

# Regional Data Assimilation and Modeling Activities with Hyperspectral Sounder Profiles at the SPoRT Center: Current Results and Future Plans

Bradley Zavodsky (SPoRT/MSFC)

Gary Jedlovec (SPoRT/MSFC)

Shih-Hung Chou (SPoRT/MSFC)

Matthew Rigney (SPoRT/UAHuntsville)

NASA Sounder Science Team Meeting

Greenbelt, Maryland

3 November 2010



transitioning unique NASA data and research technologies to operations



# Outline

- Brief SPoRT overview
- Summary of final AIRS profile assimilation results
  - Precipitation and vertical structure
  - Journal article submitted to Weather and Forecasting
- SPoRT's upcoming plans for hyperspectral sounder assimilation
  - Transition of research to operations
  - Future research
- SPoRT's new "Weather in a Box"
  - What it is and its role in future SPoRT activities
- ROSES10 Proposal Activity
  - Use AIRS profiles to better understand limitations of AIRS radiance assimilation



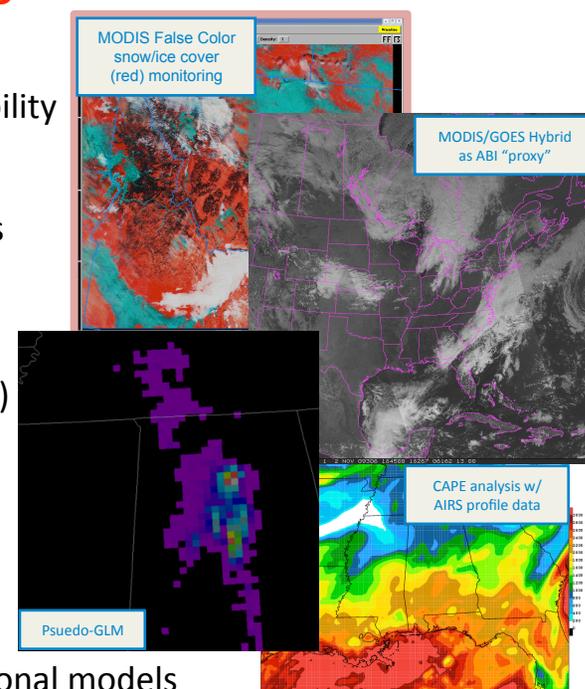
transitioning unique NASA data and research technologies to operations



# NASA/MSFC Short-term Prediction Research and Transition (SPoRT) Center

**Mission: Apply NASA measurement systems and unique Earth science research to improve the accuracy of short-term weather prediction at the regional and local scale**

- Development of new products and capabilities
  - Work with end users to identify forecast problems then match NASA capability
- Test-bed for rapid prototyping of new products
  - Contributions to GOES-R Proving Ground and AWIPS II development efforts
- Transition research capabilities/products to operations
  - Real-time MODIS and GOES data and products to NWS weather forecast offices and private companies (e.g. Worldwinds, Inc., The Weather Channel)
  - Lightning products from Lightning Mapping Array (LMA)
  - Multiplatform SST composites, AMSR-E rain rates, ocean color products
  - On-site and distance learning modules for training on new products
- Modeling and data assimilation
  - Regional assimilation of L2 T & q profiles and radiances from AIRS into regional models
  - Land (Land Information Systems) and water (SPoRT SST) lower boundary adjustments
- All work with AIRS has application to other current and future hyperspectral sounder instruments



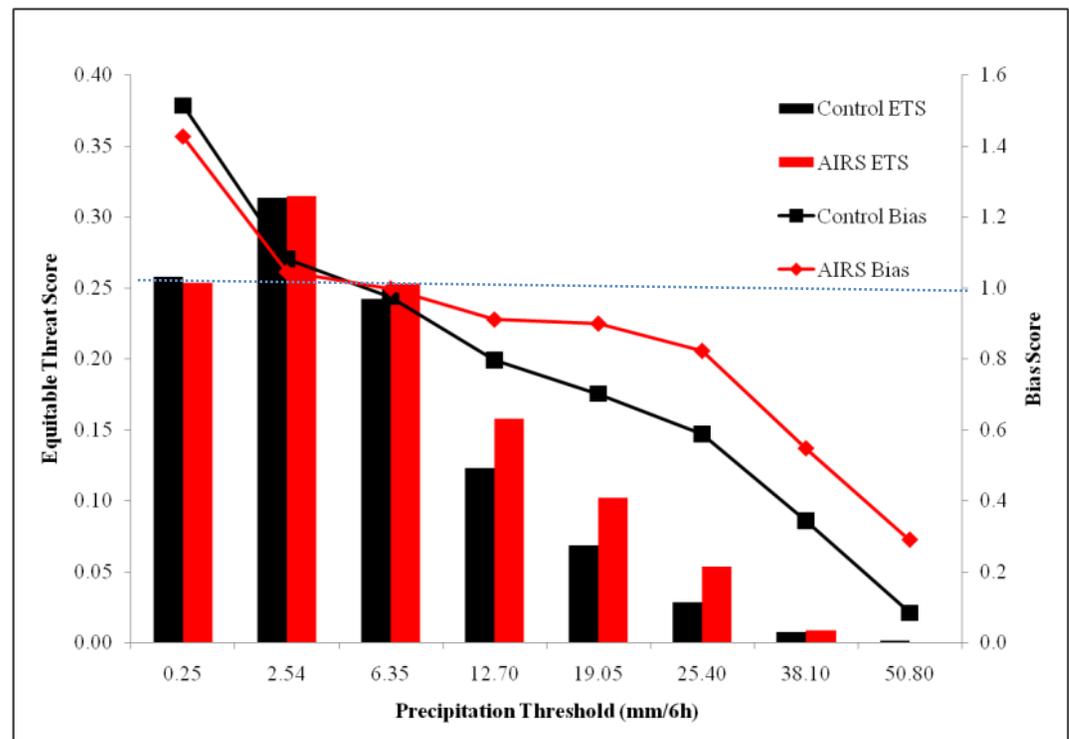
transitioning unique NASA data and research technologies to operations



# Research Summary: Setup and Precipitation

- Assimilated AIRS profiles using WRF-Var on a regional WRF domain
  - Only highest quality AIRS data assimilated using  $P_{\text{best}}$  quality indicator
  - Observation errors from instrument error over water and Tobin et al. (2006) over land
  - Background errors generated using NMC method for same case study timeframe
- Series of 37-cold start, non-cycled forecasts from January-February 2007
- Overall precipitation statistics show improvements at most precipitation intensities (most positive impact for heavy rainfall cases)

## *Accumulated Precipitation Statistics Combined for All Forecast Hours for 37-Day Case Study*

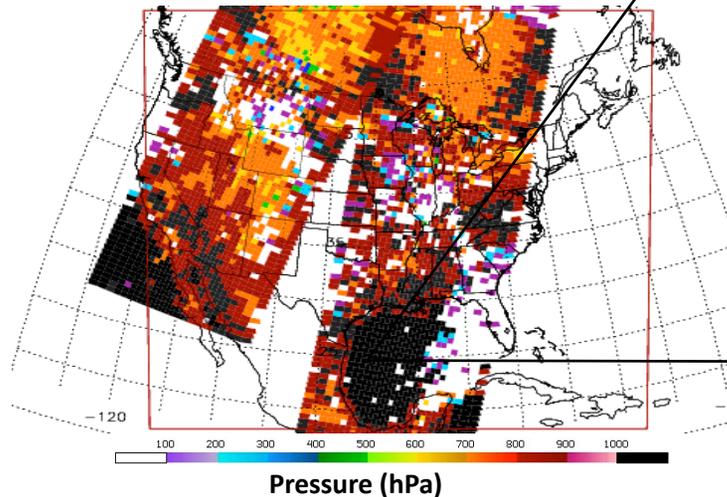


transitioning unique NASA data and research technologies to operations

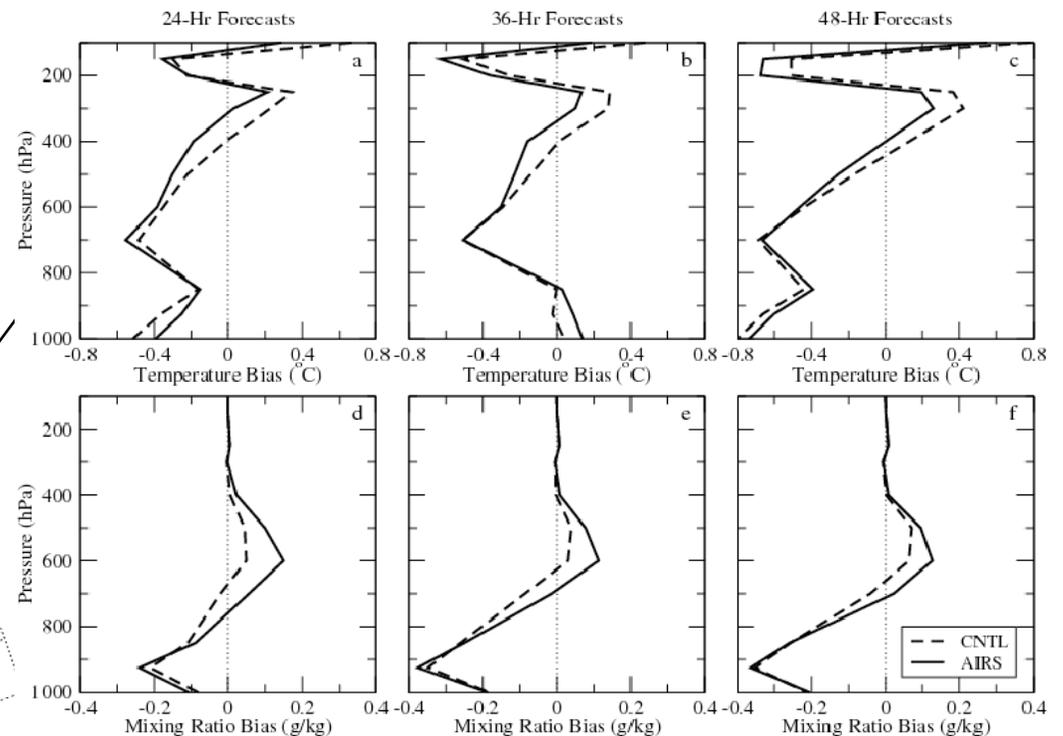


# Research Summary: Sounding Structure

- Assimilated AIRS profiles change vertical sounding structure
- Warms near-surface; cools upper levels
- Most of column is moistened
- Result is a more unstable sounding



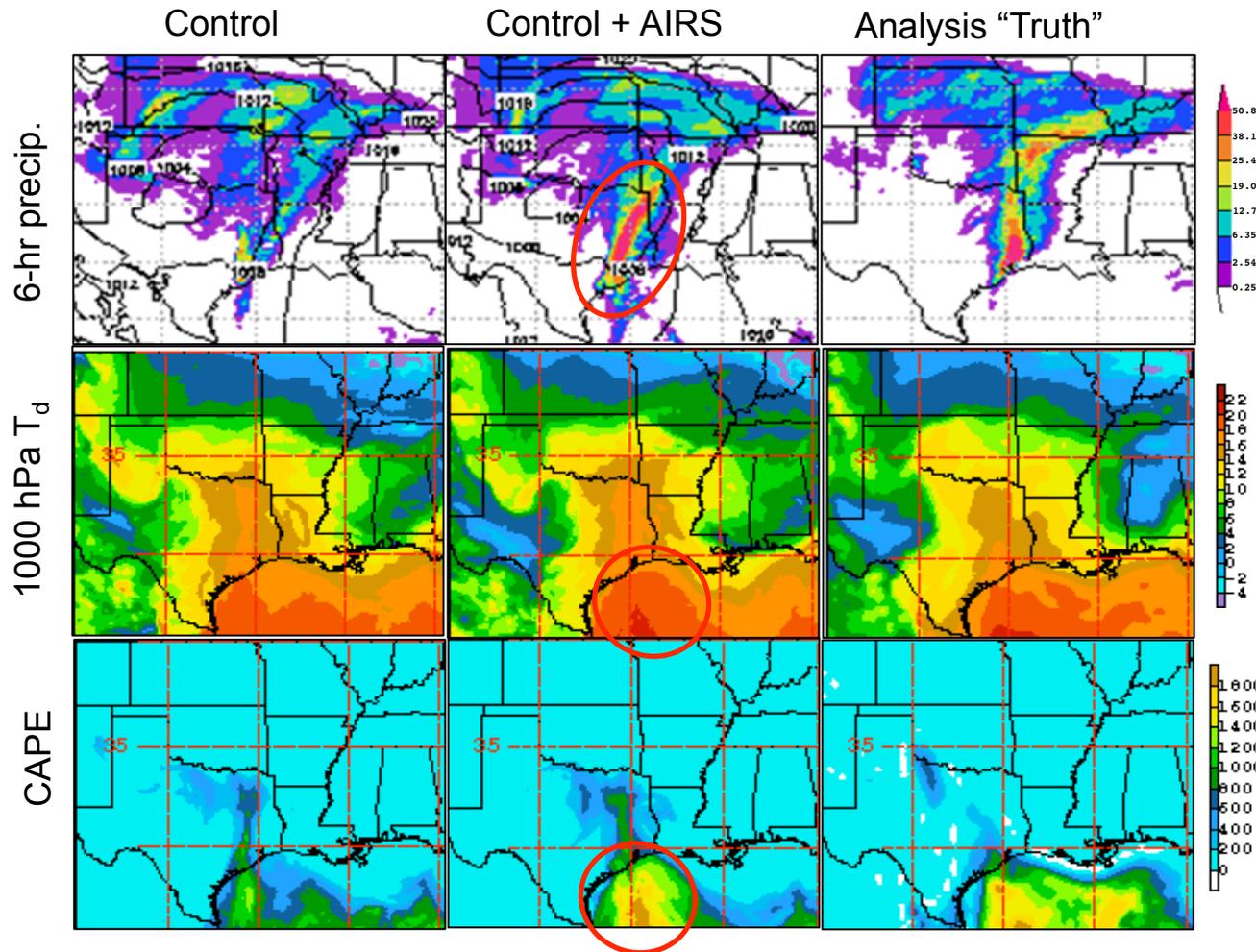
## Accumulated Statistics of $T$ and $q$ by Forecast Hour for 37-Day Case Study



Bulk statistics from 37-day case study forecasts compared to NAM analyses tell similar story

# Research Summary: Severe Storm Case

24-h forecast valid 00Z 2/13/07



- Convective precipitation in Eastern Texas
  - Control (upper left) produces some rain but does not capture significant precipitation
  - AIRS (upper middle) reproduces convective precipitation line
- Better representation of lower level moisture
- CAPE values above 1800 J/kg in NAM analysis (lower right)
  - AIRS (lower middle) nicely represents CAPE
  - Control run (lower left) gives no hint of higher CAPE values

# Transition of Research to Operations

- Real-time website to display analysis and verifying forecast images with assimilated AIRS profiles from our research with WRF-Var
  - Allows SPoRT researchers and operational partners to evaluate “weather-of-the-day” impact
  - Exposes end users to data set and analysis
  - Precedes formal transition of a product
- Similar analyses and verifying forecasts to be made assimilating IASI profiles
- Assimilation of conventional and satellite data using GSI/NMM to mimic operational DA/modeling configuration with cycled forecasts for research purposes
  - AIRS and IASI profile data included in configuration
  - Evaluate the potential impact of these data sets on the operational system
- Provide real-time, enhanced analyses for local-scale applications using current and future hyperspectral profile data
  - Diagnostic variables (CAPE, low-level moisture)
  - Initialize local NWS WRF runs

*Rigorous computational resources to be handled by SPoRT “Weather in a Box” supercomputer*



transitioning unique NASA data and research technologies to operations



# SPoRT Weather in a Box: Overview

- SPoRT is testing a set of “desktop” supercomputers called “Weather in a Box (WiB)”
  - Requires no additional cooling or large computer room space
  - Two 64-node clusters for real-time data assimilation and modeling capabilities
  - Pre-loaded data assimilation and modeling tools
- Provided by Tsengdar Lee of NASA HQ
- Future distribution of these systems will allow a new set of scientists to contribute to data assimilation research



- Especially useful for universities or regional centers that want to do in-house NWP applications
- Will take SPoRT beyond sensitivity studies with hyperspectral sounder profile data

## 8 Compute Nodes

- 3 GHz Intel Xeon Processors (8 cores total)
- 24 GB RAM
- 320 GB 7.2k HDD

InfiniBand Ports and Cables

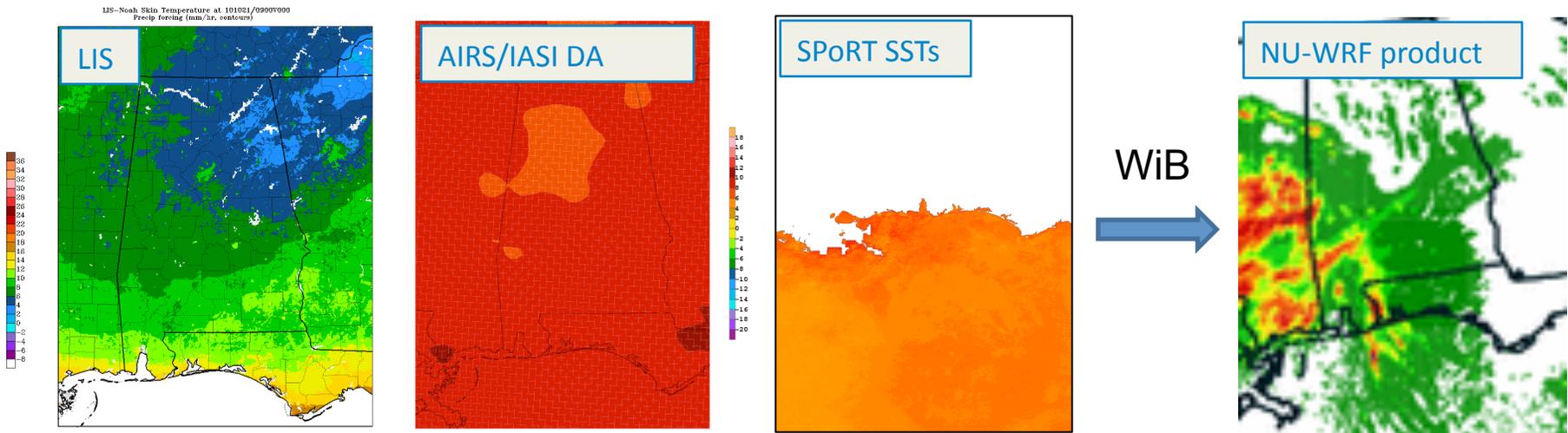


transitioning unique NASA data and research technologies to operations



# SPoRT Weather in a Box: Example Application

- WiB systems will allow SPoRT to test assimilation of hyperspectral radiance and profile data in a near-real-time environment
- Couple multiple SPoRT capabilities for unified analysis/forecast process
  - AIRS and IASI profile/radiance 3D atmosphere analysis
  - Land Information Systems (LIS) land surface model
  - Use SPoRT SSTs within LIS for overwater boundary conditions
- NASA Unified WRF (NU-WRF) to produce real-time products for transition to SPoRT partners for application to local forecasts

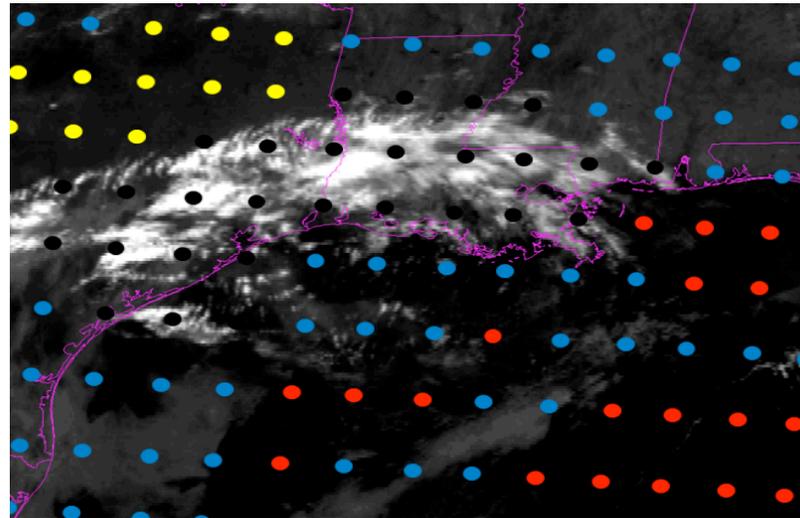


transitioning unique NASA data and research technologies to operations



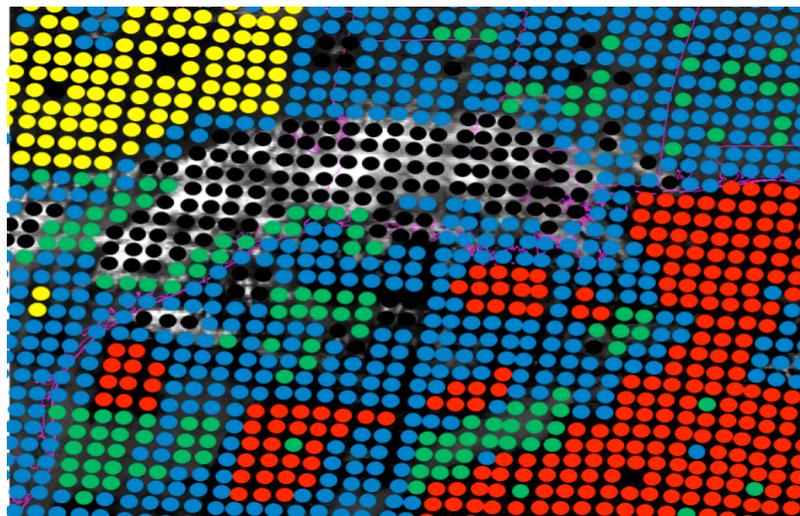
# ROSES Proposal: Understanding Impact of AIRS Radiances using AIRS Profiles

- Use AIRS profiles to better understand weaknesses in AIRS radiance assimilation methodology
- Regional/Local scale to focus on specific weather processes
- Proposal objectives
  - Cloud detection (contamination)
  - Reduced number of channels due to clouds and surface emissivity
  - Spatial Data Reduction Techniques
- Analysis increment examination
  - Show where AIRS profiles and radiances have different impacts
  - Relate to profile strengths to understand how radiances can be used for larger impact
- Opportunity to transition “research knowledge” to operations



**Current  
Operational**

- Clear
- Cloudy (all channels)
- Lower levels impacted by emissivity
- Clear channels above cloud
- Additional channels available above cloud



**Proposed**



transitioning unique NASA data and research technologies to operations



# Summary

- SPoRT continues to transition NASA products and capabilities to its ever-growing set of end users
- Completed current research with AIRS profiles
  - Improved precipitation forecasts; overall more unstable sounding
  - Submitted article to Weather and Forecasting
- SPoRT's upcoming plans for hyperspectral sounder assimilation
  - Transition of current research product to operations
  - Future research involving “operational configuration” of GSI
- SPoRT's new “Weather in a Box”
  - Dual 64-node “Desktop” supercomputers
  - Enables data assimilation research and dissemination of real-time products
- AIRS Radiance Impact (ROSES10 Proposal)
  - Use AIRS profiles to better understand limitations of AIRS radiance assimilation



transitioning unique NASA data and research technologies to operations



# Questions?

For More Information About SPoRT or Our  
Hyperspectral Sounder Data Assimilation Work:

Contact me:

[brad.zavodsky@nasa.gov](mailto:brad.zavodsky@nasa.gov)

Visit our website:

<http://weather.msfc.nasa.gov>

Visit our Wide World of SPoRT blog:

<http://nasasport.wordpress.com>



transitioning unique NASA data and research technologies to operations

---

---

