Assimilation of Global Hawk/AVAPS data into NCEP operational models

Vijay Tallapragada
Chief, Global Climate and Weather Modeling Branch, NCEP/EMC
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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
Inner core and environmental recon data from P3 TDR, AF/G-IV/P-3/GH Dropsondes operationally assimilated at 2km resolution.
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
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

NOAA SHOUT - Hurricane Matthew October 7, 2016 (~ 09 – 19 UTC)
HIWRAP Ku Band Reflectivity and Wind Vectors at 1 km Height
By Steve Guimond (UMD/NASA GSFC), Matt McHendey (NASA GSFC) and Gerald Heymsfield (NASA GSFC)

NOAA IFEX - Hurricane Matthew October 7, 2016 (~ 1830 UTC)
WP-3D LF Reflectivity and TDR/dropsonde Wind Vectors at 1 km Height
By Rob Rogers (NOAA/OAR/AOML/HRD), Frank Marks (NOAA/OAR/AOML/HRD) and Peter Black (NOAA/UASPO/CNT)
Hot off the press: GH Dropsonde Data Impact Experiments w/NCEP GFS

Studies:

• **Global Hawk inclusion study (ongoing)**

• El Nino Rapid Response Field Campaign 2016

• Results to be presented at IHC (Miami) and ENRRRR workshop (NCEP)
ATLANTIC: GH targeted storms

![Track Error (NM) Statistics](image)

- **CTRL: 2017 GFS retro**
- **GHDS: 2017 GFS retro + GH drops**

**Axes:**
- **Y-axis:** TRACK ERROR (NM)
- **X-axis:** Forecast lead time (hr)

**Legend:**
- CASE 130
- CASE 125
- CASE 118
- CASE 112
- CASE 103
- CASE 95
- CASE 91
- CASE 88
- CASE 80
- CASE 74
- CASE 67

Source: NOAA/NCEP/EMC
A great example: Hurricane Matthew

~37% reduction in track error at 168 hrs (drop from 400nm to 250nm).
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 the 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.
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