Assimilation of Global Hawk/AVAPS data into NCEP operational models

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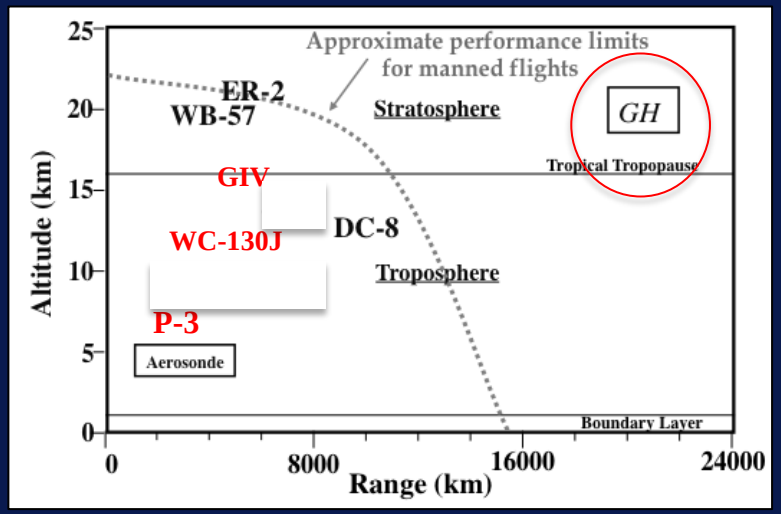
Outline

- Exploring the Potential for Assimilation of Unmanned Aircraft Observations to Benefit Hurricane Analyses and Forecasts
- Operational use of Global Hawk Dropsonde data in HWRF
- Latest results from GH dropsonde data impact experiments with 2017 GFS
- Review of data impact experiments at EMC
- Ongoing work on ENRR/AR & SHOUT data impact experiments

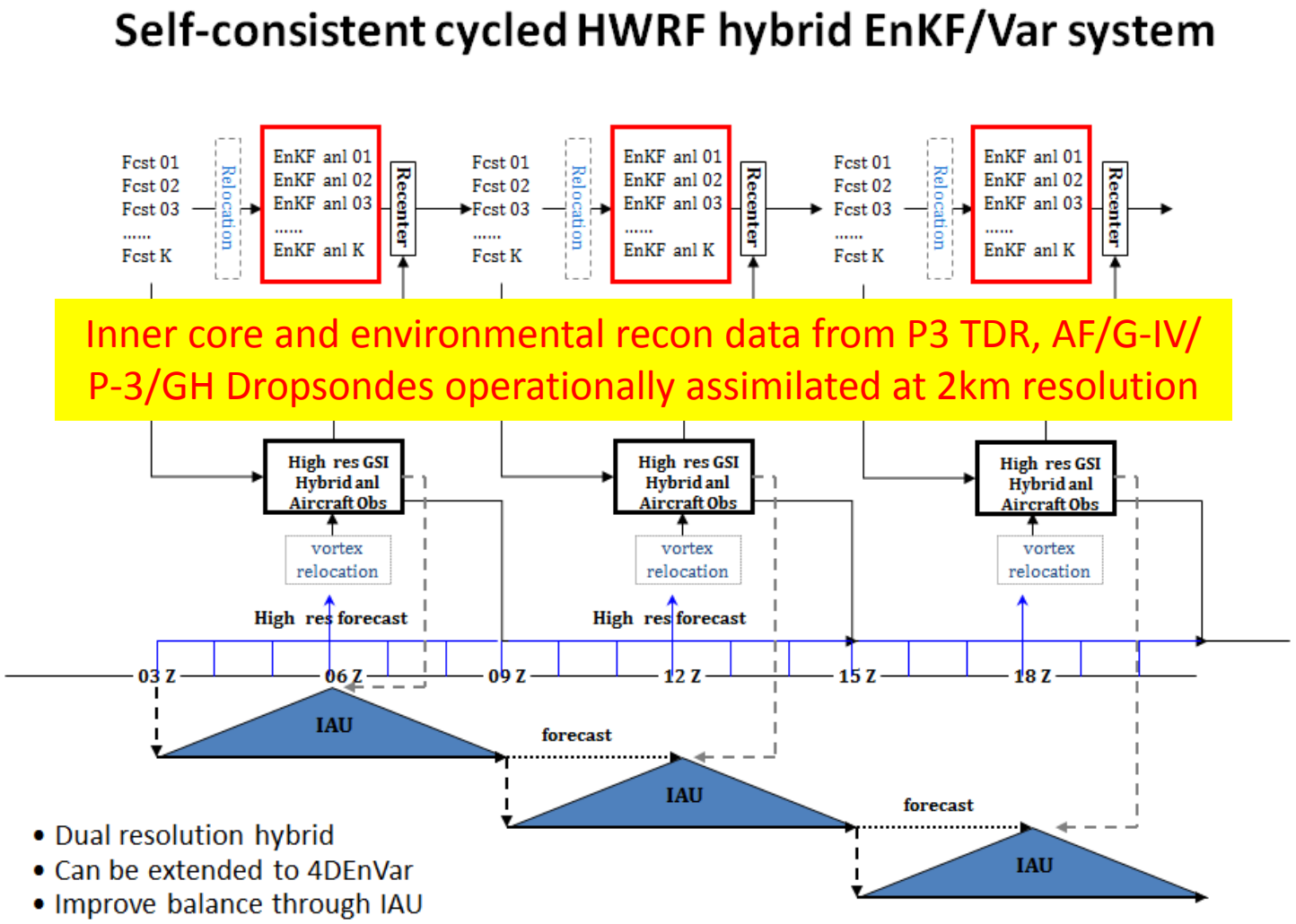
Global Hawk for Hurricane Recon

- NASA unmanned GH recently used in GRIP, HS3 and SHOUT experiments
- GH presents unique opportunities for hurricane reconnaissance due to its extreme endurance
- Data from GH useful for improving hurricane forecasts


Global Hawk

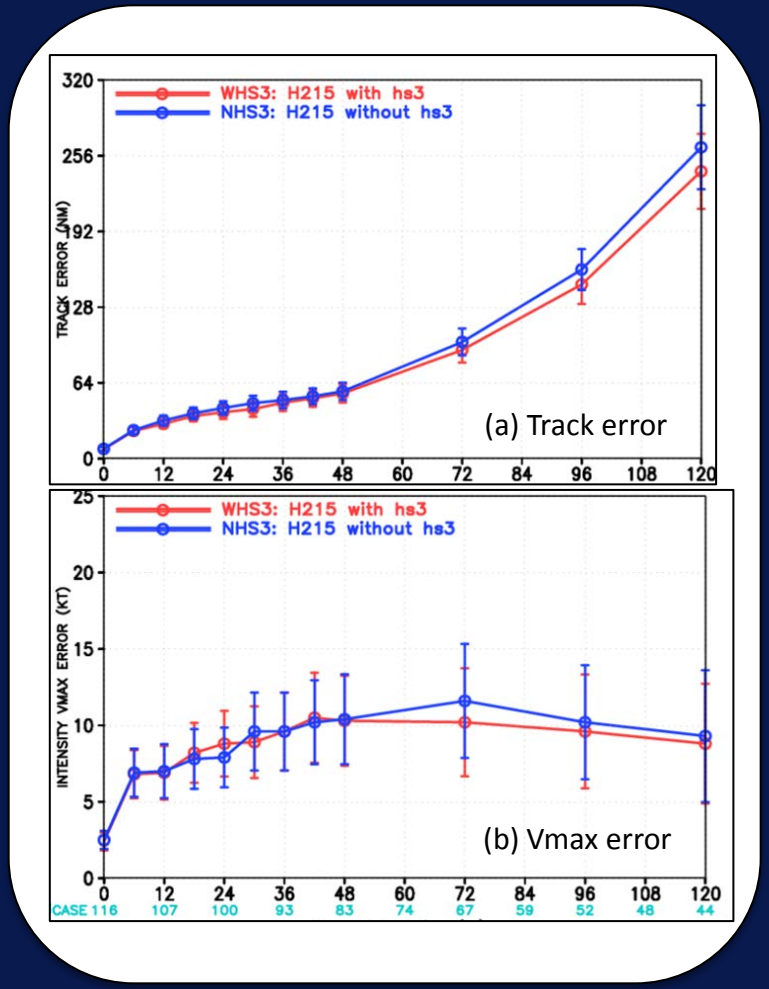


HWRF Data Assimilation System



HWRF: GH dropsonde DA benefits (Early results from 2015)

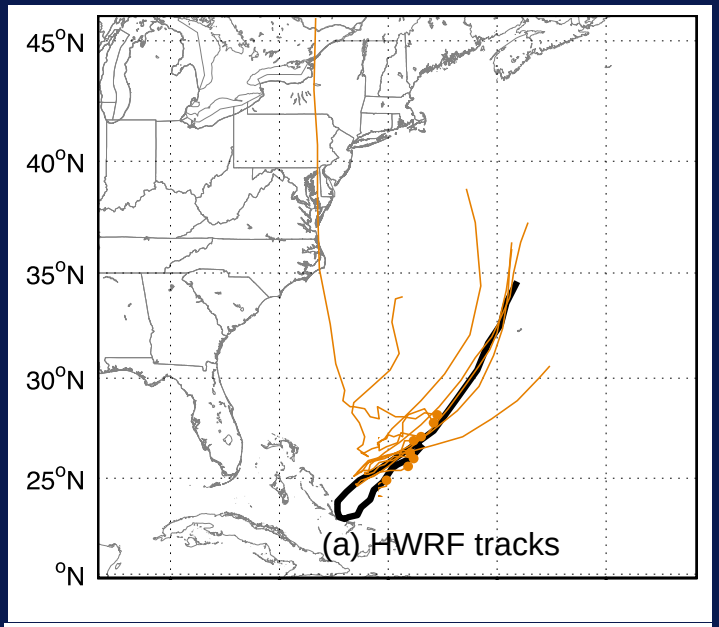
- Assimilating GH dropsondes results in track improvements
- Intensity improvements are confined to long-term forecast
- Short-term improvements probably limited by sub-optimal DA
- Most benefit when other dropsonde data is sparse

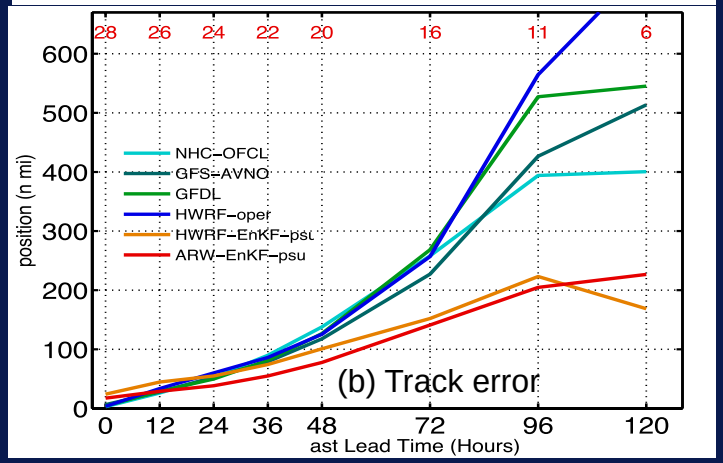


GH denial experiments

Additional Experiments using HWRF-EnKF

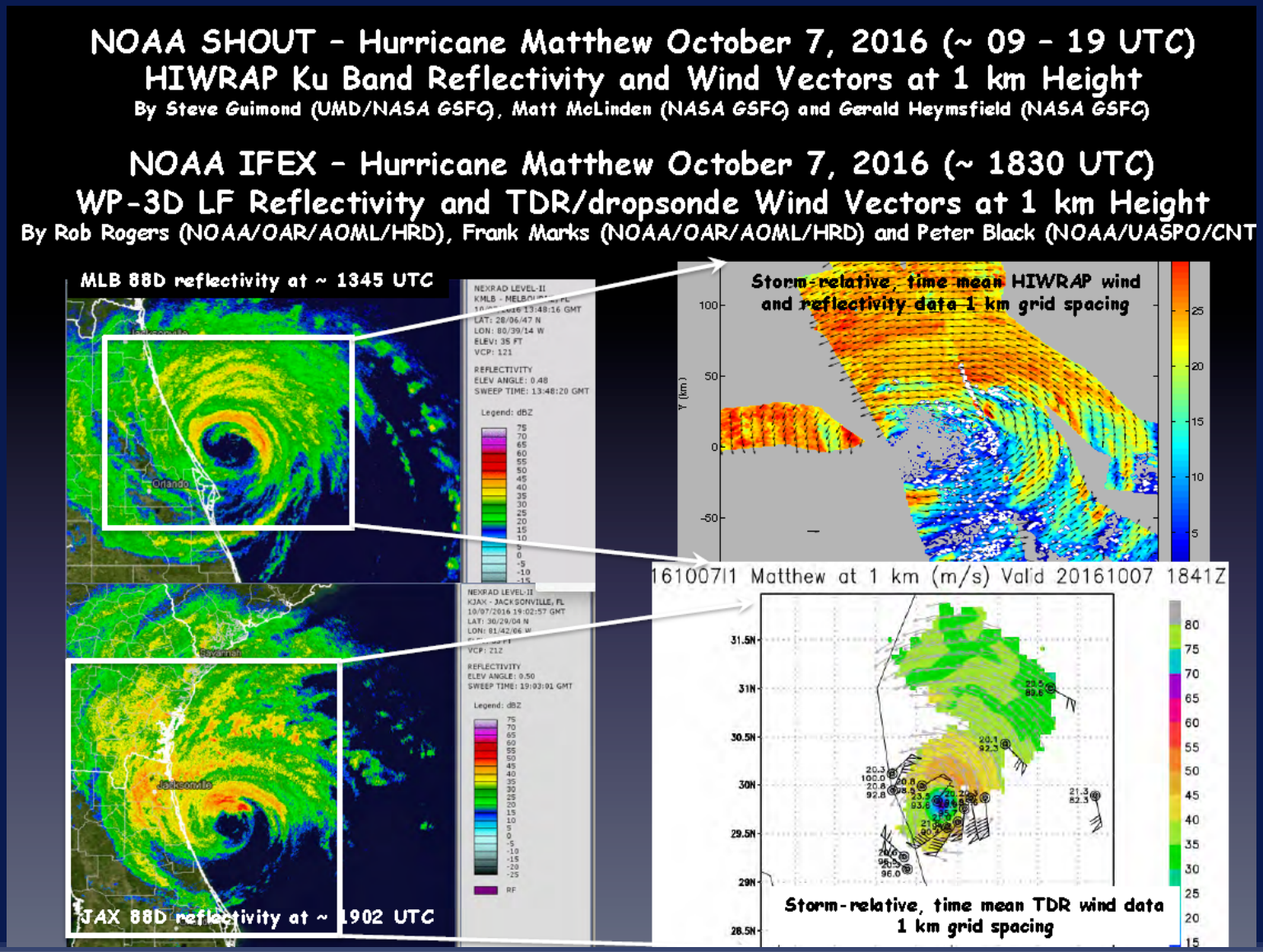
- HWRF-EnKF system is used to evaluate the impact of GH dropsondes
- Cycling initialized with GDAS-EnKF 80 members
- After spin-up, assimilates conventional obs + recon flight level, SFMR and TDR every 3 h until end of storm

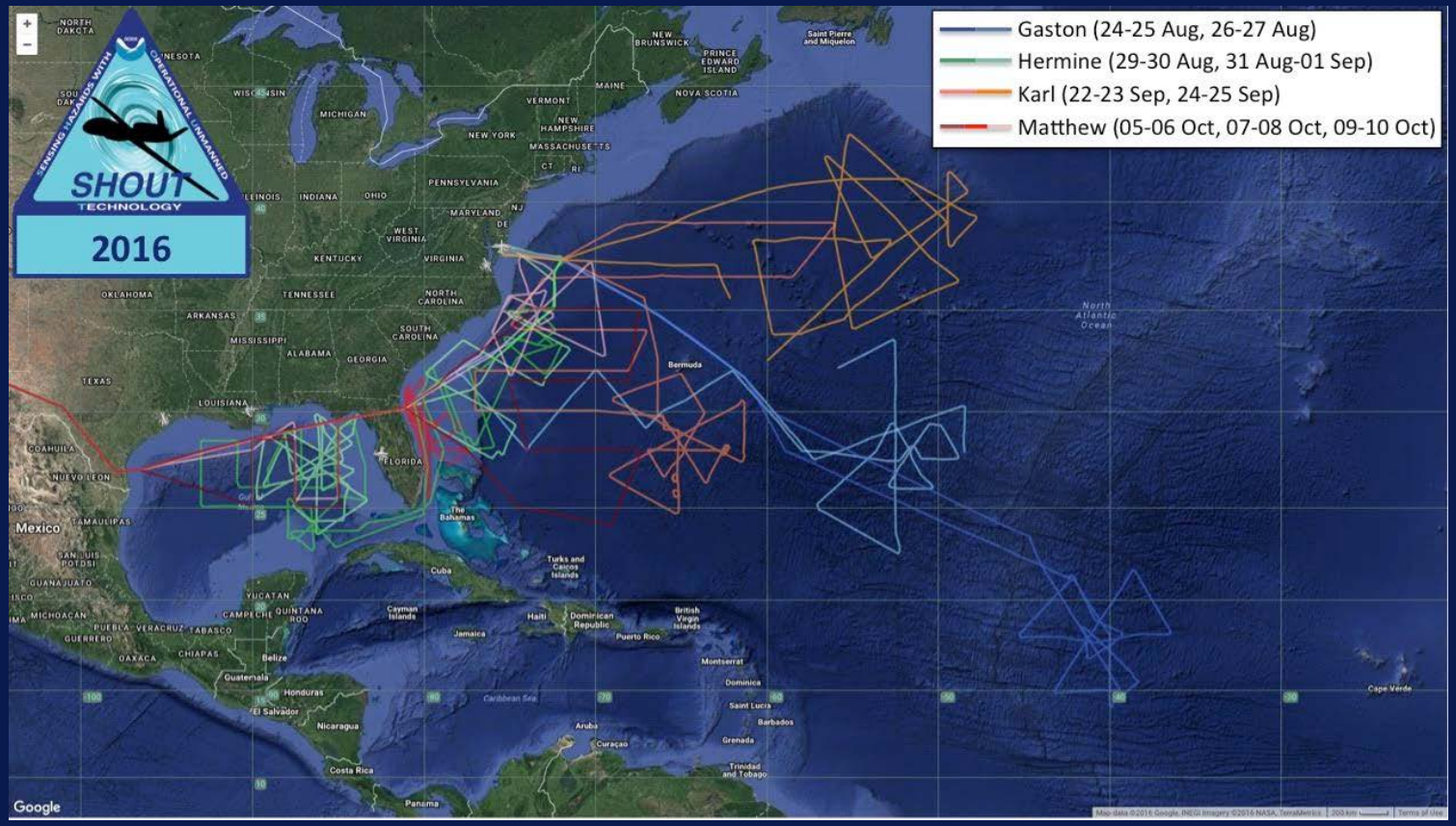




HWRF results for Joaquin

Potential use of HIWRAP Data in HWRF

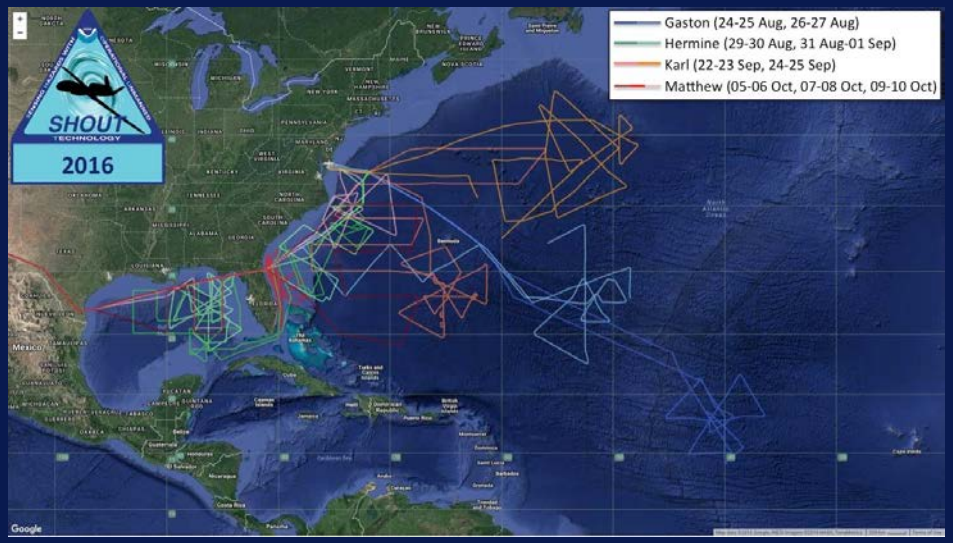


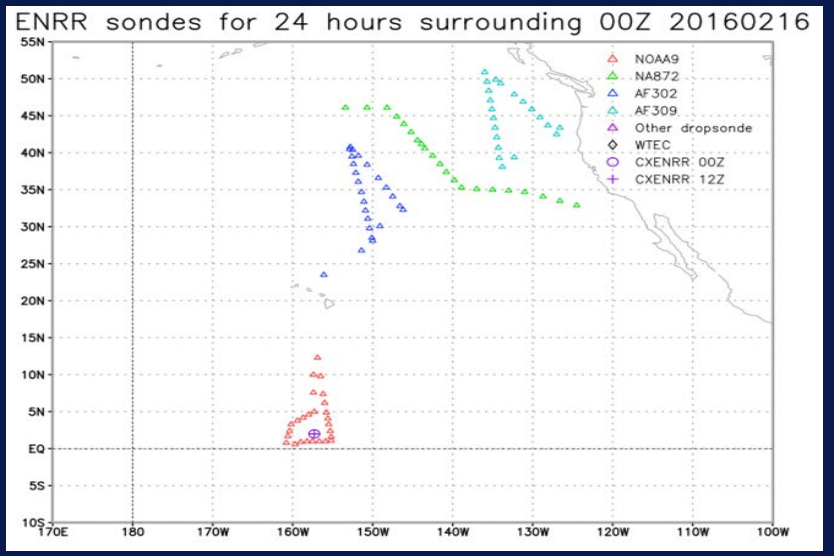

Gaston (24-25 Aug, 26-27 Aug)
Hermine (29-30 Aug, 31 Aug-01 Sep)
Karl (22-23 Sep, 24-25 Sep)
Matthew (05-06 Oct, 07-08 Oct, 09-10 Oct)
SHOUT
TECHNOLOGY
2016
Google

Hot off the press: GH Dropsonde Data Impact Experiments w/NCEP GFS

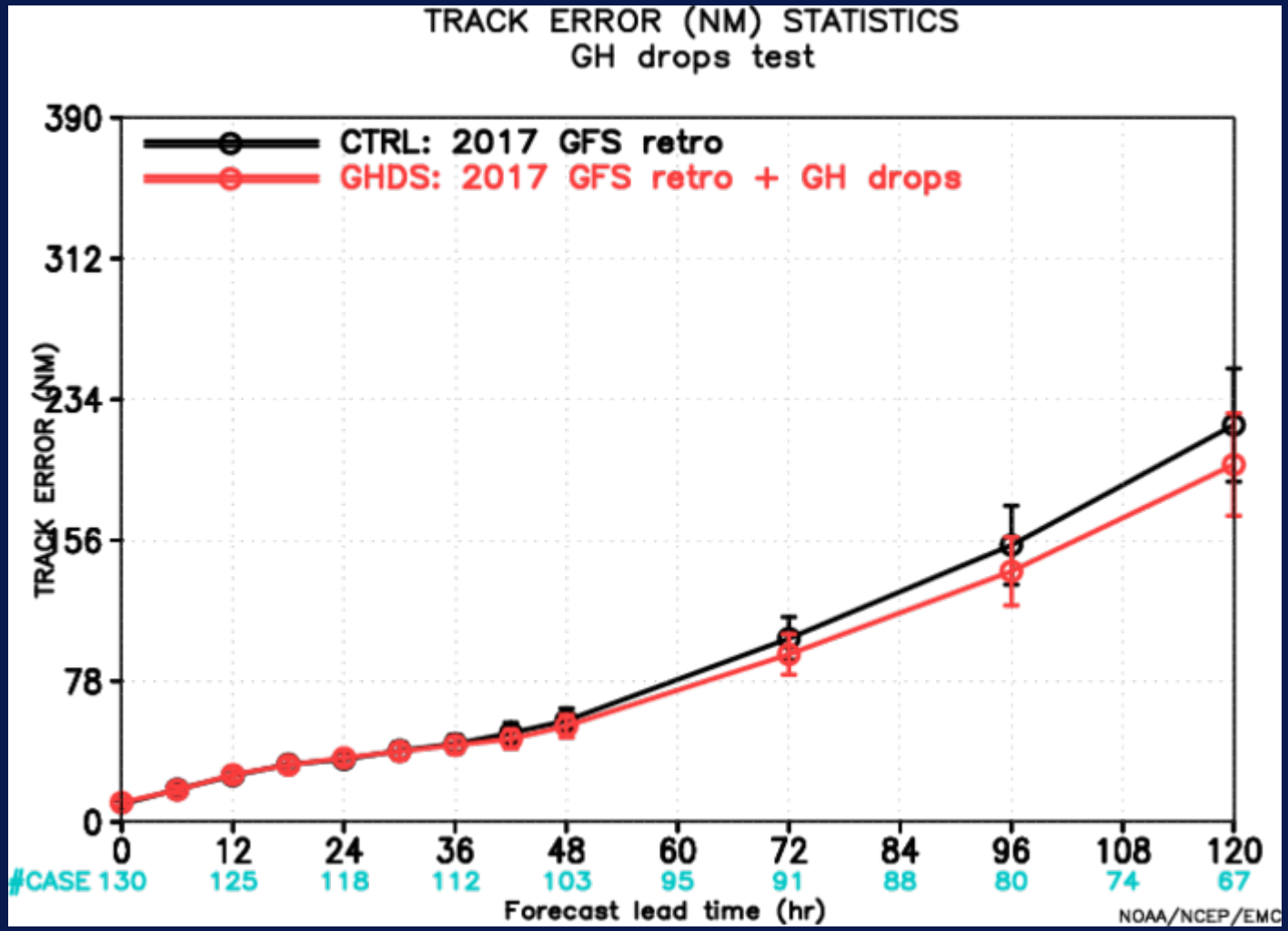
Studies:

- **<u>Global Hawk inclusion study (ongoing)</u>**
- El Nino Rapid Response Field Campaign 2016
- Results to be presented at IHC (Miami) and ENRRR workshop (NCEP)

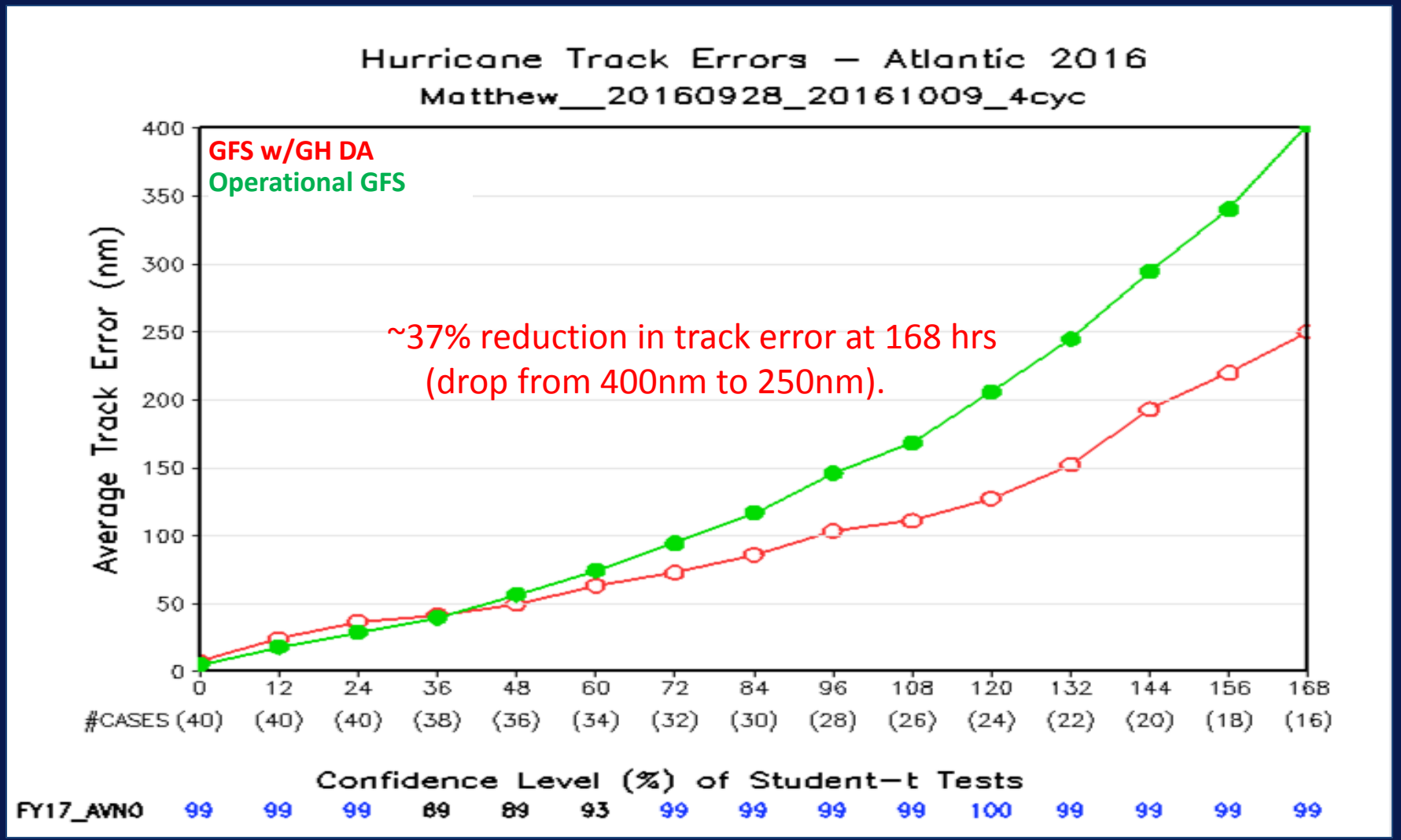




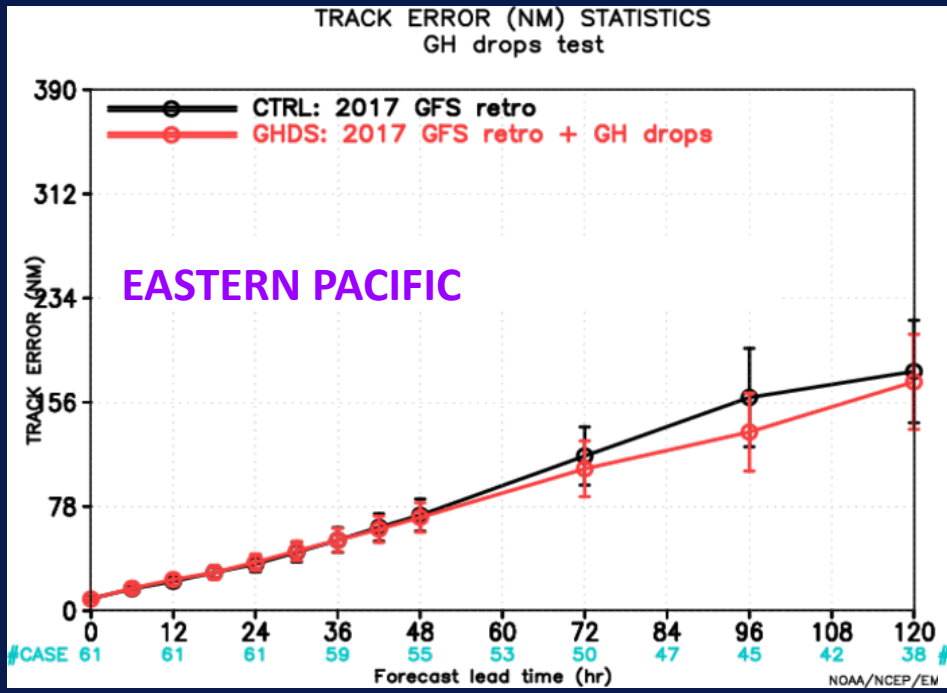
ATLANTIC: GH targeted storms

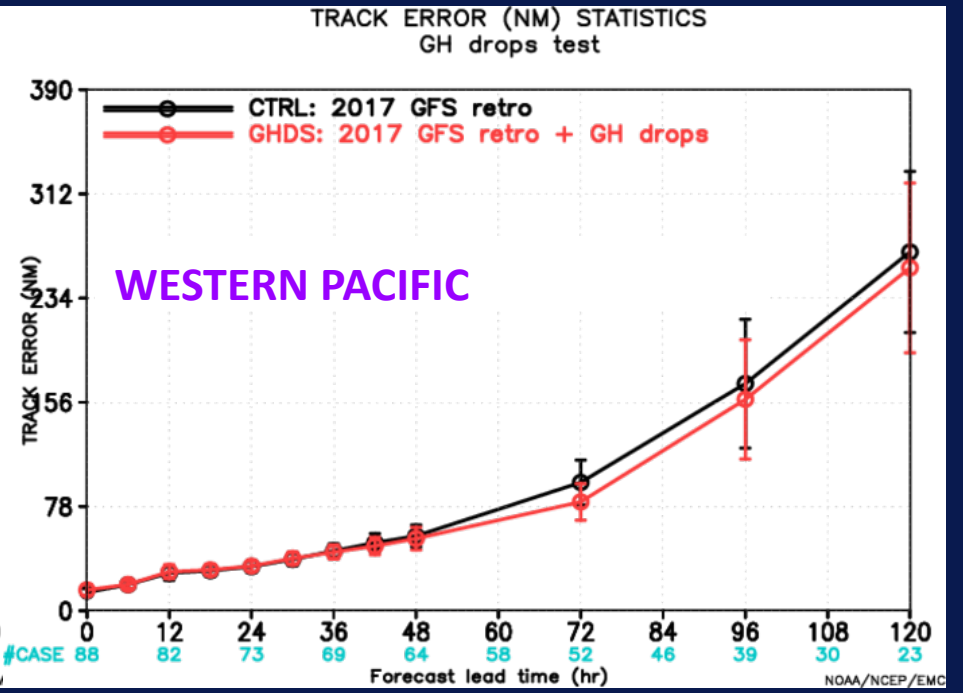


A great example: Hurricane Matthew



Extended benefits of GH Dropsonde Data in NCEP GFS



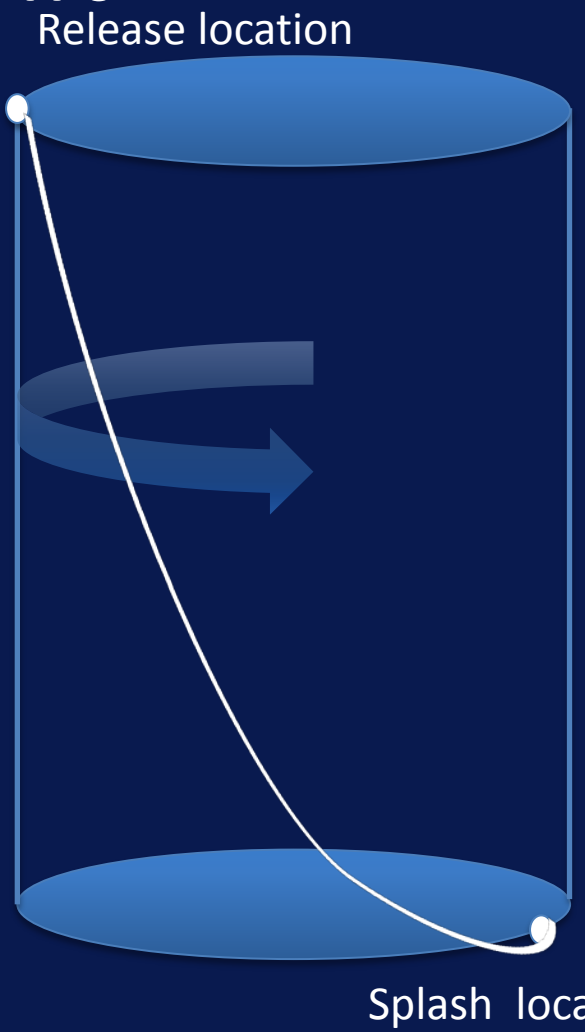


Impact was also noted for Eastern and Western Pacific storms by including the global hawk observations in the Atlantic. Indicates an overall improvement on a global scale.

Potential for transition to operations in 2017

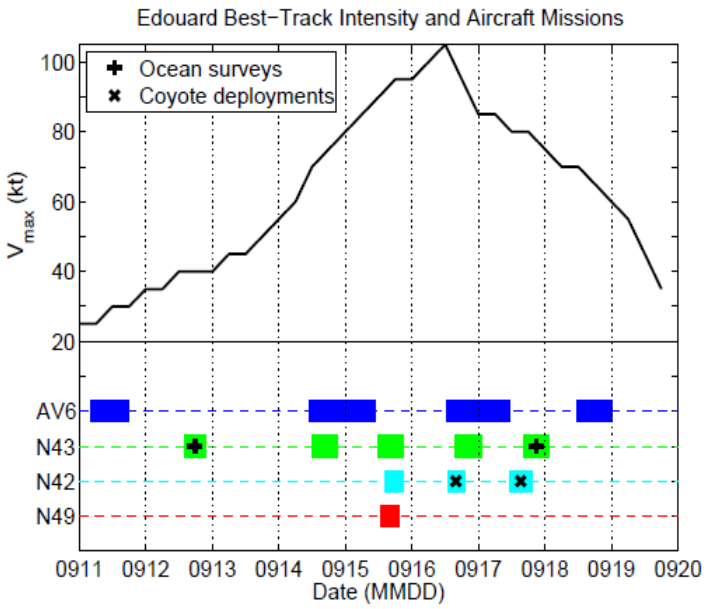
Issues to be addressed: Dropsonde Drift

- TEMPDROP messages only report release location in main body
- Splash location is in comments section, which gets truncated in NCEP data tanks
- In inner core, release and splash locations can be very far apart
- For HWRF DA, we need dropsonde data to be sent in BUFR format *from the plane via GTS*



Continuous coverage for maximum benefit (addressing data gaps)

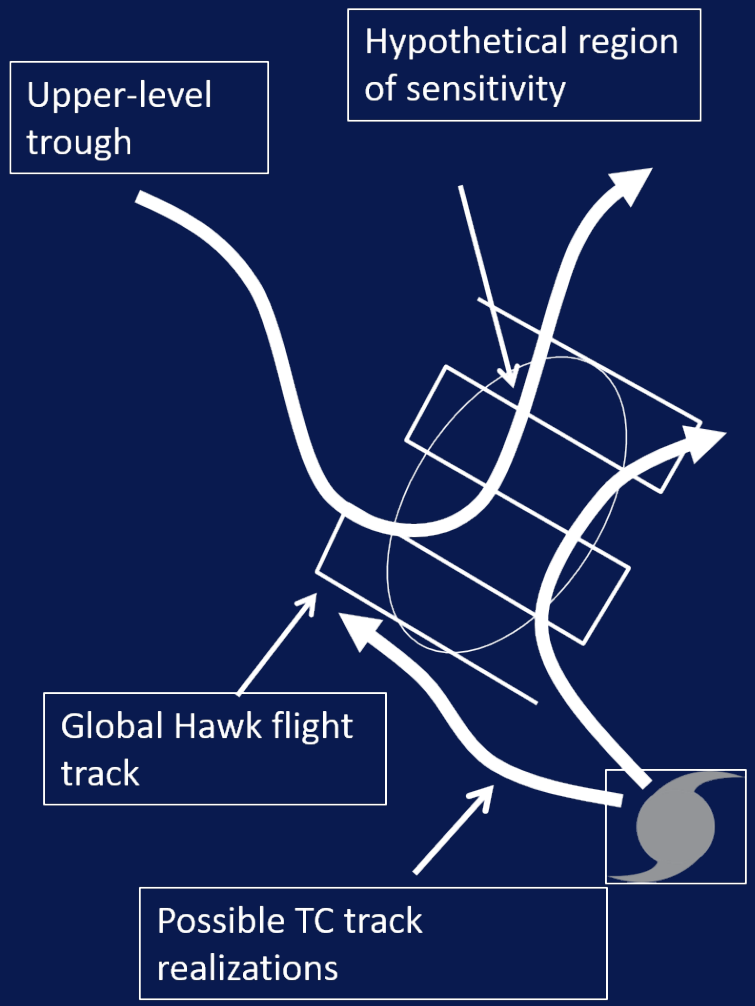
- In best-case scenario, we only have good data coverage for ~1/2 a day
- During times of rapid intensity or structural changes, this is insufficient
- This might be alleviated with multiple Global Hawk missions along with other recon missions



Global Hawk data coverage

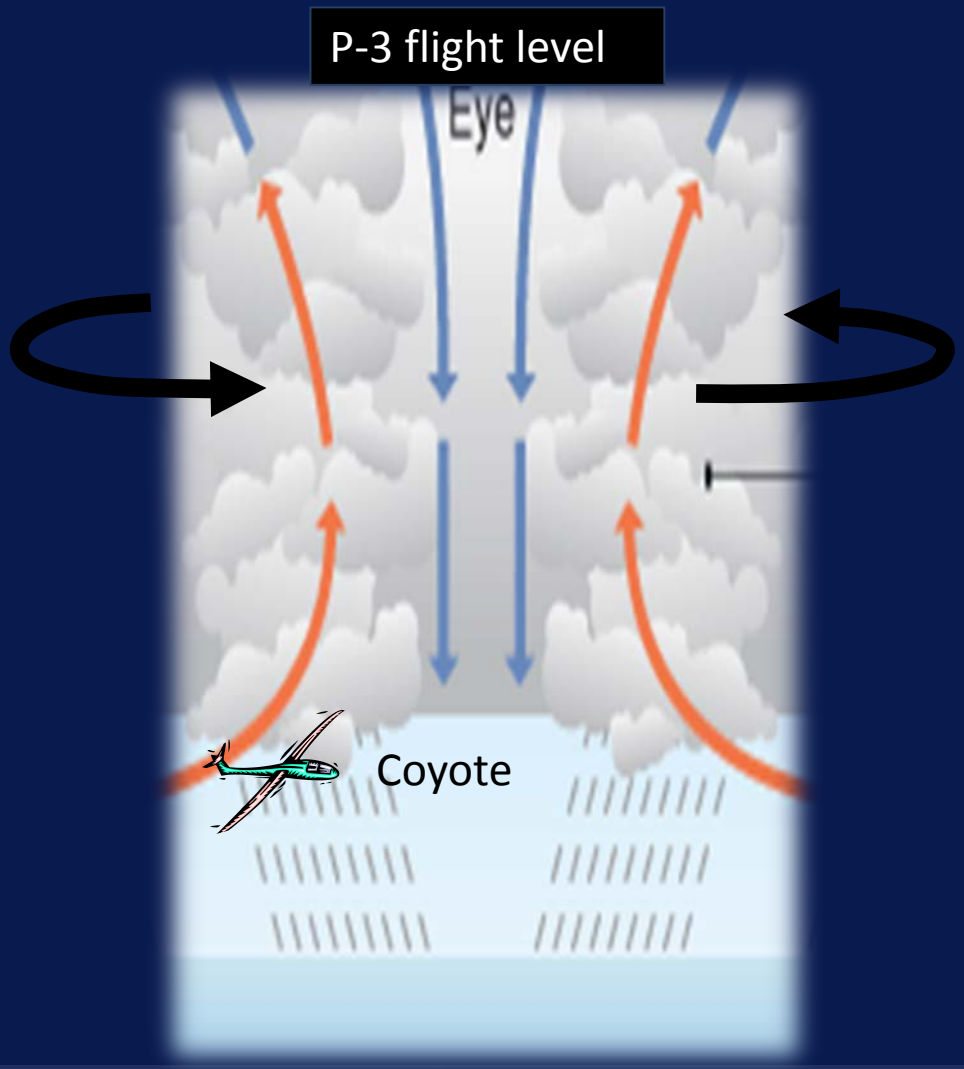
Targeted observing strategies to maximize data use

- TC track is often sensitive to poorly observed upstream troughs (Joaquin) or poleward ridges (Sandy)
- Large sensitivity regions currently difficult or impossible to observe
- UAVs such as the Global Hawk can target such regions



Low-level thermodynamic observations to augment GH/P3 data

- Low-level thermodynamic data difficult to observe
- Dropsondes only provide intermittent data from reconnaissance levels
- Hurricane intensity is very sensitive to low-level moisture
- UAVs such as the Coyote can observe this region



Summary

- HWRF is the first hurricane model to assimilate real-time Global Hawk Dropsonde data in operations
- Global Hawk dropsonde impact experiments have shown significant positive impact for NCEP GFS – potential for transitioning to operations
- Future UAS technologies to augment data in sparse regions sensitive to high-impact weather forecasts