Using Reconnaissance Data in Weather Models

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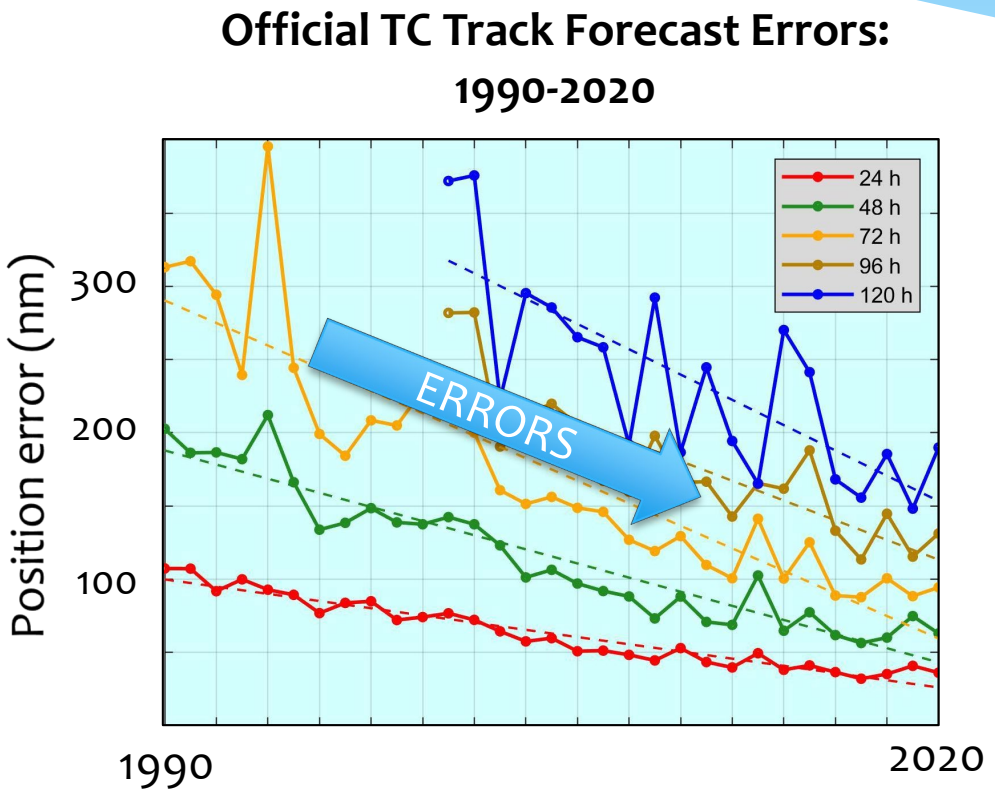
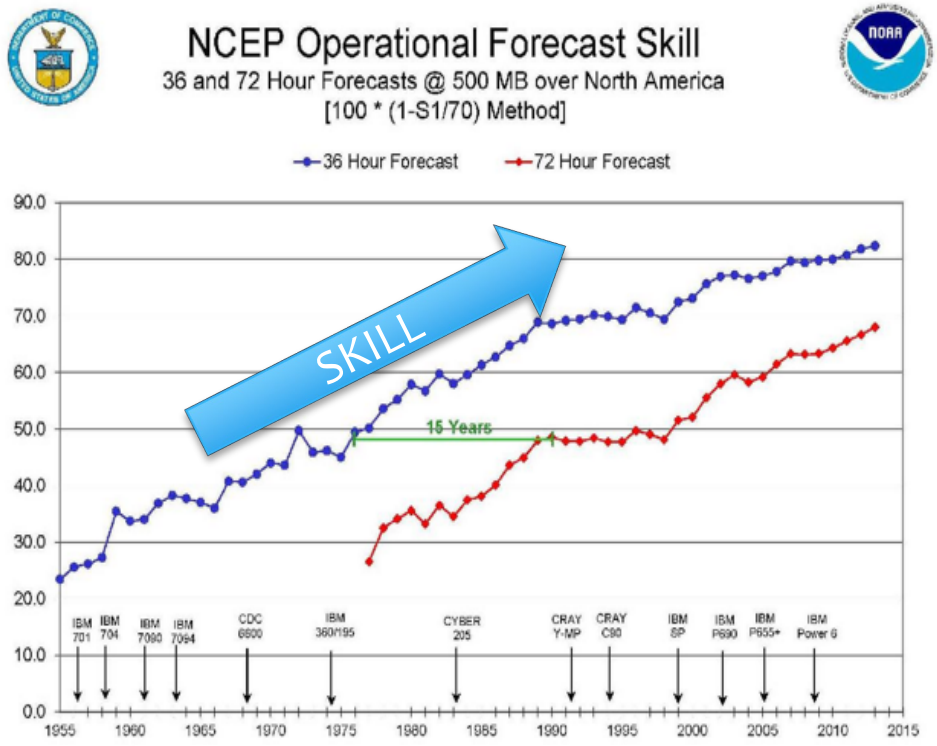
2021 SECART series

Error trends



- 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

Error trends



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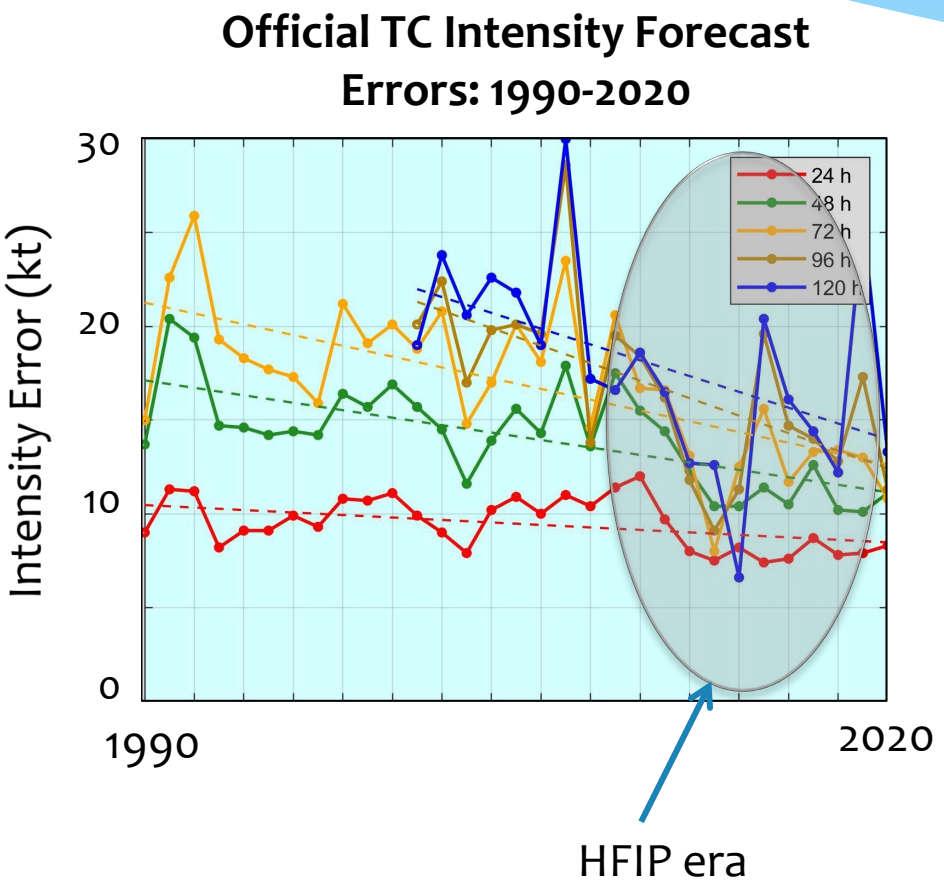
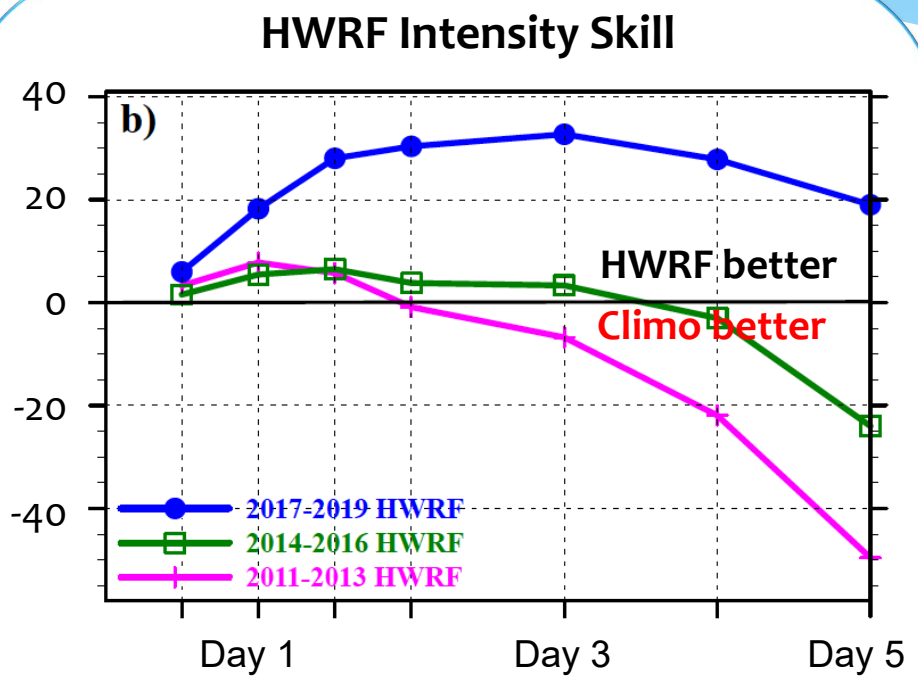


- Hurricane intensity forecasts have only recently improved
- Improvement in intensity forecast largely corresponds with commencement of Hurricane Forecast Improvement Project

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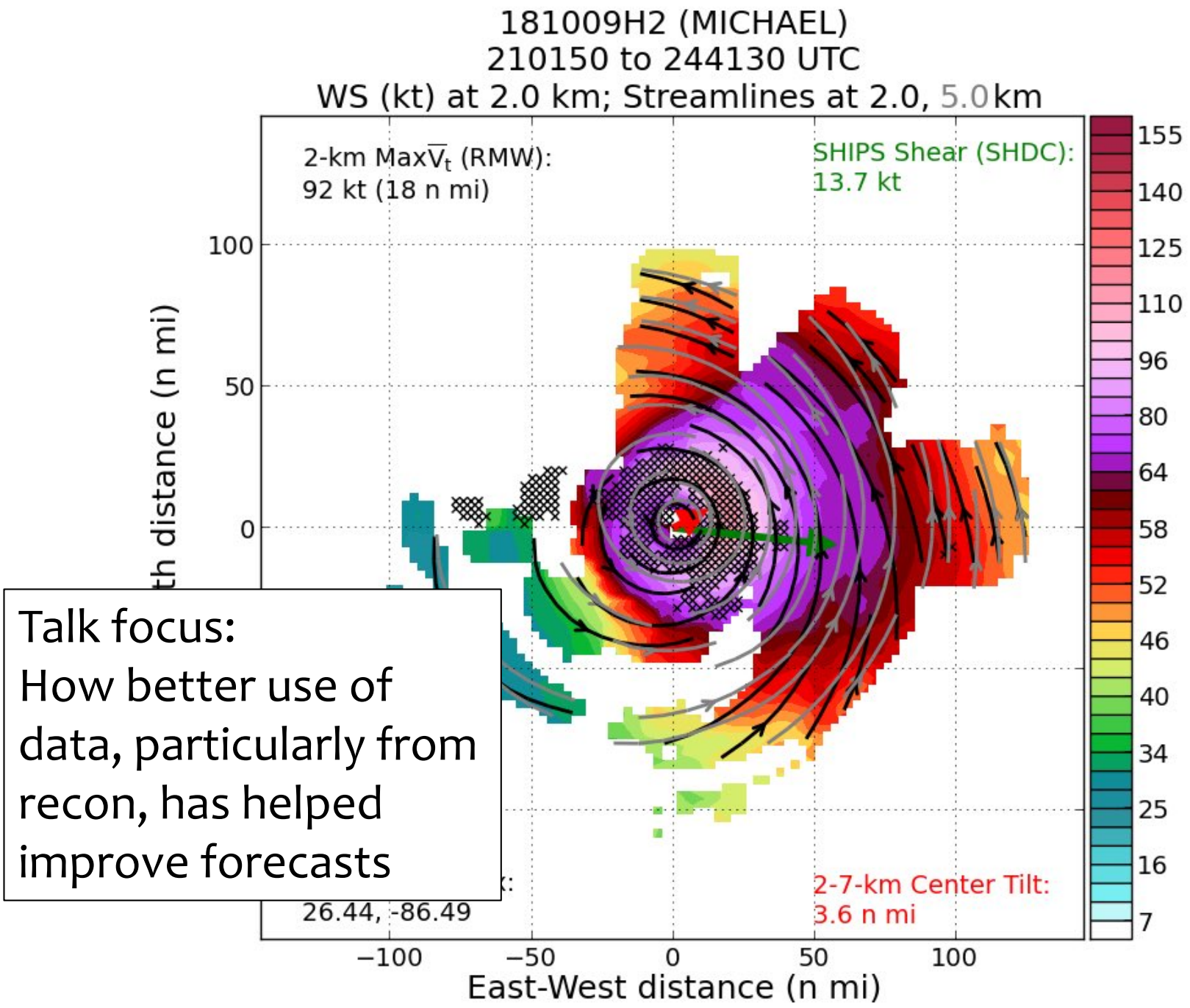
Talk focus:
How better use of data, particularly from recon, has helped improve forecasts



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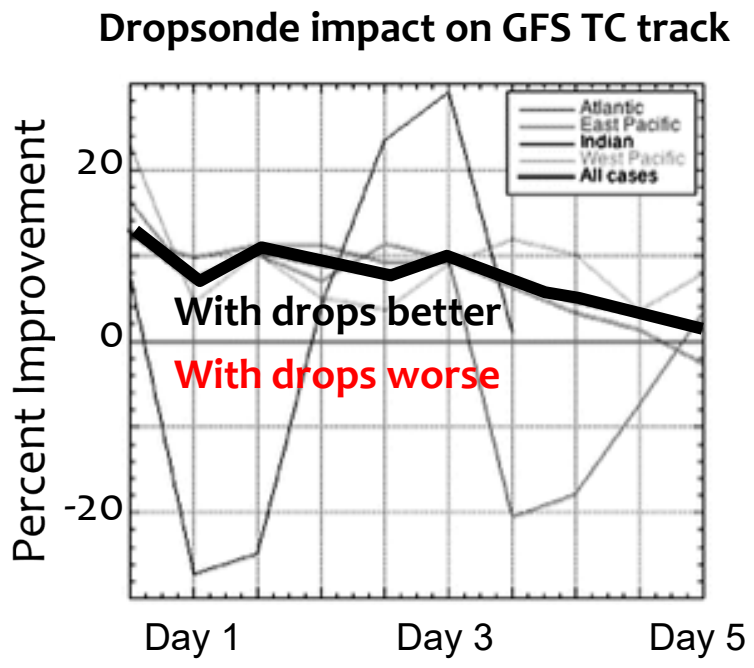
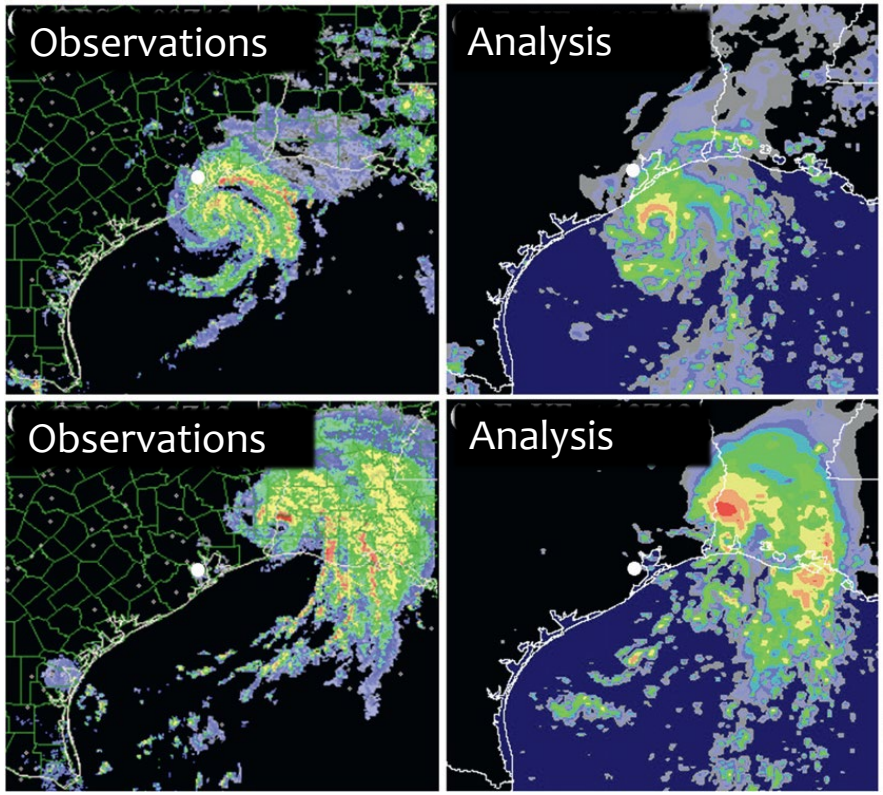
Using TC Observations



Impact of dropsondes in September 2008

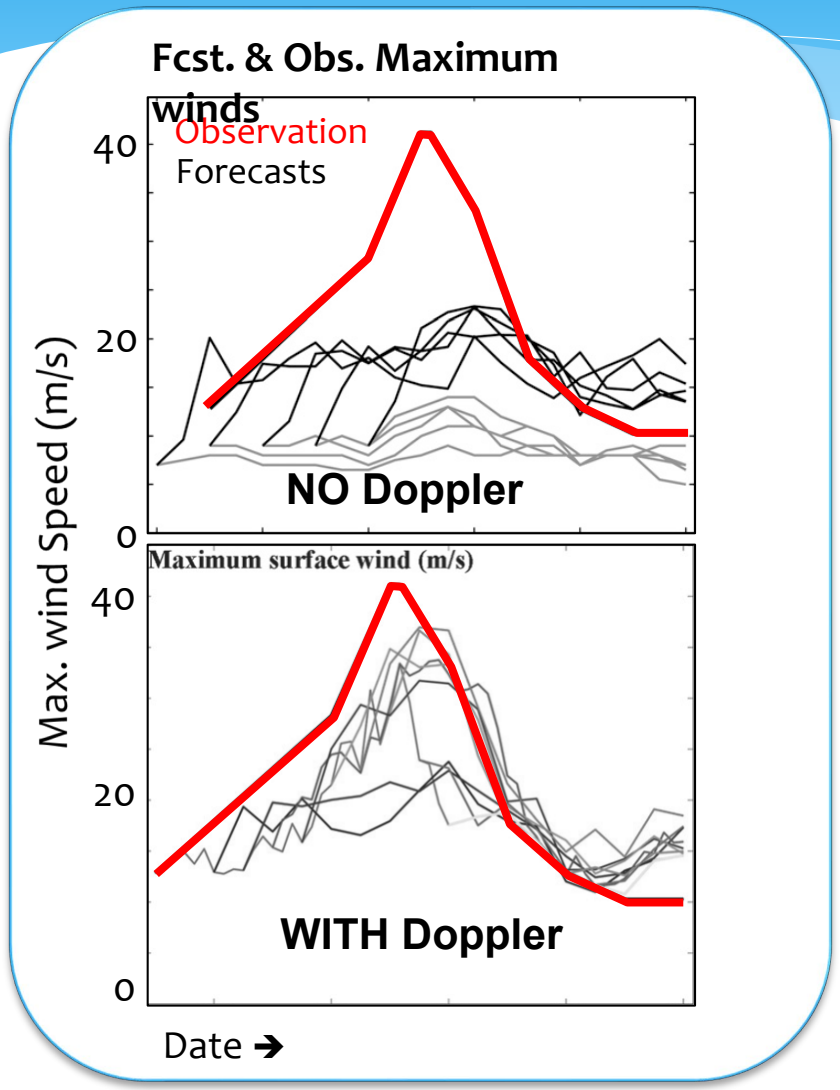
- US has used dropsondes for TC model forecast improvement since 1997
- Significant track improvement globally
- Consistent across many studies

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

Using TC Observations



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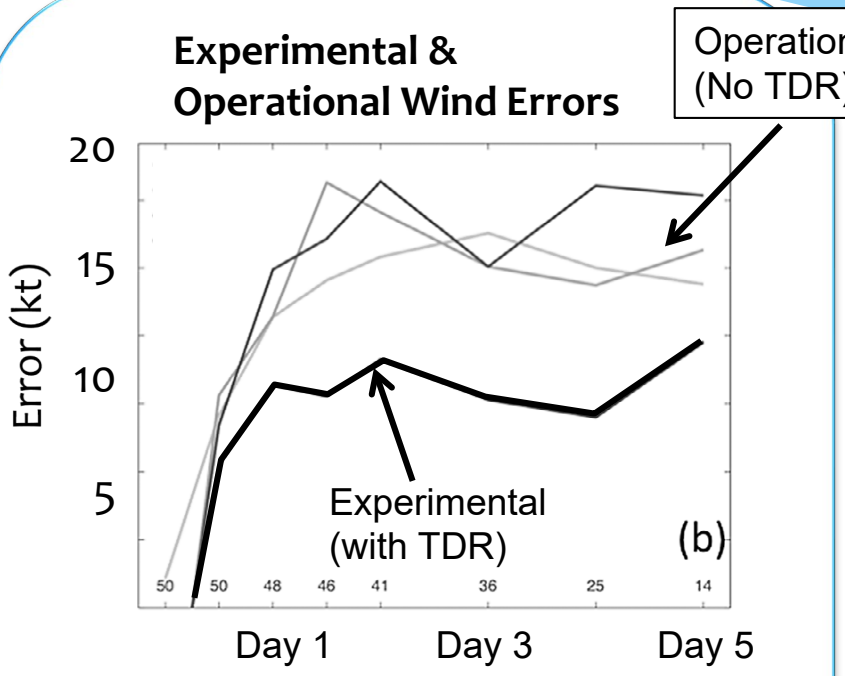
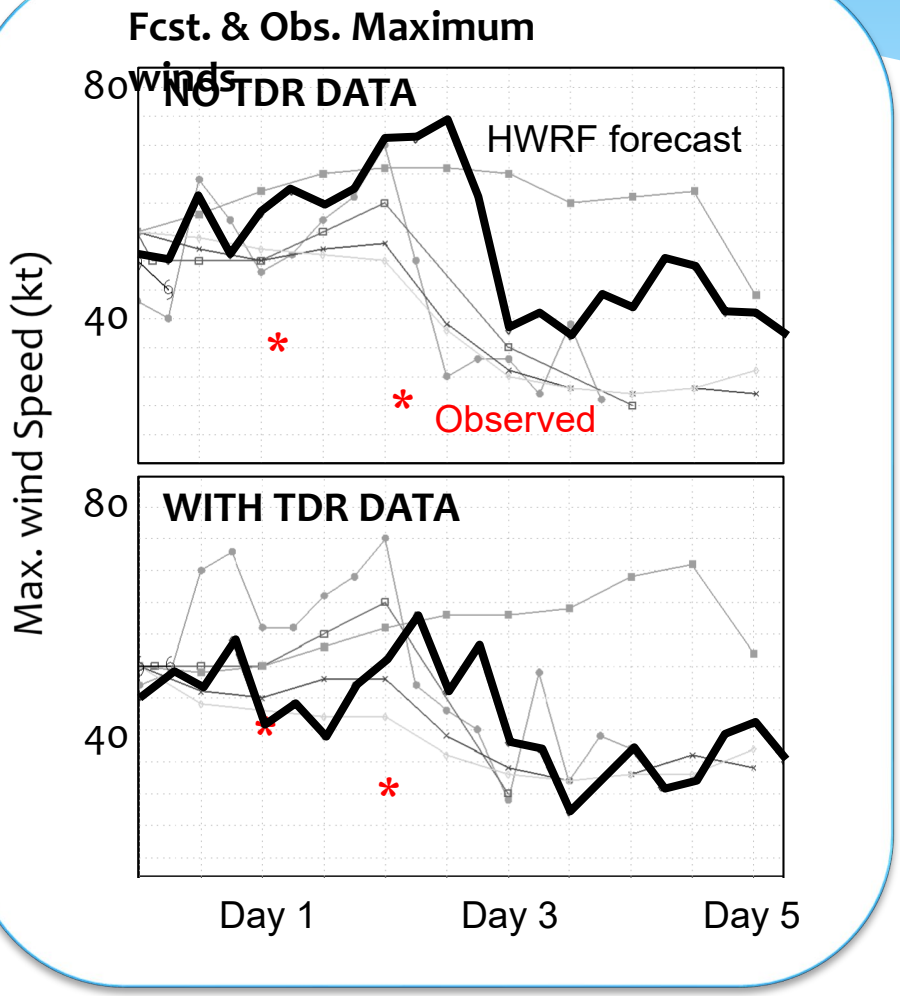


Maximum wind errors from operational forecasts (no TDR) and an experimental system that assimilated TDR data.

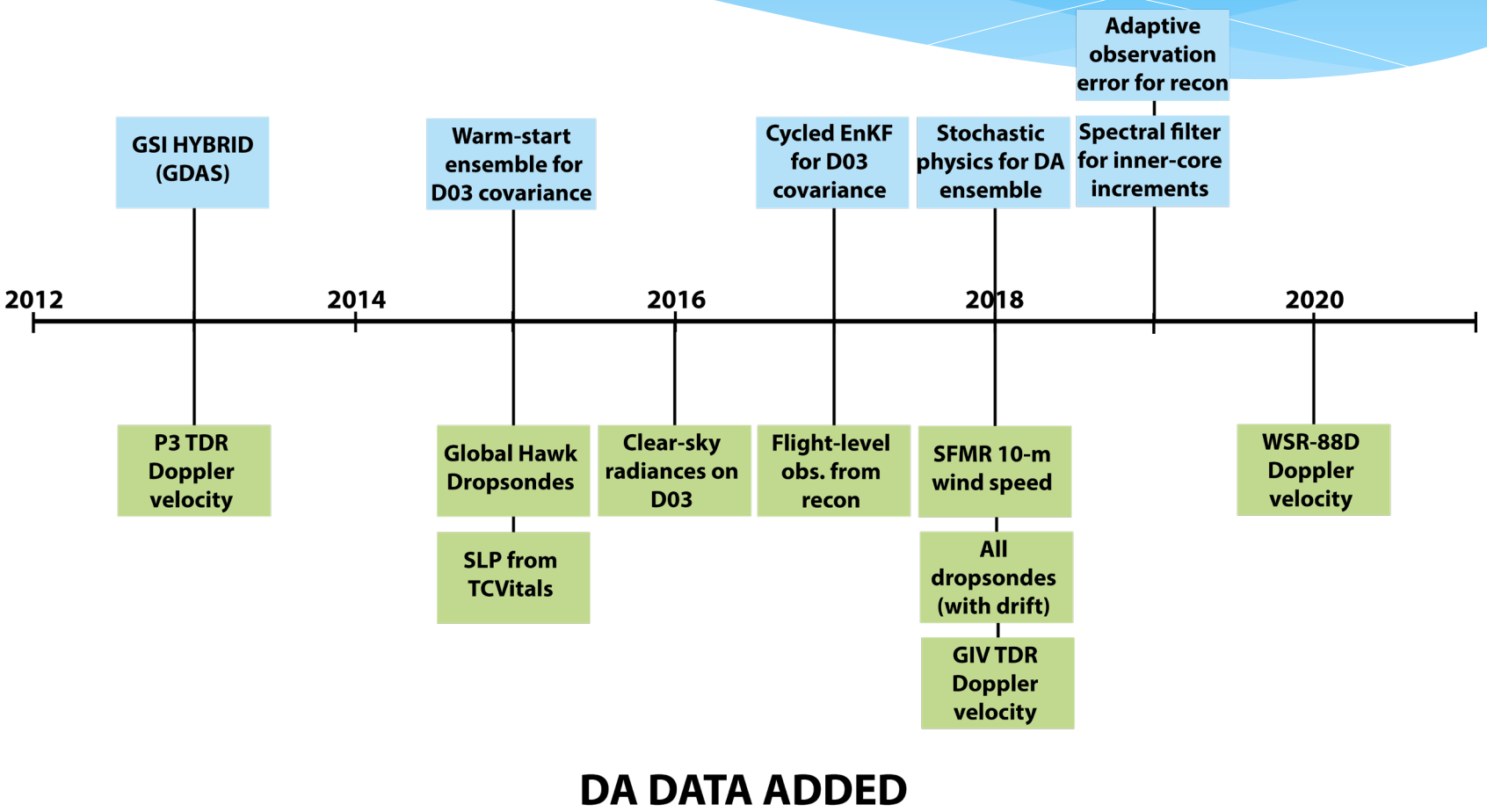
- Subsequent work showed forecast improvements from assimilating tail Doppler radar (TDR) velocity from NOAA recon
- These results led to a dedicated effort to assimilate TDR operationally

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



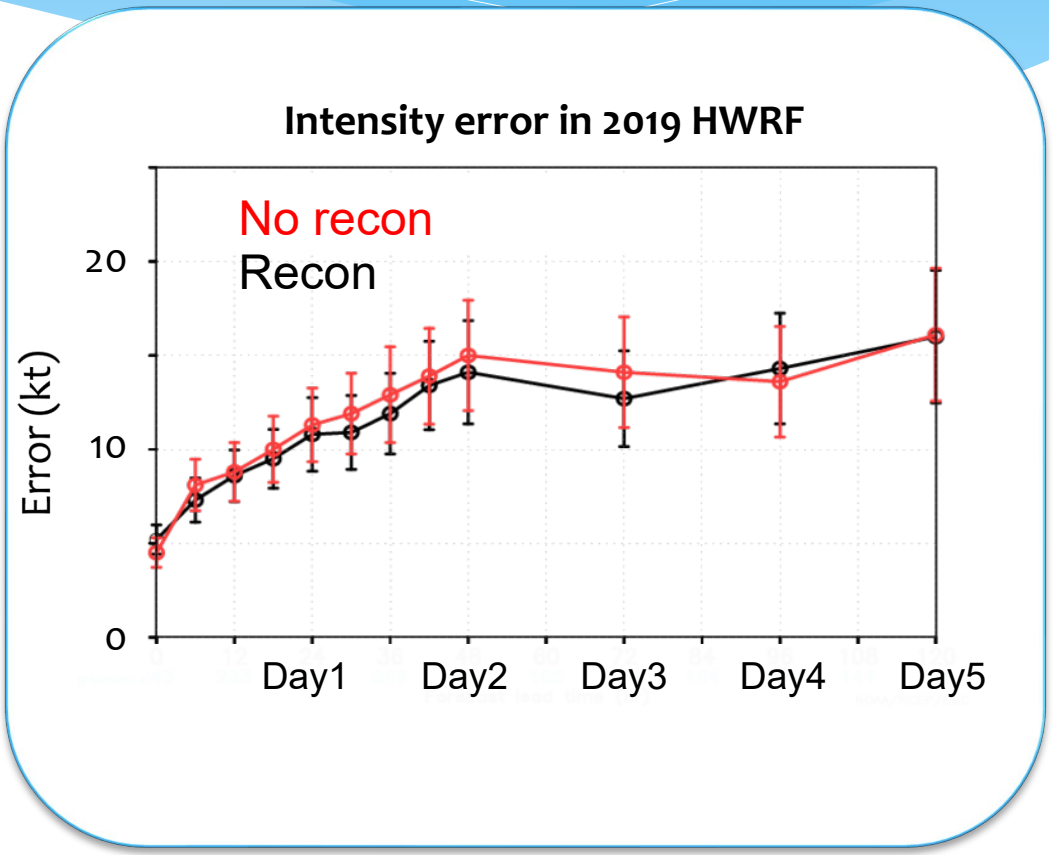
HWRF improvements

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

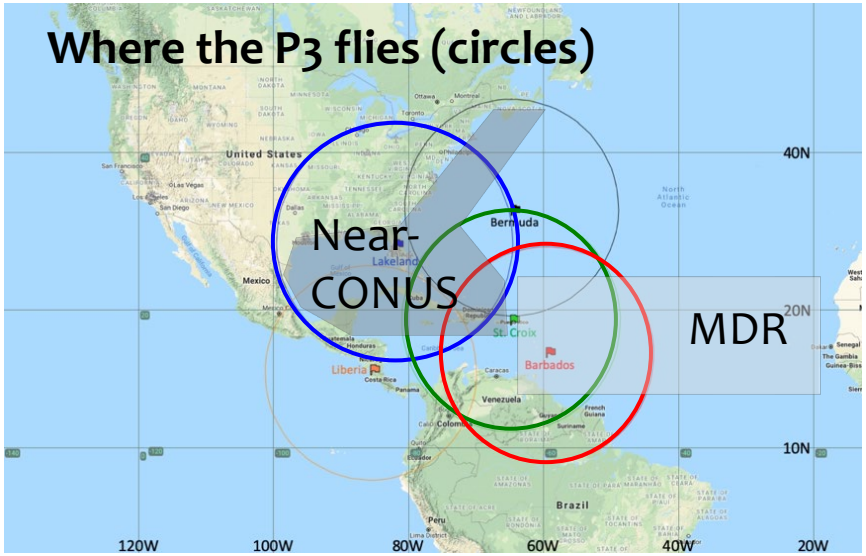
HWRF improvements

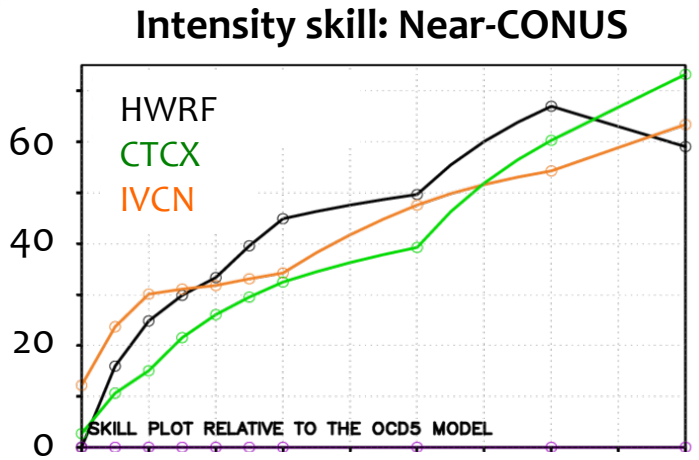
- Recon benefit assessed in 2016-2018 high impact storms
- Many major hurricanes in this sample
- Recon has a clear positive impact on intensity, 10-15% improvement through 72h

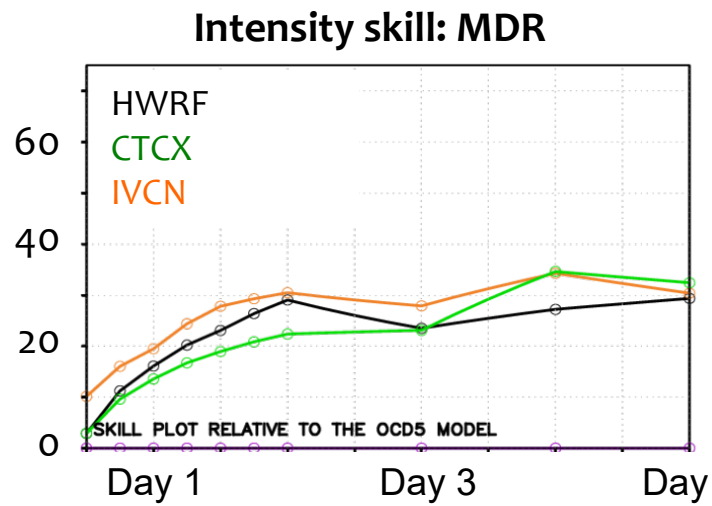


Recent Performance

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





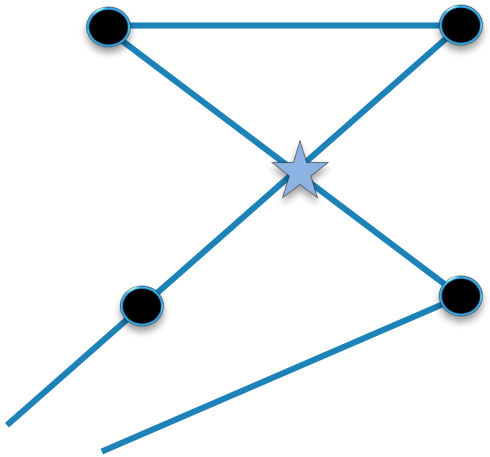


Recent Changes

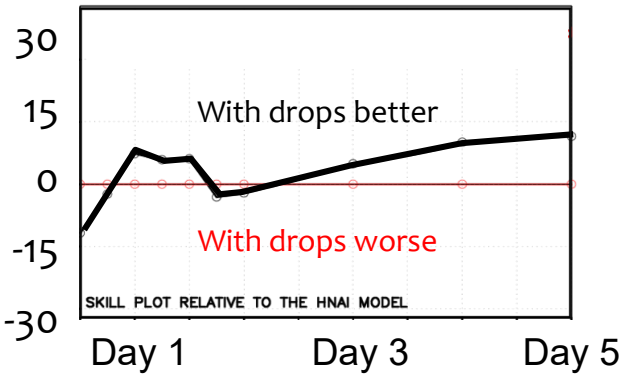
"End-point" dropsondes from USAF C-130 missions

- 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

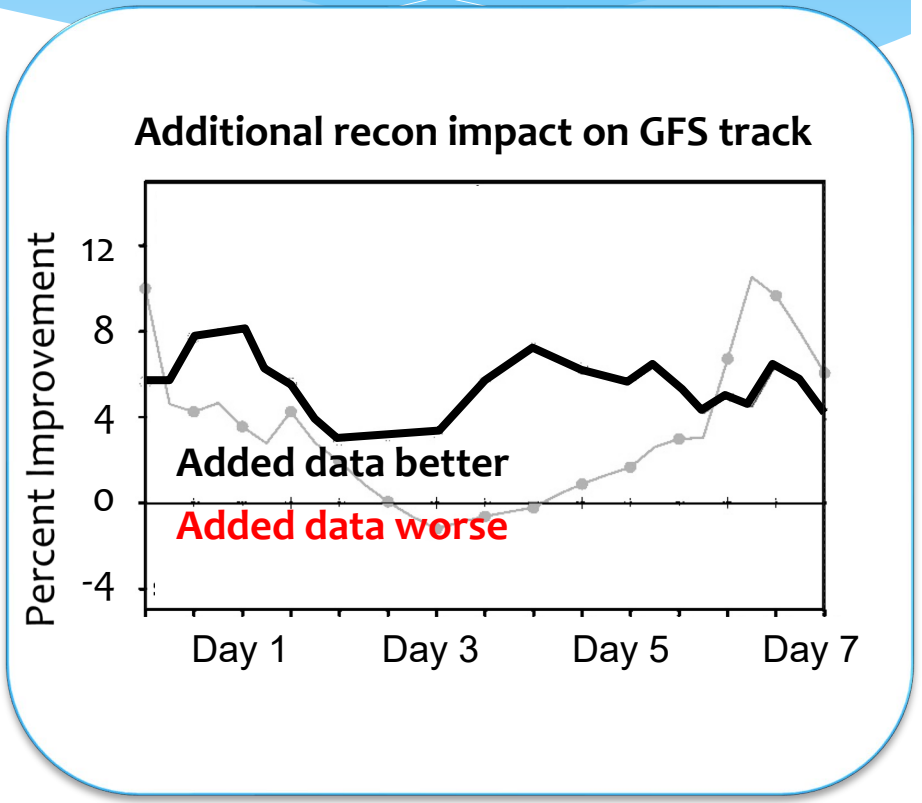


Impact on intensity skill



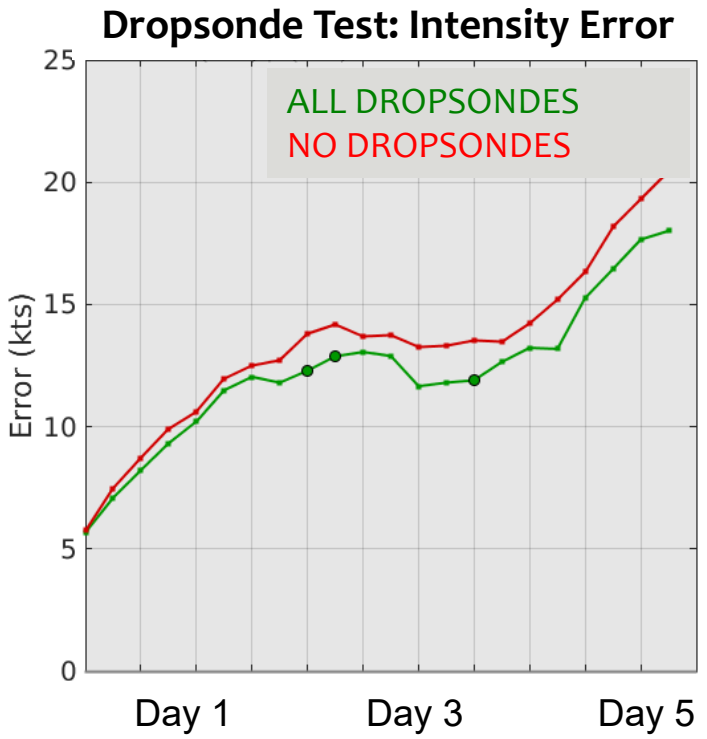
Recent Changes

- 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



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)