P.88 REGIONAL PRECIPITAION FORECAST WITH ATMOSPHERIC INFRARED SOUNDER (AIRS) PROFILES

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1. MOTIVATION

- **To improve precipitation forecasts using AIRS temperature and moisture profiles**

2. USE OF AIRS PROFILES

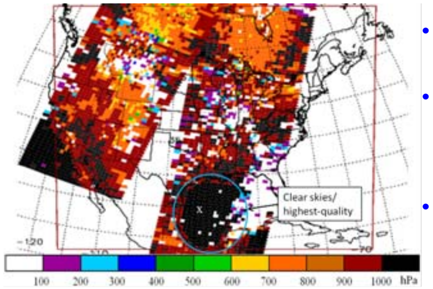

Fig. 1. Quality indicators for AIRS profiles assimilated at 0900 UTC on 12 February 2007. The black points represent the highest quality data, and each colored box denotes the pressure level above which there are quality data. The red rectangle denotes the bounds of the WRF model domain. The "X" denotes the location of the sounding comparison shown in Fig. 5.

- **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 (Fig. 2)**
  - **Land: from Tobin et al. (2006)**
  - **Water: from AIRS instrument specs**

3. ANALYSIS/FORECAST MODEL

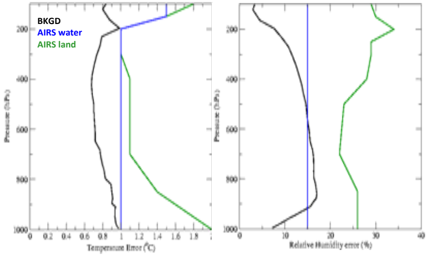

Fig. 2. Background (black line) and observation (blue: AIRS water, green: AIRS land) errors for WRF-Var analysis. It is the ratio of the background vs. observation errors that controls the magnitude of the analysis increment during the assimilation process.

- **12-km resolution, 450 x 360 horizontal grid; 50 vertical levels topped at 50 hPa**
- **ARW initialized at 0000 UTC each day using 40-km NAM**
- **6-8 h ARW forecast used as first-guess for WRF-Var; AIRS profiles assimilated at observation time**
- ***B* matrix generated using NMC Method using 37 control WRF forecasts (Fig. 2).**

4. OVERALL FORECAST IMPACT ON 6-h ACCUMULATED PRECIPITATION

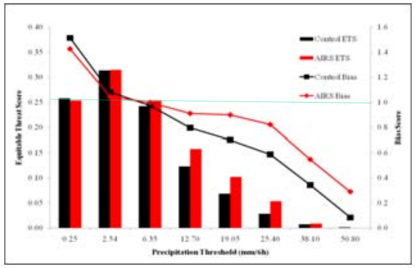

Fig. 3. Six-hourly accumulated precipitation statistics for the 37-day case study period combining all 6-hourly forecasts from 18 to 48 hours. The bars represent equitable threat scores (left axis) and the lines represent bias scores (right axis). White bar and dashed line are for the CNTL runs; black bar and solid line are for the AIRS runs.

Average over 37 forecasts: 17 January – 22 February, 2007 (Fig. 3):

- **Bias score > 1 means over forecasting; bias score < 1 means under forecasting**
- **ETS takes into account forecast hits and misses and indicates how well the forecasted rainfall region matches the observed region (ETS=1 is perfect match).**
- **Inclusion of AIRS improves ETS and bias scores at most precipitation thresholds**

5. CASE STUDY OF 12-13 FEBRUARY 2007 SEVERE WEATHER OUTBREAK

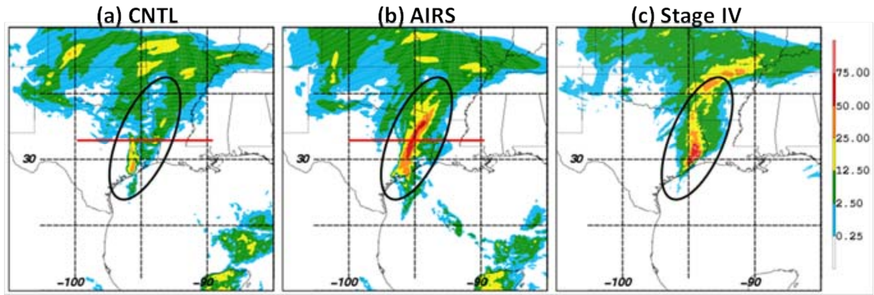

Fig. 4. The 6-h accumulated precipitation valid at 0000 UTC 13 February 2007. The red lines represent the cross-sections shown in Fig. 7. Note the CNTL under-forecasts the 6-h precipitation, while A IRS produces precipitation closer to observed amount and location.

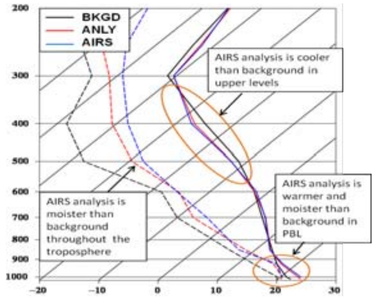

Fig. 5. Temperature and moisture sounding profiles at (24ºN; 94ºW; marked X in Fig.1) at 0900 UTC 12 February 2007. Black lines represent the background, red lines represent the WRF-Var analysis, and blue lines represent the AIRS profile data. Black lines are for temperature and gray lines dew point temperature.

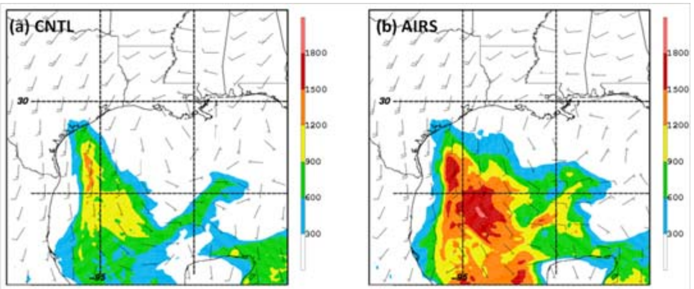

Fig. 6. Spatial distribution of convective available potential energy (CAPE; shaded) at 0900 UTC 12 February 2007 for the (a) CNTL and (b) AIRS runs. The 850 hPa wind barbs (m s^{-1}) indicate the prevailing southern flow.

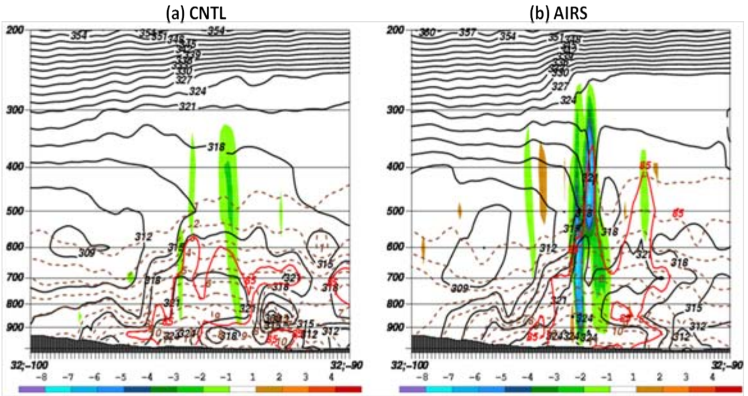

Fig. 7. Vertical cross-section of vertical velocity (hPa s^{-1}; color shaded), equivalent potential temperature (ºC; black contour), mixing ratio (g kg^{-1}; brown contour), and 85% RH contour (red contour) along 32ºN between 100ºW and 90ºW (straight line in Fig. 6) at 0000 UTC 13 February 2007 for the (a) CNTL and (b) AIRS runs.

- **Severe weather occurred on 12-13 February with reports of heavy rain, hail in Eastern Texas and tornados in Southern Louisiana and Mississippi.**
- **Clear skies ahead of the front and over the Gulf of Mexico on 12 February allow for high-quality AIRS data to be assimilated (Fig. 1)**
- **The CNTL run under-forecast the 6-h accumulated precipitation, while the AIRS run increases the intensity of the rainfall and is better match to the Stage IV precipitation (Fig. 4).**
- **Sounding from Western Gulf of Mexico shows a more unstable PBL and more tropospheric moisture when AIRS profiles are assimilated (Fig. 5)**
- **AIRS analysis also produces higher CAPE over the Gulf, compared to the CNTL analysis (Fig. 6).**
- **AIRS forecast produces vertical velocity, low-level moisture, and moist instability that are more conducive for convective activities than the CNTL forecast (Fig. 7).**

6. CONCLUSIONS

- **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 than the CNTL; forecasts with AIRS profiles are generally closer to NAM analyses than CNTL for sensible weather parameters (not shown here).**
- **Assimilation of AIRS leads to an overall QPF improvement in 6-h accumulated precipitation forecasts.**
- **Including AIRS profiles in assimilation process enhances the low-level instability and produces stronger updrafts and a better precipitation forecast than the CNTL run.**