THE IMPACT OF GLOBAL HAWK DATA UPON HWRF FORECASTS

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Assimilating Global Hawk obs

- HIWRAP is a high-altitude airborne Doppler radar
- WRF-EnKF assimilation of HIWRAP data is good
- Adding dropsondes and HIRAD (sfc. winds) is even better

Is this relevant to HWRF?



Ourrent operational HWRF system

• Major DA issues that need to be addressed

Impact of HIWRAP data

2015 HWRF: DA status

 GSI-based hybrid system assimilates conventional obs, satellite radiances/winds, dropsondes, and tail Doppler radar (TDR)

 Flow dependent covariance is supplied by 6-h ensemble, weighted 80%

 Vortex initialization provides vortex size/intensity updates, first guess for GSI

HWRF FORECAST - INTENSITY VMAX ERROR (KT) STATISTICS VERIFICATION FOR NATL BASIN 2014



2015 HWRF: DA milestones

- HWRF ensemble for covariance when tail
 Doppler radar is available
- Ensemble relocation available for testing
- Real-time assimilation of Global Hawk dropsondes
- Assimilation of min SLP from TCVitals



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Major DA issues that need to be addressed

Impact of HIWRAP data

DA Issues: Bias and spindown

- Model bias + vortex initialization = strong upper-level vortex
- Biases aloft + DA = Negative Vmax bias
- Imbalance and spindown (bias/covariance)
- For now we don't use DA increments within 150 km of center below 400 hPa



TDR assimilation: Forecast error for weak vs. strong storms in H213 (Tong et al. 2015)

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HWRF FORECAST - TRACK FORECAST SKILL (%) STATISTICS VERIFICATION FOR NATL BASIN 2014



DA issues: Deficiencies/Needs

 Covariance cycling: Covariance from GDAS (no TDR) or uncycled HWRF covariance (TDR) terrible for strong/small storms

 High-frequency cycling: 6-h windows are WAY too long when the flow is rapidly changing (X. Wang, OU)

 Initialization of clouds and hydrometeors: not currently done in HWRF

These are likely major reasons for spindown!

Ourrent operational HWRF system

Major DA issues that need to be addressed

Impact of HIWRAP data

HIWRAP: Data in Gonzalo

- Limited spatial coverage due to:
 - Geometry
 - Substantial QC
 - Limited on-station time of WB-57 compared to GH
- Limited coverage poses major issues for suboptimal error covariance



HIWRAP: Blending-off example

- Ensemble relocation on, blending & vortex correction off (H215)
- Most data on northeast side of storm results in much stronger increments on that side
- Extreme asymmetry results in 50-kt spindown for this cycle



HIWRAP: Summary w/ blending

- HIWRAP available
 15/1800, 16/0000,
 16/1800
- TDR available 16/1200, 17/1200, 17/1800
- Stats computed from 15/1800-19/1200
- Results are decent for TDR, poor for HIWRAP



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Impact of GH data

Upcoming HWRF developments

2016:

- Address physics biases leading to weak surface winds (Cd)
- Get rid of blending for weak storms

2017:

- Address physics bias leading to inner core size bias
- Upgrade to fully cycled covariance
- Get rid of blending for most storm/cycles

• Long-term:

 Replace vortex initialization with assimilation of tcvitalsbased pseudo-obs

Summary

 HWRF DA system is improving, but current deficiencies limit our ability to fully use inner-core data

WRF DA is particularly susceptible to asymmetric data distribution, as with HIWRAP here, which causes strong imbalances and spindown

A number of ongoing developments in HWRF are major advancements that should help us alleviate some of these issues

15/1800: blending on

- Ensemble relocation on, blending & vortex correction on
- Inner-core anaysis replaced with first guess (vortex initialization)
- Much more symmetric
- Some spindown due to upper-level increments





2015 HWRF: AL workflow

