Evaluating the Impact of Atmospheric Infrared Sounder (AIRS) Data on Convective Forecasts

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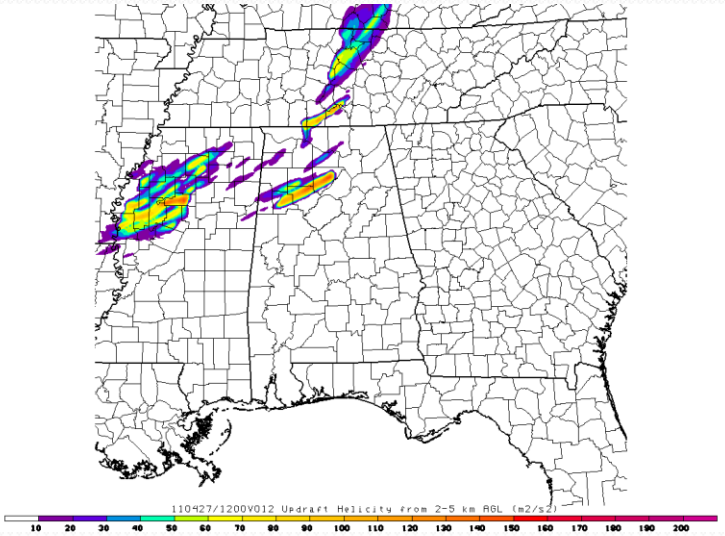
Background

- Motivation
  - Forecasting convective weather is a challenge for operational forecasters
  - Current numerical weather models may struggle to properly forecast location, timing, intensity, and/or mode of convection
- SPoRT is attempting to improve convective forecasts by creating a real-time modeling system called the SPoRT-WRF that adds unique NASA data and capabilities
- Goal of this project is to determine impact of AIRS profiles on SPoRT-WRF forecasts by comparing to NSSL WRF and SPoRT-WRF with no AIRS
- Evaluation period: April 25-27, 2011 Tornado Outbreak
  - Over 450 tornadoes and 300 fatalities occurred over this three day outbreak across 24 states

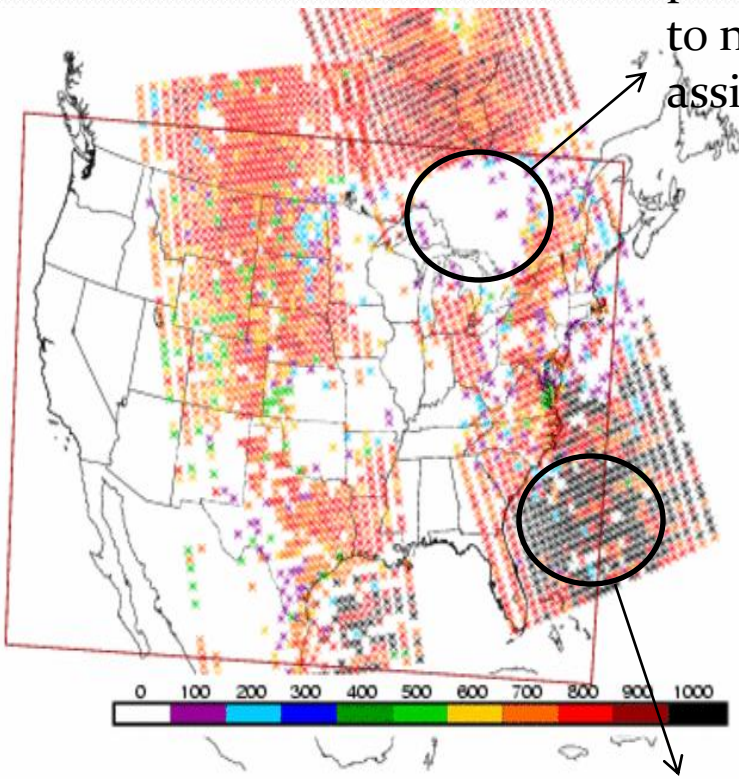
SPoRT WRF Model

- Desktop supercomputing systems acquired from NASA HQ enable SPoRT to perform more rigorous modeling projects
- SPoRT-WRF merges SPoRT DA and modeling projects into one real-time system for testbed evaluation by operational forecasters
  - Identical configuration to National Severe Storms Laboratory WRF used by SPC
    - NASA data sets address forecast challenges of convection in NWP models
    - daily 1-km SPoRT SST composite product
    - daily 1-km LIS surface characterization
    - daily 1-km MODIS GVF composite product
    - AIRS retrieved thermodynamic profiles
- Evaluated at this year's Hazardous Weather Testbed Spring Experiment
  - Tendency to under-forecast convection
  - Cooled and dried lower levels
- Version 2 development under way
  - Improved GVF product
  - Cycling assimilation methodology using GSI to bring in more satellite and conventional observations and remove start/stop of model forecast

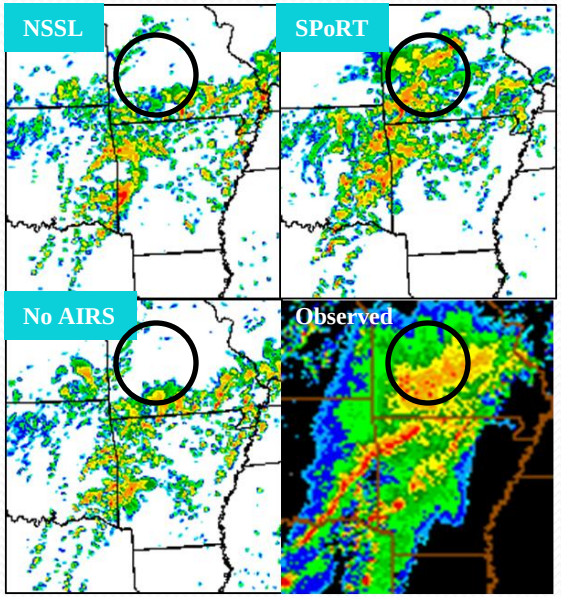


Atmospheric Infrared Sounder (AIRS)

- Hyperspectral sounder aboard NASA's Aqua polar orbiting satellite
- Provides temperature and moisture profiles of the atmosphere, in clear and party cloudy scenes
- Quality indicator, P_{best}, approximates cloud level and selects the most favorable data from each profile for assimilation

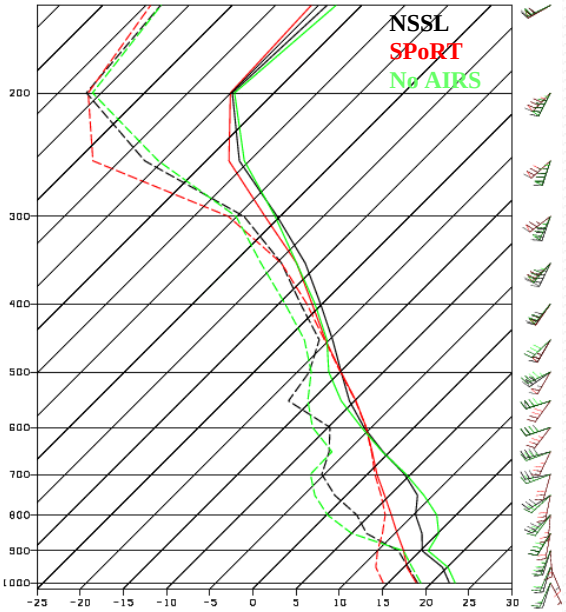


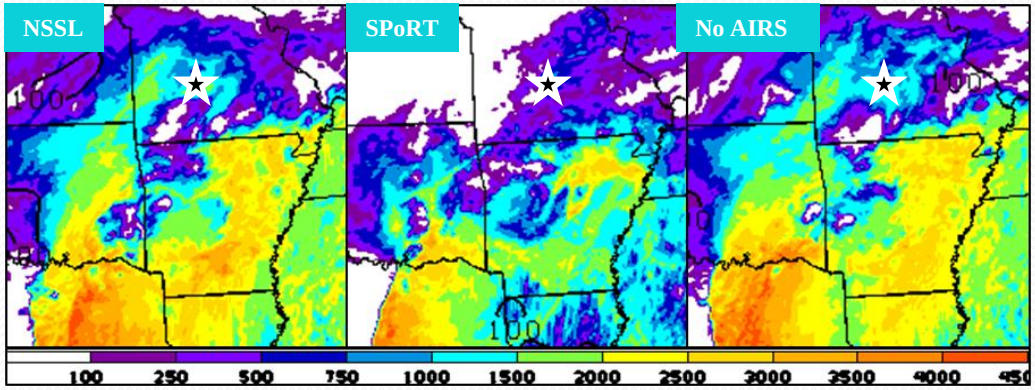
25 April 2011



Figures for 21-h forecast valid at 21 UTC on 25 April

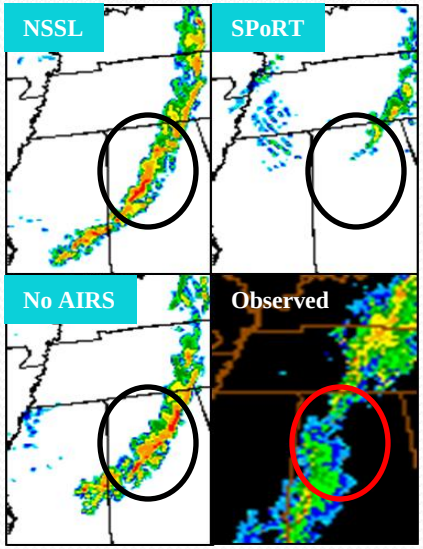
- NSSL and No AIRS produce convective structures but no distinct squall line as is seen in the observed reflectivity
- SPoRT WRF has a cooler more moist sounding resulting in the production of the heavy rain over southern Missouri





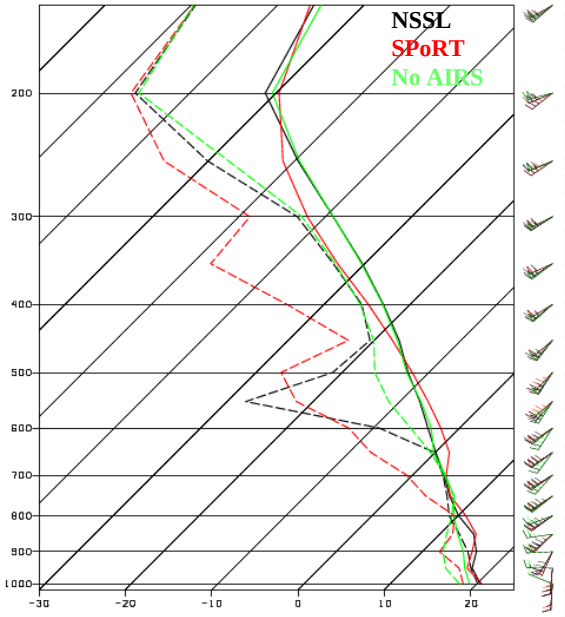
- NSSL and No AIRS forecasts have more CAPE, which one would expect to produce more model reflectivity than SPoRT-WRF with lower CAPE

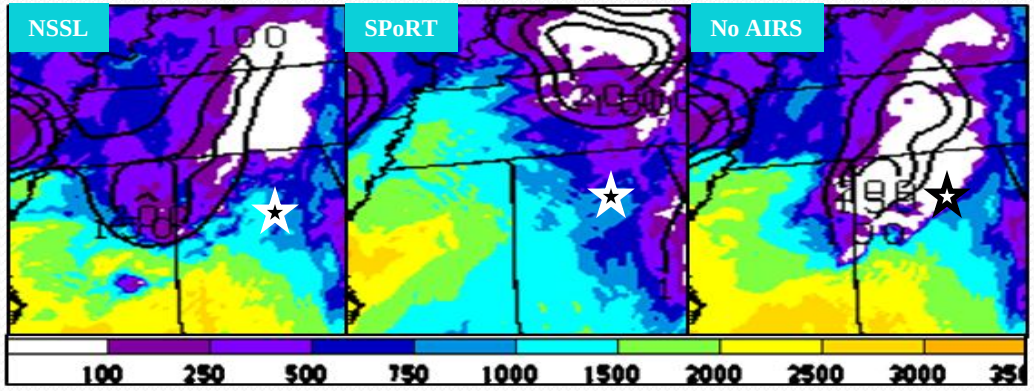
26 April 2011



Figures for 15-h forecast valid at 15 UTC on 26 April

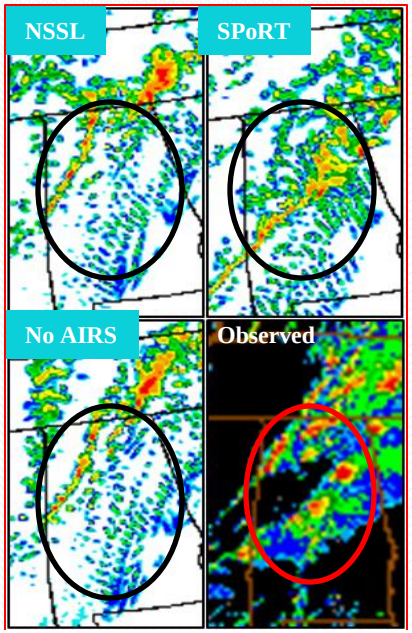
- Late evening and early morning convection is handled well by all three models until 1500 UTC
- From 1500 UTC onward, all three models poorly forecast the precipitation location and intensity
- SPoRT-WRF has the driest sounding which would reduce convection





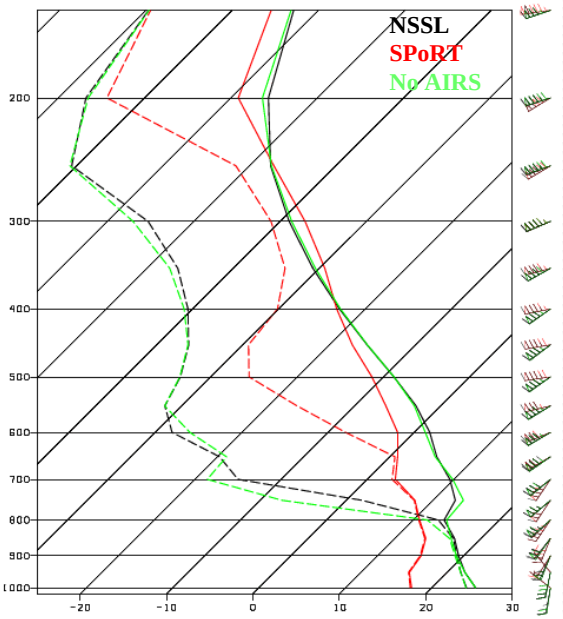
- NSSL and No AIRS have near 2500 J/kg CAPE with little convective inhibition (CIN), which likely helps form a large convective line of storms across Alabama

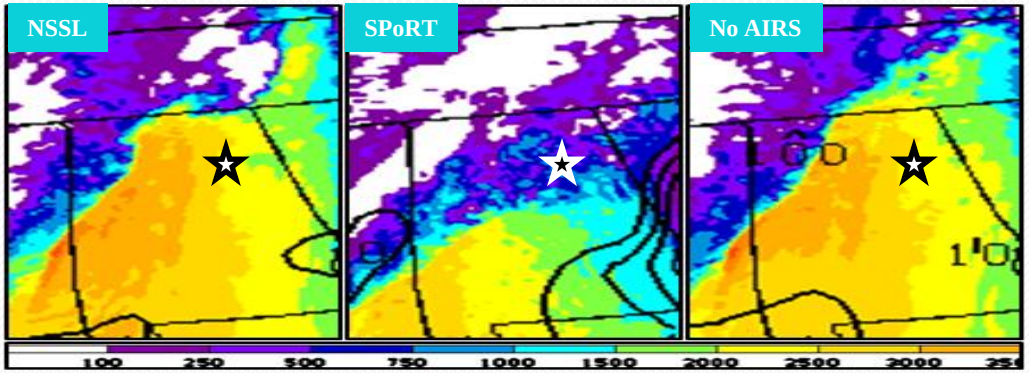
27 April 2011



Figures for 24-h forecast valid at 00 UTC on 28 April

- All three models predict a significant severe weather outbreak, but none forecast the location and track of exact super cells
- SPoRT-WRF too fast with frontal passage
- NSSL and No AIRS have better cold front location but still a bit too fast





- CAPE gradient represents location of cold front
- Cold front verified in sounding wind field, SPoRT winds out of the northwest

Conclusions

- Assimilation of AIRS thermodynamic profiles into the SPoRT-WRF does impact convective forecasts, but with mixed results
  - Increased precipitation in 25 April case
  - Decreased convection in 26 April case
  - Frontal speed in 27 April case
- Performing a 3-day case study did not show enough evidence to determine which model handles severe weather forecasting the best
- Additional analysis is needed in order to demonstrate what changes at the assimilation time show up in the forecasts at later times to determine whether AIRS data has a positive or negative impact on convective forecasts