Impact of CYGNSS Data on Hurricane Analyses and Forecasts in a Regional OSSE Framework

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OSSE Framework

The regional OSSE (Observing System Simulation Experiment) framework described here was developed at NOAA/AOML and UM/RSMAS and features a high-resolution regional nature run embedded within a lower-resolution global nature run. Simulated observations are generated and provided to a data assimilation scheme which provides analyses for a high-resolution regional forecast model.

Experiments and Results

- Two synthetic CYGNSS datasets generated to span the WRF nature run.
  - "low resolution": ~25km effective footprint... nominal product
  - "high resolution": ~12km effective footprint... experimental product (much greater noise in the retrieval results in many dropped data points after quality control is applied)
- All experiments listed use identical configurations of GSI for data assimilation and HWRF for forecasts.

1) CONTROL: conventional data minus scatterometers
2) PERFECT_UV: CONTROL plus all available high-resolution CYGNSS data points; wind speed and direction are interpolated from WRF nature run and assumed to have zero error
3) PERFECT_SPD: CONTROL plus all available high-resolution CYGNSS data points; only wind speed is interpolated from WRF nature run and assumed to have zero error
4) REAL_SPD: CONTROL plus quality-controlled low-resolution CYGNSS data points; synthetic realistic wind speeds and errors are used
5) REAL_SPD_HI: CONTROL plus quality-controlled high-resolution CYGNSS data points; synthetic realistic wind speeds and errors are used

Analysis of Storm Structure

- Addition of CYGNSS surface wind observations generally improves the CONTROL run (brings it closer to NATURE) in terms of symmetry, peak intensity, central pressure, and wind radii.

- However, due to the nature of GSI, if observation coverage is not symmetric in a TC, the analysis will suffer. This example is from 36 hours after the previous example.

Summary

- Assimilation of CYGNSS data with GSI almost always improves hurricane intensity and track analyses
- Assimilation of CYGNSS data with GSI almost always improves large-scale analyses of wind, pressure, temperature, etc.
- Assimilation of CYGNSS data with GSI almost always improves hurricane analyses in GSI
- GSI analyses are very sensitive to the exact location of the observational data... symmetry and coverage affect the result
- The stronger a storm is in an analysis, the more severely the short-range forecast suffers from vortex spin-down and adjustment
- We have very few samples from one storm, so error statistics are not robust, but provide some guidance

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