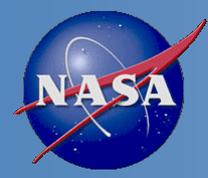


Suomi-NPP VIIRS Land Product Quality Assessment Approach and Collection V1.1 Reprocessing

**Sadashiva Devadiga^{1,2}, Carol Davidson^{1,2}, Sudipta Sarkar^{1,2},
Gang Ye^{1,2}, Maki Hattori^{1,2}, Cid Praderas^{1,2}, Virginia Kalb¹,
Anhquan Nguyen^{1,2}, Cynthia Hamilton^{1,2}, James Kuyper^{1,2},
Miguel Román^{1,2}, and Ed Masuoka^{1,2}**

¹NASA Goddard Space Flight Center, ²Sigma Space Corporation





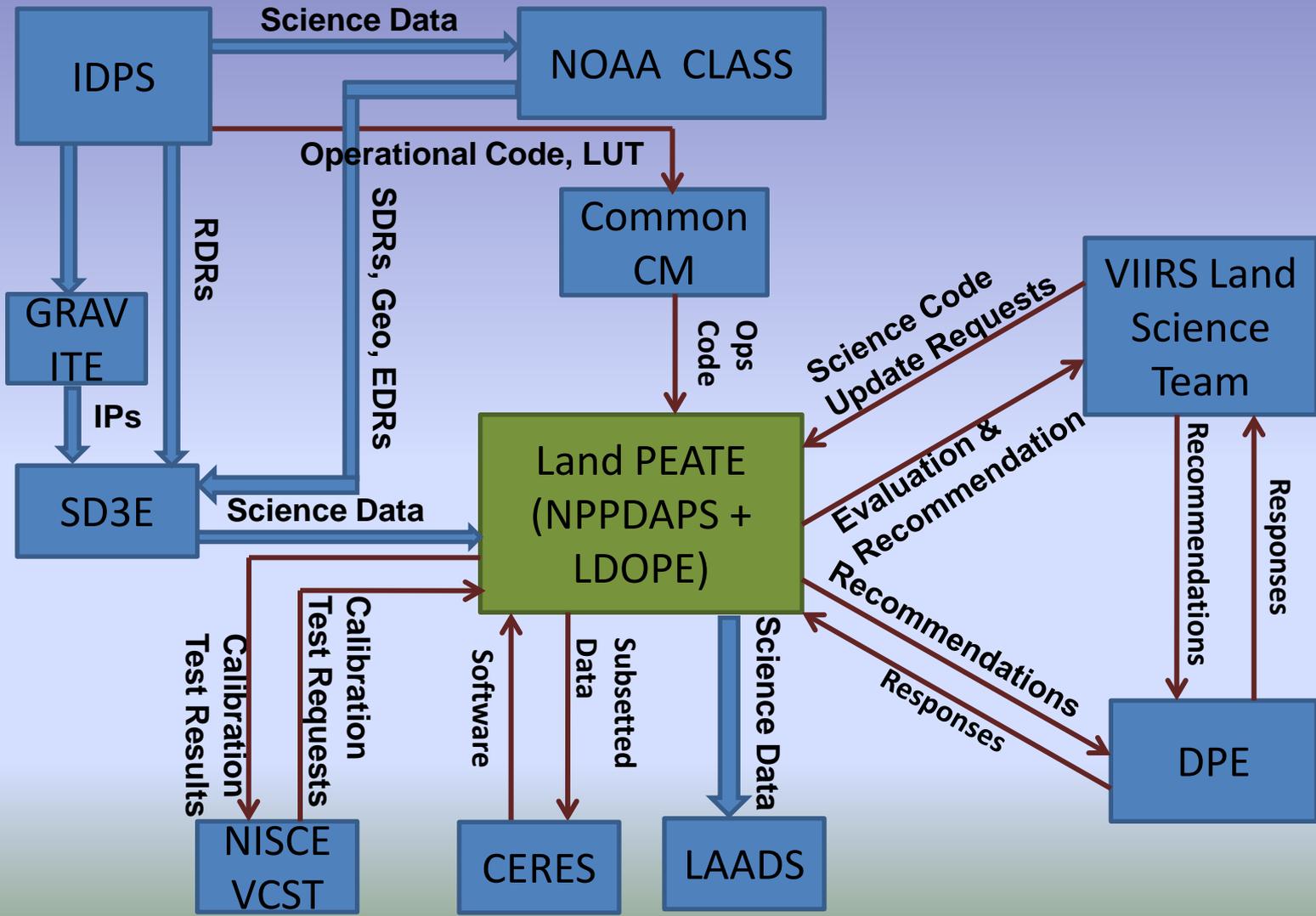
Land Product Evaluation and Analysis Tool Element

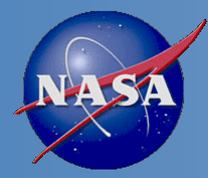


- **Component of NASA's Science Data Segment (SDS) of the Suomi NPP**
 - Assess the quality of the Visible Infrared Imaging Radiometer Suite (VIIRS) Land Products made by the Interface Data Processing System (IDPS)
 - Recommend improvements to the VIIRS Land science algorithms.
- **Uses NPP Data Processing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

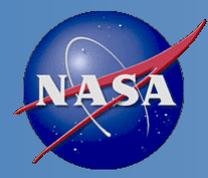




Land PEATE Data Ingest & Production



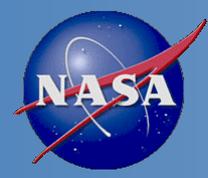
- Land PEATE has been receiving VIIRS data and processing data. Data products are in HDF4 format, archived and distributed from LAADS <http://ladsweb.nascom.nasa.gov>
 - **IDPS (LAADS AS 3000)**: Aggregate IDPS generated SDRs, Geolocation, EDRs and IPs. (LAADS Archive Set 3000). Downsized to 1 global 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.



Land Product QA Web Page



National Aeronautics and Space Administration
Goddard Space Flight Center

Suomi NPP - Land Product Evaluation and Analysis Tool Element

VIIRS Land Product
Quality Assessment
Visible Infrared Imaging Radiometer Suite



Home

Browse

Time Series

Land Products

QA Info

Alg Updates/Eval

Links

Early Images

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 samples 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 OPS (Operation System) algorithms, and the Land PEATE adjusted version of the IDPS OPS 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 MODIS data and the results from the science test of changes to algorithm done post-launch using on-orbit data are posted on the Algorithm Updates/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. Please direct your questions and comments to [Sadashiva Devadiga](mailto:Sadashiva.Devadiga).

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

What's New

- [C11 Reprocessing Underway](#)
- C11 Reprocessing in progress: Reprocessing of L1B SDRs completed for the period 01/19/12 - 07/09/2013. Reprocessing of Land xDRS expected to start in Oct 2013. Data products from the reprocessing available in AS 3100 of [LAADS](#)
- Land PEATE is currently using IDPS Mx6.3/6.7 build versions of the algorithm in the forward processing. Mx7.2 build, put in operation on 8/20 at IDPS, is currently under testing and is expected to be in operation by end of Sept 2013
- VIIRS xDR from the processing of on-orbit data at Land PEATE using the same algorithm version as IDPS is available from AS 3001 of LAADS. Data products from IDPS processing aggregated 5min granule is available from AS 3000 and products from science team improved version of algorithm available from AS 3002. Please see the [Land LPEATE data production and retention policy](#) to verify availability of data online.
- Data products from the early mission period were labeled as of **BETA** quality. Many products have now reached [maturity stage](#) of "provisional quality".



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Responsible NASA Official : [Edward Masuoka](#)

Content Owner: [Sadashiva Devadiga](#)

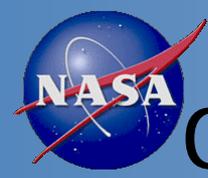
Web Curator: [Demi Feng](#)

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Page Last Updated: Mar. 12, 2014

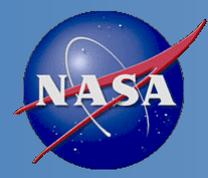
http://landweb.nascom.nasa.gov/NPP_QA/



Land Product Quality Assessment

Global Browse Images of Operational Products

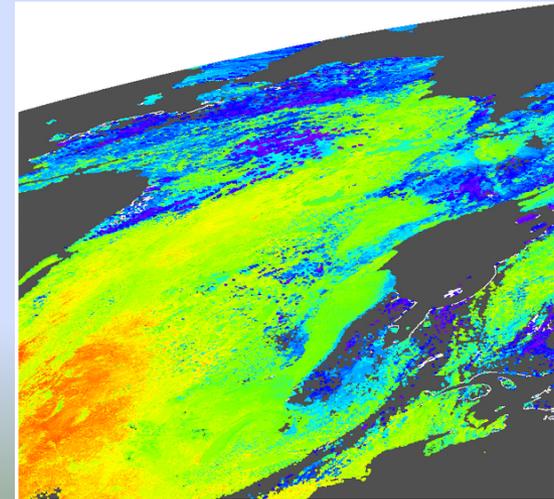
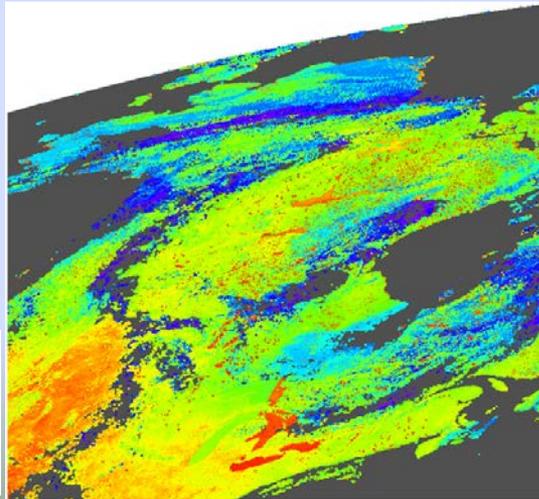
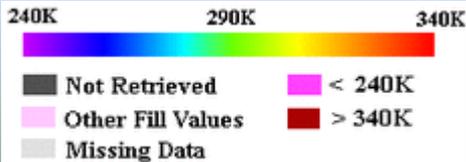
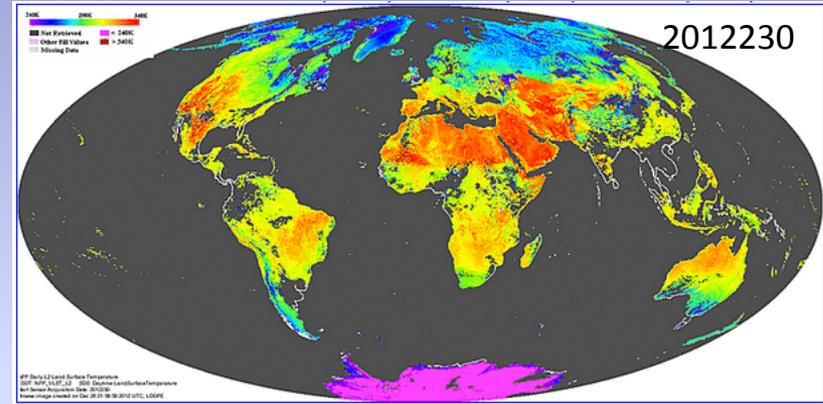
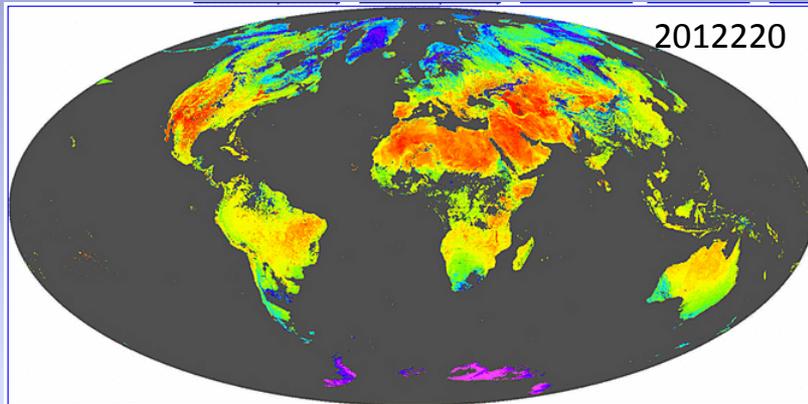
Julian day		NPP_VMAE_L1 L1B Moderate input, Day Band 5,4,3	NPP_VIAE_L1 L1B Imagery input, Day Band 1,2,1	NPP_CMIP_L2 Cloud Mask IP Day	NPP_CMIP_L2 Cloud Mask IP Night	NPP_VAMIIP_L2 Aerosol Model IP	NPP_VAOTIP_L2 Aerosol Optical Thickness IP	NPP_VCOPIP_L2 Cloud Optical Properties COT	NPP_VCOPIP_L2 Cloud Optical Properties EPS	NPP_VISA_L2 Surface Albedo
2014 128 05/8										
2014 127 05/7										
2014 126 05/6										
2014 125 05/5										
2014 124 05/4										
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2014 118 04/28										

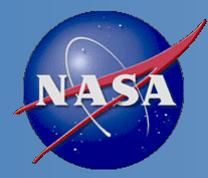


Land Product Quality Assessment Product Issue – LST EDR



- 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)

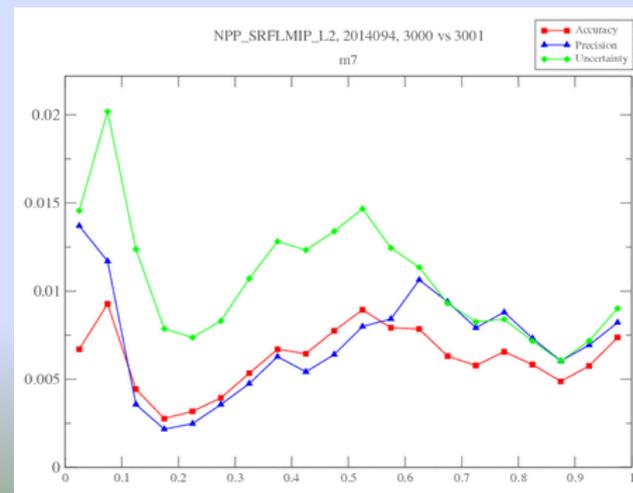
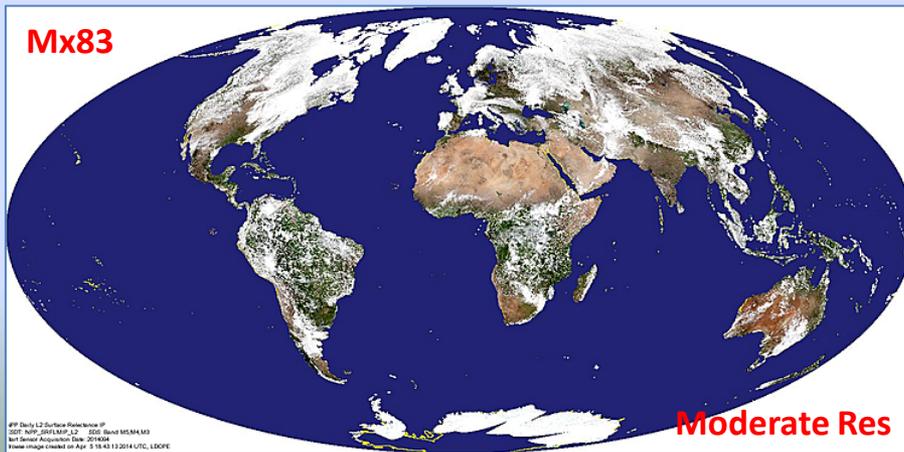
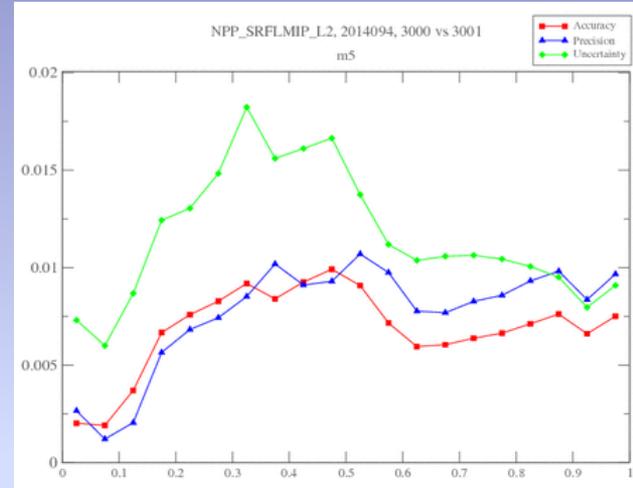
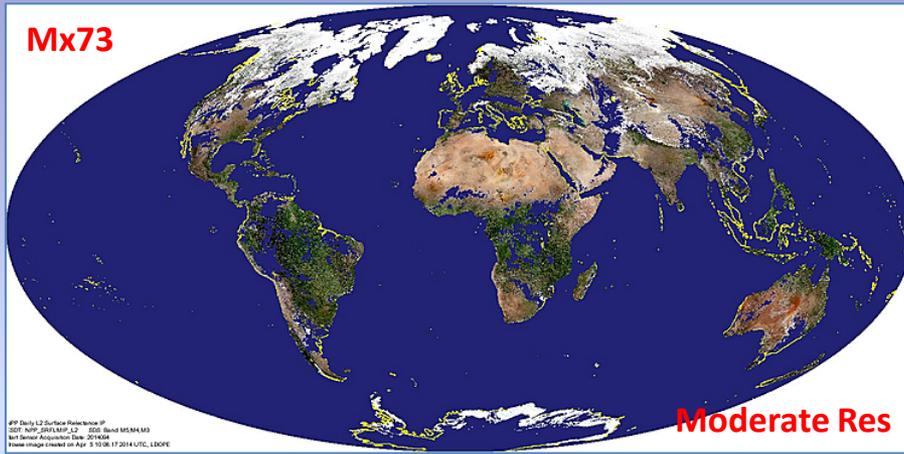




Land Product Quality Assessment Algorithm Change/Improvement – SR IP



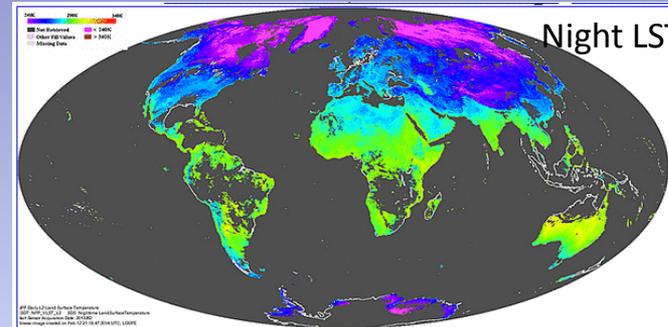
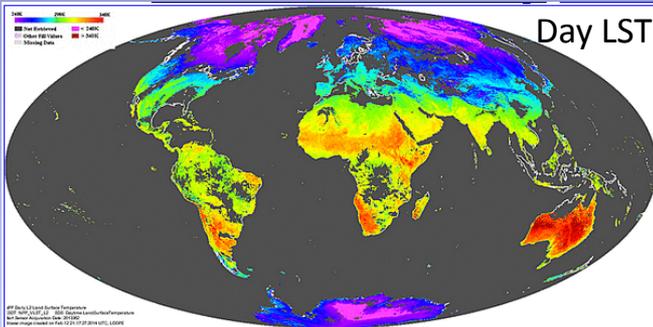
- The VIIRS Surface Reflectance IP algorithm was changed to retrieve reflectance all atmospheric conditions in Mx8.3 put in operation on 03/18/2014. Uses MODIS Climatology instead of the NAAPS/Climatology when AOTIP is not retrieved. Mean difference in reflectance < 0.005 .



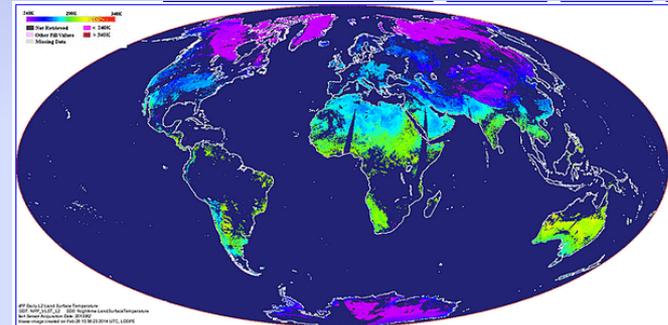
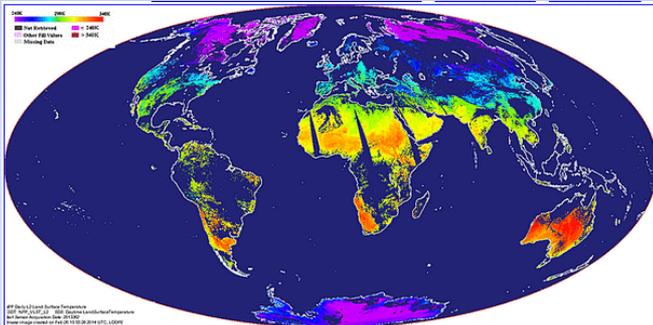
Land Product Quality Assessment Science Test – Coefficient LUT Update

- 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.

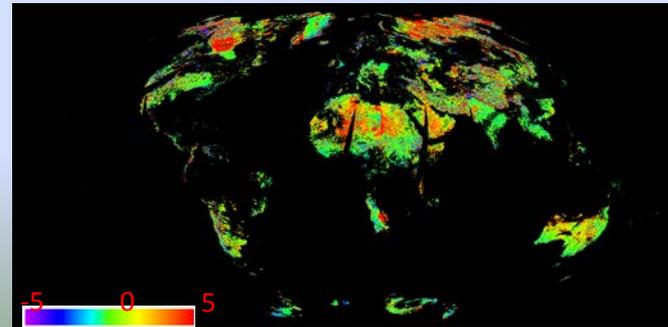
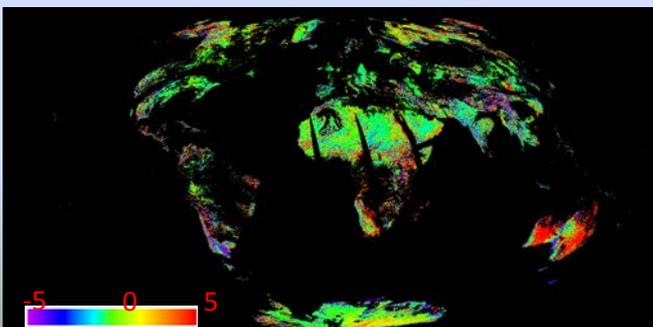
VIIRS – Mx8



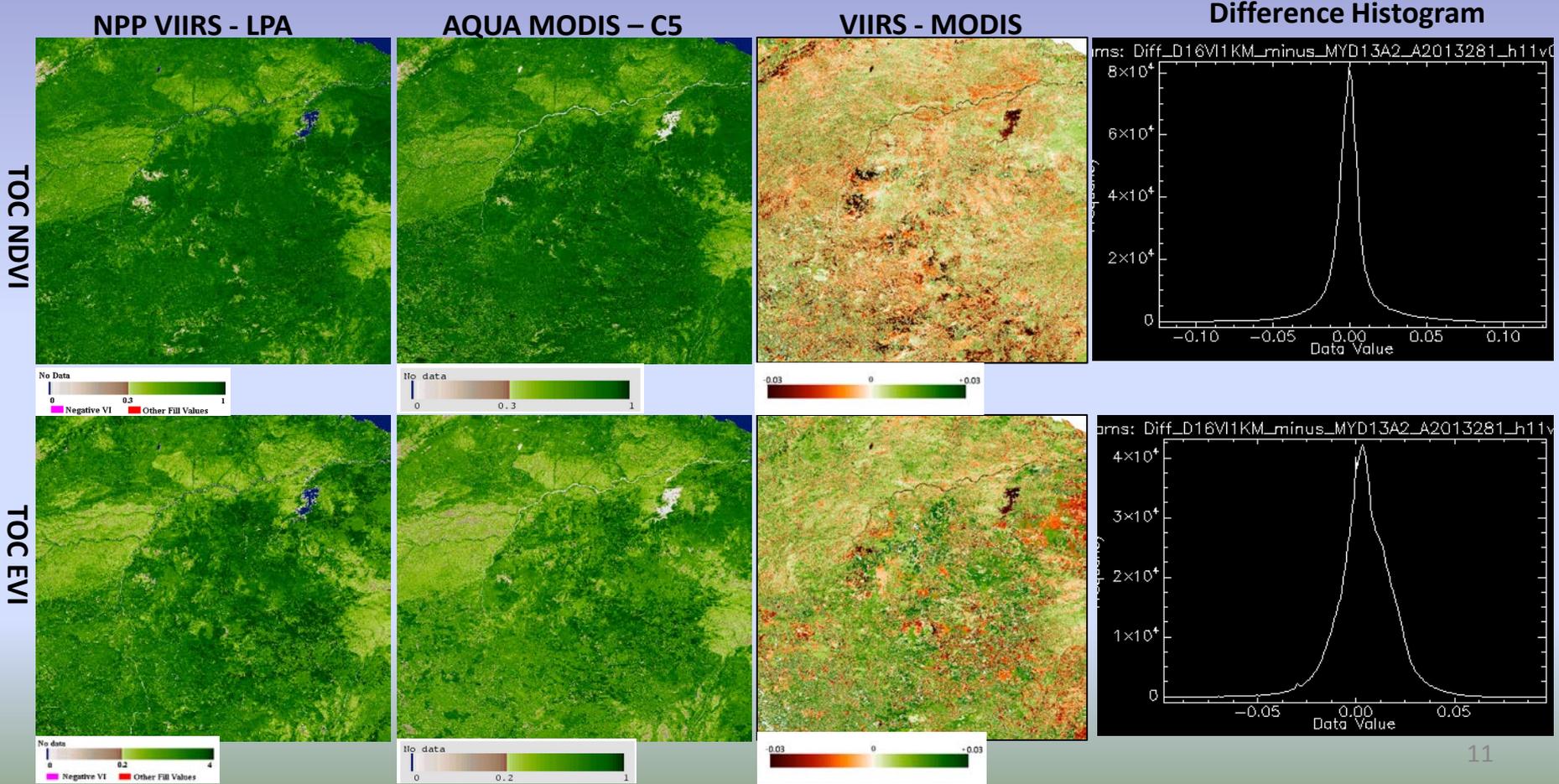
MODIS – C5

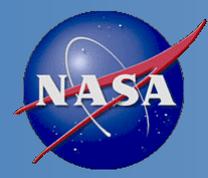


VIIRS – MODIS



- 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.

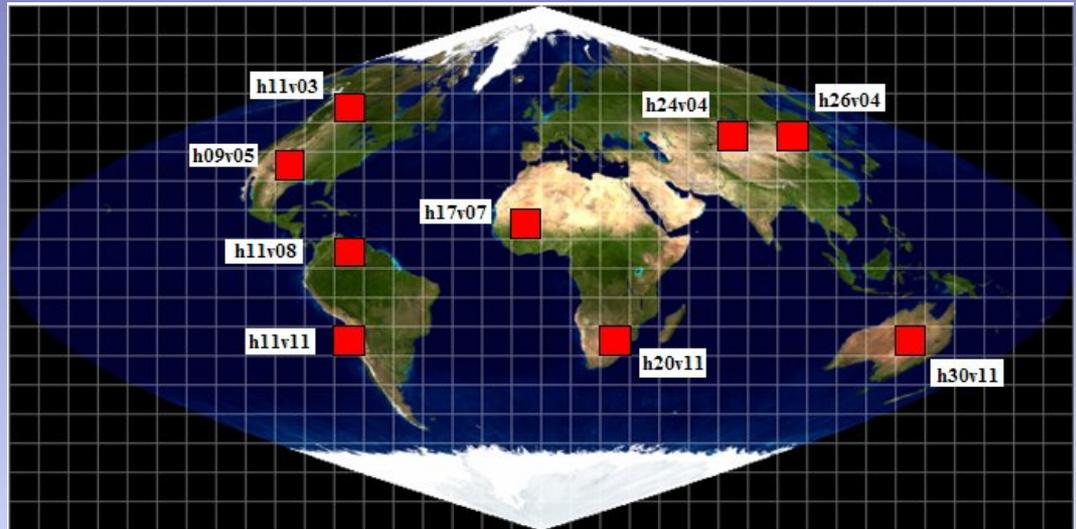




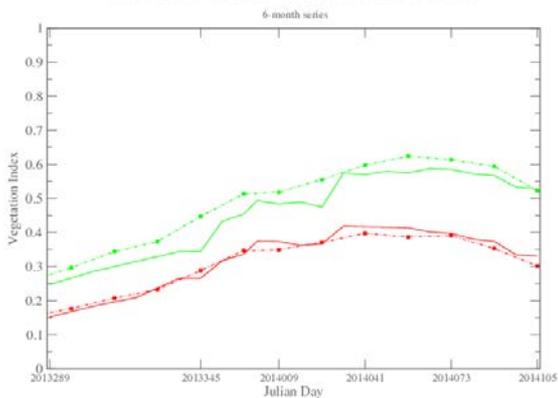
Land Product Quality Assessment Golden Tile Time Series



- 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.

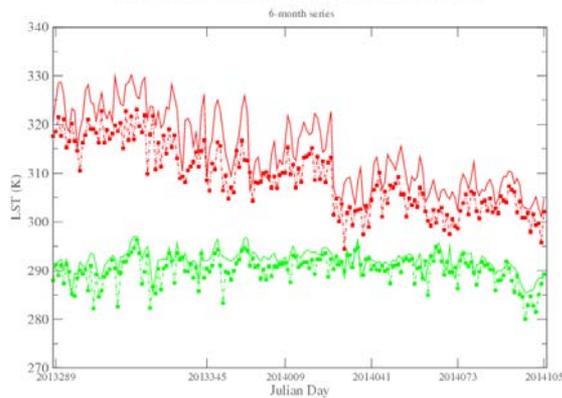


h20v11 (Southern Africa) 16 day VI
Savanna_Biome
MODIS Aqua C5 vs NPP LPEATE (Aqua data dash line with square)



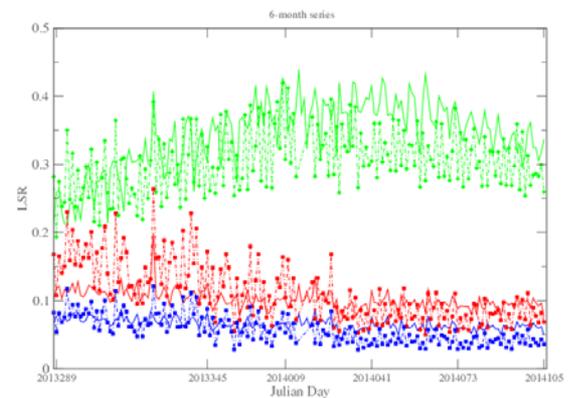
Fri May 9 13:27:31 2014

h20v11 (Southern Africa) Daily LST
Savanna_Biome
MODIS Aqua C5 vs NPP LPEATE (Aqua data dash line with square)



Fri May 9 13:28:13 2014

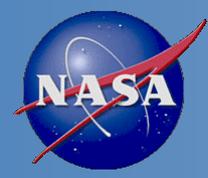
h20v11 (Southern Africa) Daily Surface Reflectance
Savanna_Biome
MODIS Aqua C5 vs NPP LPEATE (Aqua data dash line with square)



Fri May 9 13:55:37 2014

- **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.

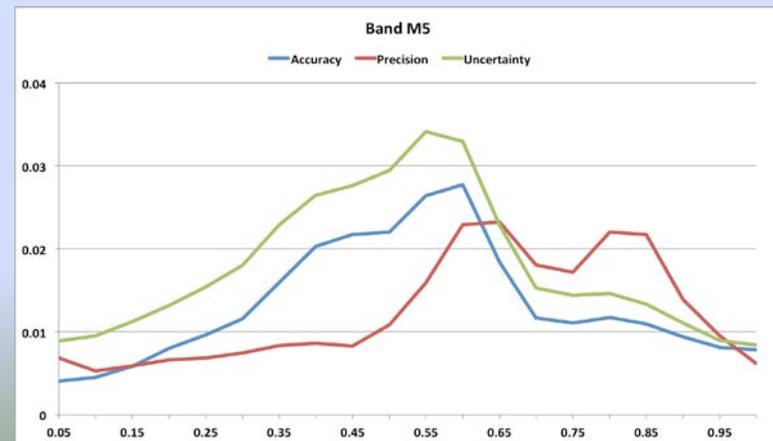
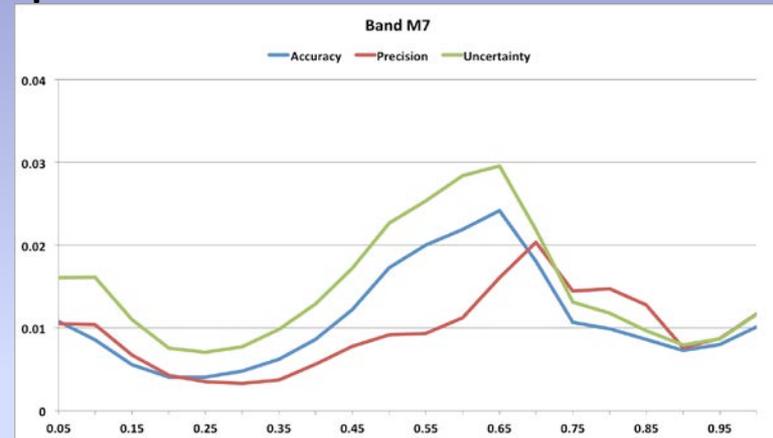
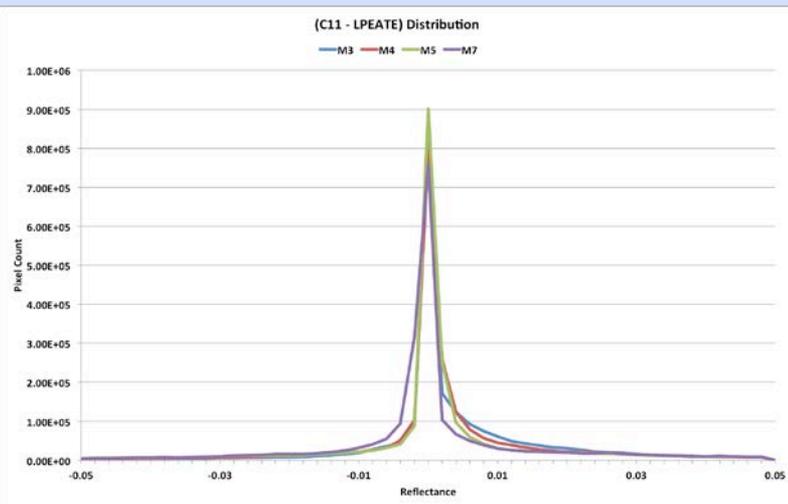
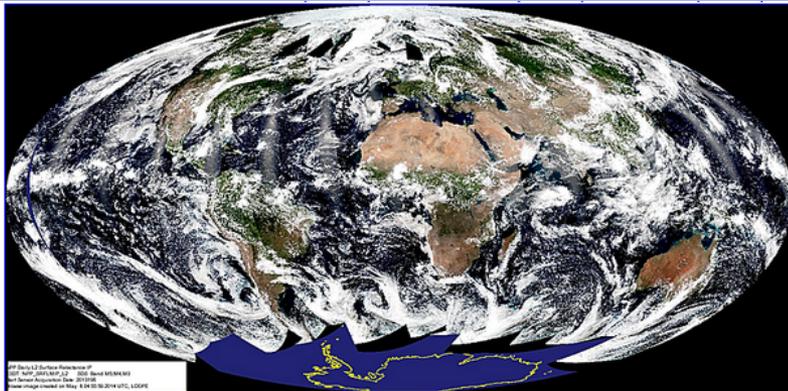


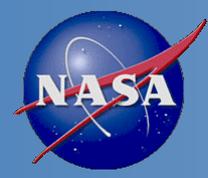
V1.1 Reprocessing – Evaluation in progress

Surface Reflectance IP - 2013195



- 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.



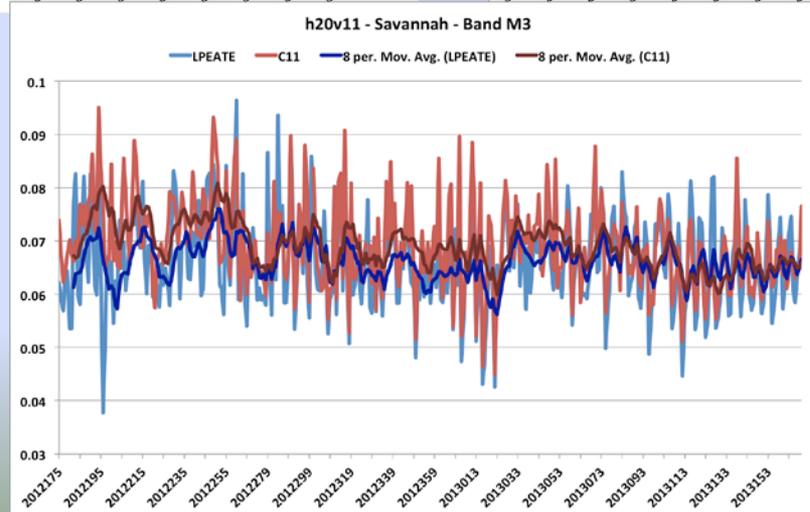
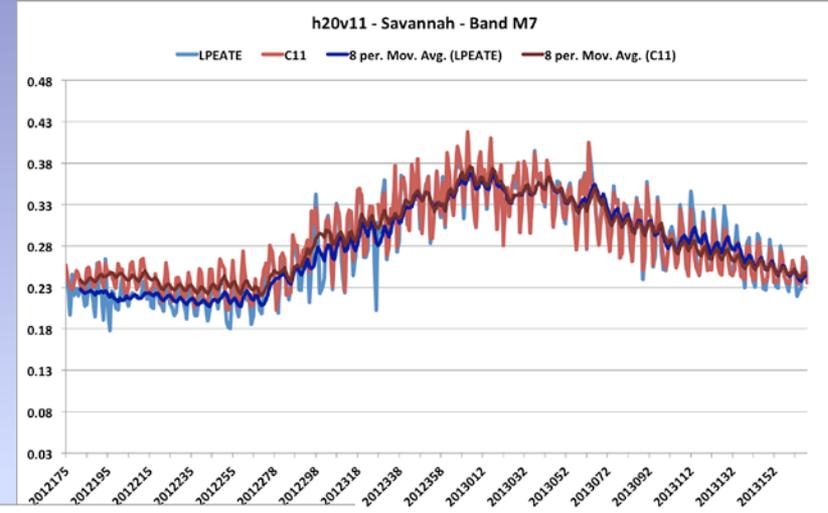
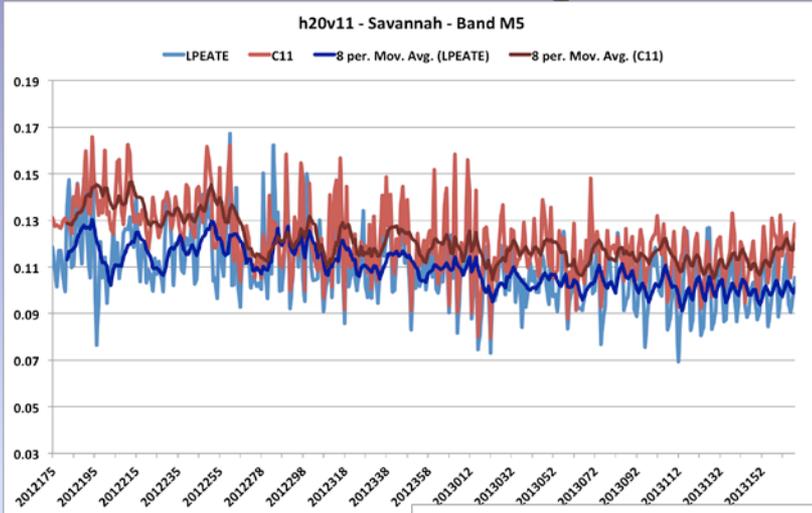


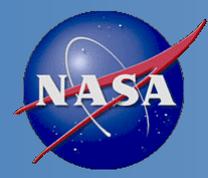
V1.1 Reprocessing – Evaluation in progress

Time Series of Daily Reflectance: C11 vs LPEATE



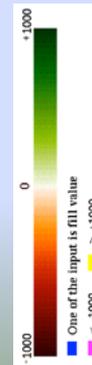
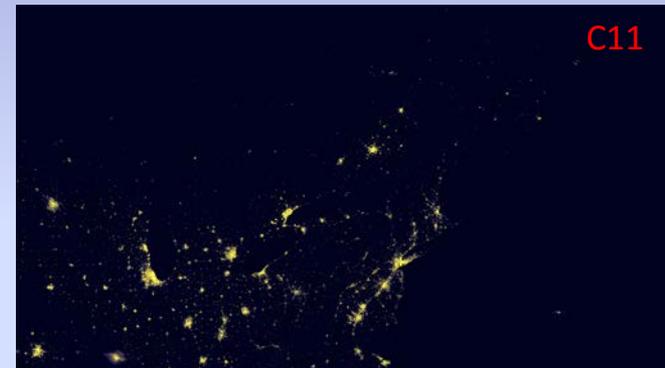
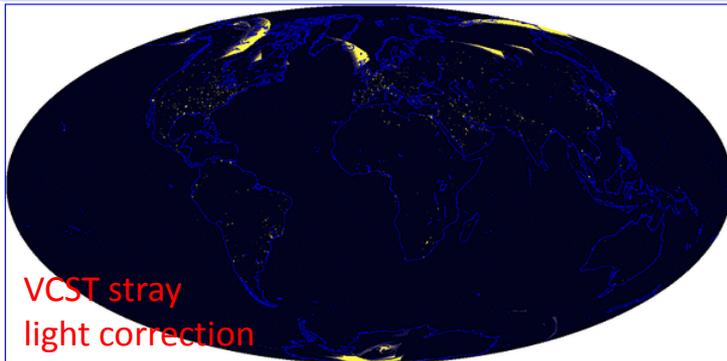
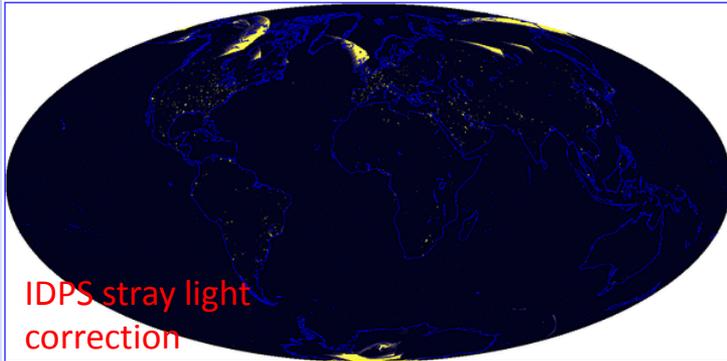
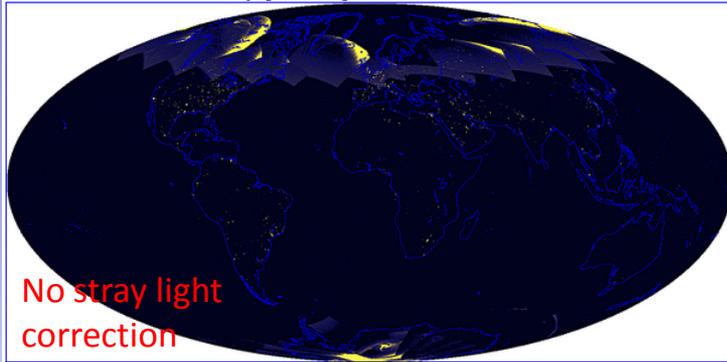
- Time series comparing the daily gridded surface reflectance in the L2G 1km resolution product from C11 reprocessing and LPEATE. This times series used observation from the 1st layer i.e. maximum observation coverage.

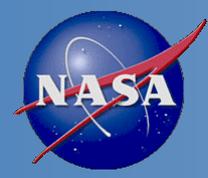




- **C11 reprocessing uses the calibration and stray light correction LUT provided by the NASA VCST and the product will have TC geolocation.**
- **Stray light correction in C11 reprocessing and the operational processing in AS 3001 and 3002 may have failed because of some software bug.**
- **The PGEs 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.





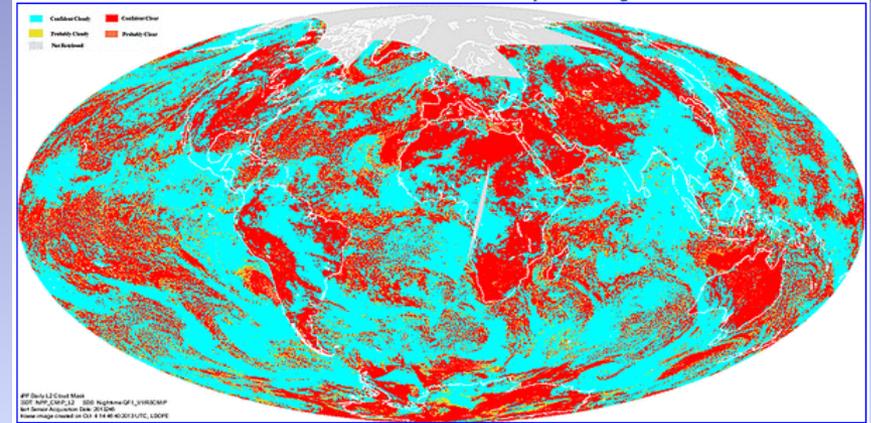
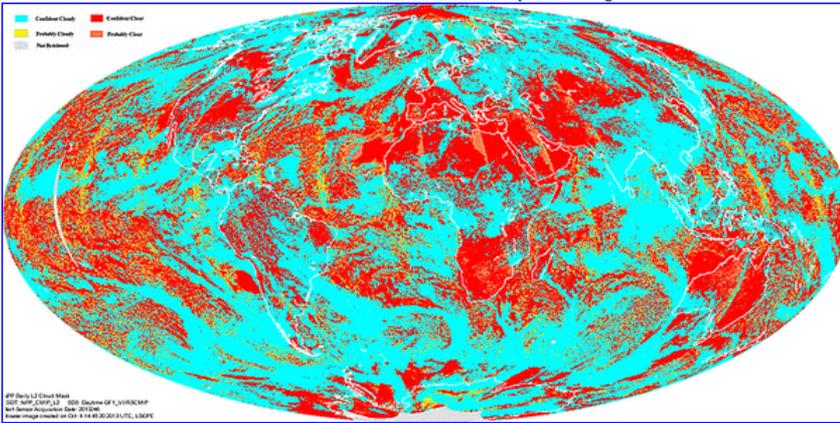
- **C11 reprocessing uses MODIS approach to generating Cloud Mask using Climatology NDVI and daily NISE data**
- **This approach uses**
 - **QST LWM (same as IDPS)**
 - **16-day VI Seed File: Generated 4-year (2009-2012) climatology NDVI from the 16-day composite MODIS Aqua VI product, MYD13A2. Global 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**

- Day Time Cloud Confidence from NPP_VCM_IP: Day 2013246

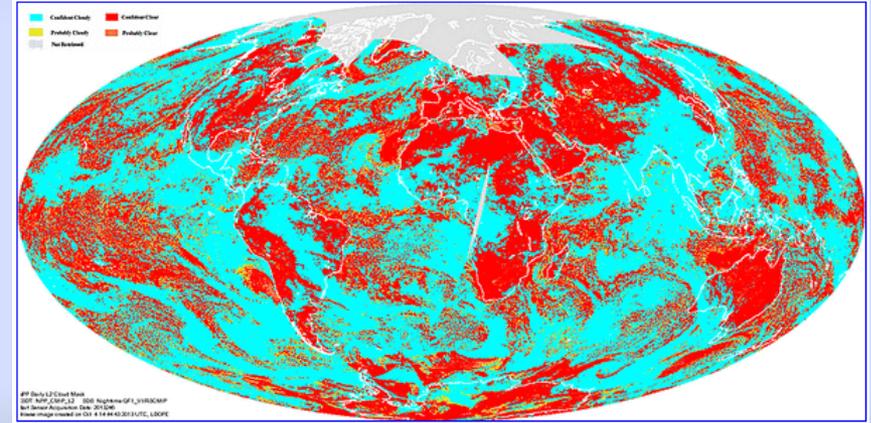
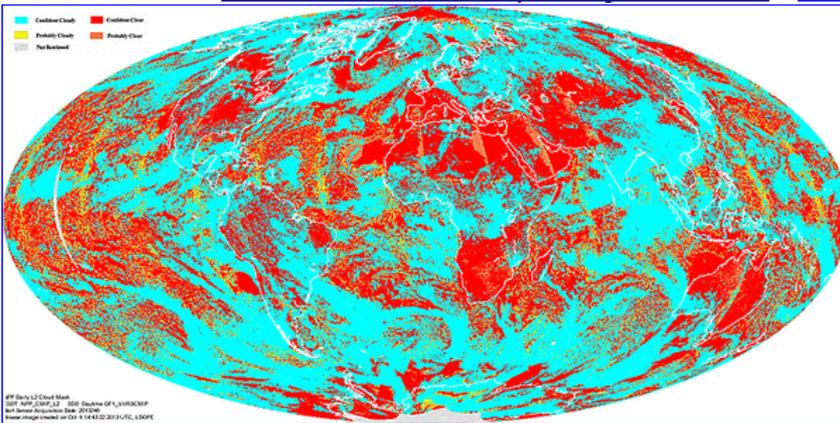
Day time

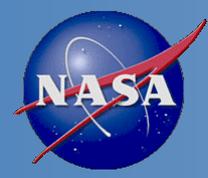
Night time

IDPS



LPEATE-C1





C11 VCM: C11 vs IDPS



- Statistics from comparison of cloud confidence in VCM_IP

GranID		%Cloud	%Cloud_match	%Clear_Match	%Comm_Diff	%Omm_Diff
A2013246.0350	Australia - East	16.68	97.43	99.82	0.88	2.57
A2013246.0520	Antarctica	62.7	99.91	98.77	0.73	0.09
A2013246.0530	Australia - West	32.56	98.51	99.7	0.63	1.49
A2013246.0600	Northern Russia	64.3	99.52	99.49	0.28	0.48
A2013246.0605	Arctic	43.4	99.02	98.51	1.94	0.98
A2013246.0700	Antarctica	62.4	99.25	98.24	1.06	0.75
A2013246.0740	Northern Russia	60.82	99.54	99.64	0.23	0.46
A2013246.0745	Arctic	48.88	99.76	99.08	0.96	0.24
A2013246.1025	Antarctica	69.95	96.05	99.99	0	3.95
A2013246.1205	Antarctica	69.8	98.53	99.76	0.1	1.47
A2013246.1225	Africa - equitorial	52.64	99.8	98.25	1.57	0.2
A2013246.1230	Africa - Sahel	17.43	99.9	99.64	1.69	0.1
A2013246.1745	Canada - East	58.11	97.2	99.01	0.71	2.8
A2013246.1750	Canada - North	54.29	99.04	97.82	1.83	0.96
A2013246.1920	NA – Gulf of Mexico	19.23	99.39	99.19	3.41	0.61
A2013246.1925	Central NA	35.98	96.21	99.94	0.11	3.79
A2013246.1930	Canada - North	59.88	98.62	98.51	1	1.38

IDPS is used as reference

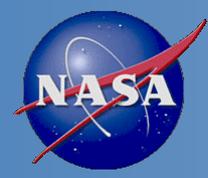
$\%Cloud = TotalCloudyPixels / TotalPixels$

$\%CloudMatch = AllMatch / Total_Ref_Cloudy$

$\%ClearMatch = AllClear / Total_Ref_Clear$

$\%Comm = (TotalNumpixels \text{ where } C1 \text{ is showing cloud and IDPS not}) / TotalRefCloudy$

$\%Omm = (TotalNumpixels \text{ where } C1 \text{ is not showing cloud and IDPS is}) / TotalRefCloudy$



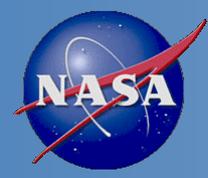
VCM and Gridding/Granulation

Land Gridded IPs and Consumer IPs/xDRs

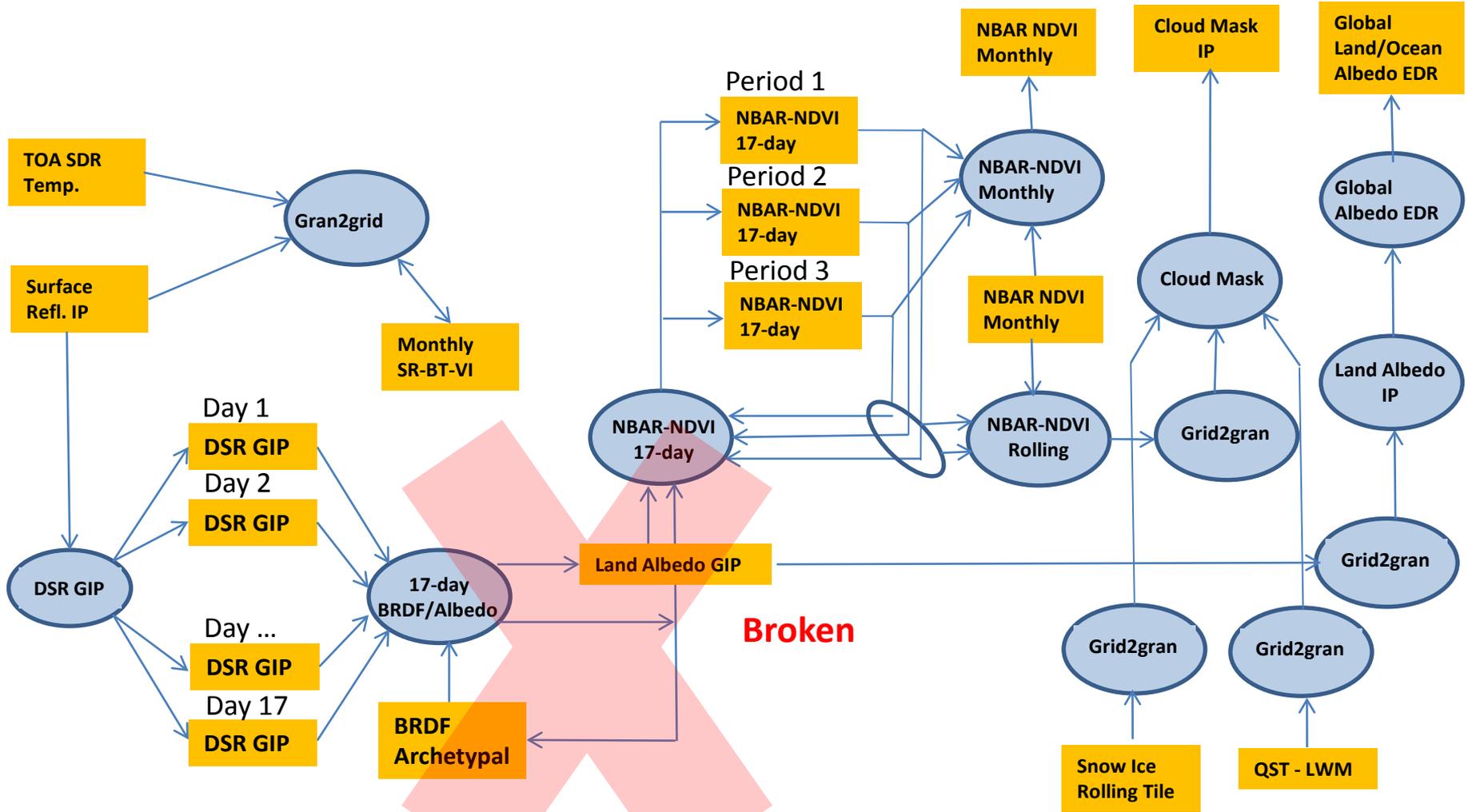


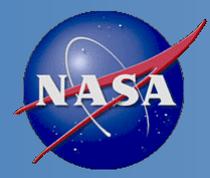
Gridded IP	Generating Process	Consumer IP/xDR Process
Snow Ice Cover	Currently: Monthly seed file Original design: Rolling tile updated daily from ICIP and VSCD	Cloud Mask IP
Quarterly Surface Type	Delivered to IDPS by offline processing – uses Monthly SR/TB/VI. Not clear if this is annual or quarterly. 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

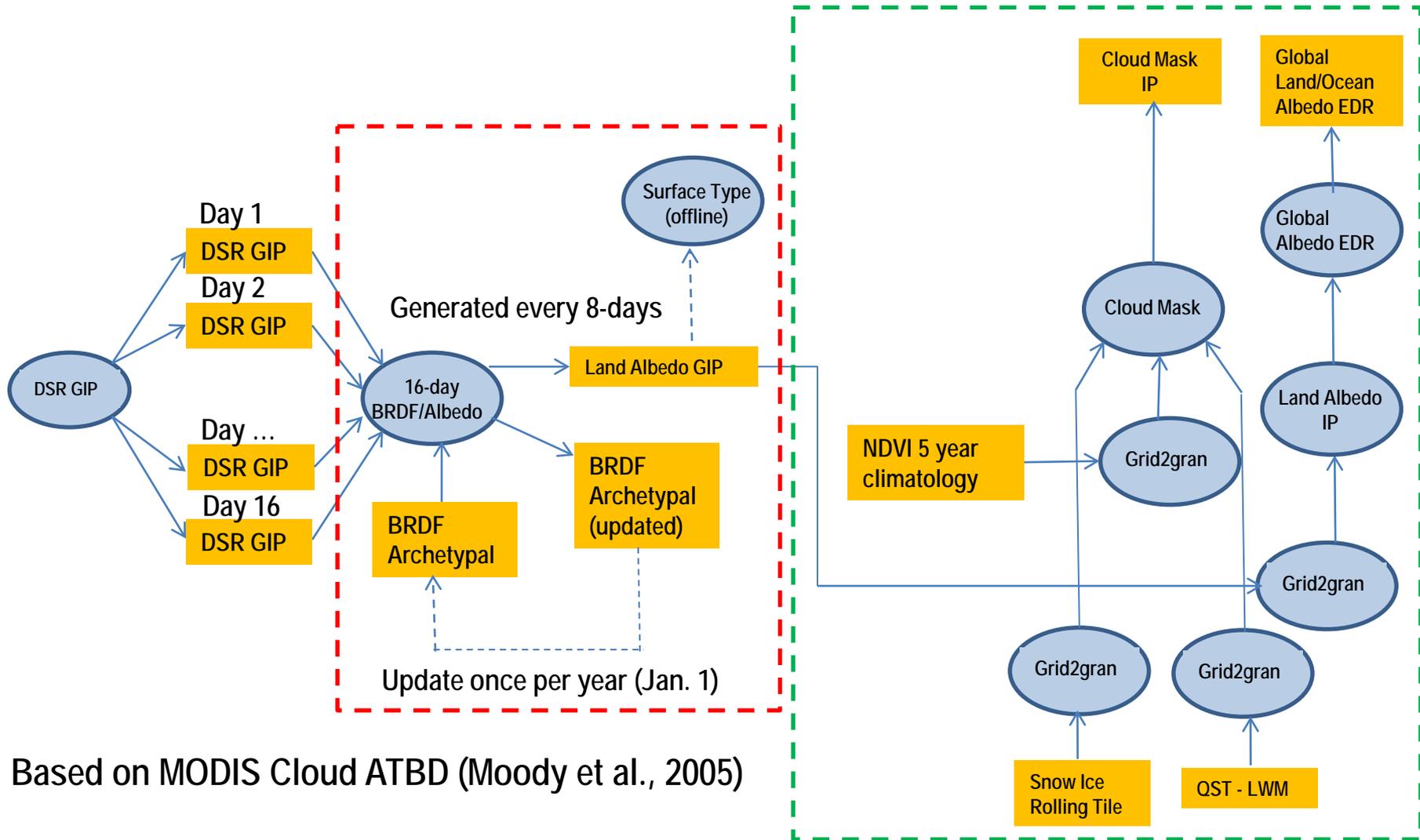


Gridding/Granulation - Current

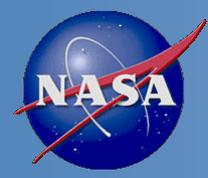




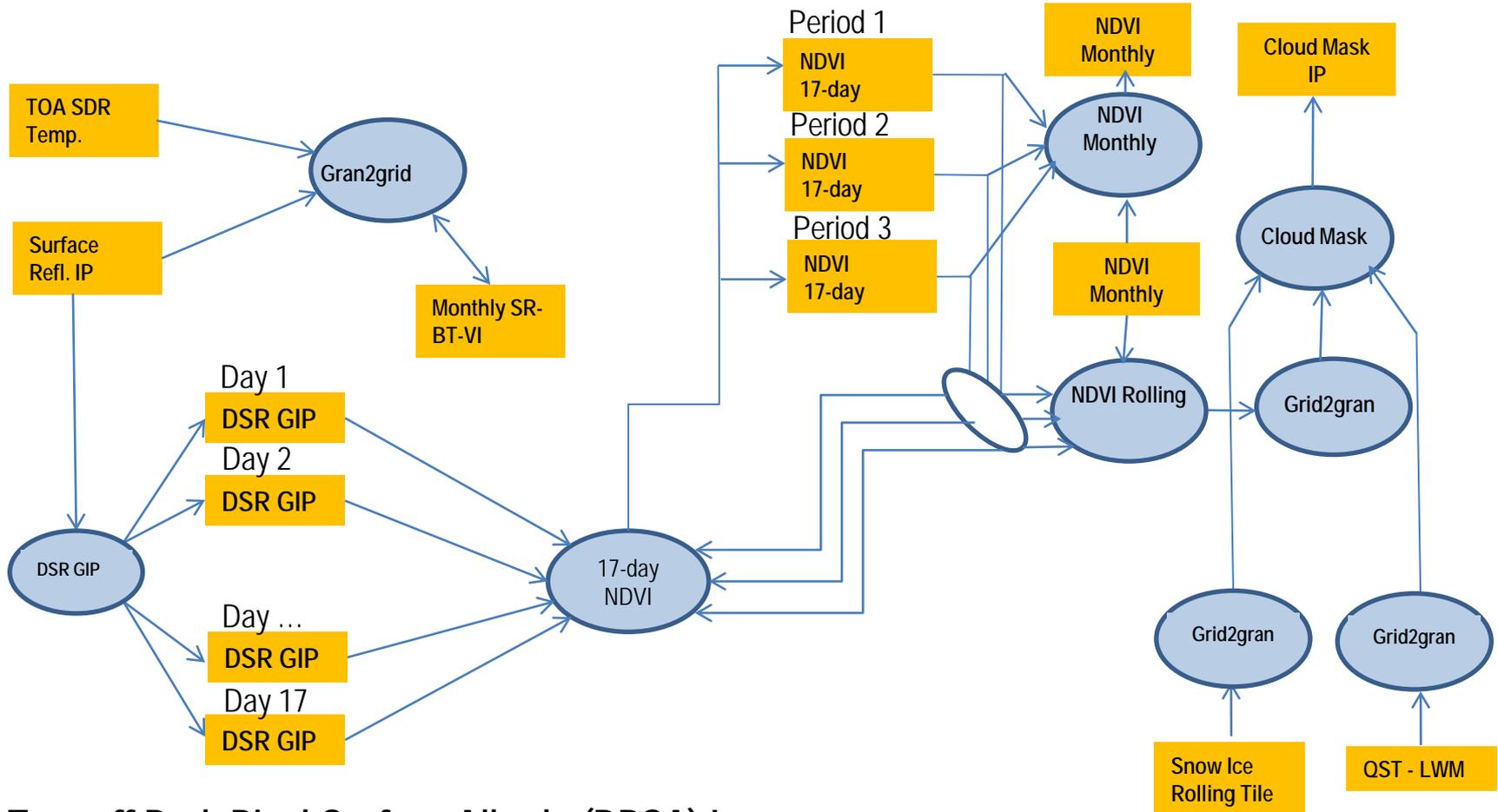
Gridding/Granulation - NASA Approach



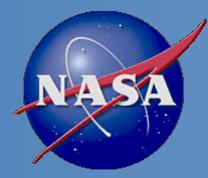
- Based on MODIS Cloud ATBD (Moody et al., 2005)



Gridding/Granulation - Land and VCM Compromise



- 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