U.S. JCSDA Use and Continuous Optimization of the S-NPP data assimilation

Presented by

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With Contributions from JCSDA Associate Directors and Scientists:

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New JCSDA Director

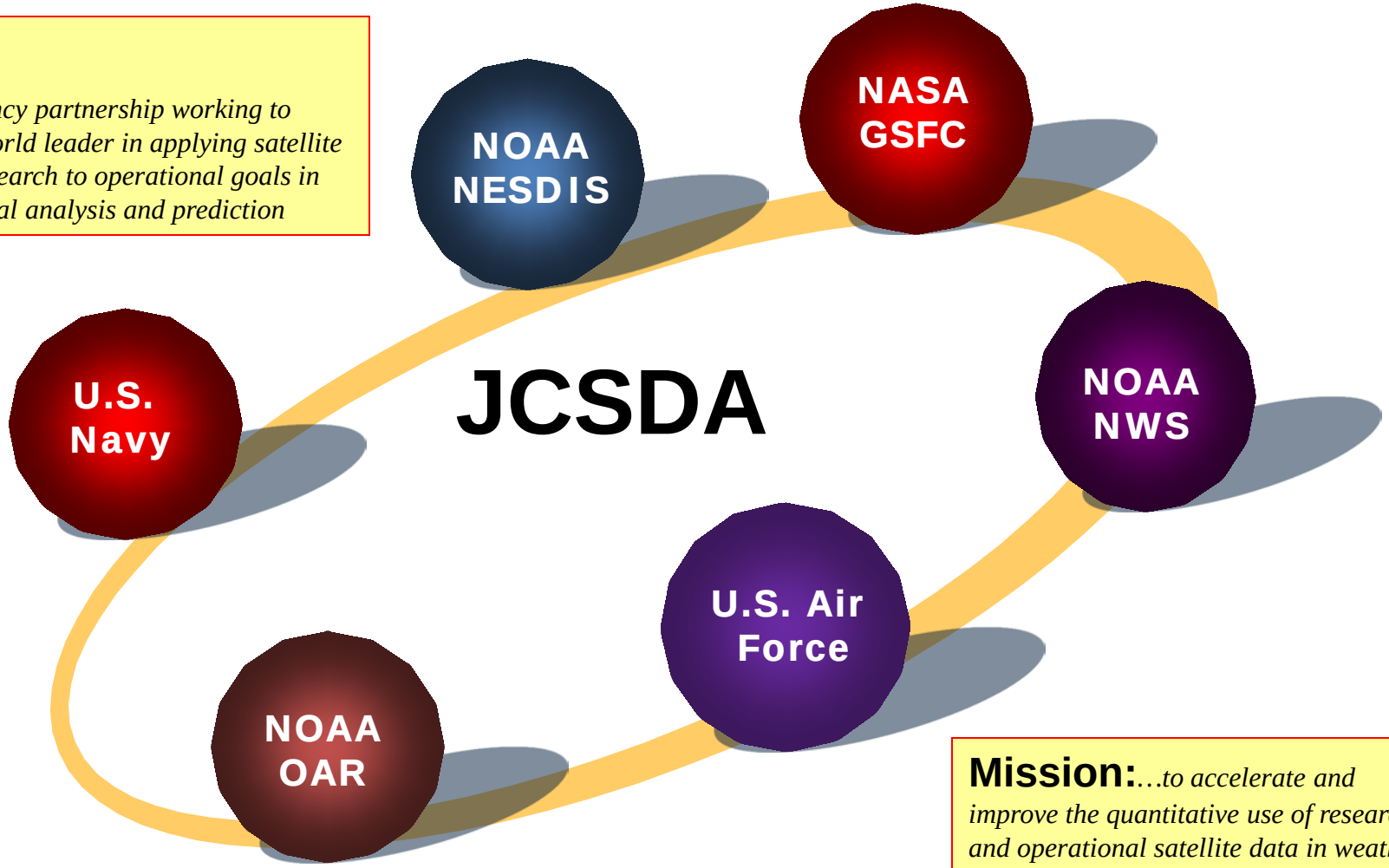
Agenda

1. Description of the JCSDA (Structure & Mode of Operation)
2. JCSDA Infrastructure Support to S-NPP Use/Optimization
3. Assimilation of S-NPP data
4. Summary/Conclusion

Description of the JCSDA

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 Mode of operation

JCSDA Modes of Operation

Directed Research

- Directed by JCSDA affiliated scientists

-Example of DRT between NESDIS and NWS

-Carried out by the partners

- Mixture of new and leveraged funding

- Short-term ROI expected

External Research

- Grants and/or contracts awarded

- Administered alternately by NOAA, NASA with contribution from DoD)

- Open to the broader research community

- Funding awarded competitively

- Near-term ROI expected

Visiting Scientist Program (VSP)

-Great way to initiate/strengthen involvement with JCSCA

-Open to scientists from everywhere

-Short-term (a few weeks/months)

- Requires to Identify host at partner institution; work on JCSDA-relevant topic

- Mid-term ROI expected

In-Kind Research

- Research undertaken independently by partners, overlapping with JCSDA priorities

-Results/deliverable are made available and shared with/between partners

- JCSDA mainly coordinates

O2R Facilitation

- Offers O2R environment

-Open to External scientists, even not funded by JCSDA

-Goal: funnel efforts toward helping the JCSDA partners (incl. NOAA)

- Carrot is access to HPC & operational systems in R&D

- S4 and JIBB

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2. **JCSDA Infrastructure Support to S-NPP Use/Optimization**
3. JCSDA Scientific Support: Assimilation of S-NPP data
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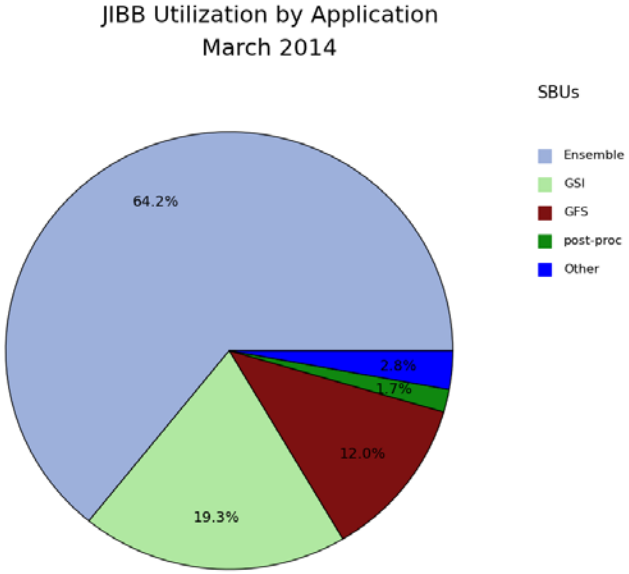
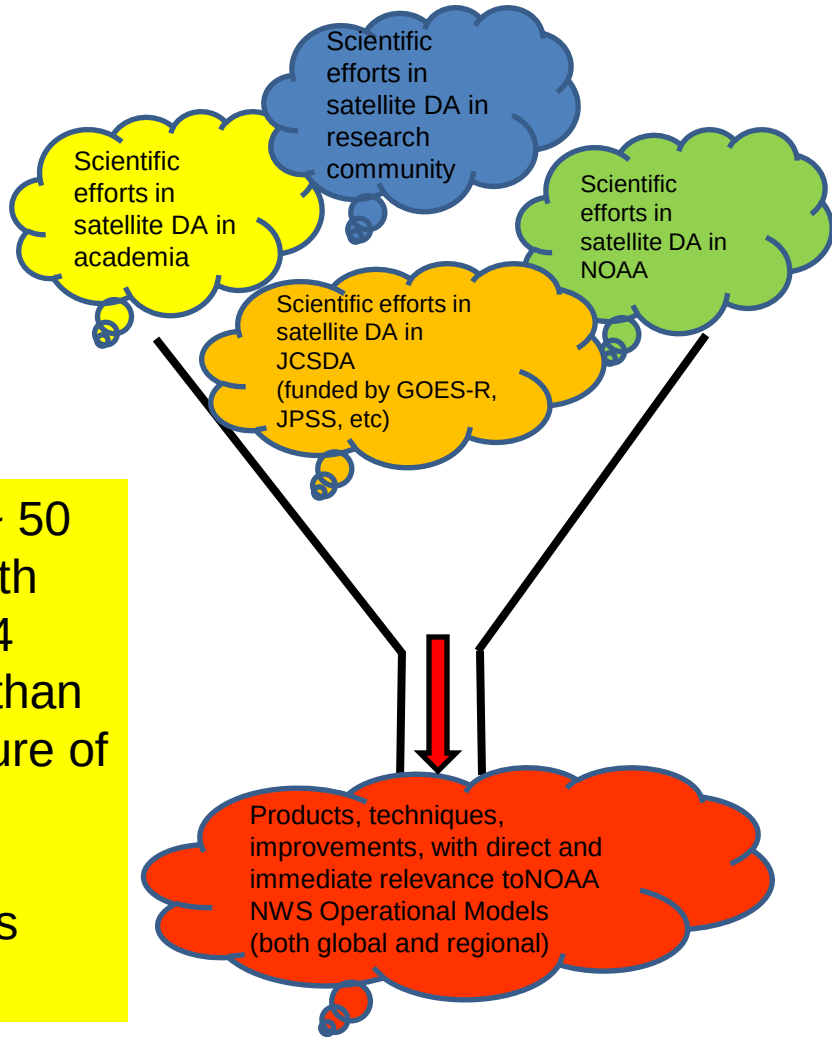
O2R Environment Supports S-NPP Focused Research

- **This is a critical piece for a successful R2O. O2R involves:**
  - Supercomputer(s) : JIBB, S4, Zeus Allocation
  - Porting/benchmarking codes/systems/libraries
  - Documentation to help researchers navigate
  - User Support
- **Status:**
  - GSI, GFS implemented/benchmarked
  - HWRF implemented and benchmarked
  - Synchronization with T1534 completed
  - On-going porting of the 4D Hybrid
- **In progress:**
  - Extension of O2R to include Ocean DA (NCODA, HYCOM)
  - Extension of O2R to include Land Systems (LIS).
- **Available to:**
  - JPSS Proving Ground projects
  - JPSS Risk Reduction projects
  - R2O projects



More than ~ 50 users on both JIBB and S4 (total more than ~100). Mixture of NOAA and external Researchers



Examples of S-NPP Projects Benefiting from O2R

(Not directly funded by JCSDA, but supported through the O2R: HPC, user support, Porting of codes, etc)

#	PI/Scientist	Project Title	Main Sensor used
1	**Jinlong Li**	Near real-time assimilation system development for improving tropical cyclone forecast with NPP/JPSS sounder data	-CrIS, ATMS
2	**Banglin Zhang**	-Improve Hurricane Structure Monitoring and Intensity Forecast Using NPP ATMS and GCOM-W AMSR2	-ATMS
3	**Jianjun Xu**	Application of hyper-spectral satellite data in severe weather forecasts with GSI/WRF regional data assimilation system	-CrIS
4	**Lin Lin**	-Evaluation of BG-Remapped ATMS on Hurricane Sandy Forecast & Test of Mie and DDA Scattering in the Simulation of ATMS	-ATMS
5	**Marouane Temimi**	Assessment of Assimilating NPP/JPSS ATMS Ground Surface Observations	-ATMS
6	**Li Fang, et al.**	Dual Assimilation of Microwave and thermal-infrared observations of soil moisture into NLDAS for improved drought monitoring	- ATMS, VIIRS
7	**Marouane Temimi**	Assessment of Assimilating NPP/JPSS ATMS Ground Surface Observations	-ATMS
8	**Hu Yang**	Scientific Support for JPSS Instrument Calibration	-S-NPP Sensors (ATMS)
9	**Daisuke Hotta**	Proactive-QC based on Ensemble Forecast Sensitivity to Observations (EFSO)	-All S-NPP assimilated sensors (ATMS)
10	**Xinjia Zhou**	BTs validation of CRTM simulations against AVHRR, MODIS and VIIRS BTs in SST bands	-VIIRS
11	**Johnathan W. Smith**	WRF-Chem data assimilation of NOAA-Unique CO retrievals: Impact study on tropospheric ozone enhancement observed during the 2010 AEROSE Campaign	-IASI (potential application to CrIS)
12	**Agnes Lim Huei Ni**	Impact analysis of LEO Hyperspectral Sensor IFOV size on the next generation NWP model forecast performance	-CrIS

CRTM, CLBLM & Spectroscopy

CRTM Mission

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

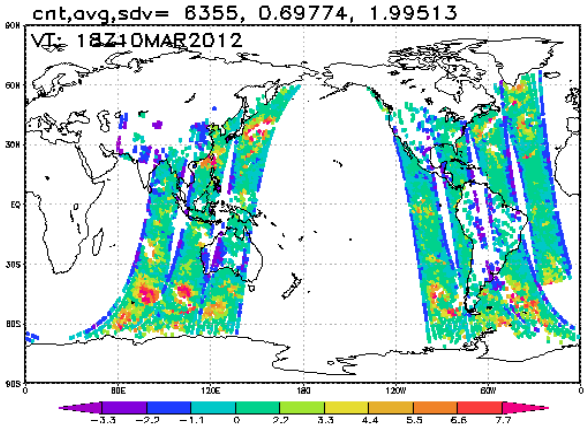
CRTM Applications

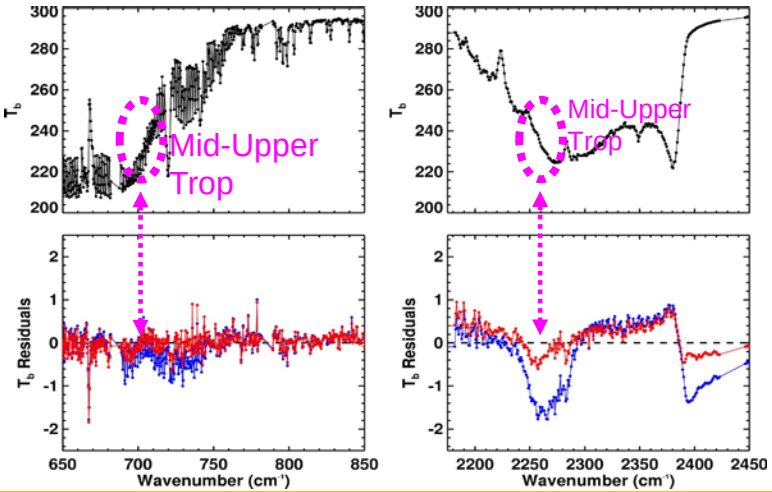
- Data assimilation in supporting of weather forecasting
- Physical retrieval algorithm for products
- Stability and accuracy monitoring of satellite observations
- Education and Research: reanalysis, climate studies, air quality forecasting, and a radiative tool for students

CLBLM:

- Serves as the new LBLRTM (under development). To train CRTM
- Uses the newest spectroscopy and introduces new features

ATMS Ch. 4 (O-B) GDAS



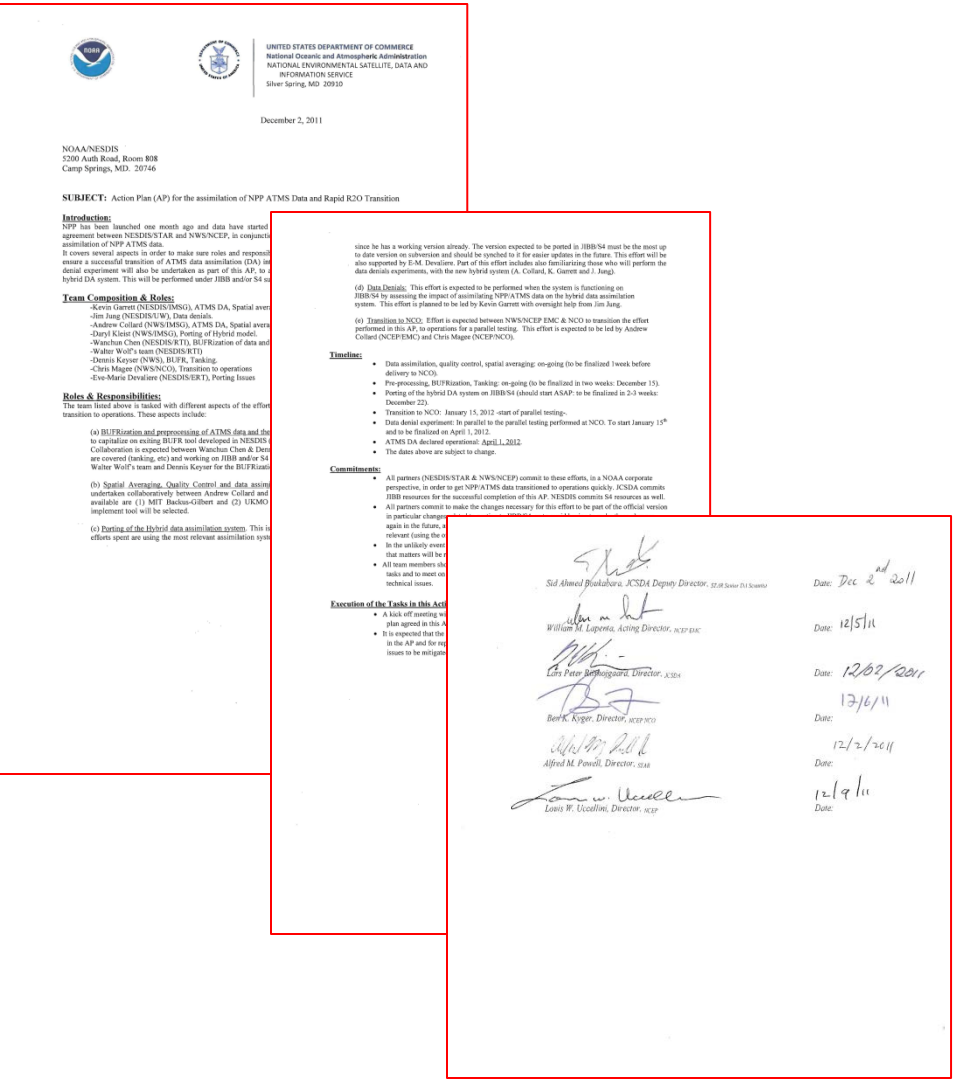


These fundamental improvements in RT, LBL and spectroscopy are critical for calibration, retrieval, validation and assimilation of all S-NPP sensors data (and other missions)

(slide based on Q. Liu and AER's presentations)

Coordination & Synchronization:

JCSDA Accelerated R2O coordination for SNPP/ATMS



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL ENVIRONMENTAL SATELLITE, DATA AND INFORMATION SERVICE
Silver Spring, MD 20910

December 2, 2011

NOAA/NESDIS
5200 Auth Road, Room 808
Camp Springs, MD. 20746

SUBJECT: Action Plan (AP) for the assimilation of NPP ATMS Data and Rapid R2O Transition

Introduction:
NPP has been launched one month ago and data have started
agreement between NESDIS/STAR and NWS/NCEP, in conjuncti
assimilation of NPP ATMS data.
It covers several aspects in order to make sure roles and responsi
ensure a successful transition of ATMS data assimilation (DA) in
denial experiment will also be undertaken as part of this AP, to
hybrid DA system. This will be performed under JIBB and/or S4 s

Team Composition & Roles:
-Kevin Garrett (NESDIS/IMSG), ATMS DA, Spatial aver
-Jim Jung (NESDIS/UW), Data denials.
-Andrew Collard (NWS/IMSG), ATMS DA, Spatial avera
-Daryl Kleist (NWS/IMSG), Porting of Hybrid model.
-Wanchun Chen (NESDIS/RTI), BUFRization of data and
-Walter Wolf's team (NESDIS/RTI)
-Dennis Keyser (NWS), BUFR, Tanking.
-Chris Magee (NWS/NCO), Transition to operations
-Eve-Marie Devaliere (NESDIS/ERT), Porting Issues

Roles & Responsibilities:
The team listed above is tasked with different aspects of the effort
transition to operations. These aspects include:

(a) BUFRization and preprocessing of ATMS data and the
to capitalize on exiting BUFR tool developed in NESDIS
Collaboration is expected between Wanchun Chen & Den
are covered (tanking, etc) and working on JIBB and/or S4
Walter Wolf's team and Dennis Keyser for the BUFRizati

(b) Spatial Averaging, Quality Control and data assim
undertaken collaboratively between Andrew Collard and
available are (1) MIT Backus-Gilbert and (2) UKMO
implement tool will be selected.

(c) Porting of the Hybrid data assimilation system. This i
efforts spent are using the most relevant assimilation sys

since he has a working version already. The version expected to be ported in JIBB/S4 must be the most up to date version on subversion and should be synched to it for easier updates in the future. This effort will be also supported by E-M. Devaliere. Part of this effort includes also familiarizing those who will perform the data denials experiments, with the new hybrid system (A. Collard, K. Garrett and J. Jung).

(d) Data Denials: This effort is expected to be performed when the system is functioning on JIBB/S4 by assessing the impact of assimilating NPP/ATMS data on the hybrid data assimilation system. This effort is planned to be led by Kevin Garrett with oversight help from Jim Jung.

(e) Transition to NCO: Effort is expected between NWS/NCEP EMC & NCO to transition the effort performed in this AP, to operations for a parallel testing. This effort is expected to be led by Andrew Collard (NCEP/EMC) and Chris Magee (NCEP/NCO).

Timeline:
- Data assimilation, quality control, spatial averaging: on-going (to be finalized 1week before delivery to NCO).
- Pre-processing, BUFRization, Tanking: on-going (to be finalized in two weeks: December 15).
- Porting of the hybrid DA system on JIBB/S4 (should start ASAP: to be finalized in 2-3 weeks: December 22).
- Transition to NCO: January 15, 2012 -start of parallel testing-.
- Data denial experiment: In parallel to the parallel testing performed at NCO. To start January 15th and to be finalized on April 1, 2012.
- ATMS DA declared operational: April 1, 2012.
- The dates above are subject to change.

Commitments:
- All partners (NESDIS/STAR & NWS/NCEP) commit to these efforts, in a NOAA corporate perspective, in order to get NPP/ATMS data transitioned to operations quickly. JCSDA commits JIBB resources for the successful completion of this AP. NESDIS commits S4 resources as well.
- All partners commit to make the changes necessary for this effort to be part of the official version in particular change
again in the future,
relevant (using the o
- In the unlikely event
that matters will be
- All team members sh
tasks and to meet on
technical issues.

Execution of the Tasks in this Acti
- A kick off meeting w
plan agreed in this A
- It is expected that the
in the AP and for ma
issues to be mitigate

Sid Ahmed Boukabara, JCSDA Deputy Director, ST/JR Senior TA Scientist — Date: Dec 2nd 2011
William M. Lapenta, Acting Director, NCEP EMC — Date: 12/5/11
Lars Peter Riishojgaard, Director, JCSDA — Date: 12/02/2011
Ben K. Kyger, Director, NCEP/NCO — Date: 12/6/11
Alfred M. Powell, Director, STAR — Date: 12/2/2011
Louis W. Uccellini, Director, NCEP — Date: 12/9/11

- **SNPP Was launched Nov 2011**
- **Dec 2011, the JCSDA coordinated the signature of the R2O Action Plan for ATMS R2O between NESDIS and NWS**
- **The main points were: Who, does what and when and where (between NESDIS and NWS)**
- **Strong backing from STAR and NCEP Directors (present at kick off meeting)**
- **7 months after launch, ATMS was assimilated operationally in NOAA**
- **Important of coordinate & synch**

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3. **JCSDA Scientific Support: Assimilation of S-NPP data**
   - ATMS
   - CrIS
   - VIIRS
   - OMPS
4. Summary/Conclusion

Status of Navy's Use of S-NPP Data

(in NAVDAS-AR)

ATMS has positive impact on Navy Global NWP (operationally assimilated)

ATMS is consistently showing a positive impact on Navy global NWP via the NAVGEM/NAVDAS-AR system. The impact is very similar to that of SSMIS and is an improvement over a combined AMSU-A/MHS sensor suite from the NOAA or MetOp satellite series.

VIIRS Atmospheric Motion Vectors (AMV) are operational

A small subset was assimilated real time (via direct broadcast Fairbanks, AK), but global real-time feed established Nov2014.

CrIS will be operationally assimilated

All pre-operational testing is showing the CrIS sensor has beneficial impact on the NAVGEM/NAVDAS-AR system. It is being prepared as one of the updates with the NAVGEM v1.3.1 system, and will include both temperature and moisture channel assimilation.

Ozone from OMPS-NP is awaiting activation

Assimilation capability was delivered with NAVGEM v1.2.1, it does not have a dramatic impact on the global atmospheric forecasts, particularly in the troposphere. Decision made to wait for photochemistry update.

Information courtesy of Nancy Baker and Ben Ruston

Status of Air Force's Use of S-NPP Data

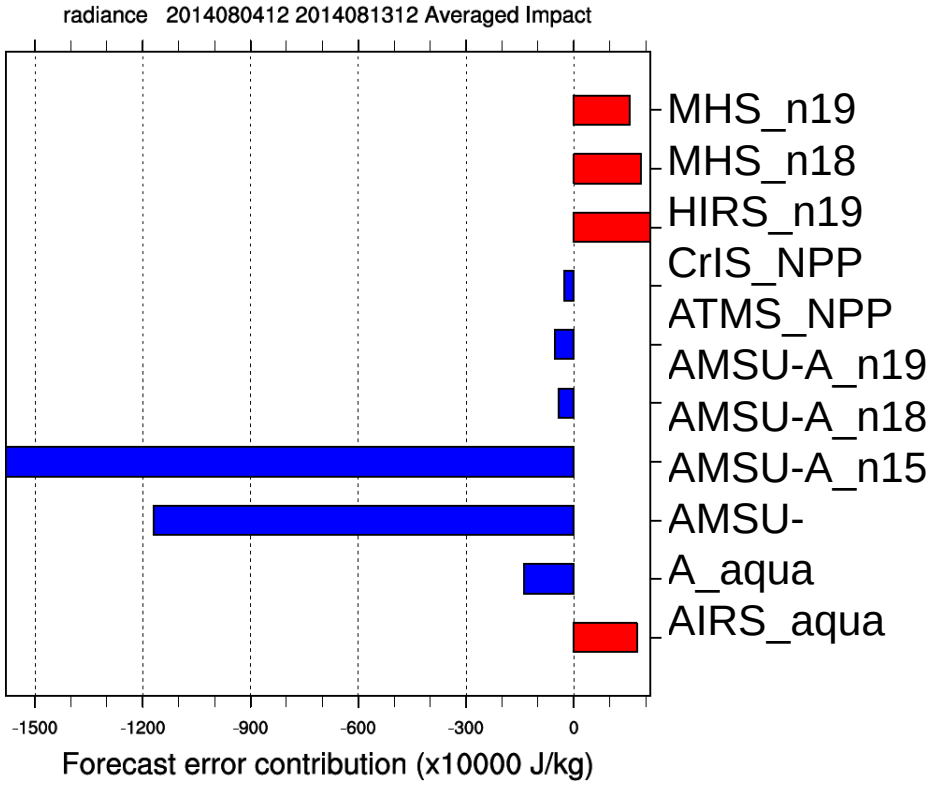
(in WRF/GSI)

CrIS and ATMS operationally assimilated

CrIS and ATMS are operationally assimilated into WRF runs each cycle for all theaters where such data are available +/- 90 minutes of cycle time.

VIIRS not operational yet

Work continues to use VIIRS data in Air Force cloud analysis and cloud optical property analyses.



FSO results show slight positive /neutral impact of CrIS

GSI-Based FSO tool based on NCAR MMM tool

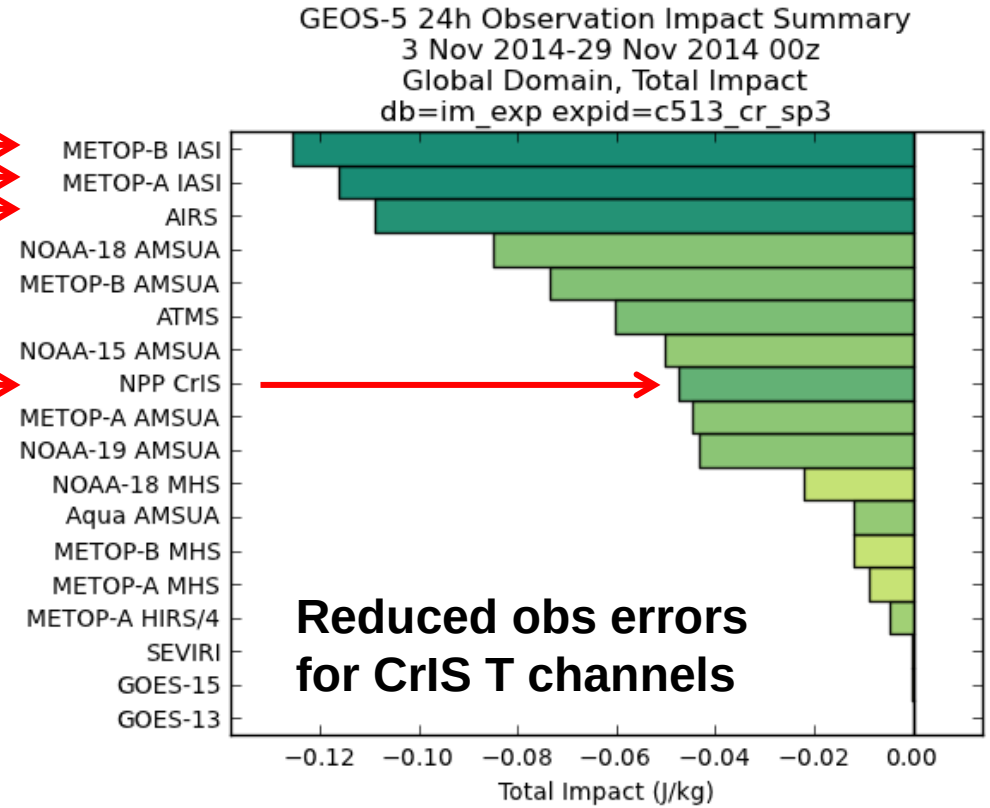
Information courtesy of J. Zapotocny/H. Shao (DTC)

Improved CrIS Usage at NASA/GMAO

Systems routinely using CrIS data
- Forward Processing (FP) GMAO realtime 'operational' stream
- FP Parallel (3D-hybrid to replace FP shortly)
- MERRA-2 Reanalysis

CrIS impact is currently significantly smaller than that of AIRS or IASI, and roughly half that of AMSU-A
- Initial observation error values were conservative to accelerate usage and minimize risk

Recent tests with adjusted observation errors result in larger impact of CrIS
- Reduced observation errors for temperature channels
- Impact smaller than AIRS and IASI, but comparable now to a single AMSU-A



Slide Courtesy of R. Gelaro and W. McCarty

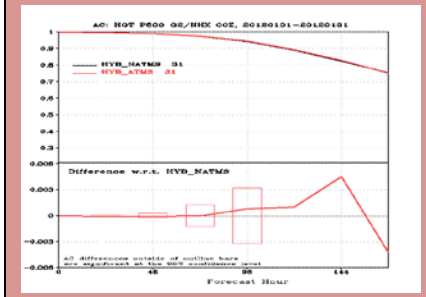
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

SNPP ATMS Assimilation Optimization

(in NOAA/JCSDA)

Current Assimilation

- **S-NPP ATMS assimilated operationally at NCEP since May 2012 GDAS/GFS upgrade (L+6 months)**
- **Next generation MW sounder should have some positive impact on NWP forecast.**
  - Additional channels (1 51 GHz, 2 183 GHz)
  - Scan geometry (Nyquist sampling, wider swath)



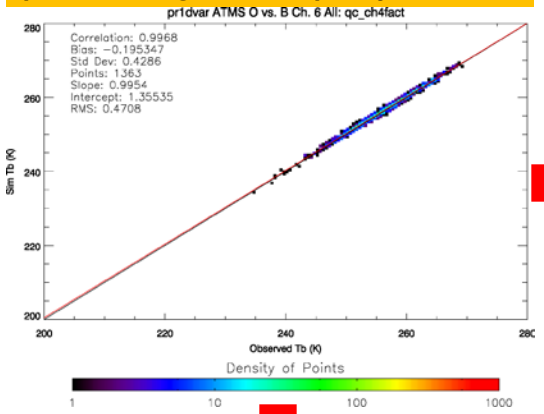
Forecasts with ATMS (and no AMSU) show similar performance to forecasts with no ATMS (with AMSU)

Assimilation Improvements

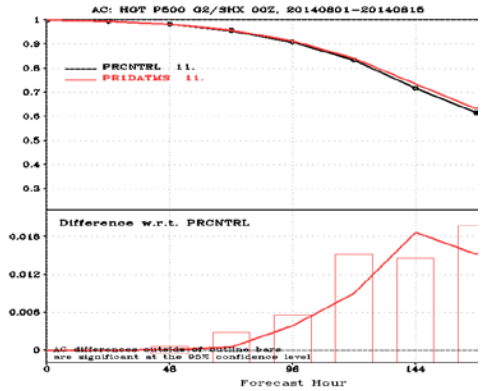
- **Enhance data thinning/data selection from coarse (skip 5 out of every 6 FOVs) to intelligent thinning (CSTROT).**
- **Optimize spatial averaging (maintain high resolution for sounding/water vapor channels).**
- ***Implement dedicated ATMS Quality Control routine based on 1DVAR preprocessor to increase the number and quality of assimilated observations.***

Optimization Results

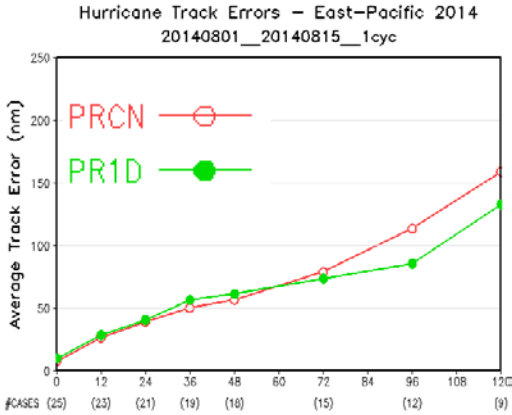
Assimilating 10% more observations per sounding channel, per cycle.

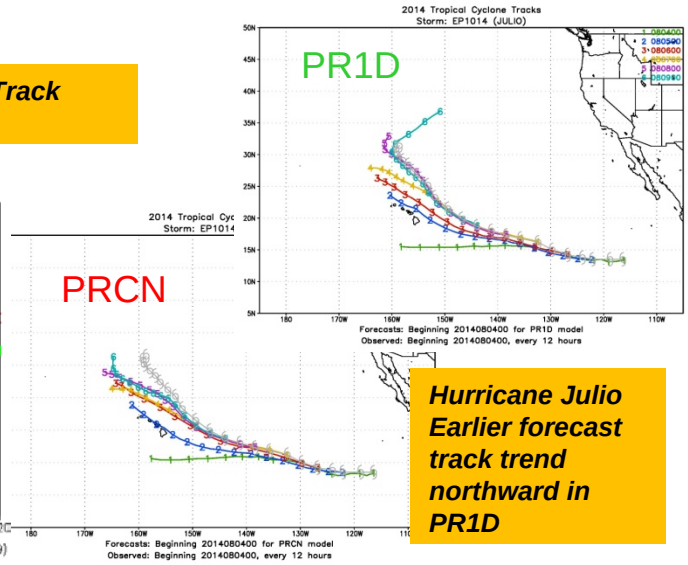


Statistically significant increase in SH Anomaly Correlation (500 mb). Neutral NH.



25 km Reduction in Tropical Cyclone Track Forecast Error at Day 4-5.

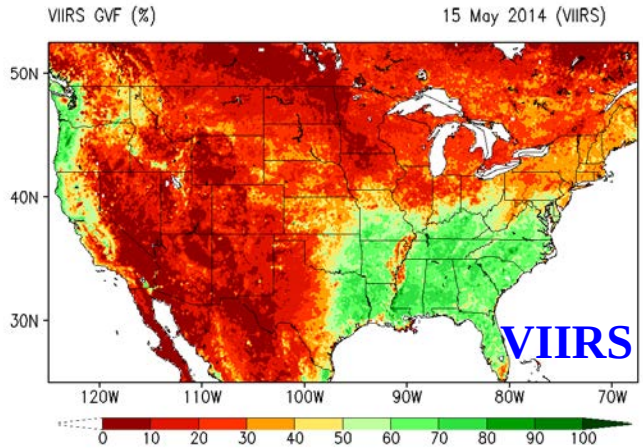




Hurricane Julio Earlier forecast track trend northward in PR1D

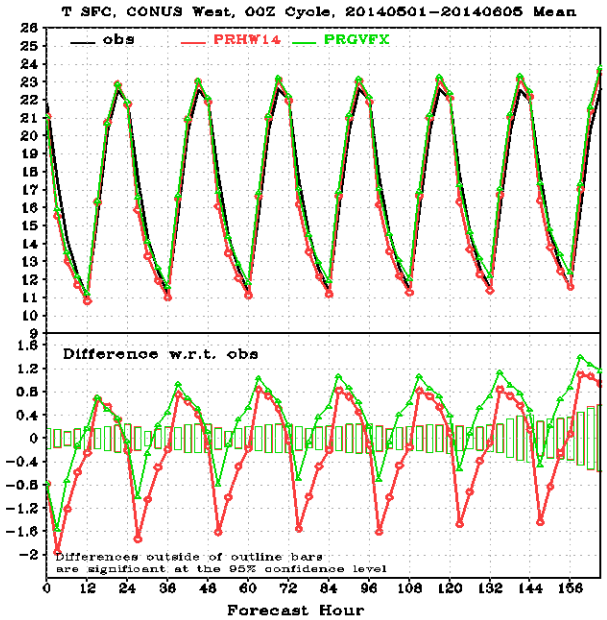
Land Data Assimilation

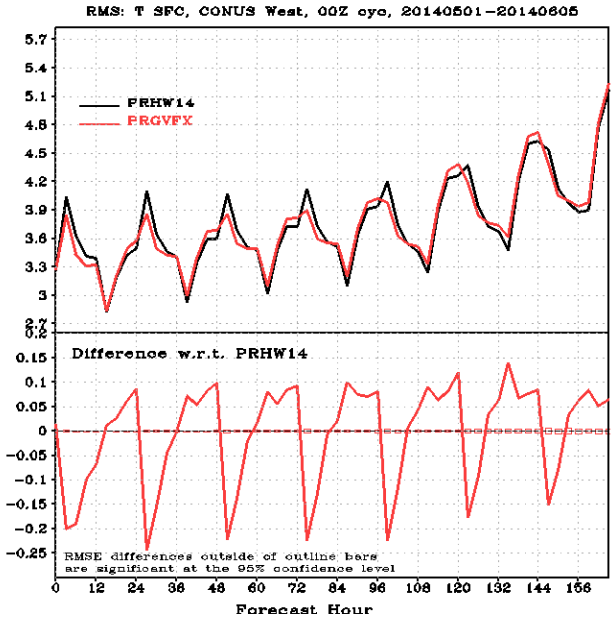
Case of VIIRS Green Vegetation Fraction (GVF)



Objective: **Use weekly real-time VIIRS GVF data set in the NCEP models to replace 5-year mean monthly climatology from AVHRR.**

Results: **Assimilating VIIRS GVF resulted in improved SST, and Precipitation forecasts and land-atmosphere interaction.**





Slide based on efforts by Courtesy of M. Ek and W. Zheng

Reduced cold bias(~1 °C) and RMSE (~0.25 °C) afternoon and night time, but increase a little daytime RMSE.

Aerosols Data Assimilation (VIIRS)

(POCs: NESDIS Kondragunta - NWS S.Lu & Mcqueen)

Improving NCEP global aerosol forecasts using JPSS S-NPP VIIRS aerosol products

The Scope of the Project

NOAA Model

NEMS GFS Aerosol Component (NGAC)

Satellite Observations

Aerosol observations from S-NPP VIIRS

first guess

input observations

NOAA DA System

The hybrid EnKF-GSI system

New Capability to assimilate aerosol optical depth (AOD) observations

NOAA Products

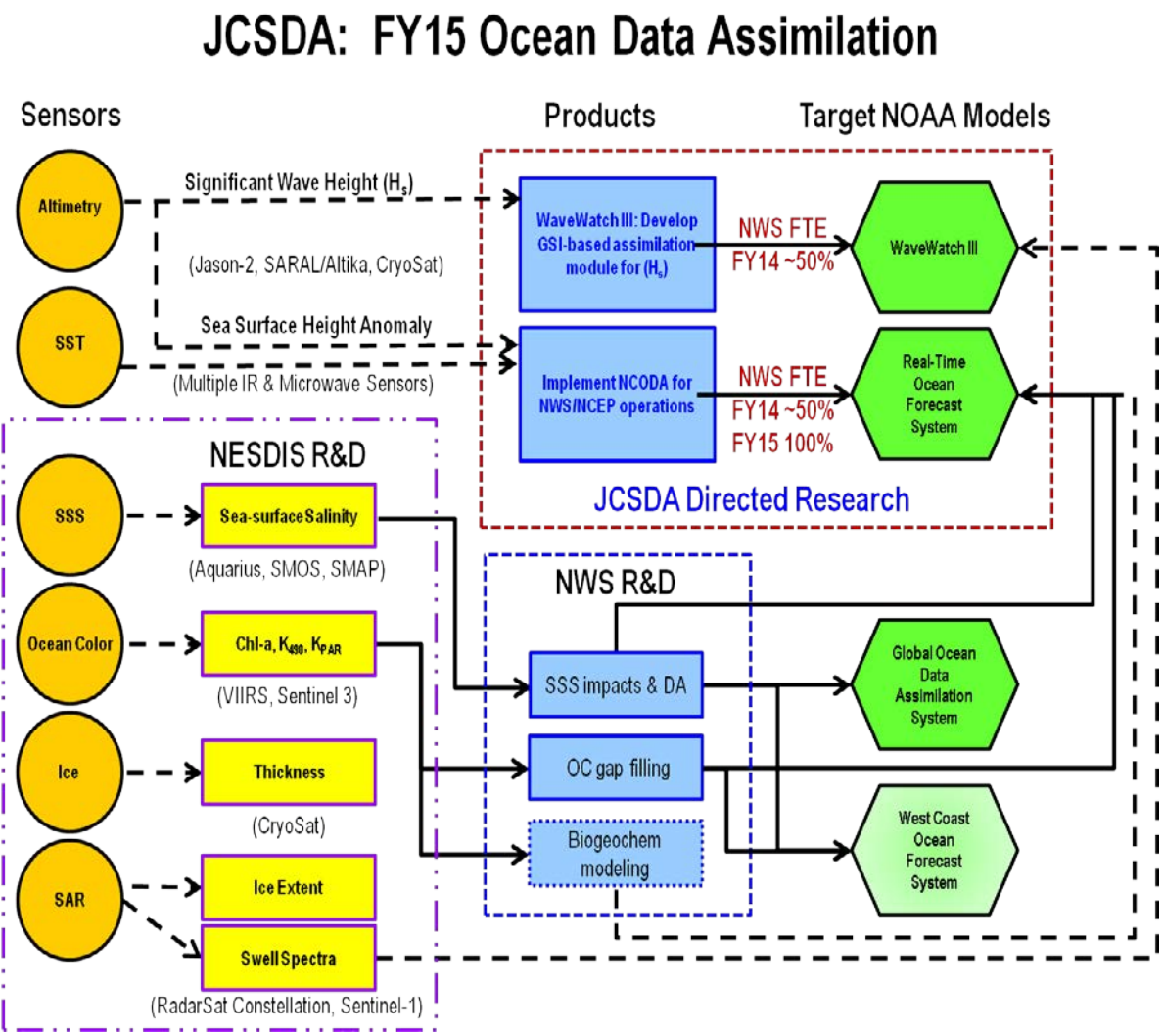
New Product: Aerosol analysis for multi-species

Improve real-time NGAC aerosol forecasts

Enhance aerosol capability in Next-Generation Global Prediction System (NGGPS)

Ocean Data Assimilation Coordination

(POCs: NESDIS Eric Bayler- NWS Avichal Mehra)



Objective:

Implement NCODA (Navy's Coupled Ocean Data Assimilation) for NCEP ocean forecasting operations

Sensors/Data:

-SST:
- -IR: NOAA & METOP GAC/LAC (AVHRR); VIIRS; COMS; GOES, MTSAT, MSG;
- - Microwave: AMSR-E, AATSR, WindSat

- SSS: Aquarius, SMOS

- Sea Ice concentration and temperature:
  - -AMSR-E, SSMI

- Altimeter SSH: Jason-2, SARAL/AltiKa, CryoSat

- T, S and Velocity profiles from in situ platforms: ARGO, ships, buoys, variety of other profilers

Target models & products:

– **Global RTOFS**: SSH; sea-Ice concentrations and drifts; T, S and velocity fields for full 3D ocean.

Ozone Data Assimilation Plans (OMPS)

Plans, Milestones and Deliverables. PIs : NESDIS Larry Flynn-NWS Craig Long .

	Q3 FY15	Q4 FY15	Q1 FY16	Q2 FY16	Final Objective(s)
Activity #1: **Ozone Assimilation**	***Milestone(s) and/or Deliverable(s):*** *- Hire contractor* *- Spin up contractor on past ozone assimilation practices*	***Milestone(s) and/or Deliverable(s):*** *- Access OMPS ozone BUFR products* *-Compare OMPS ozone products with N19 SBUV/2 profile Oz and OMI TOz*	***Milestone(s) and/or Deliverable(s):*** *- Develop validation procedures using ozonesondes* *- Begin testing OMPS ozone assimilation*	***Milestone(s) and/or Deliverable(s):*** *- Evaluate replacing OMI TOz with OMPS NM* *- Evaluate using latest V8 profile and total ozone products.*	*- Assimilate OMPS NP data along with N19 SBUV/2, replace OMI TOz with NPP NM.* *- Improve real time information to monitor quality of assimilated ozone*
Activity #2: **Production of Validated Operational Ozone Products**	***Milestone(s) and/or Deliverable(s):*** -	***Milestone(s) and/or Deliverable(s):*** *-Validated V8Pro from IDPS (consistent with NOAA-19 SBUV/2 V8Pro) into BUFR from NDE*	***Milestone(s) and/or Deliverable(s):*** *- Validated OMPS Total Column Ozone from IDPS (Consistent with Profile product) into BUFR from NDE.*	***Milestone(s) and/or Deliverable(s):*** *- Validated OMPS V8TOz from IDPS*	-
Activity #3: **Name**	***Milestone(s) and/or Deliverable(s):*** -	***Milestone(s) and/or Deliverable(s):*** -	***Milestone(s) and/or Deliverable(s):*** -	***Milestone(s) and/or Deliverable(s):*** -	-

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4. **Summary/Conclusion**

Summary/Conclusions

- Among JCSDA's chief objectives is the use and optimization of satellite data in numerical environmental systems.
- JCSDA Supports S-NPP focused projects either funded directly by JCSDA partners or by other Programs (such as JPSS) through the O2R environment.
- Internal projects (in JCSDA partners NOAA, Navy, NASA, AF) are also funded to use and optimize the use of S-NPP sensors data
- Main Sensors used so far are ATMS, CrIS and VIIRS
- Applications targeted are diverse, varying from partner to partner:
  - NWP medium-range weather forecasting
  - Hurricane/Storm forecasting
  - Land forecasting
  - Ocean
  - Aerosols and air quality
- Plans funded to initiate assimilation of S-NPP Aerosol data as well as Ozone OMPS data (in NOAA). Initiated in FY15.