



# Overview of NPP EDR Products

**Ivan Csiszar**

**NOAA/NESDIS/STAR NPP EDR LEAD**

**with input from**

**NOAA/NESDIS/STAR Algorithm and Data Products Algorithm Leads and Co-leads**

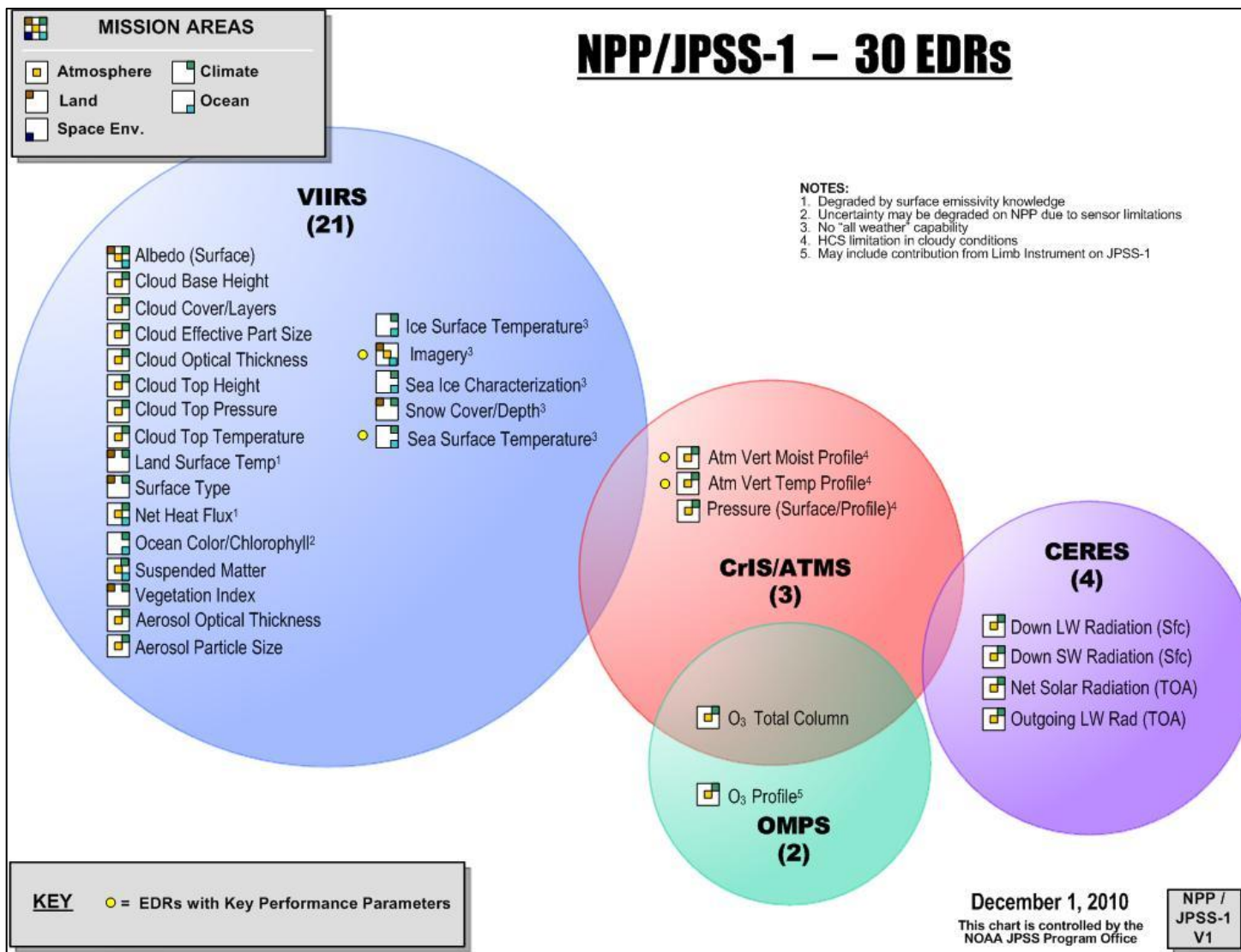
**(see credit on each slide)**

# Introduction



- Delivery of **real-time** EDRs from NPP will allow for continuation and improvement of support for operational **weather forecasting**, **environmental monitoring** and **disaster management**.
- NPP will provide a continuation of major **long-term observations** initiated by the Earth Observing System (EOS) TERRA, AQUA, and Aura missions, for Land, Ocean, Cloud, Aerosol, Atmosphere Soundings, Ozone and Trace Gases to enhance our understanding of the **climate** change processes.
- All NPP EDR responsibilities have transitioned to **government-led** algorithm and cal/val teams.
  - Team leadership and composition are a mix of NOAA/NESDIS **STAR** and **heritage** team members, many of which were from STAR.
  - Product **validation** is an integral part of the product development and evaluation process
- Coordination and collaboration between **NOAA JPSS** and **NASA NPP** Science Team will continue.
- Objective - provide an **overview** and **update** of selected NPP EDRs.

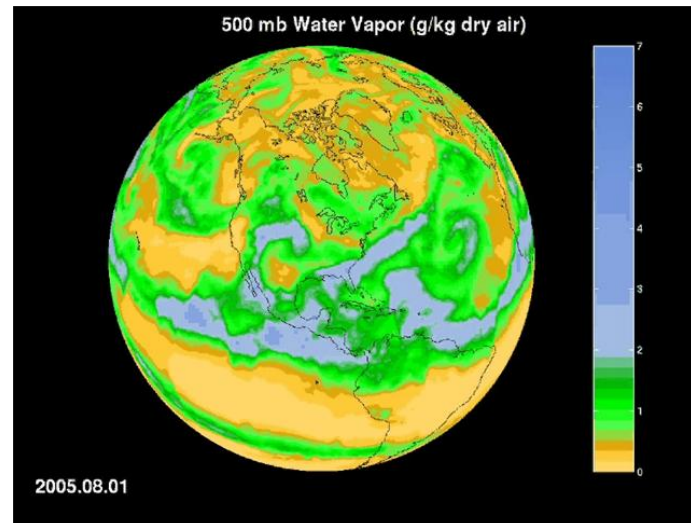
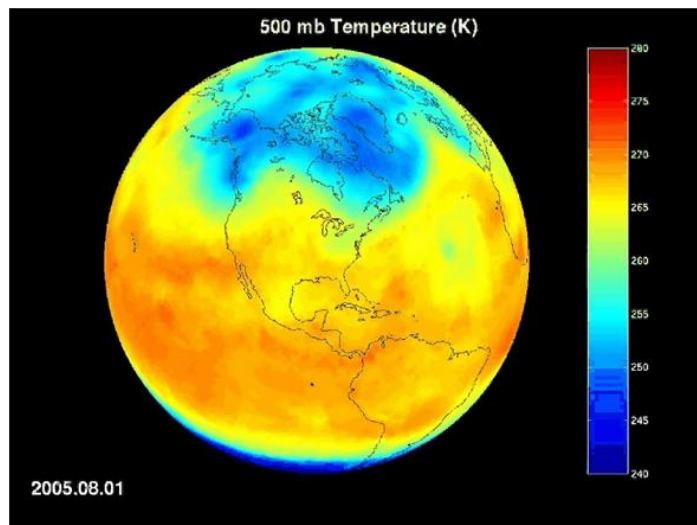
# NPP/JPSS-1 Operational Environmental Data Records



# CrIMSS Temperature and Moisture EDR



- **EDR description:** Atmospheric Vertical Temperature Profile (AVTP) and Moisture Profile (AVMP) products are provided.
- **Current Retrieval Strategy:**
  - Cross-track Infrared Microwave Sounder Suite (CrIMSS) algorithm is an **optimal estimation approach** using co-registered cloud cleared infrared and microwave radiances.
  - Uses radiometric signals from CrIS and ATMS to produce AVTP and AVMP along with a pressure profile (AVPP) and intermediate ozone profile product.
- **Product Status and Expected Updates:** This is a **new algorithm** using the Optimal Spectral Sampling (OSS) forward model. The CrIMSS algorithm is being **tested with proxy data** derived from heritage hyperspectral infrared and microwave sounders. Product will **be compared post-launch to the NOAA-Unique CrIS/ATMS Processing System (NUCAPS)** which is based on the heritage AIRS Science Team algorithm and will be run operationally within the NDE environment.



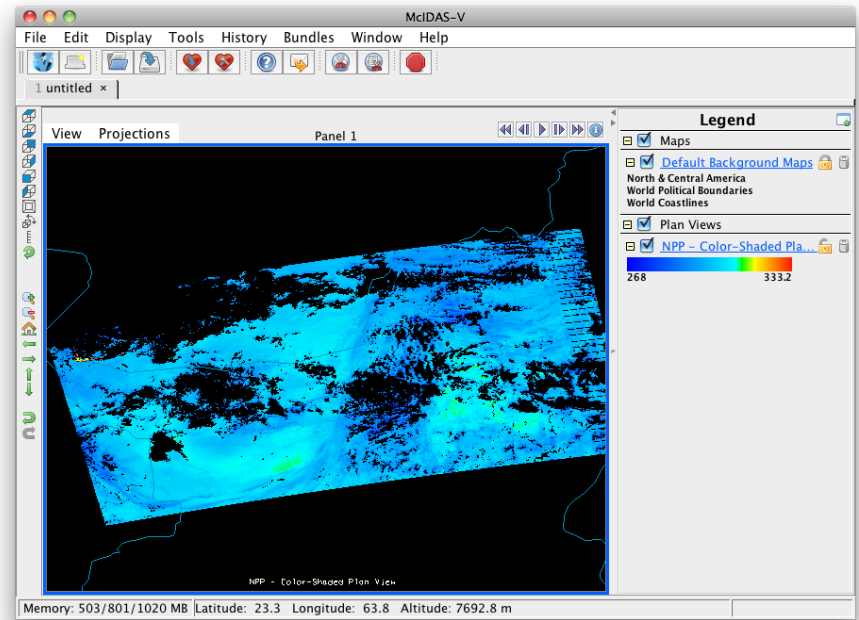
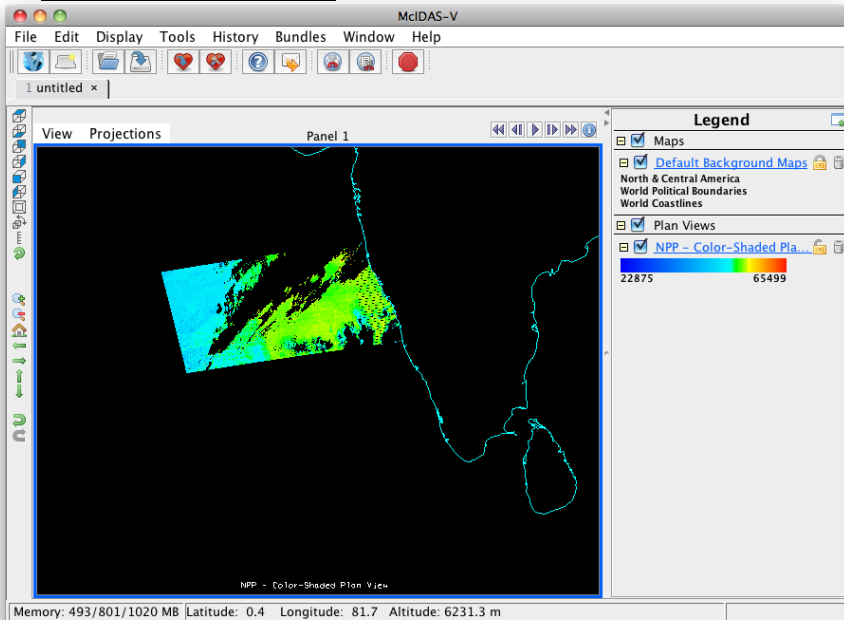
*Example of AVTP and AVMP products from Atmospheric Infrared Sounder (AIRS) on the NASA Aqua Satellite*

Aug. 1, 2005 AIRS composite  
courtesy of Tom Pagano, AIRS Science Team

# VIIRS Imagery EDR



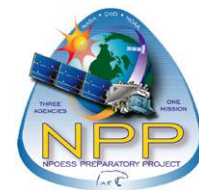
- **EDR description:** Ground Track Mercator remapping of VIIRS SDR granules.
- **Current Retrieval Strategy:**
  - Assessment for basic imagery characteristics, such as noise levels and detector-to-detector striping, in addition to many other imager characteristics related to calibration and navigation.
  - Assessment of the true quality of VIIRS data: I, M and Day-Night-Band (or Near Constant Contrast).
  - Independent and collaborative analysis using team members' respective facilities and capabilities, using tools and display software such as McIDAS-X/McIDAS-V and TeraScan/NEXSAT.
- **Product Status and Expected Updates:** Feedback will be documented and provided to VIIRS SDR Team.



Examples of VIIRS proxy EDRs displayed in McIDAS-V

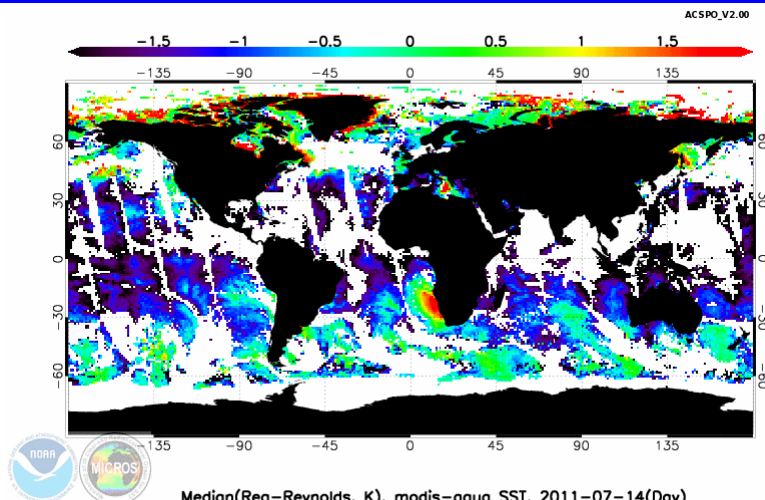
Don Hillger, NOAA/NESDIS/STAR

# VIIRS Sea Surface Temperature EDR

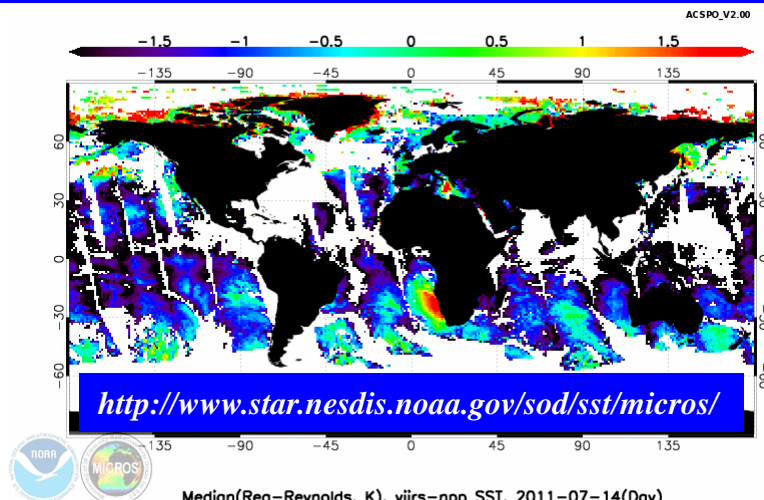


- **EDR description:** Bulk and Skin Sea Surface Temperature (SST).
- **Current Retrieval Strategy:**
  - The algorithm is **regression** Non-Linear SST (NLSST).
  - **Day equation** is two-channel split-window 11-12  $\mu\text{m}$ ; **Night equation** is three-channel (+3.7  $\mu\text{m}$ ).
  - Skin SST is calculated from bulk by adding a **constant offset**, which may be day and night specific.
- **Product Status and Expected Updates:** The algorithm is **heritage** AVHRR/MODIS. Elements from the new NESDIS Advanced Clear-Sky Processor for Oceans (ACSPPO), Community Radiative Transfer Model with first-guess SST/atmosphere fields for **improved cloud screening** and **SST retrievals**, will be explored.

*End-to-end processing VIIRS SDR Proxy data into ACSPPO SST set up at NESDIS*



Median(Reg-Reynolds, K), modis-aqua SST, 2011-07-14(Day)  
**MODIS minus Reynolds SST  
from Aqua MODIS**



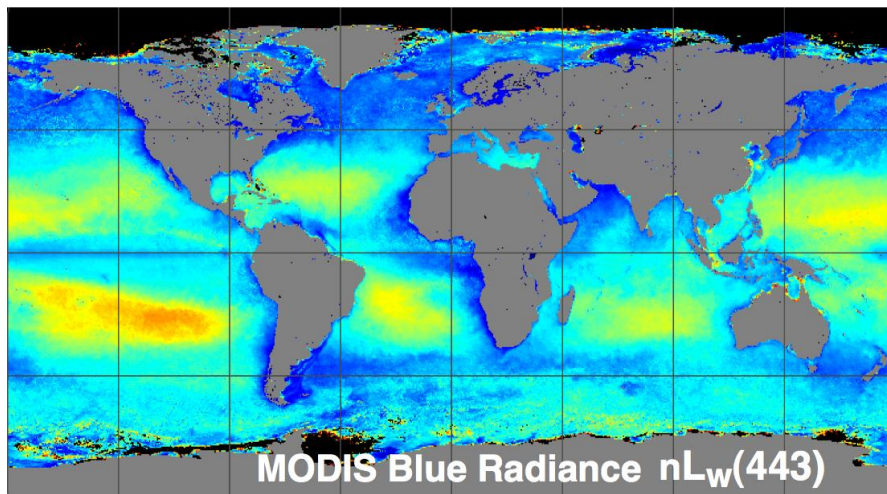
Median(Reg-Reynolds, K), viirs-npp SST, 2011-07-14(Day)  
**VIIRS minus Reynolds SST  
from NPP VIIRS Proxy  
Alexander Ignatov, NOAA/NESDIS/STAR**

# VIIRS Ocean Color EDR

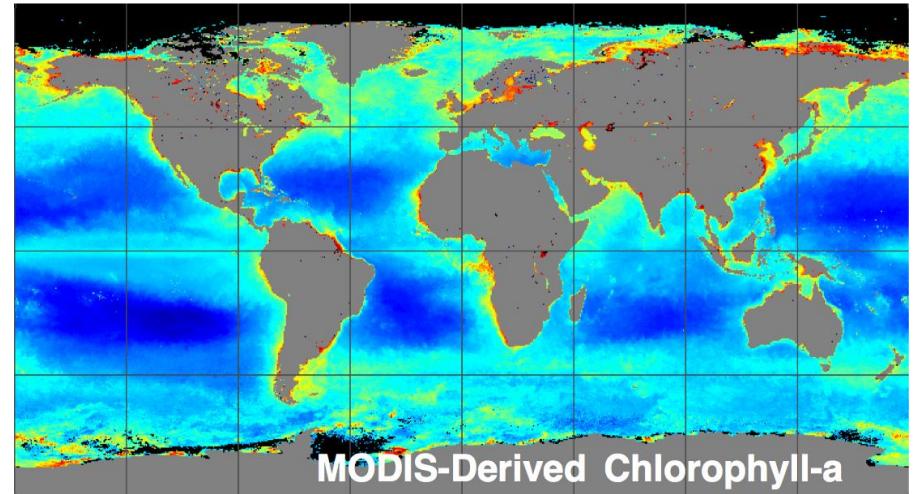


- **EDR description:** Water-leaving Radiance Spectra and Chlorophyll-a Concentration.
- **Current Retrieval Strategy:**
  - The VIIRS atmospheric correction algorithm uses bands M6 (746 nm) and M7 (865 nm) to establish atmosphere and aerosol models to convert sensor-measured top-of-atmosphere radiance to the normalized water-leaving radiance. This is basically the same as the SeaWiFS/MODIS algorithm.
  - Chlorophyll-a concentration is derived from VIIRS-measured water-leaving radiance spectra data using the radiance ratio between blue and green bands.
- **Algorithm Status and Expected Updates:** The heritage chlorophyll-a algorithm (empirical algorithm as for SeaWiFS/MODIS) will be used for VIIRS chlorophyll-a product. Thus, consistent chlorophyll-a data with SeaWiFS/MODIS can be produced.

## MODIS-Aqua-Measured Global Ocean Color Product in 2005



$nL_w(443)$  (scale 0-4) ( $\text{mW cm}^{-2} \mu\text{m}^{-1} \text{sr}^{-1}$ )



Chlorophyll-a ( $\text{mg m}^{-3}$ ) (logscale 0.01-16)

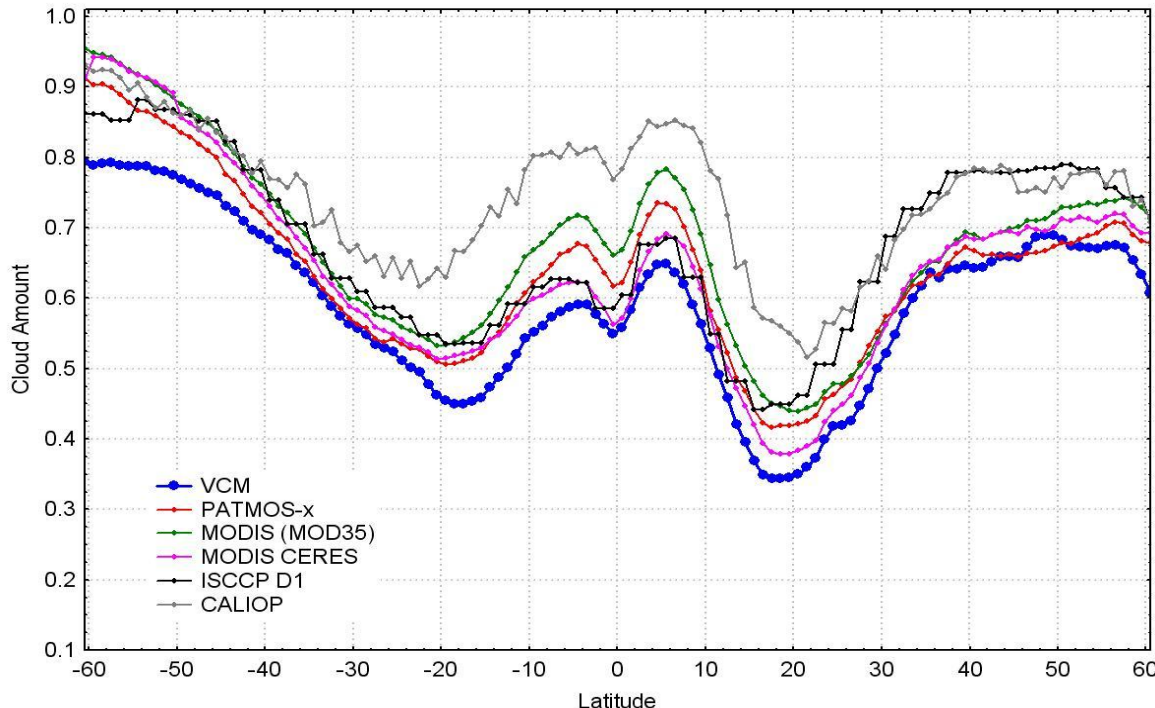
Menghua Wang, NOAA/NESDIS/STAR

# VIIRS Cloud Mask (VCM) EDR



- **EDR description:** Detection of Cloud within each VIIRS Moderate Resolution Pixel.
- **Current Retrieval Strategy:**
  - Uses **spectral and spatial tests** to classify a pixel's cloudiness into 4 –levels (clear, probably-clear, probably-cloudy and cloudy).
- **Product Status and Expected Updates:** The algorithm has evolved from and in parallel with the MODIS (MOD35) and CLAVR-x cloud masks. We expect **post-launch tuning** to correct most issues. Some application specific issues may require adoption of methods developed at NOAA and NASA. Currently, VCM generally **underestimates** cloud relative to most other cloud mask products.

Zonal Mean Daytime Cloud Amounts  
April 2007



*Comparison of the zonally averaged cloud fraction from the VCM and other popular cloud mask products for April 2007.*

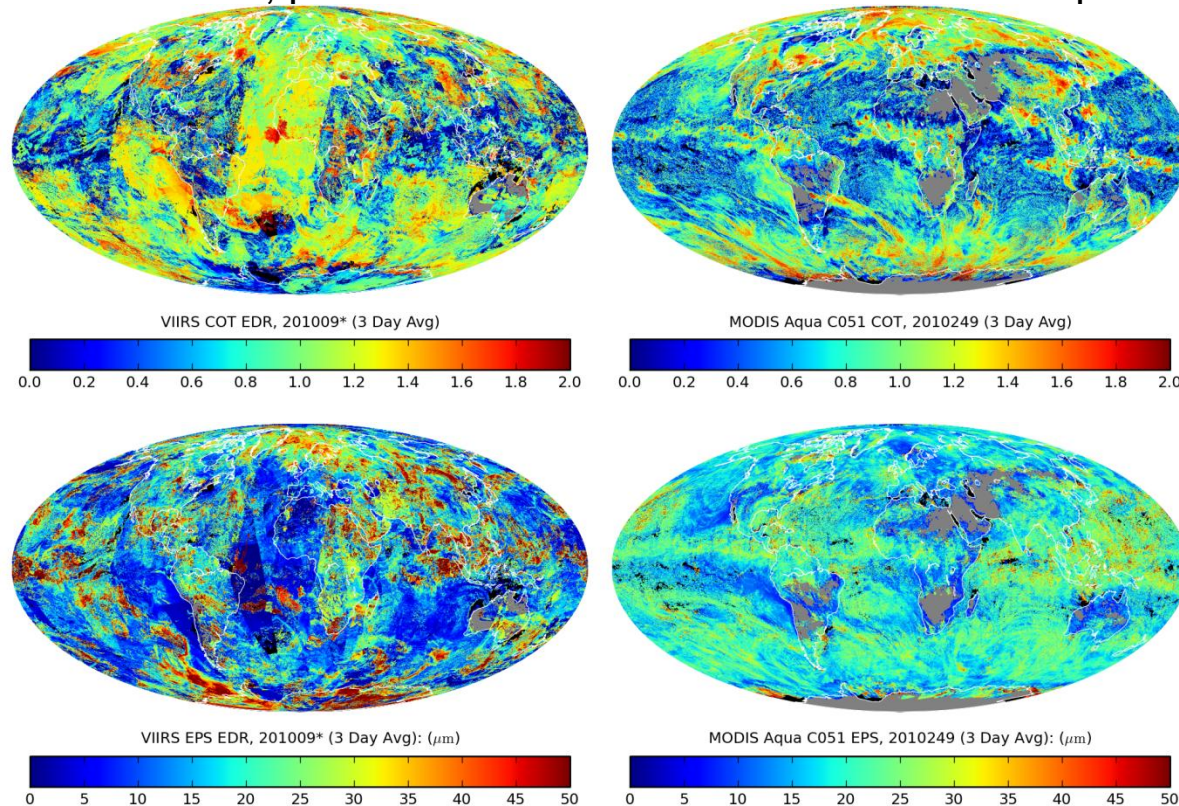
*VCM data generated by the UW/SSEC/PEATE and figure generated by Rich Frey (CIMSS).*



# VIIRS Cloud Optical Properties EDR



- **EDR description:** Estimation of the cloud optical thickness and particle size.
- **Current Retrieval Strategy:**
  - The algorithm developed by NGAS and UCLA.
  - Uses a **direct inversion** of the VIIRS 0.65, 1.6 and 3.75  $\mu\text{m}$  **solar reflectances**.
- **Product Status and Expected Updates:** The algorithm has evolved outside of those algorithms run at NOAA and NASA but shares similar physical basis. Current **water cloud scattering tables are not appropriate** for scientific use but are being regenerated now. Therefore, performance relative to NOAA and NASA products is still to be determined.

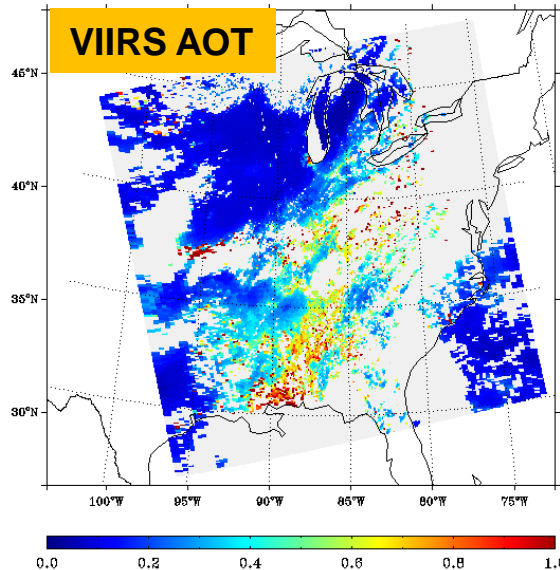
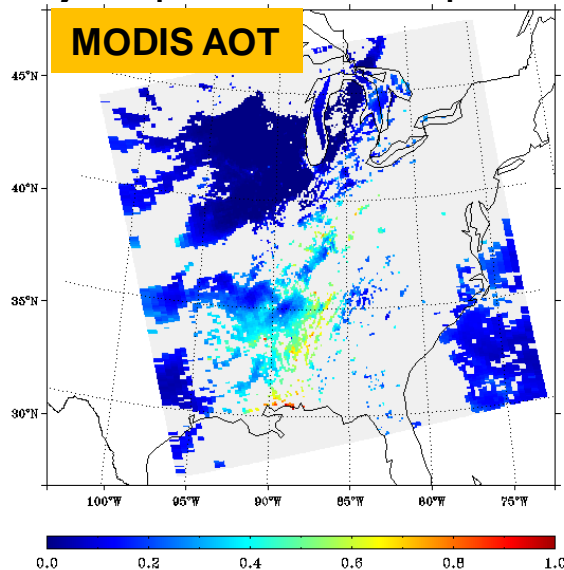


*Comparison of the mean values of the cloud optical depth (top) and cloud particle size (bottom) for the three days of VIIRS P72 data (left) and the MODIS data (right) for the same days. This data set is **not meant for scientific analysis**. Images generated by the UW/SSEC/PEATE and figure generated by Geoff Cureton.*

# VIIRS Aerosol Optical Thickness EDR



- **EDR description:** Sum of scattering and absorption optical thickness (AOT) of the vertical atmospheric column in a narrow band about a specified wavelength.
- **Current Retrieval Strategy:**
  - Uses radiometric signals from M1-3, M5-8, and M10-11.
  - **Separate** algorithms are used for retrieval **over land and ocean**.
  - **AOT and aerosol type** (model) are retrieved **simultaneously** by minimizing the difference between observed and calculated reflectances in multiple channels.
- **Product Status and Expected Updates:** The **over-land** algorithm is based on the MODIS Surface Reflectance (**MOD09 Collection 5**) algorithm; the **over-ocean** algorithm is derived from the MODIS Aerosol (**MOD04 Collection 5**) algorithm. No major updates are expected in the immediate future.



*AOT from MODIS and VIIRS are generally similar over water; over land VIIRS is somewhat larger in this example. Update is planned.*

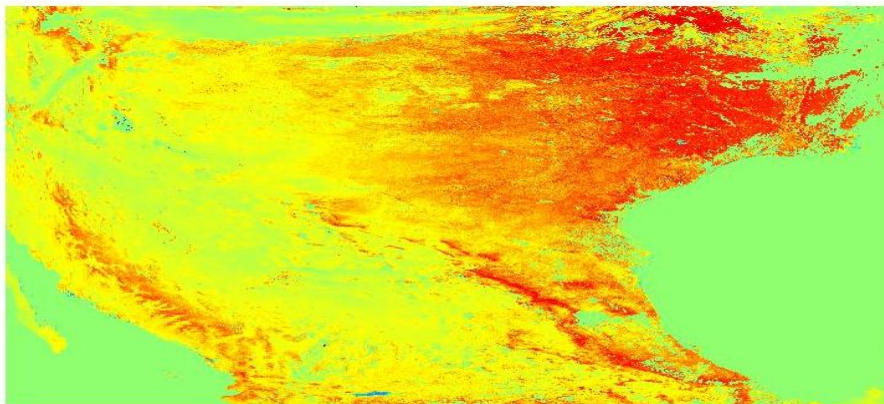
AOT at 550 nm from MODIS Aqua granule on Aug 15, 2010 18:55 UTC

# VIIRS Vegetation Index EDR

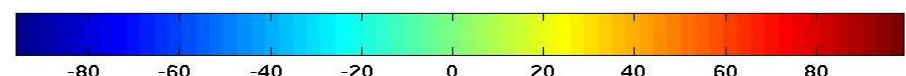
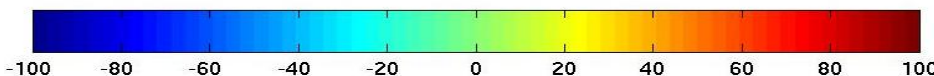
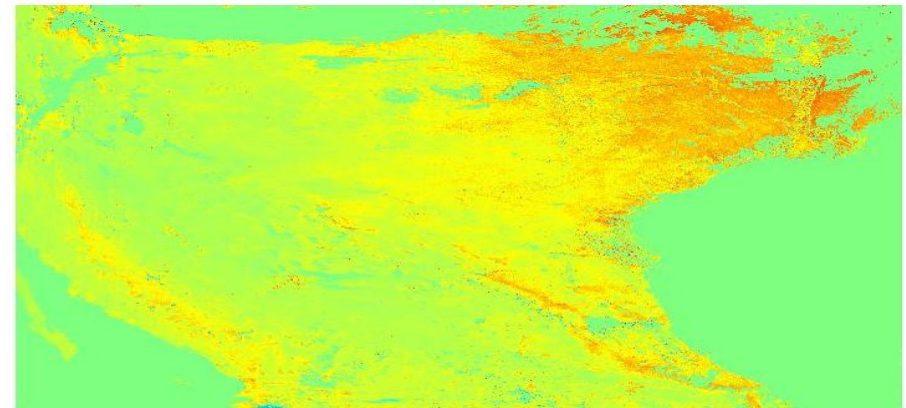


- **EDR description:** The VIIRS Vegetation Index EDR produces a top-of-atmosphere (TOA) NDVI and a top-of-canopy (TOC) Enhanced Vegetation Index (EVI).
- **Current Retrieval Strategy:**
  - The TOA NDVI calculation uses the traditional **NDVI** formulation with **TOA reflectance** inputs.
  - To develop the NDVI product, the algorithm will combine inputs from reflectances acquired by the VIIRS 375 m resolution bands in the red part of the visible range (I1; 600 – 680 nm) and in the near infrared (I2; 845 – 885 nm).
  - The **TOC Enhanced Vegetation Index (EVI)** is computed utilizing a combination of 375 m resolution bands.  
640 nm and 865 nm (I1 and I2) and one 750 m resolution band, M3 (478 - 498 nm).
- **Product Status and Expected Updates:** The algorithm is based on AVHRR and MODIS heritage. No known issues in generating the Vegetation Index products. **TOC NDVI is proposed** to be included.

VI: TOA NDVI



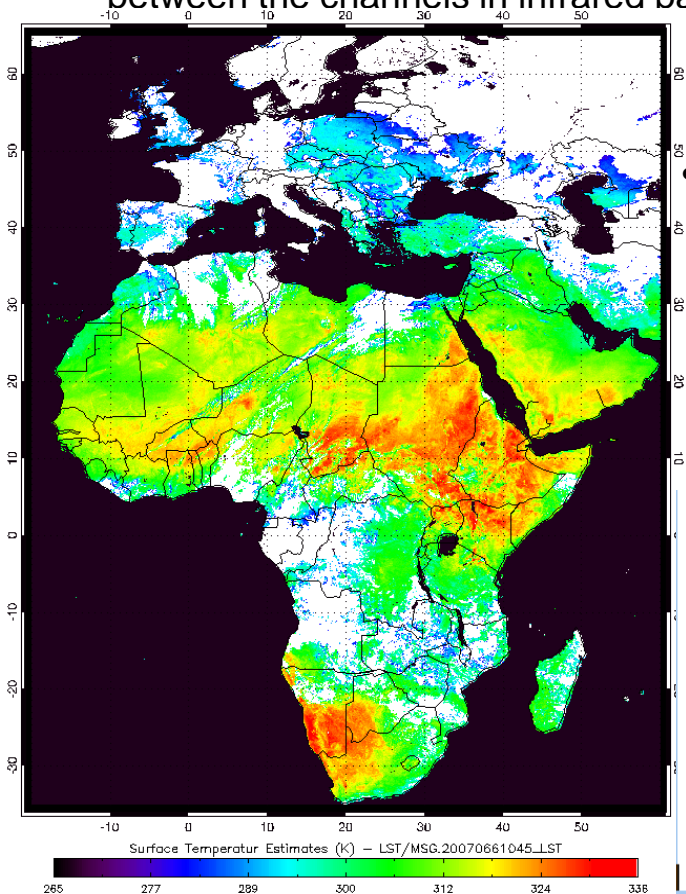
VI: TOC EVI



# Land Surface Temperature EDR

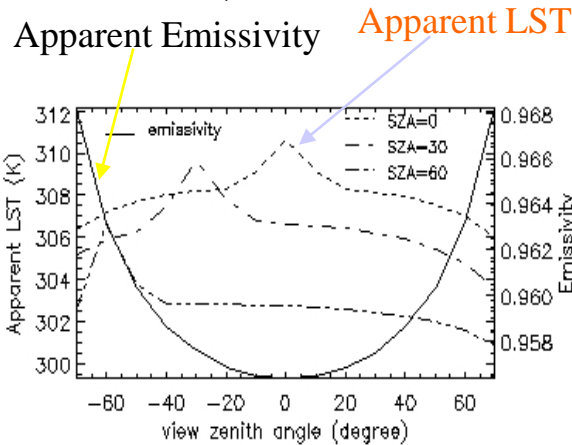


- **EDR Description:** Provides land surface skin temperature at the satellite overpass time under cloud-free conditions.
- **Current Retrieval Strategy:**
  - **Multichannel Linear Regression Approach** (Atmospheric absorption is corrected using signal differences between the channels in infrared band; derived from linearization of the radiative transfer process).

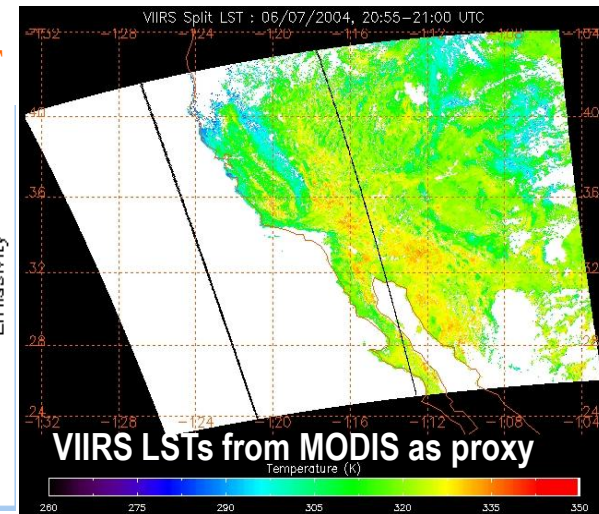


LST Retrieval from SEVIRI, as proxy of VIIRS

- **Surface Type Dependency** (Coefficients of the regression algorithms are surface type dependent with the IGBP types.)
- **Product Status and Expected Updates:** The regression coefficients have been populated using global synthetic data. Once on-orbit, the regression coefficients can be adjusted with in-situ data, as available.



Observed LST is angle dependent

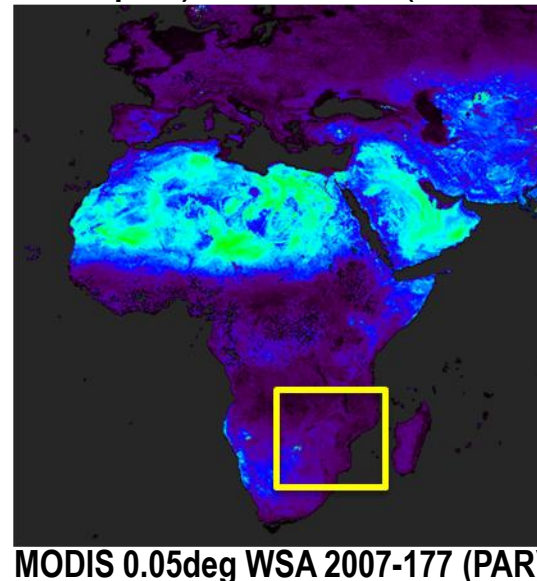
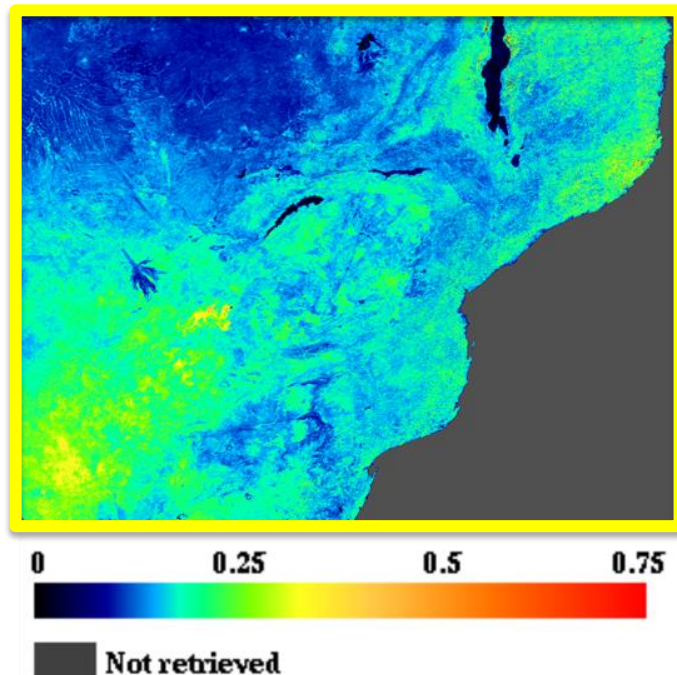
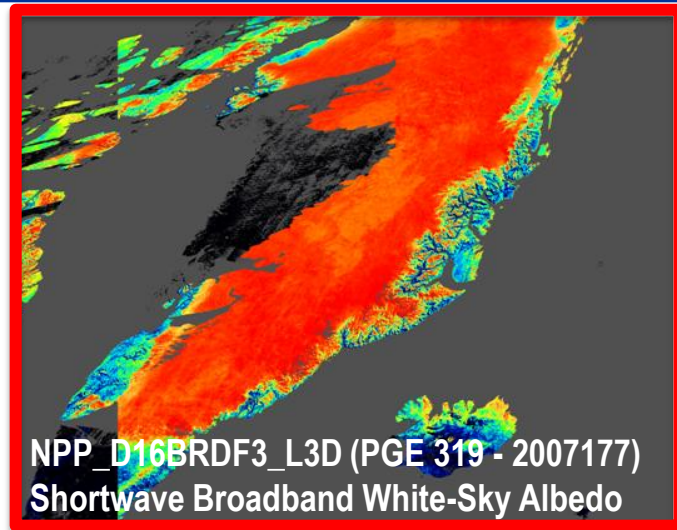


Yunyue (Bob) Yu, NOAA/NESDIS/STAR

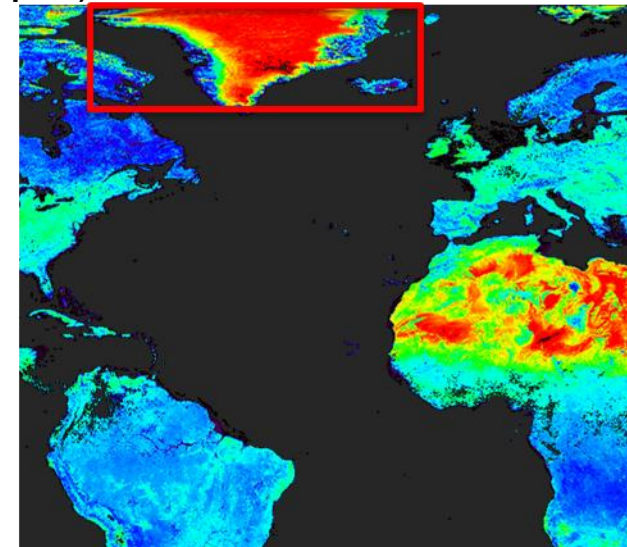
# Surface Albedo EDR



- **EDR Description:** Broadband surface albedo (0.3-5.0 $\mu\text{m}$ ) on a daily basis under cloud-free conditions.
- **Current Retrieval Strategy:**
  - Single-day BPSA (Uses TOA radiances and pre-computed radiative transfer model information)
  - Multidate DPSA (Uses MODIS BRDF/Albedo heritage)
- **Product Status and Expected Updates:** Both Climate and NWP models call for a representation of the surface radiation in terms of at least PAR (0.3-0.7 $\mu\text{m}$ ) and NIR (0.7-5.0 $\mu\text{m}$ ) radiation.



MODIS 0.05deg WSA 2007-177 (PAR)



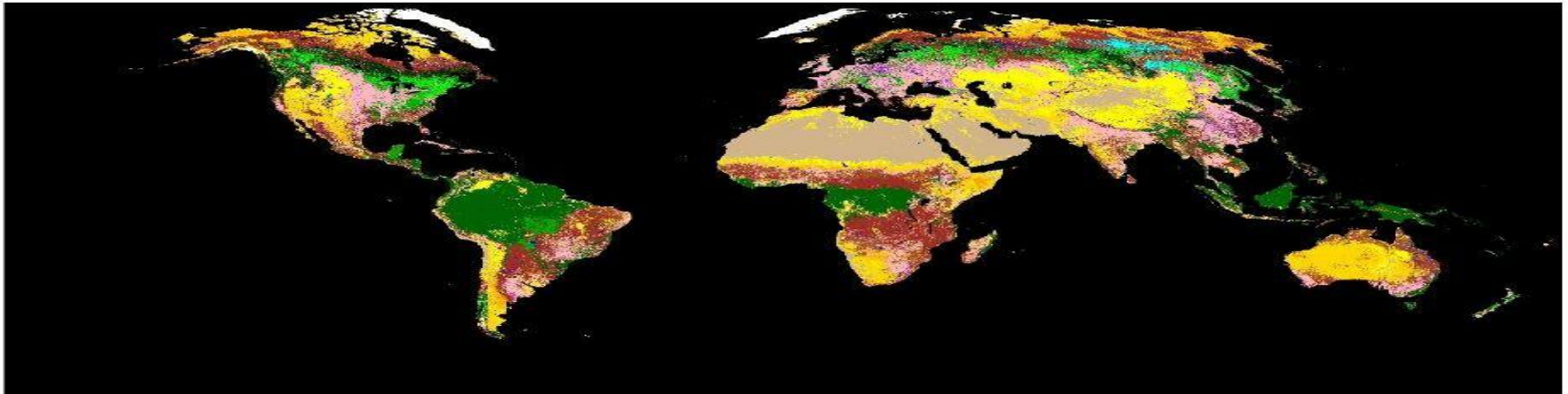
MODIS 0.05deg WSA 2007-177 (NIR)



Crystal Schaaf, Umass/Boston

# VIIRS Surface Type EDR



- **EDR description:** Label each pixel with one of the 17 IGBP Surface Types.
- **Current Retrieval Strategy:**
  - The algorithm is the C5.0 **Decision Tree** algorithm.
  - Uses annual trajectories of metrics based on **VIIRS NDVI and TIR** channel observations.
  - Uses areas with known surface type for each pixel for Decision Tree **training**.
- **Product Status and Expected Updates:** The algorithm is based on the algorithm for the **MODIS Collection 4** land cover product. Updates are expected to include algorithms (such as **Support Vector Machines**) tested at University of Maryland; About **500 sites with surface type truth** will be used to validate the VIIRS EDR.

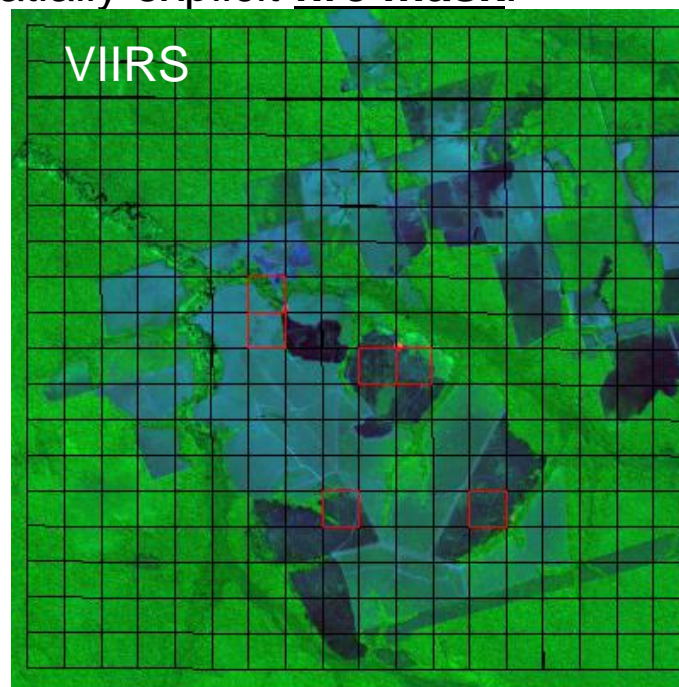
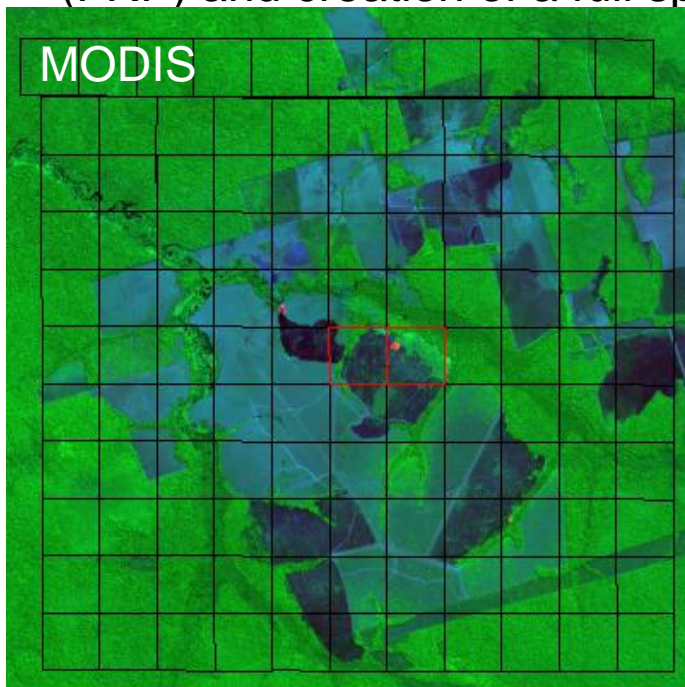


 Water Bodies	 Mixed Forests	 Grasslands	 Snow/Ice
 Everg. Needl. For.	 Closed Shrublands	 Perm. Wetlands	 Barren
 Everg. Broadl. For.	 Open Shrublands	 Croplands	
 Dec. Needl. For.	 Woody Savannas	 Urban/Built-up	
 Dec. Broadl. For.	 Savannas	 Nat. Veg./Crop. Mosaic	

# VIIRS Active Fire EDR



- **EDR description:** Geolocation of pixels for which fires are detected.
- **Current Retrieval Strategy:**
  - The algorithm is a hybrid **thresholding and contextual** algorithm.
  - Uses radiometric signals from M13 and M15, and tests spatial heterogeneity to identify candidate pixels.
  - Uses additional bands and a suite of tests for **internal cloud mask** and the rejection of **false alarms**.
- **Product Status and Expected Updates:** The algorithm is based on the algorithm for the **MODIS Collection 4** fire product. Updates are expected to include algorithm elements from **MODIS Collection 6** product; retrieval of **Fire Radiative Power** (FRP) and creation of a full spatially explicit **fire mask**.



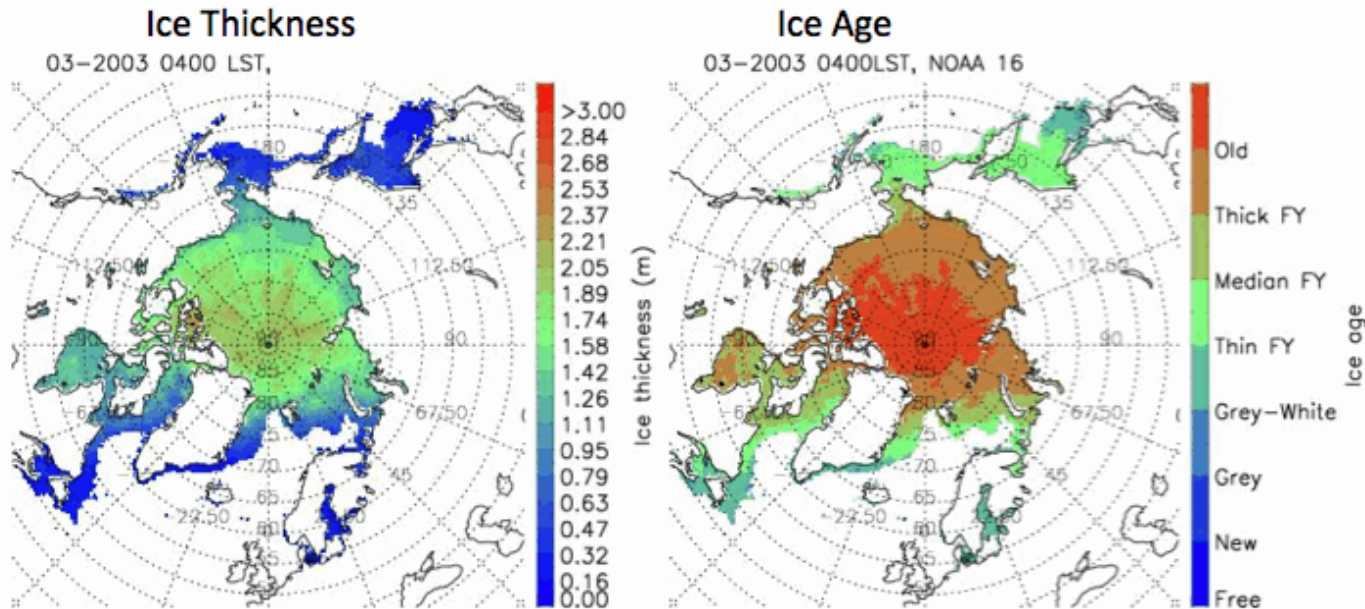
*Red boxes  
represent pixels  
flagged as fire*

7 Aug 2004 1405 UTC  
~11.7° S 56.6° W  
(Brazil)

# VIIRS Ice Characterization EDR



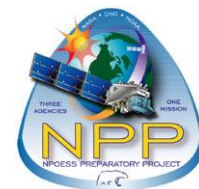
- **EDR description:** An ice age classification for the categories: Ice -free, New/Young Ice (less than 30 cm thickness), and All Other ice. Freshwater ice is not included.
- **Current Retrieval Strategy:**
  - An energy budget approach is used to estimate sea ice thickness.
  - Daytime and nighttime algorithms use different approaches.
  - While the algorithm generates age categories, it actually uses temperature, reflectance and estimated thickness as proxies for age (i.e., age is not calculated directly).
  - Ice concentration is an intermediate product (IP) in the ice characterization EDR.
- **Product Status and Expected Updates:** The uncertainty of the product is highest for nighttime retrievals. An alternative model is being investigated.



Examples of ice thickness (left) and ice age (right) over the Arctic. **Jeff Key, NOAA/NESDIS/STAR**

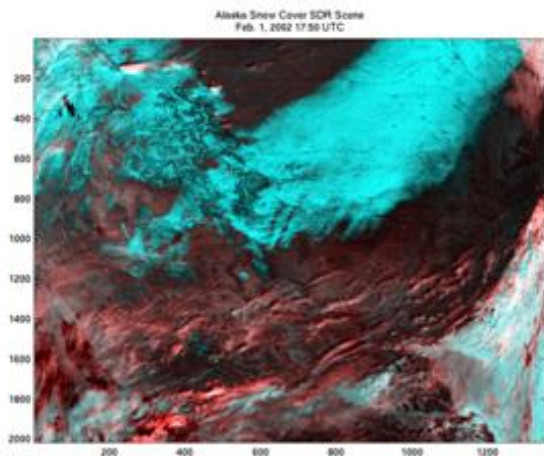


# VIIRS Snow Cover EDR

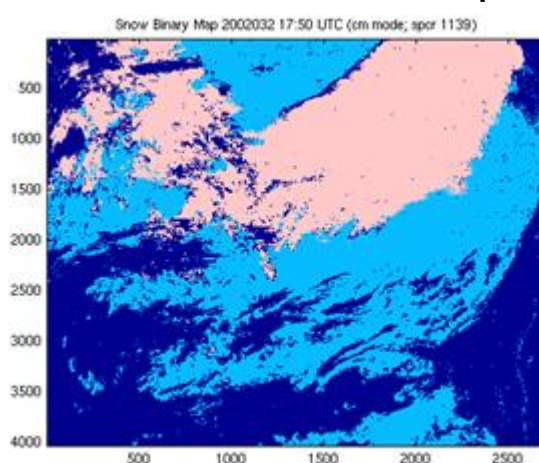


- **EDR description:** The horizontal and vertical extent of snow cover. In addition, a binary product will give a snow/no-snow flag. While the original EDR definition included snow depth, the current specification is for snow cover only.
- **Current Retrieval Strategy:**
  - Algorithm Heritage: **MODIS MOD10** L2 “SnowMap” algorithm (NASA) based on the Normalized Difference Snow Index (NDSI).
  - A threshold-based **decision-tree** algorithm is employed to separate snow free and snow covered pixels. An **external cloud mask** is used to exclude cloudy pixels from the classification process.
  - A snow cover **binary map** produced at the VIIRS imagery resolution. Snow cover **fraction** is calculated by 2X2 **aggregation** of the binary snow cover map is produced at VIIRS moderate resolution.
- **Product Status and Expected Updates:** The Binary Snow Map product should meet its target requirement of 90% probability of correct classification.

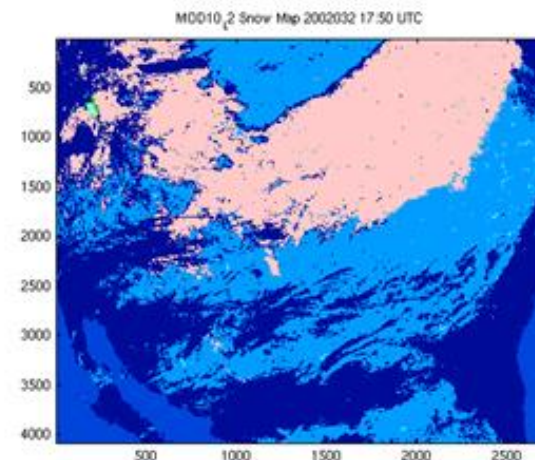
RGB Image



VIIRS Snow Map



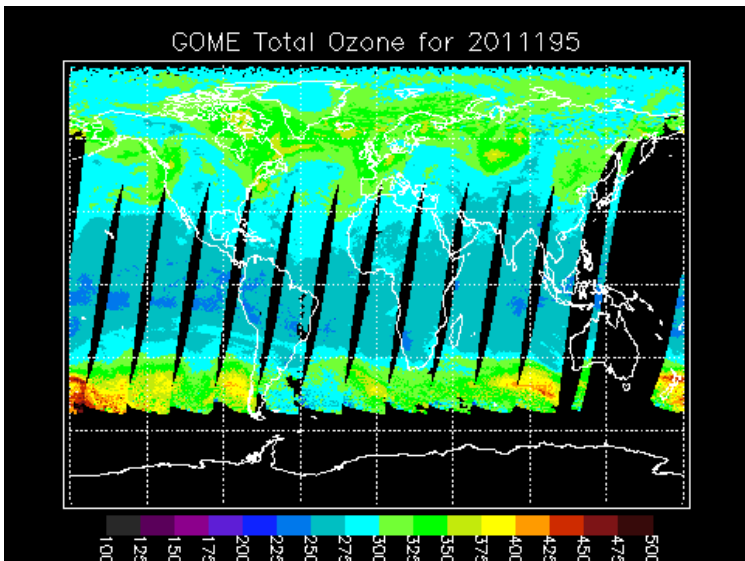
MOD10 Snow Map



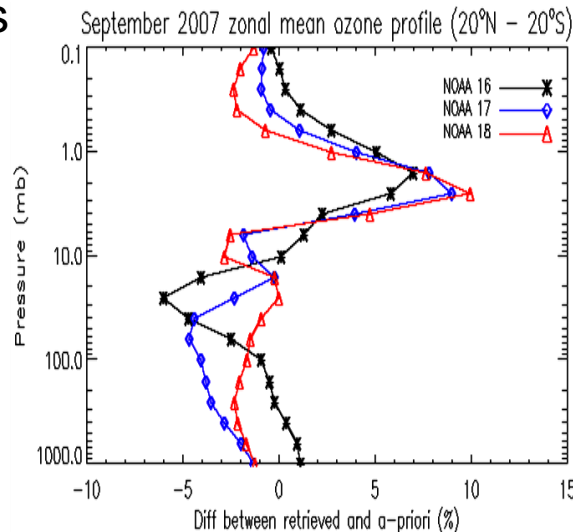
# OMPS Ozone EDRs



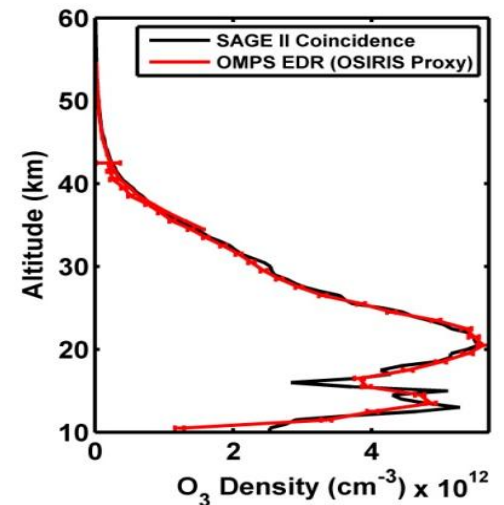
- **EDR description:** Total Ozone and Ozone Profiles.
- **Current Retrieval Strategy:**
  - OMPS Nadir Mapper: total ozone, UV reflectivity, and an aerosol index are retrieved by using **radiative transfer lookup tables** for standard total ozone profiles matching triplets of radiances to irradiance ratios.
  - OMPS Nadir Profiler: vertical ozone profiles are retrieved using **optimal estimation** from measurements at **12 wavelengths** from 253 to 340 nm and an **a priori ozone profile climatology**.
- **Product Status and Expected Updates:** **Newer versions** of both algorithms in use at NOAA with GOME-2 and SBUV/2 measurements will be implemented as resources allow. A **higher vertical resolution** ozone product using the OMPS Limb Profiler measurements will start out as a NASA NPP Science Team research product but transition to NOAA operations



Daily Level 2 GOME-2 (Dobson Units)



SBUV/2 ozone profile monthly zonal mean differences between Retrieved and A Priori (in %) for NOAA POES-16, -17 & -18.



SAGE II occultation ozone profile retrieval compared to OMPS LP using OSIRIS proxy measurements

Larry Flynn, NOAA/NESDIS/STAR

# More information (open access)



- **NOAA/NESDIS/STAR JPSS website:**  
**<http://www.star.nesdis.noaa.gov/jpss/index.php>**
  - Algorithm Theoretical Basis Documents (ATBDs)
  - Common Data Format Control Book
  - Code and proxy dataset information
  
- **NOAA/NESDIS JPSS website:**  
**<http://www.nesdis.noaa.gov/jpss/>**
  - JPSS program information
  
- **NASA NPP website:**  
**<http://jointmission.gsfc.nasa.gov/>**
  - Algorithm Theoretical Basis Documents (ATBDs)
  - Common Data Format Control Book
  - etc.