



# Projected Applications of a "Weather in a Box" Computing System at the NASA Short-term Prediction Research and Transition (SPoRT) Center

<sup>1</sup>Gary J. Jedlovec, <sup>1</sup>Andrew L. Molthan, <sup>1</sup>Bradley T. Zavodsky, <sup>2</sup>Jonathan L. Case, <sup>3</sup>Frank J. LaFontaine, and <sup>4</sup>Jayanthi Srikishen

<sup>1</sup>NASA Short-term Prediction Research and Transition (SPoRT) Center, Marshall Space Flight Center, Huntsville, AL

<sup>2</sup>NASA SPoRT/ENSCO, Inc., <sup>3</sup>NASA SPoRT/Raytheon, and <sup>4</sup>NASA SPoRT/Universities Space Research Association, Huntsville, AL



## What is the NASA SPoRT Center?

❖ The NASA Short-term Prediction Research and Transition (SPoRT) Center partners with several universities and government agencies to:

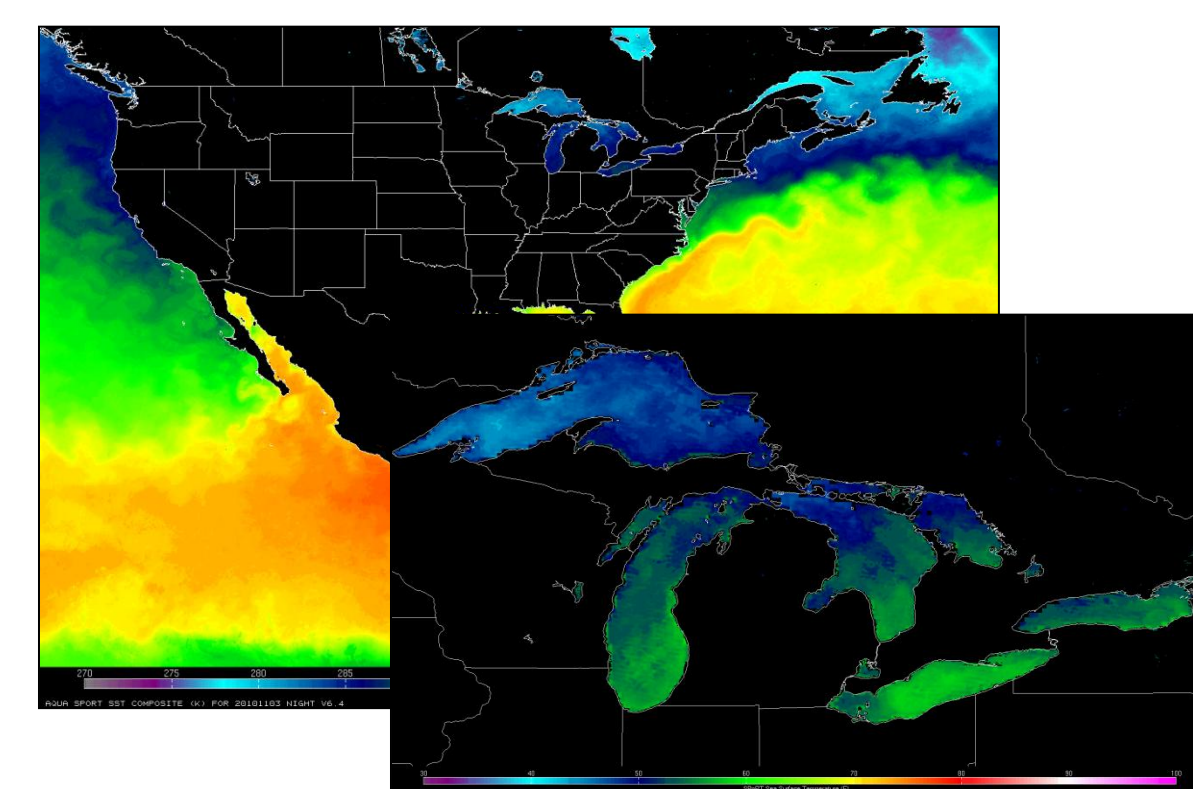
- Improve short-term (0-48 hr) weather forecasts
- Facilitate and promote the use of Earth Observing System satellite data for weather analysis and forecasting
- Promote the use of unique, advanced NASA modeling and data assimilation techniques applicable to regional forecasting

## Mission Statement

❖ Serve as a focal point and facilitator for the transfer of NASA Earth Science technologies to the operational weather community, emphasizing short-term forecasting.

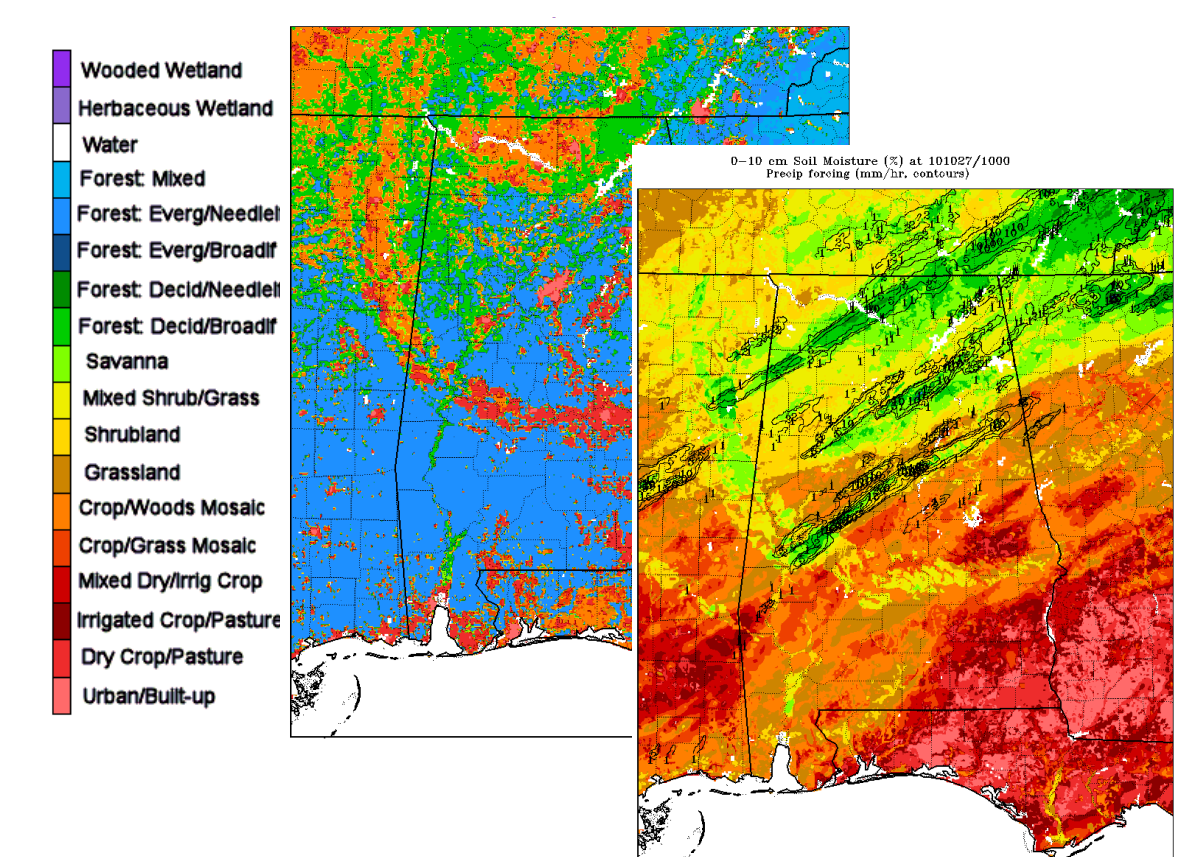
## SPoRT Contributions to the Weather Research and Forecasting (WRF) Model

❖ SPoRT has developed several techniques and unique data products to support high resolution, short-term weather forecasts:



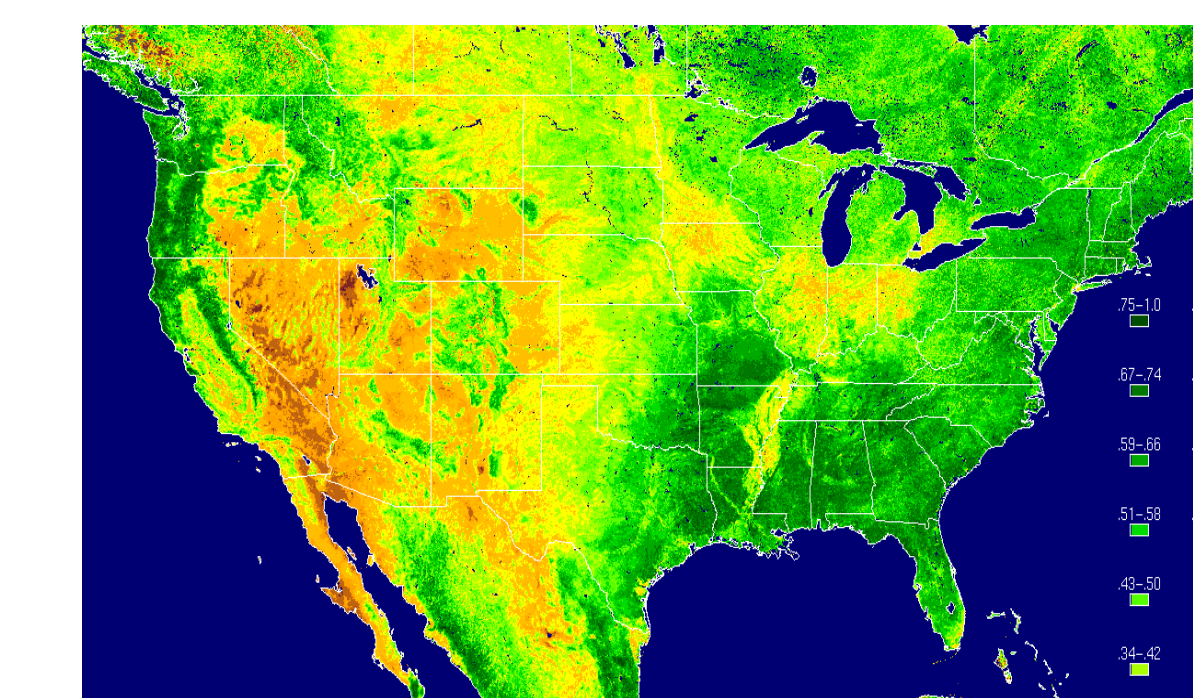
### Sea and Lake Surface Temperature Composites

- ❖ Produced four times per day at one 1km spatial resolution, derived from MODIS/AMSR-E data and available ice cover data sets.
- ❖ 1 km spatial resolution
- ❖ Derived from MODIS/AMSR-E



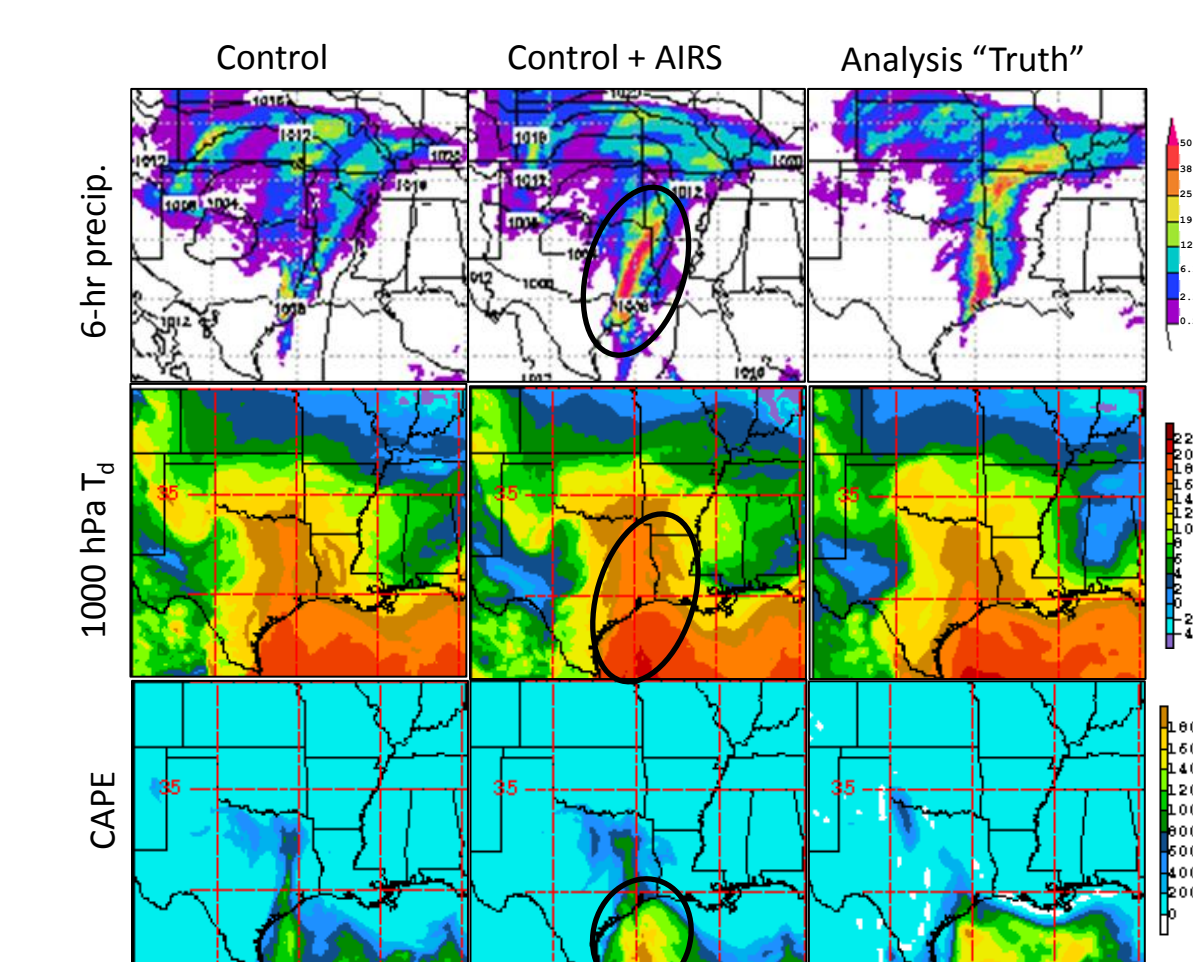
### NASA Land Information System

- ❖ Unique NASA research tool
- ❖ 3 km spatial resolution
- ❖ Receives inputs of radar estimated precipitation and satellite vegetation composites.
- ❖ Outputs high resolution soil moisture, soil type, and vegetation characteristics.



### Normalized Difference Vegetation Index (NDVI) Composites

- ❖ Daily composites at 1 km resolution, derived from MODIS, to serve as a proxy for vegetation cover and greenness fraction.
- ❖ Replaces coarse climatology fields in model forecasts.



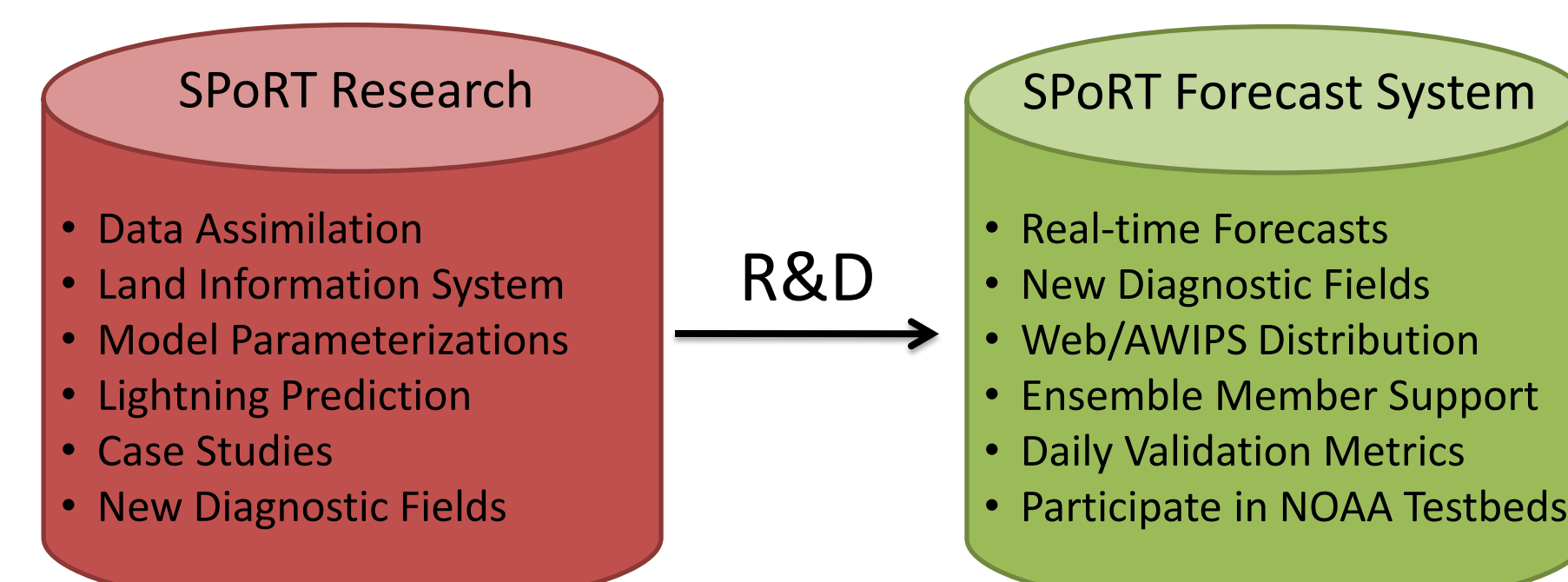
### Advanced Infrared Sounder (AIRS) Profile Assimilation

- ❖ Provides vertical profiles of temperature and moisture with horizontal resolution of 50 km.
- ❖ Supplements rawinsonde network with observations at atypical hours.
- ❖ Used in variational assimilation techniques to improve the three-dimensional atmospheric analysis.

## SPoRT "Weather in a Box" Systems

❖ SPoRT is acquiring two new modeling systems to support weather forecasting experiments utilizing unique NASA research tools and products:

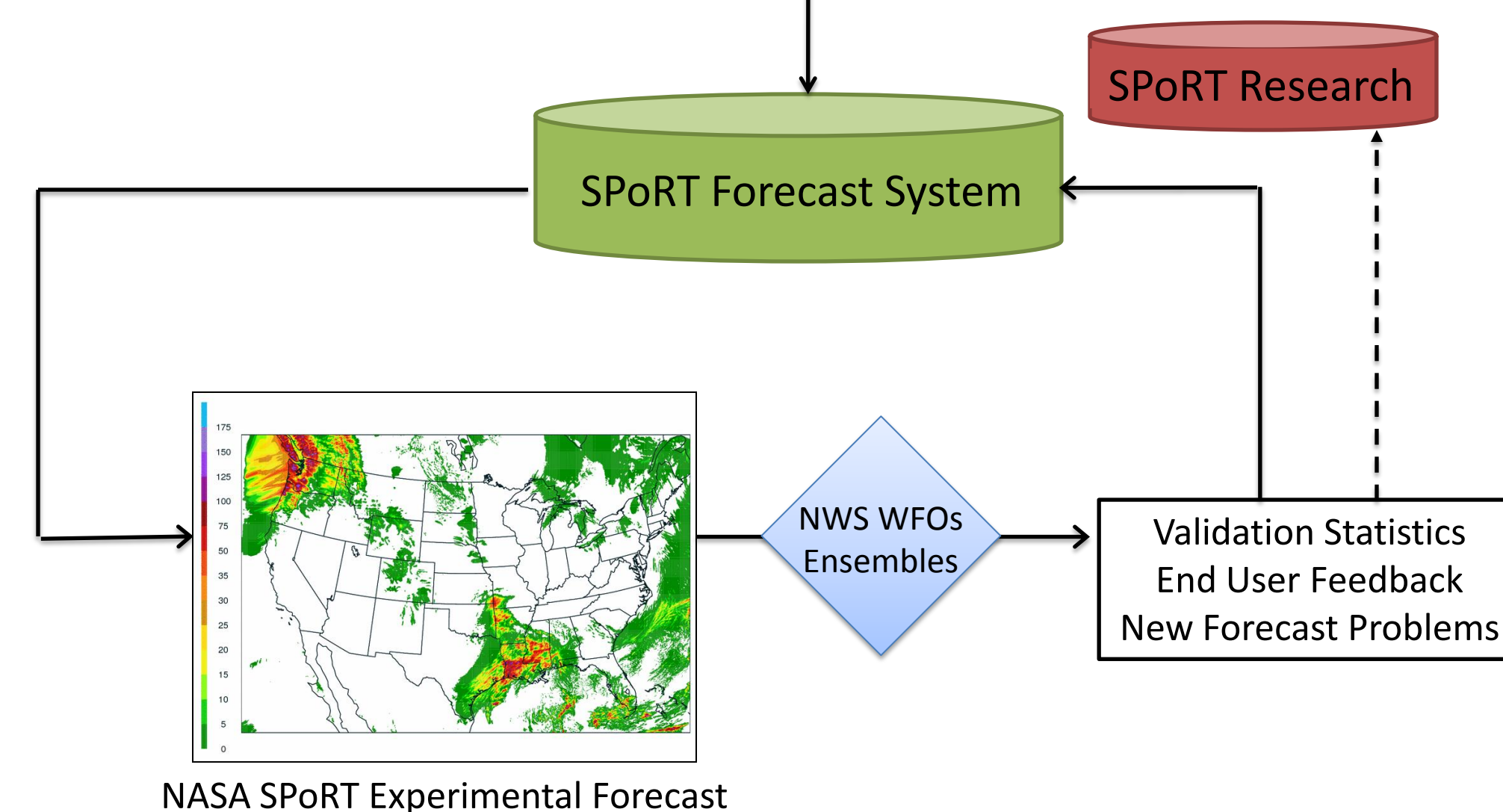
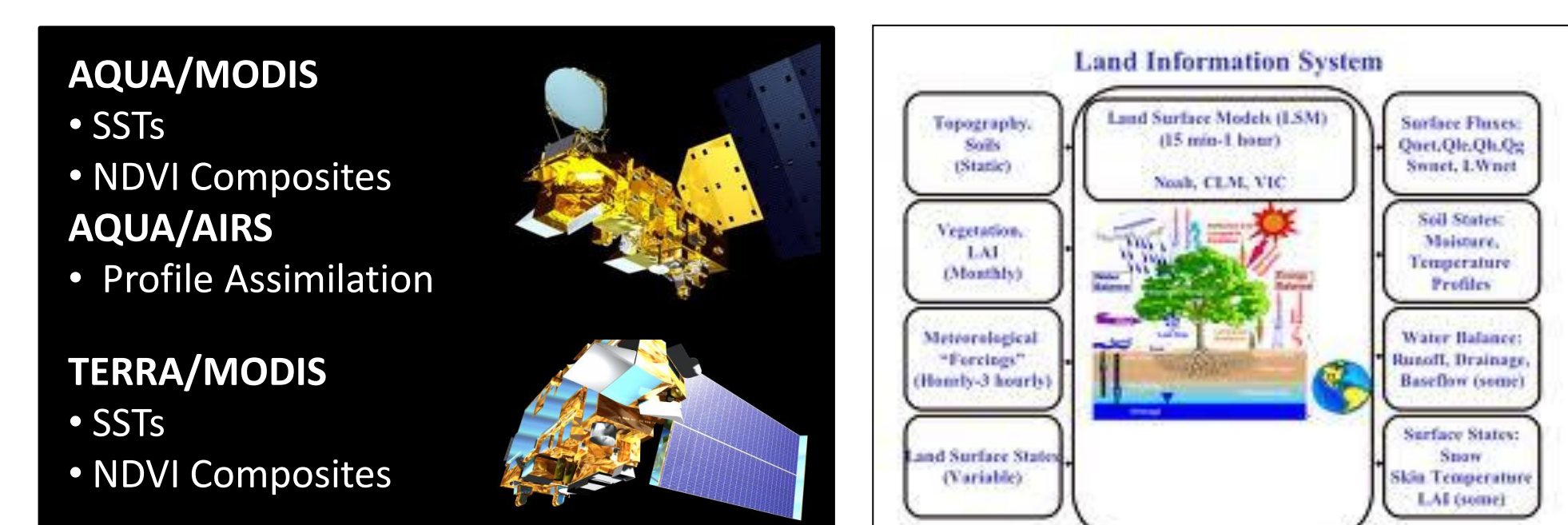
- | Research and Development   | Real-Time Forecasting      |
|----------------------------|----------------------------|
| ➢ CRAY CX1 Chassis         | ➢ CRAY CX1 Chassis         |
| ➢ 8 Compute Nodes          | ➢ 8 Compute Nodes          |
| ➢ Each node contains:      | ➢ Each node contains:      |
| ▪ 8 Intel Xeon X5550 Cores | ▪ 8 Intel Xeon X5472 Cores |
| ▪ 2.67 GHz                 | ▪ 3.00 GHz                 |
| ▪ 24 GB RAM                | ▪ 32 GB RAM                |
| ▪ 320 GB 7.2k HDD          | ▪ 320 GB 7.2k HDD          |
| ▪ Infiniband connectivity  | ▪ Infiniband connectivity  |



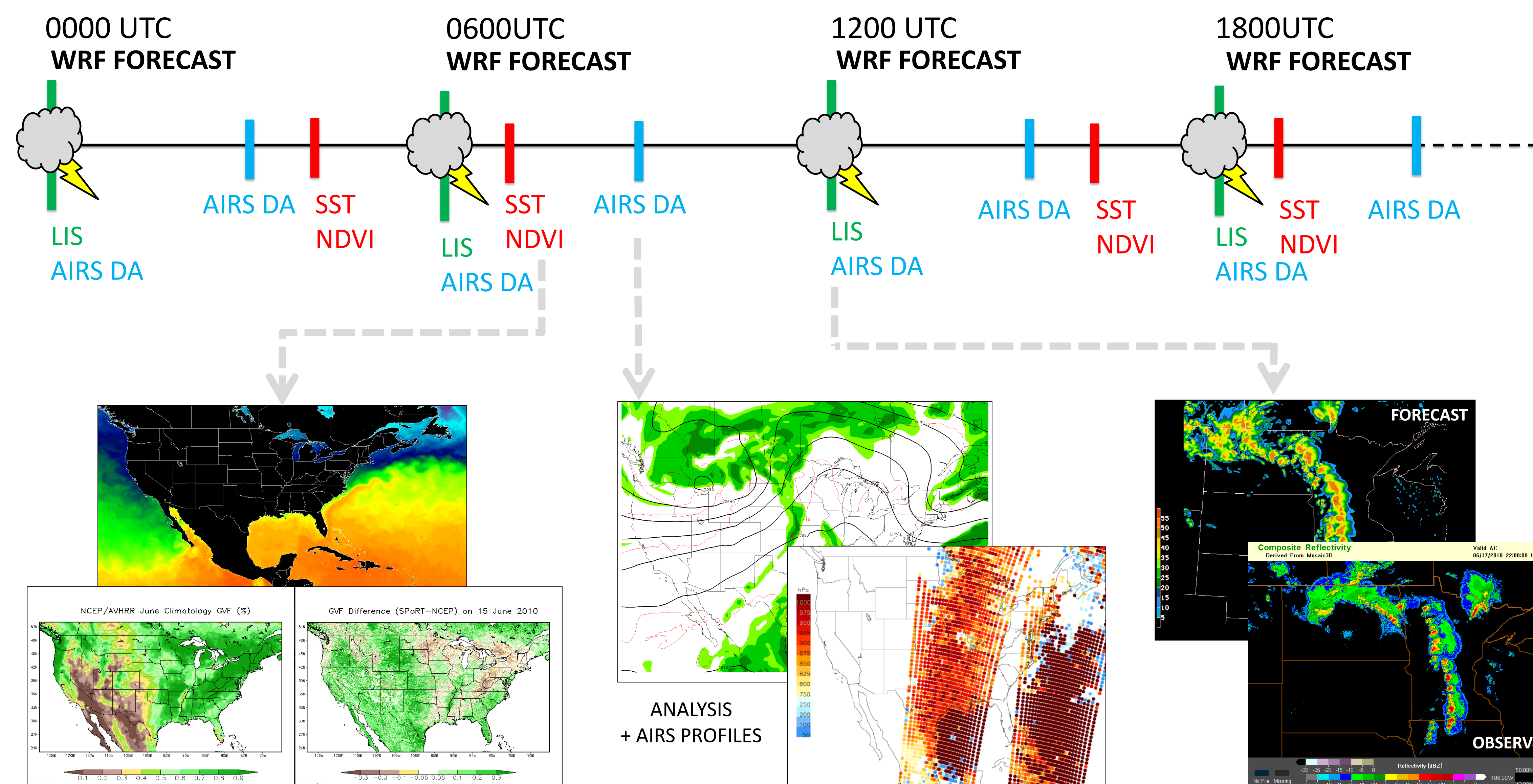
## SPoRT "Weather in a Box" Software

❖ High resolution forecasts will be generated using the NASA Unified Weather Research and Forecasting (NU-WRF) modeling suite, which includes:

- Advanced Research WRF (WRF-ARW)
- NASA Land Information System (LIS) with internal coupling
- NCAR Model Evaluation Tools (MET) Package
- Goddard Chemistry Aerosol Radiation and Transport (GOCART)
- Goddard Satellite Data Simulator Unit (SDSU)
- Unique diagnostic fields for severe weather forecasting
- Lightning forecasting capabilities based upon cloud microphysics
- WRF Pre- and Post-Processors



## Hypothetical Forecast Cycle Example: June 17, 2010



### SSTs, Soil Moisture, and GVF

- ❖ High resolution, accurate surface water temperatures for coastal processes and moisture return.
- ❖ Soil moisture and greenness vegetation fractions derived from the NDVI to improve evapotranspiration and land contributions to low level moisture sources.

### AIRS Profile Assimilation

- ❖ AIRS profiles contribute moisture and temperature data above cloud top to adjust model initial conditions.
- ❖ Above: Warm colors represent widespread, contribution of AIRS data in cloud-free conditions.
- ❖ Available on orbital times between the 00/12 UTC rawinsonde network.

### NU-WRF Model Forecast

- ❖ Goal: Generate high resolution (4 km) forecasts that simulate precipitation and storm structure.
- ❖ Determine improvements gained through use of NASA data sets.
- ❖ Contribute our unique, NASA-driven forecast to ensemble efforts characterizing forecast uncertainty.

## Summary

- ❖ SPoRT's new "Weather in a Box" resources will provide weather research and forecast modeling capabilities for real-time application.
- ❖ Model output will provide additional forecast guidance and research into the impacts of new NASA satellite data sets and software capabilities.
- ❖ By combining several research tools and satellite products, SPoRT can generate model guidance that is strongly influenced by unique NASA contributions.

## Acknowledgements

- ❖ SPoRT modeling clusters were provided by Dr. Tsengdar Lee, High End Computing Program Manager at NASA Headquarters.
- ❖ Software installation and configuration was performed by NASA Goddard Space Flight Center under the guidance of Tom Clune.
- ❖ Local software and installation support at NASA Marshall Space Flight Center was performed and managed by Rita Edwards and David Cross.