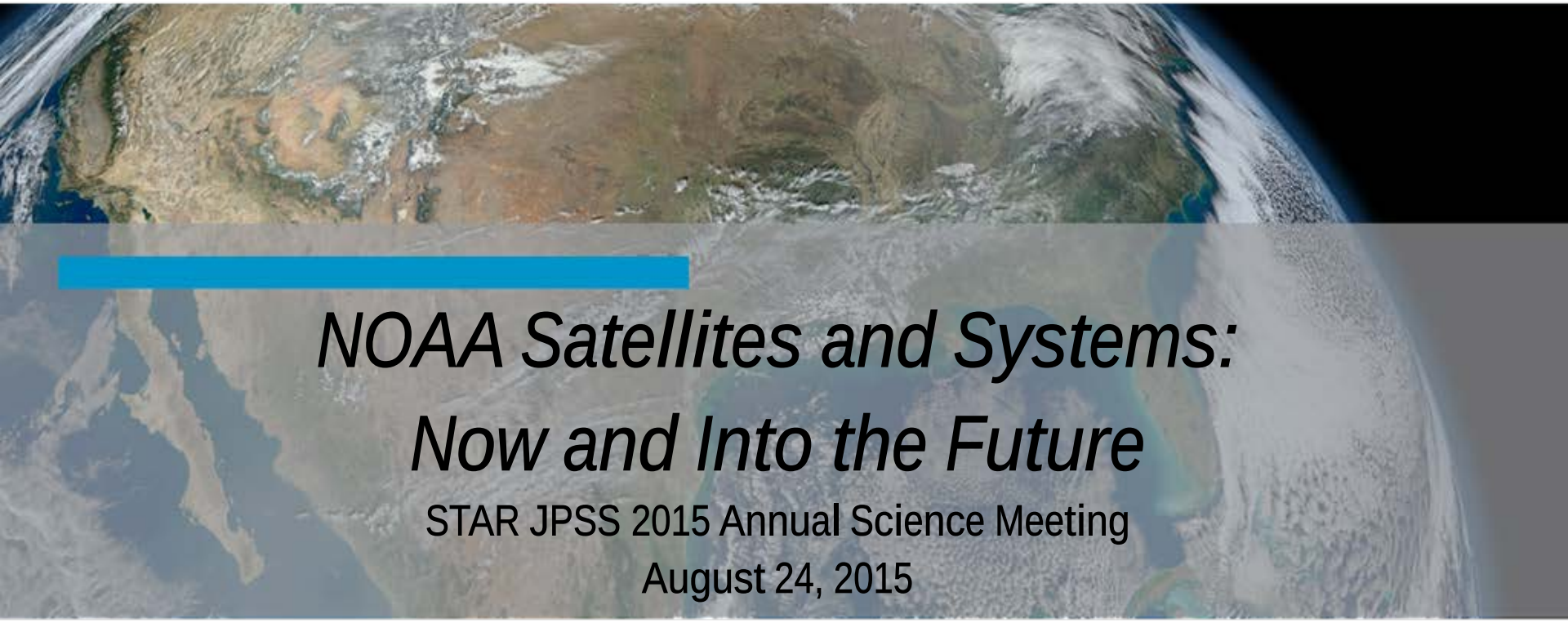


NOAA Satellites and Systems: Now and Into the Future

STAR JPSS 2015 Annual Science Meeting

August 24, 2015

NOAA Satellite and Information Service

Dr. Stephen Volz, Assistant Administrator

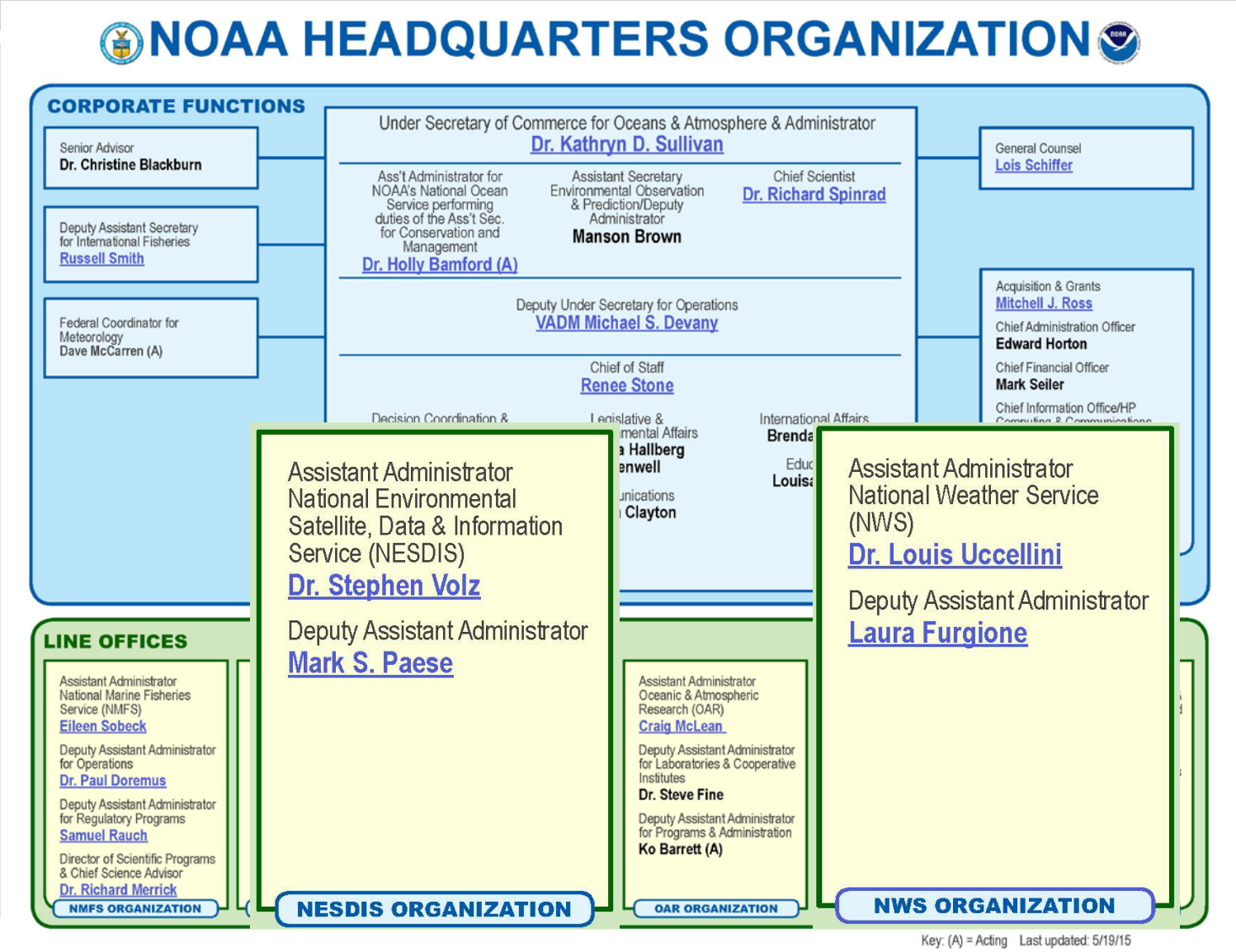
Supporting NOAA's Mission

NOAA is a science-based services agency engaged with the entire Earth system science enterprise.

NOAA's Top Four Priorities:

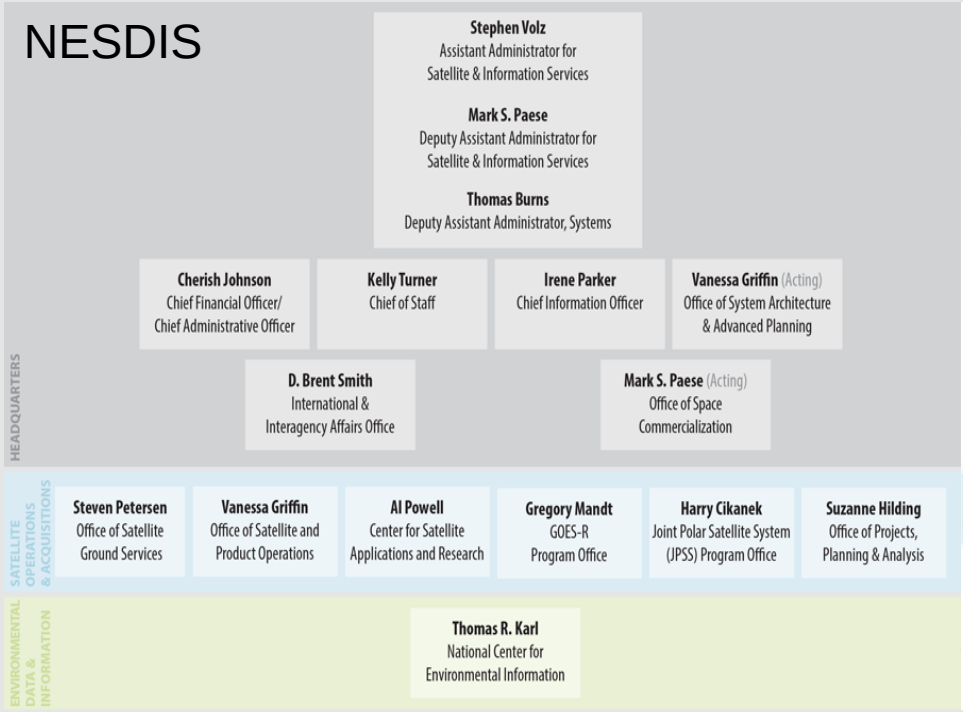
1. To provide information and services to make communities more resilient
2. To evolve the National Weather Service
3. To invest in observational infrastructure
4. To achieve organizational excellence

Supporting NOAA's Mission

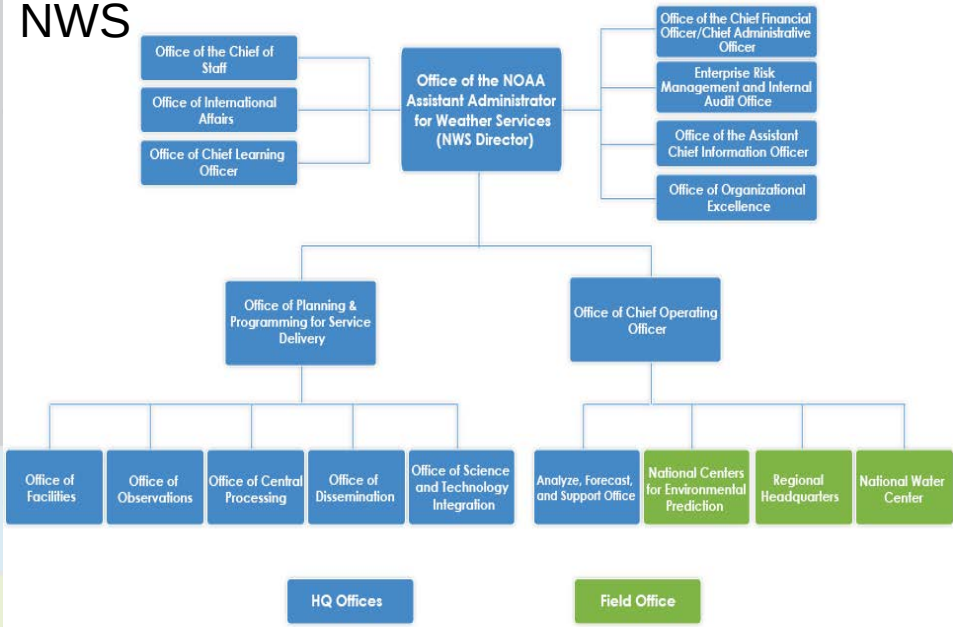


Supporting NOAA's Mission

NESDIS



NWS

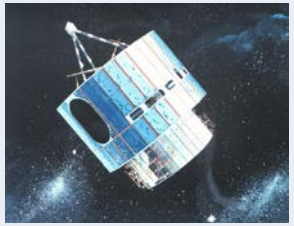


NESDIS works particularly close with NWS to ensure we meet the Weather Service data flow needs

- Acquires and manages the Nation's operational environ
- Operates the NOAA National Data Centers
- Conducts related research.

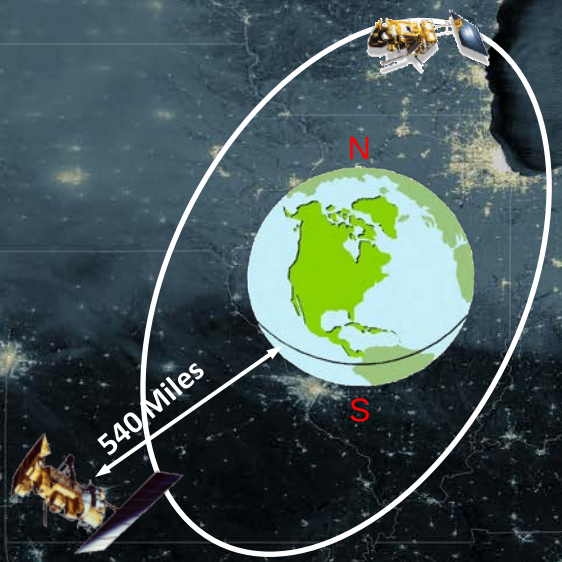
NESDIS satellite and data information is critical within NOA

Weather Observations Have Seen Several Transitions

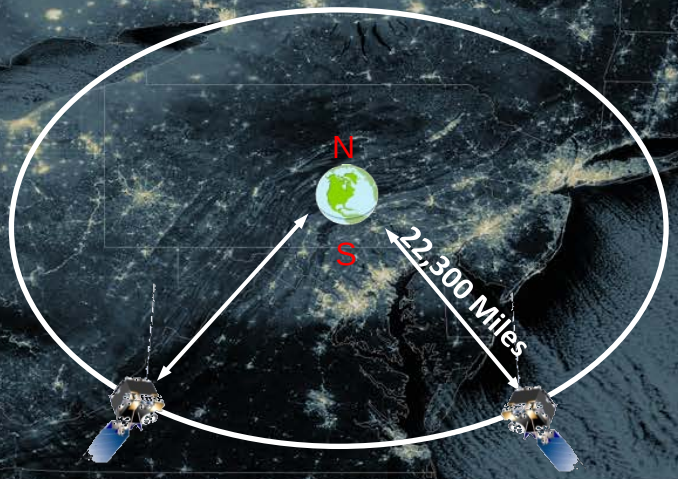
1960	1980	2000	2020	2040
Tiros-1 launch in April 1960. 48º inclination. Nimbus-1 launch in Aug. 1964. First infrared sensor. Tiros-9 launch in 1965. "Cartwheel configuration." First polar orbit.	NOAA-6 launch in June 1979. First AVHRR. NOAA-8 launch in March 1983. Physically larger and had more power than their predecessors	NOAA-15, 16, 17. Heavier and more microwave channels. NOAA-18, 19 Direct orbit insertion. JPSS development. NOAA + EUMETSAT IJPS agreement Nov. 19, 1998.	JPSS series operational. 22 channel imager. Next-gen CrIS & ATMS.  Jason-2/3 COSMIC-2 GNSS RO EON-MW	
GOES-1 launch in 1975. 	GOES-I (GOES-8) launch in 1994. GOES-I through –M. Three-axis stabilized. First independently operating sounder and imager. GOES-10 launched as on-orbit spare.	GOES-N/O/P operational. Imager and Sounder with flexible scan control.  GOES-R development.	GOES-R through –U operational. Himawari 8 Next-gen ABI. First lightning mapper from GEO. Next generation development	

NOAA's Observational Paradigm Has Been: Two Orbits, One Mission

Polar-orbiting Operational Environmental Satellites (POES) Followed by S-NPP and JPSS-1 thru -4



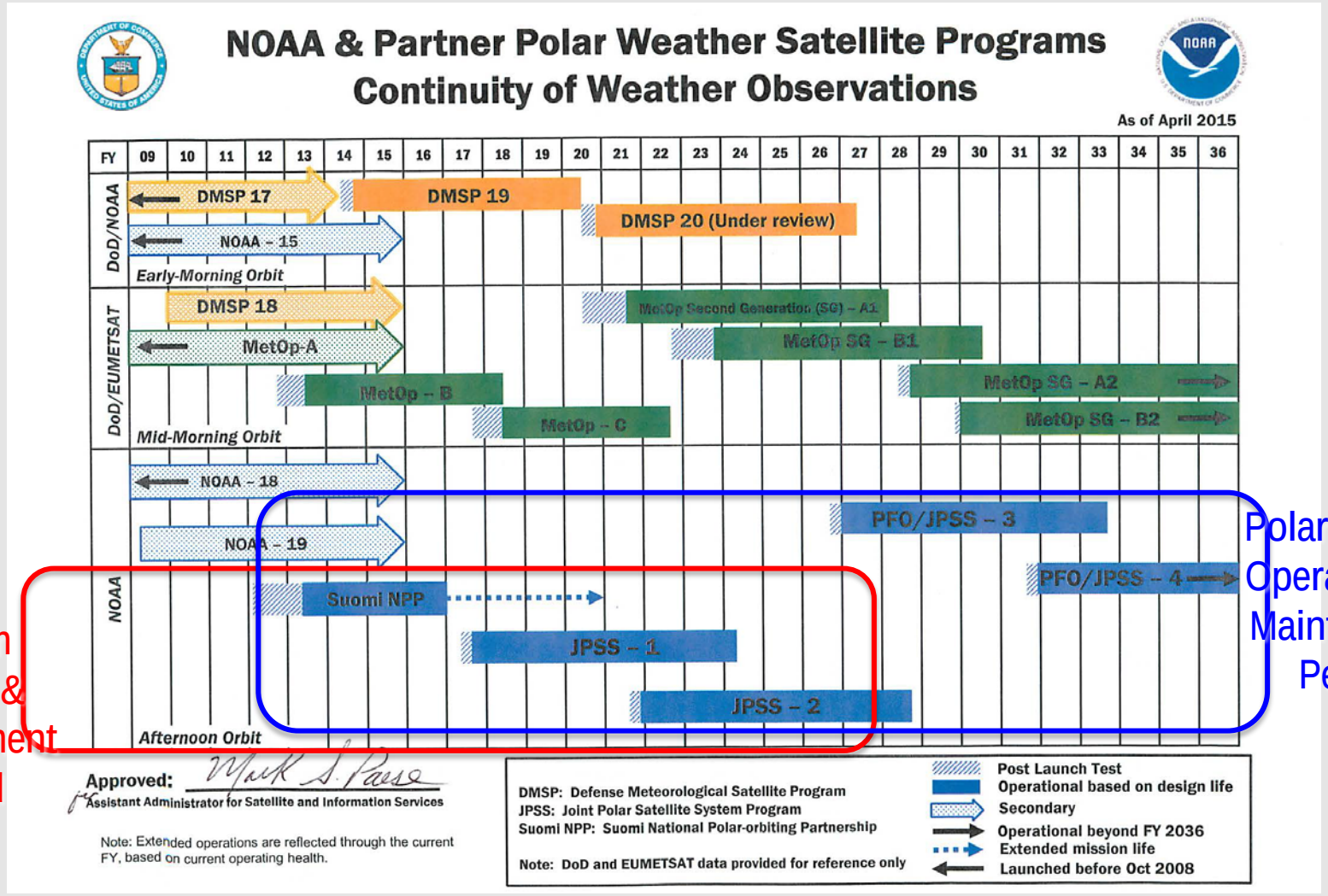
Geostationary Operational Environmental Satellites (GOES), Followed by GOES-R thru -U



NOAA/NASA

S-NPP image of North America

Polar Flyout Chart



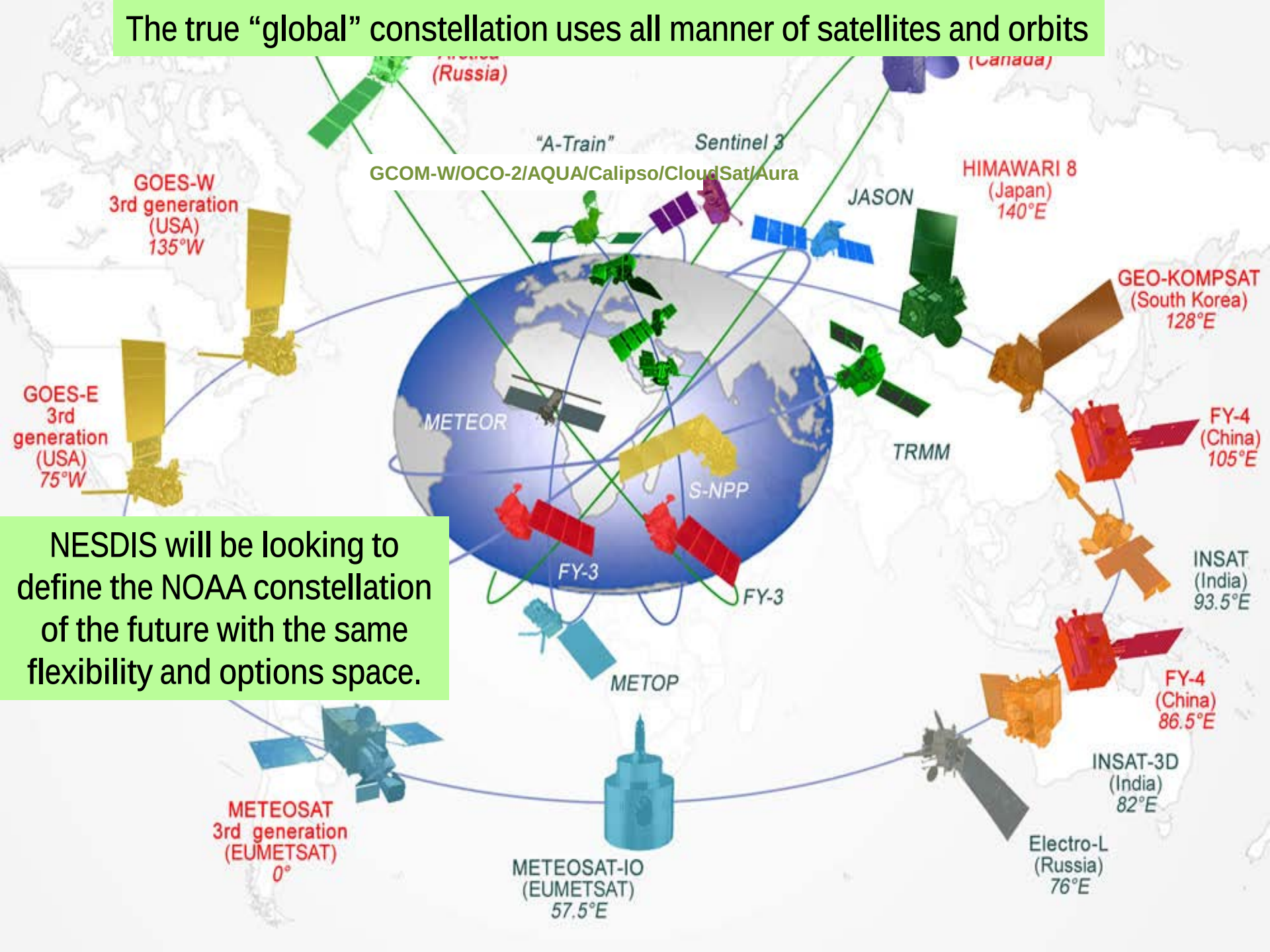
Polar System Design & Development Period

Polar System Operations & Maintenance Period

Our Observations Involve Much More than NOAA

- NASA and ESA research satellites
- DOD, EUMETSAT & JMA operational satellites
- EC Sentinel satellites

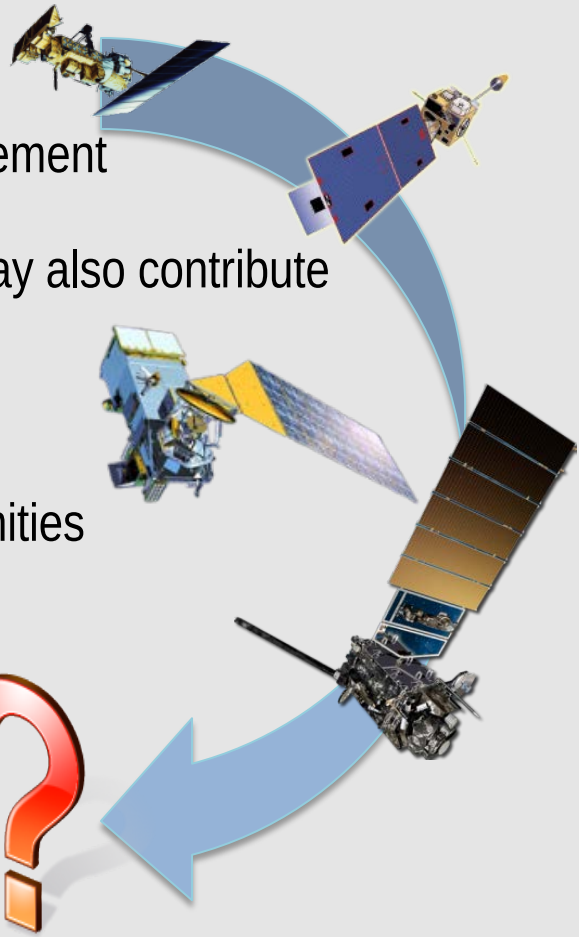
The true “global” constellation uses all manner of satellites and orbits



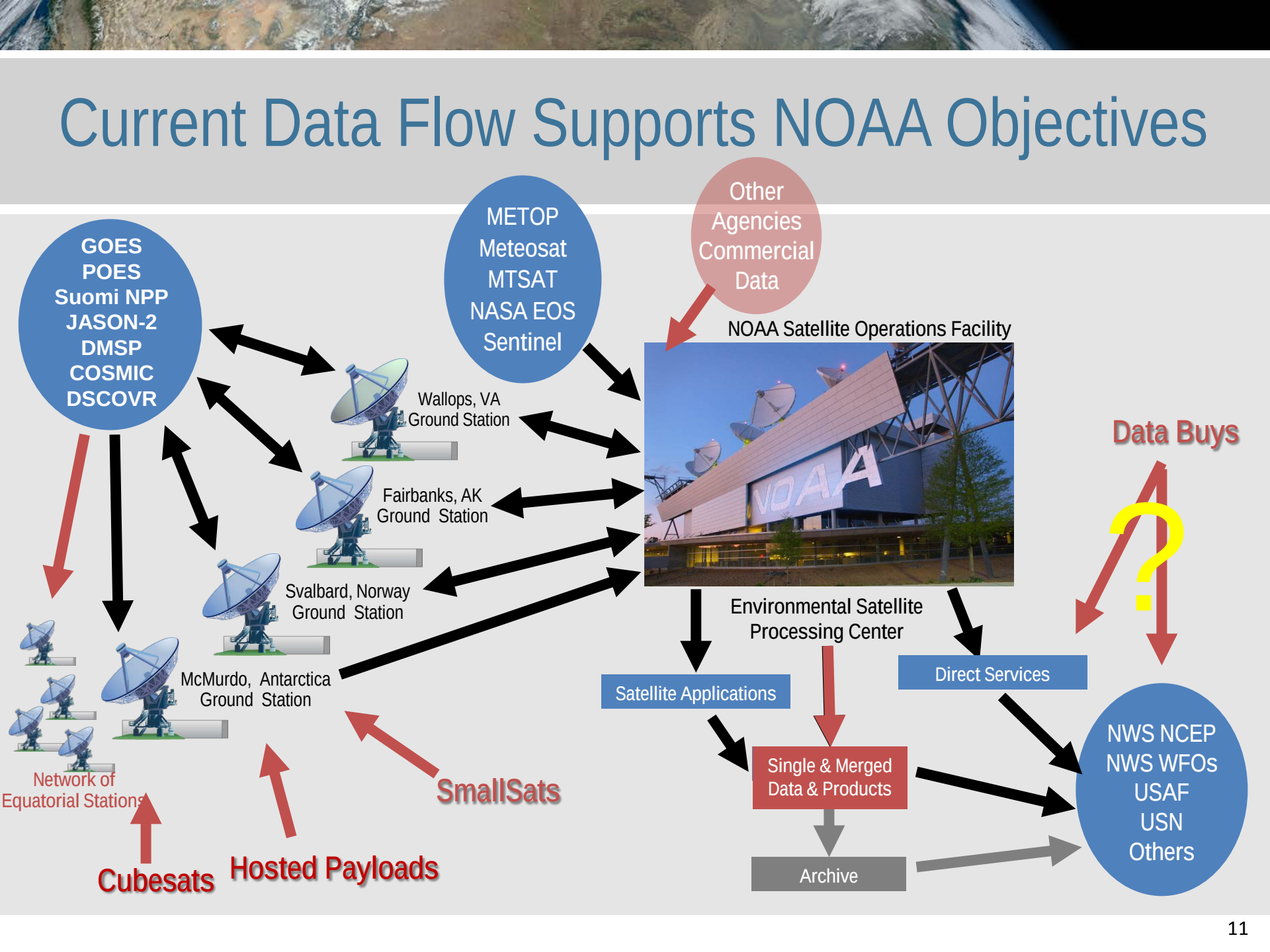
NESDIS will be looking to define the NOAA constellation of the future with the same flexibility and options space.

What's Next? Moving Beyond "Two Orbits"

- We are broadening our "polar satellite" LEO perspective
  - Core POES/JPSS satellites through ~2038 augmented with:
    - Cosmic-2 RO mission, Earth Observing Nanosatellite-MW
    - Additional complementary evolving and emerging measurement capabilities, from NASA and elsewhere
    - Smallsats or hosted payloads, alone or in constellation, may also contribute
- We will also broaden our GEO perspective
  - GOES-R series through ~2036, possibly augmented with:
    - Alterative architectures, including hosted payload opportunities
    - Possibly to include alternative orbits
- Increasingly, the services we provide will be driving towards more integrated data products, merging:
  - Across platforms, both LEO and GEO
  - Across Agencies, using observations from multiple sources
  - Across public-private domain



Current Data Flow Supports NOAA Objectives



Achieving the New NESDIS Architecture

"Develop a space-based observing enterprise that is flexible, responsive to evolving technologies, and economically sustainable"

-FY15 NOAA Annual Guidance

- This will be implemented with a Paradigm shift affecting all aspects of NESDIS
  - NESDIS to develop plan for transition to future in FY15
  - Conduct Analysis of Alternatives, Build Architecture Options in FY15–16
  - Conduct Concept Development Studies, Technology Risk Reduction in FY17+ (budget permitting)

- We seek an End-to-End Solution, considering all elements of the Earth Observing System
  - Focus the space observation constellation to achieve flexibility, leverage technology, and achieve greater efficiencies
  - Establish Enterprise Ground to maximize efficiencies, minimize complexity, and reduce cost both in the ground system and in the development of operational data products
  - Establish program management and integration structures to minimize overhead, simplify interfaces, and enable flexibility in execution and acquisitions
  - Establish Enterprise Architecture and Enterprise Systems Engineering and Integration as a core competency of NESDIS
  - Partner with NASA, other Labs, Industry, and Academia to leverage investments in science and technology to enable more frequent and predictable refresh opportunities

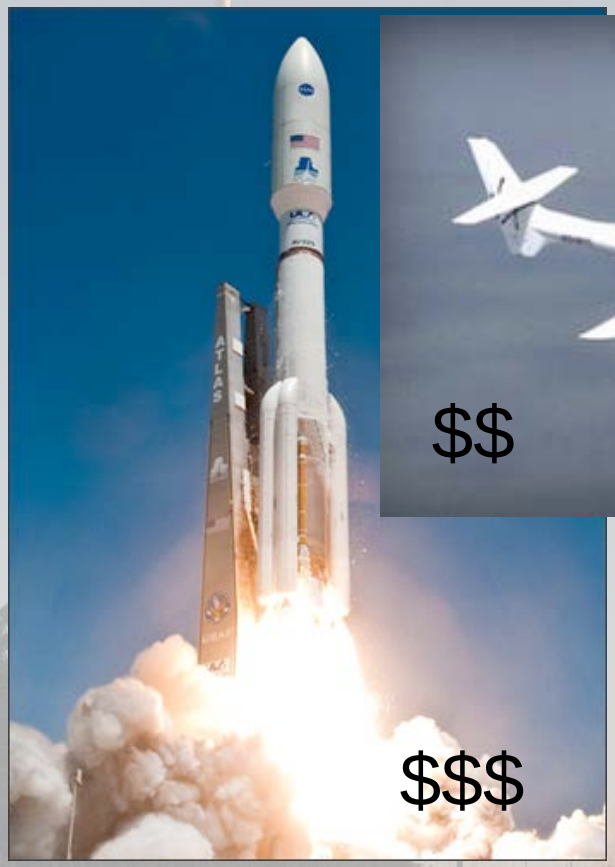
Implementation Characteristics for Architecture Studies

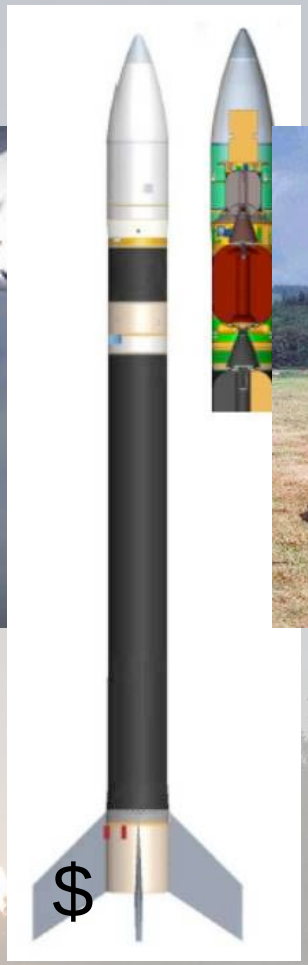
1. **Comprehensive.**
   The trade space must consider a wide range of possible options and solutions and not be anchored on the single satellite multiple measurement paradigm.
2. **Requirements Driven.**
   The studies must include an aggressive and comprehensive look at the requirements definition *AND* prioritization upfront and throughout. This area will require a broad NOAA and Administration commitment.
3. **Affordability.**
   We must consider the satellite and system end-to-end cost and technical readiness at the start and throughout the study, not only as a late activity assessment, to ensure we are building best value into the system.
4. **Traceable & Transparent.**
   We need to be transparent with our approach and execution, with pre-planned engagement activities with all NOAA LOs, within the USG (OMB, OSTP, NASA, DOD), and with the public (industry, users, customers) throughout the iterative study. The level of details shared and included will vary, but the spirit of engagement must be consistent.

What Community Changes Could Change Our Operating Paradigm?

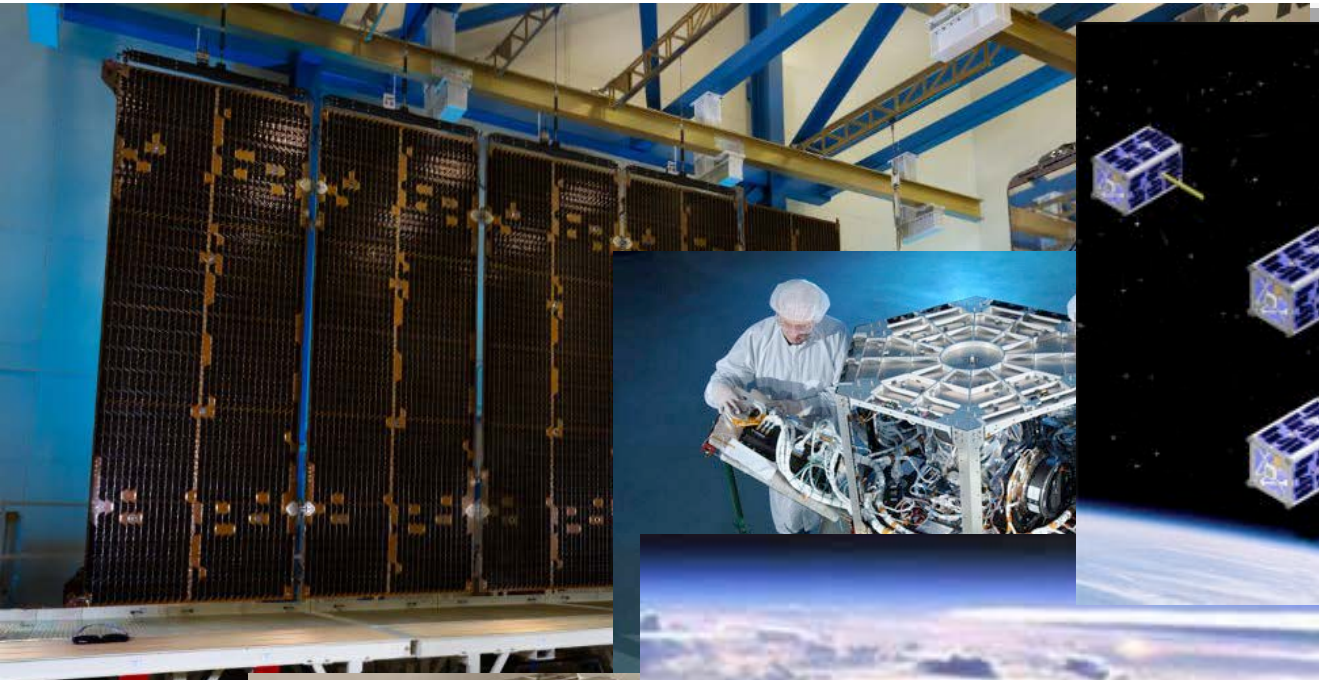
- Access to space
- Satellite technologies
- Data Integration, Quality, Ownership, Continuity

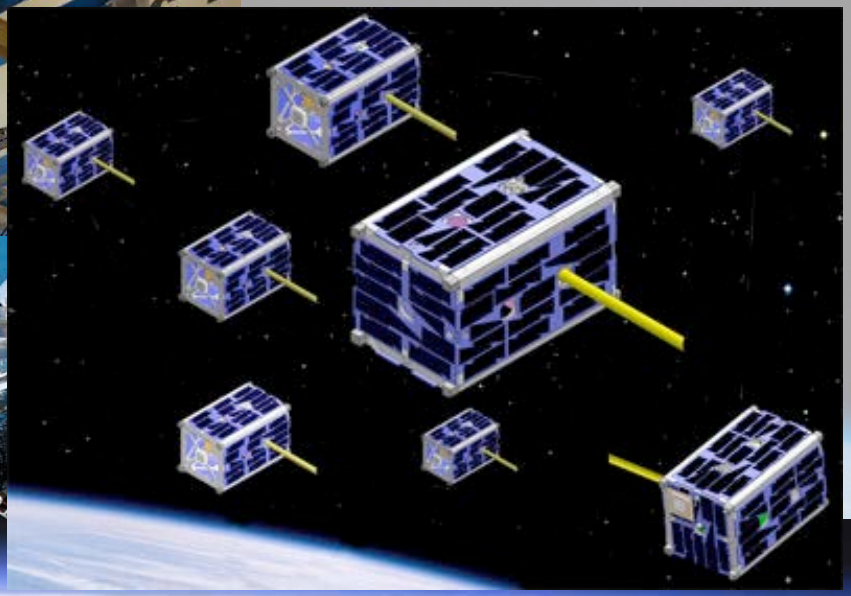
Access to Space

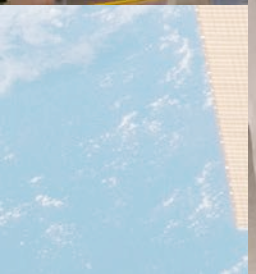


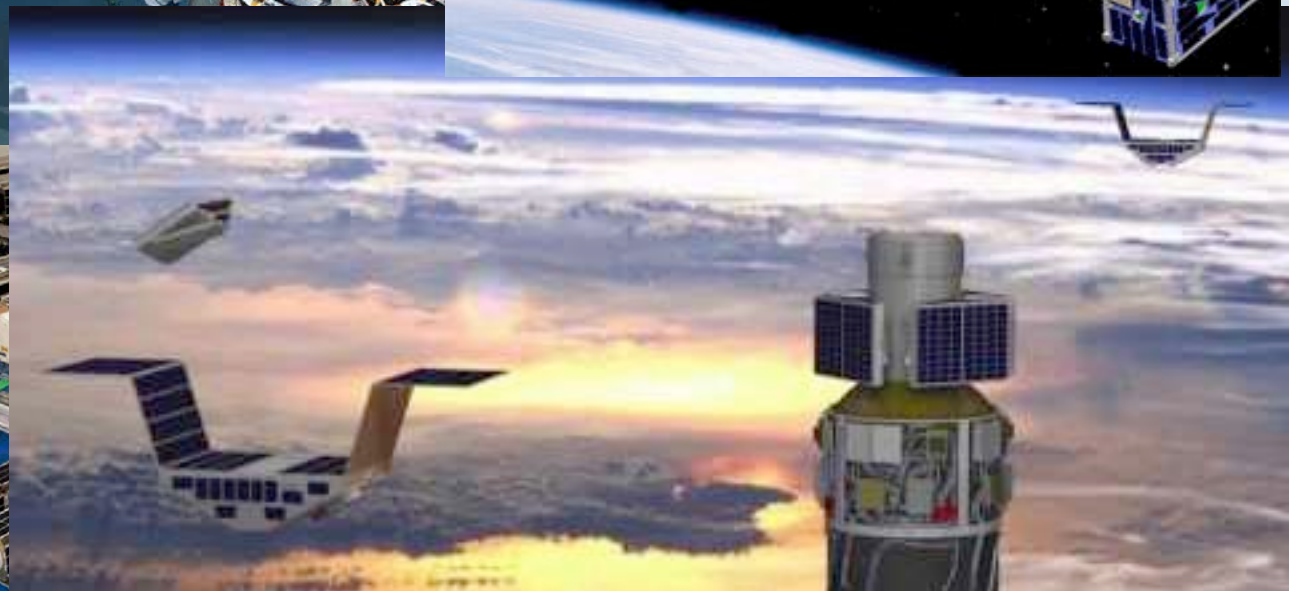


Satellite Technologies

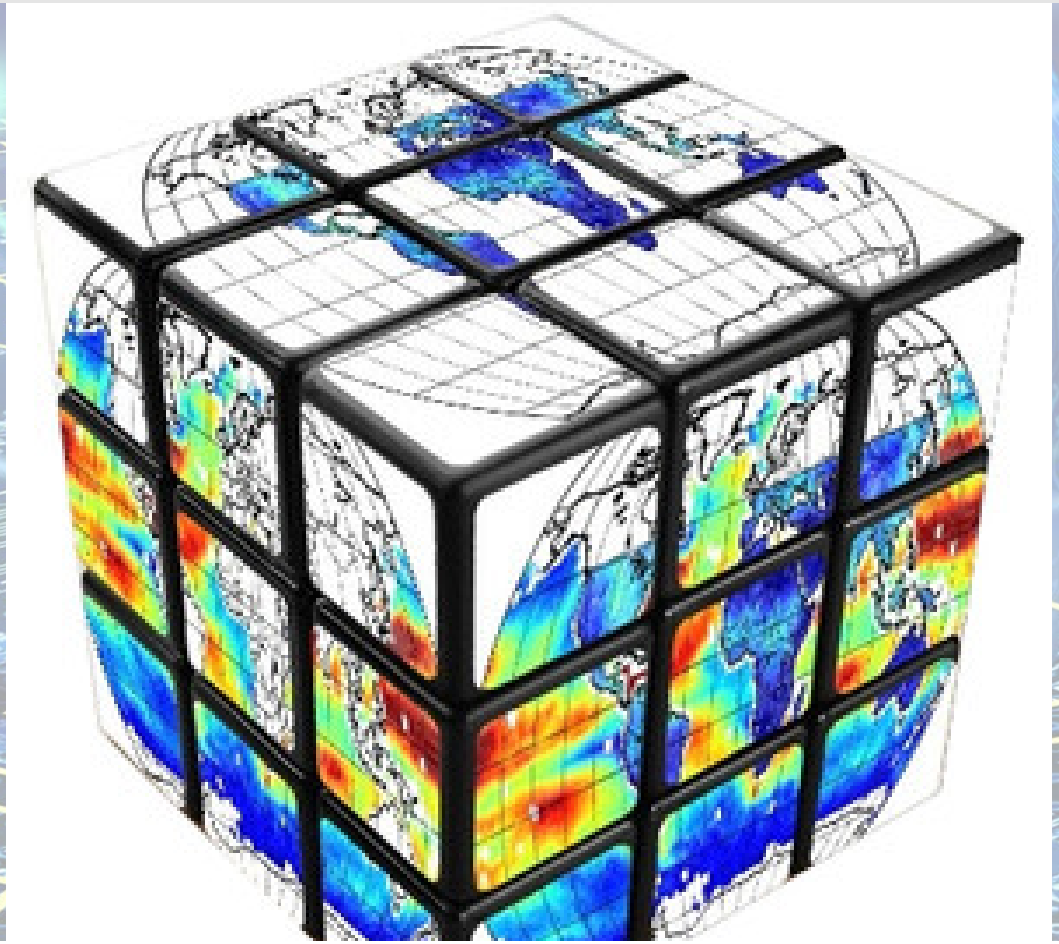








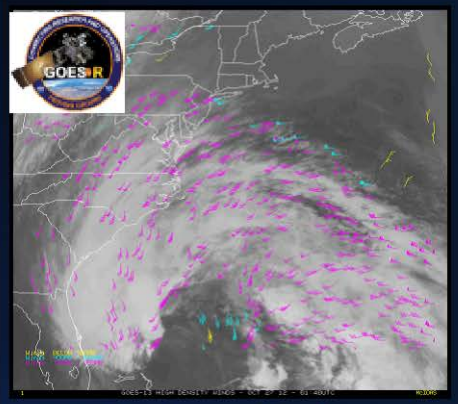
Data Integration, Quality, Ownership, Continuity



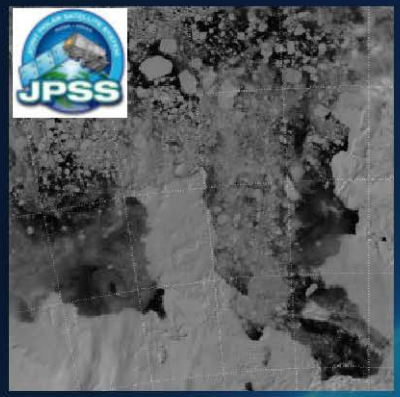
Ultimately most of our products fuse different data sets, so we need to be able to do that fusion efficiently and reflexively, regardless of where the data come from, and with confidence that the fusion will produce reliable information

Satellite Proving Ground

Supporting demonstration and utilization of new capabilities by the end users
Facilitating the transition of GOES-R and JPSS to operations
Incorporating user feedback for product improvements

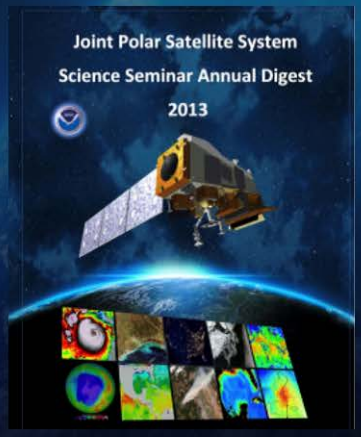


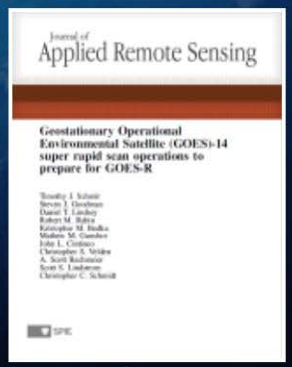
Hurricane Sandy-
GOES High Density
Atmospheric Motion Vectors



S-NPP Day/Night Band
Ice Detection

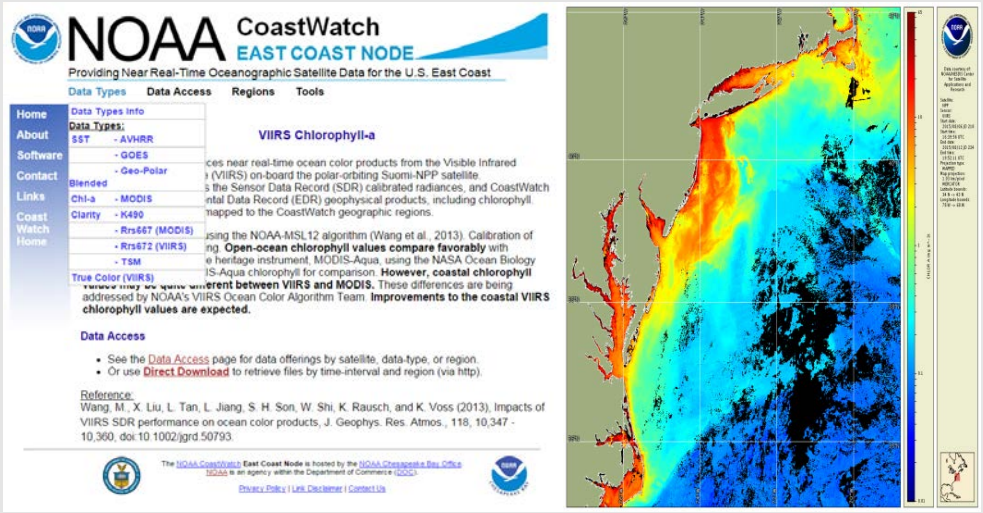
NOAA Hazardous Weather Testbed (HWT)

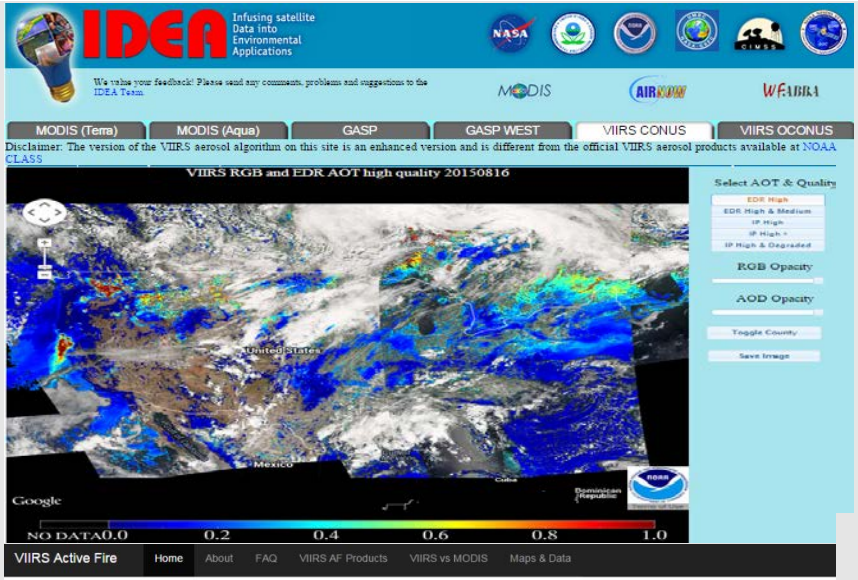


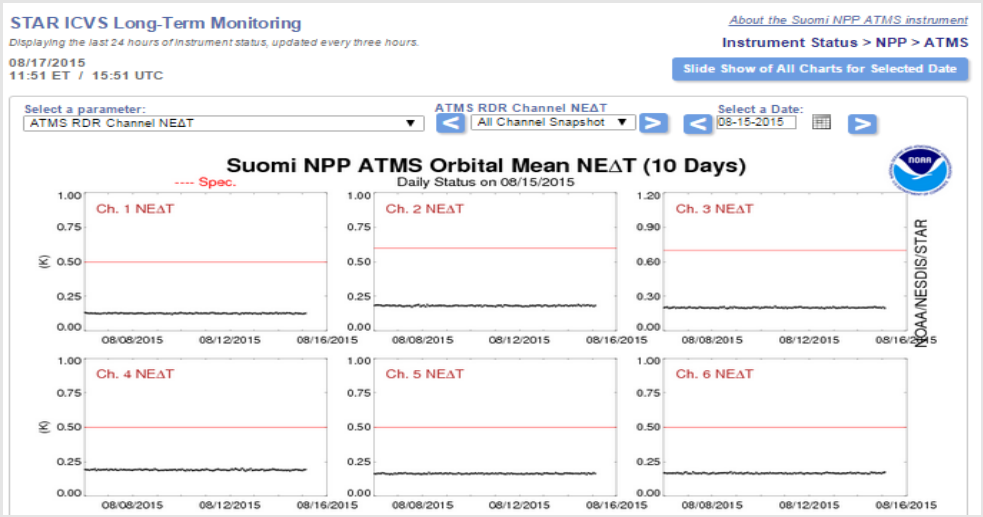


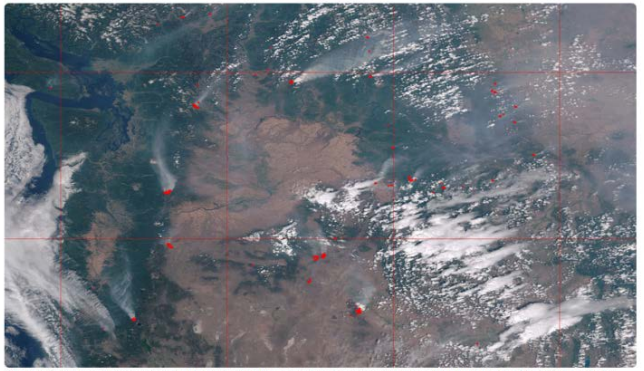
http://www.goes-r.gov/users/proving-ground.html

Visualization and interacting with data is important









Fire activity shows no slowing down in the western states and this is reflected in the true-color image captured by VIIRS yesterday (August 13th) at 1:15pm, local time. In fact, the National Interagency Fire Center (NIFC) in Boise, Idaho, announced yesterday morning that the National Fire Preparedness Level would be increased to 5, the highest level and not seen since 2013. The M-band image (bands 5-4-3) and fire detections shows the many active fires and smoke emissions in the northwest. The most active, currently, include the Cougar (lower-left), Wolverine (center-left), Soda (lower-right), and the North Boulder 2.

Active Fire Team

Ivan Csiszar
Chris Justice
Louis Giglio
Evan Ellicott
Wilfrid Schroeder
Krishna Vadrevu
Antonio Sanchez

Links

JPSS
VIIRS
University of Maryland
NOAA
NOAA-STAR

NASA-Developed Example: Giovanni

Giovanni (Geospatial Interactive Online Visualization and Analysis Interface) is an interactive data analysis tool, that can provide data visualization and download in minutes upon providing data space, time, and parameter specification

Exploratory Data Analysis

- Find
- Download
- Learn format

WRITE CODE

- Read
- Subset
- Quality Filter
- Summarize / Analyze
- Visualize

Main Analysis Phase

- Select Data
- Analyze
- Derive Conclusions
- Publish

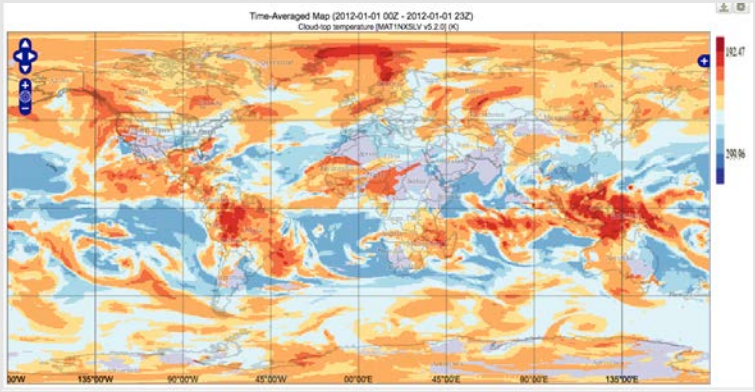
Giovanni provides *Quick-Start Exploratory Data Analysis:*

no coding necessary

Web-based Services

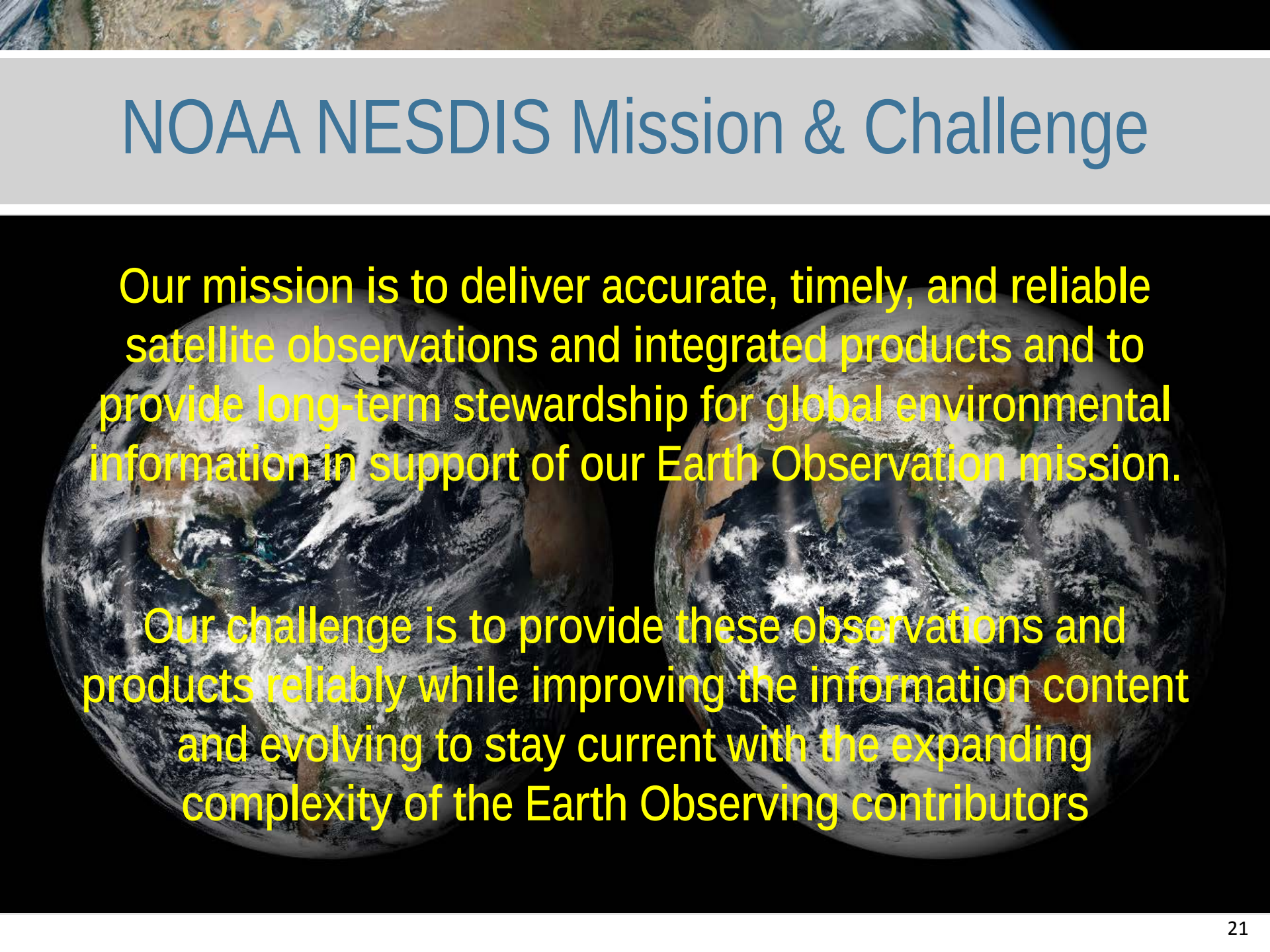
Giovanni

- Find
- Fetch
- Reformat
- Filter
- Regrid
- Summarize
- Visualize



From NASA/GES DISC

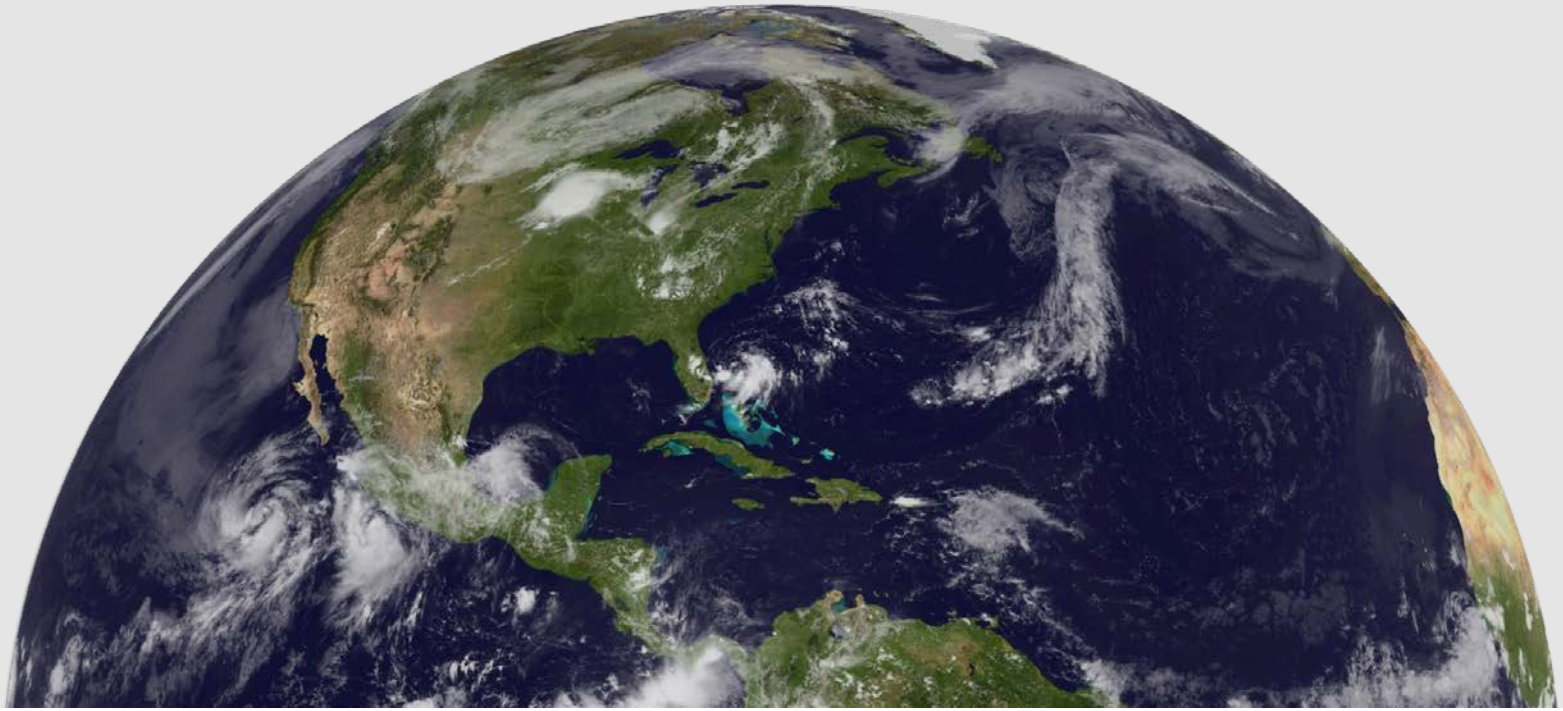
NOAA NESDIS Mission & Challenge



Our mission is to deliver accurate, timely, and reliable satellite observations and integrated products and to provide long-term stewardship for global environmental information in support of our Earth Observation mission.

Our challenge is to provide these observations and products reliably while improving the information content and evolving to stay current with the expanding complexity of the Earth Observing contributors

Questions?



NESDIS Center for Satellite Applications & Research

Present and Future Value

Mike Kalb, Acting Director

JPSS 2nd Annual Science Meeting

August 24, 2015

Center for Satellite Applications & Research

- *STAR provides NOAA-relevant applied research, development, and science services to accelerate the transition and transformation of raw satellite observations into operational information products that support environmental assessments and predictions by NOAA land, atmosphere and ocean user communities.*

  – Leads NESDIS research, development, validation and maintenance of satellite derived products and applications from NOAA's operational geostationary and polar-orbiting satellites and from non-NOAA research and international satellites

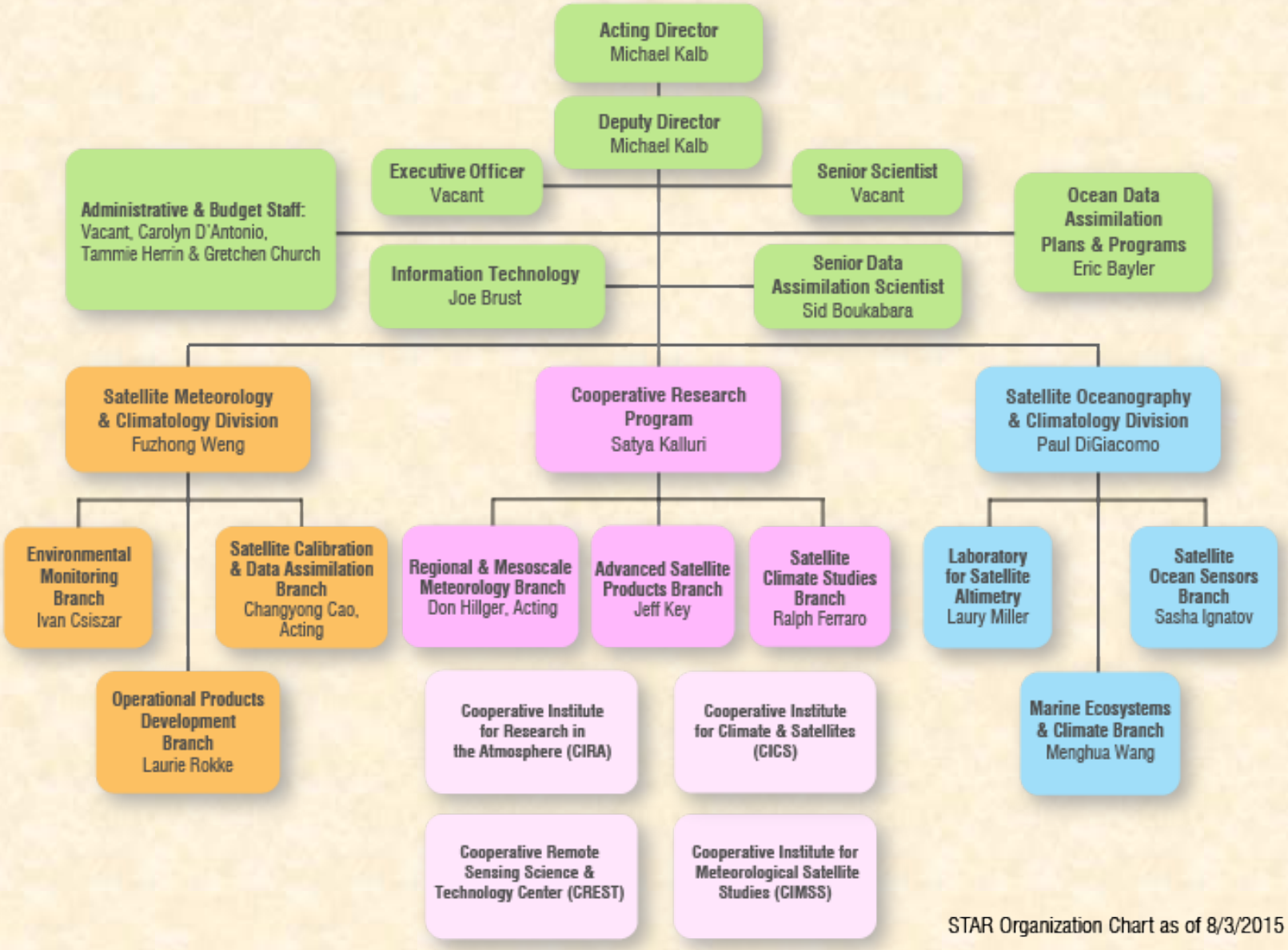
  – Develops new environmental applications, techniques and algorithms for transforming raw satellite observations into scientifically meaningful, quality assured and calibrated environmental measurements and products, and develops the pre-operational computer codes to implement them;

  – Supports the calibration and validation of all satellite sensors used in NOAA's satellite operations, develops methods and maintains systems for inter-calibrating NOAA satellite data with other agency and international satellites constellations.

  – Works with other NESDIS and NOAA offices, universities, NASA and other U.S. agencies, and with international organizations on exchange and evaluation of operational and research satellite data and products;

  – Interfaces with NESDIS and NOAA operational organizations to improve the use of satellite data in operations, accelerating the transfer of new techniques and new satellite data sources (domestic or foreign) into NOAA operations to improve environmental prediction.

STAR Organization



STAR Organization Chart as of 8/3/2015

Major STAR Mission Commitments

- JPSS Algorithm and Data Products, Cal/Val
- GOES-R Algorithm Working Group (AWG)
- GOES-R Calibration/Validation Working Group (CWG)
- Joint Center for Satellite Data Assimilation (JCSDA)
- Community Radiative Transfer Model (CRTM)
- Calibration / Validation (ICVS, NCC, WMO/GSICS)
- Satellite Altimetry support to JASON-x series

The Mission Side - STAR Science Services

4.1	**Science & Product Systems Development**
4.1.1	Scientific algorithm & product systems development
4.1.2	Calibration / validation systems development
4.1.3	Software and Algorithm Integration
4.1.4	Configuration control and change management
4.1.5	Quality Assurance
4.2	**Science & Product Services**
4.2.1	Requirements development and analysis
4.2.2	Scientific algorithm & applications research, prototype development, testing, and validation
4.2.3	Risk Reduction & Proving Grounds
4.2.4	User Readiness
4.2.5	Product Improvement

4.3	**Instrument & Product Calibration /Validation**
4.3.1	Development, coordination and execution of instrument and product Cal/Validation techniques, technologies & activities;
4.3.2	Interagency and international cal / val program coordination
4.3.3	Cal/Val campaigns
4.4	**Science Project & Program Management**
4.4.1	Program and Project level mission science leadership and coordination
4.4.2	Science Team Management & Support
4.4.3	Organization and coordination of internal and / or external science working groups, review boards, & advisory services
4.5	**Post Launch Science Maintenance**
4.5.1	Science algorithm and instrument performance monitoring
4.5.2	Satellite / instrument performance issues mitigation services
4.5.3	Calibration updates and algorithm changes needed to ensure product quality or correct for anomalies or artifacts
4.6	**Long Term Monitoring**
4.6.1	Product Monitoring and long term error assessment
4.6.2	Reprocessing of long term data to ensure highest quality

5

STAR Provides Mission Life-Cycle Science Support

Requirements	Instrument Build and Design	Pre-Launch	Post-Launch	Operations and Sustainment
Requirements Definition	Design Requirements	Research to Operations (R2O)	Acceptance Testing	Lifecycle R2O
Product Research, Test, and Evaluation			Science Maintenance	
	Instrument Calibration	Calibration / Validation		
		Instrument and System Checkout		Product Improvements

TIME

6


Arctica
(Russia)
PCW
(Canada)
"A-Train"
Sentinel 3
GCOM-W/OCO-2/AQUA/Calipso/CloudSat/Aura
HIMAWARI 8
(Japan)
140°E
GOES-W
3rd generation
(USA)
135°W
JASON
GEO-KOMPSAT
(South Korea)
128°E
GOES-E
3rd
generation
(USA)
75°W
METEOR
TRMM
FY-4
(China)
105°E
S-NPP
INSAT
(India)
93.5°E
FY-3
FY-3
METOP
FY-4
(China)
86.5°E
INSAT-3D
(India)
82°E
METEOSAT
3rd generation
(EUMETSAT)
0°
METEOSAT-IO
(EUMETSAT)
57.5°E
Electro-L
(Russia)
76°E

Satellite Strategies in Transition

PRESENT

PAST	FUTURE
Calibrate **individual instruments**	Inter-calibrate **multiple instruments globally**
Develop **independent LEO & GEO Algorithms**	Develop **common algorithms for GEO and LEO instruments**
Develop **individual products**	Develop **product suites and blended products**
Transfer algorithms to **NESDIS/OSPO**	Transfer algorithms to **NESDIS/OSPO & International & non-gov't partners**
Address **internal NOAA** requirements	Participate in **multiple US and international collaborations**
Study climate using **single instruments**	Study climate using **overlapping chains of instrument data**
Assimilate data from **individual satellites**	Assimilate data from **suites of satellites**
Manage projects for **Principal Investigators**	Manage algorithm deliveries to **entire acquisition programs**

Strategic Mission R&D Priorities
Bridging Present and Future

Development of technical methods among NOAA, allied agencies and communities of practice to ensure **traceable calibration and inter-calibration process standards among remote observing sensors, platforms and systems** necessary for NOAA to maintain long term consistency among remote sensing satellite and in situ observations and for **establishing and validating continuous, reliable and well-characterized global and regional Environmental Data Records across current, past and future generations of observing systems.**

Integrated Observing Systems and Data Fusion – Development of internally consistent multi-variate, and multi-scale 4D environmental state descriptions (initially atmospheric and surface state variables) to provide improved situational awareness for forecasting and other decision support, **based on adaptation of advanced dynamical-mathematical optimization methods employed in NOAA's hydrodynamical prediction model data assimilation.**

Development of NOAA enterprise technical means for **leveraging non-NOAA domestic, and international satellite observations and capabilities** into service to NOAA's global and regional observing missions and operational decision support needs.

Development of **physically consistent satellite data products across orbits and sensors (e.g. "blended" GEO & LEO) enabled by adoption of universal standard channel selections**, further **enabling use of common scientific retrieval algorithms** that can be implemented more effectively within a single enterprise development, testing and processing framework **built on consistent physics, radiative transfer, and analysis utilities, and accelerated with consistent repeatable business processes.**

Organizational Perspectives

Requirements	**vs.**	**Needs (L0)**
Present Value		**Future Value**
• Defined by Boundaries		• Broader Mission Context
• Inward Focus by Design		• Externally Engaged
• Self Contained / Constrained		• Collaborative
• Motivated by Fear of Failure *but often perceived as Fear of Success*		• Motivated by Possibility
• Projects		• Programs

Ultimately, Needs have to Drive Requirements, or Organizations Struggle

Limitations as Excuses

If (lower Level) Requirements drive (higher level) Needs:

- Limitations Lead

When Limitations Lead, it is easier to:

- Defer Leadership
- Stop Investing and Innovating
- Stop Pursuing Excellence

Who Knows Why?

Limitations as Excuses

If (lower Level) Requirements drive (higher level) Needs:

- Limitations Lead

When Limitations Lead, it is easier to:

- Defer Leadership
- Stop Investing and Innovating
- Stop Pursuing Excellence

Why? It's not in the requirements

Balancing Past, Present and Future Making the Future

- Challenge recognizing and transitioning significant technical capabilities that may not meet official "requirements“, but none-the-less constitute important future strategic "needs”, and leveraging of investments made by NOAA and external partners.
- It is a discussion about *achieving excellence* and full value of the nation's investment in NOAA; long term / short term.
- It is about a *forward looking culture ... advanced skills and concepts*
- It is about creating *future value …. and a future*
- It motivates !

Backup

Excellence

Pursuit of Excellence

I. How does NOAA measure Excellence?

II. We are Excellent when others say we are excellent, not when we say.

Innovation Investment (***Assuring continuity of NOAA Excellence and Leadership***)

i. What we investment in communicates direction, Identity and brand

ii. Strategic IRD Equivalent

iii. Leverage Innovation Potential of Cooperative Institutes

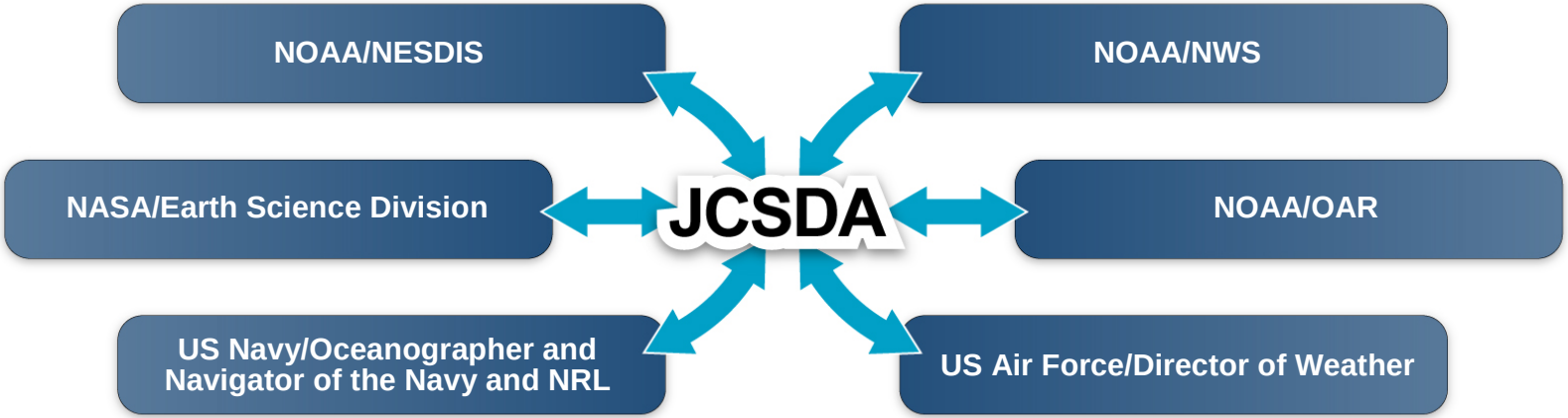
iv. High TRL, Strategic Importance, Maximum Leveraging of Investment,

Succession Investments

- Radiative Transfer
- Ocean Science Modeling
- Data Assimilation
- Science Data Systems
- Instrument Science & Engineering
- Science Liaison

Joint Center for Satellite Data Assimilation

The JCSDA was established in 2001 to improve and accelerate the use of research and operational satellite data in numerical weather, ocean, and climate analysis and prediction.



A major focus of the JCSDA is to contribute to making the forecast skill of the operational NWP systems of the JCSDA partners internationally competitive by assimilating the largest possible number of satellite observations in the most effective way

STAR's Contributions to the JCSDA

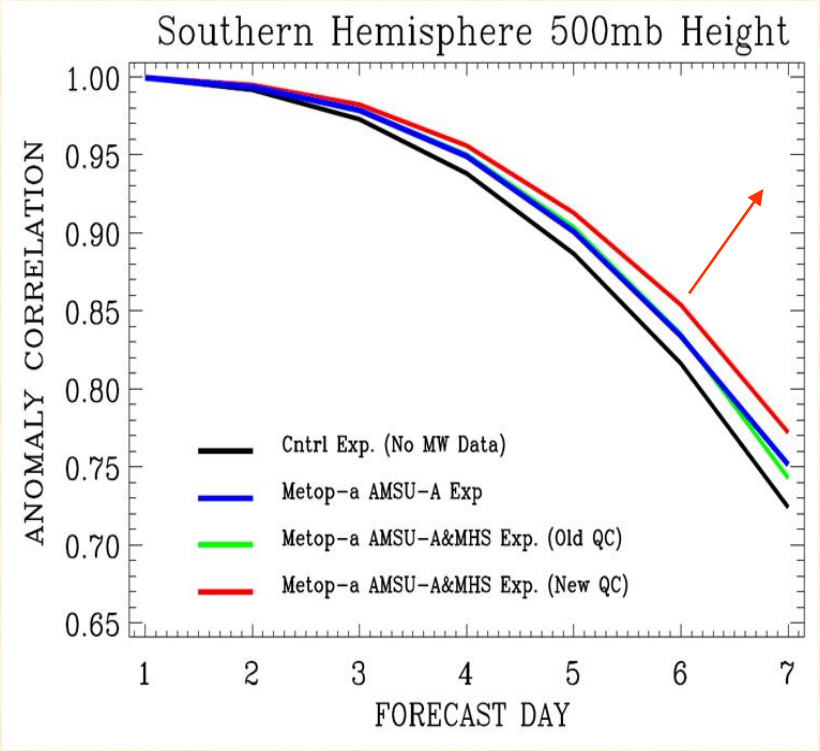
Community Radiative Transfer Model and Surface Emissivity modeling

Data assimilation of new sensors (AIRS, IASI, SSMIS, COSMIC)

Implementation of Cloudy Radiance assimilation

Data Impact Experiments: Observing System Simulation Experiments (OSEs, OSSE's)

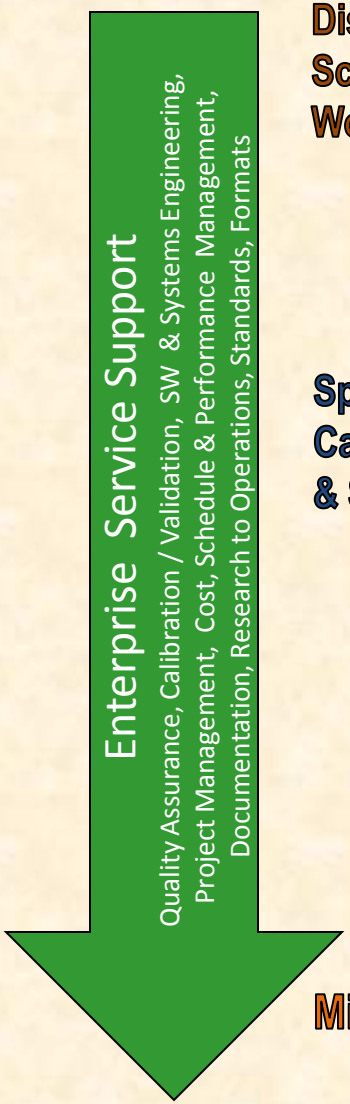
Improvement in the assimilation of existing sensors (new QC approach for Metop-A and POES data assimilation)



Example showing positive impact of Metop-A on global forecast skill

18

Center for Satellite Applications and Research (STAR)



Discipline Scientific Workforce

- Satellite Meteorology & Climatology Division
- Cooperative Research Program Division
- Satellite Oceanography & Climatology Division

Specialized Capabilities & Systems

- Level-2 Product Validation Tools — NOAA STAR
- GOES-R / JPSS Facility for Instrument Impacts — NOAA STAR, CIMSS
- NOAA Profile Validation System (NPROVS) — NOAA STAR, Int'l
- Integrated Calibration & Validation System (ICVS) — NOAA STAR
- Community Radiative Transfer Model / CRTM — NOAA STAR, Int'l
- Collaborative Processing Environment / SCDR — NOAA STAR
- NOAA Calibration Center (NCC) — NOAA STAR, NASA, NIST
- (GSICS) Global Satellite Intercalibration System — NOAA STAR, WMO, CEOS, Int'l
- Joint Center for Satellite Data Assimilation JCSDA — NOAA STAR, NCEP, NASA, USN, USAF

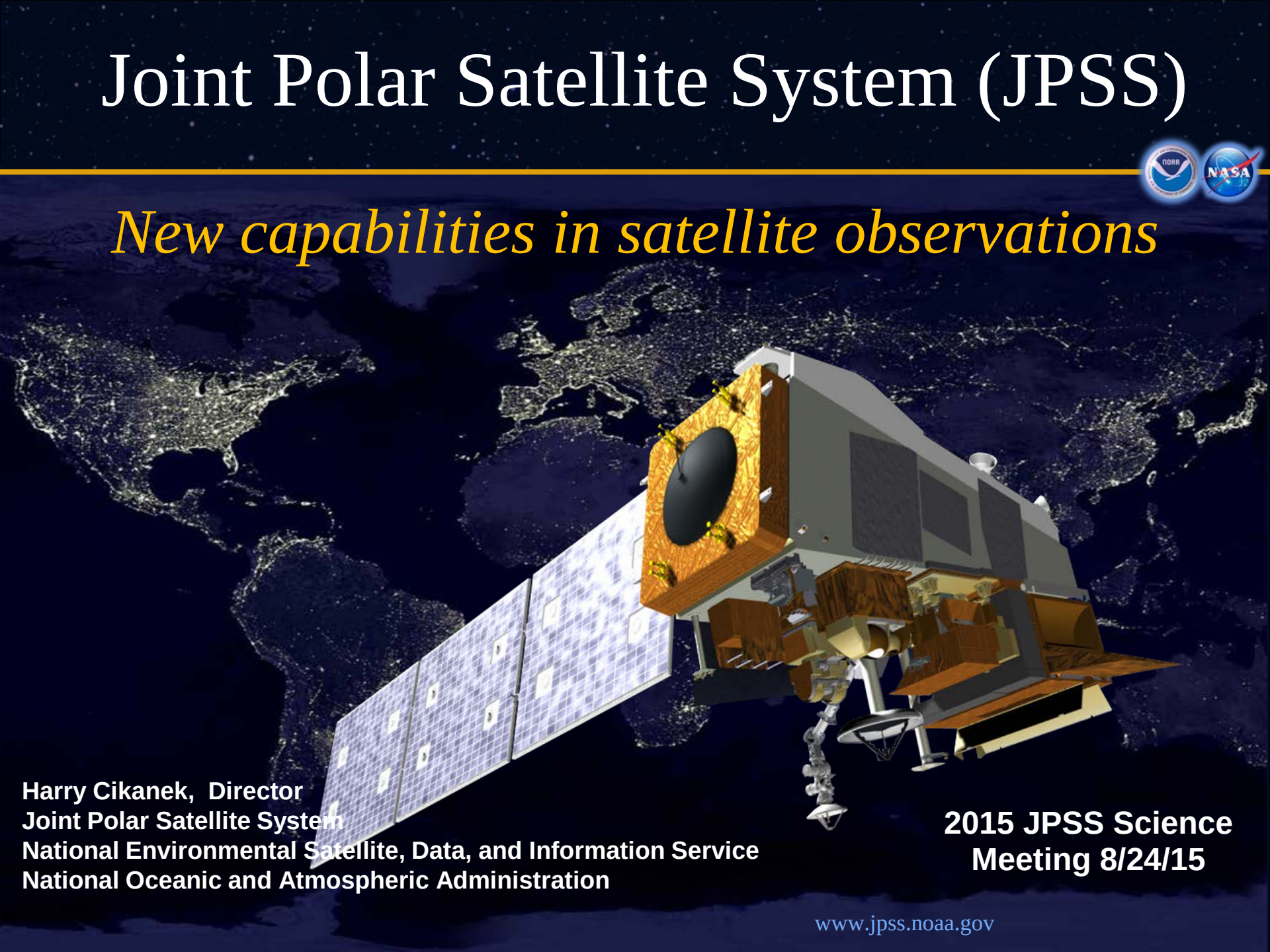
Missions

- NASA Decadal Survey
- NPP / JPSS
- GOES-R
- NOAA LEO / GEO
- JASON
- DMSP
- METOP
- International Constellations

U.S. and International Research Satellites Considered for Operational Use in NOAA

Joint Polar Satellite System (JPSS)

New capabilities in satellite observations



Harry Cikanek, Director
Joint Polar Satellite System
National Environmental Satellite, Data, and Information Service
National Oceanic and Atmospheric Administration

2015 JPSS Science Meeting 8/24/15

www.jpss.noaa.gov

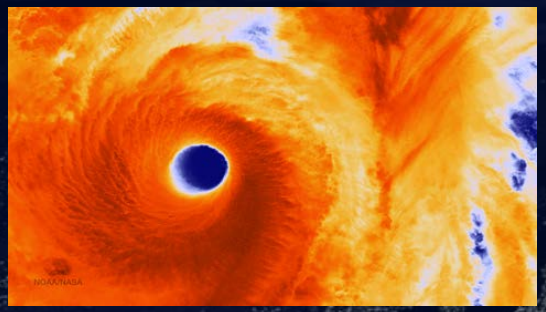
Why JPSS?
JPSS provides…

…the most critical data for numerical weather prediction to enable accurate 3-7 day ahead forecasts, giving high confidence to emergency managers in advance of severe weather events

…operational weather and environment satellite observations for Alaska and Polar Regions operational forecasting

…global coverage and unique day and night imaging capabilities in support of civilian and military needs

Without JPSS, the Nation will experience an immediate degradation in weather forecasting capability

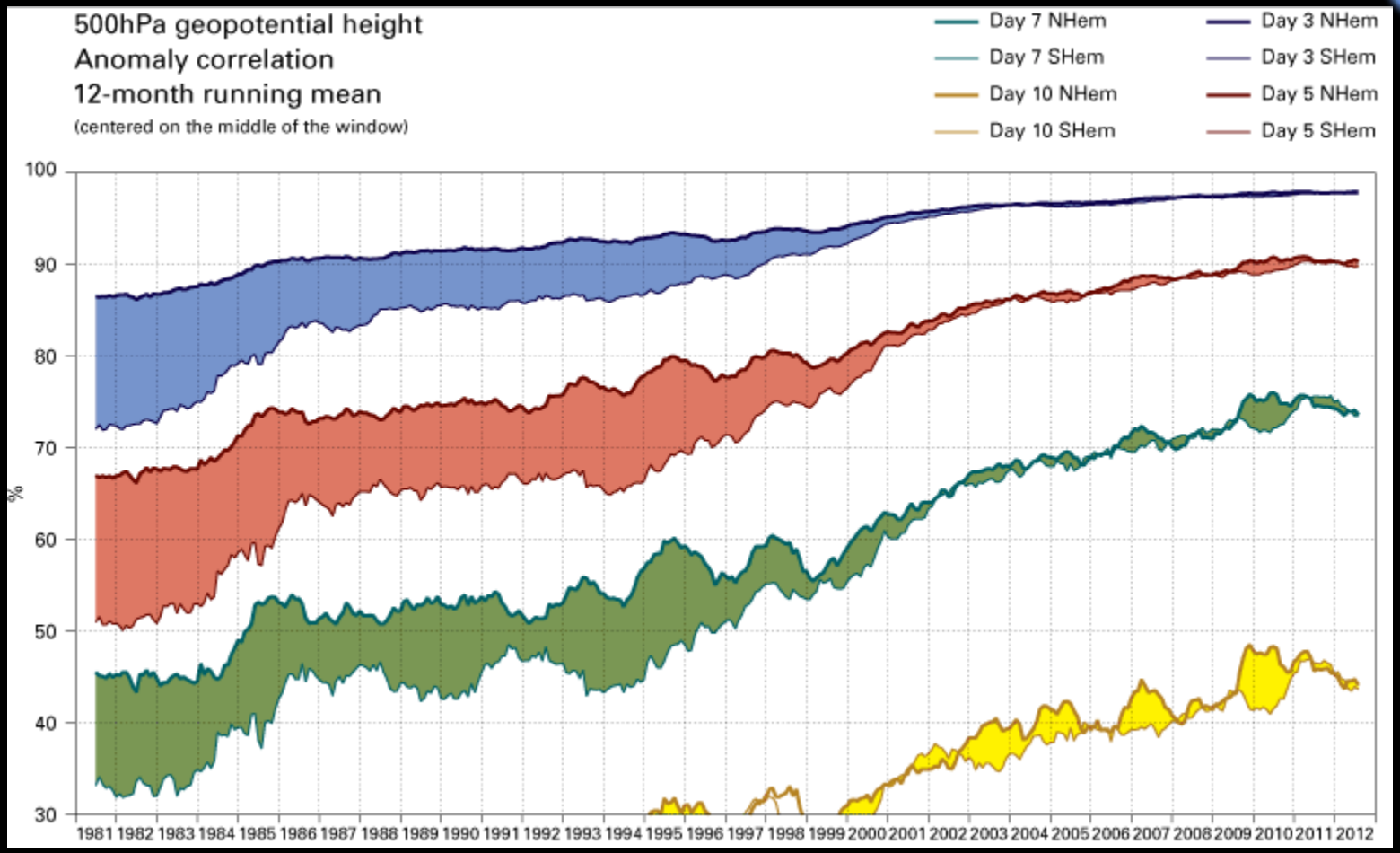


October 2014 - Vongfong IR

March 2015 - ice congests Chesapeake Bay

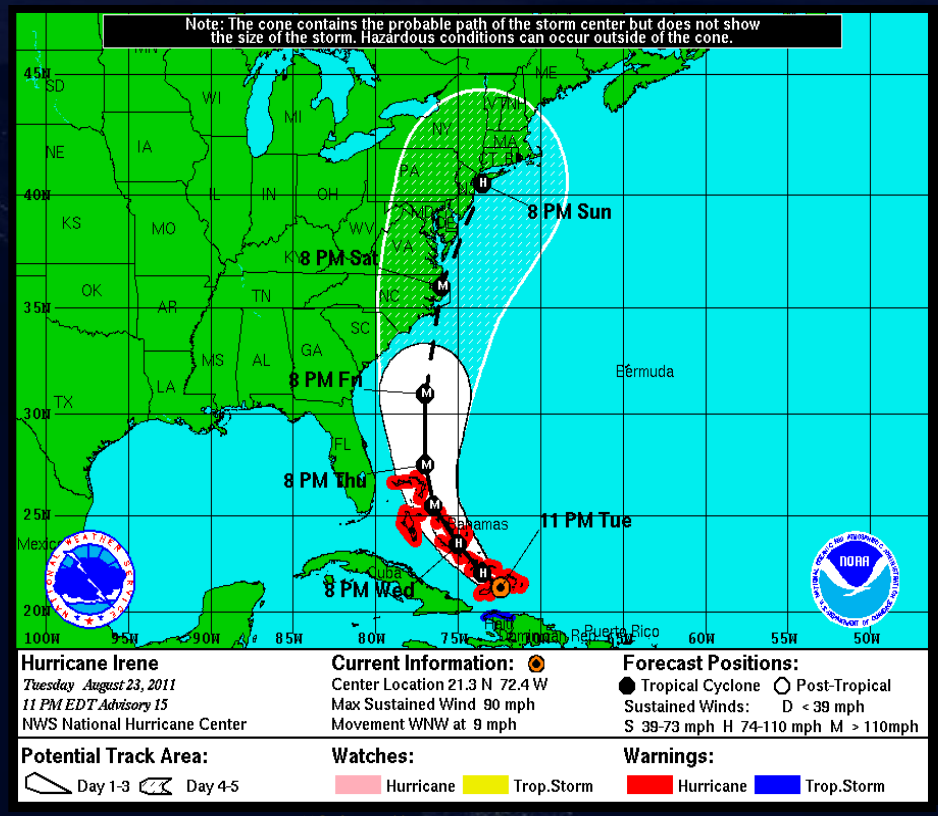
May 2013 - Tropical Cyclone Mahasen

Improvements in forecasting

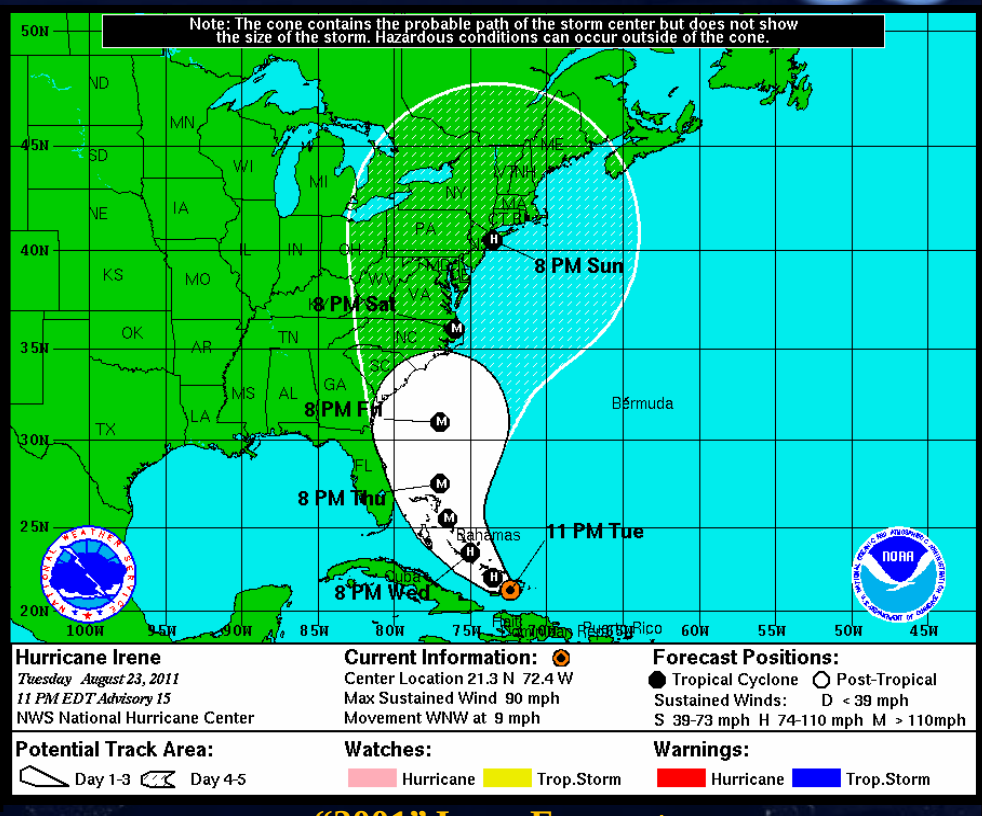


From ECWMF

JPSS: Supporting the Advanced Forecast Enterprise



"2011" Irene Forecast



"2001" Irene Forecast

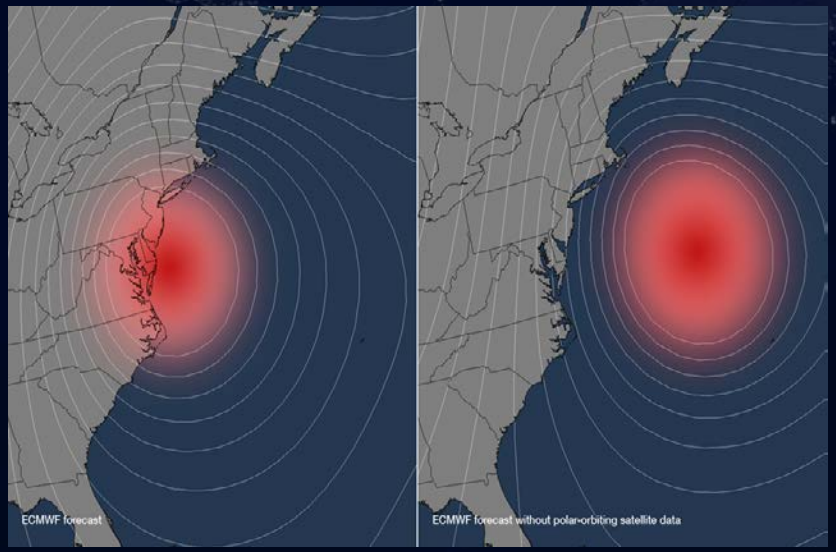
Advanced Forecast Enterprise

Observations + Models + Supercomputers + Expert Forecasters

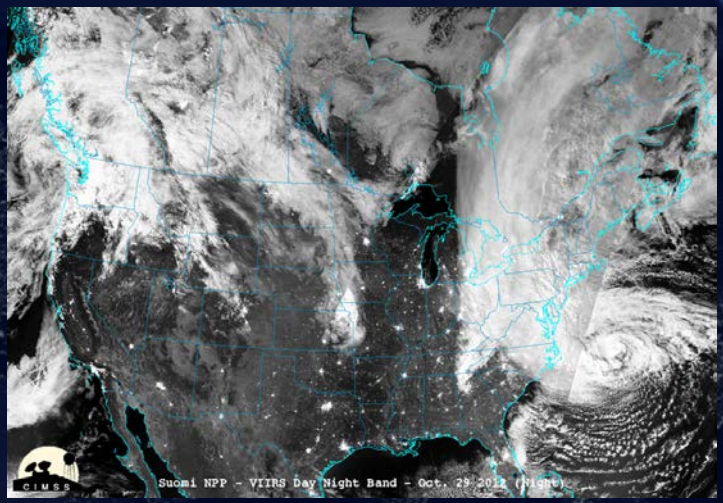
Without JPSS data in the models, Irene's path would have been less accurately predicted, resulting in more evacuations and greater economic impact to coastal communities

Hurricane Sandy

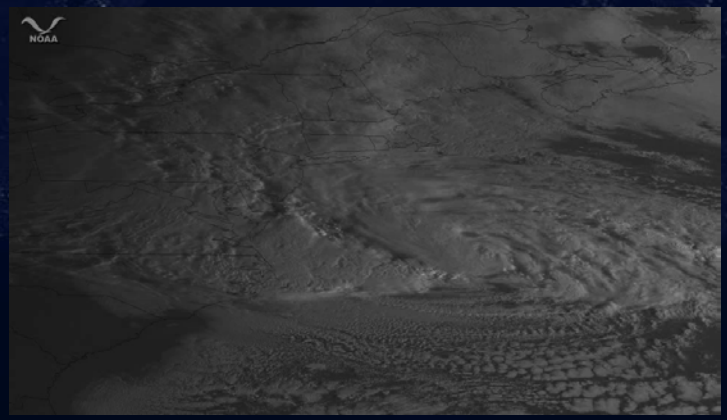
Measurements from polar satellites enabled forecasters to predict Sandy's infamous "left hook." Without this data, weather models would not have identified this left-hand turn and forecasts would have placed the storm out to sea.



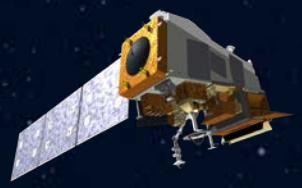
Hurricane Sandy's path with and without polar satellite data



Suomi NPP VIIRS Day/Night Band image of Sandy
Credit: CIMSS



NOAA satellite imagery reveals the intensity of the storm.
Credit: GOES-13



JPSS: Integral to 3-Orbit Global Polar Coverage

- JPSS implements U.S. Space Policy and international agreements to ensure:

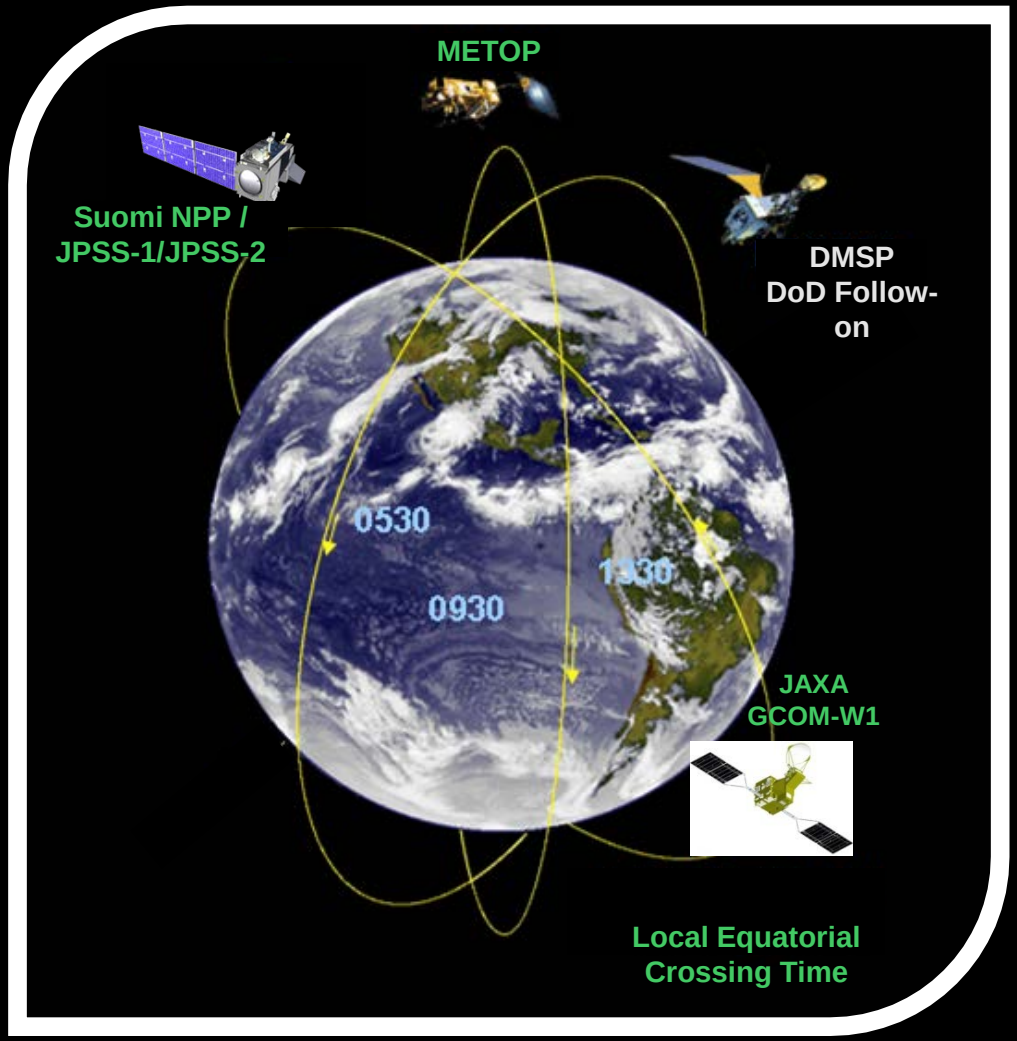
Global coverage Observational continuity for the afternoon orbit

- Orbits:

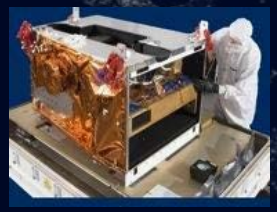
Early Morning: DoD
Mid Morning: EUMETSAT
Afternoon: NOAA

- 3-orbit coverage provides vast majority of data critical to 3-7 day ahead forecast and environmental monitoring

- JAXA provides microwave imagery



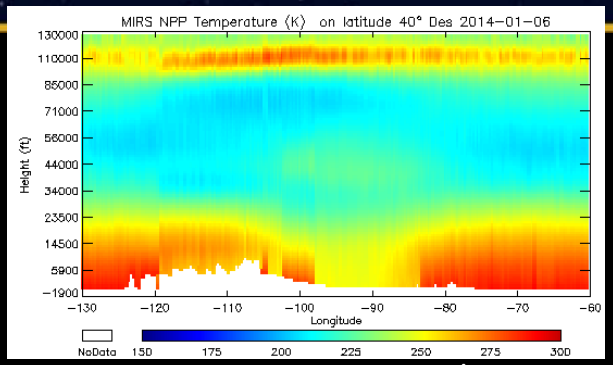
JPSS Instruments

JPSS Instruments		Measurements
	**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 (ERB)

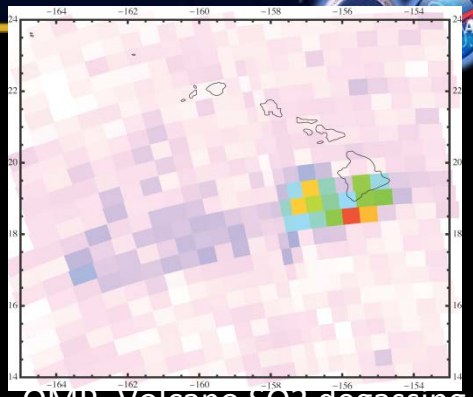
JPSS-1 Spacecraft

JPSS provides a wide range of capabilities

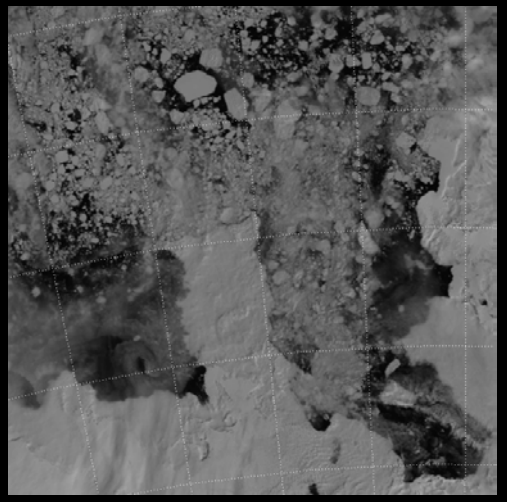
- Microwave – provides temperature and moisture soundings in cloudy conditions and rainfall rates, sea ice, snow, surface temperature
- Infrared – provides high vertical resolution temperature and moisture soundings in clear and cloud corrected regions; atmospheric chemistry - CO, CH4, SO2, … and cloud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

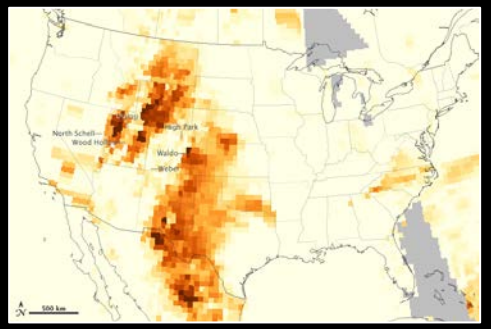


Temperature X-Section Polar Vortex


OMP- Volcano SO2 degassing


Algae in Lake Erie

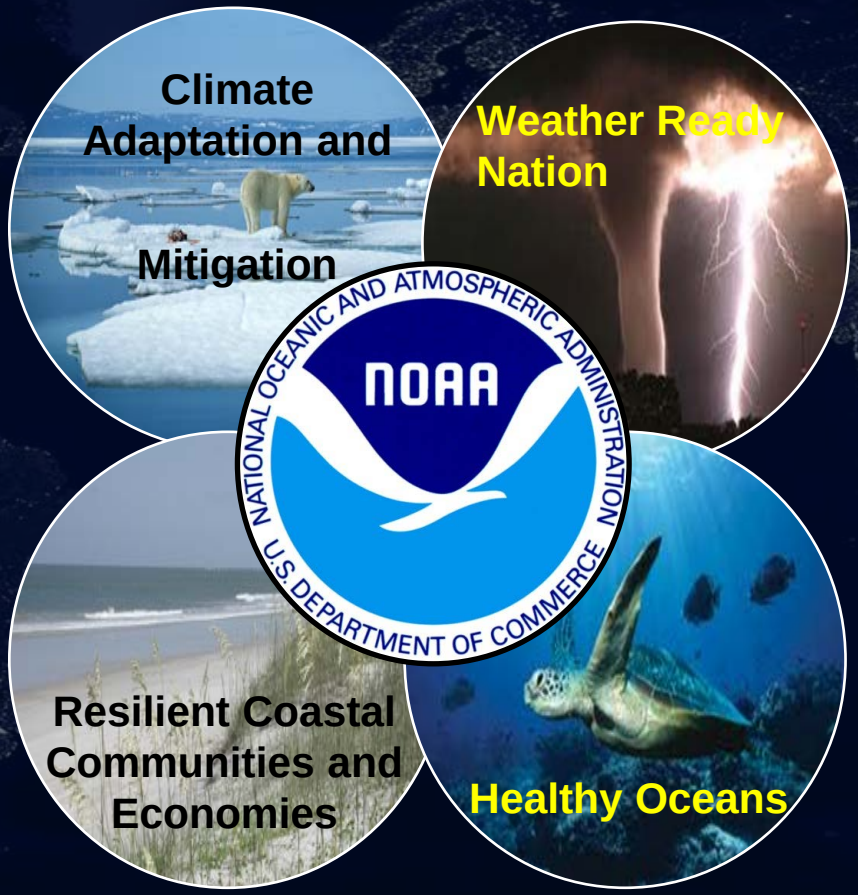

DNB Ice detection


OMPS Aerosols from Fires

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

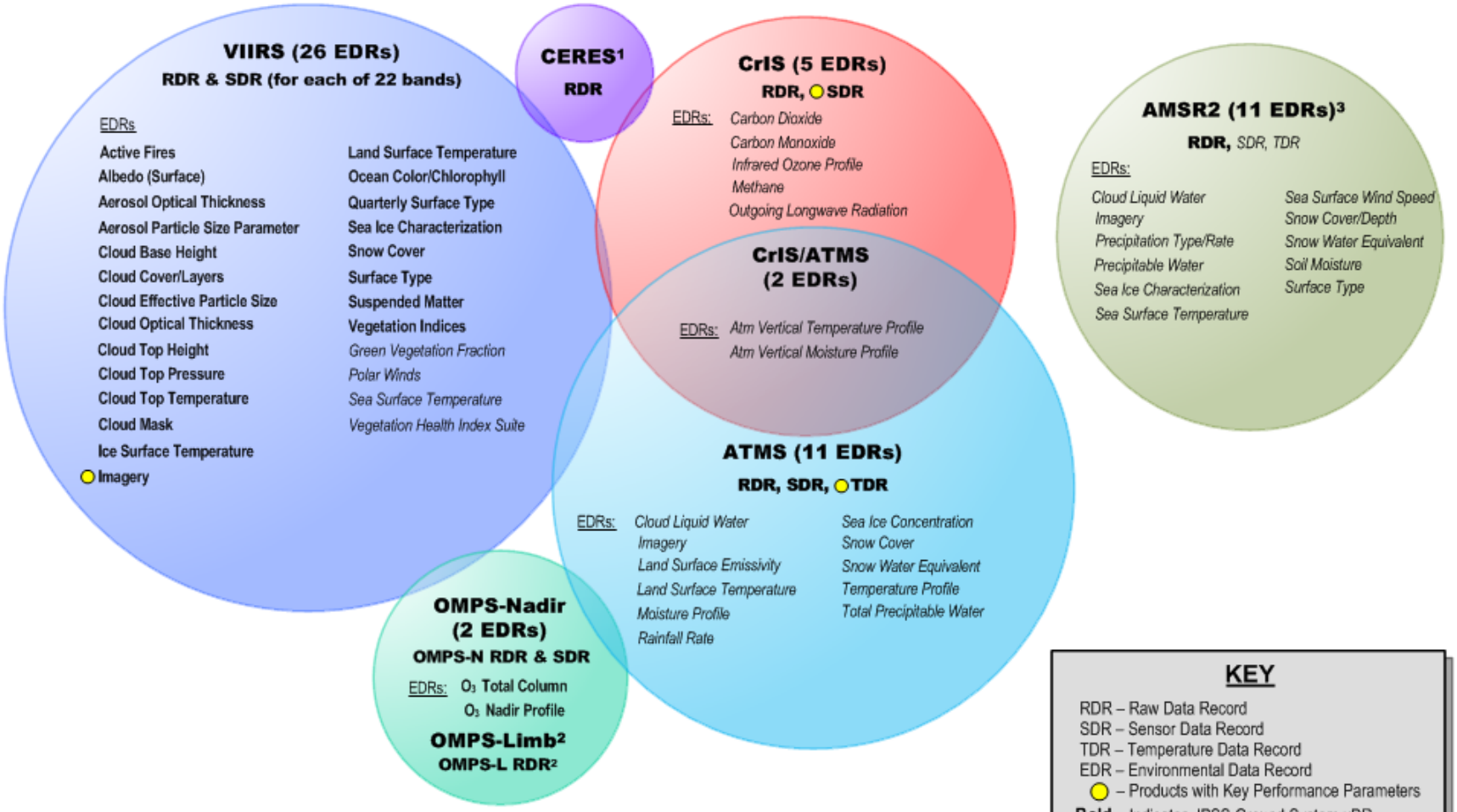


Reduced loss of life from high-impact weather events while improving efficient economies through environmental information

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 Program Data Products



KEY

RDR – Raw Data Record
SDR – Sensor Data Record
TDR – Temperature Data Record
EDR – Environmental Data Record
● – Products with Key Performance Parameters
Bold – Indicates JPSS Ground System xDR
Italics – Indicates NOAA Polar Legacy (ESPC) xDR

Notes:
[1]RDRs for the JPSS-2 Mission are contingent on NASA manifest of the Radiation Budget Instrument (RBI)
[2]Not applicable to JPSS-1; contingent on NASA manifest of OMPS-Limb on the JPSS-2 Mission
[3]Dependent on the Global Change Observation Mission (GCOM) provided by the Japan Aerospace Exploration Agency

The JPSS Program includes Ground System Support for the Metop, DMSP, and GCOM missions

December 18, 2014
This chart is controlled by JPSS Program Systems Engineering

JPSS-P Rev C

JPSS System Architecture

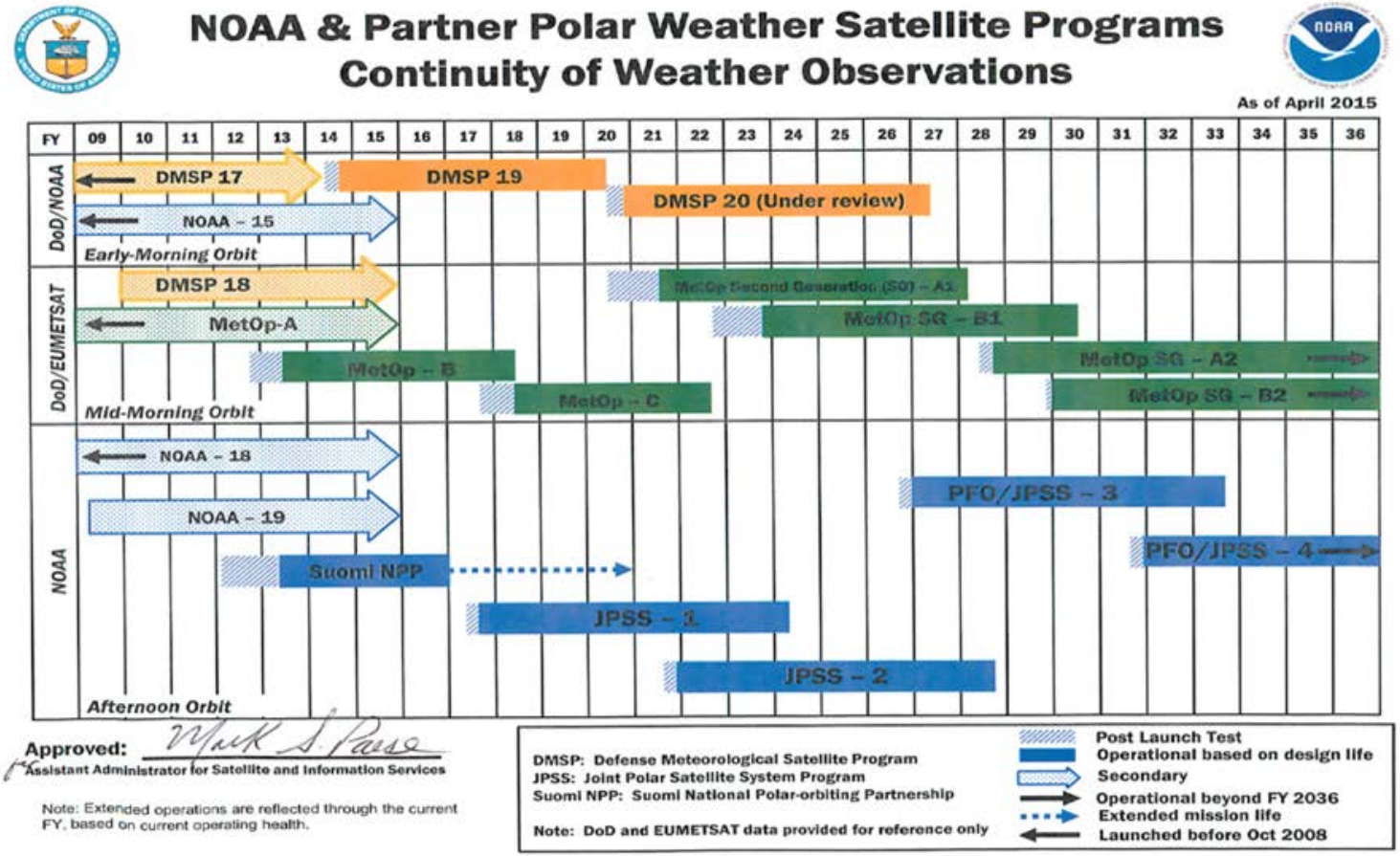
- Svalbard, Norway
- Fairbanks, Alaska

- NWS-National Weather Service
- NOS-National Ocean Service

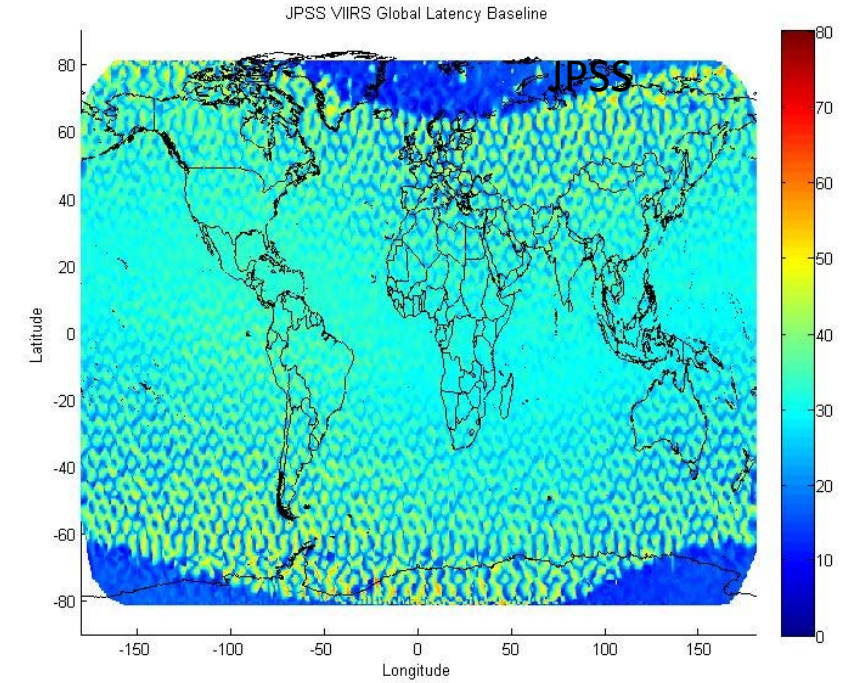
- NSOF-National Satellite Operations Facility

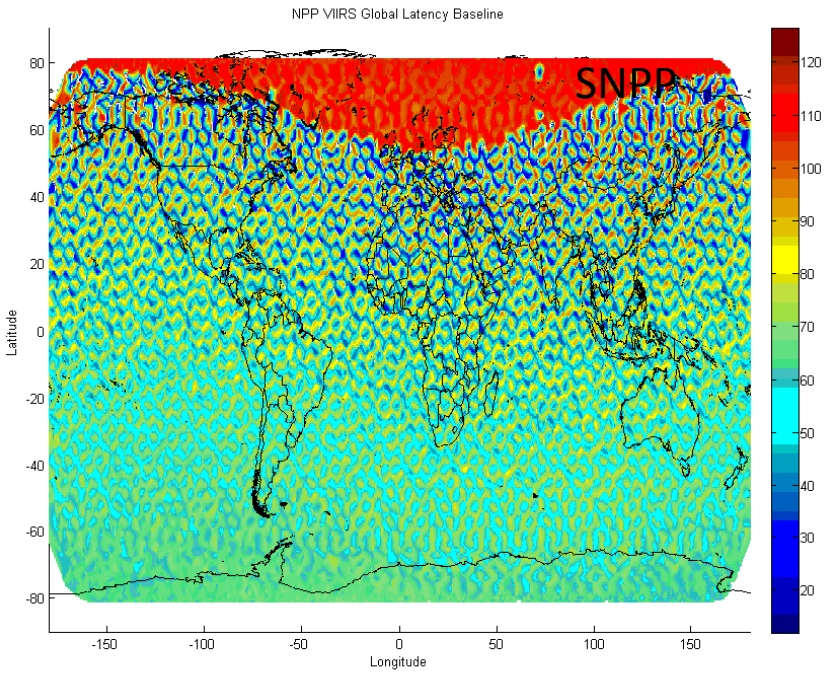
- McMurdo, U.S. Antarctic Research Station

Polar Satellite Launch Schedule



Much improved latency starting with JPSS-1





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

Priorities

- ✓ Launch JPSS-1 by March 2017
- ✓ Ensure KPP operational readiness (CriS, ATMS and VIIRS Imagery) 90 days after launch
- ✓ More efficient - use enterprise algorithms to reduce overall costs
- ✓ Need user plans/engagement to be more aligned with product development and operational availability

Lifecycle

Development
(new or enhanced algorithm)

Validation
(Is the product meeting requirements?)

Long Term Monitoring
(Sustainment)

Application
(why we are in business)

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

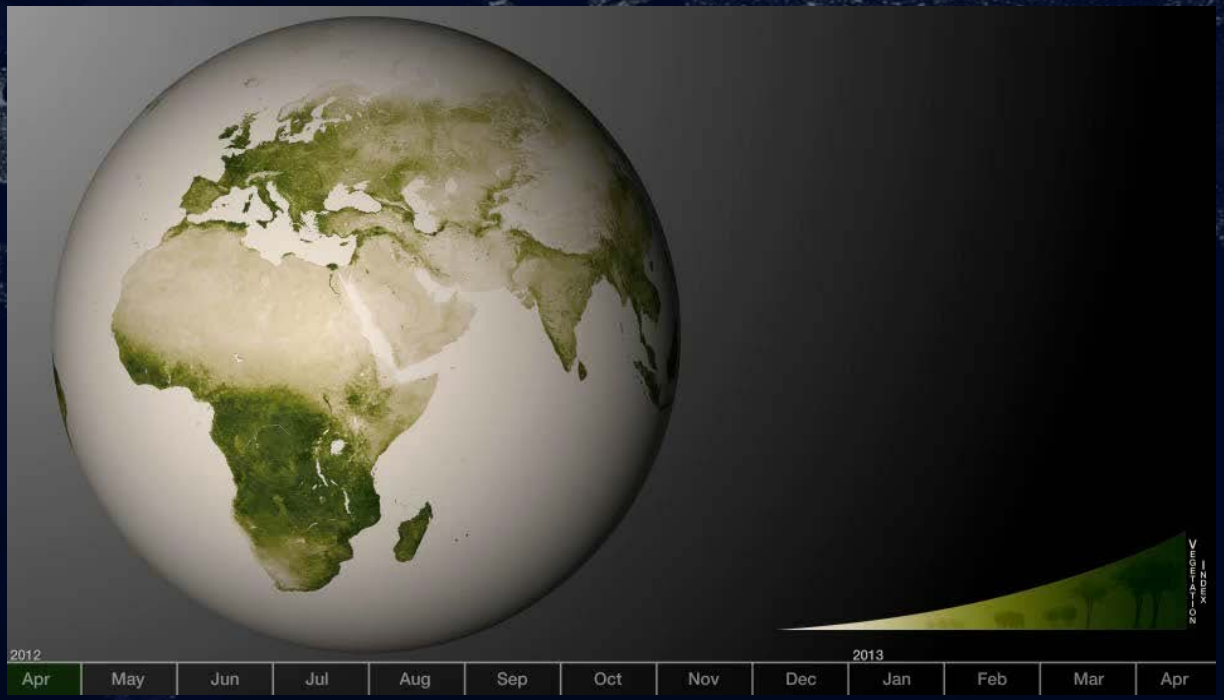
- Instruments and spacecraft are proceeding well
- Instruments are assembled and undergoing testing; one is prepared for integration
- The spacecraft bus is built and undergoing testing
- Development and implementation of the new ground data processing system are underway

JPSS-2 development underway

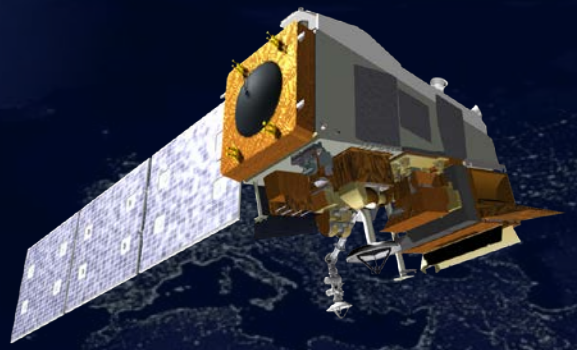
- The instruments are progressing well
- Spacecraft has started

Thank you so much!

Excellent feedback from our users - Worldwide



This animation depicts a year's worth of vegetation data from the VIIRS instrument on Suomi NPP



Thank You

www.jpss.noaa.gov

JPSS Program Science

Mitch Goldberg, Program Scientist

Arron Layns, Bill Sjoberg, Kathyrn Shontz, Lihang Zhou, Tom Schott, Bonnie Reed ……

August 2015 JPSS Science Meeting

Program Science provides the oversight for Science Operations

1) NOAA JPSS Program Scientist provides the link between the JPSS operational user community and the JPSS Program through
   - Chairing the Low Earth Orbiting Requirements Working Group for gathering and defining requirements,
   - Managing the JPSS Proving Ground and Risk Reduction program to foster improved user applications and science feedback.
   - Provides overarching science oversight for the Program

2) NASA JPSS Project Scientist ensures instruments meet their requirements through oversight of prelaunch and post launch commissioning.

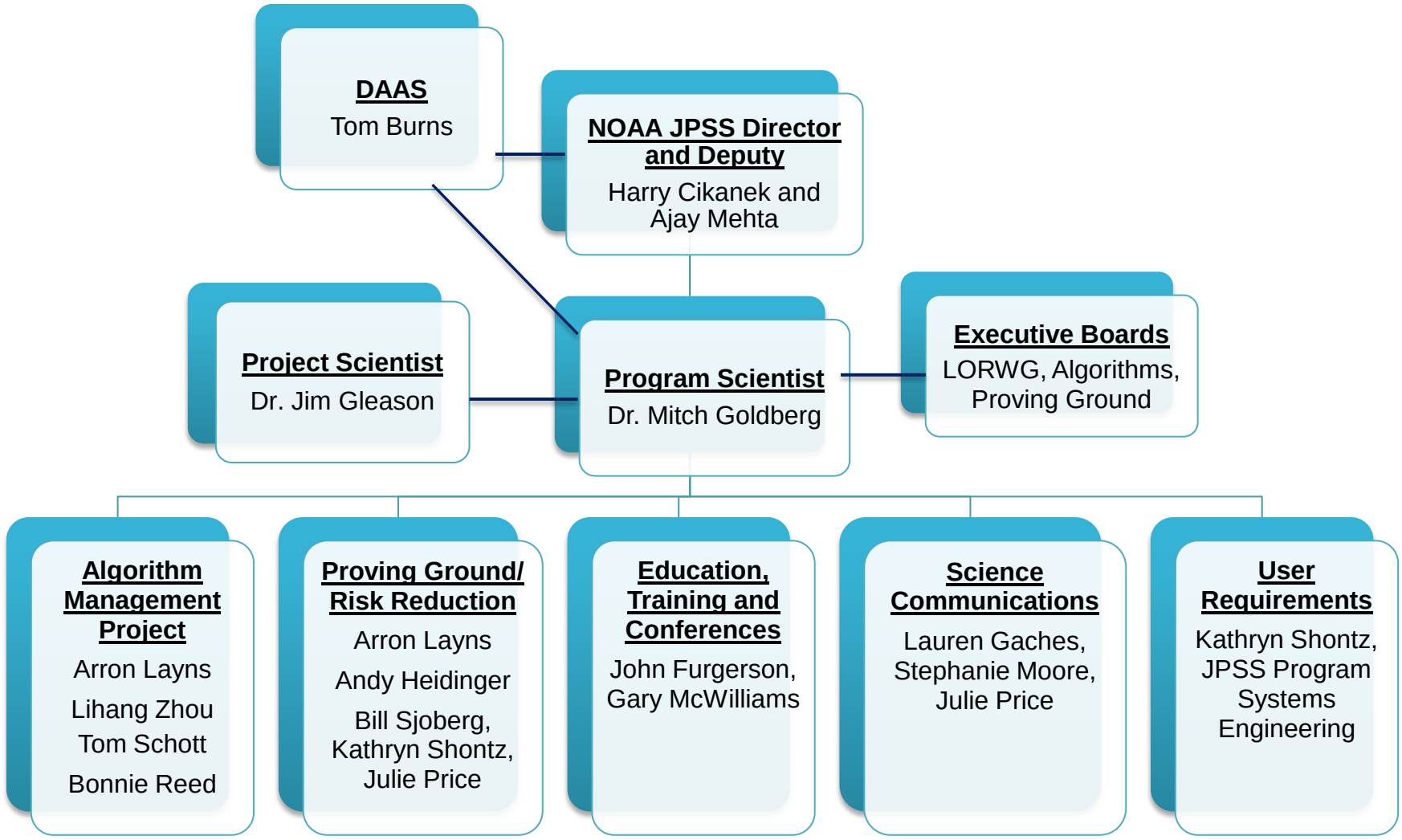
3) NOAA/NESDIS Center for Satellite Applications and Research (STAR) provide cal/val algorithm support to Ground Segment Product Generation and algorithm maintenance/sustainment

*** STAR supports 2) and 3) and OSPO supports 3 with operational science quality monitoring*

Role of Science in JPSS Operations

- To ensure scientific expertise, processes and organization structure is in place to meet the level 1 performance requirements.
  - Including a well define set of documentation providing artifacts beginning with the traceability of user requirements, to processes for algorithm development/updates, and science performance verification
- The science algorithms for the XDRs are well defined and described by algorithm theoretical basis documents and the validation CONOPS of the XDRs are described in cal/val plans. The verification of performance is carefully reviewed by Program Science and the users.
  - SNPP continues to be an excellent risk reduction for JPSS-1, so successful that SNPP is NOAA's Primary Weather Satellite
- Users are continuously engaged and provide feedback to Program Science through support from JPSS Proving Ground and Risk Reduction.

JPSS Program Science Virtual Staff Chart



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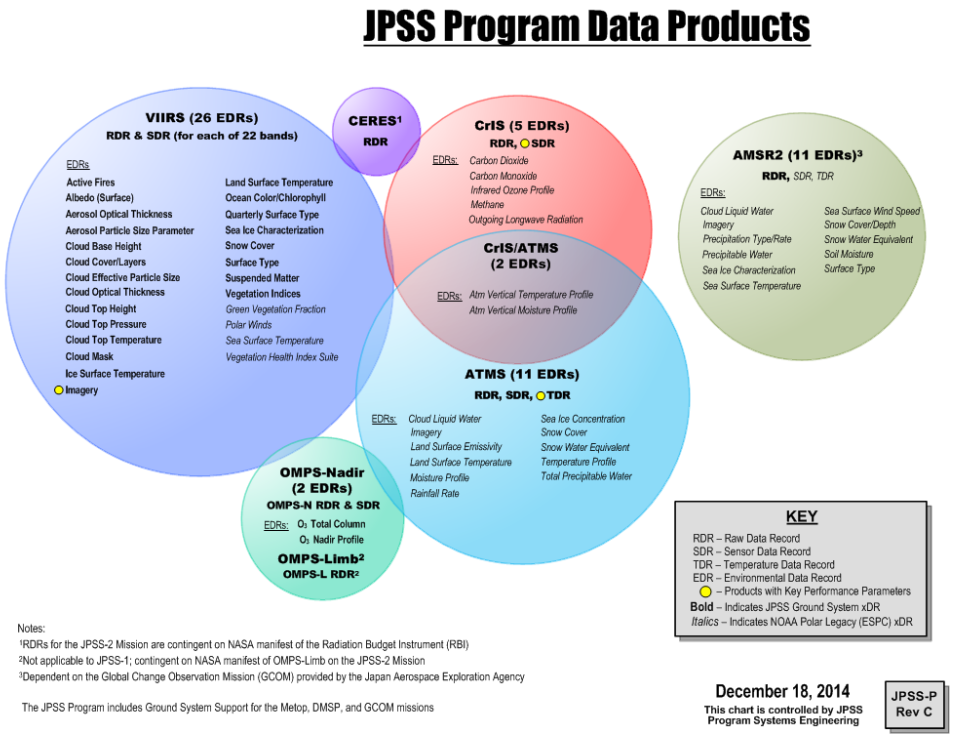
Challenge

- User Readiness: Products to Applications
- Ensure users are ready for NPP/JPSS data and improve their key operational and research product and services
  - ✓ Severe weather forecasts and warnings
  - ✓ Aviation weather forecasts and warnings
  - ✓ Improve fire and air quality forecasts and warnings
  - ✓ Improve warnings and prediction of 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 identify improvements needed for products and applications



Lifecycle

Development
(new or enhanced algorithm)

Validation
(Is the product meeting requirements?)

Long Term Monitoring
(Sustainment)

Application
(last mile)

What is the Proving Ground & Risk Reduction Program for JPSS?

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

.

JPSS Proving Ground and Risk Reduction Application Areas

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

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

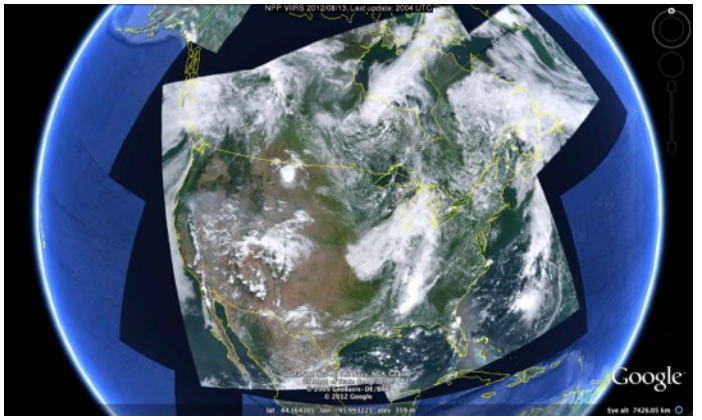
PGRR Initiatives

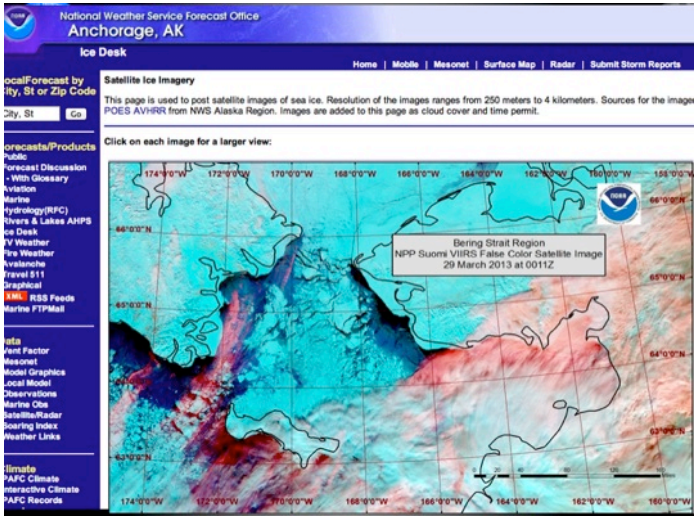
An initiative is a group (~10-20 participants) focused on a common goal and operational demonstration and includes product developers and users

- 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

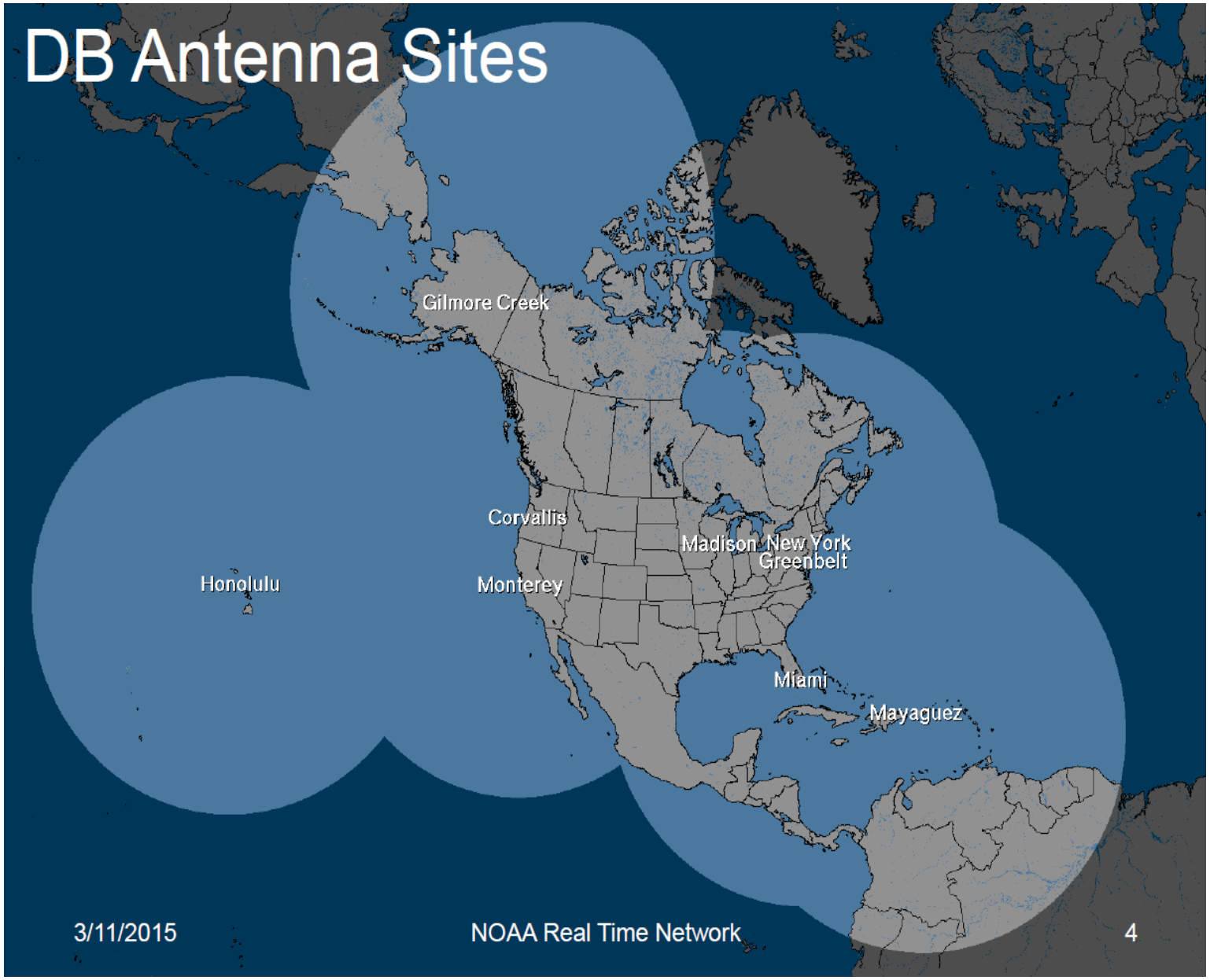
JPSS Significant Proving Ground Accomplishments

- 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





NOAA DB Demo Network Antenna Sites



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

Easy data access from CLASS

NOAA • NESDIS JPSS Joint Polar Satellite System

NOAA's Comprehensive La ×

www.class.ncdc.noaa.gov/saa/products/welcome

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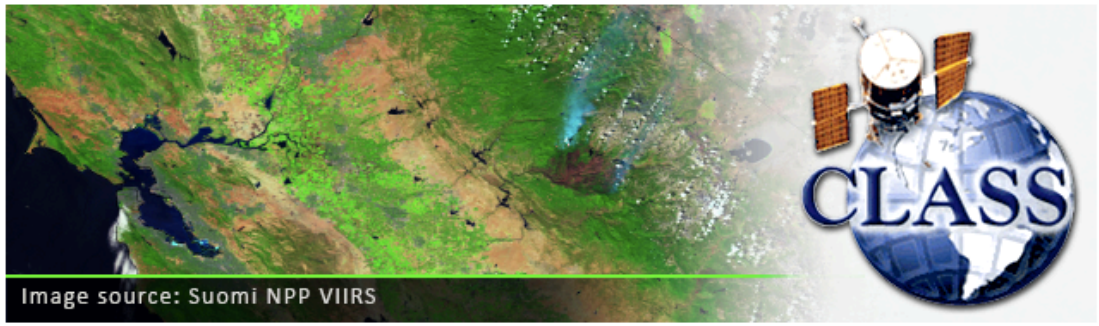


NEWS

Attention CORS users (06/23/14):
Starting January 1, 2014, the National Geodetic Survey's CORS data archived at CLASS now includes GPS+GLONASS data for stations with GNSS-capable equipment. The GLONASS broadcast navigation file (BRDC) is also available for users at the same starting date. (GLO navigation file name example: brdc1680.14g.gz)

CORS data collections include RINEX since 1994 and raw GPS from selected CORS sites since 2004. The original at-sampling rate was retained except where there was only the 30-second decimated rate data. For more info see the CORS CLASS search page.

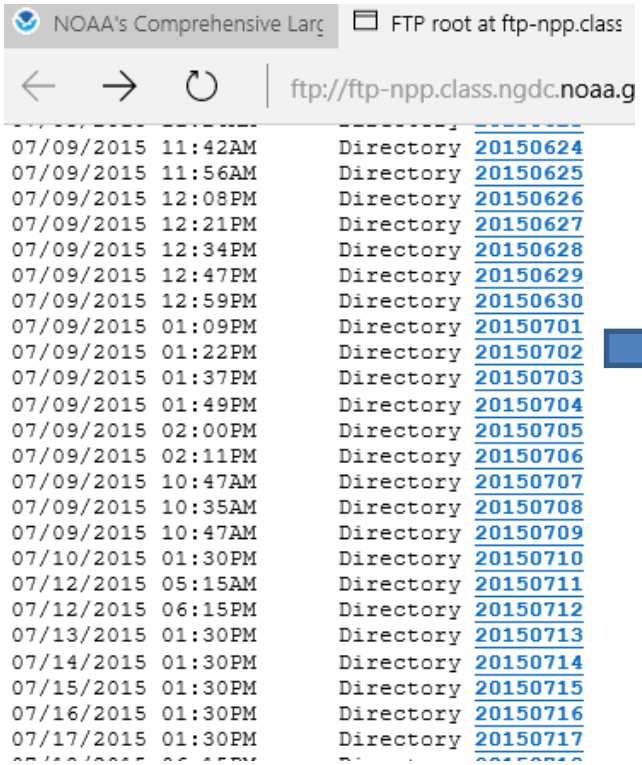
Attention Suomi NPP Users:
The most recent global NPP operational products are now available in daily tar files for quick and easy downloads at: ftp://ftp-npp.class.ngdc.noaa.gov/. Please see the **NPP help page** for instructions. Up to the most recent 85 days of data will be available for direct online access.

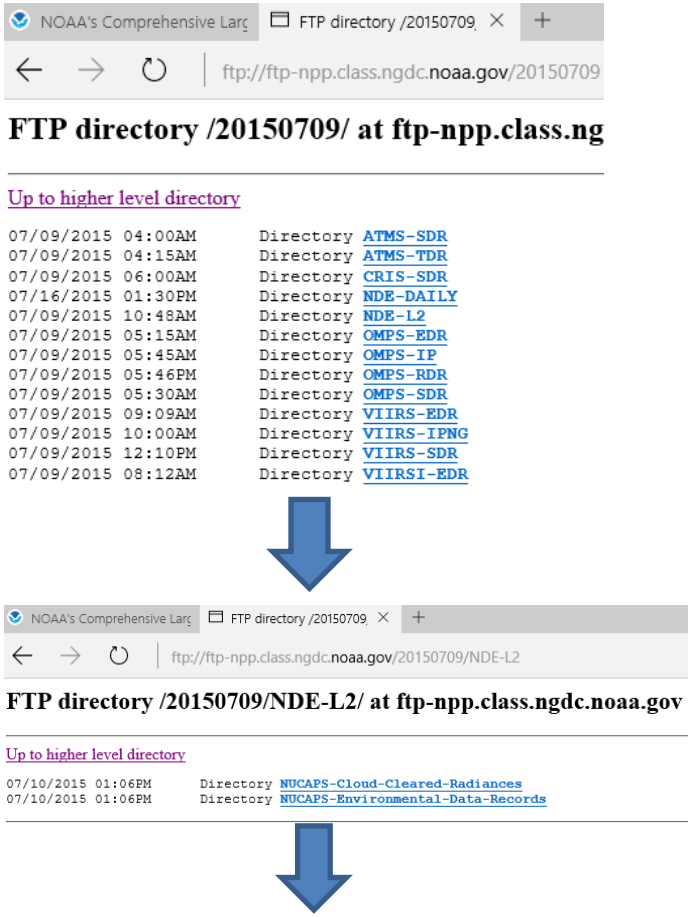
Suomi NPP data access status (11/25/14):
The majority of S-NPP products are now available and can be ordered through CLASS. The ones available to the public will show the begin dates after the product name on the search page. Also, a "quick look" of which products are at which maturity stages can be easily viewed at the **STAR Algorithm Product Maturity Matrix** website. Details of high priority issues related to the data quality are contained in the Readme files provided by the S-NPP Project Scientist. Many of these have recently been updated. Please read these before ordering and using the 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)
- Global Navigation Satellite Systems (GNSS)
- Other - Miscellaneous products in CLASS

SEARCH COLLECTION METADATA
» GO

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

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Program Science Accomplishments

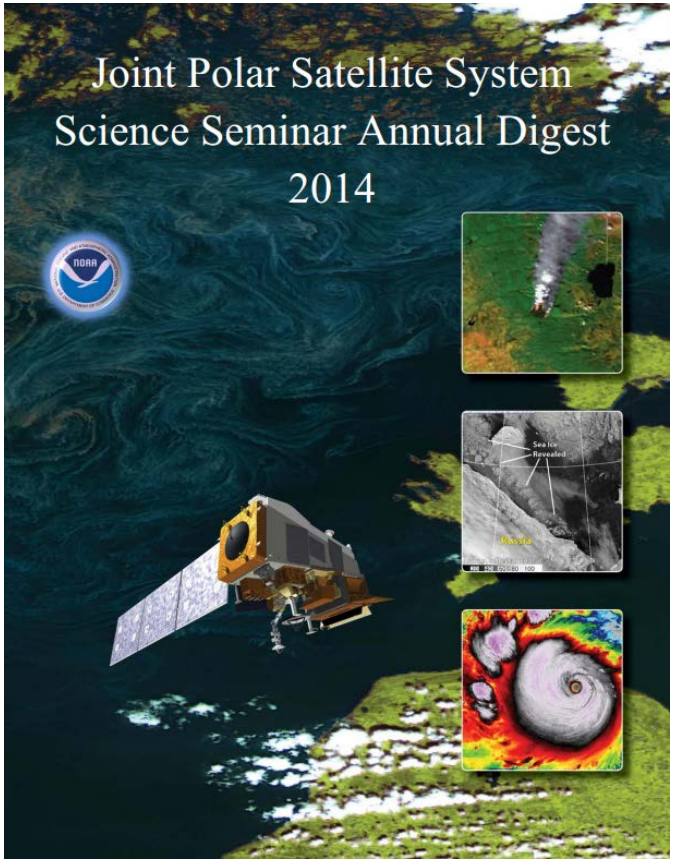
- Advocated STAR leadership for Algorithms and Cal/Val
  - Complete success!!!!
- Establish Proving Ground Program
  - 40% SNPP products used operationally now.
  - Expect to expand to 75% by 2018 via PG Initiatives
- Advocate replacing IDPS algorithms with Enterprise within ESPC (Mission Unique and Enterprise)
- Advocating reprocessing as part of the Cal/Val process
  - Demonstrations of SST, Ocean Color and Soundings (NUCAPS)
  - Using same science software as operations with the same outputs
    - Enables efficient “Archive Refresh” which will be supported by the NOAA Archive
- Using the Configuration Change Request (CCR) process to propose improvement to sensors.

Summary

- Science leadership is well established with management and processes in place.
- There has been an increase in the use of SNPP for operational use over the past year
  - The use of ATMS in the Hurricane Weather Research Forecast (HWRF) model which was a JPSS PGRR project is now operational at NCEP
  - The use of VIIRS for river ice and flood detection is being routinely used now by NWS River Forecast Centers, and will follow the path to operations.
  - The use of VIIRS for cloud imagery. fire /smoke monitoring, fog detection ,ice detection is now routine.
  - VIIRS ocean color and SST being used routinely by NMFS and NOS
- 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
- Next priority - reprocessing via Cal/Val and archive refresh (within current budget)

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



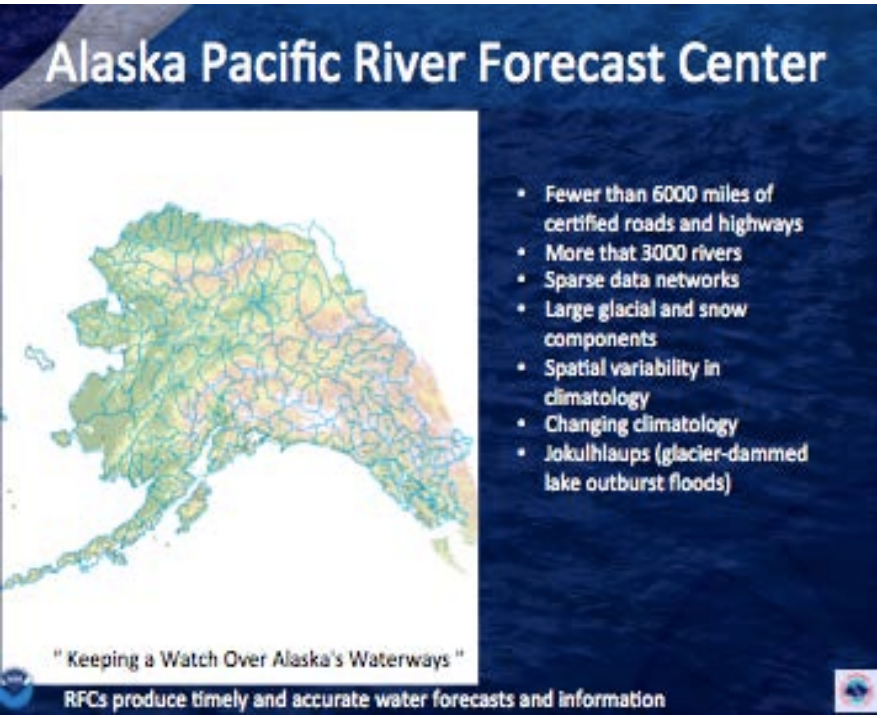
Additional backup content charts discussing initiatives

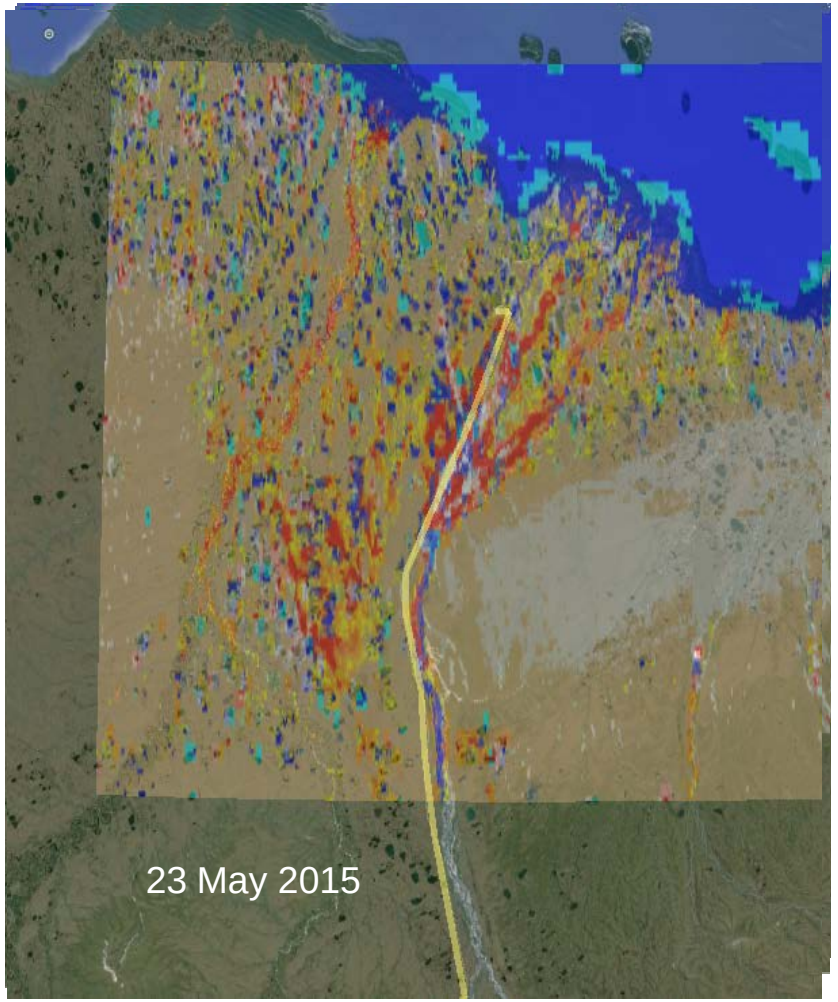
River Ice and Flooding

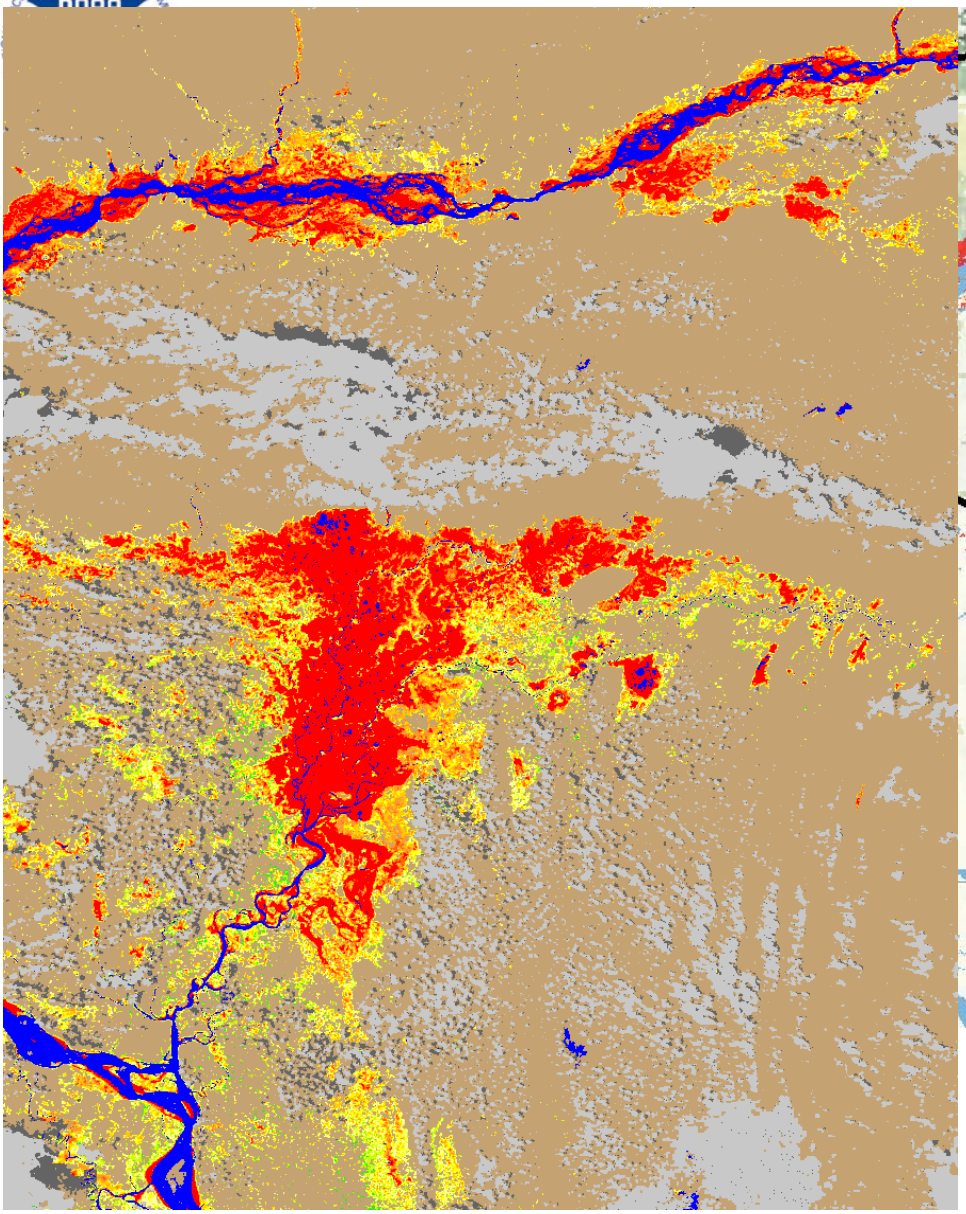
- Ice products to identify locations of river ice and its state
- The flood product should specify the areal extent of the flooding and the capability of overlaying the product on geographic maps and provide an estimation of the depth of the flood waters.
- Users: Primarily the NWS River Forecast Centers
- Focused on VIIRS

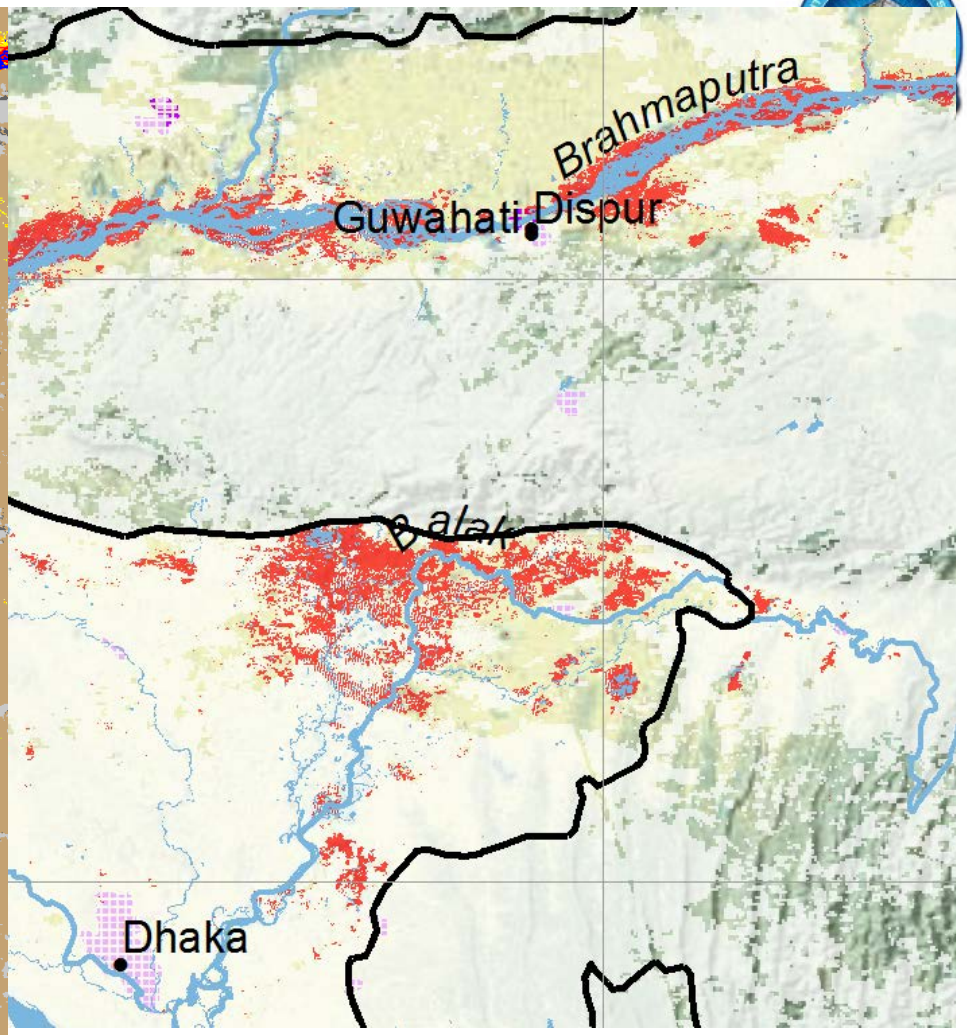
Hanibal, MO
Ice Jam
(Jan-Feb 2014)

Working with Alaska River Forecast Center





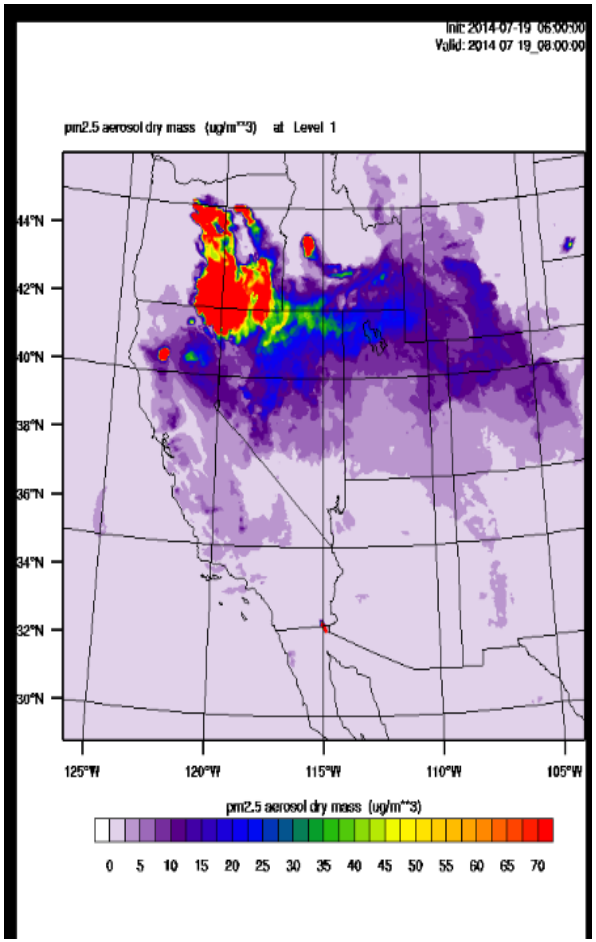




Higher spatial resolution VIIRS and better handling of cloud shadows provides better coverage than MODIS

Bangladesh, August 29, 2014,
Left: VIIRS, right: MODIS

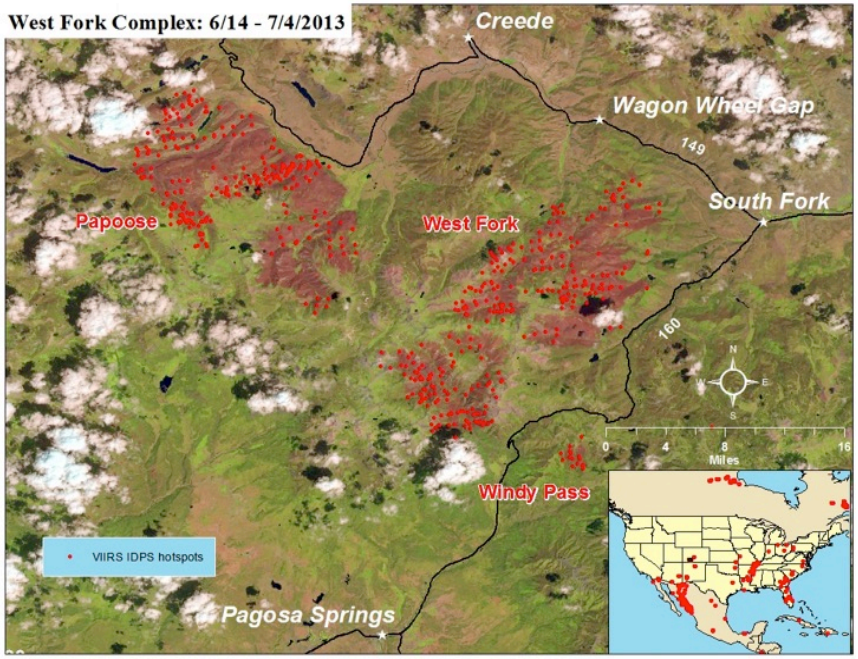
Fire and Smoke



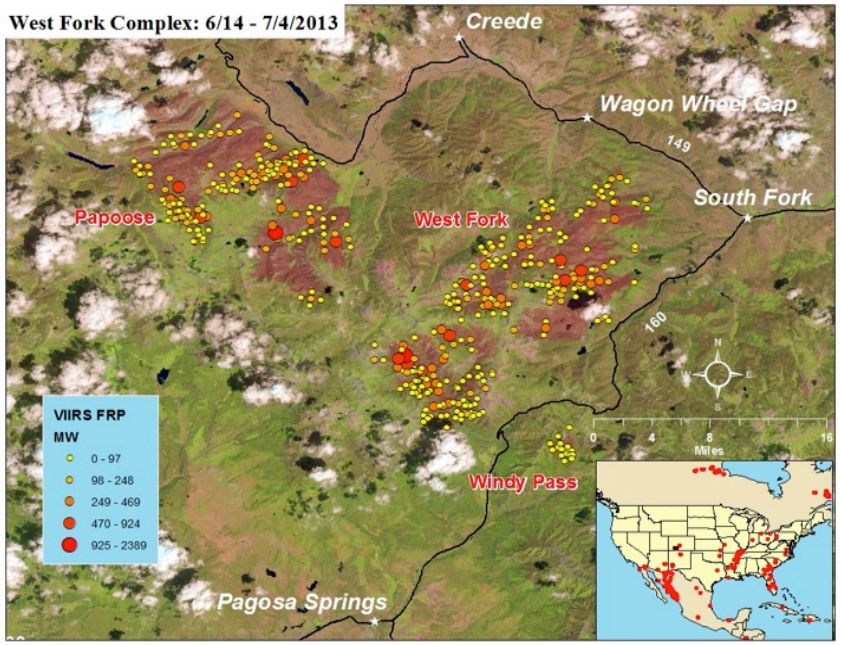
Example of HRRR Smoke Product

- 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.

Fire locations



Fire Radiative Power



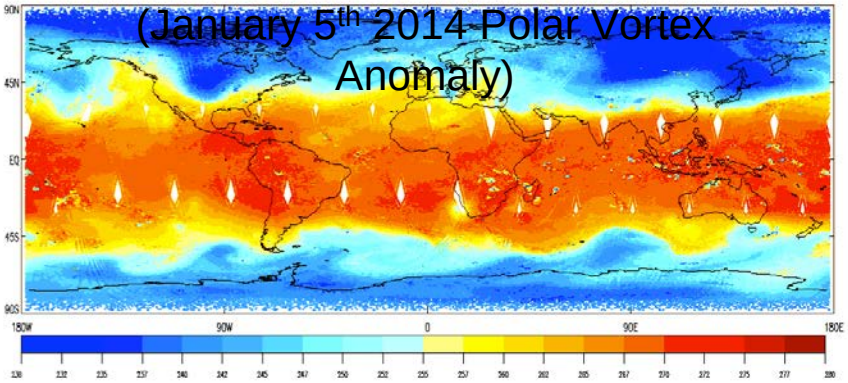
JPSS PGRR has is funding the use of fire locations and radiative power in NOAA's High Resolution Rapid Refresh (HRRR) model to better forecast fire spread and smoke dispersion.

Fire locations is in the NESDIS Hazard Mapping System

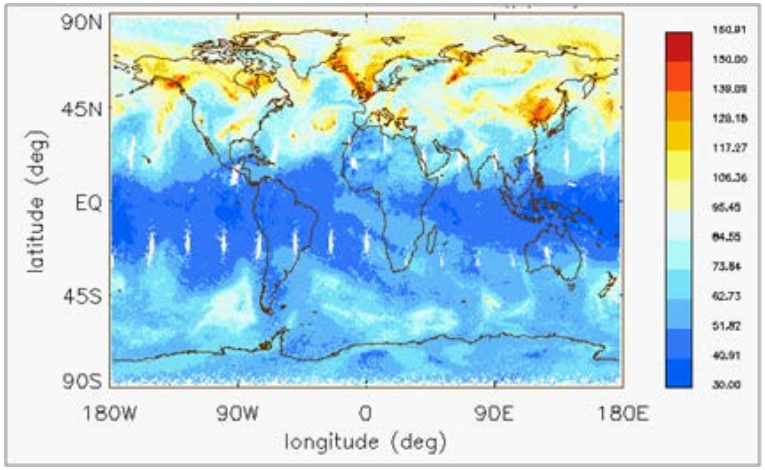
Sounding

- 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 or derive trace gases

NUCAPS Temperature retrieval @ 500mb

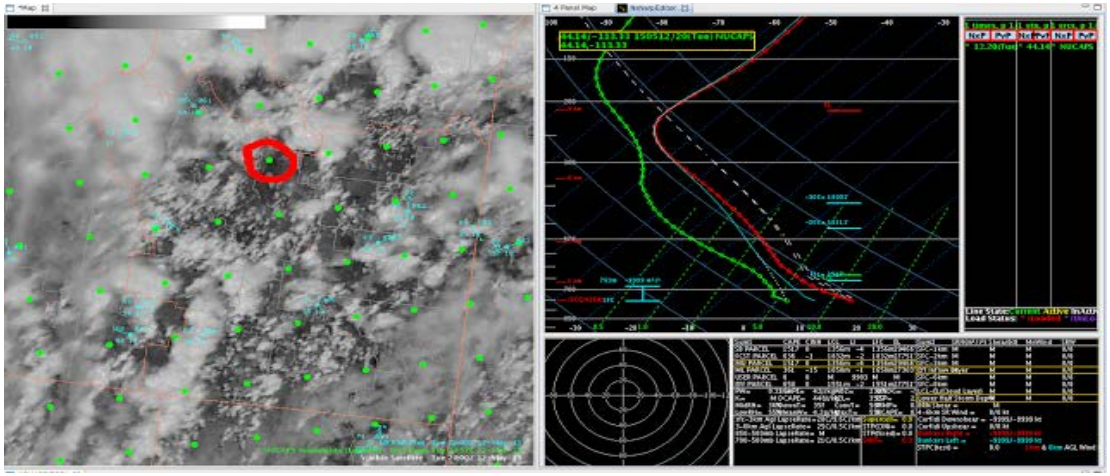


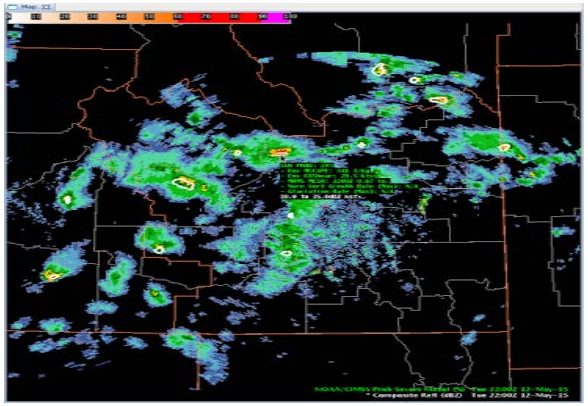
NUCAPS Ozone retrieval @ 500mb



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

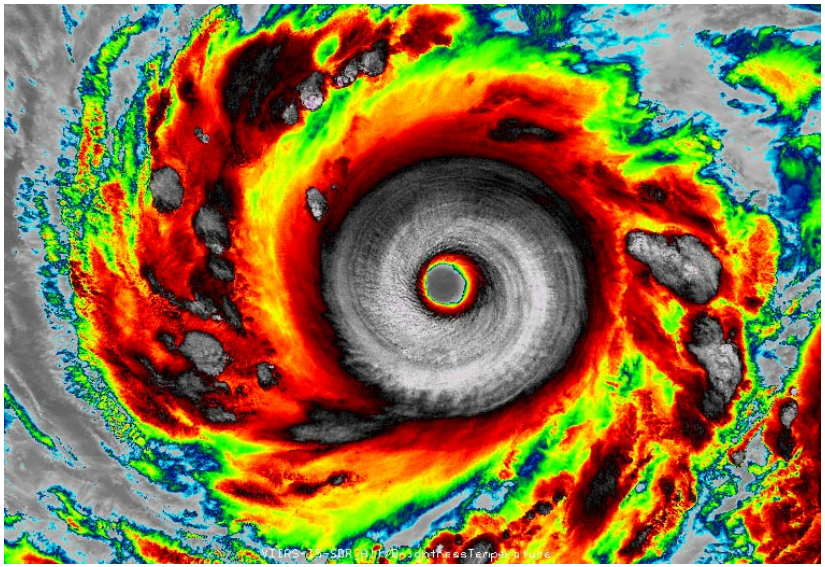
Waiting for deep convection to start. Denver's 18z special sounding showed a strong inversion around 700mb. The 20Z NUCAPS showed the lower levels not quite fully mixed. NUCAPS increased confidence that deep convection would occur but not quite yet. (comment edited)

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.

NWP Impact Studies and Critical Weather Applications

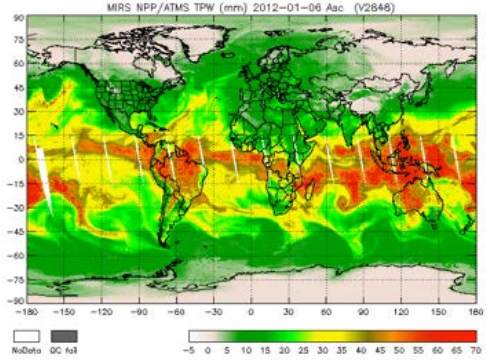
- Studies on the impact of CrIS and ATMS on the GFS, HRRR, and other operational models to evaluate the performance of these sounders in context with legacy instruments in order to provide feedback on capabilities
- Critical weather applications include focus on use of data products for improving tropical cyclones and other sever weather events.



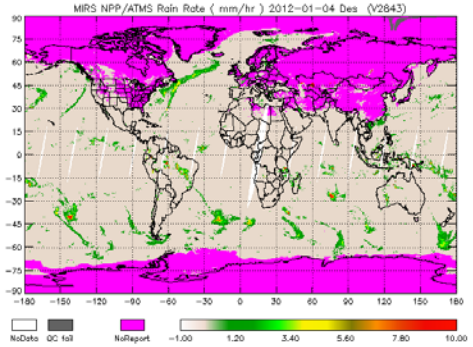
Infrared VIIRS image, October 7, 2014
Super Typhoon Vongfong

OCONUS and NCEP AWIPS

- Seeks new, innovative applications for satellite imagery, products, and derivatives that exploit the information from polar-orbiting satellites, particularly S-NPP and GCOM, for improving the analysis and forecast of weather phenomena. Priority applications under this PGI, in no order of preference, include:
  - multi-source, integrated quantitative and qualitative products that combine like information from multiple geostationary and polar-orbiting satellites, potentially composited with in-situ observations and model forecasts,
  - techniques that limit the impact of space and time gaps between polar-orbiting satellite passes,
  - improvements to current satellite products and imagery that make them more useful in data sparse regions (e.g., rainfall rate, cloud properties, etc.),
  - concepts that apply satellite data to address longstanding forecast concerns (e.g., ice, very cold tropospheric temperatures, fog, etc.), and
  - innovations for displaying and interacting qualitative and quantitative data.



Total Precipitable Water



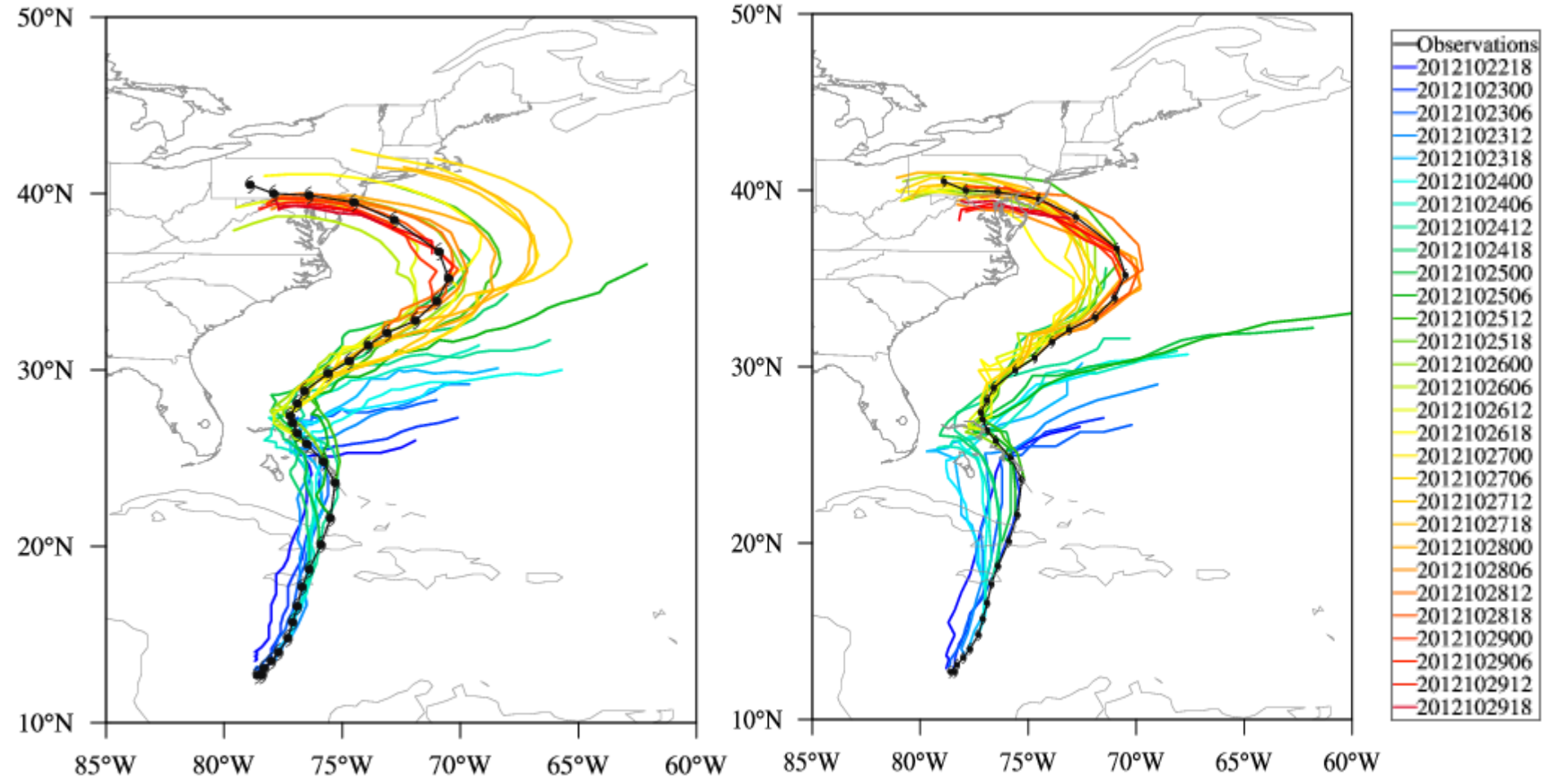
Rain Rates

Direct Assimilation of ATMS into Models

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

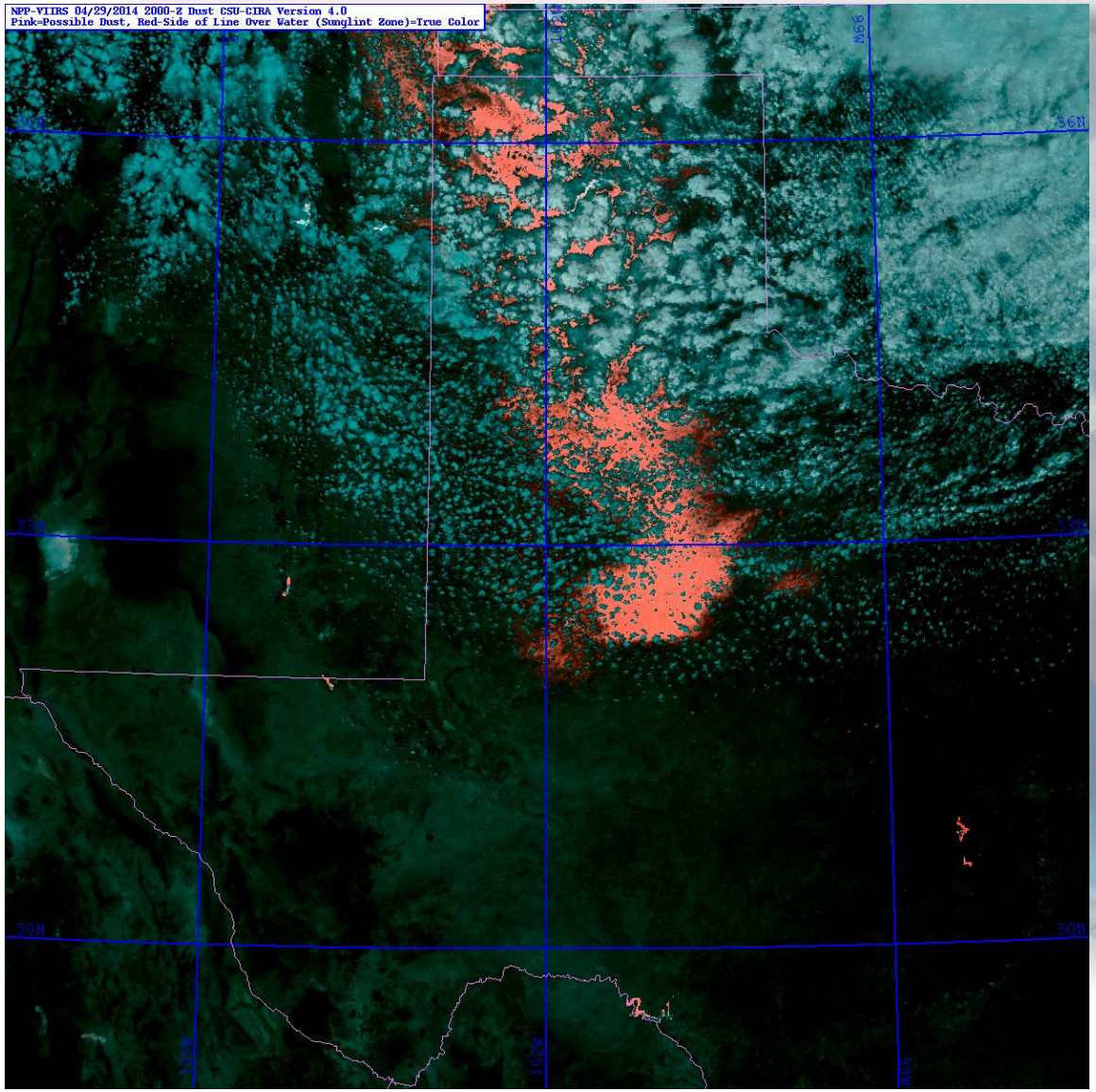
HWRF-NCEP Operational

Modified HWRF-NCEP with ATMS



Credit: Fuzhong Weng

RGBs at the AWC…

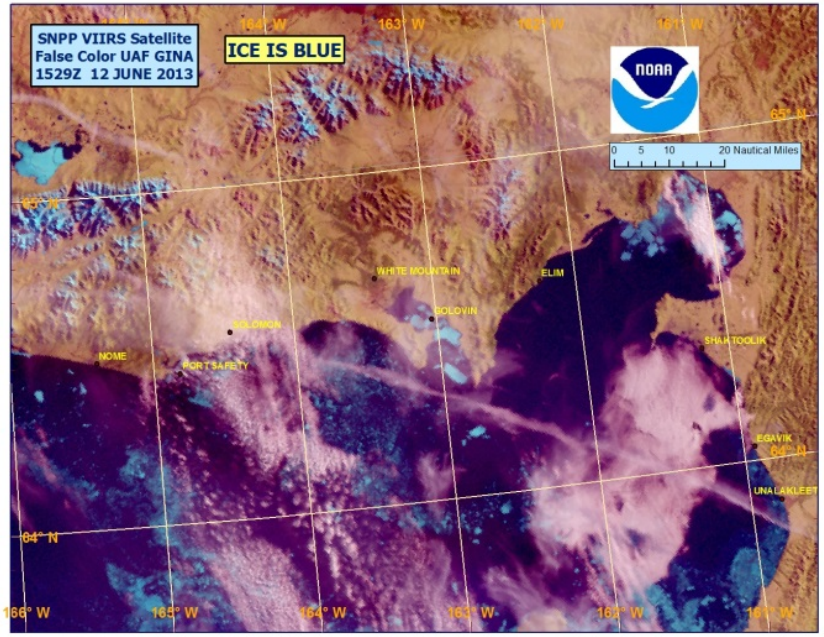


April 29th, 2014

- Three day event
- True color imagery showed some vague dust features
- Dust enhancement uses visible and IR properties, as well as characteristics of dust particles to highlight **only dust**
- Used in SIGMETs for blowing dust

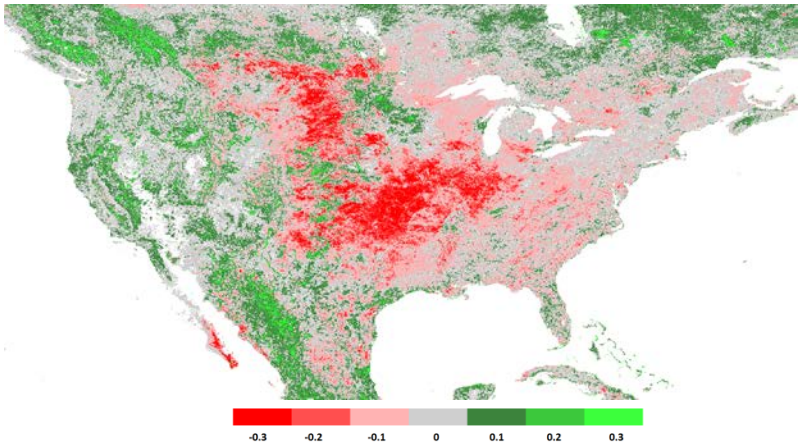
Cryosphere

- Improve the utilization of JPSS and other snow and ice products in numerical weather prediction, hydrological analysis and forecasting, climate reanalyses, and ice operations.
- Users: NOAA's Alaska Pacific River Forecast Center (APRFC), NCEP, the National Operational Hydrologic Remote Sensing Center (NOHRSC) and their SNOw Data Assimilation System (SNODAS), and the National Ice Center



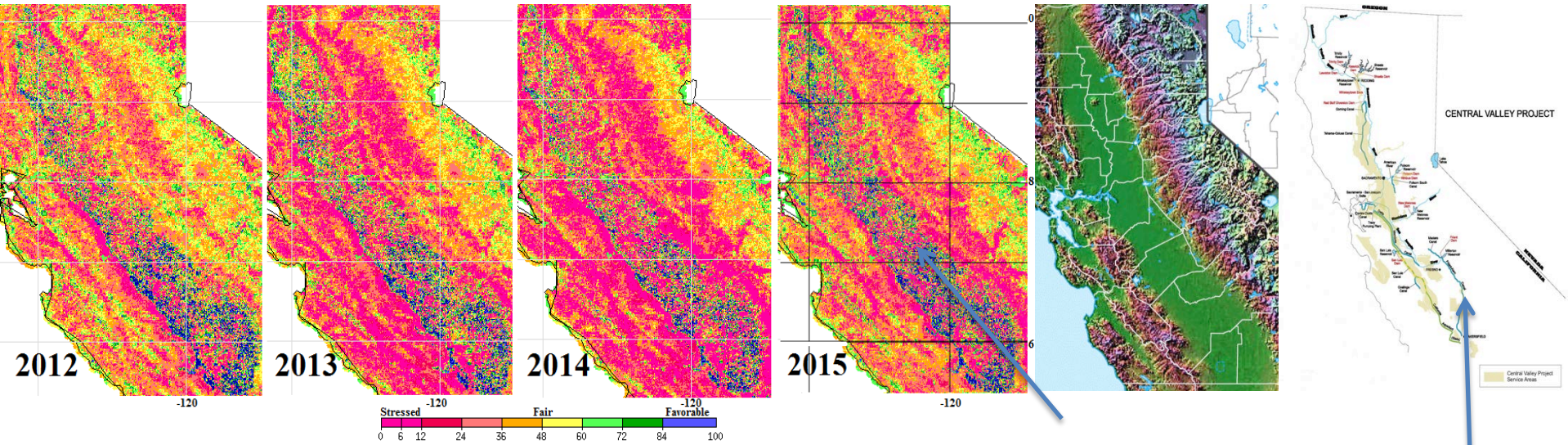
Land Data Assimilation

- Maximize the utilization of JPSS land surface environmental data products, as well as data products from other environmental satellites, by the NOAA numerical weather prediction community.
- Top priority is given and initial efforts will focus on the utilization of Green Vegetation Fraction (GVF) and Land Surface Temperature (LST) from the S-NPP satellite and a suite of soil moisture products.
- Users: NWS/NCEP



VIIRS GVF difference (15 Aug 2012 minus 15 Aug 2014)

VIIRS 500m resolution gridded vegetation health provides indication of vegetation stress and capability to monitor irrigation zones



S-NPP/VIIRS-500m Vegetation health, June 12, USA, California, Central Valley

June 2012 -2015 Vegetation Health – Note improvement in 2015 due to late spring precipitation which increased vegetation. (temporary reprieve since snow pack is low and dry summer setting up).

NOAA Service Report on the 2014 California Drought included the need to use remote sensing for assessments of temporal changes in the Central Valley configuration, channel shapes, vegetation cover….

Blue areas show irrigation, If irrigation is cutback, depending on the magnitude, VIIRS VH maps in the central valley can be used for monitoring

Irrigation areas shown in upper right map

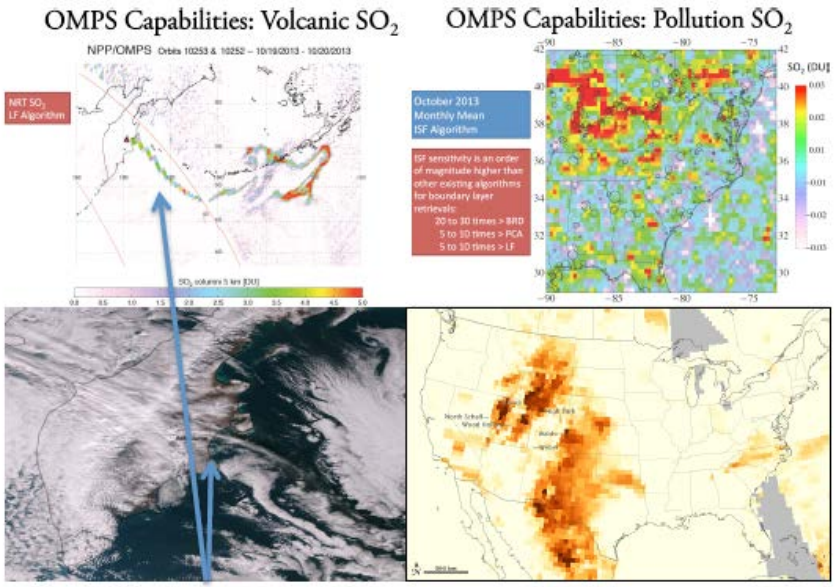
Oceans and Coastal

VIIRS coastal true color image of Lake Erie, August 3, 2014 depicting the large bloom of the cyanobacterium, Microcystis sp. threatened the water supply of Toledo, OH

- Support the activities that provide users with fit-for-purpose, accurate, consistent and timely ocean data and derived products from VIIRS.
- Focus on the following NOAA service areas: Modeling and Forecasting Physical & Biological Ocean and Coastal Dynamics, Harmful Algal Blooms (HABs), Water Quality, and Ecological Forecasting, Living Marine Resources, and Ocean Acidification and Air Quality

Atmospheric Chemistry

- Increase the utilization of the JPSS atmospheric chemistry products, including improved SO2 and aerosol products

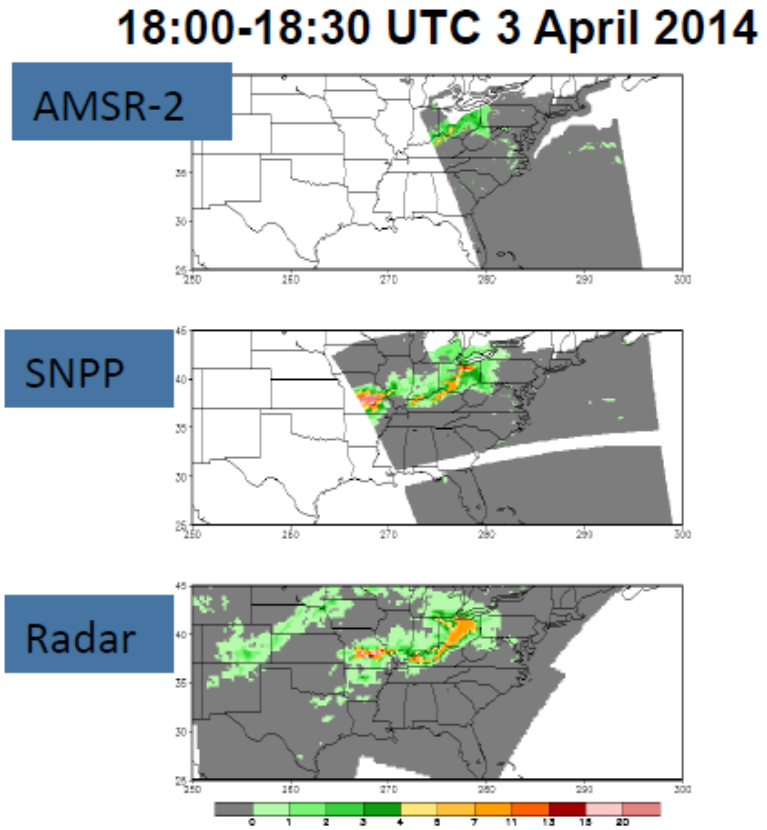


VIIRS sees the ash, but OMPS sees the SO2

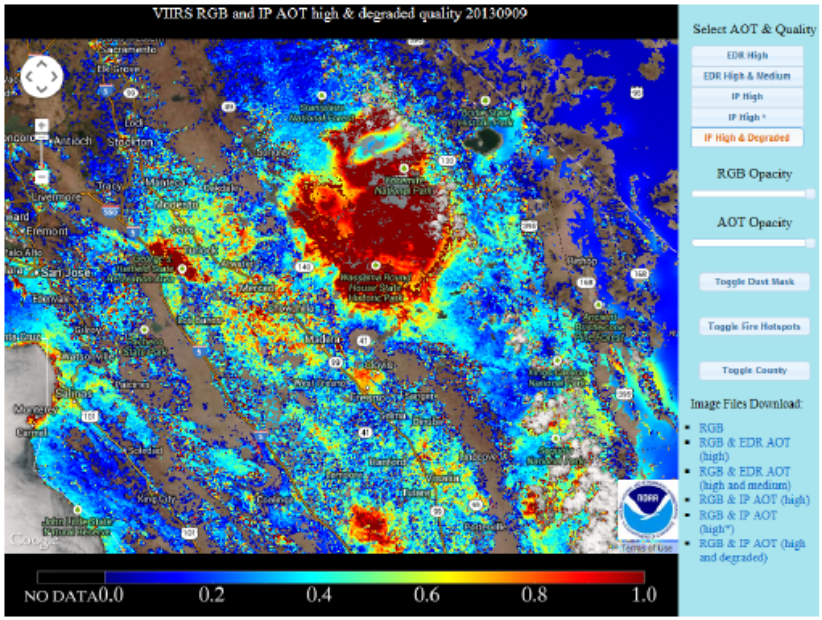
OMPS aerosols over generally bright surfaces from fires

Hydrology

- Use of S-NPP, JPSS, and GCOM precipitation products in areas such as
  - Synergistic use of VIIRS with ATMS or AMSR-2 to improve rainfall and snowfall retrieval
  - Regional algorithm development and application to exploit direct broadcast data
  - Extension of global climate hydrological products from POES/AMSU to JPSS/ATMS
  - Improvements to precipitation retrievals under conditions of orographic forcing, where conventional retrieval algorithms are known to break down.



Aerosol Data Assimilation



- Improve the use of VIIRS and OMPS aerosol products in operational models at Numerical Weather Prediction (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.

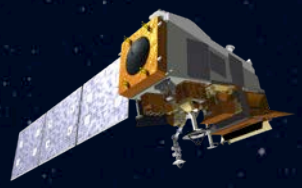
Innovation

- Looking for “out-of-the-box” ideas and concepts that keep science fresh
- Can include new applications of existing products or development of new algorithms or products

Training

- Focus on improving the utilization of JPSS products and applications by the user community
- Also supports education and training of the next generation of scientists

Not a complete photo – 9 people missing



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VIIRS-Snow-Cover-Depth-Snow-Fraction-EDR/	
VIIRS-Surface-Type-EDR/	
VIIRS-Suspended-Matter-EDR/	
VIIRS-Vegetation-Index-EDR/	

Summary - JPSS Program Status

Suomi NPP is producing outstanding data

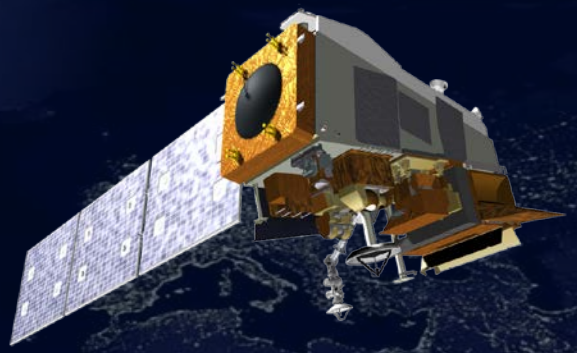
- The satellite is healthy and producing a high availability of data (~99.99%)
- Operations of the satellite transferred from NASA to NOAA in 2013
- Suomi NPP is the primary operational polar-orbiting satellite for NOAA

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 bus procurement is underway



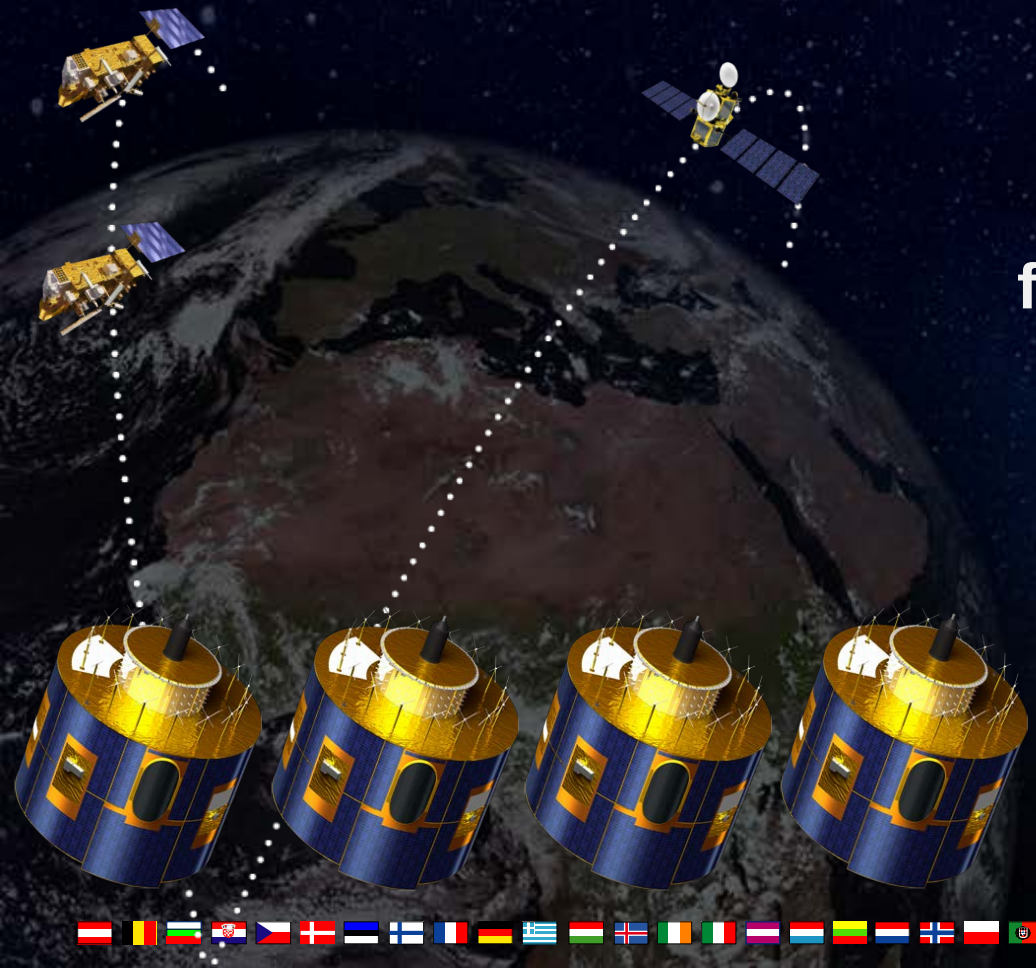
Thank You

www.jpss.noaa.gov

INTO THE FUTURE
AN OVERVIEW OF THE EUMETSAT SATELLITE PROGRAMMES

EUMETSAT

Kenneth Holmlund
EUMETSAT
And many other contributors
from EUMETSAT and its partners



Current EUMETSAT satellite fleet

METOP -A and -B
(LOW-EARTH, SUN – SYNCHRONOUS ORBIT)

EUMETSAT POLAR SYSTEM/INITIAL JOINT POLAR SYSTEM

JASON-2
(LOW-EARTH, 63° INCL. NON SYNCHRONOUS ORBIT)

OCEAN SURFACE TOPOGRAPHY MISSION

METEOSAT SECOND GENERATION -8.-9.-10, MSG-4 (-11)
(GEOSTATIONARY ORBIT)

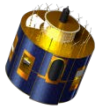
TWO-SATELLITE SYSTEM:
- MSG-4 (METEOSAT-11) under commissioning

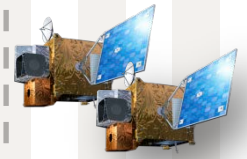
- METEOSAT-10: FULL DISK IMAGERY MISSION AT 0° (15 MN)
- METEOSAT-9: RAPID SCAN SERVICE OVER EUROPE AT 9.5°E (5 MN)
- METEOSAT- 8: BACK UP AT 3.5°E

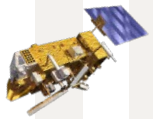
METEOSAT – 7 (1st GENERATION)
(GEOSTATIONARY ORBIT)

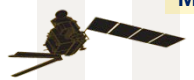
INDIAN OCEAN DATA COVERAGE MISSION
AT 57°5 E (UNTIL END 2016)

EUMETSAT programmes overview









YEAR... 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

METEOSAT FIRST GENERATION

METEOSAT-7

METEOSAT SECOND GENERATION

METEOSAT-8 …Extended lifetime .....

METEOSAT-9 …Extended lifetime .....

METEOSAT-10 …Extended lifetime ...

MSG-4/METEOSAT-11 ……..

METEOSAT THIRD GENERATION

MTG-I-1 : IMAGERY

MTG-S-1: SOUNDING

MTG-I-2: IMAGERY

MTG-I-3: IMAGERY

MTG-S-2: SOUNDING

MTG-I-4: IMAGERY

Mandatory Programmes

EUMETSAT POLAR SYSTEM (EPS)

METOP-A …Extended lifetime .....

METOP-B …Extended lifetime .....

METOP-C …Extended lifetime .....

METOP SECOND GENERATION

METOP-SG-A1

METOP-SG-B1

METOP-SG-A2

METOP-SG-B2

METOP-SG-A3

METOP-SG-B3

Operational Development

JASON

JASON-2

JASON-3

JASON CONTINUITY OF SERVICE (JASON-CS)

Optional and Third Party Programmes

COPERNICUS

SENTINEL-3

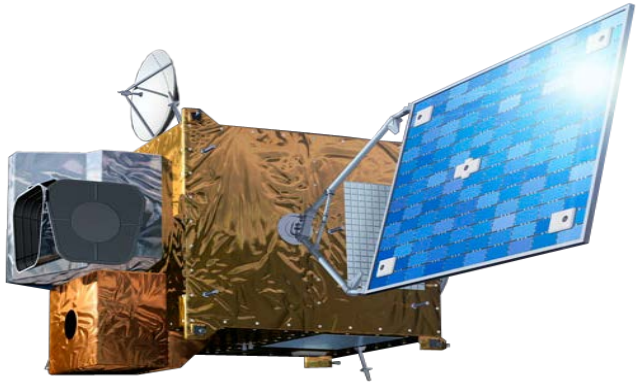
SENTINEL-4 ON MTG-S

SENTINEL-5 ON EPS-SG

YEAR... 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

EUMETSAT

Future programmes shape the 2018 – 2040 timeframe



MTG: Approved, under development
Sentinel-4 approved (funded by Copernicus)

Jason-CS/Sentinel-6:
Approval process ongoing

EPS-SG: Approved, under development
Sentinel-5 approved (funded by Copernicus)

Process for user requirements elaboration

User Needs

Should drive

User Requirements

Process for user requirements elaboration

Users

Can't always formulate

User Needs

Should drive

User Requirements

Are not always aware of

Process for user requirements elaboration

Users

Can't always formulate

User Needs

Should drive

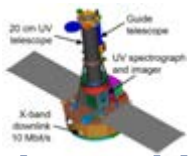
User Requirements

Trigger / justify evolution

Open possibilities

Constrain the fulfilment

Are not always aware of



Technological Capabilities

Process for user requirements elaboration

Users

Can't always formulate

User Needs

Know / translate

Should drive

Formulate

Experts

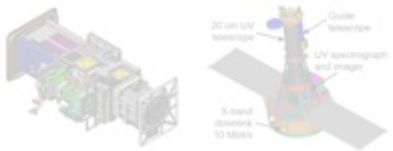
User Requirements

Trigger / justify evolution

Open possibilities

Constrain the fulfilment

Are not always aware of



Technological Capabilities

Consider

EUMETSAT

Process for user requirements elaboration

Users

Can't always formulate

User Needs

Know / translate

Should drive

Guide

Discuss / endorse

User Workshop

Formulate

Experts

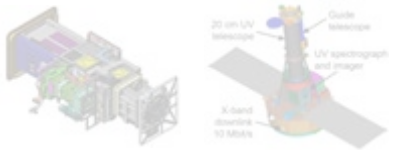
User Requirements

Trigger / justify evolution

Open possibilities

Constrain the fulfilment

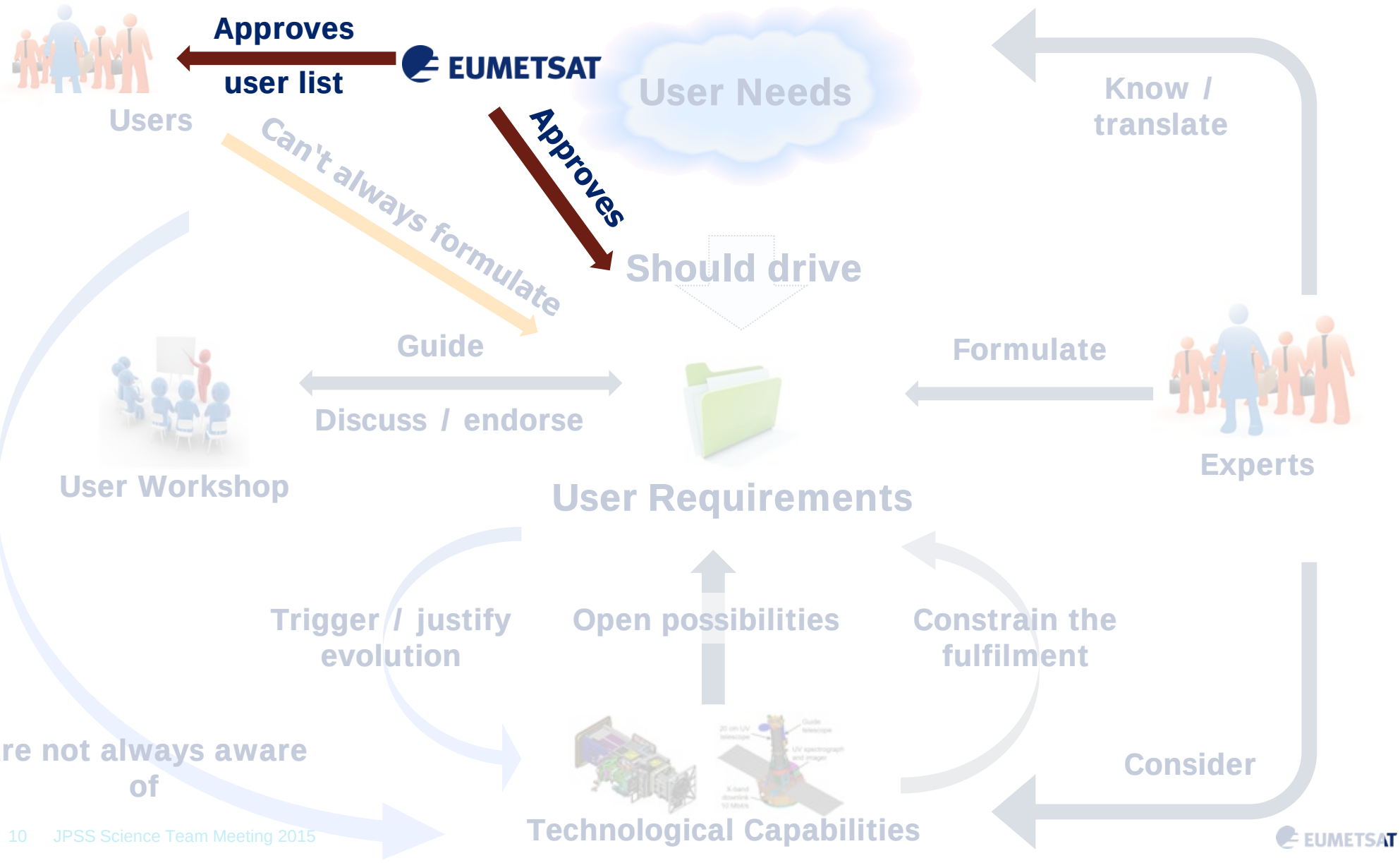
Are not always aware of



Technological Capabilities

Consider

Process for user requirements elaboration



Process for user requirements elaboration

Users

Approves user list

EUMETSAT

User Needs

Know / translate

Can't always formulate

Approves

Should drive

Guide

Discuss / endorse

User Workshop

User Requirements

Formulate

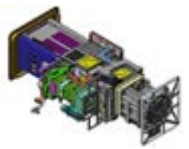
Experts

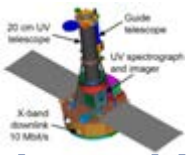
Trigger / justify evolution

Open possibilities

Constrain the fulfilment

Are not always aware of

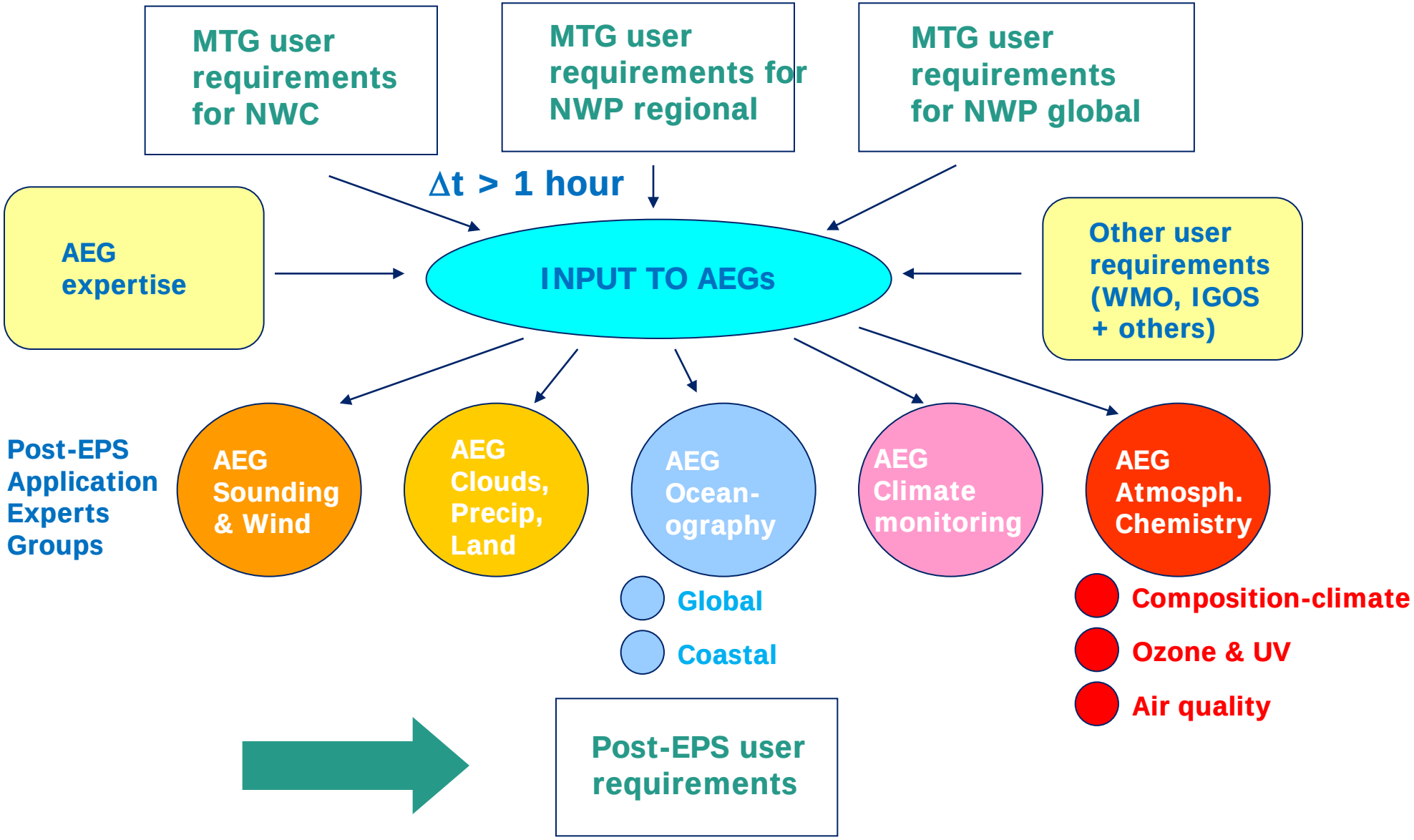




Technological Capabilities

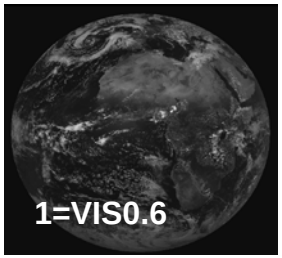
Consider

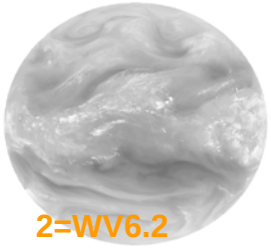
EUMETSAT

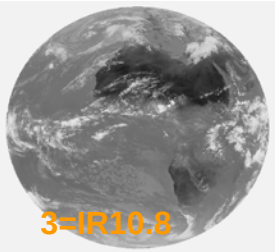

MTG user requirements for NWC
MTG user requirements for NWP regional
MTG user requirements for NWP global
Δt > 1 hour
AEG expertise
INPUT TO AEGs
Other user requirements (WMO, IGOS + others)
Post-EPS Application Experts Groups
AEG Sounding & Wind
AEG Clouds, Precip, Land
AEG Ocean-ography
AEG Climate monitoring
AEG Atmosph. Chemistry
Global
Coastal
Composition-climate
Ozone & UV
Air quality
Post-EPS user requirements

From MVIRI on MTP...

Meteosat-7 is the last
Located over
- Indian Ocean
Operational
- until end of 2016







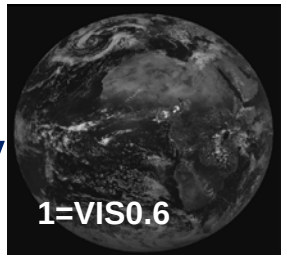
EUMETSAT

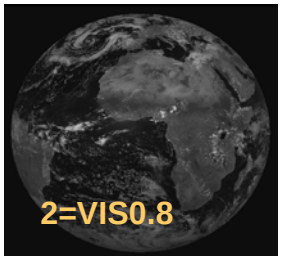
From MVIRI on MTP to SEVIRI on MSG...

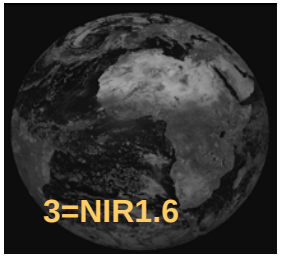
MSG-4 (Meteosat-11)
- is the last
- in-orbit storage 2.5 y

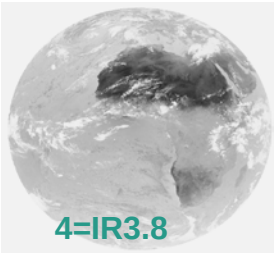
Indian Ocean Data
- coverage is considered using Meteosat-8

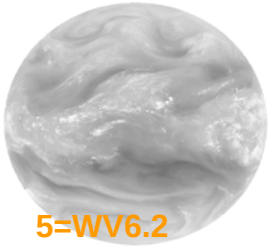
Operational programme
- until 2025 (TBC)

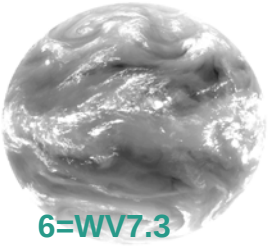


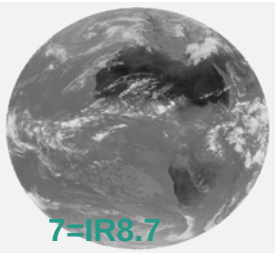


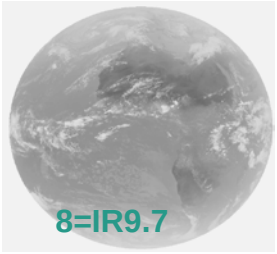


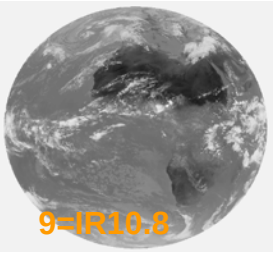


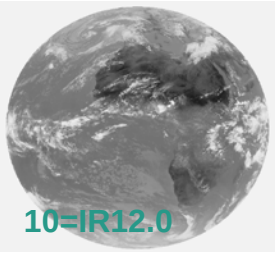


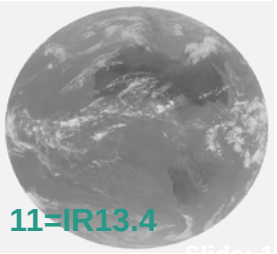






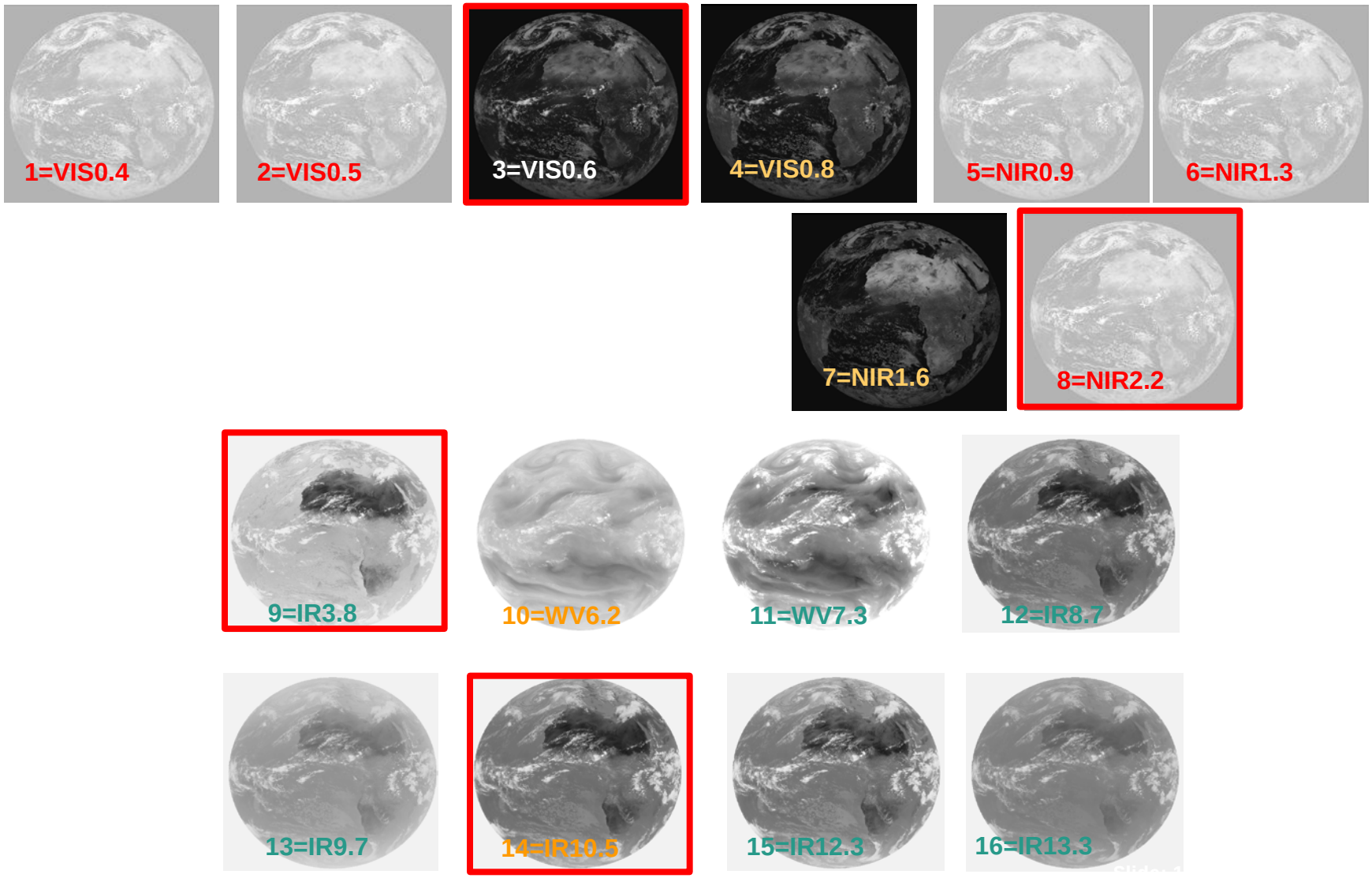






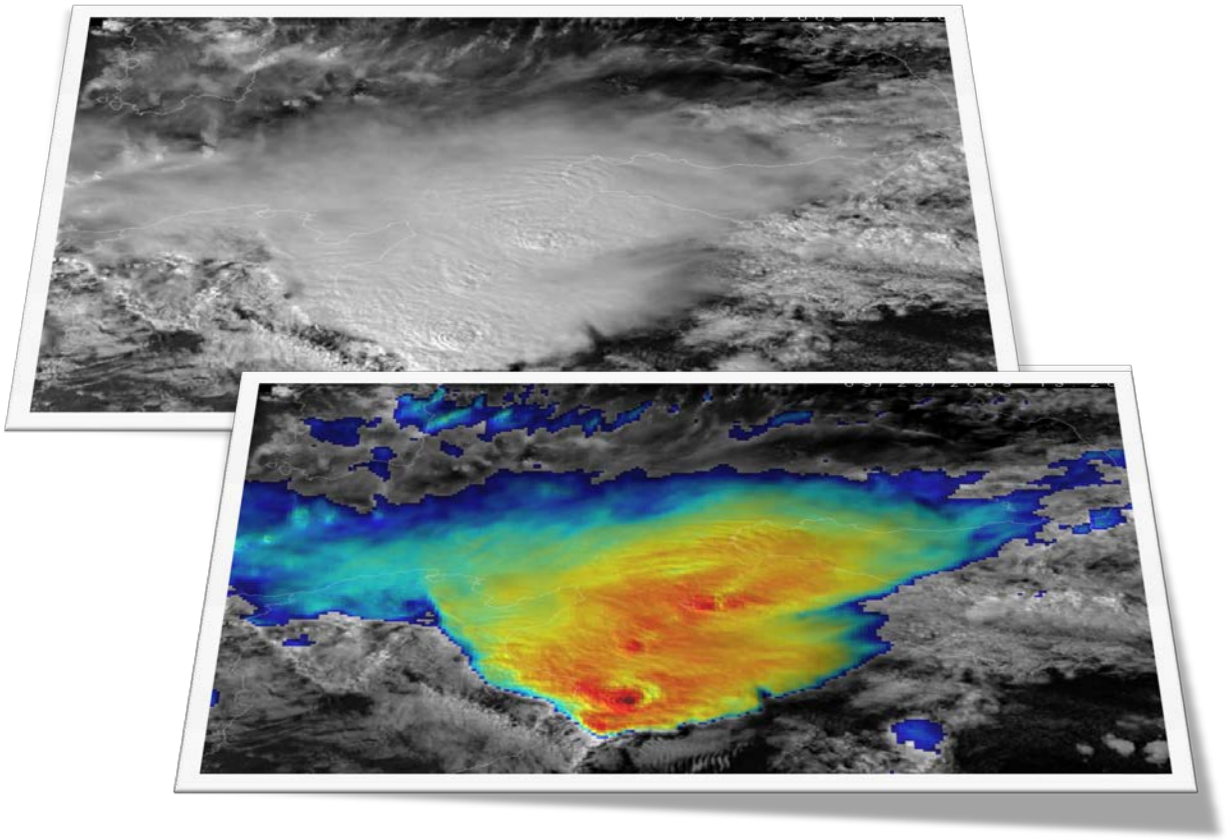
EUMETSAT

From MVIRI through SEVIRI to FCI on MTG

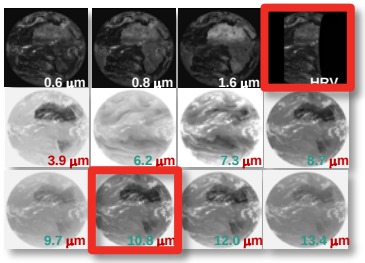


EUMETSAT

Visual Analysis: Monitoring Stages of Convection

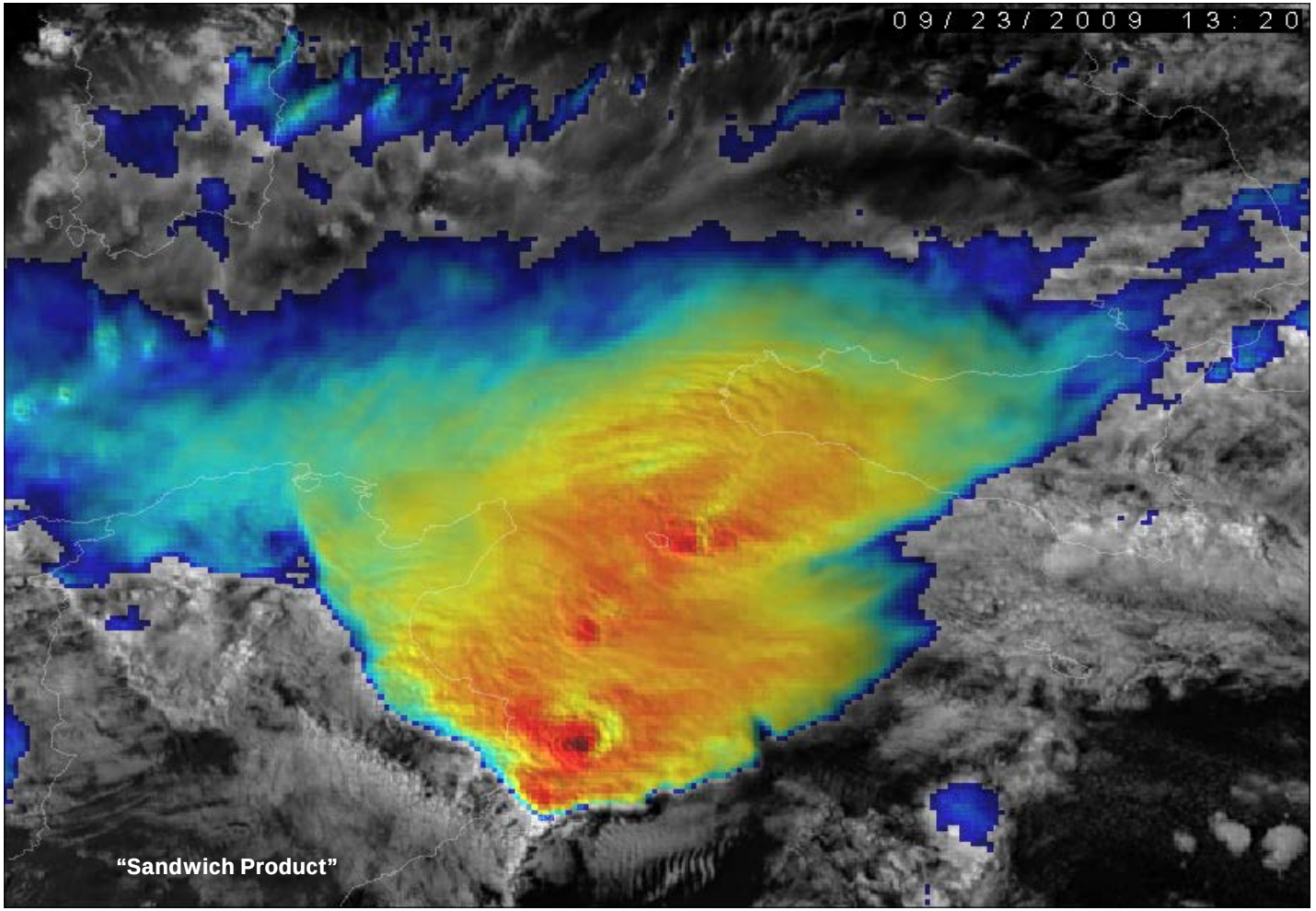


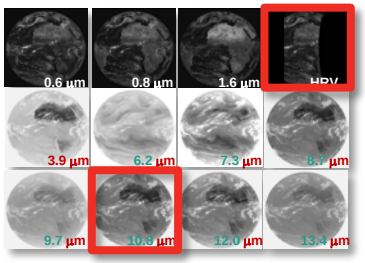
23. September 2009
Mediterranean Sea



EUMETSAT

Visual Analysis: Monitoring Stages of Convection

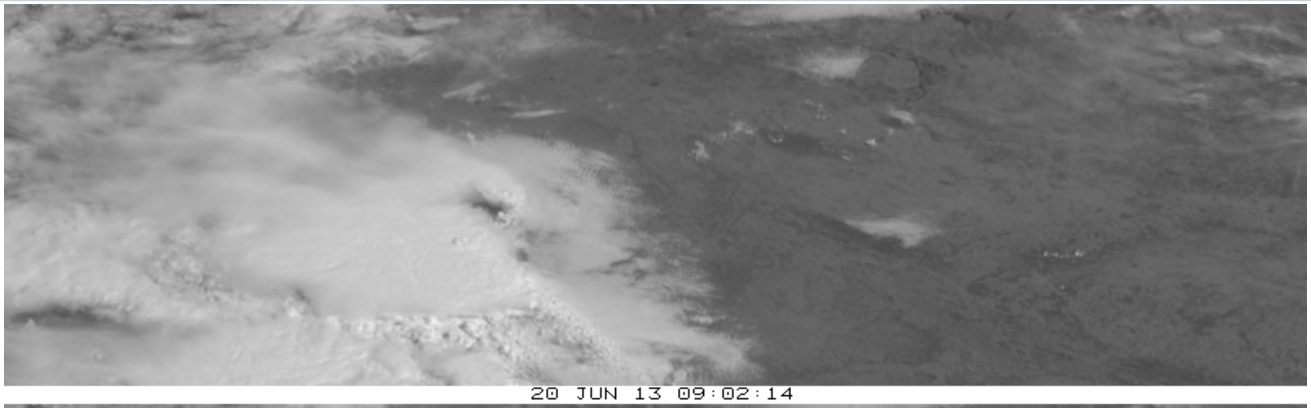




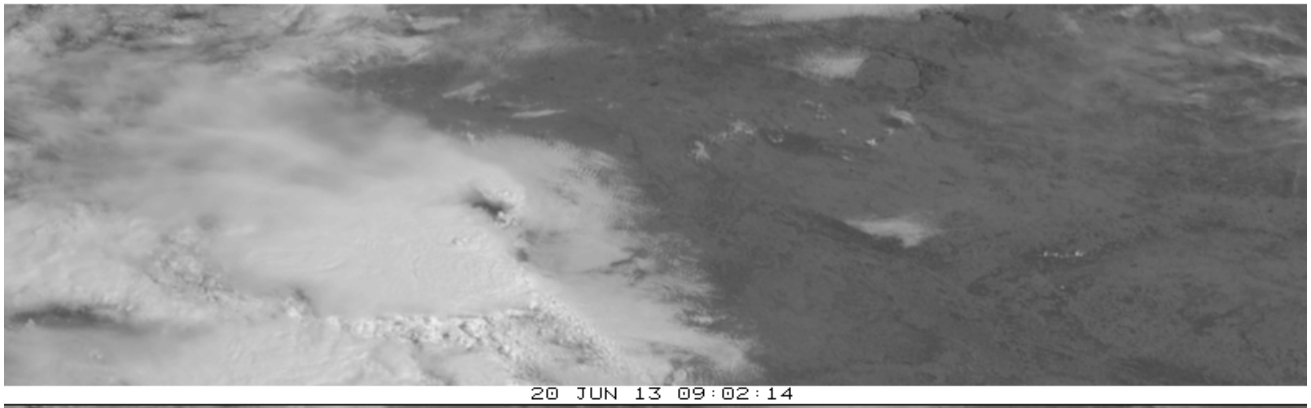
EUMETSAT

Met-8 super-rapid scans 2.5 min experiment

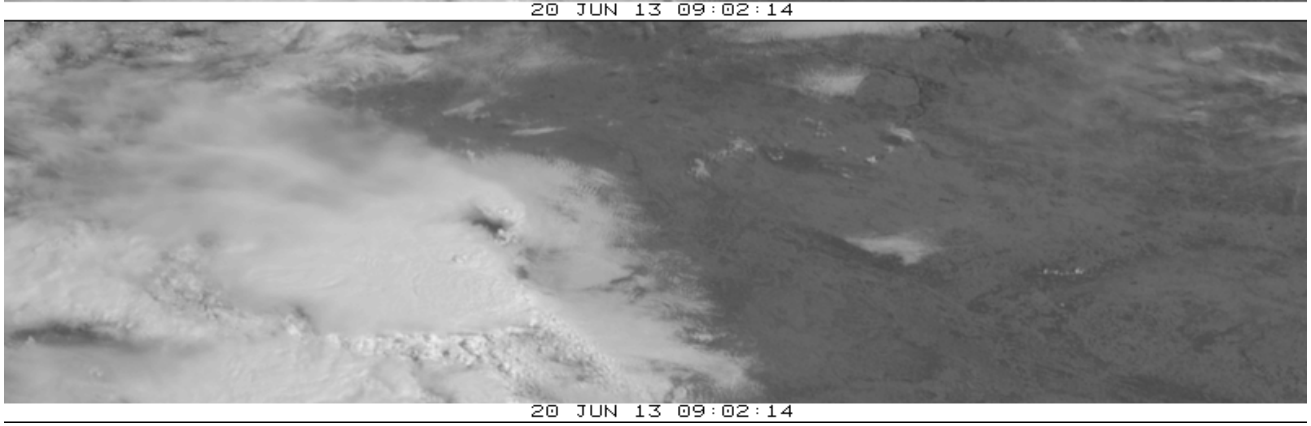
2.5 minutes Repeat Cycle



5 minutes Repeat Cycle



15 minutes Repeat Cycle



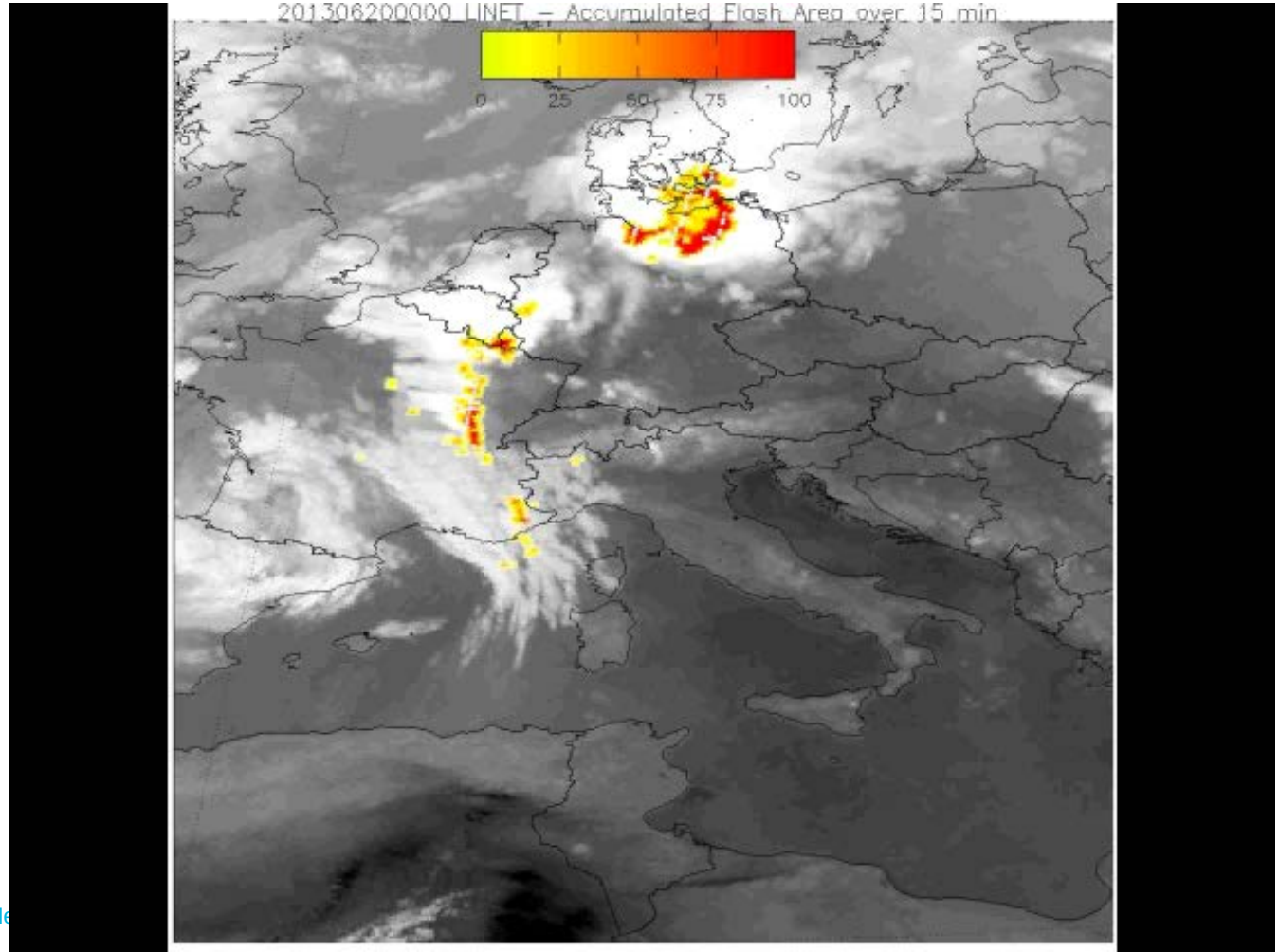
EUMETSAT

Meteosat Third Generation: Mission overview

- Imagery mission implemented by a two-satellite MTG-I system:
  1. Full disk imagery every 10 minutes in 16 spectral bands
  2. Fast imaging of European weather every 2.5 minutes
  3. Lightning Imager (LI)
- Hyperspectral Infrared (IRS) Sounding mission:
  4. 3D mapping of water vapour, temperature, O3 every 1 hour
  5. Air quality monitoring and atmospheric chemistry in synergy with Sentinel-4 Ultraviolet Visible
- start of operations in 2019 and 2021
- operational exploitation: 2019– 2040

LI reference processor development – product example

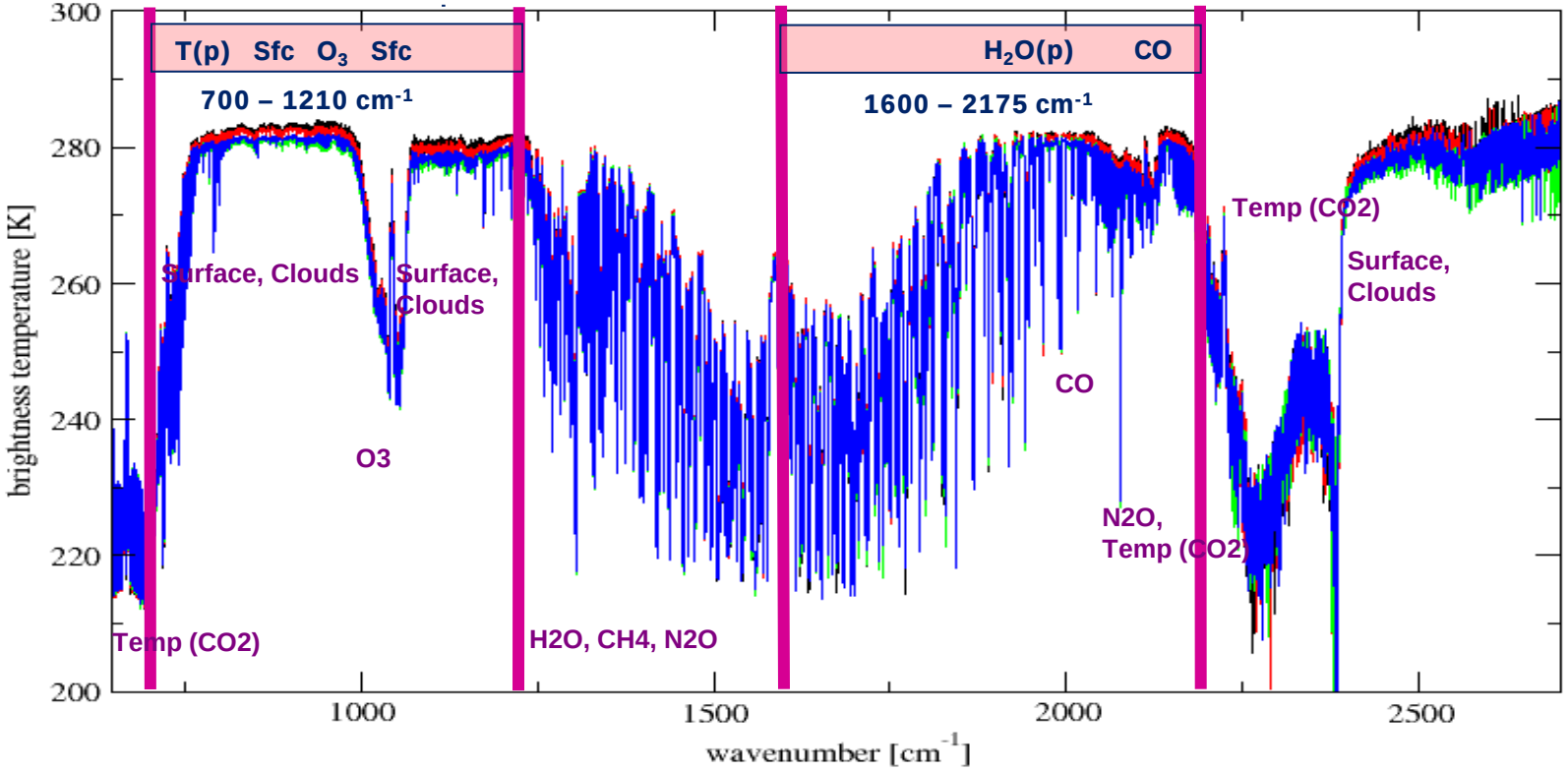
“Accumulated flash area” product, integrated over 15 minutes and updated every 30 seconds
Date: 20 June 2013.



EUMETSAT

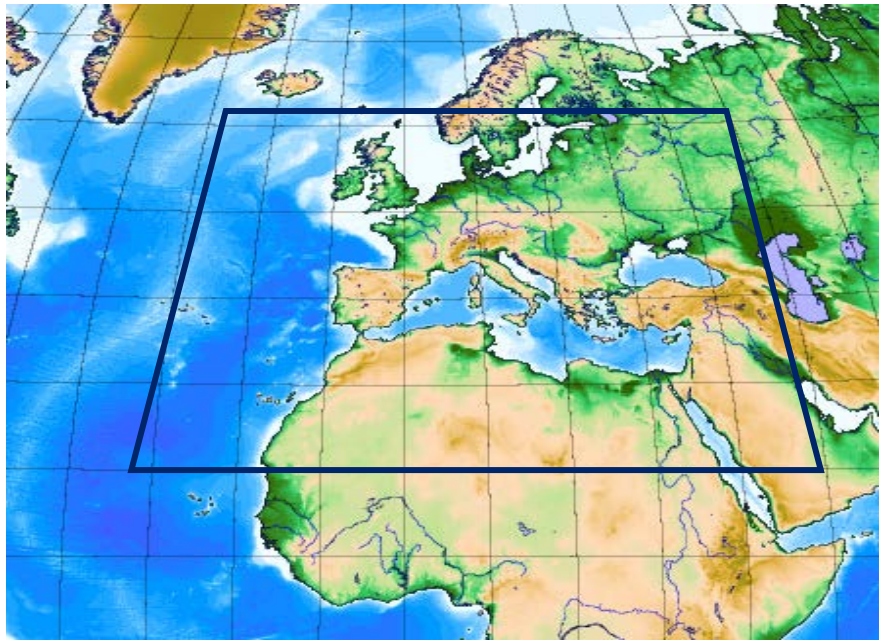
MTG Mission: InfraRed Sounder (IRS)

- MTG-IRS will deliver unprecedented information on horizontal and vertical gradients of moisture, wind and temperature from the geostationary orbit:
  - Full Disk Sounding;
  - Repeat Cycle = 60 min;
  - spatial resolution of 4 km,
  - hyperspectral soundings at 0.625 cm-1 spectral sampling in two bands:
    - Long-Wave-IR (LWIR: 700 – 1210 cm-1 ~820 spectral samples)
    - Mid-Wave-IR (MWIR: 1600 – 2175 cm-1 ~920 spectral samples)

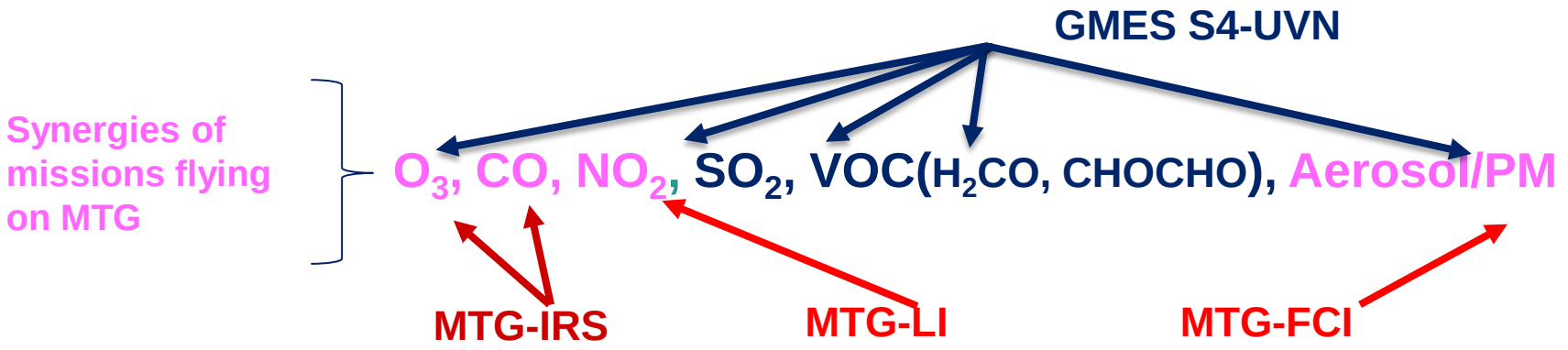


EUMETSAT

MTG Mission: hosting GMES Sentinel-4



- The GMES Sentinel-4 sounding mission is achieved through the Ultraviolet, Visible & Near-infrared (UVN) Instrument accommodated on the MTG-S satellites
  - covering Europe every hour
  - taking measurements in three spectral bands (UV: 305 - 400 nm; VIS: 400 - 500 nm, NIR: 750 - 775 nm)
  - with a resolution around 8km.
- The primary data products are O3, NO2, SO2, HCHO and aerosol optical depth.

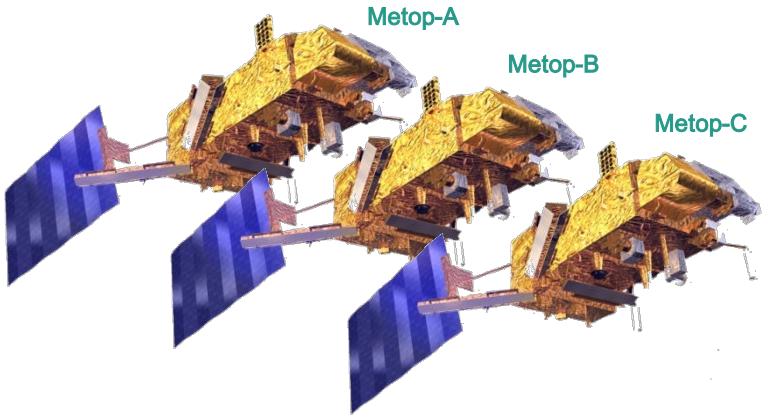


EUMETSAT

EUMETSAT Polar System Programme

Polar Stations
Svalbard, 78 deg North

Launcher Service
(Soyuz, Baikonur)



LEOP Service
(ESOC)

EUMETSAT
Mission Control Centre

Satellite Application
Facilities (SAF)
8 Meteorological Themes

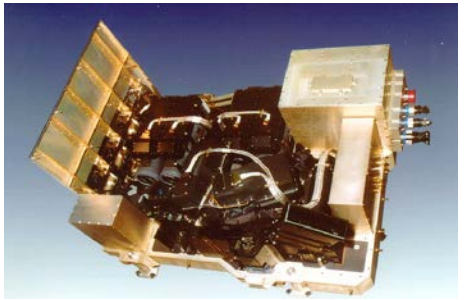
- Metop-A launched in 2006
- Metop-B launched in 2012
- Metop-C launch scheduled for 2019
- Sun Synchronous orbit
- 820 km, 9h30 LST,100 min
- Sole source of mid-morning orbit data
- 11 Instruments
- Soyuz Launcher Service (Baikonur/Kourou)
- ESOC LEOP Service (Darmstadt)
- Central & distributed Ground Segment components
- 14+ years of operations

EUMETSAT

The EUMETSAT polar system as part of the initial joint polar system shared with the US

- Coordinated programmes
- Exchange of instruments
- Coordinated operations, data and services
- Only Metop provides mid-morning service
- And now China has committed to the early morning orbit

Current Capabilities - EUMETSAT Polar System



AVHRR
Advanced Very High Resolution Radiometer

HIRS/4
High-resolution Infrared Radiation Sounder

IASI
Infrared Atmospheric Sounding Interferometer

AMSU-A1
Advanced Microwave Sounding Unit-A1

MHS
Microwave Humidity Sounder

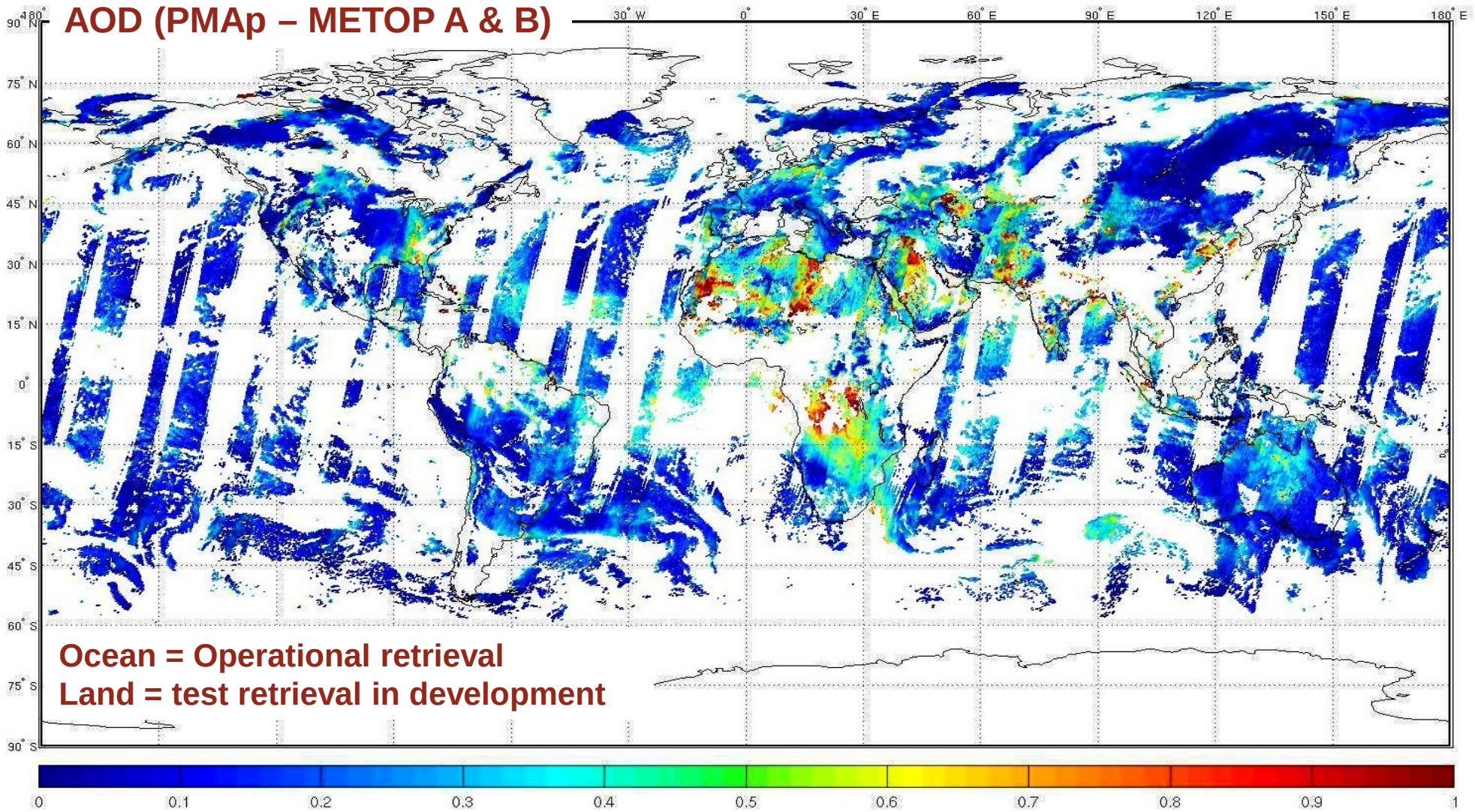
GRAS
GPS Receiver for Atmospheric Sounding

GOME-2
Global Ozone Monitoring Experiment

AMSU-A2
Advanced Microwave Sounding Unit-A2

ASCAT
Advanced SCATterometer

Aerosol: PMAp (GOME-2 + AVHRR) Metop A & B combined



EUMETSAT

Metop-B is in the same orbital plane as Metop-A

Morning Orbit

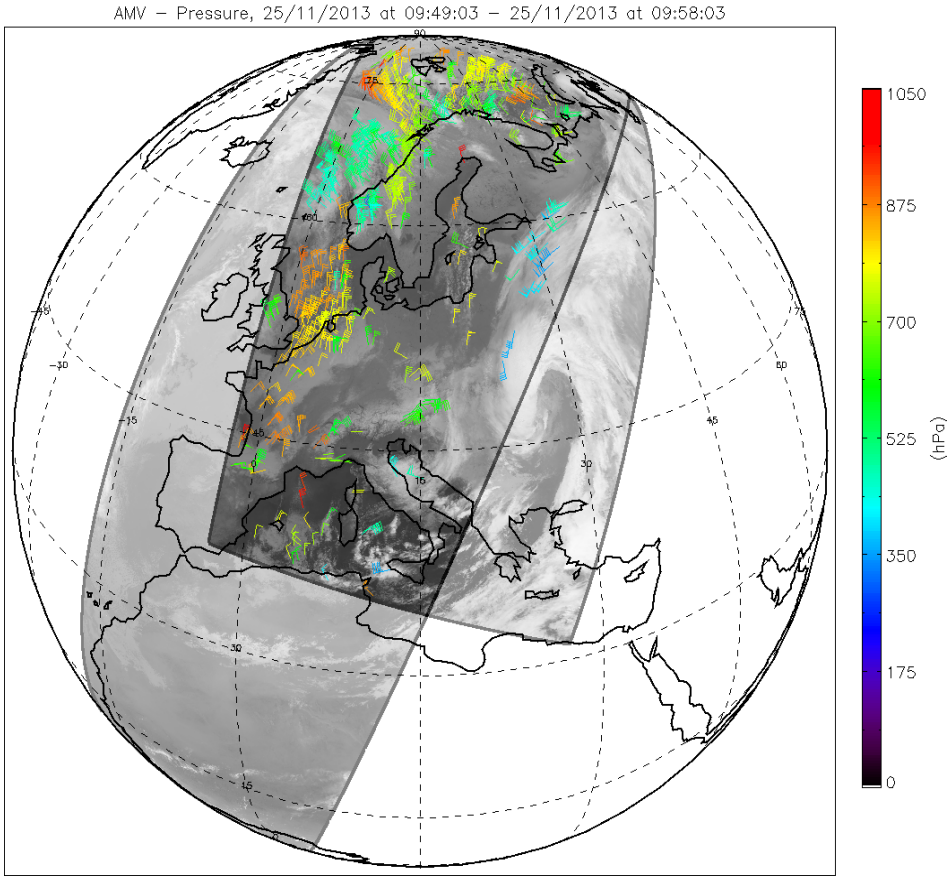
Equator crossing time: 09:30 LST
Orbit phasing: 48.93 min.

Metop-C in 2018

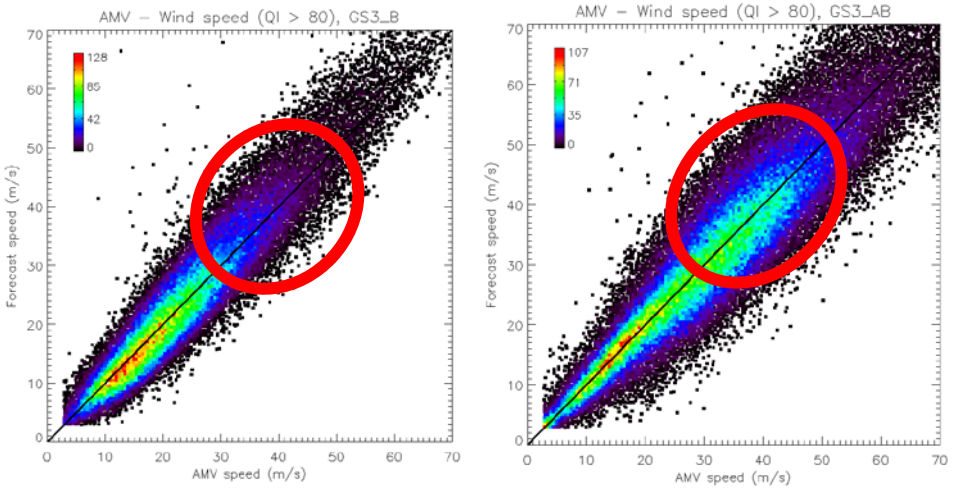
EUMETSAT

Dual Metop winds:
Global coverage and quality improvement in polar regions

Global dual Metop winds



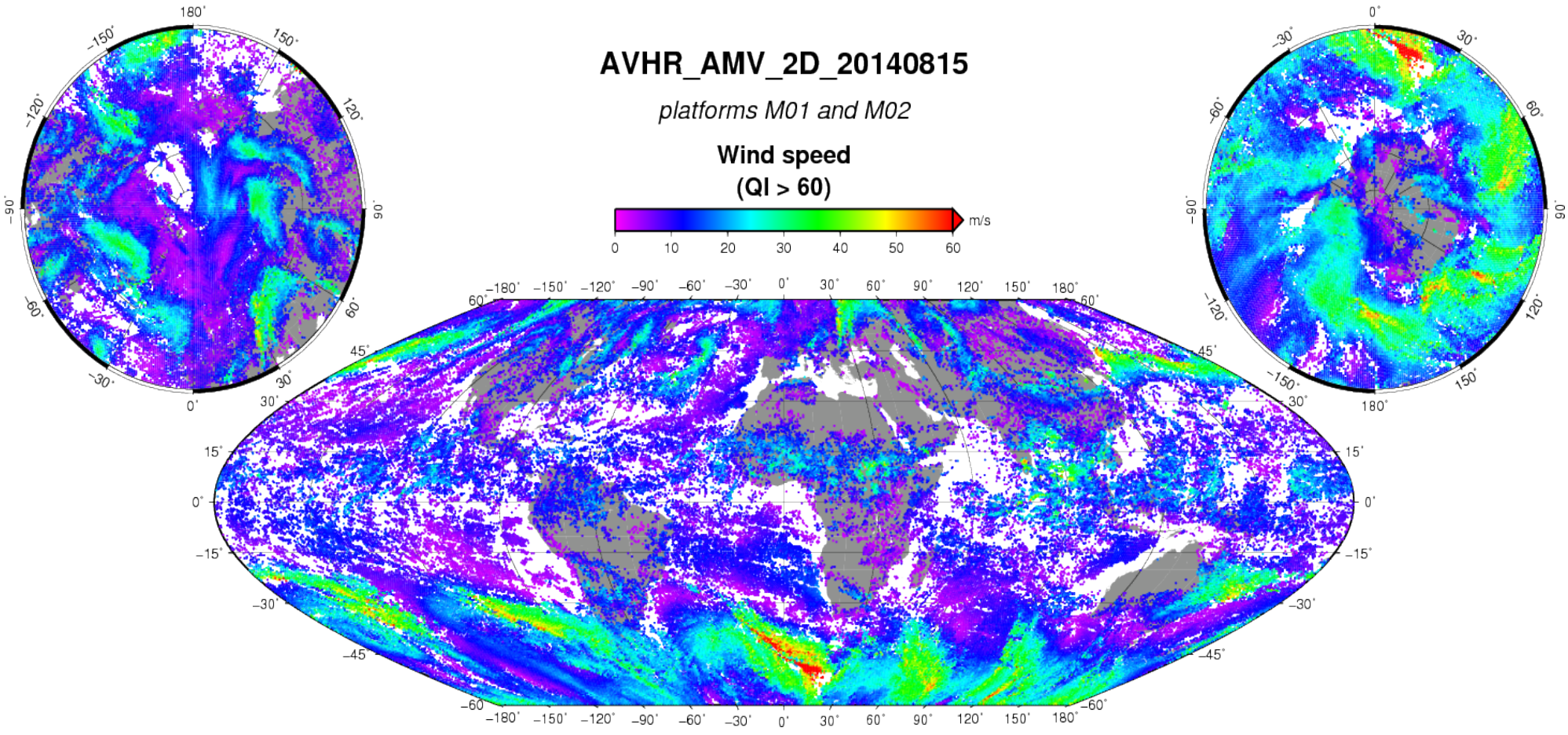
Metop winds over South Pole (QI>80)



One Metop **Dual Metop**

EUMETSAT

EUMETSAT dual Metop winds: Global coverage



Bin size = 80x80 km²

EUMETSAT

EPS Second Generation

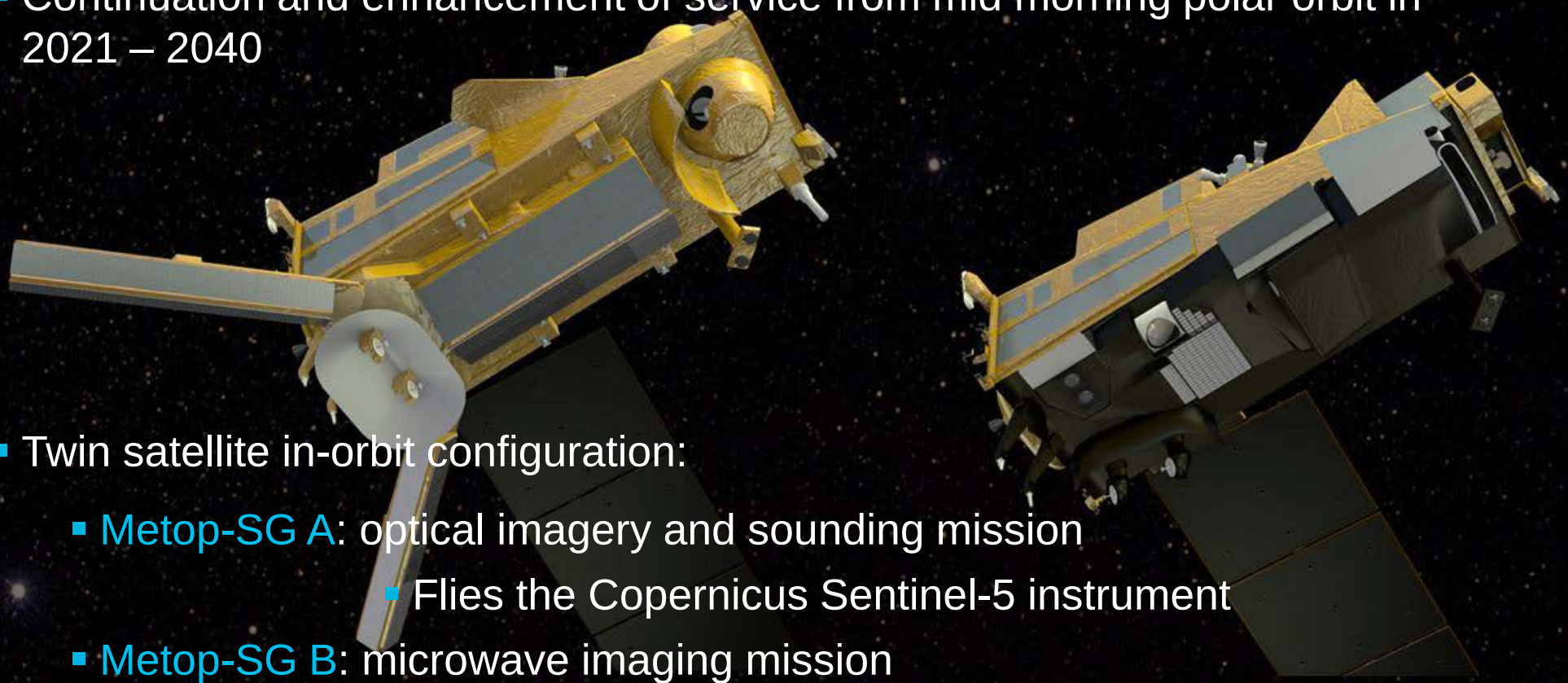
- Primary mission: further improve observational inputs to Numerical Weather Prediction models

- Significant contributions to other real time applications:
  - Nowcasting at high latitudes
  - Marine meteorology and operational oceanography
  - Operational hydrology
  - Air quality monitoring

- Climate monitoring: expand by 20+ years the climate data records initiated in 2006 with EPS

EPS Second Generation

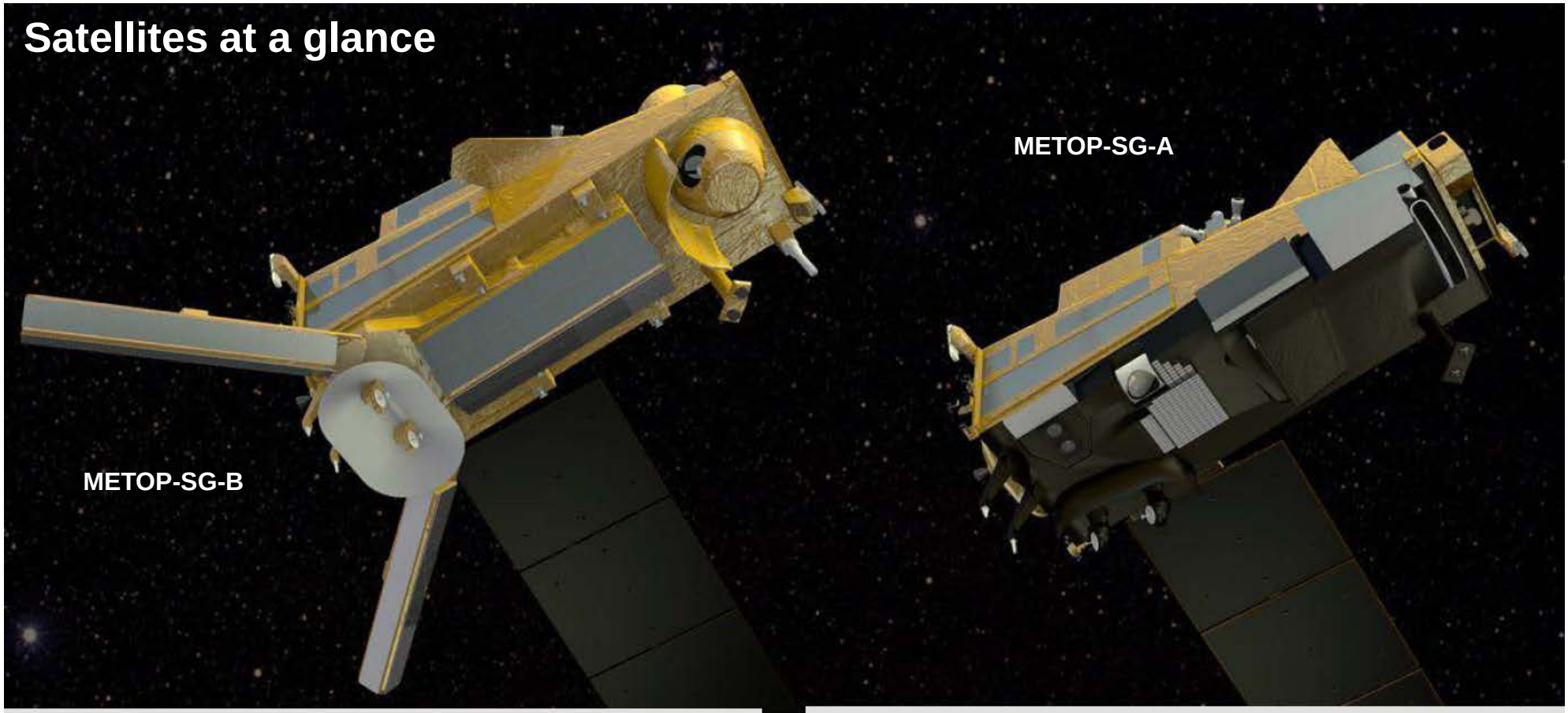
- Continuation and enhancement of service from mid morning polar orbit in 2021 – 2040



- Twin satellite in-orbit configuration:
  - Metop-SG A: optical imagery and sounding mission
    - Flies the Copernicus Sentinel-5 instrument
  - Metop-SG B: microwave imaging mission
- Two series of 3 successive satellites for 21 years of operations
- European contribution to the Joint Polar System (JPS) shared with the US/NOAA

EPS Second Generation

Satellites at a glance



METOP-SG-B

- Launch mass = 3.79 tons
- Mean power consumption = 2.7 kW
- Data rate = day / night / peak
  14 / 14 / 17 Mbps

METOP-SG-A

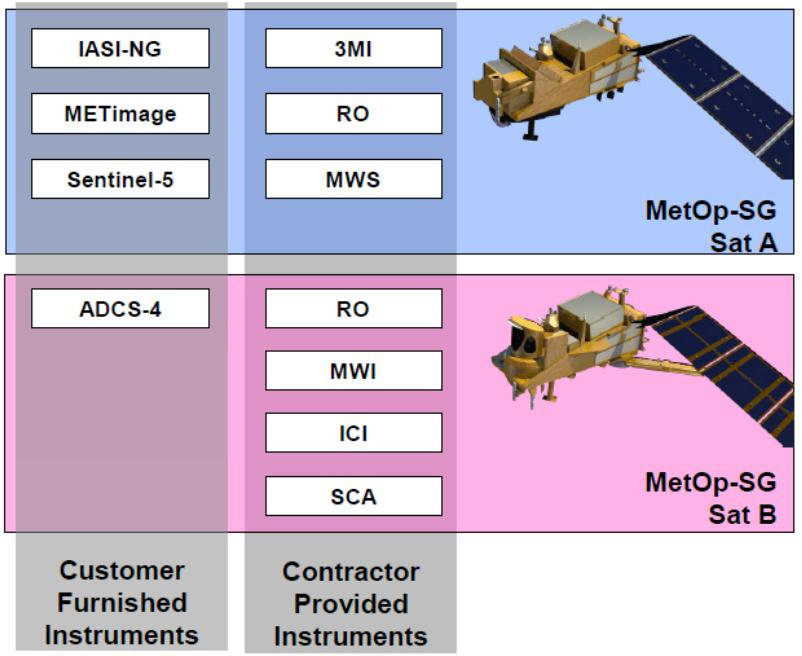
- Launch mass = 4,08 tons
- Mean power consumption = 3.4 kW
- Data rate = day / night / peak
  60 / 22 / 77 Mbps

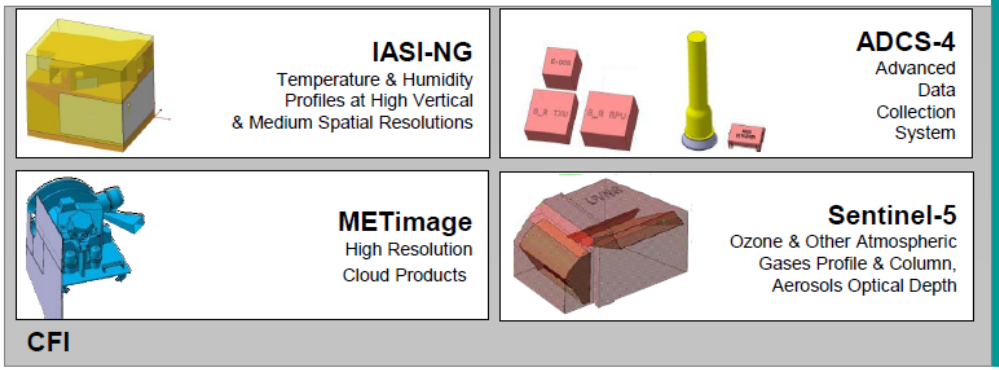
- Launcher: Soyuz in Kourou / Falcon 9 / Ariane 5
- Orbit: MetOp Sun Synchronous Orbit 817 km, 9h30 Local Time at Descending Node
- Controlled re-entry into the South Pacific Ocean Uninhabited Area

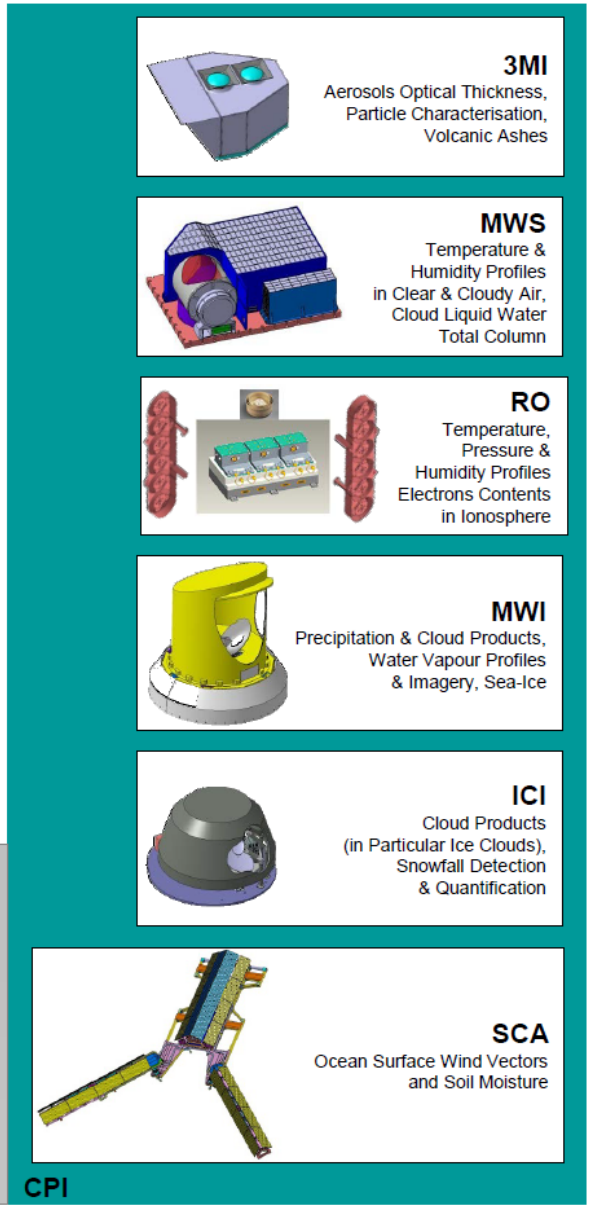
EUMETSAT

EPS Second Generation Instruments' Overview

Distribution of Instruments per Satellite





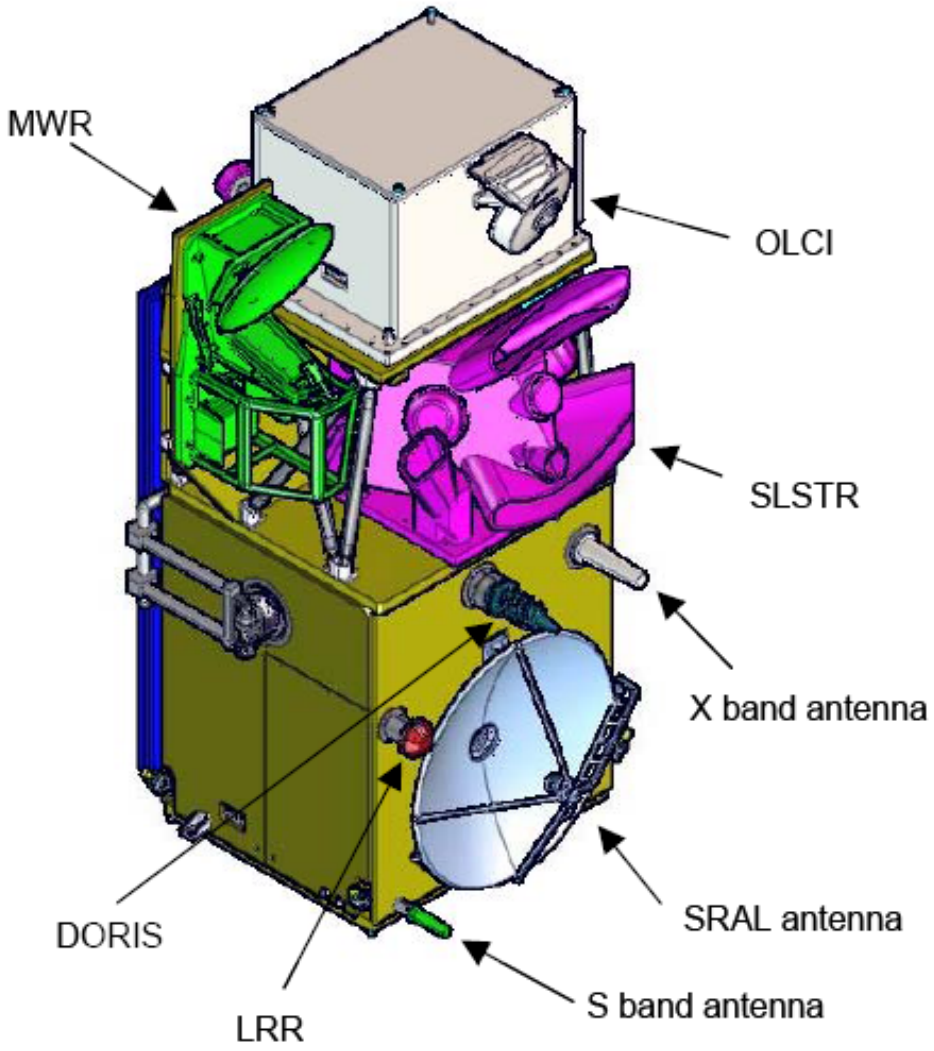


EPS-SG Current Status

- Achieved approval of the scope and contents of the EPS-SG Programme Proposal which includes the draft cooperation agreements with ESA, CNES, DLR and NOAA
- Achieved in June 2015 approval of full EPS-SG programme from January 2016 onwards
- System Preliminary Design Review (PDR) successfully completed in June 2015
- ESA: Prime contractors for the Metop-SG A and B satellites selected and Phase B2 kicked off in June 2014, PDR planned for September 2015
- CNES: IASI-NG PDR successfully completed in May 2015
- CNES: The first flight model of A-DCS4 for EPS-SG is under assembly
- DLR: METimage instrument PDR successfully completed in July 2015
- EUM: Overall Ground Segment PDR planned for September 2015

MONITORING THE OCEAN IN SUPPORT OF COPERNICUS

Sentinel-3 Satellite and Payload

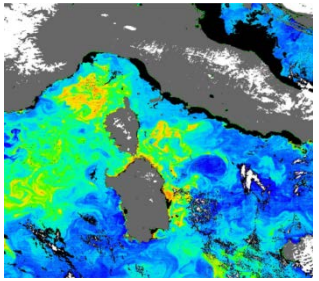


- SLSTR: Sea and Land Surface Temperature Radiometer
- SRAL: Synthetic Aperture Radar Altimeter
- OLCI: Ocean and Land Colour Instrument
- MWR: Micro-Wave Radiometer
- LRR: Laser Retro-Reflector
- DORIS: Doppler Orbitography and Radiopositionning Integrated by Satellite
- STM: Surface Topography Mission = SRAL + MWR

Sentinel-3 Marine product contents

Level 1B: SLTSR (radiance, BT at TOA) and OLCI (radiance at TOA) and SRAL(waveforms)

(ESA and EUMETSAT)



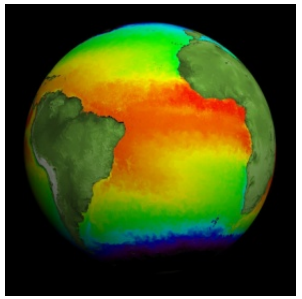
Level 2 OLCI:

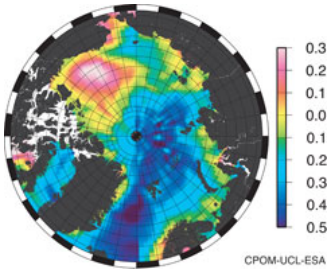
- Normalised water surface reflectance
- Algal pigment concentration for open and for coastal waters
- Total suspended matter concentration
- Diffuse attenuation coefficient
- Coloured dissolved matter absorption
- Photosynthetically active radiation
- Integrated water vapour
- Aerosol optical depth
- Aerosol Angström exponent

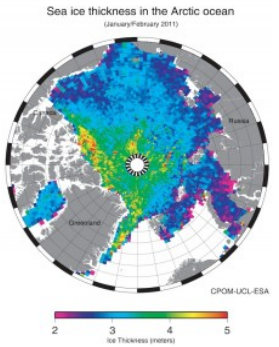
Level 2 SLTSR:

- Sea surface temperature

(L2P GHRSST standard)





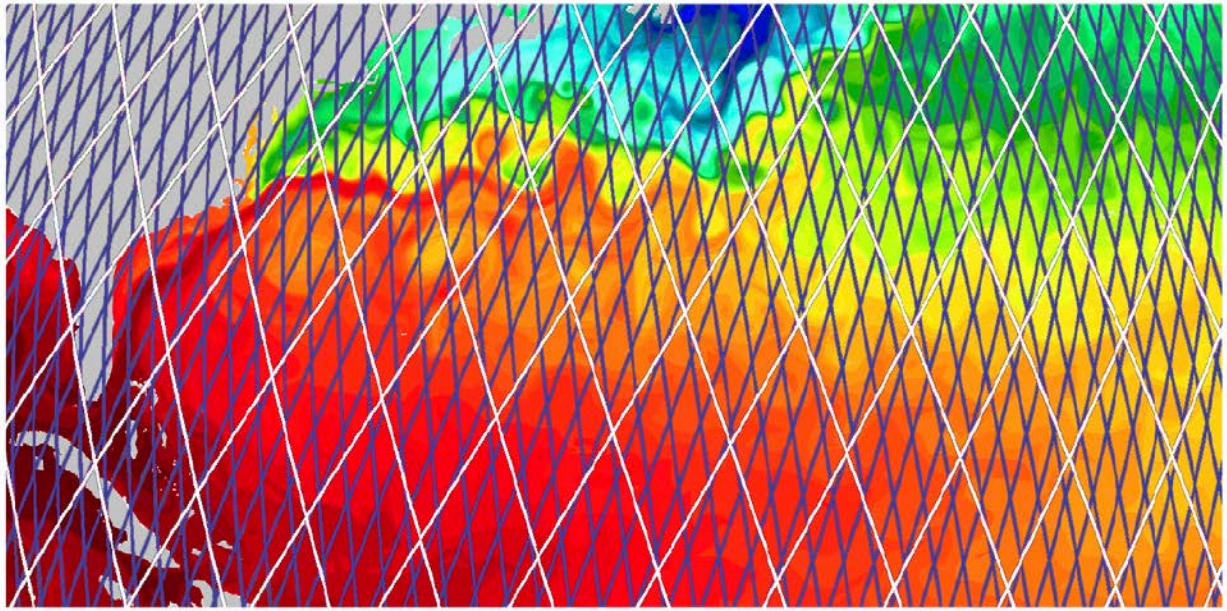


Level 2 SRAL:

- Sea/coastal zone surface height
- Significant wave height
- Wind speed
- Backscatter coefficient σ_0
- Sea ice height, freeboard
- Total water, liquid water (from MWR)

EUMETSAT

Combining Sentinel-3 & Jason altimetry for operational oceanography and climate change monitoring

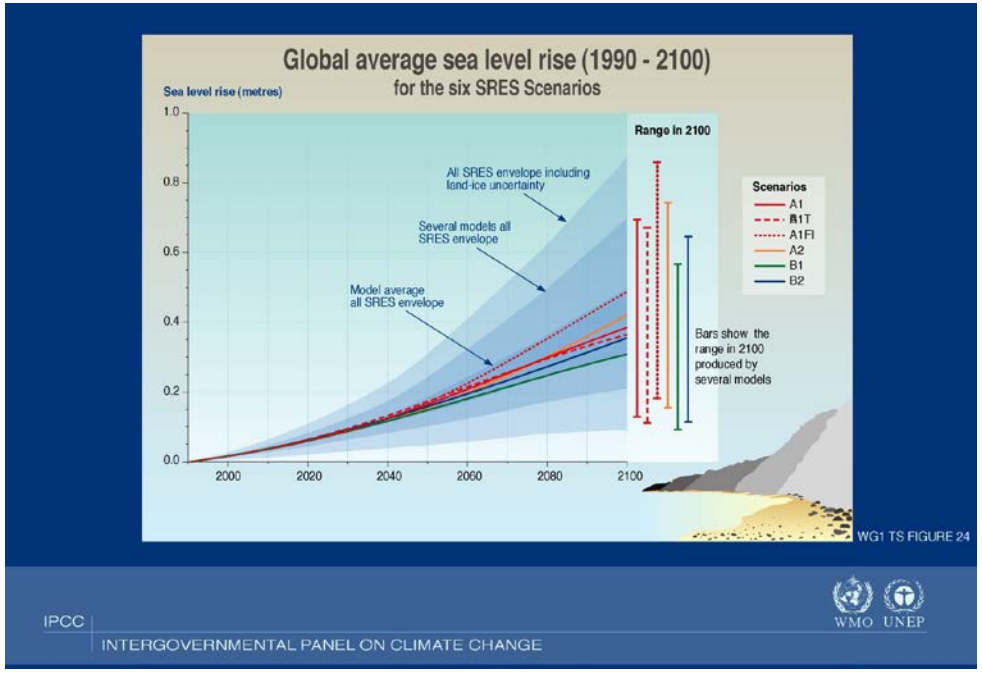


(Courtesy CNES/CLS/ESA)

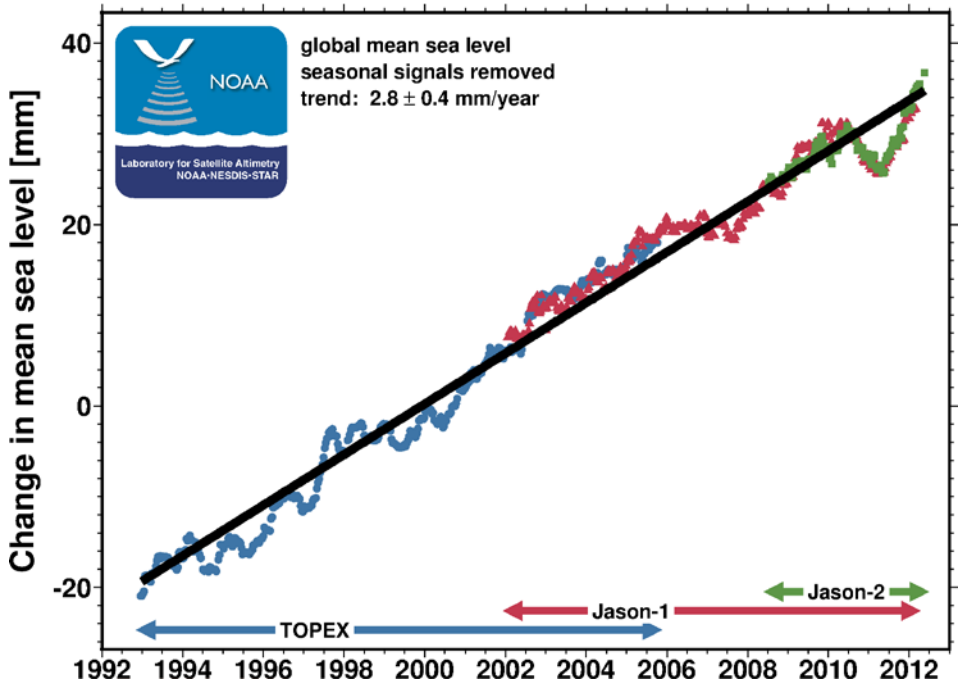
EUMETSAT

From Jason-2 to Jason- 3, Jason-CS: Global sea level rise

IPCC projections: Uncertainties



Observational evidence: Unique Climate Data Record

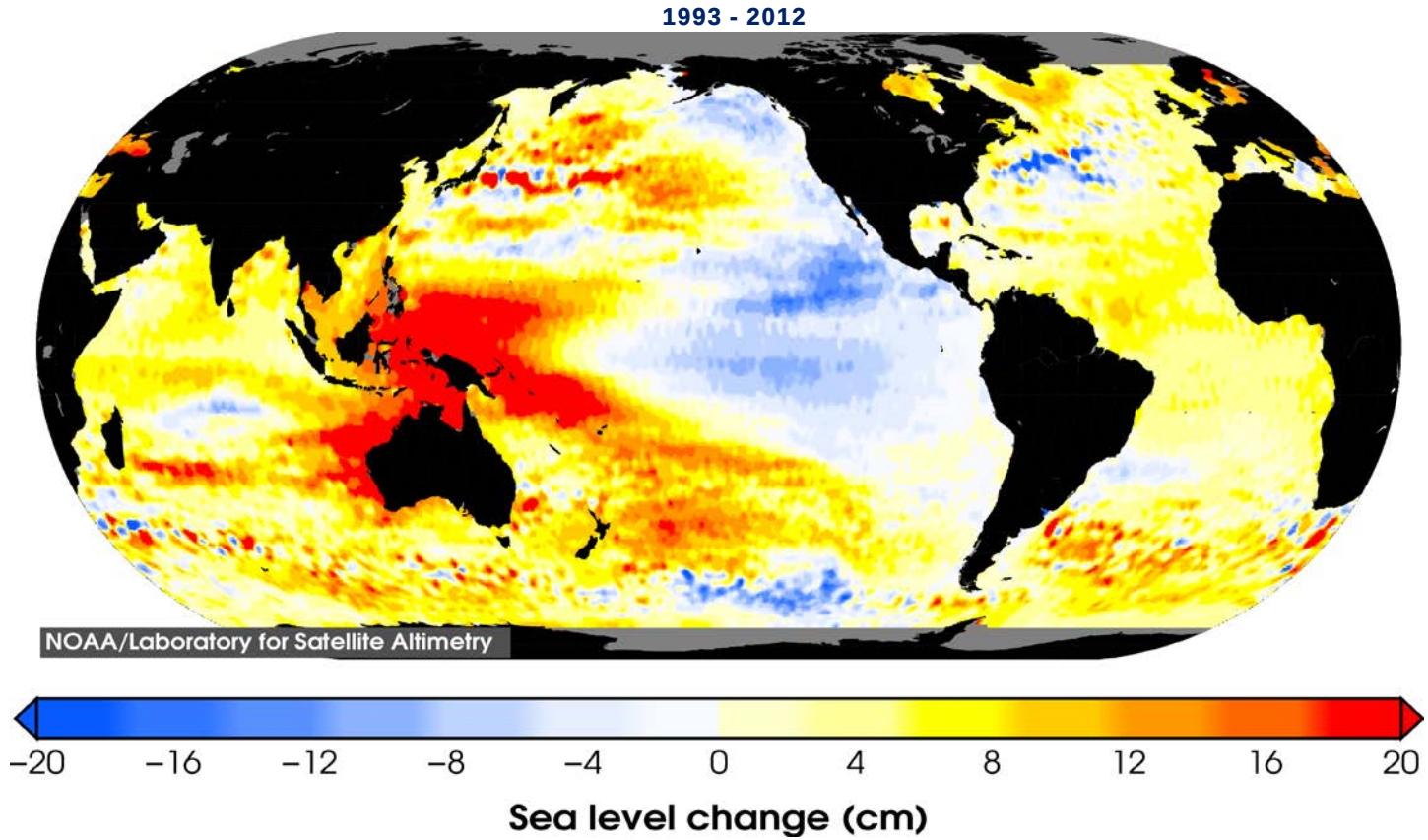


Global mean sea level during the altimetry era has risen at a nearly constant rate since 1993 (+- 3 mm/year) .

Relatively consistent despite large regional interannual variations and accelerations in the melting of land ice.

EUMETSAT

Mean sea level trends : regional differences



- Why has the western Pacific risen 3 times faster?
- Why has sea level dropped near the U.S. West Coast?
- How will regional sea level change in the future?

PRODUCT STATUS AND SCIENCE MATURITY

Product Status

STATUS	DEMONSTRATIONAL	PRE-OPERATIONAL	OPERATIONAL
PRODUCT QUALITY	**First version of the Product**	**Quality approaching to expected levels**	**Expected Quality (as per Requirements)**
STATUS OF VALIDATION PROCESS	Limited Validation performed	Validation almost completed (if not completed), with documented limitations	Validation performed and fully documented
PRODUCT LIMITATIONS	Potentially unknown or Major	Known & Not Major or None	None or Known limitations agreed with Users
PRODUCT DOCUMENTATION	Product Validation report & User manual Not Available	Product Validation report & User manual (mainly) completed	All completed, published and available
AUDIENCE	Internal Users + Investigators Usually not more than a very limited set of users	Varying from 'limited set of Users' to 'All Registered Users'	Usually 'All Registered Users' (unless exceptions)
ACCESS BY EXTERNAL USERS	No Access to the Documentation	Documentation on the WEB	Documentation on the WEB

CDR Maturity Matrix - Top Layer

			CDR Name Here			Maturity level as of mm/dd/yyyy
Maturity	**Software Readiness**	**Metadata**	**Documentation**	**Product Validation**	**Public Access**	**Utility**
1	Conceptual development	Little or none	Draft Climate Algorithm Theoretical Basis Document (C-ATBD); paper on algorithm submitted	Little or None	Restricted to a select few	Little or none
2	Significant code changes expected	Research grade	C-ATBD Version 1+ ; paper on algorithm reviewed	Minimal	Limited data availability to develop familiarity	Limited or ongoing
3	Moderate code changes expected	Research grade; Meets int'l standards: ISO or FGDC for collection; netCDF for file	Public C-ATBD; Peer-reviewed publication on algorithm	Uncertainty estimated for select locations/times	Data and source code archived and available; caveats required for use.	Assessments have demonstrated positive value.
4	Some code changes expected	Exists at file and collection level. Stable. Allows provenance tracking and reproducibility of dataset. Meets international standards for dataset	Public C-ATBD; Draft Operational Algorithm Description (OAD); Peer-reviewed publication on algorithm; paper on product submitted	Uncertainty estimated over widely distributed times/location by multiple investigators; Differences understood.	Data and source code archived and publicly available; uncertainty estimates provided; Known issues public	May be used in applications; assessments demonstrating positive value.
5	Minimal code changes expected; Stable, portable and reproducible	Complete at file and collection level. Stable. Allows provenance tracking and reproducibility of dataset. Meets international standards for dataset	Public C-ATBD, Review version of OAD, Peer-reviewed publications on algorithm and product	Consistent uncertainties estimated over most environmental conditions by multiple investigators	Record is archived and publicly available with associated uncertainty estimate; Known issues public. Periodically updated	May be used in applications by other investigators; assessments demonstrating positive value
6	No code changes expected; Stable and reproducible; portable and operationally efficient	Updated and complete at file and collection level. Stable. Allows provenance tracking and reproducibility of dataset. Meets current international standards for dataset	Public C-ATBD and OAD; Multiple peer-reviewed publications on algortihm and product	Observation strategy designed to reveal systematic errors through independent cross-checks, open inspection, and continuous interrogation; quantified errors	Record is publicly available from Long-Term archive; Regularly updated	Used in published applications; may be used by industry; assessments demonstrating positive value

Maturity Matrix – Validation Layer Guideline

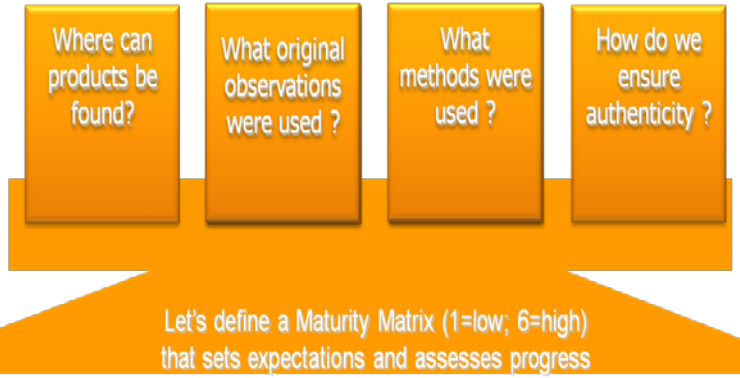
Maturity	PRODUCT VALIDATION	Independent validation	Uncertainty (for TCDRs)	Quality flag	Operational monitoring
1	Little or None	Incomplete	Little or no information on biases and errors	None	Incomplete
2	Minimal	Comparison to training set, test dataset, or previous product	Limited information on biases and errors	Data gaps identified or flagged as appropriate	Incomplete
3	Uncertainty estimated for select locations/times	At least 1 comparison to models, in-situ data, or other indpendent products as available and appropriate to particular CDR	Biases and errors identified and documented	Data gaps identified or flagged as appropriate; Masks applied as appropriate (e.g., land masks, cloud masks)	Incomplete
4	Uncertainty estimated over widely distributed times/location by multiple investigators; Differences understood.	At least 2 comparisons to models, in-situ data, or other indpendent products as available and appropriate to particular CDR; differences in results understood	Biases and errors quantified	Masks applied as appropriate (e.g., land masks, cloud masks); algorithm failures identified	Method for operational monitoring being developed
5	Consistent uncertainties estimated over most environmental conditions by multiple investigators	At least 5 comparisons to models, in-situ data, or other indpendent products as available and appropriate to particular CDR; differences in results understood	Biases and errors minimized	Masks applied as appropriate (e.g., land masks, cloud masks); algorithm failures identified; instrument degradation flags applied	Operational monitoring in place
6	Observation strategy designed to reveal systematic errors through independent cross-checks, open inspection, and continuous interrogation; quantified errors	At least 10 comparisons to models, in-situ data, or other indpendent products as available and appropriate to particular CDR; observation strategy designed to reveal systematic errors through independent cross checks, open inspection, and continuous interrogation	Biases and errors minimized	Masks applied as appropriate (e.g., land masks, cloud masks); algorithm failures identified; instrument degradation flags applied. Additional flags or modification of flag algorithms as a result of additional validation and user feedback	Operational monitoring in place with results fed back to quality flags

As an example ERA-Interim

Maturity	Software Readiness	Metadata	Documentation	Product Validation	Public Access	Utility
1	Conceptual development	Little or none	Draft Climate Algorithm Theoretical Basis Document (C-ATBD); paper on algorithm submitted	Little or None	Restricted to a select few	Little or none
2	Significant code changes expected	Research grade	C-ATBD Version 1+ ; paper on algorithm reviewed	Minimal	Limited data availability to develop familiarity	Limited or ongoing
3	Moderate code changes expected	Research grade; Meets int'l standards: ISO or FGDC for collection; netCDF for file	Public C-ATBD; Peer-reviewed publication on algorithm	Uncertainty estimated for select locations/times	Data and source code archived and available; caveats required for use.	Assessments have demonstrated positive value.
4	Some code changes expected	Exists at file and collection level. Stable. Allows provenance tracking and reproducibility of dataset. Meets international standards for dataset	Public C-ATBD; Draft Operational Algorithm Description (OAD); Peer-reviewed publication on algorithm; paper on product submitted	Uncertainty estimated over widely distributed times/location by multiple investigators; Differences understood.	Data and source code archived and publicly available; uncertainty estimates provided; Known issues public	May be used in applications; assessments demonstrating positive value.
5	Minimal code changes expected; Stable, portable and reproducible	Complete at file and collection level. Stable. Allows provenance tracking and reproducibility of dataset. Meets international standards for dataset	Public C-ATBD, Review version of OAD, Peer-reviewed publications on algorithm and product	Consistent uncertainties estimated over most environmental conditions by multiple investigators	Record is archived and publicly available with associated uncertainty estimate; Known issues public. Periodically updated	May be used in applications by other investigators; assessments demonstrating positive value
6	No code changes expected; Stable and reproducible; portable and operationally efficient	Updated and complete at file and collection level. Stable. Allows provenance tracking and reproducibility of dataset. Meets current international standards for dataset	Public C-ATBD and OAD; Multiple peer-reviewed publications on algorithm and product	Observation strategy designed to reveal systematic errors through independent cross-checks, open inspection, and continuous interrogation; quantified errors	Record is publicly available from Long-Term archive; Regularly updated	Used in published applications; may be used by industry; assessments demonstrating positive value
5.083333 	4.5	2	6 C-ATBD too restrictive	6 Global reanalysis has more comparisons to observations than anyone else before using them (short forecast). Plus some datasets are withheld completely, yet compared with.	6	6

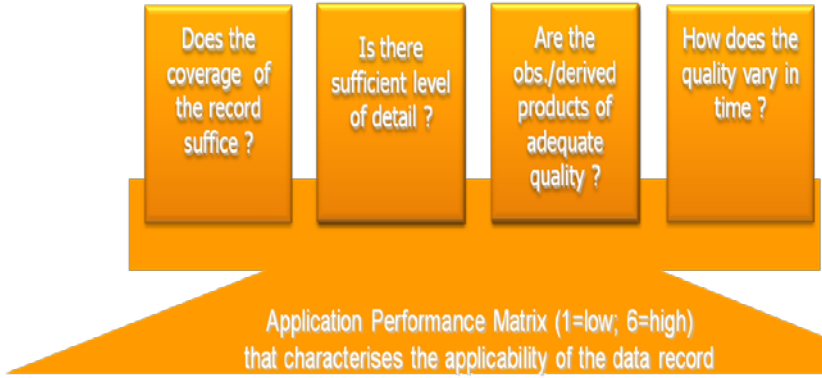
FP7 CORE-CLIMAX
Establishing Common Practices for Climate Observations

System Maturity Matrix



Software	Metadata	Documents	Uncertainties	Access	Utility
Are to codes compliant with standards, stable, portable and reproducible?	Do the metadata meets int. standards, and allow provenance tracking?	Are the formal documents and peer-reviewed papers up-to-date and public?	Are the uncertainties assessed systematically in a standard manner?	Are the data, source code, and documents publicly available?	Are the data wildly used in the scientific, decision and policy making communities?

Application Performance Matrix



Coverage	Sampling	Uncertainty	Stability
Are the record length and spatial coverage meeting the application's requirements?	Does the spatial and temporal sampling meet the applications requirements?	Does the random and systematic uncertainties meet the requirements?	Does the temporal stability meet the requirements?

Courtesy: John Bates (NOAA)

NASA Data Maturity Levels

- Beta level
  - Products intended to enable users to gain familiarity with the parameters and the data formats
- Provisional
  - Product was defined to facilitate data exploration and process studies that do not require rigorous validation. These data are partially validated and improvements are continuing
- Validated
  - Stage 1-4 validated

NASA Validation Stages

- **Stage 1 Validation:** Product accuracy is estimated using a small number of independent measurements obtained from selected locations and time periods and ground-truth/field program efforts.
- **Stage 2 Validation:** Product accuracy is estimated over a significant set of locations and time periods by comparison with reference in situ or other suitable reference data. Spatial and temporal consistency of the product and with similar products has been evaluated over globally representative locations and time periods. Results are published in the peer-reviewed literature.
- **Stage 3 Validation:** Product accuracy has been assessed. Uncertainties in the product and its associated structure are well quantified from comparison with reference in situ or other suitable reference data. Uncertainties are characterized in a statistically robust way over multiple locations and time periods representing global conditions. Spatial and temporal consistency of the product and with similar products has been evaluated over globally representative locations and periods. Results are published in the peer-reviewed literature.
- **Stage 4 Validation:** Validation results for stage 3 are systematically updated when new product versions are released and as the time-series expands.

Science Maturity Index (1/2)

- Initiated by concepts developed for Climate data record Generation
  - (see e.g. Bates and Privette 2012)
- However, there are also significant technical aspects in the CDR maturity model, whereas here we are trying to assess the scientific maturity of the centrally derived products
- The proposed index is based on four major maturity categories:
  - Scientific Understanding
  - Modelling of the physical principals
  - Instrument capability and characterisation
  - Validation
- All categories receive an estimate:
- 3= Highest achievable status, 2 = medium maturity and 1 = initial/immature
- The Scientific Maturity Index =
- Sum of the estimates per category (Max = 12, Min = 4)

Science Maturity Index (2/2)

- The purpose of the Index is to provide guidance on where efforts should be invested for future development.
- It is considered a useful complementary dimension based on an agreed assessment methodology.
- However, it is only one aspect that has to be considered.
- In addition the utility of the product for scientific application and exploitation has to be considered.
- Should also aid setting the overall priorities wrt to available resources..

An example for Metop Level-1 data

Product Processing Facility (PPF)	*Metop-A Status*	*Metop-B Status*	*Maturity Total (SU, M, ICC, VAL)*	*Remarks*
AVHRR Level 1	Operational	Operational	12 (3,3,3,3)	
AMSU-A Level 1	Operational	Operational	11 (3,3,2,3)	Some channel out of spec / failed
HIRS/4 Level 1	Operational	Operational	11 (3,3,2,3)	Some channels on Metop-B are at times out of specification
MHS Level 1	Operational	Operational	12 (3,3,3,3)	
IASI Level 1	Operational	Operational	12 (3,3,3,3)	
IASI L1 PCC	Operational	Operational	9 (3,2,2,2)	
ASCAT Level 1	Operational	Operational	10 (3,2,2,3)	
GOME-2 Level 1	Operational	Operational	11 (3,3,2,3)	Metop-A operating in 960km and Metop-B in 1920km swath mode.
GRAS Level 1	Operational	Operational	9 (3,2,2,2)	GO

Metop Level-2 Products (Derived at EUMETSAT HQ)

PPF	*Product Status*	*Maturity Total (SU, M, ICC, VAL)*	*Remarks*
IASI temperature and humidity retrieval	Operational	11 (3,2,3,3)	
IASI Ozone total column	Operational	11 (3,3,3,2)	
IASI CO profiles	Operational	10 (3,2,3,2)	Validation on-going with O3M SAF
IASI trace gases (ozone profiles, N_2O, CH_4, CO_2)	Demonstrational	7 (2,2,2,1)	Development started for CH_4
IASI surface emissivity	Pre-operational	7 (2,2,2,1)	
IASI Cloud Parameters	Operational	11 (3,3,2,3)	
IASI SST L2Pcore	Operational	11 (3,3,3,2)	
ATOVS Level 2	Operational	12 (3,3,2,3)	Some degradation for Metop-A due to noisy or missing AMSU-A channels
ASCAT Soil Moisture	Operational	8 (2,2,2,2)	H-SAF product operated
Polar Cap Winds from AVHRR	Operational	9 (3,2,2,2)	
Global AVHRR Winds	Operational	7 (3,2,1,1)	
Triplet AVHRR Winds	Pre-operational	7 (3,2,1,1)	
Polar Multi-sensor Aerosol properties over sea	Operational	9 (3,2,2,2)	
Polar Multi-sensor Aerosol (v2) including land	Pre-operational	8 (3,2,2,1)	Validation on-going

Science Readiness Level - Another matrix approach
Initial attempt (in coop with SAFs, DBs, ESA)– to be refined

SRL	Name	Associated documents	Theory / Model	Observation	Validation / Verification	User
1	Scientific Idea		Scientific idea	Non	non	define Application Area Interest from Users
2	Conceptual Technique		Conceptual model, physical principal is clearly defined (no software is needed)	Gap analysis; complementary in observation system; uniqueness		Set high level draft EURD
3	Scientific / Observation Requirements	Mission proposal	Forward model is available (i.e. RTM simulation of measur.)		Initial capability assessment (Info content anal.)	Scientific requirements vs user requirements approved
4	Proof of concept	MRD	Consolidated approach 1st sim. obs are available	Simulated measurements		Consolidated EURD
5	End-to-end performance simulations	Stable MRD, E2E (End-to-end simulator)	Consolidated retrieval and draft ATBD (+ prototype) are available	Demonstrator (e.g. airborne instr) “real data”	Calibration and Validation Plan established	Final EURD Committed Beta-User (e.g. through AO call’s)
6	Consolidated science and products (end: launch of sat)	ATBD’s	Final ATBD and operational processor / implementation	Pre-launch	Test data and sampled data processing	User studies with simulated or pre-cursor data
7	Demonstrated science (commissioning phase)			In orbit characterisations; perf vs. spec (EURD)	CAL/VAL conducted,; Early release of data; beta /demo data ava.	User feedback (validation team)
8	Validated and matured science(sat declared op)	Science feedback			Full validation	Operational validation and quality assurance via network
9	Science Impact quantification	Advancement in scientific understanding				User impact

Thank You
Questions?

JPSS-STAR (JSTAR) Program

Meeting Objectives, Agenda, and JSTAR Overview

Lihang Zhou
AMP Deputy for Science & JPSS STAR Program Manager
M. Divakarla, X. Liu, T. Valenzuela, and T. Atkins

August 24, 2015
NCWCP, College Park, MD

Meeting Objectives

1. **Review Science Teams Readiness for JPSS-1**
   - SDR/EDR Algorithm Development/Improvements for J1
   - R2O, Support for Operational flow Transitions
   - Schedules and Milestones
   - Cal Val plans
   - Major Accomplishments/Highlights Moving Towards J1
2. **Review Science Teams Support for Suomi NPP**
   - Suomi NPP Long Term Monitoring and Adaptation to JPSS-1
   - Integrated Calibration Validation System (ICVS) for SDRs/EDRs
3. **Interaction/Communication Among Stake Holders**
4. **Feedback from User Community**

Please submit the RFA form or email me: Lihang.Zhou@noaa.gov

Meeting Agenda

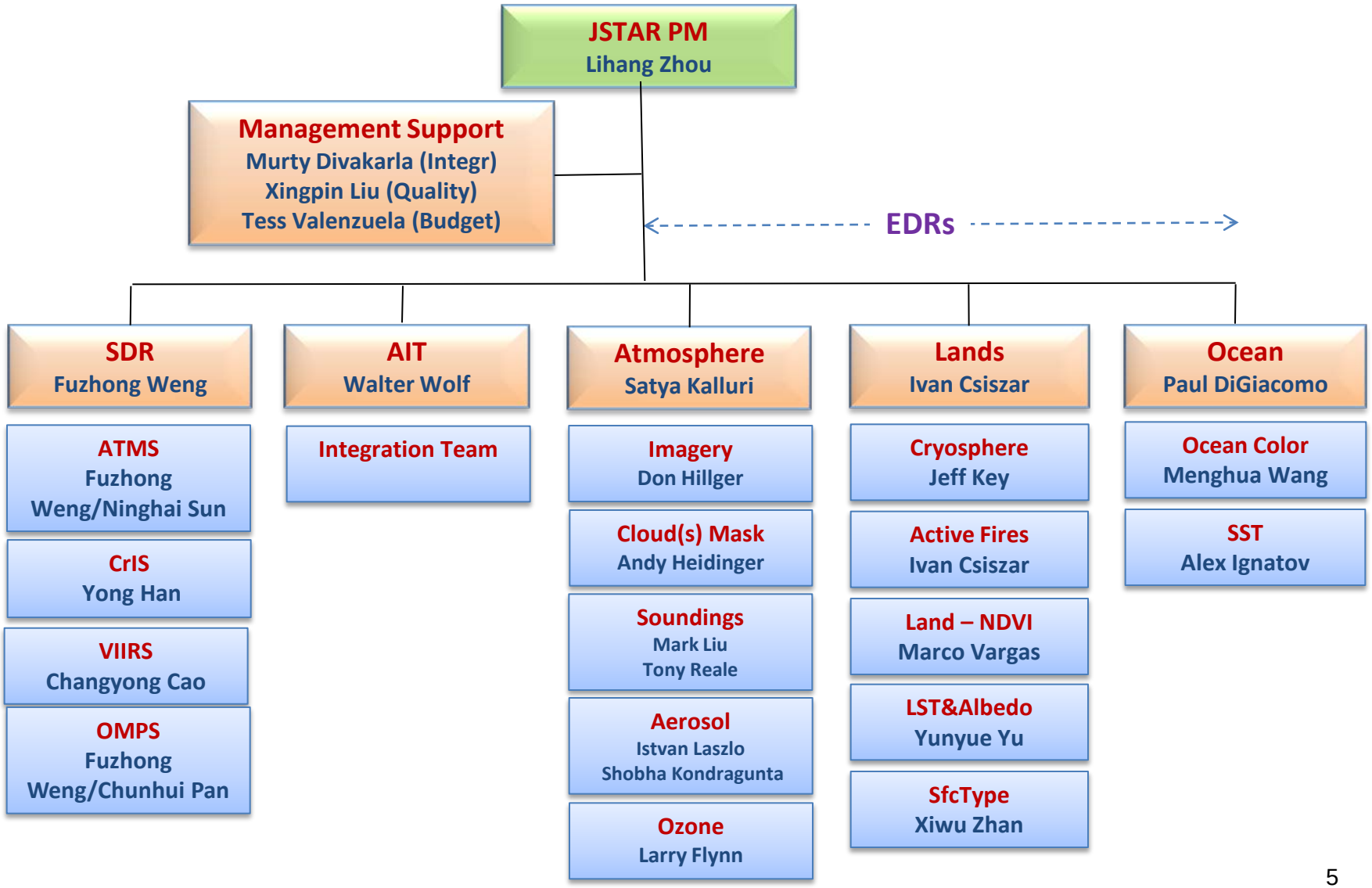
Monday August 24	Tuesday August 25	Wednesday August 26			Thursday August 27				Friday August 28
	Session 3 - EDR Overviews	Session 5			Session 6				Session 8 - Data Access
		VIIRS (6a)	OMPS/Ozone (6b)	ATMS + CrIS (6c)	Soundings	Land / Cryo (7b)	Ocean Color (7d.1)	SST (7d.2)	
	Break	Break			Break				Break
	Session 3 (cont'd.) - EDR Overviews	VIIRS	OMPS/Ozone	ATMS + CrIS	Soundings	Land / Cryo	Ocean Color	SST	Session 9 - Science Quality Data Processing
	Lunch / Poster I	Lunch			Lunch / Poster II				
Session I - Welcome and Opening Remarks	Session 4 - Users	VIIRS	OMPS/Ozone	ATMS + CrIS	Aerosols/ Clouds (7e)	Land / Cryo	Ocean Color		
Break	Break	Break			Break				
Session 2 - SDR Overviews	Session 5 - Advanced Applications	VIIRS	OMPS/Ozone	Soundings (7a)	Aerosols/ Clouds	Land / Cryo Imagery (7c)	Ocean Color		

JPSS-STAR (JSTAR) Program

PURPOSE: To provide ***robust, affordable, and flexible*** *state-of-art* scientific solutions to meet JPSS requirements

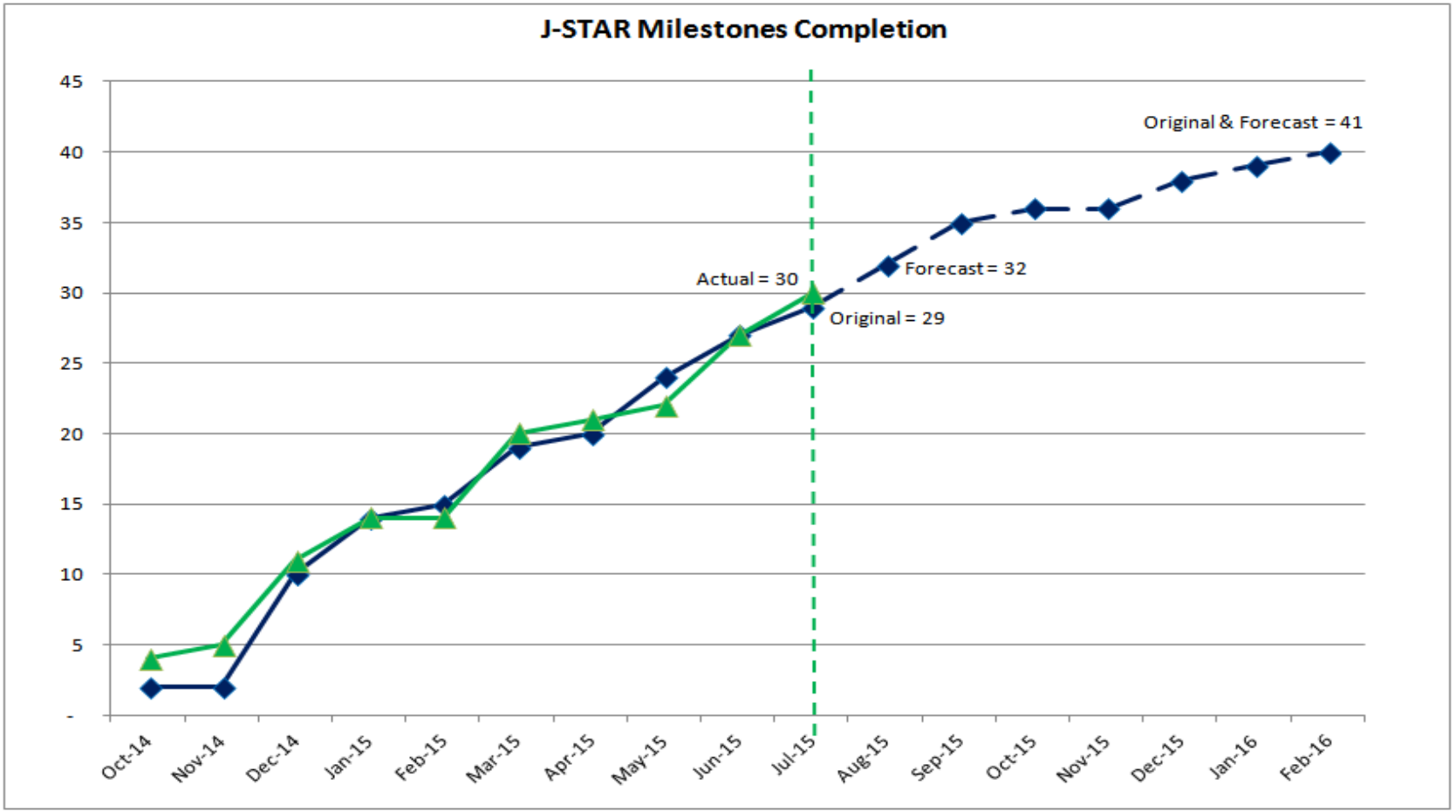
- Leverages hundreds scientists from NOAA, NASA, DOD, and NOAA's Cooperative Institutes (University partners) and Industry Partners
- Applies first-hand knowledge of algorithms and cal val, developed in POES, GOES, DMSP, EOS, MetOP, and GOES-R, for JPSS Program
- Works closely with JPSS Program Science and all other elements to ensure the developments are in line with the users' requirements, and efficient science to operation transitions
- Facilitate algorithm consistency across platforms
  - **Supports science for multiple satellite systems (Enterprise Approaches)**

JPSS-STAR (JSTAR) Teams



JSTAR Integrated Management

- **Cost, Performance, Schedules and Milestones**
  - Coordinate with leads on budget/schedule/milestones
  - Consolidated NJO STAR Technical Task Agreement (TTA)
  - Integrated Master Schedule (IMS)



JSTAR FY15 Key Deliveries/Milestones to the JPSS Program

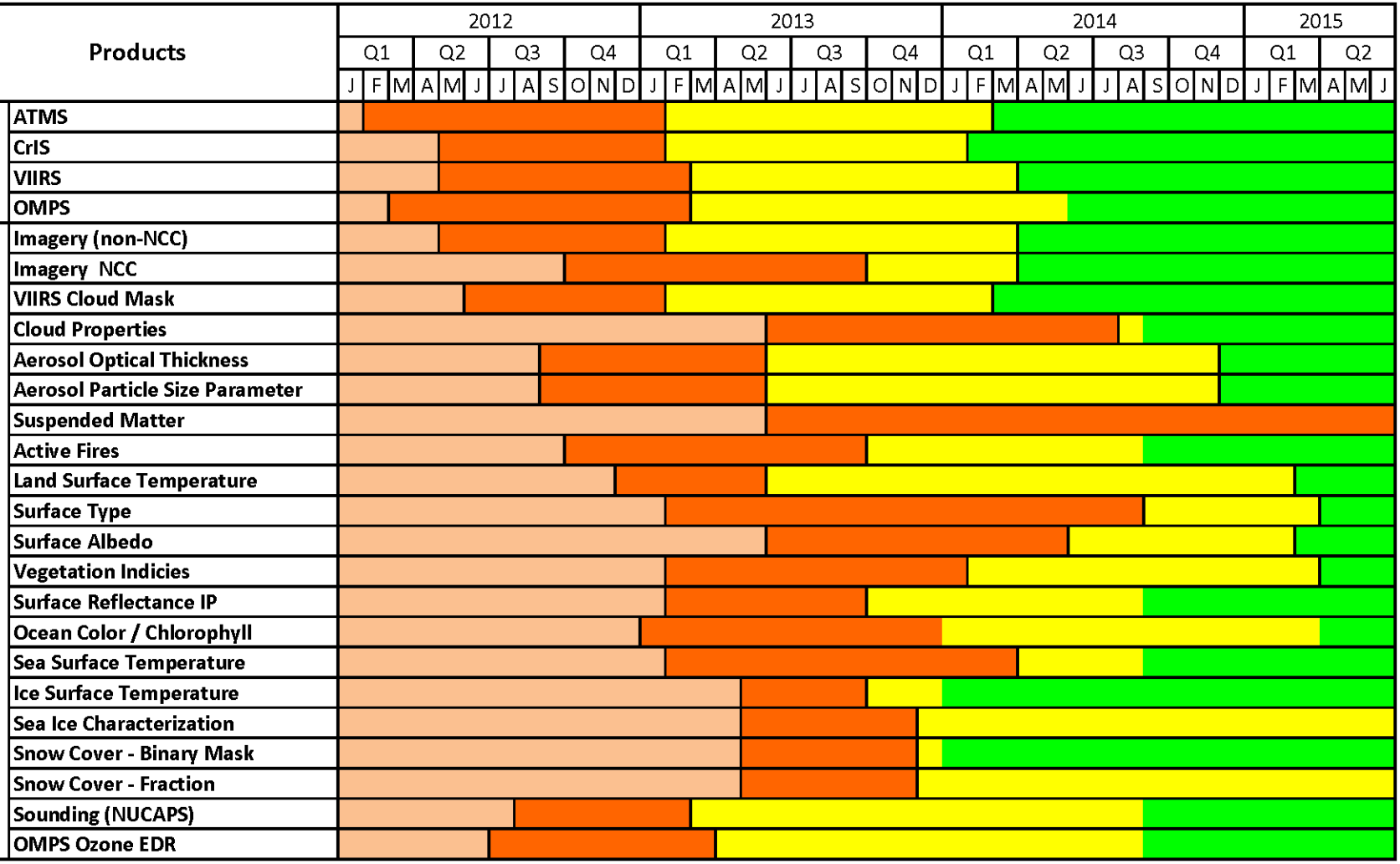
Milestones	Delivery Date
CrIS SDR: Full spectral resolutions SDR	Jan-15
CrIS SDR: Fringe Count Error module update	Jun-15
CrIS SDR: JPSS-1 Instrument Test Data Analysis Report	Mar-15
VIIRS SDR: JPSS-1 Instrument Test Data Analysis Report	Aug-15
OMPS SDR: JPSS-1 Instrument Test Data Analysis Report	Jul-14
OMPS SDR: Algorithm improvements to support extended spectral range, and reduced horizontal cell size at nadir	Apr-15 (TC) May-15 (NP)
OMPS Ozone NP: V8Pro	Feb-15
OMPS Ozone TC: V8TOz	Jul-15
Vegetation Indices: Add top-of-canopy NDVI	Mar-15
Ocean Color: OCC for coastal and inland water	Apr-15
Active Fires: 2D fire mask; include water for global coverage	Jun-15
JPSS-1 Cal Val Plans Draft Delivery	Jul-15
VIIRS SDR: LUT and GEO code update for JPSS-1	Aug-15

JSTAR FY15 Other Accomplishments

Milestones	Review Date
EDR Long Term Monitoring (LTM) Workshop	Oct-14
Cal/Val Maturity Readiness Review: Validated Maturity: LST, LSA, Surface Type	Dec-14
Transitioned ATBD documents from NASA CM to STAR CM	Jan-15
JPSS-2 and Beyond Sensor Improvement Science Recommendations	Jan-15
JPSS-1 Instrument Waiver Analysis	Jan-15
Participated NASA Post-Launch-Test (PLT) Planning and Provided Science Teams Inputs	Feb-15
JPSS Enterprise Algorithms Meetings for Priority 3 and 4 Products	Feb-15
Cal/Val Maturity Readiness Review: Validated Maturity: OCC	Mar-15
CrIS FS SDR Meeting with Key NWP Users	Mar-15
Coordinated Science Inputs to the JPSS Mission Operation Readiness (MOR) Review	Apr-15
STAR ICVS Instrument Status Annual Review	May-15

Suomi NPP Product Maturity

Will be applied to all JPSS-1 products



JPSS-1 Test Data Sets

- JPSS Test Data Working Group (TDWG) generated J1 RDRs from J1 TVAC and Suomi NPP data sets as desired by STAR SDR teams.

- STAR teams utilized J1 RDRs to develop and test SDR algorithms for sensor changes and waiver mitigations.

- STAR SDR teams also developed tools to manipulate the data sets and create new proxy data sets to verify SDR and EDR algorithms at several levels.

- Running J1 test data sets though the algorithms helps us better prepare for J1 post launch cal val activities.

JSTAR Program Priorities Moving Forward

- **Ensure Cal/Val Team Readiness for JPSS-1**
  - Develop roadmap/plans toward ***enterprise algorithms***
  - Algorithm development/Improvements for J1
  - Implement code to meet JPSS-1 requirements
  - Develop and update the Cal/Val plans
- **Continue Support for Suomi NPP Mission Objectives**
  - Provide Suomi NPP data products to support NOAA's operational missions.
  - Provide a pre-operational demonstration for JPSS ***user engagement*** (Testbed)
  - ***Science quality data processing***

Websites of Importance

STAR JPSS Website

http://www.star.nesdis.noaa.gov/jpss/index.php

- ATBDs
- Cal/Val Docs
- OAD and CDFCB
- Requirements Documents
- SDR/EDR Team Leads/Contacts
- Links to ICVS
- Links to EDR websites

Summary

- **Highly Experienced:** Developed the algorithms for NOAA's satellite programs since their inception over 40 years ago; Understand how to calibrate, validate and verify algorithms using techniques appropriate for instrument, product, and spectral characteristics

- **Very Capable:** Developed tools and products for SNPP; Capable of generating proxy data sets for all JPSS-1 instruments (ATMS, CrIS, VIIRS, and OMPS) for use in pre-launch characterization and risk mitigation

- **Well Coordinated:** Work with all elements of the JPSS Program, maintain, upgrade, demonstrate, document, and deliver algorithms to meet program requirements

- **On-time:** Demonstrated clear progress toward our algorithm development plan
  - Draft JPSS-1 Cal Val plans for all the products have been delivered on schedule
  - JPSS-1 updates have been delivered as planned
  - All scheduled SNPP validation maturity reviews have been completed

- **Enterprise Solution:** Same science supporting multiple satellites / systems. Establish JSTAR management processes with a defined schedule that is aligned with JPSS Program to provide status and track progress

Thank You and Enjoy the Meeting!