JPSS Proving Ground Projects for CrIS and ATMS Applications

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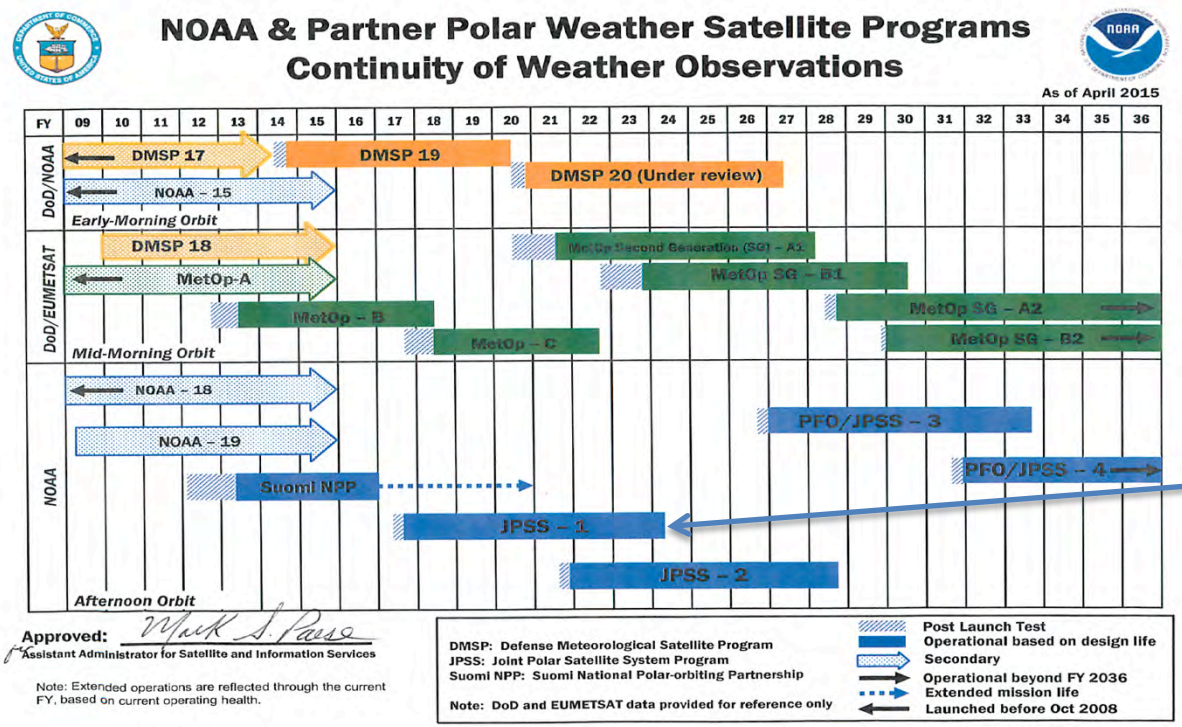
NSSTM 10.2015

Outline

- Update on JPSS (Satellite and Ground)
- JPSS Proving Ground and Risk Reduction
- Sounding (NUCAPS) Initiative

JPSS Overview

- JPSS consists of three satellites (Suomi NPP, JPSS-1, JPSS-2), ground system and operations through 2025
  - SNPP is now NOAA's primary weather polar orbiting satellite providing global data.

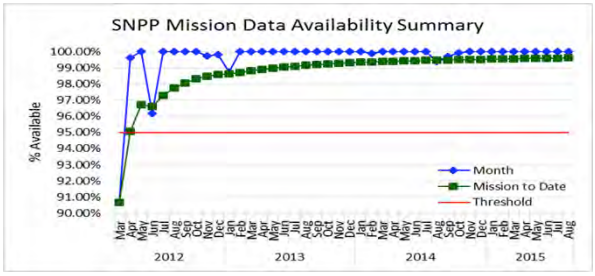


NOAA-20
50 minutes separation

Mission Status

S-NPP

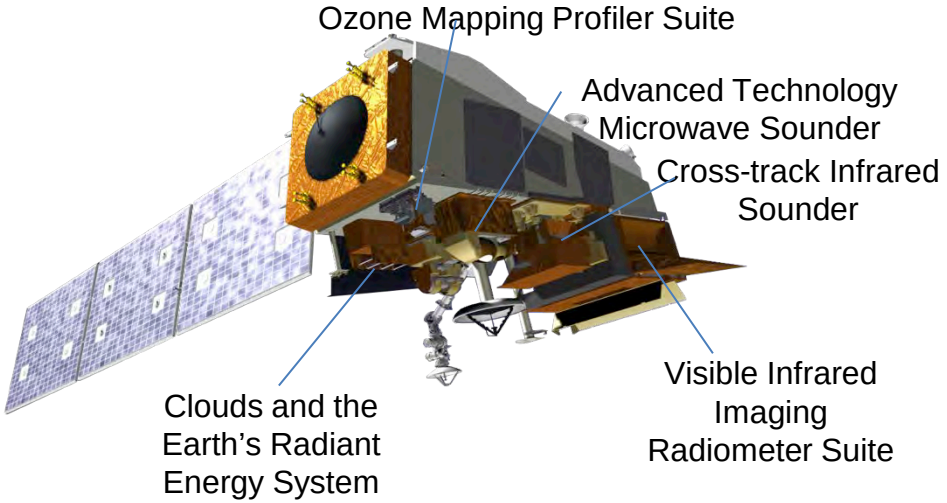
- 4 years on orbit - October 28
- Rapid data product transition to operational use
- Primary for weather since 1 MAY 2014
- Excellent health and data availability



JPSS-1

- Integrated satellite test phase
- On track for early 2017 launch

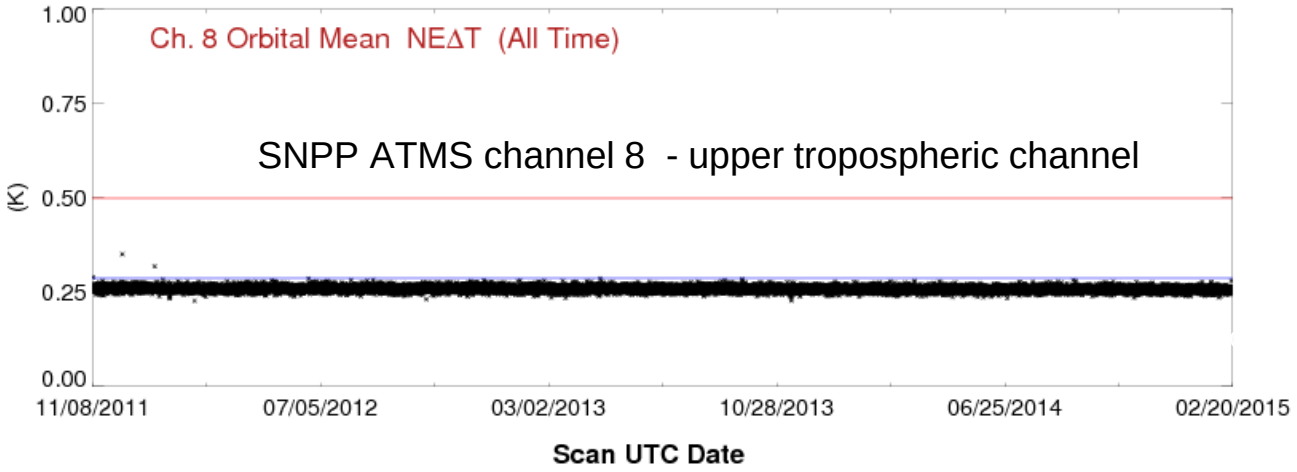
JPSS-1 Spacecraft

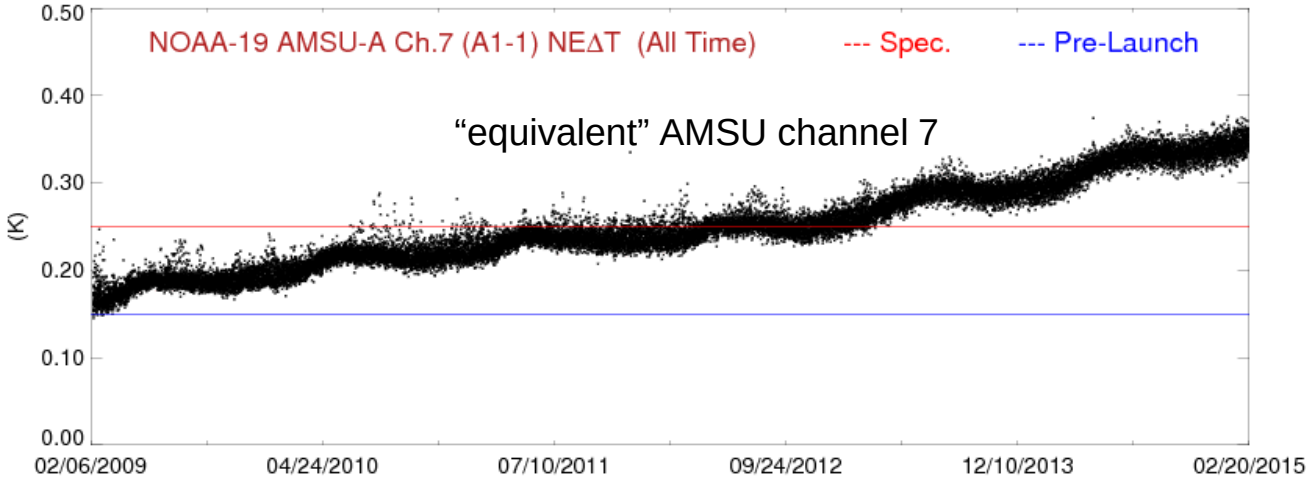


JPSS-2

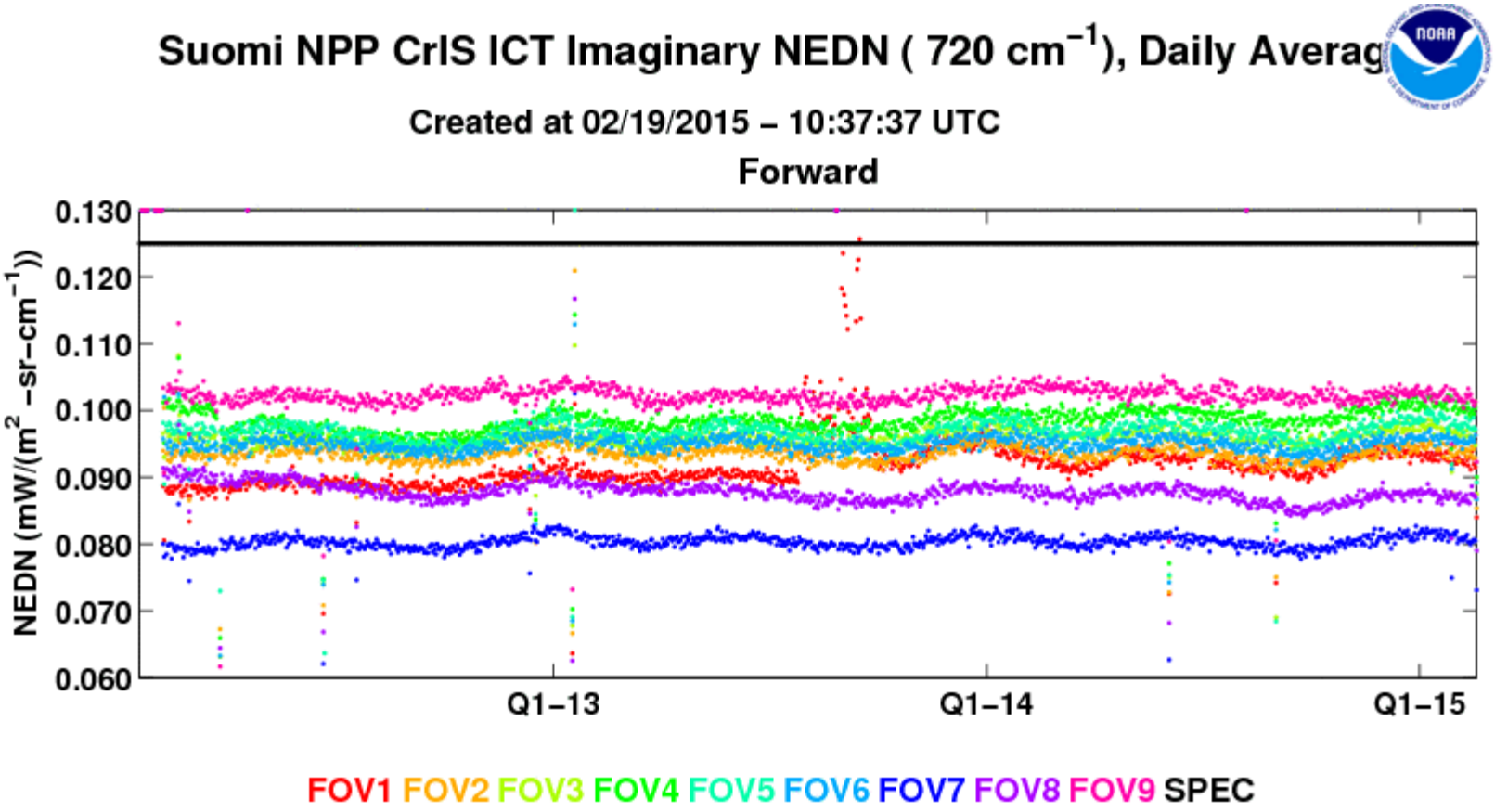
- Instrument parts/assembly phase
- Spacecraft kick-off phase

ATMS is outperforming AMSU in noise and long-term stability





CrIS noise is also very stable



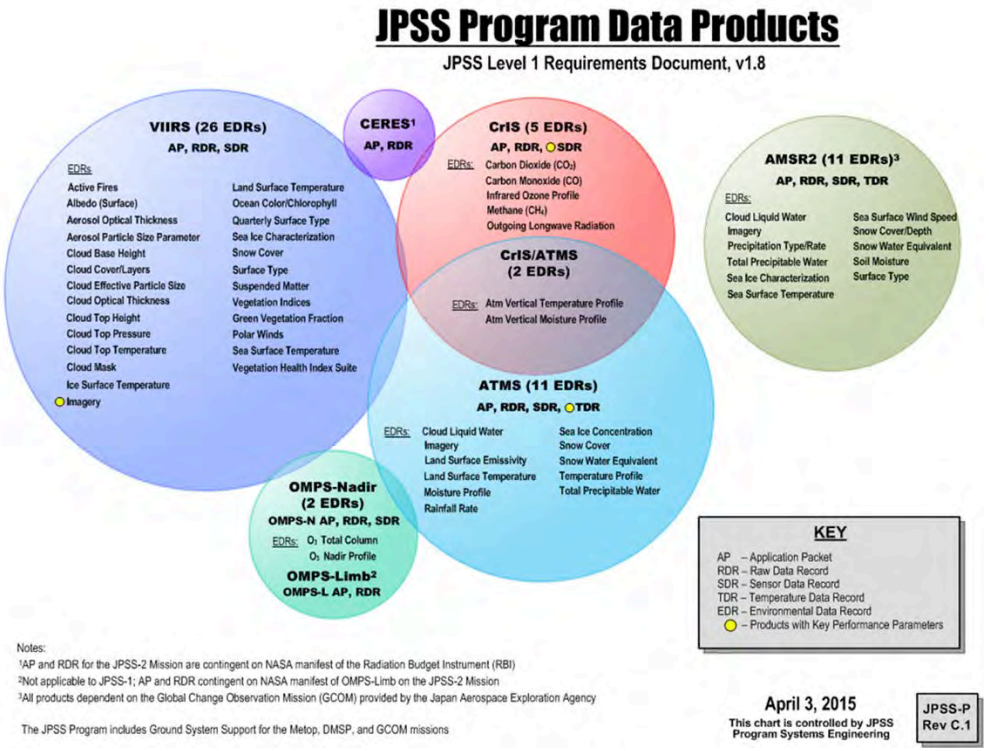
JPSS Performance for Users

Data Products Cal/Val and quality

- Three maturity levels
- Traceability to NIST standards
- Constant quality monitoring

Transition to enterprise algorithms

- JPSS inherited NOAA legacy and NPOESS heritage
- Developed sustainable / maintainable/compatible suite



User Focused Improvements

- Full spectrum CrIS, direct readout improvements
- Program Science -user readiness/risk reduction to enable quicker/broader utilization
- Half orbit latency, 17km resolution OMPS introduced with JPSS-1

JPSS Supports NOAA's Mission

- JPSS supports all four key NOAA mission areas

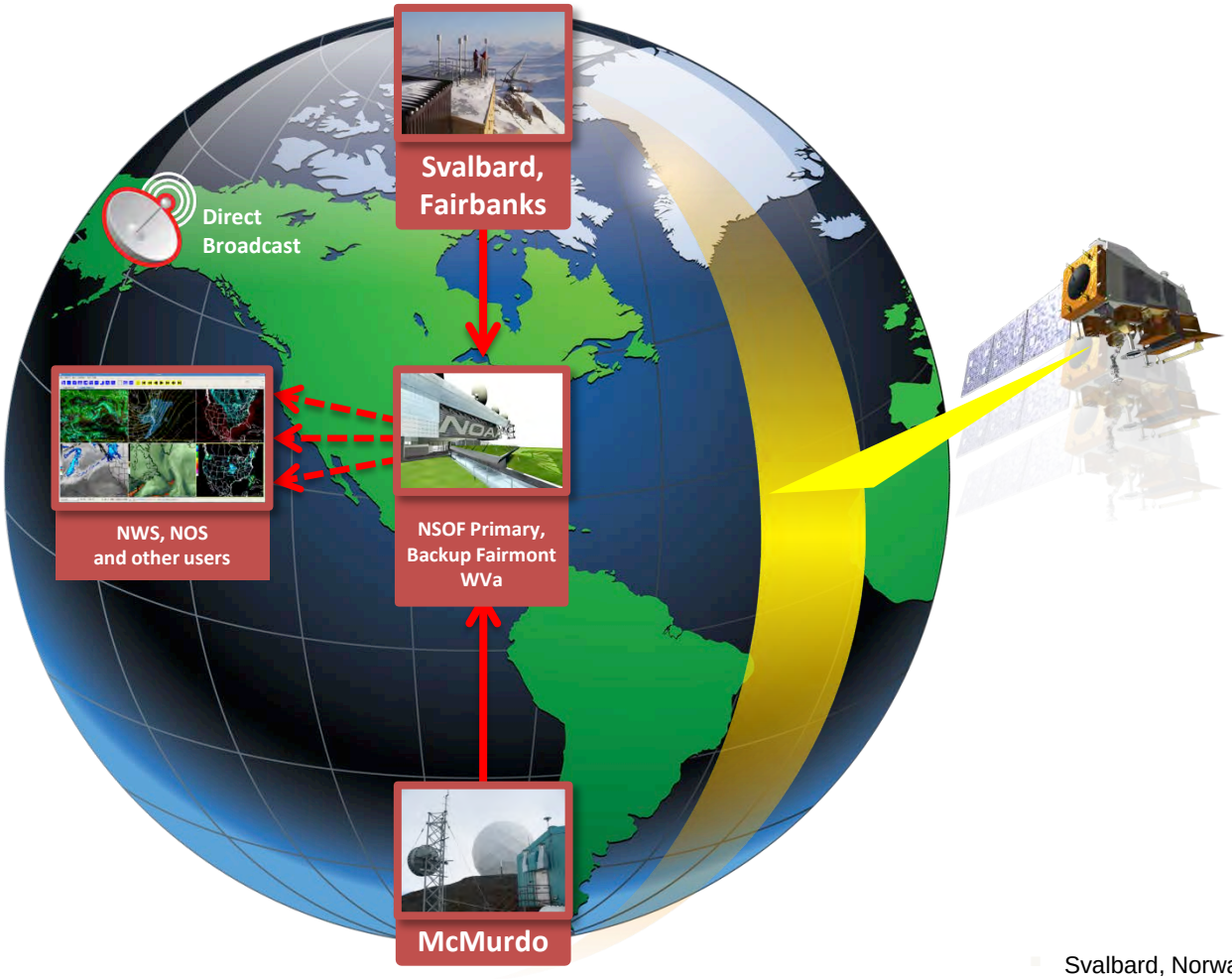
Improved understanding of a changing climate system that informs science, service, and stewardship

Reduced loss of life from high-impact weather events while improving efficient economies through environmental information

Improved coastal water quality support that enables coastal communities to effectively manage resources and improve resiliency

Improved understanding of ecosystems to inform resource management decisions

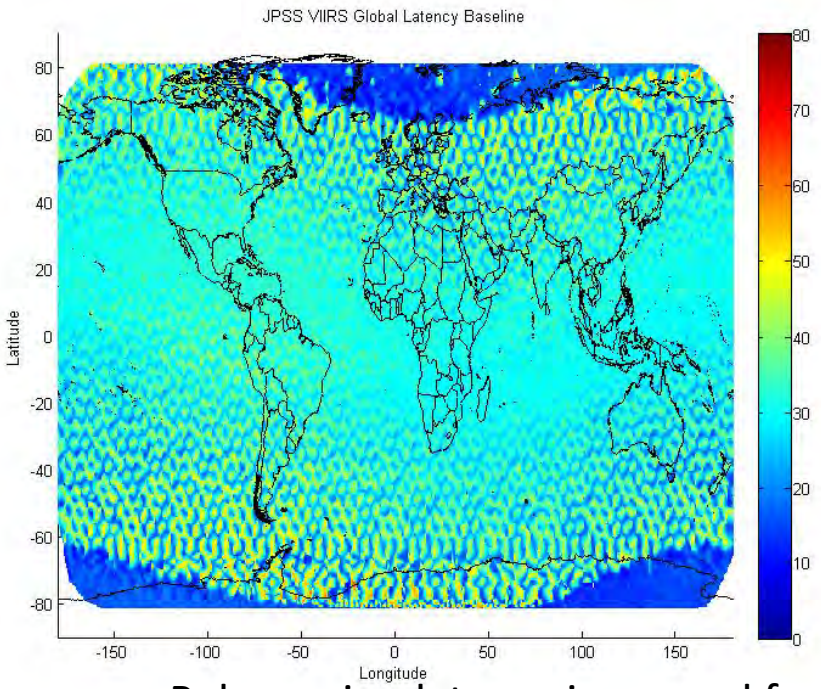
JPSS System Architecture



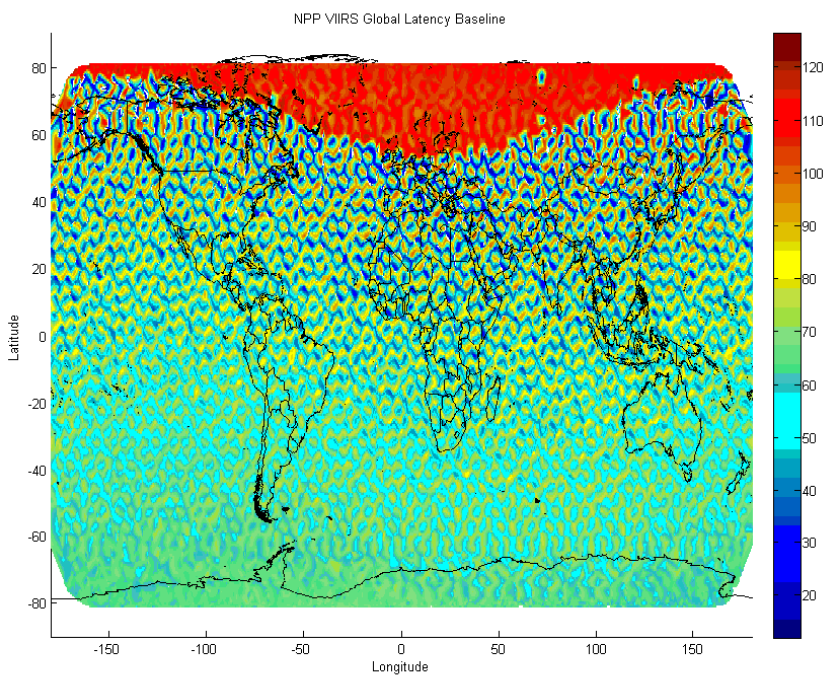
- Svalbard, Norway
- Fairbanks, Alaska
- NWS-National Weather Service
- NOS-National Ocean Service
- NSOF-National Satellite Operations Facility
- McMurdo- U.S. Antarctic Research Station

Much improved latency starting with JPSS-1

JPSS



SNPP



Polar region latency improved from 2 hours to 10 minutes

95% of the data is within 50 minutes (taking into account BUFR conversion, etc)

Between +- 50 degrees latitude ~ 30 minutes

Actual performance will be 50% better than specification

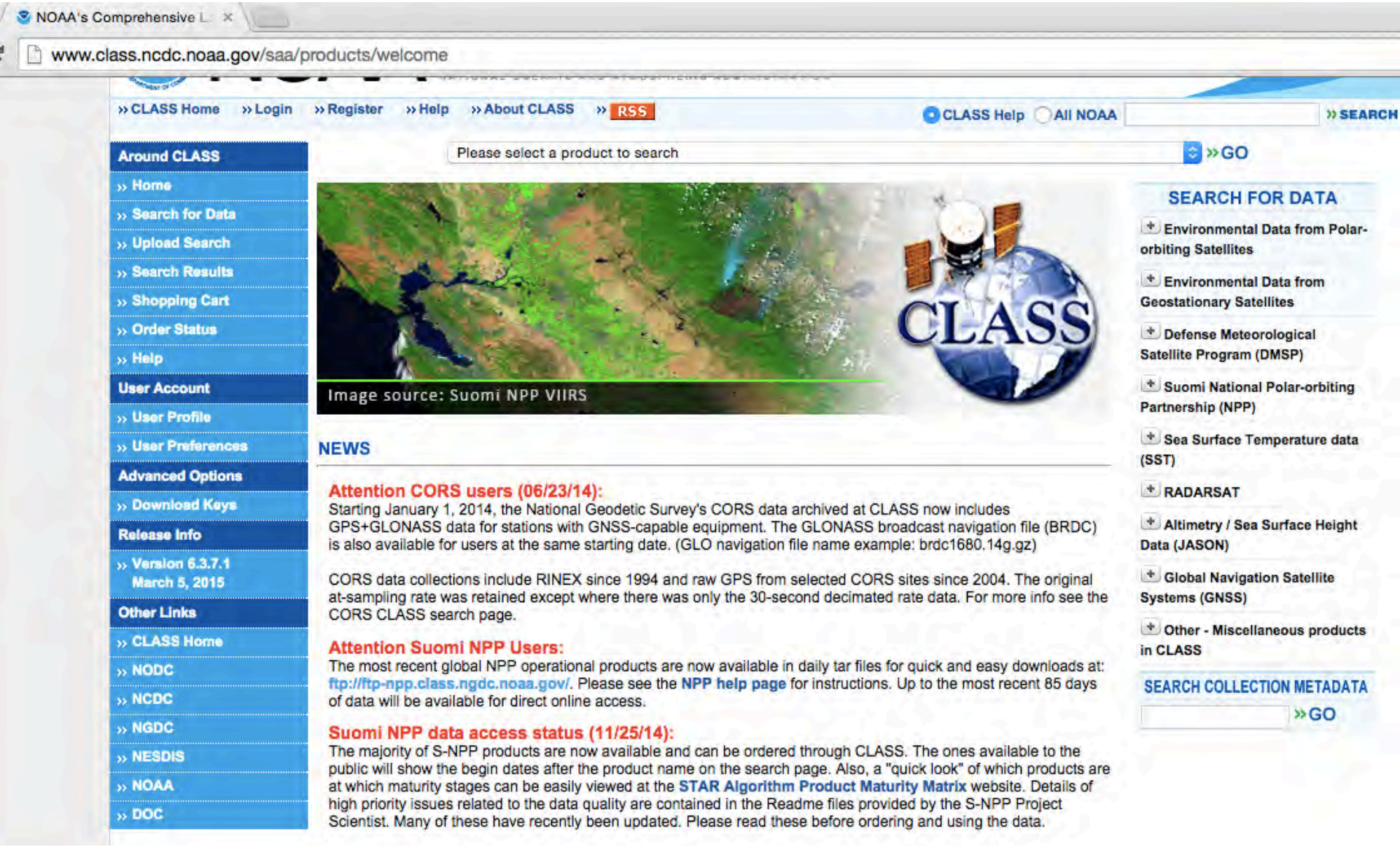
JPSS-1 uses real-time playback of data at least while still in view of the ground station, which reduces the minimum latency number, while SNPP plays back first the oldest data of the entire orbit

Data Access through National Centers for Environmental Information (NCEI)

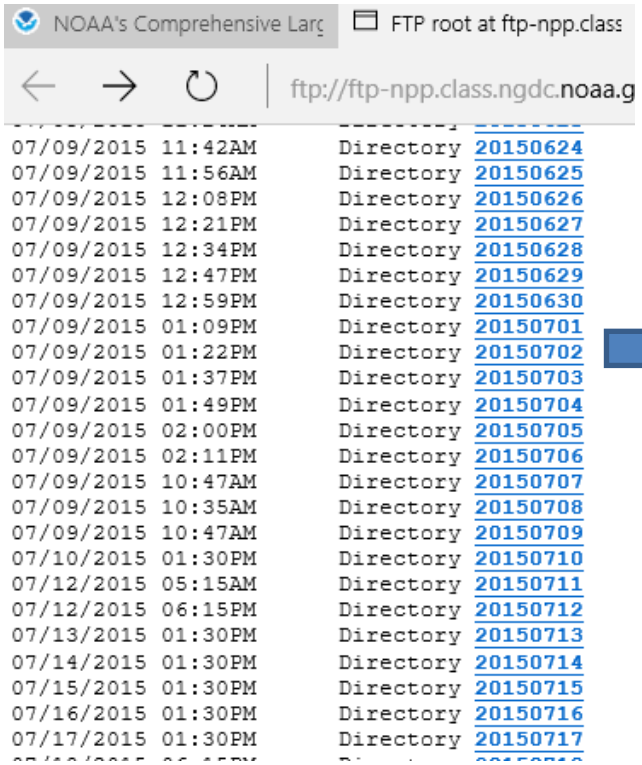
NOAA • NESDIS JPSS Joint Polar Satellite System

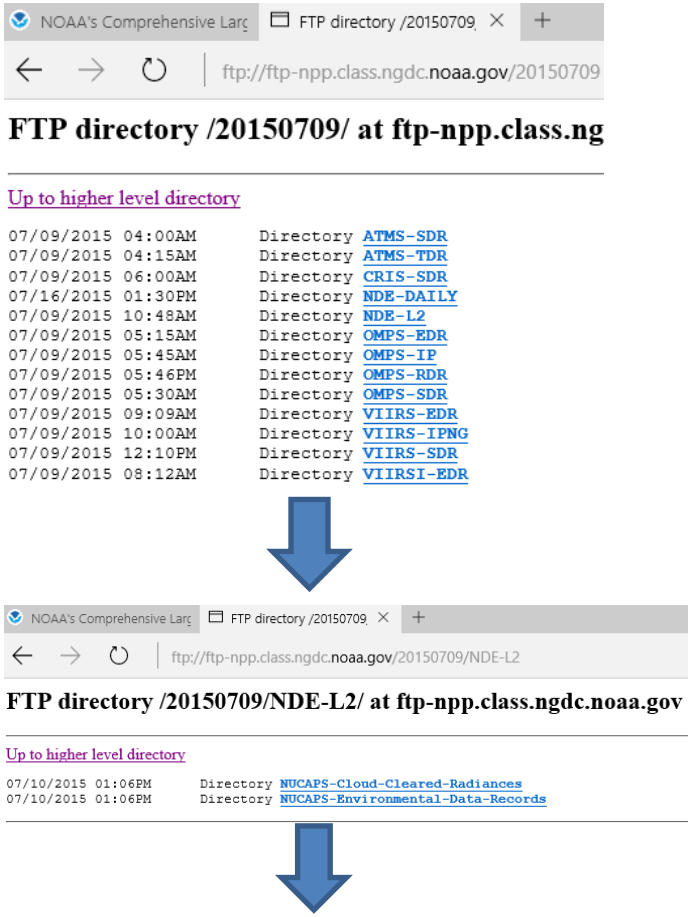
Center for Weather and Climate

Center for Coasts, Oceans, and Geophysics



Easy Access - 85-day rotating server





FTP directory /20150709/NDE-L2/NUCAPS-Environmental-Data-Records/ at ftp-npp.class.ngdc.noaa.gov

Up to higher level directory

```
07/09/2015 10:47AM         327,569 NDE-L2_NUCAPS-Environmental-Data-Records_20150709_00001.manifest.xml
07/09/2015 10:47AM   1,369,025,024 NDE-L2_NUCAPS-Environmental-Data-Records_20150709_00001.tar
07/09/2015 01:01PM          65,021 NDE-L2_NUCAPS-Environmental-Data-Records_20150709_00002.manifest.xml
07/09/2015 01:01PM     268,244,992 NDE-L2_NUCAPS-Environmental-Data-Records_20150709_00002.tar
07/09/2015 09:08PM         210,934 NDE-L2_NUCAPS-Environmental-Data-Records_20150709_00003.manifest.xml
07/09/2015 09:08PM     877,337,600 NDE-L2_NUCAPS-Environmental-Data-Records_20150709_00003.tar
07/10/2015 01:06PM          45,501 NDE-L2_NUCAPS-Environmental-Data-Records_20150709_00004.manifest.xml
07/10/2015 01:06PM     186,891,264 NDE-L2_NUCAPS-Environmental-Data-Records_20150709_00004.tar
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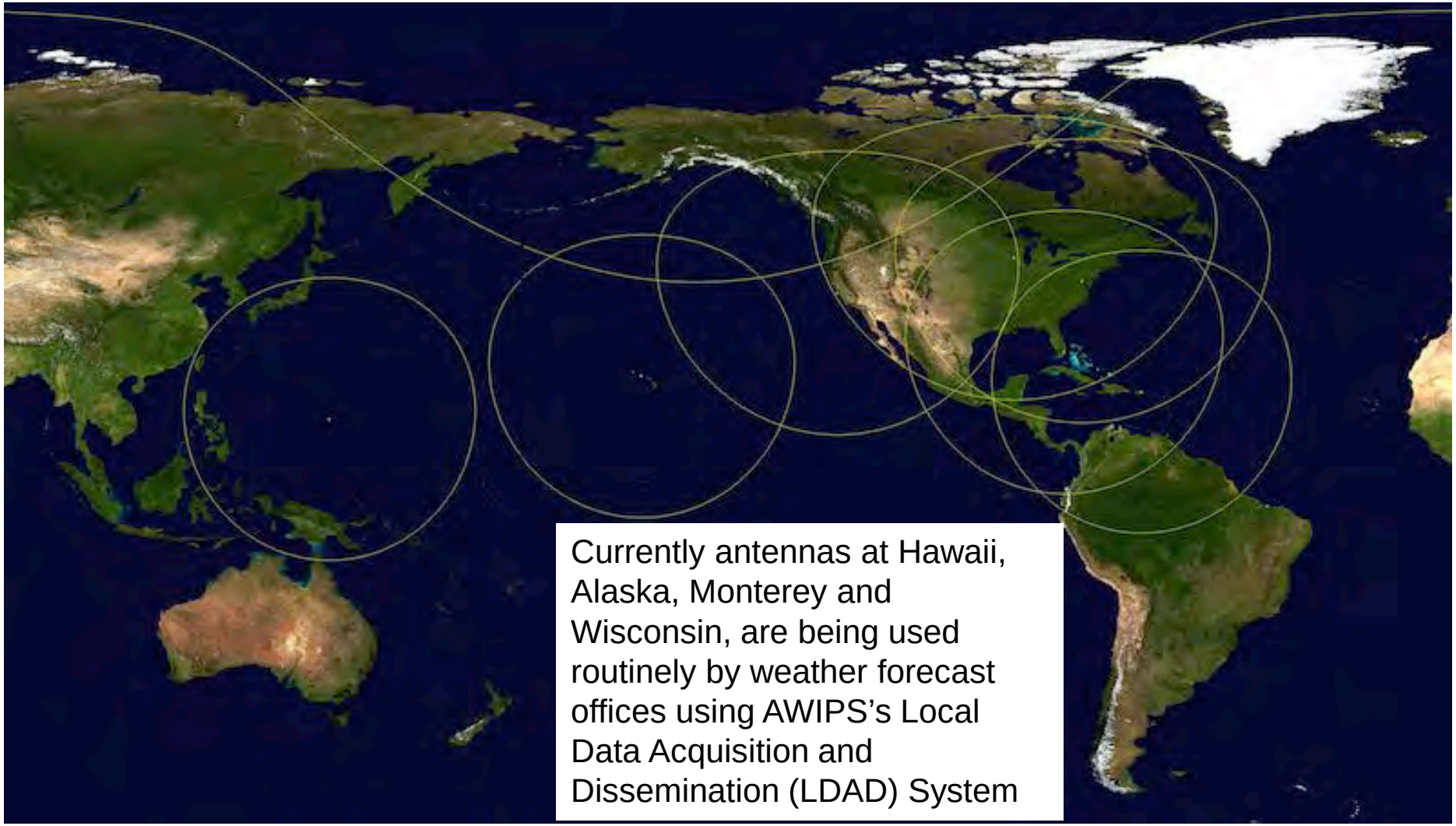
NOAA supported direct readout sites



Guam, Honolulu, Fairbanks, Monterey, Madison, NYC, Miami, Mayaguez (PR)

DIRECT BROADCAST

- JPSS shall provide the DR community with software, documentation, and periodic updates to enable them to produce data products from JPSS, using their own hardware to receive the JPSS HRD broadcasts

- NOAA provides DR software packages under the JPSS Program Science. The software is called the Community Satellite Processing Package

CSPP

Community Satellite Processing Package

Home | Download | Applications | History | Credits | Forum

The Community Satellite Processing Package (CSPP) supports the Direct Broadcast (DB) meteorological and environmental satellite community through the packaging and distribution of open source science software. CSPP supports DB users of both polar orbiting and geostationary satellite data processing and regional real-time applications through distribution of free open source software, and through training in local product applications. CSPP is funded through NOAA JPSS.

Suomi National Polar-orbiting Partnership (NPP) Products

CSPP software to support Suomi NPP:

- VIIRS, ATMS and CrIS calibration and geolocation software (Raw Data Records (RDRs) to Sensor Data Records (SDRs));
  Learn more ...
- VIIRS Environmental Data Records (EDRs), including a subset of Land, Ocean and Atmosphere Products;
  Learn more ...
- VIIRS SDR reprojection software for the creation of GeoTIFFs and/or AWIPS NetCDF files;
  Learn more ...
- NOAA/NESDIS/STAR NOAA Unique CrIS/ATMS Processing System (NUCAPS) EDR Hyperspectral Sounding Retrieval Software;
  Learn more ...
- CrIS, AIRS and IASI University of Wisconsin dual regression single Field-of-View (FOV) Temperature, Moisture, Surface and Cloud Retrieval Environmental Data Record (EDR);
  Learn more ...
- S-NPP VIIRS, ATMS,CrIS and EOS Aqua and Terra HYDRA2 multispectral data analysis toolkit;
  Learn more ...
- NOAA/NESDIS/STAR Microwave Integrated Retrieval System (MIRS) supporting S-NPP ATMS, NOAA-18, 19 and Metop-A, B AMSU-A and MHS instruments;
  Learn more ...
- VIIRS Imagery Environmental Data Records (EDRs).
  Learn more ...
- VIIRS, MODIS and AVHRR (POES and Metop) Cloud and Land Surface Retrievals from CLAVR-x

What's New

- MIRS Microwave Retrieval Software v2.0
- Suomi-NPP SDR v2.1.1 Patch for CrIS
- Sounder Quicklook Software v1.0
- ACSPO SST Retrieval Software v1.0
- IAPP Retrieval Software v1.0
- NUCAPS CrIS/ATMS EDR Retrieval Software v1.0

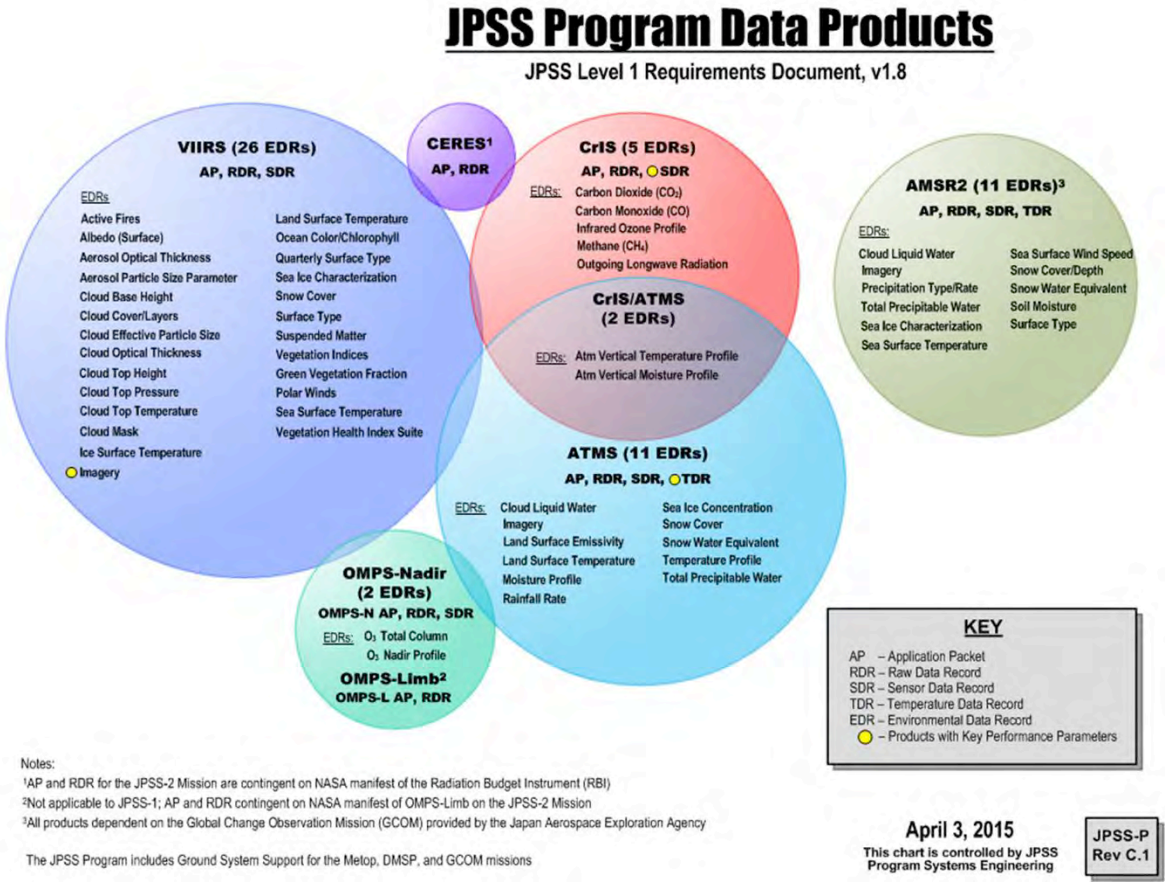
2015 Spring Direct Readout Users Meeting at EUMETSAT

CSPP Satellite/Sensor/Product Matrix

Satellite	Multispectral Imager	Infrared Sounder	Microwave Sounder
Suomi NPP	**VIIRS** *SDRs (Level 1B), Images, Visualization, Clouds, Aerosols, Land, Ocean*	**CrIS** *SDRs (Level 1B) Atmospheric Profiles, Clouds, Visualization*	**ATMS** *SDRs (Level 1B), Atmospheric Profiles, Precipitation, Visualization*
Metop-A/B	**AVHRR** *Clouds, Aerosols, Land Surface, SST, Visualization*	**IASI, HIRS** *Atmospheric Profiles, Clouds, Visualization*	**AMSU, MHS** *Atmospheric Profiles, Precipitation*
NOAA-18/19	**AVHRR** *Clouds, Aerosols, Land Surface, SST, Visualization*	**HIRS** *Atmospheric Profiles*	**AMSU, MHS** *Atmospheric Profiles, Precipitation*
Terra	**MODIS** *Images, Visualization*	*N/A*	*N/A*
Aqua	**MODIS** *Images, Visualization*	**AIRS** *Atmospheric Profiles, Clouds, Visualization*	**AMSU** *Atmospheric Profiles, Precipitation, Visualization*

Challenge

- User Readiness: Products to Applications
- Ensure users are ready for NPP/JPSS data and improve their key operational and research product and service
  - ✓ Severe weather forecasts and warnings
  - ✓ Aviation weather forecasts and warnings
  - ✓ Improve fire and air quality forecasts and warnings
  - ✓ Improve warnings and prediction poor water quality in coastal regions
  - ✓ Improve drought, precipitation, snow and ice assessments and predictions
- Periodic feedback from keys users on the impact of NPP/JPSS data and to identif improvements needed for products and applications



Proving Ground & Risk Reduction Program

The JPSS Proving Ground and Risk Reduction (PGRR) program's primary objective is to maximize the benefits and performance of NPP/JPSS data, algorithms, and products for downstream operational and research users (gateways to the public) through:

- Engaging users to enhance/improve their applications through the optimal utilization of JPSS data.
- Education, Training and Outreach
- Facilitating transition of improved algorithms to operations.
- Detailed characterization of data attributes such as uncertainty (accuracy and precision) and long-term stability
- Provides user feedback to the cal/val program

Proving Ground versus Risk Reduction

- Proving Ground
  - Demonstration and utilization of data products by the end-user operational unit, such as a NWS Weather Forecast Office or Modeling Center.
  - Promote outreach and coordination of new products with the end users, incorporating their feedback for product improvements

- Risk Reduction
  - Address potential risk in algorithms and data products by testing alternative algorithms.
    - JPSS Risk Reduction Algorithms: Replaced many NPOESS algorithms not meeting spec/or the cost to do so was high with NESDIS/STAR Enterprise Algorithms to reduce cost by using same algorithms for GOES-R and VIIRS when possible. Also reduced risk in science overload – algorithm lead does not have to be an expert in two different algorithms.
  - Development of new research and applications to maximize the benefits of JPSS satellite data
    - Example - use of Day Night Band for improved fog and low visibility products at night, benefitting transportation industry.
  - Encourages fusion of data/information from multiple satellite, models and in-situ data

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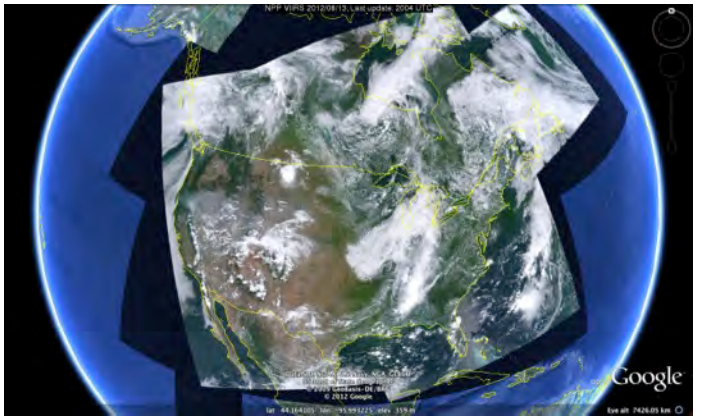
JPSS Proving Ground and Risk Reduction Application Areas

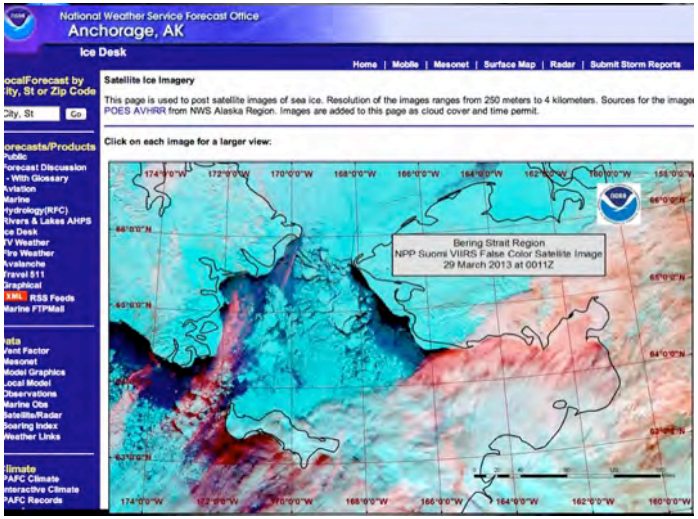
- Weather Forecasting (Improving Global, Regional forecasts)
  - Tropical Cyclones << NUCAPS
  - Severe Weather (Nowcasting) << NUCAPS
- Ocean/Coastal (Coral Bleaching, Harmful Algal Bloom alerts)
- Land (Droughts, Agriculture)
- Hazards (Smoke, Fire, Volcanic Ash, Air Quality) <<NUCAPS
- Hydrological (Precipitation, Floods, Soil Moisture, Snow/Ice, River Ice) <<NUCAPS
- Climate (integrated products, real-time anomaly products) <<NUCAPS
- Education and Training <<NUCAPS
- Infrastructure (Direct Readout and Software (CSPP), Airborne campaigns) <<NUCAPS

JPSS Proving Ground Partners :
NWS, NOS, NMFS, OAR, NESDIS, NOAA Cooperative Institutes, NASA, and NRL

JPSS Significant Proving Ground Accomplishments

- S-NPP Direct Broadcast for Alaska, Hawaii, Continental US, and World Wide Users
  - Provide Community Satellite Processing Package (CSPP)
- Routine use of VIIRS Imagery by forecast offices (significant use by Alaska)
- VIIRS Active Fire, Air Quality, and Ocean Color imagery and data portals
- Tropical Cyclone Forecasting Improvements using ATMS and CrIS
- Global Data Assimilation Experiments of ATMS and CrIS
- Education and Training (New COMET VIIRS Day Night Module)
- Two (2013, 2015) Airborne Validation Campaign via NASA ER2 to assess CrIS SDR accuracy @0.1K level
- Established monthly science seminars and operational demonstration initiatives to continue broad user involvement
- Supported pathfinders for reprocessing



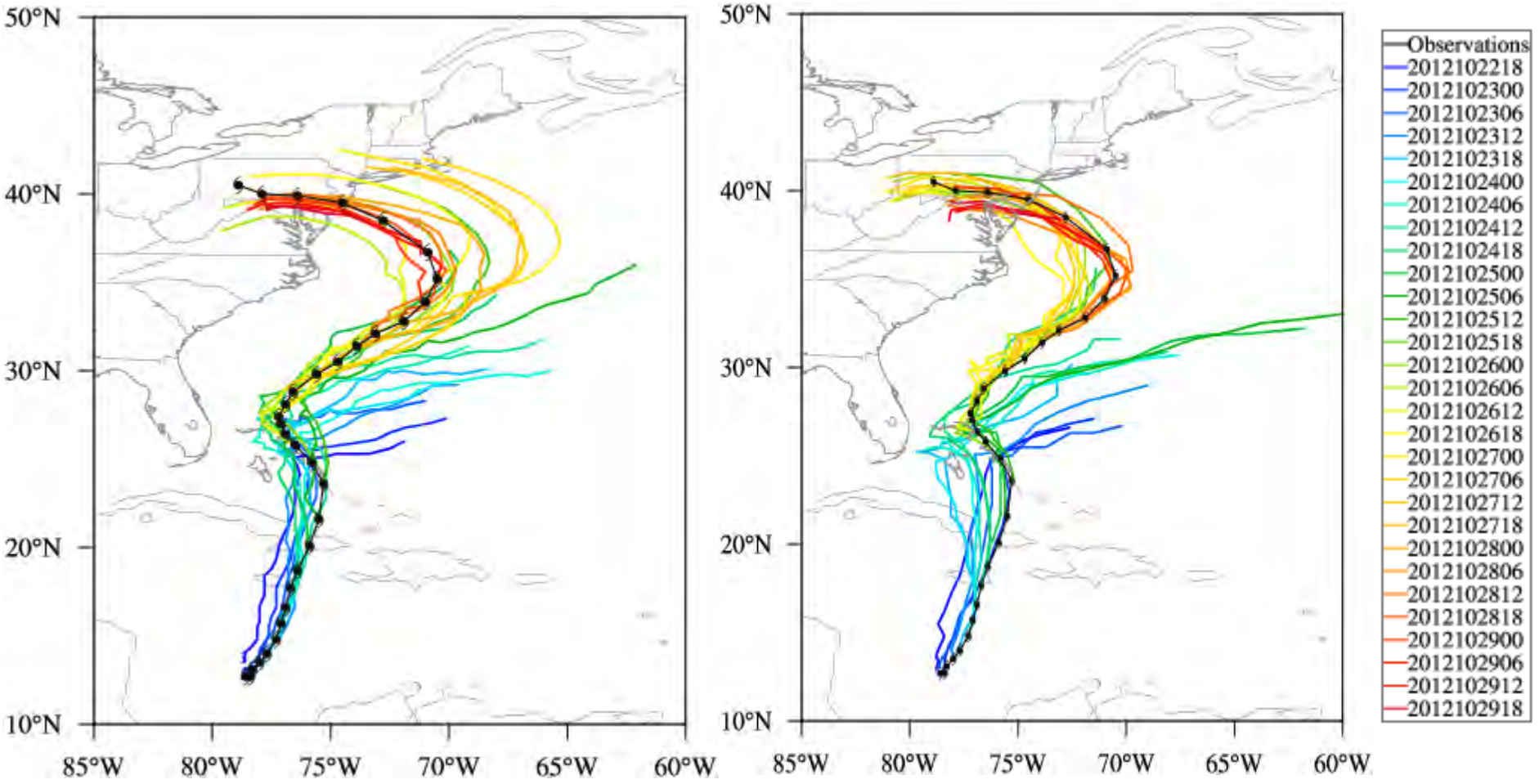


Direct Assimilation of ATMS into Models

Experimental results showing improvements in Sandy track forecasts from Hurricane Weather Research Forecast model with ATMS: NOW OPERATIONAL

HWRF-NCEP Operational

Modified HWRF-NCEP with ATMS



Credit: Fuzhong Weng

PGRR Initiatives

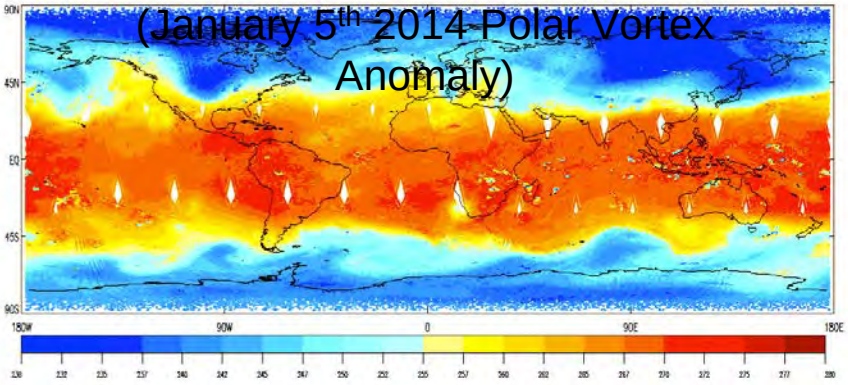
An initiative is a group (~10-20 participants) focused on a common goal and operational demonstration and includes product developers and users

- Fire and Smoke
- Aerosol Data Assimilation
- River Ice and Flooding
- Atmospheric Sounding Applications
- NWP impact studies (via HRRR and GFS) and other critical weather applications
- AWIPS Operational Demonstrations
- Cryosphere Initiative
- Land Data Assimilation
- Ocean and Coastal
- Atmospheric Chemistry
- Hydrology
- Innovation
- Training

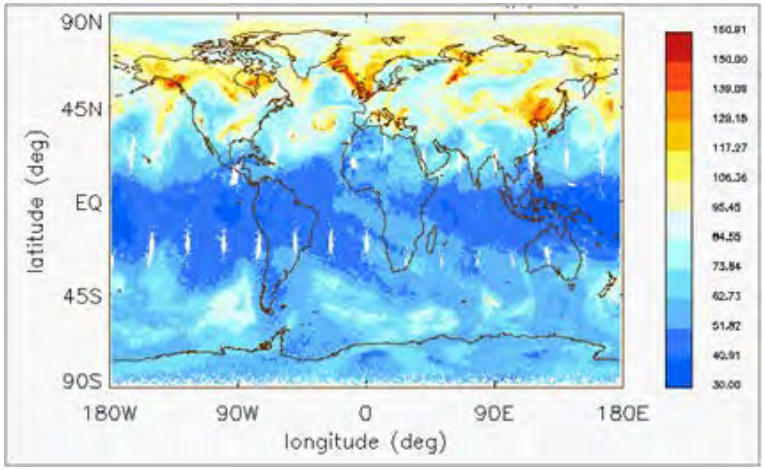
Sounding

- Assist WFOs to make better use of NUCAPS temperature and moisture soundings
- Support NWS/NCEP plans to improve data assimilation of radiances in cloudy conditions
- Use NUCAPS to solve for derive trace gases

NUCAPS Temperature retrieval @ 500mb

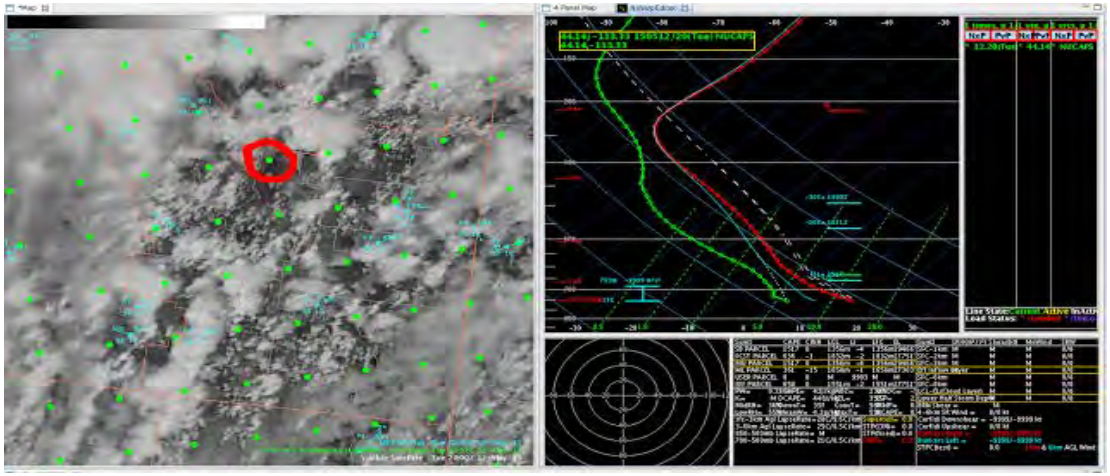


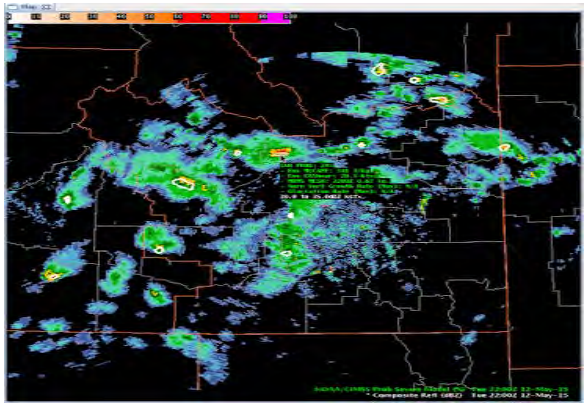
NUCAPS Ozone retrieval @ 500mb



NUCAPS Evaluated in NWS Hazardous Weather Testbed (HWT)

- Background
  - What is the HWT: a joint testbed in Norman OK managed by the NWS Storm Prediction Center, the NWS Weather Forecast Office and the National Severe Storms Laboratory
  - Purpose: plan and execute operational tests focused on national hazardous weather needs
  - Spring Experiment: annual, 5-week test periods. Researchers, forecasters, and broadcast meteorologists evaluate emerging research concepts and tools through experimental forecast and warning generation exercises. NUCAPS was a key focus area in the Spring Experiment 2015





Examples of Forecaster feedback

Waiting for deep convection to start. Denver's 18z special sounding showed a strong inversion around 700mb. The 20Z NUCAPS showed the lower levels not quite fully mixed. NUCAPS increased confidence that deep convection would occur but not quite yet. (comment edited)

NUCAPS sounding shows the presence of a cold pocket aloft and relatively low precipitable water values around a half an inch confirm elevated convection along with the scattered reports of severe hail in eastern Idaho.

A VIIRS Satellite Pass at 1944Z provided a NUCAPS Profile near some developing storms in Texas. It provided a nice snapshot of the atmosphere in between [radiosonde] soundings.

Improving NUCAPS Soundings for CONUS Severe Weather Applications via Data

Daniel T. Lindsey

SYNOPSIS: This project's team members plan to use the NOAA Unique CrIS/ATMS Processing System (NUCAPS) vertical profiles of temperature and moisture from the JPSS satellites and combine them with observed surface observations and numerical model output to produce improved vertical soundings over the CONUS. These modified, "fused" data soundings will be displayed in AWIPS-2 for the National Weather Service.

WHY IS THIS RESEARCH IMPORTANT?

Sharp vertical variations in temperature and moisture are common near the surface prior to warm-season, severe convective events. These sharp gradients, along with the amount and depth of low-level water vapor, can be determining factors in whether convective storms initiate, and if they do, how those storms evolve. One of the key uncertainties on many days when severe weather is possible is whether the low-level temperature inversion, or "cap", will be eliminated due to daytime heating of the earth's surface or cooling above the surface. Currently, the only observations having adequate vertical resolution of temperature and moisture for severe thunderstorm applications are radiosondes. However, the major limitation of radiosonde data is inadequate temporal and horizontal resolution. Balloons are launched only at 00 and 12 UTC (and occasionally at 18 UTC), and the launch sites are 300-500 km apart in the central U.S.

Advancing Hyperspectral Sounder Applications in the Direct-Broadcast Environment

Elisabeth Weisz

SYNOPSIS: BY performing a rigorous validation and evaluation of the UW hyperspectral (dual-regression) retrieval system and the NOAA Unique CrIS/ATMS Processing System (NUCAPS), project team members aim to address concerns raised by users on how to best use these retrieval systems:. In addition, project team members will characterize product performance, such as attributes of accuracy and precision and their stability over time (both short- and long-term). This will contribute significantly to our continued efforts to serve DB users by making the best possible data products available.

WHY IS THIS RESEARCH IMPORTANT?

Hyperspectral infrared sounders, such as AIRS (Atmospheric Infrared Sounder) on EOS-Aqua, IASI (Infrared Atmospheric Sounding Interferometer) on MetOp-A and MetOp-B, and CrIS (Cross-track Infrared Sounder) on Suomi NPP (S-NPP), measure the top-of-atmosphere (TOA) radiance emitted by the Earth system with very high spectral resolution using several thousand channels. The great advantage of high spectral resolution is an increased sensitivity to changes in the vertical atmospheric column (from surface to TOA). Thus, hyperspectral measurements can be inverted into vertical temperature, moisture and ozone profiles, as well as information describing Earth surface and cloud properties. With hyperspectral sounder retrievals now operationally available from four

The Utility of NUCAPS Retrieved Profiles to Diagnose Extratropical Transition

Emily Berndt

SYNOPSIS: The goal of this proposal is to demonstrate how NUCAPS infrared retrieved temperature, moisture, and ozone profiles can complement the Air Mass RGB by giving forecasters insight about the vertical distribution of various atmospheric variables that are influencing the Air Mass RGB imagery and are important for anticipating a tropical to extratropical transition. Additionally, NOAA G-IV dropwindsondes will be used as a verification dataset to compare to the NUCAPS soundings and Air Mass RGB, especially over data sparse regions.

WHY IS THIS RESEARCH IMPORTANT?

Currently NOAA Unique CrIS/ATMS Processing System (NUCAPS) temperature and moisture soundings are available in AWIPS-II as a point-based display. Traditionally soundings are used to anticipate and forecast severe convection, however unique and valuable information can be gained from soundings for other forecasting applications, especially in data sparse regions. Forecasters at the National Centers (i.e. the National Hurricane Center (NHC), Weather Prediction Center (WPC), and Ocean Prediction Center (OPC)) have GOES-R/JPSS Proving Ground proxy products, such as the Air Mass RGB, to assist in monitoring extratropical transition of hurricanes. These extreme events often occur over the ocean in data sparse regions.

https://nasasport.wordpress.com/2015/10/08/next-generation-s-nppjpss-nucaps-soundings-highlight-the-environment-around-severe-tropical-storm-choi-wan/

Understanding Emissions and Tropospheric Chemistry Using NUCAPS and VIIRS

Gregory Frost

SYNOPSIS: Project team members will develop an approach using NOAA aircraft field measurements and atmospheric chemical-transport models to deliver products to characterize NUCAPS (CrIS/ATMS) retrieval quality, with the goal of improving the accuracy of the NUCAPS daily global measurements of methane (CH4) and carbon monoxide (CO). The goals are to test and improve the accuracy of JPSS-retrieved data and demonstrate their usefulness in air quality and climate modeling studies.

WHY IS THIS RESEARCH IMPORTANT?

Methane

CH4 is an important climate-forcing agent and mediator of global tropospheric chemistry. Recent assessments using field and satellite data demonstrate significant knowledge gaps about the magnitude, trends, and location of CH4 sources in the US and globally. Current CH4 inventories for the US differ significantly from one another, and many inventories do not capture changes in emission from rapidly evolving sectors, such as fossil fuel production. Changes to drilling technology have significantly decreased the cost of producing oil and natural gas (ONG). Assessing the environmental benefits of natural gas vs. coal depends on accurate knowledge of natural gas leaks in extraction, processing and distribution.

Carbon Monoxide

CO, a regulated pollutant due to its air quality impacts, is produced predominantly by fossil fuel combustion, tropospheric oxidation of VOCs, wildfires, and agricultural burning. Data from aircraft, roadside monitoring, and regulatory networks demonstrate that CO emissions have been declining in US urban areas for many decades as light-duty gasoline vehicles have gotten cleaner (Warneke et al., 2012; Pollack et al., 2012; McDonald et al., 2013). While inventories capture these long-term declines in US CO emissions, inverse modeling using NOAA aircraft observations (Brioude et al., 2011; Brioude et al., 2013) demonstrates that inventories do not accurately quantify the magnitude of US CO emissions.

Direct Readout Enhancement of Short-Range Forecast Impact for Global and Regional Models

Stanley G. Benjamin and Stephen S. Weygandt

SYNOPSIS: The goal of this research is to more effectively assimilate JPSS and S-NPP satellite data in rapidly updating (hourly) mesoscale and global models via application of direct readout data with lower latency. Enhanced skill for these rapidly updated short-range forecasts means improved decision-support guidance for hazardous weather, such as severe thunderstorms including aviation hazards (turbulence, icing, ceiling, visibility, convection for air-traffic management).

WHY IS THIS RESEARCH IMPORTANT?

The Rapid Refresh (RAP) and High-Resolution Rapid Refresh (HRRR) are closely linked hourly updated NOAA operational mesoscale prediction models (Benjamin et al. 2015, Alexander et al. 2015, respectively) run at the National Centers for Environmental Prediction (NCEP) to improve decision support guidance for weather events that endanger lives and economic activity. The RAP runs at a coarser 13km resolution and provides most of the information for initial conditions for the 3km HRRR model. Because of the increased water domain coverage of RAP compared with its predecessor, the RUC, satellite radiance data are playing an important role in the RAP assimilation and forecast skill, also affecting HRRR skill. In 2013, RAP was updated at NCEP to use hybrid variational/Ensemble Kalman Filter (EnKF) assimilation within GSI, using ensemble information from

High Resolution Trajectory-Based Smoke Forecasts using VIIRS Aerosol Optical Depth and NUCAPS Carbon Monoxide Retrievals

R. Bradley Pierce

SYNOPSIS: This work addresses the need for low latency, web-based, high resolution forecasts of smoke dispersion for use by NWS Incident Meteorologists (IMET) to support on-site decision support services for fire incident management teams.

WHY IS THIS RESEARCH IMPORTANT?

Forecasts of smoke trajectories and dispersion are important for characterizing fire activity, and tracking the movement of smoke and haze. Assessment of the effects downwind smoke can also play a significant role in planning for the evacuation of threatened communities, towns or larger urban areas, and also guide the choice of suppression tactics. However, these forecasts can be of little value if, when needed, are not ready for use, or cannot be accessed. As the current latency is insufficient for Near Real Time (NRT) applications, an agile and dynamic model that enables forecasters to anticipate major fire events, fire development as well as smoke trajectories and dispersion, could be advantageous to fire management agencies by supporting better response to forest fires and smoke events. More specifically, high resolution forecasts of smoke dispersion would really be of benefit to NWS Incident Meteorologists (IMET) to support on-site decision support services during fire and smoke events.

The primary user community for the IDEA-I smoke forecasts is the Western regions of the NWS and US EPA due to the significant impacts of wildfires in these regions. Secondary users include Alaskan NWS offices and Western State and Local air quality management agencies such as the Western Regional Air Partnership (WRAP).

Summary

Substantial Progress in 5 years since program started

- Program Base-lined to Focus on Weather mission
- 5 instrument suite; S-NPP, JPSS-1, JPSS-2 Missions, Block 2 Ground development
- Nearing four years of S-NPP operations, observatory working well, excellent user feedback

Focus on Users

- Rapid user readiness, extensive calibration/ validation, risk reduction
- Increased performance

Plan for Continuity

- Impact Mitigations
- Robust plan
- Two new missions requested: PFO/ JPSS-3, JPSS-4

Summary - JPSS Program Status

Suomi NPP is producing outstanding data

- The satellite is healthy and producing a high availability of data (~99.99%)
- Operations of the satellite transferred from NASA to NOAA in 2013
- Suomi NPP is the primary operational polar-orbiting satellite for NOAA

JPSS-1 is executing as planned

- Instruments and spacecraft are proceeding well
- Instruments are assembled and undergoing testing; one is prepared for integration
- The spacecraft bus is built and undergoing testing
- Development and implementation of the new ground data processing system are underway

JPSS-2 procurement activities are progressing well

- The VIIRS, OMPS, CrIS, and ATMS and Radiation Budget Instrument are under contract
- The spacecraft kickoff is underway

Focus on Users

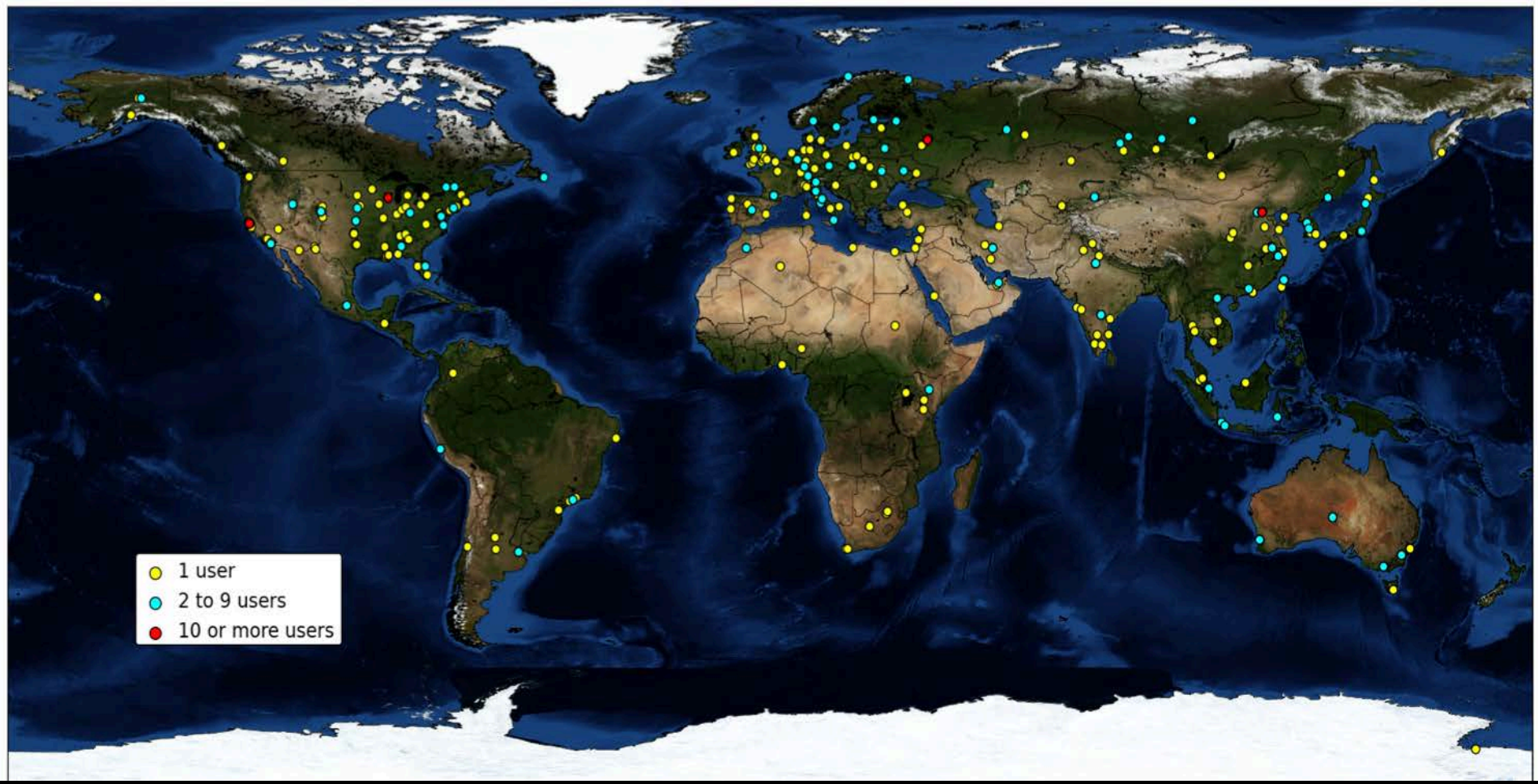
- Rapid user readiness, extensive calibration/validation, risk reduction

Want to learn more?

- 2013 and 2014 Annual Science Digests are available
- 2012-2015, and 2015-2018 Portfolios are available
- Join our monthly JPSS Science Seminars http://www.jpss.noaa.gov/science-seminars.html
- Check out the JPSS Website http://www.jpss.noaa.gov/science.html

Backup Slides

CSPP Registered User Locations



CSPP Software (Apr 2015)

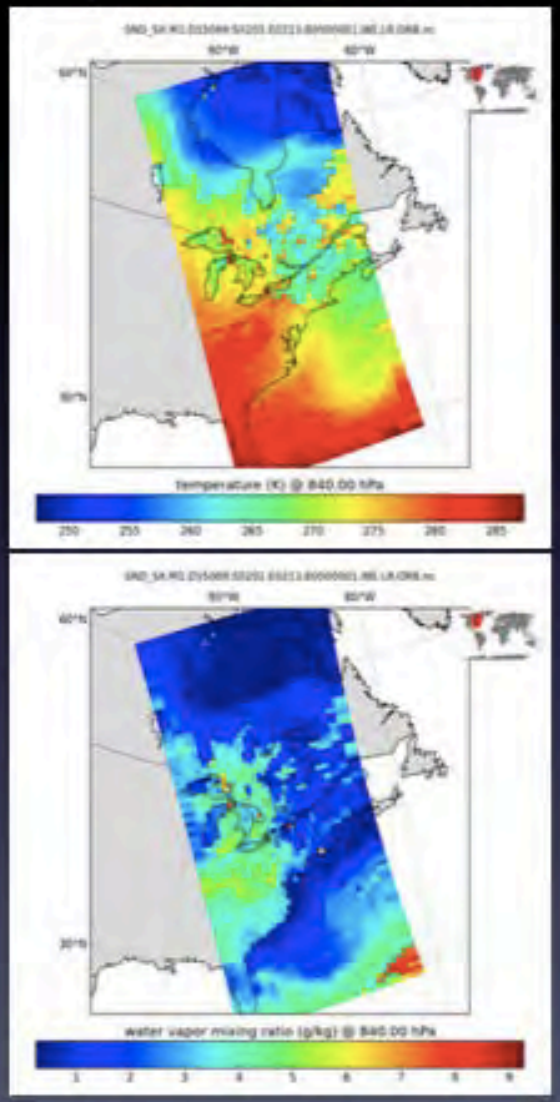
CSPP Software	Product Description
1. SDR	VIIRS, CrIS, and ATMS geolocated and calibrated earth observations.
2. VIIRS EDR	VIIRS imager cloud mask, active fires, surface reflectance, vegetation indices, sea surface temperature, land surface temperature, and aerosol optical depth.
3. HSRTV	Hyperspectral infrared sounder retrievals of temperature and moisture profiles, cloud properties, total ozone, and surface properties.
4. Polar2grid	Reprojected imagery (single and multi-band) in GeoTIFF and AWIPS formats.
5. Hydra	Interactive visualization and interrogation of multispectral imagery and hyper spectral soundings.
6. MIRS	Microwave sounder retrievals of temperature and moisture profiles; surface properties; snow and ice cover; rain rate; and cloud/rain water paths.
7. CLAVR-x	Multispectral imager retrievals of cloud properties; aerosol optical depth; surface properties; ocean properties.
8. NUCAPS	Combined hyperspectral infrared sounder and microwave sounder retrievals of temperature and moisture profiles, cloud cleared radiances, and trace gases.
9. IAPP	Combined infrared sounder and microwave sounder retrievals of temperature and moisture profiles, water vapor, total ozone, and cloud properties.
10. ACSPO	Multispectral imager retrievals of sea surface temperature.

MIRS Examples

Metop-B 2015/03/30 02:01 UTC
SNPP 2015/03/18 11:03 UTC

SSEC

Metop-B AMSU/MHS 840 hPa temperature and water vapor



SNPP ATMS Surface Skin Temperature with Rain Rate contours and isosurface of Rain Mass Profile