Land Products from the Suomi NPP VIIRS Instrument

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National Oceanic and Atmospheric Administration (NOAA)
National Environmental Satellite Data and Information System (NESDIS)
Center for Satellite Applications and Research (STAR)

NOAA JPSS Land Calibration and Validation Team
NASA SNPP VIIRS Land Discipline Team
JPSS Spacecraft

- Ozone Mapping Profiler Suite (OMPS)
- Advanced Technology Microwave Sounder (ATMS)
- Cross-track Infrared Sounder (CrIS)
- Visible Infrared Imaging Radiometer Suite (VIIRS)
- Clouds and the Earth’s Radiant Energy System (CERES)
Polar orbiter flyout chart

http://www.nesdis.noaa.gov/flyout_schedules.html
<table>
<thead>
<tr>
<th>Band</th>
<th>Range (um)</th>
<th>HSR (m)</th>
<th>MODIS Equivalent</th>
<th>AVHRR-3 Equivalent</th>
<th>OLS Equivalent</th>
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<tr>
<td>DNB</td>
<td>0.500 - 0.900</td>
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<tr>
<td>M1</td>
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<td>750</td>
<td>8 0.405 - 0.420</td>
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<td>M2</td>
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<td>M3</td>
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<tr>
<td>I1</td>
<td>0.600 - 0.680</td>
<td>375</td>
<td>1 0.620 - 0.670</td>
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<tr>
<td>M5</td>
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<tr>
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<td>1.580 - 1.640</td>
<td>375</td>
<td>6 1.628 - 1.652</td>
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<tr>
<td>M10</td>
<td>1.580 - 1.640</td>
<td>750</td>
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<td>3a  SAME</td>
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<td>20  SAME</td>
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<td>3b  SAME</td>
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<tr>
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<td>11.538 - 12.488</td>
<td>750</td>
<td>32 11.770 - 12.270</td>
<td>1000</td>
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</tbody>
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**VIIRS and heritage imagers**

**Low light capabilities**

Ocean Color, Aerosol

Imagery

Ocean Color, Aerosol

Atm Correction

NDVI

Cloud Particle Size

Thin Cirrus

Snow Map

Snow Fraction

Cloud

Imagery, Clouds

SST, Fire

Cloud Top Properties

SST, Fire

SST, Fire

SST

Cloud Imagery
SNPP VIIRS M3-M4-M5 RGB

October 14, 2014 12:33 - 12:38 UTC (5 VIIRS granules)
Aqua MODIS Global Browse

landweb.nascom.nasa.gov

Daily Land Surface Reflectance Bands 1,4,3 (MYD09)

September 21, 2012

NASA LandPEATE
Suomi NPP VIIRS Global Browse

landweb.nascom.nasa.gov

NPP_VMAE_L1 L1B Moderate input, Day Band 5,4,3

September 21, 2012

NASA LandPEATE
VIIRS Detector Aggregation Scheme

Nadir
Aggregate 3 Samples
SNR \sim \sqrt{3} \times \text{Baseline}

\pm 850 \text{ Km}
Aggregate 2 Samples
SNR \sim \sqrt{2} \times \text{Baseline}

\pm 1,500 \text{ Km}
No Aggregation
SNR = \text{Baseline}

JPSS program
Because of aggregation VIIRS has much better resolution away from nadir, pixel area 8 times smaller than AVHRR or MODIS
Comparing MODIS (250m) to VIIRS (375m)
Comparing MODIS (250m) to VIIRS (375m)
VIIRS vs. MODIS for land monitoring

• What can **VIIRS** do better than **MODIS**?
  – Better coverage and scanning geometry, including higher resolution of “M” bands
    • Improved fire detections (25% higher VIIRS fire counts than MODIS in the three-pixel VIIRS aggregation zone)
    • No gaps at low latitudes, more consistent data for temporal compositing

• What can **VIIRS** do that **MODIS** cannot?
  – VIIRS Day/Night Band: VIIRS can directly assess a variety of phenomenon associated with human settlements (e.g., population, socio-economic activity, the built environment, and urbanization).

• What can **MODIS** do better than **VIIRS**?
  – **MODIS can ‘see’ the Amazon better**: TERRA-MODIS was designed to cross the equator at a time when cloud cover is at its daily minimum (10:30AM, descending).

• What can **VIIRS** do that is currently missing?
  – VIIRS can/should be used to measure the Earth’s Biosphere: (i.e., not just daily VI and Surface Type, but also LAI/FPAR, NPP/GPP, Burned Area, Phenology, etc.)
  – Multiple threads of VIIRS product development and generation: IDPS, NOAA JPSS (NDE), Proving Ground, NASA Science Team and Applied Science etc.
Surface Reflectance IP from Day 2014094
Retrieved under all atmospheric conditions for all non-ocean (not seawater) pixels except for night pixels and where input L1B is invalid

Retrieval using Mx73 at Land PEATE – SRIP not retrieved under confidently cloud and heavy aerosol, using NAAPS/Climatology when AOTIP is not retrieved.

Retrieval using Mx83 at IDPS – SRIP retrieved under all atmospheric conditions replacing NAAPS/Climatology with MODIS Climatology.

E. Vermote, S. Devadiga, NASA GSFC
SNPP VIIRS TOA NDVI

October 14, 2014 12:33 - 12:38 UTC (5 VIIRS granules)

M. Vargas et al., NOAA STAR
VI EDR Validation

Using AERONET Based SR (Matchup Data)

Sample of global daily distribution of match-up sites (August 21, 2013) covering different surface types and including urban areas. Global Land cover is derived from Combined Terra & Aqua MODIS LAI/FPAR LC product (MCD12C1, ver. 5.1).

Global APUs

(Jan 1, 2013 – Mar 31, 2014)

<table>
<thead>
<tr>
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<th>TOC EVI</th>
<th>TOC NDVI</th>
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<tbody>
<tr>
<td>A</td>
<td>-0.004</td>
<td>0.009</td>
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<tr>
<td>P</td>
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<tr>
<td>U</td>
<td>0.016</td>
<td>0.038</td>
</tr>
</tbody>
</table>

M. Vargas et al., NOAA STAR
VIIRS Green Vegetation Fraction

4-km Global GVF (Sep 1-7, 2014)

Coverage Lat 90°N - 90°S, Lon 180°W - 180°E

M. Vargas et al., NOAA STAR
VIIRS Green Vegetation Fraction

1-km Regional GVF (Sep 1-7, 2014)

Coverage Lat 90°N - 7.5°S, Lon 130°E - 30°E

M. Vargas et al., NOAA STAR
GVF animation

Weekly GVF change from Apr 8, 2014 to Oct 7, 2014

M. Vargas et al., NOAA STAR
Maps of 16-day mean albedo


Top: the VIIRS BPSA albedo
Bottom: the MODIS albedo

An LUT update for the VIIRS provisional albedo (BPSA – Bright Pixel Surface Albedo) is being implemented in IDPS Mx8.6 (October 2014)

Y. Yu et al., NOAA STAR
The LSA retrievals in the summer of 2012 over two Libya desert sites (Site 1: 24.42°N 13.35°E and Site 2: 26.45°N, 14.08°E) are used to illustrate the issue of temporal variability of LSA.

"Forward" means pixels with relative azimuth angle >90° and "backword" means those with relative azimuth angle <90°. Jumps around 8/9 were caused by the bugs in a early version of the operational codes.

**New albedo estimated with the BRDF LUT has improved in temporal stability**

LSA retrieved from new BRDF LUT. The spurious retrievals caused by undetected cloud and cloud shadow are excluded with the threshold of mean ± 0.05.
VIIRS Land Surface Temperature

VIIRS LST over Central Europe on 20140719 Nighttime

Y. Yu et al., NOAA STAR
LST Product Monitoring

Index of /pub/smed/emb/pyu/VIIRS_monitoring/current/year/

Cron start

Online Data inquiry

Geo-location &
temporal matchup

VIIRS
SURFRAD

FTP server

QC & Cloud
Screening

Graphics, Data
table, & log

Email to users

End

DesertRock: 2014001-2014116

Y. Yu et al., NOAA STAR
Surface Type: Comparison with MODIS C4/C5 LC

Legend
- Evergreen Needleleaf Forest
- Evergreen Broadleaf Forest
- Deciduous Needleleaf Forest
- Deciduous Broadleaf Forest
- Mixed Forest
- Closed Shrublands
- Open Shrublands
- Woody Savannas
- Savannas
- Grasslands
- Permanent Wetlands
- Croplands
- Urban and Built-Up
- Cropland/Natural Vegetation Mosaic
- Snow and Ice
- Barren or Sparsely Vegetated
- Water Bodies

X. Zhan et al., STAR
Validation Sample Design

Each sample block (black squares) contains between 10 and 35 1-km VIIRS pixels.
Overall Accuracies for Different Products

- MODIS C4
- MODIS C5 (Seed)
- VIIRS
- VCF

70% Accuracy Threshold

There is more variance in overall accuracies across aggregation levels than between maps.

M. Friedl, D. Sulla-Menashe (BU)
VIIRS NOAA Active Fire Product

- Represents **continuity** with NASA EOS MODIS and NOAA POES AVHRR fire detection (and also international missions such as (A)ATSR)
- VIIRS **design allows for radiometric measurements** to detect and characterize active fires over a wide range of observing and environmental conditions
- Product is expected to be used by **real-time resource and disaster management; air quality monitoring; ecosystem monitoring; climate studies** etc.

NW Canada
07 July 2013
20:14:55-20:20:34 UTC
The operational SNPP VIIRS Active Fire product is a sparse array containing **locations of pixels** flagged as “fire” by the detection algorithm.

The science team is developing a suite of improved products, including **fire radiative power** to characterize the fire intensity.

End users are engaged through **Proving Ground and User Readiness efforts**.

Fire detections from the operational Suomi NPP VIIRS Active Fire product in NW US on July 24, 2014. Data in various user-friendly formats are available from the product evaluation portal at [viirsfire.geog.umd.edu](http://viirsfire.geog.umd.edu).
NOAA VIIRS Fire Product

October 13, 2014

http://viirsfire.geog.umd.edu/

Data from NOAA CLASS: http://www.nsof.class.noaa.gov/
NOAA VIIRS Fire Product

October 13, 2014

http://viirsfire.geog.umd.edu/

Data from NOAA CLASS: http://www.nsof.class.noaa.gov/
West Fork Complex: 6/14 - 7/4/2013

Landsat-8 background: July 31, 2013

New MODIS-compatible Active Fire product

Current: locations only
Replacement: full mask and fire radiative power (FRP)
Global fires from VIIRS I-band data

VIIRS 375 m fire algorithm output showing the accumulated daytime nominal confidence fire pixels (upper left), low confidence daytime pixels (upper right), nighttime fire pixels (purple; lower left), and SAMA-related low confidence nighttime pixels (dark blue; lower right) during 1–30 August 2013.

Improved Satellite Mapping of Active Fires Achieved Using VIIRS I-bands

Wildfire in southern Brazil, March/2013

Aqua/MODIS 1 km
Spotty detection pixels and coverage gap at low latitudes

S-NPP/VIIRS 750 m
Spotty detection pixels

S-NPP/VIIRS 375 m
Improved fire line mapping

W. Schroeder, UMD
Global Observation of Forest and Land Cover Dynamics Fire Implementation Team Meeting

NOAA Center for Weather and Climate Prediction, College Park, MD, July 29-31 2014
New Landsat-8 30 m Active Fire Data

Built on proven ASTER/Landsat (5&7) fire algorithms [Giglio et al., 2008; Schroeder et al., 2008]
Day & nighttime detections 16/8-day revisit (day/night)
Spatial resolution providing detailed fire perimeter information (plus area estimate)
VIIRS 750 m Active Fire Algorithm Validation Using Airborne Reference and Auxiliary (fire mask replacement code) Input Data

Grassland fire 04 Nov 2012
(~35ha flaming/smoldering; 158MW)

W. Schroeder, UMD
For more information

- NOAA JPSS
  http://www.jpss.noaa.gov/
- NOAA STAR JPSS
  http://www.star.nesdis.noaa.gov/jpss/
- NASA VIIRS Land
  http://viirsland.gsfc.nasa.gov/
- VIIRS Fire Evaluation and Data Portal
  http://viirsfire.geog.umd.edu
- STAR JPSS 2014 Annual Science Team Meeting
  http://www.star.nesdis.noaa.gov/star/meeting_2014JPSSAnnual_agenda.php
- JGR-Atmospheres Special Issue Papers
JGR Special Issue on Suomi NPP Calibration and Validation

34 papers have been published in AGU Journal Geophysical Research Special Issue on Suomi NPP satellite calibration, validation and applications.

*Guest Editor: Fuzhong Weng*
Summary and Conclusions

• S-NPP VIIRS land IDPS and NOAA-Unique NDE development and evaluation is progressing well
• Development of data products not in the suite of operational NOAA products (i.e. IDPS or NDE)
  – NOAA JPSS Proving Ground and Risk Reduction
  – NASA SNPP Science Team – transitioning to production mode
• Teams are continuing the development of improved and additional products
• Development and operational implementation of products to meet new Level 1 requirements
  – Top-of-canopy vegetation index
  – Full active fire mask and fire radiative power