

# Using Reconnaissance Data in Weather Models

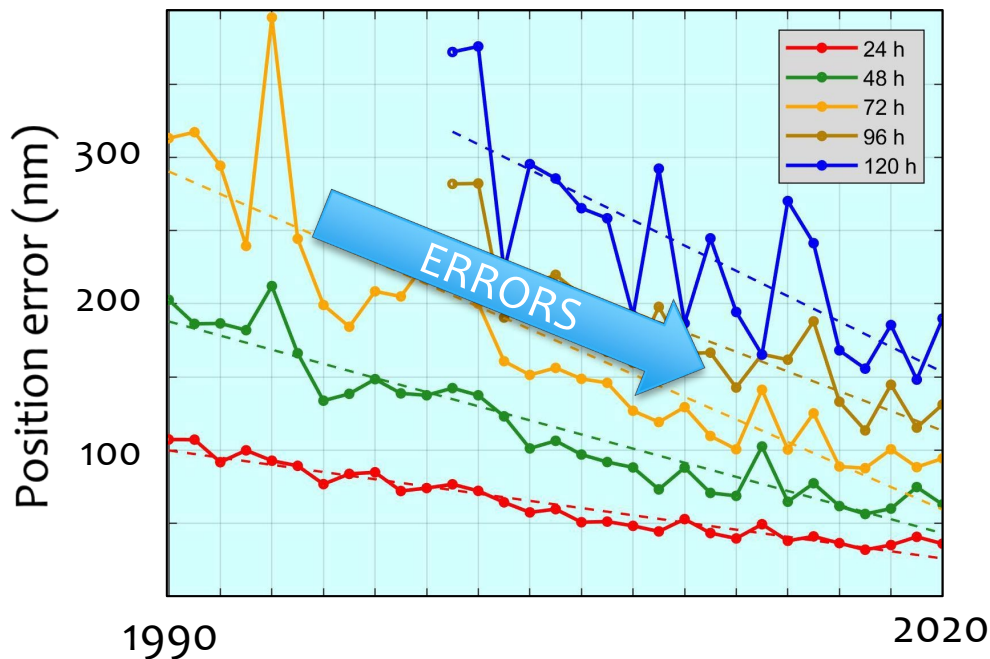


Jason Sippel NOAA AOML/HRD  
2021 SECART series



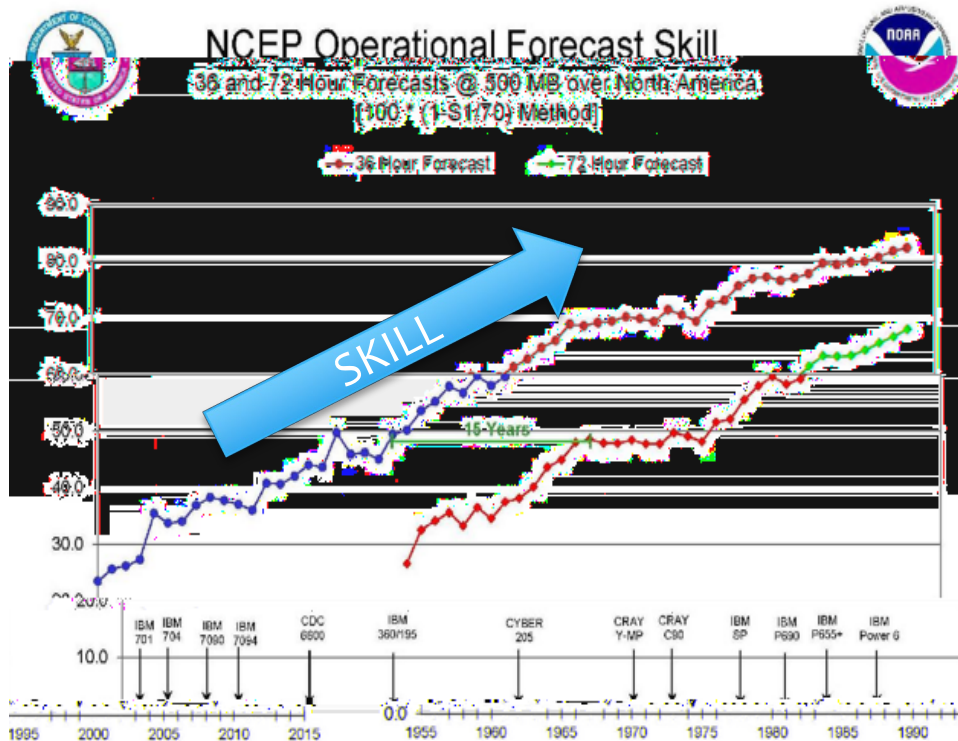
# Error trends

## Official TC Track Forecast Errors: 1990-2020



- Hurricane track forecasts have improved markedly
- The average Day-3 forecast location error is now about what Day-1 error was in 1990
- These improvements are largely tied to improvements in large-scale forecasts

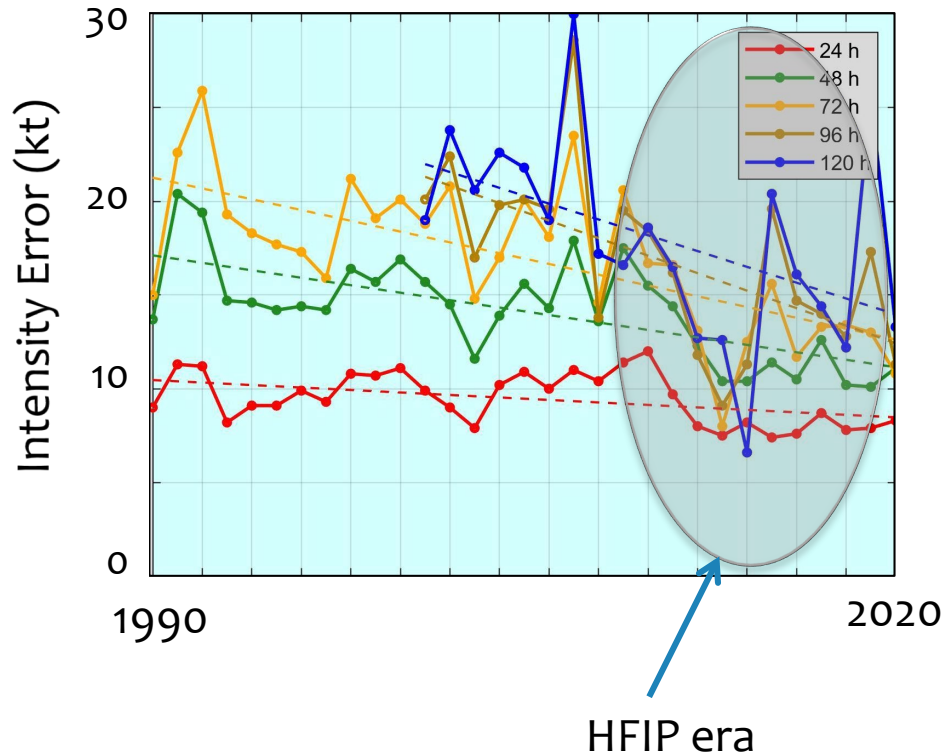
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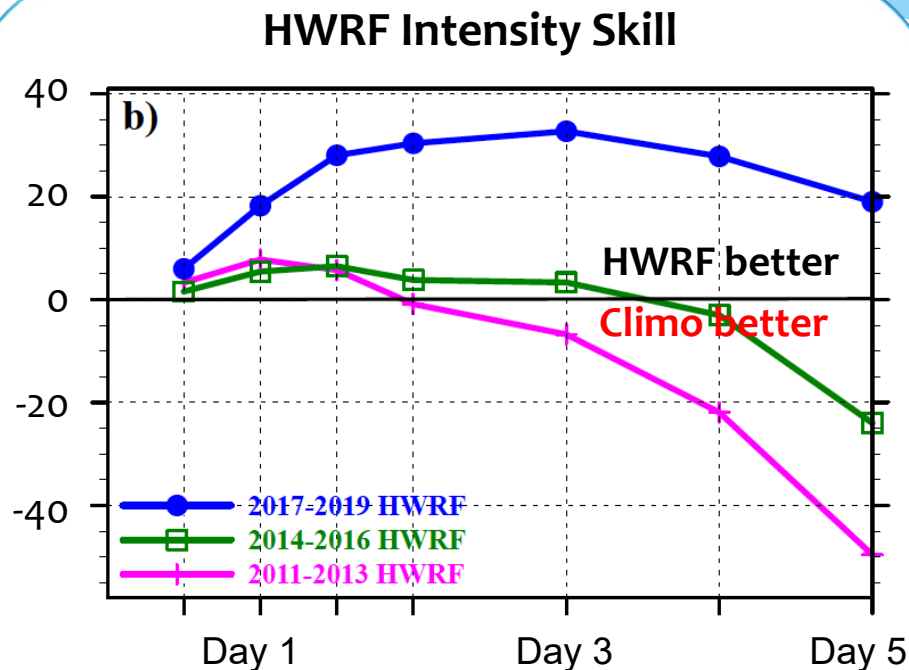
# Error trends

Official TC Intensity Forecast  
Errors: 1990-2020



- Hurricane intensity forecasts have only recently improved
- Improvement in intensity forecast largely corresponds with commencement of Hurricane Forecast Improvement Project

# Error trends



HWRF skill has improved up to 60%!

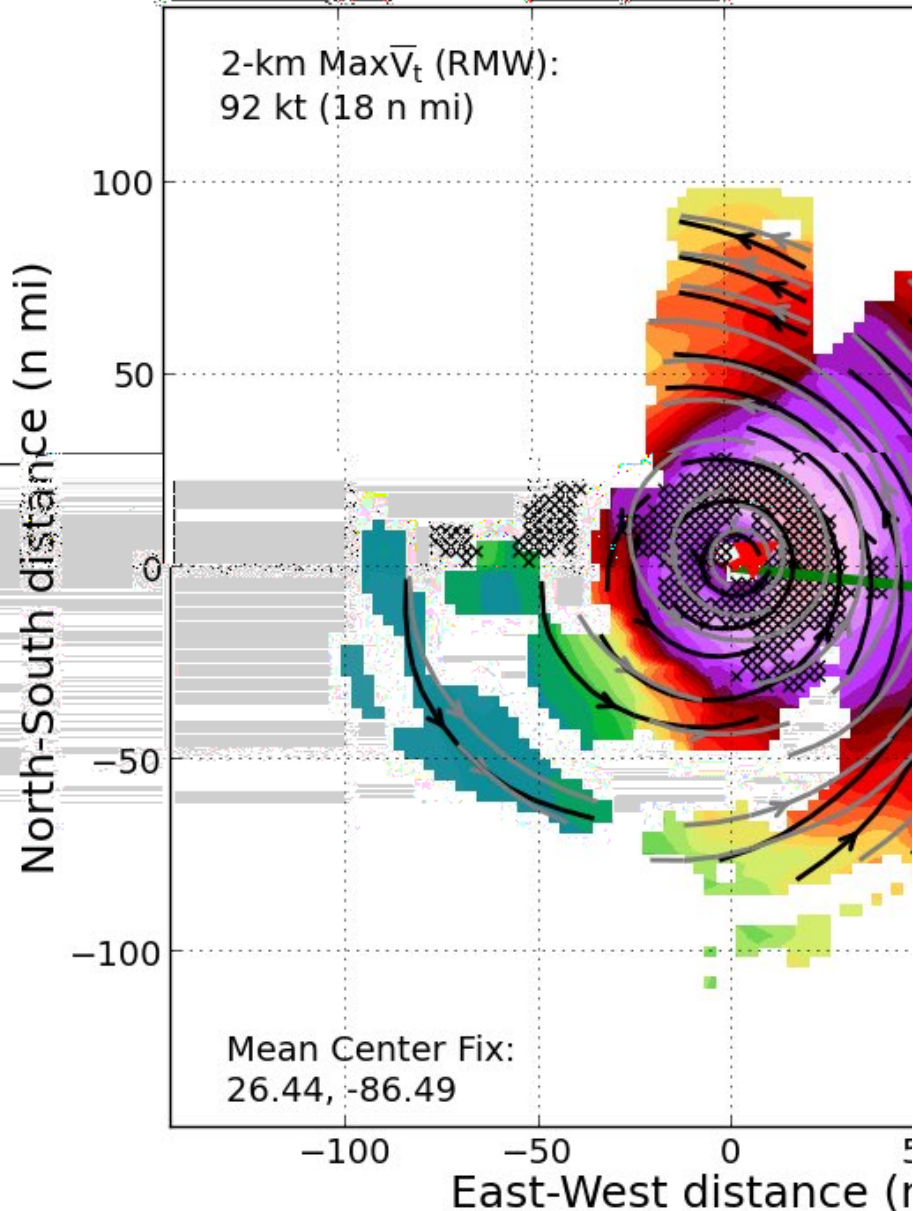
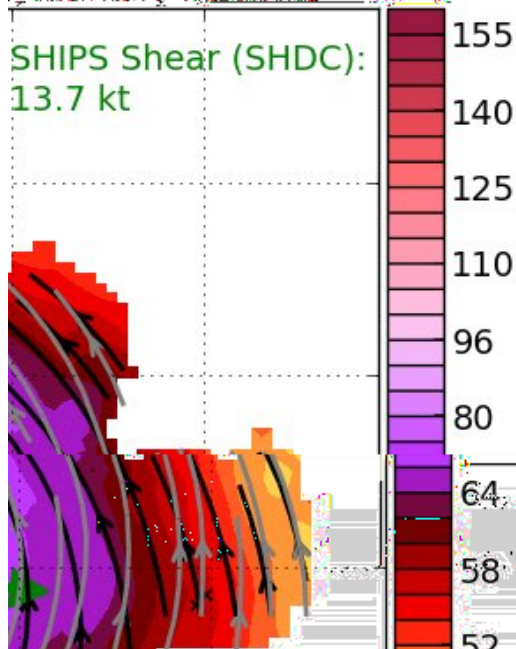
- Significant focus of HFIP has been the development of the HWRF model
- As a result, HWRF intensity has improved significantly over the past decade



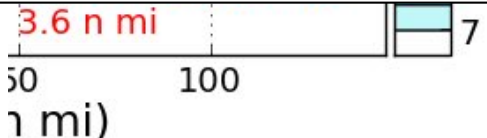
Michael

Talk focus:  
How better use of  
data, particularly from  
recon, has helped  
improve forecasts





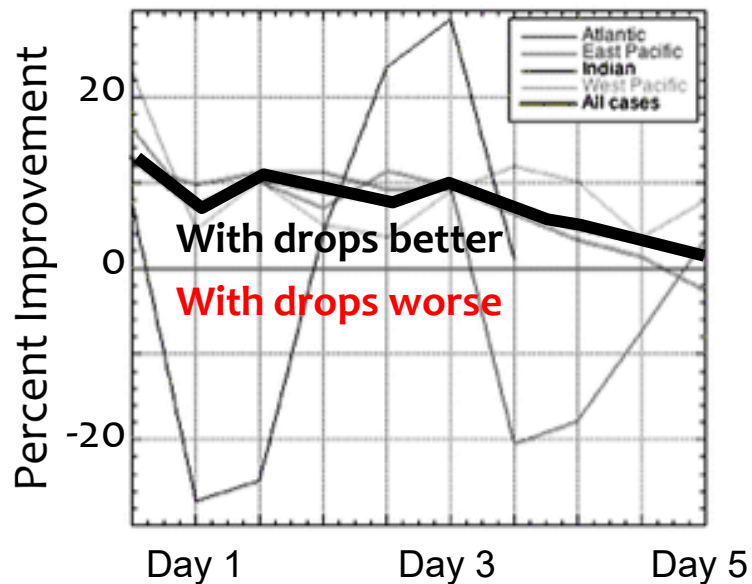
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# Using TC Observations

Dropsonde impact on GFS TC track

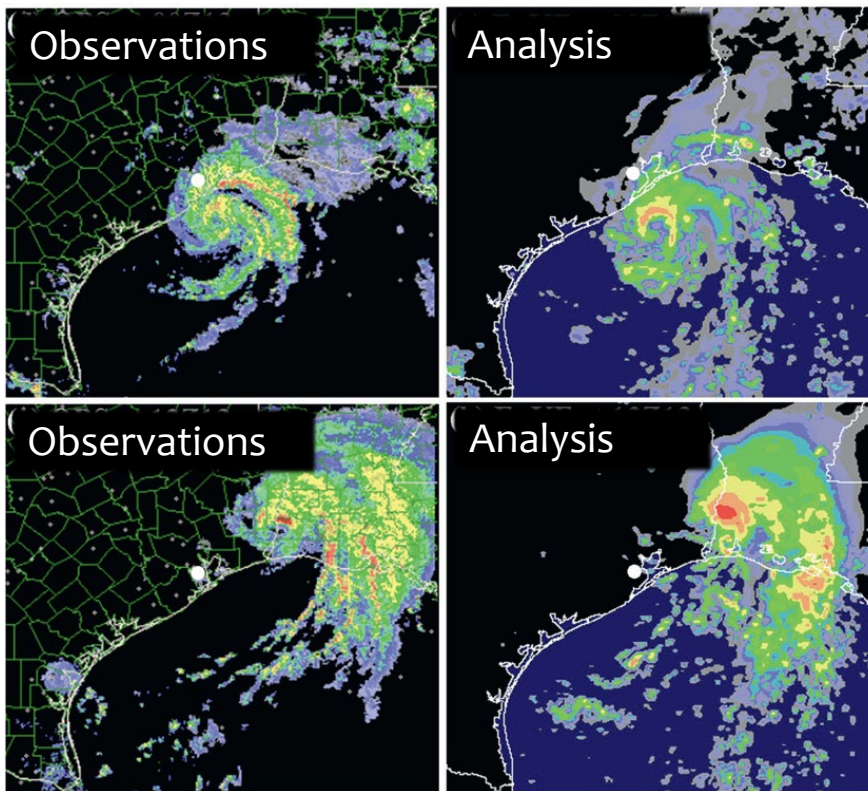


Impact of dropsondes in September 2008

- US has used dropsondes for TC model forecast improvement since 1997
- Significant track improvement globally
- Consistent across many studies

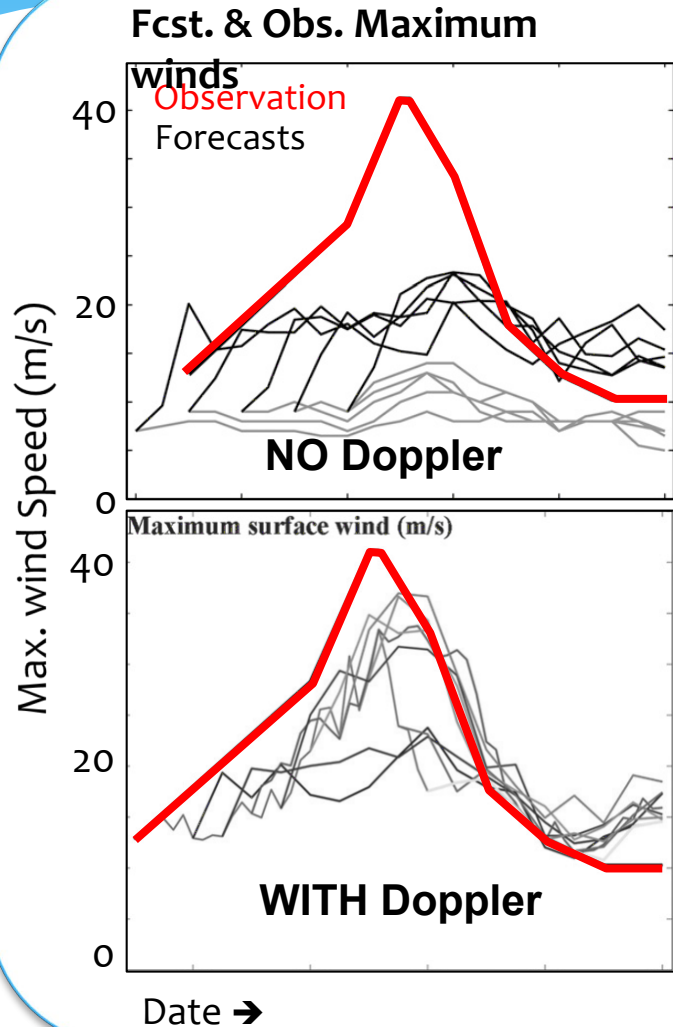


# Using TC Observations



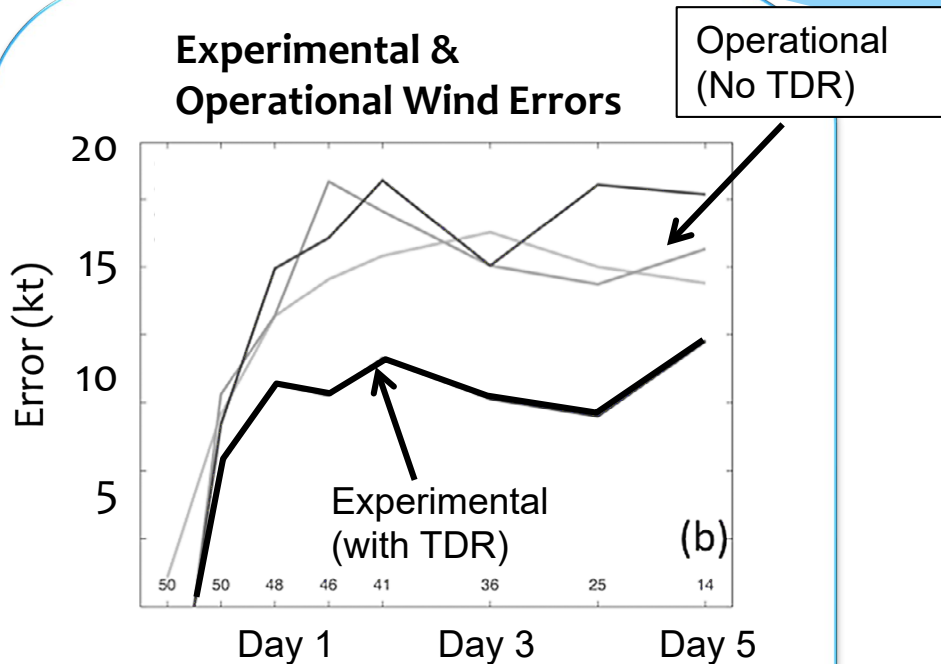
- Starting in 2008, it became apparent that assimilating 88D Doppler velocity could improve coastal TC forecasts
- Assimilating radar data significantly improved analyses and forecasts of Hurricane Humberto

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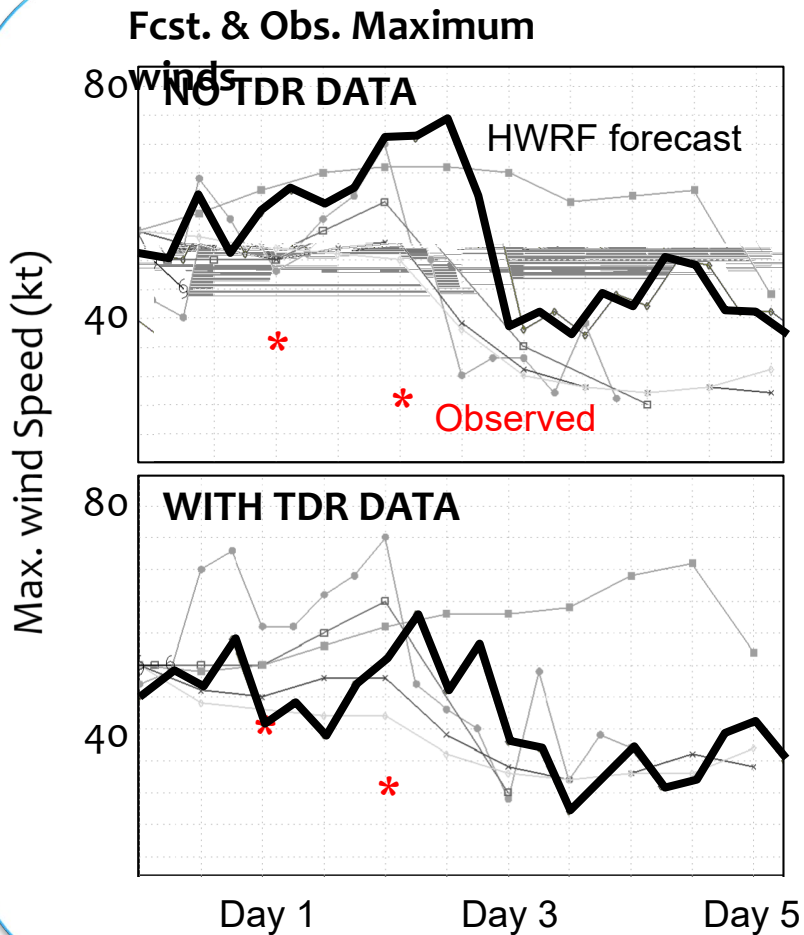
# Using TC Observations



Maximum wind errors from operational forecasts (no TDR) and an experimental system that assimilated TDR data.

- Subsequent work showed forecast improvements from assimilating tail Doppler radar (TDR) velocity from NOAA recon
- These results led to a dedicated effort to assimilate TDR operationally

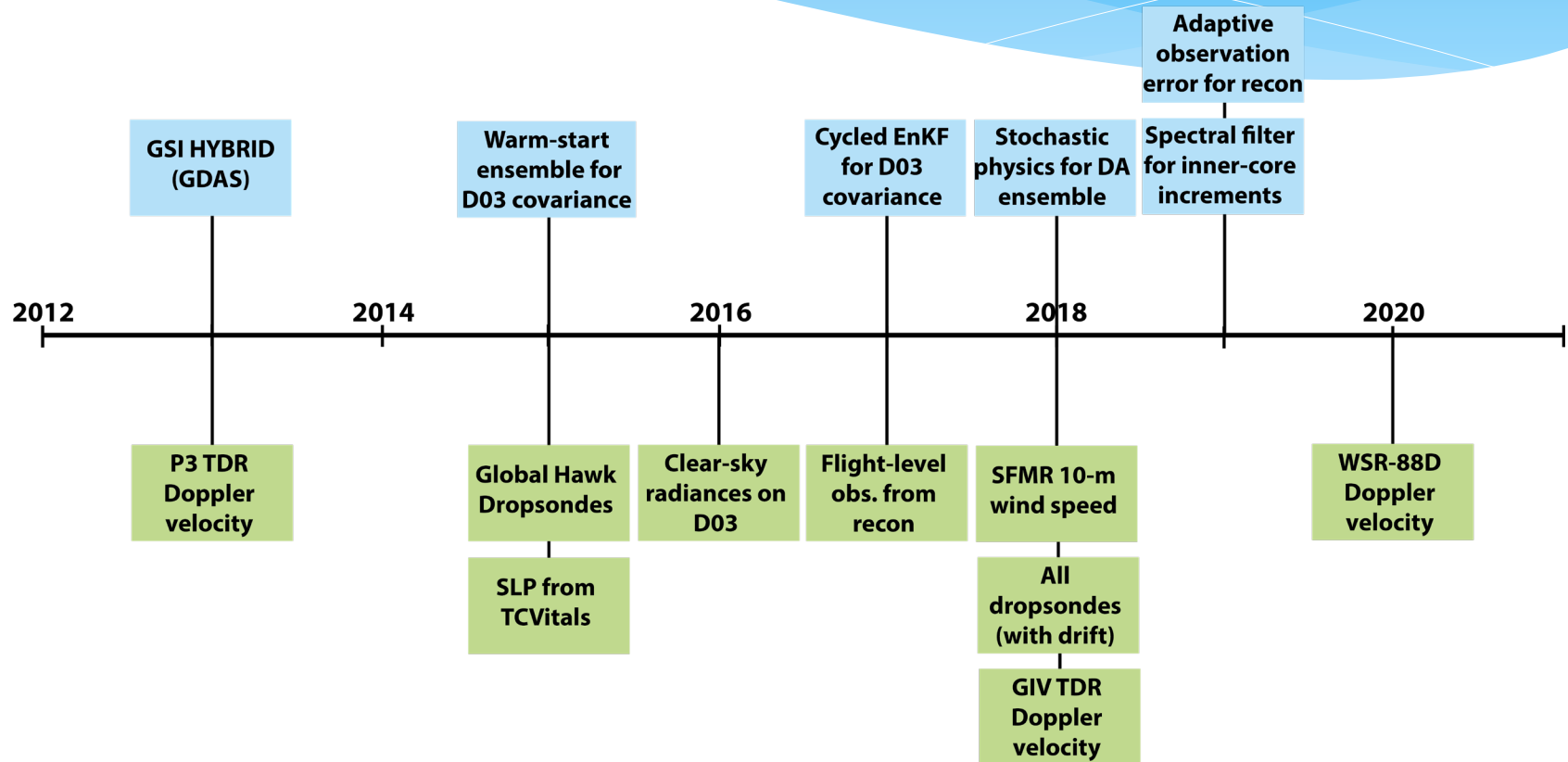
# Using TC Observations



- TDR data began being assimilated in HWRf in 2013
- For weak storms like Karen (left), there was substantial improvement of a positive intensity bias in HWRf

# HWRF DA improvements

## DA INFRASTRUCTURE ADVANCES



DA DATA ADDED



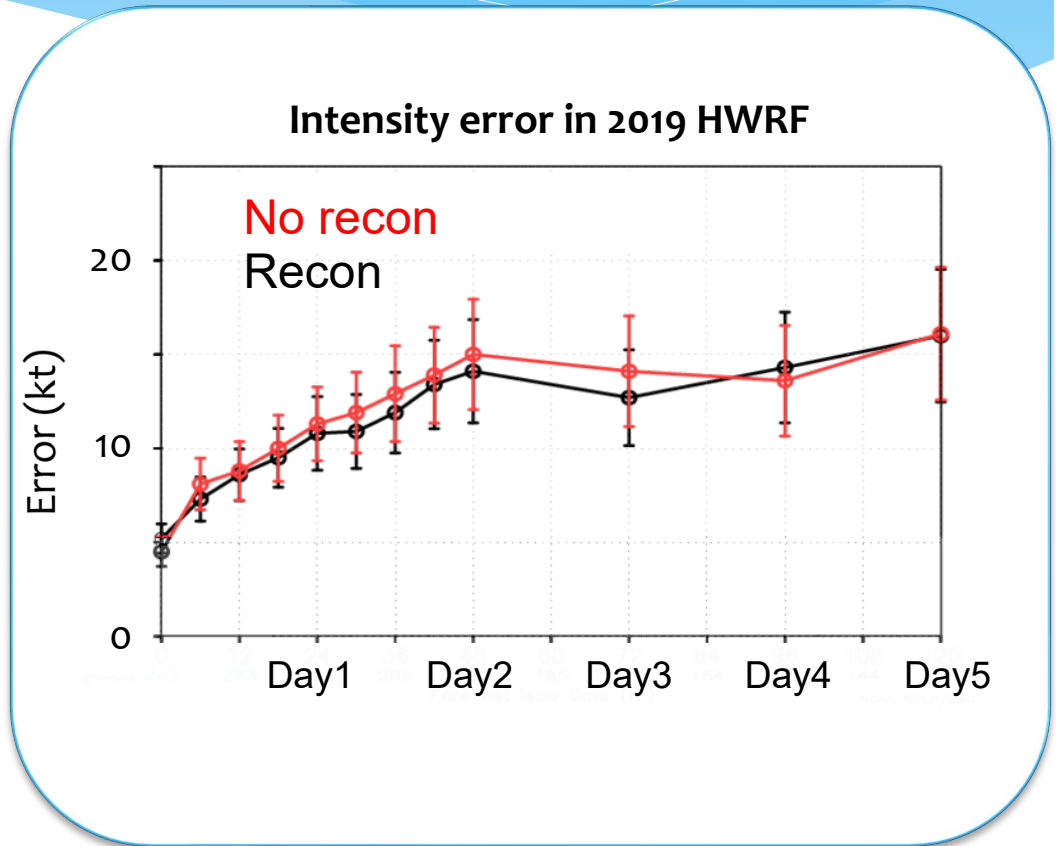
# HWRF improvements

## CURRENT OBSERVATIONS ASSIMILATED BY HWRF INCLUDE:

- Conventional observations (radiosondes, dropwindsondes, aircraft, ships, buoys, surface observations over land, scatterometer, etc)
- NEXRAD 88-D Doppler velocity
- **ALL reconnaissance (HDOB, TDR)**
- Atmospheric motion vectors
- Clear-sky satellite radiance observations

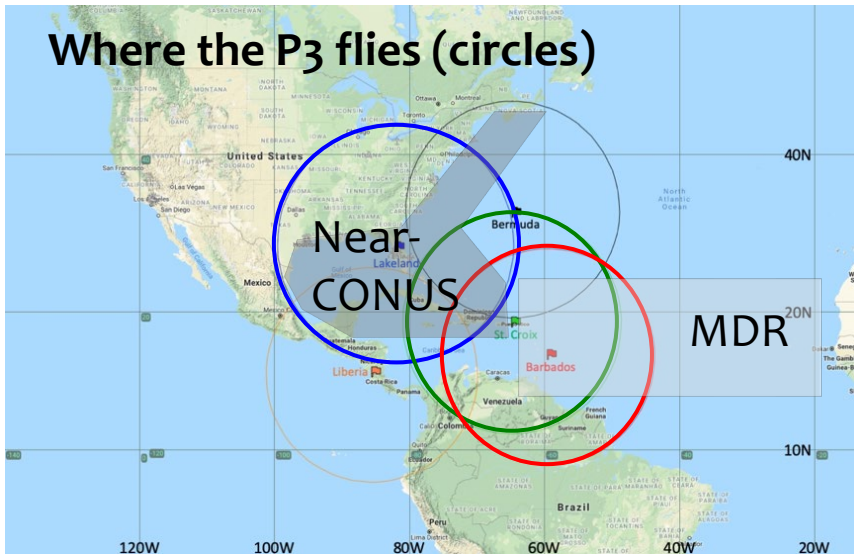
# HWRF improvements

- Recon benefit assessed in 2016-2018 high impact storms
- Many major hurricanes in this sample
- Recon has a clear positive impact on intensity, 10-15% improvement through 72h

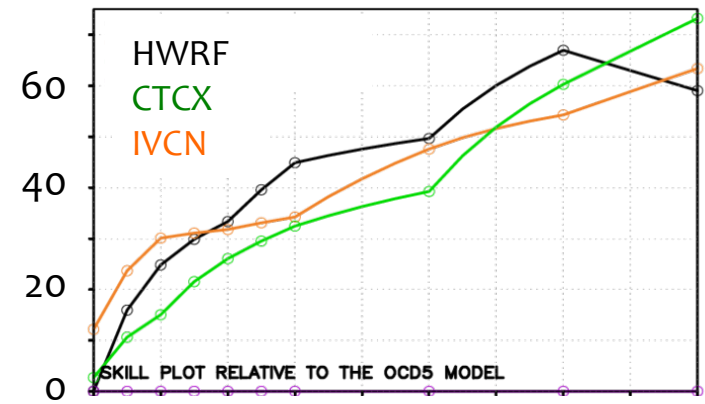


# Recent Performance

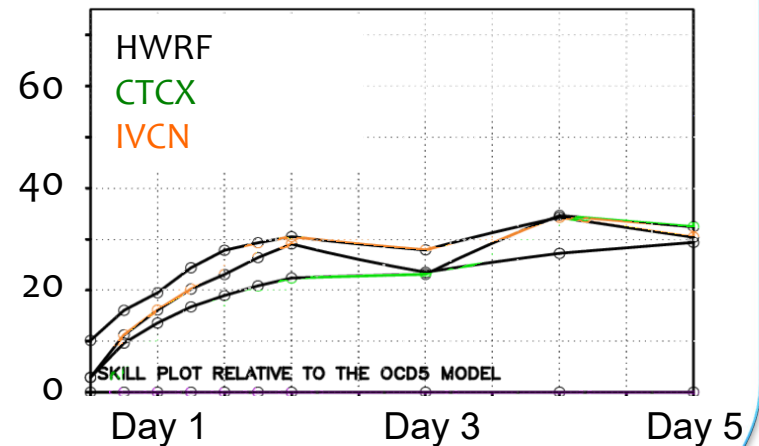
- Model intensity skill varies greatly by region
- Highest skill is where we have the most data (esp. HWRf)



Intensity skill: Near-CONUS



Intensity skill: MDR

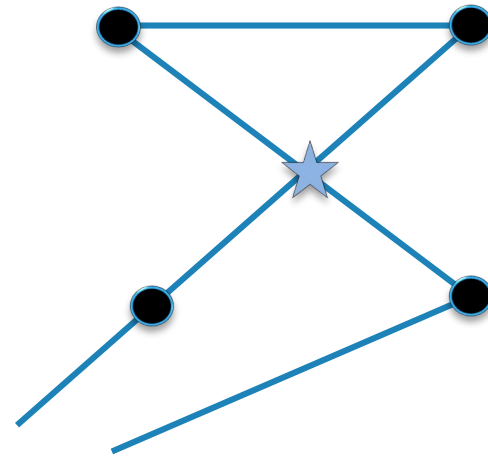


# Recent Changes

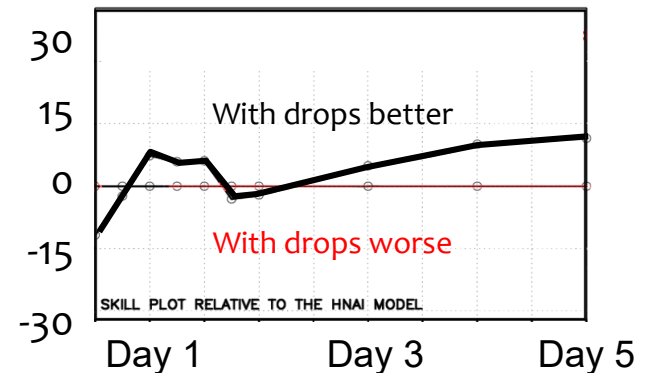
## “End-point” dropsondes from USAF C-130 missions

- Dropsondes at end-points of “alpha” pattern from C-130 missions tested in 2017
- Data denial tests suggested a 10% impact on intensity skill
- Based on these results, this practice was implemented operationally in 2018

Example of end-point drop positions



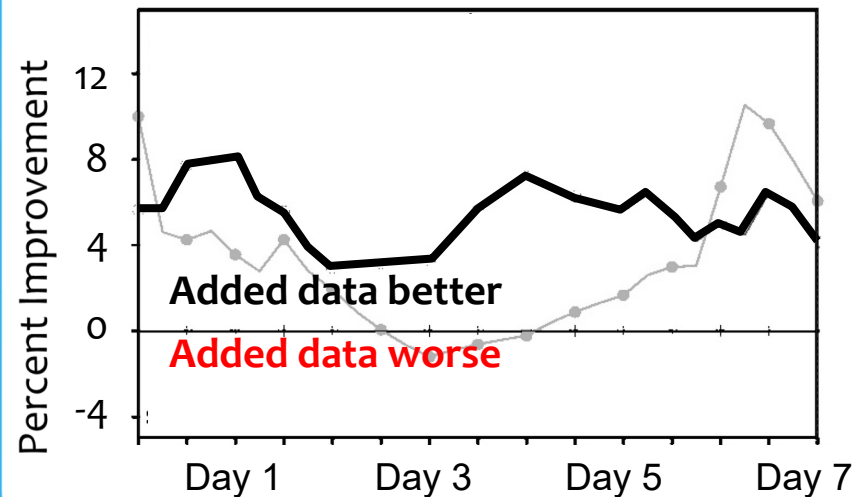
Impact on intensity skill



# Recent Changes

- Upgrade to GFSV16 in March included better use of dropsondes and flight-level data
- Added data improves entire NATL sample track by ~5%
- Higher impact in cycles with data & strong storms

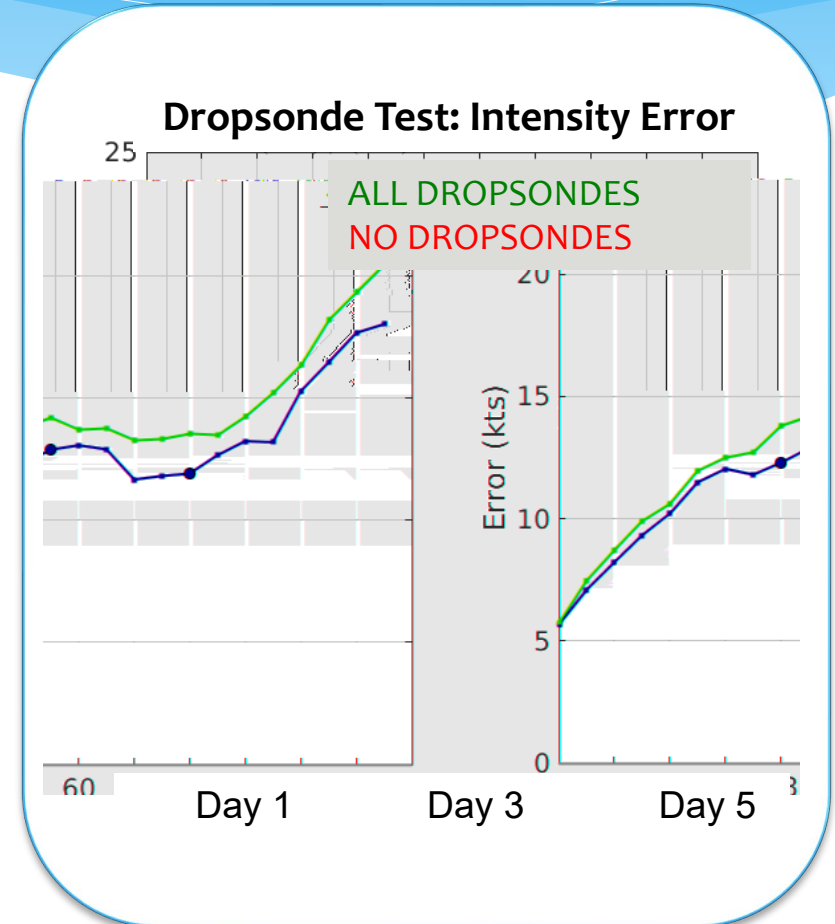
Additional recon impact on GFS track





# Ongoing developments

- Ongoing work assessing how best to deploy dropsondes using basin-scale HWRF
- Dropsondes directly benefit track by 5-10% and intensity by 10-15%
- Removing dropsondes *anywhere* (e.g., inner core vs. environment, etc.) has negative consequences



# Conclusions

- NOAA TC prediction is undergoing dramatic advancements, lead by improvements in global models and HWRF
- We are using more of the available data in DA
- DA results are guiding us on how to approach reconnaissance, which should further improve forecasts

# Future direction: HAFS

(Hurricane Analysis and Forecast System)

**Hurricane Analysis and Forecast System V0.1A**

**Mean Sea-Level Pressure (mb; shaded, lines)**

Init: 00z Tue, Sep 15 2020 Forecast Hour:[000] valid at 00z Tue, Sep 15 2020

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