Joint Polar Satellite System

JPSS overview and plans for aerosol assimilation

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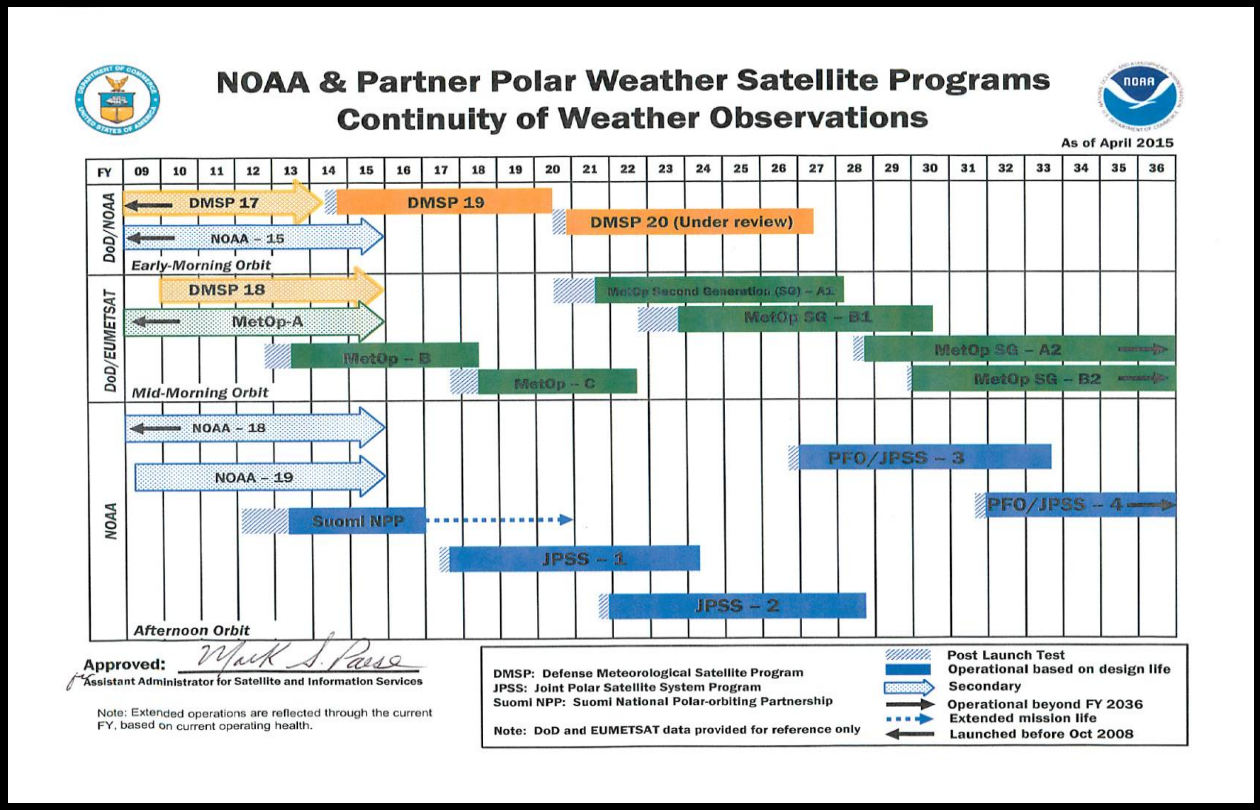
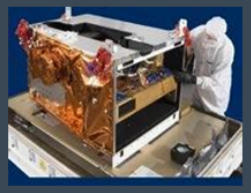
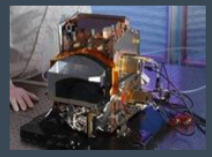
Nineteenth Annual George Mason University Conference on
Atmospheric Transport and Dispersion Modeling

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.

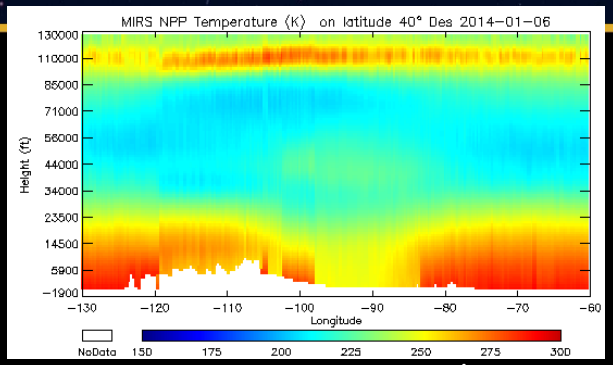


JPSS Instruments

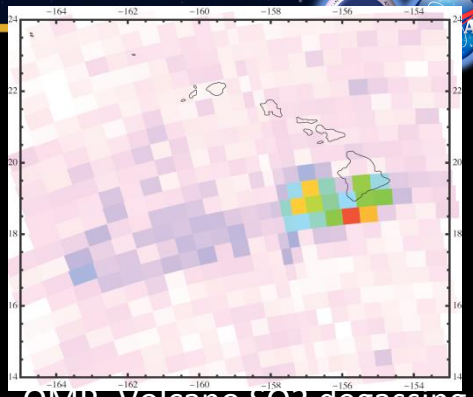
JPSS Instruments		Measurements & Products	Contractor
	**ATMS** - Advanced Technology Microwave Sounder	High vertical resolution temperature and water vapor information critical for forecasting extreme weather events, 5 to 7 days in advance	Northrup Grumman Electronic Systems
	**CrIS** - Cross-track Infrared Sounder		Exelis
	**VIIRS** – Visible Infrared Imaging Radiometer Suite	Critical imagery products, including snow/ice cover, clouds, fog, aerosols, fire, smoke plumes, vegetation health, phytoplankton abundance/chlorophyll	Raytheon Space and Airborne Systems
	**OMPS** - Ozone Mapping and Profiler Suite	Ozone spectrometers for monitoring ozone hole and recovery of stratospheric ozone and for UV index forecasts	Ball Aerospace and Technologies Corp.
	**CERES** – Clouds and the Earth's Radiant Energy System (S-NPP and JPSS-1) **RBI** – Radiation Budget Instrument (JPSS-2, 3, 4; provided by NASA)	Scanning radiometer which supports studies of Earth Radiation Budget (ERB)	CERES - Northrup Grumman Aerospace Systems RBI - Exelis

JPSS provides a wide range of capabilities

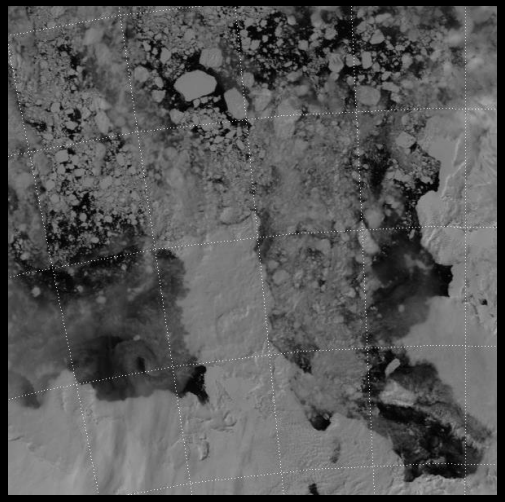
- Microwave – provides temperature and moisture soundings in cloudy conditions and rainfall rates, sea ice, snow, surface temperature
- Infrared – provides high vertical resolution temperature and moisture soundings in clear and cloud corrected regions; atmospheric chemistry - CO, CH4, SO2, … and cloud 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)…

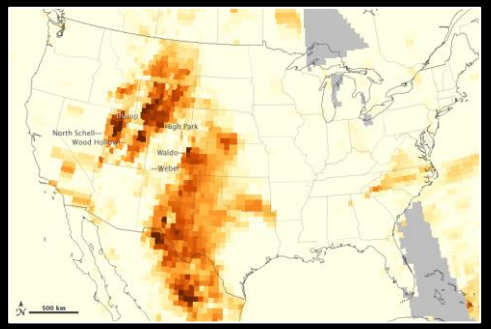


Temperature X-Section Polar Vortex

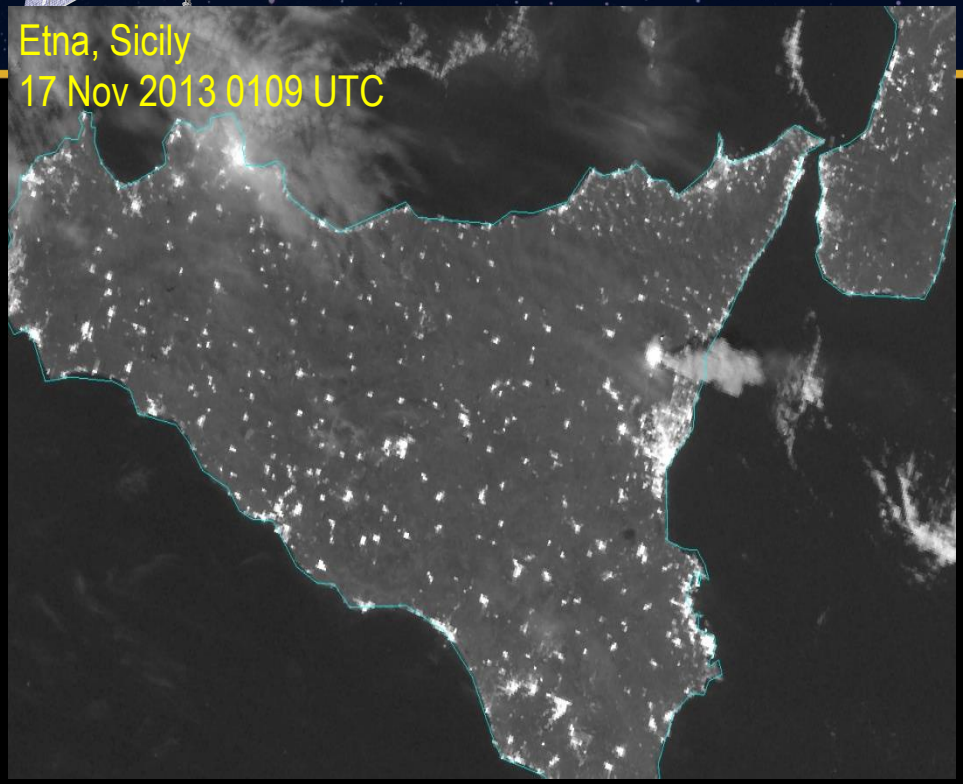

OMP- Volcano SO2 degassing


Algae in Lake Erie


DNB Ice detection

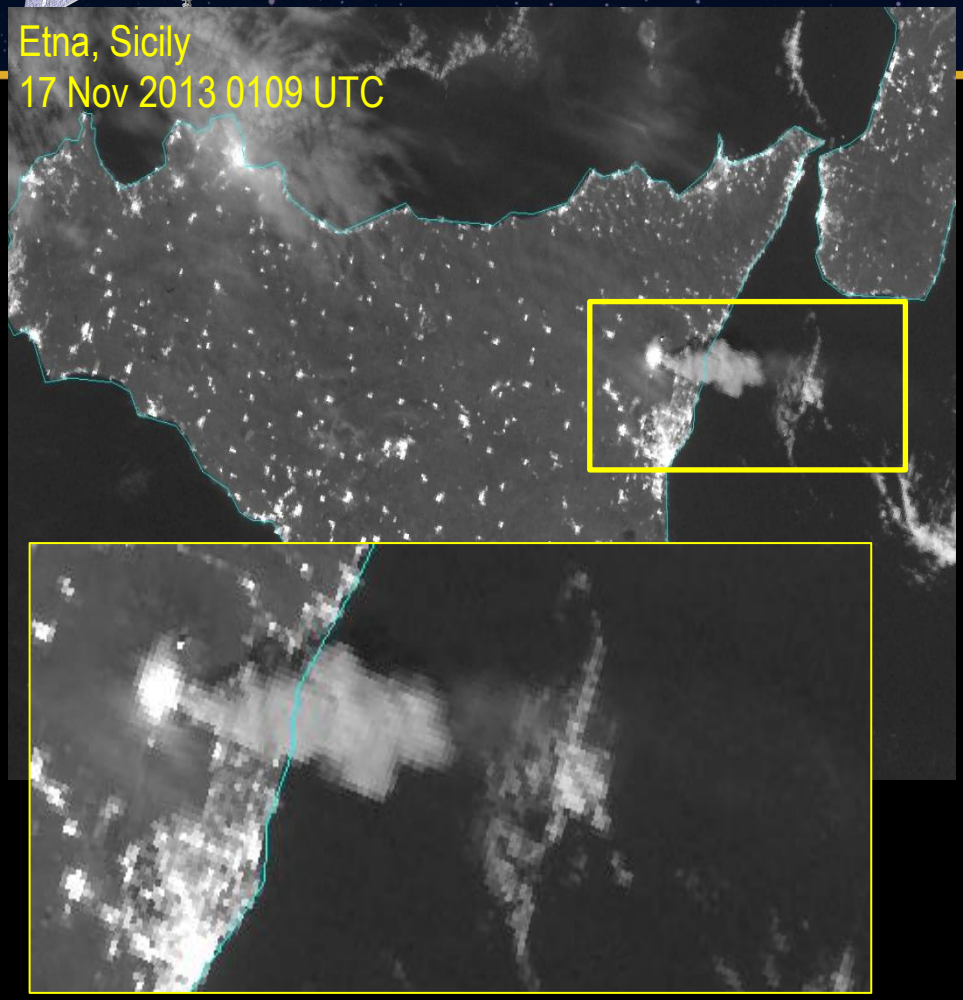

OMPS Aerosols from Fires

The ‘Pyrosphere’ and its Atmospheric Effluents



Complementary information on ash/smoke particles having weak IR signatures.

The ‘Pyrosphere’ and its Atmospheric Effluents



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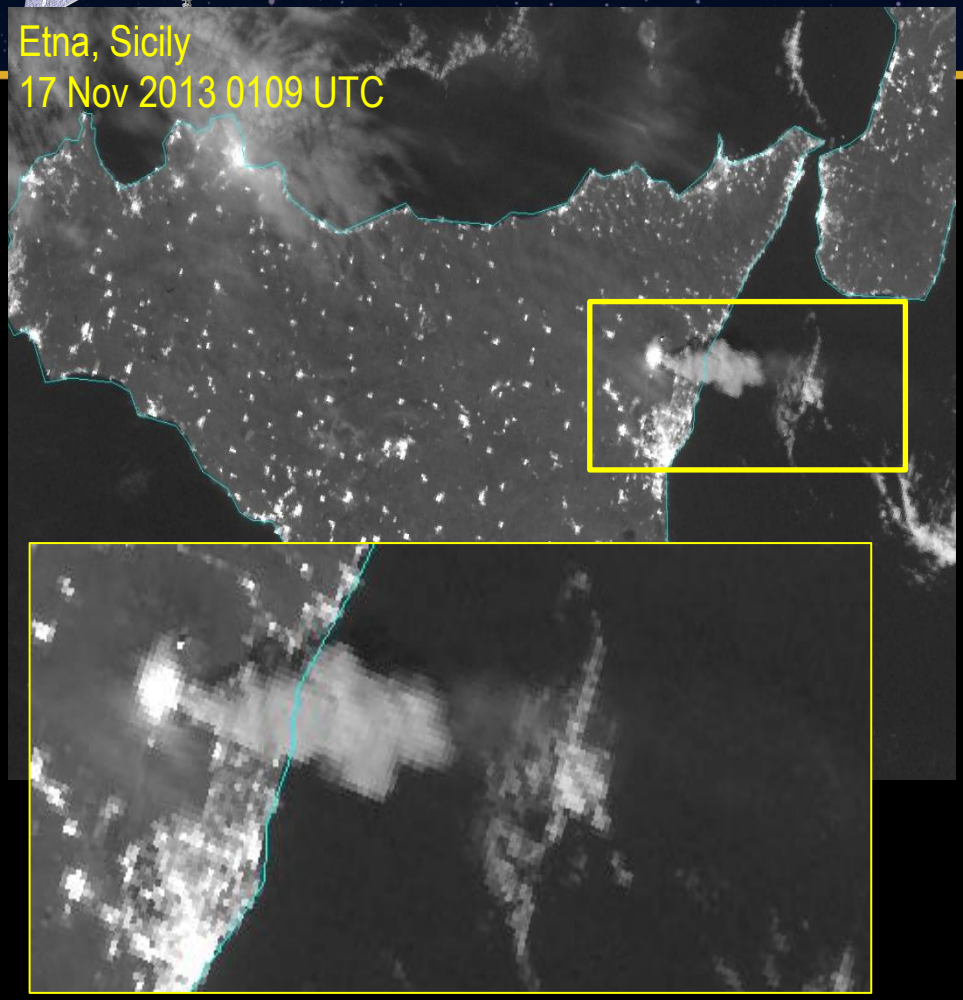

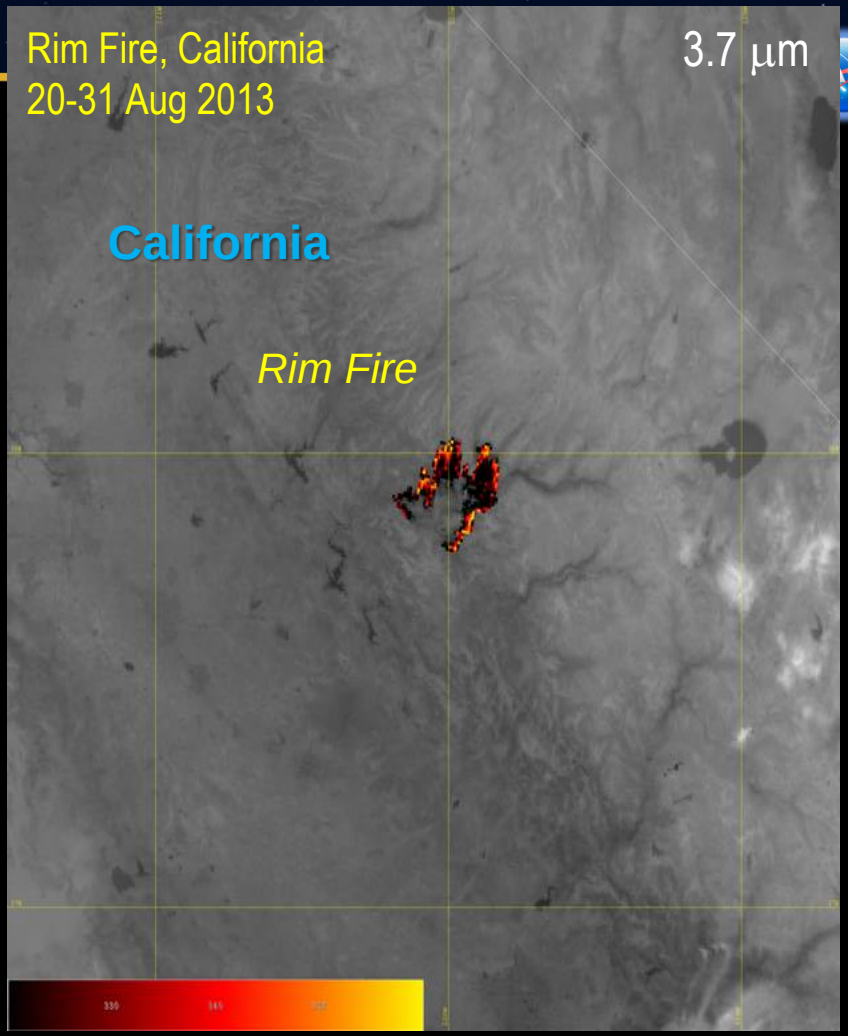

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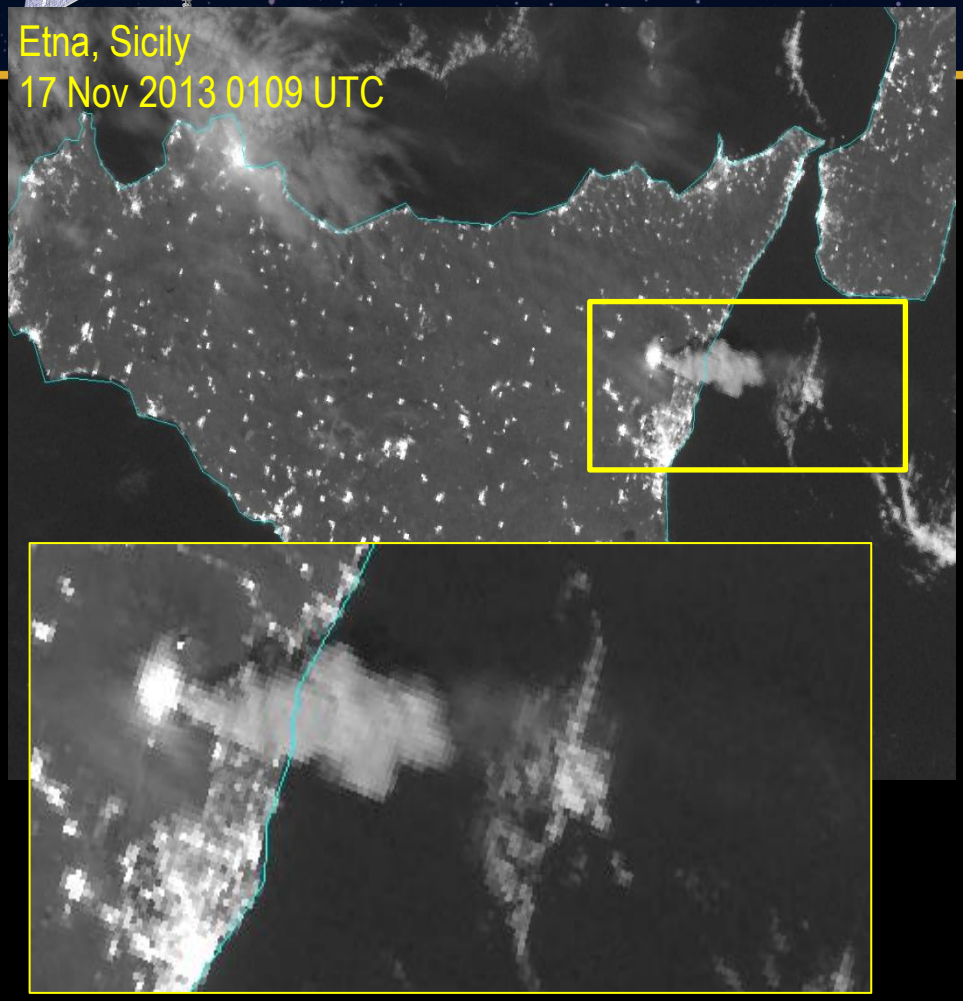

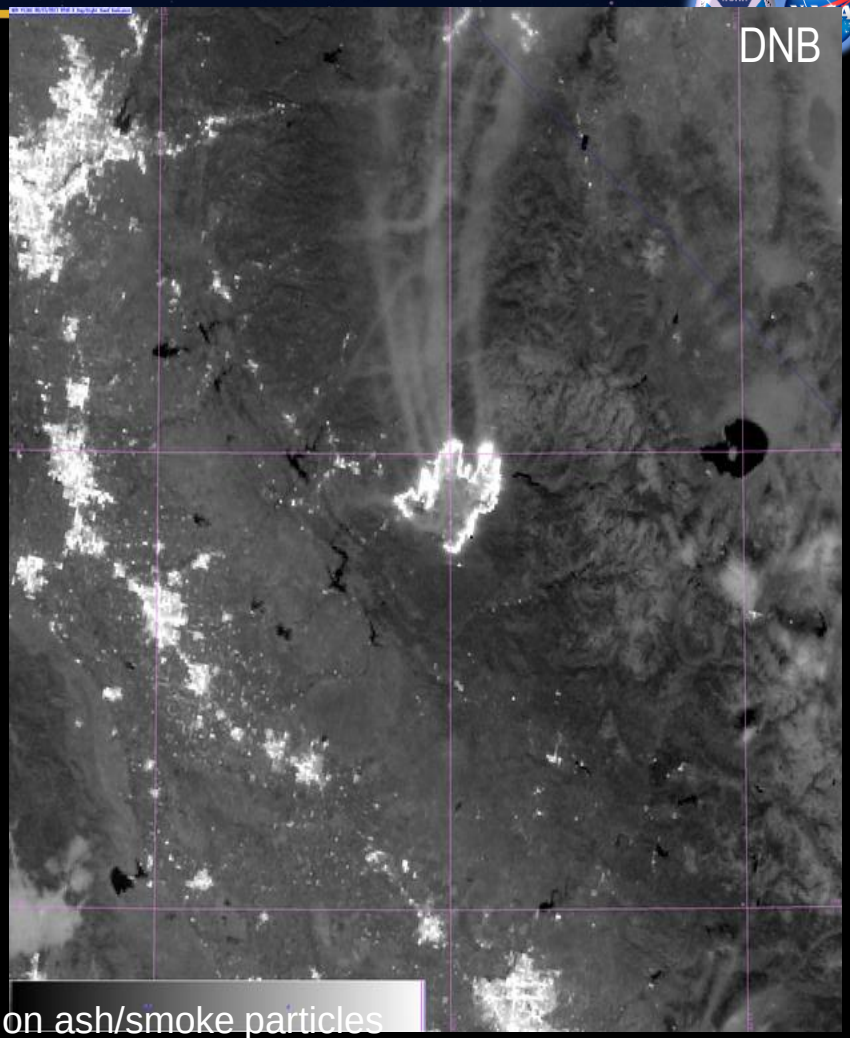

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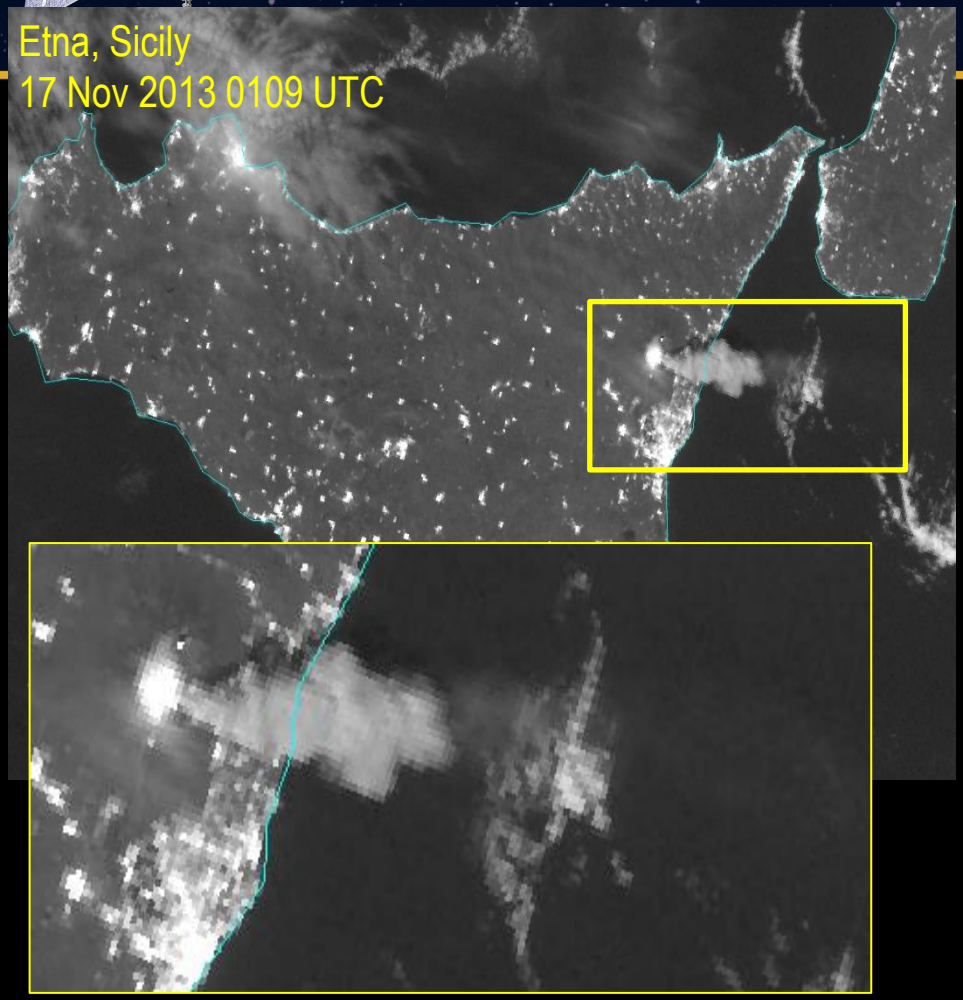

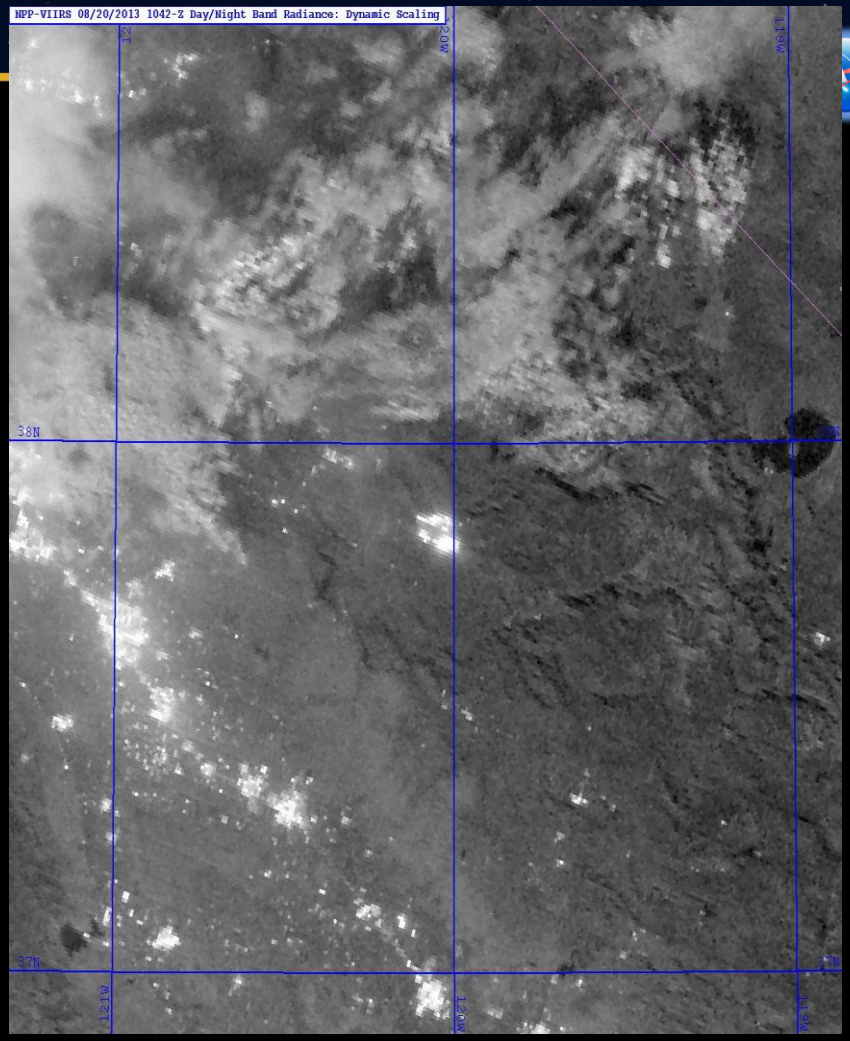

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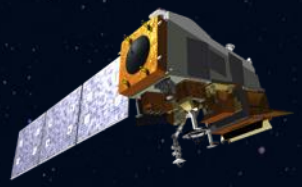


S-NPP and JPSS Data Products

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)
OUTGOING LONGWAVE RADIATION

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

CERES(1)
RDRs

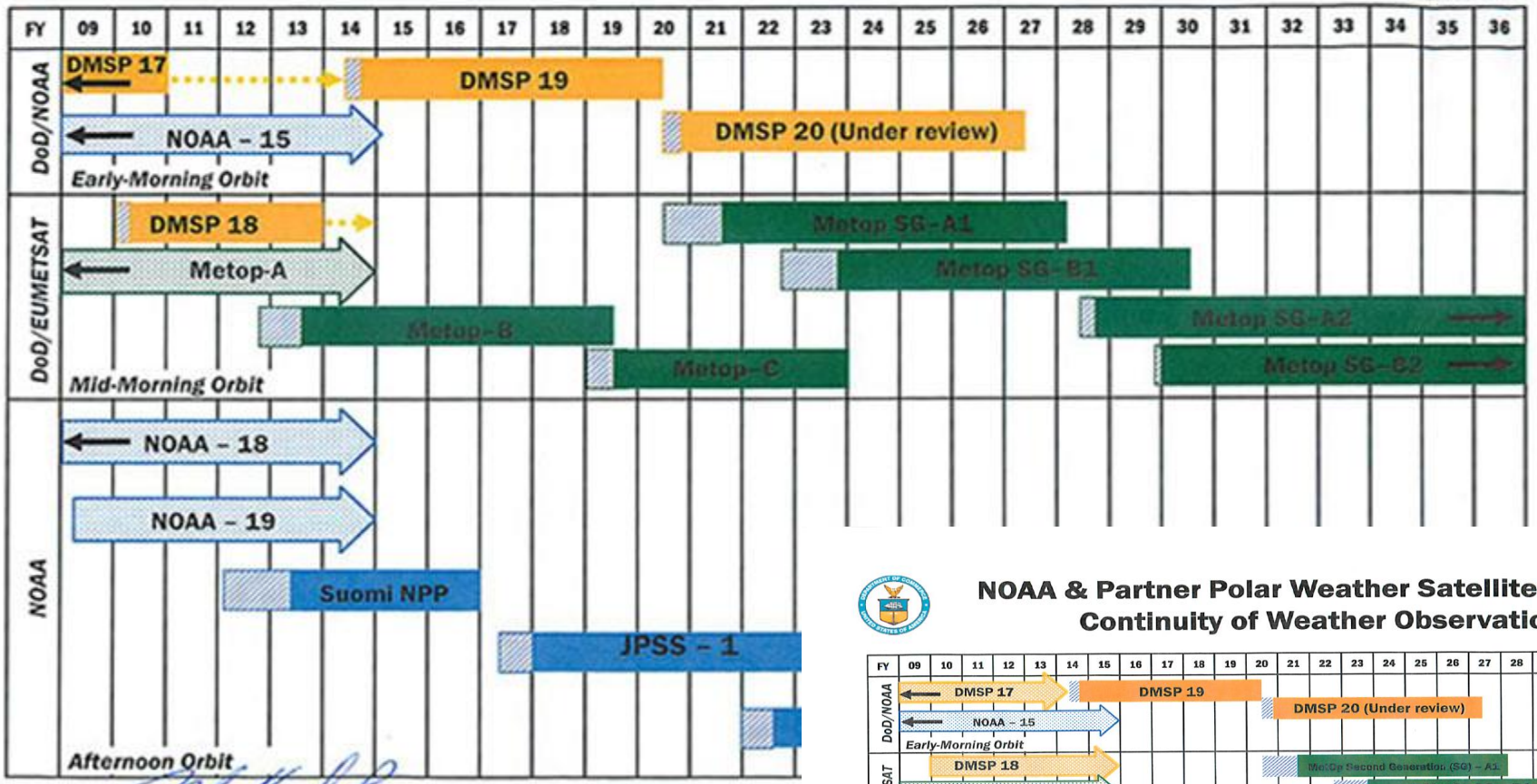
OMPS (2)
O_3 TOTAL COLUMN
O_3 NADIR PROFILE
SO2 and Aerosol Index

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

Data available through PDA , CLASS, and Direct Readout

NOAA & Partner Polar Weather Satellite Programs
Continuity of Weather Observations

As of August 2014



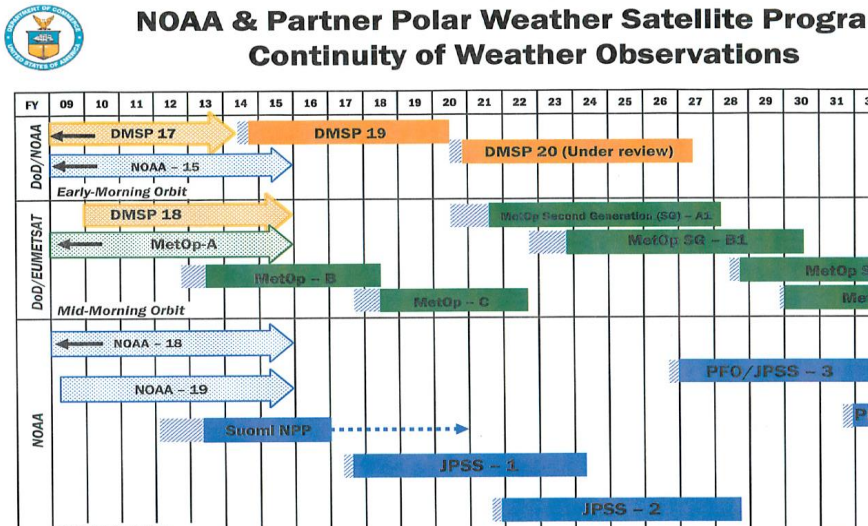
Approved: _____

Assistant Administrator for Satellite and Information Services

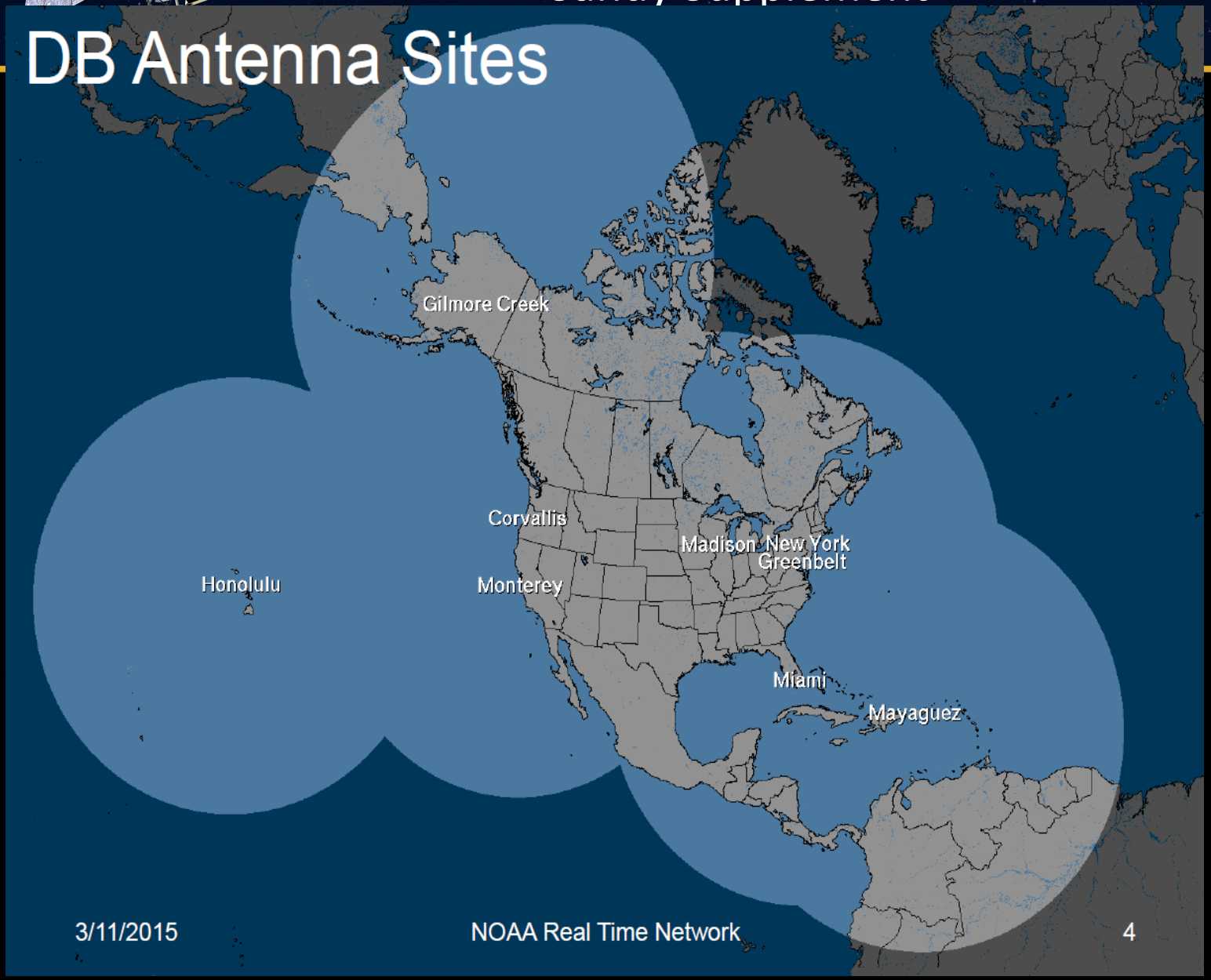
*Follow-on funding required for operations in FY 2025 and beyond.

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

DMSP: Defense Meteorol
JPSS: Joint Polar Satellite
Suomi NPP: Suomi Nation
Metop SG: Metop Second



NOAA DB Network Antenna Sites funded through the Sandy Supplement

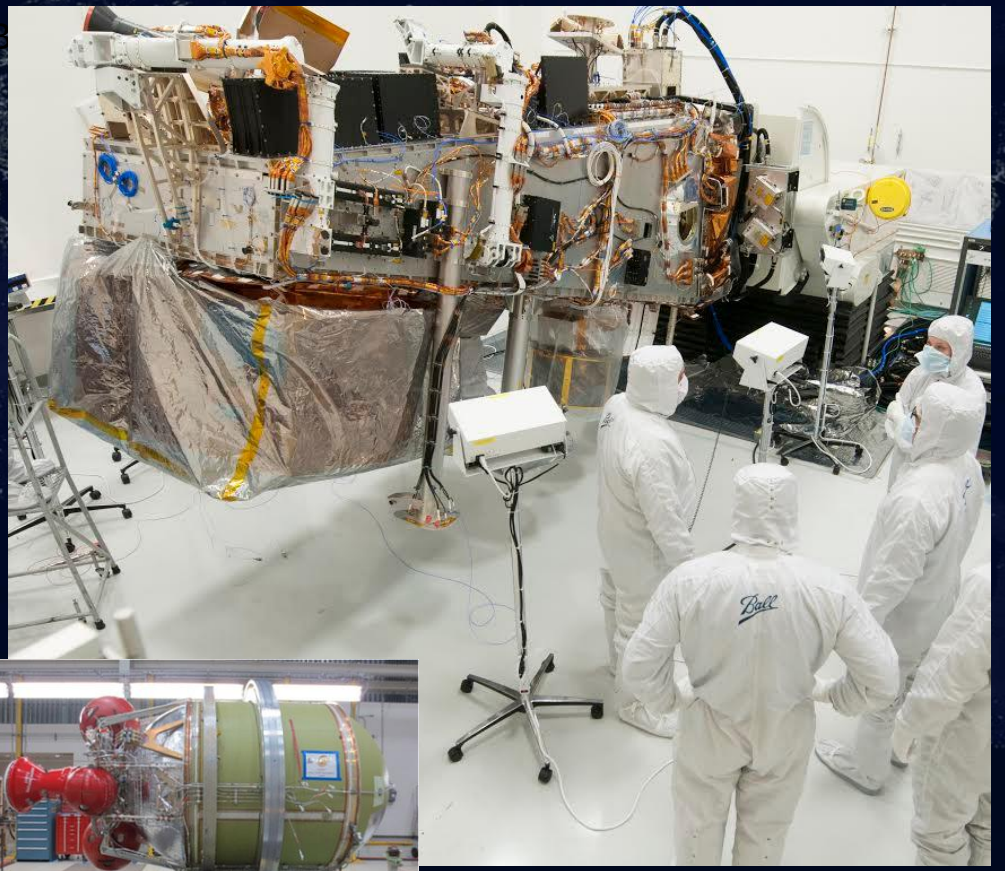


Currently antennas at Hawaii, Alaska, and Wisconsin, are being used routinely by weather forecast offices using AWIPS's Local Data Acquisition and Dissemination (LDAD)

Program Status
JPSS-1

ATMS EDU integration
(Ball Aerospace)

Spacecraft with CrIS, VIIRs, OMPS, CERES integrated
(Ball Aerospace)



Delta II Fairing and Booster Assembly
(United Launch Alliance)

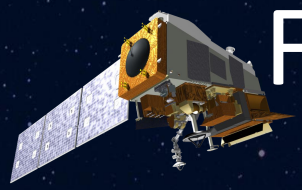
Delta II Second Stage
(United Launch Alliance)

JPSS Proving Ground & Risk Reduction Program

The JPSS Proving Ground and Risk Reduction 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

Significant amount of NOAA operational use of SNPP data has been made possible through JPSS PGRR and Direct Readout



FY15 & 16 Call for Proposals

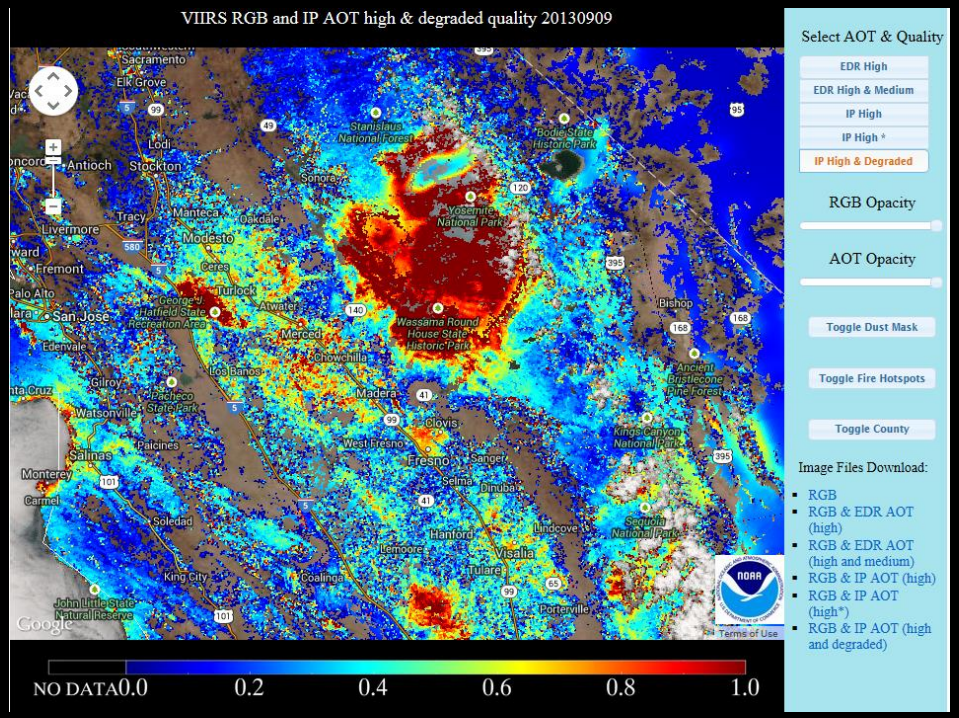
- New JPSS PGRR Call for Proposals was released on December 2, 2014.
  - Call focuses on 13 initiatives
- Over 130 Letters of Intent were received.
- New projects will be selected by the JPSS PGRR Executive Board (with feedback from relevant users and stakeholders) in March/April

PGRR Initiatives

About 40 proposals selected so far out of 87 full proposals out of 136 LOIs

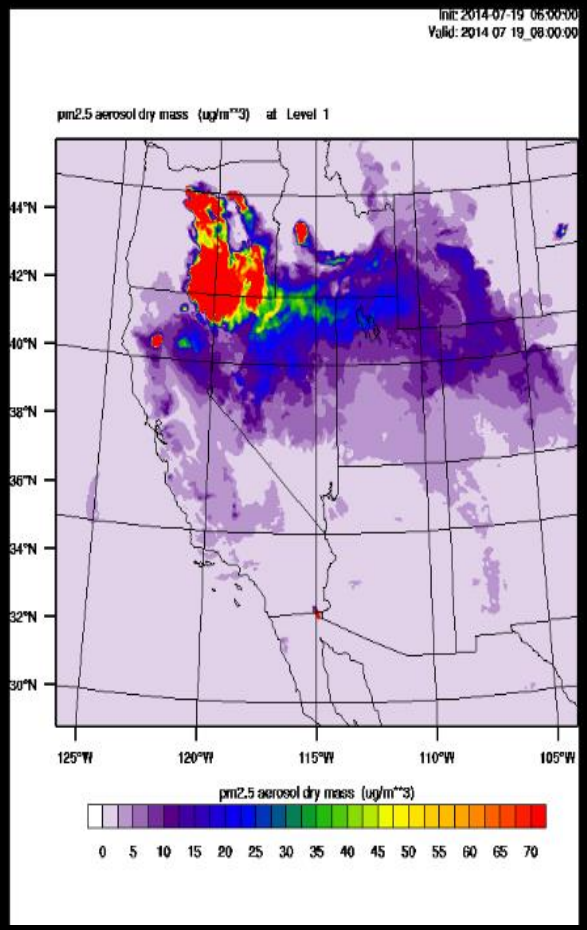
- Aerosol Data Assimilation
- Fire and Smoke
- River Ice and Flooding
- Atmospheric Sounding Applications
- NWP impact studies (via HRRR and GFS) and other critical weather applications
- OCONUS and NCEP Service Centers AWIPS Initiative
- Cryosphere Initiative
- Land Data Assimilation
- Ocean and Coastal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

Aerosol Data Assimilation (1)



- Improve the use of VIIRS and OMPS aerosol products in operational models at NWP centers or developmental models at partner agencies that have defined pathways to transition to NWP centers.
- Make use and demonstrate the value of VIIRS aerosol optical depth, aerosol (smoke, dust, volcanic ash) detection, and OMPS UV Aerosol Index products in improving forecasts.

Fire and Smoke (4)



- Makes use of the VIIRS active fire location, fire radiative power and aerosol optical depth, and potentially OMPS derived aerosols to predict fire movement and dispersion of smoke using high spatial resolution and timely forecast models
- Products focus on determining the current location of a fire and gathering as much information as possible on its history.

Status of SNPP VIIRS Aerosol Products

At NOAA Comprehensive Large Array-data Stewardship System (CLASS):

- **Intermediate Product (IP)**
  - 0.75-km pixel
    - AOT (550 nm); valid range: 0-2
    - Aerosol Particle Size Parameter
    - AMI (Aerosol Model Information)
    - quality flags
- **Environmental Data Record (EDR)**
  - 6-km cell aggregated from 8x8 IPs filtered by quality flags
    - **AOT** (10 M bands + 550 nm)
    - **APSP (over-land product is not recommended!)**
    - quality flags
  - 0.75 km
    - **SM (not recommended)**
    - quality flags

At NOAA/NESDIS/STAR

- **Gridded 550-nm AOT EDR**
  - regular equal angle grid: 0.25°x0.25°
    - only high quality AOT EDR is used

Land	Accuracy		Precision	
AOT	Requirement	SNPP/VIIRS	Requirement	SNPP/VIIRS
<0.1	0.060	0.012	0.150	0.058
0.1 - 0.8	0.050	0.016	0.250	0.117
>0.8	0.200	0.186	0.450	0.414

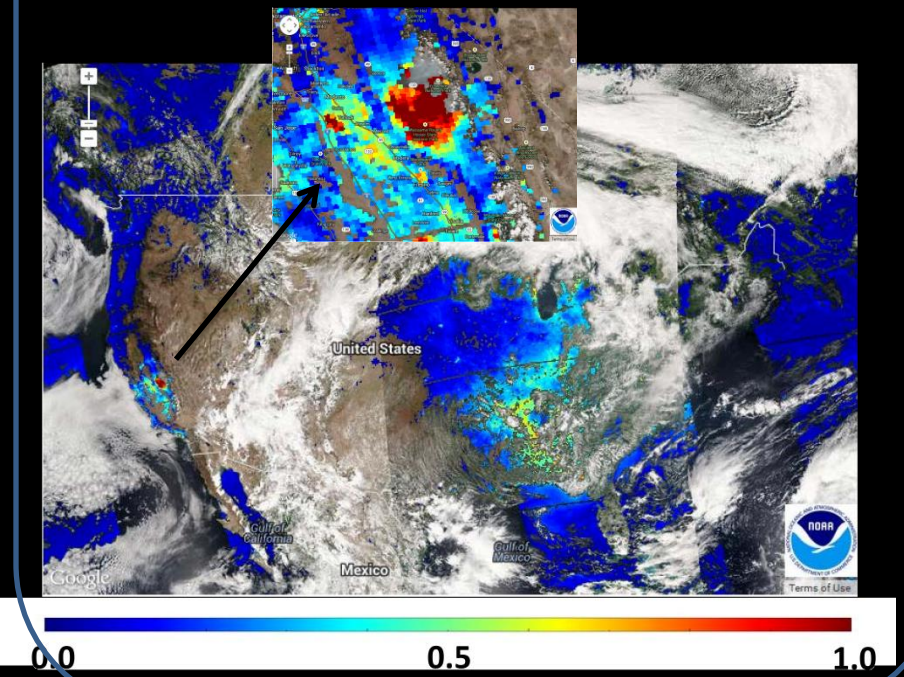
Ocean	Accuracy		Precision	
AOT	Requirement	SNPP/VIIRS	Requirement	SNPP/VIIRS
<0.3	0.080	0.007	0.150	0.041
≥0.3	0.150	0.020	0.350	0.144

AOT EDR Product Maturity: **Validated**

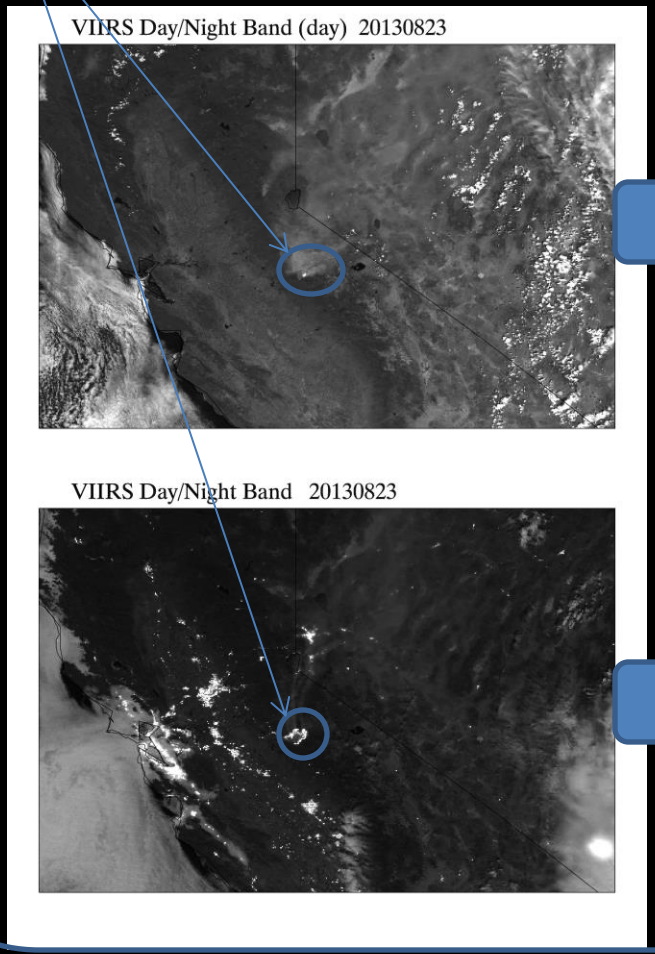
Current Air Quality Applications

SNPP VIIRS Day and Night Band (DNB) information on night time smoke plume detection and fire hot spots that are not visible in the day. Allows for overnight plume tracking.

SNPP VIIRS Aerosol Optical Thickness for California Rim Fire

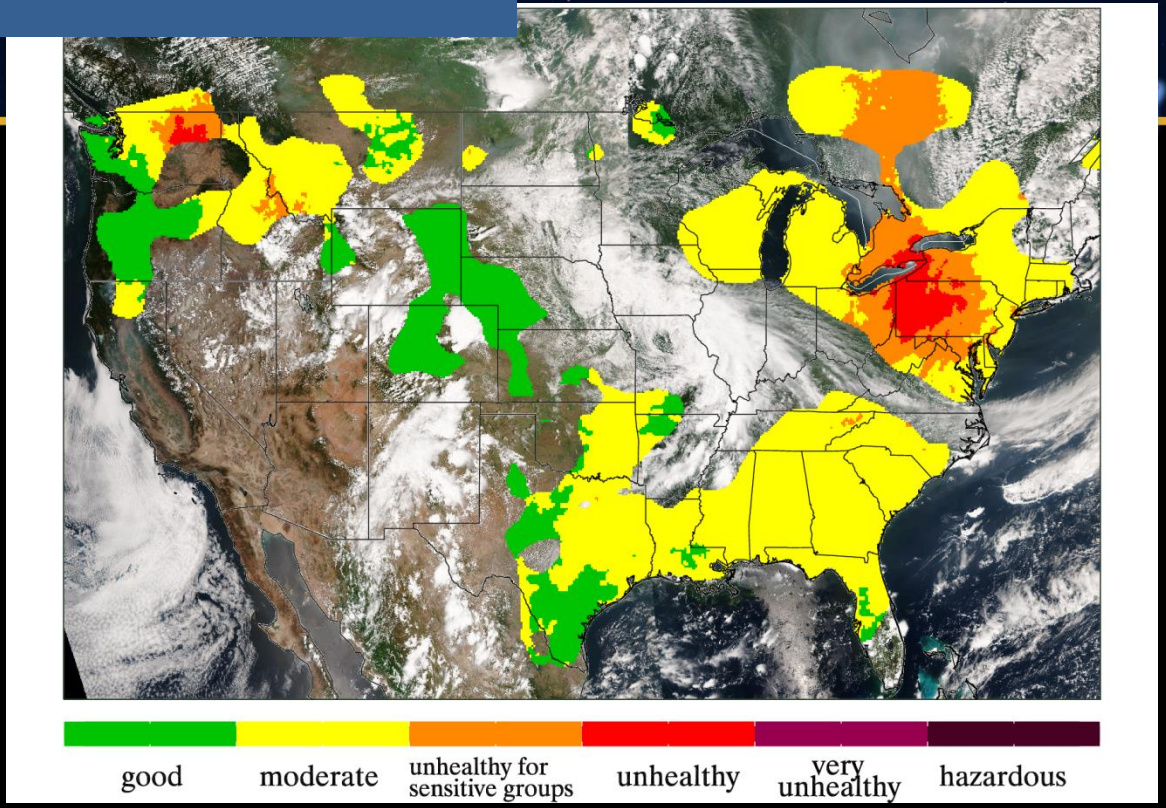


SNPP VIIRS Day and Night Band for California Rim Fire



Current Air Quality Applications

- Aerosols from natural (fires, volcanic eruptions, dust storms) and man-made (cars, industry) sources are harmful to human health. **More than 3 million premature deaths globally per year*.**
- EPA ground monitors not dense enough to provide monitoring and warnings for 40 million people living in rural areas in the US.
- Satellite data help fill the spatial gaps

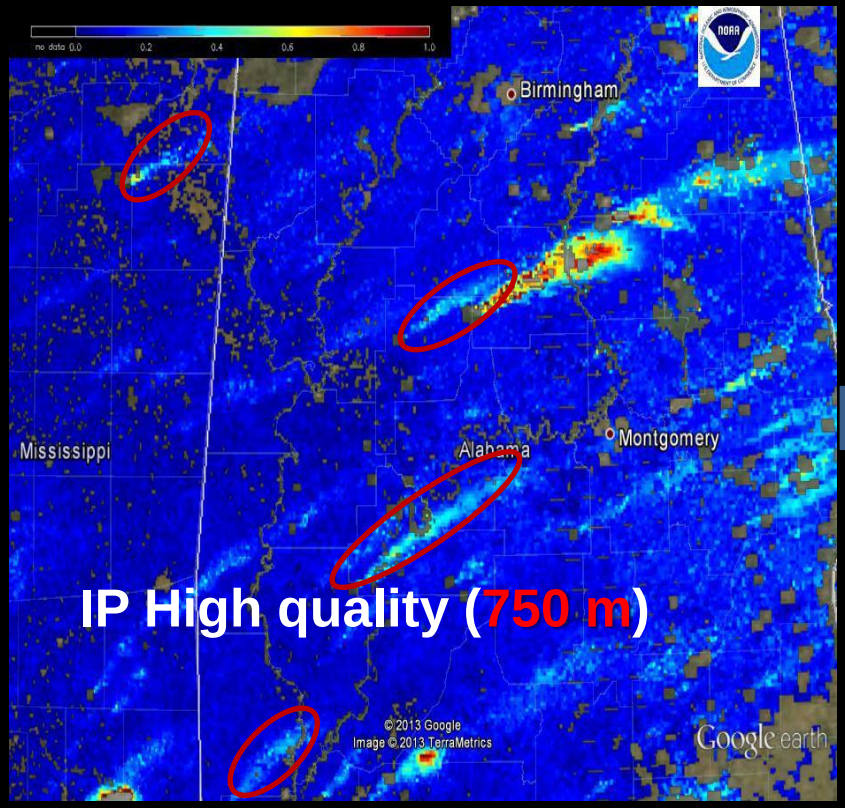


NESDIS satellite-derived air quality products used in Environmental Protection Agency (EPA) Air Quality Index (AQI) forecasts. Currently using Aqua/Terra MODIS with plans to transition to SNPP VIIRS. *AQI derived for August 7, 2014 using **SNPP VIIRS** aerosol optical thickness is shown above as an example.*

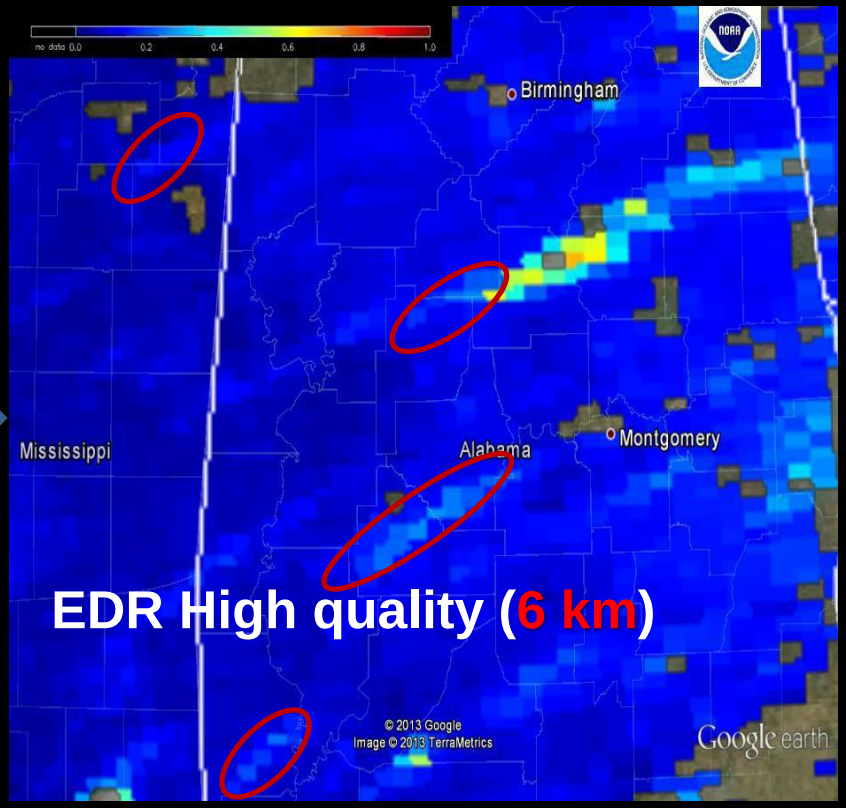
Current Air Quality Applications

Pixel level AOT clearly shows smoke plumes from different fires including the small ones.

EDR AOT looks pixelated with smoke plumes not very obviously visible



IP High quality (750 m)



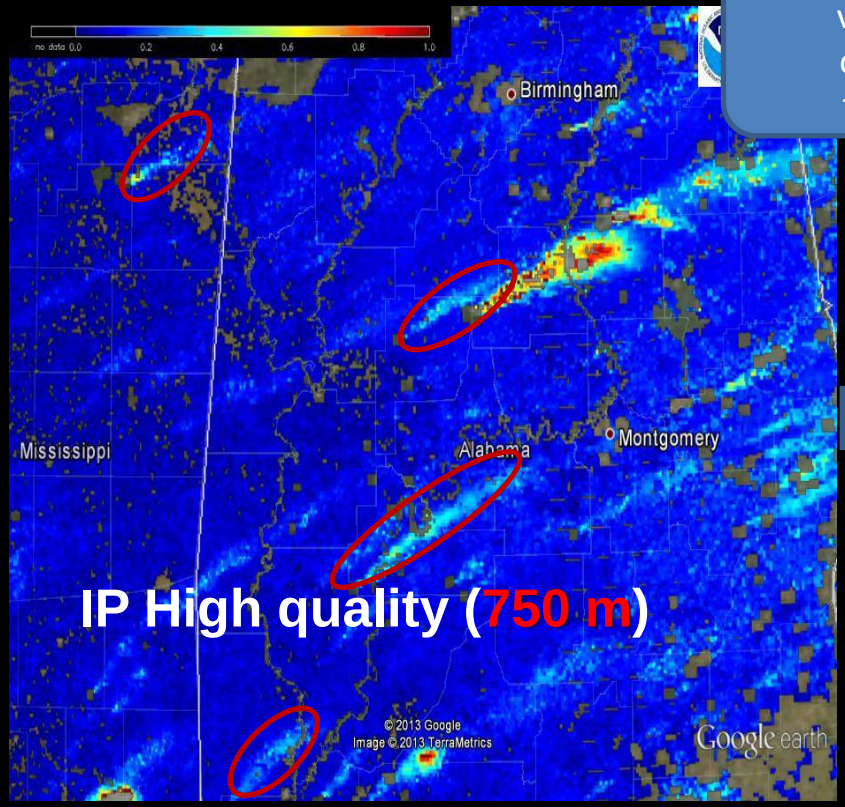
EDR High quality (6 km)

Current Air Quality Applications

Pixel level AOT clearly shows smoke plumes from different fires including the small ones.

EDR AOT looks pixelated with smoke plumes not very obviously visible

High spatial resolution valuable for operational forecasters



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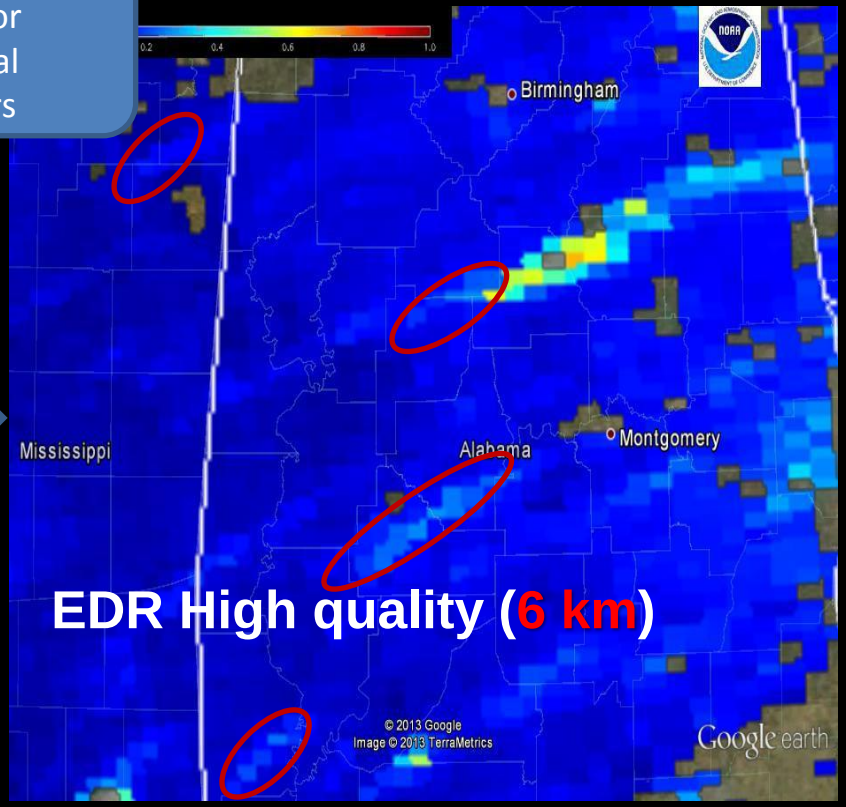
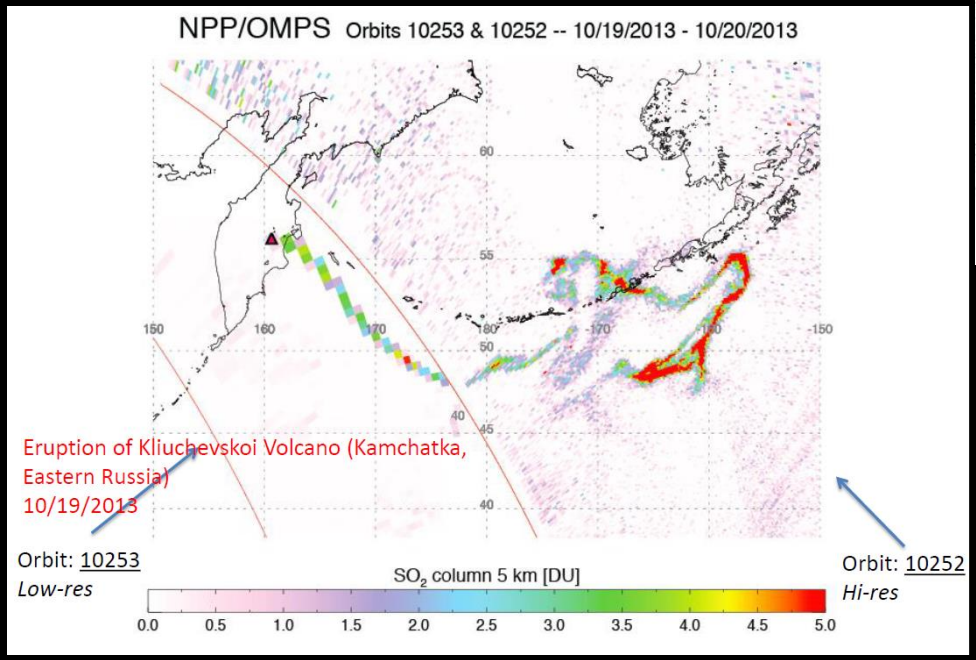
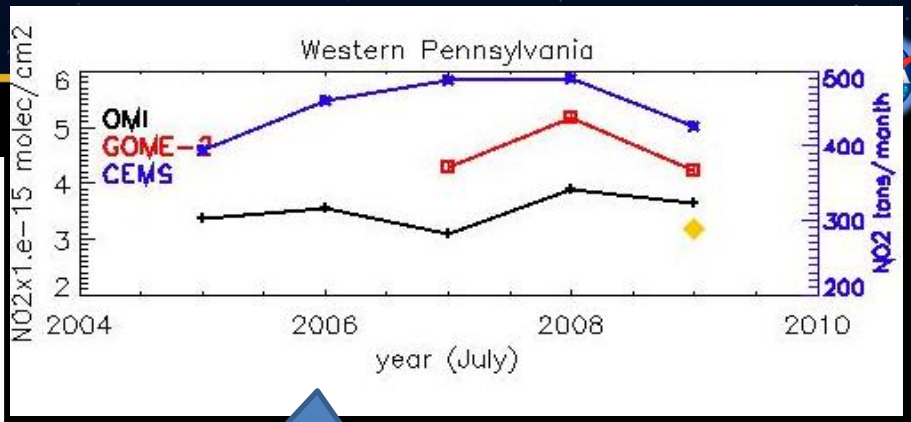


EDR High quality (6 km)

Future Capabilities





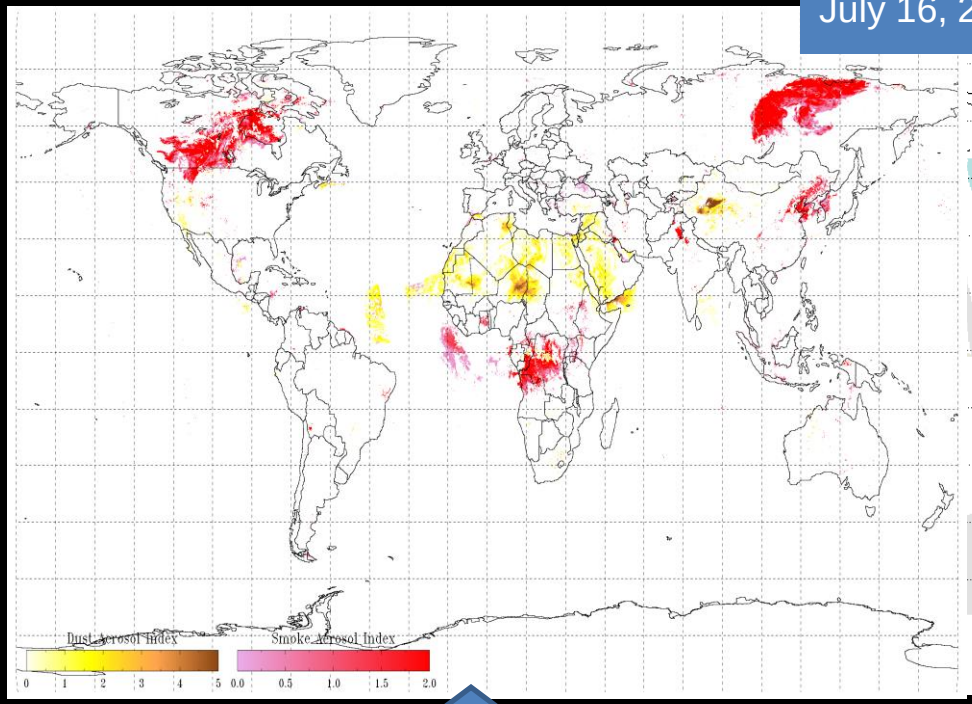
NOAA GOME-2 NO2 data provided to NASA for NOx emissions trending work. OMPS and GOME-2 on operational platforms will extend the data into the next few decades.

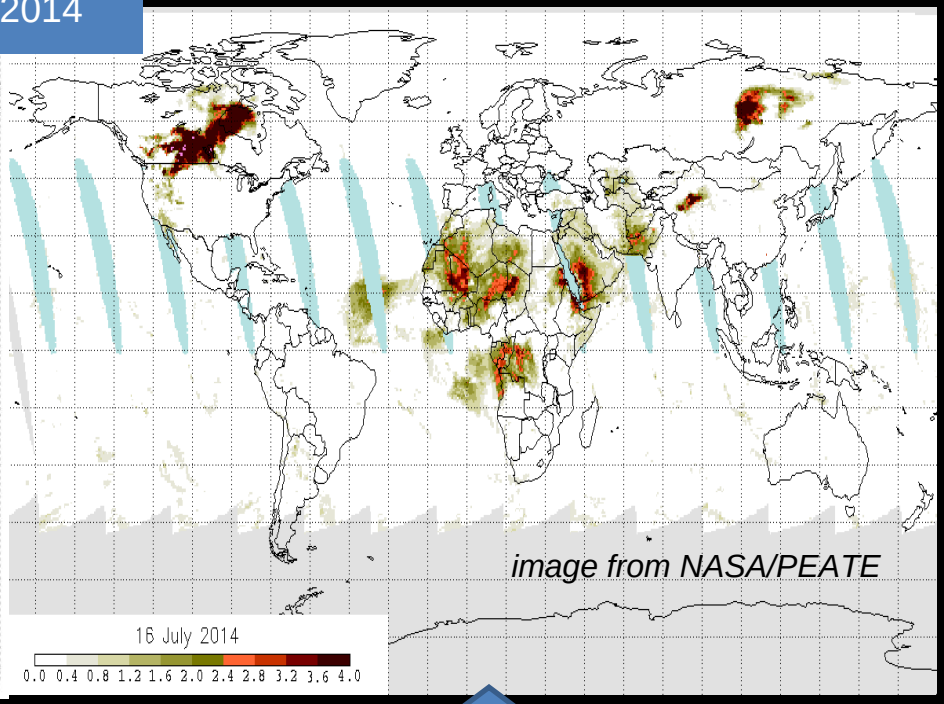
OMPS SO2 and NO2 retrievals will bring additional capabilities supporting the community needs for hazards (volcanic ash/SO2) monitoring and tracking anthropogenic emissions

Sensor Synergy

Combine VIIRS and OMPS radiances to generate aerosol indices that can clearly separate smoke, dust, urban/industrial aerosol

July 16, 2014





VIIRS: Aerosol Index separates dust and smoke but urban haze (sulfate aerosol) can be mis-identified as smoke

OMPS: Aerosol Index separates absorbing aerosol (dust and smoke) from scattering aerosol (sulfate aerosol).

Sensor Synergy

- GEO-LEO/GEO-GEO
  - Common algorithms across Advanced Baseline Imager (ABI) instruments flying on multiple geostationary satellites and VIIRS instruments on JPSS
    - Aerosols
    - Biomass burning emissions
    - Fires/Fire Radiative Power
  - Uniformity required for these products that are used to initialize models that forecast aerosols and air quality.
  - Product generation from direct broadcast (DB) data
  - Use of multiple sensors in decision support systems (e.g., use of DNB to monitor night-time smoke plume transport)

NOAA Cal/Val web: VIIRS aerosol information and gridded AOT

http://www.star.nesdis.noaa.gov/smcd/emb/viirs_aerosol/index.php

Products page has a link to FTP site for data download

Document links to ATBD, user's guide, etc.

Software to display VIIRS aerosol products and convert data to MODIS-like EOS HDF format are available for download

Latency for daily global gridded product availability is 1-2 days

NOAA STAR CENTER FOR SATELLITE APPLICATIONS AND RESEARCH

National Oceanographic & Atmospheric Administration website

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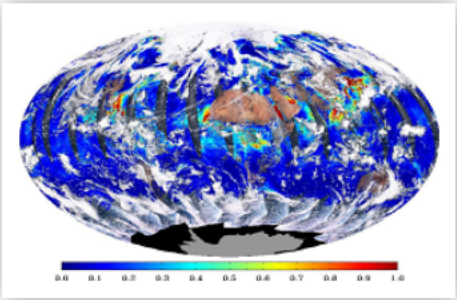
STAR / SMCD / VIIRS Aerosol Calibration and Validation

VIIRS AEROSOL | GRIDDED DATA | AOT MOVIE | SOFTWARE

Aerosol from SNPP/VIIRS

The Visible Infrared Imaging Radiometer Suite (VIIRS) sensor onboard the Suomi National Polar-orbiting Partnership (SNPP) satellite provides a key set of aerosol Environmental Data Records (EDRs) based on daily global observations from space. These products are:

- **Aerosol Optical Thickness (AOT)**, providing a measure of the aerosol content of the atmospheric column,
- **Aerosol Particle Size Parameter (APSP)**, given as the Ångström Exponent (AE), a qualitative measure of particle size with larger AE corresponding to smaller particles, and vice-versa,
- **Suspended Matter (SM)**, indicating the presence of dust, smoke, sea salt, volcanic ash above a threshold amount.



Global high quality AOT EDR at 550 nm on May 22, 2013. True color (RGB) image is provided as background to show the absence of retrievals due to cloud, sunglint and bright surface.

More information on these products is available from the Products page. Detailed instructions on how to access the data from their official archive location at the NOAA Comprehensive Large Array-data Stewardship System (CLASS) are provided in the subpages of the Products page.

Global gridded aerosol optical thickness

The operational VIIRS 550-nm AOT EDRs at nominal 6-km resolution, and collected during a 24-h period, are gridded at STAR on a regular 0.25 x 0.25-degree equal angle (~28x28 km at the equator) grid.

[illegible] daily gridded AOTs can be displayed from the Gridded Data page. The gridded data can also be downloaded from the

Summary

- The JPSS Proving Ground program is working with NOAA users to further promote the use of SNPP data for operational use.
  - Use of fire location and radiative power in regional fire and smoke models
  - Assimilation of VIIRS aerosols and land products in NCEP global models
  - Assimilation of VIIRS snow fraction and ATMS snow information in hydrological models.
  - Better utilization of CrIS/ATMS soundings by forecasters
  - Improved use of VIIRS, ATMS and AMSR-2 for nowcasting imagery.
  - Better assimilation of CrIS in NCEP models
  - Use of CrIS and ATMS is regional models via direct broadcast

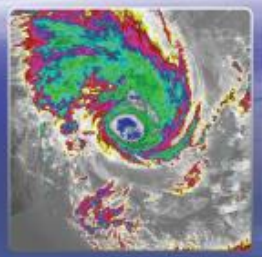
Want to learn more?

- 2013 and 2014 Annual Science Digests 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

JPSS

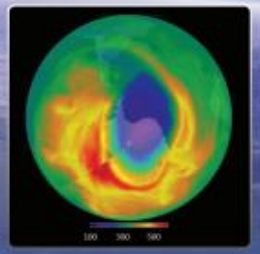
JOINT POLAR SATELLITE SYSTEM

The next generation of polar-orbiting environmental satellites



Advanced weather prediction instruments

High-resolution weather monitoring



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