

Observing System Simulation Experiment Analysis for Evaluating Impact of Global Hawk Observations

Altug Aksoy^{1,2}, Robert Atlas¹, Lidia Cucurull³

¹NOAA/AOML

²University of Miami/CIMAS

³NOAA/ESRL/GOSA

Contributors: NOAA/AOML OSSE Team & NOAA/ESRL GOSA Group

9 March 2017



Goal

Investigate how the Global Hawk aircraft can be utilized in the most effective manner to:

1. Improve forecasts (global and hurricane)
2. Mitigate potential satellite data gaps

Approach

Conduct Observing System Simulation Experiments (OSSEs) to simulate various observing scenarios and test them in existing data assimilation and modeling systems

OSSEs As Tools for Quantitative Observing Assessment: Value for NOAA

- **Measurability and accountability:** Objective means to evaluate potential impact on forecasts of weather phenomena of concern
- **Cost savings:** Evaluate costly observing platforms before they are physically deployed
- **Design options:** Evaluate tradeoffs in the design and configuration of proposed observing systems (e.g., coverage, resolution, accuracy, and data redundancy)
- **Optimization:** Sampling strategies for current and future observing systems (especially critical for airborne and space-based platforms)

Scientific Method: OSSEs

Based on the idea of utilizing a
“Simulated Atmosphere”

1

Nature Run

2

Simulate
Observations

3

Assimilate
Observations

4

Carry Out
Forecasts

Requires
Development

Where Impact
is Measured

Investigating Potential Global Hawk Impact: Two-Faceted Approach

Data from the Global Hawk UAS could have impact on the Global and Regional models

1. Global

- Targeting based on ensemble transform sensitivity (ETS)
- New automated track generation
- Impact on GFS forecasts

2. Regional/Hurricane

- Targeting based on OSE results
- New simulators for all reconnaissance aircraft platforms
- Impact on HWRF forecasts

Accomplishments: Global Facet

- Ensemble Transform Sensitivity (ETS) technique successfully implemented in an OSSE environment – Science
- Developed an automated flight track algorithm to sample sensitive regions based on ETS – Science & Operations
- Conducted OSSE study for dropwindsondes:
 - Sampling regions of largest ETS sensitivity using flight track algorithm
 - Sampling combination of meteorological features and areas of potential error growth

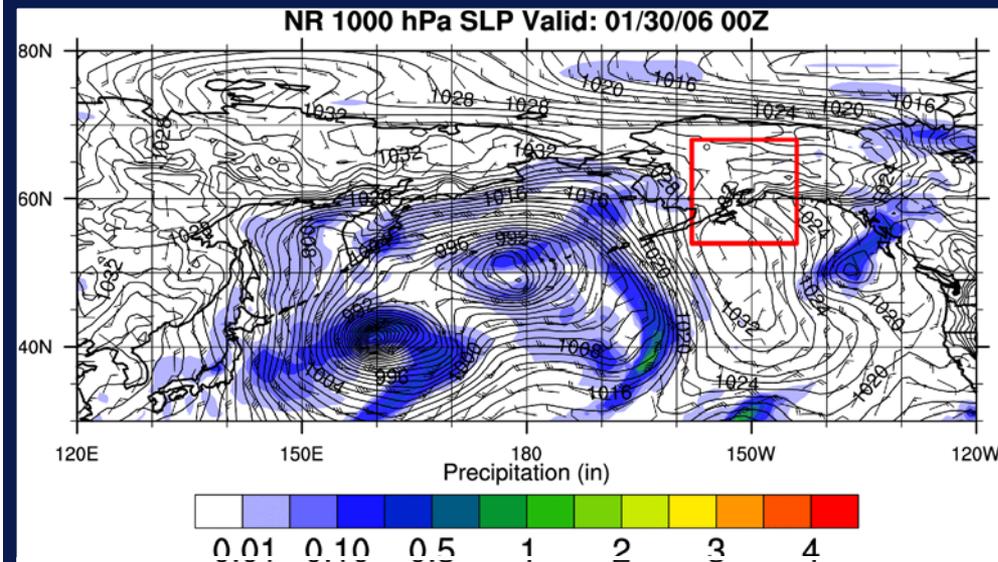
Accomplishments: Regional/Hurricane Facet

- Adapted operational flight track software for use in OSSEs – Science
- Developed simulation capability for the full suite of reconnaissance aircraft platforms – Science
- Conducted OSSE study for dropwindsondes:
 - Sampling strategy to target the hurricane inner core versus the near environment
 - Impact of Global Hawk observations in the presence of data from other reconnaissance aircraft

1. GLOBAL OSSE: IMPACT OF GLOBAL HAWK DROPWINDSONDES

(Contributed by NOAA/ESRL/GOSA)

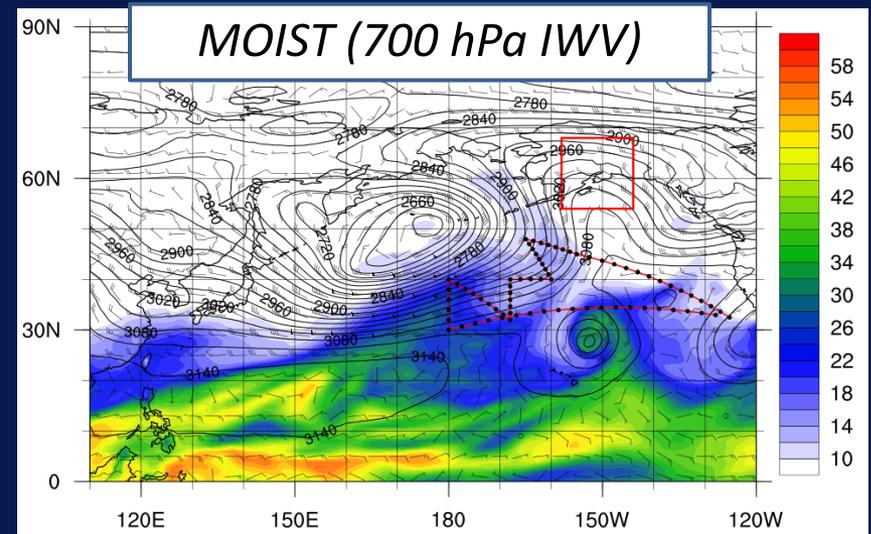
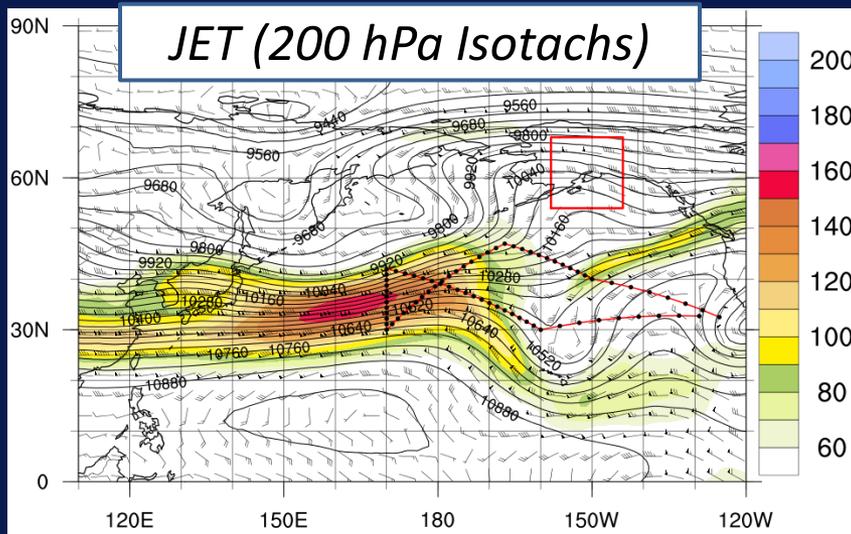
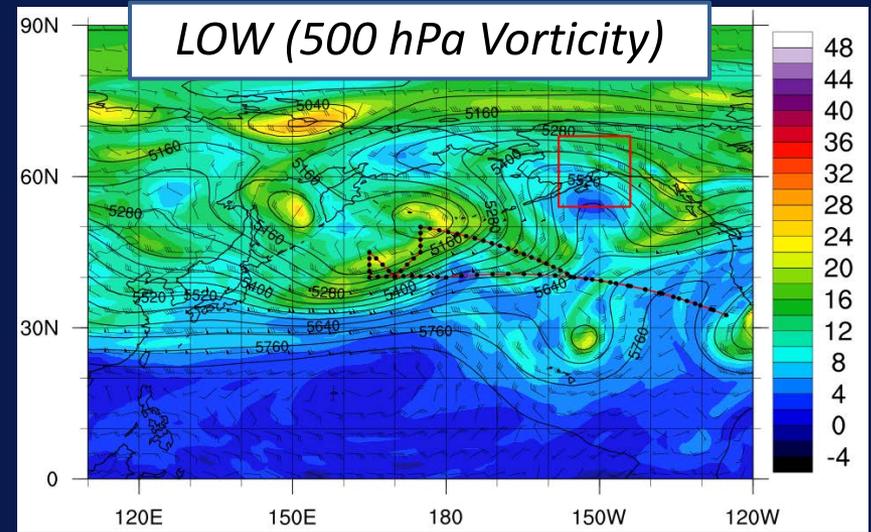
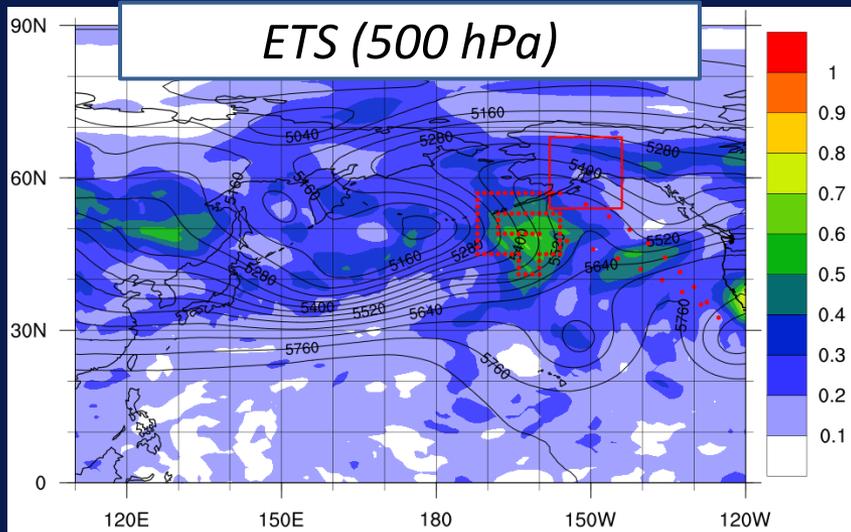
Global OSSE Experiment Design



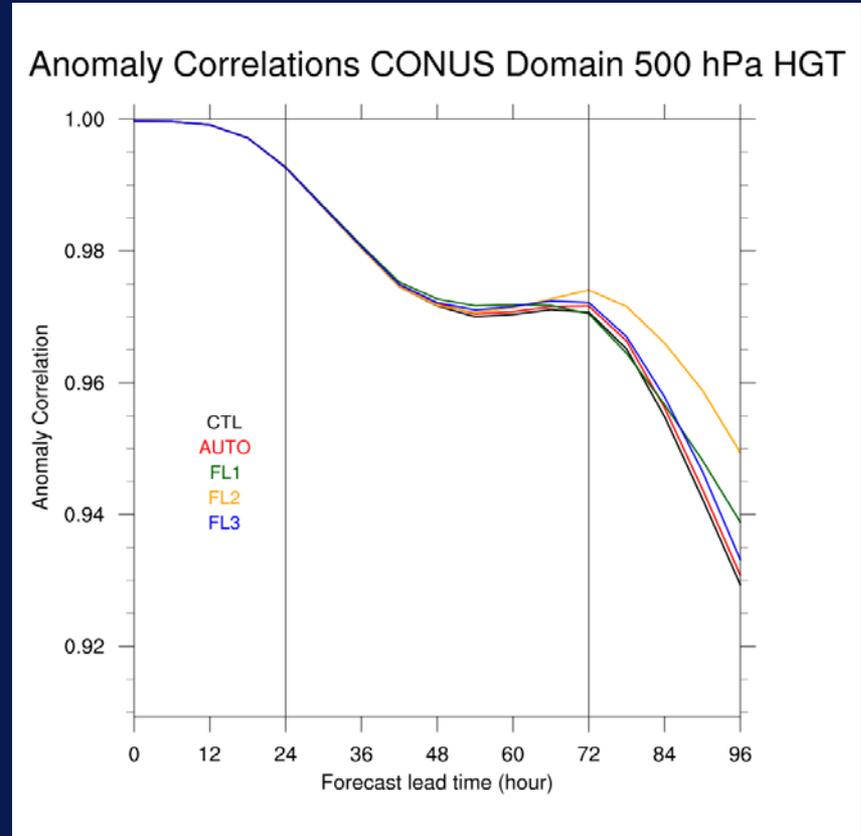
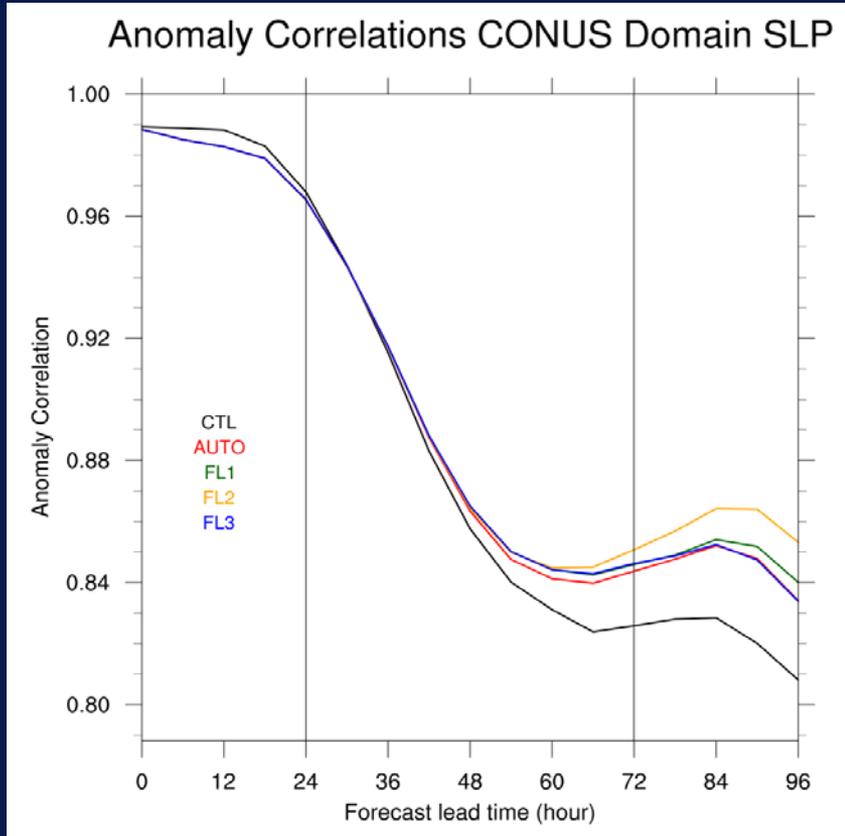
- Simulated February Alaska storm
- Cycling GFS 2-3 days in advance of verification time (00Z 2 Feb)
- *ETS* Experiment: Based on average 2-3 day ETS sensitivity
- Simulated 70-80 dropwindsondes

Experiment Name	Description
<i>CTL</i>	Operational obs. only
<i>ETS</i>	Automated ETS flight path design
<i>LOW</i>	Sample rapidly developing Low-pressure
<i>JET</i>	Sample jet exit region
<i>MOIST</i>	Sample Atmospheric river

Simulated Flight Tracks



Impact on Forecast Skill



Simulated dropsondes increase forecast skill for all flight tracks

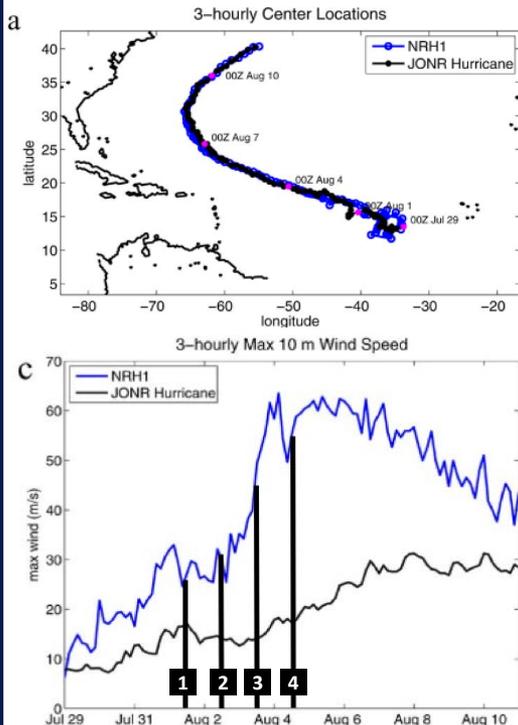
2. REGIONAL/HURRICANE OSSE: IMPACT OF GLOBAL HAWK DROPWINDSONDES

(Contributed by NOAA/AOML/HRD)

Regional/Hurricane OSSE Experiment Design

Nature Run:

Nolan et al. (2015) – Winner of AMS Banner I. Miller Award (2016)

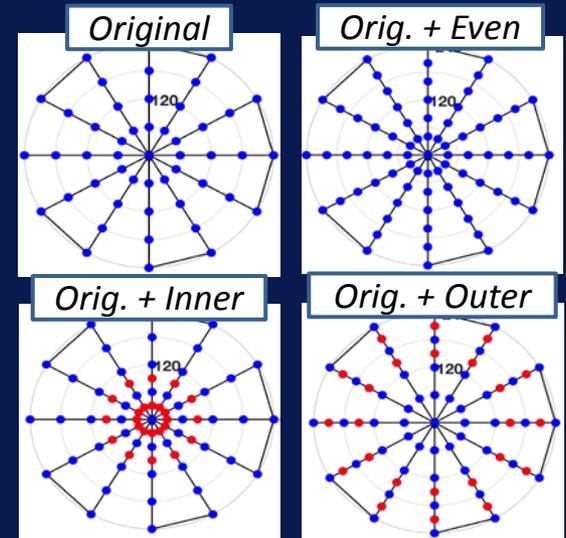


Selected Cases:

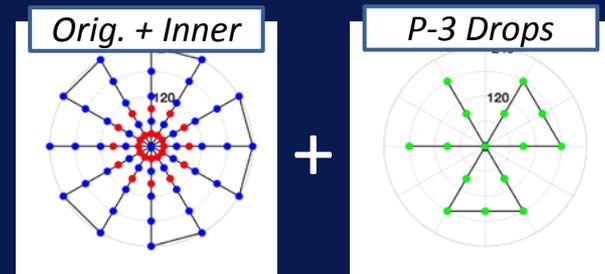
1. Trop. Dep.
2. Trop. Storm
3. Rapidly Intens. Hurricane
4. Major Hurricane

Experiment Setup:

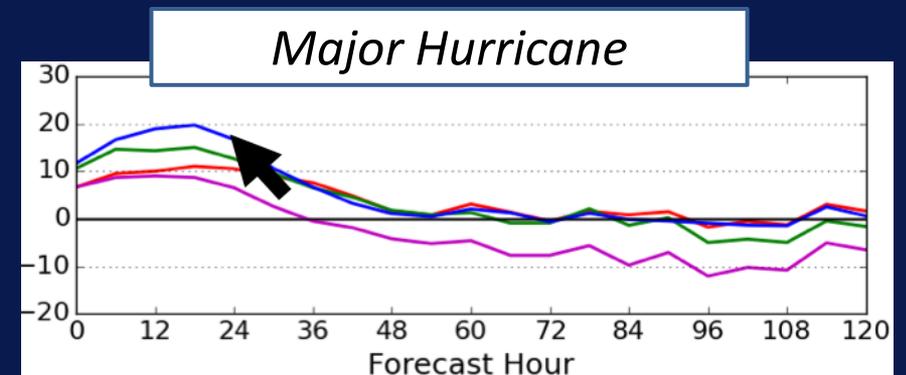
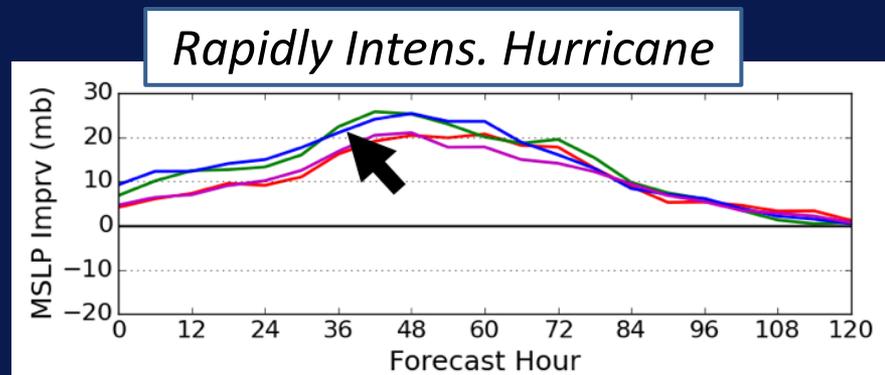
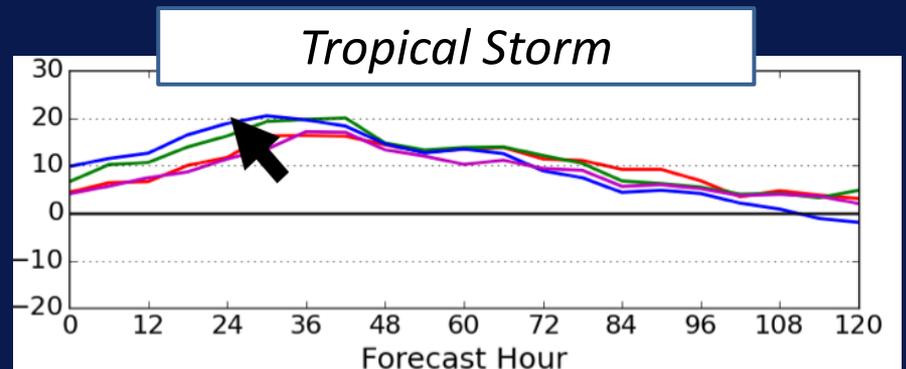
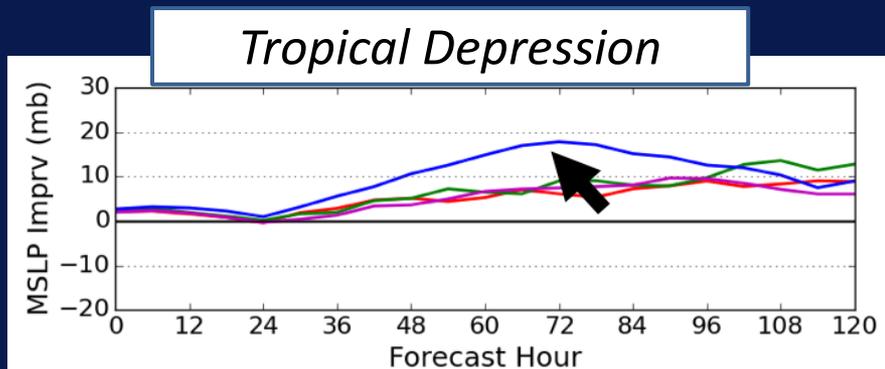
Global Hawk Only



Global Hawk + NOAA P-3

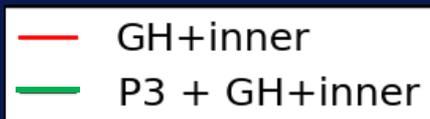
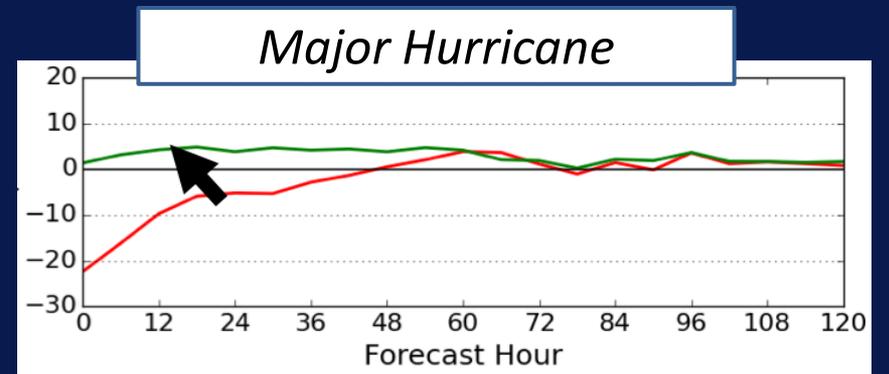
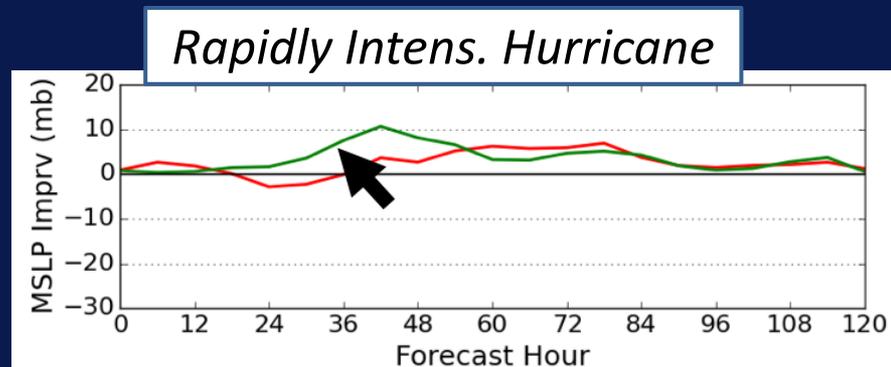
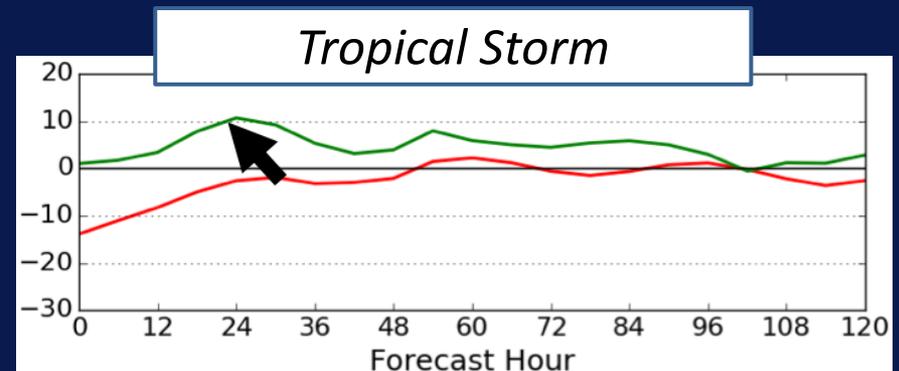
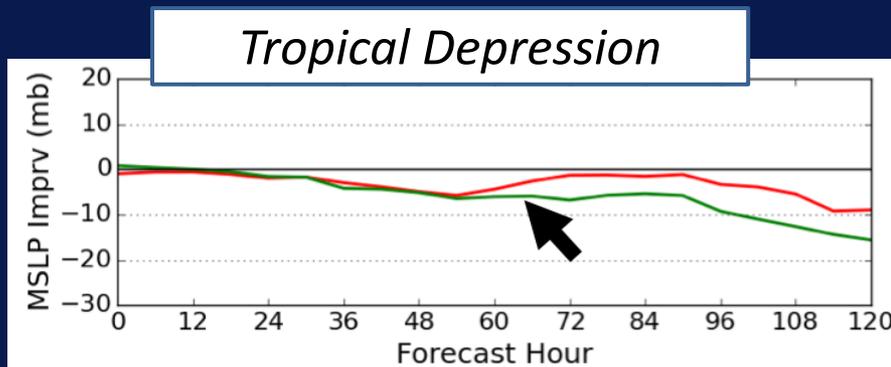


Impact on Forecast Error (Global Hawk Only)



All Global Hawk patterns improve forecasts,
but Orig. + Inner improves the most

Impact on Forecast Error (Global Hawk + NOAA P-3)



Adding GH Inner to P-3 outperforms both P-3 alone and GH Original

Summary

- Significant progress has been made to set up OSSEs to understand and improve impact from Global Hawk observations
- Global model:
 - Ensemble Transform Sensitivity technique successfully implemented
 - Automated flight track algorithm developed
 - All types of flight tracks generated improved global forecasts for a February winter storm case
- Regional/Hurricane model:
 - Operational flight track software successfully adapted
 - Simulation capability for full suite of reconnaissance observations developed
 - Tests indicate GH dropwindsondes to be more valuable in the inner core
 - Adding Global Hawk dropwindsondes to NOAA P-3 observations improves hurricane forecasts

Ramifications and Future Directions

- Global Hawk OSSEs demonstrate the value of dropwindsondes in both global and regional/hurricane applications
- Positive impact is persistent even when data from other reconnaissance aircraft are available
- Preliminary tests demonstrate that where in a hurricane GH dropwindsondes are released impacts forecasts significantly
- OSSE results highlight the value of a sustained GH field program both for winter storms and hurricanes
- Future work could ensure running extensive systematic OSSEs to better optimize GH sampling strategies
- Future work could also enable extending OSSE tests to other GH instruments (HAMSR, HIRAD, HIWRAP, SHIS)