



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?

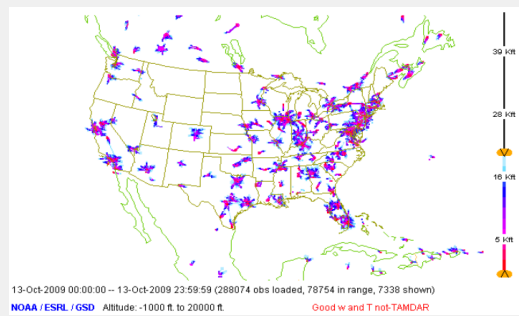
- The government is being asked to purchase or deploy new observational data systems.
- Will these systems improve relevant forecasts? **Where should NOAA invest its resources?**
- **ESRL is helping NOAA make these decisions.**

We use the RUC model. Why?

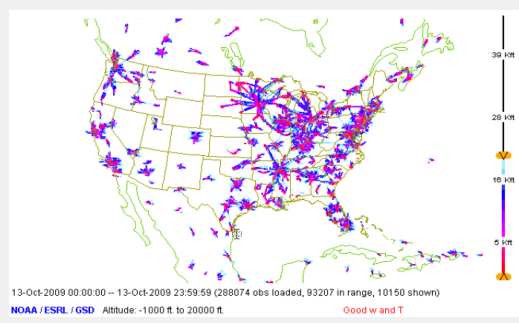
- It is a NOAA operational model
- Has been used for previous OSEs (wind profiler, AMDAR, GPS precipitable water)
- It ingests most currently available data, so new data are tested in a **realistic context**

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?**



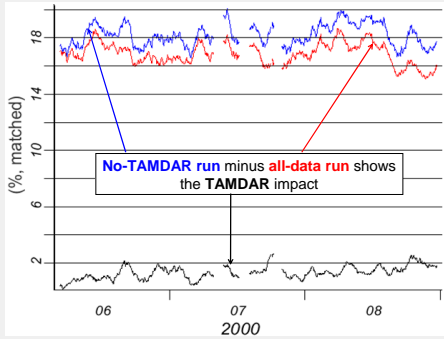
Aircraft observations below 20,000 ft without TAMDAR



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.)

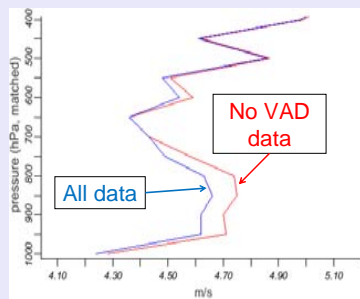


TAMDAR reduces errors over a three year period for 3-h relative humidity forecasts.

(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**



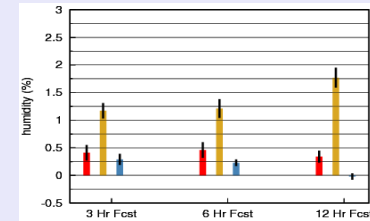
Model RMS error (vs RAOBs) For 3h wind forecasts

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

Data Impact on Winter Forecasts

(bar height indicates impact*)

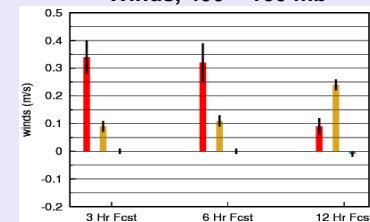
RH, 1000 – 400 mb



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

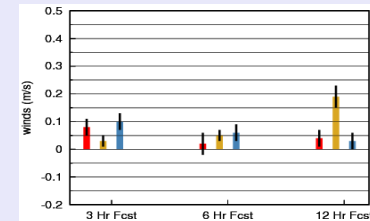


Winds, 400 – 100 mb



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.