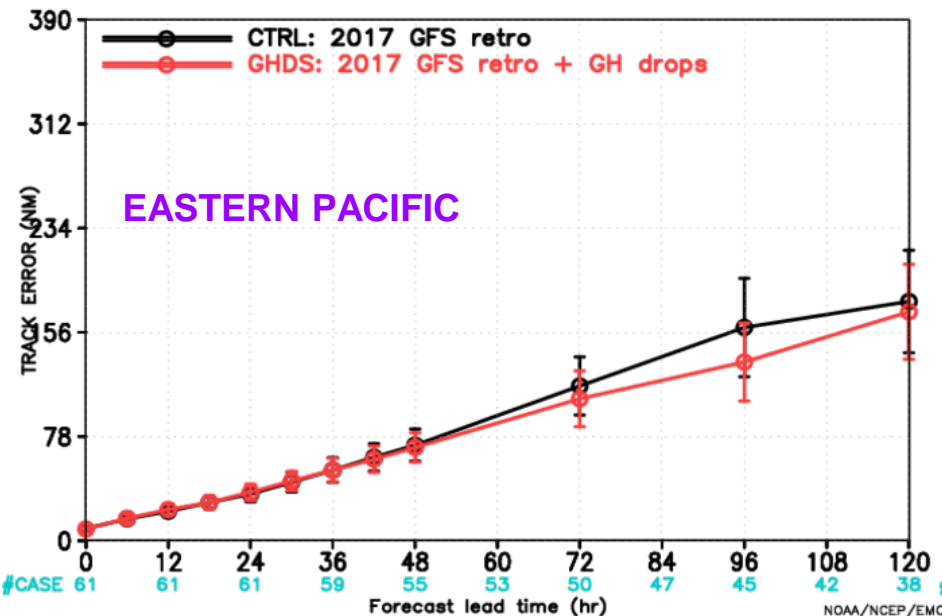
TRACK FORECAST SKILL (%) STATISTICS
GH drops test



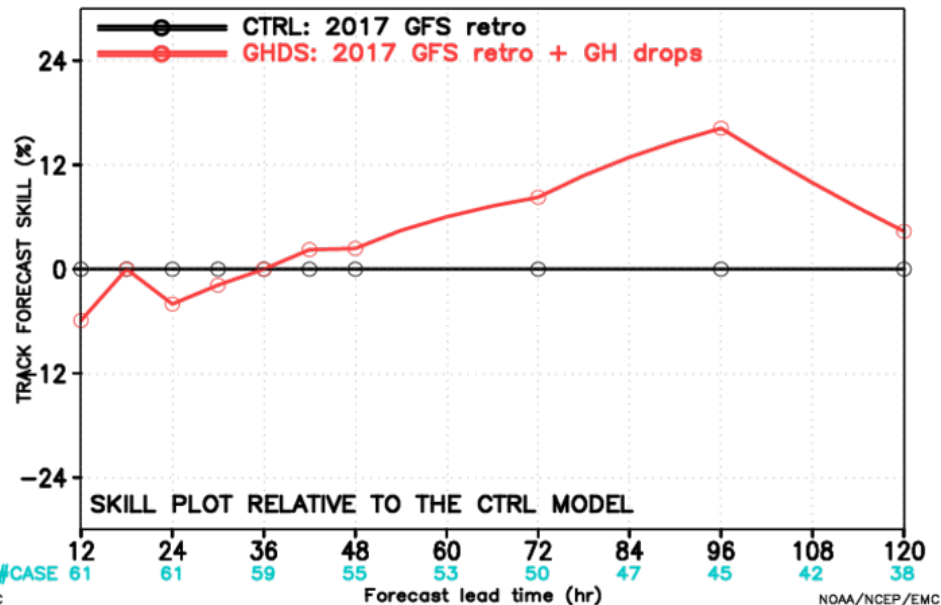
Global Impacts from Global Hawk Dropsonde Assimilation in the Atlantic

An impact was also noted for Eastern and Western Pacific storms by including the global hawk observations in the Atlantic. Indicates an overall improvement on a global scale.

TRACK ERROR (NM) STATISTICS
GH drops test

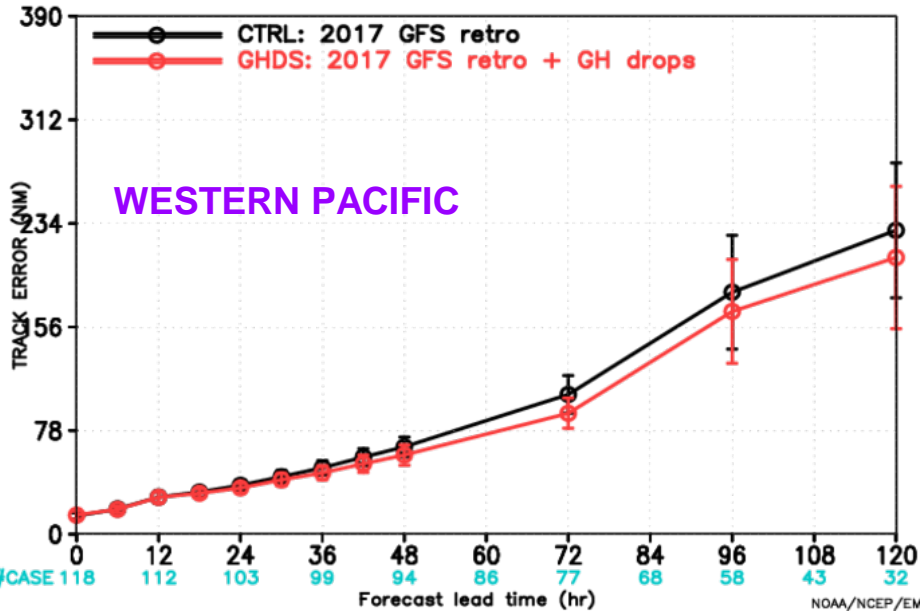


TRACK FORECAST SKILL (%) STATISTICS
GH drops test

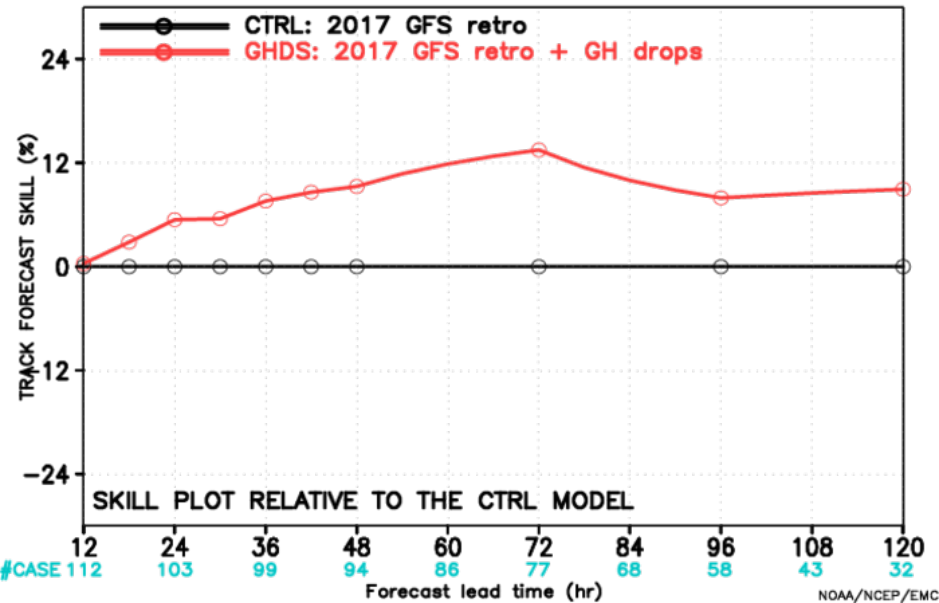


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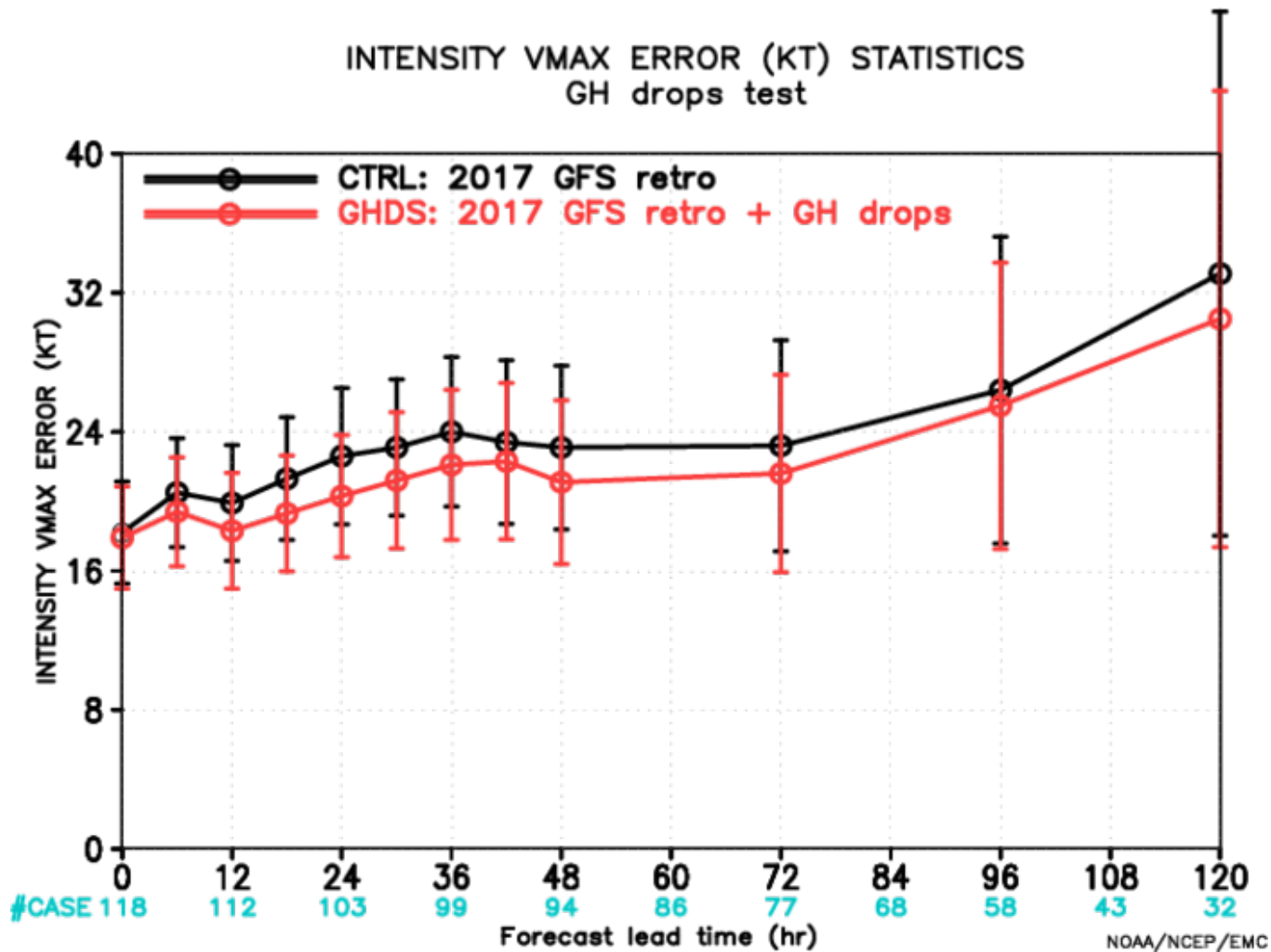
TRACK ERROR (NM) STATISTICS
GH drops test



TRACK FORECAST SKILL (%) STATISTICS
GH drops test



WESTERN
PACIFIC



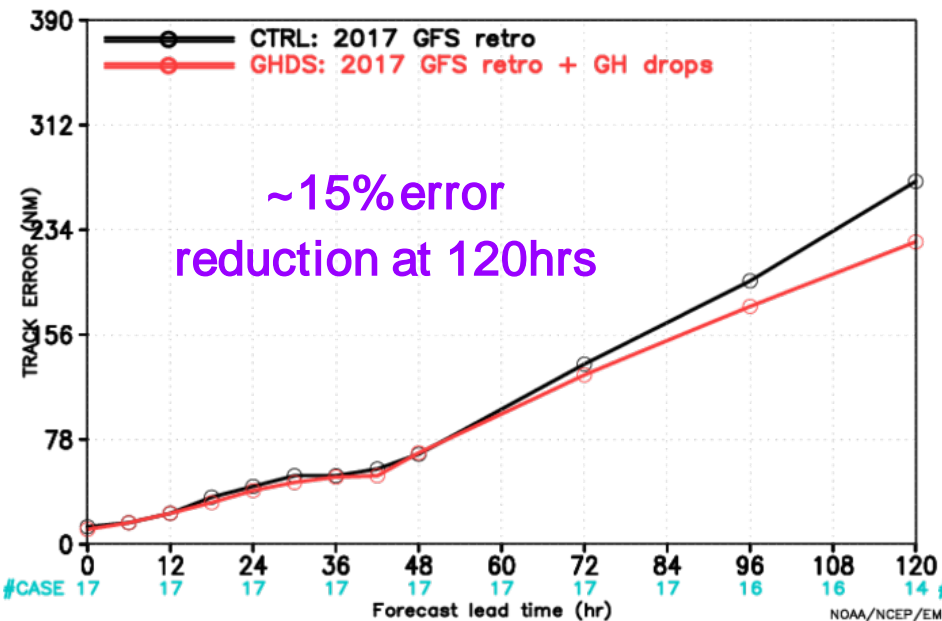
Track Error Reduction

Hermine & Matthew

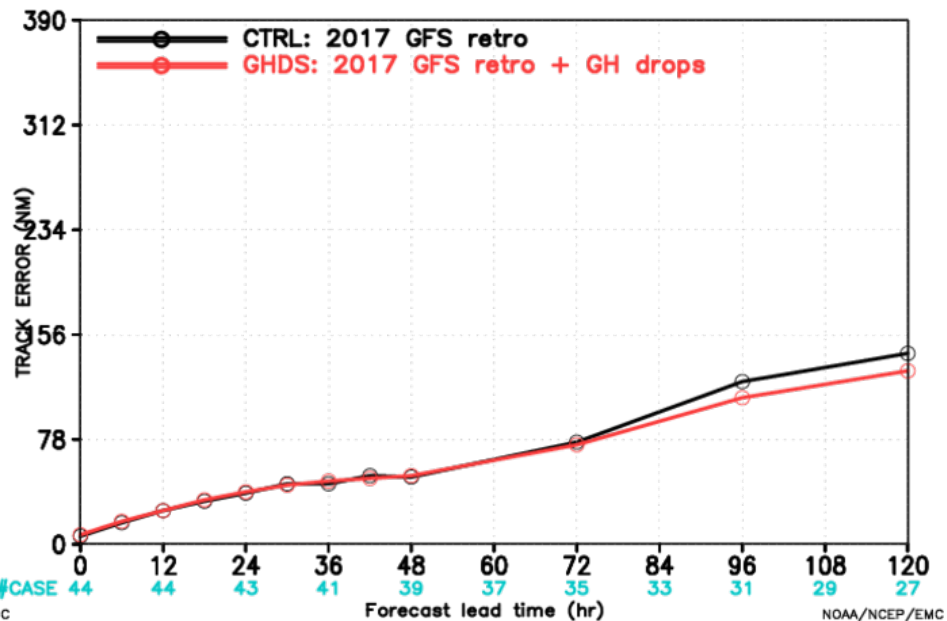
Hurricane Hermine

Hurricane Matthew

TRACK ERROR (NM) STATISTICS
STATISTICS FOR A SINGLE CASE - a1092016_HERMINE

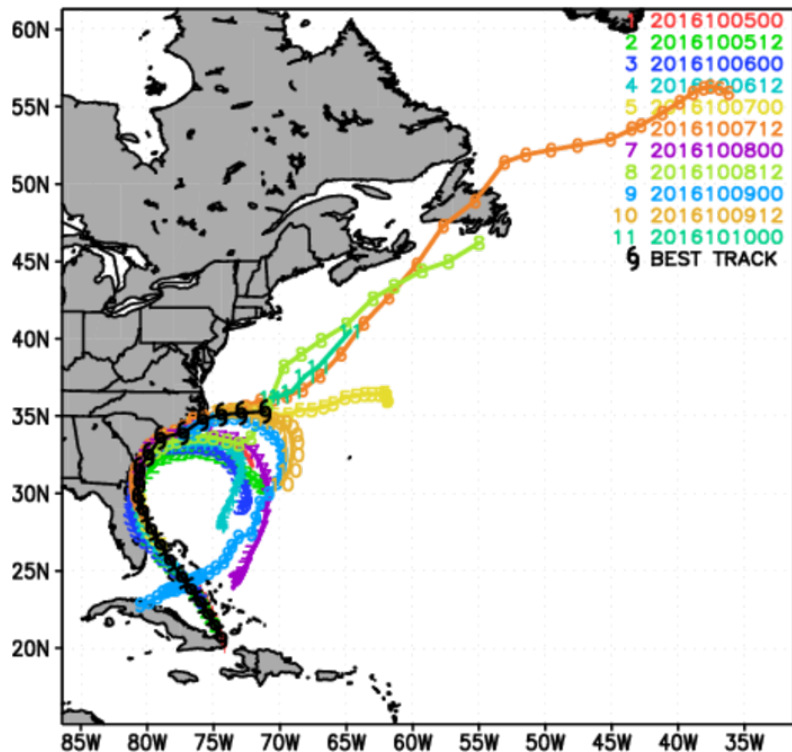


TRACK ERROR (NM) STATISTICS
STATISTICS FOR A SINGLE CASE - a1142016_MATTHEW

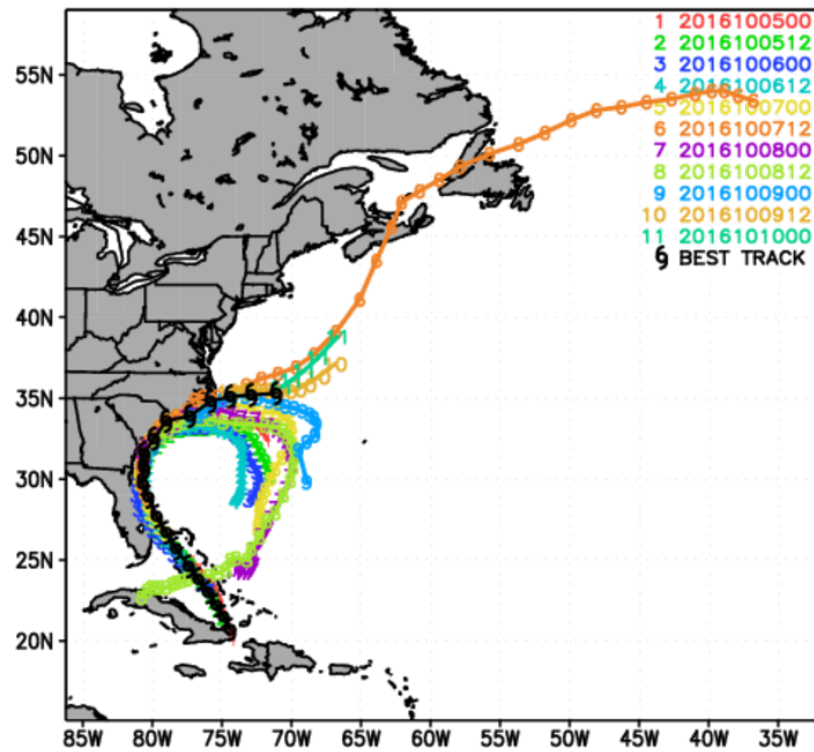


Hurricane Matthew tracks

CTRL forecast: Matthew (al142016)



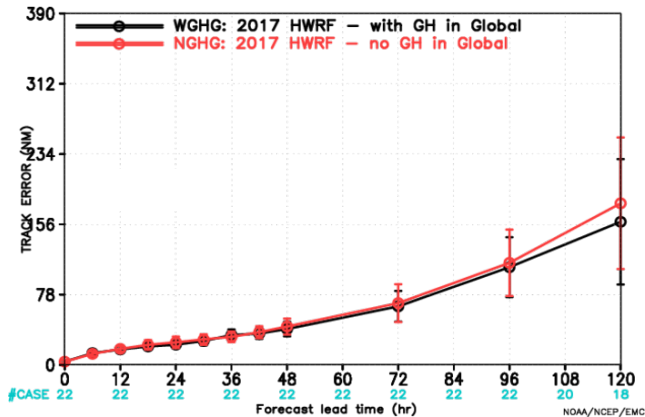
GHDS forecast: Matthew (al142016)



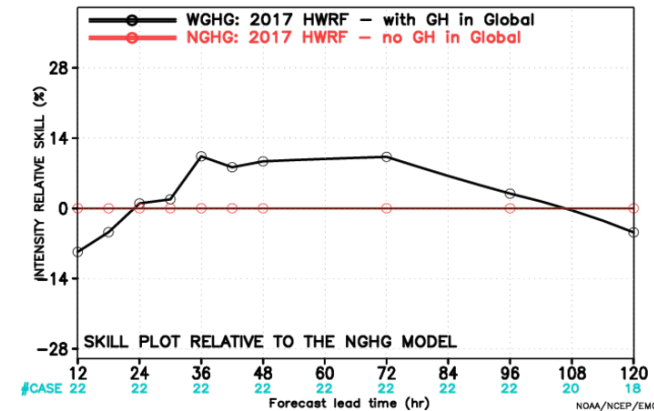
BONUS

Impact to HWRF

TRACK ERROR (NM) STATISTICS
H217 GH test



INTENSITY RELATIVE SKILL (%) STATISTICS
H217 GH test



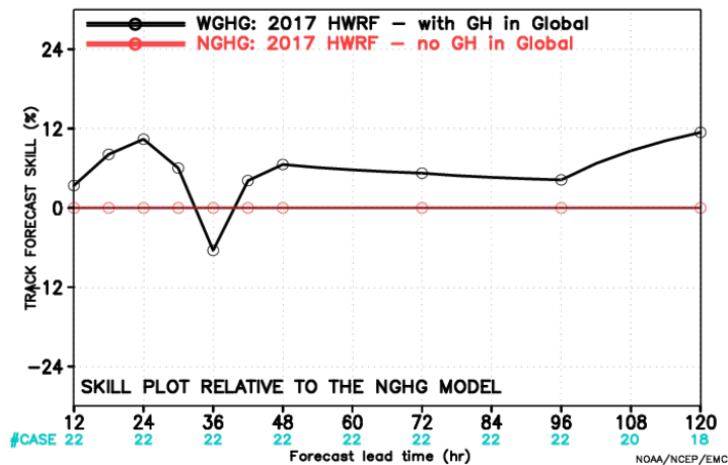
HWRF

Track & Intensity Improvement w/ GFS+GH IC/BC

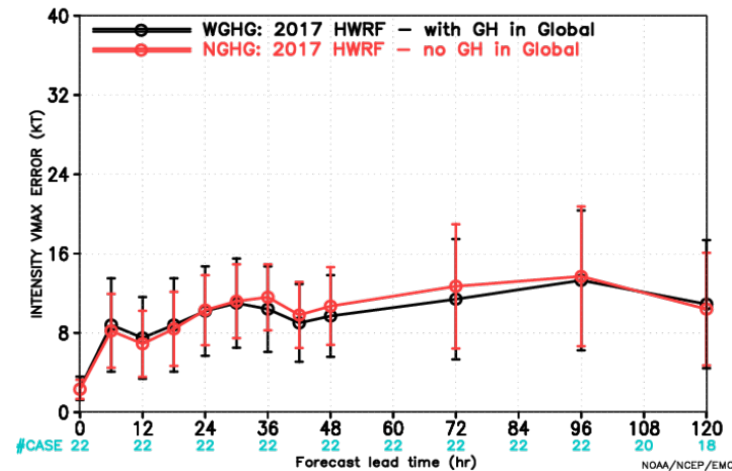
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Gaston

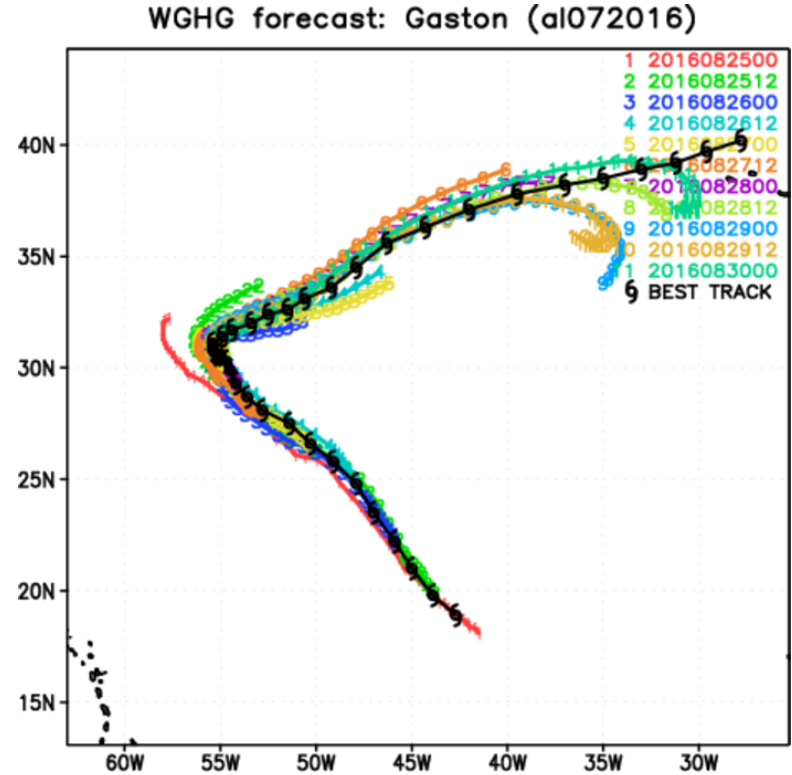
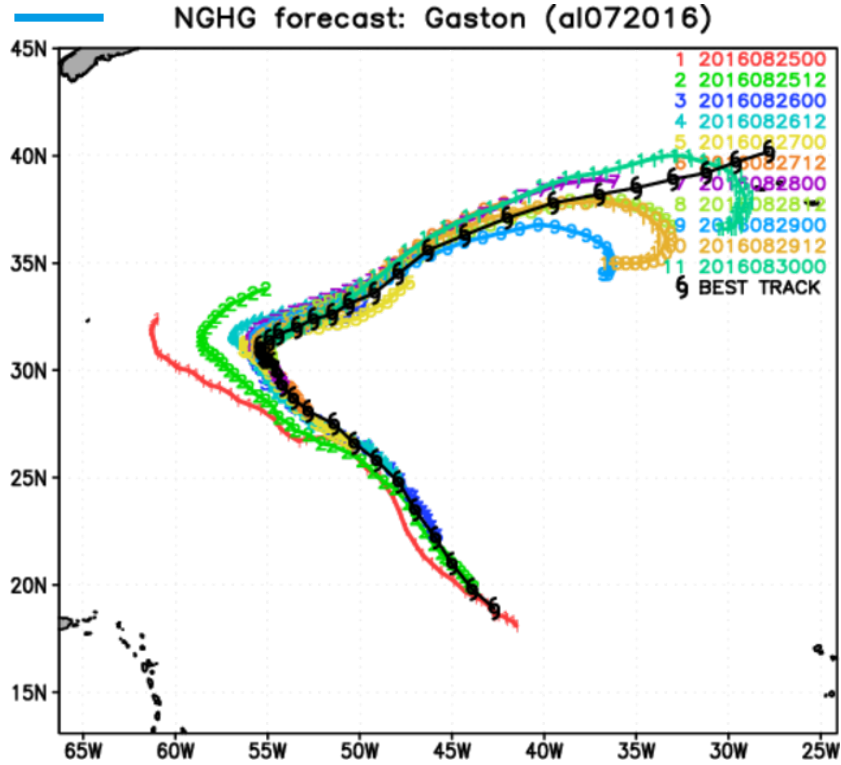
TRACK FORECAST SKILL (%) STATISTICS
H217 GH test



INTENSITY VMAX ERROR (KT) STATISTICS
H217 GH test



Hurricane Gaston - HWRF



Future/Ongoing work

- **First study with significant positive impact from dropsondes.**
Investigate more fully the underlying reasons for improvement.
- Additional cases:
 - Storms in 2012 and 2014
 - Non-tropical cases (i.e. El Nino Rapid Response 2016 campaign)
- Early results are very promising, therefore currently in discussion to turn on Global Hawk in operational GFS.

Thank you!

Special thanks to Daryl Kleist, Mingjing Tong, Andrew Collard, and Dennis Keyser at EMC for their help setting up and running these experiments.

Questions?

Extra Slides

Hurricane Matthew

- In plot:

FY17 - Q3FY17 w/ GH data included

AVNO - Q3FY16 operational GFS

- Track error reduction begins at 48hrs.
- ~37% reduction in track error at 168 hrs (drop from 400nm to 250nm).

