An overview of algorithm development status for the Suomi NPP Environmental Data Records

Ivan Csiszar, Lihang Zou

NOAA/NESDIS/Center for Satellite Applications and Research (STAR)

JPSS/SNPP Algorithm and Data Products (ADP)

Bonnie Reed, Janna Feeley

JPSS/SNPP Data Products and Algorithms (DPA)

Algorithm and Data Products Algorithm Leads, Co-leads and Team Members, JPSS and STAR management

JPSS ENVIRONMENTAL PRODUCTS

VIIRS (22 EDRs)
RDRs & SDRs (for each band)

EDRs
- ALBEDO (SURFACE)
- CLOUD BASE HEIGHT
- CLOUD COVER/LAYERS
- CLOUD EFFECTIVE PART SIZE
- CLOUD OPTICAL THICKNESS
- CLOUD TOP HEIGHT
- CLOUD TOP PRESSURE
- CLOUD TOP TEMPERATURE
- ICE SURFACE TEMPERATURE
- NET HEAT FLUX
- OCEAN COLOR/CHLOROPHYLL
- SUSPENDED MATTER
- VEGETATION INDEX
- AEROSOL OPTICAL THICKNESS
- AEROSOL PARTICLE SIZE
- ACTIVE FIRES
- IMAGERY
- SEA ICE CHARACTERIZATION
- SNOW COVER
- SEA SURFACE TEMPERATURE
- LAND SURFACE TEMP
- SURFACE TYPE

GCOM AMSR-2 (11 EDRs)

RDR

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

OMPS (2 EDRs)
RDR & SDR

EDRs
- O_3 TOTAL COLUMN
- O_3 NADIR PROFILE

CERES (2 EDRs) (1)
RDR & SDR

EDRs
- NET SOLAR RADIATION (TOA)
- OUTGOING LW RADIATION (TOA)

SDRs
- LONG WAVE RADIANCE (TOA)
- REFLECTED SOLAR RADIANCE (TOA)
- TOTAL RADIANCE (TOA)

CrIS/ATMS (3 EDRs)
RDR & SDR

EDRs
- ATM VERT MOIST PROFILE
- ATM VERT TEMP PROFILE
- PRESSURE (SURFACE/PROFILE)

TSIS (1)
RDR & SDR
SOLAR IRRADIANCE

A-DCS
PLATFORM REPORTS

SARR & SARP
DISTRESS BEACON REPORTS

CrIS Thinned Radiances	Land Surface Temperature (ATMS)	Trace Gases (Carbon)
CrIS Cloud Cleared Radiances	Temperature Profiles (ATMS)	SST (AVHRR-like)
Total Precipitable Water (ATMS)	Moisture Profiles (ATMS)	Aerosol (AVHRR-like)
Snow Cover (ATMS)	Rain Water Path (ATMS)	Cloud Top Fraction (CrIS)
Precipitation Rate (ATMS)	Blended SST	Cloud Top Pressure (CrIS)
Land Surface Emissivity (ATMS)	SST Anomalies	Stability Products (CrIS)
Cloud Liquid Water (ATMS)	SST Degree Heating Weeks	Polar Winds (VIIRS)
Sea Ice Concentration (ATMS)	SST Hot Spots	Green Vegetation Fraction
Snow Water Equivalent (ATMS)	Coral Reef Bleaching Indices/Alerts	Blended Total Precipitable Water
Ice Water Path (ATMS)	Total Ozone (CrIS)	

NOAA Unique Products (NUPs)

Figure 3-4, Rev B, 4/5/12

PSE v3 4/5/12

SNPP/JPSS Algorithm Science and Product Working Group

STAR ASPWG
Ivan Csiszar, Chair
NESDIS/STAR

NJO
STAR management
DPA
DPE
NGAS
RAYTHEON
NASA SNPP

STAR Team leads

Soundings – Chris Barnet
Imagery – Don Hillger
SST – Sasha Ignatov
Clouds – Andrew Heidinger
Aerosols – S. Kondragunta, I. Laszlo
Cryosphere – Jeff Key
Land – Ivan Csiszar
Net Heat Flux – X. Li
Ocean Color – Menghua Wang
Ozone – Larry Flynn
CERES – Istvan Laszlo

Cal/val leads

Soundings – Chris Barnet, STAR
Imagery – Tom Kopp, Aerospace
SST – Bob Arnone, NRL
Clouds – Andrew Heidinger, Tom Kopp (VCM)
Aerosols – S. Kondragunta, I. Laszlo
Cryosphere – Pablo Clemente-Colon, STAR
Land – Jeff Privette, NOAA/NCDC
Net Heat Flux – X. Li
Ocean Color – Bob Arnone, NRL
Ozone – Larry Flynn, STAR
CERES – Xiaofan Li

End-to-End Product Development and Validation

Robust, Affordable, & Flexible

Pre-Launch → **Post-Launch**

Early Orbit Period — **Long Term Monitoring (LTM)**

Prelaunch	Early Orbit Period	Transition Zone to Ops	Long-Term	Uses
Generate requirements Future Systems planning Instrument Definition Simulation development **Validation of algorithm performance** **Algorithm development** Ground [illegible]ment definition Ground[illegible]ment testing	Radiometric calibration Geolocation/navigation **Validation of radiances and products** Computer co[illegible]ests Li[illegible]	Ground Segment monitoring Images Archi[illegible] Ope[illegible] Algorithm maintenance Distribution Info/Data requests **NWP Operational Impact**	Corrections New products **Routine Long Term sensor/product monitoring and calibration** **Scienti[illegible]Output** publica[illegible] algori[illegible] analy[illegible] prod[illegible]	Retrievals Radiances Images Time-series Nowcasting Regional and Global NWP
		[illegible]lications		

❖ ***We are here for GOES-R AWG***
- Focus is on validation of algorithm's performance
- Determine validation strategies
- Identification of validation data

❖ ***We are here for SNPP ADP, GCOM-W, and METEOP-B***
- Focus is on *intensive validation* of algorithms using instrument data from new sensor
- High quality validation data from field sites (ie., DOE ARM), flight campaigns
- Routine validation data

❖ ***We are here for SNPP ATMS***
❖ ***May 24 2012***
- Focus is on *impact studies and error modeling for assimilation studies*

❖ ***We are here for GOES/POES***
- Focus is on *routine validation* of algorithms
- QC/QA processes in place
- Continuous assessment & monitoring, trend analysis, of product quality

NPP EDR Product Maturity Levels

1. **Beta**
- Early release product
- Minimally validated
- May still contain significant errors.
- Versioning not established until a baseline is determined.
- Available to allow users to gain familiarity with data formats and
- Product is not appropriate as the basis for quantitative scientific p applications

2. **Provisional**
- Product quality may not be optimal
- Incremental product improvements are still occurring.
- Version control is in affect
- General research community is encouraged to participate in the C product, but need to be aware that product validation and QA are
- Users are urged to consult the EDR product status document prio publications
- May be replaced in the archive when the validated product becor
- Ready for operational evaluation

3. **Validated**
- Product performance is well defined over a range of representative conditions
- Ready for use by the Centrals and in scientific publications
- There may be later improved versions
- There are three validation stages (see next column)

Stage 1 Validation: Pro demonstrated to comply small number of indepe from selected locations, ground-truth/field progr

Stage 2 Validation: Pr demonstrated to comply widely distributed set of several ground-truth and validation efforts.

Stage 3 Validation: Product performance has been demonstrated to comply with the specification and the uncertainties in the product well established via independent measurements in a systematic and statistically robust way representing global conditions.

SDR and EDR Maturity Status

- **SDR**
  - **All products** reached **Beta version in early 2012** – Integrated Calibration / Validation System is up and running for all sensors on SNPP
  - SDR teams held **Provisional Product Review in October 2012**; formal approval for Provisional maturity in January

- **EDR**
  - **Many products** have been **declared Beta** – including Sounding, Aerosols, Non-NCC Imagery, Cloud Mask, Ozone, Active Fire, LST, Ocean Color.
  - **Provisional Readiness Review** for Sounding, Ozone, Non-NCC Imagery and VIIRS Cloud Mask are to be held on January 17-18, 2013

J. Feeley, I. A. Csiszar, B. Reed, H. Kilcoyne, Product Maturity Status for the SNPP Sensor and Environmental Data Records - Poster # 688

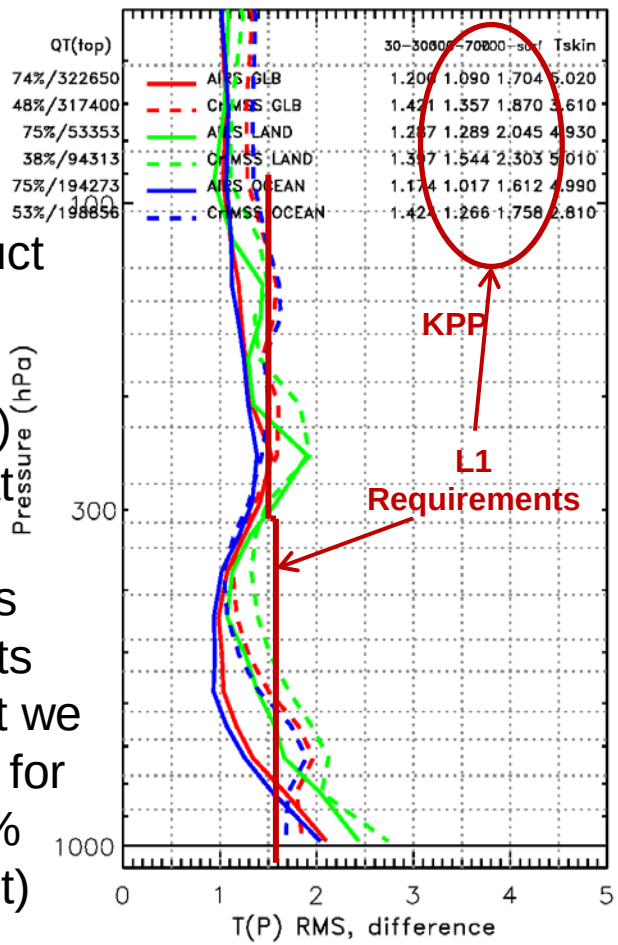
Sponsored by the NOAA JPSS Office.

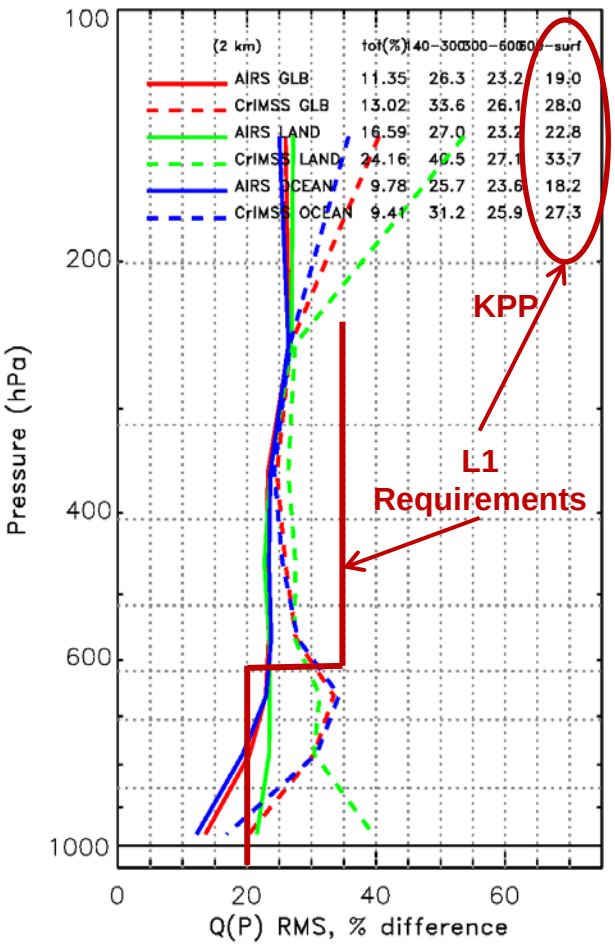
Status of Suomi NPP: CrIMSS Products

Beta in August 2012, Provisional in January 2013

Comparison of the IR+MW EDR w.r.t. ECMWF for May 15, 2012

- Global (red), land (green) and ocean (blue) statistics are comparable with heritage AIRS product (solid), but CrIMSS EDR (dashed) has lower yield (38-53%) than AIRS (~75%) at this time
- KPP performance is close to requirements (1.6K) for AVTP, but we still have work to do for AVMP (global is 28% vs. 20% requirement)





CRITICAL INFORMATION FOR NUMERICAL WEATHER FORECASTING

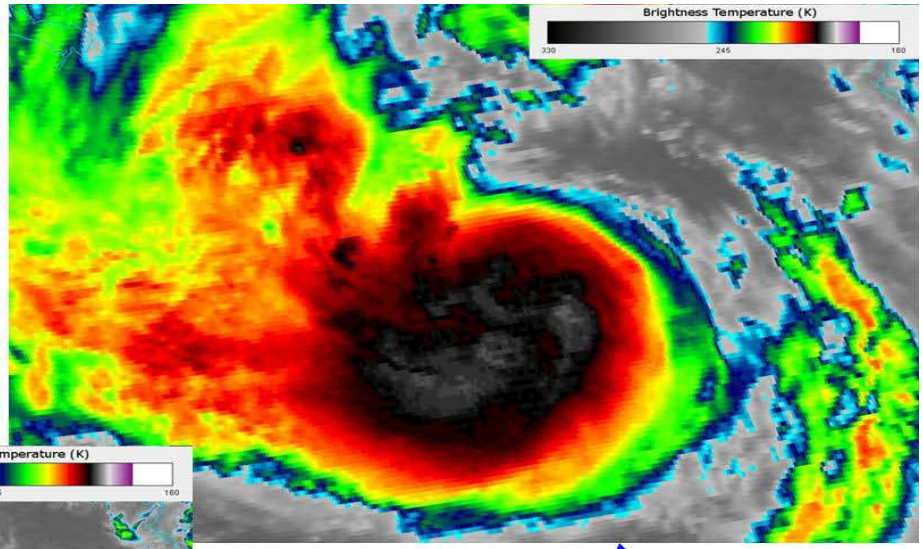
Status of Suomi NPP: Imagery Products

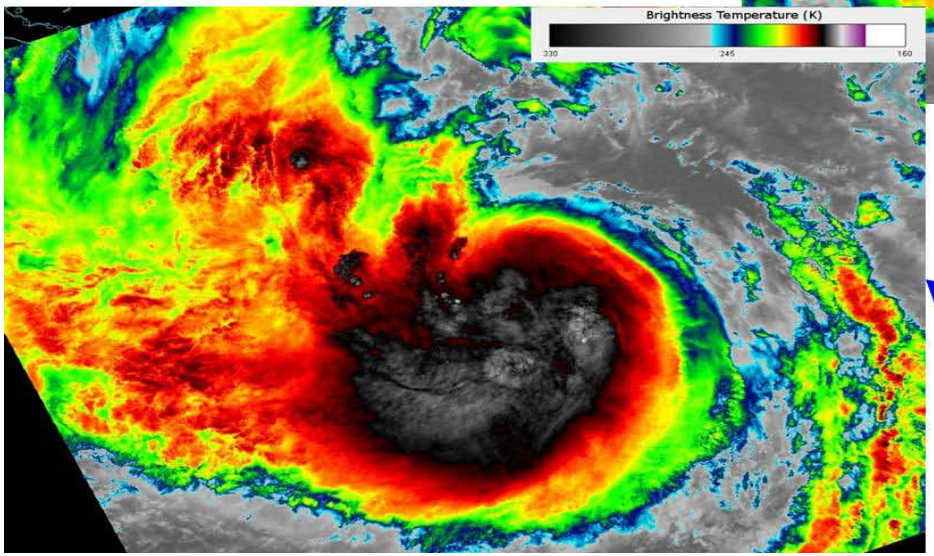
Beta in May 2012, Provisional in January 2013

- Non-NCC Imagery declared “Beta” in June 2012; advance to “Provisional” (early FY13)
- EDR Imagery and Visualization Team website:

http://rammb.cira.colostate.edu/projects/npp/

Tropical Storm Isaac
27 August 2012

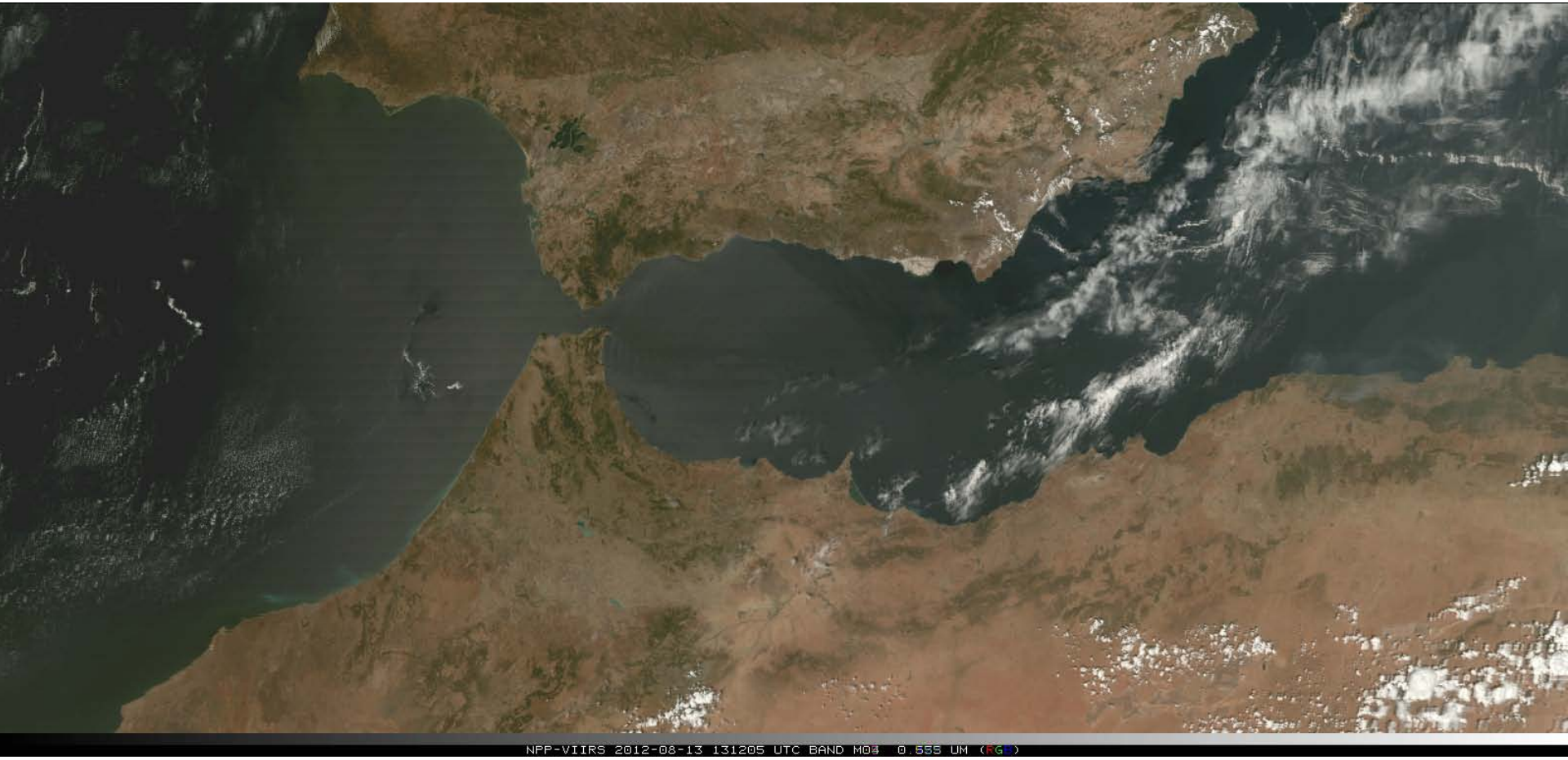




GOES Imager
channel 4 (10.7 µm)
taken at 18:45 UTC

VIIRS Imager
channel I-05 (11.45 µm)
taken at 18:50 UTC

Visible/True-color Imagery



Rayleigh-corrected true-color M-band imagery – Strait of Gibraltar 2012-08-13 @ 13:12 UTC

D. Hillger/JPSS Imagery Team

Status of Suomi NPP: SST Products
Advance to Beta Maturity in January 2013

SQUAM - SST Quality Monitor
www.star.nesdis.noaa.gov/sod/sst/squam/

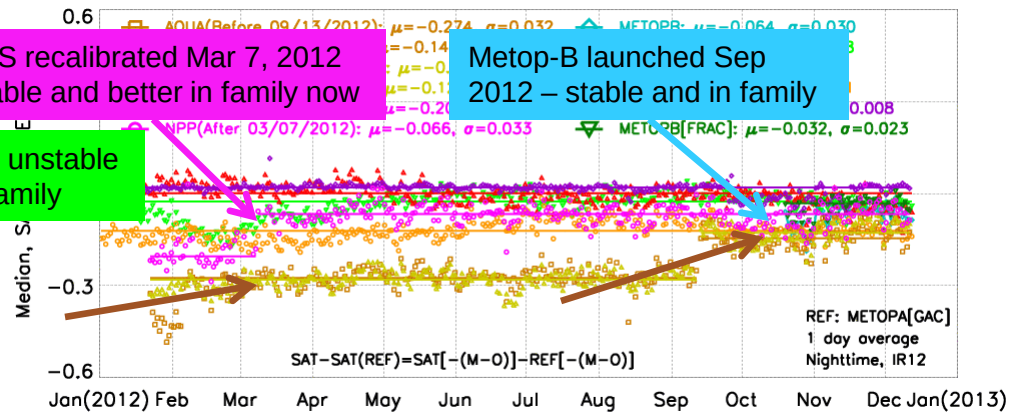
- ✓ Monitor SST Products (L2, L3, L4) for Self- and Cross-Consistency; Validate against *in situ* SSTs (*iQuam*)

MICROS - Monitoring IR Clear-sky Radiances over Oceans for SST
www.star.nesdis.noaa.gov/sod/sst/micros/

- ✓ Monitor Clear-sky ocean radiances for Self- and Cross-Consistency; Validate against CRTM simulations

iQuam - In situ Quality Mo
www.star.nesdis.noaa.gov

- ✓ QC *in situ* SSTs, M
- ✓ Input to SQUAM



Continue meeting program respo

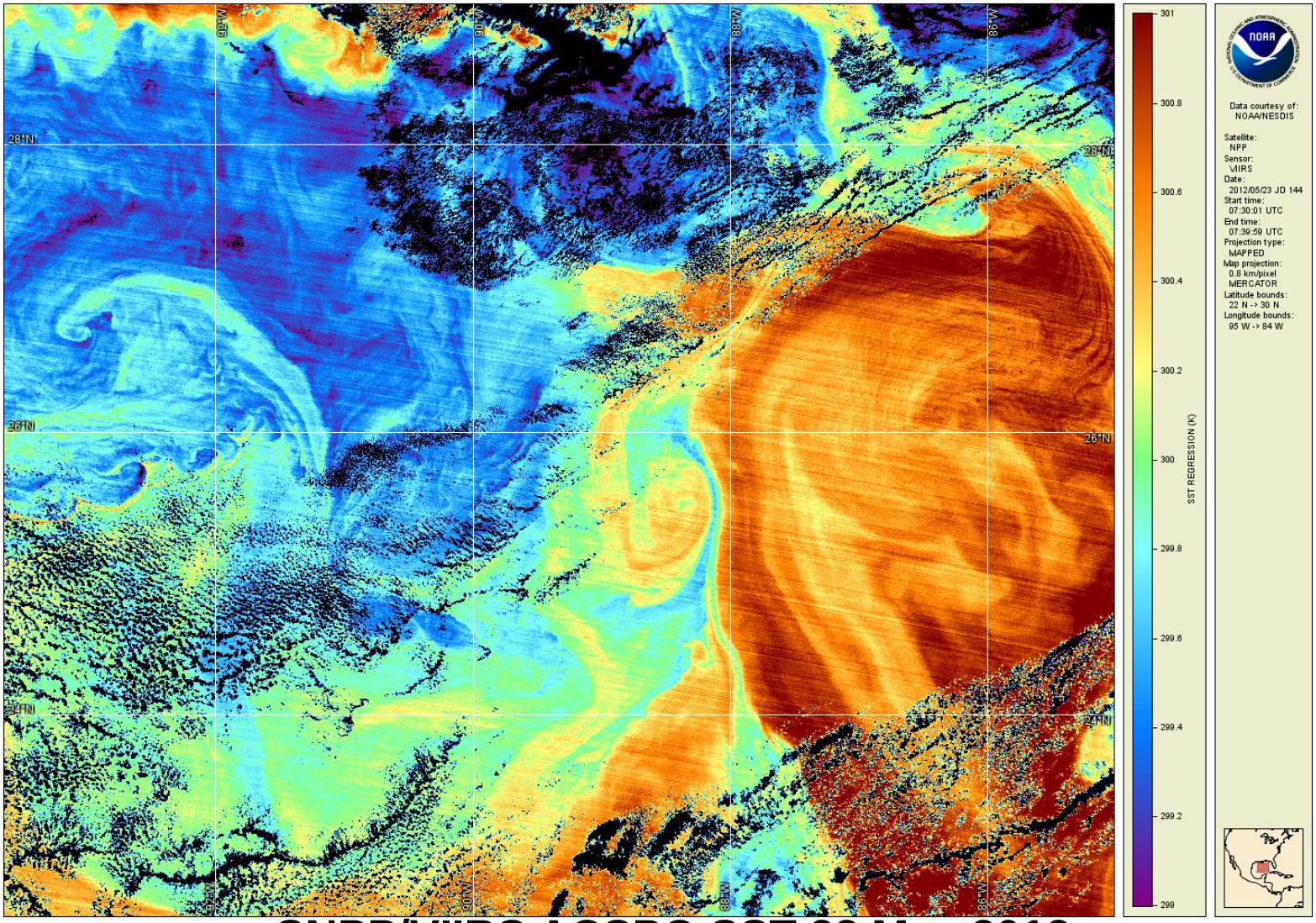
Declare SST EDR Beta – January 2013

Declare SST EDR Provisional – July 2013

Slide courtesy of Sasha Ignatov and SST Team.

Sea Surface Temperature

ACSPO_V2.10_NPP_VIIRS_2012-05-23_0730-0740_20120526.053954.hdf



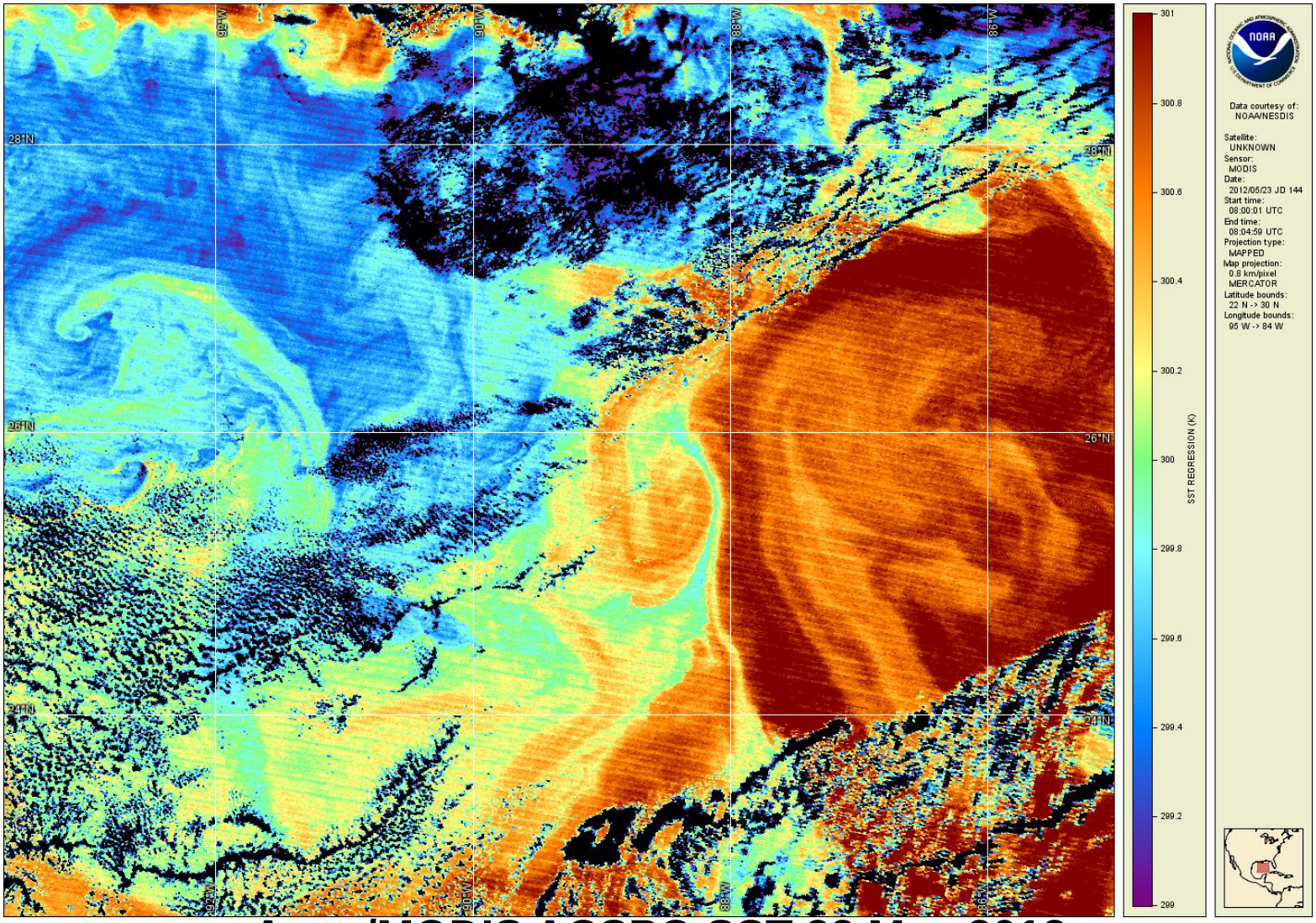
SNPP/VIIRS ACSPO SST 23 May 2012

0730-0740 UTC – Night – Mapped onto 0.8km grid

A. Ignatov/JPSS SST Team

Sea Surface Temperature

ACSPO_V2.10_AQUA_MODIS_2012-05-23_0800-0805_20120527.093405.hdf



Aqua/MODIS ACSPO SST 23 May 2012

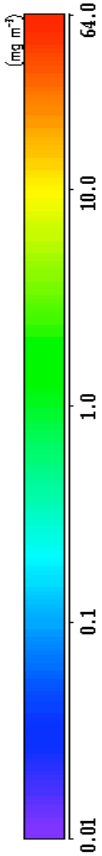
0800-0805 UTC – Night – Mapped onto 0.8km grid

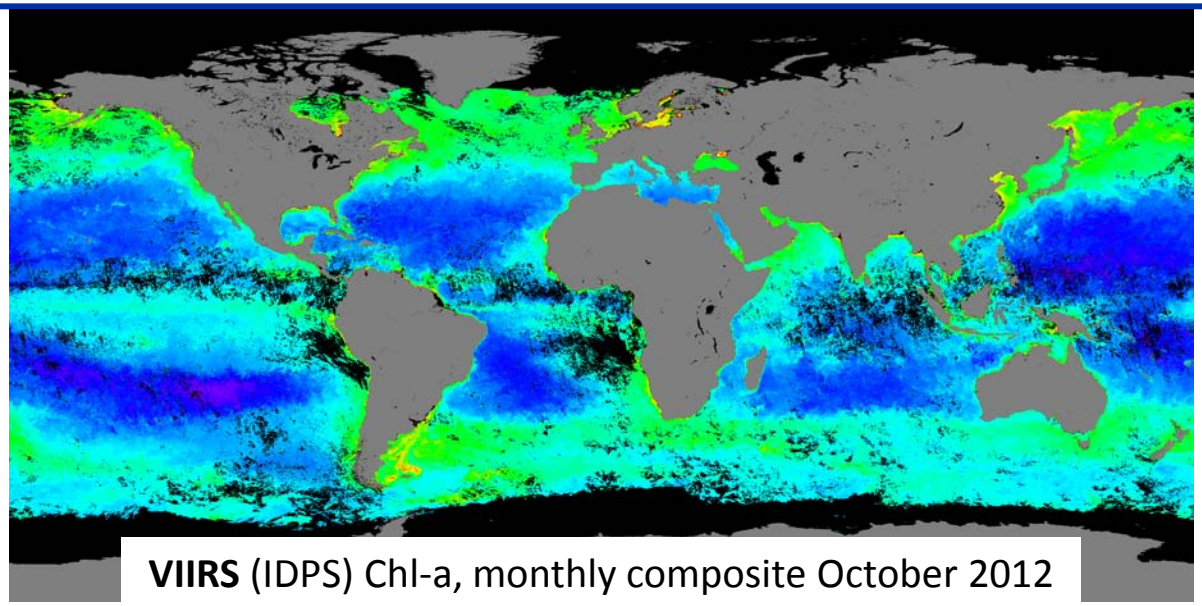
A. Ignatov/JPSS SST Tean

VIIRS Chlorophyll-a Data Overall Performance
Advanced to Beta in December 2012

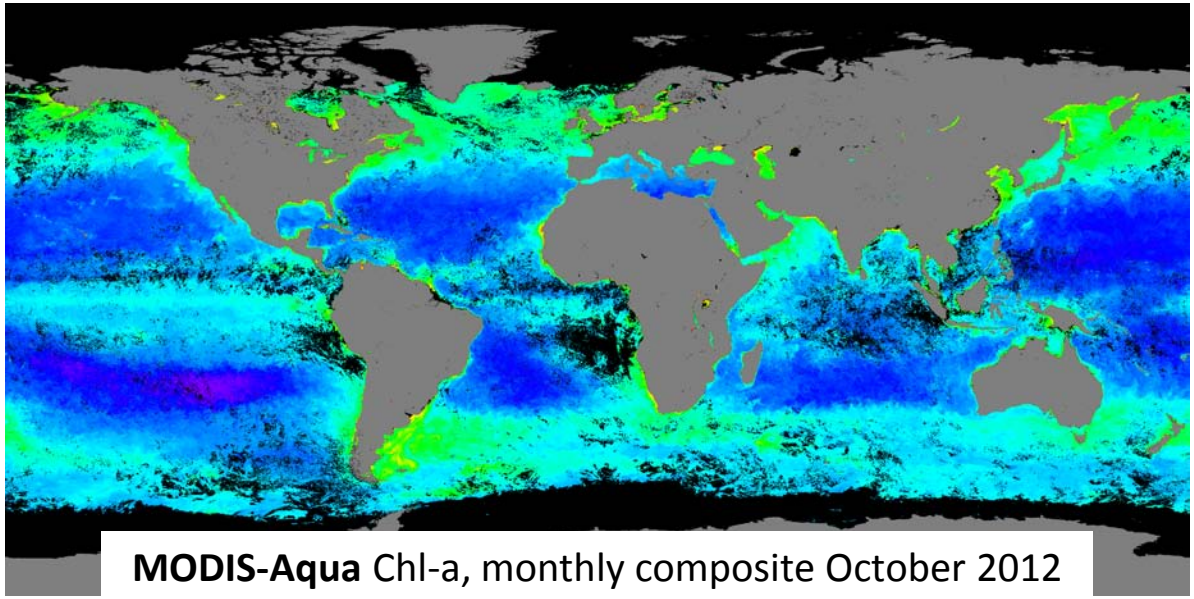
Chlorophyll-a

Log scale:
0.01 to 64 mg/m3





VIIRS (IDPS) Chl-a, monthly composite October 2012



MODIS-Aqua Chl-a, monthly composite October 2012

MODIS-Aqua data were obtained from NASA/OBPG ocean color website.

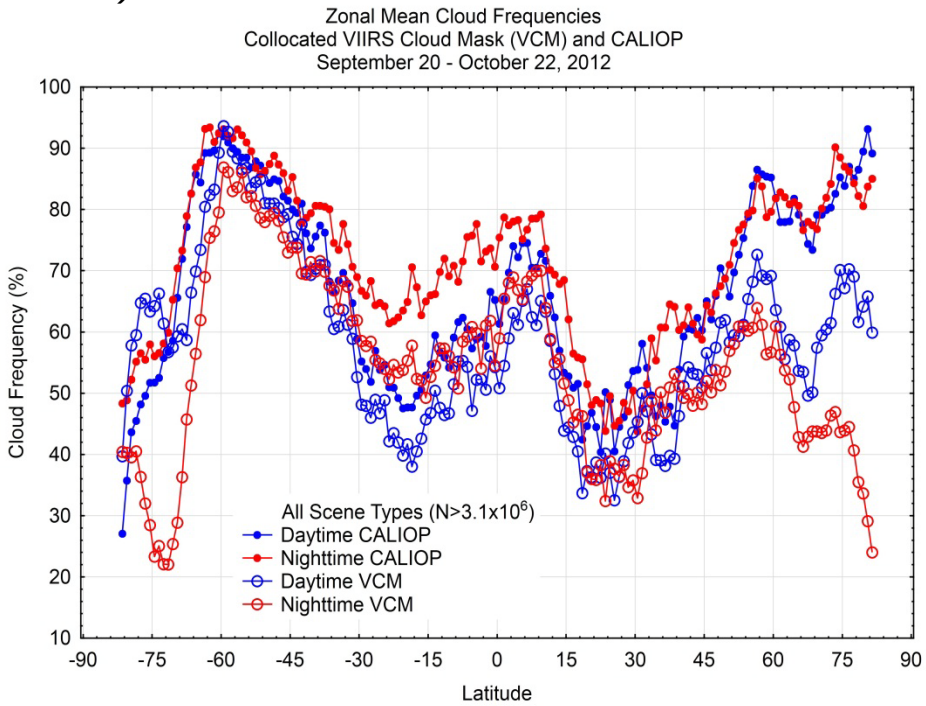
Slide courtesy of Menghua Wang and Ocean Color Team.

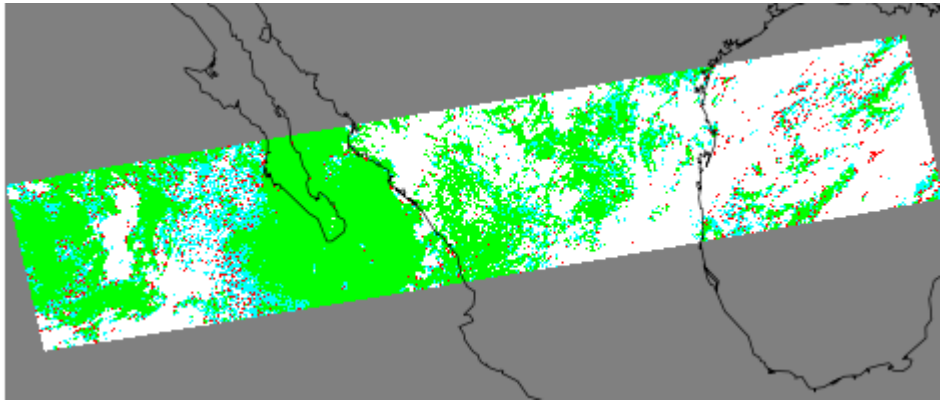
VIIRS Cloud Mask Overall Performance

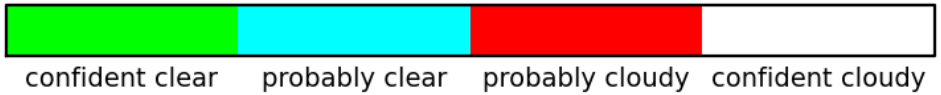
Beta in June 2012 – Provisional in January 2013

1. 30 day post-launch tuning completed and modifications implemented into IDPS.
2. Tuning and validation against multiple Golden Granules and through global comparisons with CALIPSO/CALIOP continue
3. Almost all post-launch IDPS builds have included VCM threshold adjustments.
4. Current work includes modifying VCM aerosol detection and application-specific optimization.

Zonal Cloud Amount Comparison of IDPS VCM against NASA's CALISO/CALIOP (a spaceborne lidar) for one month.



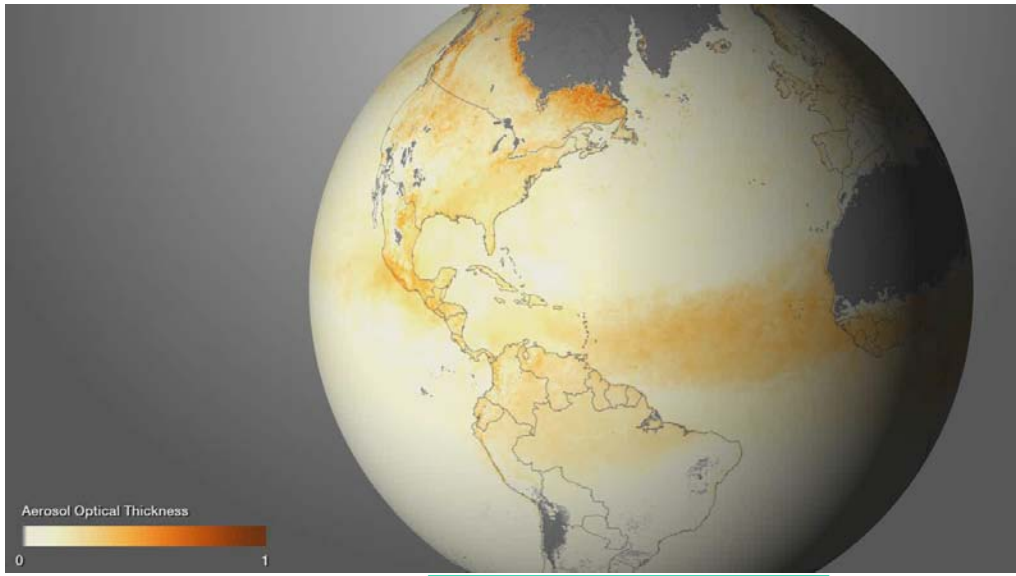




Slide courtesy of Andrew Heidinger and Clouds Team.

VIIRS Aerosol Products
Beta in September 2012

- **Aerosol Optical Thickness (AOT) and Aerosol Particle Size Parameter (APSP)**
  - **Intermediate Product (IP) at 750 nm nadir pixel resolution**
  - **Environmental Data Record (EDR) at 6 km nadir pixel resolution**
- **Suspended Matter (SM)**
  - **Aerosol type (dust, smoke, sea salt, volcanic ash) EDR at 750 m nadir pixel resolution**



Monthly mean May-Sep 2013

Error bounds for AOT defined by one standard deviation (68% of Retrievals)

	Land	Ocean
AERONET	±0.13 ± 15%	±0.04 ± 5%
MODIS	±0.09 ± 10%	±0.02 ± 10%

Product User/Applications when Data become Provisional

- Naval Research Laboratory (NRL)
  - Assimilation to improve Navy Aerosol and Analysis Prediction System (NAAPS)
  - Enhanced dust imagery for internal DoD applications
- Environmental Protection Agency (EPA)
  - Air quality monitoring and assessment
  - Environmental Rules
  - AIRNOW surface PM2.5 maps
- State and local air quality forecasters
  - Data and 48-hr trajectories initialized with VIIRS AOD through NESDIS IDEA web site
- State and local governments
  - File waivers with EPA for Exceptional Events (EE) rule
  - Environmental hazards monitoring (smoke and dust outbreaks)

Data Access:

- NRL from Atmospheric PEATE
- EPA from NESDIS/STAR
- State and local forecasters through IDEA website at NESDIS/STAR
- State and local governments from NESDIS/CLASS
- Access to data from DB web portal (in the planning by JPSS program office) is important to avoid 6+ hr latency for data access from CLASS

S. Kondragunta, I.Laszlo and JPSS Aerosol Team

Status of Suomi NPP: Active Fire Products

Beta Maturity October 2012

VIIRS Active Fire

Joint Polar Satellite System

NPP- Land Product Evaluation and Testing Element

VIIRS Land Product Quality Assessment

Home | About | FAQ | Download | Contact Us

Active Fire Team

Ivan Csiszar

Wilfrid Schroeder

Louis Giglio

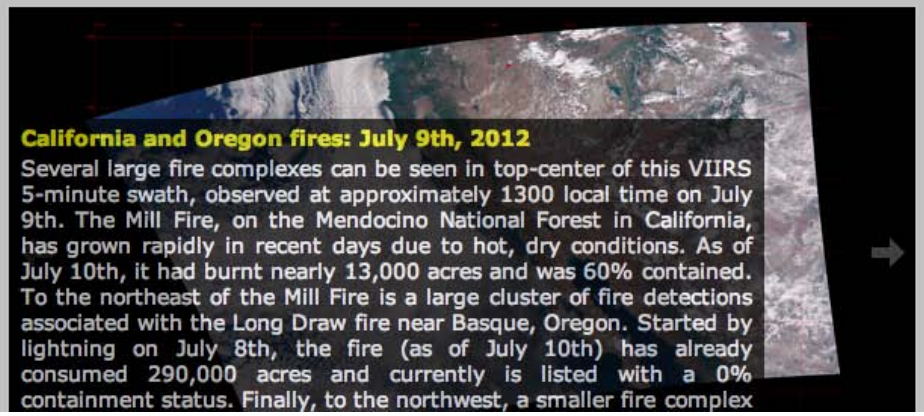
Evan Ellicott

Chris Justice

Krishna Vadrevu

VIIRS fire detections

The Visible Infrared Imager Radiometer Suite (VIIRS) sensor was launched aboard the Suomi National Polar-orbiting Partnership (NPP) satellite on October 28th, 2011 and on January 18th, 2012 cooler doors for the thermal sensor were opened. Within hours data were being retrieved and fire detections produced. The 84 second swath quicklooks presented here highlight recent fire detections superimposed on corrected reflectance RGB images (bands 5-4-3). VIIRS data are still preliminary and will continue to undergo testing and calibration over the coming weeks before being released for public use.



California and Oregon fires: July 9th, 2012

Several large fire complexes can be seen in top-center of this VIIRS 5-minute swath, observed at approximately 1300 local time on July 9th. The Mill Fire, on the Mendocino National Forest in California, has grown rapidly in recent days due to hot, dry conditions. As of July 10th, it had burnt nearly 13,000 acres and was 60% contained. To the northeast of the Mill Fire is a large cluster of fire detections associated with the Long Draw fire near Basque, Oregon. Started by lightning on July 8th, the fire (as of July 10th) has already consumed 290,000 acres and currently is listed with a 0% containment status. Finally, to the northwest, a smaller fire complex

Links

JPSS

VIIRS

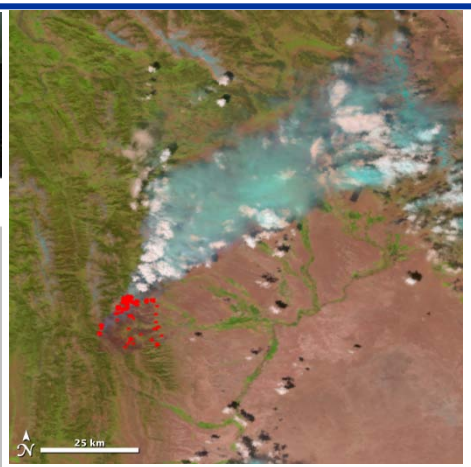
University of Maryland

NOAA

NOAA-STAR

USFS RSAC

VIIRS vs MODIS



viirsfire.geog.umd.edu

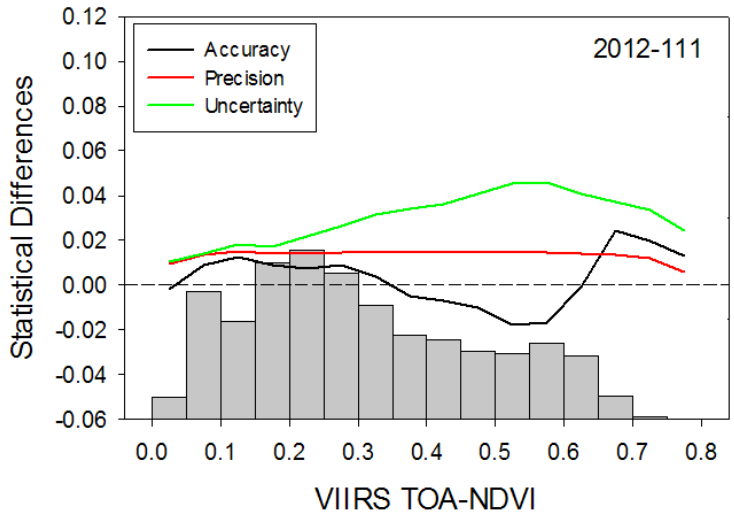
CRITICAL INFORMATION AIR QUALITY, ECOSYSTEM MANAGEMENT AND DISASTER MANAGEMENT

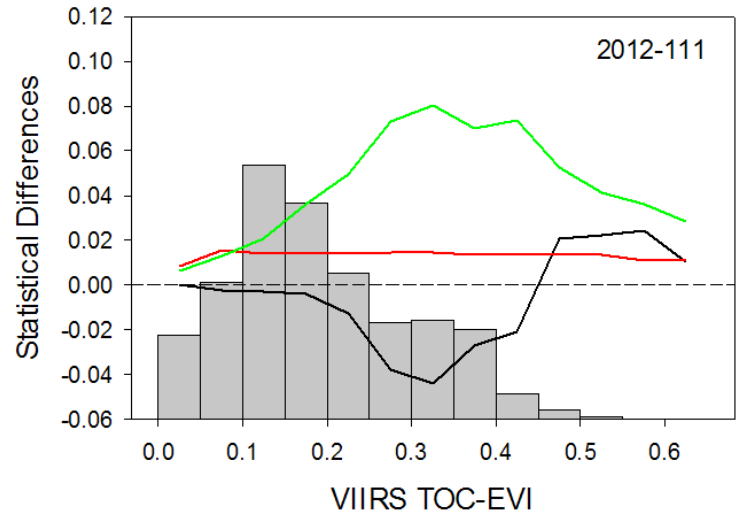
VIIRS Vegetation Index EDR

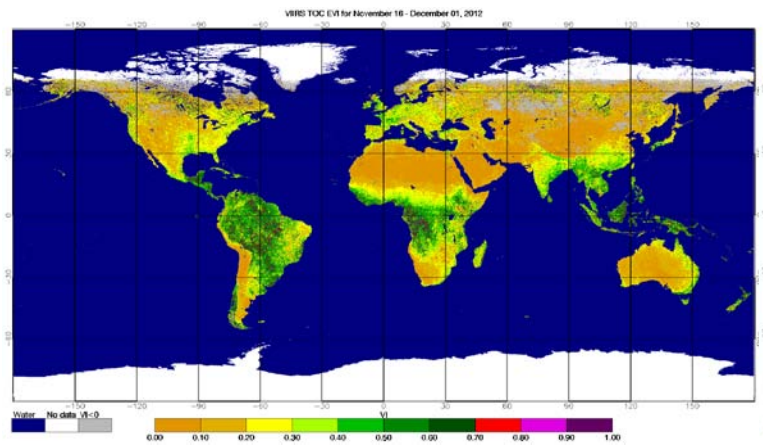
Started Beta process in December 2012

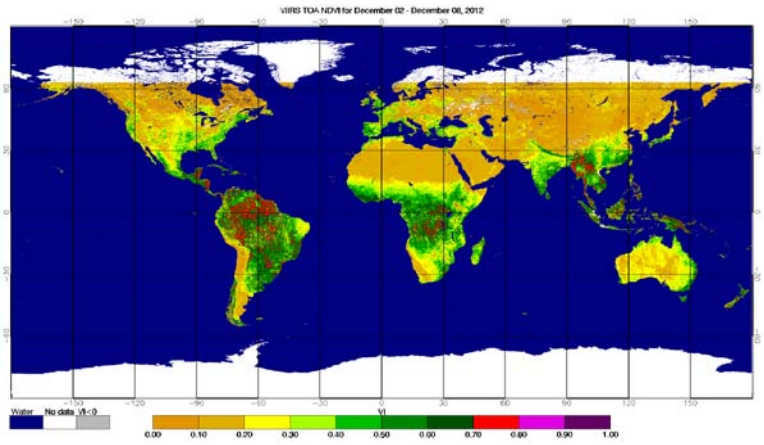
- Characterize AVHRR/VIIRS and MODIS/VIIRS continuity
- VIIRS & MODIS data were screened for clouds, shadows, snow/ice, and medium-to-high aerosols.
- Overall accuracy meeting the threshold requirement.
- Overall precision meeting the specification.

Performance Metrics with Respect to Aqua MODIS





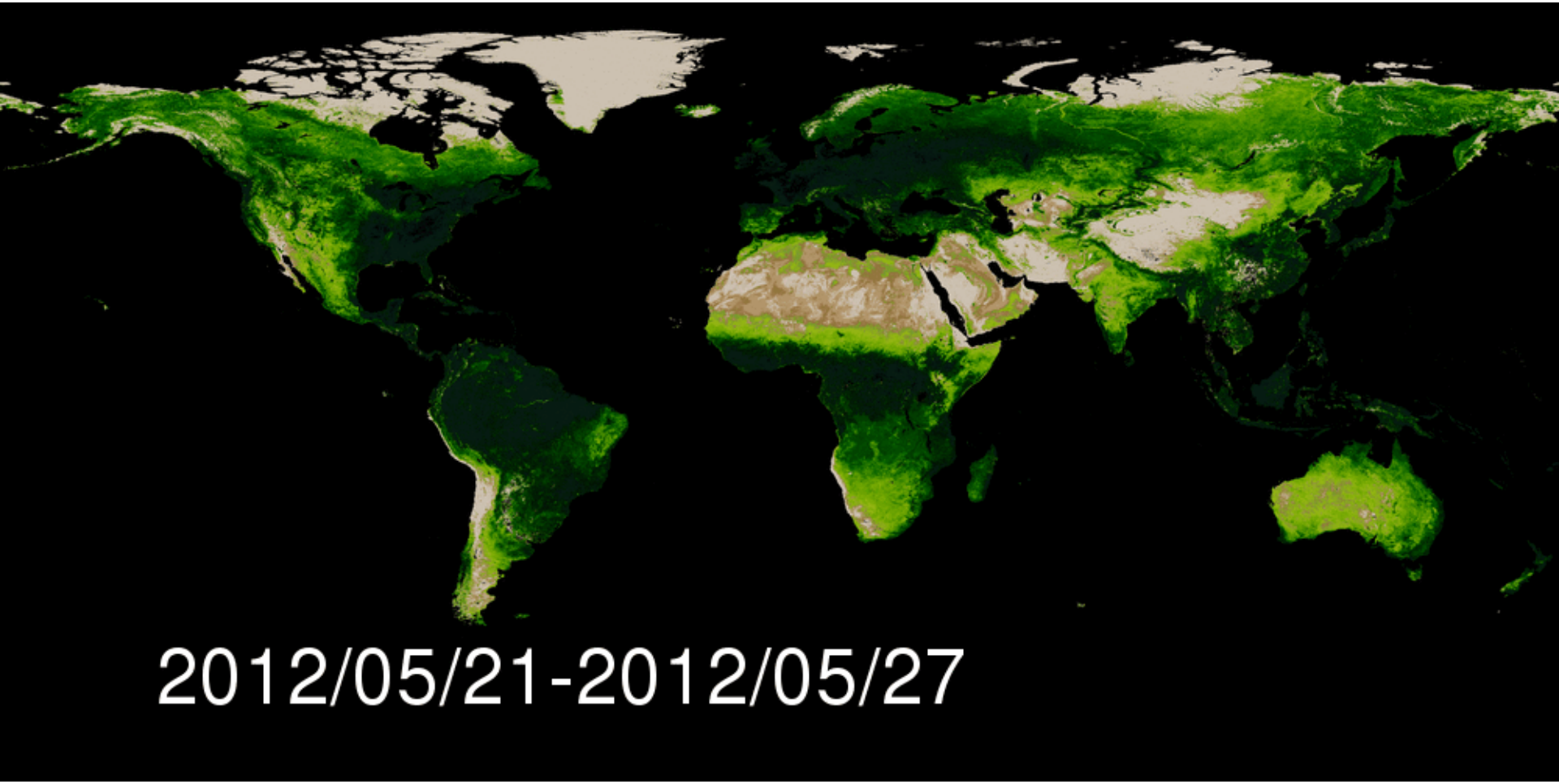




TOC-EVI 16-day composite (Nov 16 – Dec 01, 2012) ***TOA-NDVI 7-day composite (Dec 02– Dec 08, 2012)***

Slide courtesy of T. Miura and M. Vargas

Global Daily Rolling Weekly VIIRS Green Vegetation Fraction Product



GVF is a critical input for Land Surface Models . The SNPP GVF is based on EVI and calibrated using Landsat-class data.

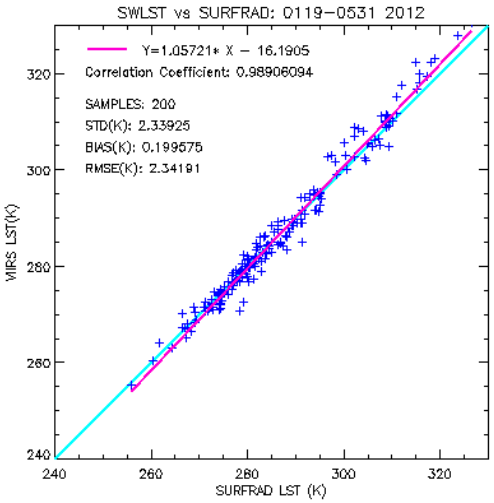
M. Vargas/NDE GVF Team

VIIRS LST EDR

Advanced to Beta in December 2012

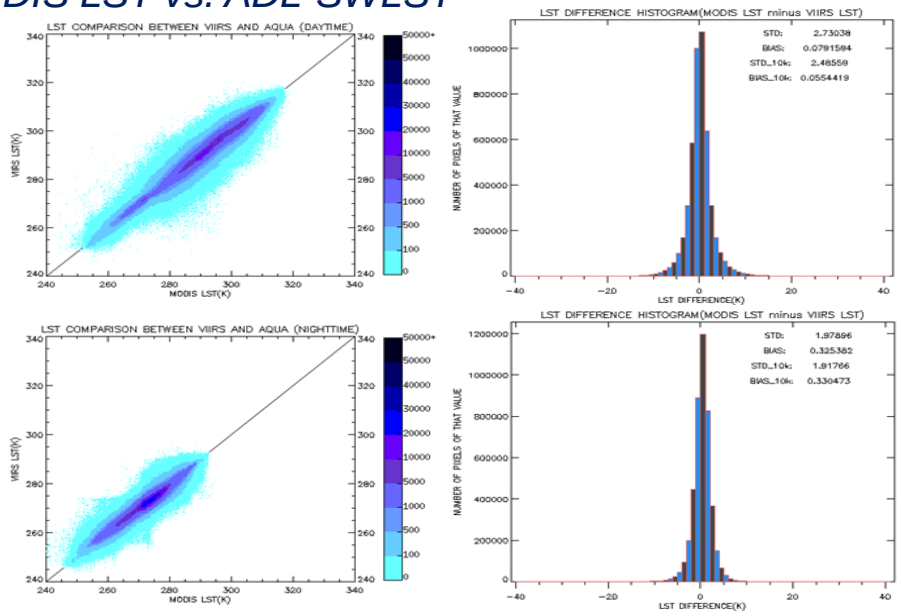
Current Status:

- VIIRS LST values are close to the MODIS LSTs over surface types of deciduous broadleaf forests and Croplands/Natural Vegetation Mosaics, but have significant difference over permanent wetlands, barren, water bodies, evergreen needle leaf forests and closed shrub lands.
- LST values on Inland Water is high.
- Due to snow flag error, nighttime LST on snow surface may be incorrect.



Validation Against Ground Truth: *Sample scatter plots of the VIIRS LSTs and the SURFRAD LSTs*

MODIS LST vs. ADL-SWLST



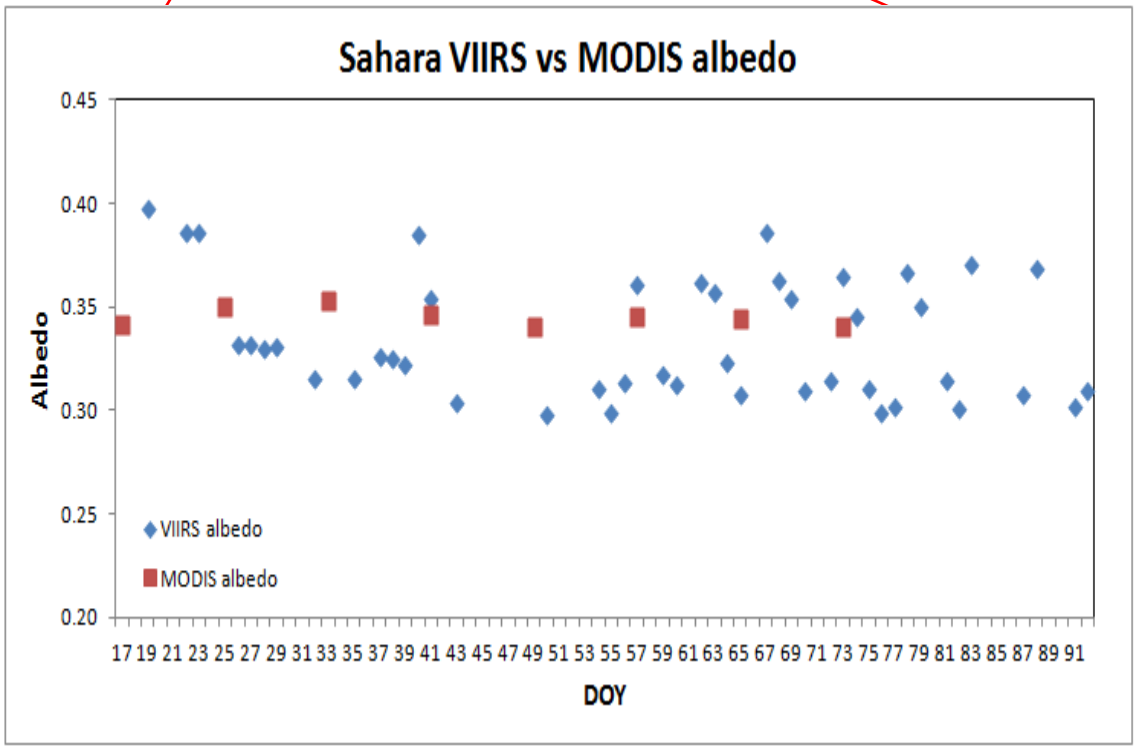
Slide courtesy of Bob Yu, Jeff Privette, Pierre Guillevic and the LST Team.

VIIRS Albedo

To advance to Beta in May 2013

- **VIIRS Albedo algorithm produces a single daily broadband value at the time of overpass.**
- **Two algorithms have been implemented**
  - **Bright Pixel Surface Albedo (BPSA) is a TOA LUT approach.**
    - > **Designated as primary algorithm**
  - **Dark Pixel Surface Albedo (DPSA) is based on heritage MODIS.**
    - > **Currently switch off**
- **Evaluation underway**
  - **Comparison with MODIS products.**
  - **Comparison with tower albedometer measurements .**
    - > **At spatially representative sites**

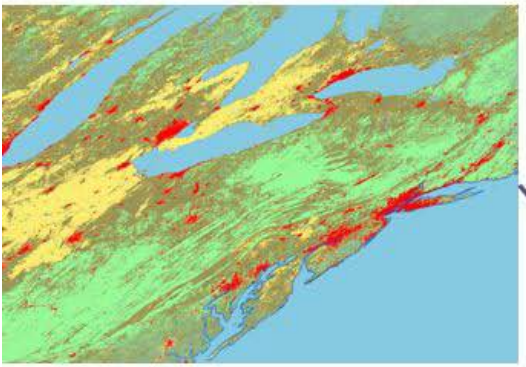
Desert area is a good site for testing the albedo product stability. Such stable albedo is observed in the MODIS data. However, VIIRS BPSA shows great variation.



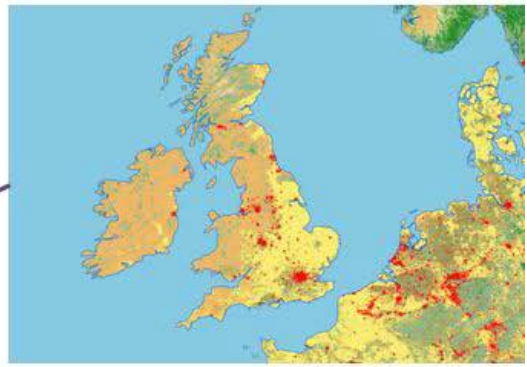
Slide courtesy of Bob Yu and the Albedo Team.

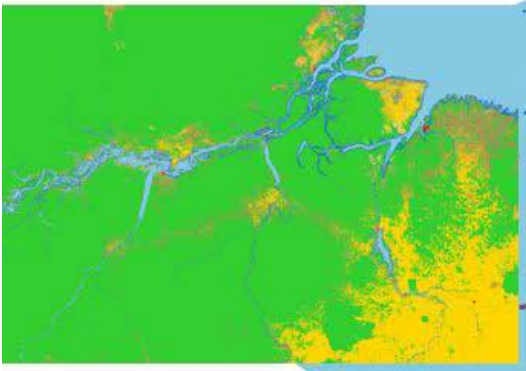
Surface type

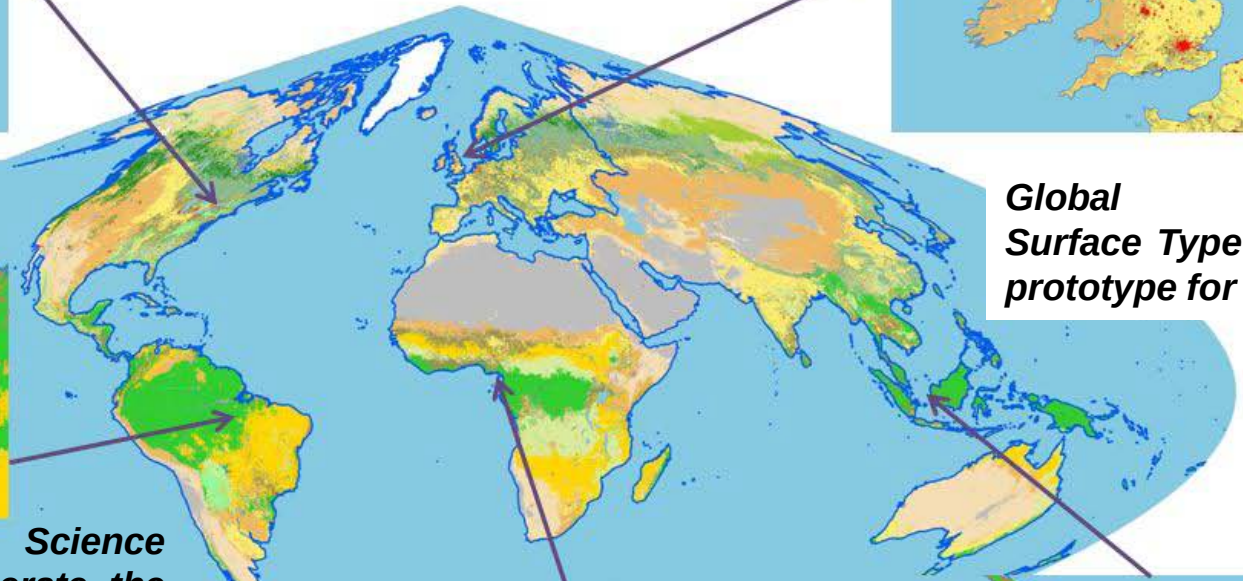
Advance to Beta in Jan 2013



VIIRS Surface Type is used in Land Surface Models, for global and large-scale ecosystem assessments, and for ecosystem change monitoring. It is also an auxiliary input for other data products.







Global MODIS Surface Type map as prototype for VIIRS.

The JPSS Surface Type Science Team is preparing to generate the first Quarterly Surface Type IP based on one full year VIIRS data.

- Water Bodies
- Evergreen Needleleaf Forests
- Evergreen Broadleaf Forests
- Deciduous Needleleaf Forests
- Deciduous Broadleaf Forests
- Mixed Forests
- Closed Shrublands
- Open Shrublands
- Woody Savannas
- Savannas
- Grasslands
- Permanent Wetlands
- Croplands
- Urban and Built-up Lands
- Cropland/Natural Vegetation Mosaics
- Snow and Ice
- Barren

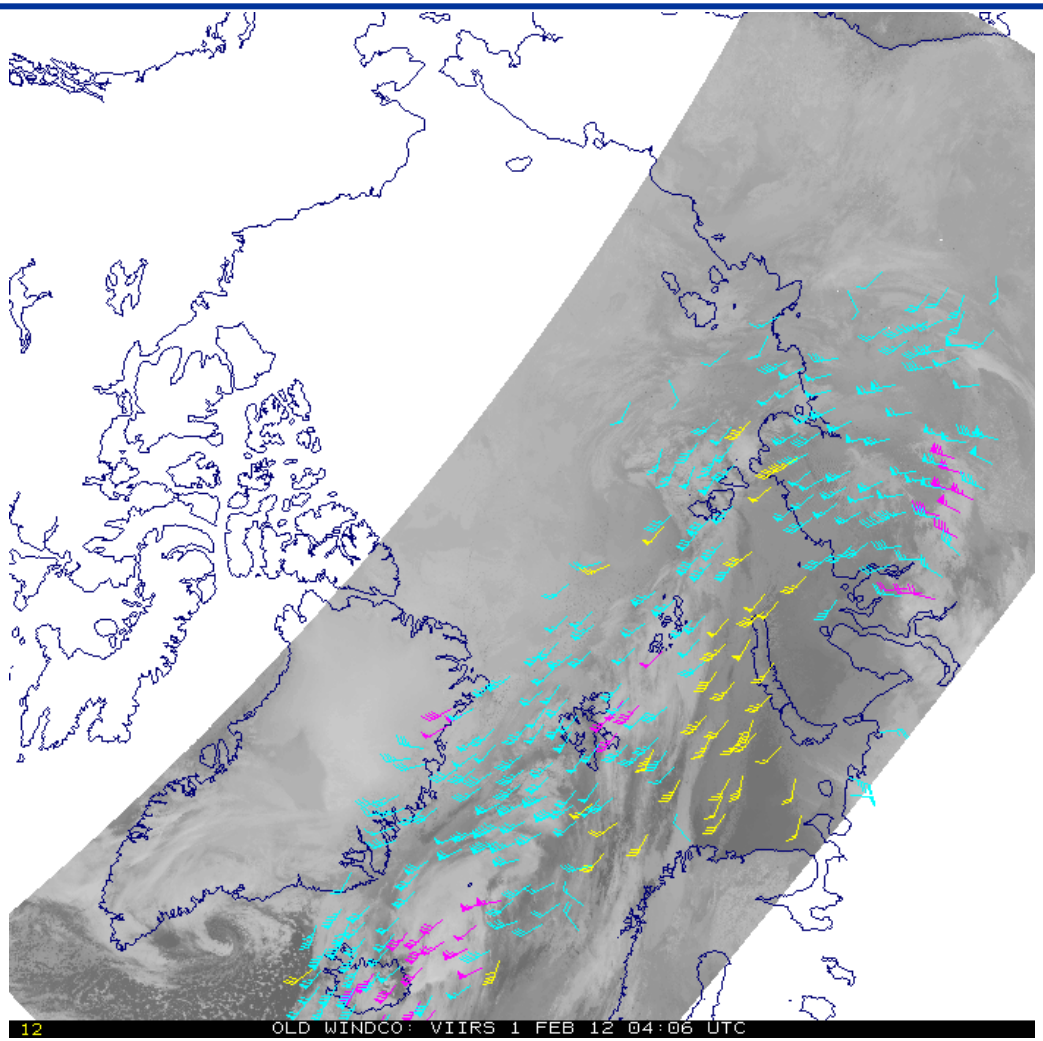
X. Zhan/JPSS Land Surface Type Team

VIIRS Polar Winds (NDE)

Description: Tropospheric wind speed, direction, and height based on cloud tracking. Based on the GOES-R ABI wind retrieval methodology.

Characteristics: Winds are generated for the area of overlap of three consecutive orbits. The product will be operational in early 2013.

Users: MODIS and AVHRR polar winds are assimilated in numerical weather prediction systems at 13 operational centers in 8 countries. VIIRS winds are expected to be used by the same centers.

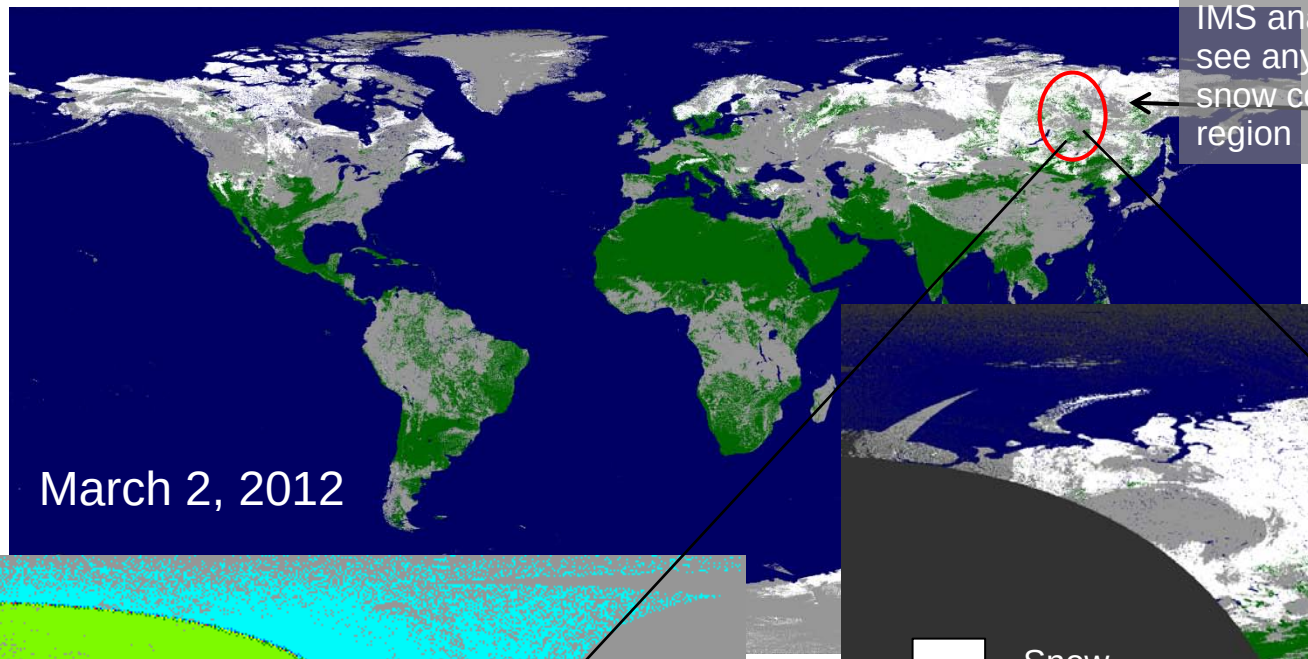


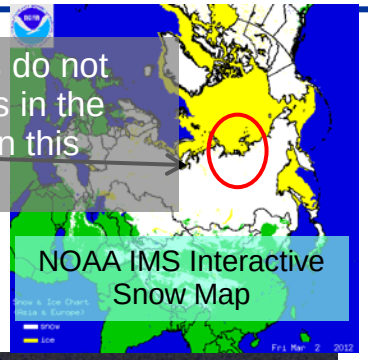
Winds from VIIRS data for one pass (actually, a triplet of passes) over the Arctic on 1 February 2012. While precise heights are retrieved, the figure groups the vectors into low (yellow), middle (cyan), and high (magenta) categories.

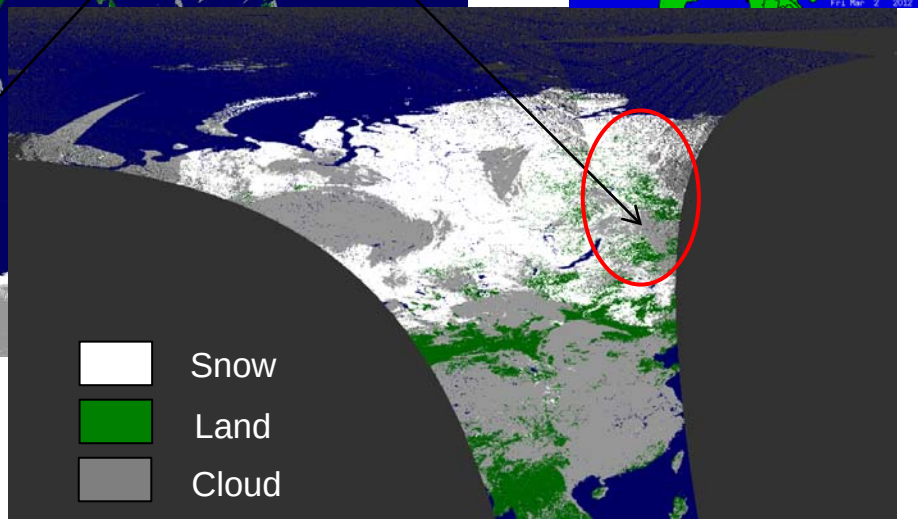
J. Key/NDE Polar Winds Team

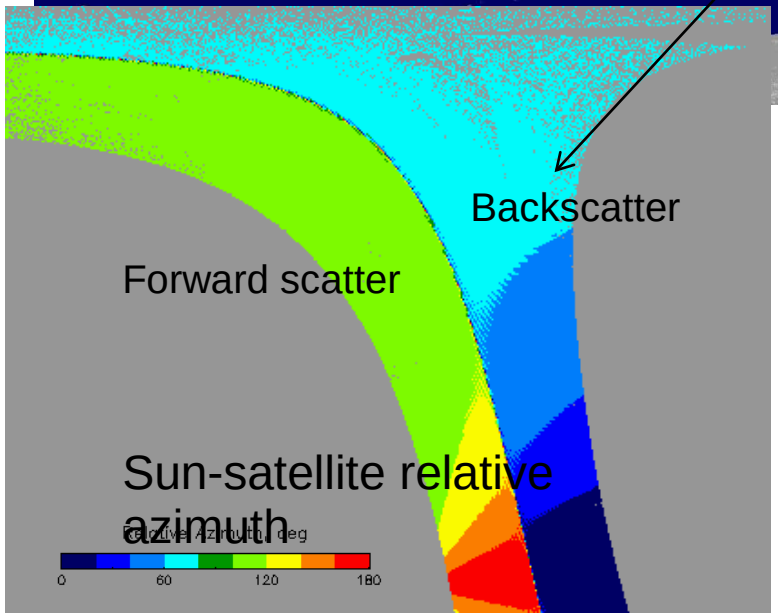
Snow cover

Advance to Beta in June 2013









Realistic, detailed characterization of regional snow cover at high spatial resolution. VIIRS sees less snow than MODIS, and has some false snow in tropical areas.

Slide courtesy of Jeff Key and the Cryosphere Team.

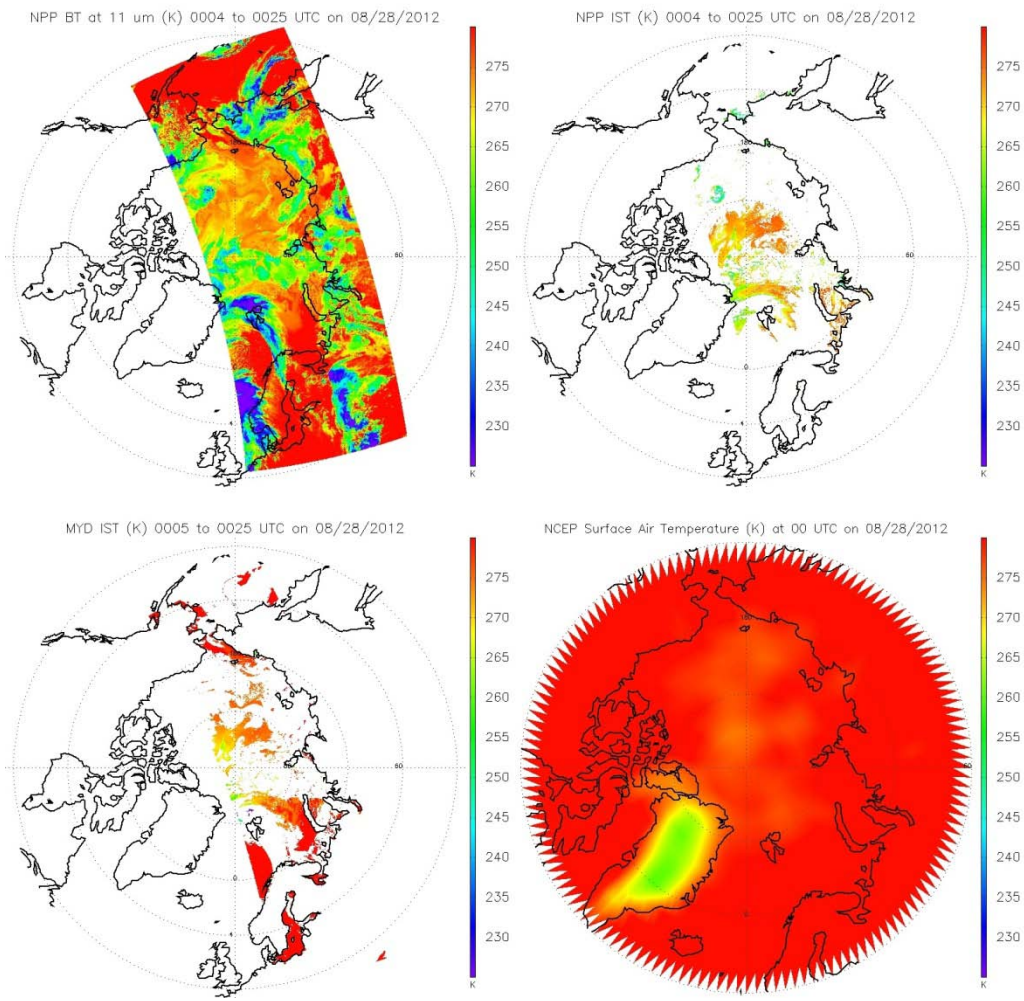
VIIRS Ice Surface Temperature

Advance to Beta in June 2013

Description: The surface (skin, or radiating) temperature of sea ice.

Status: **VIIRS IST has a 1-2 K cold bias relative to MODIS.** The bias for VIIRS Land Surface Temperature over the ice sheet (not shown) is less than for IST. Compared to drifting ice buoy near-surface air temperatures, the **mean difference (buoy minus VIIRS IST) is 4.8K.**

Users: Ice centers, NWP model verification (not assimilated), science applications.

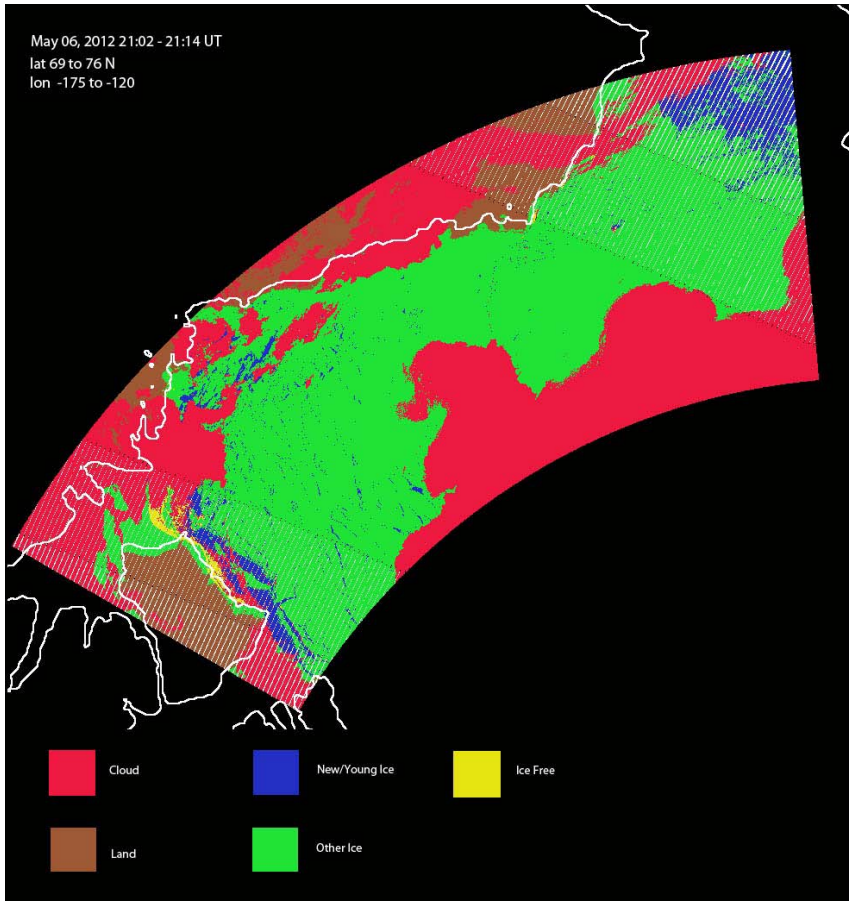


Comparison of IST from VIIRS and MODIS

Slide Courtesy of Genevieve Valliere-Kelley and Jeffrey Key.

Sea Ice Cover and Characterization

Description: An ice age classification for: Ice -free, New/Young Ice (less than 30 cm thickness), and All Other ice. Freshwater ice is not included.



Sea ice characterization on 6 May 2012 just north of Alaska and eastward to the Canadian Archipelago. New/young ice (less than 30 cm) is blue; older ice is green.

Status: **Sea ice extent is realistic**, but with some false ice over open water, misclassification of new/young vs. other ice, and some misplacement of land values. Ice characterization (age) is better for daytime than nighttime. VIIRS ice concentration is **biased high relative to passive microwave data** overall, but biased low at the low end.

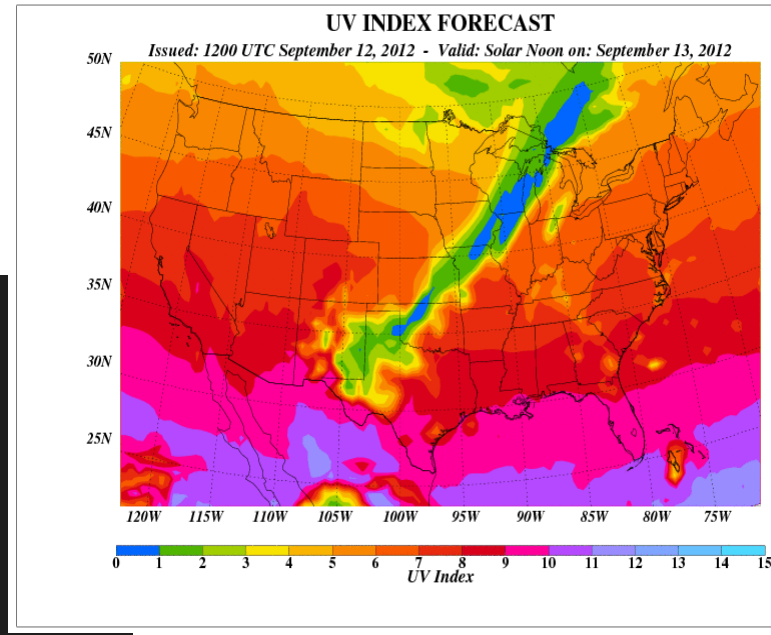
Users: Ice centers (navigation), NWP model verification (not assimilated), science applications.

J. Key/JPSS Cryosphere Team

Status of Suomi NPP: Ozone Products

Beta in August 2012, Provisional in January 2013

The ozone team has been using OMPS data to track the Antarctic Ozone Hole.



UV Index Forecast for September 13, 2012

Values below 220 Dobson Units are regarding as evidence of Ozone Hole conditions.

Summary and conclusions

- **The Suomi NPP sensors have proven to provide <u>excellent radiometric observations</u> to generate high quality environmental data products**
  - **Provisional SDRs expected by early 2013**
- **EDRs are in the process of <u>achieving Beta and Provisional</u> maturity**
- **Identified issues in the data product algorithms are <u>integrated into the operational system</u> as they are resolved.**
- **Lessons learned are being incorporated in <u>J1 algorithm development</u> and cal/val planning.**
- **Review and revision of JPSS <u>L1 requirements</u> is ongoing**
  - **Algorithm improvements and product enhancements for SNPP and JPSS**

SNPP Algorithm Maturity Status

Algorith Maturity Status EOM December 2012	Priority	Status to Date	D-12	J-13	F-13	M-13	A-13	M-13	J-13	J-13	A-13	S-13	Q1-14	Q2-14	Q3-14	Q4-14	Q1-15	Q2-15	Q3-15	Q4-15	Q1-16	Q2-16
ATMS SDR	1	β		Prov									Valid									
CrIS SDR	1	β		Prov						Valid												
VIIRS SDR GEO	1	β		Prov			Valid															
VIIRS SDR	1	β		Prov							Valid											
VIIRS EDR Imagery (not NCC)	1	β		Prov										Valid	V-2	V-3						
VIIRS EDR NCC Imagery	1			β						Prov				Valid	V-2	V-3						
ATMS TDR	2	β		Prov									Valid									
VIIRS EDR Sea Surface Temperature (SST)	2		β	β								Prov		Valid		V-2		V-3				
VIIRS EDR Ocean Color / Chlorophyll	2						β				Prov				Valid			V-2				V-3
OMPS SDR Earth View (Includes 2 products: NP and TC)	3	β		Prov									Valid									
OMPS EDR Ozone (Includes 2 products: NP and TC)	3	β		Prov						Valid		V-2		V-3								
VIIRS EDR Cloud Mask (VCM)	3	β		Prov									Valid		V-2			V-3				
CrIMMS EDR Atmospheric Profiles (Includes 2 products: Moisture and Temperature)	3	β				Prov							Valid				V-2				V-3	
VIIRS EDR Suspended Matter (SM)	3	β						Prov							Valid		V-2				V-3	
VIIRS EDR Land Active Fires	3	β									Prov					Valid				V-2	V-3	
OMPS SDR Calibration	3					β			Prov		Valid											
VIIRS EDR Sea Ice - Concentration	3						β						Prov	Valid		V-2		V-3				
VIIRS EDR Sea Ice - Characterization (Age)	3						β						Prov			Valid	V-2		V-3			
VIIRS EDR Snow Cover - Binary Mask	3						β						Prov	Valid		V-2		V-3				
VIIRS EDR Snow Cover - Fraction	3						β						Prov			Valid	V-2	V-3				
VIIRS EDR Cloud-1 (Includes 4 products: Coverage/Layers, Effective Particle Size, Optical Thickness, Top Height	3							β						Prov		Valid		V-2				V-3
CrIS IP Ozone Profile (TBD)	3																					
CERES SDR (TBD)	3																					
CERES EDR (TBD)	3																					
VIIRS EDR Aerosols (Includes 2 products: Aerosol Optical Thickness and Aerosol Particle Size)	4	β						Prov							Valid		V-2				V-3	
VIIRS EDR Land Surface Temperature	4	β	β					Prov					Valid		V-2				V-3			
VIIRS EDR Surface Type	4	β	β										Prov			Valid				V-2	V-3	
VIIRS IP Surface Reflectance	4	β	β									Prov			Valid			V-2				V-3
VIIRS EDR Vegetation Index	4	β	β									Prov			Valid			V-2				V-3
VIIRS Gridding and Granulation (Not an L1RD product)	4			β				Prov					Valid		V-2		V-3					
VIIRS EDR Ice Surface Temperature	4					β						Prov	Valid	V-2		V-3						
VIIRS EDR Land Surface Albedo (Not an L1RD product)	4							β					Prov			Valid		V-2				V-3
VIIRS EDR Cloud-2 (Includes 3 products: Cloud Base Height,	4							β						Prov		Valid		V-2				V-3
VIIRS EDR Sea Ice & Combined Surface Albedo	4								β				Prov		Valid		V-2				V-3	