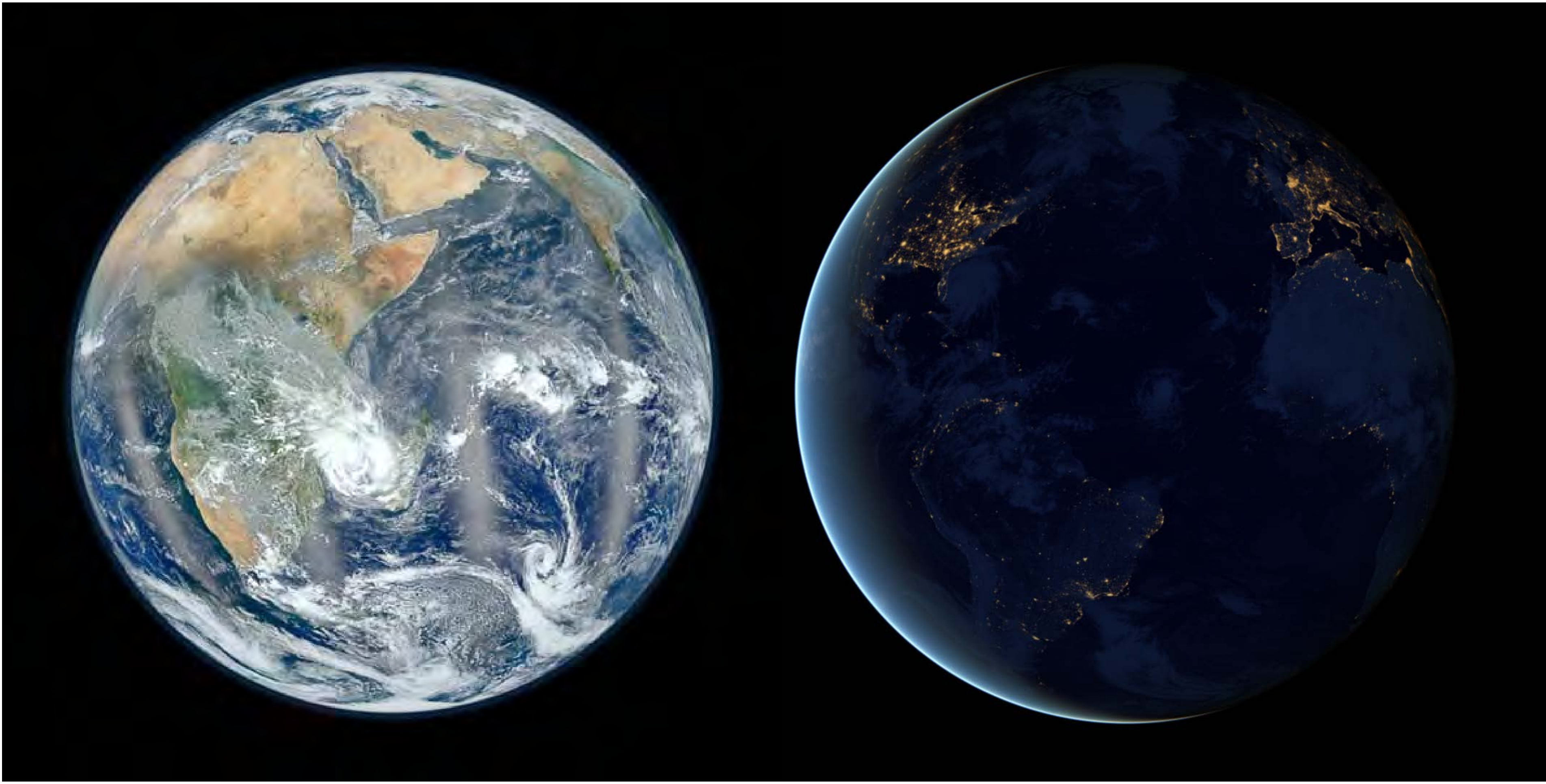
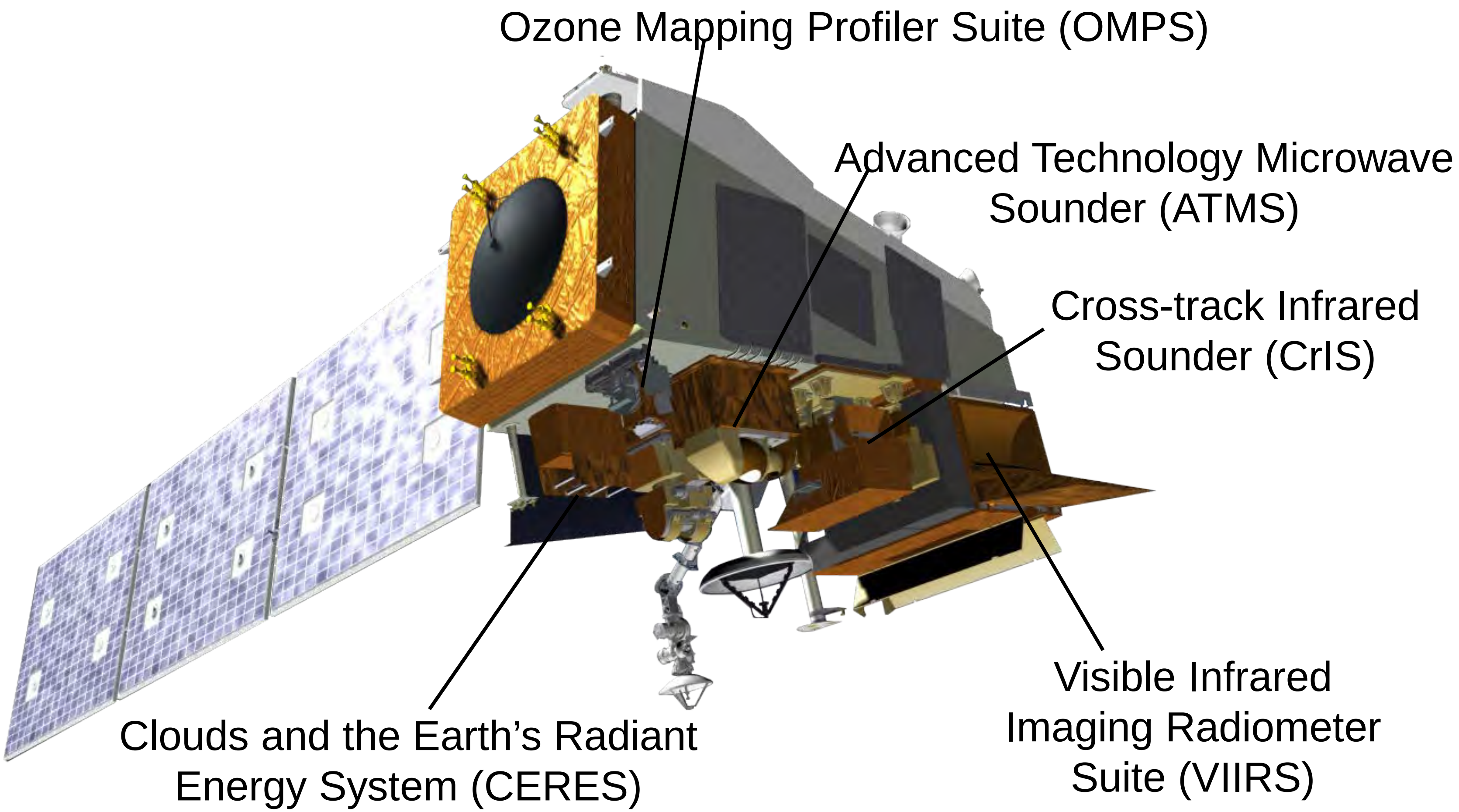
Land Monitoring using S-NPP VIIRS



Chris Justice (UMd),
Ivan Csiszar (NOAA), Miguel O. Román (NASA),
and the VIIRS Land Discipline Team

JPSS Spacecraft



The JPSS Enterprise

JPSS consists of:
- Suomi NPP* satellite, JPSS-1 satellite, and JPSS-2 satellite
- Four primary instruments
- Global ground system (Alaska, Colorado, Maryland, West Virginia, Norway, Antarctica)

NOAA Responsibilities:
- End-to-end responsibility, requirements, funding, delivering to National Weather Service
- Operations, data product science, enterprise ground services

NASA Goddard Space Flight Center Responsibilities:
- Systems Engineering lead
- Procurement and acquisition
- Safety and Mission Assurance

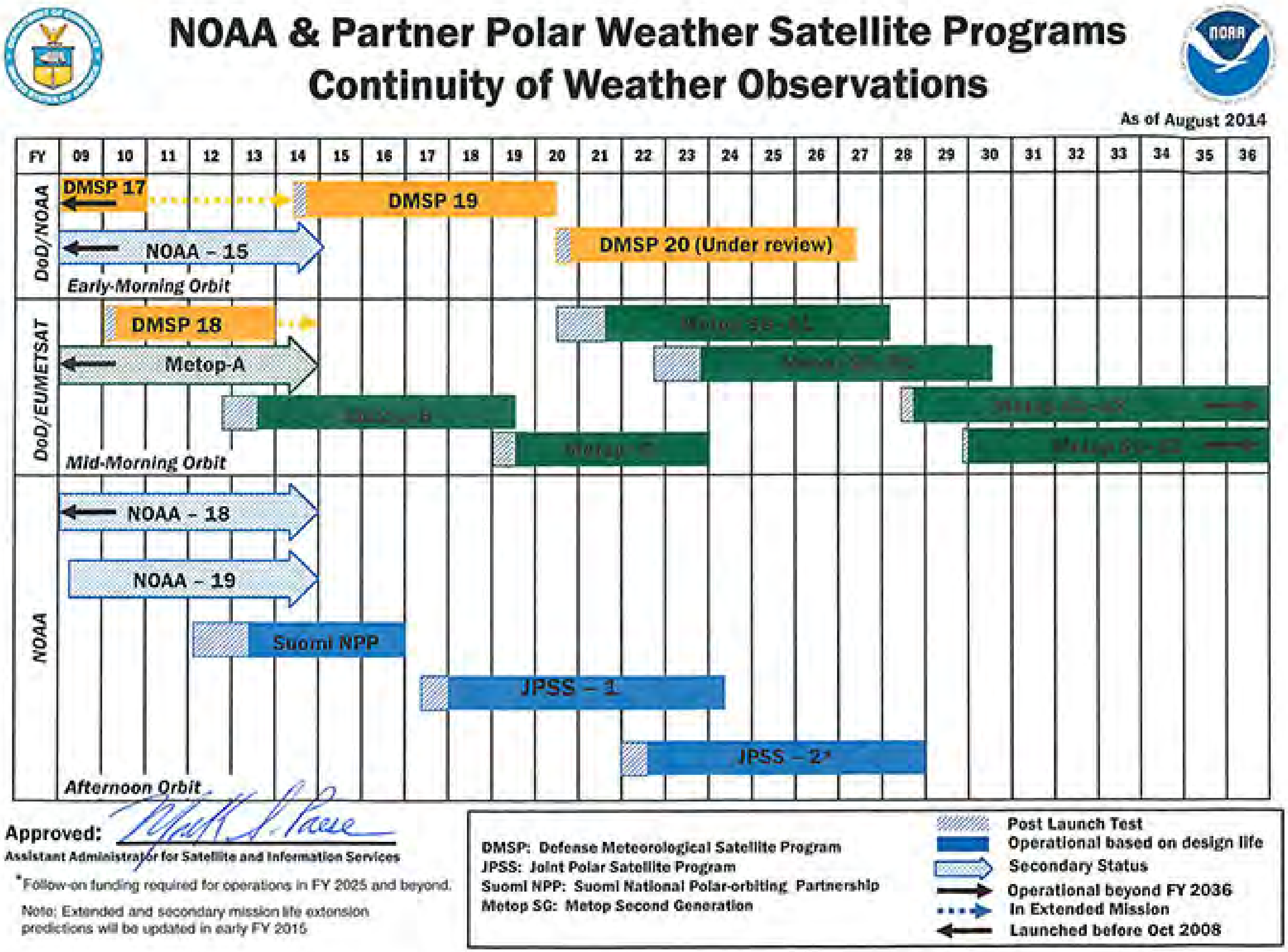
JPSS Schedule	
Launch Dates*	No later than 2nd Quarter FY 2017 (JPSS-1); 1st Quarter FY 2022 (JPSS-2)
Program Architecture	3 Satellites (Suomi NPP, JPSS-1, JPSS-2) Suomi NPP: 5-year operational design life; JPSS-1: 7-year operational design life
Program Operational Life	FY 2012 - FY 2025
Program Life-cycle (FY 2014 President's Budget)	$11.349 billion

*Suomi-NPP is a joint NASA / NOAA mission

*Launch Date based on FY 2014 President's Budget Request

Polar orbiter flyout chart

http://www.nesdis.noaa.gov/flyout_schedules.html



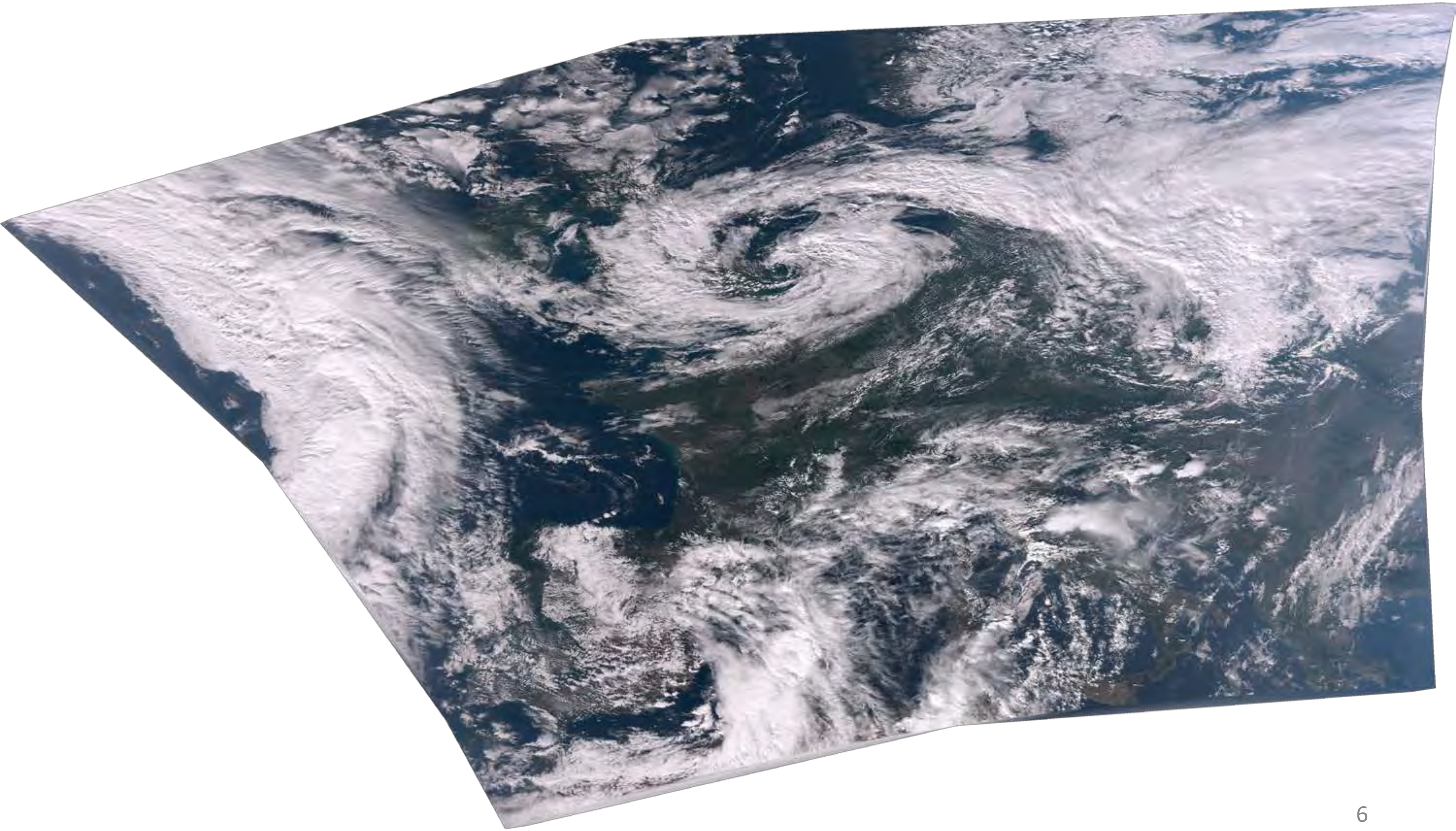
VIIRS and heritage imagers

VIIRS: Greater spectral coverage with increased radiometric quality

VIIRS			MODIS Equivalent			AVHRR-3 Equivalent			OLS Equi[illegible]		
Band	Range (um)	HSR (m)	Band	Range	HSR	Band	Range	HSR	Band	[illegible]	[illegible]SR
DNB	0.500 - 0.900	750	NONE			Low light capabilities			HRD [illegible]	[illegible]560	550 2700
M1	0.402 - 0.422	750	8	0.405 - 0.420	1000	NON[illegible]			Ocean Color, Aerosol		
M2	0.436 - 0.454	750	9	0.438 - 0.448	1000						
M3	0.478 - 0.498	750	3 10	0.459 - 0.479 0.483 - 0.493	500 1000						
M4	0.545 - 0.565	750	4 12	0.545 - 0.565 0.546 - 0.556	500 1000						
I1	0.600 - 0.680	375	1	0.620 - 0.670	250	[illegible]	[illegible] - 0.703	1100	Imagery		
M5	0.662 - 0.682	750	13 14	0.662 - 0.672 0.673 - 0.68[illegible]	[illegible]	[illegible]	0.572 - 0.703	1100	Ocean Color, Aerosol		
M6	0.739 - 0.754	750	15	0.743 - [illegible]	[illegible]	NONE			Atm Correction		
I2	0.846 - 0.885	375	2	0.[illegible]	[illegible]50	2	0.720 - 1.000	1100	NDVI		
M7	0.846 - 0.885	750	16	[illegible]	1000	2	0.720 - 1.000	1100	Ocean Color, Aerosol		
M8	1.230 - 1.250	750	[illegible]	[illegible]E	500	NONE			Cloud Particle Size		
M9	1.371 - 1.386	7[illegible]	[illegible]	[illegible]360 - 1.390	1000				Thin Cirrus		
I3	1.580 - 1.640	[illegible]	[illegible]	1.628 - 1.652	500				Snow Map		
M10	1.580 - [illegible]	[illegible]	6	1.628 - 1.652	500	3a	SAME	1100	Snow Fraction		
M11	2.[illegible]	[illegible]50	7	2.105 - 2.155	500	NONE			Cloud		
I4	[illegible]	375	20	3.660 - 3.840	1000	3b	SAME	1100	Imagery, Clouds		
[illegible]	[illegible].840	750	20	SAME	1000	3b	3.550 - 3.930	1100	SST, Fire		
[illegible]	3.973 - 4.128	750	21 22 23	3.929 - 3.989 3.929 - 3.989 4.020 - 4.080	1000 1000 1000	NONE			SST, Fire		
M14	8.400 - 8.700	750	29	SAME	1000				Cloud Top Propoerties		
M15	10.263 - 11.263	750	31	10.780 - 11.280	1000	4	10.300 - 11.300	1100	SST, Fire		
I5	10.500 - 12.400	375	31 32	10.780 - 11.280 11.770 - 12.270	1000 1000	4 5	10.300 - 11.300 11.500 - 12.500	1100 1100	HRD	10.300 - 12.900 Cloud Imagery	550
M16	11.538 - 12.488	750	32	11.770 - 12.270	1000	5	11.500 - 12.500	1100	SST		

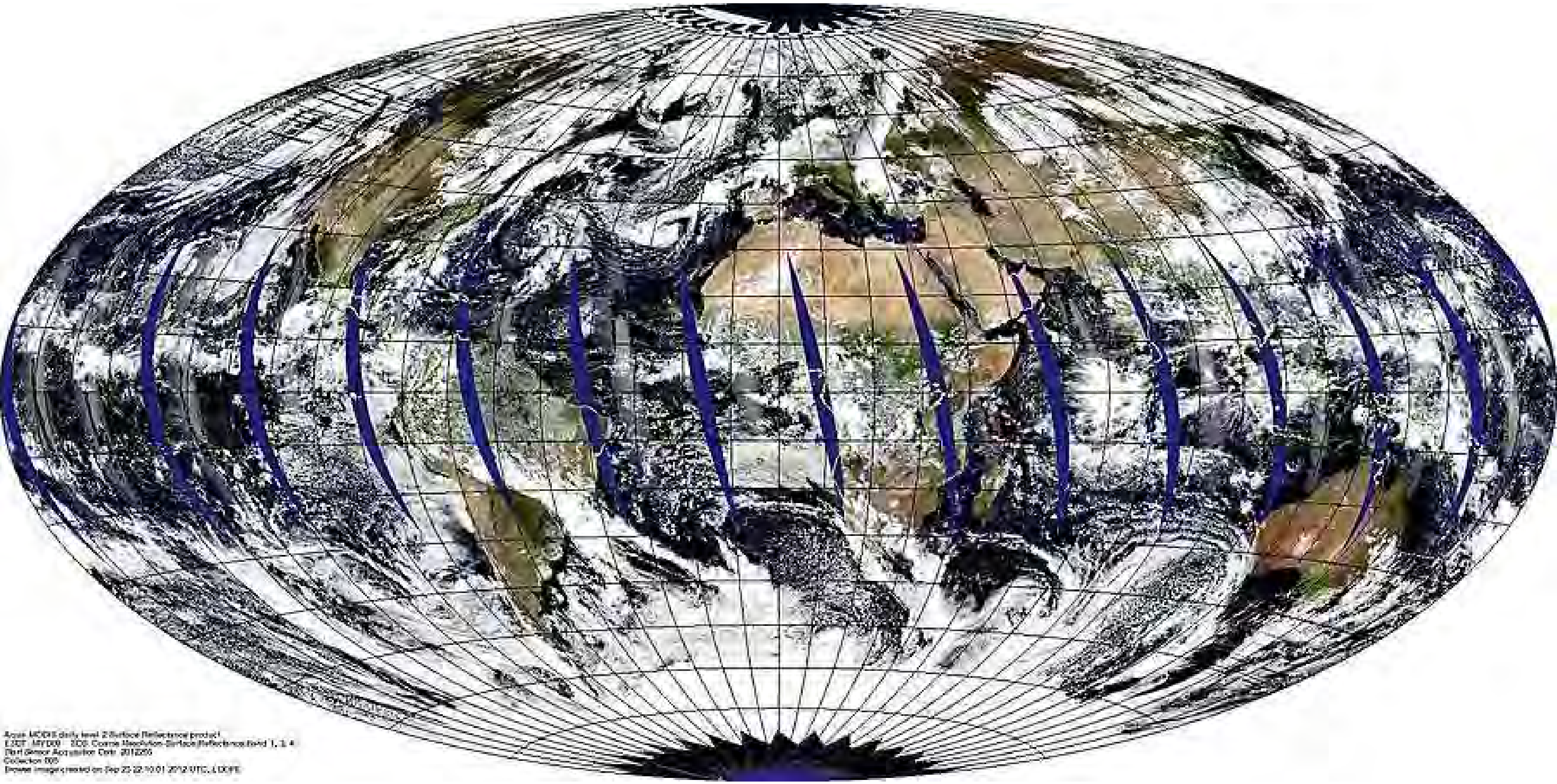
SNPP VIIRS M3-M4-M5 RGB

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



Aqua MODIS Global Browse

landweb.nascom.nasa.gov



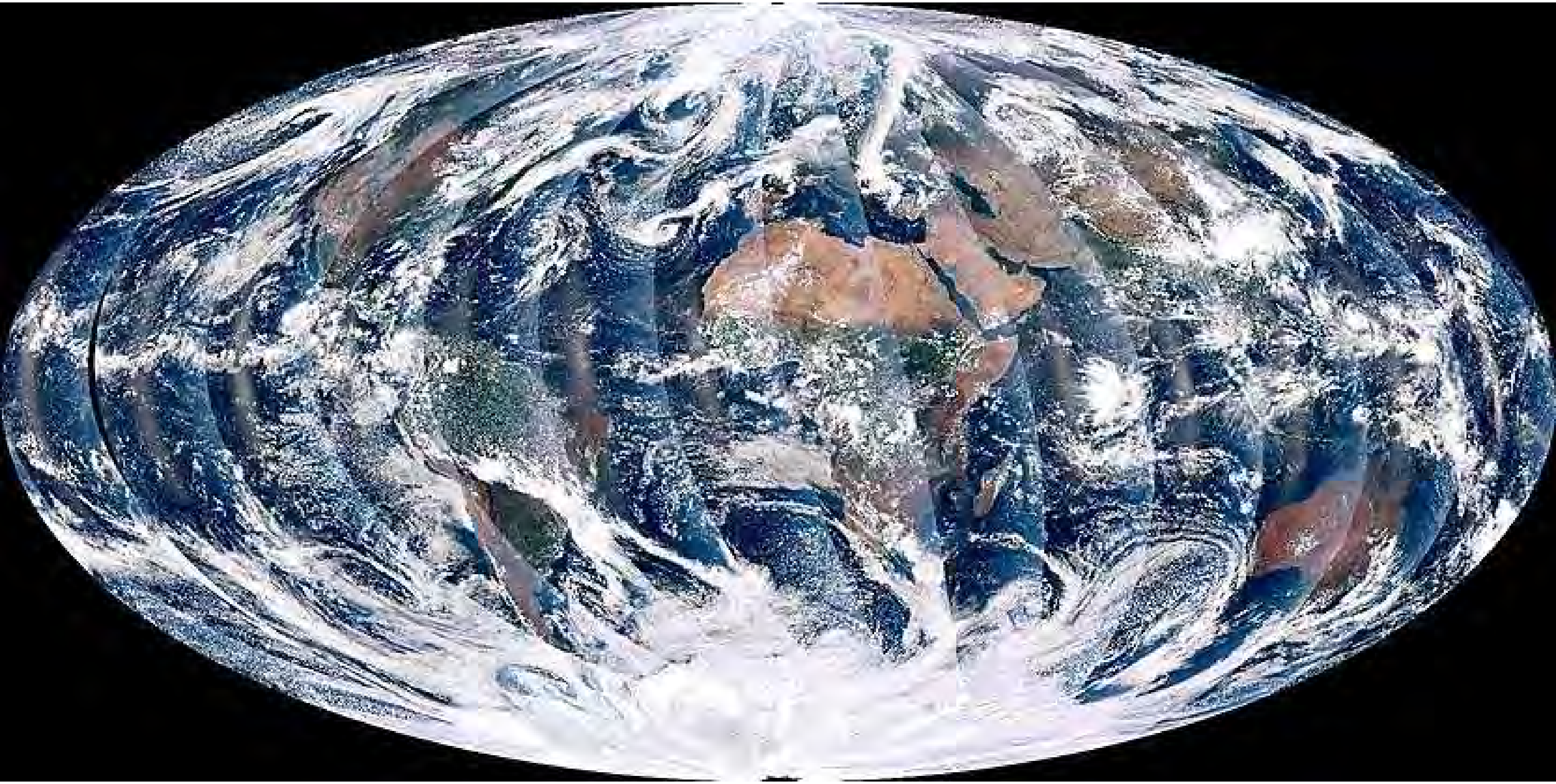
Daily Land Surface Reflectance Bands 1,4,3 (MYD09)

September 21, 2012

NASA LandPEATE

Suomi NPP VIIRS Global Browse

landweb.nascom.nasa.gov

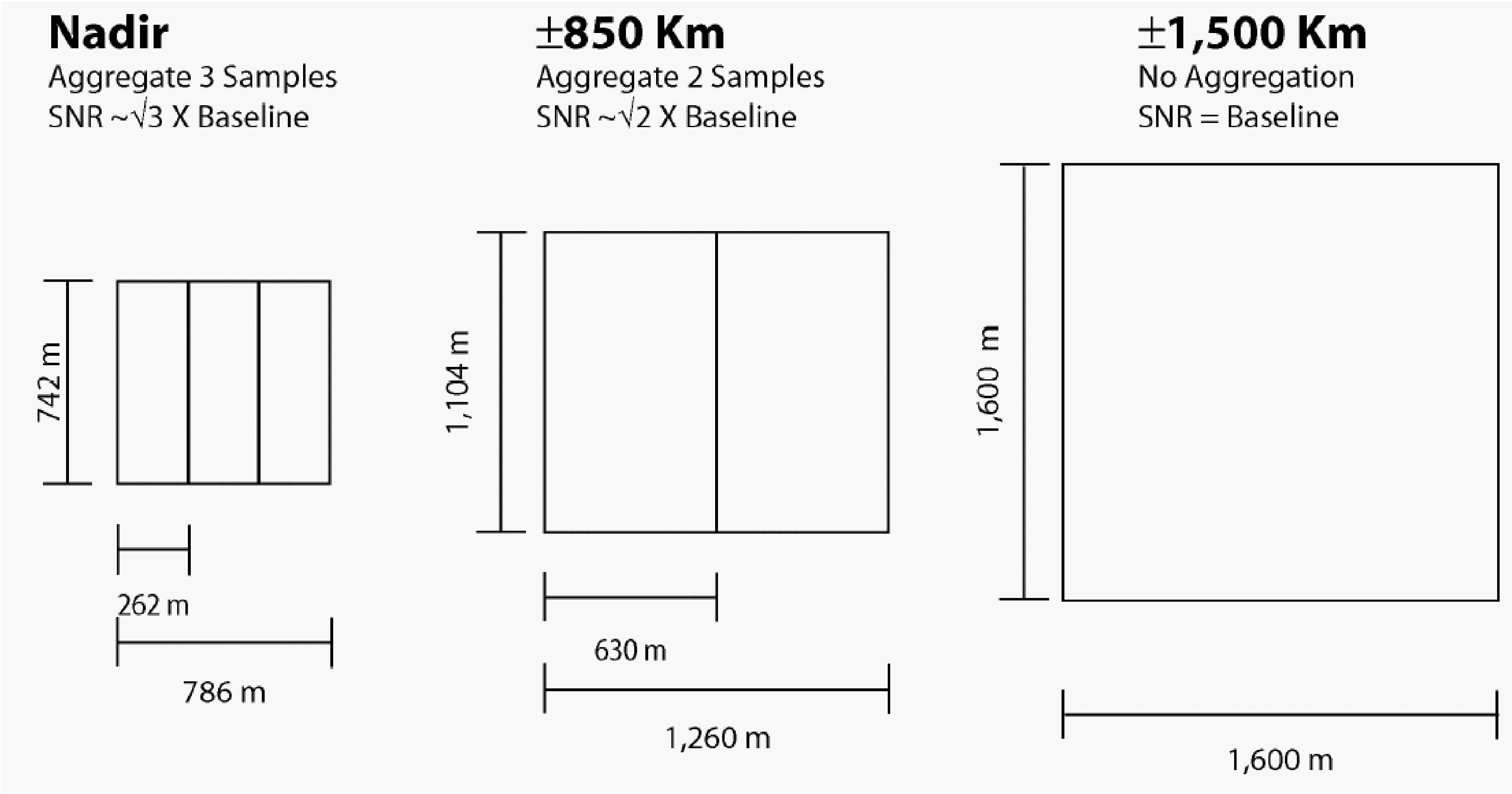


NPP_VMAE_L1 L1B Moderate input, Day Band 5,4,3

September 21, 2012

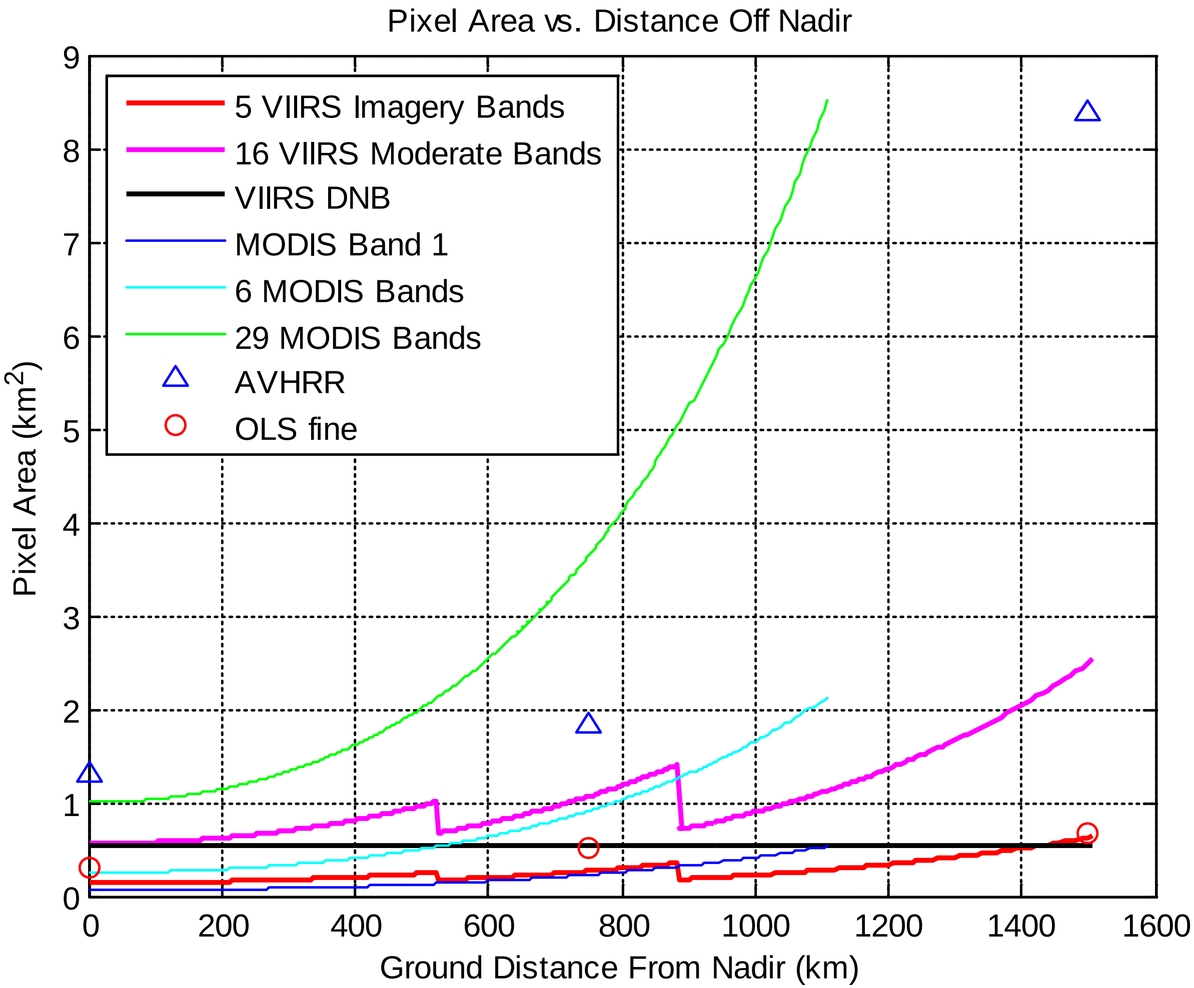
NASA LandPEATE

VIIRS Detector Aggregation Scheme



JPSS program

Near-constant pixel size

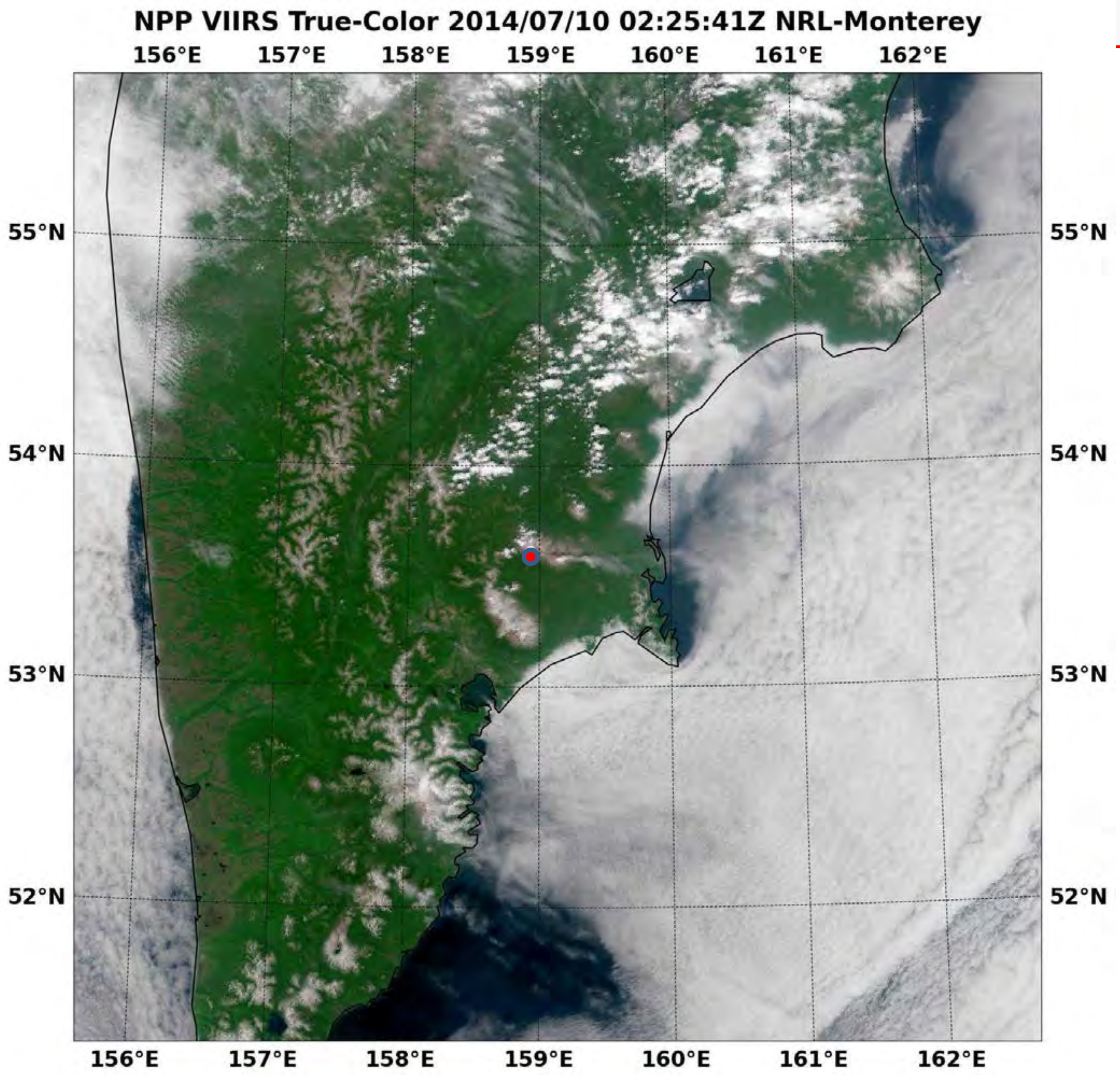


Spatial Resolution Comparisons for VIIRS, AVHRR, MODIS and OLS at Nadir and Across Swath

Because of aggregation VIIRS has much better resolution away from nadir, pixel area 8 times smaller than AVHRR or MODIS

Northrup Grumman & Raytheon

Comparing MODIS (250m) to VIIRS (375m)

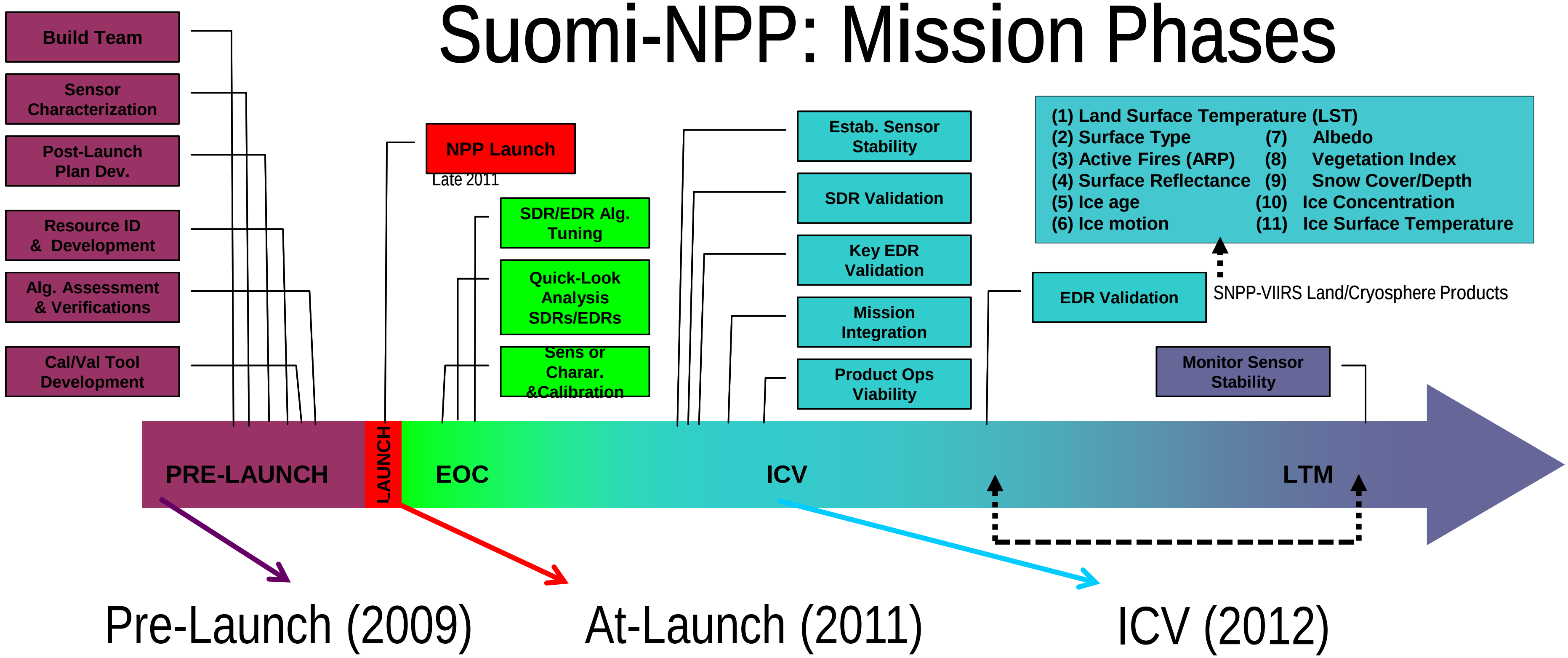


Edge of Scan

VIIRS vs. MODIS for land monitoring

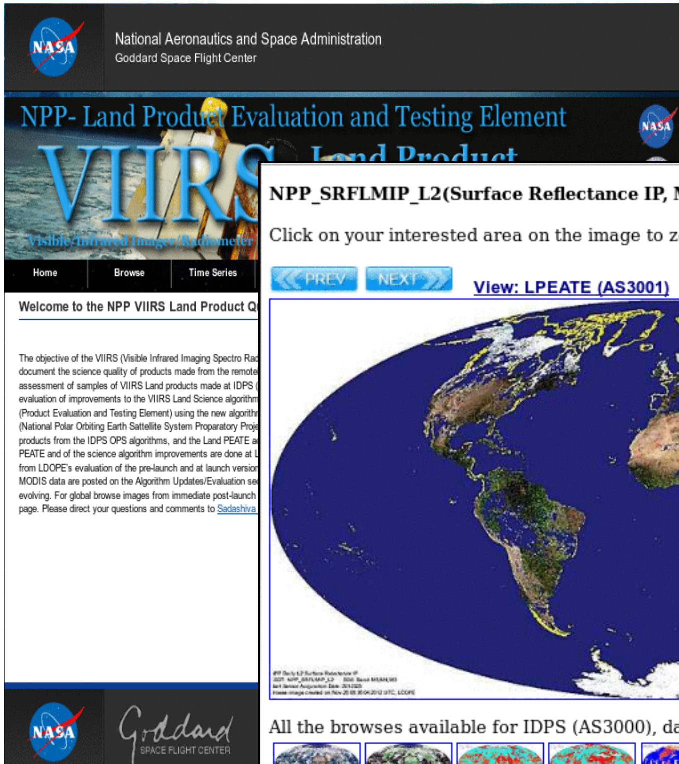
- What can VIIRS do better than MODIS?
  - Better coverage and scanning geometry, including higher resolution of "M" bands
    - Improved fire detections (25% higher VIIRS fire counts than MODIS in the three-pixel VIIRS aggregation zone)
    - No gaps at low latitudes, more consistent data for temporal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

Suomi-NPP: Mission Phases

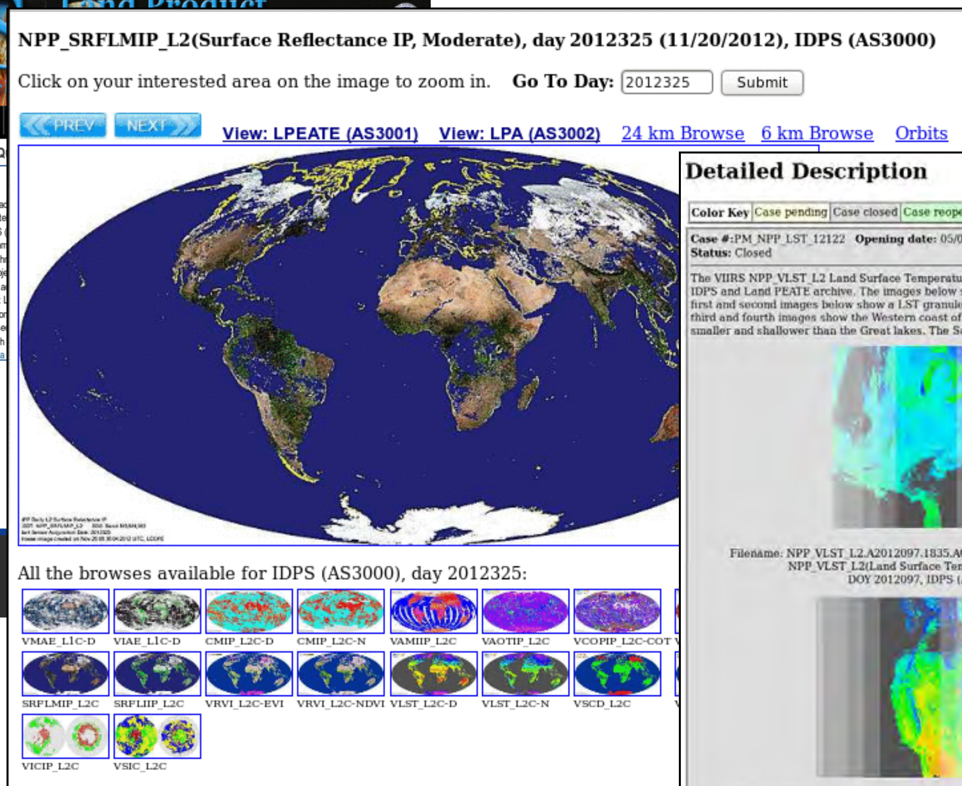


The Land PEATE: meeting the needs of the NASA Science Team and collaborating with NOAA IDPS

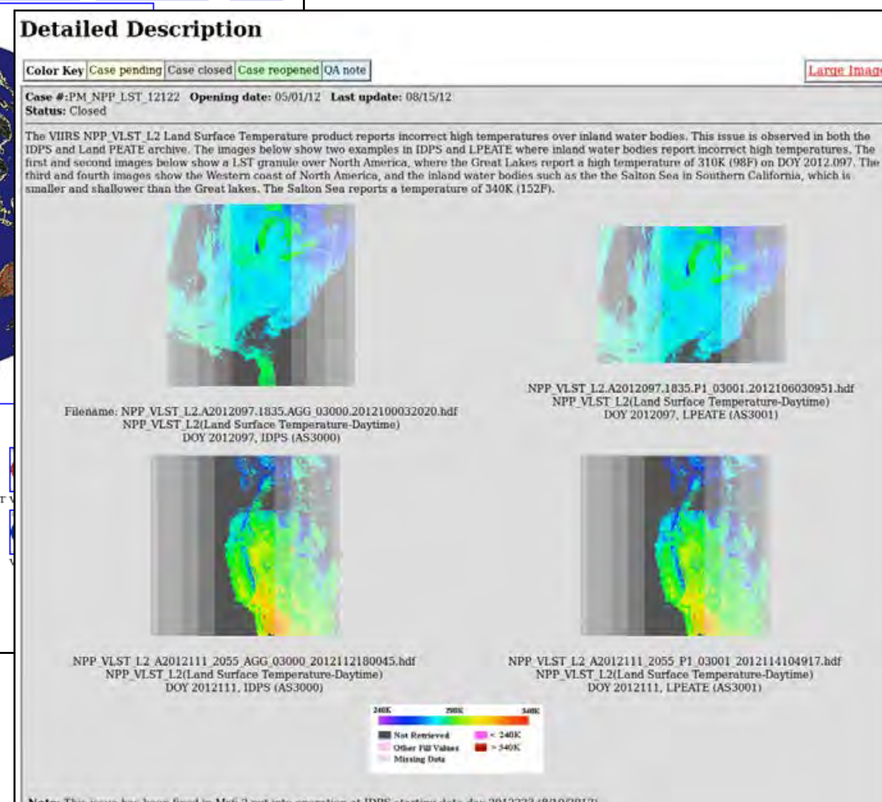
VIIRS LDOPE QA: http://landweb.nascom.nasa.gov/NPP_QA/



VIIRS Global Browse

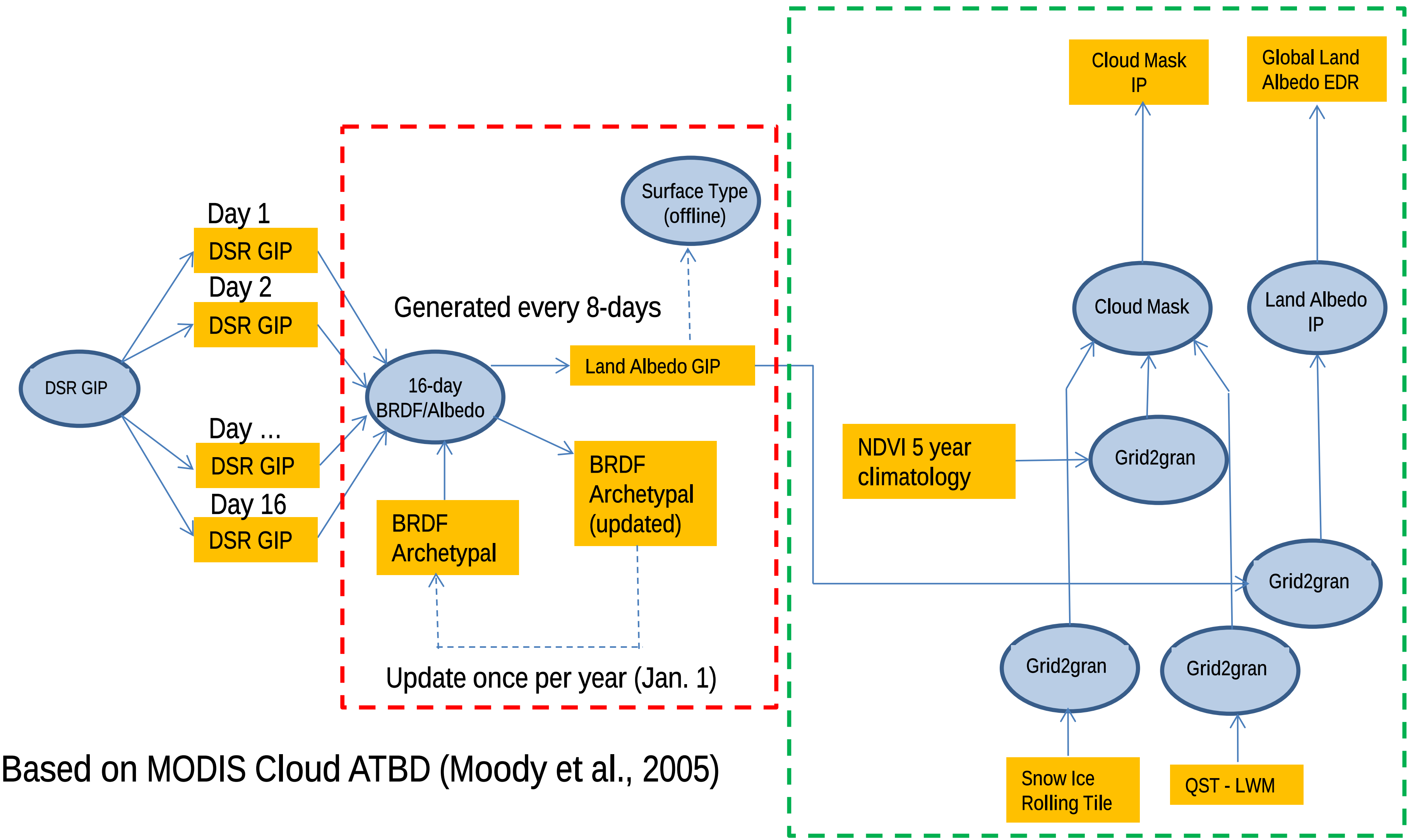


Known Issues Page



VIIRS Level 3 Products

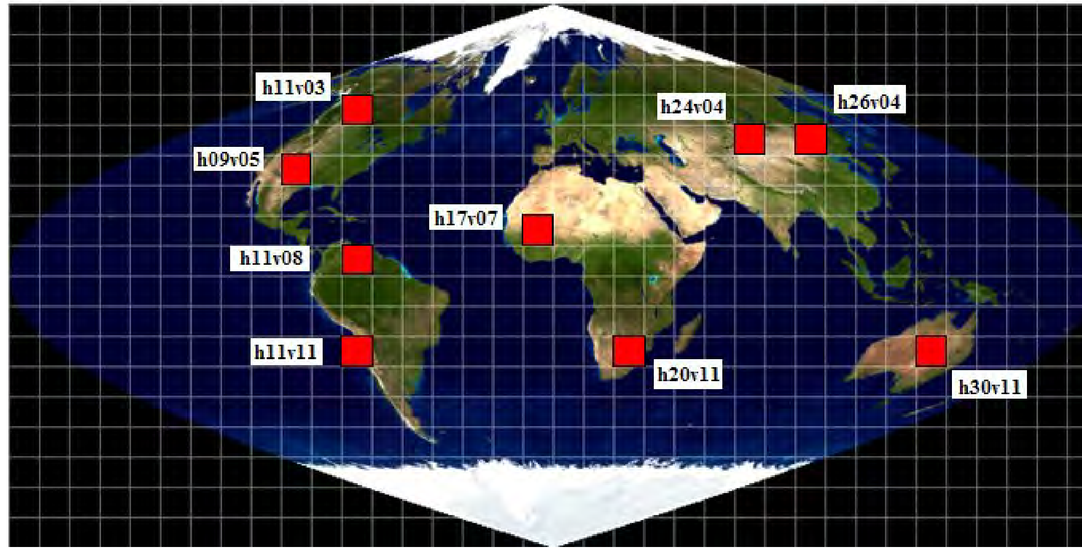
NASA (V1.1) Land Gridding/Granulation

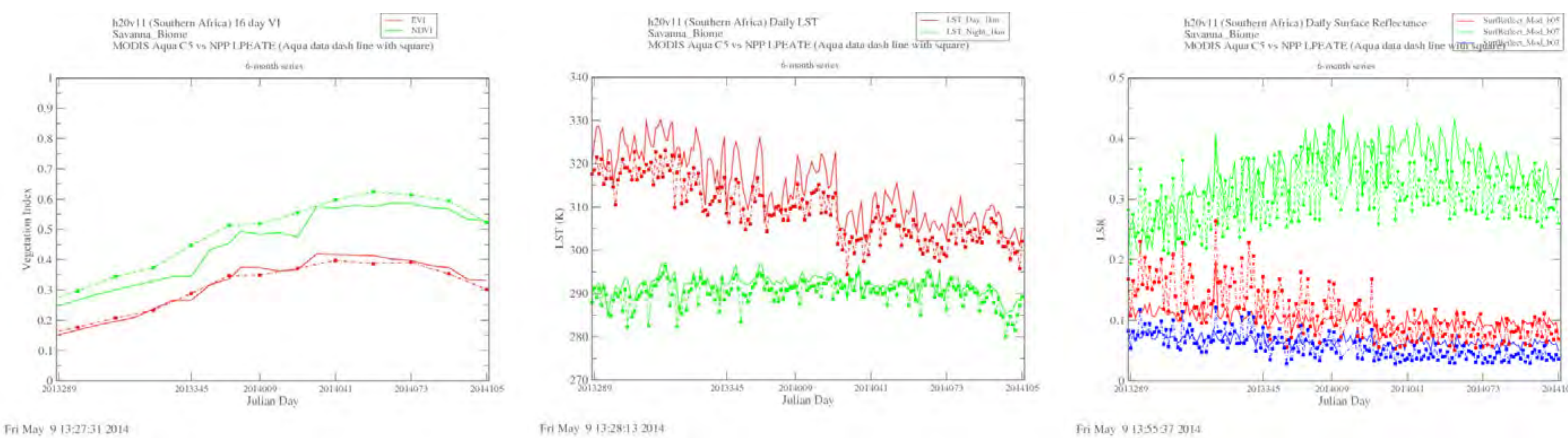


Based on MODIS Cloud ATBD (Moody et al., 2005)

Land Product Quality Assessment Golden Tile Time Series

Approach: Summary statistics derived at a number of fixed globally distributed locations (10° X 10° tiles) include mean, standard deviation, min, max, and number of good quality observations.





VIIRS (V1.1) vs. MODIS (V5) **Vegetation Index** (left), **LST** (center), and **Surface Reflectance** (right). 6-month trending shown for observations from savanna class (tile h20v11).

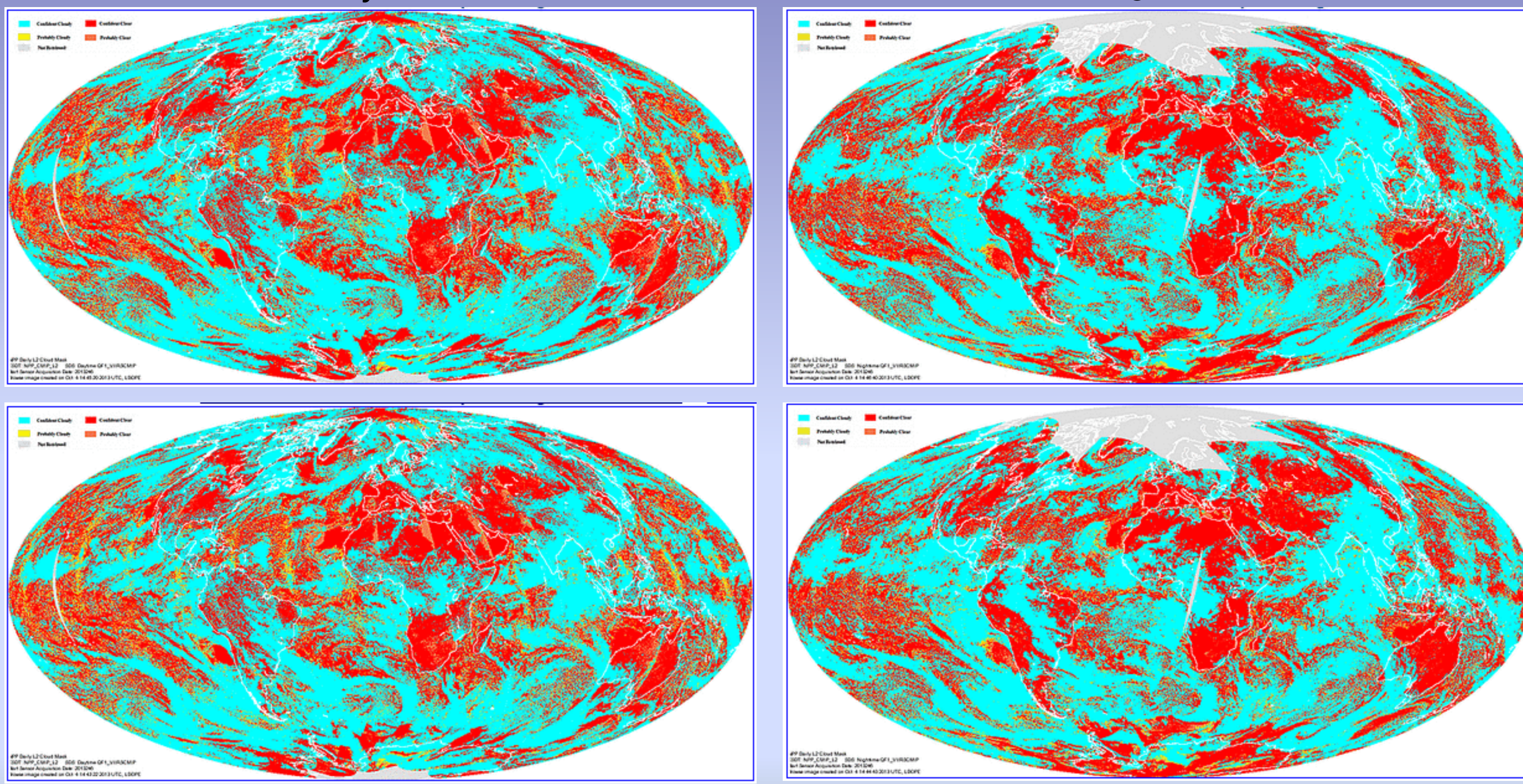
VIIRS Cloud Mask: C11 vs. IDPS

Day time

Night time

IDPS

LPEATE- C11



Confidently clear

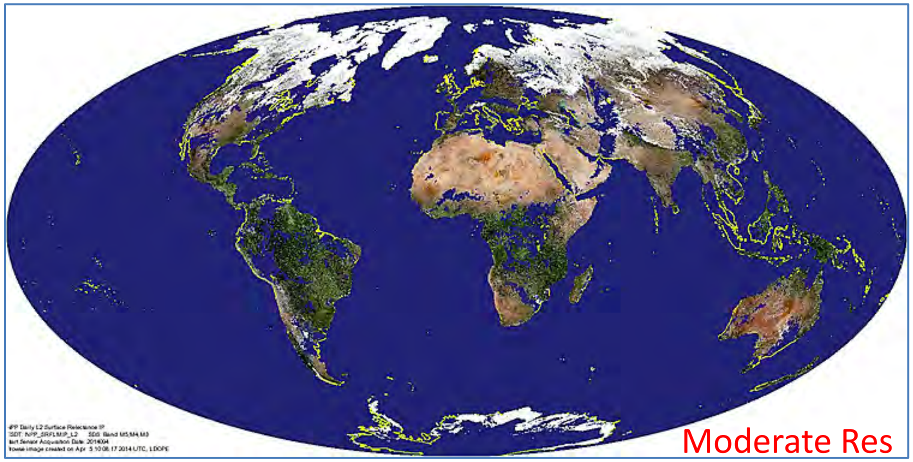
Probably clear

Probably cloud

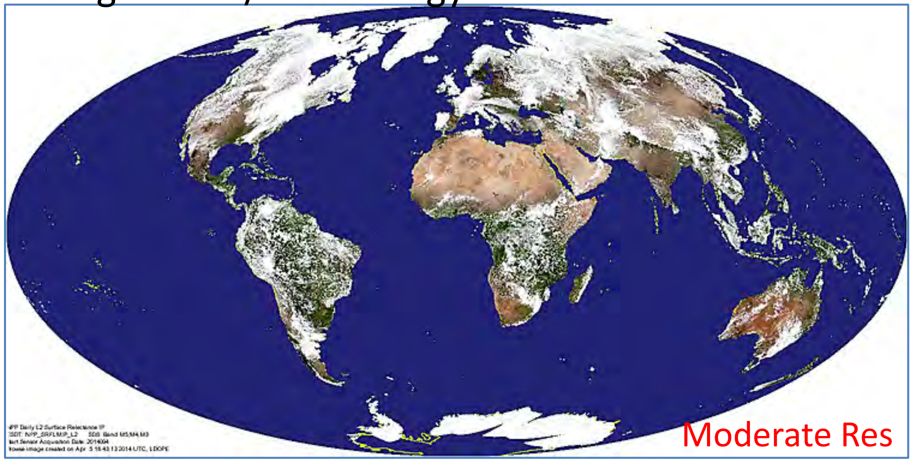
Confidently cloud

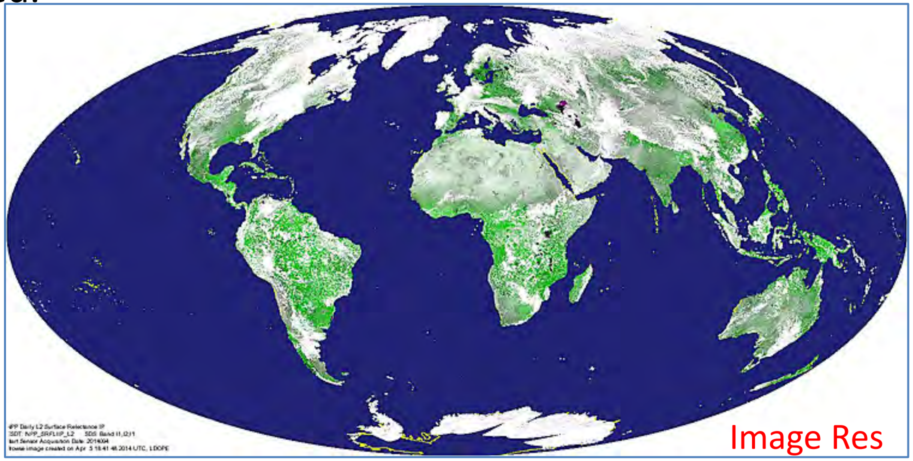
Surface Reflectance IP from Day 2014094

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.



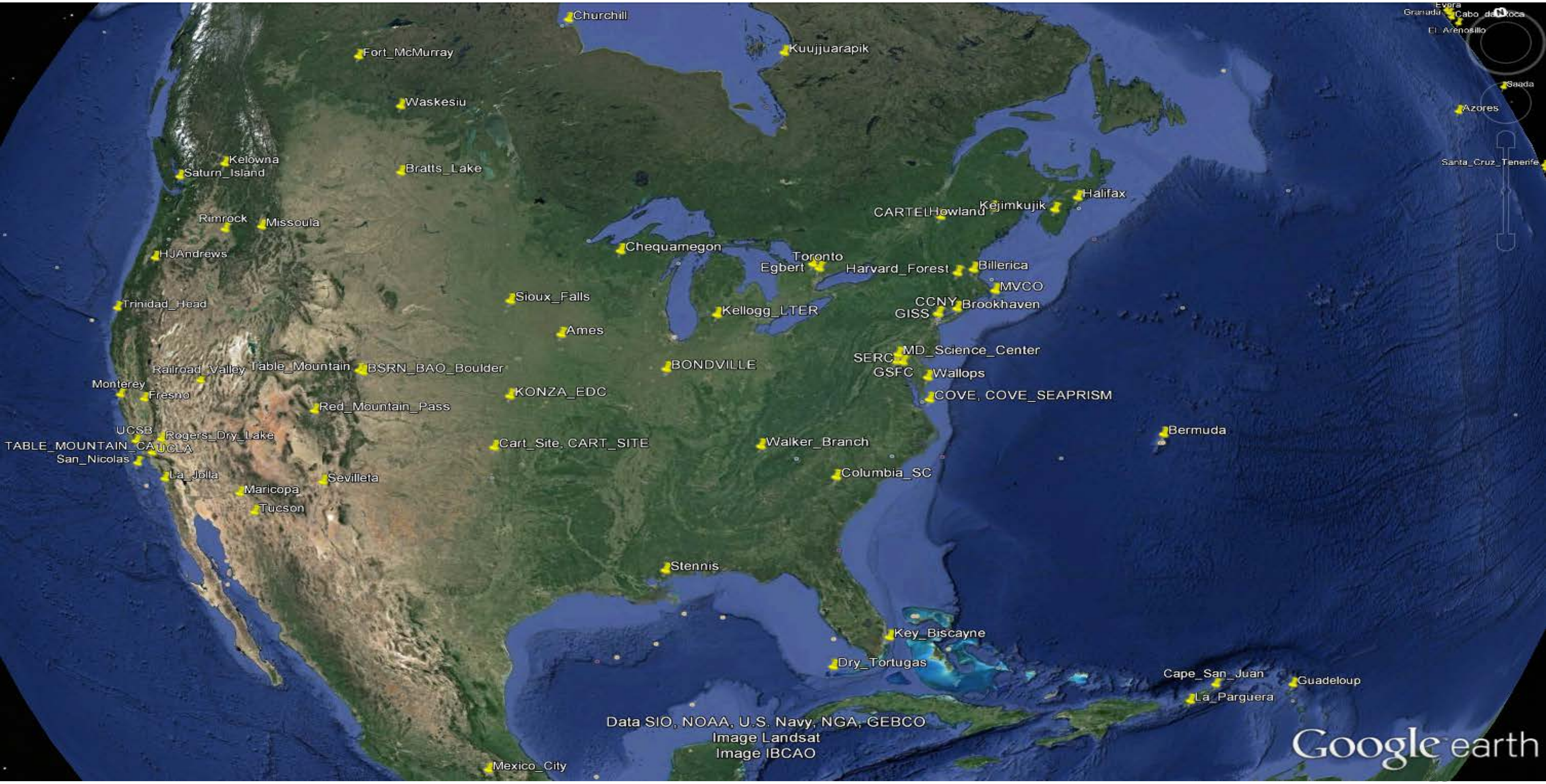


Retrieval using Mx83 at IDPS – SRIP retrieved under all atmospheric conditions replacing NAAPS/Climatology with MODIS Climatology.

E. Vermote, S. Devadiga, NASA GSFC

VI EDR Validation: Matchup Data Analysis

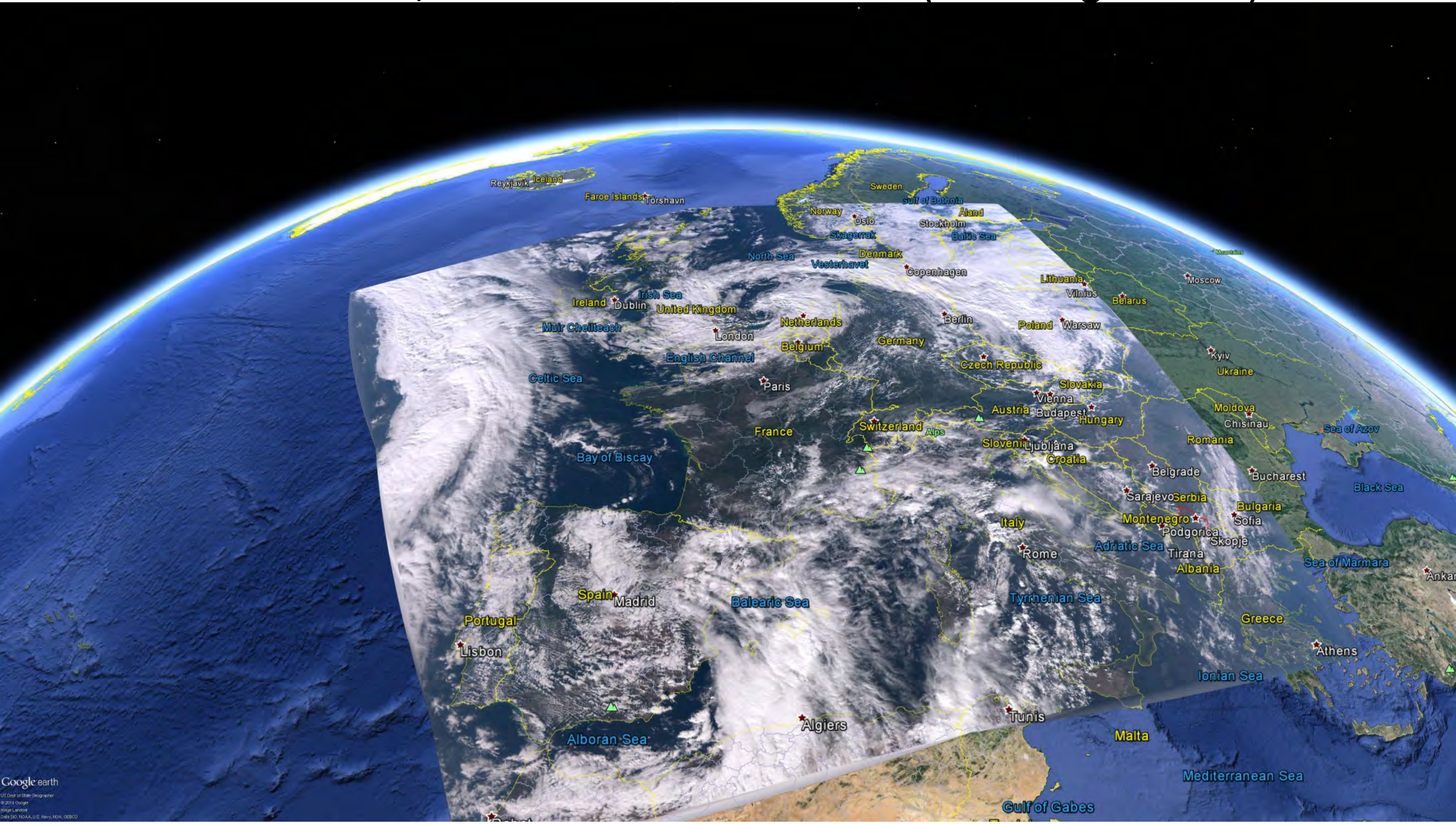
Surface Reflectance and VI cutouts collected daily at 229 Aeronet sites: North America Example



M. Vargas et al., NOAA STAR

SNPP VIIRS M3-M4-M5 RGB

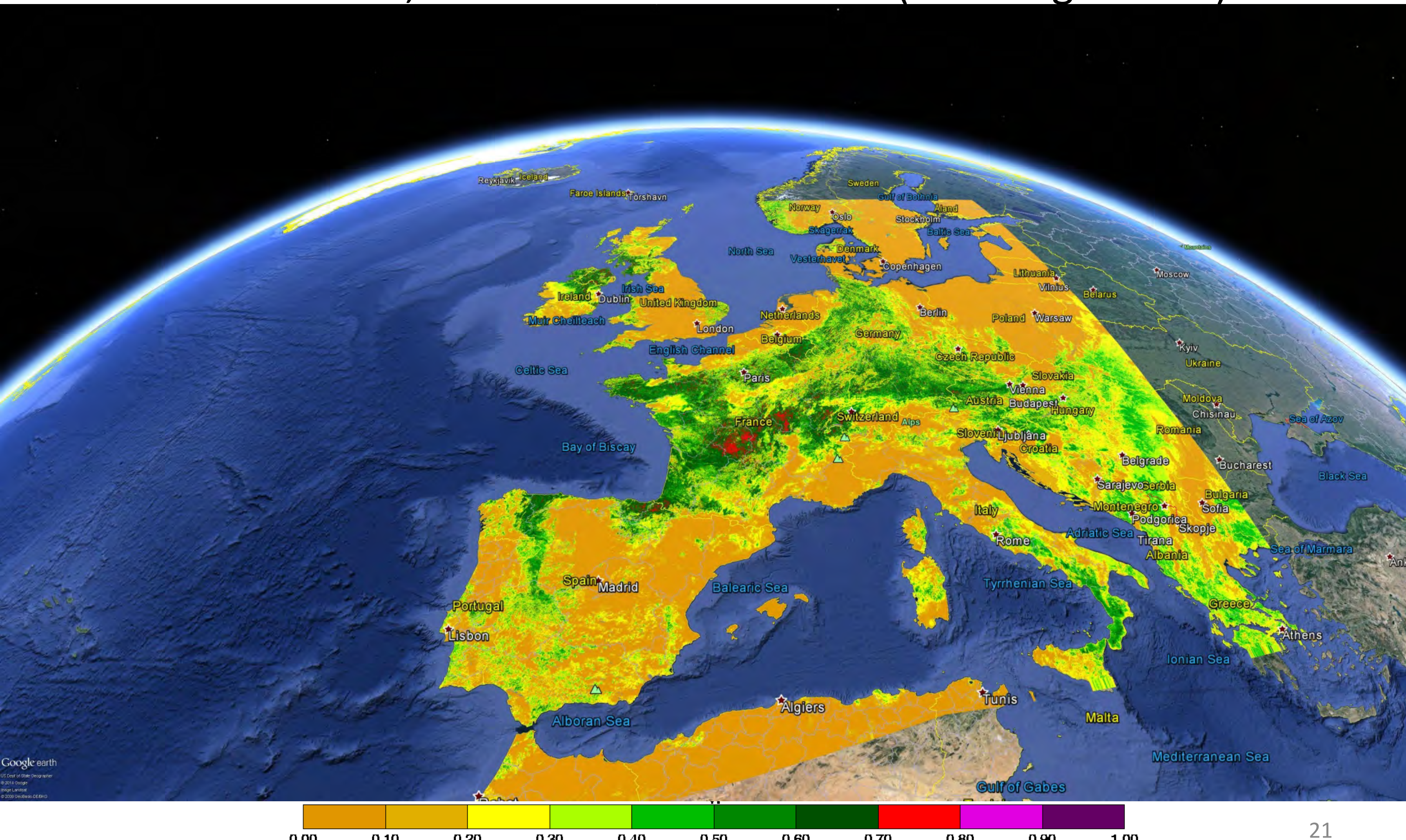
October 14, 2014 12:33 - 12:38 UTC (5 VIIRS granules)



M. Vargas et al., NOAA STAR

SNPP VIIRS TOA NDVI

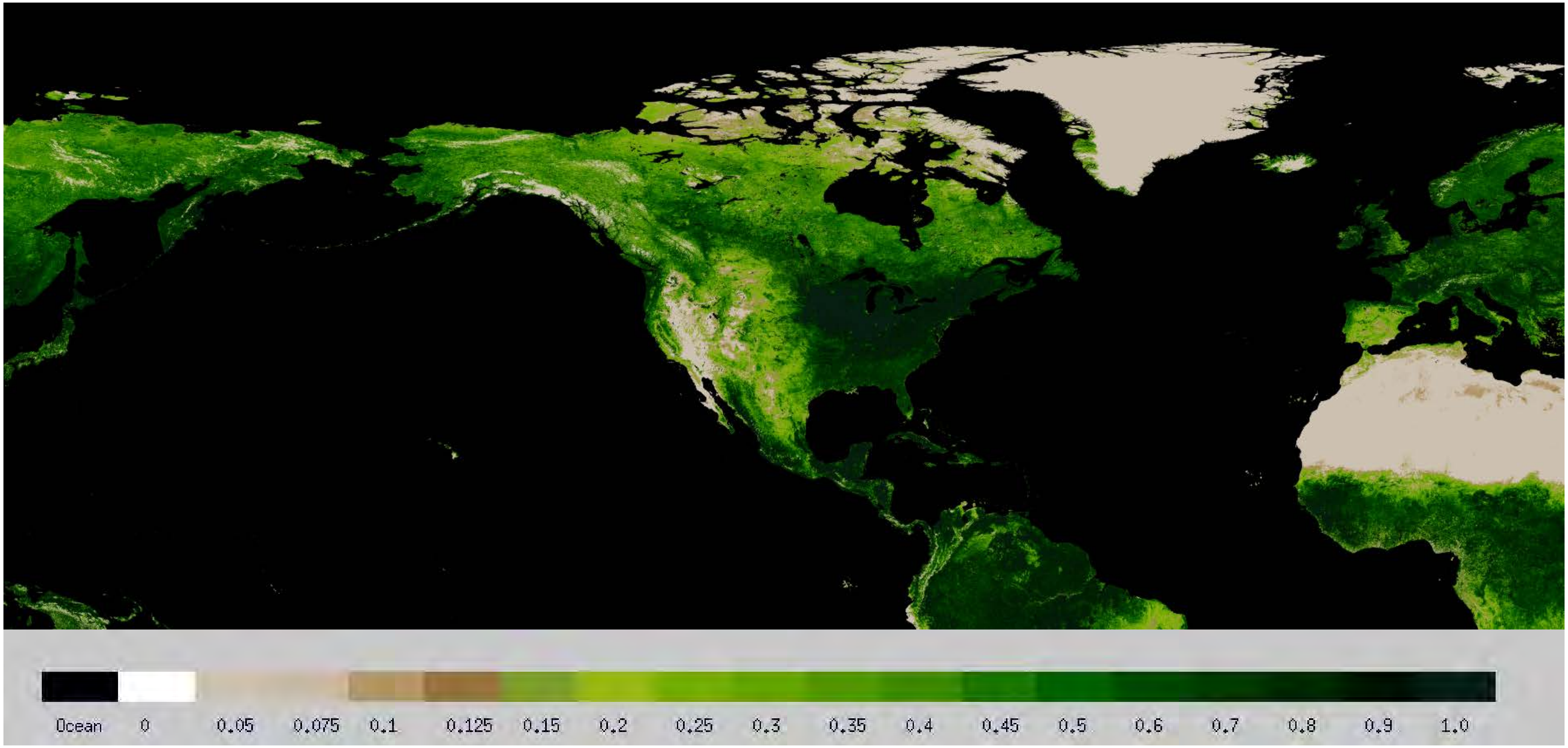
October 14, 2014 12:33 - 12:38 UTC (5 VIIRS granules)



M. Vargas et al., NOAA STAR

VIIRS Green Vegetation Fraction

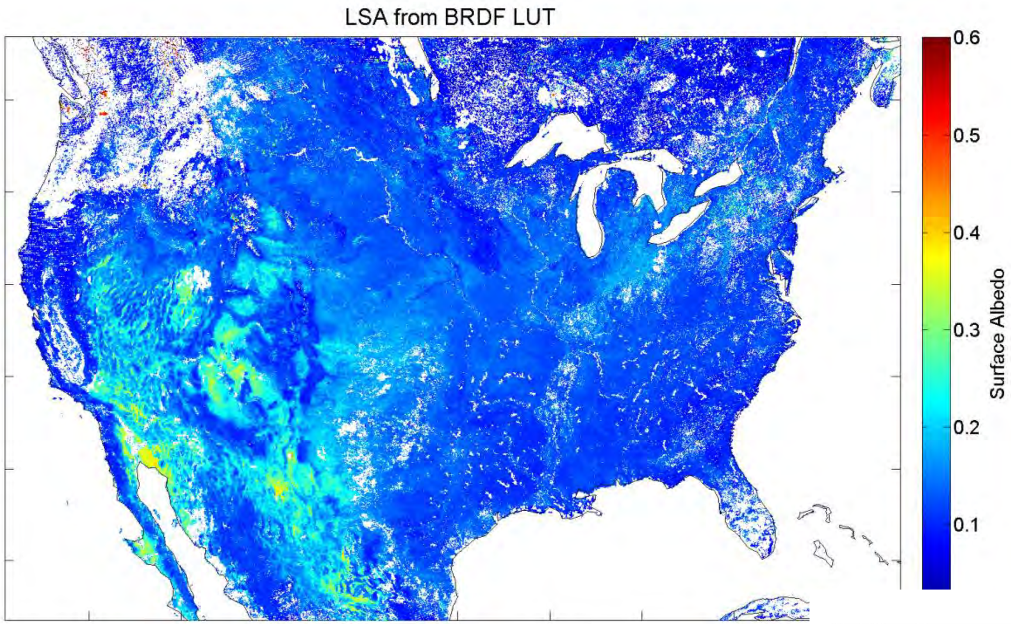
1-km Regional GVF (Sep 1-7, 2014)



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

M. Vargas et al., NOAA STAR

Maps of 16-day mean albedo

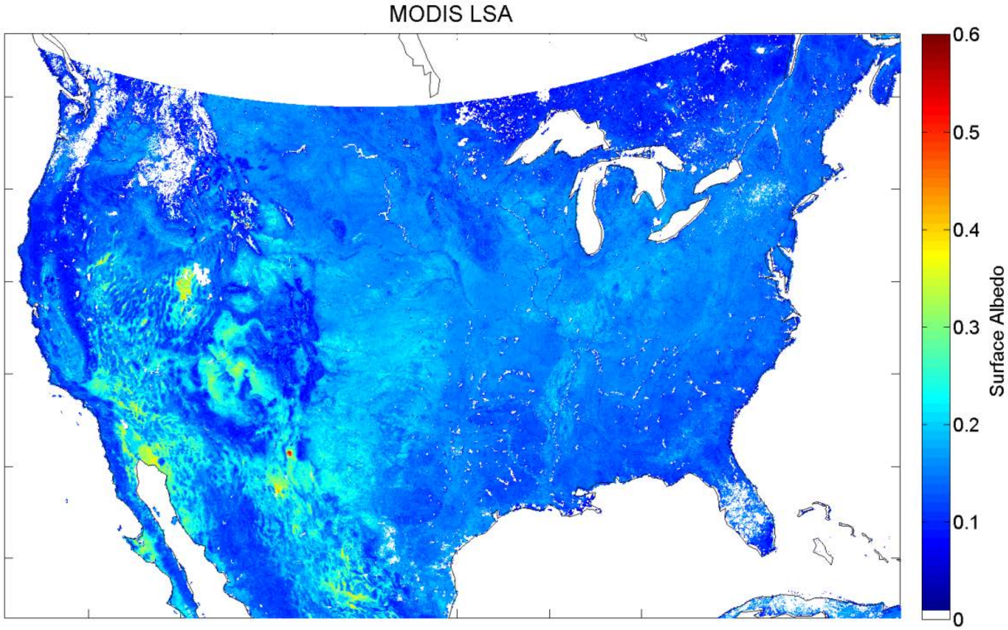


An LUT update for the VIIRS provisional albedo (BPSA – Bright Pixel Surface Albedo) is being implemented in IDPS Mx8.6 (October 2014)

Contiguous US maps of 16-day (DOY 145-160, 2012) mean LSA and MODIS albedo.

Top: the VIIRS BPSA albedo

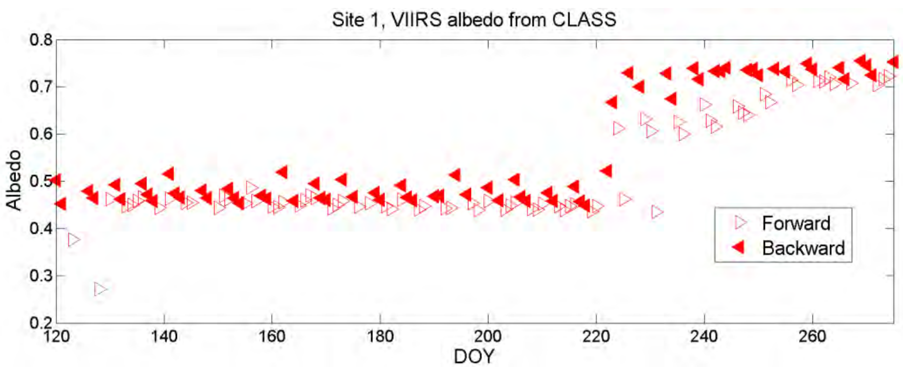
Bottom: the MODIS albedo

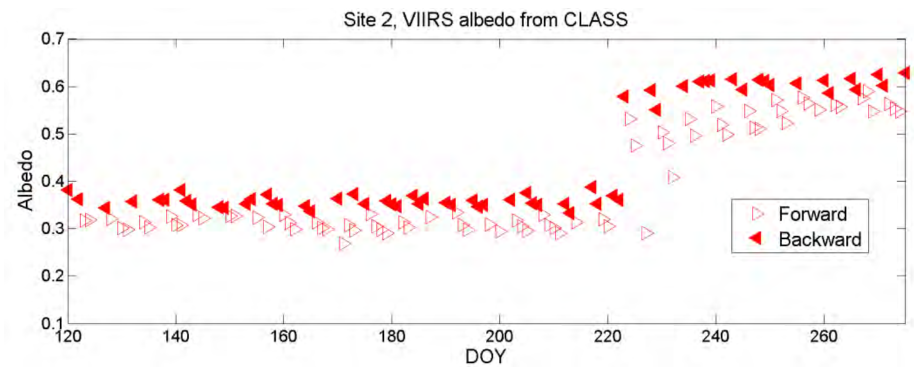


Y. Yu et al., NOAA STAR

Land Surface Albedo

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.

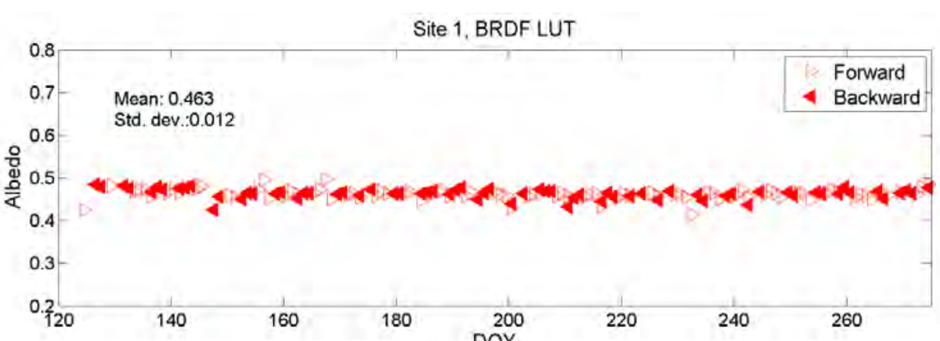


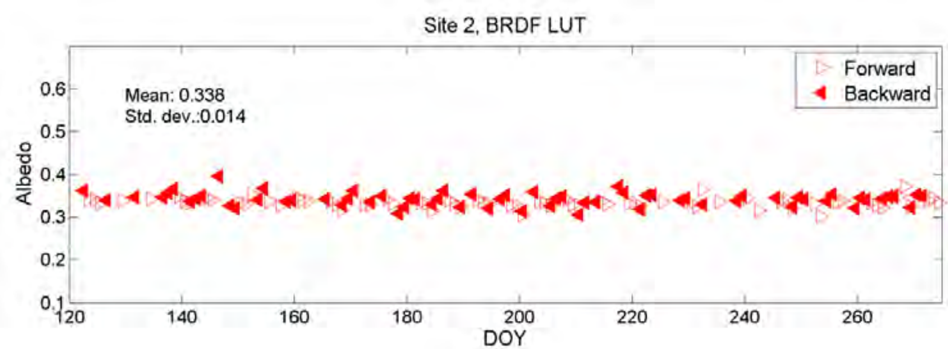


“Forward” means pixels with relative azimuth angle >90° and “backword” means those with relative azimuth angle <90°.
Jumps around 8/9 were caused by the bugs in a early version of the operational codes.

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.





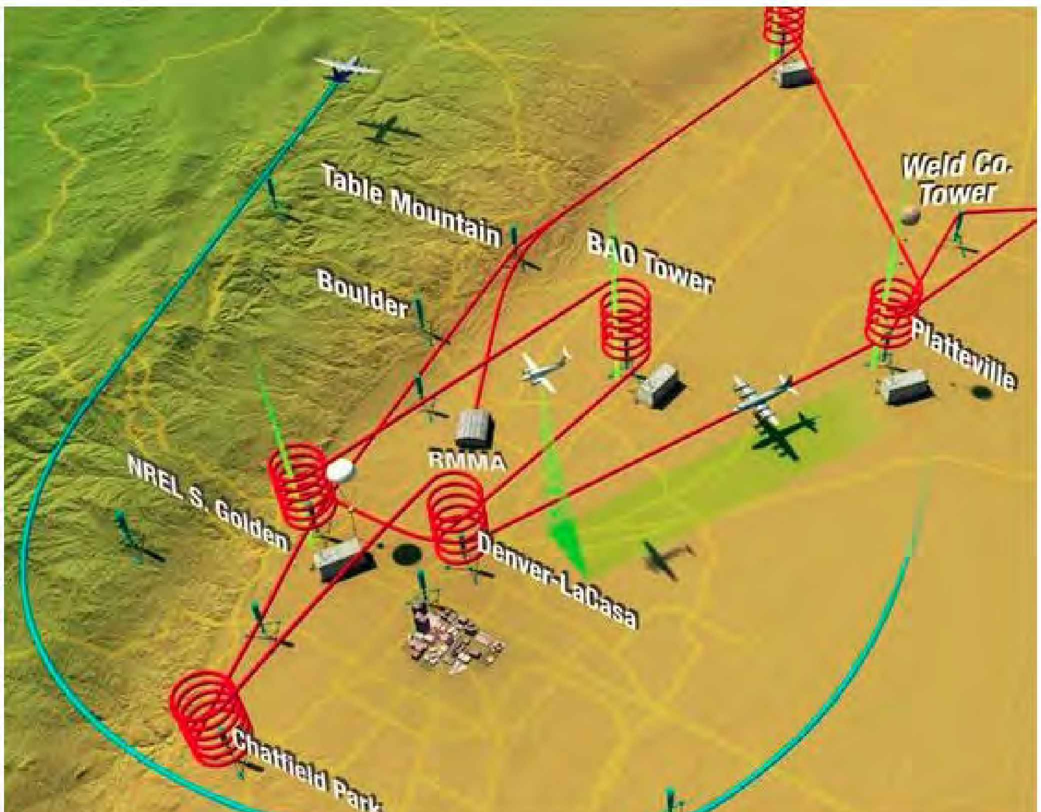
Y. Yu, NOAA/STAR, D. Wang (UMD)

Ongoing Land Validation Activities

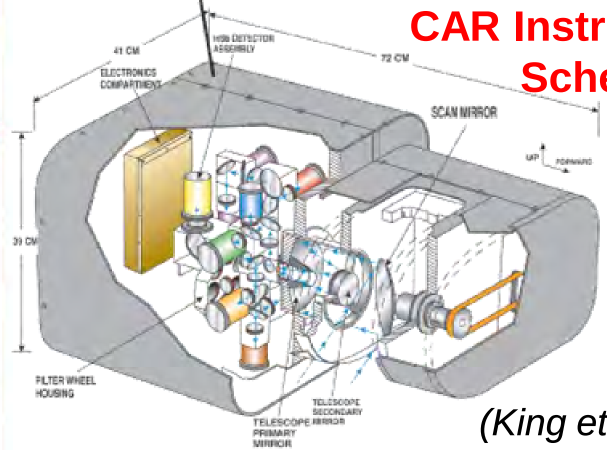
NASA
@NASA

Our #DISCOVERAQ air pollution field campaign is heading to Denver. go.nasa.gov/1ohdmSN #EarthRightNow

Reply Retweeted Favorite More



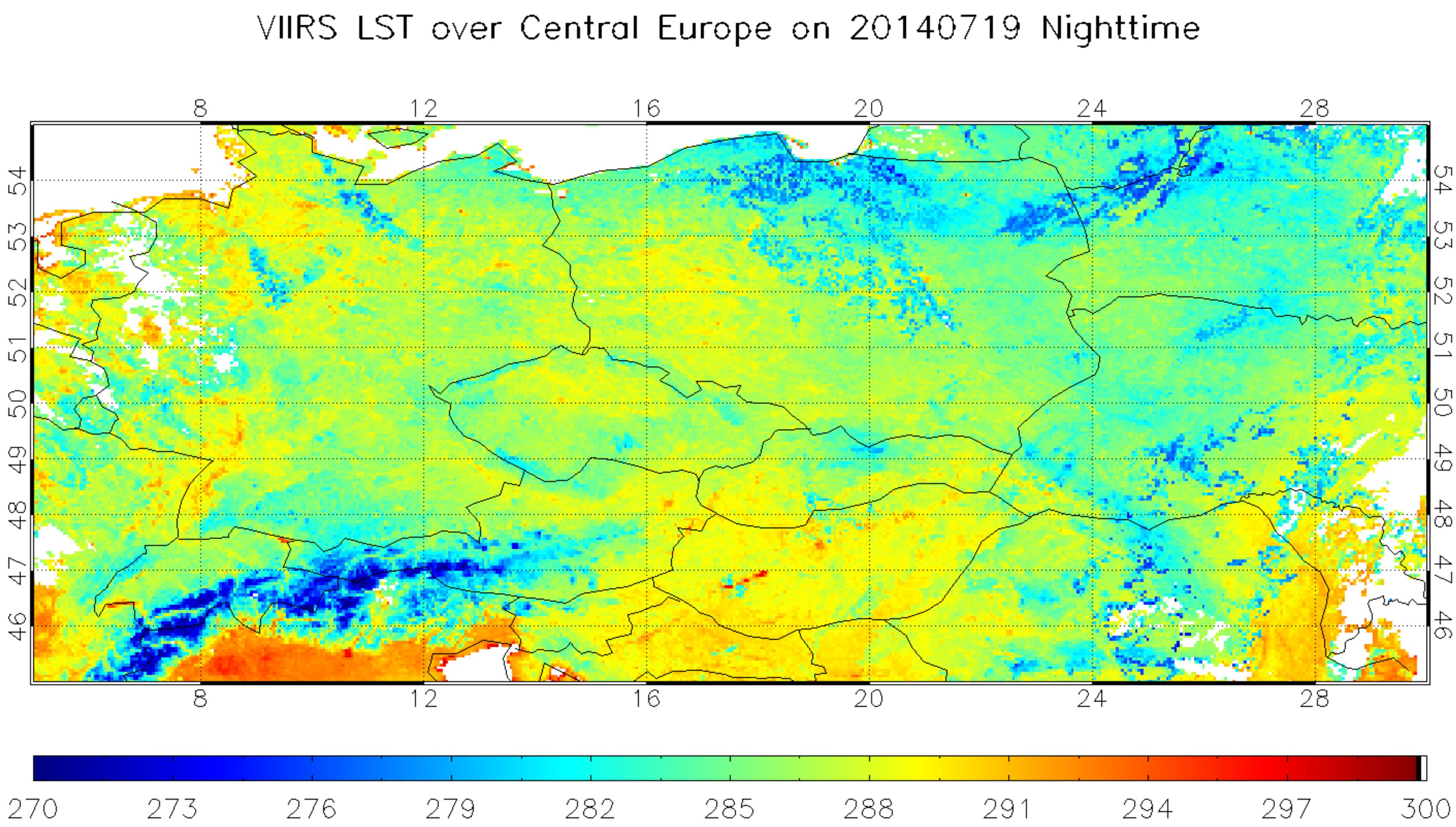
CAR Instrument Schematic



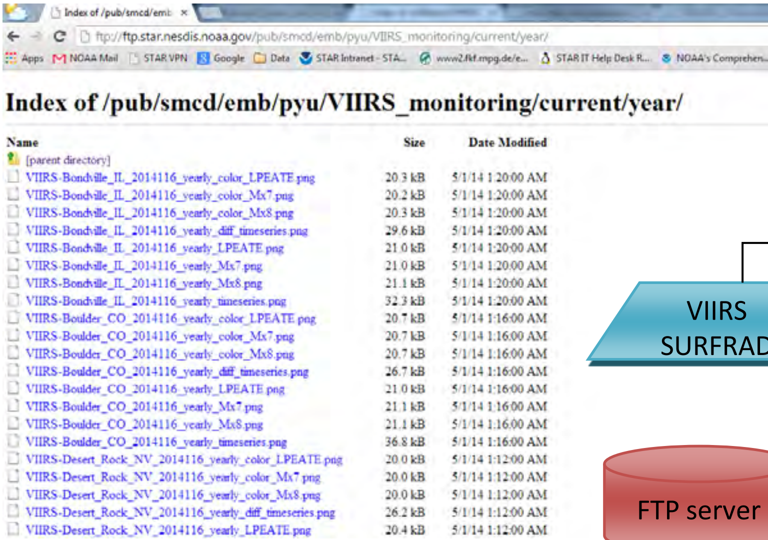
(King et al., 1986)
(Gatebe et al., 2003)

Spiral flight patterns are being taken at multiple heights to achieve an even sampling of the surface reflectance anisotropy (aka BRDF).

VIIRS Land Surface Temperature



LST Product Monitoring



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

Name	Size	Date Modified
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VIIRS-Bondville_IL_2014116_yearly_color_Mx8.png	20.3 kB	5/1/14 1:20:00 AM
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VIIRS-Boulder_CO_2014116_yearly_Mx7.png	21.1 kB	5/1/14 1:16:00 AM
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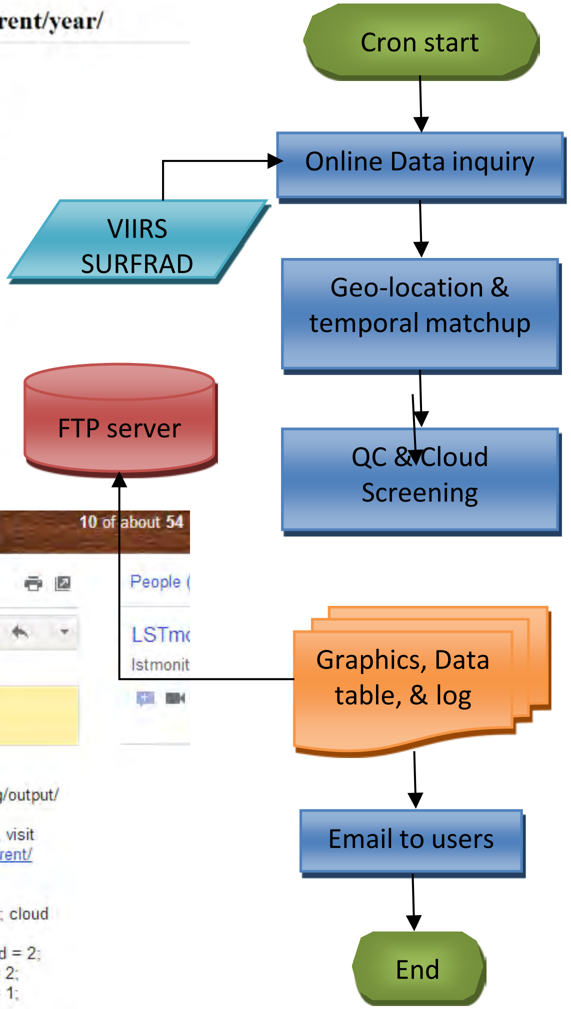
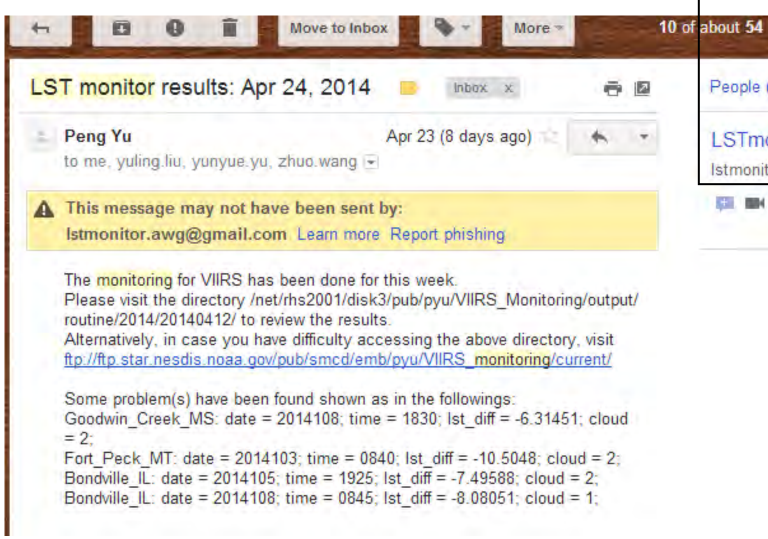




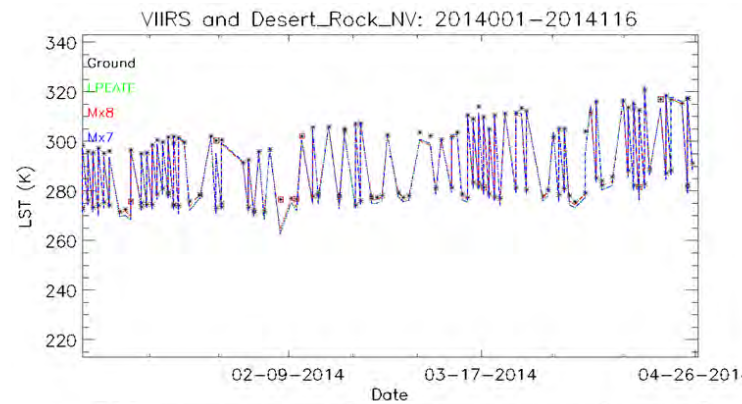
LST monitor results: Apr 24, 2014

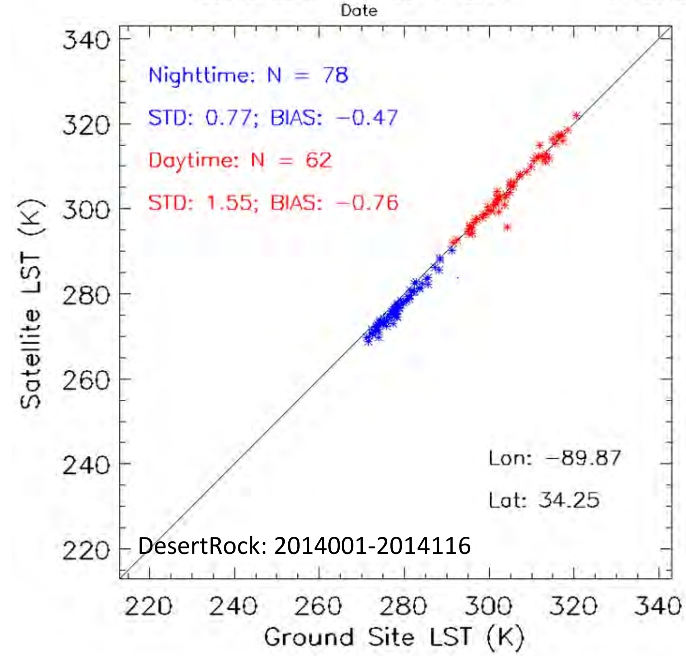
Peng Yu Apr 23 (8 days ago)
to me, yuling.liu, yunyue.yu, zhuo.wang

This message may not have been sent by: lstmonitor.awg@gmail.com Learn more Report phishing

The monitoring for VIIRS has been done for this week.
Please visit the directory /net/rhs2001/disk3/pub/pyu/VIIRS_Monitoring/output/routine/2014/20140412/ to review the results.
Alternatively, in case you have difficulty accessing the above directory, visit ftp://ftp.star.nesdis.noaa.gov/pub/smcd/emb/pyu/VIIRS_monitoring/current/

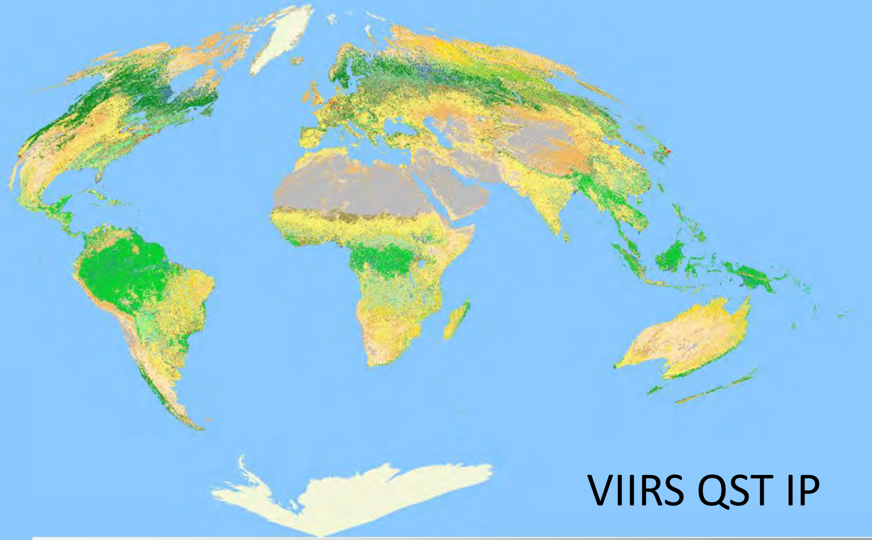
Some problem(s) have been found shown as in the followings:
Goodwin_Creek_MS: date = 2014108; time = 1830; lst_diff = -6.31451; cloud = 2;
Fort_Peck_MT: date = 2014103; time = 0840; lst_diff = -10.5048; cloud = 2;
Bondville_IL: date = 2014105; time = 1925; lst_diff = -7.49588; cloud = 2;
Bondville_IL: date = 2014108; time = 0845; lst_diff = -8.08051; cloud = 1;



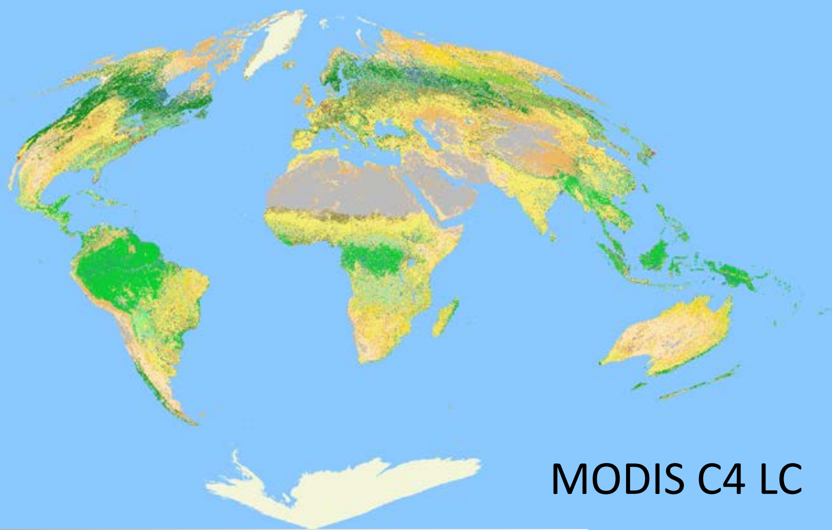


Y. Yu et al., NOAA STAR

Surface Type: Comparison with MODIS C4/C5 LC



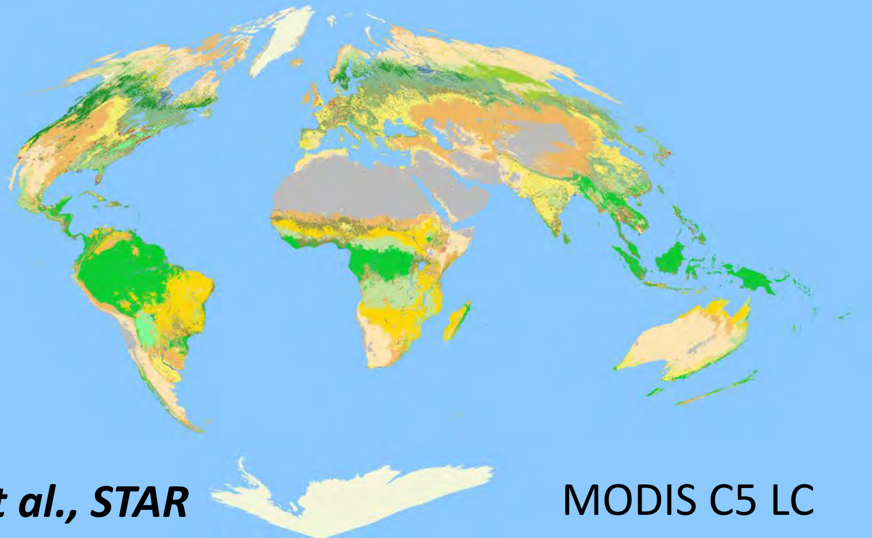
VIIRS QST IP



MODIS C4 LC

Legend

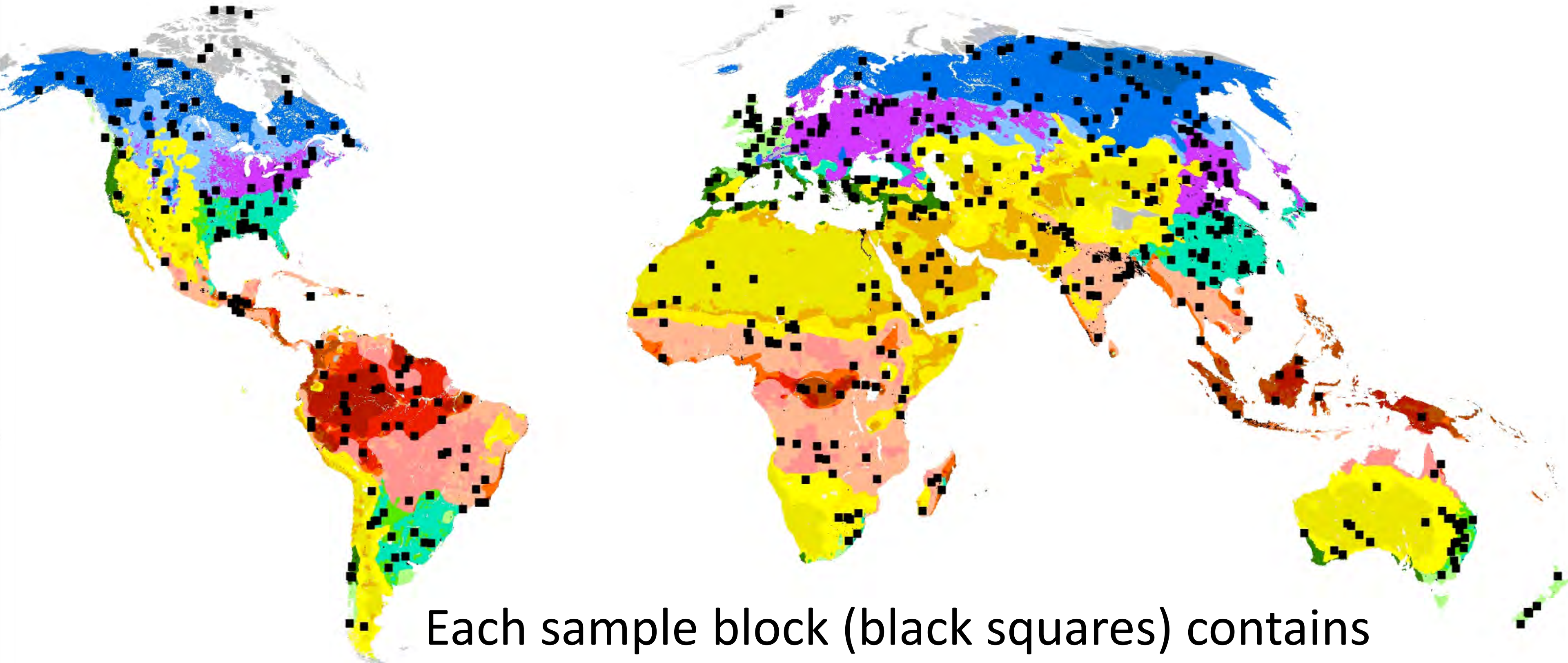
- Evergreen Needleleaf Forest
- Evergreen Broadleaf Forest
- Deciduous Needleleaf Forest
- Deciduous Broadleaf Forest
- Mixed Forest
- Closed Shrublands
- Open Shrublands
- Woody Savannas
- Savannas
- Grasslands
- Permanent Wetlands
- Croplands
- Urban and Built-Up
- Cropland/Natural Vegetation Mosaic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



MODIS C5 LC

X. Zhan et al., STAR

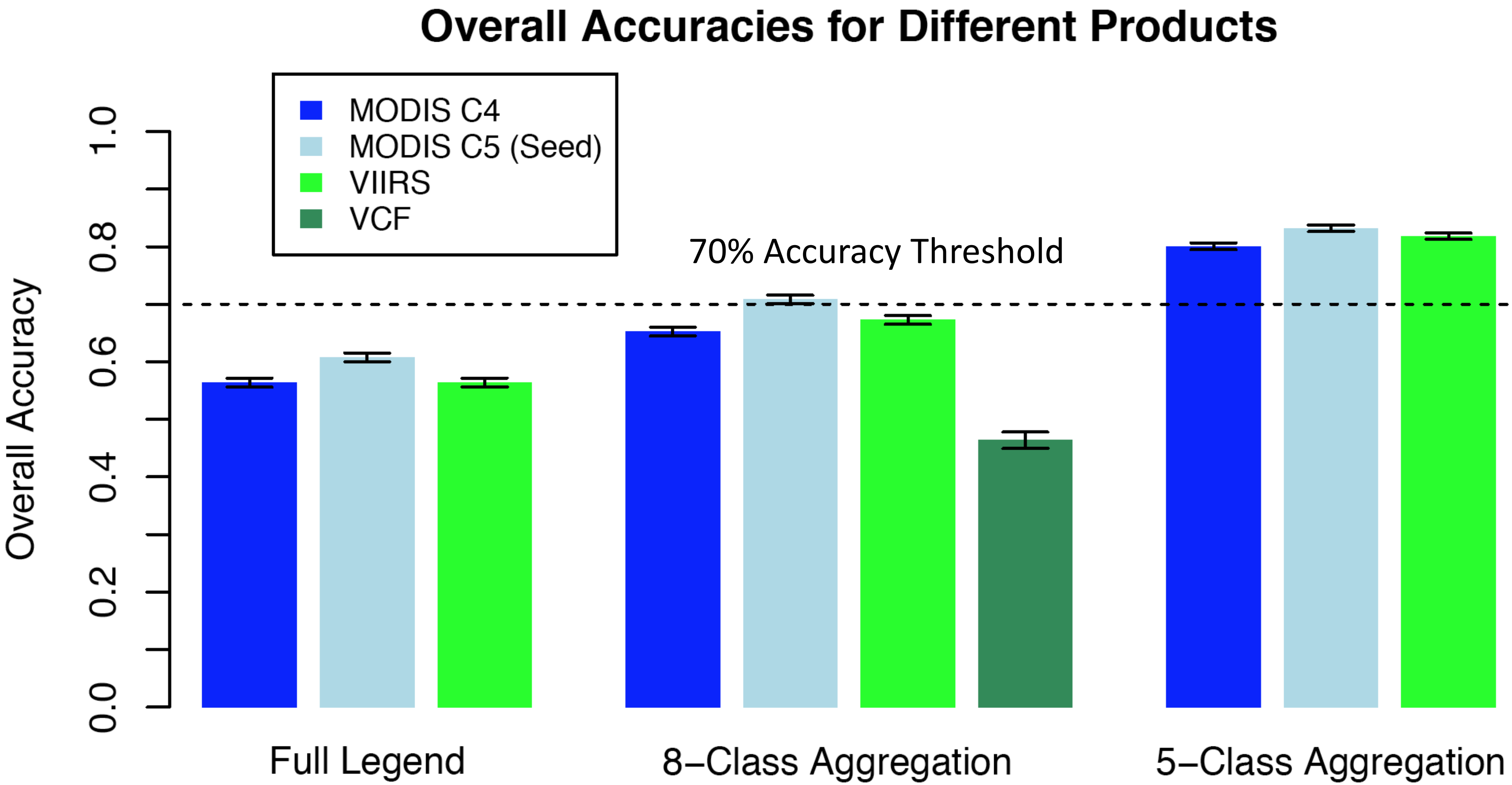
Validation Sample Design



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

M. Friedl , D. Sulla-Menashe (BU)

Surface Type Validation Results

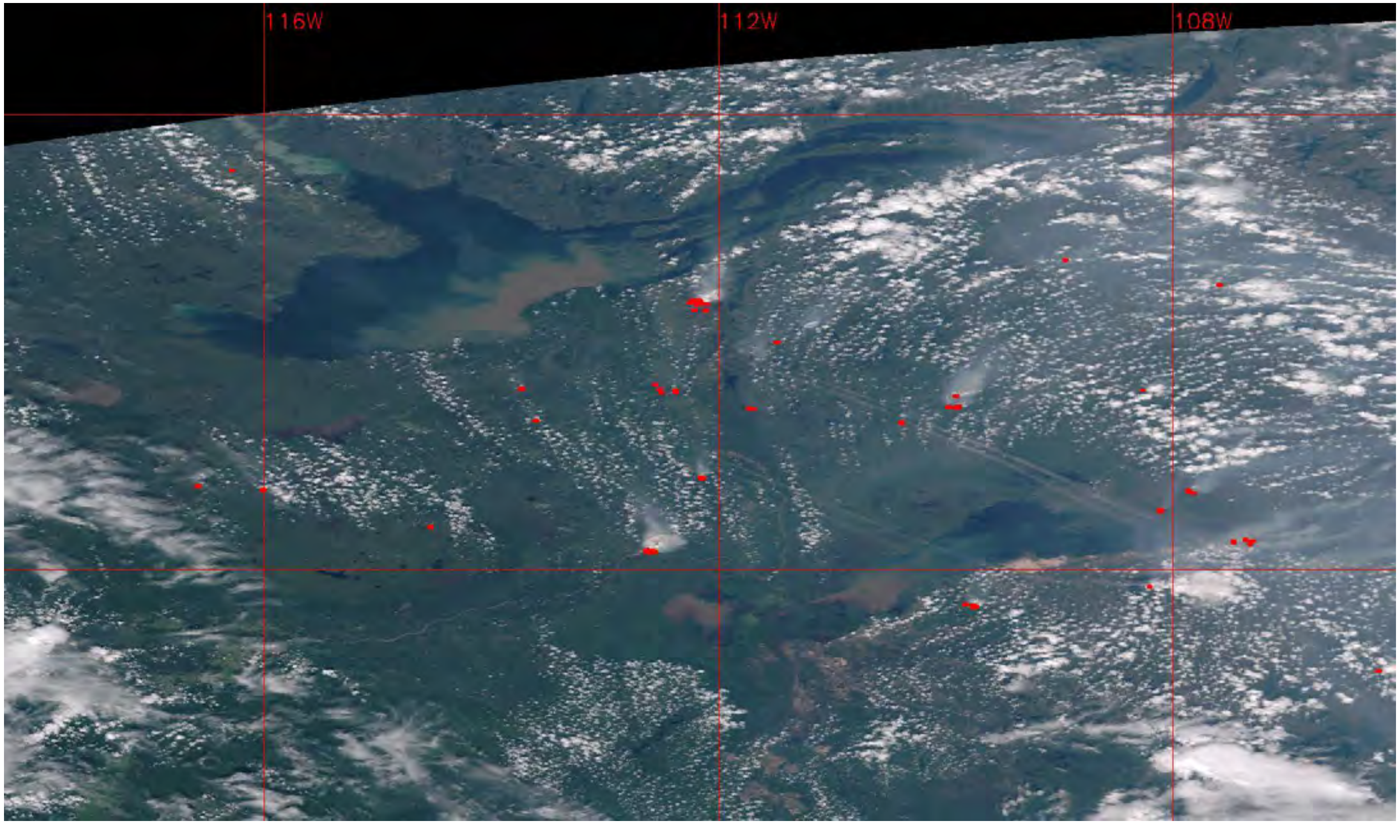


There is more variance in overall accuracies across aggregation levels than between maps.

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.

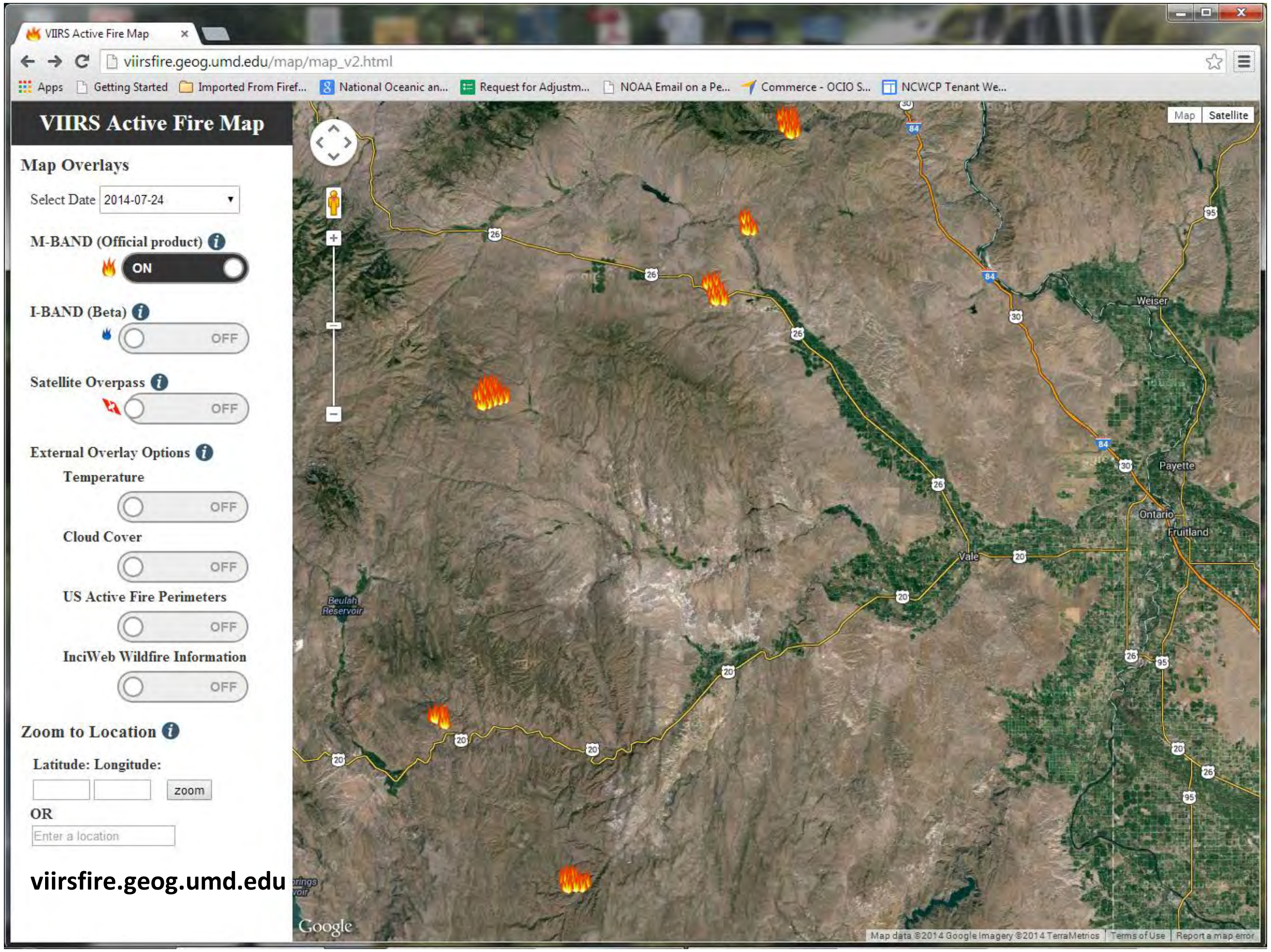


NW Canada
07 July 2013
20:14:55-20:20:34 UTC

VIIRS Fire Product and User Outreach

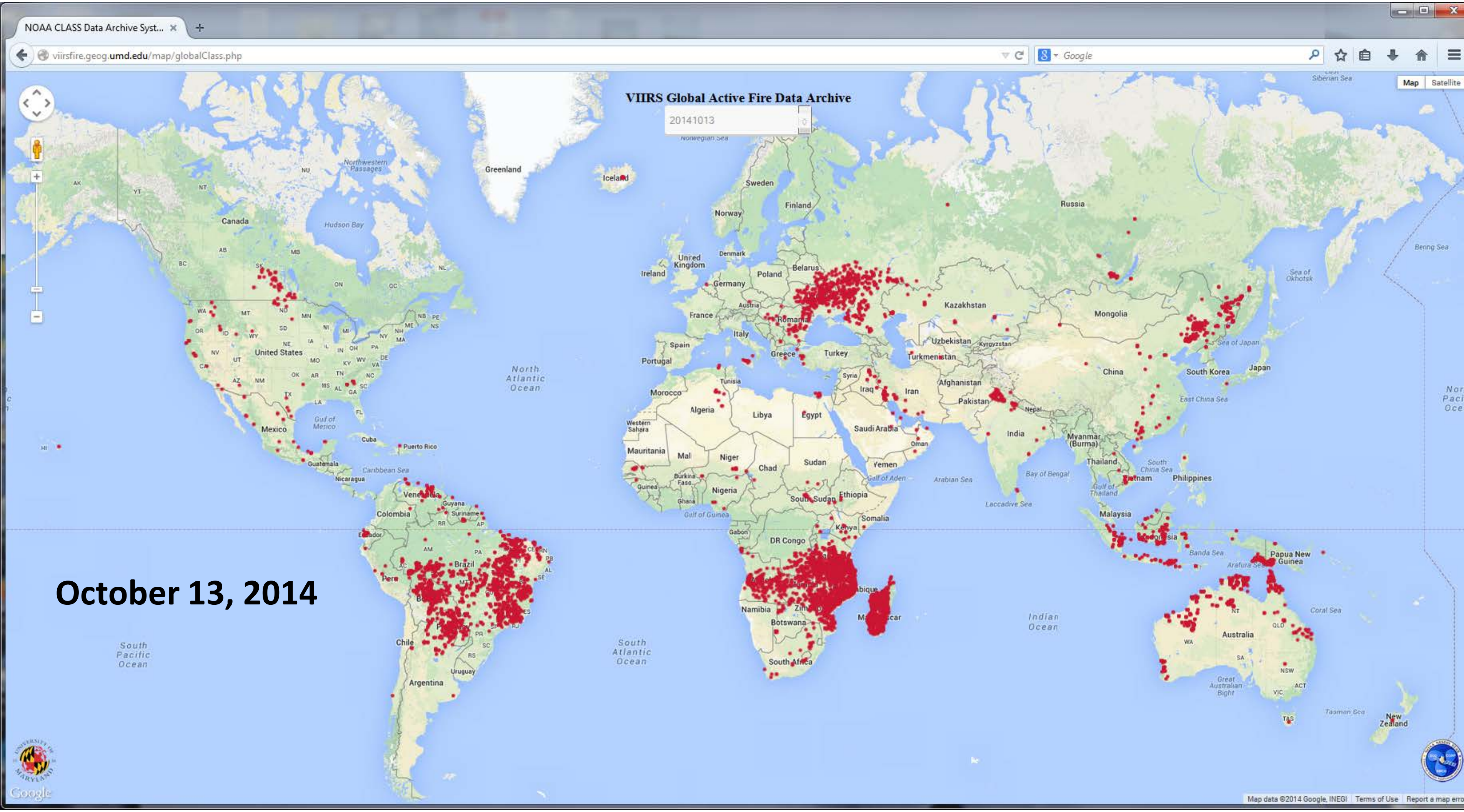
- The operational SNPP VIIRS Active Fire product is a sparse array containing **locations of pixels** flagged as "fire" by the detection algorithm
- The science team is developing a suite of improved products, including **fire radiative power to characterize the fire intensity**
- End users are engaged through **Proving Ground and User Readiness efforts**

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



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 .

NOAA VIIRS Fire Product



October 13, 2014

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

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

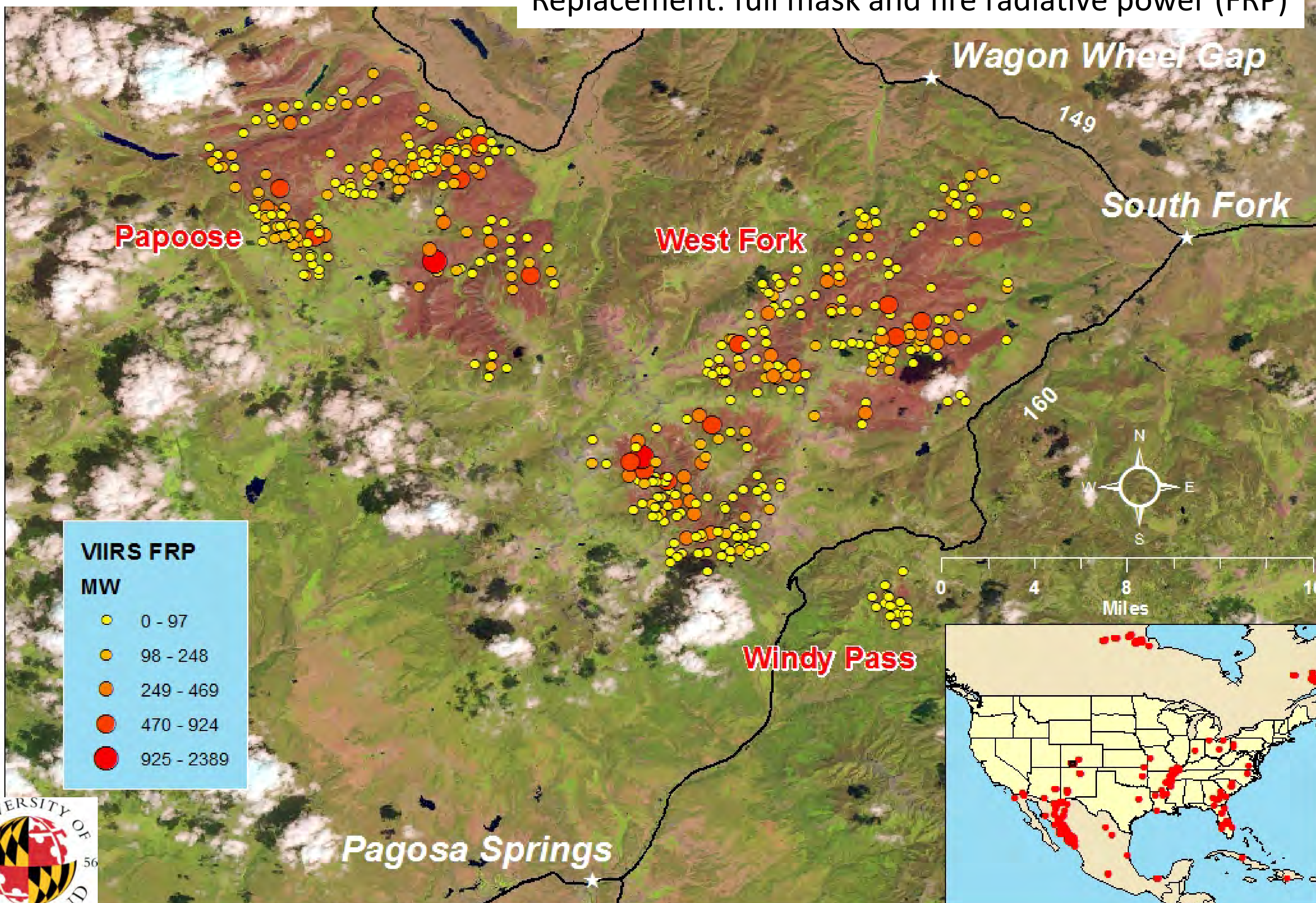
West Fork Complex: 6/14 - 7/4/201

Landsat-8 background: July 31, 2013

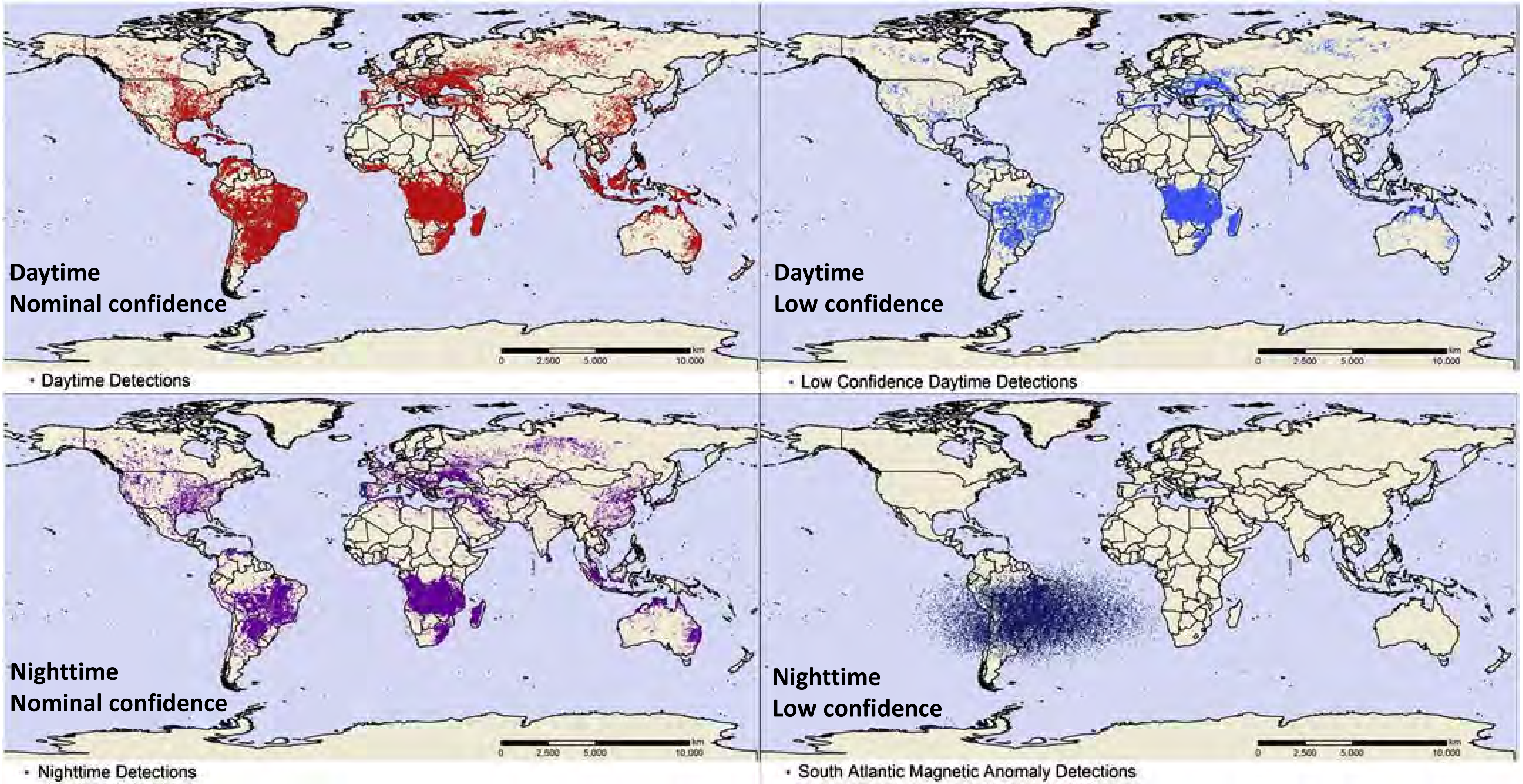
New MODIS-compatible Active Fire product

Current: locations only

Replacement: full mask and fire radiative power (FRP)



Global fires from VIIRS I-band data

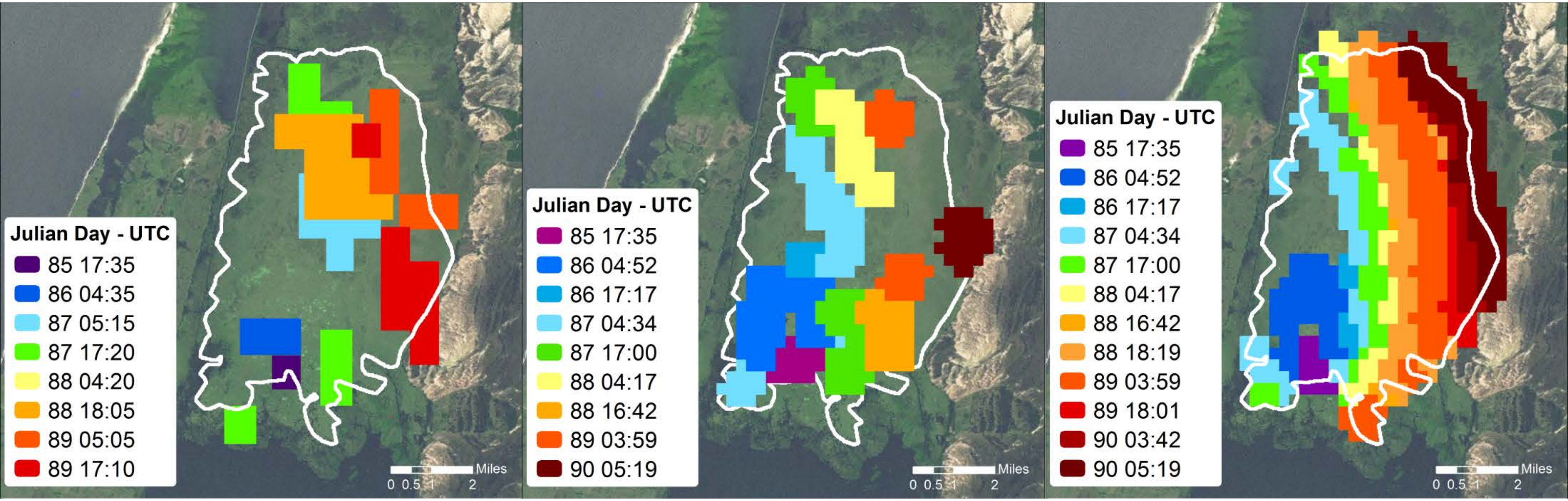


VIIRS 375 m fire algorithm output showing the accumulated daytime nominal confidence fire pixels (upper left), low confidence daytime pixels (upper right), nighttime fire pixels (purple; lower left), and SAMA-related low confidence nighttime pixels (dark blue; lower right) during 1–30 August 2013.

Wilfrid Schroeder, Patricia Oliva, Louis Giglio, Ivan A. Csiszar, The New VIIRS 375 m active fire detection data product: Algorithm description and initial assessment, Remote Sensing of Environment, Volume 143, 5 March 2014, Pages 85-96, ISSN 0034-4257, http://dx.doi.org/10.1016/j.rse.2013.12.008.

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

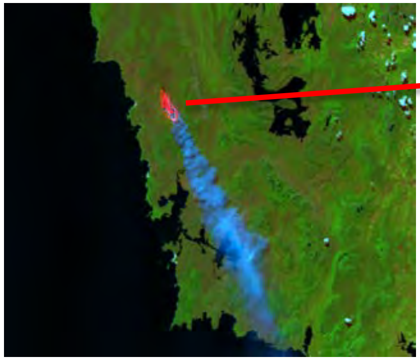
Wildfire in southern Brazil, March/2013

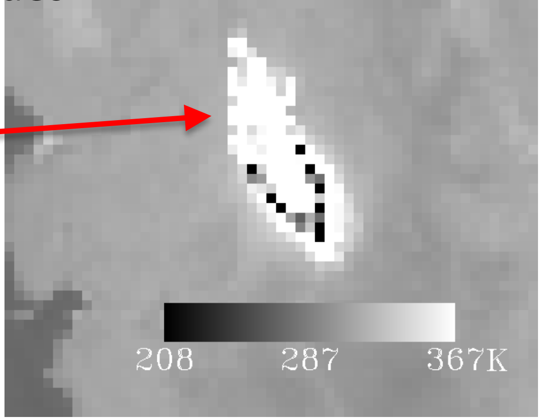


Aqua/MODIS 1 km
Spotty detection pixels and coverage gap at low latitudes

S-NPP/VIIRS 750 m
Spotty detection pixels

S-NPP/VIIRS 375 m
Improved fire line mapping





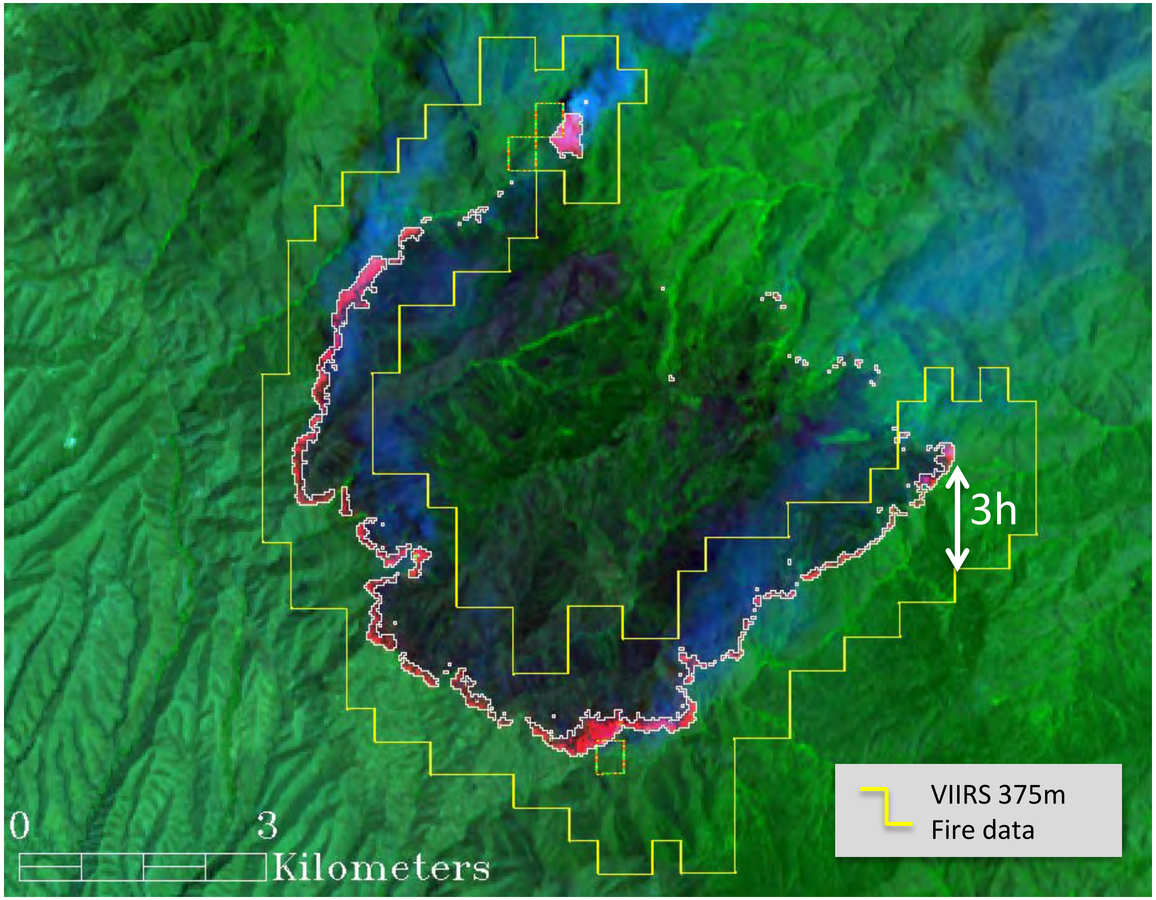
Issues of VIIRS fire detection:

- Anomalous behavior at sensor saturation
- Inconsistent quality flags
- Unknown saturation of native resolution pixels prior to aggregation (single-gain bands)
- South Atlantic Magnetic Anomaly

W. Schroeder, UMD

New Landsat-8 30 m Active Fire Data

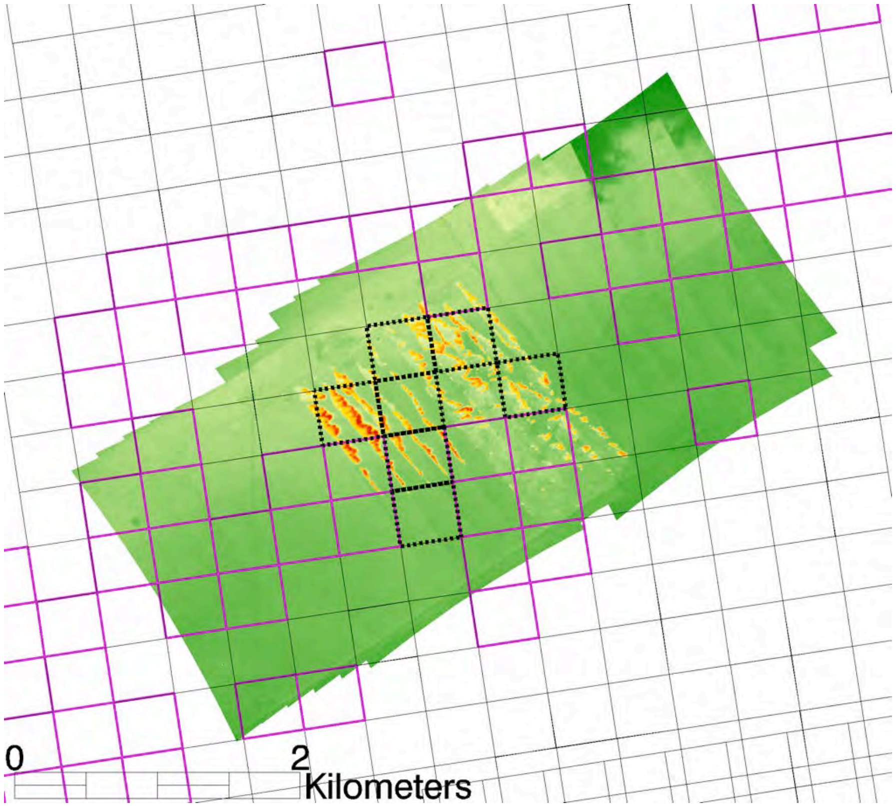
Built on proven ASTER/Landsat (5&7) fire algorithms [Giglio *et al.*, 2008; Schroeder *et al.*, 2008]
Day & nighttime detections 16/8-day revisit (day/&night)
Spatial resolution providing detailed fire perimeter information (plus area estimate)



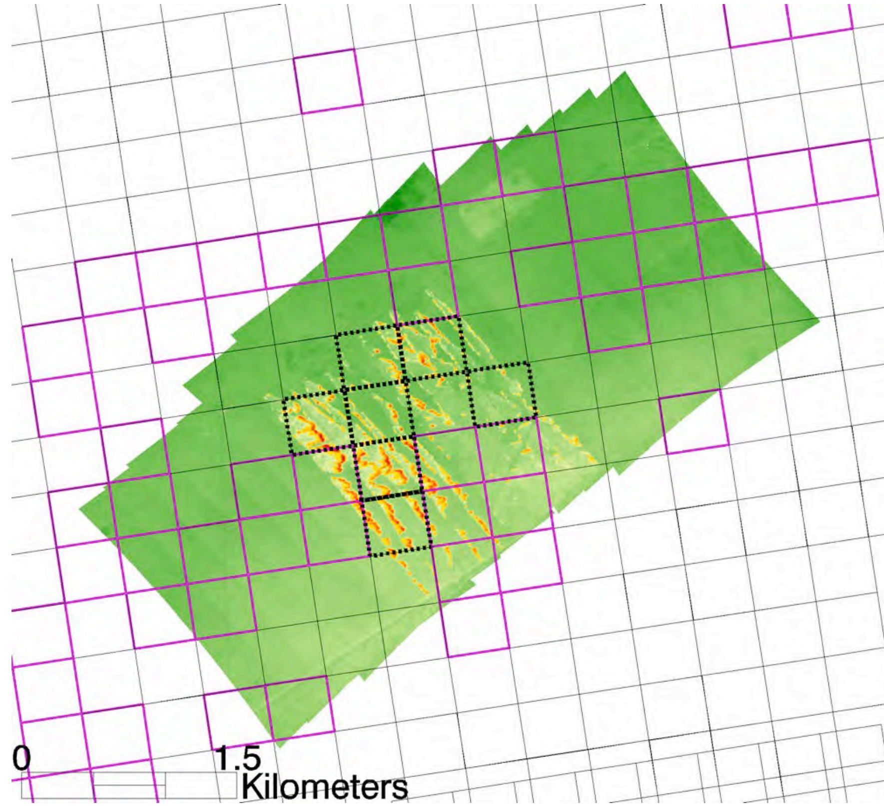
W. Schroeder, UMD

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)



VIIRS 18:59:54 UTC
WASP 18:58:55-18:59:43 UTC

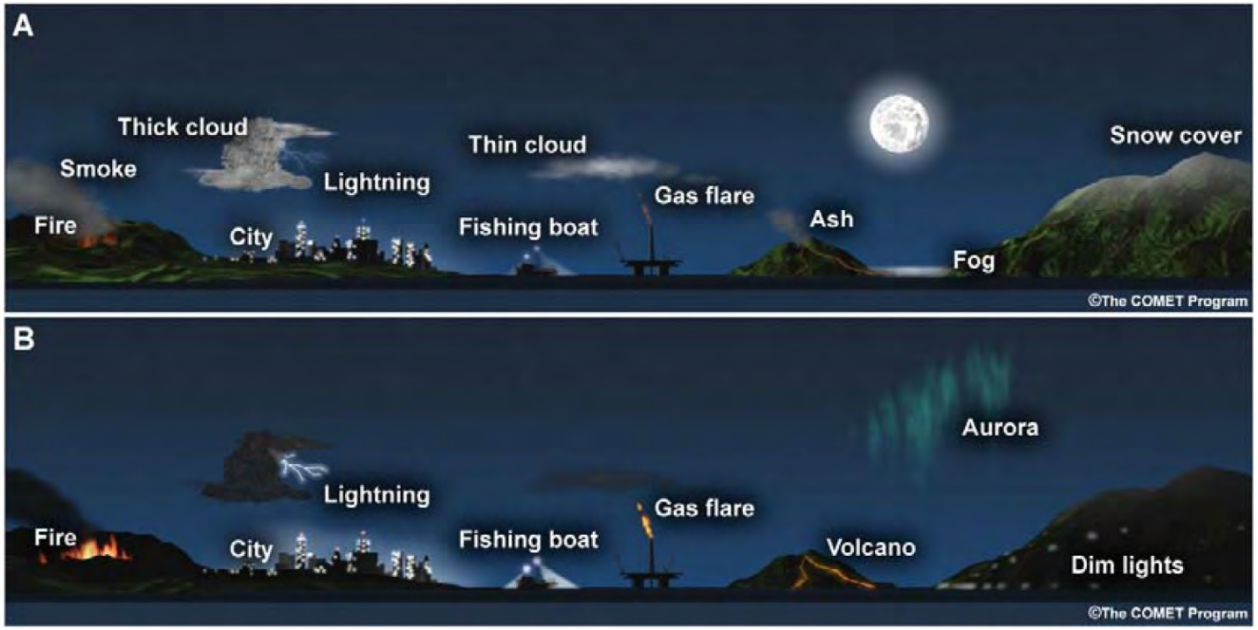


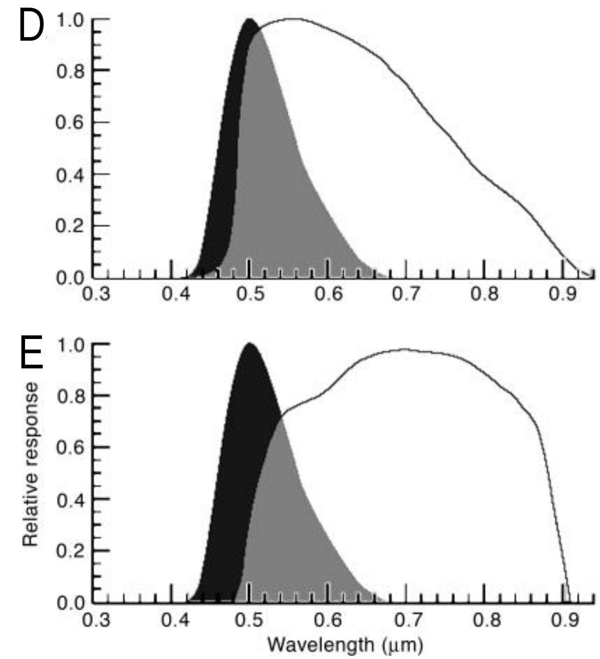
VIIRS 18:59:54 UTC
WASP 19:03:05-19:03:44 UTC

Cloud pixel
Fire pixel
Land pixel

W. Schroeder, UMD

VIIRS DNB nighttime detection capabilities (A) with and (B) without lunar illumination*



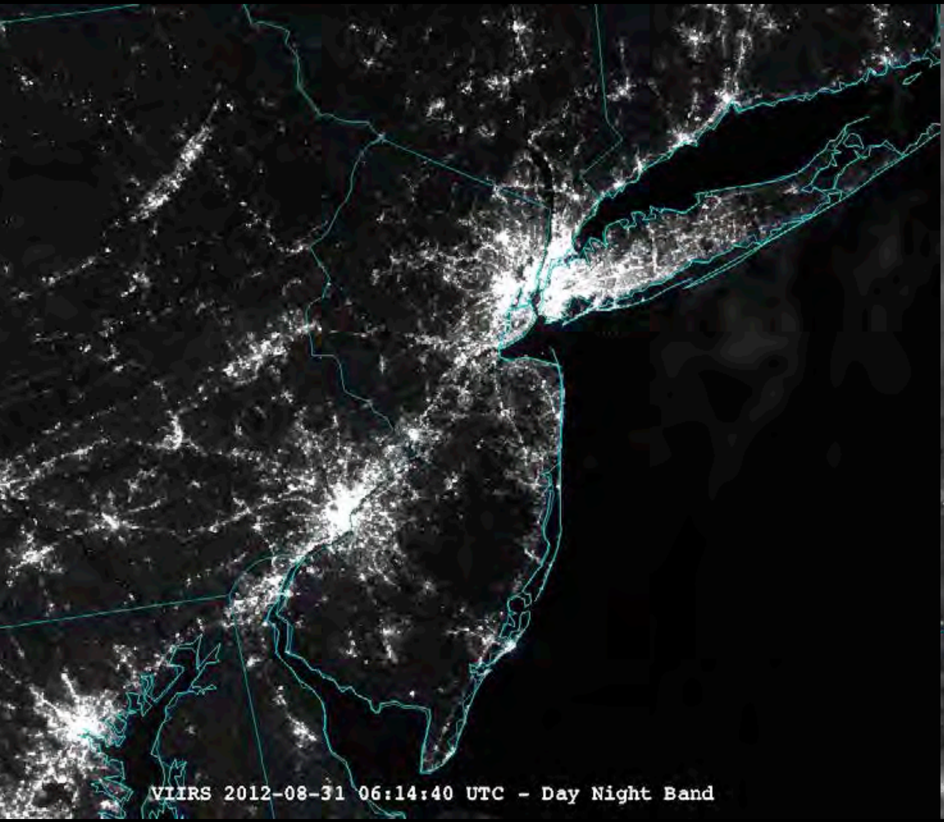


Bioluminescent bacteria (black area) compared with OLS (D.) and VIIRS (E.) spectral response functions. Regions of spectral overlap are shown in gray.

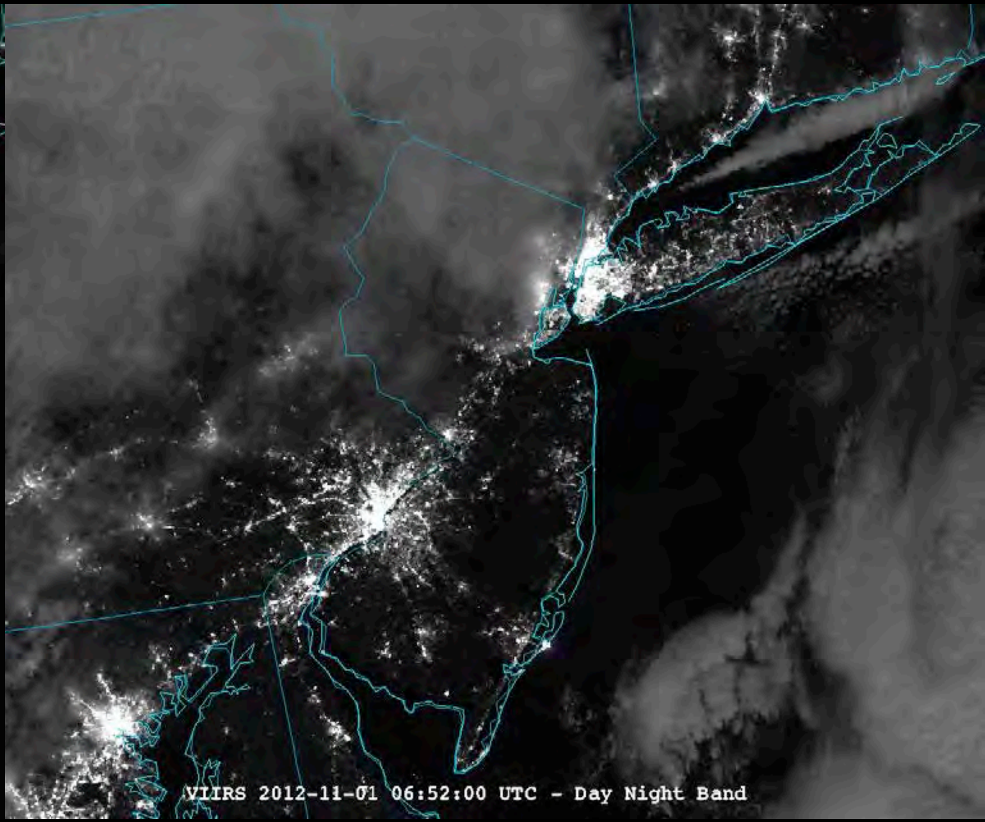
*JPSS does not have a requirement for low-light detection

from Miller et al., 2005

Infrastructure Changes: Outages During Hurricane Sandy



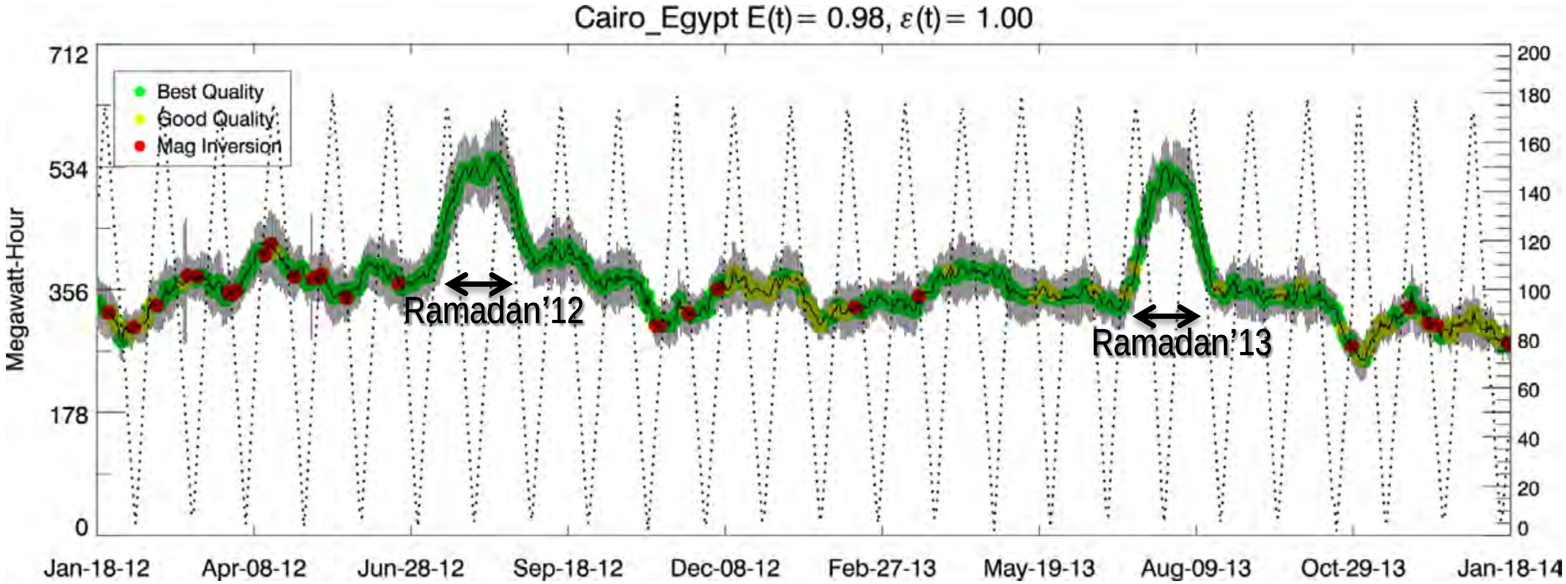
Before Power Outage

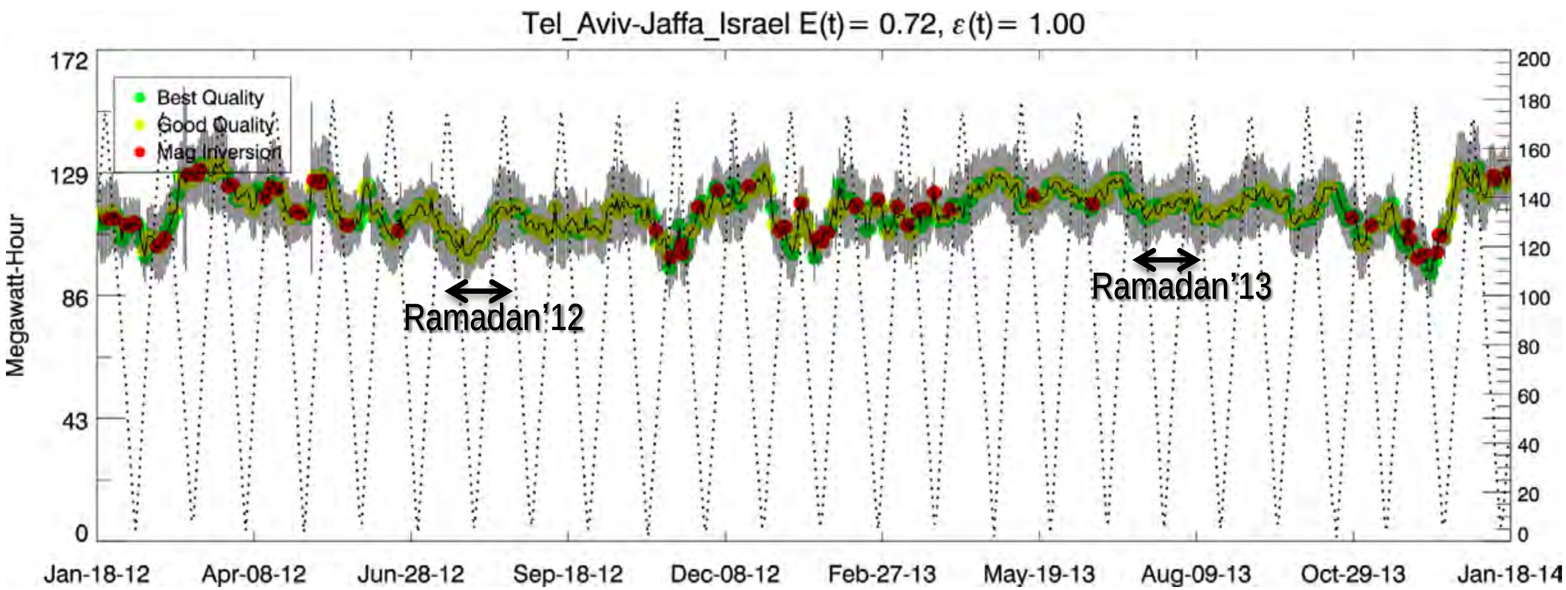


After Power Outage

Images from CIMSS, University of Madison Wisconsin

Outdoor Electricity Usage from Lighting (VIIRS C11 Reprocessing)





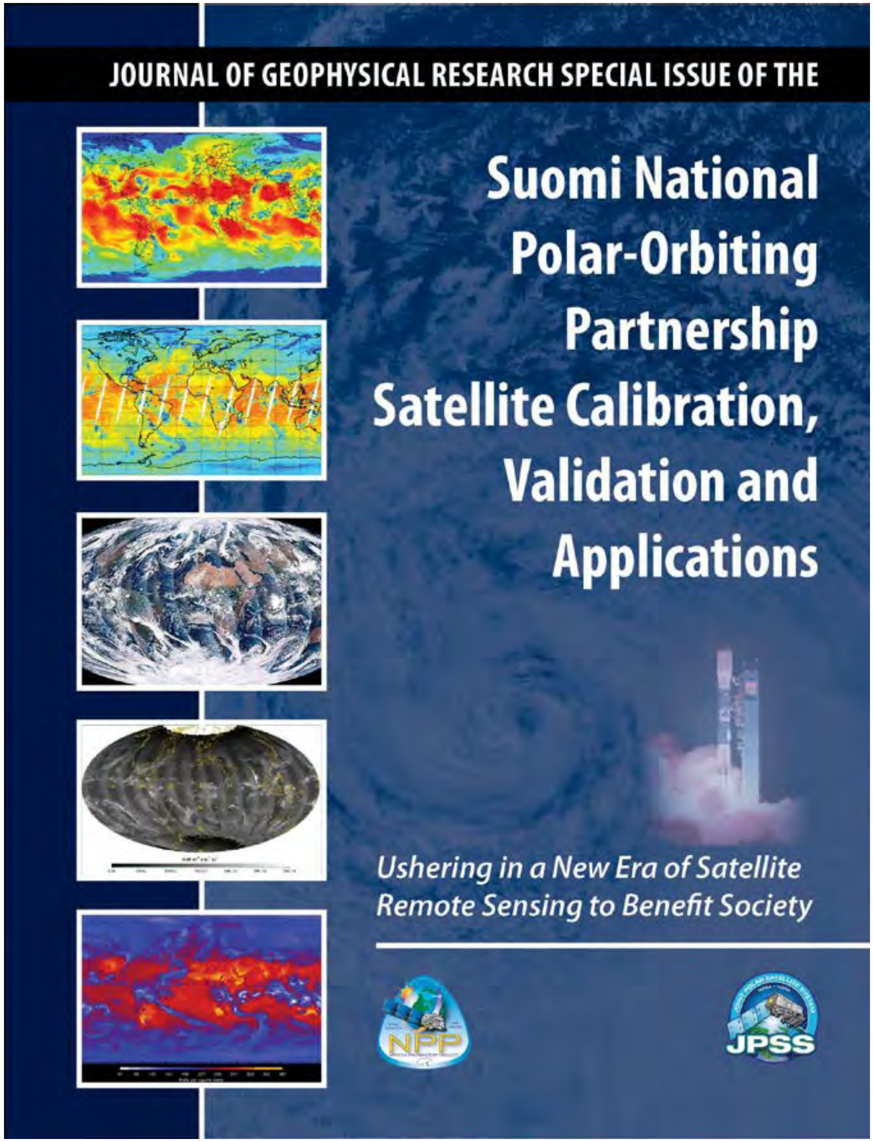
Román & Stokes (2014) submitted

Human Activity: Ramadan, 2012 (Jul19 – Aug 18) and 2013 (Jul 8-Aug 7)

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

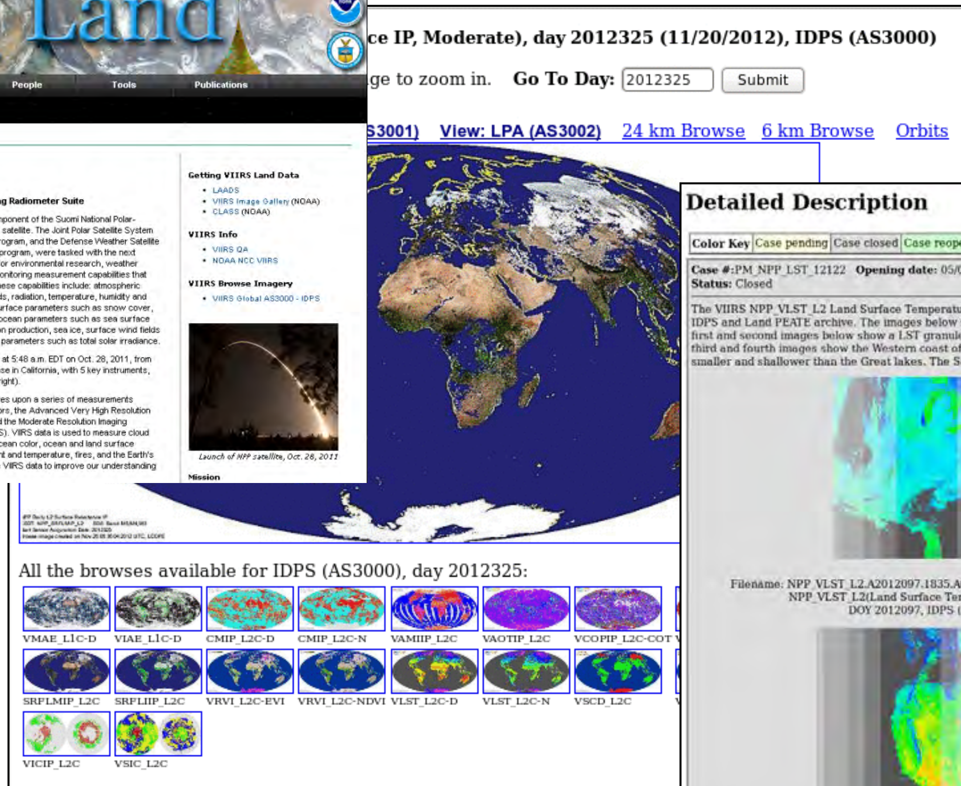


For more information

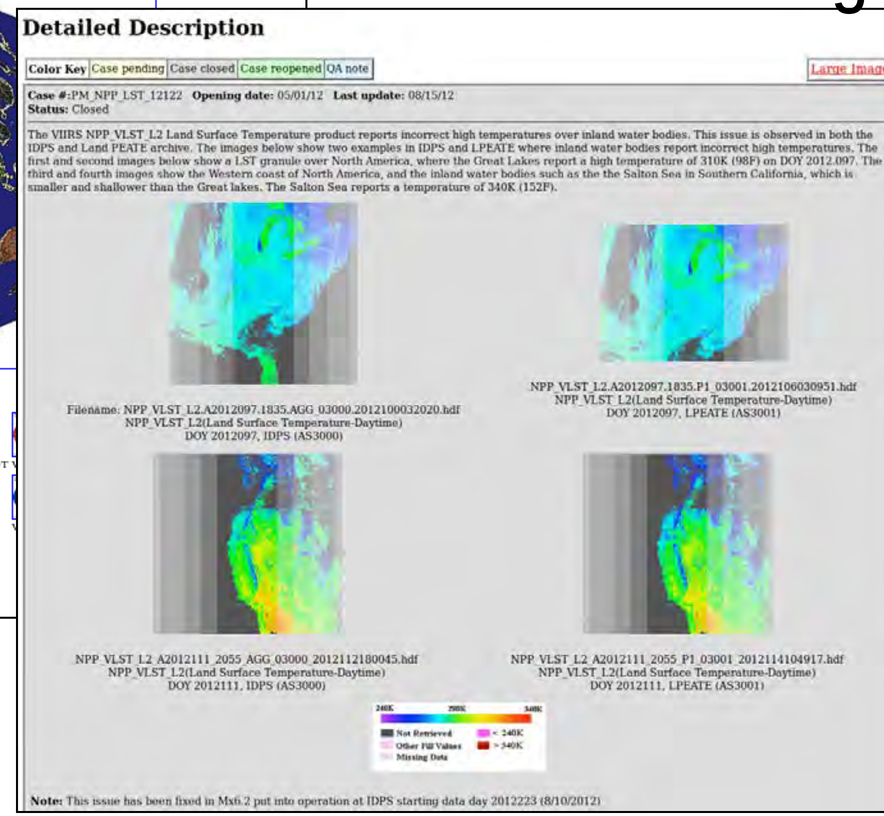
- NOAA JPSS
  http://www.jpss.noaa.gov/
- NOAA STAR JPSS
  http://www.star.nesdis.noaa.gov/jpss/
- NASA VIIRS Land
  http://viirsland.gsfc.nasa.gov/
- VIIRS Fire Evaluation and Data Portal
  http://viirsfire.geog.umd.edu
- STAR JPSS 2014 Annual Science Team Meeting
  http://www.star.nesdis.noaa.gov/star/meeting_2014JPSSAnnual_agenda.php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

Suomi-NPP VIIRS Land Website: http://viirsland.gsfc.nasa.gov/

VIIRS Global Browse



Known Issues Page



NASA's Land PEATE (Product Evaluation and Analysis Tool Element):

Meeting the needs of the Suomi-NPP Science Team and helping the NOAA IDPS.

Next Steps

- Continue to develop and enhance the IDPS generated products and NDE
  - New Level 1 requirements for TOC VI and full Active Fire mask and FRP
  - Proving ground for new ‘applications; products
- Form NASA VIIRS Land Science Team
  - Land SIPS = Land PEATE
  - SR, BRDF VI, LAI, Snow/Ice, Fire, Burned Area, Phenology, Ag Applications
  - Establish process for ATBD review
  - Move quickly to develop and distribute NASA VIIRS products
- Start to develop the NASA VIIRS Product Suite with an emphasis on MODIS Continuity
- Continue to liaise with NOAA / STAR concerning transition of improvements into the operational chain