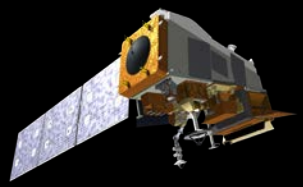
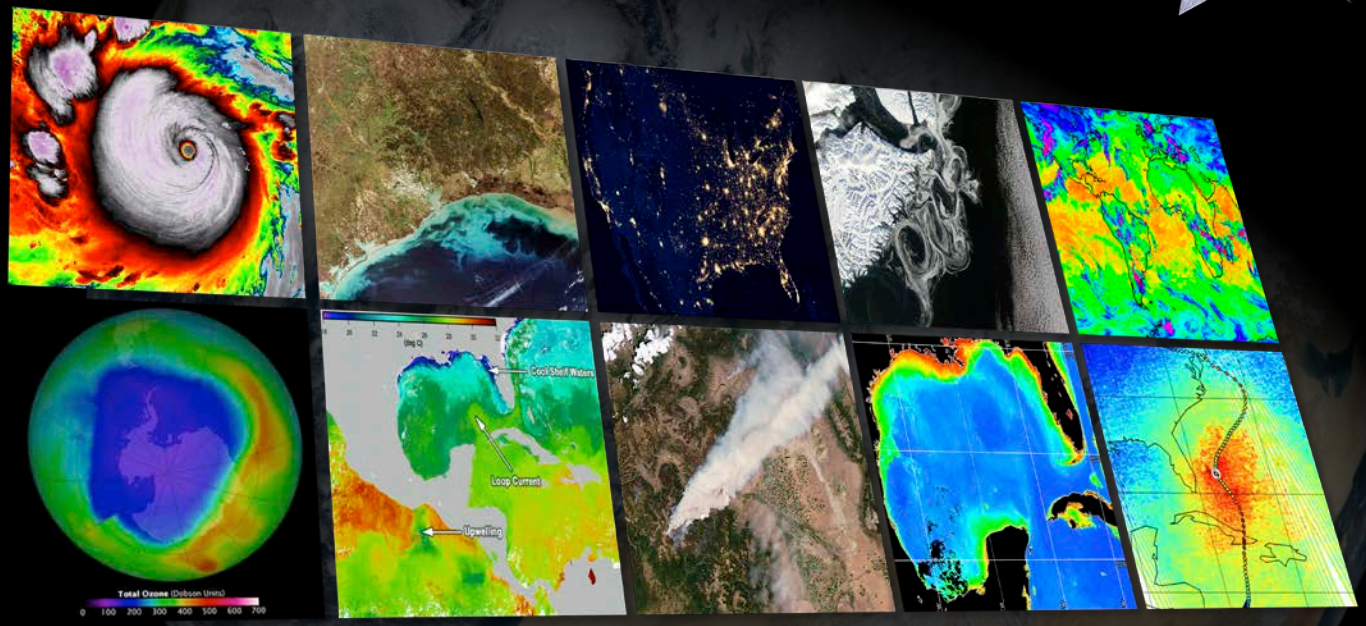
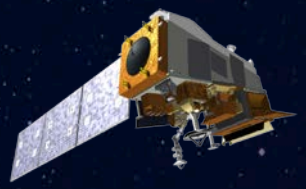
JPSS Overview





Mitch Goldberg, JPSS Program Scientist
Joint Polar Satellite System
National Environmental Satellite, Data, and Information Service
National Oceanic and Atmospheric Administration
September 30, 2014 - WGCV

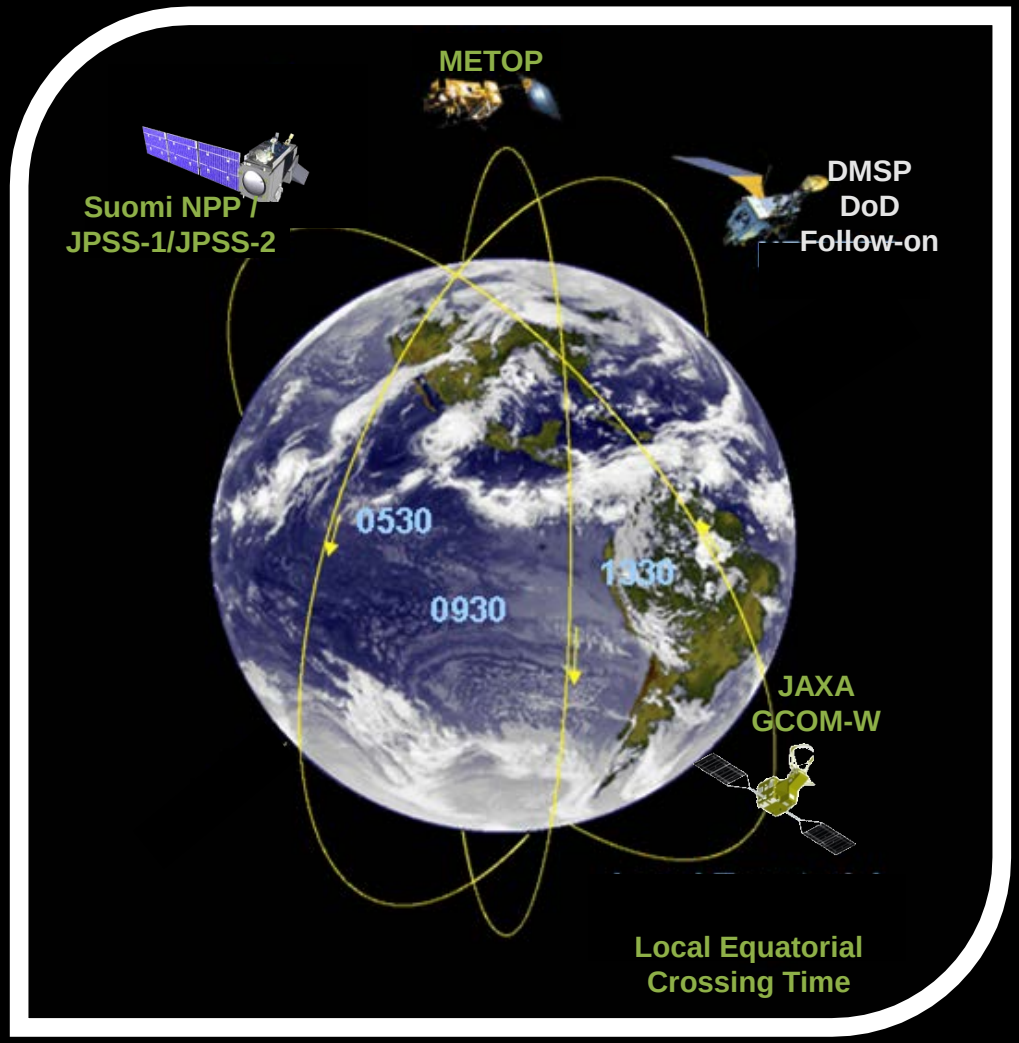


JPSS Overview

- JPSS is NOAA's next generation operational polar orbiting satellites
- JPSS consists of three satellites (Suomi NPP, JPSS-1, JPSS-2), ground system and operations through 2025
  - JPSS mission is to provide global imagery and atmospheric measurements using polar-orbiting satellites
- JPSS is a partnership between NOAA and NASA
  - NOAA has final decision authority and is responsible for overall program commitment
  - NASA is the acquisition agent for the flight system (satellite, instruments and launch vehicle), ground system, leads program systems engineering, and program safety and mission assurance
  - NOAA is responsible for operations, science, data exploitation and archiving, infrastructure

JPSS Integral to 3-Orbit Global Polar Coverage

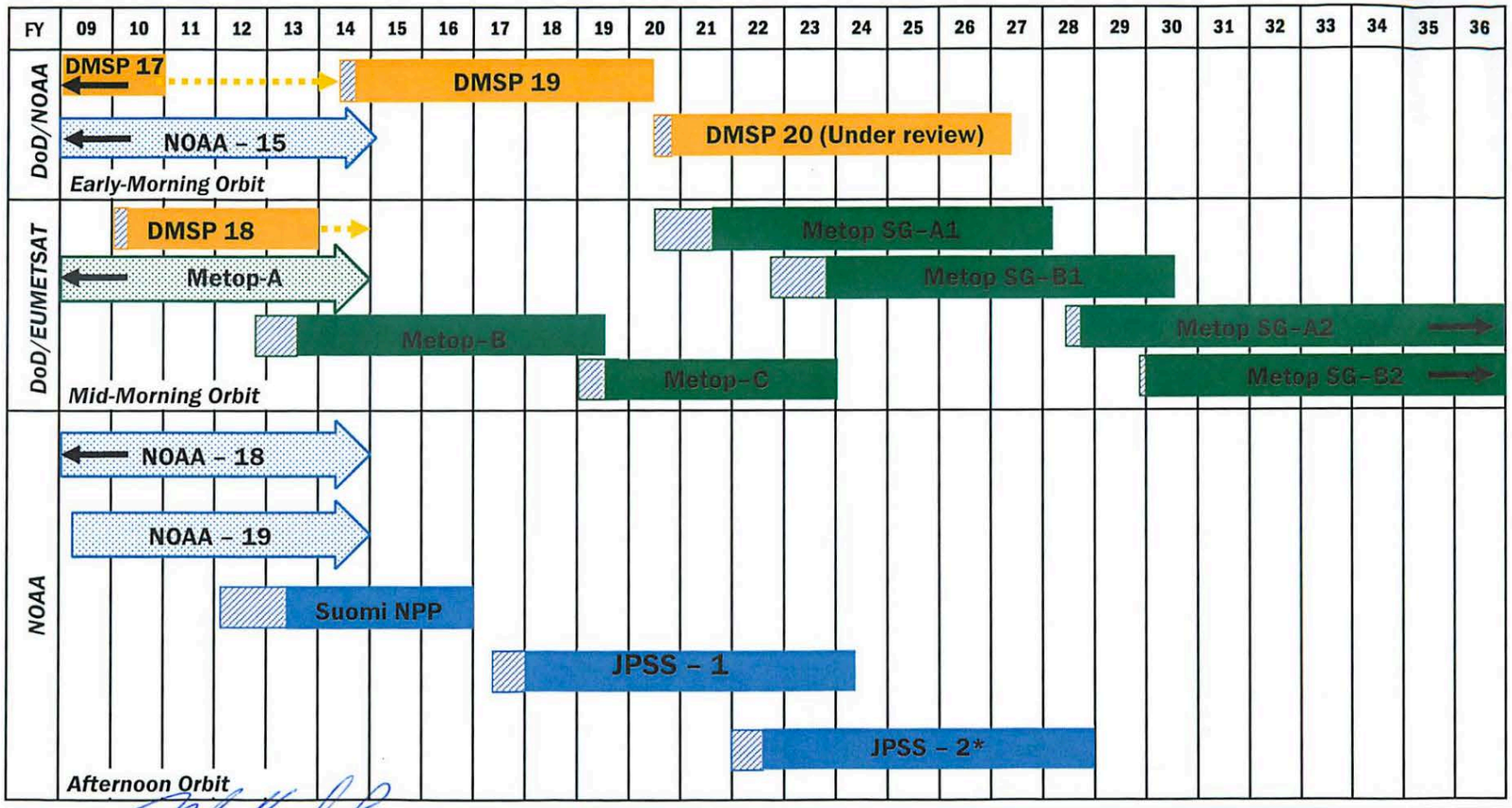
JPSS implements US civil commitment, interagency and international agreements to afford 3-orbit global coverage



JPSS is also a partnership with DOD, EUMETSAT and JAXA

NOAA & Partner Polar Weather Satellite Programs
Continuity of Weather Observations

As of August 2014



Approved:

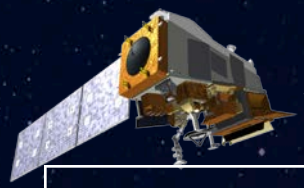
Assistant Administrator for Satellite and Information Services

*Follow-on funding required for operations in FY 2025 and beyond.

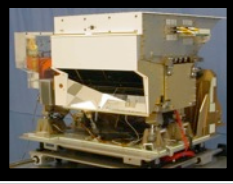
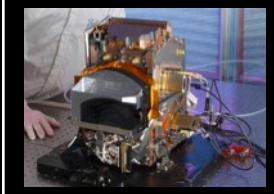
Note: Extended and secondary mission life extension predictions will be updated in early FY 2015

DMSP: Defense Meteorological Satellite Program
JPSS: Joint Polar Satellite Program
Suomi NPP: Suomi National Polar-orbiting Partnership
Metop SG: Metop Second Generation

- Post Launch Test
- Operational based on design life
- Secondary Status
- Operational beyond FY 2036
- In Extended Mission
- Launched before Oct 2008

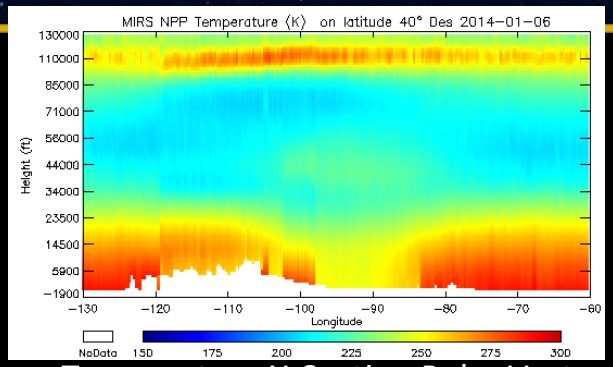


JPSS-1 Instruments (same as S-NPP)

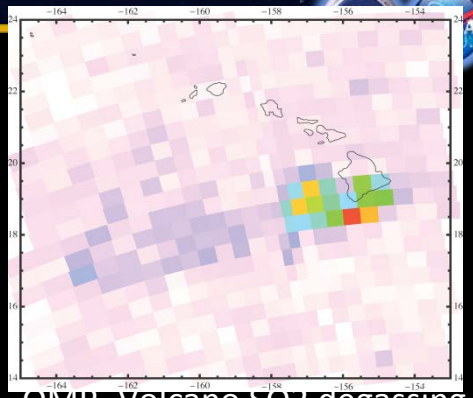
JPSS Instrument		Measurement
	**ATMS** - Advanced Technology Microwave Sounder	ATMS and CrIS together provide high vertical resolution **temperature** and **water vapor information needed to maintain and improve forecast skill** out to 5 to 7 days in advance for extreme weather events, including hurricanes and severe weather outbreaks
	**CrIS** - Cross-track Infrared Sounder	
	**VIIRS** – Visible Infrared Imaging Radiometer Suite	VIIRS provides many **critical imagery products** including snow/ice cover, clouds, fog, aerosols, fire, smoke plumes, vegetation health, phytoplankton abundance/chlorophyll
	**OMPS** - Ozone Mapping and Profiler Suite	Ozone spectrometers for **monitoring ozone** hole and recovery of stratospheric ozone and for UV index forecasts
	**CERES** - Clouds and the Earth's Radiant Energy System	Scanning radiometer which supports studies of Earth Radiation Budget

JPSS provides a wide range of capabilities

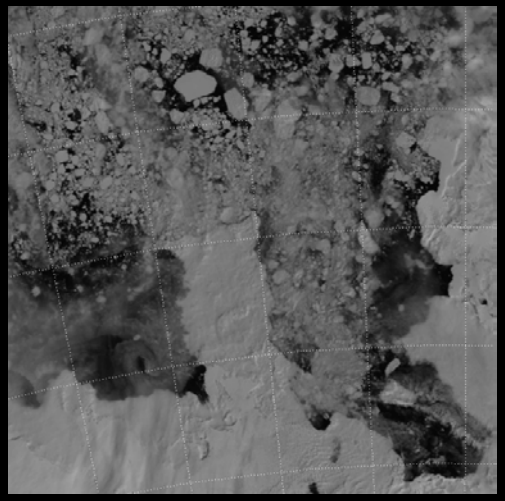
- Microwave – provides temperature and moisture soundings in cloudy conditions and rainfall rates, sea ice, snow, surface temperature
- Infrared – provides high vertical resolution temperature and moisture soundings in clear and cloud corrected regions; atmospheric chemistry - CO, CH4, SO2, … and cloud products
- Visible (day & night) and Infrared Imagery (including deep blue channels) – chlorophyll, cloud imagery, cloud products, SST, Active Fires, Smoke, Aerosols, land products, Snow, Ice, oil spills… at exceptional resolution/global coverage
- UV - ozone - Aerosols over bright surfaces, SO2 plumes, NOx (air quality)…

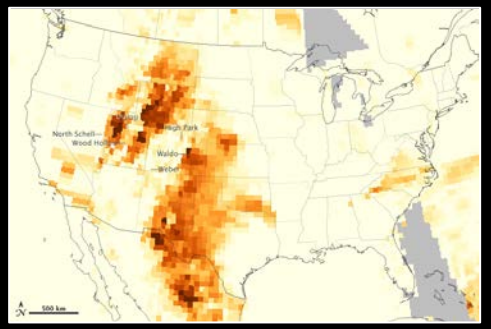


Temperature X-Section Polar Vortex


OMP- Volcano SO2 degassing


Algae in Lake Erie


DNB Ice detection


OMPS Aerosols from Fires

S-NPP and JPSS Data Products From NOAA available in real-time

VIIRS (24)

ALBEDO (SURFACE)
CLOUD BASE HEIGHT
CLOUD COVER/LAYERS
CLOUD EFFECTIVE PART SIZE
CLOUD OPTICAL THICKNESS
CLOUD TOP HEIGHT
CLOUD TOP PRESSURE
CLOUD TOP TEMPERATURE
ICE SURFACE TEMPERATURE
OCEAN COLOR/CHLOROPHYLL
SUSPENDED MATTER
VEGETATION INDEX, FRACTION, HEALTH
AEROSOL OPTICAL THICKNESS
AEROSOL PARTICLE SIZE
ACTIVE FIRES
POLAR WINDS
IMAGERY
SEA ICE CHARACTERIZATION
SNOW COVER
SEA SURFACE TEMPERATURE
LAND SURFACE TEMP
SURFACE TYPE

CrIS/ATMS (3)

ATM VERT MOIST PROFILE
ATM VERT TEMP PROFILE
CARBON (CO2, CH4, CO)

OMPS (2)

O_3 TOTAL COLUMN
O_3 NADIR PROFILE
SO2 and Aerosol Index

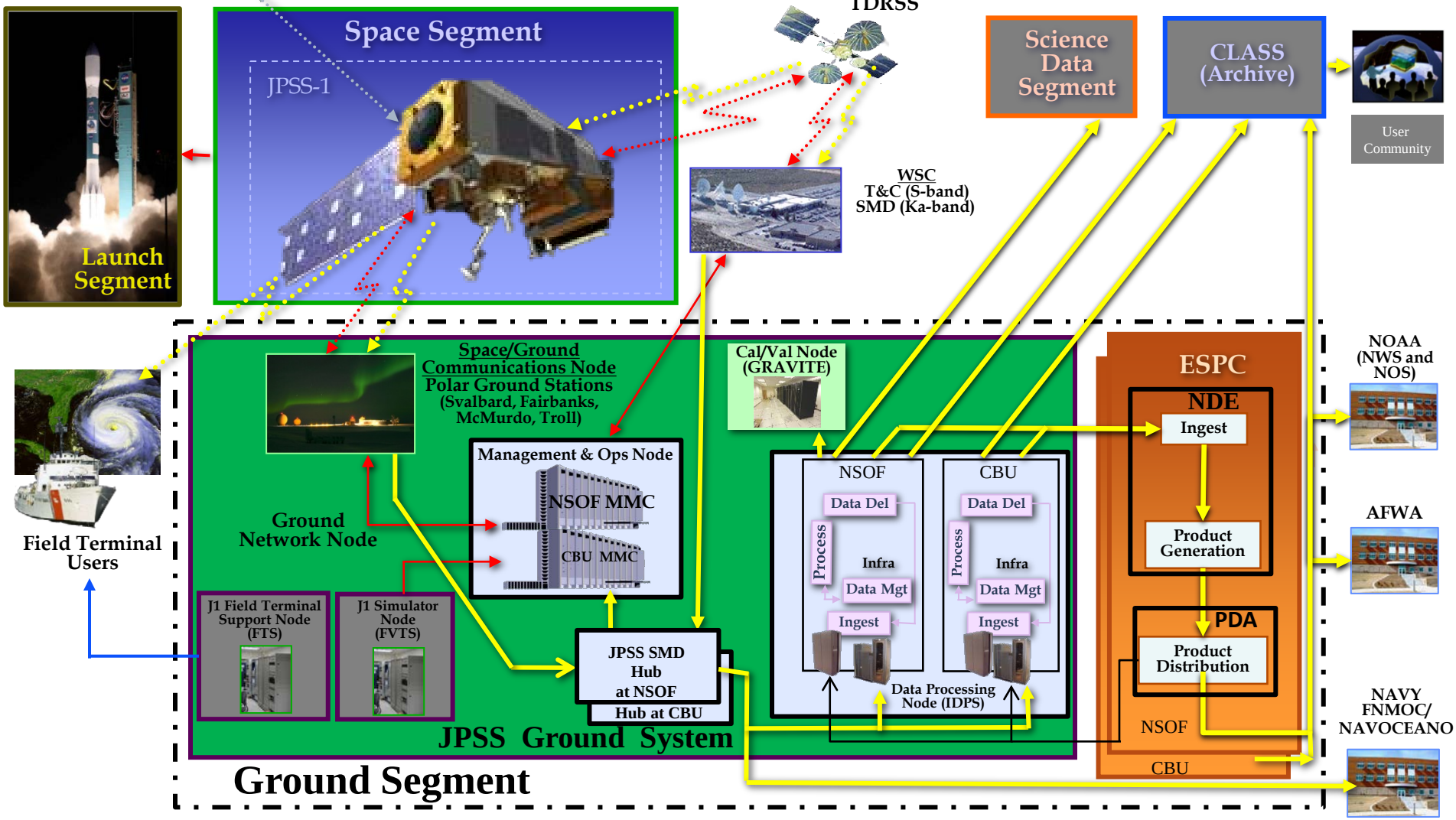
ATMS (11)

CLOUD LIQUID WATER
PRECIPITATION RATE
PRECIPITABLE WATER
LAND SURFACE EMISSIVITY
ICE WATER PATH
LAND SURFACE TEMPERATURE
SEA ICE CONCENTRATION
SNOW COVER
SNOW WATER EQUIVALENT
ATM TEMPERATURE PROFILE
ATM MOISTURE PROFILE

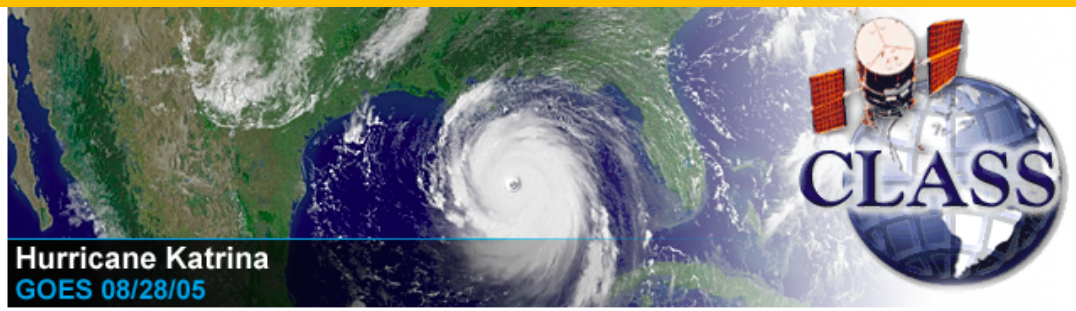
GCOM AMSR-2 (11)

CLOUD LIQUID WATER
PRECIPITATION TYPE/RATE
PRECIPITABLE WATER
SEA SURFACE WINDS SPEED
SOIL MOISTURE
SNOW WATER EQUIVALENT
IMAGERY
SEA ICE CHARACTERIZATION
SNOW COVER/DEPTH
SEA SURFACE TEMPERATURE
SURFACE TYPE

JPSS-1 Mission Architecture



Non-Real-Time User Access Products from CLASS



NEWS

Attention Metop users::
Except for the HIRS 1b data all Metop-B level 1b satellite data is now publicly available beginning on January 15, 2013. Data collected prior to that date remains restricted. We will post another message on the HIRS data once it becomes available. For any questions or assistance in obtaining the data please contact the CLASS Help Desk

Attention CORS users:
The National Geodetic Survey's CORS data is now available for ordering from the CLASS archive. Older data are currently in the process of being migrated from the NGDC archive to CLASS. While every effort is made to retain data in the original at-sampling rate, there may be cases where only the 30-second decimated rate data exists. For more details select 'Continuously Operating Reference Stations (CORS)' from the product drop down menu and click on Go.

Suomi NPP data access status:
Below is a list of S-NPP products released to the public and now available through CLASS. The complete list of products along with the begin dates of product availability are located on the Suomi NPP FAQ page. The remaining NPP products will be released to the user community over a time frame of several months. Please note that all newly released products are at 'Beta' maturity level as defined in the Product Maturity Level page. Details of high priority issues related to the data quality are contained in the Readme files provided by the NPP Project Scientist. Please read these before ordering and using the data!

ATMS
Readme for released S-NPP ATMS SDR data

CrIS
Readme for released S-NPP CrIS SDR data

CrIMSS
Readme Readme for released S-NPP CrIMSS EDR data

OMPS
Readme for released S-NPP OMPS Nadir Ozone Profile data
Readme for released S-NPP OMPS SDR data

SEARCH FOR DATA

- Environmental Data from Polar-orbiting Satellites
- Environmental Data from Geostationary Satellites
- Defense Meteorological Satellite Program (DMSP)
- Suomi National Polar-orbiting Partnership (NPP)
- Sea Surface Temperature data (SST)
- RADARSAT
- Altimetry / Sea Surface Height Data (JASON-2)
- Global Navigation Satellite Systems (GNSS)
- Other - Miscellaneous products in CLASS

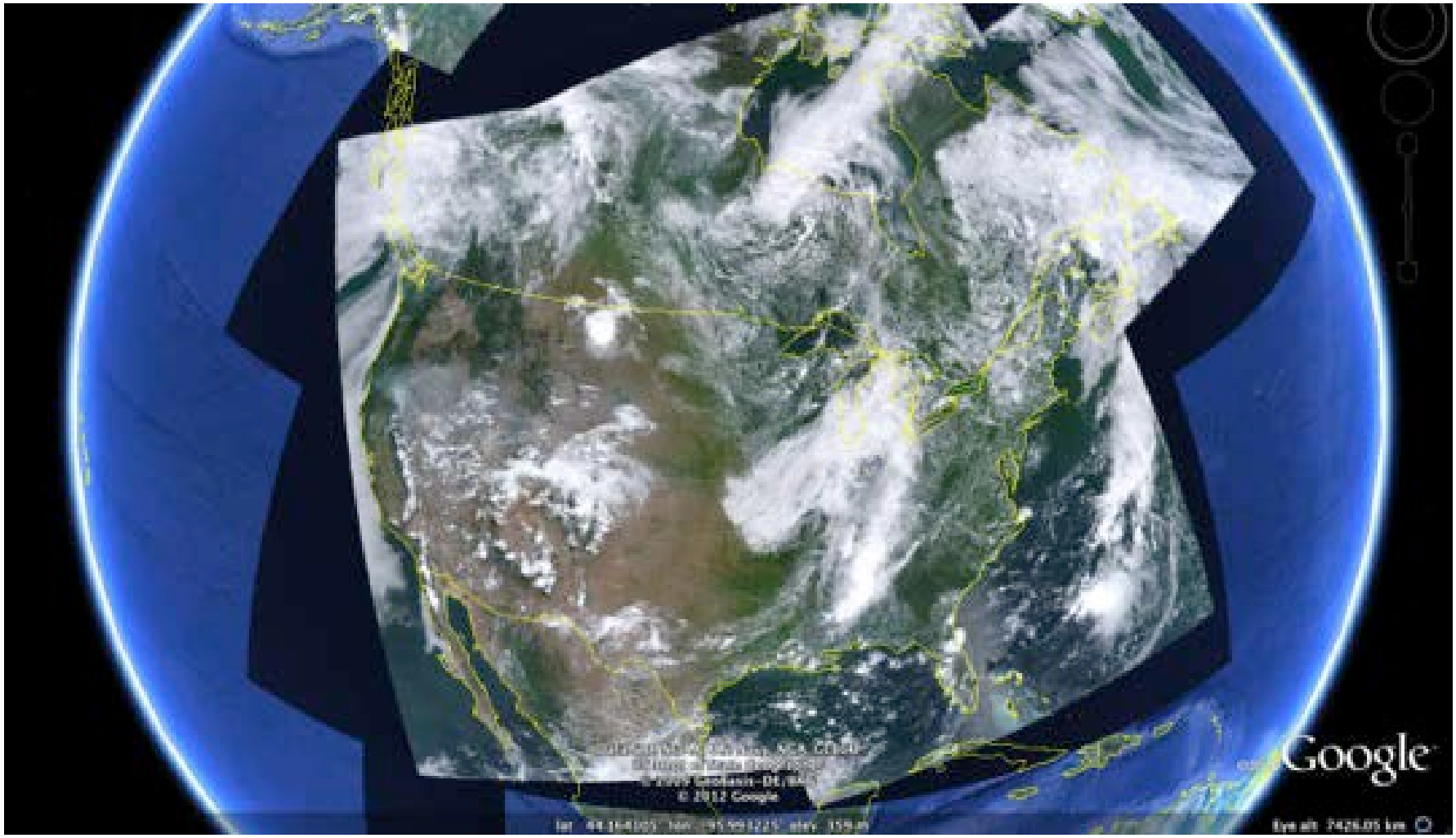
SEARCH COLLECTION METADATA

»GO

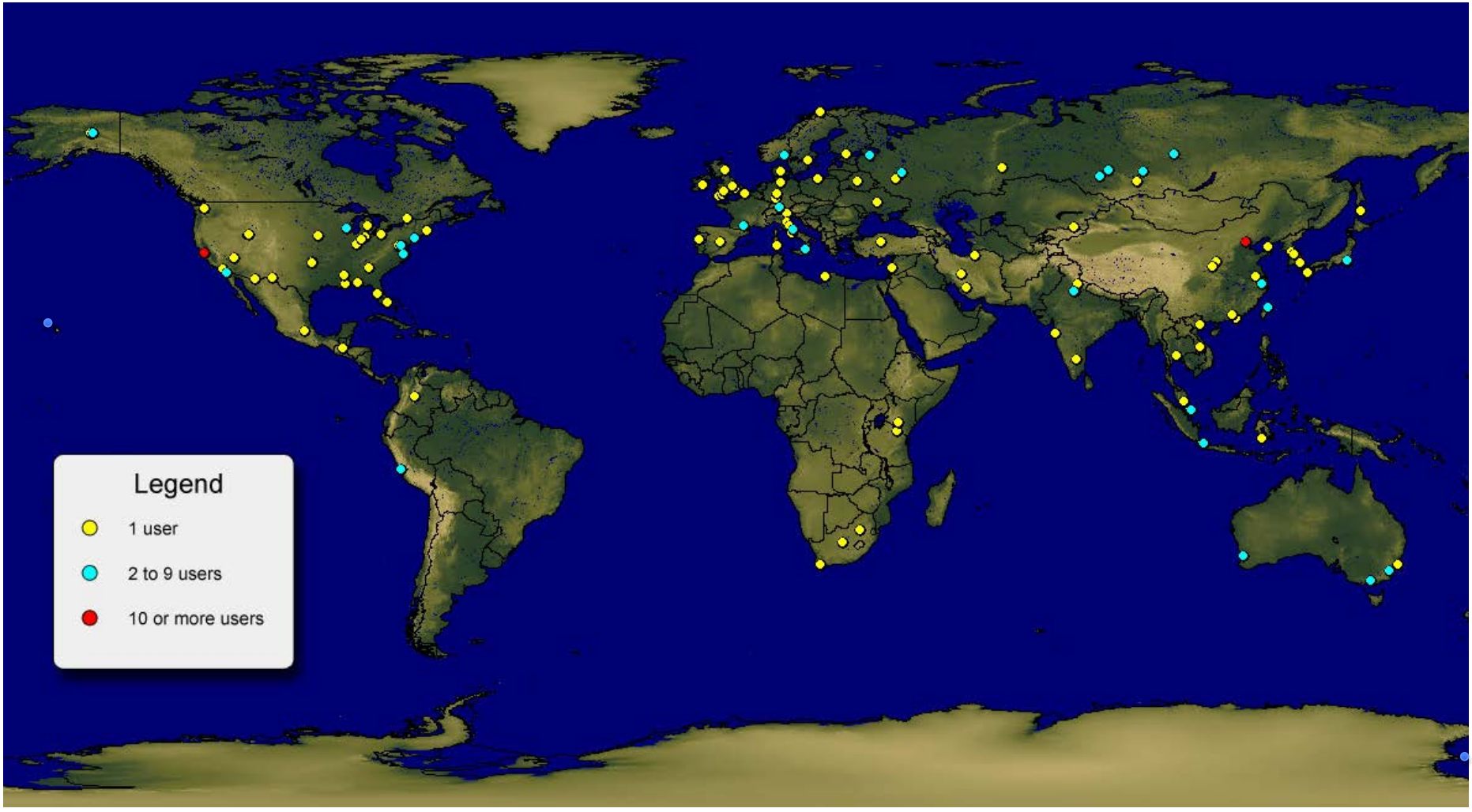
Direct Readout

- **SNPP/JPSS data is widely used by the direct readout community.**
- **NOAA has a long practice of providing open and free data**
  - direct readout provides anyone, with a ~$300,000 dual L-X band antenna, with access to full SNPP/JPSS data and POES/METOP data.
- **Community Satellite Processing Package (CSPP) Software is available from NOAA's Cooperative Institute at University of Wisconsin and Direct Readout Lab.**
  - Configuration controlled software originates from JPSS Ground Segment (IDPS and NDE)
  - NOAA sponsored users generally use CSPP
- **A single antenna cover a large domain (see next slide)**

Coverage of from one antenna at Madison, Wi.



CSPP Users
23 January 2013

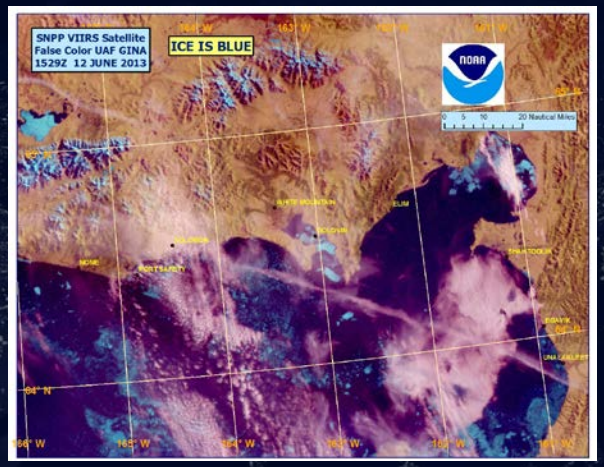


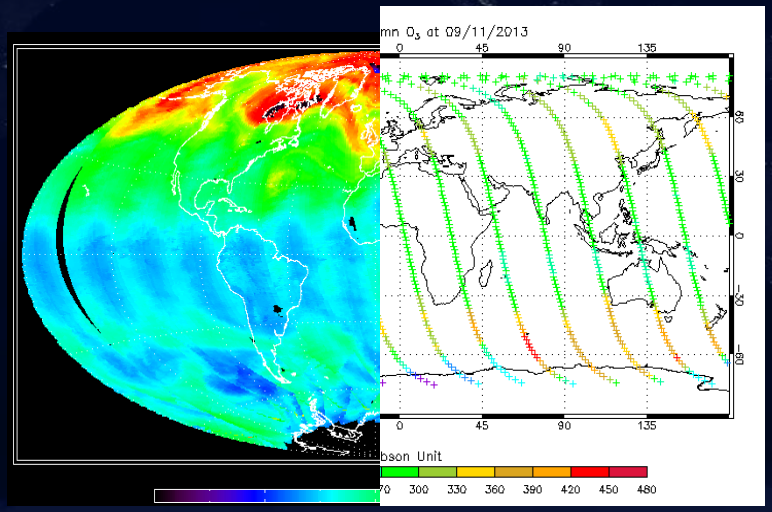
More than 250 people have registered to download some part of the CSPP suite of products representing 33 different countries.

Operational Use of S-NPP Data

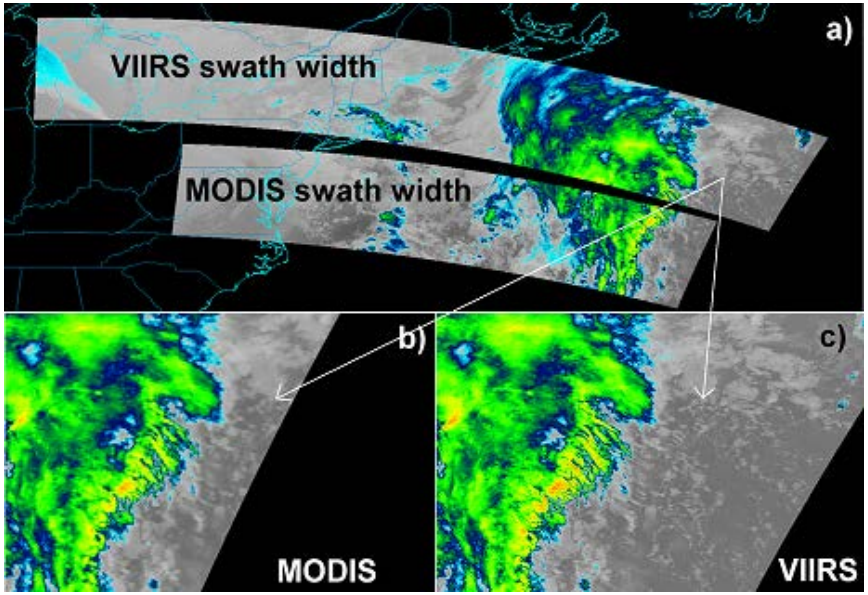
S-NPP is now NOAA's Primary Satellite

- May 1, 2012, VIIRS imagery used to support local warning and forecast operations throughout the NWS Alaska Region.
- May 22, 2012, the Advanced Technology Microwave Sounder (ATMS) radiances were operationally assimilated in the National Centers for Environmental Prediction's (NCEP)/ NWS Global Forecast System (GFS).
- September 25, 2012, ATMS data was assimilated operationally into the European Centre for Medium-Range Weather Forecasts (ECMWF) weather forecast models.
- April 2013, the United Kingdom Meteorology Office began assimilating operational data from the Cross-track Imaging Radiometer Suite (CrIS) and ATMS into its weather forecast models.
- August 20, 2013, NCEP began incorporating S-NPP CrIS satellite data operationally into the GFS.
- October 31, 2013, NCEP/CPC started to use OMPS Ozone operationally
- November, 2013, NRL started to use ATMS operationally in their global forecast model.

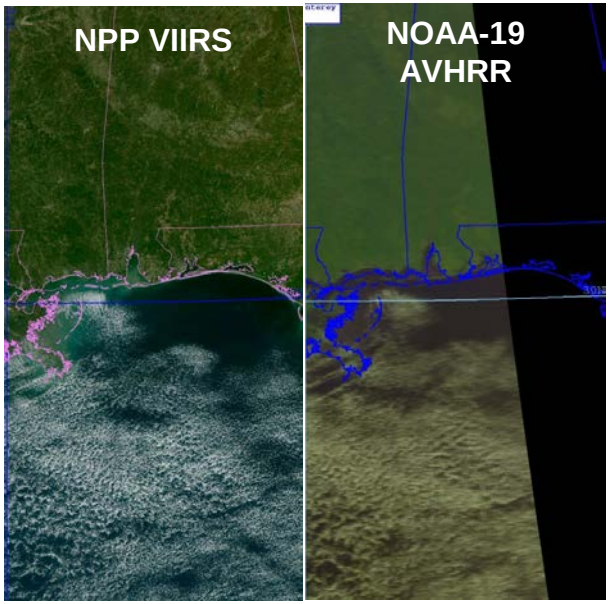


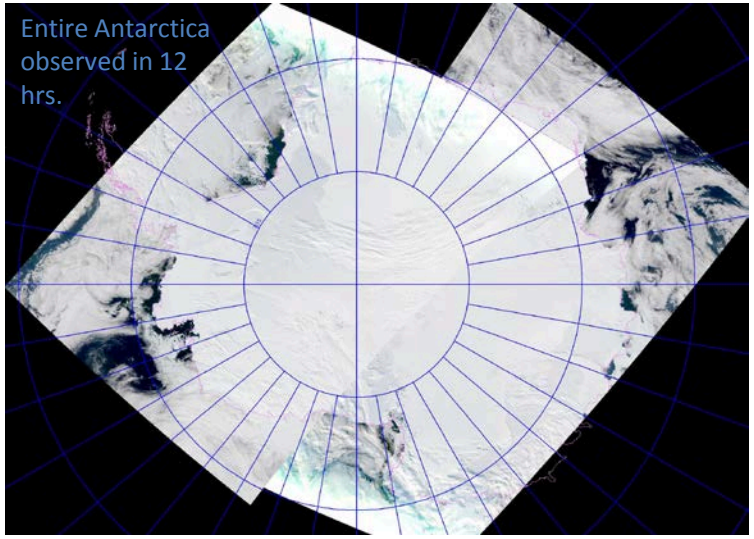


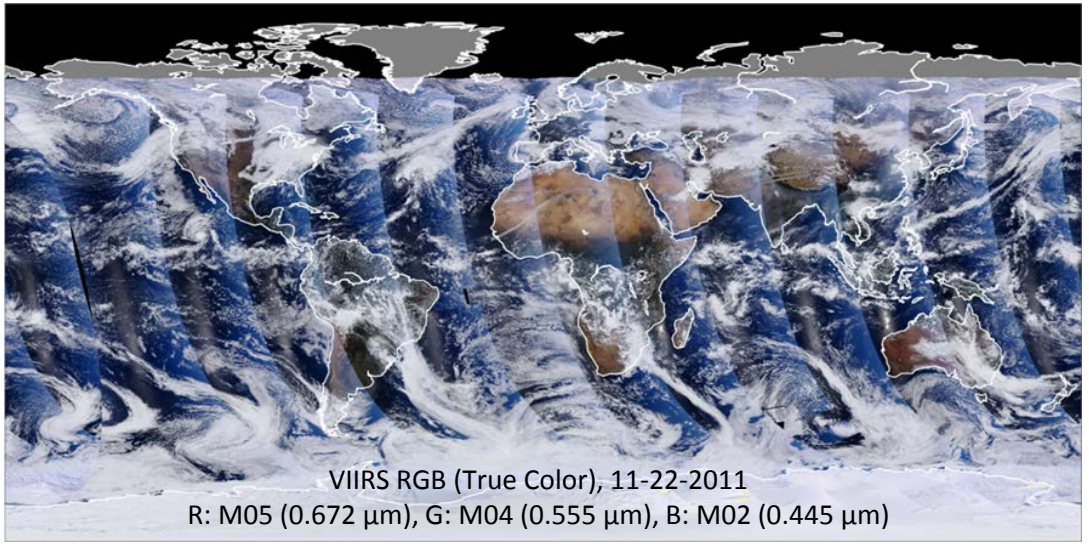
JPSS Next Generation Instruments



The Visible Infrared Imaging Radiometer Suite offers more spectral bands, higher resolution, wider swath and greater accuracy, resulting in a large number of products.







VIIRS: Next Gen Operational Polar Orbiting Imaging Radiometer

- **22 spectral bands**
  - Visible to LWIR
  - Spatially registered
- **Better spatial resolution**
  - Reduced variation over scan
  - Higher resolution imaging bands
- **High radiometric accuracy**
  - NIST-traceable
  - Supported by on-board calibrators

		Band No.	Wave-length (μm)	Horiz Sample Interval (km Downtrack x Crosstrack)		Driving EDRs
				Nadir	End of Scan	
VIS/NIR FPA	Silicon PIN Diodes	M1	0.412	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols
		M2	0.445	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols
		M3	0.488	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols
		M4	0.555	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols
		I1	0.640	0.371 x 0.387	0.80 x 0.789	Imagery
		M5	0.672	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols
		M6	0.746	0.742 x 0.776	1.60 x 1.58	Atmospheric Corr'n
		I2	0.865	0.371 x 0.387	0.80 x 0.789	NDVI
		M7	0.865	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols
CCD		DNB	0.7	0.742 x 0.742	0.742 x 0.742	Imagery
S/MWIR	PV HgCdTe (HCT)	M8	1.24	0.742 x 0.776	1.60 x 1.58	Cloud Particle Size
		M9	1.378	0.742 x 0.776	1.60 x 1.58	Cirrus/Cloud Cover
		I3	1.61	0.371 x 0.387	0.80 x 0.789	Binary Snow Map
		M10	1.61	0.742 x 0.776	1.60 x 1.58	Snow Fraction
		M11	2.25	0.742 x 0.776	1.60 x 1.58	Clouds
		I4	3.74	0.371 x 0.387	0.80 x 0.789	Imagery Clouds
		M12	3.70	0.742 x 0.776	1.60 x 1.58	SST
		M13	4.05	0.742 x 0.259	1.60 x 1.58	SST Fires
LWIR	PV HCT	M14	8.55	0.742 x 0.776	1.60 x 1.58	Cloud Top Properties
		M15	10.763	0.742 x 0.776	1.60 x 1.58	SST
		I5	11.450	0.371 x 0.387	0.80 x 0.789	Cloud Imagery
		M16	12.013	0.742 x 0.776	1.60 x 1.58	SST

VIIRS I-band 1 (375-m) image of Pine Island Glacier – 21 January 2013

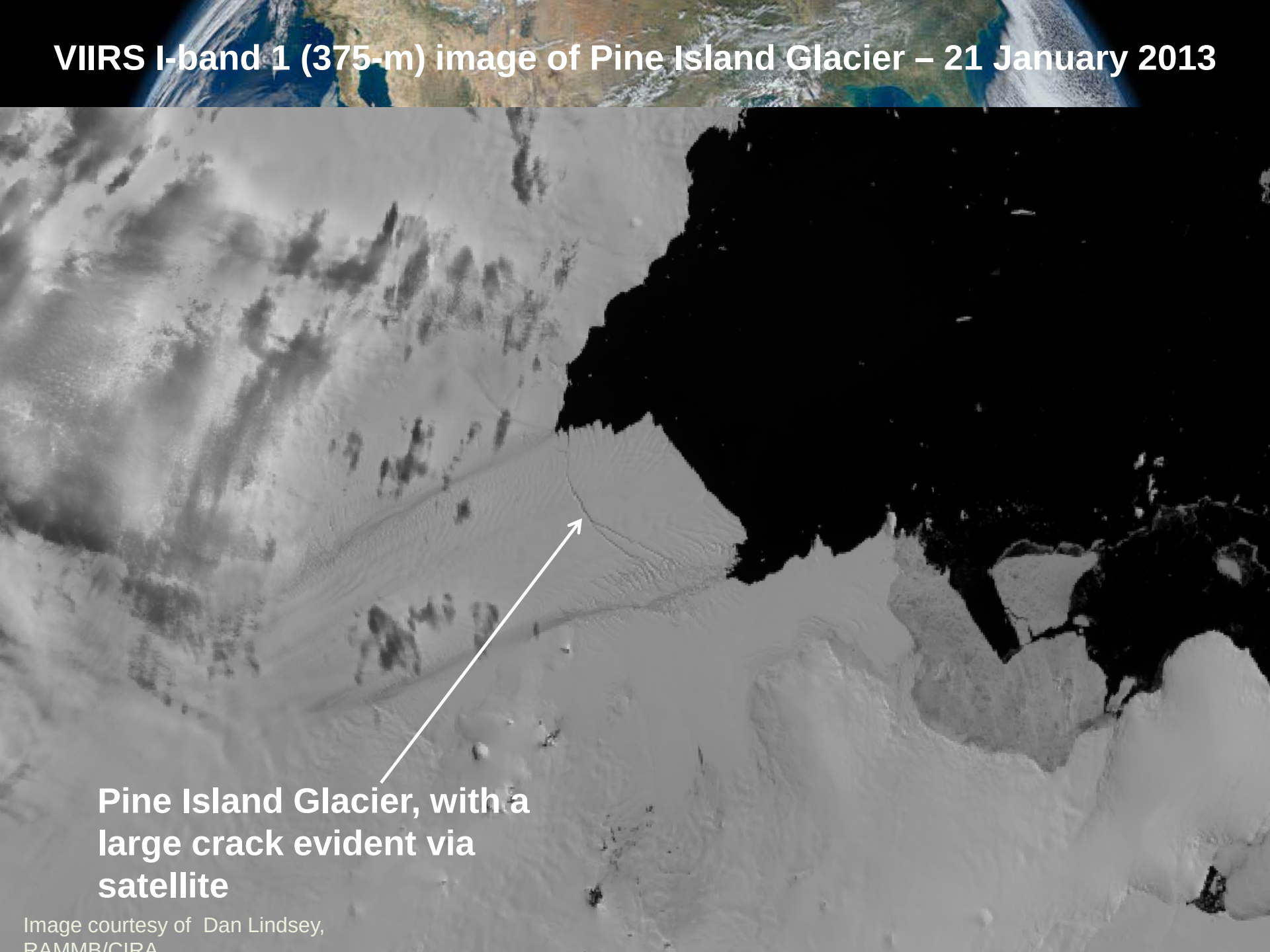
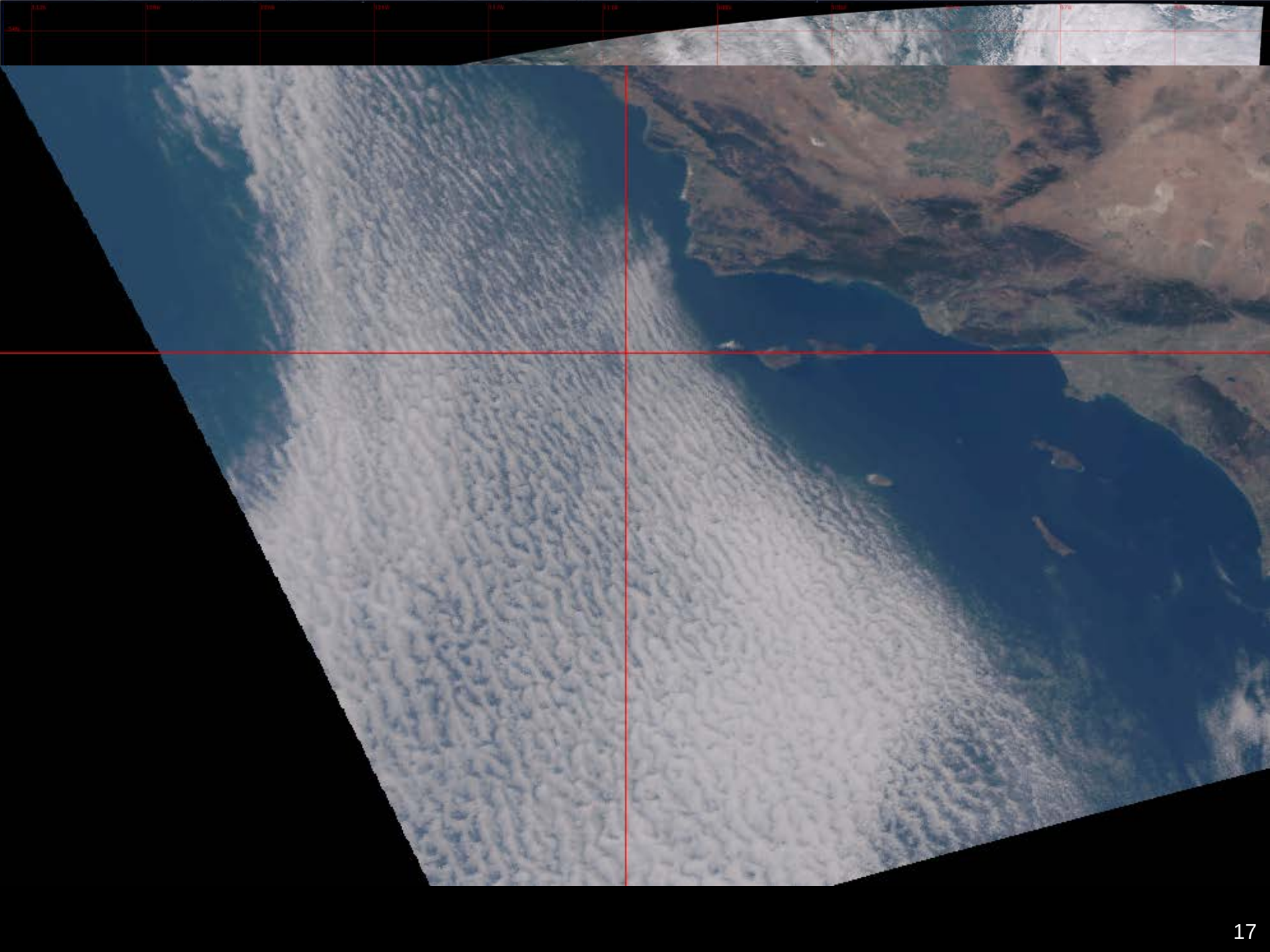
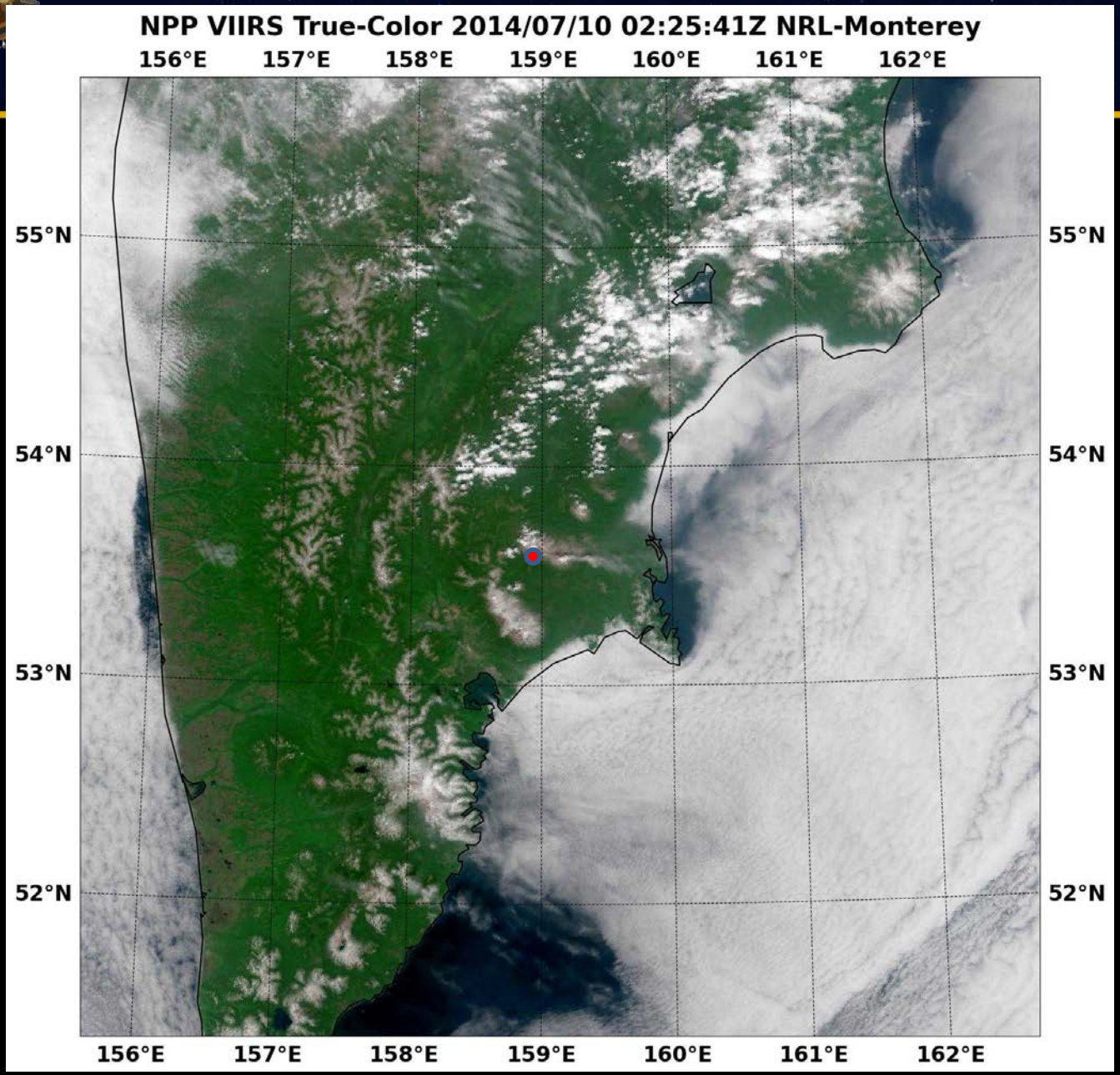


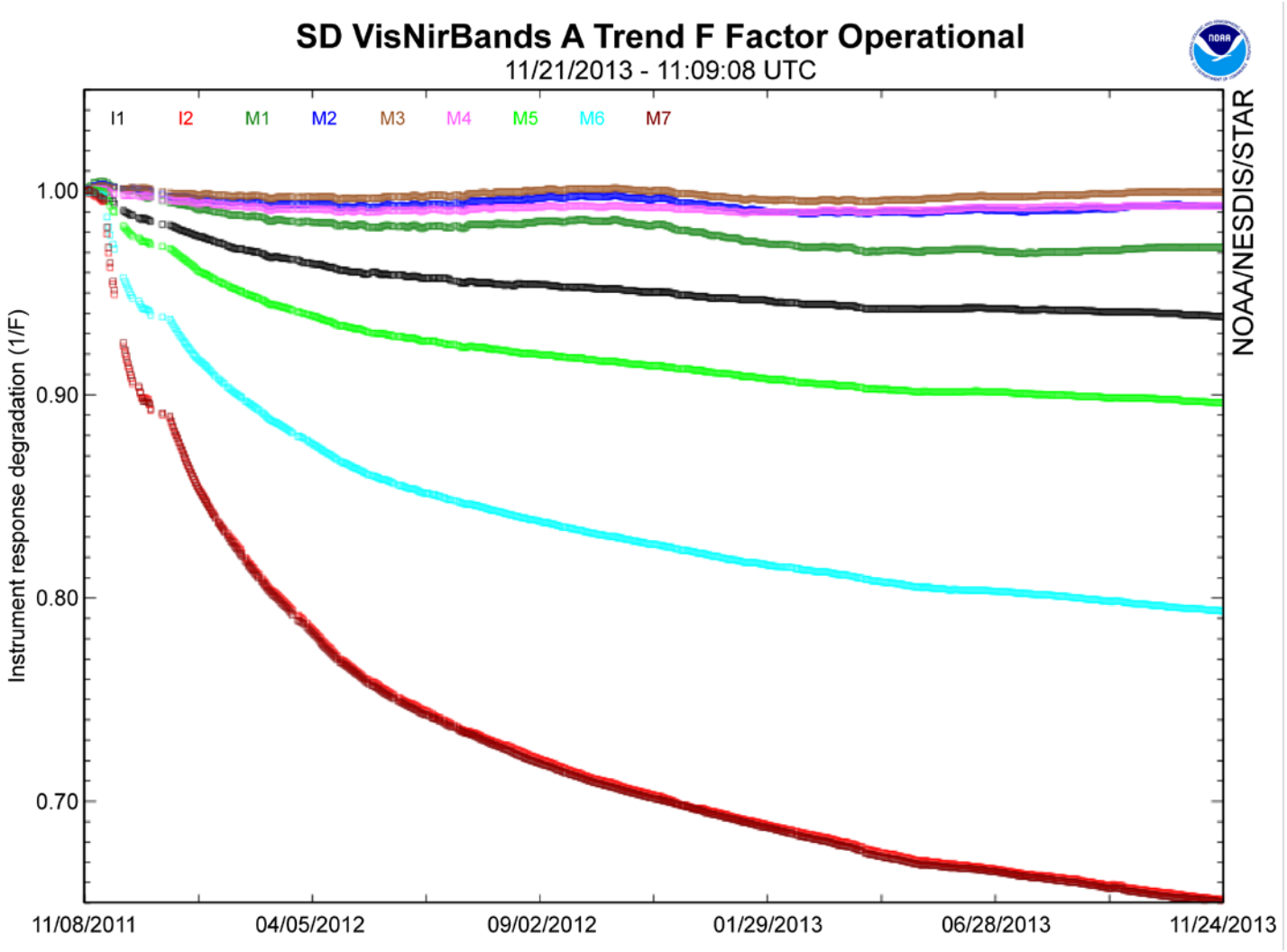
Image courtesy of Dan Lindsey, RAMMB/CIRA



Comparing MODIS (250m) to VIIRS (375m) Edge of Scan



VIIRS Long-term Trending



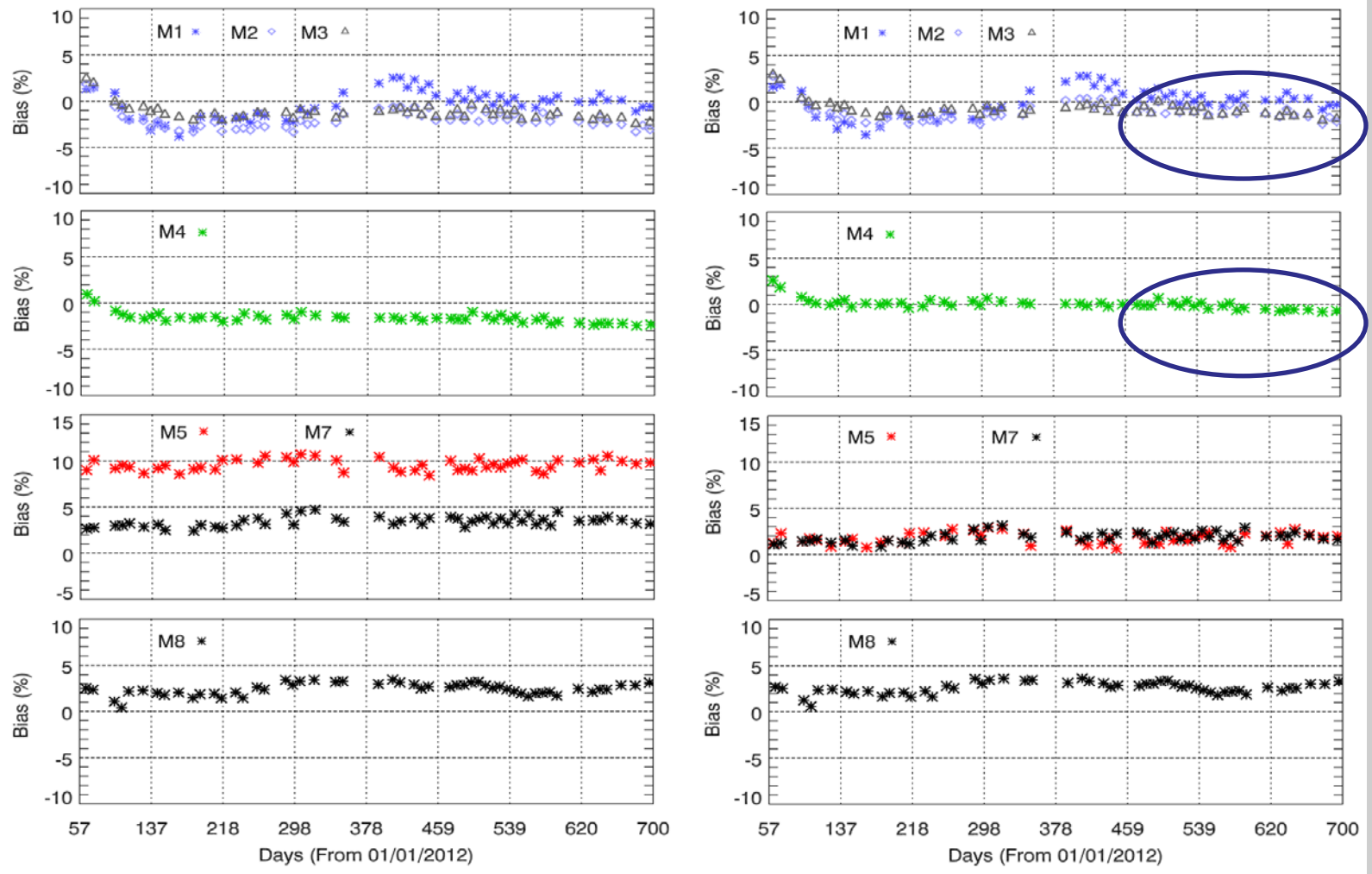
Initial degradation >2% per week

- RTA degradation leveling off
- For M7, initially > 2% per week; Currently ~0.1% per week

VIIRS and MODIR RSB Inter-comparison at SNO-x (over desert)

BEFORE accounting for SRF difference

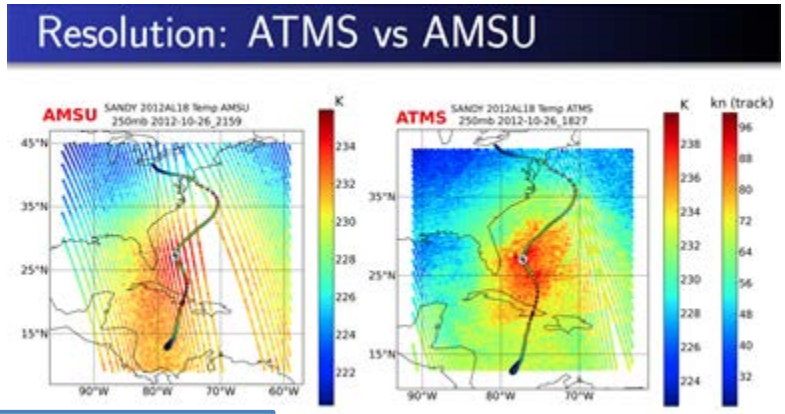
AFTER accounting for SRF difference



Cao

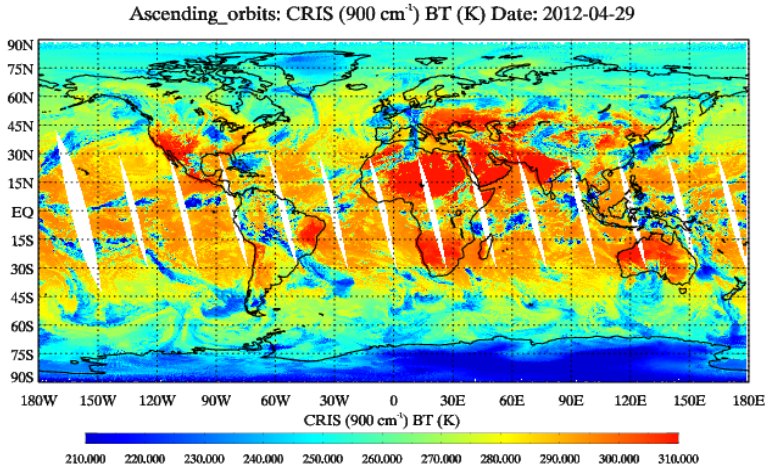
JPSS Next Generation Instruments

Advanced Technology Microwave Sounder



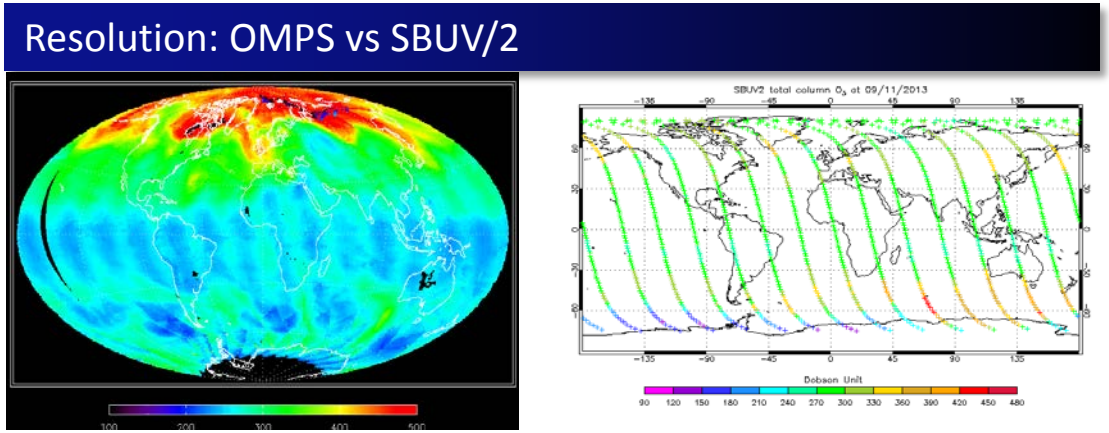
Higher resolution, wider swath, smaller gaps

Cross-track Infrared Sounder



6x more vertical resolving power

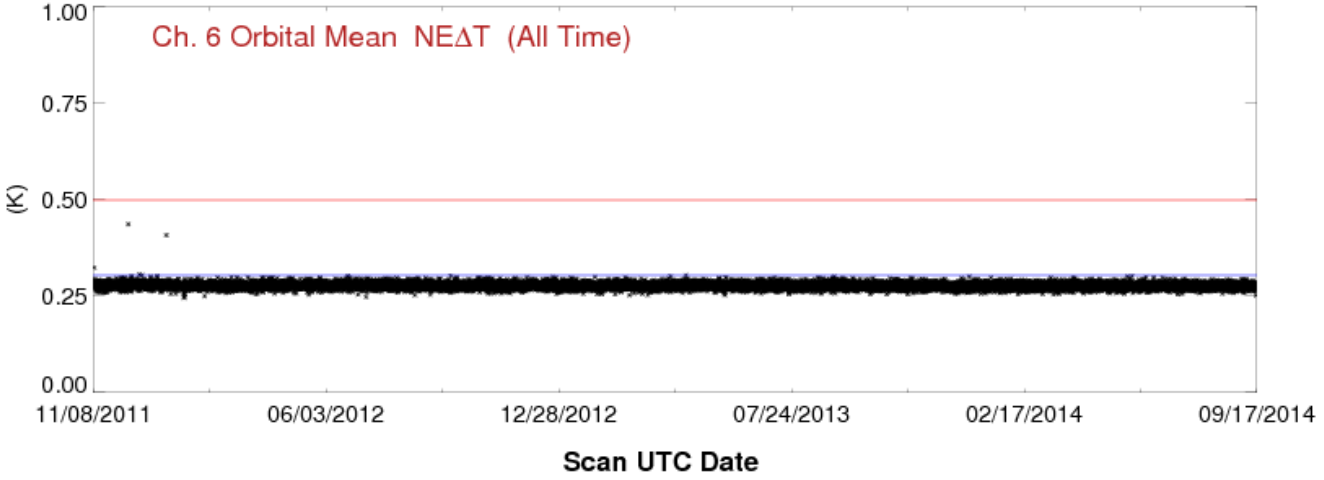
Ozone Mapping Profiler Suite



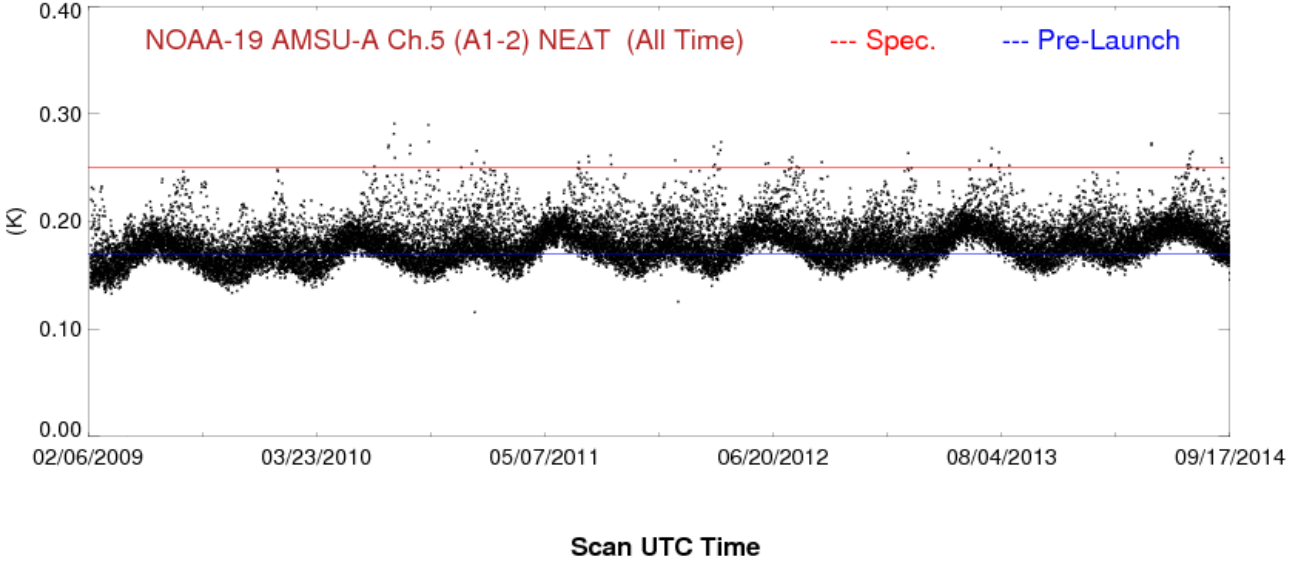
Provides global coverage ozone monitoring

ATMS vs AMSU noise performance

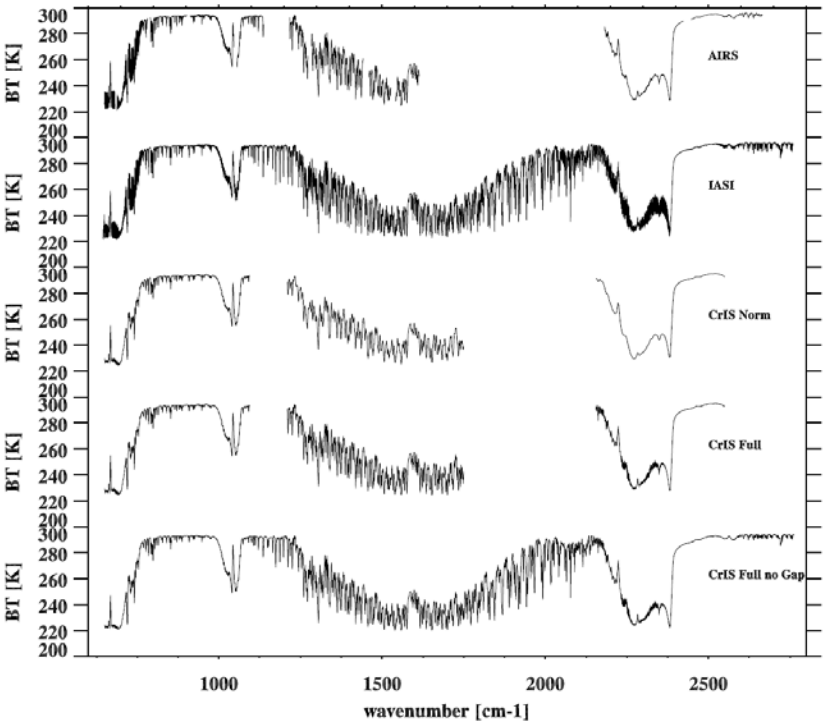
AMSU equivalent field of view reduce by factor of 3 ~ .09 K

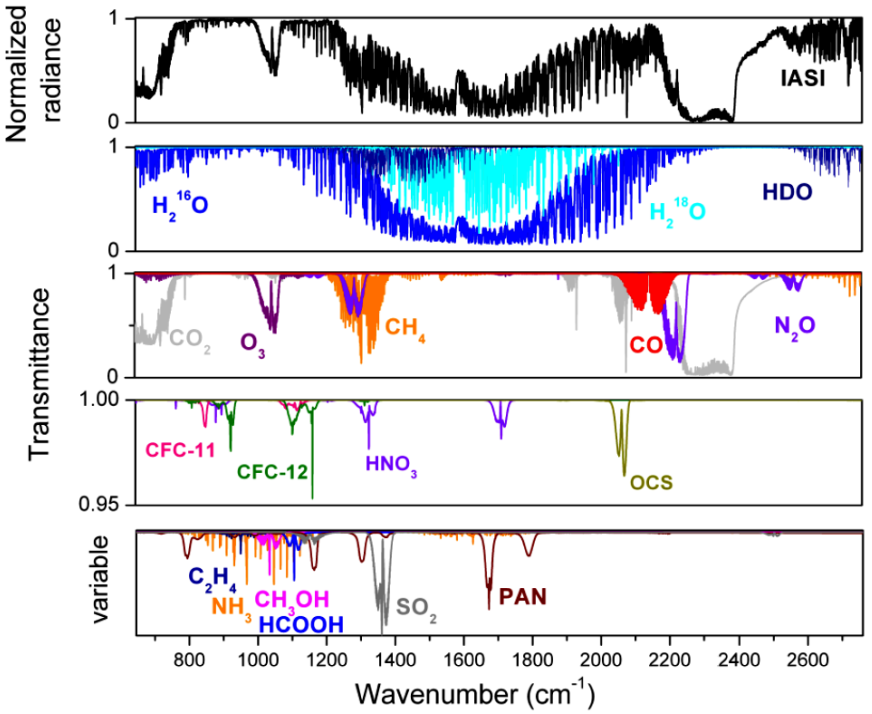


AMSU instrument temperature varies more due to solar hearing causing seasonal noise effect

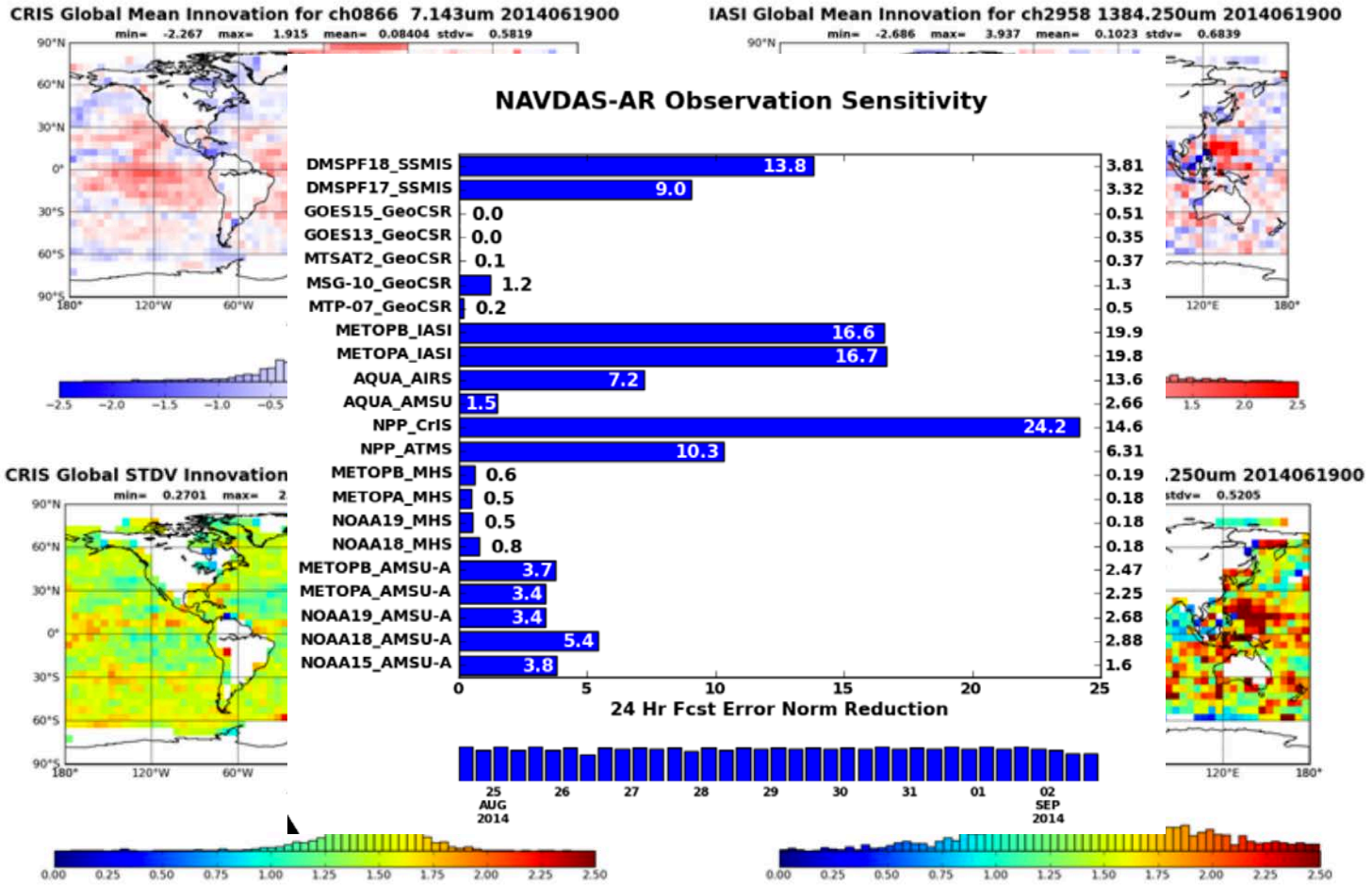


AIRS, IASI, and CrIS Spectra





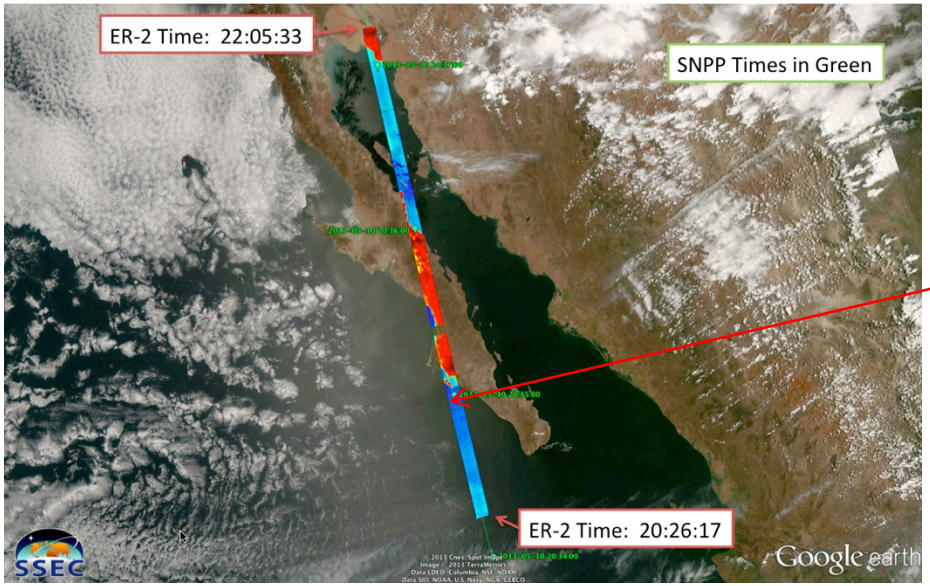
Source: Ben Ruston (Personal Comm.)



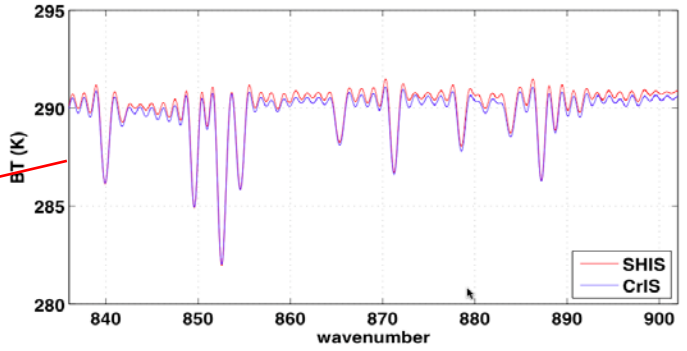
JPSS PGRR Deep-Dive Validation
First S-NPP ER-2 Aircraft Campaign to provide validation for CrIS, ATMS and VIIRS

NIST traceable absolute calibration for CrIS

S-HIS 895-900 cm^{-1} (280 – 320K) over VIIRS Imagery



Zero-th Order S-HIS / CrIS comparison: Window region comparison. Same spectral resolution.



SSEC

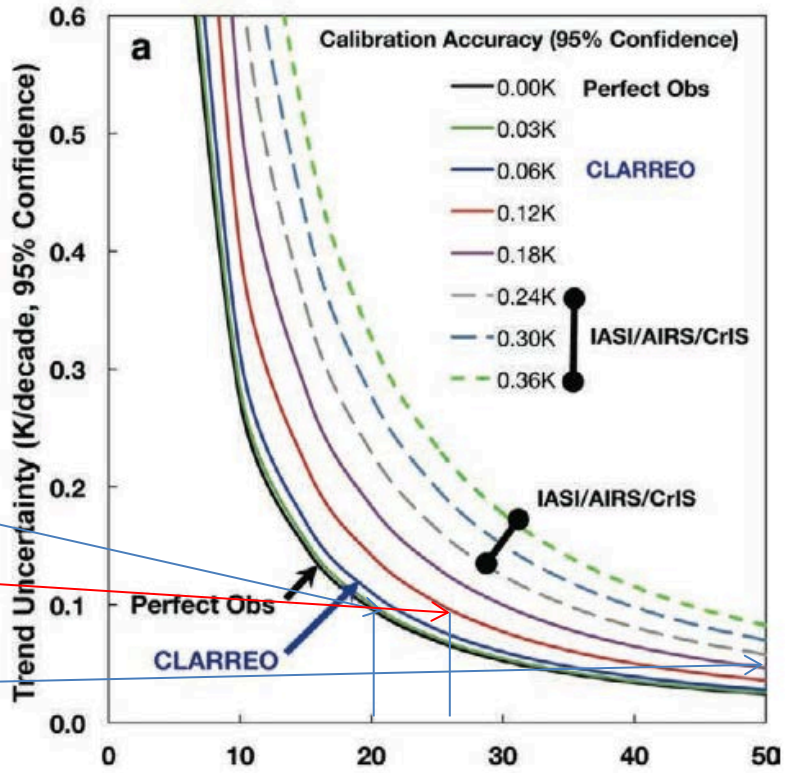
May 10, 2013 – first look

10

ER-2 with aircraft validation sensors under flies Suomi NPP sensors. In the case of CrIS, the validation sensor in this example is from the Scanning High-resolution Interferometer Sounder (S-HIS) which has been tied to a NIST traceable calibration source. Quick look comparisons show excellent agreement. Significance – NIST traceable validation is critical for uncertainty analysis needed to fully assess data quality of S-NPP and JPSS sensors.

Achieving 0.1 K absolute calibration is important for verifying real climate trends

- Through detail validation we have demonstrated that both CrIS and IASI have achieved a high level climate monitoring performance capability.
- Climate monitoring performance allows you to minimize the time to detect a real climate trend from natural variability.
- In the figure to the right, we see that a trend of 0.1 K per decade would take 20 years to confirm with perfect observations.
- While a calibration accuracy of 0.1 would take about 25-27 years
- While a calibration accuracy of 0.3 would take about 50 years.
- This chart would imply that CrIS and IASI are not good for monitoring trends. The accuracy noted in the chart for IASI, AIRS, CRIS are from the specification
- Good news - CrIS and IASI are approaching 0.1 K - beating the specification by significant margins

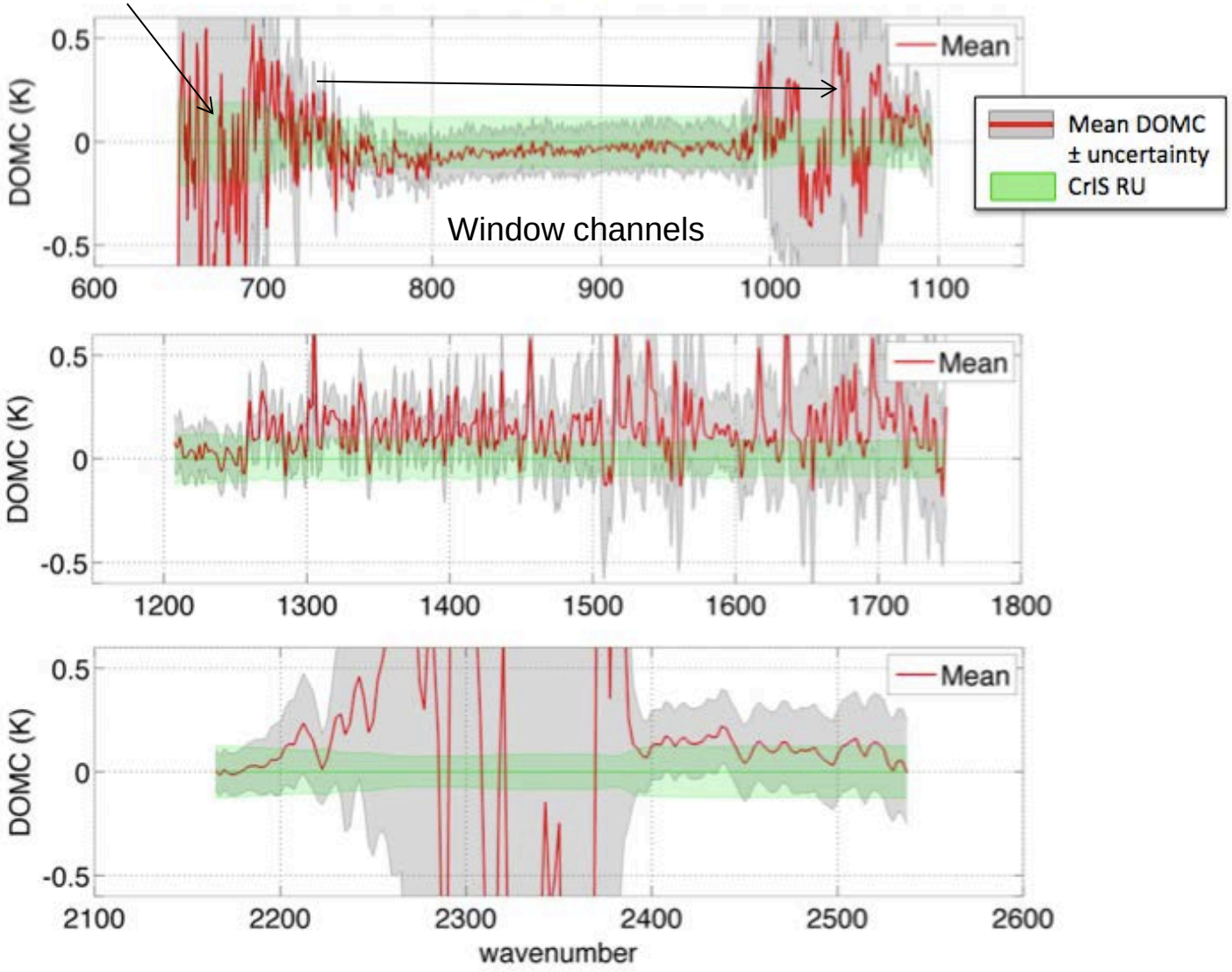


Wielicki, Bruce A., and Coauthors, 2013: Achieving Climate Change Absolute Accuracy in Orbit. *Bull. Amer. Meteor. Soc.*, **94**, 1519–1539. doi: http://dx.doi.org/10.1175/BAMS-D-12-00149.1

CrIS/S-HIS Underflight Results

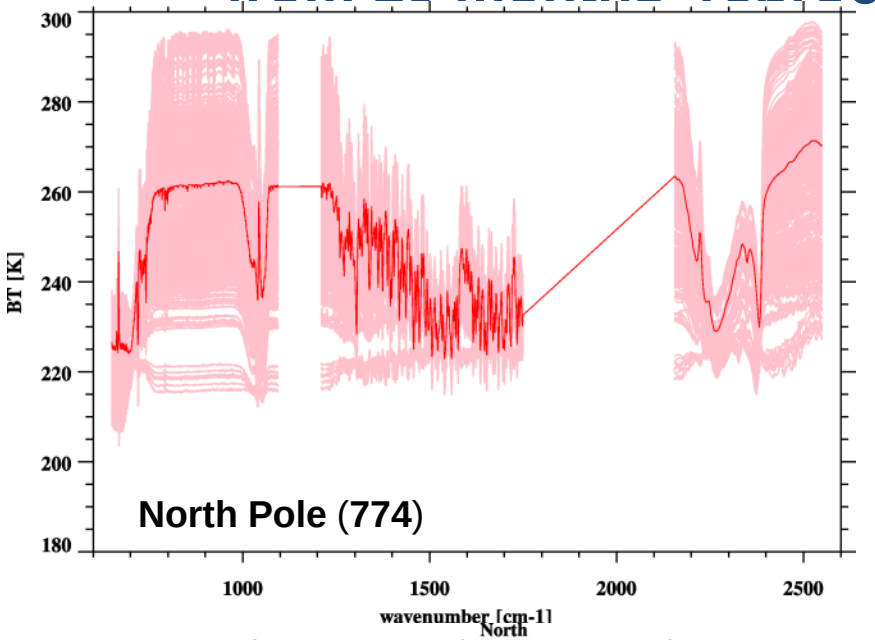
Hamming apodization

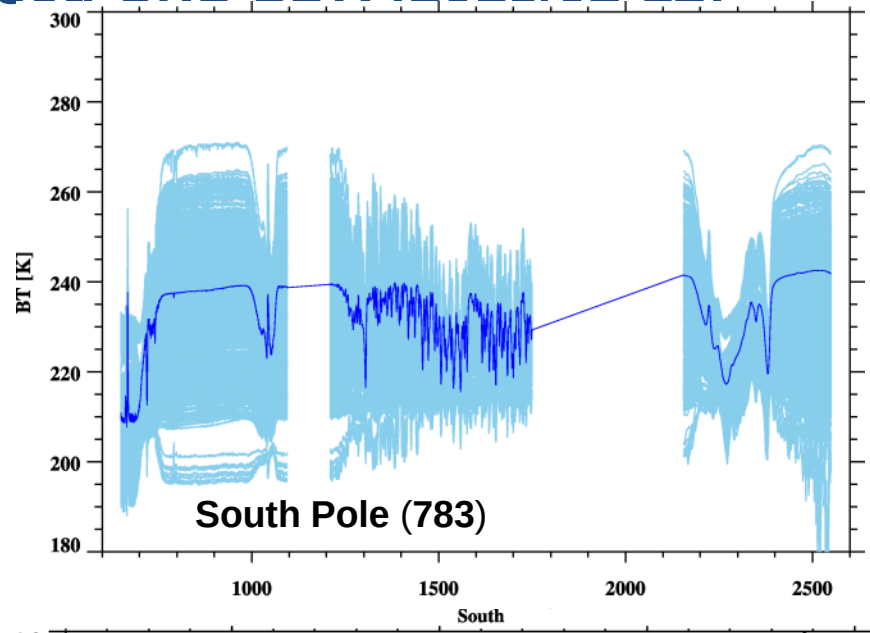
Atmospheric absorption above the aircraft

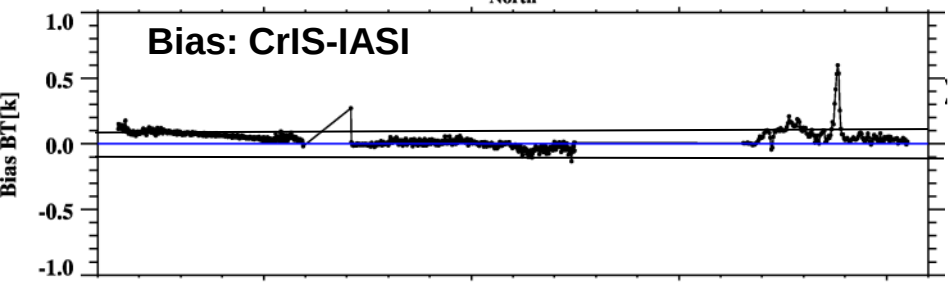


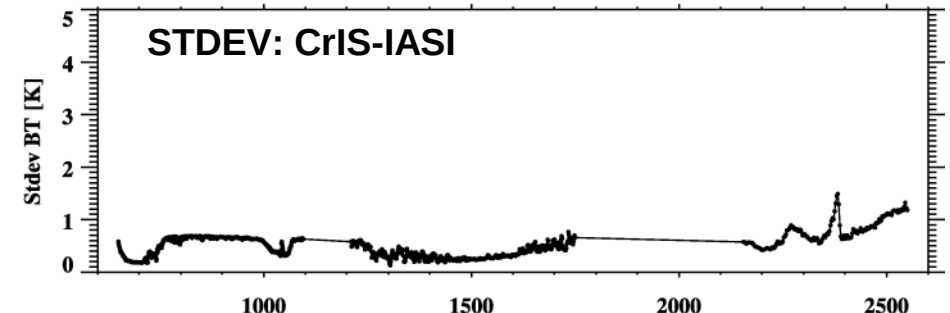
- Aircraft underflights provide periodic end-to-end verification of CrIS RU estimates with 0.1-0.2K uncertainty over most of the spectrum.

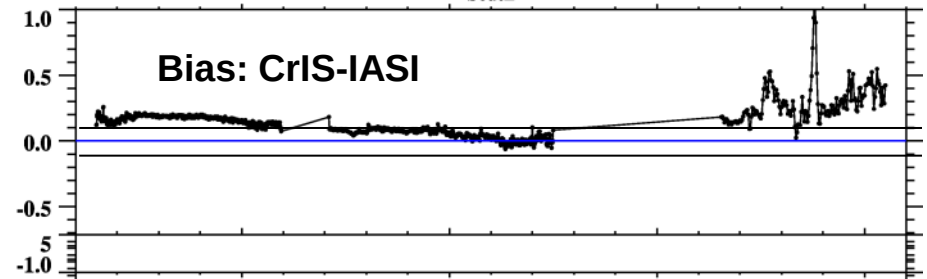
SNO Results between CrIS and IASI/Metop-B from 10 months' reprocessed CrIS SDR (2013/02-12)

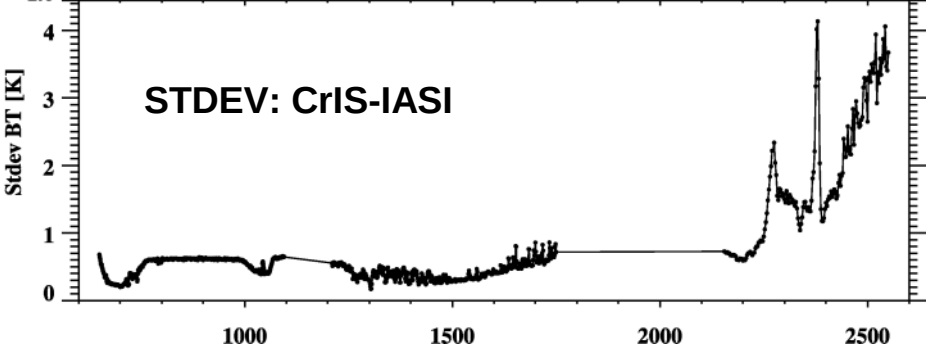


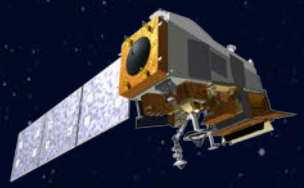








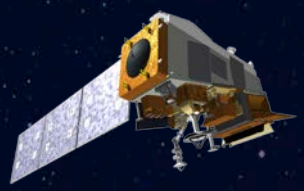




Conclusion

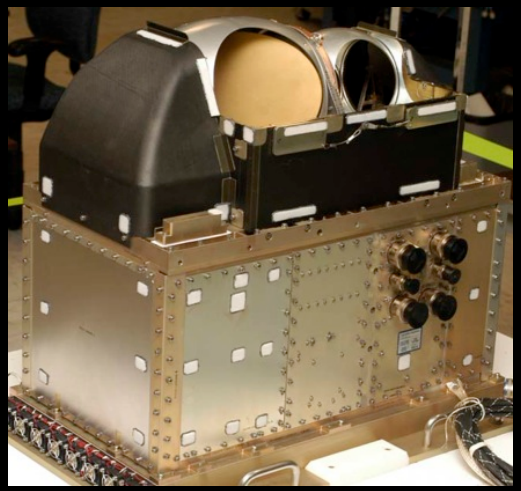
- Current suite of instruments on Suomi NPP will be flown on JPSS-1 satellite mission and offer significant improvements in observational capability from the legacy POES satellite series and continue and improve upon NASA EOS research capabilities.
- The JPSS mission is critical to provide the U.S. and international community with operational continuity of key weather , ecosystems. climate observations established by NOAA and NASA.
- The NOAA satellite climate data records from 1970s will be continued by JPSS.
- JPSS is on track, on budget and schedule for upcoming JPSS-1 satellite mission in early 2017.
- JPSS Proving Ground promotes improve applications and user engagement and feedback

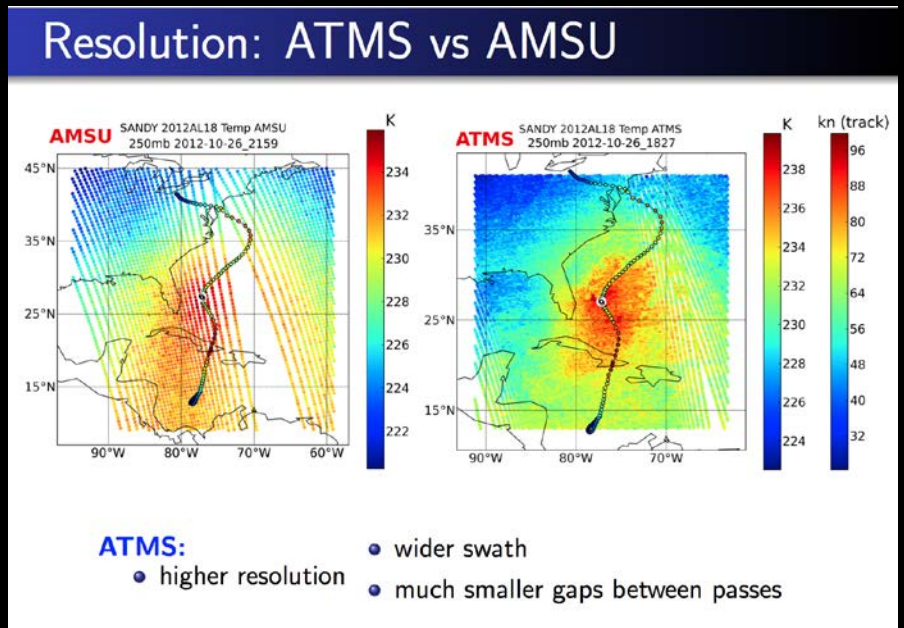
Additional slides



Advance Technology Microwave Sounder (ATMS)

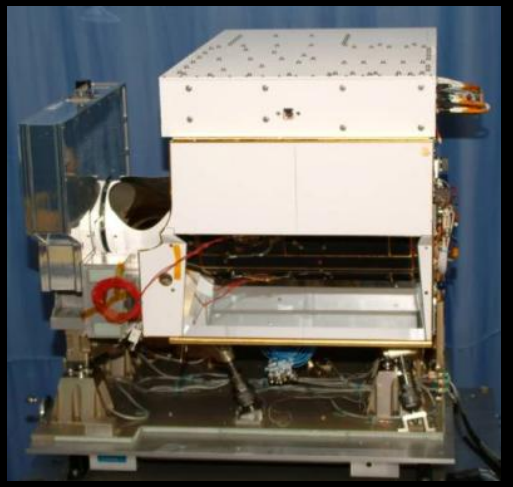
ATMS offers more channels, better resolution and a wider swath than previous legacy microwave instruments. This improves the accuracy of short- and medium-term forecasting, storm tracking and, with continued measurements over time, climate prediction models. It helps collect essential data for accurate near-term weather predictions needed for farming, commercial and defense aircraft flight path planning, terrestrial extreme weather preparedness and oceanographic inputs for civilian and defense ships. ATMS measurements also provide rainfall rates, snow and ice information.

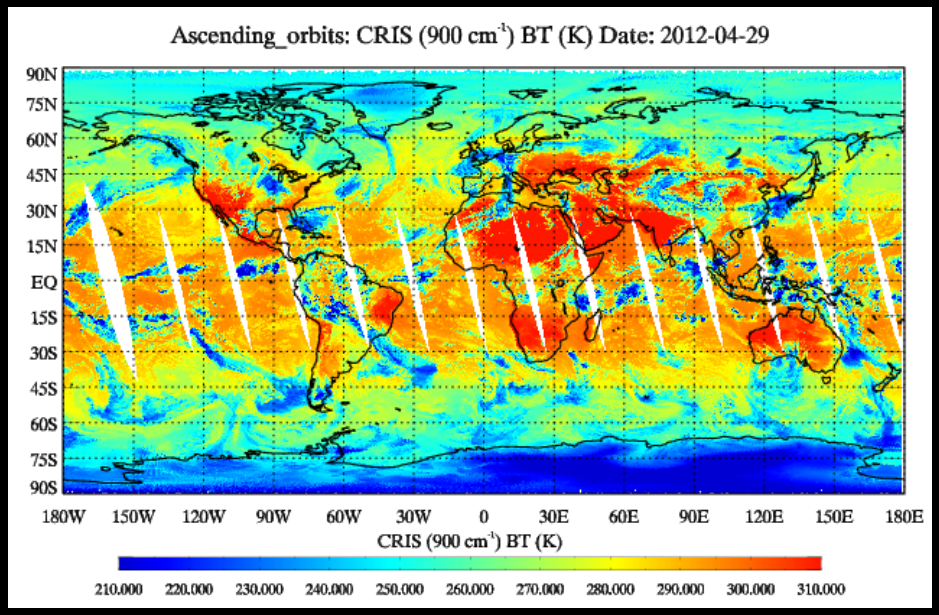




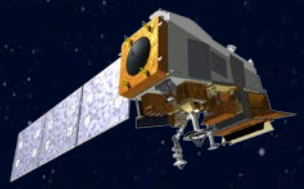
Cross-track Infrared Sounder (CrIS)

The CrIS is the first in a series of advanced operational sounders that provides more accurate, detailed atmospheric temperature and moisture observations for weather and climate applications. CrIS provides temperature and moisture profiles with 6x more vertical resolving power than previous NOAA infrared sounders. A single hyperspectral IR sounder provides the largest improvement to the forecast skill than any other instrument.



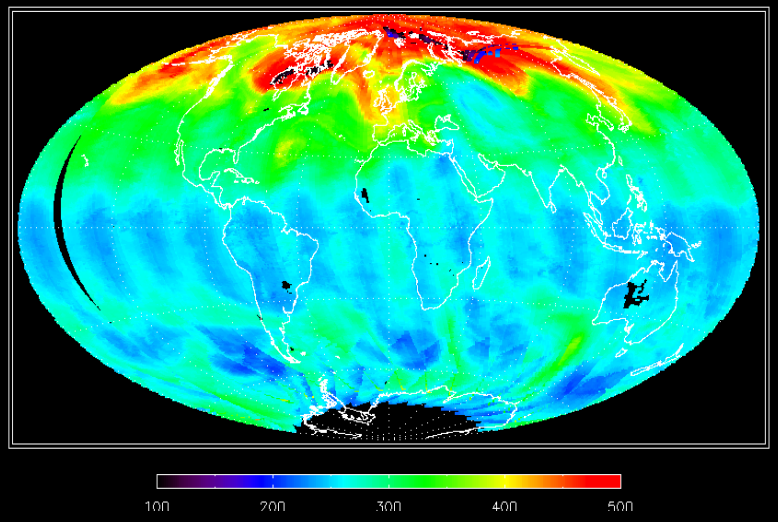


CrIS long-wave surface temperature channel

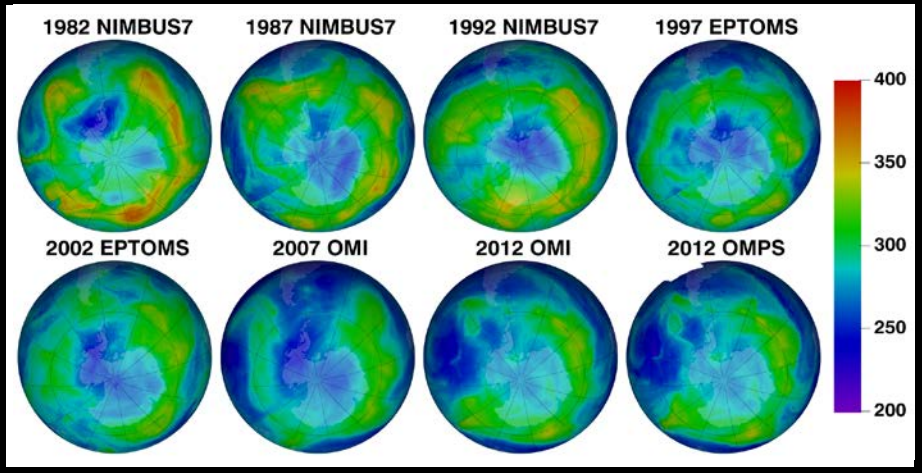


Ozone Mapping and Profiler Suite (OMPS)

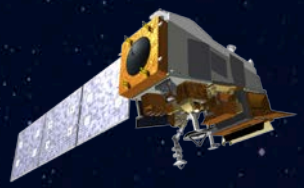
OMPS tracks the health of the ozone layer and measures the concentration of ozone in the Earth's atmosphere. Data from OMPS continues three decades of total ozone and ozone profile records, which fulfill the U.S. treaty obligation to monitor ozone concentrations for the Montreal Protocol. This important data is used by ozone assessment researchers and policy makers to create global climate models.



Total Ozone for APR 18, 2012



Credit: NOAA/NASA



Clouds and the Earth's Radiant Energy System (CERES)

CERES measures reflected sunlight and thermal radiation emitted by the Earth and helps provide measurements of the spatial and temporal distribution of Earth's Radiation Budget (ERB) components. Measurements from CERES help scientists understand the links between the Earth's incoming and outgoing energy and the properties of the atmosphere that affect that energy. The observations from CERES FM6 help measure the effect of clouds on the energy balance, which strongly influences both weather and climate.