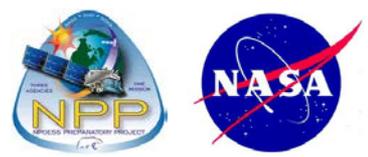




# Suomi NPP and JPSS1 Vegetation Index EDR

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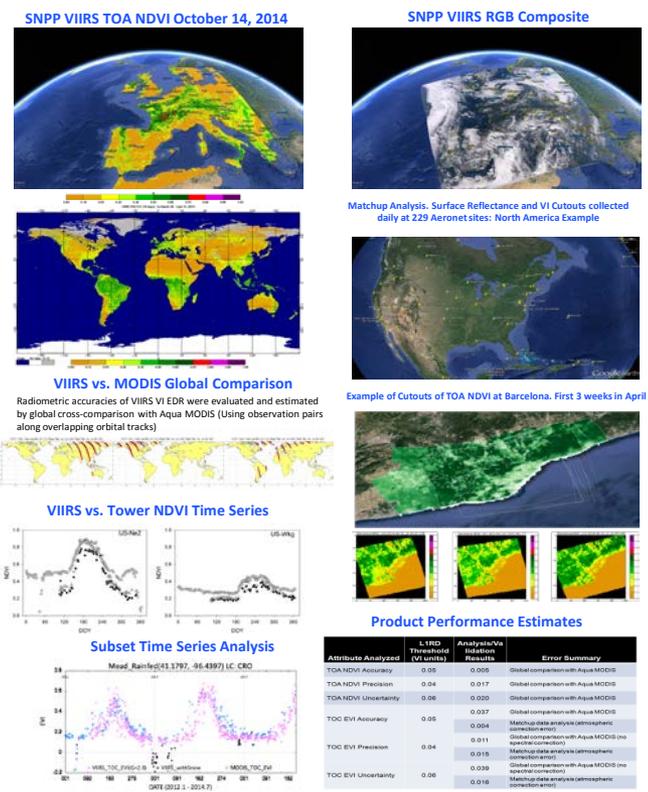
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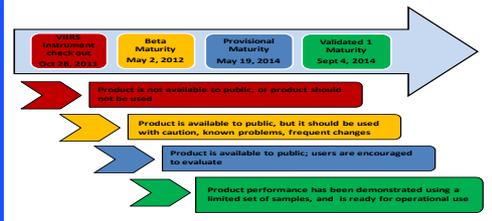
## Introduction

Vegetation indices from satellite instruments in polar orbits are used to monitor the environment including drought, the health of ecosystems, forest fires, crop monitoring, as well as for weather forecasting and climate research. The Visible Infrared Imaging Radiometer Suite (VIIRS) Vegetation Index (VI) Environmental Data Record (EDR) from Suomi NPP and JPSS1 will provide both: continuity with vegetation indices from NOAA Polar-Orbiting Operational Environmental Satellites (POES) and the NASA Earth Observing Satellites, specifically Aqua and Terra satellites. Suomi NPP was launched in October 2011, and JPSS1 will be launched no later than the 2nd quarter of FY 2017. The Suomi NPP VIIRS Vegetation Index operational product includes two vegetation indices: the Top of the Atmosphere (TOA) Normalized Difference Vegetation Index (NDVI), and the Top of the Canopy (TOC) Enhanced Vegetation Index (EVI). The VI EDR was promoted to Validated 1 maturity status in September 04, 2014, and it is now available to the general public through NOAA's Comprehensive Large Array-Data Stewardship System (CLASS). A series of improvements to the VI EDR product including enhancing the Quality Flags (QF) were implemented in build Mx8.4 (May 2014). A more comprehensive set of QFs was necessary to allow users to better screen suspicious quality pixels that could not be screened with the original set of QFs. The additional QFs include: snow/ice, cloud shadows, cloud adjacency, and aerosol quantity. The ongoing validation efforts and product improvements will lead to the VI EDR reaching Validated 2 maturity status in the near term. For JPSS1, the Vegetation Index algorithm from Suomi NPP will be updated to include a third vegetation index, the TOC NDVI. The new TOC NDVI is currently under development at NOAA/STAR, and the algorithm change package will be delivered to the JPSS Ground Project's Data Product Engineering and Services (DPES) Integrated Product Team (IPT) in early FY 2015 for further testing and implementation.

## SNPP VIIRS Vegetation Index EDR Validation Results



## Vegetation Index EDR Product Timeline



## SNPP/JPSS1 VIIRS Vegetation Index EDR Product Description

The Vegetation Index EDR consists of three vegetation indices:  
 1) Normalized Difference Vegetation Index (NDVI<sup>TOA</sup>) from top-of-atmosphere (TOA) reflectances  
 2) Enhanced Vegetation Index (EVI<sup>TOC</sup>) from top-of-canopy (TOC) reflectances  
 3) Normalized Difference Vegetation Index (NDVI<sup>TOC</sup>) from-top-of canopy (TOC) reflectances (New for JPSS1)  
 These indices are produced at the VIIRS image channel resolution (375 m at nadir), over land in granule style (swath form), and the file format is HDF5

$$NDVI^{TOA} = (\rho_{12}^{TOA} - \rho_{11}^{TOA}) / (\rho_{12}^{TOA} + \rho_{11}^{TOA})$$

$$EVI^{TOC} = (1 + L) \cdot \frac{\rho_{12}^{TOC} - \rho_{11}^{TOC}}{\rho_{12}^{TOC} + C_1 \cdot \rho_{11}^{TOC} - C_2 \cdot \rho_{M3}^{TOC} + L}$$

$$NDVI^{TOC} = (\rho_{12}^{TOC} - \rho_{11}^{TOC}) / (\rho_{12}^{TOC} + \rho_{11}^{TOC})$$

$\rho_{M3}^{TOC}$  Surface reflectance band M3 (488 nm)  
 $\rho_{11}^{TOC}$  Surface reflectance band I1 (640 nm)  
 $\rho_{12}^{TOC}$  Surface reflectance band I2 (865 nm)  
 $\rho_{11}^{TOA}$  Top of atmosphere reflectance band I1 (640 nm)  
 $\rho_{12}^{TOA}$  Top of atmosphere reflectance band I2 (865 nm)  
 $C_1, C_2$  and  $L$  are constants

## Product Performance Estimates

Attribute Analyzed	L1/RD Threshold (VI units)	Analysis/Validation Results	Error Summary
TOA NDVI Accuracy	0.05	0.005	Global comparison with Aqua MODIS
TOA NDVI Precision	0.04	0.017	Global comparison with Aqua MODIS
TOA NDVI Uncertainty	0.06	0.035	Global comparison with Aqua MODIS
TOC EVI Accuracy	0.05	0.037	Global comparison with Aqua MODIS
TOC EVI Precision	0.04	0.004	Matchup data analysis (atmospheric correction)
TOC EVI Accuracy	0.04	0.011	Global comparison with Aqua MODIS (no atmospheric correction)
TOC EVI Precision	0.04	0.015	Matchup data analysis (atmospheric correction)
TOC EVI Uncertainty	0.06	0.039	Global comparison with Aqua MODIS (no atmospheric correction)
TOC EVI Uncertainty	0.06	0.016	Matchup data analysis (atmospheric correction)

## SNPP VIIRS Vegetation Index EDR Quality Flags

Byte	VIIRS VI Flag	Result	Bits
0	Overall NDVI Quality	1 = High NOTE: NDVI quality is set to high (1) if ALL of these conditions are met: 1)11 TOA reflectance flag = avail 1)2 TOA reflectance flag = avail 2) Cloud Confidence flag = confidently clear 4) Thin Cirrus flag = no thin cirrus 5) Solar Zenith Angle < 85 deg 6) Sun glint (Geometry based) = none	1
	Overall EVI Quality	1 = High NOTE: EVI quality is set to high (1) if ALL of these conditions are met: 1)11 Surface reflectance flag = avail 1)2 Surface reflectance flag = avail 1)3 Surface reflectance flag = avail 2) Cloud Confidence flag = confidently clear 5) Thin Cirrus flag = no thin cirrus 5) Solar Zenith Angle < 85 deg 6) Sun glint (Geometry based) = none 6) EVI single flag = in range	1
	I1 TOA Reflectance	1 = Not Available 0 = Available	1
	I2 TOA Reflectance	1 = Not Available 0 = Available	1
	I1 Surface Reflectance	1 = Not Available 0 = Available	1
	I2 Surface Reflectance	1 = Not Available 0 = Available	1
	M3 Surface Reflectance	1 = Not Available 0 = No Cloud	1
	Thin Cirrus (reflective)	1 = Cloud 0 = No Cloud	1
	Thin Cirrus (transmissive)	1 = Cloud 0 = No Cloud	1
	Thin Cirrus (absorptive)	1 = Cloud 0 = No Cloud	1

Byte	VIIRS VI Flag	Result	Bits
1	Land/Water	101 = Coastal 011 = Snow/Water 010 = Inland/Water 001 = Land / No Desert 000 = Land & Desert	3
	Cloud Confidence	11 = Confidently Cloudy 10 = Probably Cloudy 01 = Probably Clear 00 = Confidently Clear	2
	Sun Glint	11 = Geometry & Wind 10 = Wind Speed Based 01 = Geometry Based 00 = None	2
1	Thin Cirrus (reflective)	1 = Cloud 0 = No Cloud	1
	Thin Cirrus (transmissive)	1 = Cloud 0 = No Cloud	1
1	Thin Cirrus (absorptive)	1 = Cloud 0 = No Cloud	1

\*Four additional QFs added to the VI EDR official product on build Mx8.4

Byte	VIIRS VI Flag	Result	Bits
2	Stratification - Solar Zenith Angle	1 = 65 Degrees <= SZA <= 85 Degrees 0 = SZA < 65 Degrees or SZA > 85 Degrees	1
	Excl - AOT > 1.0	1 = AOT > 1.0 0 = AOT <= 1.0	1
	Excl - Solar Zenith Angle > 85 Deg	1 = SZA > 85 degrees 0 = SZA <= 85 degrees	1
2	*Snow/ice	0 = False (no) 1 = True (yes)	1
	*Adjacent to Clouds	0 = False (no) 1 = True (yes)	1
2	*Aerosol Quantity	00 = Climatology 01 = Low 10 = Average 11 = High	2
	*Cloud Shadows	0 = False (no) 1 = True (yes)	1

## Validation Stages Maturity Definition

**Validated Stage 1:**  
Using a limited set of samples, the algorithm output is shown to meet the threshold performance attributes identified in the JPSS Level 1 Requirements Supplement with the exception of the S-NPP Performance Exclusions

**Validated Stage 2:**  
Using a moderate set of samples, the algorithm output is shown to meet the threshold performance attributes identified in the JPSS Level 1 Requirements Supplement with the exception of the S-NPP Performance Exclusions

**Validated Stage 3:**  
Using a large set of samples representing global conditions over four seasons, the algorithm output is shown to meet the threshold performance attributes identified in the JPSS Level 1 Requirements Supplement with the exception of the S-NPP Performance Exclusions

## Path Forward - Planned Improvements

- Implementation of DR7039 - TOC-EVI backup algorithm
- Implementation of DR7697 - Redefine Granule Level Summary QF and pro Pixel Overall QFs
- Implementation of DR 7041, implementation of a revised EVI equation
- Temporal compositing (weekly, 16-day, monthly), and spatial compositing (global) (DR7488)
- JPSS1 TOC NDVI Algorithm Readiness Review (Mar 2015)

## User Precautions

- Known issues to date are described below:
- Cloud Shadows QF is currently known to overestimate shadow affected areas. Use this flag with caution
  - Aerosol Quantity QF. Use this flag to identify the source of aerosol information and the degree of aerosol contamination in individual pixels
  - Cloud Adjacency QF. This flag can overestimate affected areas.
  - Snow/Ice QF. Use this flag to screen pixels with suspicious EVI values over snow/ice-covered surfaces
  - TOC-EVI data can contain unrealistically high/low values over snow/ice covered areas at high latitudes, over clouds, and over cloud shadows
  - The quality of the VI-EDR is sensitive to the performance of the VIIRS Cloud Mask (VCM) and Surface Reflectance (SR) Intermediate Products

## Vegetation Index EDR Data Access

The primary source for SNPP products is via NOAA's Comprehensive Large Array-Data Stewardship System (CLASS) web site (<http://www.class.ngdc.noaa.gov/saa/products/welcome>). Data delivered to CLASS from the Interface Data Processing Segment (IDPS) has a latency of 6 hours.

## Acknowledgements and Disclaimer

This work has been supported by the NOAA JPSS Office (NJO). The views, opinions, and findings contained in this poster are those of the author(s) and should not be construed as an official National Oceanic and Atmospheric Administration or U.S. Government position, policy, or decision.