



# The U.S. Joint Center for Satellite Data Assimilation (JCSDA)

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*With Contributions from:*  
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*Director, JCSDA*



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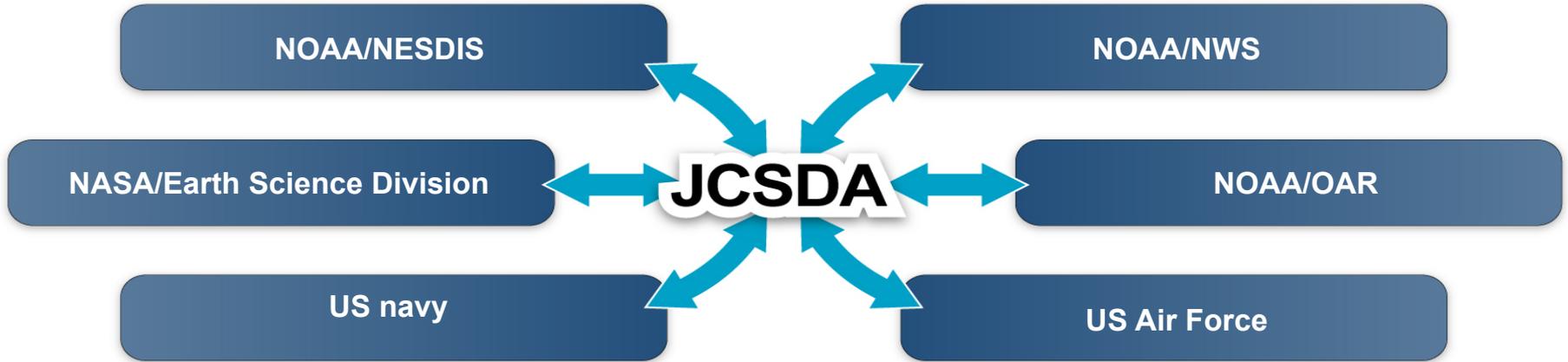
# Introduction



- ❖ **JCSDA started as a NASA/NOAA collaboration initiated in 2000**
- ❖ **Objective: Increase forecast accuracy;**
- ❖ **Approach: Gathering and leveraging of expertise in:**
  - Modeling
  - Computing
  - Observational data
- ❖ **Inclusion of DoD (Navy and AFWA)**
- ❖ **Memorandum of Agreement signed May 2008**
- ❖ **Terms of reference signed in August 2008**



# JCSDA Partners, Vision, Mission



## Vision:

### JCSDA aims at Research-To-Operations (R2O) activities:

*It has primarily the function to undertake research in various aspects of satellite data assimilation, to mature it for operational use and then help transition it to an operational environment in one or multiple JCSDA operational partners.*

*...to accelerate and improve the quantitative use of research and operational satellite data in weather, ocean, climate and environmental analysis and prediction models.*



# JCSDA Management

**Agency Executives**  
NASA, NOAA, Department of the Navy, and  
Department of the Air Force



**Management Oversight Board**  
NOAA / NWS / NCEP (Uccellini)  
NASA/GSFC/ESD (Dr Hildebrand)  
NOAA / NESDIS / STAR (A. Powell)  
NOAA / OAR (Atlas)  
Air Force Director of Weather (Col. Edwards)  
Navy / N84 and NRL (Chang, Curry)



**Advisory Panel**



**JCSDA Executive Team**  
Director (Riishojgaard)  
Deputy Director (Boukabara)  
Partner Associate Directors  
(Lapenta, Benjamin, Rienecker,  
Phoebus, Zapotocny)



**Science Steering  
Committee**



# JCSDA Budget



- ❖ JCSDA Budget is distributed in the JCSDA partners (NWS, NESDIS, OAR, NASA/ Earth Science Division, US. Air Force, US. Navy)
- ❖ It is a combination of Appropriation budget (mainly through NESDIS appropriation) and in-kind budget dedicated to JCSDA activities, from the partners.
- ❖ Total of appropriation and in-kind budget hovers around \$14M/year (varies from year to year), but with a core of \$3M of JCSDA-controlled budget (the rest being in-kind)
- ❖ These contributions (funds and in-kind) are documented annually through the JCSDA Technical Operating Plan (JTOP)
- ❖ This budget covers:
  - ❖ Data Assimilation Science projects (internal and external)
  - ❖ O2R activities
  - ❖ R2O activities
  - ❖ Software Integration
  - ❖ Administration and program planning
  - ❖ Computer resources
  - ❖ Visiting scientist program
  - ❖ Federal employees dedicated to JCSDA activities
  - ❖ Seminar Series and invitational travel
  - ❖ Training and Outreach (workshop, summer colloquium)
  - ❖ Etc



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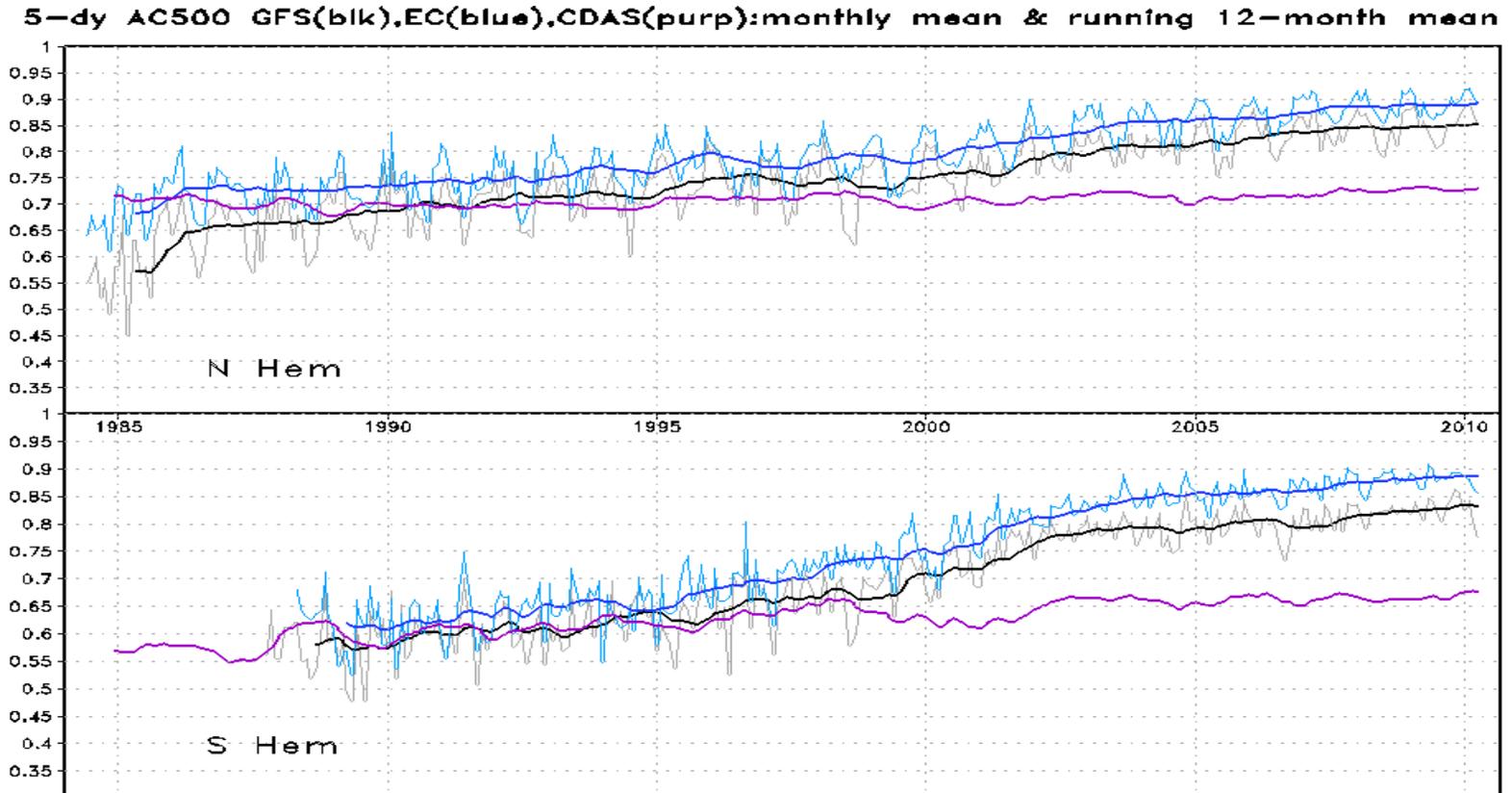
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# Why the emphasis on NWP goal?



- ❖ **JCSDA Short-term goal:** *“Contribute to making the forecast skill of the operational NWP systems of the JCSDA partners internationally competitive by assimilating the largest possible number of satellite observations in the most effective way”*





# Value of weather forecasting

*(non-official assessment)*



- ❖ Department of Commerce: “20% of overall US economy is weather sensitive”: *~\$2.8 trillion/year*
  - Impact to air and surface transportation, agriculture, construction, energy production and distribution, etc.
- ❖ Assume that half of this is “forecast sensitive”: *\$1.4 trillion/year*
- ❖ Assume that the potential savings due to weather forecasting amount to 5% of the “forecast sensitive total”: *~\$70B/year*
  
- ❖ Assume that the savings are distributed linearly over the achieved forecast range for the global NWP system:
  - 0 h useful forecast range => \$0 in savings
  - 336 h useful forecast range => \$70B in savings
  
- ❖ This implies that the value to the United States economy of NWP is *~200M per hour of forecast range per year !*



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**JCSDA Achievements and Major Activities**



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# JCSDA Performs Research and Transitions to Operations through



- ❖ **JCSDA partner' s in-Kind Research**
  - Research undertaken independently by partners, overlapping with JCSDA priorities
  - Results/deliverables made available and shared with/between partners
  
- ❖ **Directed research (short-term return-on-investment expected)**
  - Carried out by the partners
  - Mixture of new and leveraged funding
  
- ❖ **External research (near-term return-on-investment expected)**
  - Grants awarded following proposals submitted (administered alternately by NOAA, NASA and DoD on behalf on JCSDA)
  - Open to the broader research community
  - Funding awarded competitively, peer review process
  
- ❖ **Visiting scientist program (see [www.jcsda.noaa.gov](http://www.jcsda.noaa.gov))**
  - Great way to initiate or strengthen involvement with the Joint Center
  - Wide-open to data assimilation scientists from everywhere
  - Short-term (a few weeks/months) and Long-term (a few years) VS



# JCSDA Internal Research Program



- ❖ This is research for internal partners scientists, funded by JCSDA-labeled budgets
- ❖ Coordination with other programs (success story with JPSS program for funding NPP-related impact assessment study and accelerated R2O)
- ❖ This is the mechanism for immediate R2O (as opposed to longer-term R2O with the external research program)
- ❖ Examples include:
  - Assimilation of a new sensor directly into a JCSDA partner model
  - CRTM
  - NPP ATMS and CrIS data assimilation (into NOAA models)
  - SSMI/S data assimilation
  - GPS RO data assimilation
  - Etc



# JCSDA FY11 JSDI Selection

(NOAA Internal projects in support of JCSDA)



Proposal Label	Proposal Title	PI	Co-PI
<b>A</b>	JCSDA CRTM Development	Dr. Weng, STAR	Dr. Derber, NCEP
<b>B</b>	Satellite Data Handling & BUFR Tool	Dr. Derber, NCEP	Dr. Weng, STAR
<b>C</b>	Chinese FY-3 MWTS/MWHS Testing in GSI/GFS + SSMIS OSEs	Dr. Weng, STAR	
<b>D</b>	Satellite Wind Assimilation In GSI/GFS	Dr. Derber, NCEP	
<b>E</b>	Cloudy Radiance Assimilation Testing In GSI/GFS	Dr. Weng	
<b>F</b>	OSSE Support for the JCSDA	Dr. Weng	
<b>G</b>	Surface Wind Assimilation Testing/Data Denial experiments	Dr. Jung, Univ of Wisconsin	
<b>H</b>	GPSRO Support for JCSDA	Dr. Cucurull, NCEP	
<b>I</b>	Using Satellite Data to Improve Operational Air Quality Forecasting Capabilities	Dr. Pierce, STAR	Drs. Kondragunta , STAR and Derber, NCEP
<b>J</b>	STAR monitoring of SST analysis quality and EMC support of JCSDA SST analysis (task#1 and 3)	Dr. Ignatov, STAR	Dr. Grumbine, NCEP
<b>K</b>	Quantitative Use of Ocean Color Data in NCEP Operational Modeling	Dr. Bayler, NCEP	Drs. Behringer & Mehra
<b>L</b>	EMC Support for JCSDA Development: Land Data Sets	Dr. Ek, NCEP	
<b>M</b>	Assimilation of Satellite Soil Moisture Data from AMSR-E/ASCAT/ SMOS/AMSR2/SMAP	Dr. Zhan, STAR	Dr. Ek, NCEP



# JCSDA External Research Program

(1/2)



- ❖ There is a commitment in JCSDA to remain engaged with the external research community to benefit from outside expertise in satellite data assimilation
- ❖ Internal JCSDA partners NOT eligible to apply for this external research program
- ❖ Priorities revisited for each cycle
- ❖ JCSDA acquired IT resources recently (supercomputer), made available to JCSDA external partners to test their science improvement on JCSDA partner systems and codes (O2R)
- ❖ The external research program is executed through:
  - NOAA Federally-Funded Opportunity FFO (grants);
  - NASA ROSES announcement (contracts)



# JCSDA External Research Program

(2/2)



- ❖ The review, selection and funding recommendation are performed by the JCSDA executive team, then briefed to the Management Oversight Board
- ❖ Projects typically funded for 2-3 years period.
- ❖ Other programs are approached to coordinate external research funding (success story with NESDIS-GOES-R) which could be extended to testbeds and proving grounds.
- ❖ This is the longer-term R2O
- ❖ Examples of projects include:
  - Maintenance of high-quality spectroscopy
  - Assimilation of AMVs into NOAA operational models
  - Development of a common, consistent infrared and microwave emissivity database for use as a priori information in the JCSDA
  - Improved impact of Atmospheric Infrared Sounder Radiance Assimilation in Numerical Weather Prediction
  - Etc
- ❖ 42 projects funded so far, since 2004
- ❖ Upcoming FFO call in fall 2012.



# Example of JCSDA External Research

## Selected Projects through the NOAA FY10 FFO



Proposal			
Number	Title	Institution	PI
1	Radiative Transfer Modeling Support to the JCSDA (Applic. #2176792)	Atmospheric & Environmental Research (AER)	Jean-Luc Moncet, PI Vivianne Payne, Co-PI
22	Techniques for Assimilating Geostationary Lightning Mapper Data & Assessment of the Resulting Impact on Forecasts	NOAA/National Severe Storms Lab.	Don MacGorman, PI Edward Mansell, Co-PI Conrad Ziegler, Co-PI
11	Research in support of Radiance Assimilation of Clouds & Precipitation	University of Wisconsin	Tom Greenwald, PI Ralf Bennartz, Co-PI
3	Data Assimilation of Lightning in WRF 4-D VAR Using Observation Operators (Applic. #2176840)	Florida State Univ.	Henry Fuelberg, PI I. Michael Navon, Co-PI
16	Utility of GOES-R Instruments for Hurricane Data Assimilation & Forecasting	Colorado State University	Milija Zupanski, PI Louis Grasso, Co-PI Dusanka, Zupanski, Co-PI
4	Evaluation & Further Improvement of Land Surface Temperature... (Applic. #2176847)	Univ. of Arizona	Xubin Zeng, PI Michael Barlage, PI Zhou Wang, Co-PI Fei Chen, Co-PI
14	CIMSS Participation in the Utility of GOES-R Instruments for Hurricane Data Assimilation & Forecasting	University of Wisconsin	Jun Li, PI Milija Zupanski, PI Dusanska Zupanski, Co-PI Louis Grasso, Co-PI
10	MODIS & AVHRR-derived Polar Winds Experiments-using the NCEP GDAS/GFS	University of Wisconsin	David Santek, PI James Jung, Co-PI

**GOES-R funded**

*All projects have received notification of the award and have accepted*



# JCSDA Working Groups



- ❖ Technical Working groups have been established to help coordinate and leverage efforts between JCSDA partners
  - Objective is to spread knowledge, leverage efforts, share experiences (and codes)
  - By field of expertise
  - Open to all experts (not just partners)
- ❖ JCSDA WGs also serve as a link between Internal JCSDA scientists and externally funded scientists (from academia, private sector, other agencies, etc)
- ❖ Seven WGs formed so far
  - CRTM,
  - IR sounders,
  - Microwave sensors,
  - Ocean data assimilation,
  - Atmospheric constituents,
  - Land data assimilation
  - Cloudy And Rainy data assimilation



# Training, Education & Outreach



- ❖ **Monthly Seminar Series**
- ❖ **Summer colloquium in satellite data assimilation (3-year cycle)**
- ❖ **Annual JCSDA workshop on satellite data assimilation**
- ❖ **Joint Workshops with Other Programs and International Partners**
- ❖ **JCSDA Newsletters (quarterly)**
  - ❖ Highlight achievements by JCSDA scientists (internal/external)
  - ❖ Disseminate results and promote collaboration
- ❖ **Active web site: [jcsda.noaa.gov](http://jcsda.noaa.gov)**



# JCSDA Seminars



- ❖ Typically one to two seminars per month in WWB, open to everyone.
- ❖ Good mix of national & international speakers on wide variety of satellite and data assimilation related topics
- ❖ Generally well attended, both in person and virtually (Webex and phone-in)
- ❖ Eminent scientists in satellite data assimilation -from OPCs & international partners-, and associated science (radiative transfer, quality control, etc)
- ❖ Advertised widely including through newsletter and NOAA-wide seminar announcements.
- ❖ All presentations online (along with audio recording)



# JCSDA Summer Colloquium



- ❖ Two-week summer school in data assimilation to develop future pool of experts for JCSDA partners
- ❖ Last colloquium in Stevenson, WA, 07/07-07/17, 2009)
- ❖ Outstanding program of lectures given by world-renowned experts
- ❖ 38 participants (almost all Ph.D. students or post-docs) from 8 countries, including the US
- ❖ Sponsored by all JCSDA partners
- ❖ Feedback sought from lecturers and participants and an effort is made to follow up with attendees after many years
- ❖ JCSDA plans to stay engaged in training in the future;
- ❖ Next colloquium planned for summer 2012 (Santa Fe, NM)

- ❖ The purpose of annual workshops is review the ongoing and planned scientific development sponsored by JCSDA, and plan, coordinate future efforts.
- ❖ Aims also at gathering feedback from scientists on future directions JCSDA should consider.
- ❖ The 9<sup>th</sup> JCSDA Annual Workshop on Satellite Data Assimilation took place May 24-25 2011 at the University of Maryland, College Park, MD.
  - ❖ It contains high-level scientific presentations from OPC and research community
  - ❖ 160 participants from JCSDA partners, Government agencies, FFO/JSDI funded projects, academia, private industry (in May 2011).



*Picture taken during the 9<sup>th</sup> JCSDA Annual workshop on Satellite Data Assimilation, which took place May 24-25, 2011 at the University of Maryland, College Park, MD.*



# Interaction with other Programs & International Partners



## ❖ ECMWF-JCSDA Workshop on Clouds and Precipitation

- ECMWF, Reading June 2010
- Follow-on to 2006 JCSDA Workshop
- ~60 participants (20 from the US)
- Important topic for NWP and data assimilation in terms of products, modeling and observations
- Preparation of NWP users for future missions (e.g. GPM)
- Recommendations in Workshop Summary (mostly model and data assimilation system development)

## ❖ JCSDA-HFIP Workshop on Satellite Data Assimilation for Hurricane Forecasting

- AOML, Miami, Dec 2-3 2010
- 50+ scientists from research and operations
  - Current data assimilation systems used for hurricane prediction
  - Various types of satellite data used for hurricane prediction
  - Future directions
- Full Workshop Report (including recommendations) available at:

[http://www.jcsda.noaa.gov/meetings\\_JCSDA-HFIPWorkshop2010.php](http://www.jcsda.noaa.gov/meetings_JCSDA-HFIPWorkshop2010.php)

## ❖ Upcoming: JCSDA will be the local host for the Fifth *WMO Workshop on the Impact of Various Observing Systems on NWP*, 21-25 May 2012 in the US (Sedona, AZ)

# 1<sup>st</sup> Joint HFIP-JCSDA Workshop

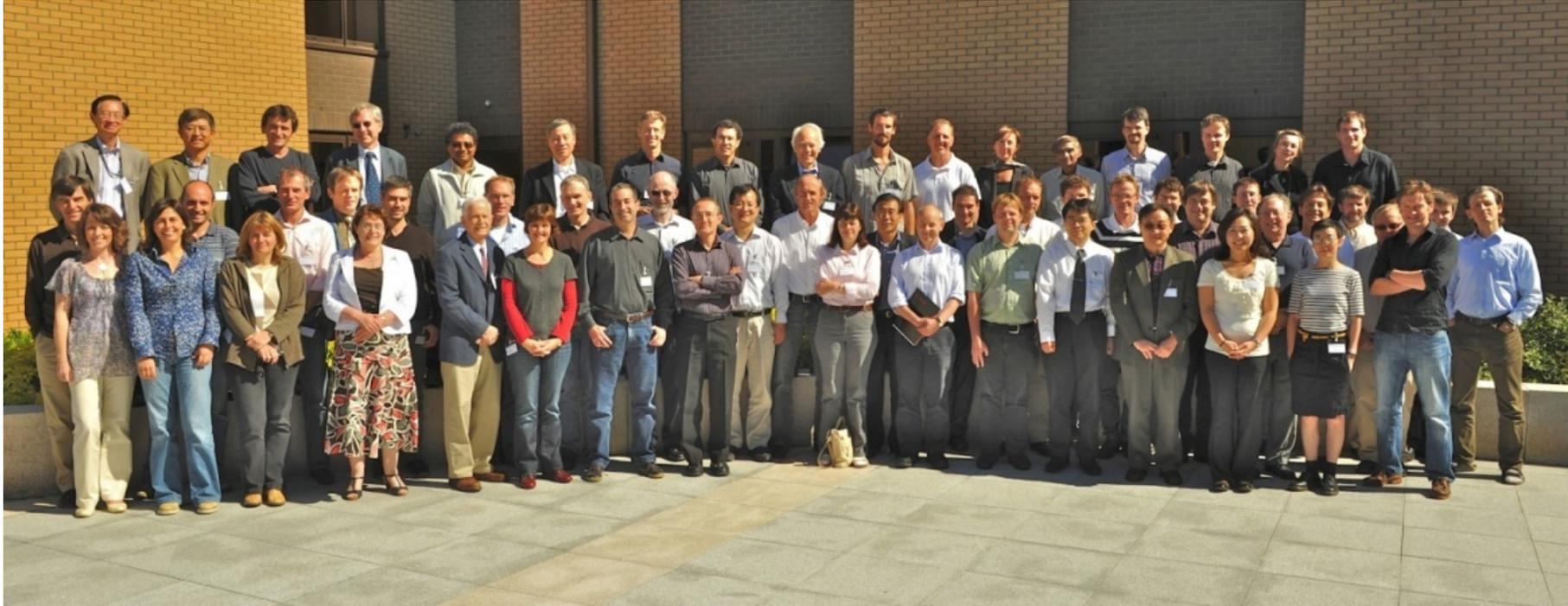
- **JCSDA and the NOAA' s Hurricane Forecasting Improvement Project (HFIP) organized a joint scientific workshop, the first of its kind, dedicated to satellite data assimilation for hurricane forecasting. It was held at the AOML, Miami, Florida December 2 -3, 2010.**
- **The purpose was to assess the status of using satellite data in hurricane and gather recommendations from scientific experts to guide future directions that would most likely help optimize the usage of satellite data in improving track and intensity forecasts.**
- **Some key recommendations that were made are :**
  - **Need for flow dependency covariances which is provided by EnKF or 4D Var/EnKF Hybrid approaches.**
  - **Need to utilize state-dependent data thinning techniques.**
  - **Need to make more effective use of satellite imagery, atmospheric motion winds, scatterometry, as well as sounding data (IR and MW) as close to core as possible.**



*Participants of the first joint JCSDA-HFIP workshop on satellite data assimilation for hurricane forecasting, held in Miami, FL on Dec 2-3, 2010.*

# Joint ECMWF-JCSDA Workshop

*Picture taken during the joint ECMWF-JCSDA workshop on assimilating satellite observations of clouds and precipitation into NWP models Reading, UK, June 2010.*



- **The Joint ECMWF-JCSDA workshop on Assimilating Satellite Observations of Clouds and Precipitation into NWP models, was held in Reading, UK, 15-17 June 2010.**
- **High level of scientific presentations and large gathering of scientists from around the world.**
- **The purpose of this workshop was to develop recommendations for both JCSDA and ECMWF on future scientific directions in the field of assimilating cloud- and rain-impacted radiances.**
- **A summary of the recommendations were published in a recent issue of a peer-review journal.**



# JCSDA Newsletter



## JCSDA Quarterly

No. 38, March 2012

Joint Center for Satellite Data Assimilation • 5200 Auth Road • Camp Springs • MD • 20746 Editor: George Ohring  
NOAA ..... NASA ..... US Navy ..... US Air Force  
Web-site: [www.jcsda.noaa.gov](http://www.jcsda.noaa.gov)

### News in This Quarter Science Update

#### Improving Tropical Cyclone Forecasts with Water Vapor and Temperature Information from Satellites

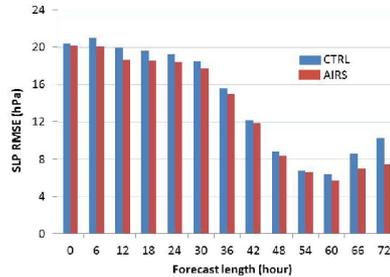


Fig 1. Hurricane Irene (2011) central sea level pressure (SLP) forecast RMSE for 0-h (analysis) and 6-h to 72-h forecasts. Every 6 hours between 06 UTC 23 and 00 UTC 25 August 2011 the data are assimilated with WRF/DART followed by a 72-hour forecast. The SLP RMSE is calculated from comparisons with the best track observations from the National Hurricane Center.

Under a grant from the JCSDA, scientists with the University of Wisconsin's Cooperative Institute for Meteorological Satellite Studies (CISS) are examining the use of water vapor and temperature observations from satellites to improve path and intensity forecasts for tropical cyclones. Lack of good temperature and water vapor information appears to be a limiting factor for accurate predictions of these systems.

The high vertical resolution atmospheric temperature and moisture profiles from the Atmospheric InfraRed Sounder (AIRS) are used to initialize/analyze the development of a hurricane. The Weather Research and Forecast (WRF) model and Data Assimilation Research Testbed - DART (WRF/DART) developed by the National Center for Atmospheric Research (NCAR) are used to assimilate the

AIRS data and generate the forecasts. By assimilating these sounding measurements, the representation of environmental conditions around the hurricane is more realistic, and thus the path and intensity forecasts should be improved. The hurricane predictions are examined with and without the satellite atmospheric temperature and moisture information. We have conducted lifecycle forecast experiments for hurricane Irene (2011). The assimilation time window is 1 hour (minus/plus 30 minutes) for AIRS. Every 6 hours between 06 UTC 23 and 00 UTC 25 August 2011, the data are assimilated with WRF/DART using 32 ensemble members, and 72-hour forecasts are performed after each assimilation. Two types of forecast sequences are conducted: a control run, which assimilates data from radiosondes, satellite cloud winds, aircraft, ships, and land surface stations; and an experimental run, which assimilates the same data as the control run plus AIRS single field-of-view (SFOV) soundings in clear skies.

The root mean square errors (RMSE) of the hurricane track and intensity forecasts are calculated using verification data from the best track observations of the National Hurricane Center. The total forecast number for each lead time is 256. Hurricane Irene (2011) intensity (central sea level pressure) forecast RMSE for 0-h (analysis) and 6-h to 72-h forecasts are shown in figure 1. Since the background fields for the first analysis are from the Global Forecast System forecasts, both control and AIRS runs show relatively large errors in sea level pressure in the early stages; these errors are gradually reduced as the model progresses in time. However, the AIRS soundings consistently lead to improvement of intensity forecasts during the process. Results of additional experiments with WRF/3DVAR were consistent with those from WRF/DART.

The impact of assimilating Moderate Resolution Imaging Spectroradiometer (MODIS) and Advanced Microwave Scanning Radiometer - Earth Observing System (AMSR-E) total precipitable water (TPW) on tropical cyclone analyses is also investigated. MODIS has a high spatial resolution of 5 km but has limited spatial coverage in clear skies; AMSR-E has a coarse spatial resolution of 21 km but has the advantage of coverage in cloudy skies. The assimilation experiments were conducted with the WRF/DART for Typhoon Sinlaku from 8 to 13 September 2008. Results show that both IR (MODIS) and microwave (AMSR-E) TPW measurements improve the track and intensity analysis when compared with the control run which assimilates radiosondes, satellite atmospheric motion vectors, QuickSCAT winds, COSMIC GPS-RO, ship and land surface observations. Microwave TPW provides a better

- ❖ JCSDA newsletter published quarterly:
- ❖ Contributions from all JCSDA partners and others welcome
- ❖ All previous newsletters available on JCSDA website <http://www.jcsda.noaa.gov>
- ❖ Funded PIs are requested to contribute to the JCSDA newsletter



# An active JCSDA Web Site:

*Where to get More Information*



- ❖ JCSDA Web site includes info about:
  - More description of the JCSDA activities/research areas of interest
  - Current Research Opportunities
  - Past and current newsletters
  - Seminar announcements
  - JCSDA-relevant career opportunities
  - Details about the visiting scientist program
  - List of past and currently funded projects
  - List of JCSDA-funded projects publications
  - Analysis of data assimilation experiments (new)
- ❖ <http://www.jcsda.noaa.gov>



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# JCSDA Science Priorities



***Overarching goal: Help the operational services improve the quality of their prediction products via improved and accelerated use of satellite data and related research***

- ❖ Radiative Transfer Modeling (CRTM)
- ❖ Preparation for assimilation of data from new instruments
- ❖ Assimilation of data impacted by Clouds and precipitation
- ❖ Assimilation of land surface observations
- ❖ Assimilation of ocean surface observations
- ❖ Atmospheric composition; chemistry and aerosol

***Driving the activities of the Joint Center since 2001,  
approved by the Science Steering Committee***



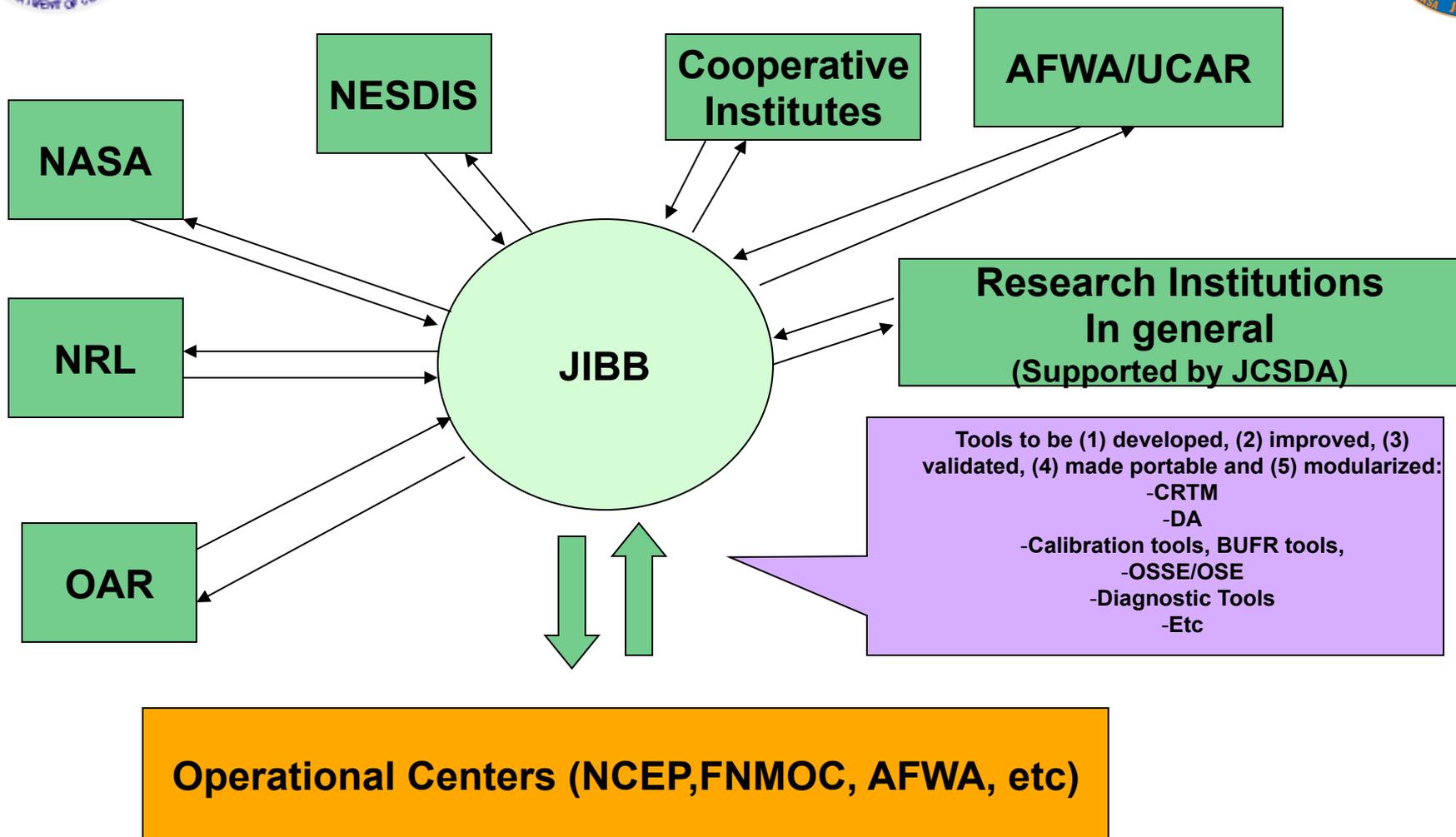
# JCSDA Technical Priorities



- ❖ Allow a robust O2R
  - Establish independent IT capability including Supercomputer to run data assimilation experiments using JCSDA partners models
- ❖ Consolidate the software integration
  - Leverage each other's achievements
  - Avoid duplication by sharing codes and experiences
  - Emphasize 'community' packages
- ❖ Formalize an R2O mechanism through a set of transparent protocols and benchmarks
  - An agreement is being formalized between NESDIS and NWS in conjunction with JCSDA



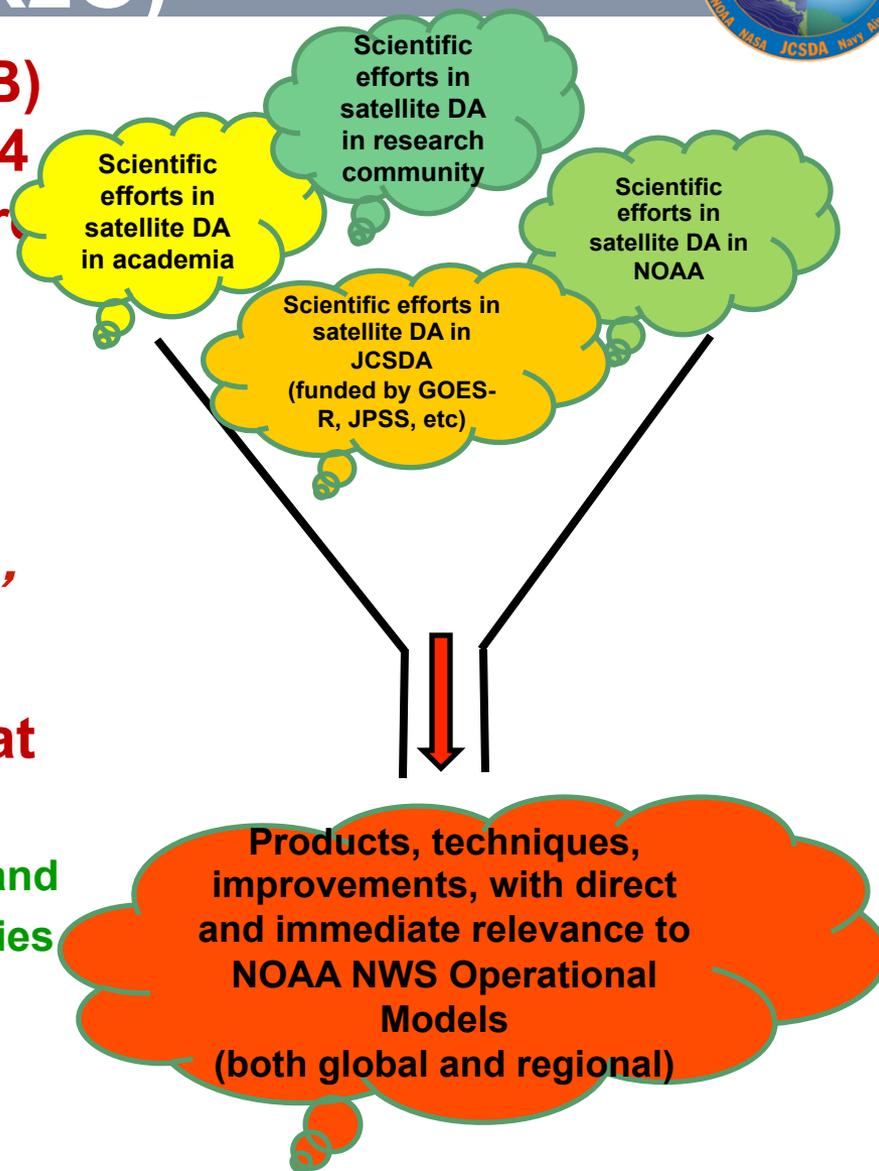
# O2R: Establishing an Operational DA Environment for Research



❖ The JCSDA Supercomputer (JIBB) and NOAA's Supercomputers (S4 for NESDIS and Zeus for NWS) are a key component in the O2R strategy of the JCSDA for the NOAA partner.

❖ JIBB strategy aims at *'funneling'* the JCSDA data assimilation activities into an environment that is

- Conducive for innovation and research, and
- Relevant to NOAA by *making sure* activities use operational models (which allows immediate benefits)
- Offers an R2O path



## ❖ The JIBB is not just the supercomputer:

- Supercomputer (Hardware, basic software and IT) (almost the easiest part!)
- Scientific Software Integration (the hardest part: keep in synch with operational models)
- User Support
- Management of resources
- Radiative Modeling (CRTM development and proxy data simulation activities)
- BUFR-formatting tool & satellite data handling ensuring proper feed to NWP
- **But perhaps more importantly.....(R2O)**
  - A path to operations for those scientific activities/outcomes that show a positive impact on the forecast skill
  - R2O is a subject of a draft agreement between JCSDA and NWS/NCEP that crystallizes the protocols and procedures that need to be followed





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# JCSDA Recent Accomplishments



- ❖ Community Radiative Transfer Model (CRTM) shared by all partners
- ❖ A robust (benchmarked) O2R infrastructure through the JIBB supercomputer
- ❖ Numerous new satellite data assimilated operationally, e.g.
  - Microwave: AMSU and MHS (radiances, new QC,...), SSMI/S, Windsat, Jason-2,...
  - AIRS and IASI hyperspectral IR radiances,
  - GPSRO sensors (COSMIC, GRAS, GRACE),
  - MODIS (winds and AOD),
- ❖ Advanced sensors tested for operational readiness, e.g.
  - ASCAT,
  - MLS,
  - SEVIRI (radiances),
  - Assessment of the impact of FY3 data (MWTS, MWHS)
  - Etc
- ❖ Accelerated Readiness to assimilate new sensors
- ❖ Improvement to the usage of sensors already assimilated operationally
- ❖ Adjoint sensitivity diagnostics
- ❖ A global OSSE capability
- ❖ Global Observing system Impact Assessment (data denials)



# Community Radiative Transfer Model (CRTM)



- ❖ CRTM is a critical component of variational satellite data assimilation
- ❖ CRTM is fully supported by JCSDA Directed research
- ❖ CRTM is being used in all JCSDA partners and others.
- ❖ CRTM benefits from outside research: many projects were funded in academia, private sector, to help improve and assess CRTM
- ❖ The components of CRTM include: Atmospheric absorption, Surface emissivity modeling, radiative solving, aerosols scattering, etc)
- ❖ More than 100 sensors are simulated by CRTM
- ❖ Latest version recently developed to include airborne simulations and increase speed of execution

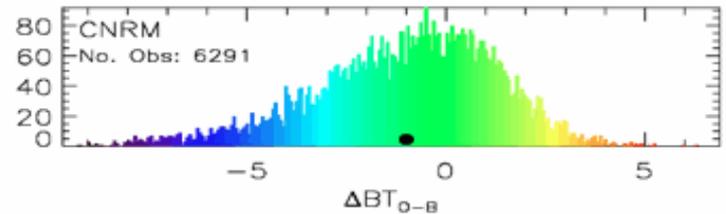
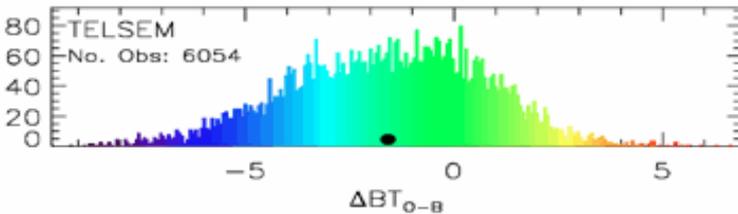
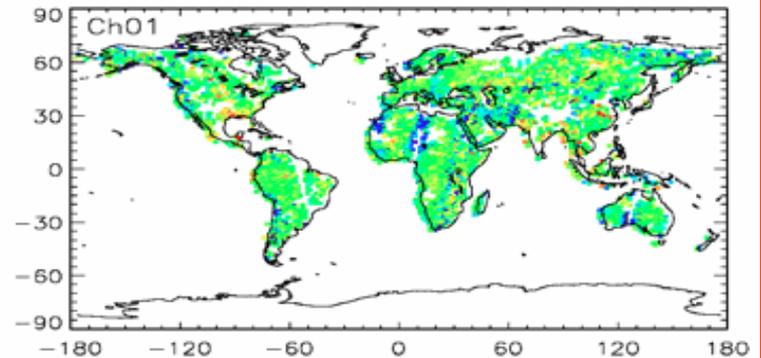
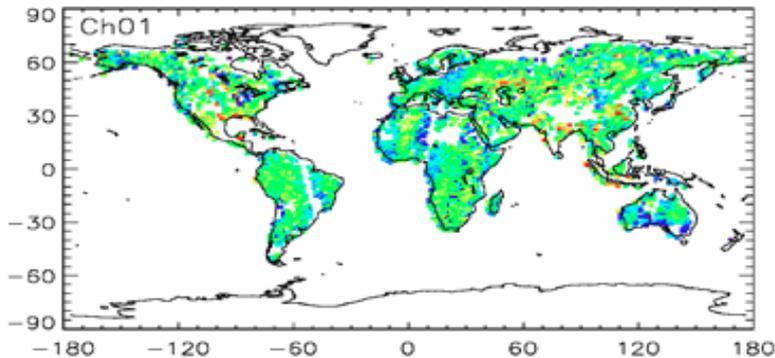
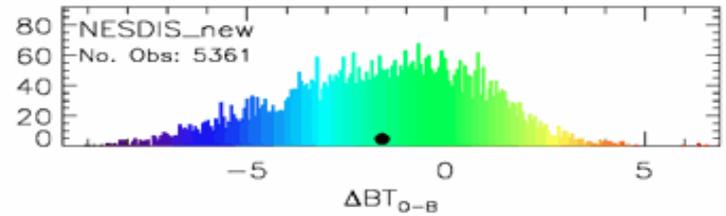
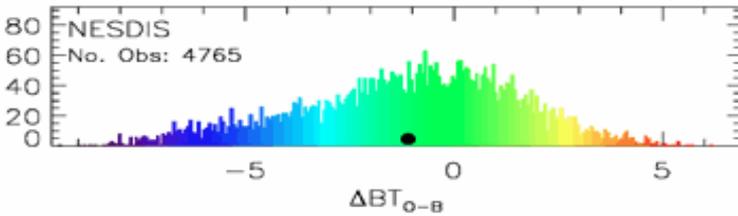
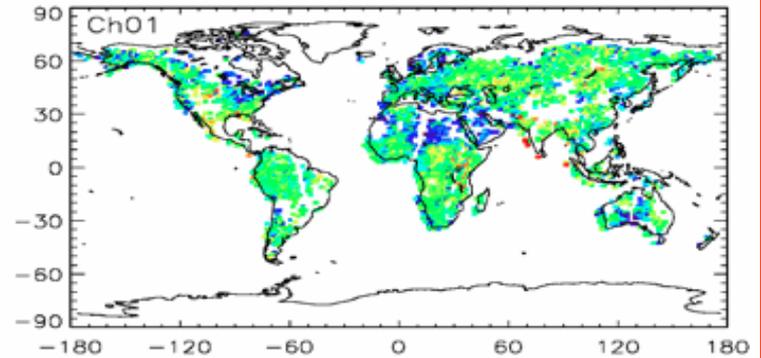
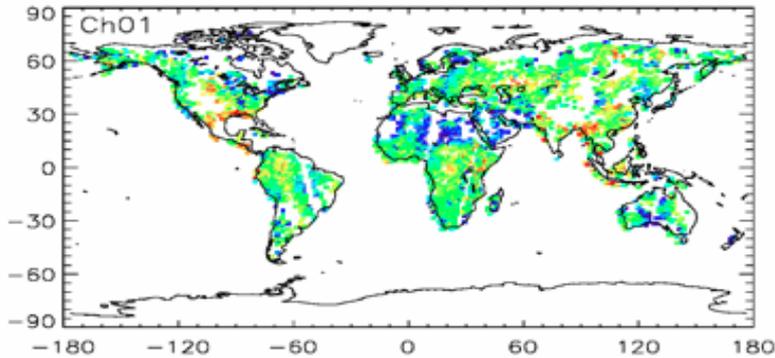


# Radiative Transfer Modeling (CRTM)

-Case of release v 2.0: Features and impact-



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- ❖ T
- ❖ E
- ❖ S
- ❖ E
- ❖ S



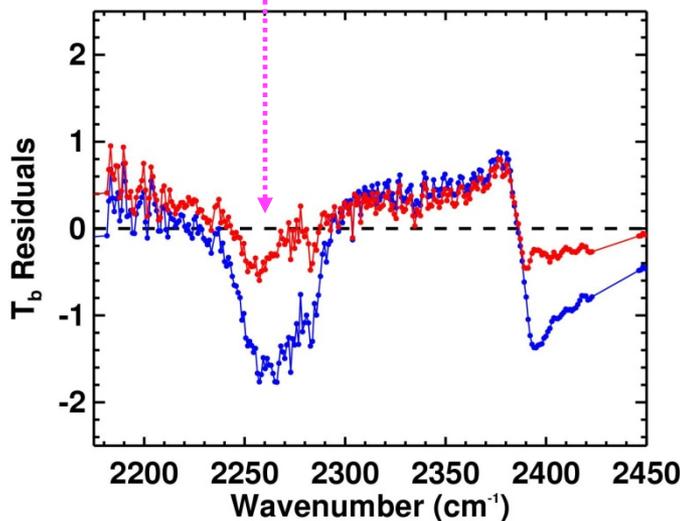
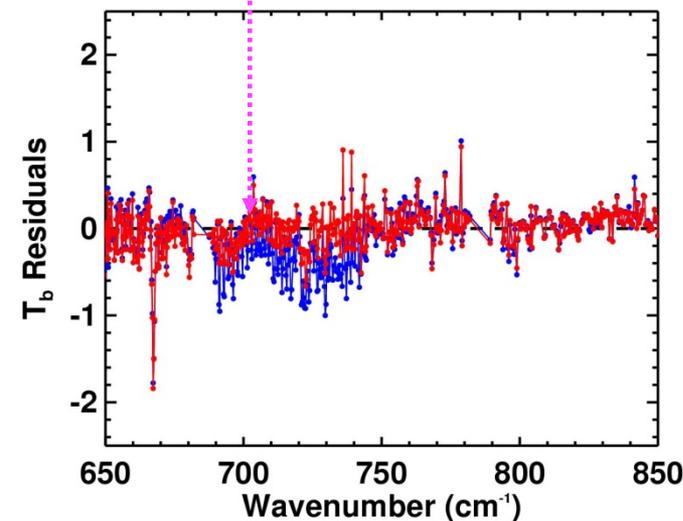
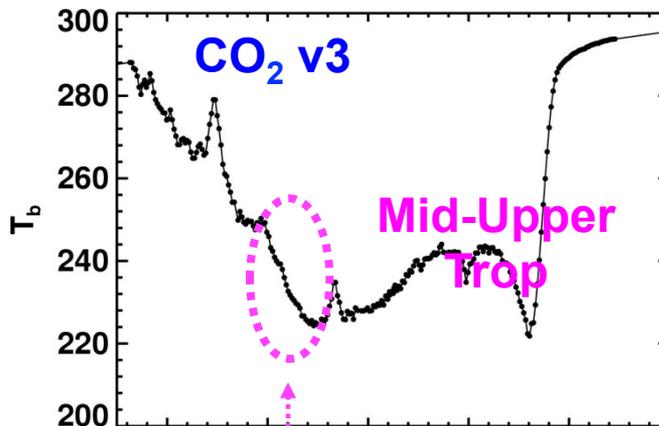
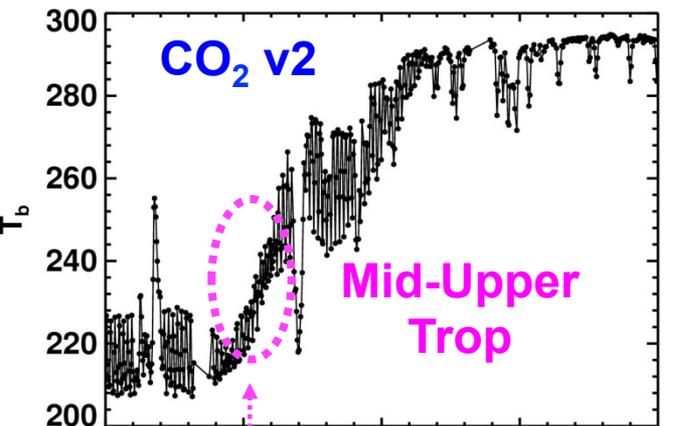
Anomaly Correction

3)

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missiv

Mean residuals from 36 AIRS ARM TWP cases using Tobin et al. best estimate sonde profiles



Previous version  
(2006)

- ❖ No P/R line cpl
- ❖ HITRAN 2000 CO2 parameters

Latest version  
(2011)

- P, Q and R line coupling
- Lamouroux et al. widths and line coupling
- Tashkun positions, intensities
- Updated CO2 and H2O continua

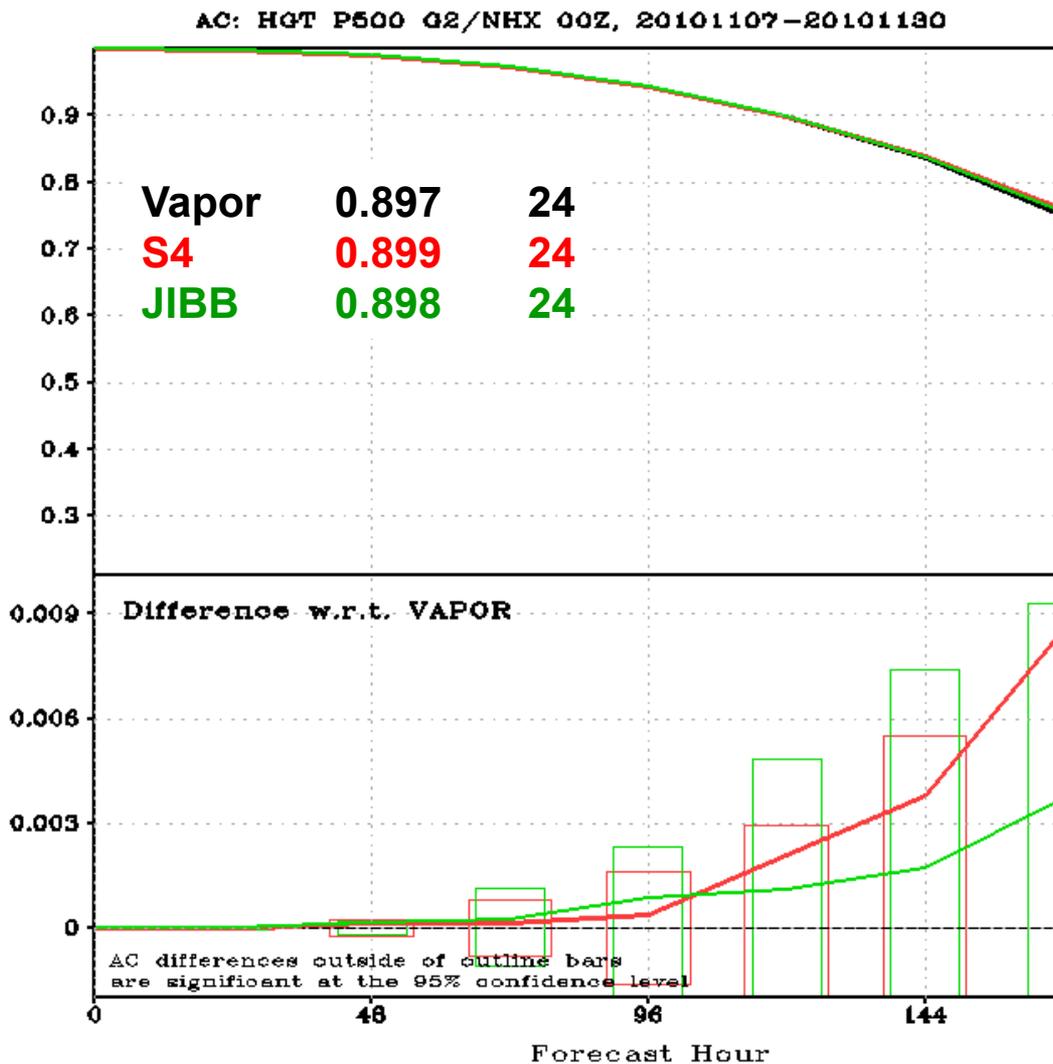
**Improved agreement (Obs - Calc) and consistency across spectral bands!**



# Benchmarking of O2R Infrastructure



- NOAA Global Satellite Data Assimilation System (GDAS) was implemented on the JCSDA supercomputer (JIBB) and the NESDIS Supercomputer (S4).
- Tests have been undertaken to compare results to those on the JCSDA machine (JIBB) and the NOAA R&D machine Vapor
- *performances comparison between a series of runs between S4-based, JIBB-based and Vapor-based supercomputers show that correlation performances are consistently similar.*
- *This allows us to declare that the O2R is ready*





# Global Observing System Impact Assessment Using NOAA Models

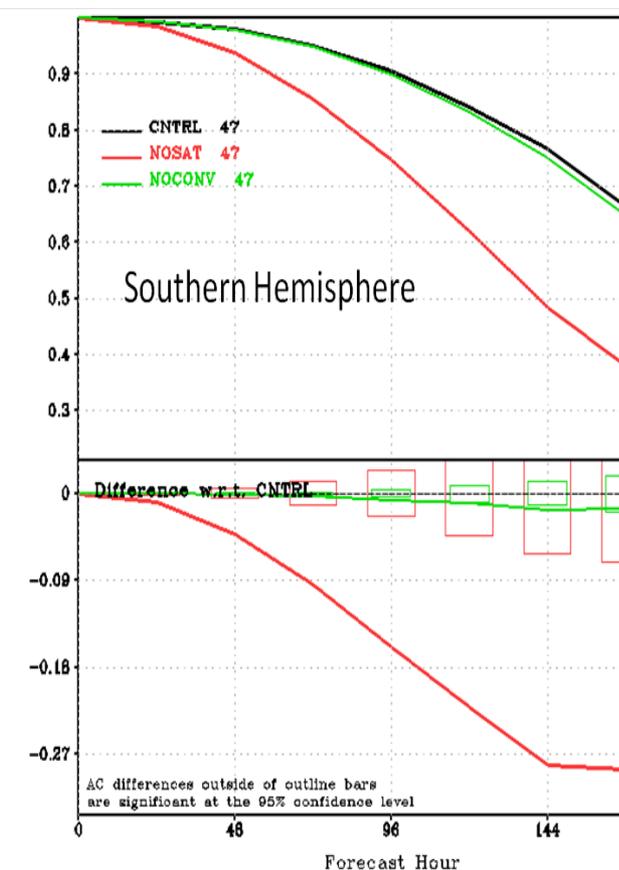
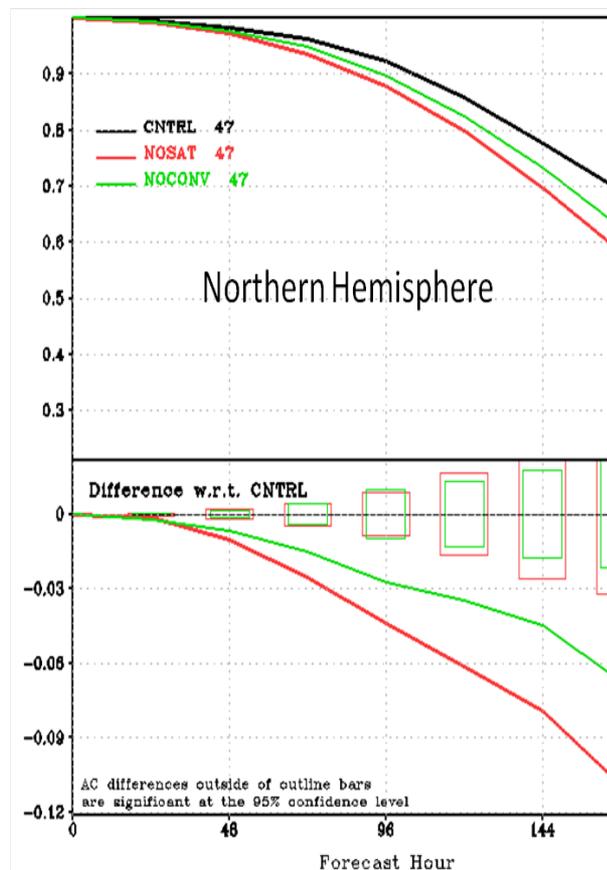


## (1) No Satellite / (2) No Conventional Data

15 Aug – 30 Sep 2010

500 hPa Anomaly Correlations

- An extensive assessment of the global observing system impact on NOAA forecast system has been undertaken.
- The impact assessment was done wrt satellite data (collectively & individually: microwave AMSU, MHS, GPS, hyperspectral IR, AMVs, etc) as well as conventional data.
- Satellite data as a group, had a very significant impact which surpasses the conventional data impact (by a wide margin), especially in the southern hemisphere.
- The impacts of individual classes of sensors did not add up to the significant impact above.
- Efforts are on-going to assess the impact of combination of sensors, in order to determine the optimal and most significant contributions.



Results from the extensive data denials experiments performed in the JCSDA, aimed at assessing the impact of the global Plots courtesy of J. Jung.



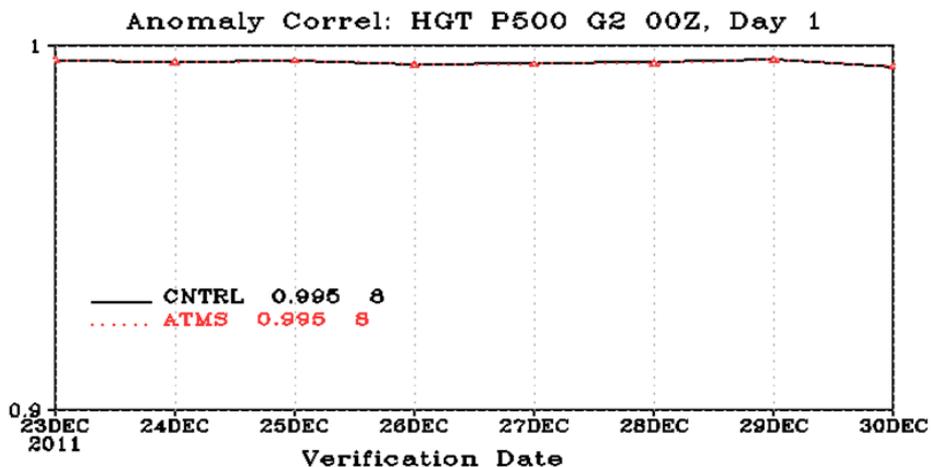
# Accelerated R2O for newly launched NPP/ATMS



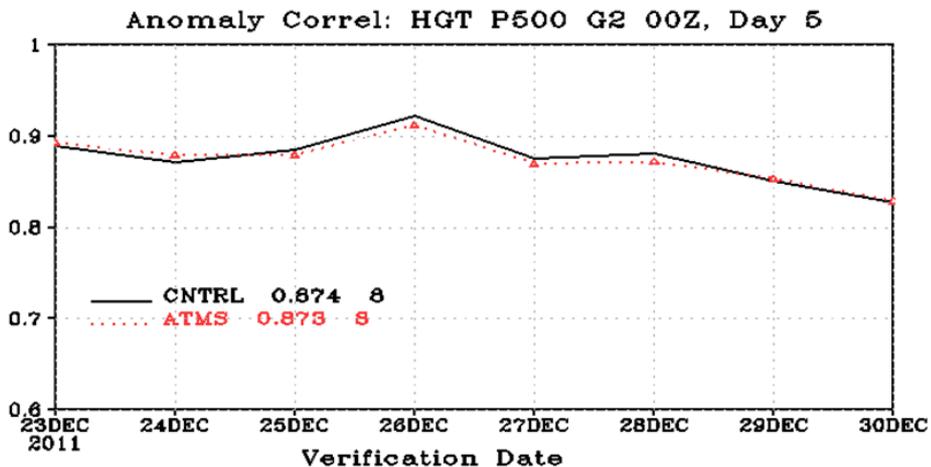
- JCSDA played a critical role in helping NWS accelerate the R2O of NPP/ATMS (one year earlier than originally planned)
- ATMS will be declared operational on May, along with the new version of the hybrid data assimilation system.
- Data Impact assessment of NPP/ATMS was performed on JCSDA infrastructure using new hybrid data assimilation system
- Results from the ATMS data denials experiments aimed at assessing the impact of the newly launched NPP/ATMS data on the NCEP hybrid assimilation/forecast system show that:
  - Effect is mostly neutral mainly due to the redundancy of sensors already present
  - Efforts will be made to assess the impact of ATMS as a replacement sensor (N19, Metop-A)

## 500 mb Height AC - Global

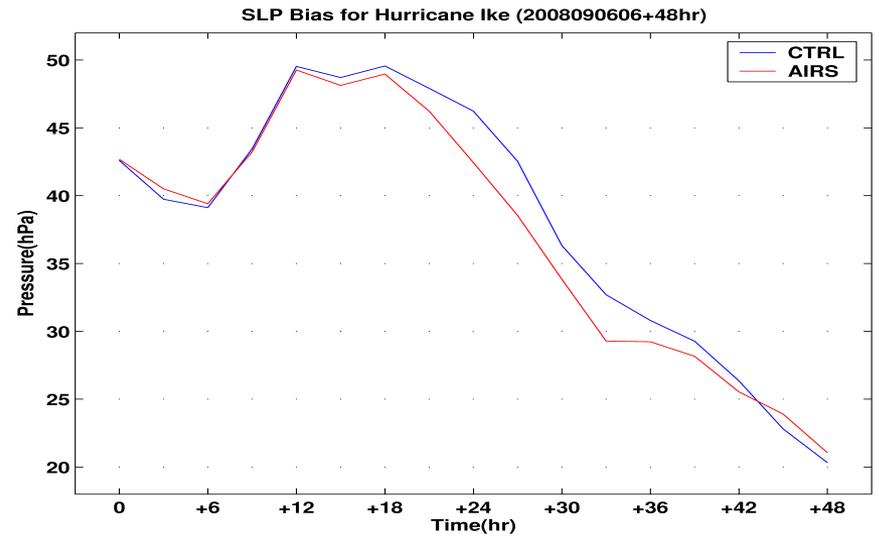
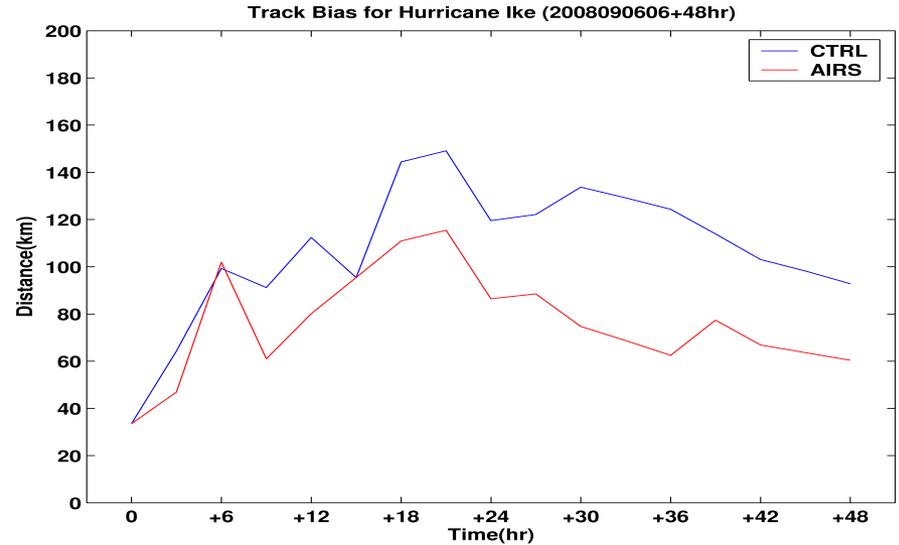
Day 1 AC



Day 5 AC



- Hurricane forecast improvement was achieved using the full spatial resolution AIRS temperature. Hurricane Ike (2008) served as test with WRF/3DVAR profiles.
- AIRS SFOV temperature soundings improve both the track and intensity forecast for Hurricane Ike (2008) (see plots).
- The plan is to do more experiments with water vapor profiles, data thinning, quality control and error covariance.
- Storm track bias and sea level pressure SLP differences (with and without assimilating 600 - 800 hPa AIRS high-resolution temperature layers). Improvements are noticeable especially for track bias.



Plots courtesy of Jun Li (CIMMS). FY10 JCSDA FFO project.



# Readiness for data assimilation of New Sensors



- ❖ **Goal is to have operational users ready to**
  - Assess data from new sensors from day 1
  - Assimilate data from new sensors within one year from launch
- ❖ **Current activities include**
  - NPP and JPSS: ATMS, CrIS
  - GOES-R: ABI, GLM
  - FY-3 microwave sounders (MWTS and MWHS)
  - GCOM-W AMSR/ASCAT/SMOS/AMSR2/SMAP (Soil Moisture)
  - GPS-RO satellites: TerraSar-X (TSX), SAC-C, and C/NOFS
- ❖ **Planned activities in the future**
  - Data Assimilation for GPM and Aquarius
  - Data Assimilation NASA/SMAP
  - GPS RO payload on: Oceansat-2(ROSA) and PAZ mission
- ❖ **Activities involve:**
  - Ready proxy data
  - BUFRization of data
  - Modification/testing of satellite data assimilation system and tools



# On-Going Improvements for Already-Assimilated Sensors



## ❖ Ongoing methodology improvement for sensors already assimilated :

- AIRS/IASI (channel selection, cloudy radiances, water vapor improvement, methodology, ...)
- Use of cloudy radiance assimilation (both IR and Microwave)
- GPSRO: COSMIC, GRAS, GRACE (methodology: bending angles vs refractivities, quality control, ...)
- MODIS winds (data selection, QC)
- OMI (observation operator, error covariances ...)
- SSMI/S (calibration correction, QC, etc)
- AMSU, MHS (water vapor channels assimilation, quality control methodology, etc)
- MLS (methodology, impact testing, etc)
- ...



# Observing Systems Simulation Experiments (OSSE)



- ❖ **JCSDA and partners (NESDIS, NWS, OAR, GMAO) established an OSSE capability (scientific expertise and IT infrastructure) in support of JPSS, GOES-R, DoD DWSS, Wind Lidar, NASA Decadal Survey and other missions. Close collaboration with ECMWF.**

**This OSSE effort serves three levels of benefits in JCSDA:**

- ❖ **Level 1 (Readiness)**

- Experiments with simulated (proxy) data from CrIS, ATMS along with existing data used in operations
- Purpose here is to test data flow and data ingest rather than data impact

- ❖ **Level 2 (Impact Assessment and Optimization of Sensor)**

- Using the Joint OSSE system
- All data simulated; purpose is to assess and optimize data impact

- ❖ **Level 3 (Decision Making Support)**

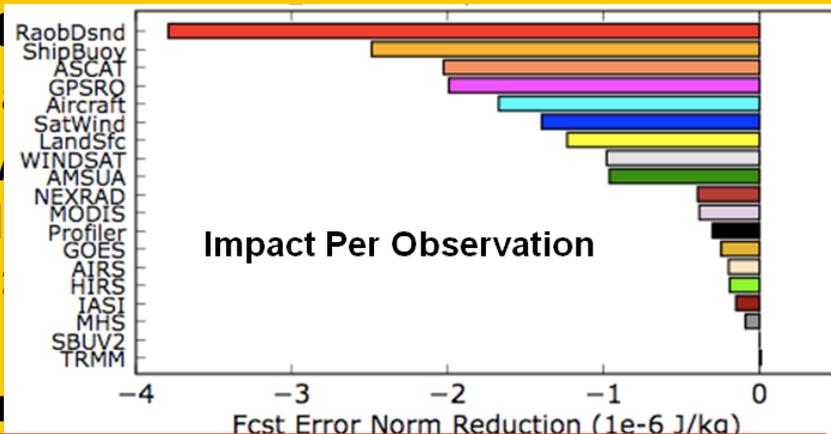
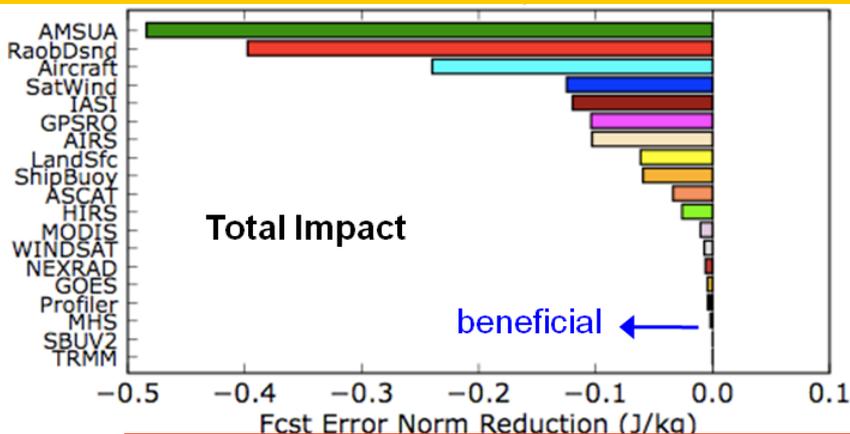
- Help optimize the Earth Observing System deployment (orbital configuration)
- Help in sensor design



# Observing Systems Evaluation (OSE) -Data Denials Experiments and Adjoint-

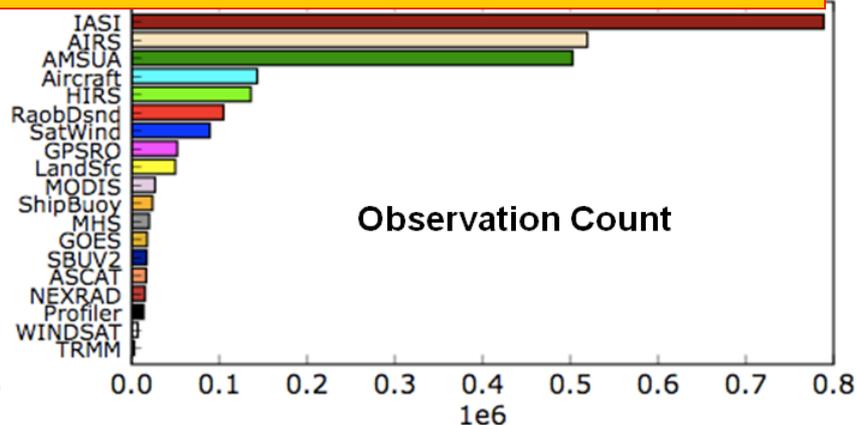
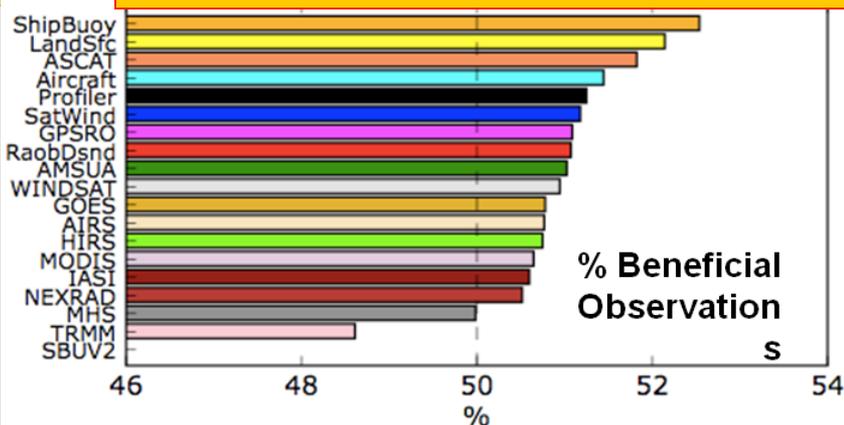


Experiments planned in the JCSDA, to assess contribution from (1) conventional and satellite data, (2) from individual satellites and (3) from individual sensors.



NOAA

Example of current impact assessment using NASA Adjoint-based Estimates  
Using GEOS-5 Forecasts 10 Nov 2010 – 02 Jan 2011



Adjoint-based estimate of 24-hr global forecast error reduction in wind, temperature and surface pressure combined as energy (J/kg), from sfc-150 hPa (plot courtesy of R. Gelaro, NASA)

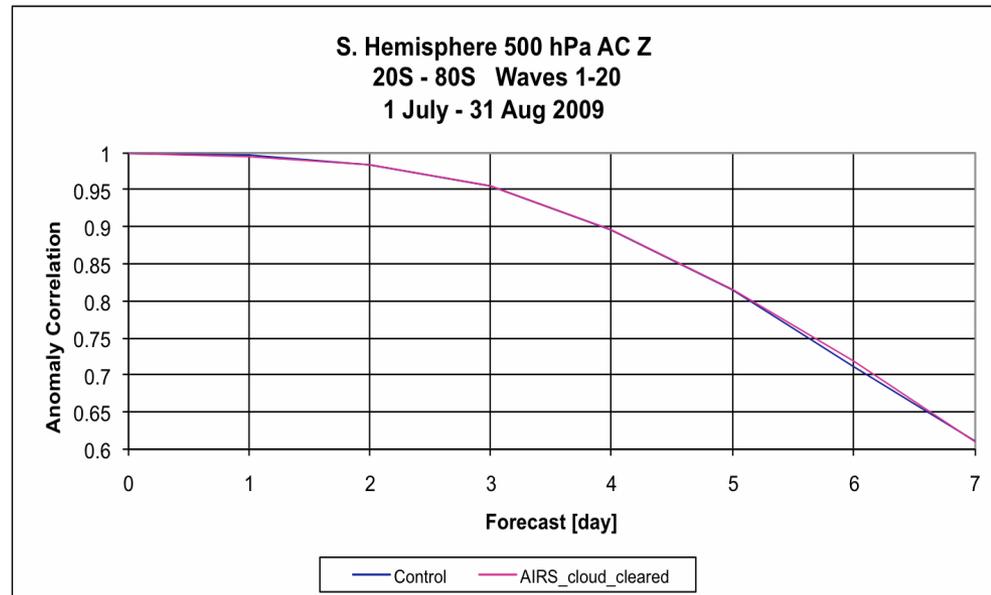
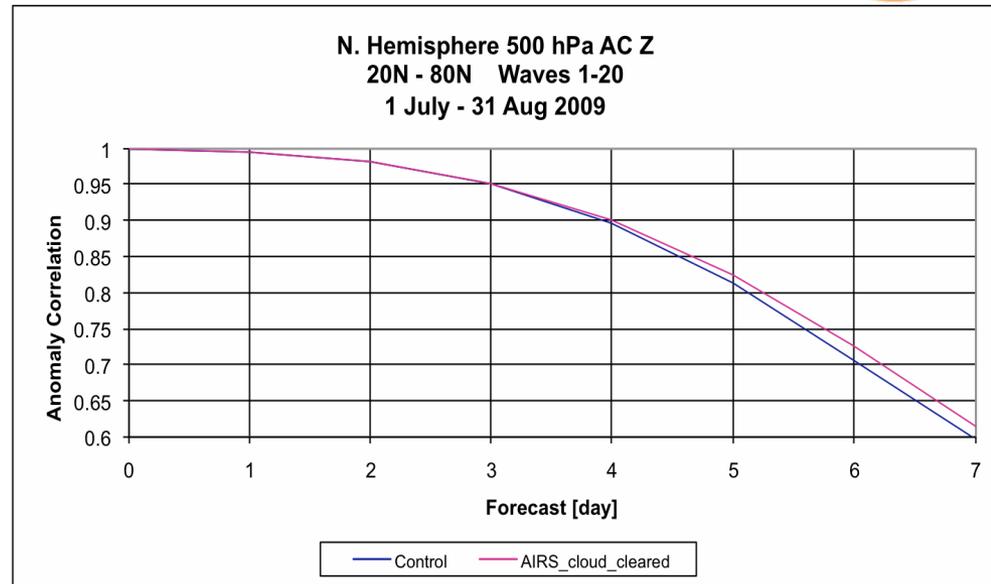
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# Cloudy/Rainy Data Assimilation -Infrared-



- ❖ Cloudy Radiance Assimilation Testing in NOAA's GDAS system (using IASI and AIRS)
- ❖ Cloud-cleared radiances tested
- ❖ Improvement noticed in N. Hemisphere (500 hPa AC)
- ❖ Results degrade when AMSU data became corrupt. Work underway to better understand this and reproduce for CrIS.





# Understanding/Reconciling Radiance and Retrievals Assimilations



- ❖ Operational centers generally assimilate radiances
- ❖ Studies performed in academia and other agencies suggest there are potential benefits in assimilating retrievals
- ❖ JCSDA-Funded effort to understand differences between retrievals and radiance assimilation
- ❖ Rigorous and independent assessment
- ❖ O2R environment critical
- ❖ Objective is to harvest the ‘best’ of both worlds in order to improve assimilation
- ❖ Initial effort focuses on Hyperspectral data (AIRS)



# Briefing Contents



1

**Introducing JCSDA and its Objectives, Vision**

2

**Link JCSDA Objectives to Economic Benefits**

3

**JCSDA's Mode of Operations & Outreach Activities**

4

**JCSDA Technical & Science Priorities**

5

**JCSDA Achievements and Major Activities**

6

**Path Forward, Summary & Conclusion**



# Path Forward & Coordination



- ❖ **Coordinate/synch calls for proposals?**
- ❖ **Or even have a unique call for proposals (and share/distribute proposals: similar to Roses model)**
- ❖ **Be part of each others' technical review committees (for merit assessment)**
- ❖ **Or establish a program selection committee to deal with programmatic decisions only**
- ❖ **Establish priorities (on annual basis) and distribute non-overlapping tasks to be handled by each program (ex. All CRTM efforts by JCSDA)**
- ❖ **Exchange visiting scientists ?**
- ❖ **Other suggestions?**



# Summary / Conclusion



- ❖ The Joint Center, a US. interagency partnership, is heavily involved in preparing US operational users to benefit from new data as soon as possible after launch
- ❖ Scientific Activities of JCSDA are diverse: RT, Ocean, Land, Aerosol, Cloudy Assimilation, etc.
- ❖ JCSDA activities have had clear impact on operational activities in all partners
  - Joint systems and code (CRTM, LIS, ...)
  - Additional sensors (AIRS, MODIS, COSMIC, IASI, SSMI/S,...)
  - Ongoing improvements to assimilation methodology and diagnostics (observation operators, adjoint sensitivity,...)
- ❖ The new O2R capability established in JCSDA should consolidate the R2O linkage between NWP community and research community
- ❖ Increased collaboration both internally (between partners), nationally and internationally, always welcome and sought
  - VSP and new JCSDA computing are vehicles to strengthen or establish this collaboration



# BACKUP SLIDES



# Other JCSDA Scientific Data Assimilation Activities



## ❖ Satellite Wind Assimilation in GSI/GFS

- *Analyze impact of various height estimates and biases in the satellite wind, Impact of QC and other quality measures: like Expected Errors EE)*

## ❖ Water Vapor – radiance data assimilation

## ❖ Surface Wind Assimilation Testing

## ❖ Improve Operational Air Quality Forecasting Capabilities *(GOES Total Ozone assimilation in GSI)*

## ❖ Quantitative Use of Ocean Color Data

- *SeaWIFS data and the HYCOM Ocean model)*

## ❖ Assimilation of Satellite Soil Moisture

- *SM Data from AMSR-E/ASCAT/SMOS/AMSR2/SMAP and using the GDAS system)*