Integrating Changes to VIIRS Vegetation Index Algorithm using Algorithm Development Library (ADL)

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1. Introduction

The Joint Polar Satellite System (JPSS) is the next generation polar-orbiting operational environmental satellite system. The first in the JPSS series of satellites, J-1, is scheduled to launch in early 2017. To comply with the J-1 requirements, an additional product, the Top-of-Canopy (TOC) Normalized Difference Vegetation Index (NDVI), has been developed and integrated into the Visible Infrared Imaging Radiometer Suite (VIIRS) Vegetation Index (VI) algorithm suite at NOAA/STAR. The enhanced algorithm was extensively tested within both the offline algorithm development tool, the Algorithm Development Library (ADL), and the operational builds (MX8.4, MX8.5, MX8.6 and the current version MX8.8) through a series of algorithm chain runs for two days of VIIRS data. Comparison studies were conducted to evaluate the impacts of upstream aerosol and surface reflectance algorithms changes on the VI products. The output data files were provided to the VI Science Team to perform the final validation of the algorithm. The algorithm change package has been delivered to the JPSS Ground Project's Data Product Engineering (DPE) Integrated Product Team (IPT) for further testing and implementation.

2. VIIRS VI Algorithm

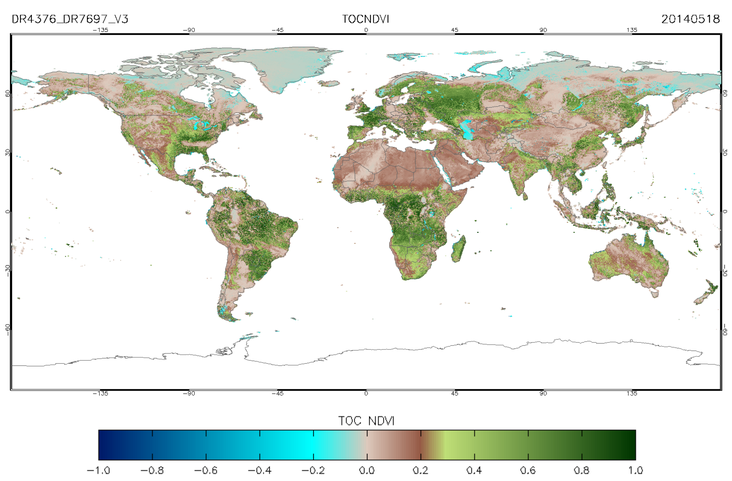
Two vegetation indices, the Top-of-Atmosphere (TOA) Normalized Difference Vegetation Index (NDVI) and the Top-of-Canopy (TOC) Enhanced Vegetation Index (EVI), have been operationally produced from the Suomi National Polar-orbiting Partnership (S-NPP) satellite data in the Interface Data Processing Segment (IDPS) system. For J-1, the VI algorithm will be enhanced to include the third index, the TOC NDVI. The VIIRS VI EDR requires calibrated TOA reflectances (bands I1, I2), SDR auxiliary data (solar zenith angle), Surface Reflectance (bands I1, I2, M3, Land Quality Flags), and Aerosol (Aerosol Quality Flags).

Product	Input	Source
TOA NDVI	TOA reflectance in bands I1 and I2	VIIRS Calibrated TOA Reflectances SDR
TOC EVI	Surface reflectance in bands I1, I2 and M3	VIIRS Surface Reflectance IP
TOC NDVI	Surface reflectance in bands I1 and I2	VIIRS Surface Reflectance IP

3. Integration of the Algorithm Changes

To comply with the J-1 requirements, 15 code/program files and 1 look-up table (LUT) have been updated and integrated into and tested with the ADL system compatible with the IDPS operational builds MX8.4, MX8.5, MX8.6 and MX8.8. The general procedures are

- ✓ Get the ADL with specific build from STAR/AIT Common CM. Install and build the ADL -- the BASELINE system
- ✓ Modify source code and rebuild – The UPDATED system
- ✓ Convert new VIIRS-VI-EDR-DQTT internal binary file from xml file
- ✓ Collect Input files: NCEP-GFS, NAAPS, PolarWander, Tiles and RDRs
- ✓ Collect LUTs from the ADL bundle
- ✓ Unpack HDF files using ADL Unpacker utility. Use IngMsd utility to create binary versions of NCEP-GFS and NAAPS files.
- ✓ Run VIIRS SDR, VIIRS Fire Mask, Cloud Mask, Aerosols and Surface Reflectance EDR/IP algorithms to generate SDR, Aerosol Optical Thickness and Surface Reflectance input files needed by the VI EDR algorithm.
- ✓ Run the BASELINE and UPDATED executables to generate VI EDRs for a few granules.
- ✓ Conduct algorithm chain runs to generate VI EDRs for two full days of data

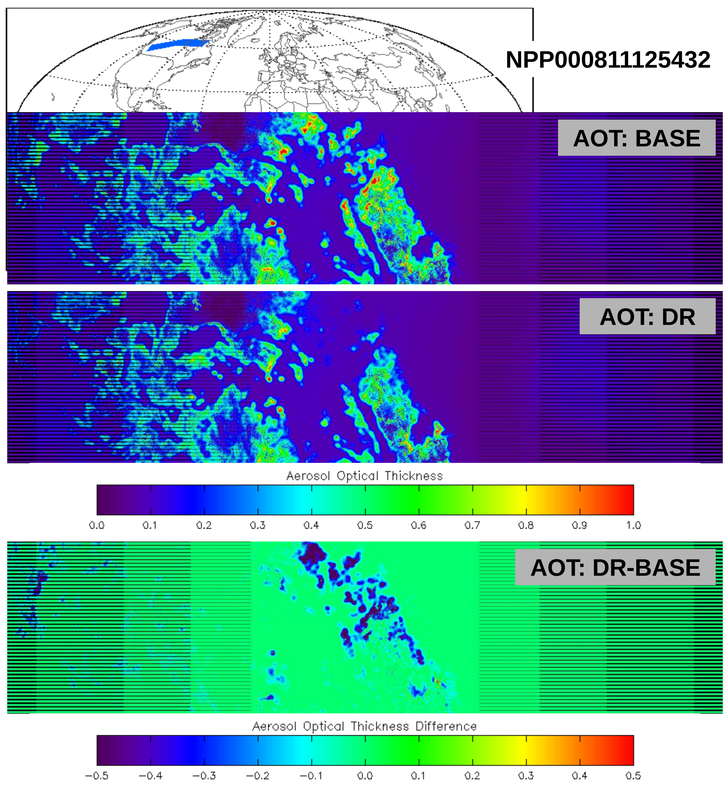


4. Impacts of Upstream Algorithm Changes

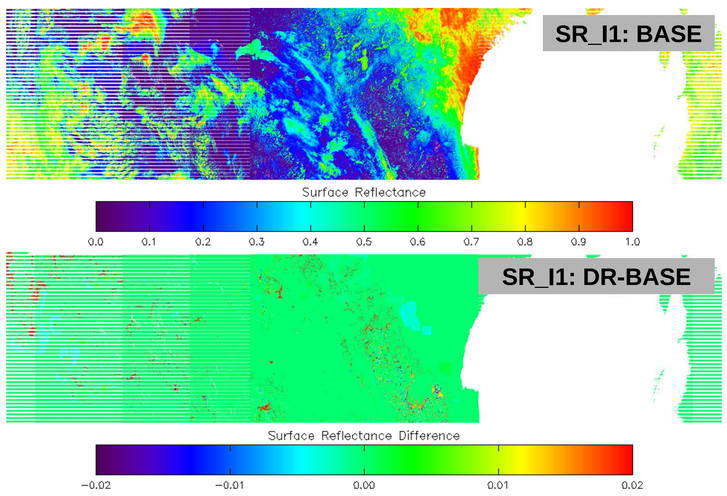
The VI EDR depends on outputs of upstream algorithms. Two series of comparison studies have been conducted to evaluate the impacts of upstream algorithm changes on the VI products.

4.1 Aerosol Code Update – DR7723

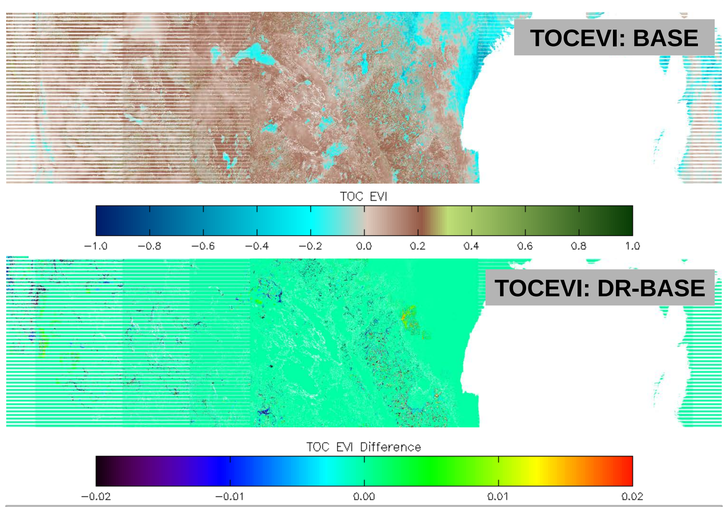
DR 7723: Improve the snow test over land in the VIIRS aerosol algorithm
Description: Residual snowmelt contamination remains an issue in the current operational VIIRS aerosol products, indicating the need of improving the internal snow test over land in the VIIRS aerosol algorithm. To address the issue, a new internal snow test based on the tests below is proposed. The new snow test replaces the current internal test.



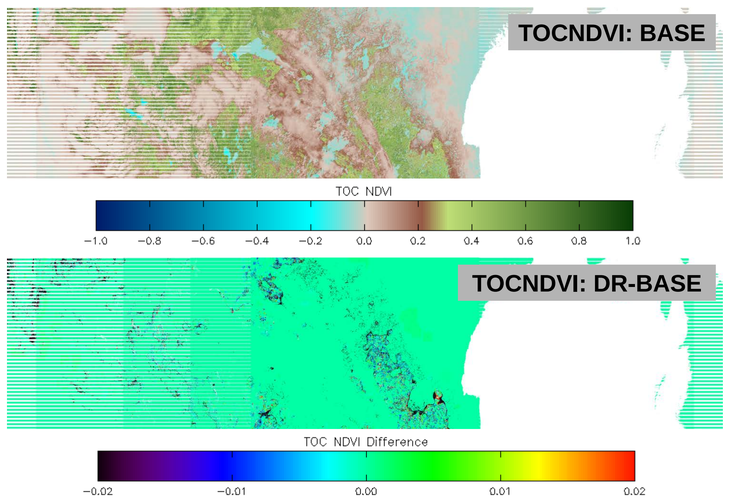
BASELINE VIIRS AOT retrievals showed high AOTs in northern high latitudes during spring thaw. The new snow test reduced "snowmelt contamination".



As a result of reduced "snowmelt contamination", the surface reflectance in band I1 is slightly increased. The surface reflectances in bands I2 and M3 change similarly (not shown)..



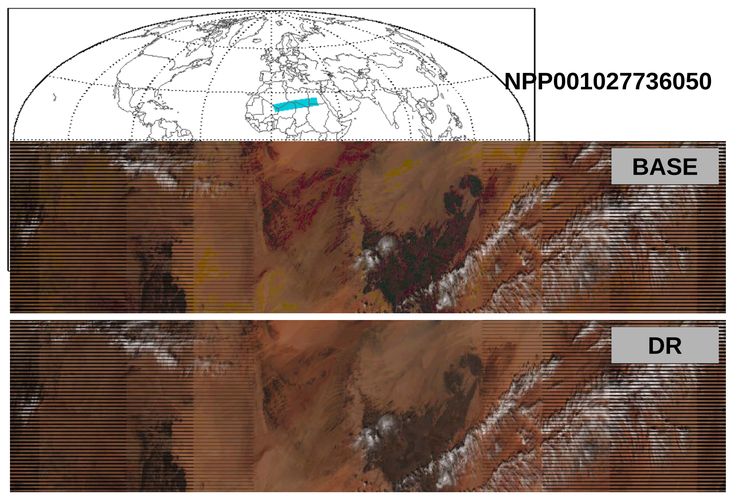
The aerosol changes from DR7723 updates have very limited impact on the TOC EVI retrievals.



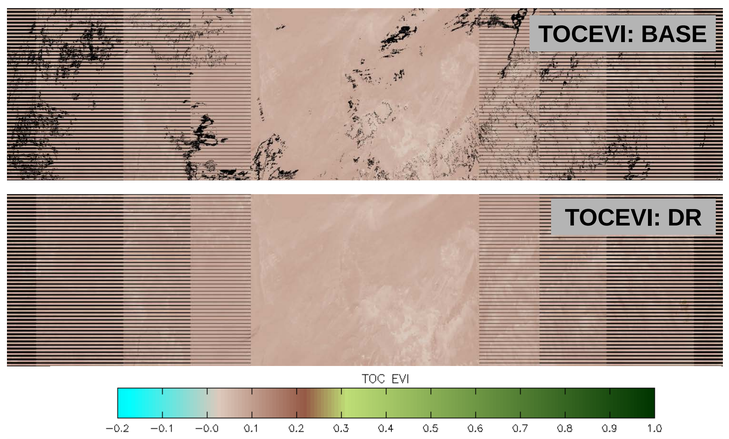
The aerosol changes from DR7723 updates have slightly more impact on the TOC NDVI retrievals.

4.2 SRIP Code Update – DR7784

DR 7784: SDR flagged as poor quality in the SDR pixel quality byte are good and good quality corrected reflectance can be retrieved from these observations.
Description: SDR contains significant number of observations flagged as poor quality in the per band pixel quality byte. Band quality value of poor for each SDR band (bits 0-1: 0: Good, 1: Poor, 2: No Calibration) in most cases may be resulting from the case of dual gain anomaly. This DR recommends retrieval of SR for pixels flagged as poor quality with following exceptions: moon in KOB, saturated pixel, missing data, and out of range data.



RGB of surface reflectances in moderate bands 5-4-3. Areas in baseline where one or more bands were not being retrieved because of 'Poor' SDR pixel quality byte are now being retrieved in the DR test as the other flags (Moon in KOB, Saturated Pixel, Missing Data and Out of Range) are all being satisfied. The yellowish areas in baseline indicate missing M3 retrievals, which will lead missing retrievals of TOC EVI.



The missing pixels in baseline are retrieved in DR test because of surface reflectances in M3 are now available.

5. Conclusions

1. A new product, the TOC NDVI, has been integrated into the VIIRS VI algorithm suite
2. The updated algorithm has been extensively tested through a series of ADL algorithm chain runs for two days of VIIRS data
3. Comparison studies were conducted to evaluate the impacts of upstream aerosol and surface reflectance algorithms changes on the VI products.

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