OSSE Evaluation of Aircraft Reconnaissance Observations and their Impact on Hurricane Analyses and Forecasts

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MOTIVATION

Study the impact of G-IV dropsondes on tropical cyclone analyses and forecasts

DATA DESCRIPTION

Dropsonde deployed via NOAA G-IV aircraft:
- Temperature, moisture, pressure and wind observations
- 8 dropsondes per mission (minimum)
- Deployed every 40 degrees (storm relative)
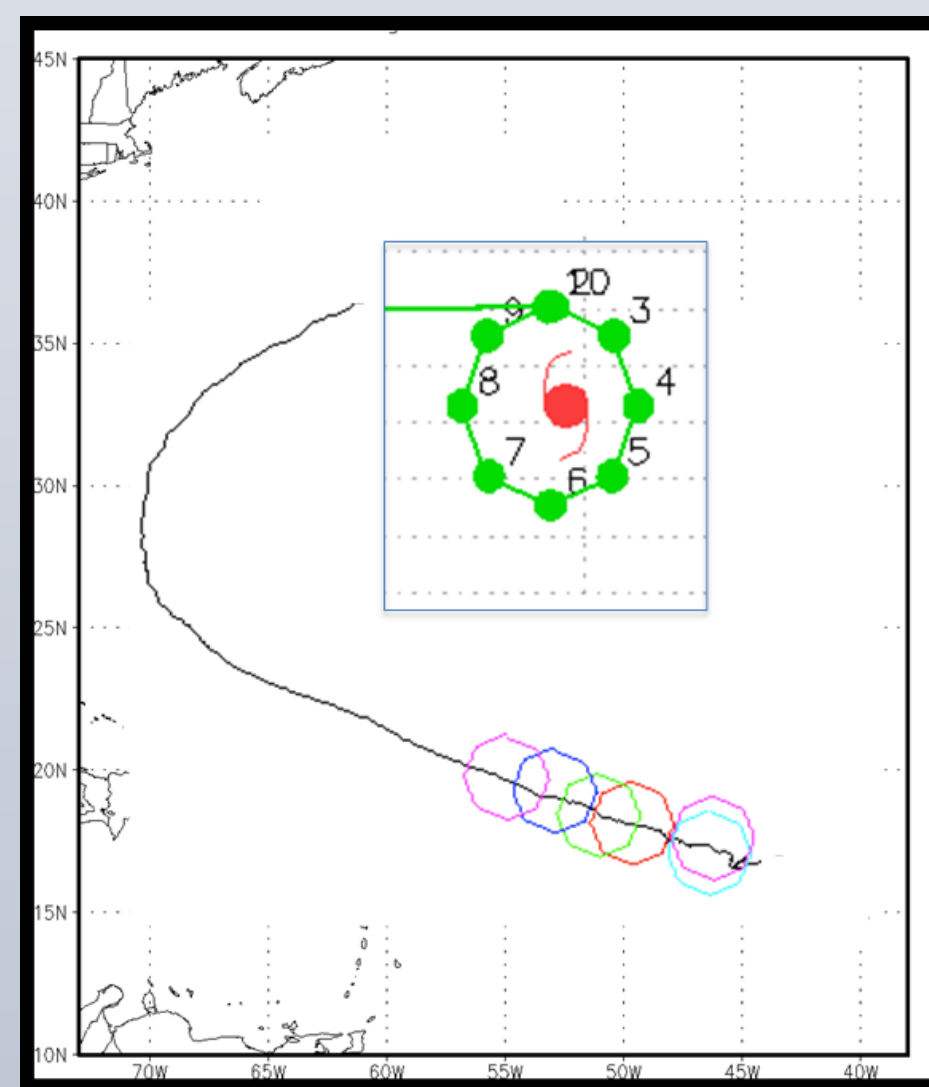- Observations every 6 seconds

Figure 1. Simulated G-IV locations (6 flights)

 # observations assimilated in experiment:
27215
 # observations assimilated in control:
26200

OSSEs for Hurricanes

*O*bserving *S*ystem *S*imulation *E*xperiments (OSSEs):
- aim to quantify the potential impact of a proposed observing system on tropical cyclone analyses and forecasts
- can also be used to assess current observing systems and methods for data retrieval

Regional OSSEs for Hurricanes

The regional OSSE system developed at NOAA/AOML and UM/RSMAS uses synthetic observations produced from the Nature Run and assimilates them to create analyses used by a high-resolution regional forecast model
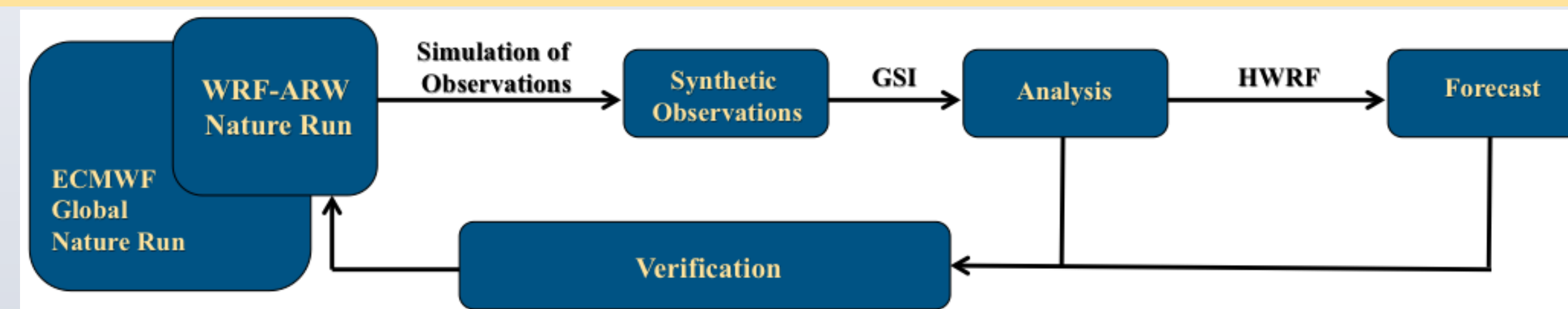

Figure 2. Schematic of NOAA/AOML regional OSSE flowchart

Nature Runs: The 27 km WRF-ARW nature run with storm-following inner nests (9km/3km/1km spatial resolution) is embedded in the T511 ECMWF Global Nature Run.

Data Assimilation: GSI (v3.3) performs 9km analysis over the 9km parent domain (d01).

Regional Forecast Model: Hurricane-WRF model (v3.5) has 9km parent domain and 3km storm-following nest (d02).

Figure 3. NOAA/AOML regional OSSE system.

Short term impact on track forecasts using both inner and outer flight paths
- Analysis errors decrease by 10-20 km
- Inner-most flight path produces better analyses and forecast improvement out to 18 hours
- Outer-most flight path provides forecast improvement for 6 hours

1-2 day impact on intensity forecasts using both inner and outer flight paths
- Analysis errors improve by 12 knots (7mb)
- Both flight paths provide forecast improvement out to 48 hours
- Little difference between flight paths
- Does not mitigate "spin-down" issue
- Does not capture rapid intensification

Experiments and Results

Each experiment included the assimilation of simulated conventional and satellite data with 120-hour forecasts launched for each analysis. Impact experiments include various configurations of G-IV dropsonde deployments.
- Control: conventional and satellite data assimilated
- Control + 1.5xR34: control and G-IV data at a radius of 1.5 x radius of 34-knot winds assimilated
- Control + 3xR34 : control and G-IV data at a radius of 3 x radius of 34-knot winds assimilated
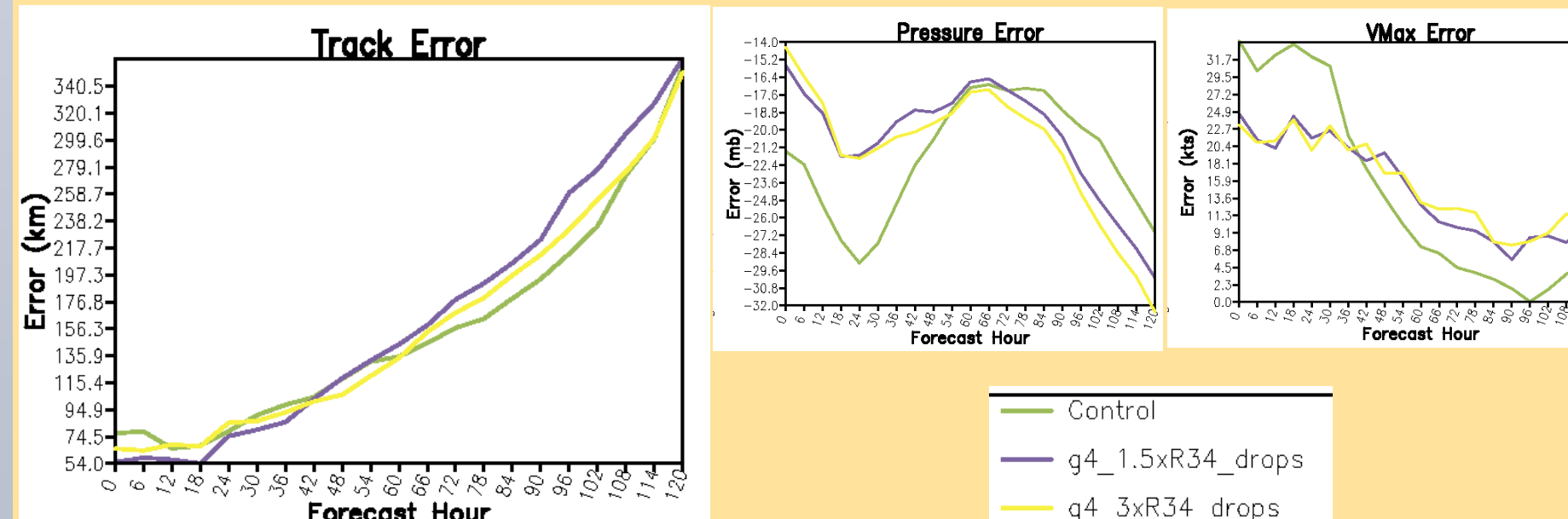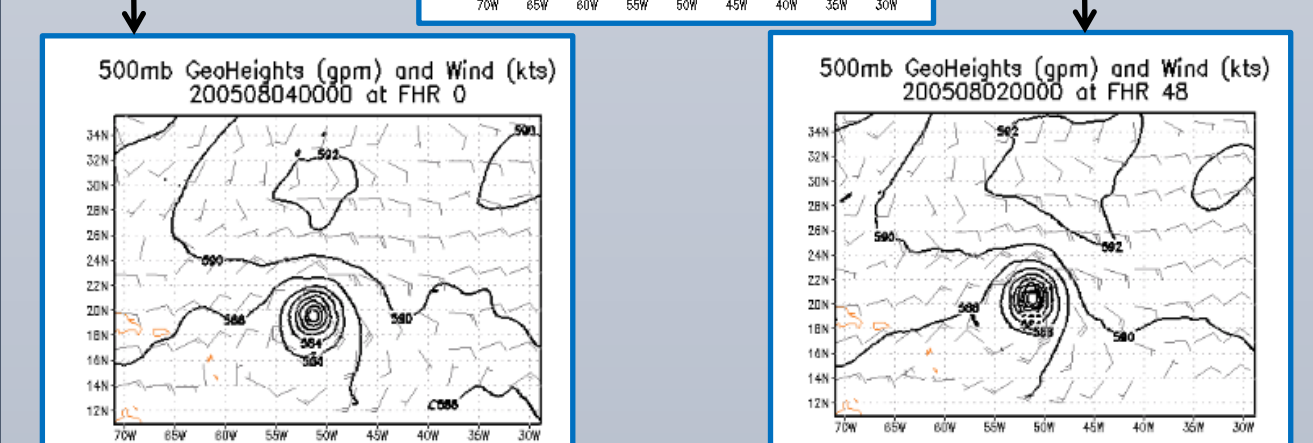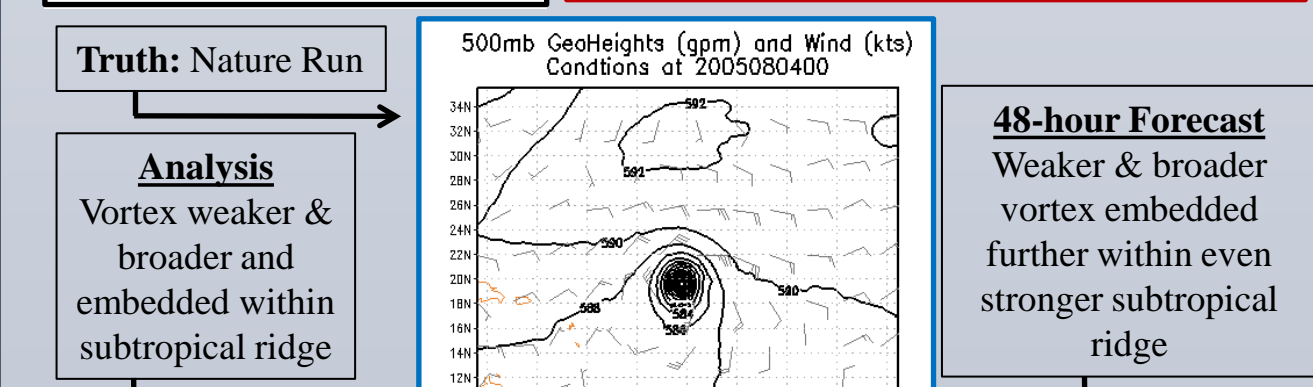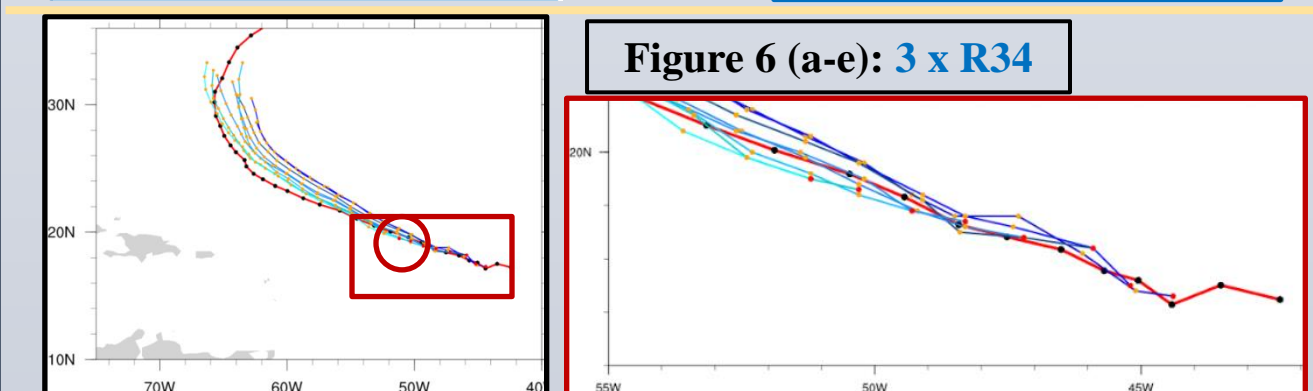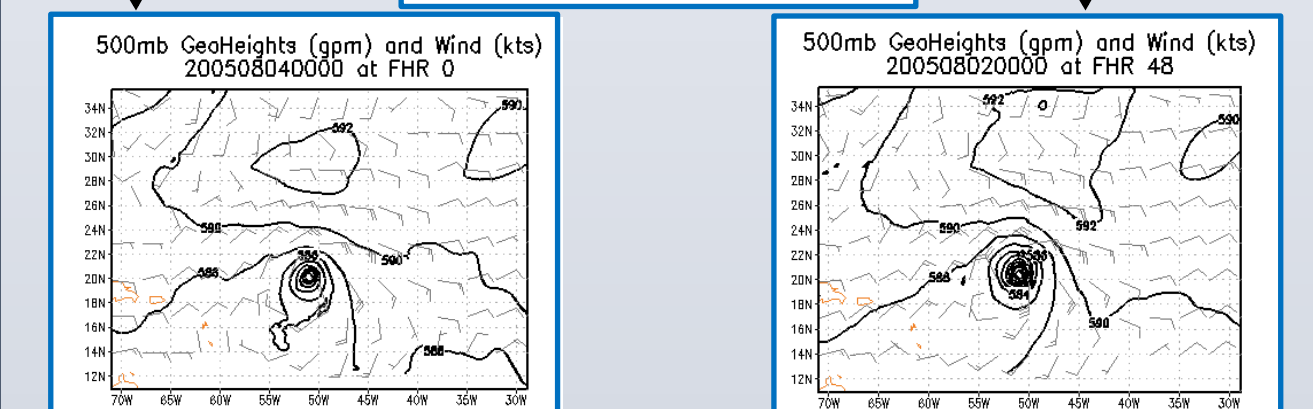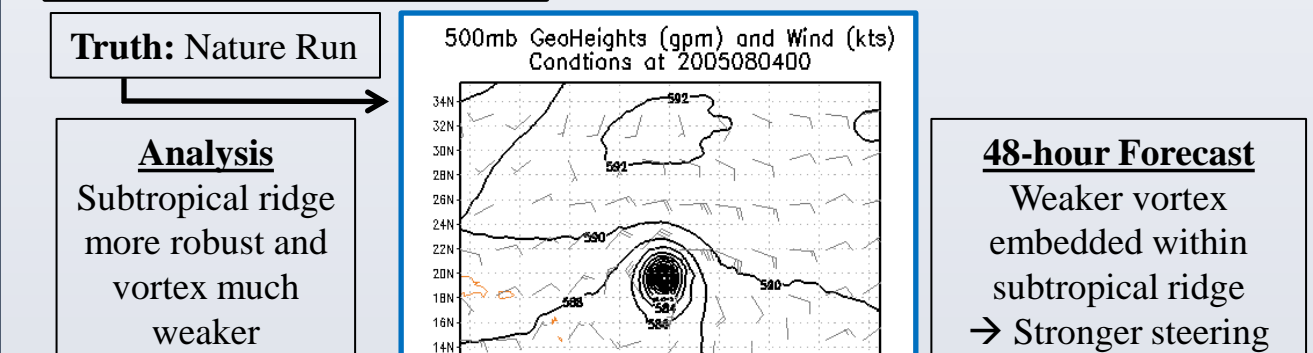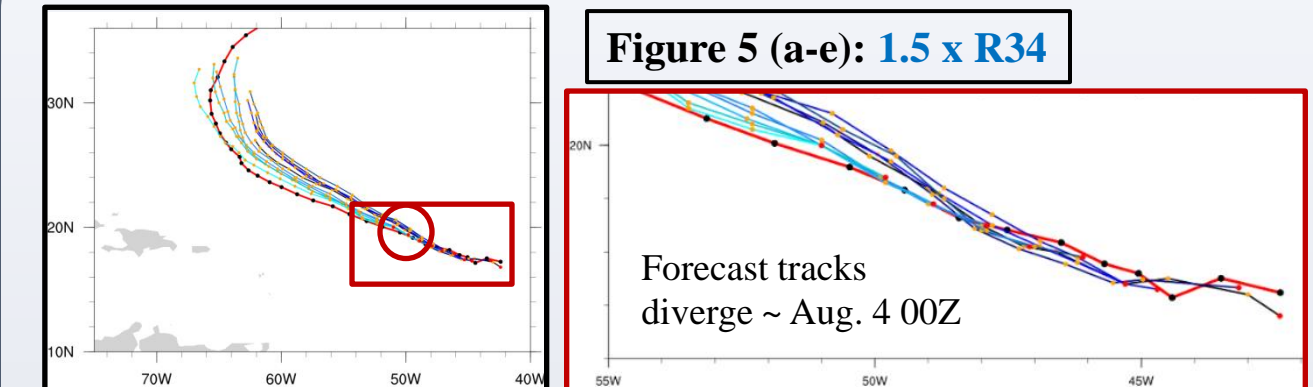
6 Hourly Results

Figure 4. Average track (left), minimum SLP (middle), and maximum surface wind (right) errors over 17 cycles of all 3 experiments

Further Analysis: Comparison of Flight Paths

Figure 5 (a-e): 1.5 x R34

Forecast tracks diverge ~ Aug. 4 00Z

Truth: Nature Run

Analysis Subtropical ridge more robust and vortex much weaker

48-hour Forecast Weaker vortex embedded within subtropical ridge → Stronger steering

Figure 6 (a-e): 3 x R34

Truth: Nature Run

Analysis Vortex weaker & broader and embedded within subtropical ridge

48-hour Forecast Weaker & broader vortex embedded further within even stronger subtropical ridge

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