



NOAA Testbeds and Proving Grounds Committee Workshop:

Overview of NOAA's Contribution to the

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

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With Contributions from

All members of the Directed Research Team (NESDIS & NWS) as well as NOAA-Funded External Partners

April 16, 2014



Outline

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Overview of JCSDA

2

JCSDA's Mode of Operations

3

Overview of Accomplishments

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NOAA's Current/Future Support to JCSDA Activities

5

Summary

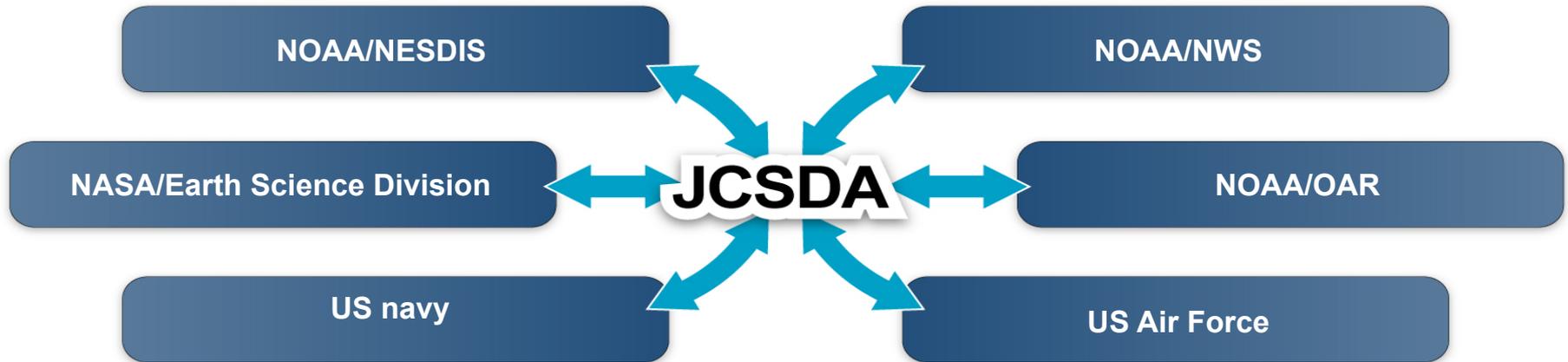


Introduction

- ❖ **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:

An interagency partnership working to become a world leader in applying satellite data and research to operational goals in environmental analysis and prediction

Mission:

...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 (Lapenta)
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)*
Chief Admin. Officer (J. Yoe)
Partner Associate Directors
(Lapenta*, Benjamin, Gelaro, Baker, Zapotocny)



**Science Steering
Committee**

~Retired + Now in WMO *Acting



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JCSDA Mode of operation

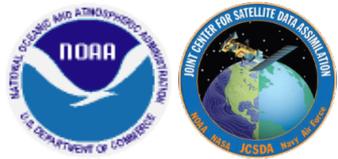
- **JCSDA partner's in-Kind Research**
 - Research undertaken independently by partners, overlapping with JCSDA priorities
 - Results/deliverables made available and shared with/between partners
- **Directed research (short-term return-on-investment expected)**
 - Carried out by the partners
 - Mixture of new and leveraged funding
- **External research (near-term return-on-investment expected)**
 - Grants awarded following proposals submitted (administered alternately by NOAA, NASA with contribution from 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)**
 - 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
 - Identify host at JCSDA partner institution; work on JCSDA-relevant topic



Internal Research Program

(within NOAA in support of JCSDA)

- This is research for internal partners scientists, funded by JCSDA-labeled budgets
- Within NOAA, this effort is traditionally coordinated with other programs –GOESR, JPSS- (success story with JPSS program for funding NPP-related impact assessment study and accelerated R2O)
- This is the mechanism for immediate R2D
- In NOAA, examples include:
 - Assimilation of a new sensor directly into a JCSDA partner model
 - CRTM
 - GOES-R Data assimilation readiness through Visiting scientist
 - NPP ATMS and CrIS data assimilation
 - SSMI/S data assimilation
 - GPS RO data assimilation
 - GPM
 - GCOM-W AMSR2
 - AMV DA, Geo DA, Cloudy DA in support of the data gap mitigation effort
 - Etc



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
- Projects typically funded for a 2 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 MISR-AMVs into operational models
 - Development of a common, consistent infrared and microwave emissivity database for use as a priori information in the JCSDA
 - Etc
- ~50 projects funded so far, since 2004
- FY13 External research (through FFO call): selection released.
- FY14 External Research (through NASA Roses): selection released.
- FY15 External research (FFO call): *In progress (identifying priorities)*



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JCSDA FY13 External Research

NOAA Federally-Funded Opportunity (FFO)

Project #	Proposal Number (s)	Title	Institution	PI	Performance Period
1	12,10	Modernization of the Community line-by-line models and CRTM-OSS Implementation	Atmospheric & Environmental Research (AER)	Jean-Luc Moncet, PI Eli Mlawer, co-PI	2 yrs, from 9/2013
2	15	Improvement and validation of JCSDA's Community Radiative Transfer Model (CRTM) Optical Properties	Texas A&M University	Ping Yang, PI	2 yrs, from 9/2013
3	4	Evaluation and Improvement of Land Surface States and Parameters to Increase Assimilation of Surface-Sensitive Channels and Improve Operational Forecast Skill	University Corporation for Atmospheric Research	Michael Barlage, PI Xubin Zeng, PI	2 yrs, from 9/2013
4	5	Assimilation of All-Sky Microwave and Infrared Satellite radiances: from research to Operations	National Center for Atmospheric Research University of Wisconsin, Cooperative Institute for Meteorological Satellite Studies	Thomas Auligne, PI	2 yrs, from 9/2013

All projects have received notification of the award and have accepted it.



JCSDA External Research

Selected Projects through the NASA FY14 Roses

Project #	Proposal Number (s)	Title	Institution	PI	Performance Period
1		Assimilation of all-sky satellite radiances from CrIS and GPM: from research to operations	National Center for Atmospheric Research (NCAR)	Thomas Auligne, PI	2 yrs, from 1/2014
2		Assimilation and evaluation of MISR cloud tracked winds with GEOS-5 operational data assimilation system	Jet Propulsion Laboratory (JPL)	Junjie Liu, PI	2 yrs, from 1/2014
3		Preparatory work for assimilation of precipitation-affected GPM observations into Numerical Weather Prediction model	Atmospheric & Environmental Research (AER)	Jean-Luc Moncet, PI	2 yrs, from 1/2014

All projects have received notification of the award and have accepted it.



Training, Education & Outreach

- ❖ **Monthly Seminar Series**
- ❖ **Annual JCSDA workshop on satellite data assimilation**
- ❖ **JCSDA Newsletters (quarterly)**
 - ❖ Highlight achievements by JCSDA scientists (internal/external)
 - ❖ Disseminate results and promote collaboration
- ❖ **NOAA is co-sponsoring a data assimilation tenure position at UMD** *(long-term benefit to JCSDA partners: training DA experts)*
- ❖ **Active web site: jcsda.noaa.gov**
- ❖ **Visiting Scientist Program**



11th Annual JCSDA Satellite Data Assimilation Workshop



Participants in JCSDA's 11th Annual Workshop on Satellite Data Assimilation, organized in the NCWCP building, in College Park, MD

- This is the prime venue used by for internal, external and associated scientists (in satellite data assimilation) for interaction, coordination and collaboration.
- JCSDA working groups play a major role in providing feedback to JCSDA management.



12th Annual JCSDA Satellite Data Assimilation Workshop

- **In preparation: Scheduled for May 21-23 2014**
- **All welcome**
- **Technical agenda**
 - *Overview*
 - *Radiative Transfer modeling*
 - *Ocean Data Assimilation*
 - *Land Data Assimilation*
 - *Air Composition/ Aerosols Data Assimilation*
 - *Cloud and Precipitation Data Assimilation*
 - *Global Observing System Assessment and Optimization*
 - *Atmopsheric Data Assimilation*

- **First Joint JCSDA/DTC GSI Tutorial & Workshops**

- 1st DTC-JCSDA GSI tutorial and science workshop, NCWCP, August 2013



Participants in 2013 Summer GSI Tutorial and Workshop, organized jointly by DTC, NWS/NCEP, NESDIS/STAR and JCSDA in the NCWCP building, in College Park, MD. August 5-8, 2013. Courtesy of Hui Shao. UCAR/DTC.

CRTM Mission

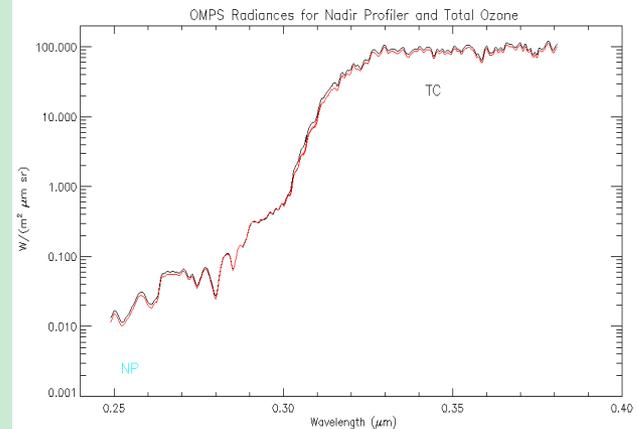
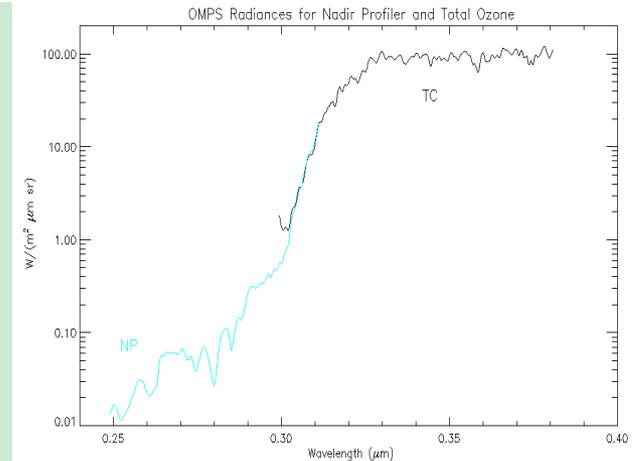
- Satellite radiance simulation and assimilation for passive MW, IR, and Visible sensors of NOAA, NASA, DoD satellites, and others (200 sensors)
- Simulation of clear/cloudy/precipitating scenes, globally

CRTM Applications

- Data assimilation in supporting of weather forecasting
- Physical retrieval algorithm for satellite products
- Stability and accuracy monitoring of satellite observations
- Education and Research: reanalysis, climate studies, air quality forecasting, and a radiative tool for students

CRTM Current Development

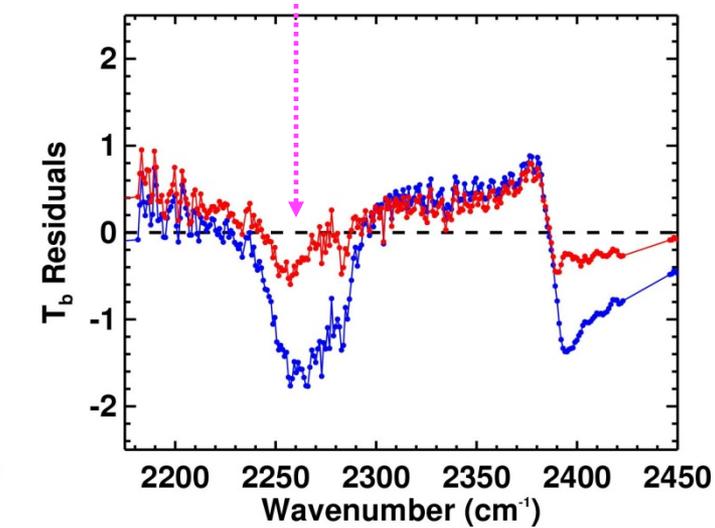
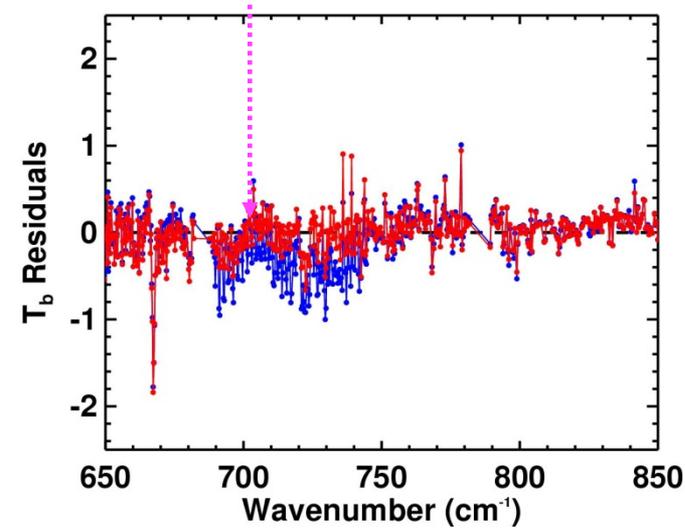
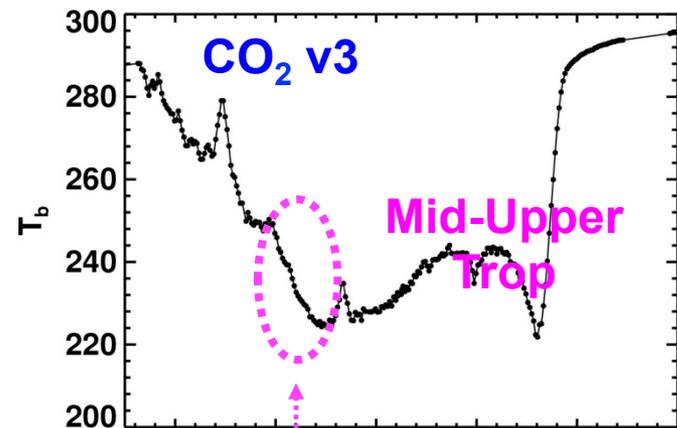
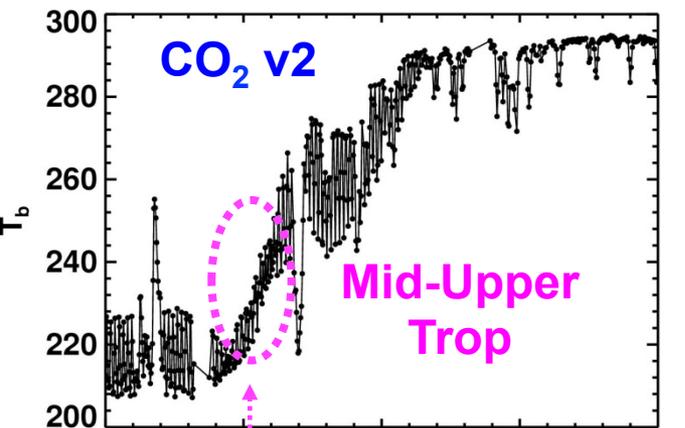
- SBUV for ozone data, JPSS ATMS, CrIS, VIIRS, OMPS, GPM, FY3, Studying feasibility of active sensors including Radar and Lidar space measurements
- CMAQ Extension
- Jacobians in cloudy/rainy conditions
- Aquarius, SMOS, SMAP extension
- Etc



Extension of the CRTM applicability to simulate OMPS radiances. The plot shows OMPS radiances for nadir profiler (NP) and total ozone (TC). The two sensors have a spectral overlap. The radiance for TC at the most left doesn't match NP measurements. The lower plot shows a comparison of OMPS nadir mapper and profiler radiance observations (black line) and CRTM-uvspec calculations (red line). The ECMWF forecasting profiles including ozone is used. Plots courtesy of Quanhua Liu, University of Maryland and JCSDA visiting scientist.

Continuous Improvements to Spectroscopy

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!

(slide courtesy of V. Payne, formerly AER Inc.)



O2R Infrastructure

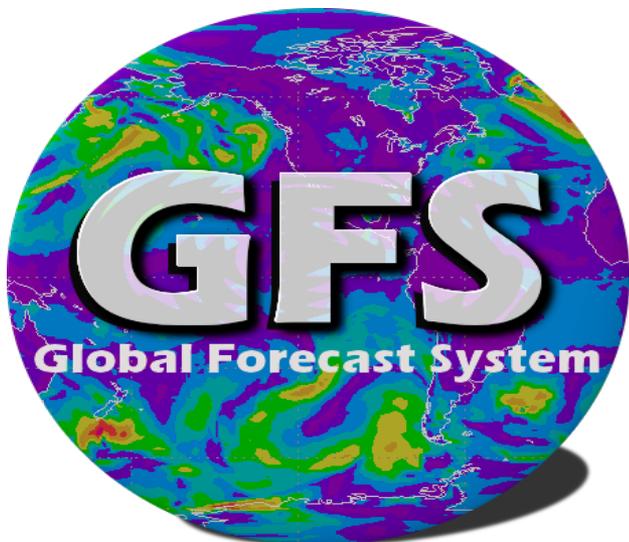
- **NOAA Global Satellite Data Assimilation System (GDAS) was implemented on the JCSDA supercomputer (JIBB) and the NESDIS Supercomputer (S4).**
- **DTC HWRF was also implemented and benchmarked**
- ***Work in progress to extend O2R to: HYCOM, NAM/NDAS.***
- ***Extension in progress to have T1534 version of GDAS be available on JCSDA O2R environment.***
- ***H. Sandy funded expansion of S4 and JIBB (almost complete) to double compute power and disk space***





O2R Processes

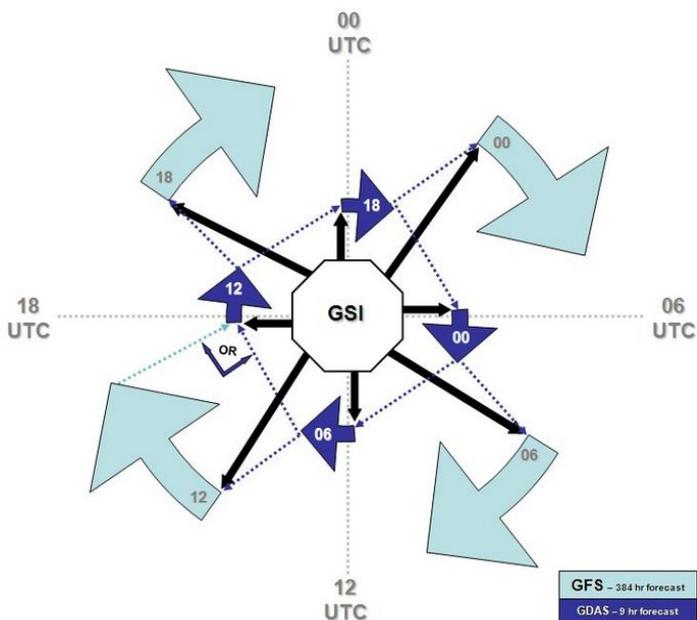
Supported NOAA Operational Models



GFS high-resolution T1534 (~13 km) Semi-Lagrangian and low-resolution models (R & D versions) are currently being tested under JCSDA's O2R environment

2014 versions of NAM/NDAS and HWRF models will be ported soon

Ocean model HYCOM will be ported in the future





JCSDA O2R and R2O Protocols

JCSDA users check out GSI from JCSDA branch on NCEP's subversion system



JCSDA members complete GSI data assimilation (DA) development on multiple research projects



JCSDA O2R-R2O lead performs the independent assessment tests and the final multiplatform regression DA tests on NOAA R & D super computer



JCSDA O2R-R2O lead co-ordinates with the NCEP EMC GSI R2O lead to merge codes to EMC GSI Trunk as per NCEP EMC R2O protocols



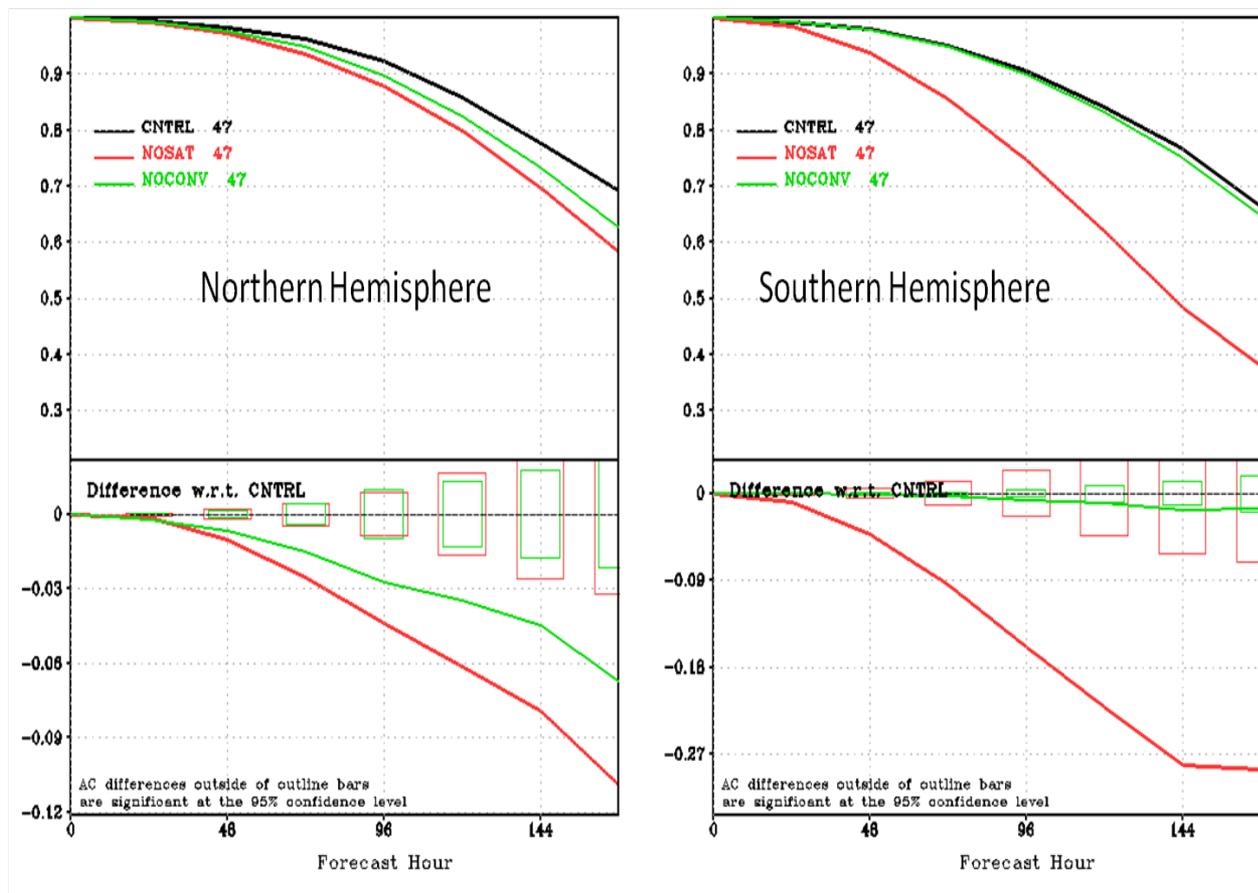
Global Observing System Impact Assessment Using NOAA Models

(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 mainly in support of JPSS program (impact of CrIS, of ATMS, etc).
- Both data impacts and data denials experiments were undertaken

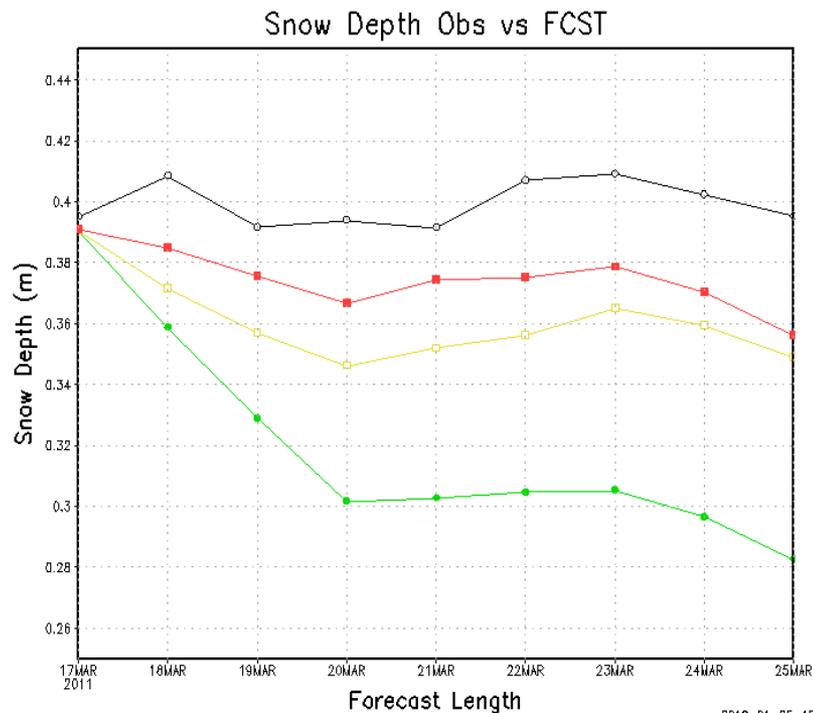


Results from the extensive data denials experiments performed in the JCSDA, aimed at assessing the impact of the global Plots courtesy of J. Jung.



Land Data Assimilation

- Land data assimilation is supported by NOAA (for the JCSDA)
- It is a close coordination between NESDIS and NWS and externally-funded projects (U. AZ)
- Improved use of emissivity, soil moisture, etc from multiple sensors.
- Effort led to improvement in LST, snow depth prediction in NWS

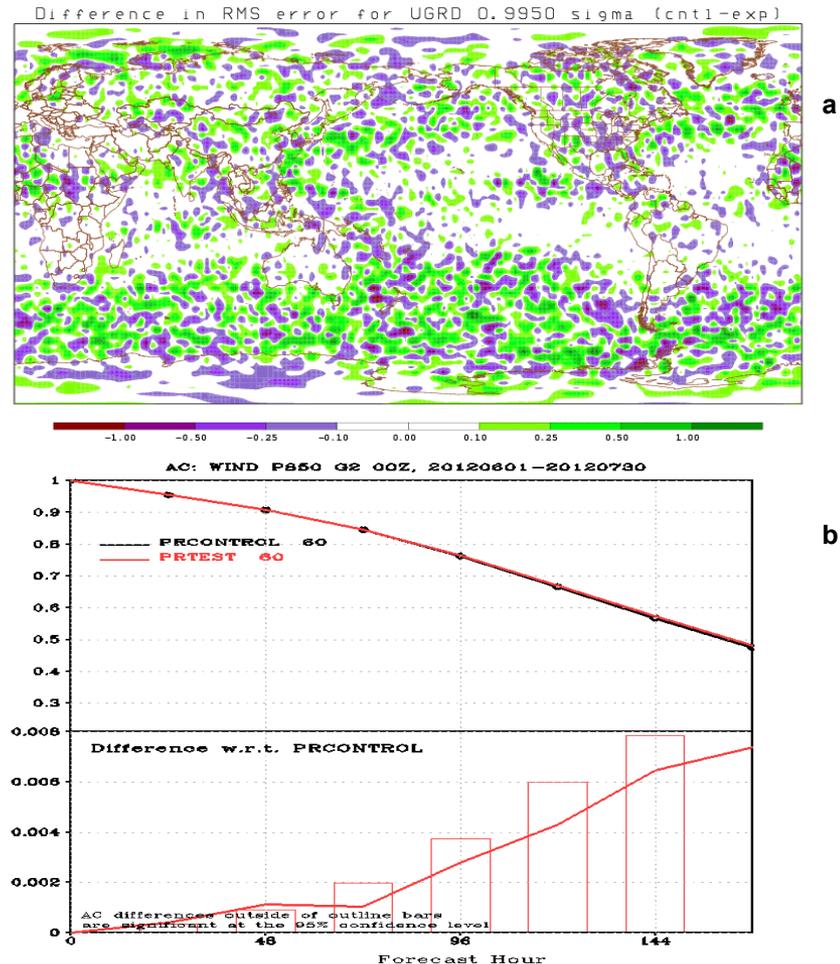


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GFS prediction of snow depth averaged over (100-120°W, 50-60°N) in March 2011. Black line: observations; green: control GFS; yellow: GFS with improvement to roughness length only; red: GFS with all snow improvements. These improvements were successfully transitioned to NOAA's NOAA/GFS system. Plot courtesy of X. Zeng, University of Arizona, effort funded through a JCSDA grant (FY10 NOAA FFO).

OSCAT Data Assimilation

- Effort has led to current parallel testing of OSCAT DA in the next version of the GDAS system
- Both NESDIS and KNMI OSCAT data were investigated
- *OSCAT recently failed, before the data could be used operationally*



Impact assessment of the OSCAT scatterometer data assimilation. These plots represent the forecast impact (b) and verification results (a) of OSCAT winds experiments. They represent the change in anomaly correlation and RMS (increase or decrease) of the surface wind speed at 0.995 sigma level. The impact, globally, at 48 hours lead time is mixed, but overall positive. Plot courtesy of Li Bi, Riverside Inc, JCSDA Active Sensors data assimilation scientist.



OSSE Activities

- Sponsor-funded OSSE activities have been undertaken in FY13:
 - Wind Lidar OSSE effort funded by NASA
 - Hyperspectral Geo sensor OSSE funded by NESDIS
 - DoD-requested OSSE in support of DMSP-follow on decision making
- A new OSSE activity has been initiated in NOAA and JCSDA is playing a big role
 - In support of H. Sandy funded mitigation strategy
 - To explore value of several hypers. Sensors
 - To explore value of GPS RO future configurations



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Current-Focus Priorities (1/2)

- Standing capability to assess impact of satellite data
- GCOM-W AMSR2 data assimilation
- GPM (GMI) Data Assimilation
- Support JPSS data gap mitigation strategy effort
 - Cloudy/Rainy data assimilation
 - AMV data assimilation (inter-agency MOU drafted)
 - Geo radiance data assimilation
 - OSSE efforts
 - Improve SSMIS data assimilation and increase impact
- Readiness for and Supporting GOES-R data assimilation (ABI, GLM)
- Perform **R2D** for new sensors, data, products, science

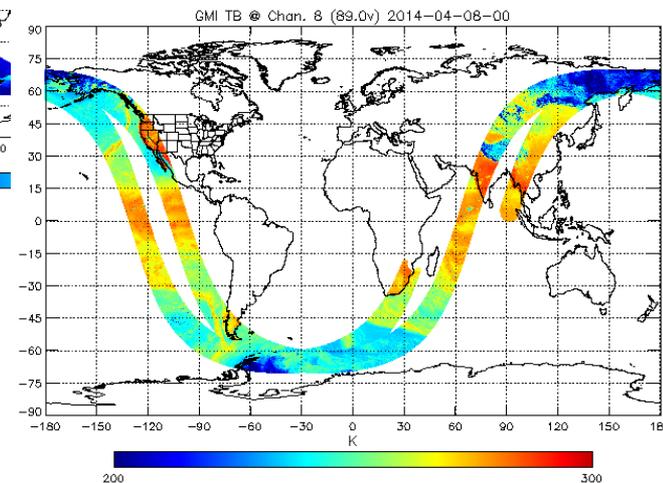
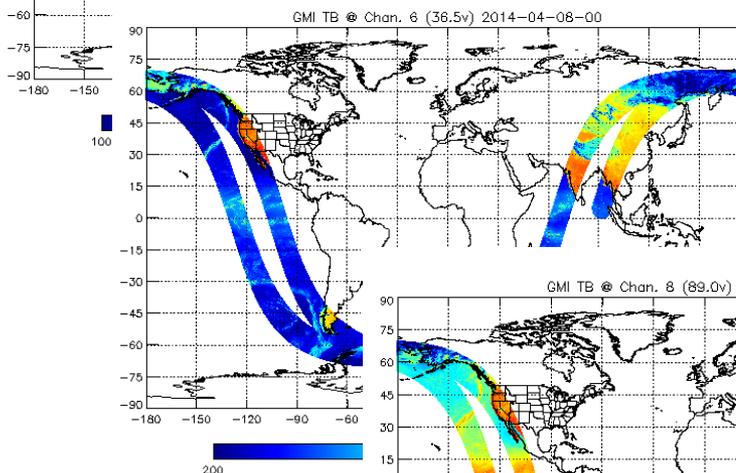
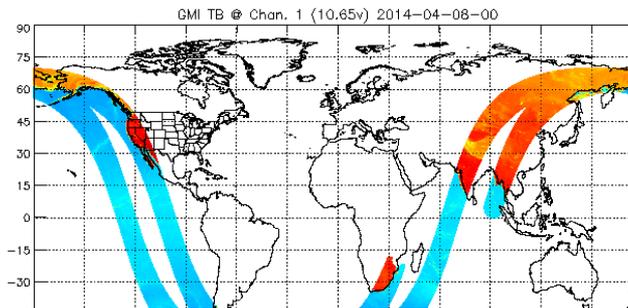


Current-Focus Priorities (2/2)

- Modernization of the LBLRTM model (CLBL)
- Continuous improvement to CRTM (aerosols, ozone, optical properties, Jacobians, efficiency)
- Develop Unified Quality Control and Data Assimilation Pre-Processing Tool for all sensors (MIIDAPS)
- Improve and Extend the O2R Environment for researchers
 - CMFT Tool for BUFrization
 - Operational Systems porting (and synchronization with upcoming versions)
 - Independent assessment Tool
- Etc (more to be shared on request)

GPM Data Assimilation in JCSDA

- **JCSDA is an early adopter of the GPM (GMI) data:**
 - Close interaction with GPM science team before launch
 - High on priority list of the JCSDA executive team (tracked action item)
 - Listed in the FY14 Directed research activities
- **Status:**
 - BUFRization of the L1B and L1C complete (in JCSDA, for testing purposes)
 - Close coordination with GMAO on-going
 - Plumbing of the GPM data ingest in GSI on-going
 - NOAA-NASA MOU in progress to coordinate on cloudy radiance assimilation
- **Future Steps:**
 - Assessment of GPM/GMI data on GSI
 - Continued coordination with NASA/GMAO
 - Close interaction with NWS/NCEP on GPM data assimilation transition to NCEP GSI trunk
 - Assess GPM data impact in active regions (Rain, ice, cloud)





AMV Activities

AMV Data Assimilation is performed in the JCSDA through:

- Directed Research. NWS led effort funded by the JCSDA, in coordination with NESDIS
- H. Sandy funded effort. This is a coordinated effort between NESDIS, NWS, Navy, NASA and U. Wisconsin

Goal:

- Maximize the impact of AMV in NOAA systems
- Benefit from Navy/NASA experience using AMVs
- R2O transition of academia projects that were proven to offer added value
- Prepare for AMV from future sensors (Himawari-8, GOES-R)

Status:

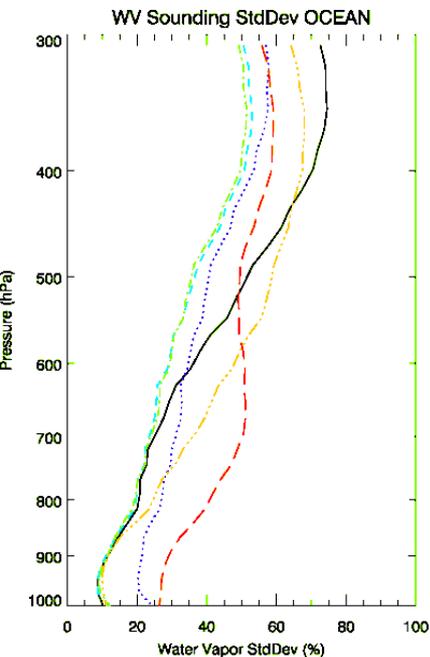
- 2 Inter-agency agreements (IAAs) or MOUs (NOAA-NASA, NOAA-Navy) being routed for approval
- Grant proposal already submitted by UW (leverage previously funded projects)
- Contract in place in JCSDA (hired expert) to work on AMV

Expected Highlights & Milestones for this effort (from MOU):

- Documenting the difference between the AMV data sets used by EMC and NRL
- Documenting the differences in preprocessing and QC methodology
- GFS impact experiments: Control with all observations, AMV denial, added NRL winds;
- Isolating the effects due to super-obing, number of AMVs, QC, etc.
- Additional experimentation and/or investigation as warranted based on the results of steps 1 through 4.
- Setting up a JCSDA AMV working group, with representatives from all partners

AMSR-2 Data Assimilation

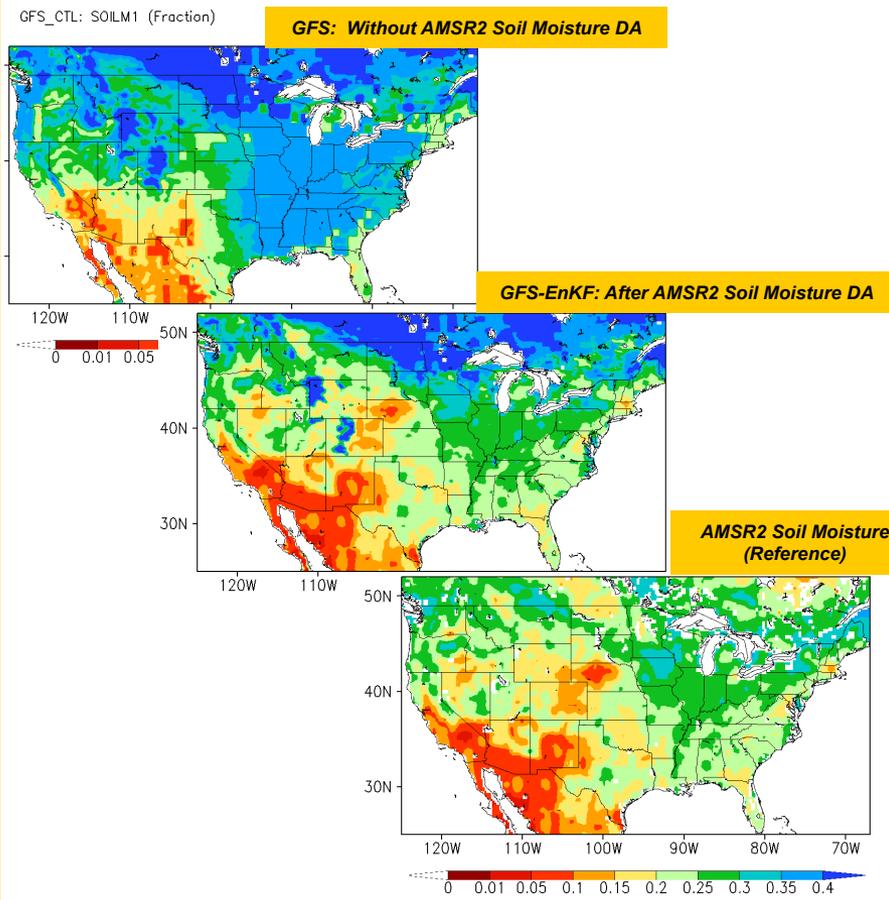
Land and Atmospheric Activities



Assessment of the vertical moisture information content in AMSR-2 data, showing tropospheric sounding capability, prior to assessing the impact in a GSI environment.

JCSDA is actively working on assimilating AMSR-2 data:

- Close interaction between NOAA Scientists
- Listed in the FY14 Directed research activities
- Land applications (soil moisture)
- Atmospheric Application (moisture)
 - **Status:**
- Soil moisture data from AMSR-2 combined with other sensors producing SM
- Impact assessment performed
- Moisture profiling information content assessed
- **Future Steps:**
- Assessment of GPM/GMI data on GSI
- Continued coordination with NASA/GMAO
- Close interaction with NWS/NCEP on GPM data assimilation transition to NCEP GSI trunk



Assimilation of Satellite Soil Moisture Product from AMSR2 in NCEP Global Forecast System. M. Ek (NCEP) and Zhan (NESDIS). JCSDA Directed research funded project. This effort is JCSDA-facilitated. In this figure, the Noah LSM multiple year means and standard deviations are used to scale the surface layer soil moisture retrievals before assimilation



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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 (ATMS, OSCAT, AIRS, MODIS, COSMIC, IASI, SSMI/S,...)
 - Ongoing improvements to assimilation methodology and diagnostics (observation operators,...)
- The new O2R capability established should consolidate the R2O linkage between NWP community and research community
- Increased collaboration both internally (between partners), nationally and internationally, is seen as critical and sought
 - VSP and new JCSDA computing are vehicles to strengthen or establish this collaboration