P3.16 DATA ASSIMILATION AND REGIONAL FORECASTS USING ATMOSPHERIC INFRARED SOUNDER (AIRS) PROFILES

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1. MOTIVATION

- Improve regional weather forecasts using AIRS thermodynamic profiles

2. USE OF AIRS PROFILES

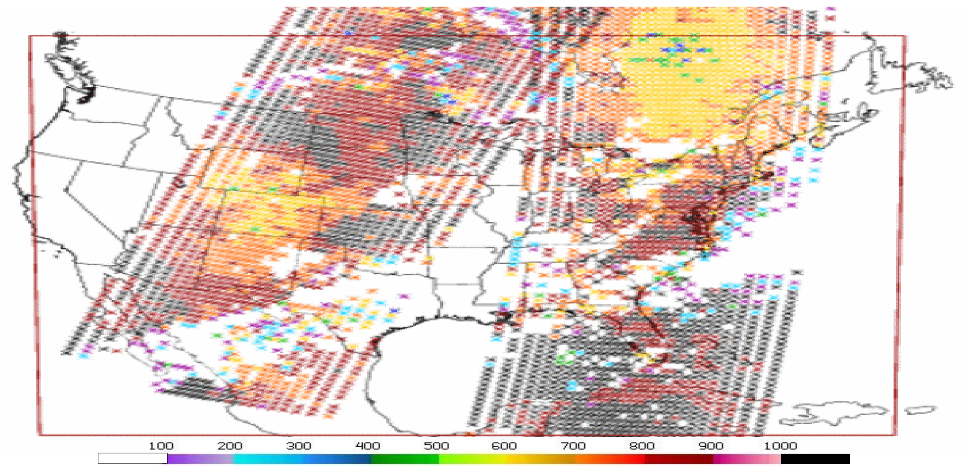

Fig. 1. Three-dimensional distribution of AIRS profile data assimilated at 0800 UTC on 17 January 2007. The red rectangle denotes the bounds of the WRF domain.

- Version 5 L2 temperature and moisture profiles over land and water
- Level-dependent quality indicators (QIs) determine maximum pressure level above which quality data should be assimilated (colored points in Fig. 1)
- Separate observation errors are used for the land and water soundings
  - Land: from Tobin et al. (2006)
  - Water: from AIRS instrument specs

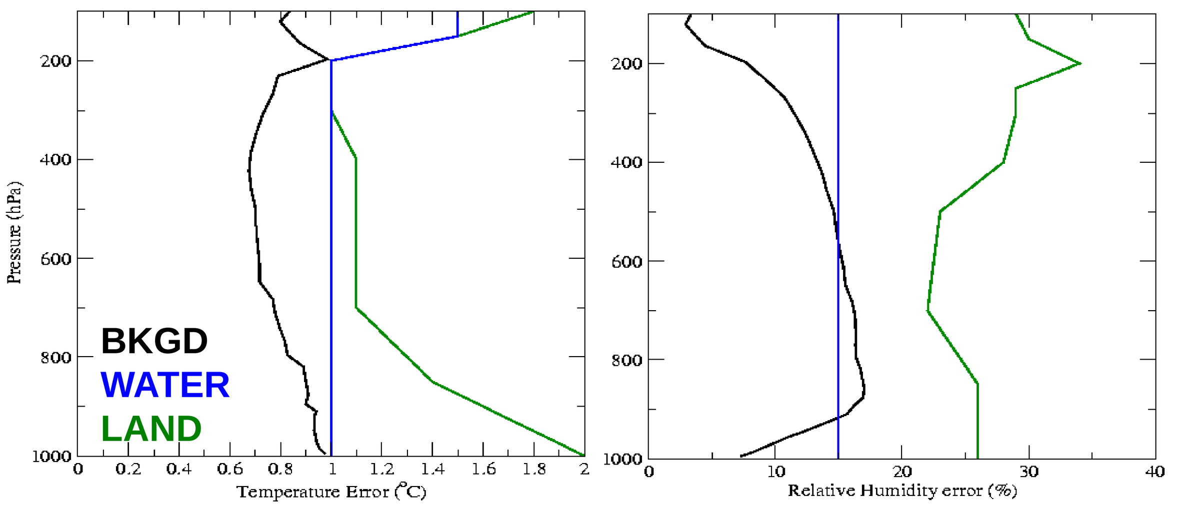

Fig. 2. Background (black line) and observation (blue: AIRS water, green: AIRS land) errors for WRF-Var analysis. It is the ratio of the background errors that controls the magnitude of the analysis increment during the assimilation process.

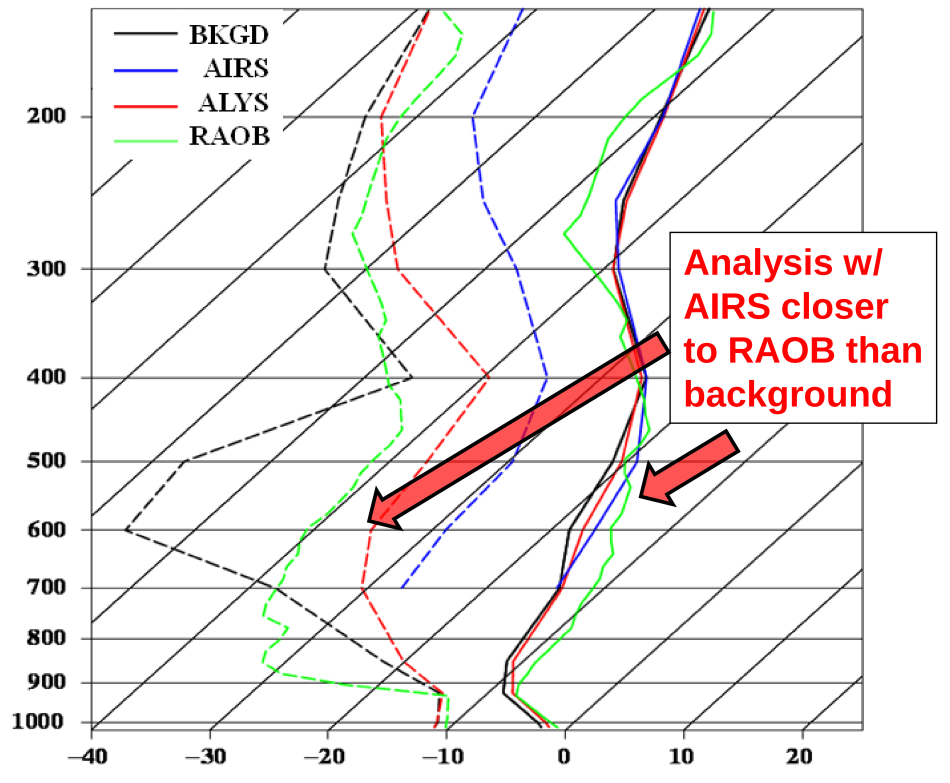

Fig. 3. Profiles of temperature (solid) and dew point (dashed) near Wallops Island, VA (WAL) for 0800 UTC 17 January 2007. The background (black) and WRF-Var (red) profiles are for the nearest grid point. The AIRS profile (blue) is for the highest-quality retrieval closest to the grid point. The radiosonde (green) is a linear interpolation of the 0000 and 1200 UTC soundings to 0800 UTC.

3. ANALYSIS/FORECAST MODEL

- WRF-ARW initialized at each day at 00 UTC using 40-km NAM
- 7-9h WRF forecast used as first-guess for WRF-Var; AIRS profiles assimilated at observation time
- ***B*** matrix generated using NMC Method using control WRF forecasts
- Observation (diagonal terms only) and background errors shown in Fig. 2

4. ANALYSIS IMPACT

- RAOB is linear interpolation of 00 and 12 UTC RAOB to 08 UTC
- BKGD, ALYS closest grid point to WAL
- AIRS closest AIRS profile to WAL
- Addition of AIRS produces analysis more comparable to probable radiosonde than background for mid- and lower troposphere temperature and dew point (Fig. 3)

5. FORECAST IMPACT: 37-DAY CASE STUDY (17 JANUARY TO 22 FEBRUARY 2007)

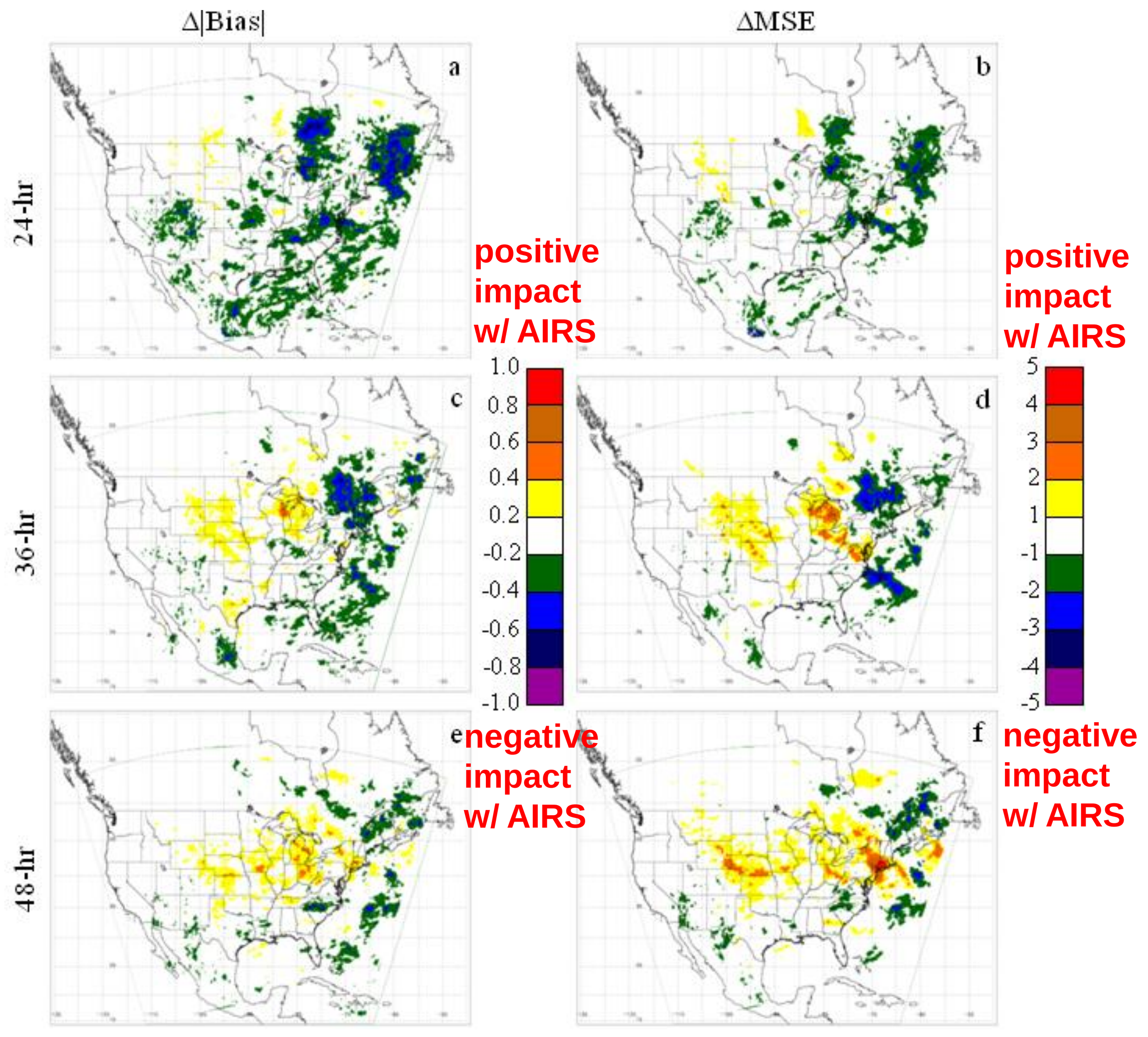

Fig. 4. 700 hPa temperature absolute bias difference (°C; left column) and mean squared error differences (°C²; right column) between AIRS and CNTL forecasts verified against corresponding NAM analyses for entire case study period for a) and b) 24-hr forecasts, c) and d) 36-hr forecasts, and e) and f) 48-hr forecasts.

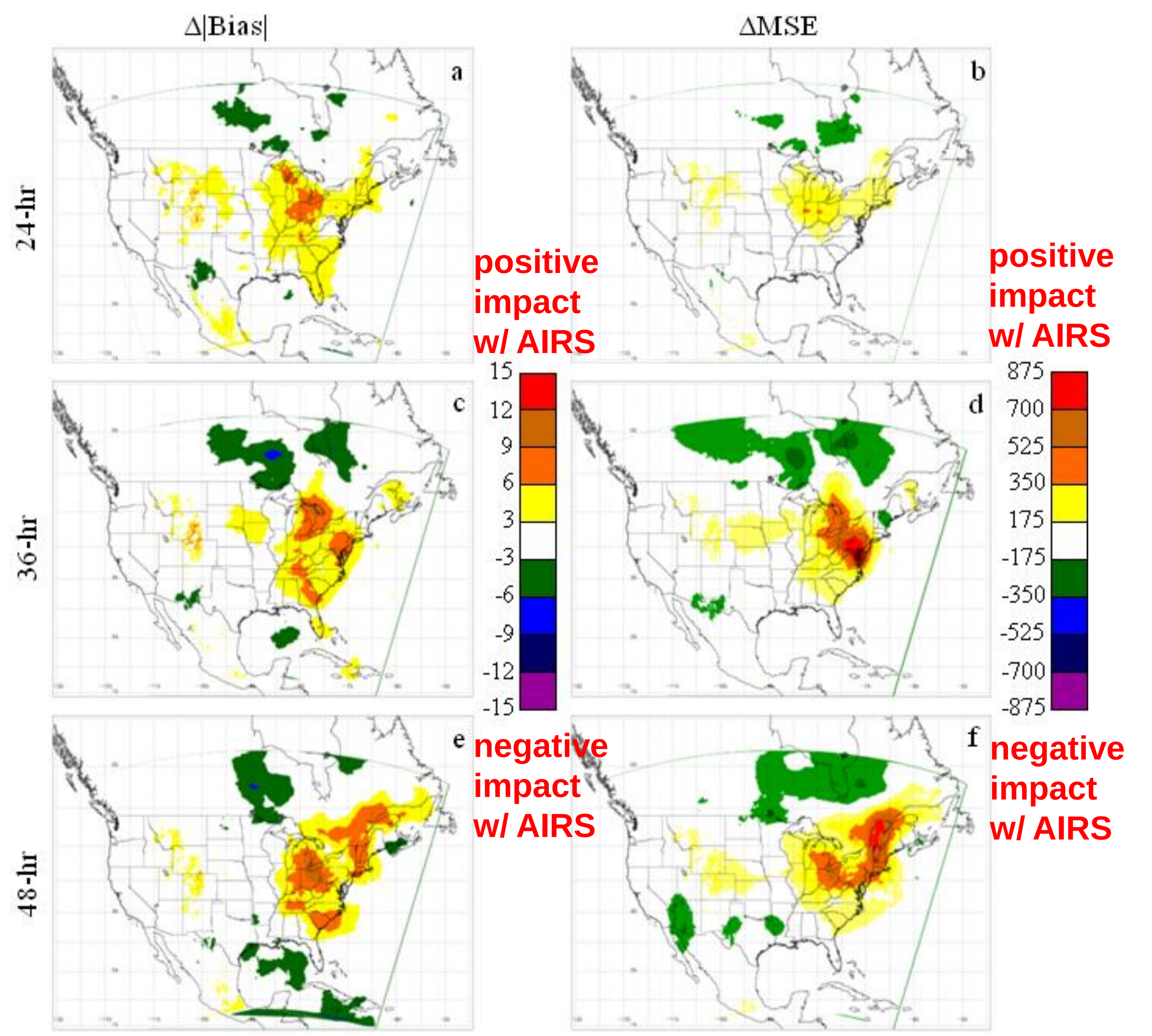

Fig. 5. 500 hPa geopotential height absolute bias difference (°C; left column) and mean squared error differences (°C²; right column) between AIRS and CNTL forecasts verified against corresponding NAM analyses for entire case study period for a) and b) 24-hr, c) and d) 36-hr, and e) and f) 48-hr forecasts

Fig. 6. Statistics for all forecasts in 37 day case study period verified against NAM analyses for grid points east of 105°W for temperature a) bias (°C) and b) RMSE and geopotential height c) bias (m) and RMSE (m).

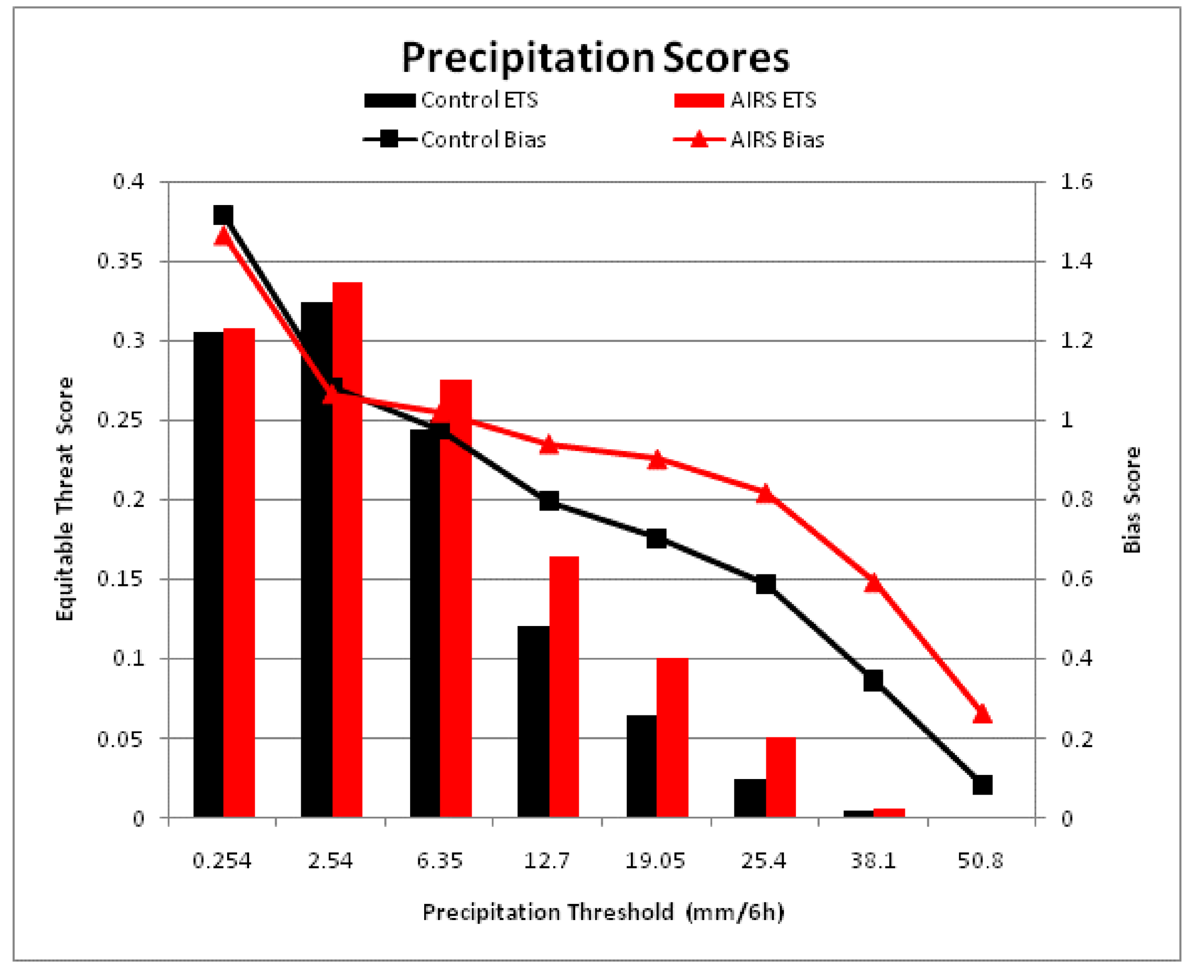

Fig. 7. Equitable Threat Score (ETS; bars, left axis) and Bias Score (lines, right axis) for 6-h cumulative precipitation for all forecasts during case study period verified against NCEP Stage IV precipitation data for grid points east of 105°W.

Temperature Results:

- CNTL too cool in lower troposphere and too warm in upper troposphere
- AIRS reduces bias by warming lower levels and cooling upper levels (Fig. 6a)
- RMSE is slightly degraded over entire profile (Fig. 6b)
- Temperature forecasts are degraded at early forecast hours but later forecast hours show broad area of improved forecasts across the Great Lakes (Fig. 4)

Geopotential Height Results:

- CNTL heights too low in the mid- and upper-troposphere but close to zero bias near surface
- AIRS raises heights at all levels degrading bias near surface but improving aloft (Fig. 6c)
- RMSE improved aloft but degraded near surface (Fig 6d)
- Overall, height forecasts show broad area of improved forecasts across the Great Lakes at all forecast times with larger area coverage and magnitude of improvement at later forecast times (Fig. 5)

6-h Cumulative Precipitation Bias Score Results:

- Bias score > 1 means over forecasting; bias score < 1 means under forcasting
- ETS takes into account forecast hits and misses and give some degree of certainty above random results
- Inclusion of AIRS improves ETS and bias scores at all precipitation thresholds (Fig. 7)

6. CONCLUSIONS/FUTURE WORK

- Prudent assimilation of AIRS thermodynamic profiles and quality indicators can improve initial conditions for regional weather models
- In general, AIRS-enhanced analysis more closely resembles radiosondes; forecasts with AIRS profiles are generally closer to NAM analyses than CNTL for sensible weather parameters
- "Apples-to-apples" comparison of AIRS profiles and radiances; similar work with IASI and eventually CrIS