# Overview on CIMSS GOES-R/JPSS research and applications


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**Space Science and Engineering Center**

**University of Wisconsin-Madison**


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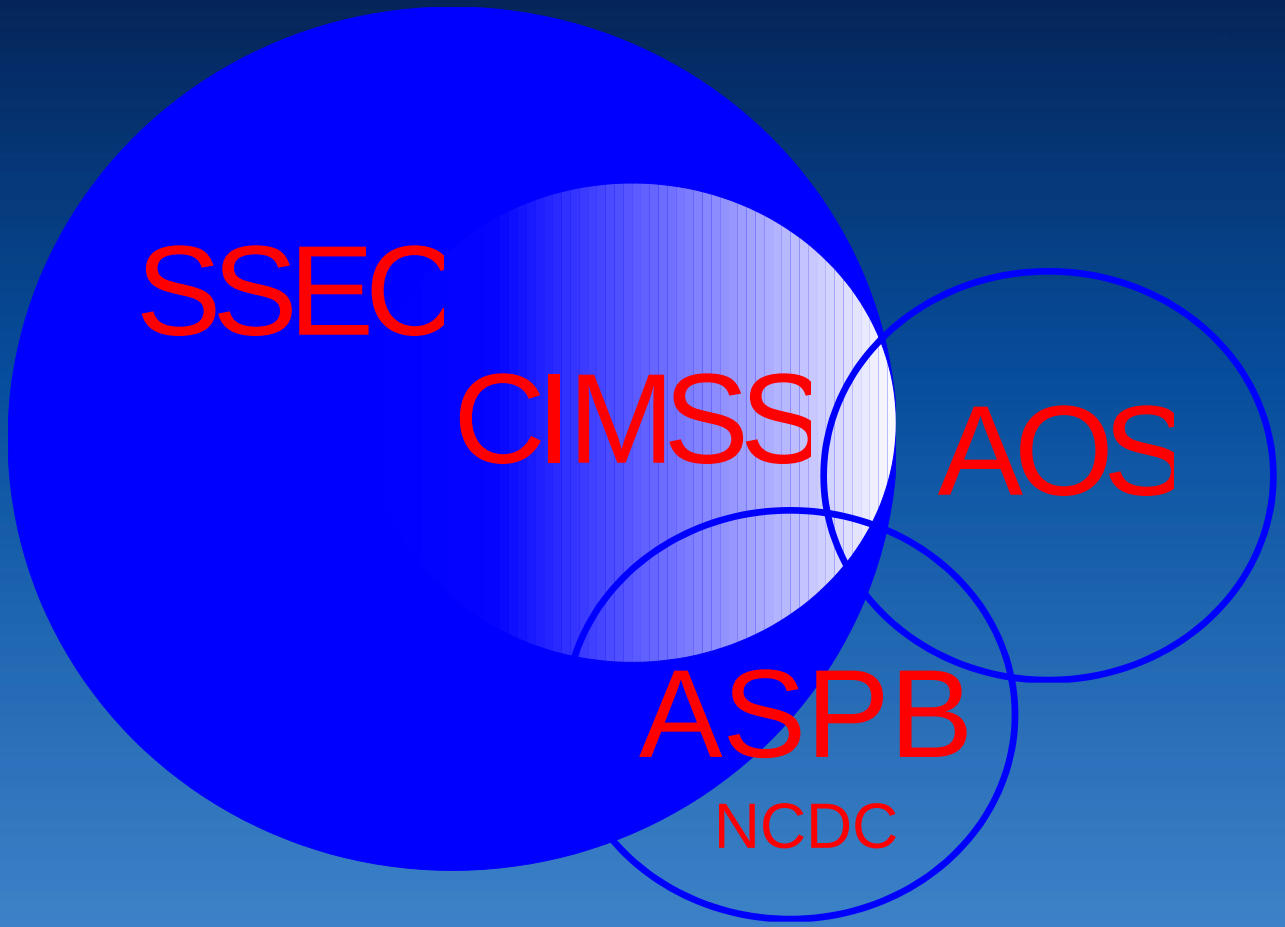
College Park, Maryland

# Outlines

- **CIMSS overview from Steve Ackerman (Director)**
- **Current research activities on GOES-R/JPSS science and applications at CIMSS**
- **One example – study on satellite data assimilation in a regional numerical weather prediction (NWP) model**

# CIMSS/SSEC/AOS




Symbiotic relationship between CIMSS, SSEC and AOS

# CIMSS Mission

- Foster collaborative research among NOAA, NASA, and the University in those aspects of atmospheric and earth system science which exploit the use of satellite technology.

- Serve as a center at which scientists and engineers working on problems of mutual interest may focus on satellite related research in atmospheric studies and earth system science.

- Stimulate the training of scientists and engineers in the disciplines involved in the atmospheric and earth sciences.

# CIMSS Core Mission Activities

- Continue NOAA collaborations with GOES and POES programs.

  GIMPAP – GOES-R, JPSS

- Maintain and expand expertise in hyperspectral observations

  CrIS, S-HIS, IASI, China's hyperspectral

- Continue to transition research to operations

  Many already used in operations

- Continue strong involvement in new satellite missions

  JPSS, Tropospheric Emissions Monitoring of Pollution (TEMPO), CLARREO

- Continue support of SSEC Data Center

  Critical for data and satellite checkout

# CIMSS Core Mission Activities

- Continue field programs with SSEC

  Rooftop, SPARC, lidar, microwave

- Maintain end-to-end capabilities.

  Collaborations with SSEC make this possible

- Maintain Cal/Val expertise

  GOES check-out, instrument calibrations

- Secure research grants

  Needed to support research to operations

# CIMSS Core Mission Activities

- Continue involvement in professional training

  SHyMet, VISITView, CIMSS Satellite Blog

- Support graduate students.

  Currently 15 grad students funded with CIMSS PIs

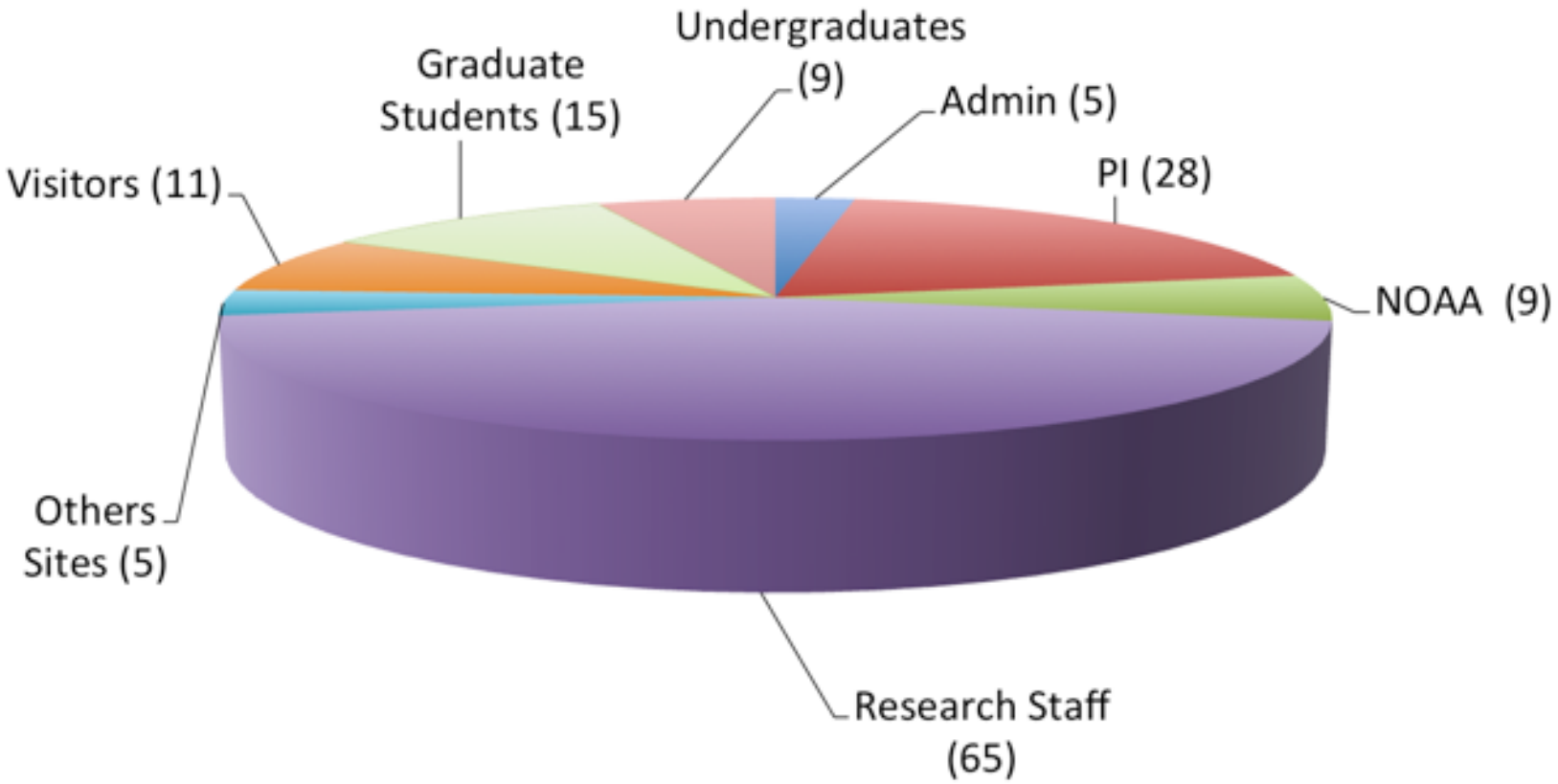
- Expand expertise in on-line instruction

  Professional development and web-based, MOOC

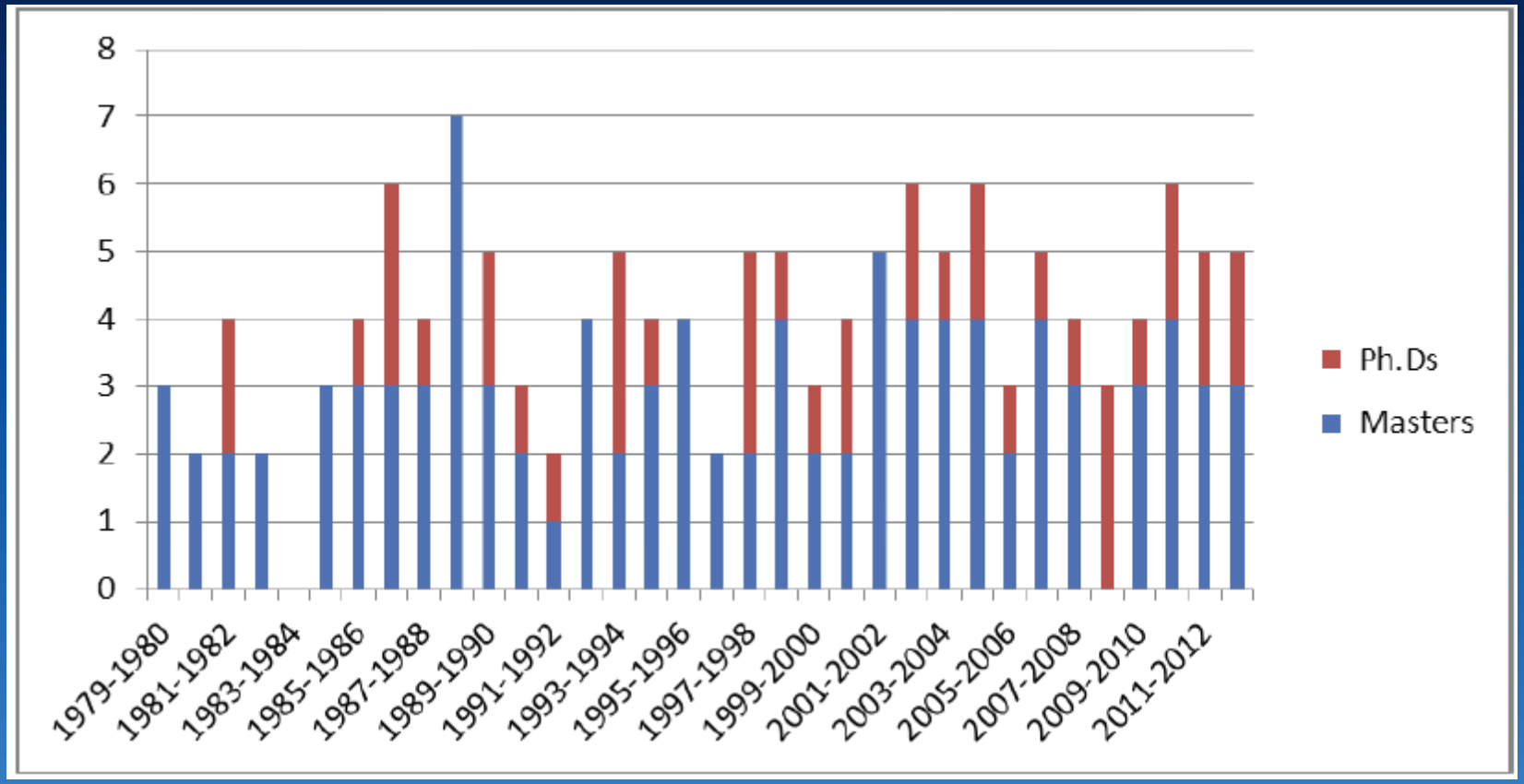
- Support public outreach and K-12 education

  Science on a Sphere, blogs, workshops

# 2014 CIMSS Personnel (143 Associates)



# CIMSS graduate students



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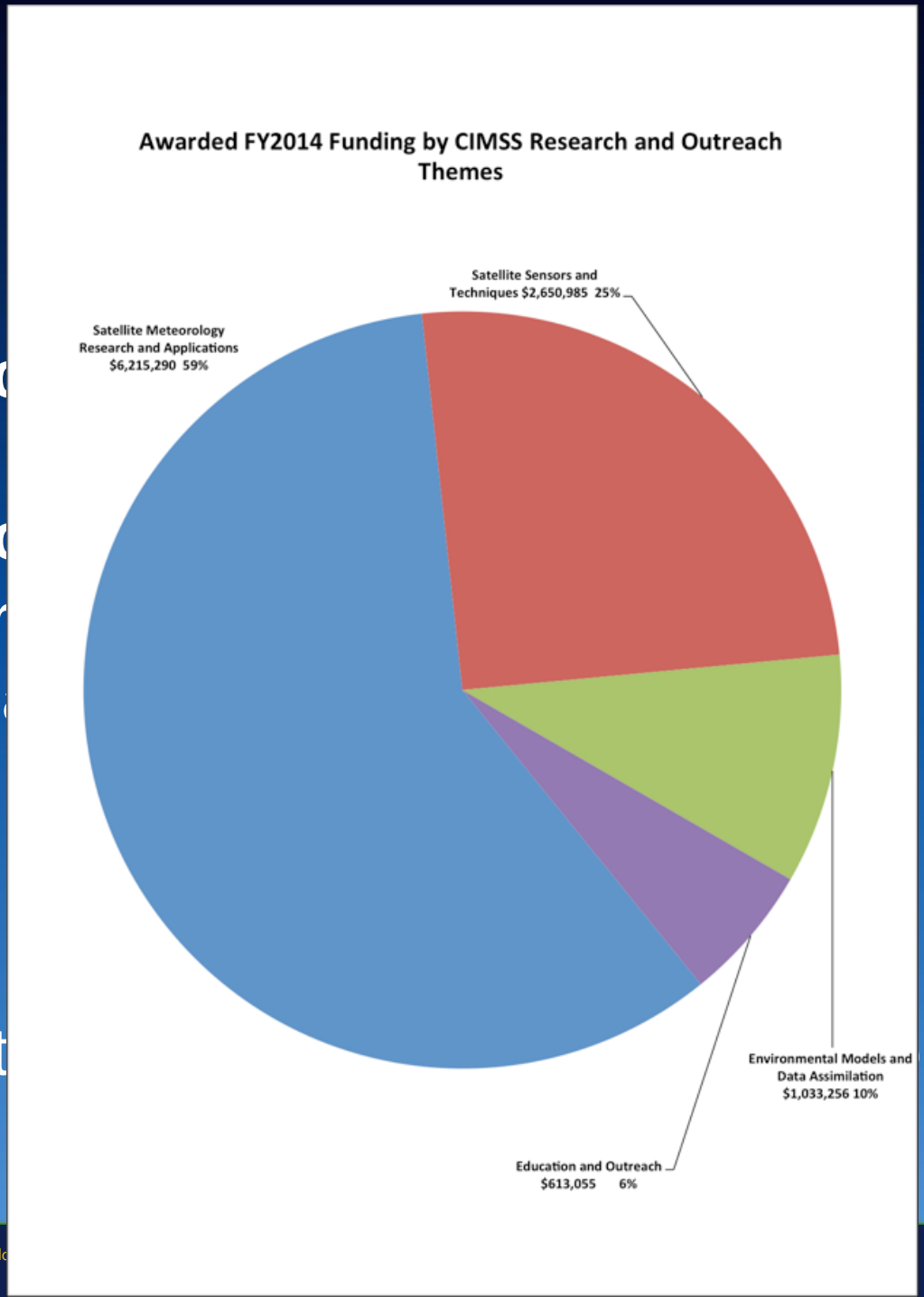


# CIMSS current ongoing research projects

- Algorithm science for new generation of NOAA satellites (NPP/JPSS and GOES-R series) – algorithm development, calibration, validation, and re-processing
- Proving Ground and Risk Reduction (PGRR) – Exploring new algorithms, new products, new applications, user readiness
- Direct broadcast (DB) software for regional real time applications of both POES/GOES data
- Visualization – McIDAS-X/McIDAS-V

# Science Examples

# Science Highlights

algorithms

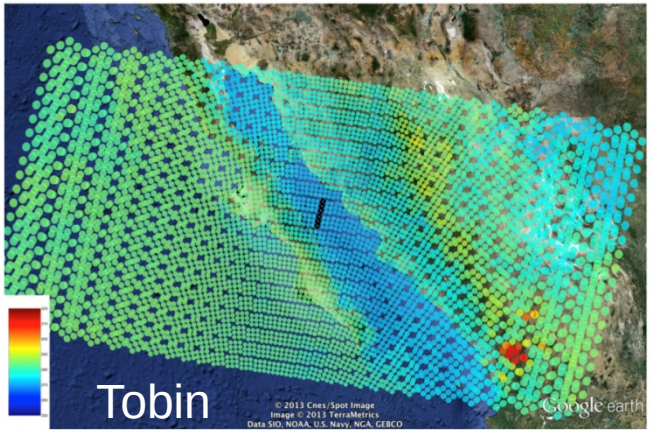
INFORMATION

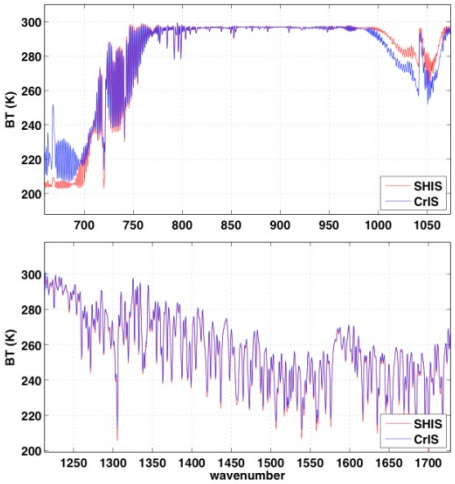
theory
modeling

KNOWLEDGE

applications

new instruments



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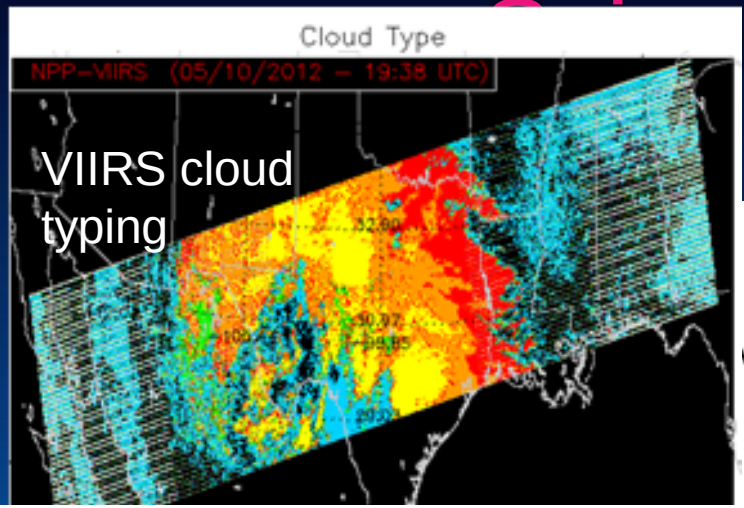



VIIRS cloud typing

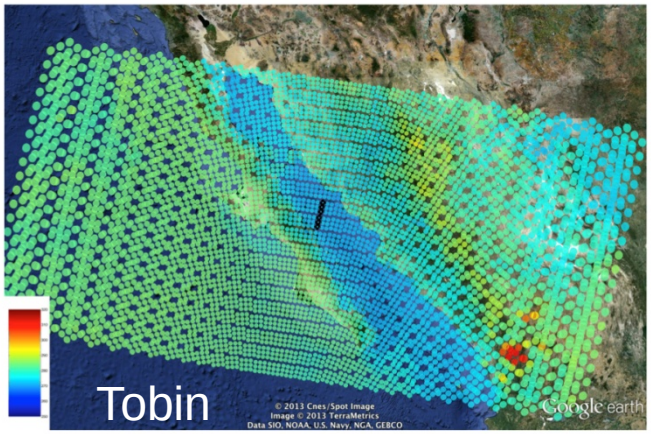
NFORMATION

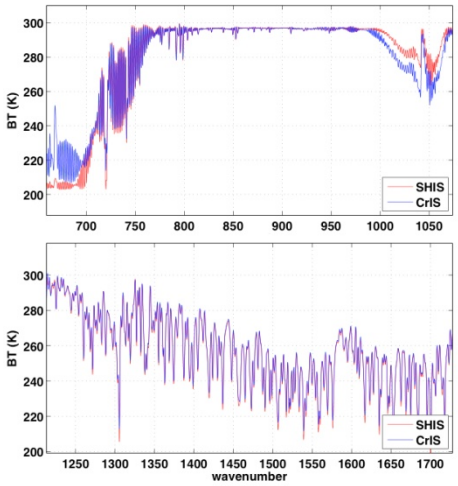
theory
modeling

KNOWLEDGE

applications

new instruments



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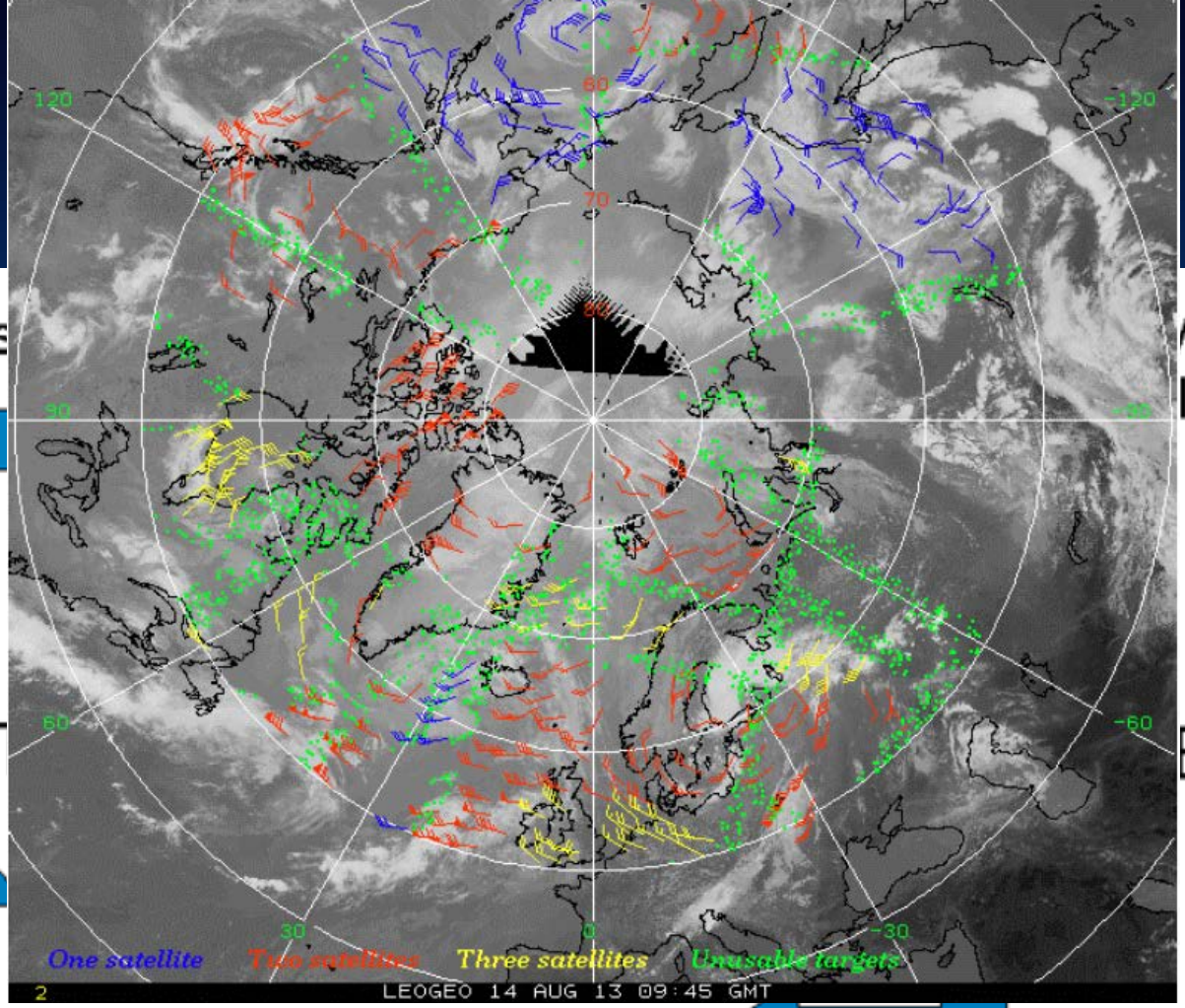


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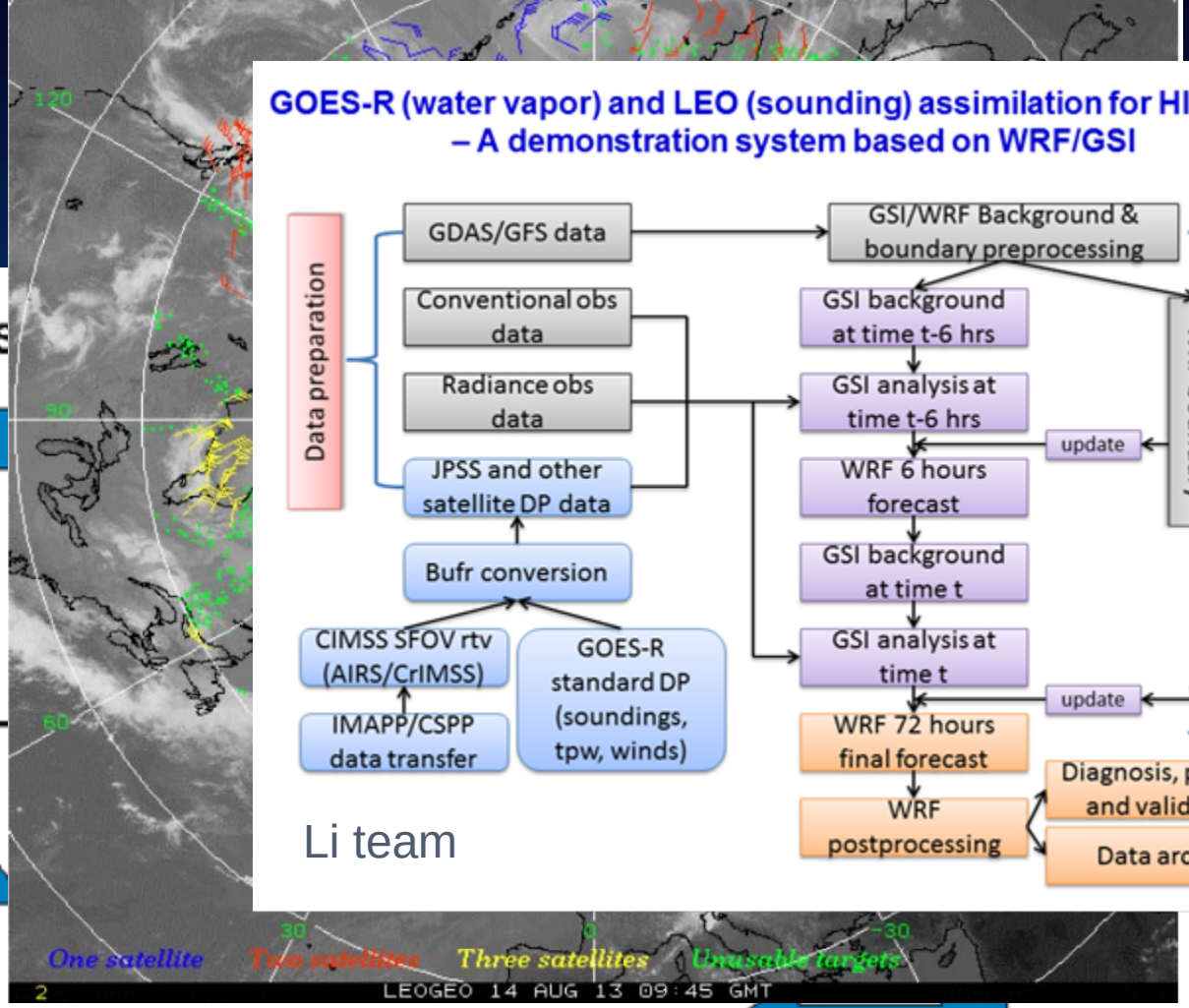
new instruments

applications




algorithms

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new instruments

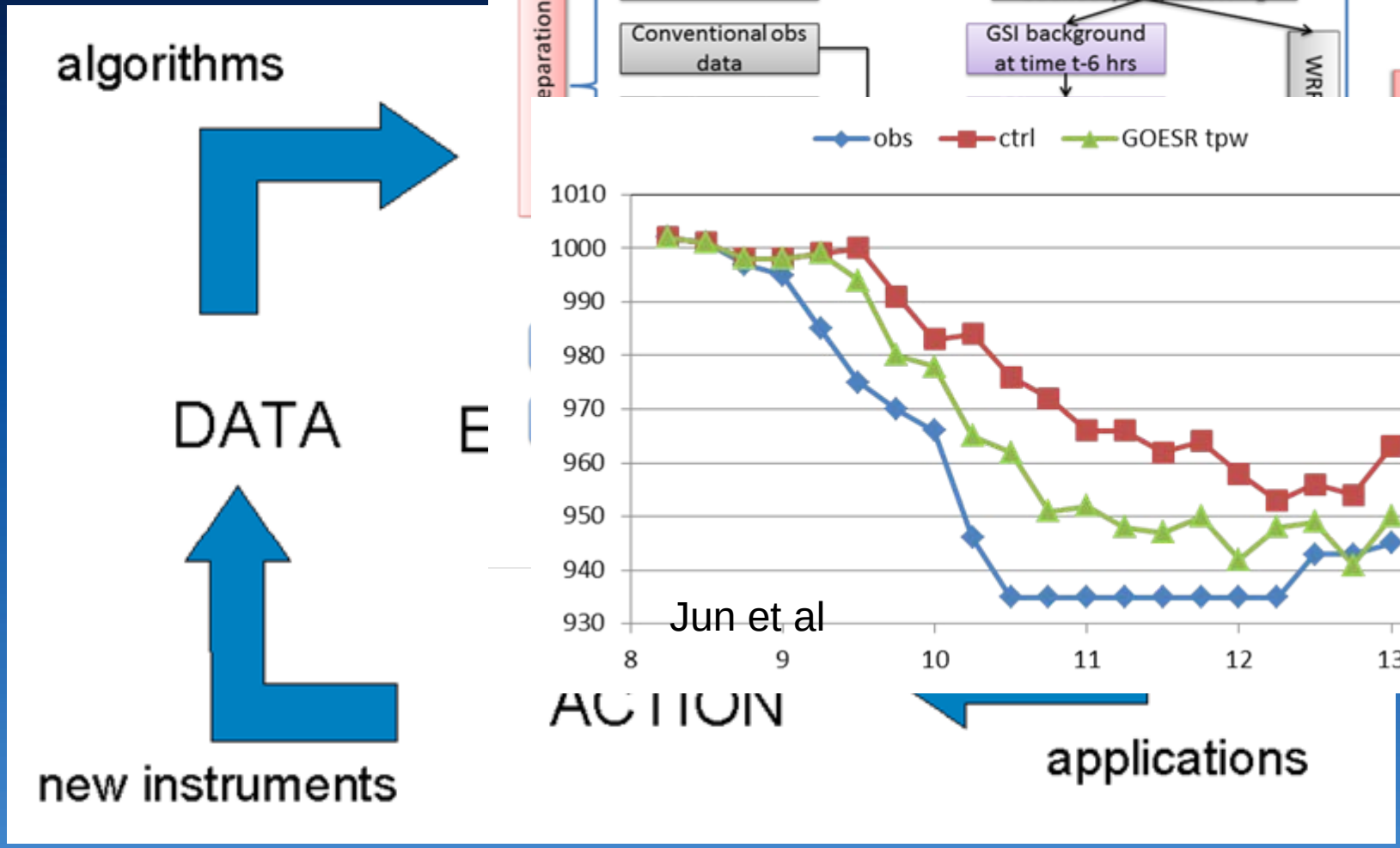
applications

## GOES-R (water vapor) and LEO (sounding) assimilation for HIW forecasts – A demonstration system based on WRF/GSI




Li team

# Scie


algorithms
DATA
new instruments
applications


GOES-R (water vapor) and LEO (sounding) assimilation for HIW forecasts
– A demonstration system based on WRF/GSI
GDAS/GFS data
GSI/WRF Background & boundary preprocessing
Conventional obs data
GSI background at time t-6 hrs
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GOESR tpw
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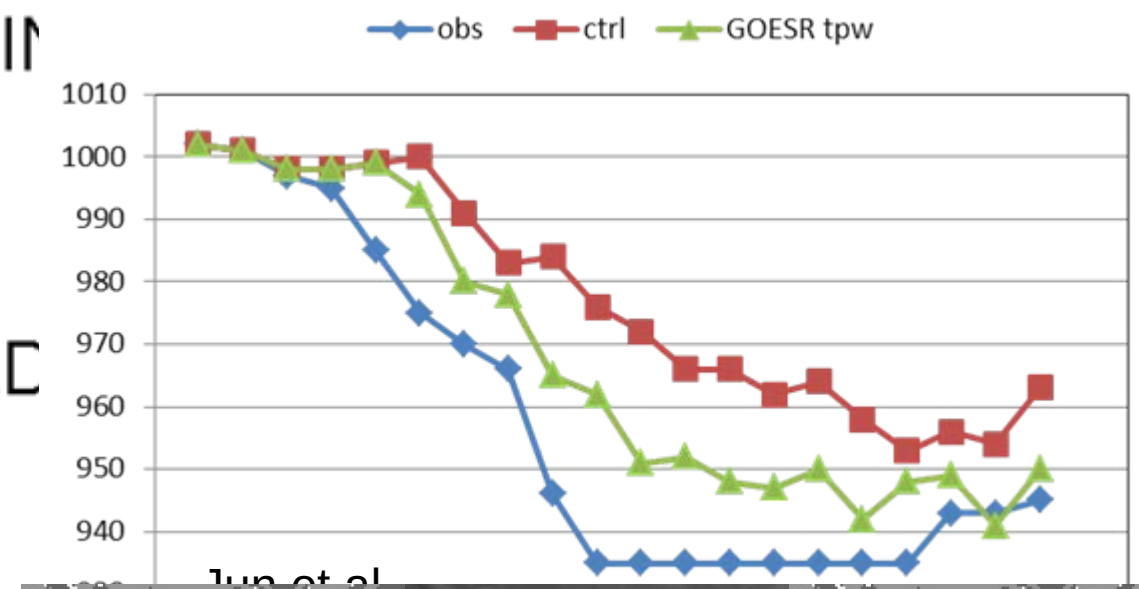
# Science Highlights


# Science Highlights

algorithms

theory

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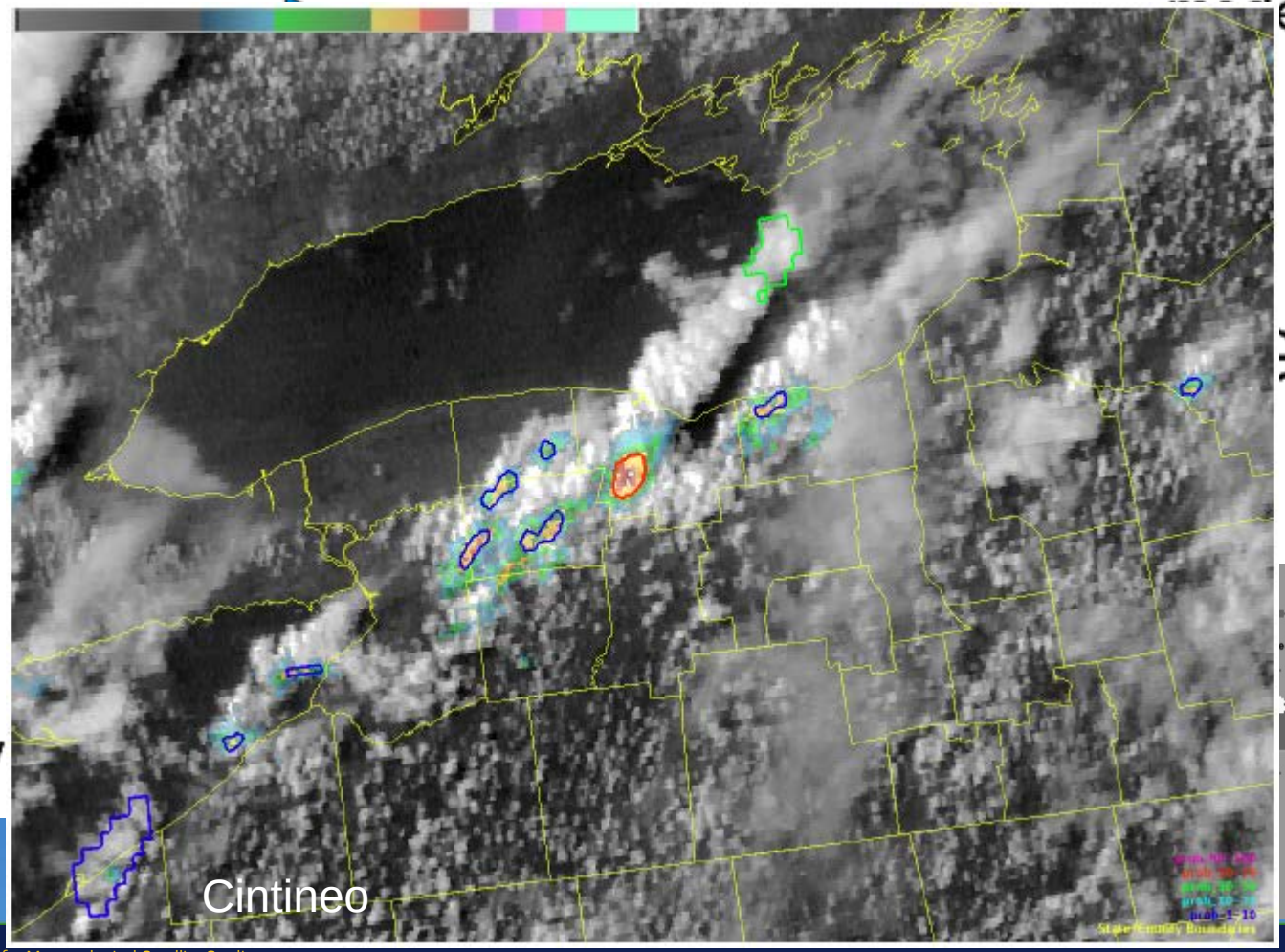
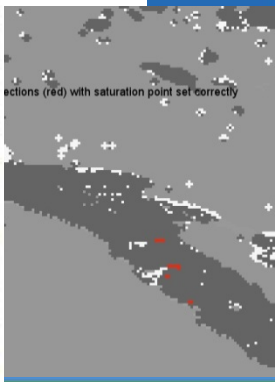
new



# Science Highlights

algorithms

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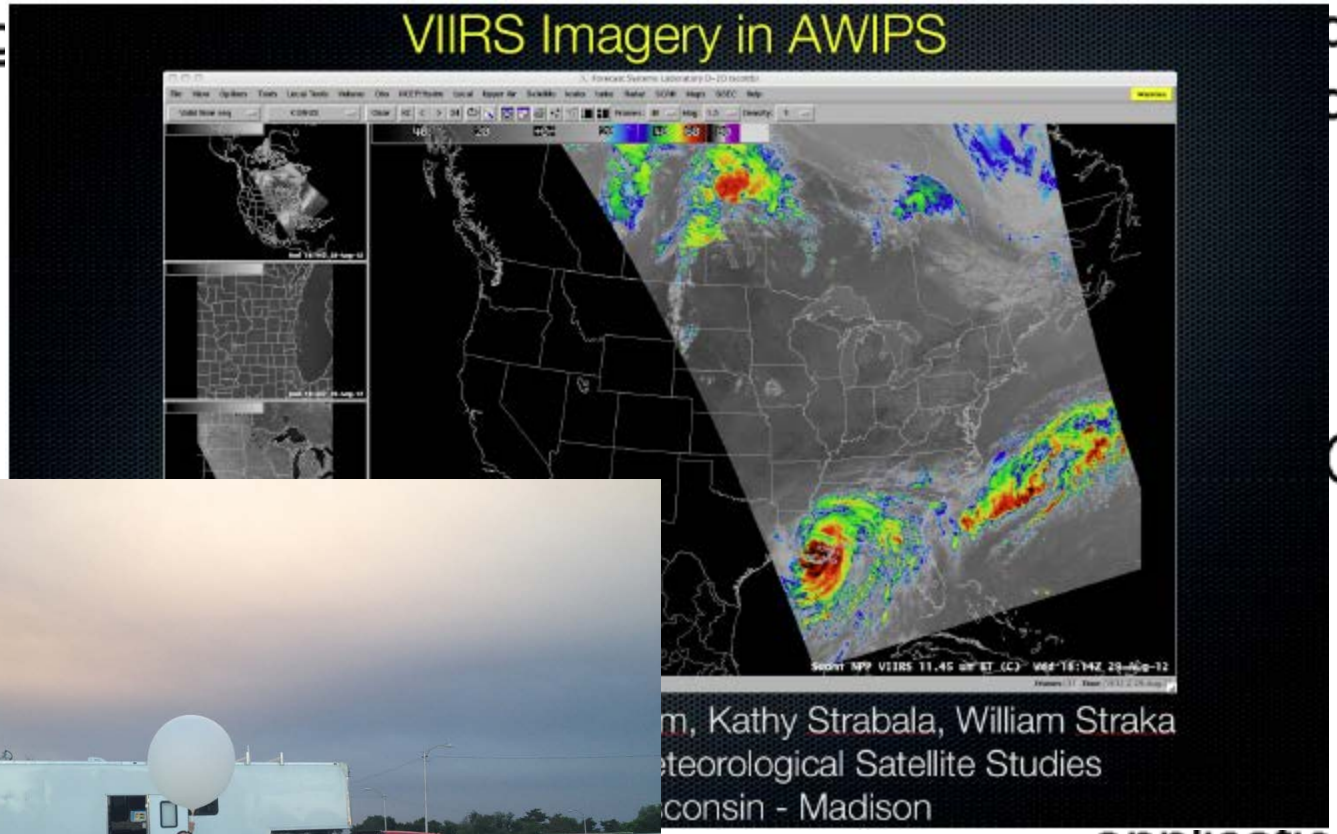
# Science Highlights




# One example: satellite data assimilation in a regional NWP model for research and applications

- Better cloud detection for both infrared (IR) and microwave (MW) radiance assimilation
- IR radiance assimilation in cloudy skies

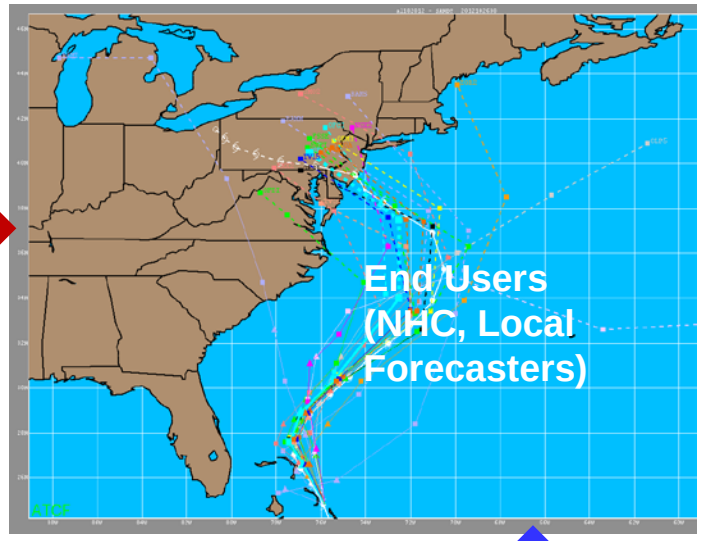
# Satellite Data Assimilation for Tropical storms (SDAT)
## (http://cimss.ssec.wisc.edu/sdat)

SDAT
(http://cimss.ssec.wisc.edu/sdat)

**Research Path**

WRF Assimilation at SSEC

Using TPW from MODIS/VIIRS LEO Sounder Profiles, and AMVs




**Hurricane Forecast Improvement**

**Research testbed**
for improving the utilization of GOES-R/JPSS data (Sounder, ABI, AMVs, Clouds)

R2O Research

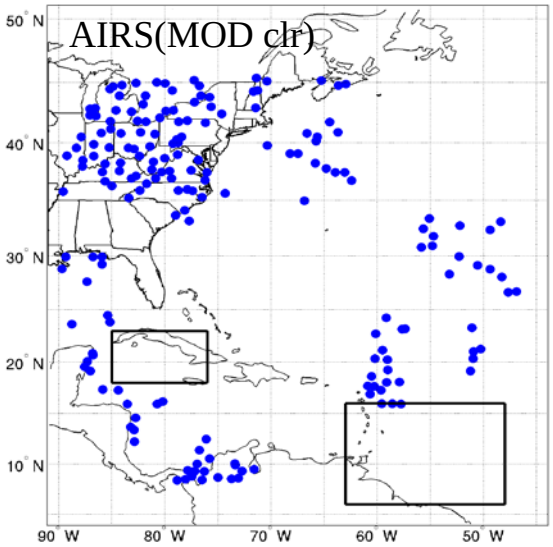
Operational NWP

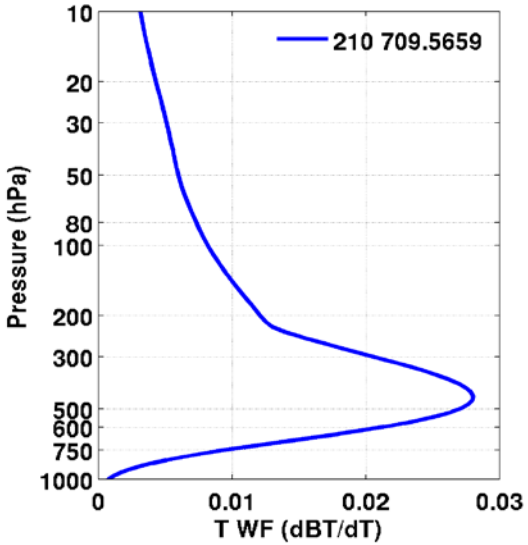
**Refining the Operational Path**

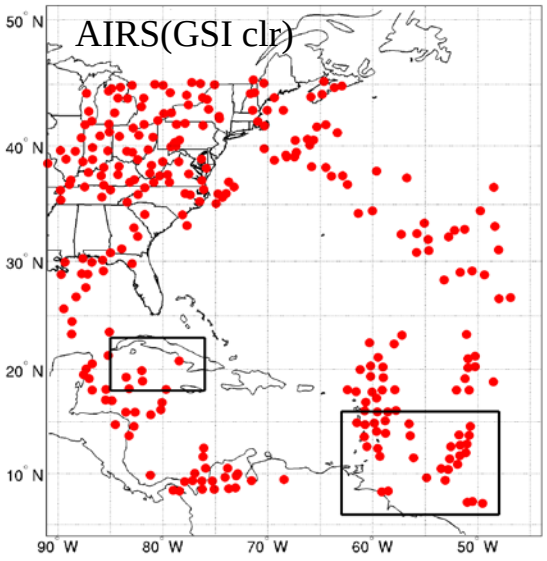
# Some ongoing methodologies for assimilating IR radiances in cloudy skies

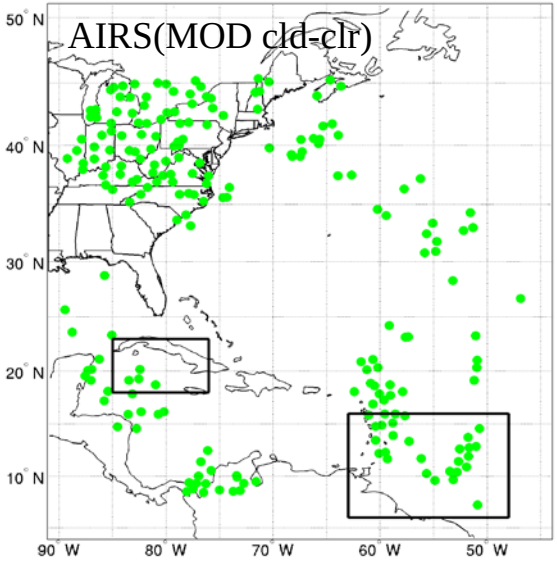
- Using radiances only from clear fields-of-view (FOVs)
- Using channels not affected by clouds (detection of clear channels is also challenging);
- Direct assimilation of cloudy radiances using RTM;
- Alternative approach for assimilating thermodynamic information
  - Cloud-clearing using background (EMC);
  - MW/IR sounder cloud-clearing (Chris Barnet)
  - IR imager/sounder cloud-clearing (keep single field-of-view spatial resolution for regional NWP applications)

# Using cloud-cleared radiances for assimilation



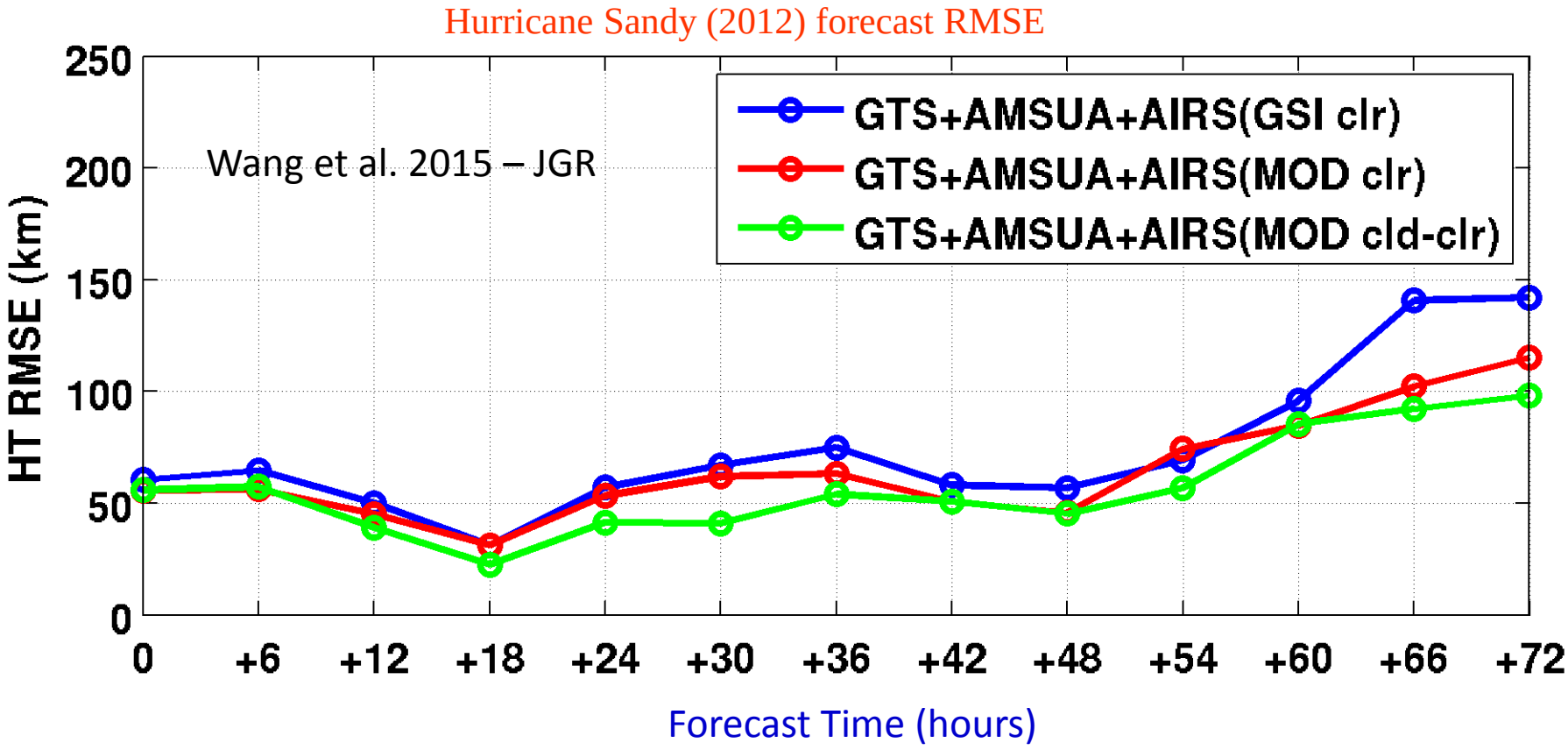

AIRS data locations at 18z 25, Oct 2012

- Data in cloudy regions according to MODIS cloud mask are assimilated as clear-sky in GSI, which contains cloud contamination.
- Cloud-clearing method generates clear equivalent radiances for assimilation in partially cloudy regions.
- Cloud-cleared radiances removes the cloud contamination and provides more clear equivalent radiances.

Li et al. 2004 - JAMC;
Li et al. 2005 – IEEE TGARS
Wang et al. 2014 – GRL
Wang et al. 2015 - JGR

# Impact of assimilating cloud-cleared radiances on forecasts

- The RMSE of the hurricane track from AIRS (MOD cld-clr) is the smallest among the three experiments for the whole process, especially after the 18-hour forecasts.
- The RMSE of the hurricane track from AIRS (MOD cld-clr) is around 10 km to 25 km smaller than that from AIRS (MOD clr), and is around 10 km to 50 km smaller than that from AIRS (GSI clr).
- For the maximum wind speed, the three experiments have comparable results, making it difficult to determine which is better experiment. So it is neutral for the three experiments.



# Microwave sounder sub-pixel cloud characterization with imager cloud product

MW sounder sub-pixel cloud characterization (see poster 1-48) with collocated imager cloud products

- ATMS/VIIRS onboard NPP
- AMSU-A/MODIS onboard Aqua

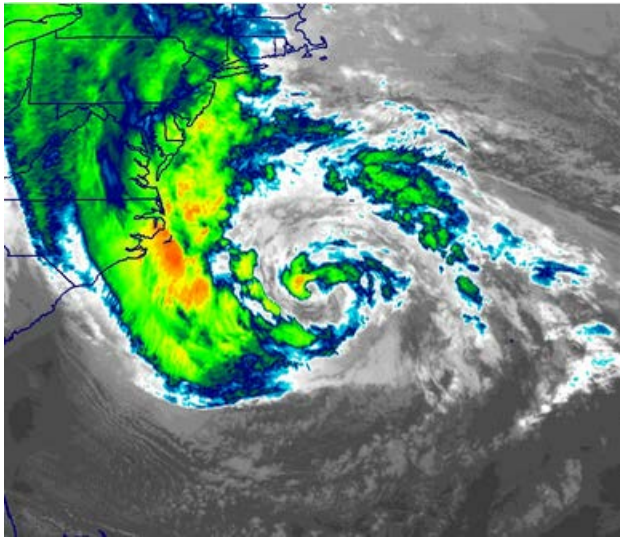
WRF-ARW v3.2.1, v3.6: 12km horizontal resolution, 35 vertical layers from SFC to 10 hPa

GSI v3.0, v3.3: 3-Dvar Data Assimilation Method

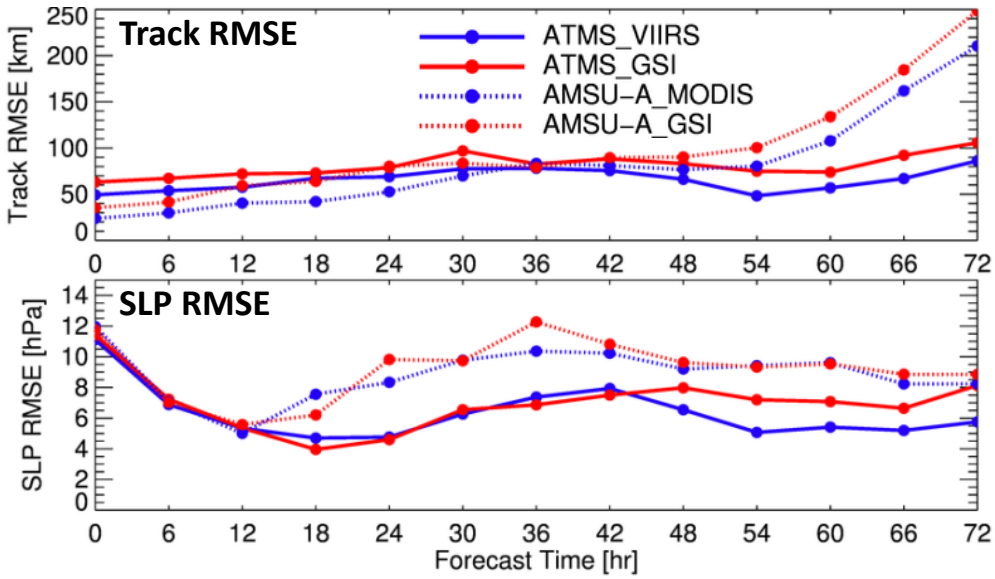
- NAM background error covariance matrix
- Cycled bias correction
- Conventional Data – from GTS
- Satellite radiances: ATMS/NPP, AMSU-A/Aqua

Hurricane Sandy

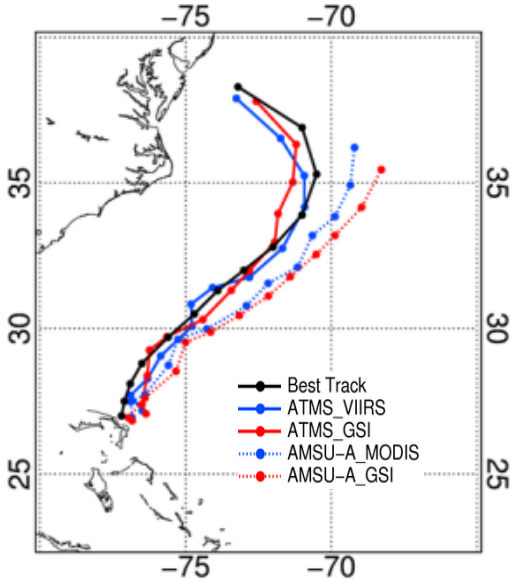
- Assimilation : Oct 25 06z to Oct 27 00z, 2012
- Forecasts: Oct 25 06 to Oct 30 00z, 2012
- Assimilation every 6 hour
- Assimilation window: 90 min



GOES-13 10.7 μm




Hurricane Sandy (2012) forecast RMSE from 8 groups.




72 hour track forecasts started at 18 UTC, 26 Oct

(1) ATMS (solid lines) is better than Aqua/AMSU-A (dashed lines) for Hurricane Sandy (2012 forecasts;
(2) MW sounder sub-footprint cloud characterization with imager cloud products (blue lines) improves GSI precipitating cloud detection (red lines) for radiance assimilation, which has the potential for operational use.

# Summary

- CIMSS is actively involved in GOES-R/JPSS science and applications
- Some CIMSS research progress are in near real time demonstration and applications
  - Tropical cyclone (http://tropic.ssec.wisc.edu/)
  - Satellite blog (http://cimss.ssec.wisc.edu/goes/blog/)
  - GOES real time product (http://cimss.ssec.wisc.edu/goes/rt/)
  - Regional satellite assimilation system (http://cimss.ssec.wisc.edu/sdat/)
  - CIMSS WRF-CHEM aerosol forecasting (http://raqms.ssec.wisc.edu/)
- CIMSS has also developed satellite data application software packages for national and international users
  - CSPP (Community Satellite Processing Package)
  - IAPP (International ATOVS Processing Package)
  - IMAPP (International MODIS/AIRS Processing Package)
  - McIDAS (Man computer Interactive Data Access System)
  - Polar Remote Sensing Software
  - VISITview