



# Observation Sensitivity Experiments (OSEs) at ESRL



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**NOAA overarching research question 4: What improvements to observing systems...will allow us to better analyze and predict the atmosphere...?**

## Why perform OSEs?

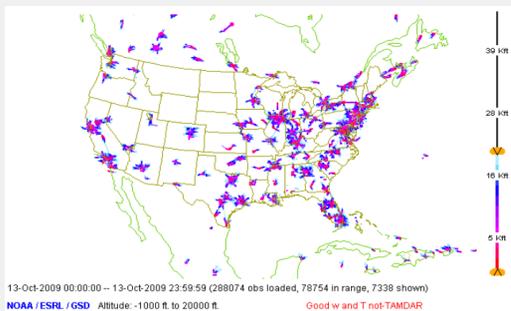
- The government is being asked to purchase or deploy new observational data systems.
- Will these systems improve relevant forecasts? **Where should NOAA invest its resources?**
- **ESRL is helping NOAA make these decisions.**

## We use the RUC model. Why?

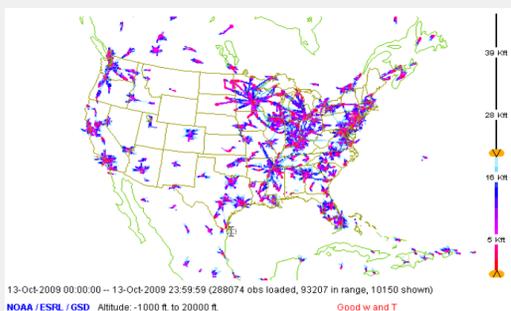
- It is a NOAA operational model
- Has been used for previous OSEs (wind profiler, AMDAR, GPS precipitable water)
- It ingests most currently available data, so new data are tested in a **realistic context**

## Example 1: TAMDAR

- A system that measures wind, temperature, **relative humidity (not often measured in-situ)** from regional commercial aircraft
- It provides data *between major hubs* already served by major airlines providing weather data
- **Are the data provided by TAMDAR useful enough for the government to purchase?**



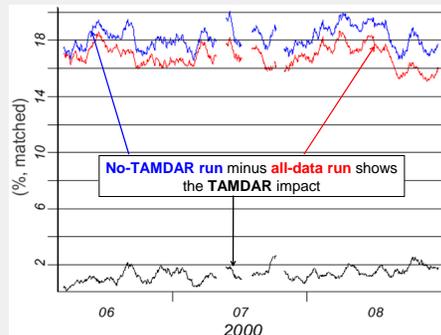
Aircraft observations below 20,000 ft without TAMDAR



Aircraft observations below 20,000 ft are increased with TAMDAR

## Results:

- TAMDAR improves short-term forecasts of relative humidity, temperature and wind in the region\* where TAMDAR flew (\*U.S. Midwest; New TAMDAR fleets now cover most of the Eastern U.S. and some of the West Coast and Alaska.)



TAMDAR reduces errors over a three year period for 3-h relative humidity forecasts.

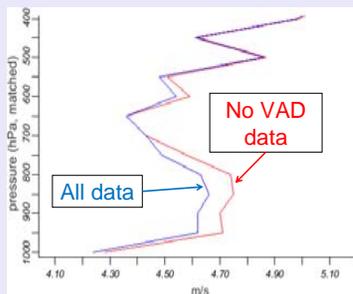
(RMS error difference between RUC and 0000 UTC RAOBs Over the Great Lakes region)

## Example 2: Relative Impact of Data Sources

- Current NWP models assimilate a wide variety of data.
- **Are all these data sources helpful?**
- **In what circumstances are they helpful?**
- We tested the impact of **9 data sources**
- We considered impact over...
  - summer and winter seasons
  - National and Midwest (a particularly data-rich region)
  - Multiple altitude ranges

### Results:

- **ALL current data sources add value to forecasts, in differing situations**



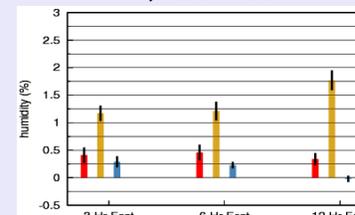
Model RMS error (vs RAOBs) For 3h wind forecasts

Removing any data source (in this case, VAD) increases the forecast error at some altitudes.

## Data Impact on Winter Forecasts

(bar height indicates impact\*)

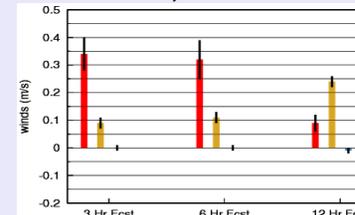
RH, 1000 – 400 mb



RAOBs have the most impact for RH forecasts in the lower atmosphere.

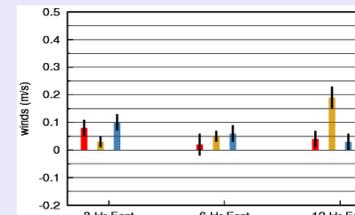


Winds, 400 – 100 mb



Aircraft have the most impact on wind forecasts < 12h at flight levels.

Winds, 1000 – 800 mb



Surface data (primarily METAR) have the most impact on wind forecasts < 12h in the lowest 200 mb of the atmosphere.

(\*Impact: differences in RMS error (vs. RAOBs) between observation denial experiments and control run. Statistical uncertainties are indicated for each observation denial experiment by narrow black lines showing +/- 1 standard error from the mean impact.)

## Impact

- This work justified NOAA's acquiring TAMDAR data as an **operational data source for NWS** — used in NWP models and directly by forecasters, improving short-term weather forecasts
- OSEs showed the forecasts for which each data source adds value, allowing policy-makers to better determine costs and benefits.