Suomi-NPP VIIRS Land Product Quality Assessment Approach and Collection V1.1 Reprocessing

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• Component of NASA’s Science Data Segment (SDS) of the Suomi NPP
  – Assess the quality of the Visible Infrared Imaging Radiometer Suite (VIIRS) Land Products made by the Interface Data Processing System (IDPS)
  – Recommend improvements to the VIIRS Land science algorithms.

• Uses NPP Data Processing System (NPPDAPS) for production of data and Land Data Operational Product Evaluation (LDOPE) for evaluation of the data products.
  – NPPDAPS is a version of the MODIS Adaptive Processing System (MODAPS) modified to make products from the IDPS operational code and software provided by the science teams.
  – LDOPE Team adopts the MODIS Land QA approach to evaluate the quality of the VIIRS Land Products.
Interface of Land PEATE with SDS Elements and External Segments

- IDPS
- NOAA CLASS
- SD3E
- GRAVITE
- NISCE VCST
- CERES
- LAADS
- DPE
- VIIRS Land Science Team

Science Data
Operational Code, LUT
SDRs, Geo, EDRs
Science Data

RDRs
IPs

Calibration Test Requests
Science Code Update Requests
Evaluation & Recommendation
Recommendations
Responses

Software
Subsetted Data
Science Data

IPs

Note: The diagram illustrates the interaction and flow of data and operations between various elements and segments, including science data, operational code, and LUT.
• Land PEATE has been receiving VIIRS data and processing data. Data products are in HDF4 format, archived and distributed from LAADS
  http://ladsweb.nascom.nasa.gov

  – IDPS (LAADS AS 3000): Aggregate IDPS generated SDRs, Geolocation, EDRs and IPs. (LAADS Archive Set 3000). Downsized to 1 global day per week. Data used to verify the accuracy of products produced in AS 3001. Build version in operation at IDPS is Mx83.

  – LPEATE (LAADS AS 3001): Process RDRs using IDPS OPS PGEs integrated to Land PEATE processing system. Products match to aggregate IDPS products in AS 3000 except for minor difference from out of sync algorithm build versions, 17-day RNDVI roll up, and monthly snow-ice GIP rolling tiles, Ancillaries, and LUTs. Build version in operation is Mx73.

  – LPA (LAADS AS 3002): Process RDRs using Land PEATE adjusted version of IDPS OPS PGEs.

  – Science team developed algorithms, Diagnostic Data Records (MODIS size gridded tiled products with VIIRS inputs) are generated from all three processing streams.

• Subsets are being generated from AS 3001 and 3002.
Land Product Quality Assessment and Algorithm Evaluation

• Adopts the MODIS Land QA approach to assess quality of VIIRS products.
  – Global browses, golden tiles browses, animation, time series
  – Visual inspection of browse images and analysis of selected sample data records

• Verify reproducibility of IDPS products at Land PEATE by processing RDRs using the IDPS operational algorithms in AS 3001.
  – Through comparison of global browse images of Land PEATE generated products to IDPS aggregated products in AS 3000
  – Accuracy, Precision and Uncertainty estimate from comparison of full resolution data records from the two archive sets.

• Assessment of VIIRS Land Algorithm Changes
  – PGE specific science test and chain tests run generating global data
  – Baseline and Test data created for comparison of different algorithm versions, LUTs, Seed Files etc.
  – Comparison to heritage MODIS products

• QA information posted on the QA web page
  – Results from all QA processes (browses, time series, APU etc.)
  – Known issues from operational product evaluation
  – Algorithm test status and evaluation results

• QA tools developed and maintained by LDOPE
  – Generic and transparent to products from different instruments
  – All operational QA processes automated to process data in real time with production and populate result on the QA web page.
Welcome to the NPP VIIRS Land Product Quality Assessment

The objective of the VIIRS (Visible Infrared Imaging Radiometer Suite) Land Product QA is to evaluate and document the science quality of products made from the remotely sensed data acquired using VIIRS. Results of quality assessment of examples of VIIRS Land products made at IDPS (Interface Data Processing System) and results of evaluation of improvements to the VIIRS Land Science algorithms derived by analyzing the products made at Land PEATE (Product Evaluation and Analysis Tool Element) using the new algorithms are placed on the web pages located at this site.

The Suomi NPP (National Polar-orbiting Partnership) satellite was launched on Oct. 28, 2011. Evaluation of products from the IDPS OPF (Operation System) algorithms, and the Land PEATE adjusted version of the IDPS OPFS algorithms run at Land PEATE and of the science algorithm improvements are done at LDOPE (Land Data Operational Product Evaluation). Results from LDOPE's evaluation of the pre-launch version of the IDPS algorithms done using simulated or proxy MOI5's data and the results from the science test of changes to algorithm done post-launch using corrected data are placed on the Algorithm Updated/Evaluation section of this web page. This web page is constantly evolving. For global browse images from immediate post-launch period please click on the Browse menu at the top of this page.

For more information about the VIIRS Land products, validation, and product maturity status, visit:
http://visdata.npp.gsfc.nasa.gov/index.html

What's New

- C11 Reprocessing Underway
- C11 Reprocessing in progress: Reprocessing of L1B SCORs completed for the period 01/19/12 - 07/05/2012. Reprocessing of Land xDRS expected to start in Oct 2013. Data products from the reprocessing available in AS 3.100 of LAADS
- Land PEATE is currently using IDPS Mx9.36.7 and IDPS 3.6.7, initial version of the algorithm in the forward processing. Mx7.2 build, put in operation on 6/20 at IDPS, is currently under testing and is expected to be in operation by end of Sept 2013.
- VIIRS xDRS from the processing of corrected data at Land PEATE using the same algorithm version as IDPS is available from AS 3.001 of LAADS. Data products from IDPS processing aggregated data at Land PEATE are available within the early mission period.
- Data products from the early mission period were labeled as BETA quality. Many products have now reached maturity stage of 'provisional quality.'

http://landweb.nascom.nasa.gov/NPP_QA/
## Land Product Quality Assessment

### Global Browse Images of Operational Products

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<th>Julian day</th>
<th>NPP_VMAF_L1 L1B Moderate input, Day Band 3, 4, 3</th>
<th>NPP_VIAF_L1 L1B Imagery input, Day Band 1, 2, 1</th>
<th>NPP CMIP_L2 Cloud Mask IP Day</th>
<th>NPP CMIP_L2 Cloud Mask IP Night</th>
<th>NPP_VAMIIP_L2 Aerosol Model IP</th>
<th>NPP_VAOITIP_L2 Aerosol Optical Thickness IP</th>
<th>NPP_VCOPIP_L2 Cloud Optical Properties COT</th>
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Land Product Quality Assessment
Product Issue – LST EDR

• The VIIRS Land Surface Temperature EDR reported incorrect high temperatures over inland water bodies. This was fixed in Mx6.2 build version put in operation on 2012223 (08/10/2012)
The VIIRS Surface Reflectance IP algorithm was changed to retrieve reflectance all atmospheric conditions in Mx8.3 put in operation on 03/18/2014. Uses MODIS Climatology instead of the NAAPS/Climatology when AOTIP is not retrieved. Mean difference in reflectance < 0.005.
Land PEATE ran science test of Mx8 LST Algorithm with the new Land Cover based Coefficient LUT for a data day (2013362) where nearly all observations from Aqua are within 30 minutes of NPP acquisition. Compared LST from VIIRS to operational MODIS C5 LST.
VIIRS Level 3 daily and n-day composite gridded products generated by modifying the MODIS C5 operational algorithms to read the VIIRS xDRs and IPs with spectral remapping of corresponding VIIRS bands and associated QA flags. DDRs are of MODIS tile size and resolution.
A time series of summary statistics derived from the NPP Land DDRs at a number of fixed globally distributed locations is maintained and monitored.

Geographical locations are of size 10 deg x 10 deg known as golden tiles.

Summary statistics include mean, standard deviation, min, max, and number of observations of good quality observations in the tile.

Following examples show product time series comparing products from VIIRS-LPEATE and MODIS-C5. Trending shown for observations from Savana biome from golden tile h20v11.
• Generate consistent records from the beginning of the mission using the best calibration LUT and best of algorithms available.
• Reprocessing started on 2/26/2014 with beginning data day 1/19/2012 will go through to the present.
• At the current rate of 8x the reprocessing is expected to complete in July 2014.
• Data products are available from AS 3110
• This reprocessing uses the calibration LUTs provided by the NASA VCST for the L1B SDR.
• DNBs are processed using the LUT for calibration and stray light correction provided by the NASA VCST.
• Processing uses the LPEATE Adjusted variations of OPS PGEs for TC DNB Geolocation (DNFT), L2 LSR (SR-IP), L2 VI (VRVI) and L2 Aerosols (AOTIP).
• Land PEATE processes the LPEATE Science DDRs using the most recent version of the DDR algorithms based on MODIS C5 operational PGEs and the CERES subsetter.
• This reprocessing does not generate the OPS L2 Land Albedo, Surface Albedo or any GIPs, and does not use rolling tiles.
• Cloud Mask uses the Climatology 16-day composite NDVI from the 4-years of Aqua MODIS observations and daily snow-ice from NISE data replacing the 17-day rolling tiles of NBAR-NDVI and the monthly snow-ice rolling tiles used in the operational process at IDPS.
• C11 Surface Reflectance algorithm in addition to the Mx83 changes, ignores dual gain anomaly flag, retrieves reflectance over ocean. Some of the difference may be from change to the AOTIP outside of min-max range. APU and difference images comparing C11 and LPEATE are derived as (C11 – LPEATE). LPEATE version of SRIP was produced by the Mx7.1 IDPS algorithm. This analysis didn’t do any quality filtering of observations except for removal of confident cloud.
Time series comparing the daily gridded surface reflectance in the L2G 1km resolution product from C11 reprocessing and LPEATE. This times series used observation from the 1st layer i.e. maximum observation coverage.
• C11 reprocessing uses the calibration and stray light correction LUT provided by the NASA VCST and the product will have TC geolocation.

• Stray light correction in C11 reprocessing and the operational processing in AS 3001 and 3002 may have failed because of some software bug.

• The PGEs from all processing streams have been fixed, tested and verified.

• The product in AS 3110 (C11) will be reprocessed in a separate AS.

• NGSA provided LUT in operation at IDPS and the VCST LUT used in C11 both seems to fix the stray light issue, however there are differences in retrieved radiance at pixel level. The difference seems to be proportional to the radiance.
• Global browse image of DNB night time radiance.

No stray light correction

IDPS stray light correction

VCST stray light correction

IDPS

C11

C11 - IDPS
C11 VCM: Using Climatology NDVI and NISE

- C11 reprocessing uses MODIS approach to generating Cloud Mask using Climatology NDVI and daily NISE data
- This approach uses
  - QST LWM (same as IDPS)
  - 16-day VI Seed File: Generated 4-year (2009-2012) climatology NDVI from the 16-day composite MODIS Aqua VI product, MYD13A2. Global product generated in MODIS tiles every 16-day at 1km and 5km resolution.
  - Daily Snow Ice Seed File: Generated by reprojecting the daily NISE data at 25 km resolution in the Lambert equal-area projection to the Sinusoidal projection at 1km resolution using nearest neighbor resampling. Global product generated in MODIS tiles.
  - Test result presented here used Mx72 build of IDPS L1B
C11 VCM: C11 vs IDPS

- Day Time Cloud Confidence from NPP_VCM_IP: Day 2013246

Day time

Night time

IDPS

LPEATE-C1

- Confident clear
- Probable clear
- Confident cloud
- Probable cloud
### Statistics from comparison of cloud confidence in VCM_IP

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IDPS is used as reference

- %Cloud = TotalCloudyPixels/TotalPixels
- %CloudMatch = AllMatch/Total_Ref_Cloudy
- %ClearMatch = AllClear/Total_Ref_Clear
- %Comm = (TotalNumpixels where C1 is showing cloud and IDPS not)/TotalRefCloudy
- %Omm = (TotalNumpixels where C1 is not showing cloud and IDPS is)/TotalRefCloudy
<table>
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<tr>
<th>Gridded IP</th>
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<th>Consumer IP/xDR Process</th>
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</table>
| Snow Ice Cover            | Currently: Monthly seed file  
Original design: Rolling tile updated daily from ICIP and VSCD                  | Cloud Mask IP                                               |
| Quarterly Surface Type    | Delivered to IDPS by offline processing – uses Monthly SR/TB/VI. Not clear if this is annual or quarterly. Currently uses seed file – pre-launch, Sept 2012, Jan 2013. | Surface Type EDR  
Surface Temperature EDR                                        |
| QST-LWM                   | Delivered to IDPS by offline processing – merges QST and LWM.                         | Cloud Mask IP  
Fire Mask IP                                                   |
| Annual Max/Min NDVI       | Delivered to IDPS by offline Processing – Uses Monthly SR/TB/VI. Generated by the same process that generates QST. | Surface Type EDR to determine vegetation fraction           |
| Daily Surface Reflectance (DSR) GIP | Gran2Grid - Uses SR-IP from one global day                                          | BRDF/Land Surface Albedo GIP                                 |
| Land Surface Albedo       | Grid2Grid - Uses 17-days of DSR GIP                                                | Land Surface Albedo IP  
NBAR-NDVI 17-day                                                  |
| BRDF Archetype            | Grid2Grid - Uses 17-days of DSR GIP                                                | NBAR-NDVI 17-day  
BRDF/Land Surface Albedo GIP                                     |
| Monthly SR-BT-VI          | Gran2Grid - Uses SR-IP and TOA SDR Brightness Temperature                           | Quarterly Surface Type                                        |
| NBAR-NDVI 17 day*         | Grid2Grid – Uses BRDF Archetype and Land Surface Albedo                             | NBAR-NDVI Rolling  
NBAR-NDVI Monthly                                                 |
| NBAR-NDVI Rolling*        | Grid2Grid – Uses NBAR-NDVI 17-day (2 recent periods) and Monthly NDVI               | Cloud Mask IP                                               |
| NBAR-NDVI Monthly*        | Grid2Grid – Uses NBAR-NDVI 17-day (3 periods)                                       | NBAR-NDVI Rolling  
NBAR-NDVI Monthly                                                 |

*5 km products
Gridding/Granulation - NASA Approach

- Based on MODIS Cloud ATBD (Moody et al., 2005)
• Turn off Dark Pixel Surface Albedo (DPSA) Loop.
• Retain DSR GIP 17-day updates
• Replace NBAR-NDVI chain with 17-day TOC NDVI (rationale: BRDF effect on NDVI should not impact the VCM’s **brightness change test**. VCM tuning should account for possible increased biases (e.g., next slide).
Conclusion

- Land PEATE is processing RDRs using the operational IDPS algorithms and current LUTs generating the L1B SDRs, Geolocation, IPs and EDRs.
- DDRs generated from the MODIS L3 PGEs, and science PGEs delivered by the science teams.
- Land PEATE is conducting routine quality check of products from the processing at Land PEATE.
- Land PEATE is running multiday science tests generating global data to help science teams in algorithm evaluation and cal/val.
- C11 reprocessing of VIIRS land data records using the NASA VCST LUT and best of available science algorithms is in progress and is expected to finish soon. Product evaluation comparing to the heritage MODIS products has started.
- C11 reprocessing used the MODIS-based approach to using the Climatology NDVI and and NISE data for generating the Cloud Mask. Land/VCM team “compromise” could be a viable approach for use at IDPS
  - Simple to use.
  - VCM generated using this approach should have the same performance as ‘corrected’ NBAR-NDVI rollup.
  - Easy to run science tests to any length of the processing chain for verification of effect of algorithm changes on downstream products