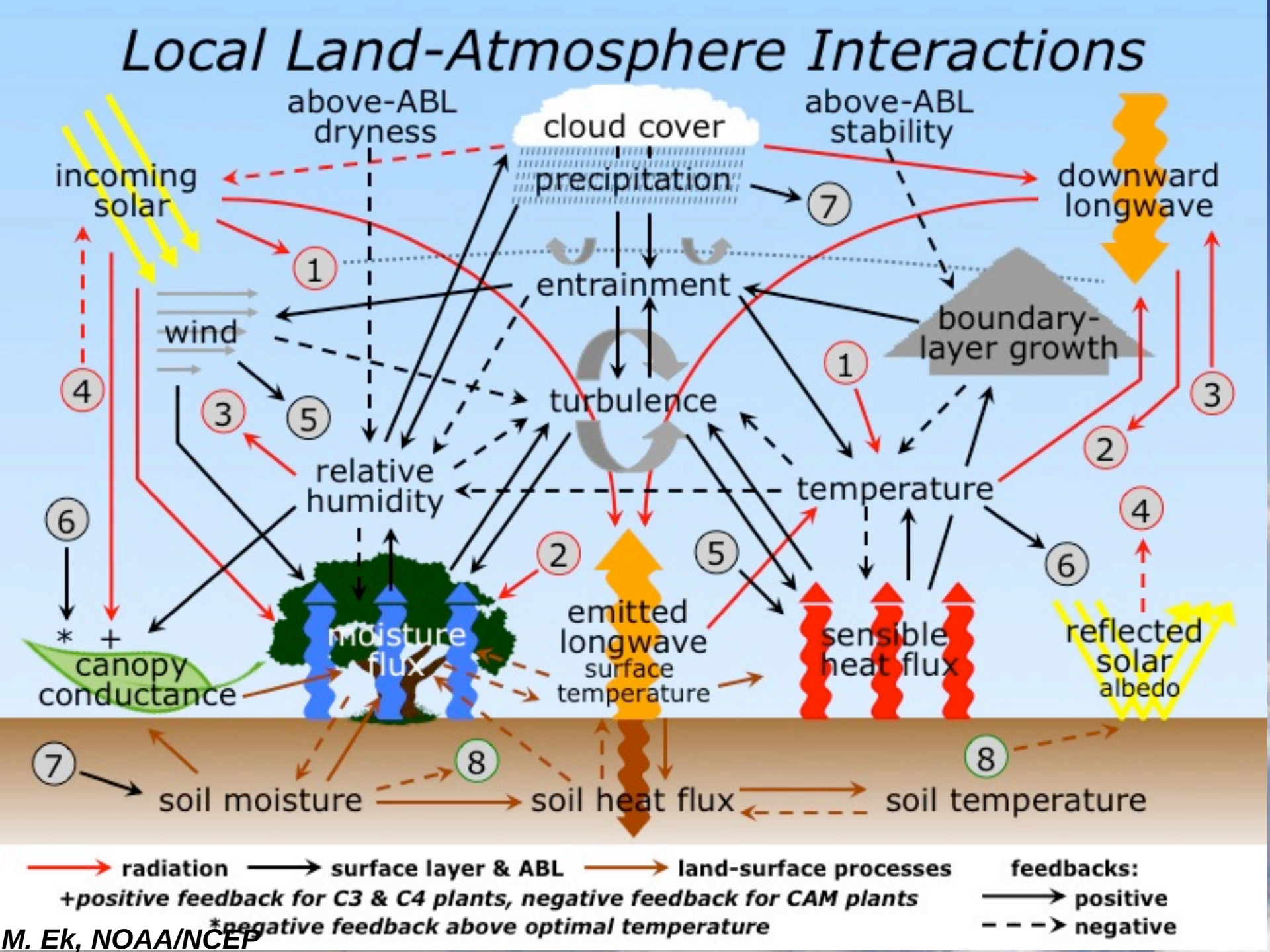
Suomi NPP Land Product Status Overview

Ivan Csiszar
NOAA JPSS Land Domain Lead
Land Product Leads and Team Members

Outline

- Overview
  - Products, Requirements, Team Members, Users, Accomplishments
- SNPP Algorithms Evaluation:
  - Algorithm Description, Validation Approach and Datasets, Performance *vs.* Requirements, Risks/Issues/Challenges, Quality Monitoring, Recommendations
- Future Plans
  - Plan for JPSS-1 Algorithm Updates and Validation Strategies, Schedule and Milestones
- Summary


Local Land-Atmosphere Interactions
above-ABL dryness
cloud cover
above-ABL stability
incoming solar
precipitation
downward longwave
entrainment
wind
boundary-layer growth
turbulence
relative humidity
temperature
canopy conductance
moisture flux
emitted longwave
surface temperature
sensible heat flux
reflected solar
albedo
soil moisture
soil heat flux
soil temperature
radiation
surface layer & ABL
land-surface processes
feedbacks:
positive
negative
+positive feedback for C3 & C4 plants, negative feedback for CAM plants
*negative feedback above optimal temperature
M. Ek, NOAA/NCEP

NOAA JPSS SNPP VIIRS Land Products and Team Principals

Role or Product Focus	Name (+ et al.)	Affiliation
NOAA Product Team Lead, **Fire**	*Ivan Csiszar* / Wilfrid Schroeder	NOAA / UMD
NASA Coordination, Validation co-lead	Miguel Román, Chris Justice	NASA / UMD
Surface Reflectance, VCM, calibration	*Eric Vermote*	NASA
Surface Reflectance	Alex Lyapustin	NASA
Vegetation Index	*Marco Vargas*	NOAA
Vegetation Index	Tomoaki Miura/ Alfredo Huete	Univ. of Hawaii / Arizona
Albedo	*Yunyue (Bob) Yu* / Shunlin Liang	NOAA / UMD
Albedo	Crystal Schaaf	Univ. Mass.
Land Surface Temperature	*Bob Yu*	NOAA
NOAA CDR coordination, LST	Jeff Privette / Pierre Guillevic	NOAA / NASA JPL
Surface Type	*Jerry Zhan*	NOAA
Surface Type	Mark Friedl	Boston Univ.
STAR AIT Land	Walter Wolf, Youhua Tang	NOAA
NASA LandPEATE, **gridding/granulation**	Robert Wolfe, Sadashiva Devadiga	NASA
Northrop Grumman	Alain Sei, Justin Ip	NGAS
Raytheon	Daniel Cumpton	Raytheon
JPSS Algorithm Manager	Leslie Belsma	Aerospace

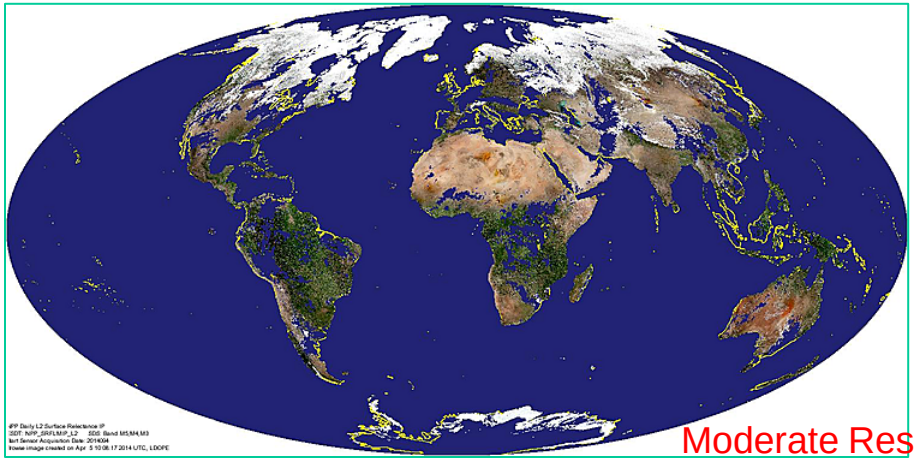
SNPP VIIRS SR Provisional Maturity

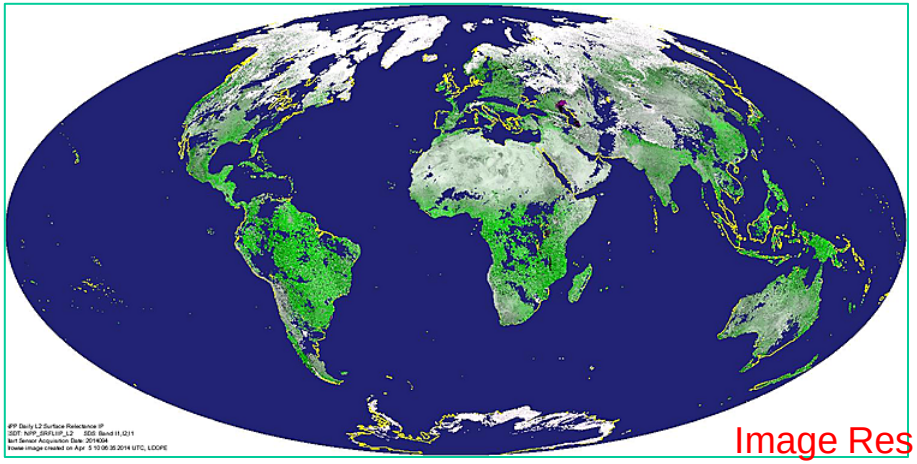
- This CCR declared that SNPP VIIRS Surface Reflectance Intermediate Product (VIIRS-Surf-Refl-IP) be upgraded to provisional maturity level with implementation of 474-CCR-13-1078 containing DRs 4488, 7141 and 7142 at IDPS.
- Algorithm build version Mx8.3 implemented 474-CCR-13-1078 and was put in operation at IDPS on March 18, 2014.
- Analysis of SR-IP from IDPS operation confirms successful implementation of the DRs with no negative impact on any downstream EDRs.

E. Vermote, S. Devadiga, NASA GSFC

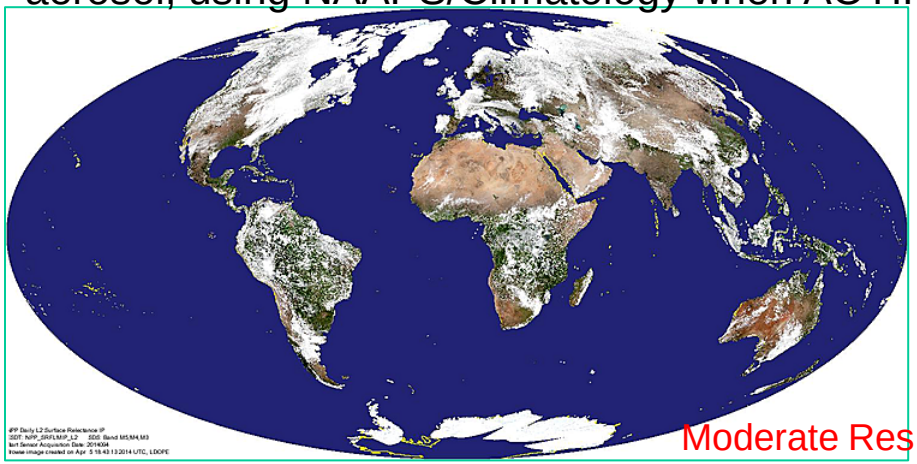
Surface Reflectance IP from Day 2014094

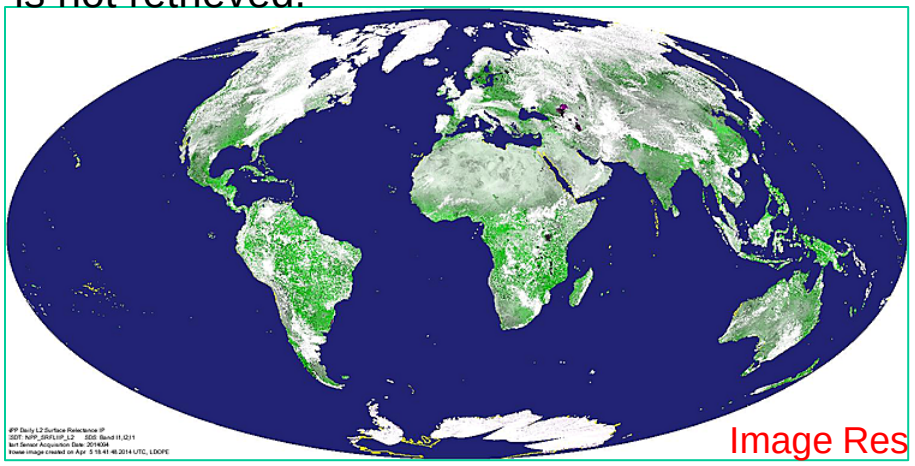
Retrieved under all atmospheric conditions for all non-ocean (not sea-water) pixels except for night pixels and where input L1B is invalid





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

VI EDR Product Requirements

Table 5.5.9 - Vegetation Indices (VIIRS)		
EDR Attribute	**Threshold**	**Objective**
Vegetation Indices Applicable Conditions		$NDVI = (\rho_{I2}^{TOA} - \rho_{I1}^{TOA}) / (\rho_{I2}^{TOA} + \rho_{I1}^{TOA})$
1. Clear, land (not ocean),day time only		
a. Horizontal Cell Size	0.4 km	0.25 km
b. Mapping Uncertainty, 3 Sigma	4 km	1 km
c. Measurement Range		
1. NDVITOA	-1 to +1	NS
2. EVI (1)	-1 to +1	NS
3. NDVITOC	-1 to +1	NS
d. Measurement Accuracy - $NDVI_{TOA}$ (2)	0.05 NDVI units	0.03 NDVI units
e. Measurement Precision - $NDVI_{TOA}$ (2)	0.04 NDVI units	0.02 NDVI units
f. Measurement Accuracy - EVI (2)	0.05 EVI units	NS
g. Measurement Precision - EVI (2)	0.04 EVI units	NS
h. Measurement Accuracy - $NDVI_{TOC}$ (2)	0.05 NDVI units	NS
i. Measurement Precision - $NDVI_{TOC}$ (2)	0.04 NDVI units	NS
j. Refresh	At least 90% coverage of the globe every 24 hours (monthly average)	24 hrs.

$$EVI = (1+L) \cdot \frac{\rho_{I2}^{TOC} - \rho_{I1}^{TOC}}{\rho_{I2}^{TOC} + C_1 \cdot \rho_{I1}^{TOC} - C_2 \cdot \rho_{M3}^{TOC} + L}$$

Notes:

1. EVI can produce faulty values over snow, ice, and residual clouds (EVI > 1).
2. Accuracy and precision performance will be verified and validated for an aggregated 4 km horizontal cell to provide for adequate comparability of performance across the scan.

Source: Level 1 Requirements Supplement – Final Version:2.9 June 27, 2013

VIIRS Vegetation Index EDR

- **VI Product**: TOA-NDVI and TOC- EVI

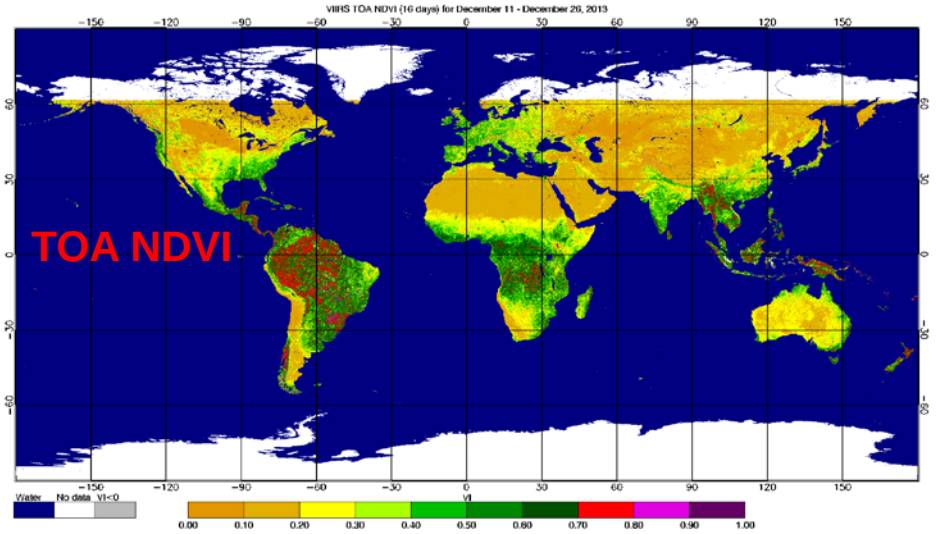
- **Maturity Status**: Provisional

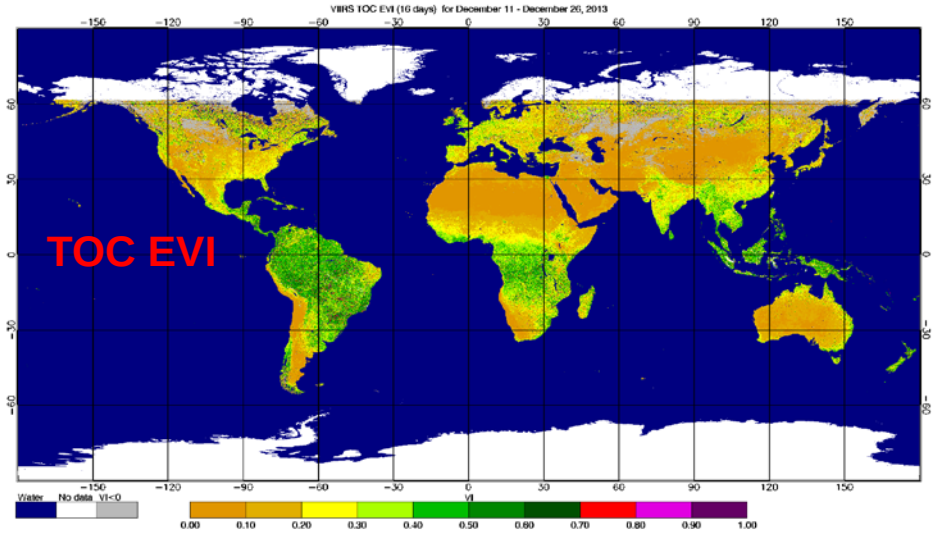
- **Validation 1 maturity :** scheduled for Summer 2014

- **Product Improvements**: Additional Quality Flags, VIIRS VI EVI Backup Algorithm

- **J1**: Add top-of-canopy NDVI

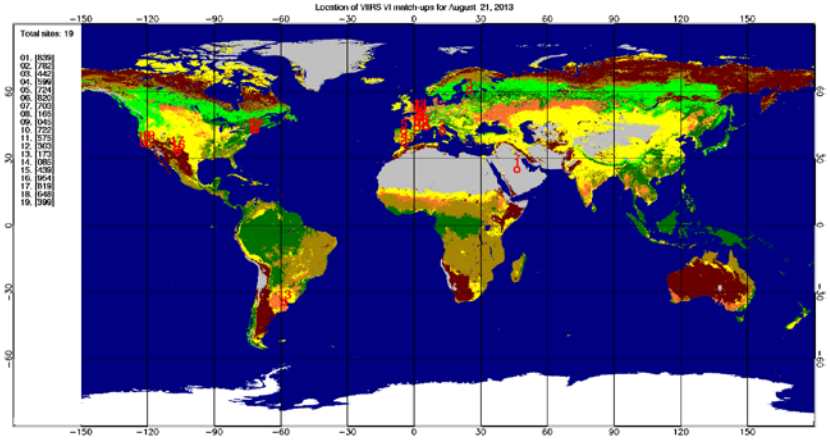
M. Vargas, NOAA/STAR

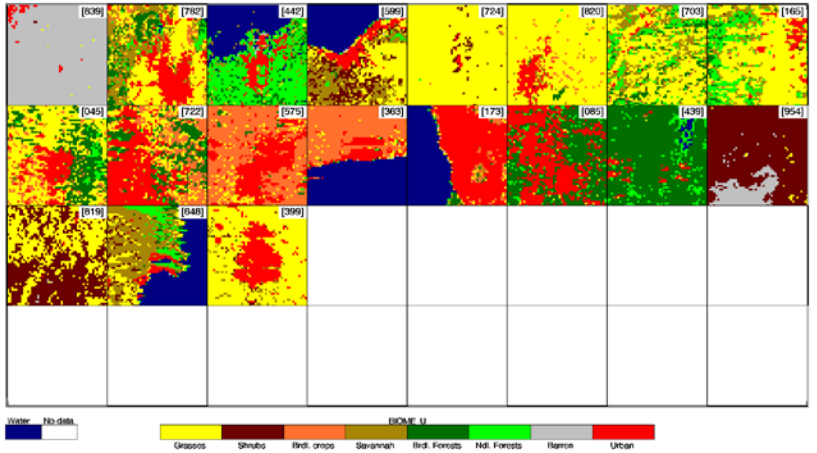




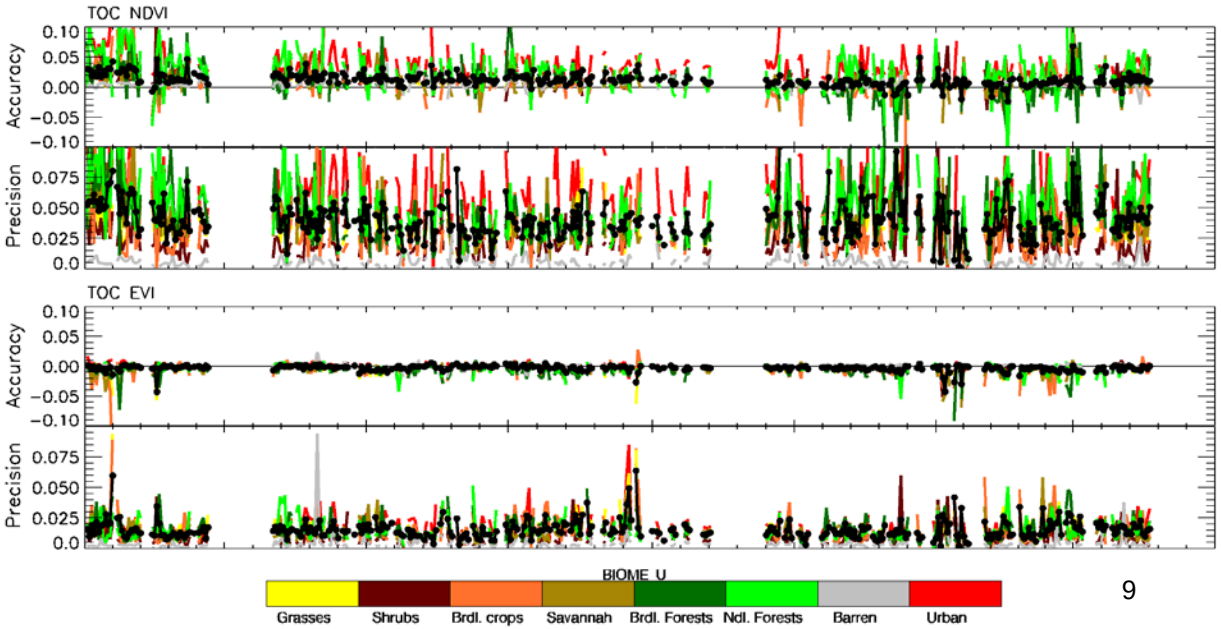
VI EDR Validation Using Aeronet Based SR

www.star.nesdis.noaa.gov/smcd/viirs_vi/Validation.htm





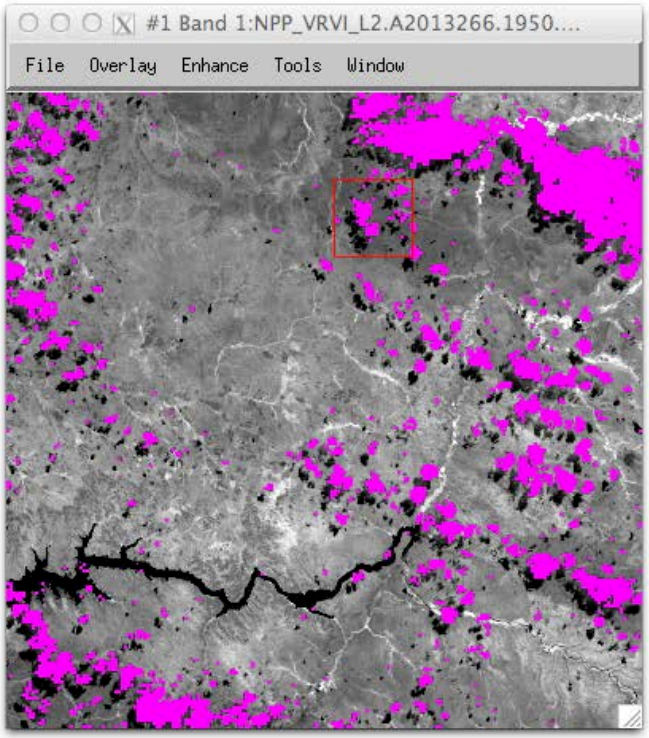
Sample of global daily distribution of match-up sites (August 21, 2013) covering different surface types and including urban areas. Global Land cover is derived from Combined Terra & Aqua MODIS LA/FPAR LC product (MCD12C1, ver. 5.1).

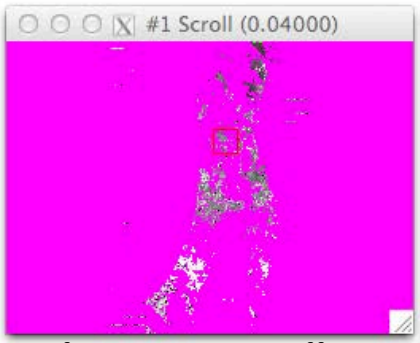


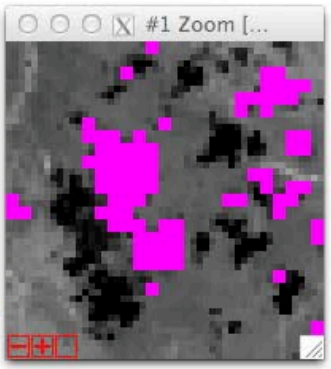
M. Vargas, NOAA/STAR

Additional QF3 Bit 7: Cloud Shadows

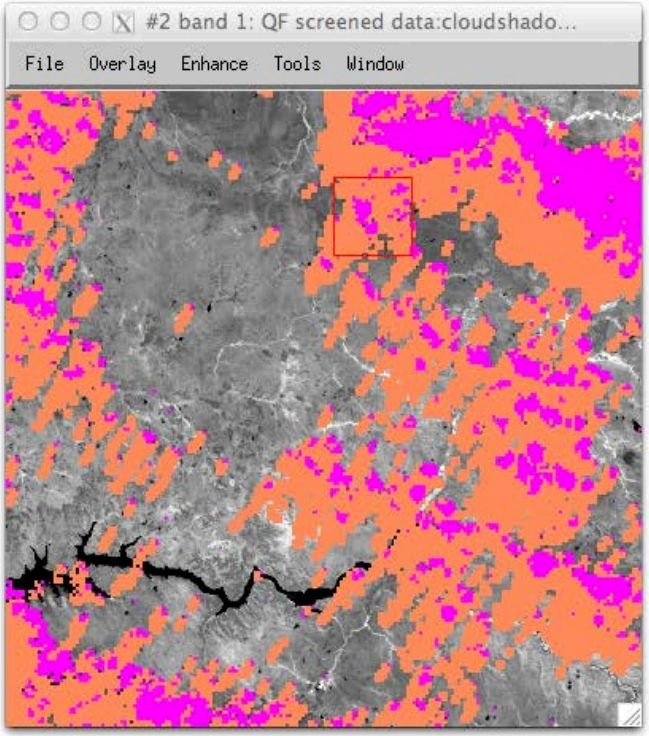
TOA NDVI:
Screened for "Confident Cloudy" & "AOT > 1.0"

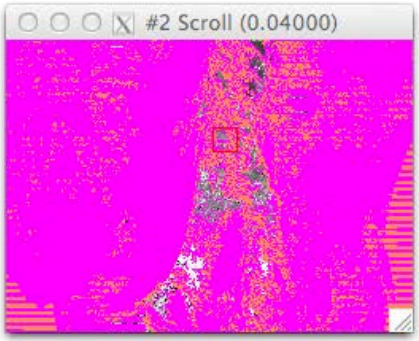


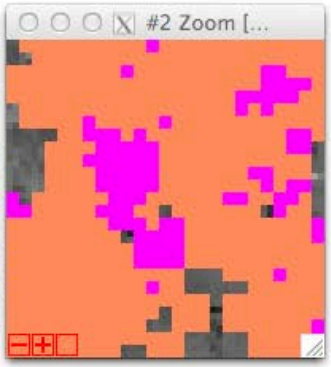




TOA NDVI:
Screened for "Cloud Shadows"







"Cloud shadow" QF can be used to screen shadow-affected pixels which produce faulty low NDVI or EVI values.

T. Miura, U. Hawaii

Green Vegetation on Our Planet

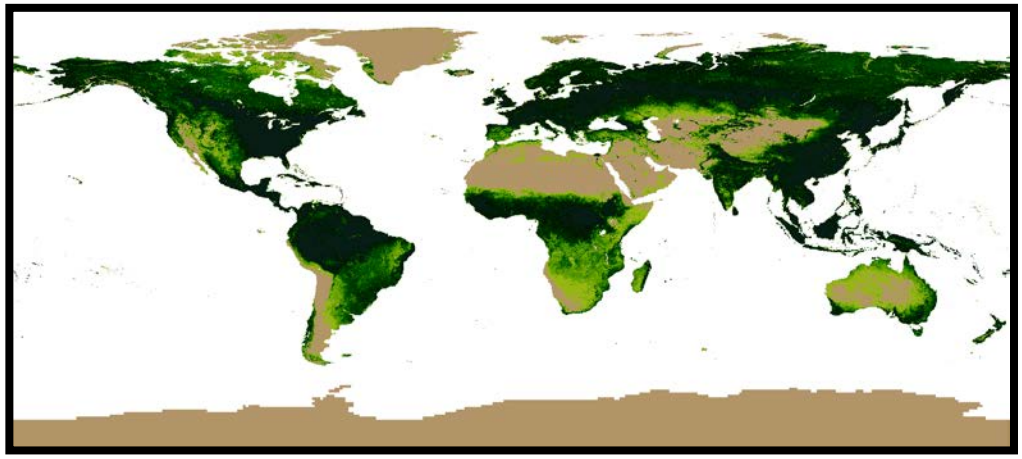
http://www.nnvl.noaa.gov/green.php

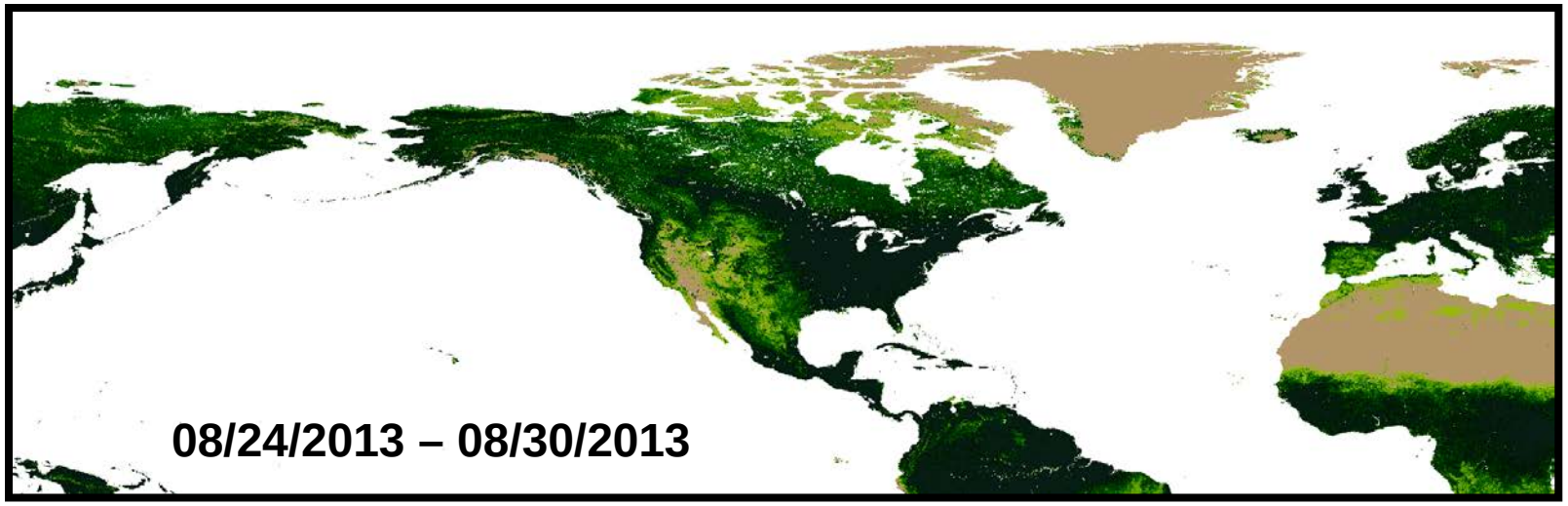
April 2012 – April 2013
500 m grid; NDVI weekly composite / gap filled

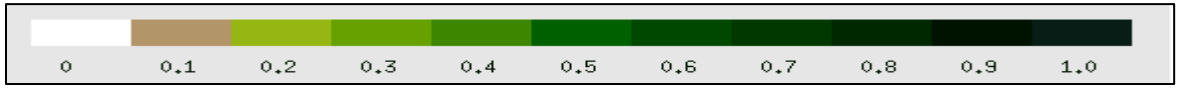
F. Kogan, NOAA/STAR
D. Pisut, NOAA Visualization Laboratory

NDE Green Vegetation Fraction

- GVF products: global (4km res) and regional (1km res)
- Global GVF product in NetCDF4 format will be archived at CLASS
- GVF transition to operations in Summer 2014

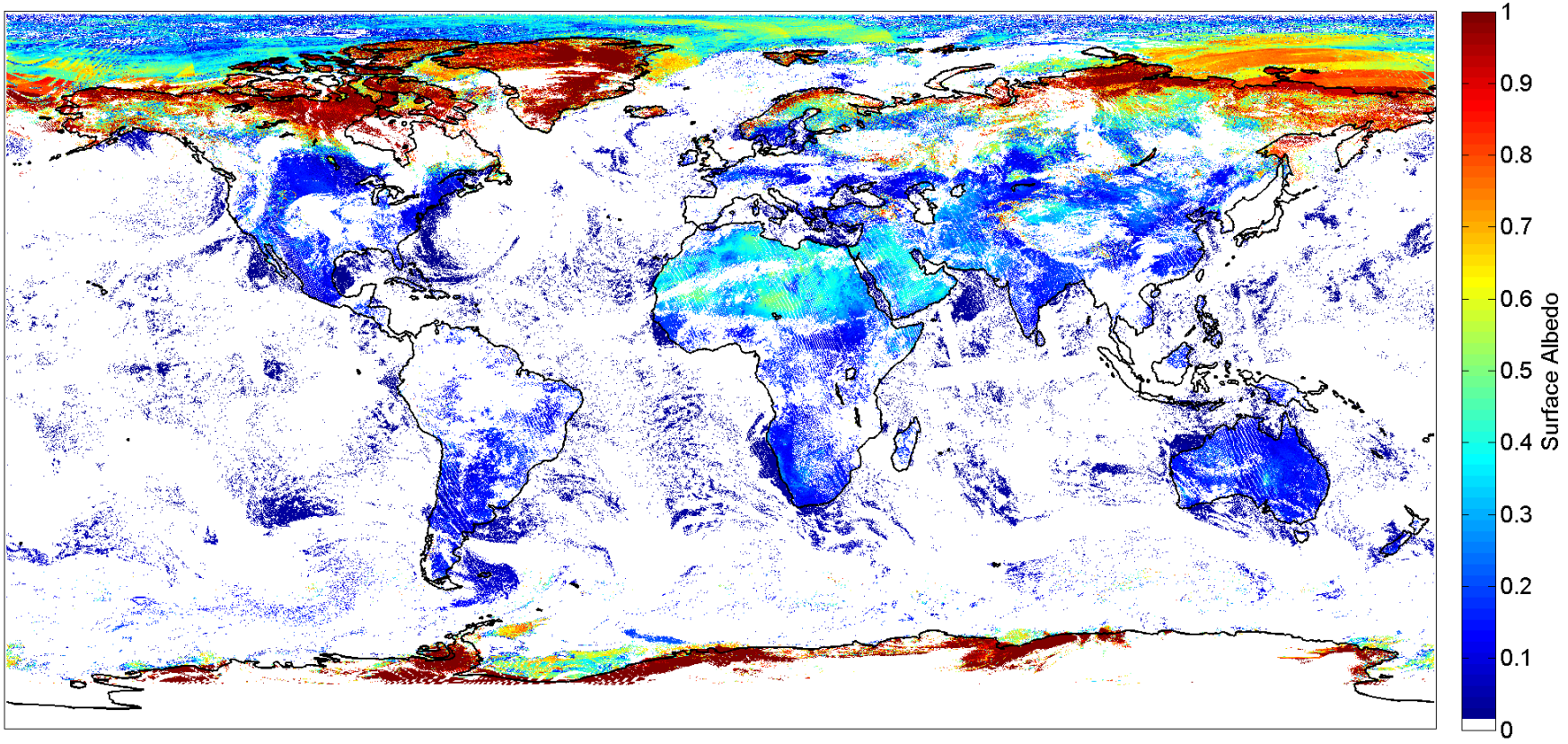






M. Vargas
NOAA/STAR

Example of VIIRS surface albedo EDR

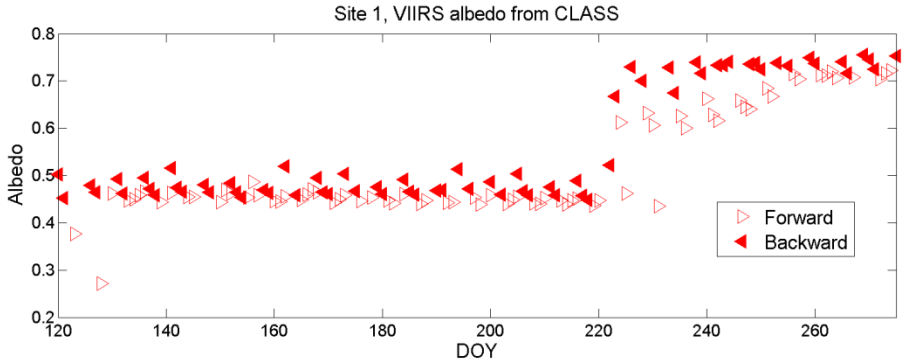


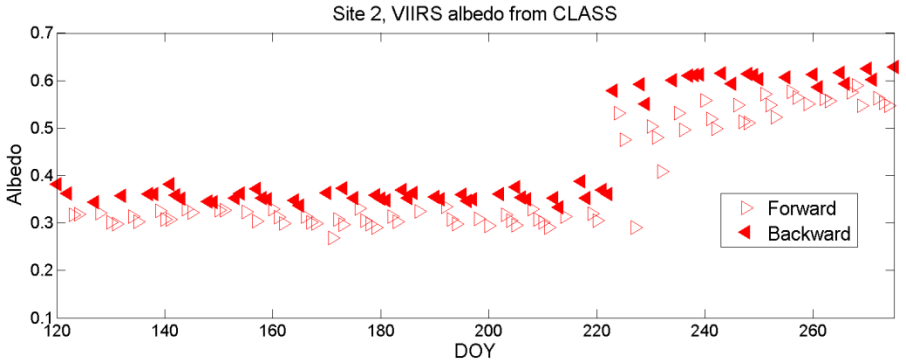
Map of VIIRS instantaneous albedo product acquired on April 3 2012

B. Yu, NOAA/STAR

Evaluation of LSA temporal variability

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.

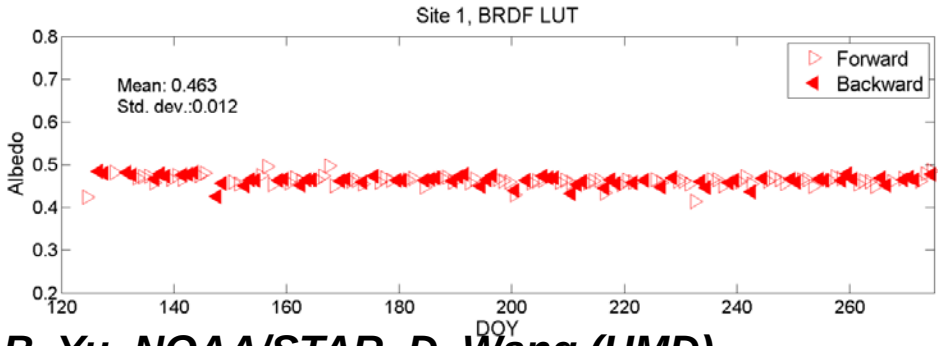


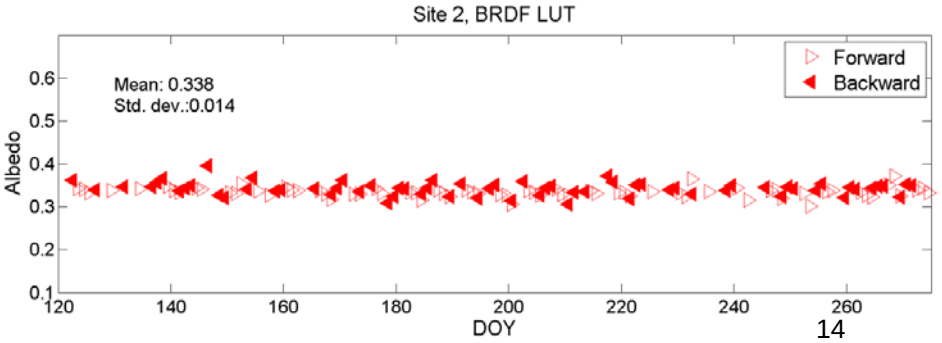


"Forward" means pixels with relative azimuth angle >90° and "backword" means those with relative azimuth angle <90°. Jumps around 8/9 were caused by the bugs in a early version of the operational codes.

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.





B. Yu, NOAA/STAR, D. Wang (UMD)

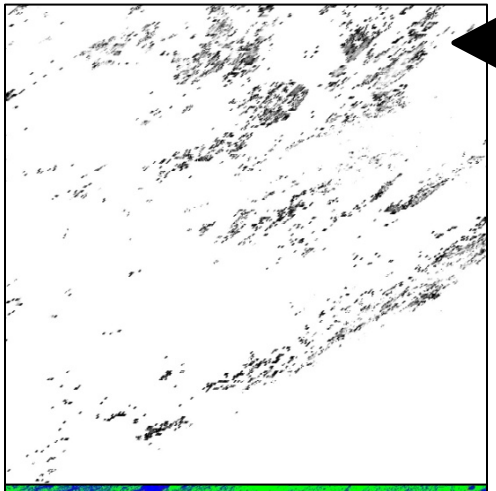
Summary of LSA validation: 2013

Summary of validation results at seven SURFRAD sites. Three satellite albedo data (VIIRS LSA from the Lambertian LUT, VIIRS LSA from the BRDF LUT and MODIS albedo) are validated against field measurements.

Site	VIIRS (BRDF LUT)			VIIRS (beta release)			MODIS		
	R^2	RMSE	Bias	R^2	RMSE	Bias	R^2	RMSE	Bias
Fort Peck	0.97	0.042	-0.006	0.94	0.063	0.001	0.99	0.064	-0.038
Goodwin Creek	0.02	0.037	-0.031	0.03	0.086	-0.010	0.02	0.048	-0.046
Desert Rock	0.06	0.038	0.029	0.07	0.101	0.048	0.29	0.013	-0.010
Penn State	0.98	0.081	-0.066	0.92	0.097	-0.069	0.28	0.066	-0.062
Sioux Falls	0.86	0.114	0.048	0.82	0.142	0.057	0.91	0.062	-0.007
Boulder	0.97	0.050	0.020	0.89	0.087	0.029	0.27	0.134	-0.037
Overall	**0.88**	**0.061**	**0.010**	**0.77**	**0.099**	**0.024**	**0.82**	**0.068**	**-0.026**

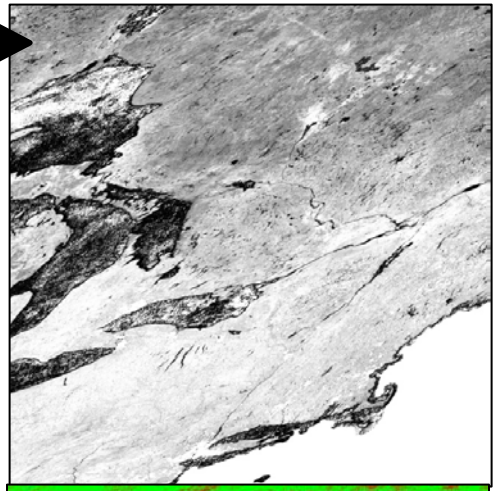
B. Yu, NOAA/STAR, D. Wang (UMD)

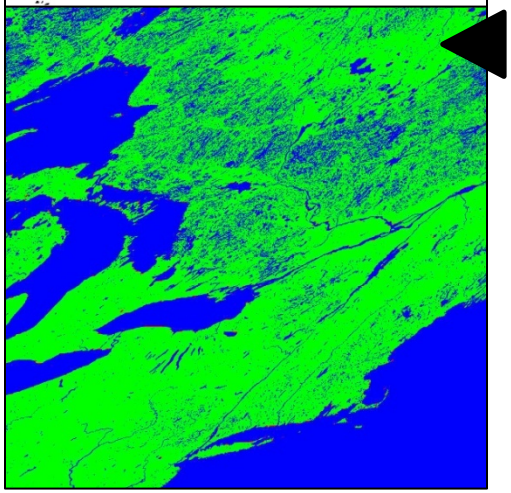
Evaluation of the VIIRS Dark Pixel Surface Albedo EDR (New England 2013183)



VIIRS DPSA White color is fill value. Valid retrievals are nearly all from history, and most of the historical data are fill values.

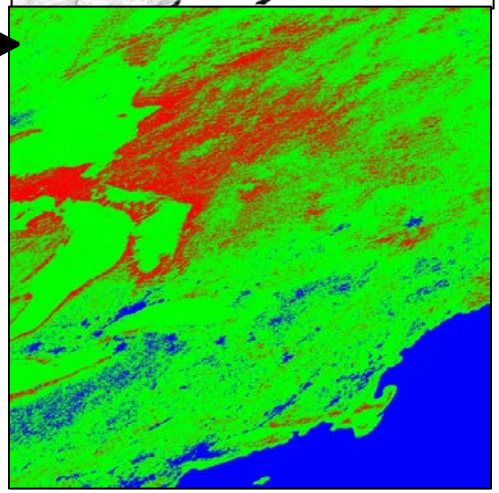
MODIS Aqua-only Black-Sky Albedo.





VIIRS DPSA QA. Red (missing) = full inversion, green = 'historical' data and blue = no-data values.

MODIS Aqua only QA. Red = full inversion, green = magnitude inversion and blue = no-data value.



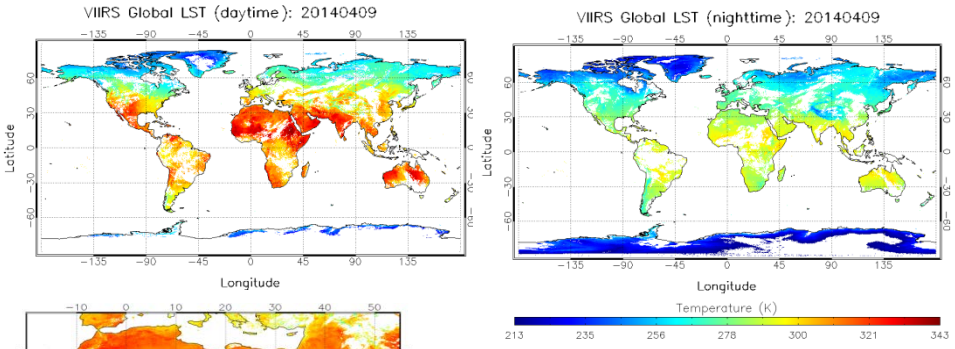
-- VIIRS DPSA albedo is uses the daily gridded surface reflectance IP as input and only few observations meet the reflectance overall quality for albedo retrieval.

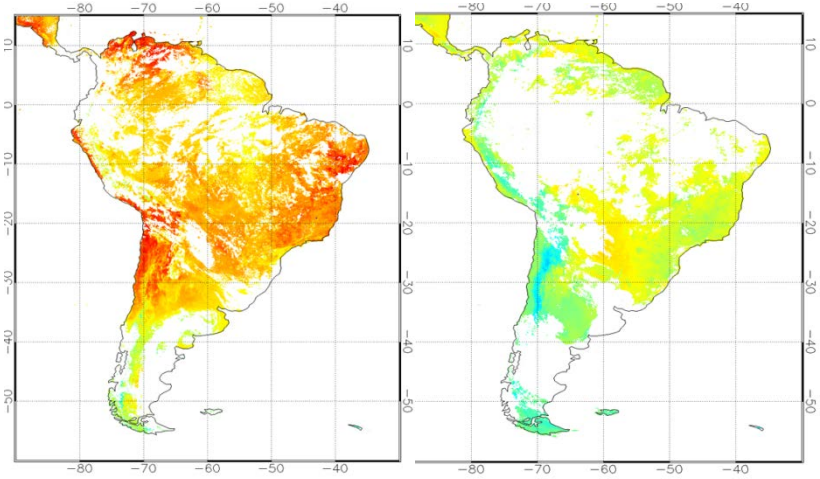
-- Current criteria for DPSA full inversion are limited. A crucial parameter, the WODs (weights of determination), which describes the angular sampling status of the input reflectances, are not even considered.

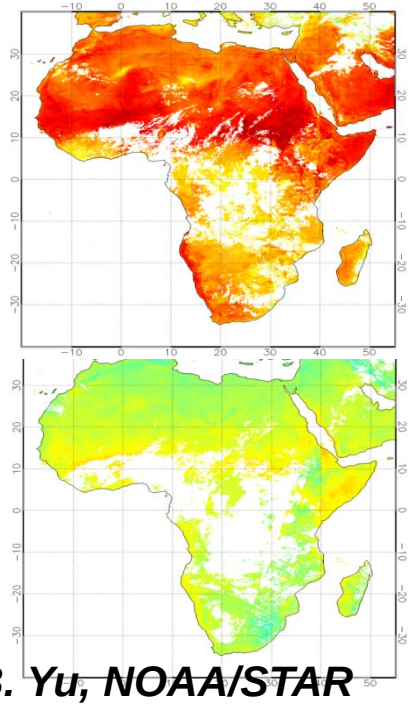
Zhuosen Wang, Yan Liu, and Crystal Schaaf (UMASS Boston)

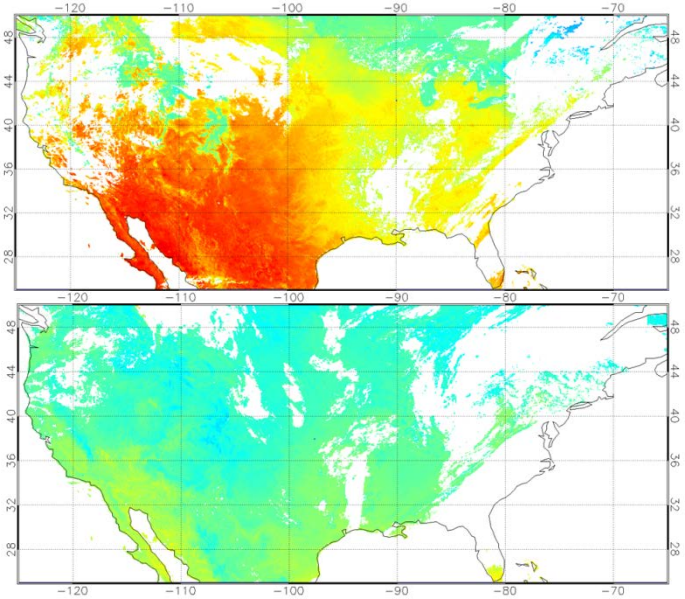
Land Surface Temperature

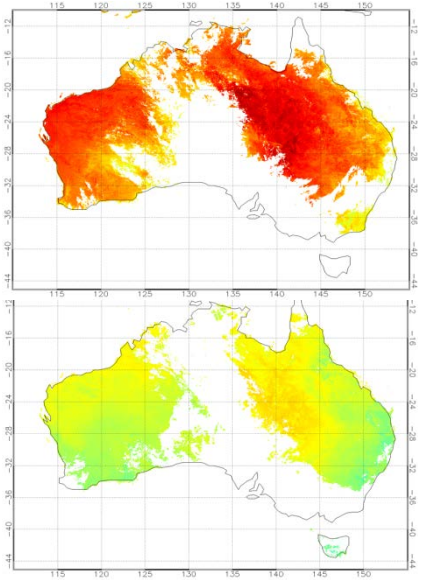
Provisional LST installed on IDPS





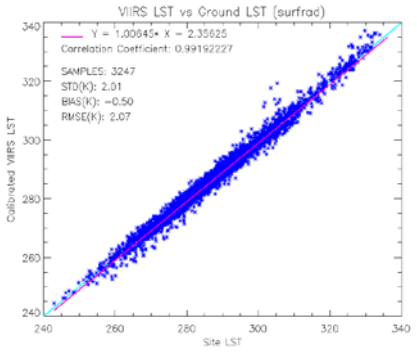


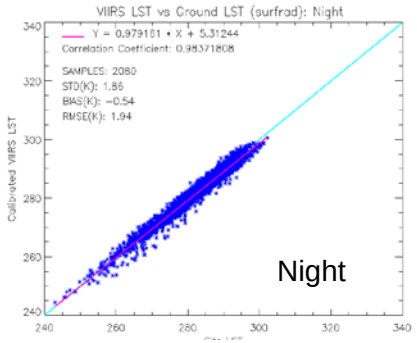


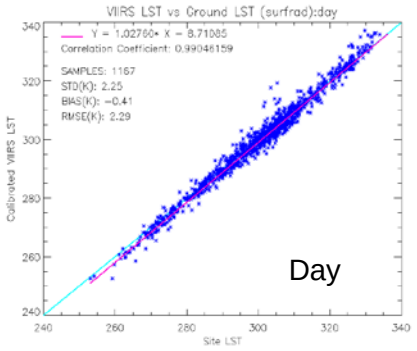


B. Yu, NOAA/STAR

LST Validation







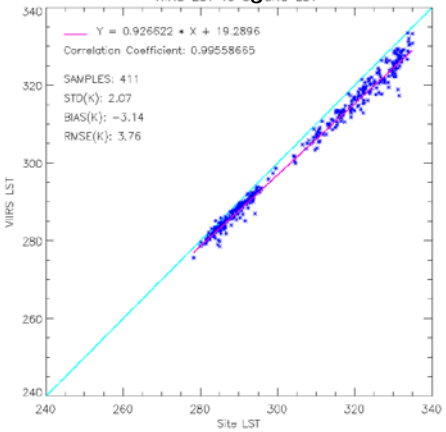
Evaluation against ground data

Surface type	Day/ Night	data num	Provisional		Beta	
			Bias	STD	Bias	STD
Deciduous Broadleaf Forest	day	4	-0.67	0.80	0.31	3.10
	night	11	-0.13	1.60	-0.13	1.60
Closed Shrub lands	day	37	-0.81	1.77	-1.16	1.77
	night	57	-1.37	0.80	-2.48	0.63
Open Shrub lands	day	277	-0.1	1.90	0.67	1.90
	night	327	-0.88	0.79	-2.38	0.79
Woody Savannas	day	46	-1.09	2.39	-0.34	2.81
	night	81	1.38	1.35	1.38	1.35
Grasslands	day	172	-0.38	1.90	1.11	2.36
	night	500	-0.35	1.41	-0.35	1.41
Croplands	day	266	0.14	2.95	2.39	3.54
	night	558	-0.21	1.58	-0.21	1.58
Cropland/Natural Veg Mosaics	day	208	-0.83	1.98	0.13	2.15
	night	459	0.47	1.94	0.47	1.94
Snow/ice	day	97	-1.16	1.67	-1.95	1.70
	night					
Barren	day	60	0.72	1.68	0.12	2.10
	night	87	-1.17	0.88	-2.67	0.88

SURFRAD LST over 6 sites covering the time period from Feb. 2012 to December 2013

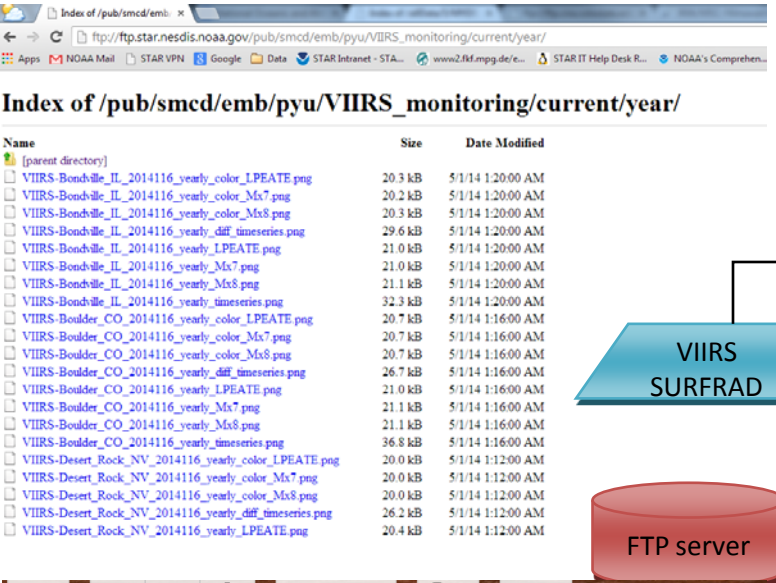
A ground dataset at Gobabeb in Namibia covering the time period of 2012.

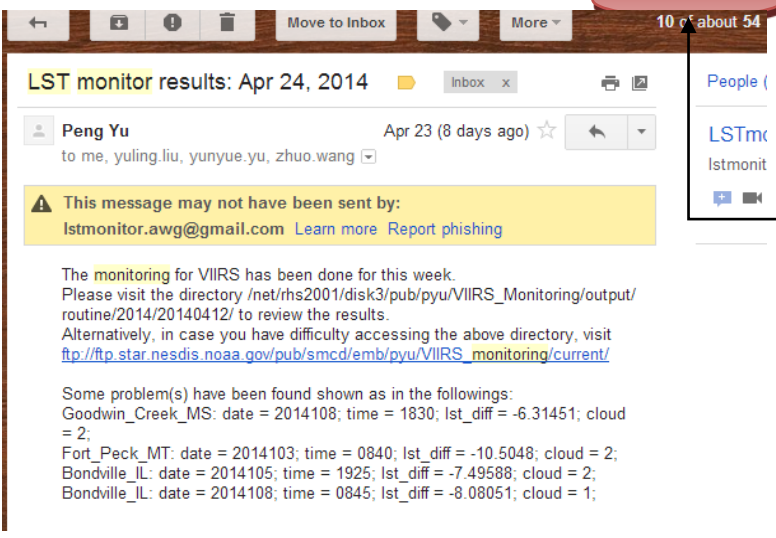
*The data is provided by Frank Goettsche, thanks Pierre for sharing the data.

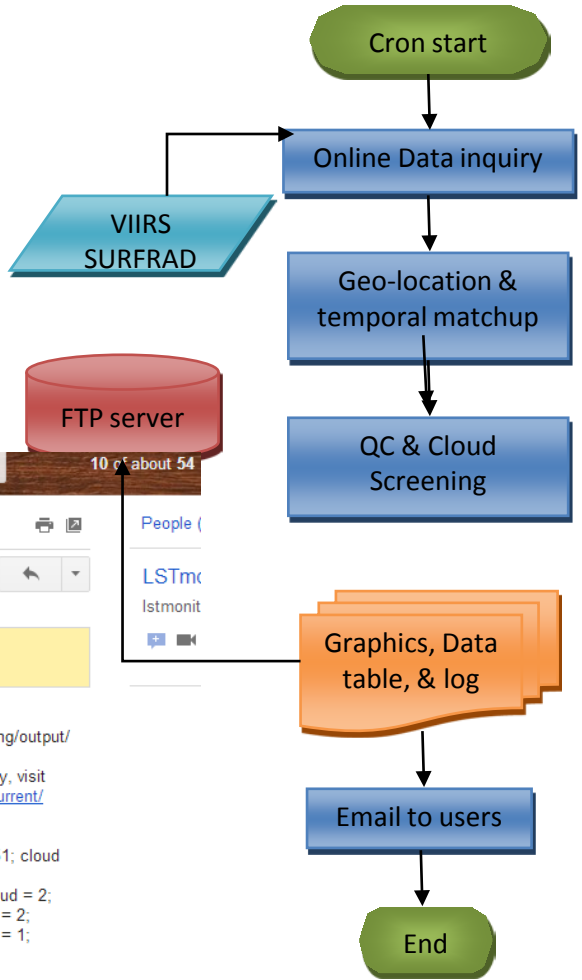


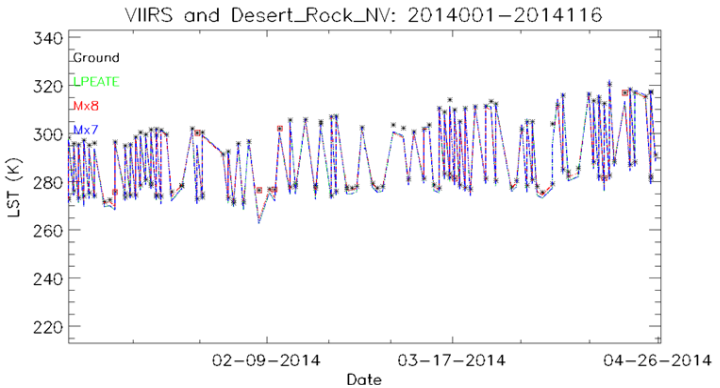
LST Monitoring

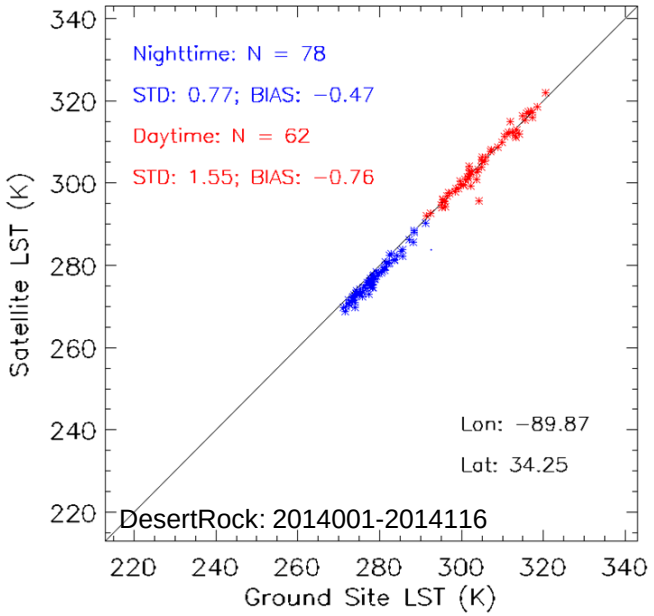
A monitoring tool developed



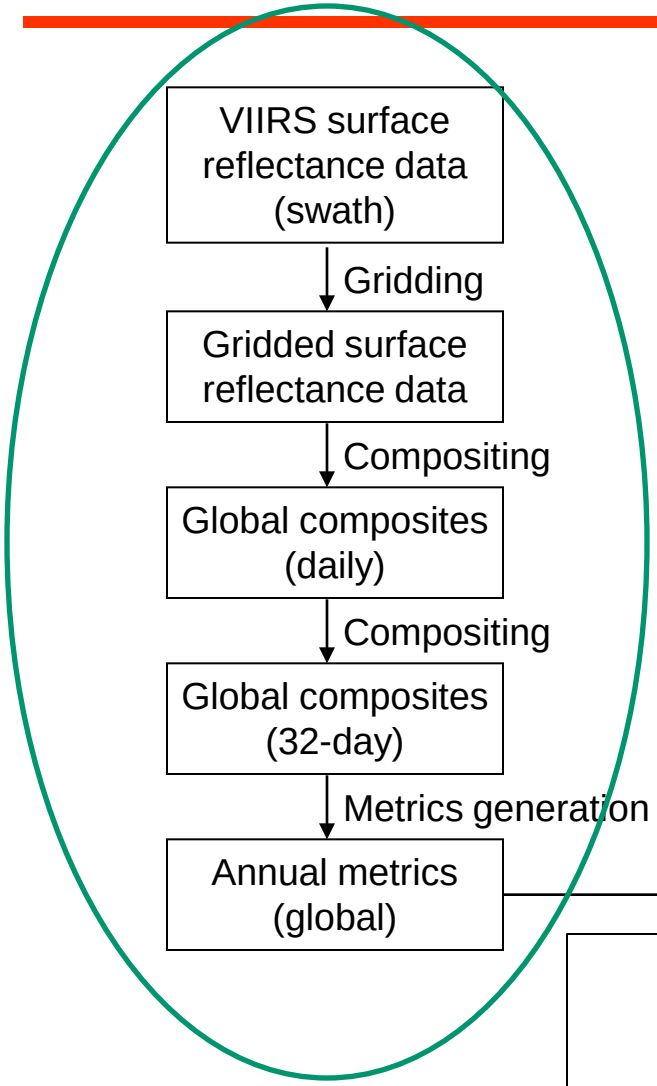


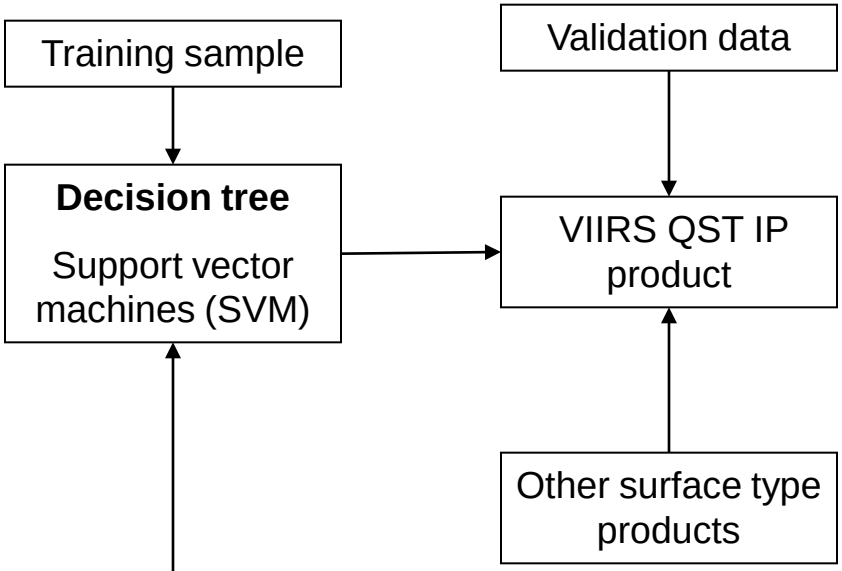






VIIRS Quarterly Surface Type IP Generation





All 2012 VIIRS data required by QST IP processed at UMD:

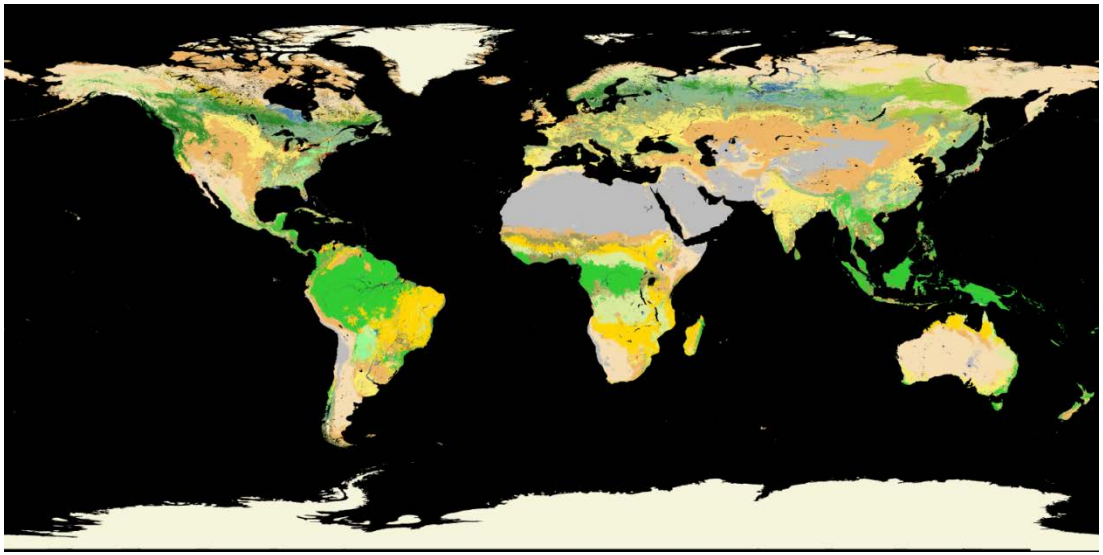
~880,000 files (80,000 granules x 11 bands), totaling ~150 TB

> 30,000 CPU hours

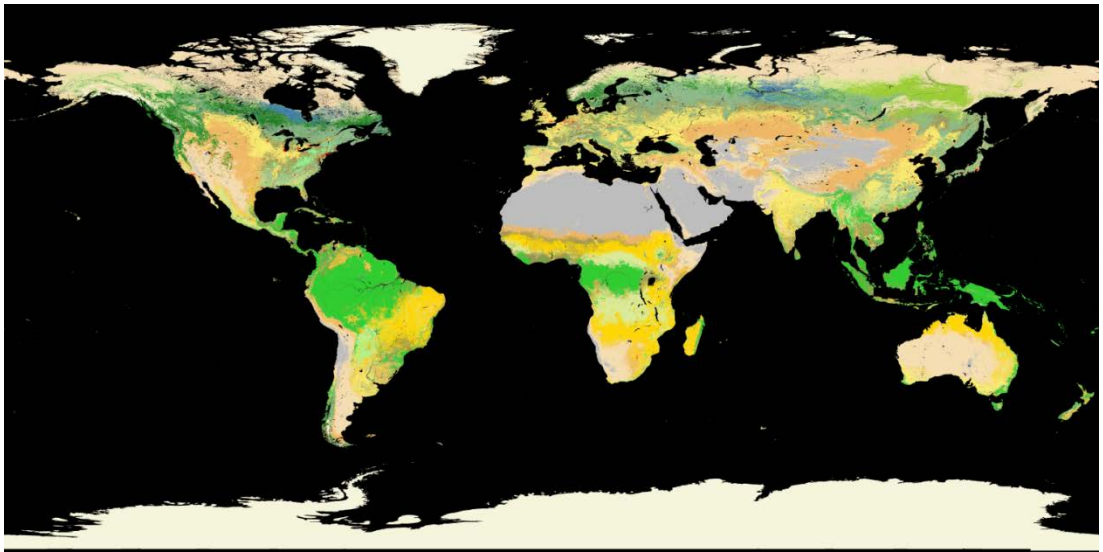
J. Zhan (STAR), C. Huang (UMD)

Similar Patterns between VIIRS QST IP and MODIS Seed

MODIS Seed



VIIRS QST IP

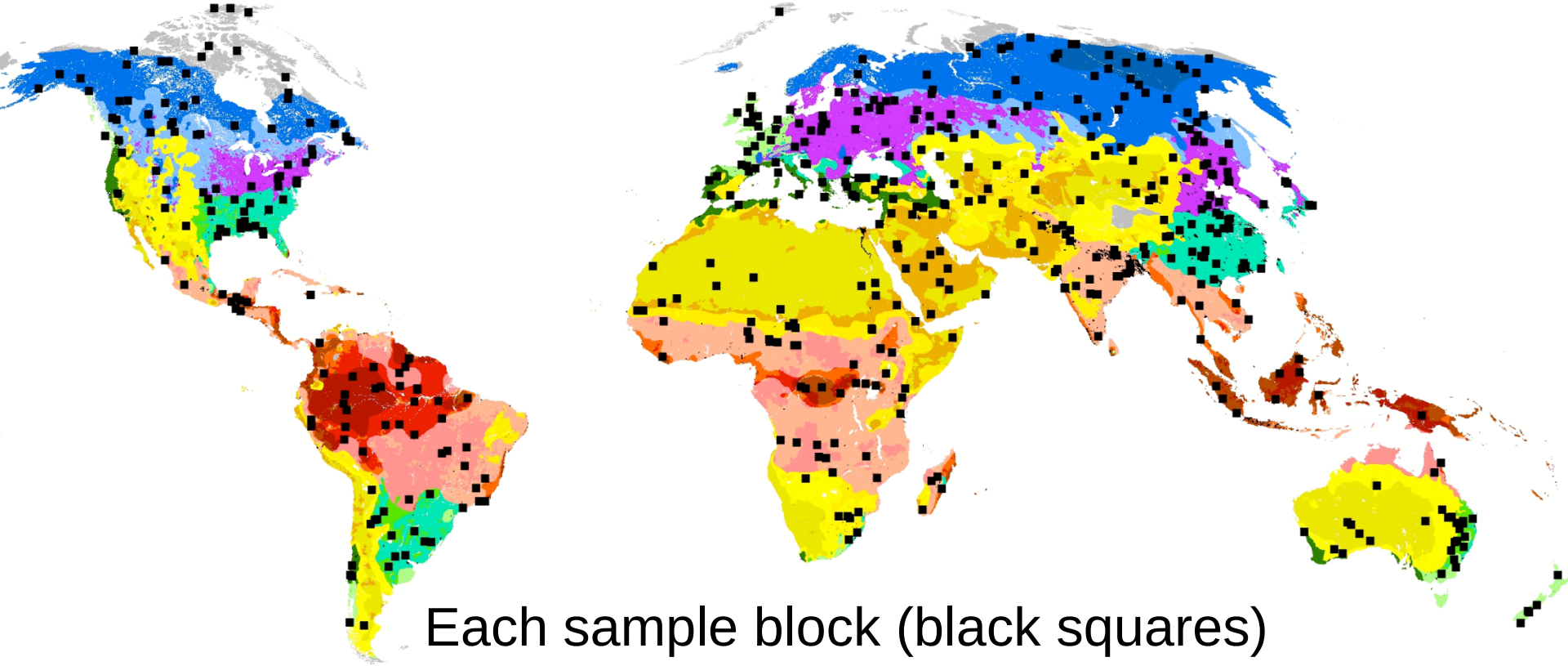


IGBP Legend

- Water Bodies
- Evergreen Needleleaf Forests
- Evergreen Broadleaf Forests
- Deciduous Needleleaf Forests
- Deciduous Broadleaf Forests
- Mixed Forests
- Closed Shrublands
- Open Shrublands
- Woody Savannas
- Savannas
- Grasslands
- Permanent Wetlands
- Croplands
- Urban and Built-up Lands
- Cropland/Natural Vegetation Mosaics
- Snow and Ice
- Barren

J. Zhan (STAR)
C. Huang (UMD)

QST Validation Sample Design

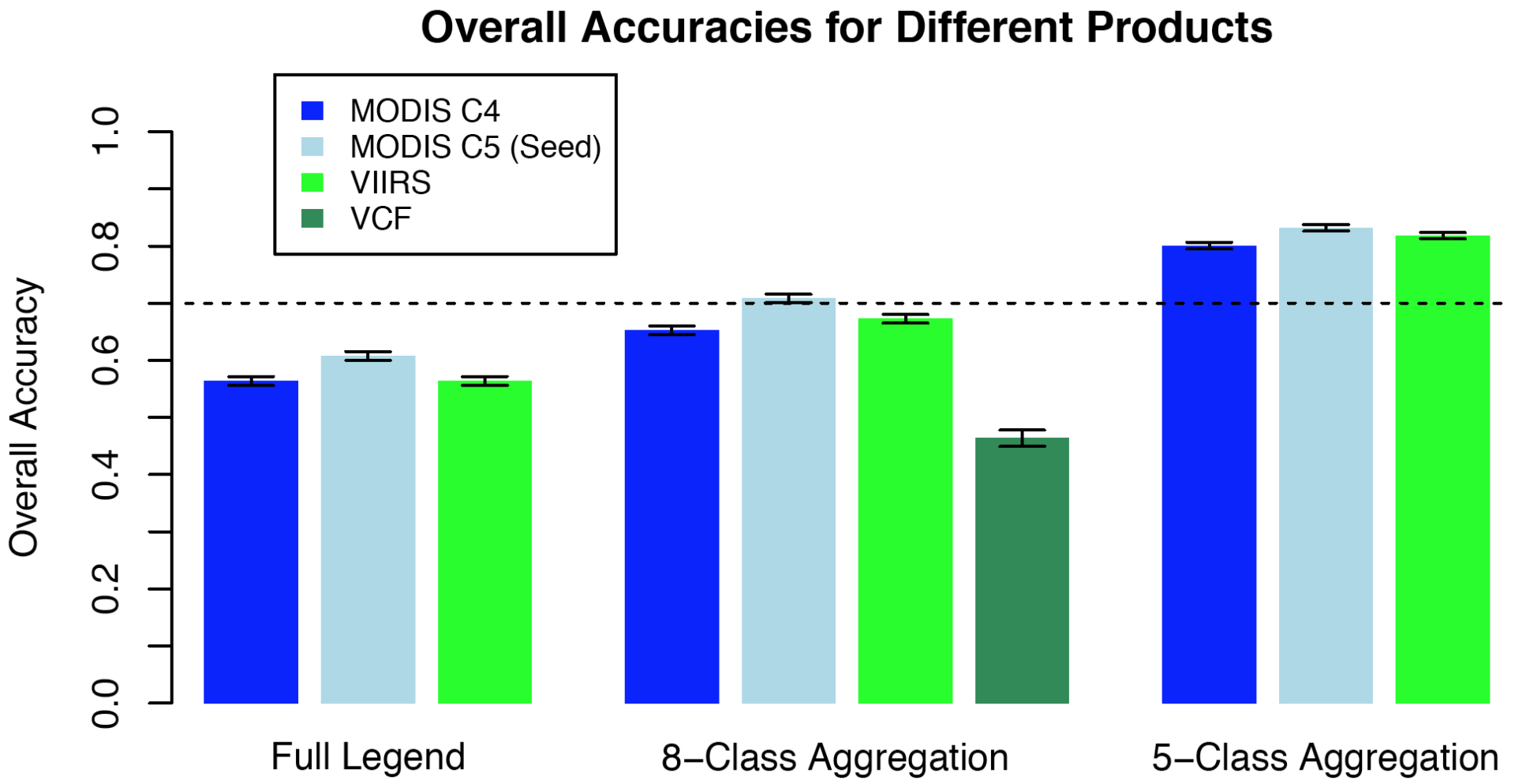


Each sample block (black squares) contains between 10 and 35 1-km VIIRS pixels.

- Tropical Rainforest
- Tropical Seasonal Forest
- Tropical Savannah
- Desert
- Steppe
- Mediterranean
- Temperate Evergreen Forest
- Marine West-coast
- Continental Forest
- Boreal Forest
- Tundra
- Snow and Ice
- Cold Boreal Forest
- pTropical Rainforest
- pTropical Seasonal Forest
- pTropical Savannah
- pDesert
- pSteppe
- pTemperate Evergreen Forest
- pContinental Forest
- Urban

Damien Sulla---Menashe, Mark Friedl, BU

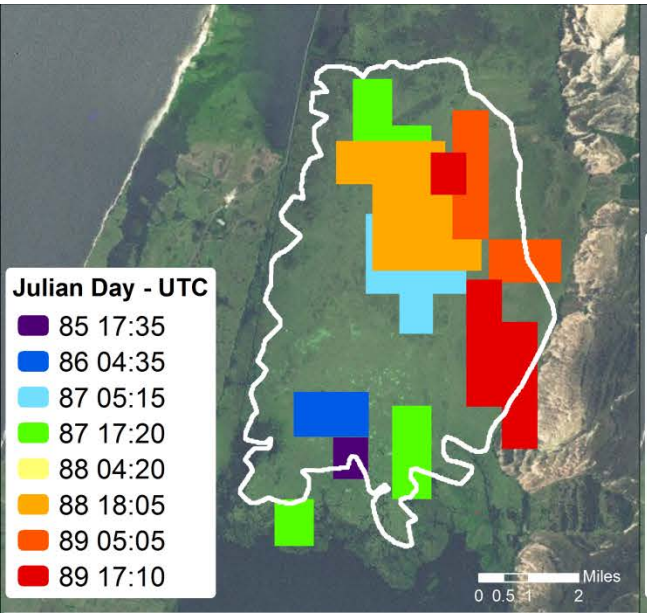
QST Algorithm Evaluation



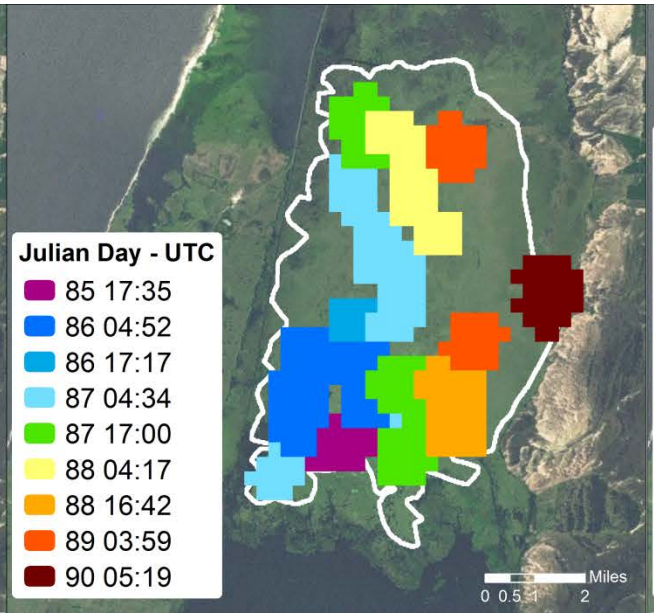
VIIRS QST overall accuracies are similar to MODIS C4 and C5 (Seed)

Development of Spatially Refined Satellite Fire Products Enabling Improved Fire Mapping

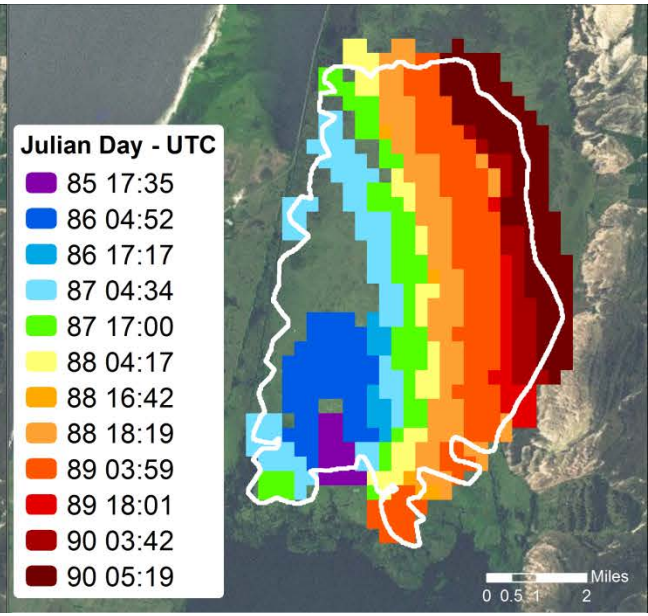
Grass fire in Southern Brazil, 26-31 March 2013



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



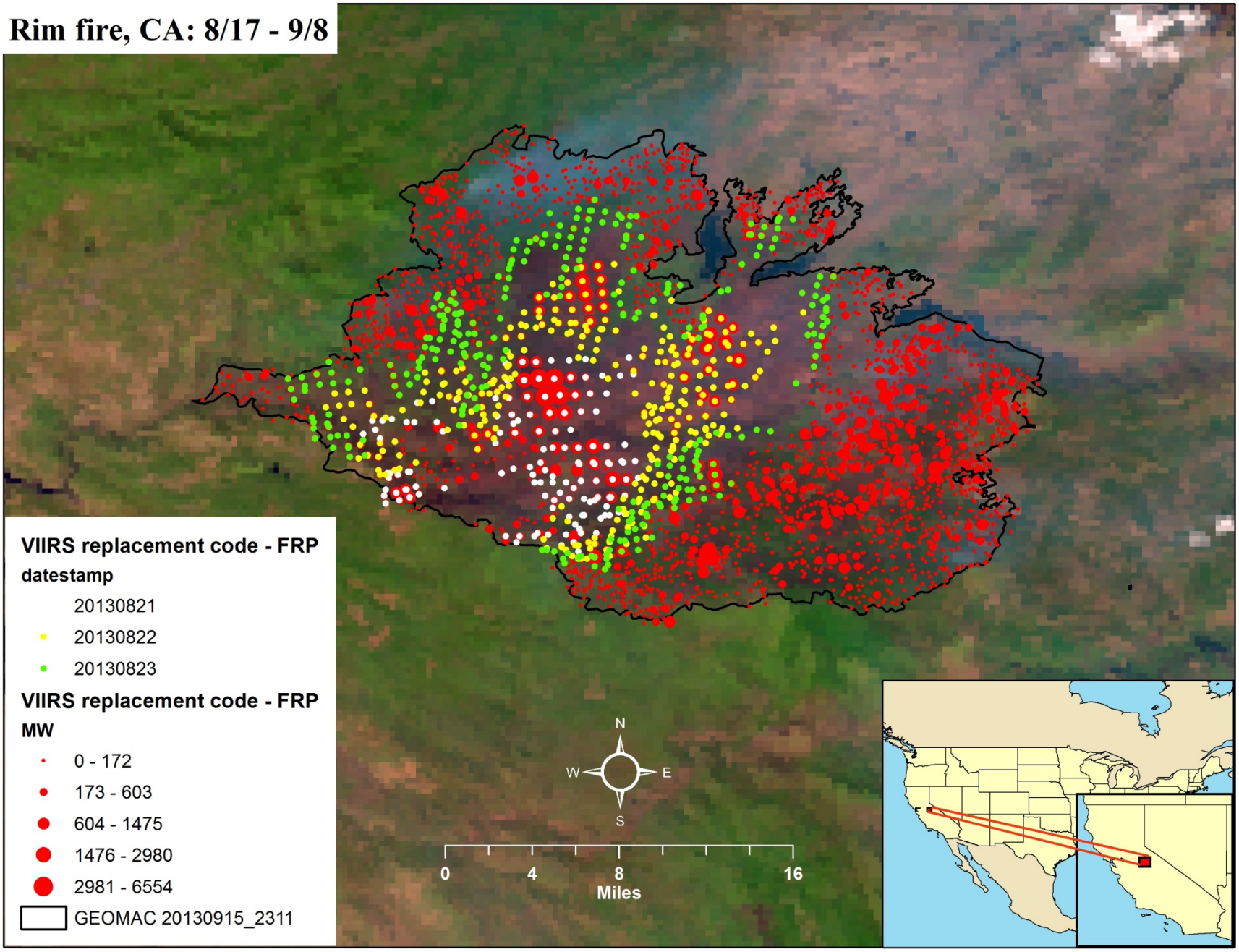
S-NPP/VIIRS 750 m
Spotty detection pixels



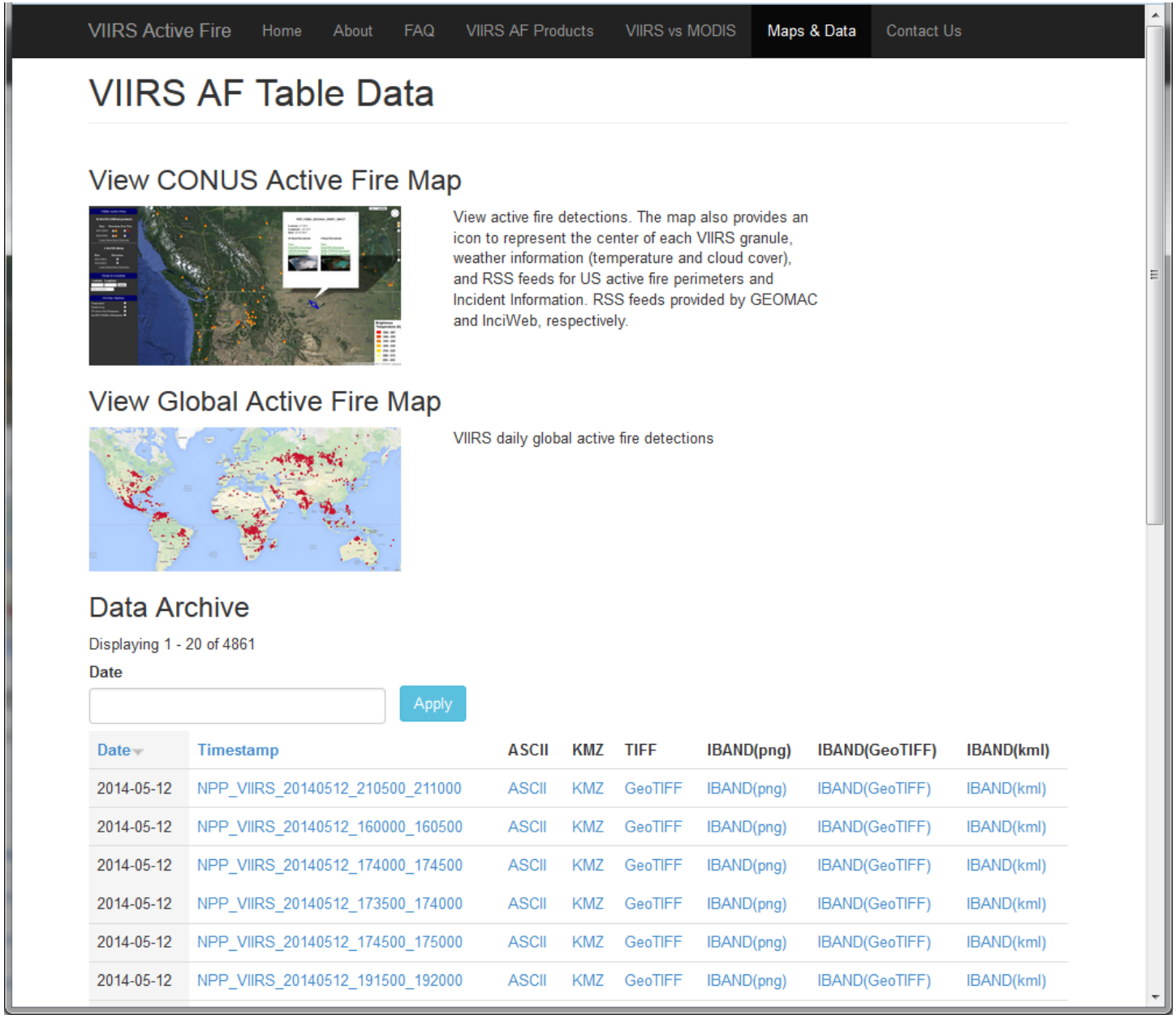
S-NPP/VIIRS 375 m
Improved fire line mapping

Credit: Wilfrid Schroeder (UMD)
See for example: Schroeder et al., 2014 [doi:10.1016/j.rse.2013.12.008]

Rim fire, CA: 8/17 - 9/8



Active Fire Data and Evaluation Portal

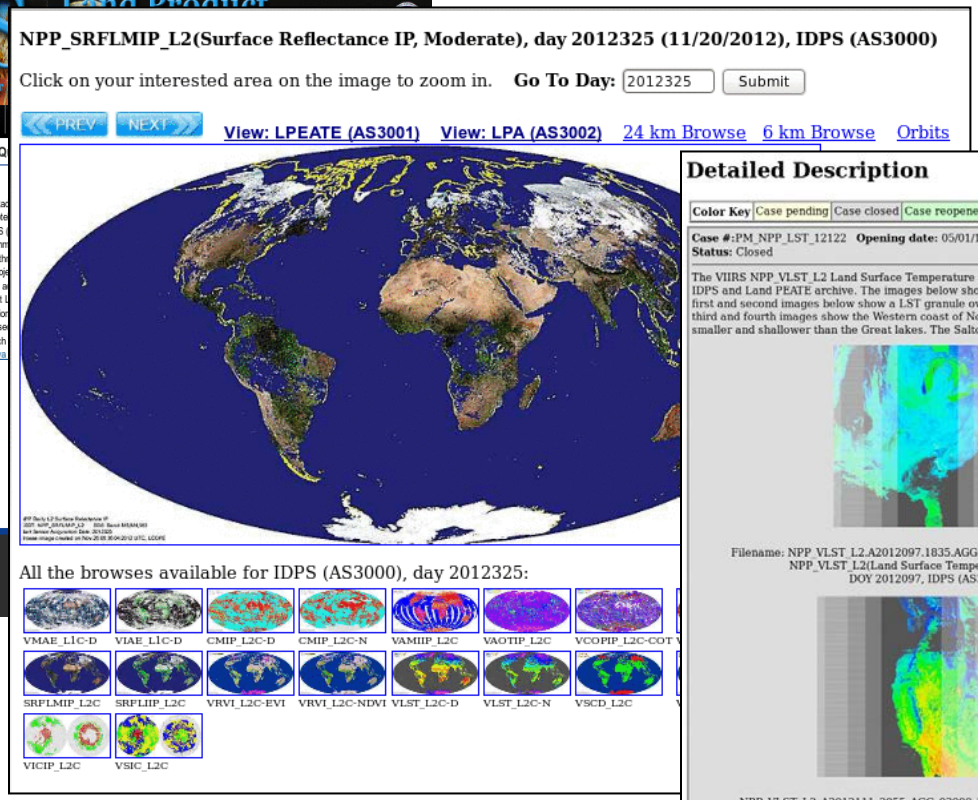


http://viirsfire.geog.umd.edu/ - new version coming soon

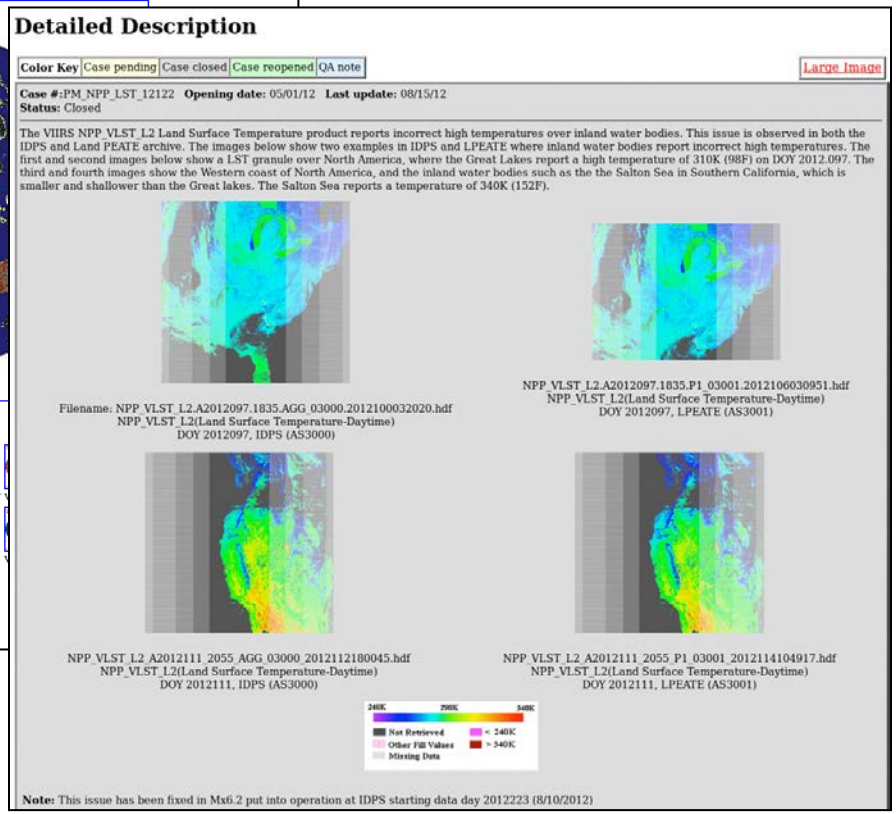
The Land PEATE: meeting the needs of the NASA Science Team and helping the NOAA IDPS

VIIRS LDOPE QA: http://landweb.nascom.nasa.gov/NPP_QA/

VIIRS Global Browse



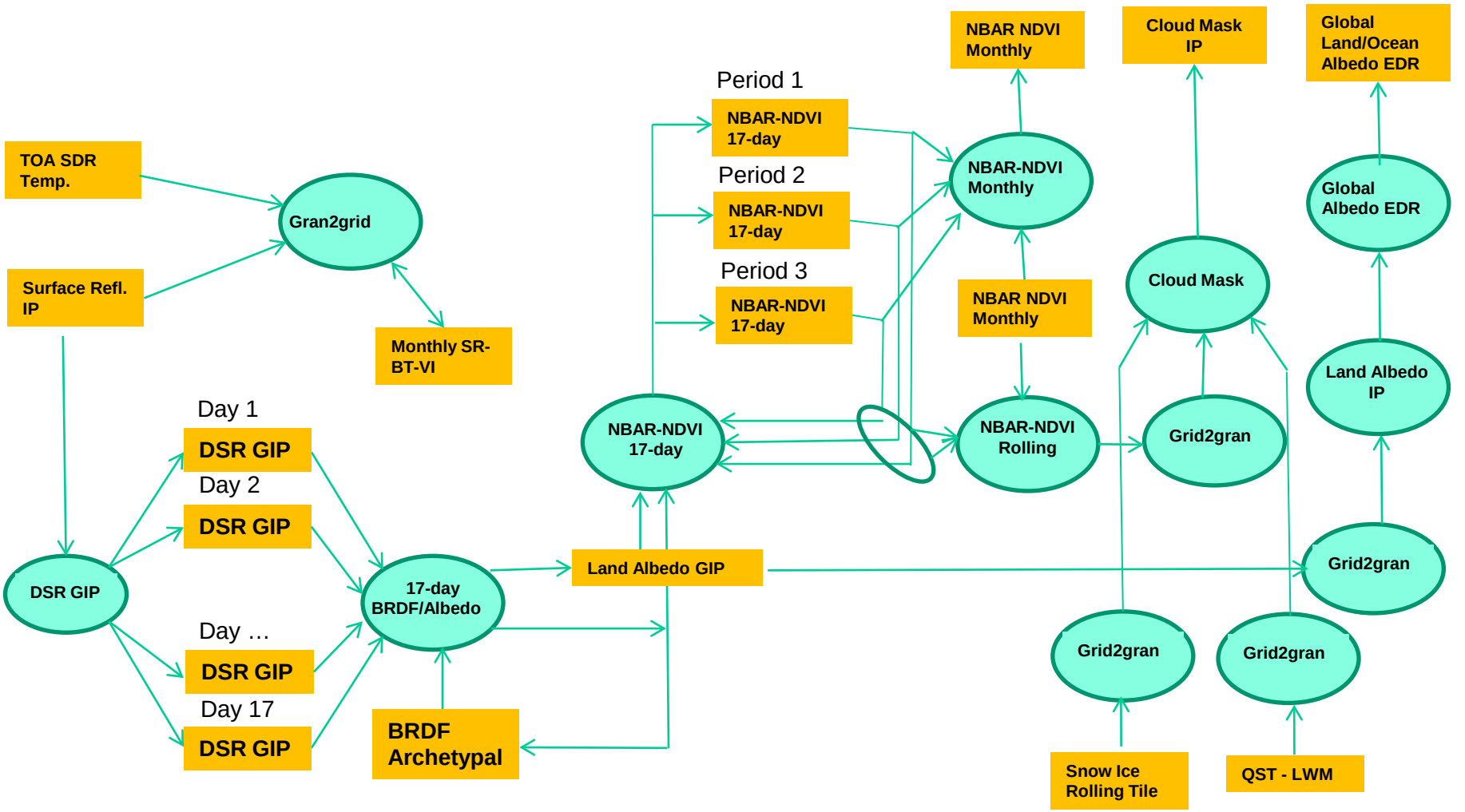
Known Issues Page



VIIRS Level 3 Products

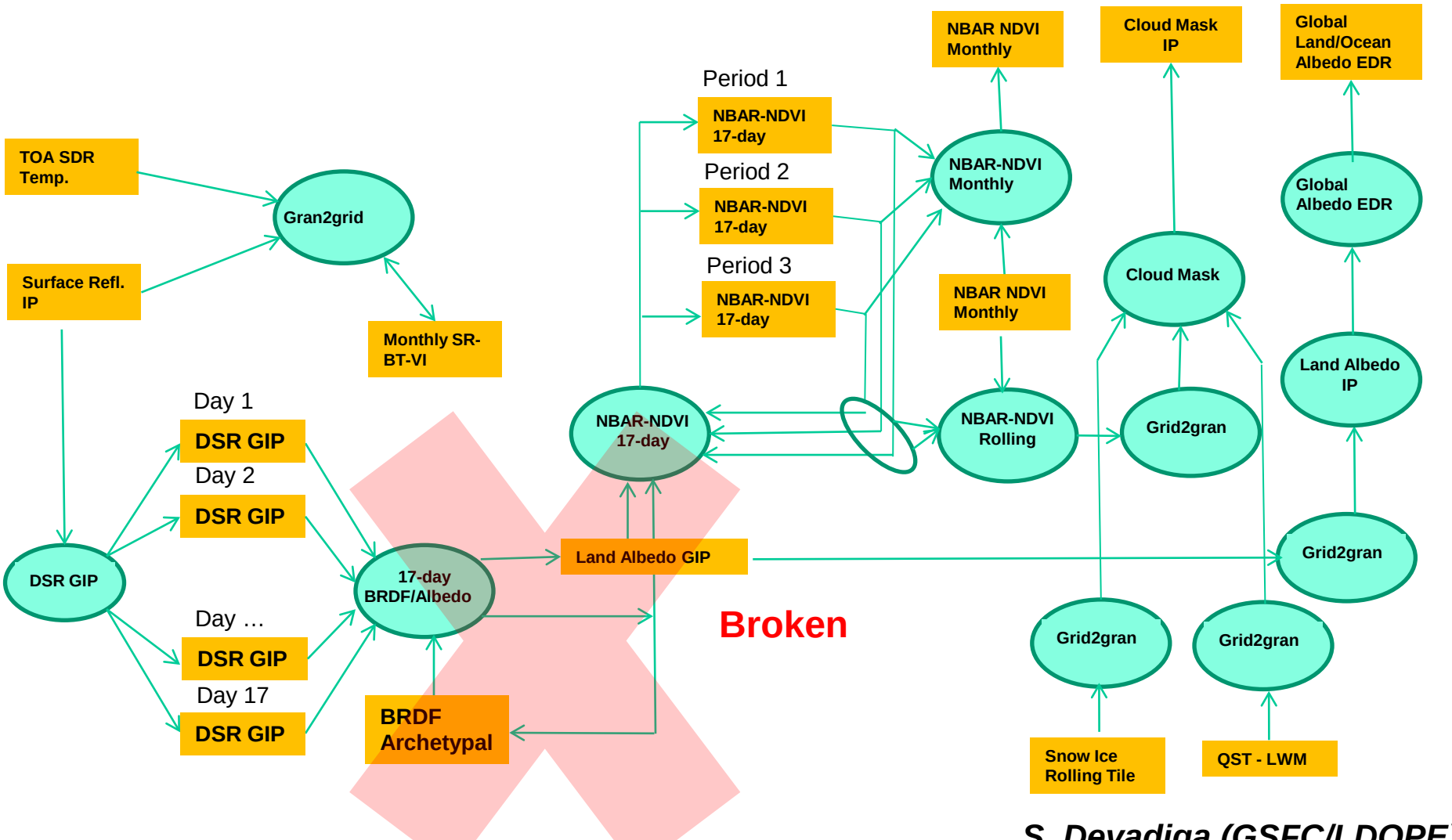
M. Román (GSFC)

Gridding/Granulation - Current



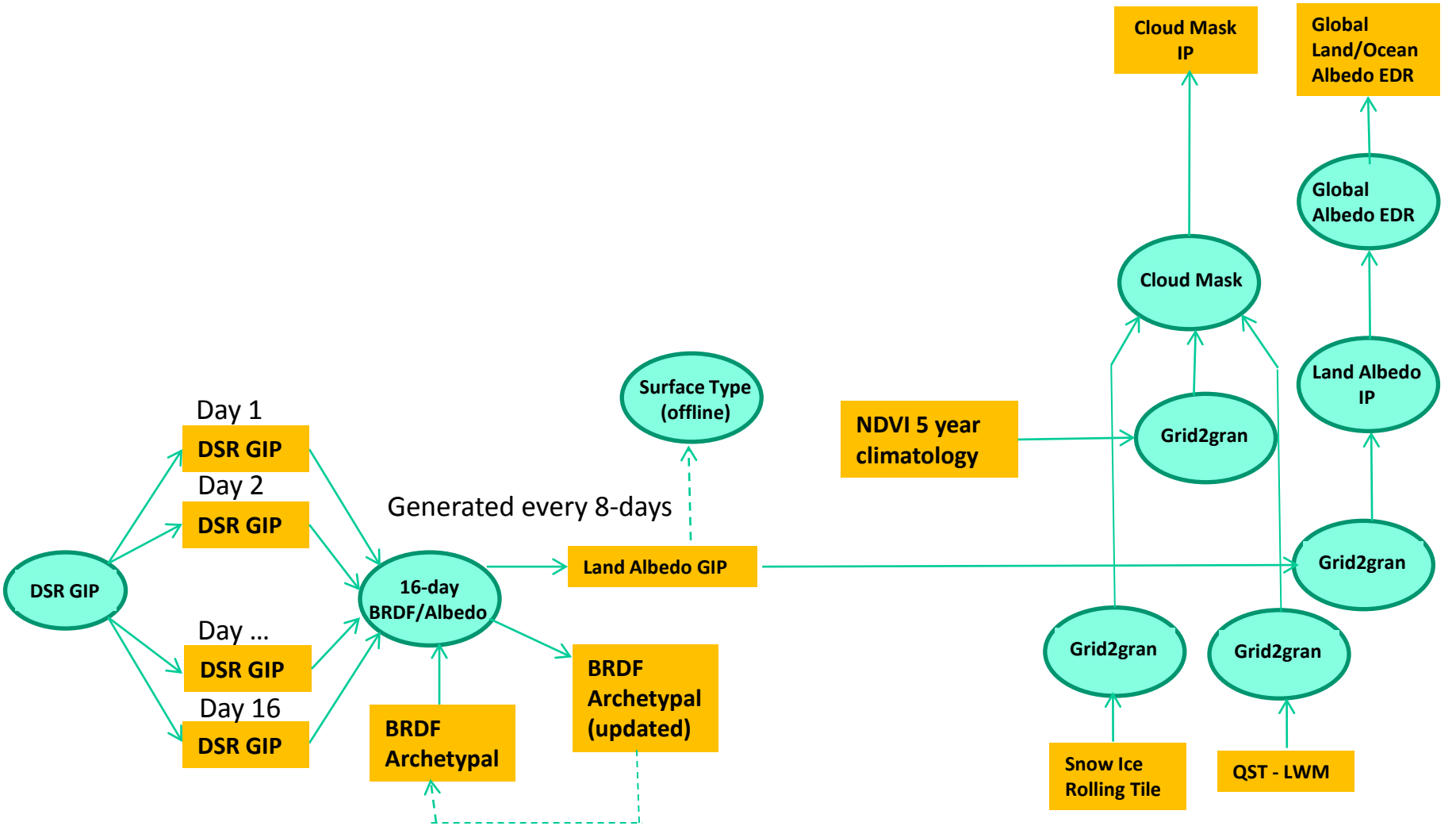
S. Devadiga (GSFC/LDOPE)

Gridding/Granulation - Current



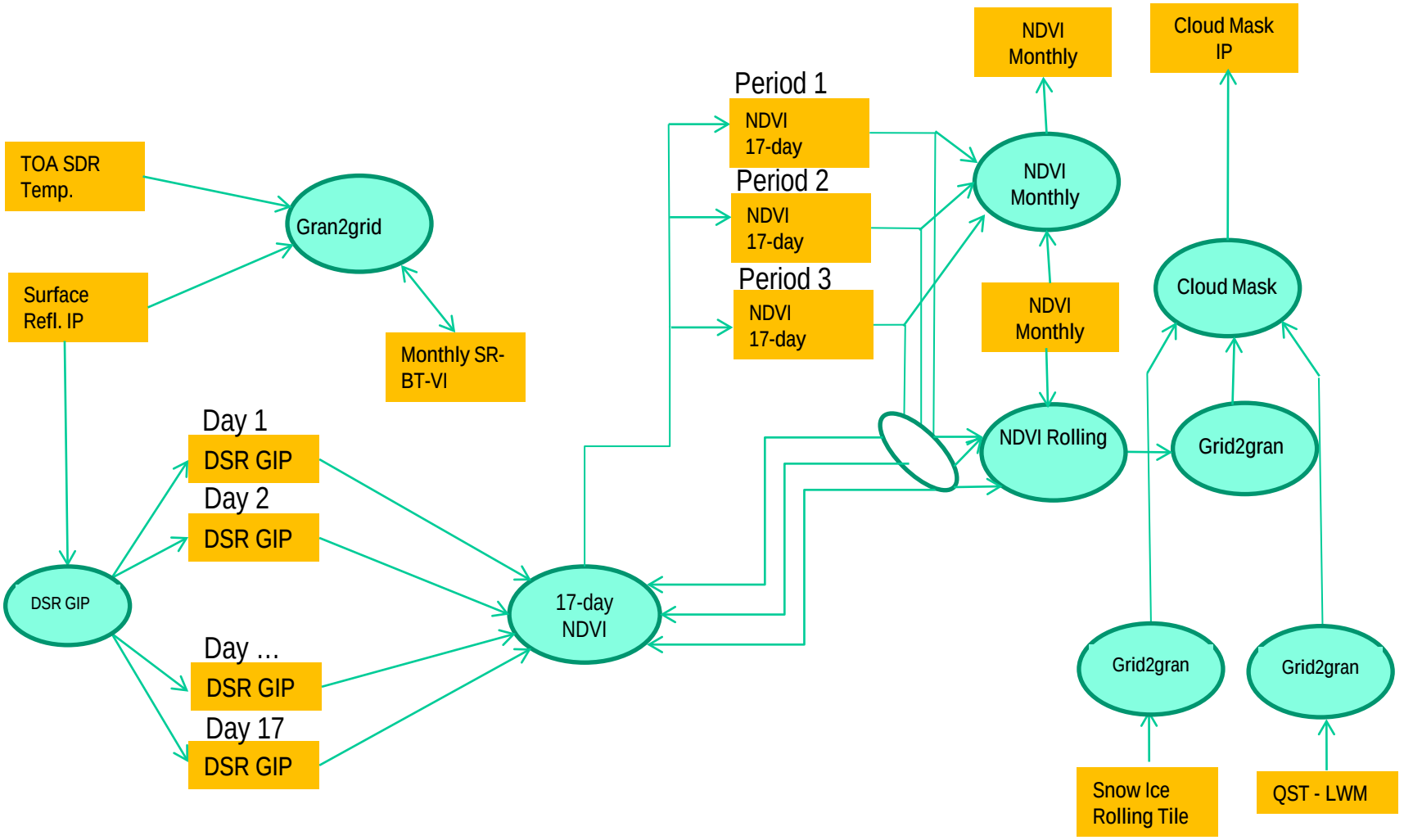
S. Devadiga (GSFC/LDOPE)

VIIRS Land Gridding/Granulation Proposed



S. Devadiga (GSFC/LDOPE)

Gridding/Granulation – Land/VCM Compromise



S. Devadiga (GSFC/LDOPE)

Summary and conclusions (1/2)

- S-NPP VIIRS land core IDPS product development and evaluation is progressing well
  - Provisional: Surface Reflectance, LST, Active Fires, Vegetation Index, Surface Type
  - Beta: albedo, science review held, up for AERB review
- Finish Suomi NPP product evaluation and development
  - Surface albedo to provisional; all products to validated
  - Gridding/granulation – specific proposals
- Continue interaction with upstream product teams
  - Overall SDR data quality is good - work is underway to resolve remaining quality flag and sensor performance issues (e.g. Active Fires)
  - VIIRS Cloud Mask – coordination regarding gridding/granulation – quality of input surface characterization feeds back to land EDR through VCM

Summary and conclusions (2/2)

- 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
- Teams are continuing the development of improved and additional products
  - Green Vegetation Fraction, I-band Active Fires, LAI/FPAR etc.
- 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
- Product continuity and reprocessing with latest algorithm
- Publications (JGR SNPP Special Issue and other)