River Ice and Flooding Initiative

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28 August 2018

Proving Ground and Risk Reduction Program Background

JPSS PGRR Background Definitions

- **Proving Ground**
  - Demonstration and utilization of data products by the end-user operational unit, such as a NWS Weather Forecast Office or Modeling Center.
  - Promote outreach and coordination of new products with the end users, incorporating their feedback for product improvements

- **Risk Reduction**
  - Development of new research and applications to maximize the benefits of JPSS satellite data
    - Example - use of Day Night Band for improved fog and low visibility products at night, benefiting transportation industry.
  - Encourages fusion of data/information from multiple satellite, models and in-situ data
  - Primary work is done at the algorithm and application developer's institution.
  - Address potential risk in algorithms and data products by testing alternative algorithms.

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JPSS PGRR Background

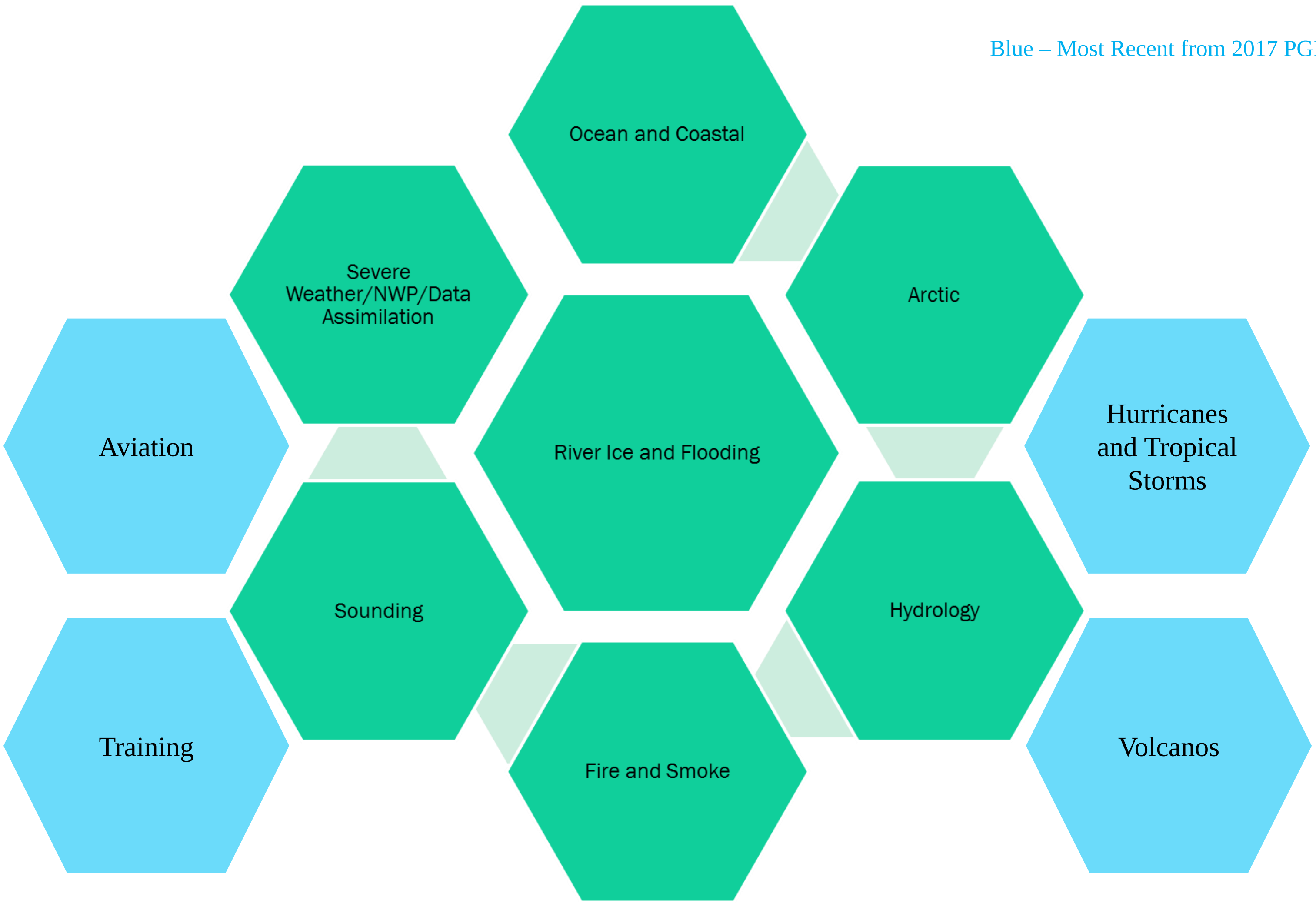
- The PGRR Program was established in early 2012, following the launch of the Suomi National Polar Partnership (SNPP) satellite on 28 Oct 2011
- Call-for-Proposals (CFPs)
  - The initial CFP in Jan 2012 resulted in 100 teams providing Letters-of-Intent (LOIs) with nearly 40 projects selected for funding
  - A second PGRR Program CFP went out in Dec 2014. PGRR Initiatives were used as a focus for the responses to this CFP. Over 130 LOIs were received.
  - A third PGRR CFP is in draft and will be sent out soon.
- These proposals went through a rigorous user-led selection – between 40-50 projects selected for funding each time
- Project managers work with the users to determine how best to use new JPSS data, and to quickly transition these capabilities to operations.

PGRR Proving Ground Initiatives Responding to User Feedback

- The River Ice and Flooding Initiative was the first attempt at this new partnership and it was established in response to Galena AK flooding in May 2013.
- The Initiative included River Ice and River Flooding Project teams, direct broadcast SMEs, and National Weather Service River Forecast Center forecasters.
- The success of River Ice and Flooding Initiative led to creation of other initiatives that guided the 2014 PGRR CFP.
- Initiatives have proven to be critical forums where JPSS personnel, product developers, and users interact. The effort is to evaluate current and future JPSS Capabilities in operational environments to determine which of these capabilities should be transitioned to operations.

PGRR Initiatives List

Blue – Most Recent from 2017 PGRR CFP

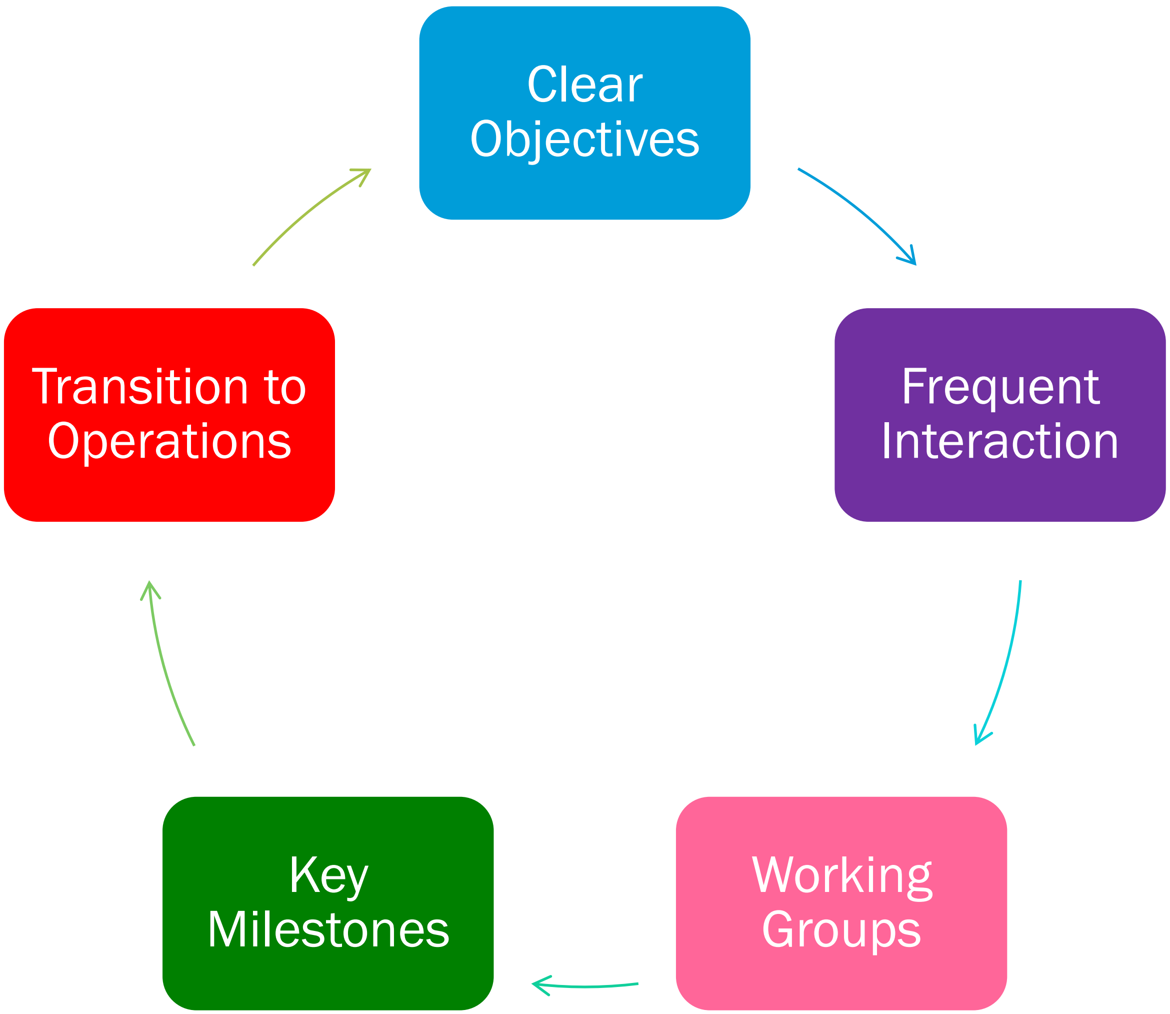


PGRR Initiatives

Initiative	Start Date
River Ice and Flooding	November 2013
Fire and Smoke	May 2014
Sounding Applications NOAA Unique CrIS/ATMS Processing System (NUCAPS)	July 2014
Hydrology	July 2015
Ocean and Coastal	March 2016
Severe Weather/NWP/Data Assimilation	March 2016
Arctic Initiative	June 2016
Hurricanes and Tropical Storms Initiative	June 2018
Aviation Initiative	June 2018
Training Initiative	June 2018
Volcano Initiative	June 2018

PGRR Initiatives Partners

PGRR Proving Ground Initiatives Best Practices



River Ice and Flooding Initiative

River Ice and Flooding Initiative
Background

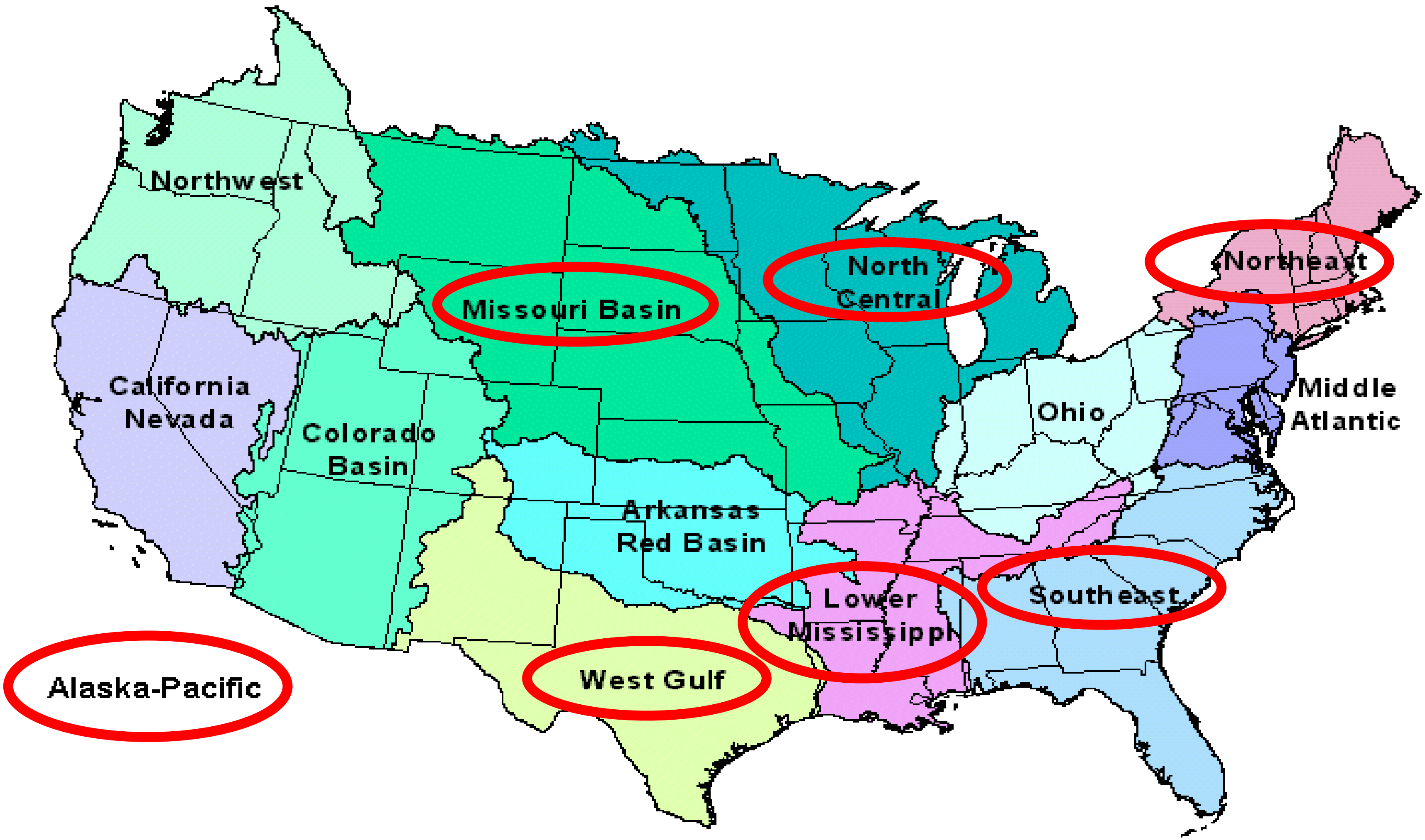
- The first PGRR Initiative joining River Ice and River Flooding into one effort and applied with great success during the 2013 Galena Flood in AK.
- Success resulted in the creation of new initiatives and more NWS River Forecast Center (RFC) involvement. Six RFCs are now regular participants.
- Worked with RFCs to provide their customers with VIIRS products to be included in their decision making systems. USA Corp of Engineer for flooding along the Illinois River as an example.
- Based on feedback from RFCs both the VIIRS River Ice and River Flood products were changed to improve their operational value.
- River Flood products have been used worldwide in response to flooding events.
- Established collaboration with the National Water Center.
- River Ice and Flooding Products key part of capabilities discussed during a NWS visit to Russia.
- Discussed with Coast Guard liaison about the use of the River Ice Product on decisions on ice breaker deployment.
- Established procedures to provide River Flood Product to FEMA to help their response to flooding events. Products critical to Hurricanes Harvey and Irma

River Ice and Flooding Initiative The First Initiative and Most Mature

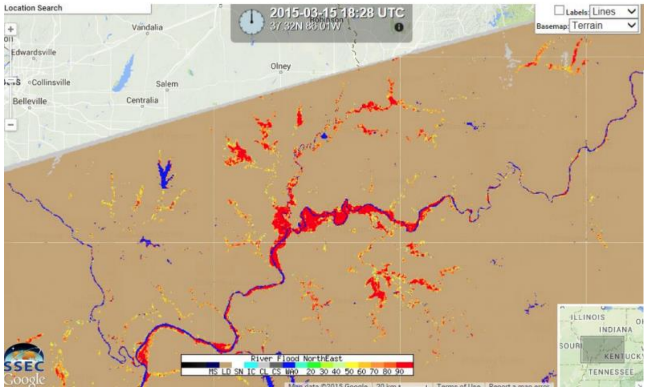
PGRR Project River Flood Product

PGRR Project River Ice Product

Success in Alaska Brings More Interest



Keep Asking the Right Questions River Flood Mapping



If the product works in AK will it work elsewhere?

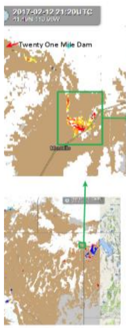
Can the product respond to rapidly changing situations?

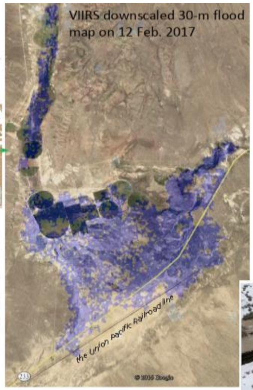
Nevada county declares emergency after earthen dam fails

THURSDAY, FEB. 9, 2017, 6:24 P.M.

On Wednesday, Feb. 8, 2017, 21 Mile Dam near Montello, Nev., broke and caused flooding to the Union Pacific railroad line near Lucin and flooded the town of Montello, Nev. The floods forced delays or rerouting for more than a dozen freight and passenger trains on a main rail line that runs through the area, said Union Pacific spokesman Justin E. Jacobs (Stuart Johnson / AP)

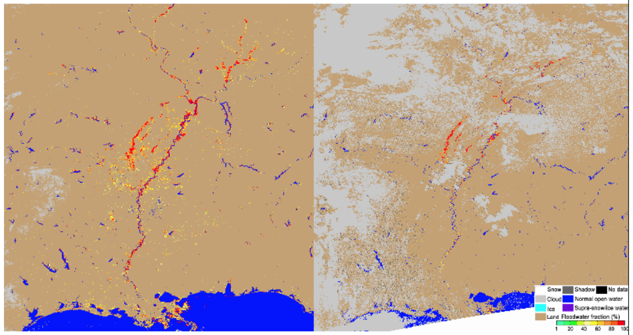
http://www.spokesman.com/stories/2017/feb/09/nevada-county-declares-emergency-after-earthen-dam/





Abnormal water was found after Twenty One Mile Dam was damaged around 8 Feb. 2017.
Part of highway 233 and the Union Pacific Railroad line near Montello were inundated.

Frequent observations from GOES-16/ABI provide more clear-sky coverage for flood detection.

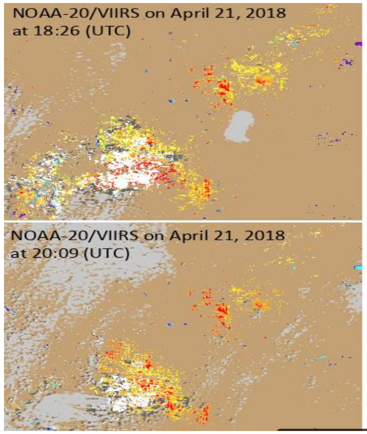


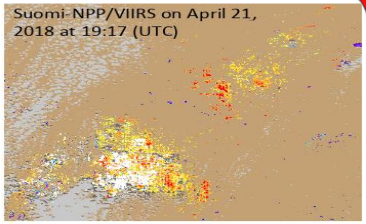
GOES-16/ABI multiple composition on May 10, 2017

VIIRS near real-time detection on May 10, 2017 at 19:30 UTC

Can the GOES-R ABI create a product similar to VIIRS

Does the product have other operational applications





With NOAA-20/VIIRS and Suomi-NPP/VIIRS flood maps, the water flow due to snow-melting in the north central region can be observed dynamically.

A Most Important Question

Would the VIIRS Flood Mapping Product be of Value to the International Community Assisting Them in Responding to their Flood Events?

Through the Use of the International Charter

Initiative Responds to International Charter

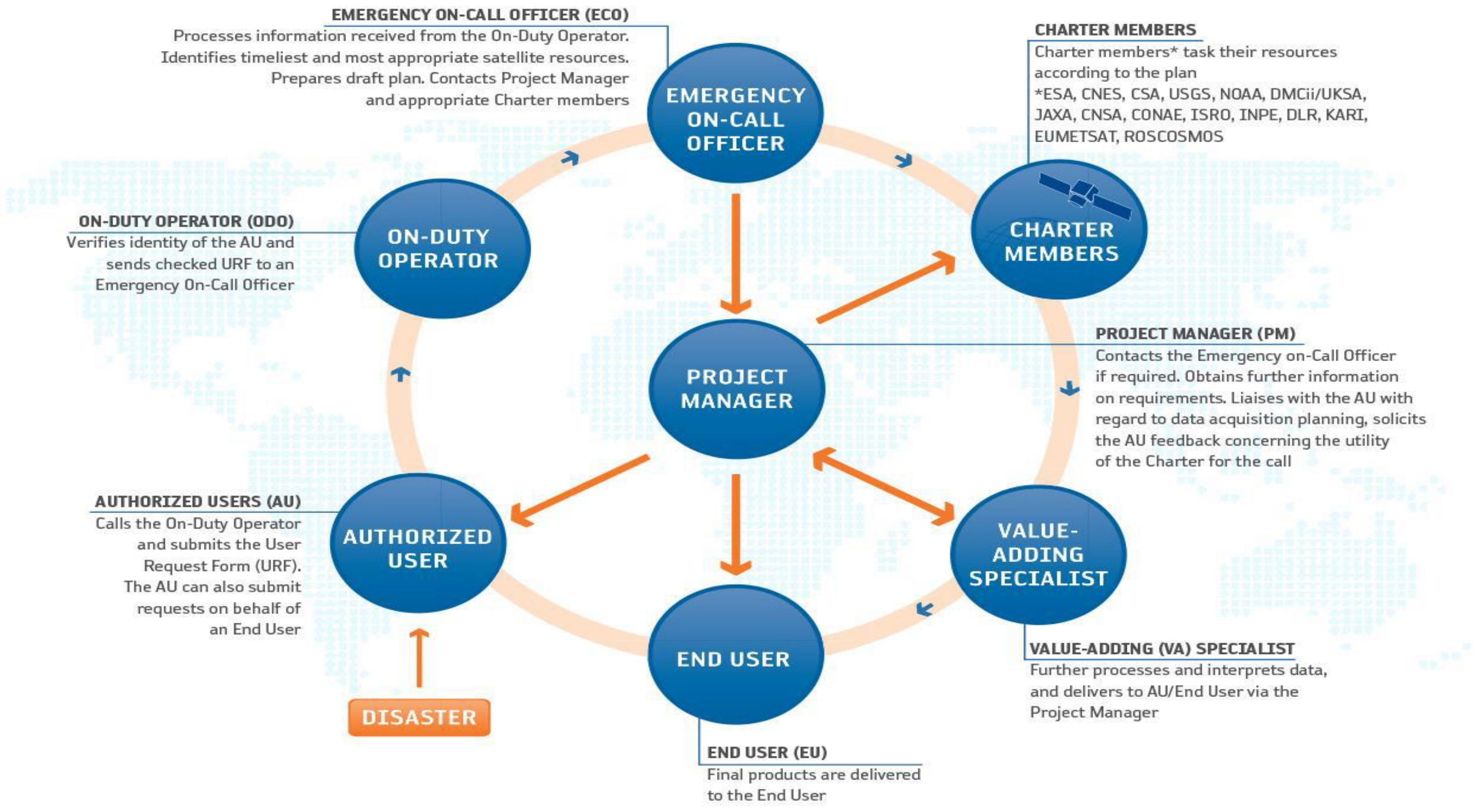
WHAT IS THE INTERNATIONAL CHARTER?

The Charter is a worldwide collaboration among space agencies to make satellite data available for the benefit of disaster management authorities during the response phase of an emergency.

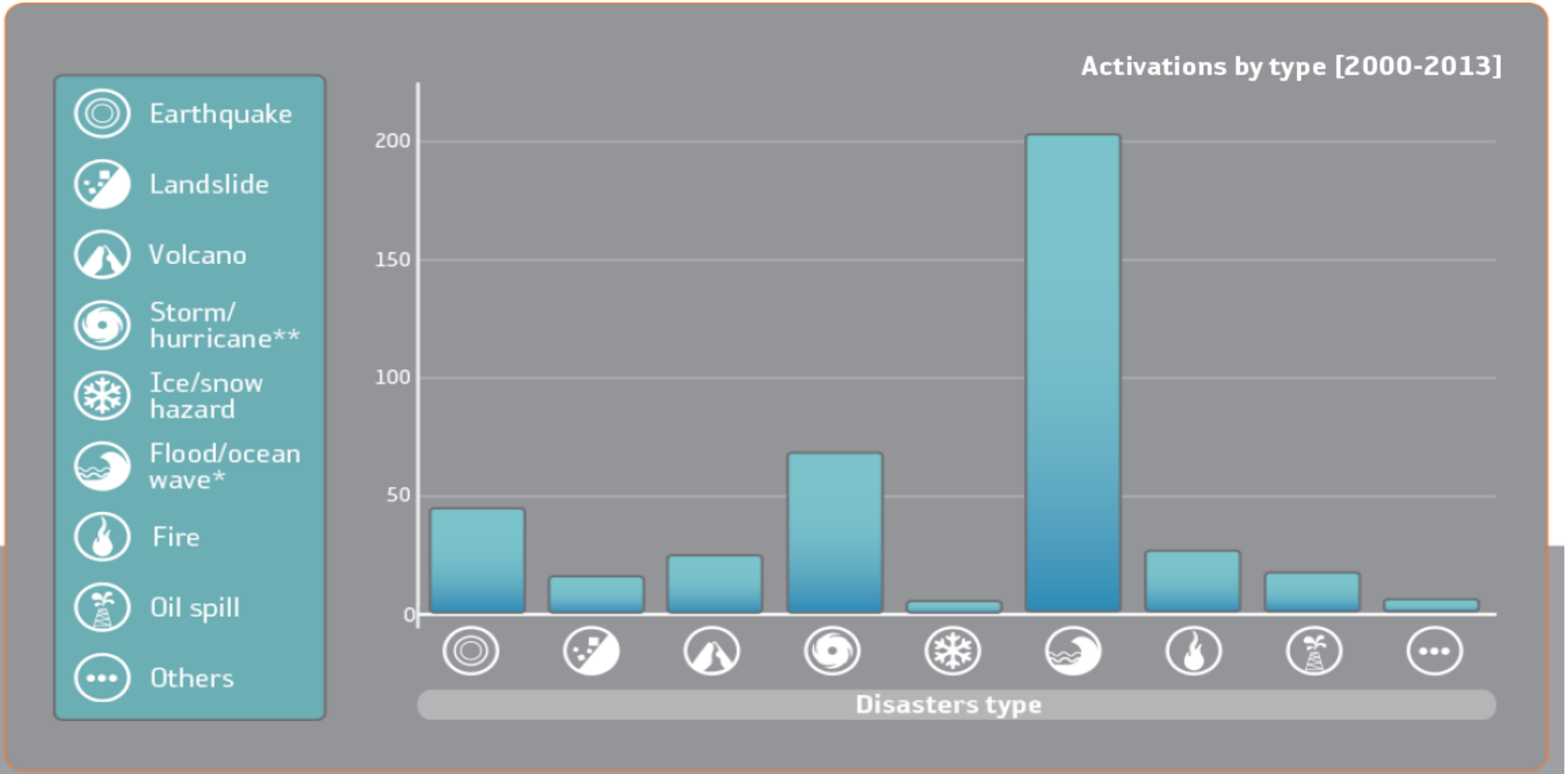
The Charter is unique in being able to mobilize agencies around the world and benefit from their know-how and satellites through a single access point that operates 24 hours a day, 7 days a week at no cost to the user.

Successfully operating since November 2000, the Charter has brought space assets into action for many natural and technological disasters including floods, hurricanes, tsunamis, earthquakes, landslides, forest fires, volcanic eruptions, ice jams, and oil spills. Since its inception, the Charter has been activated in response to over 400 major disasters in more than110 countries, including the 2004 Asian tsunami, the 2008 cyclone Nargis in Myanmar, the 2010 earthquake in Haiti, the 2010 flooding in Pakistan, the 2011 earthquake and tsunami in Japan, the 2012 cyclone Bopha and the 2013 super Typhoon Haiyan in the Philippines.

Activation of International Charter

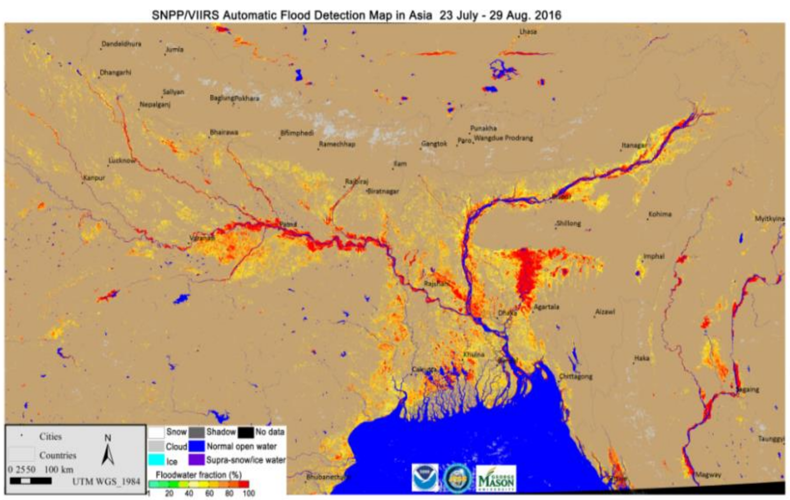


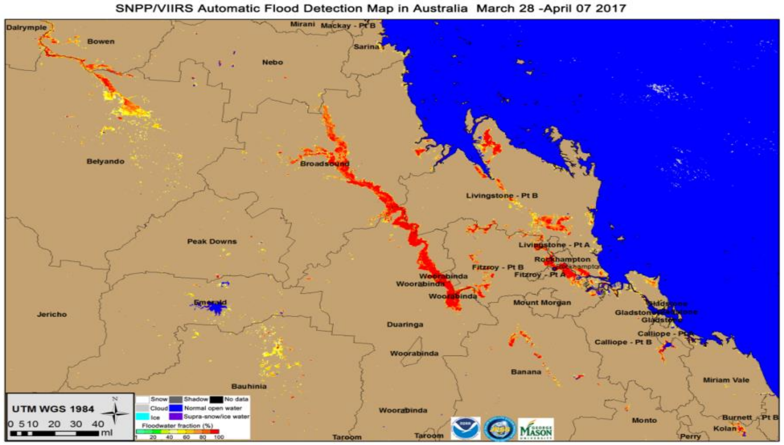
Floods are a Worldwide Concern

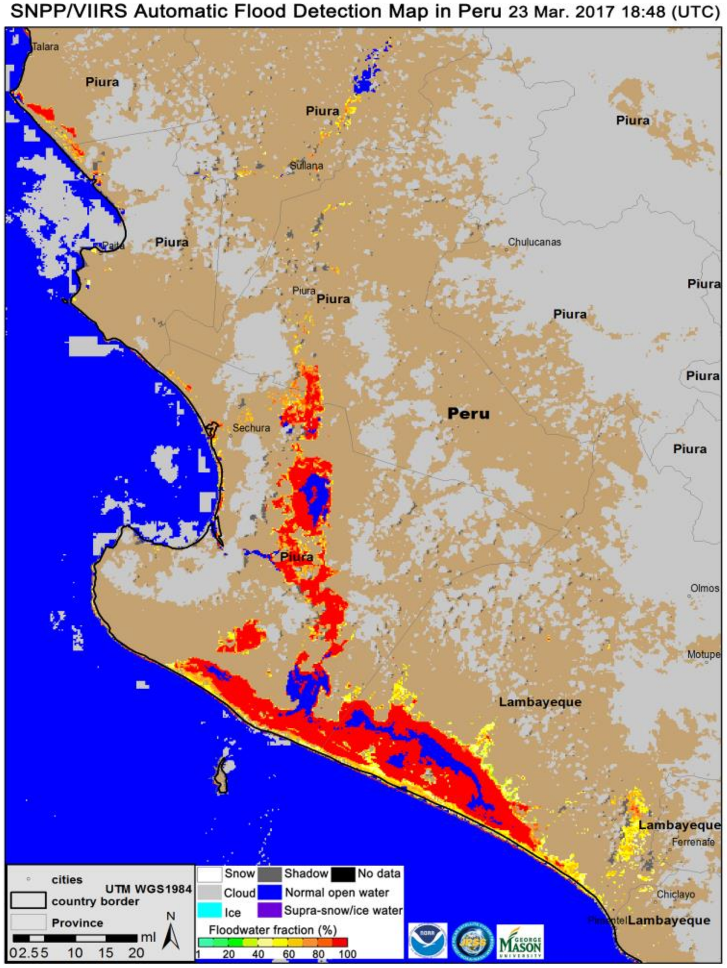


More detailed information is available on **www.disasterscharter.org/web/charter/activate**
For further inquiries please contact **ExecutiveSecretariat@disasterscharter.org**

Worldwide Capability





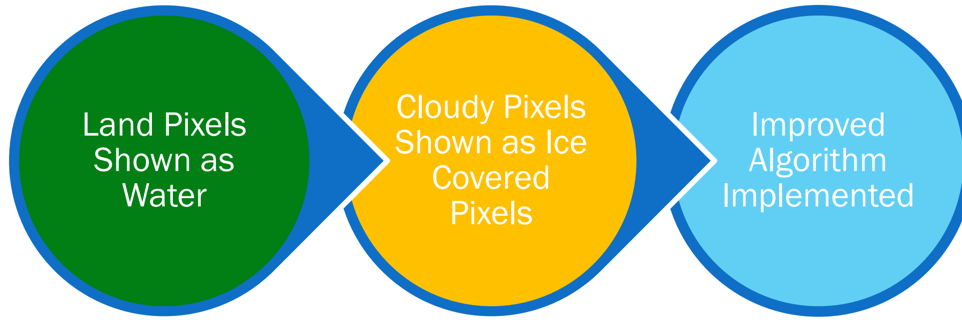


- VIIRS flood detection capability has been extended to the regions outside of USA

Keep Asking the Right Questions River Ice Product

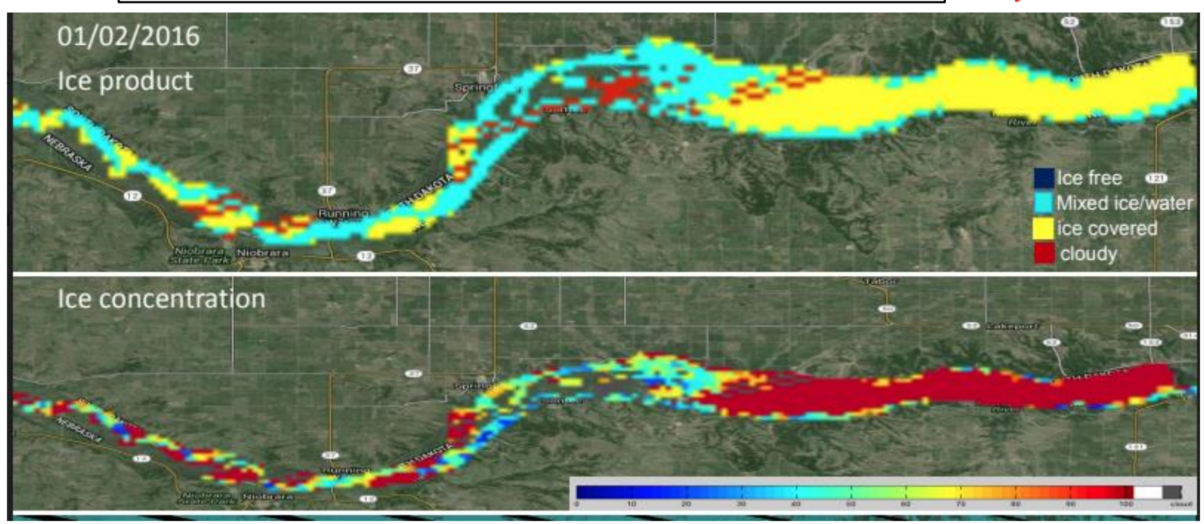
2015

We Are Seeing Some Odd Things in the Product. Can That be Fixed?



2016

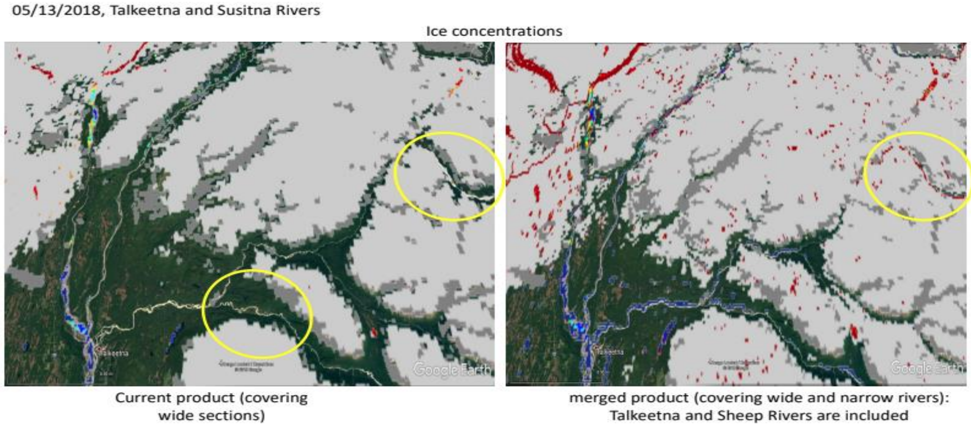
Can We Get Finer Detail on the Amount of Ice on the River?



Keep Asking the Right Questions
River Ice Product

2018

Can a Product be Created for Rivers Narrower than a VIIRS Pixel?

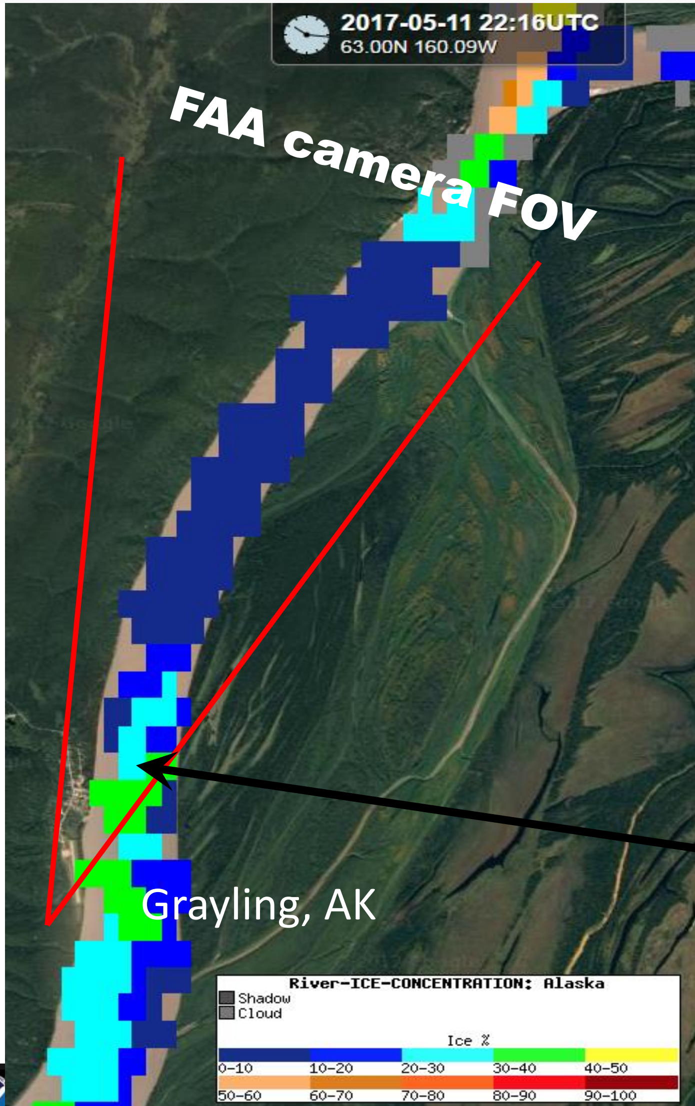


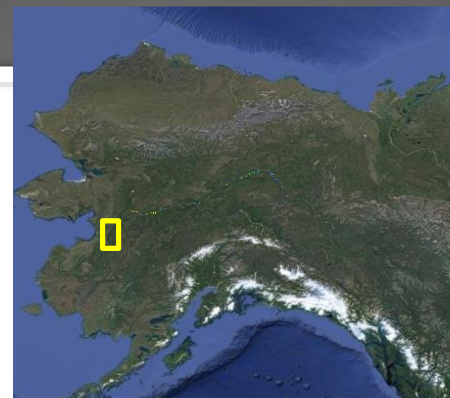
Persistent

The River Ice Product has Been Inconsistent from Pass-to-Pass, Can that be Fixed?

?

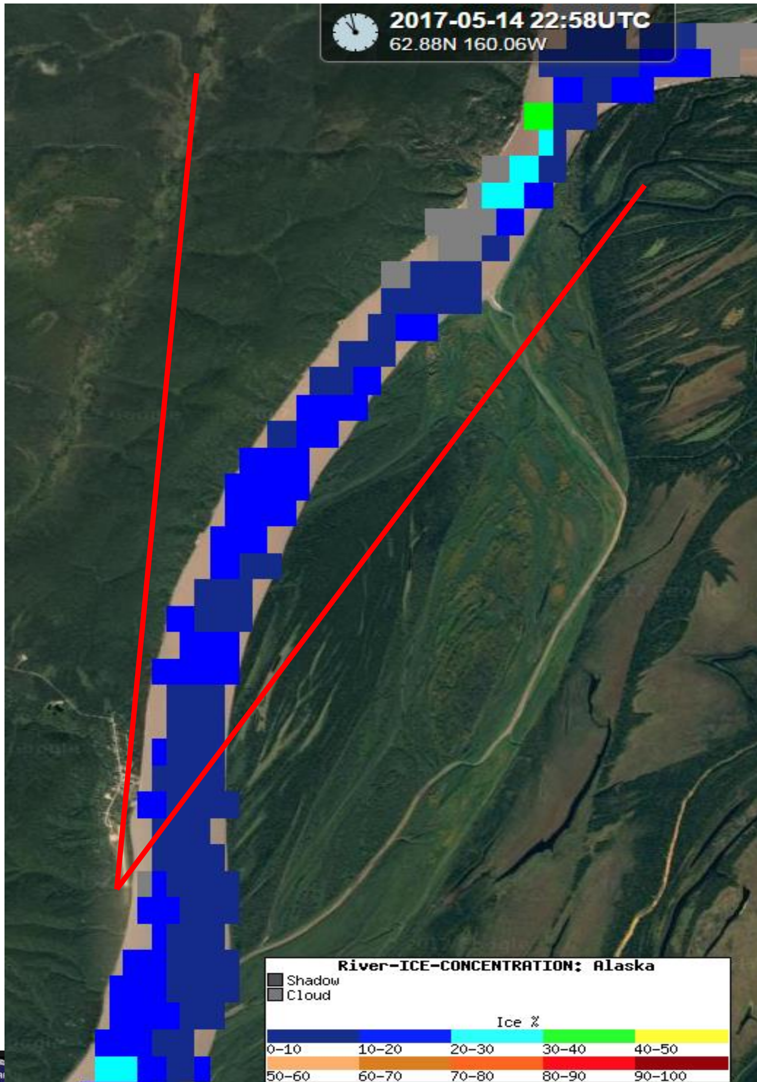
Satellite vs FAA Camera

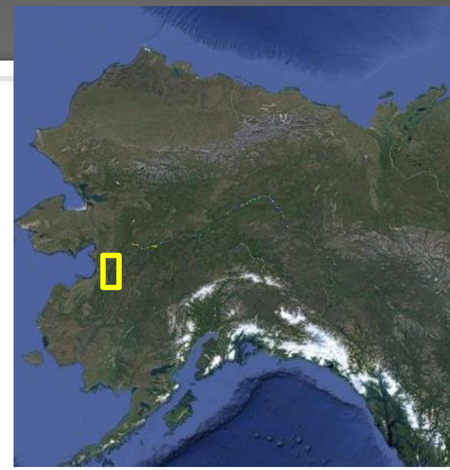


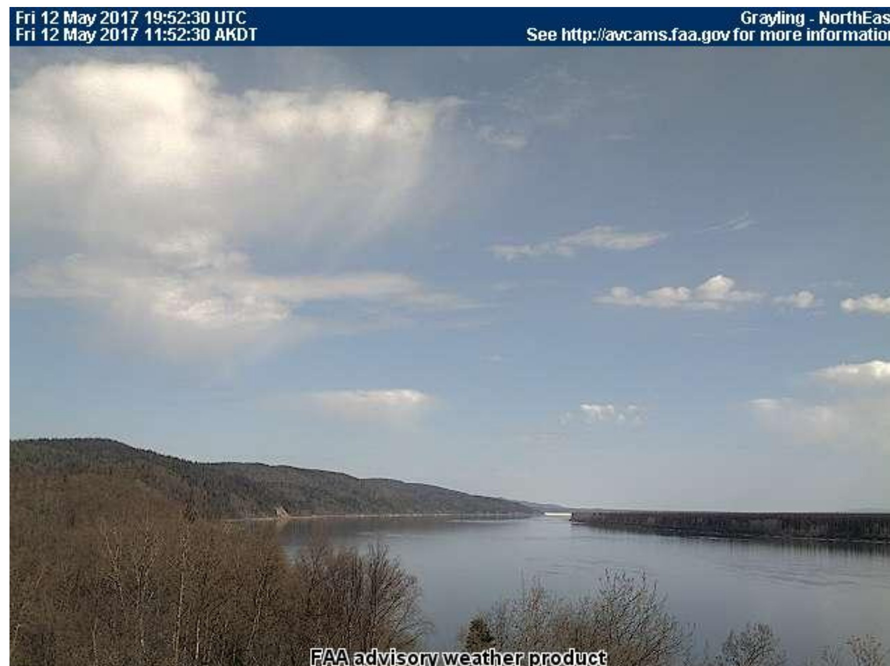


Melting ice may be quite dark causing underestimate of the ice concentration

Satellite vs FAA Camera



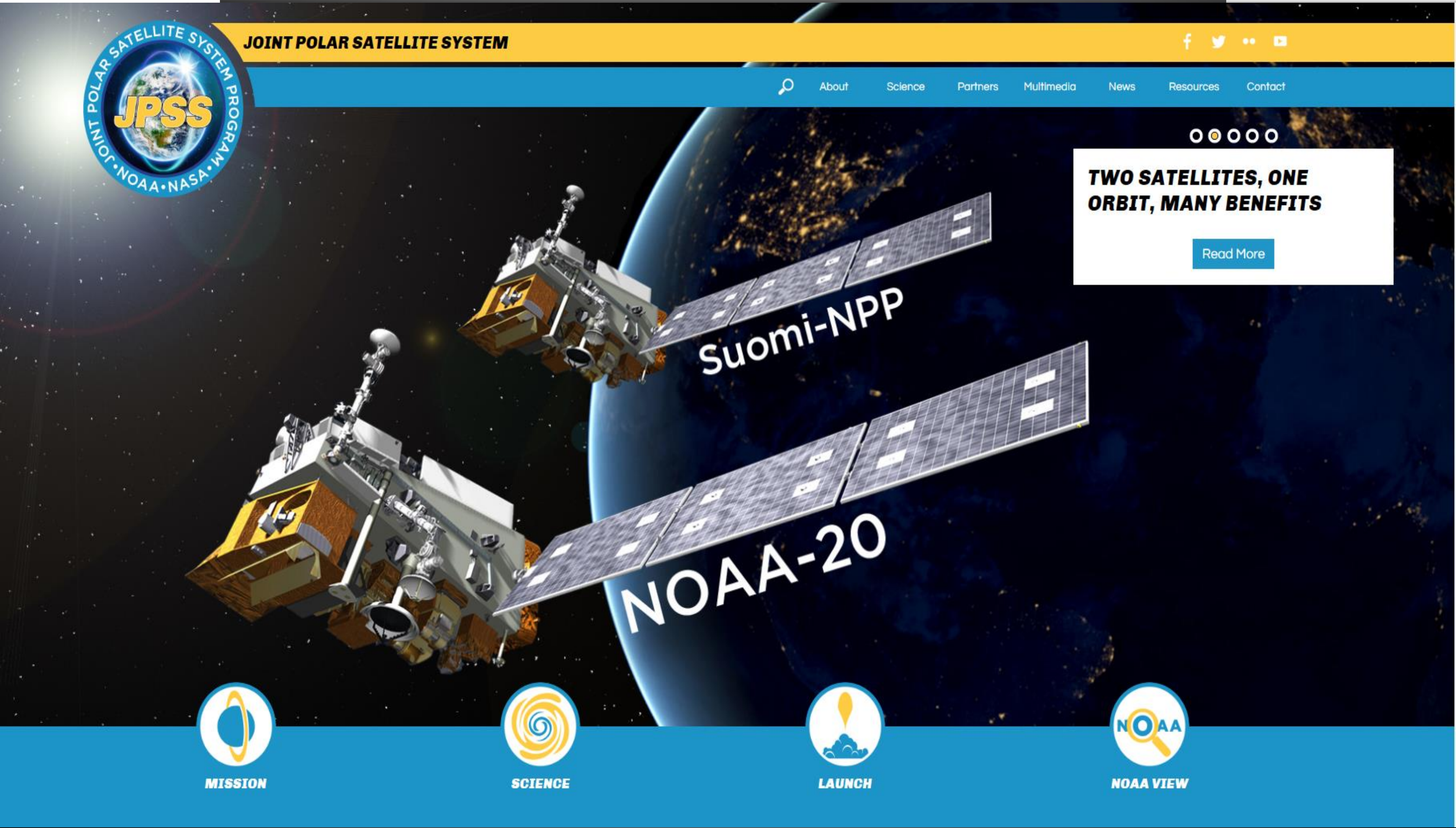




What the Future Holds?

- Flood Mapping Product is in SPSRB Process to become operational.
- RealEarth and GeoCollaborate working to make River Ice and Flood Products more accessible to decisionmakers.
- Close coordination with FEMA and US Army Corp of Engineers provide products when needed for severe weather events.
- Initiative is working to determine long-term viability of River Ice Product.

For More Information on the JPSS Program (WWW.JPSS.NOAA.GOV)



Development of VIIRS Flood Detection Software

River Ice and Flooding Initiative

Aug. 01, 2017 to July 31, 2018
(FY-17 Annual review)

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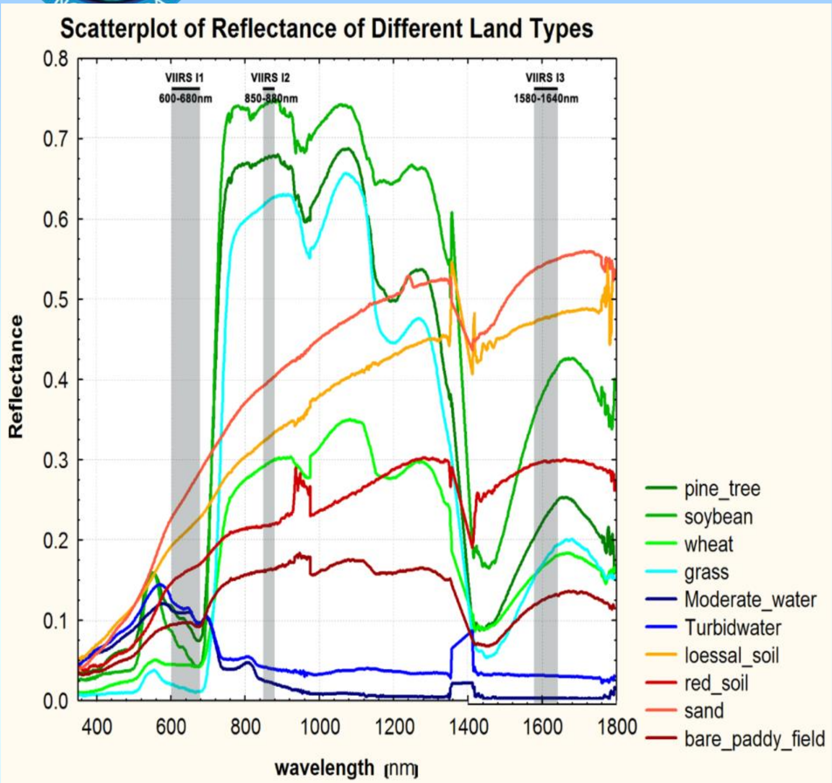
Outline

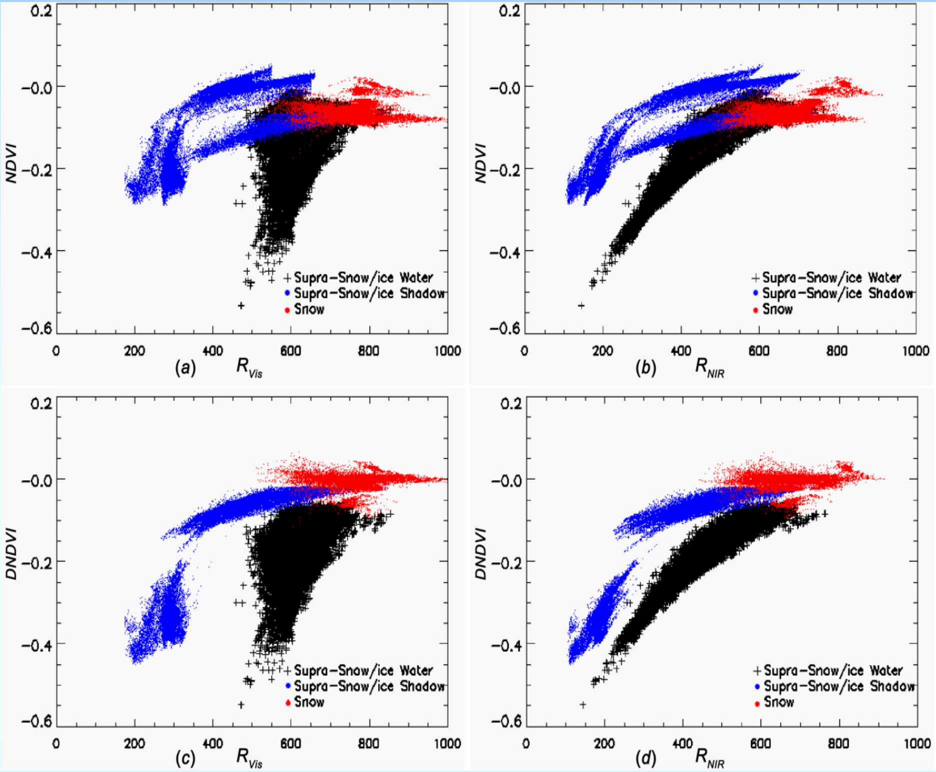
- Project Overview and Objectives
- Scientific Basis/Approach
- Key Results/Accomplishments
- Future plan
- Summary

Project Overview and Objectives

- Goal(s): Deliver global VIIRS flood product and integrate NOAA-20/VIIRS in the software
- Satellite sensors used: SNPP/VIIRS Imager and NOAA-20/VIIRS Imager
- Targeted NOAA (and non-NOAA) users:
  - NOAA/NWS-River Forecast Centers
  - NOAA/NWS-National Water Center
  - Federal Emergency Management Agency (FEMA)
  - US Army Corps of Engineers (USACE)
  - International Charter
- Period of Performance: Aug. 01, 2017 – July 31, 2018
- Budget: $100K (FY-17)

Scientific Basis/Approach





- Water detection is based on the spectral features of water surface over different underlying conditions.
- Cloud shadows and terrain shadows are differentiated by using geometry-based and object-based methods instead of spectral characteristics.
- Water fraction retrieval is based on the linear combination model by considering the mixing structure of sub-pixel land portion.

Water level calculation

- Pixel water level: $$A = \int_{min\_h}^{max\_h} \int_{1}^{N} w_i(h) f_i(h)\, di\, dh$$

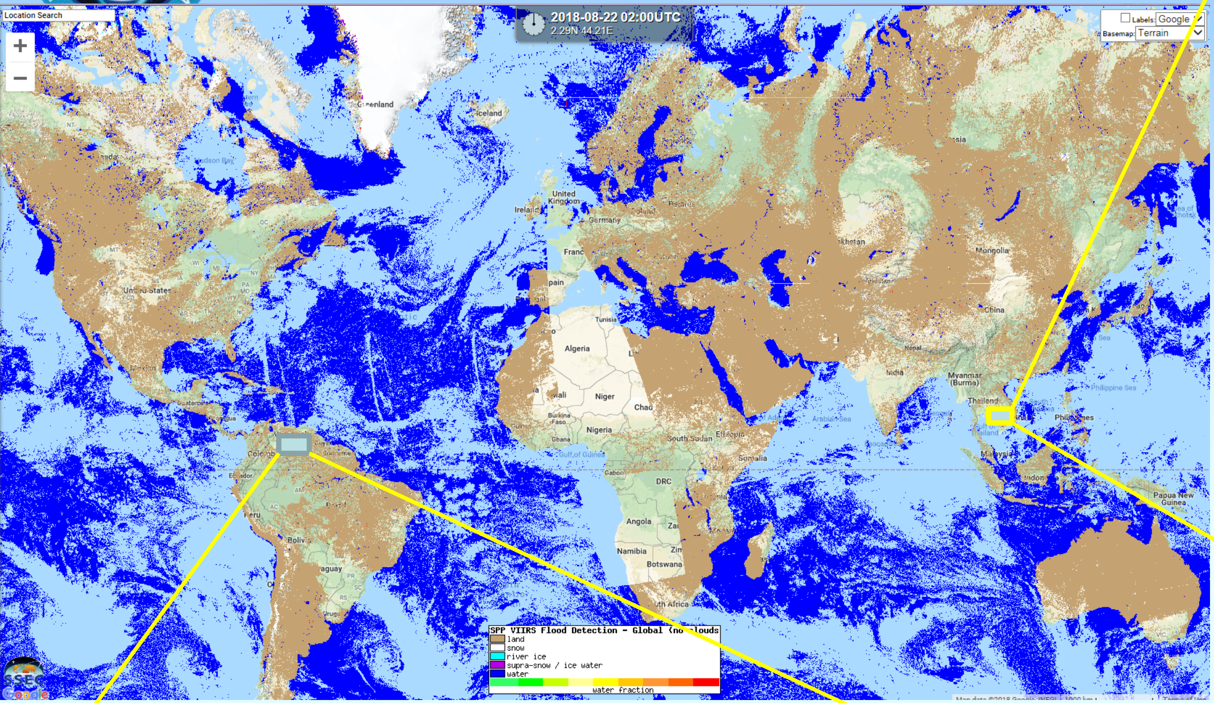
Where, A is satellite-based total water area between the minimal surface elevation, min_h , and maximal inundated surface elevation, max_h, $w_i(h)$ is the weight of land type i at height h in a VIIRS 375-m pixel, and $f_i(h)$ is the total area of land type i at height h.

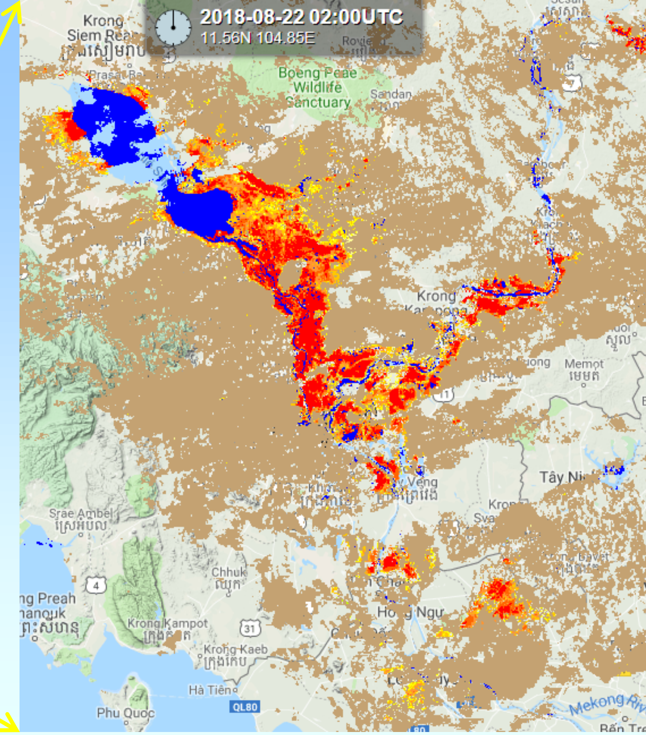
- Polygon water level: Water polygon is defined as a group of adjacent water pixels with similar water levels. Pixels within a water polygon have the same water level.

- Polygon water levels decrease from upstream to downstream. The relationship between water levels and the distance to the starting point of a river (x), can be simulated by least square error methods:

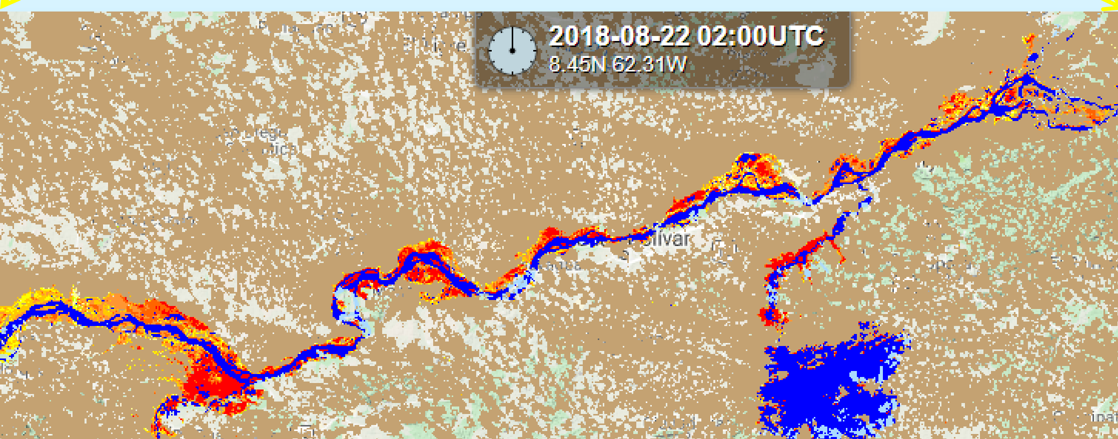
$$f(x) = a_0 + a_1(x - \bar{x}) + a_2(x - \bar{x})^2 + \cdots a_n(x - \bar{x})^n$$

Key Results/Accomplishments





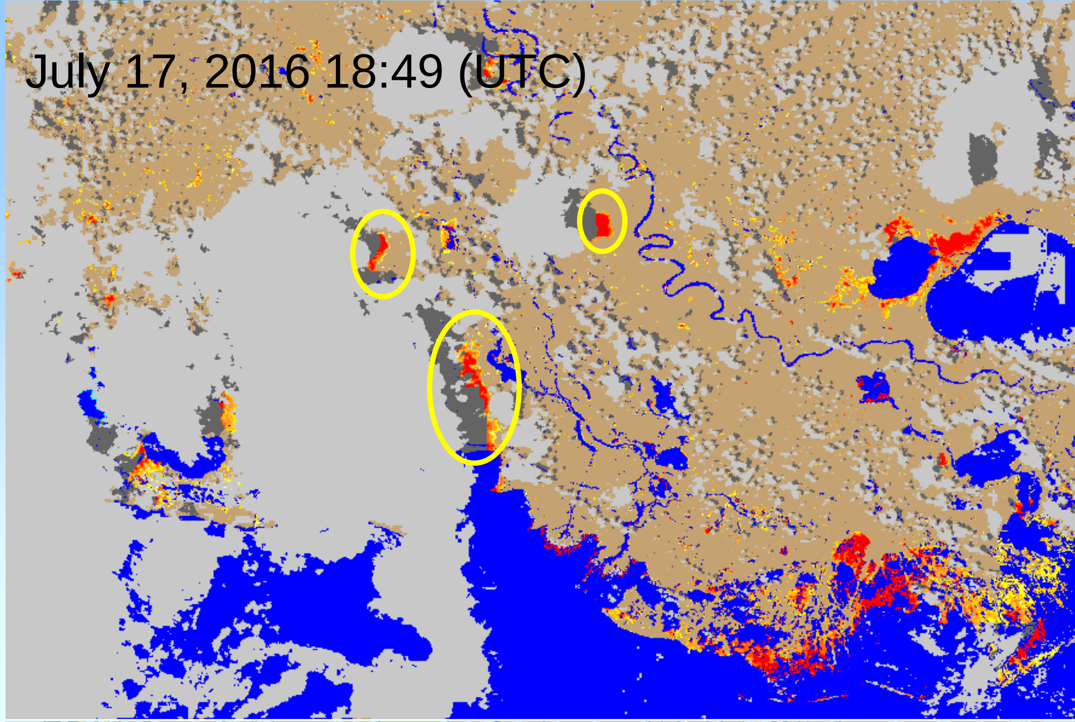
https://re.ssec.wisc.edu/s/xHfKq



- VIIRS global flood maps are now available:
  - With the delivered VIIRS flood software, CSPP group helps run the software globally and distributes global VIIRS flood maps via Real Earth

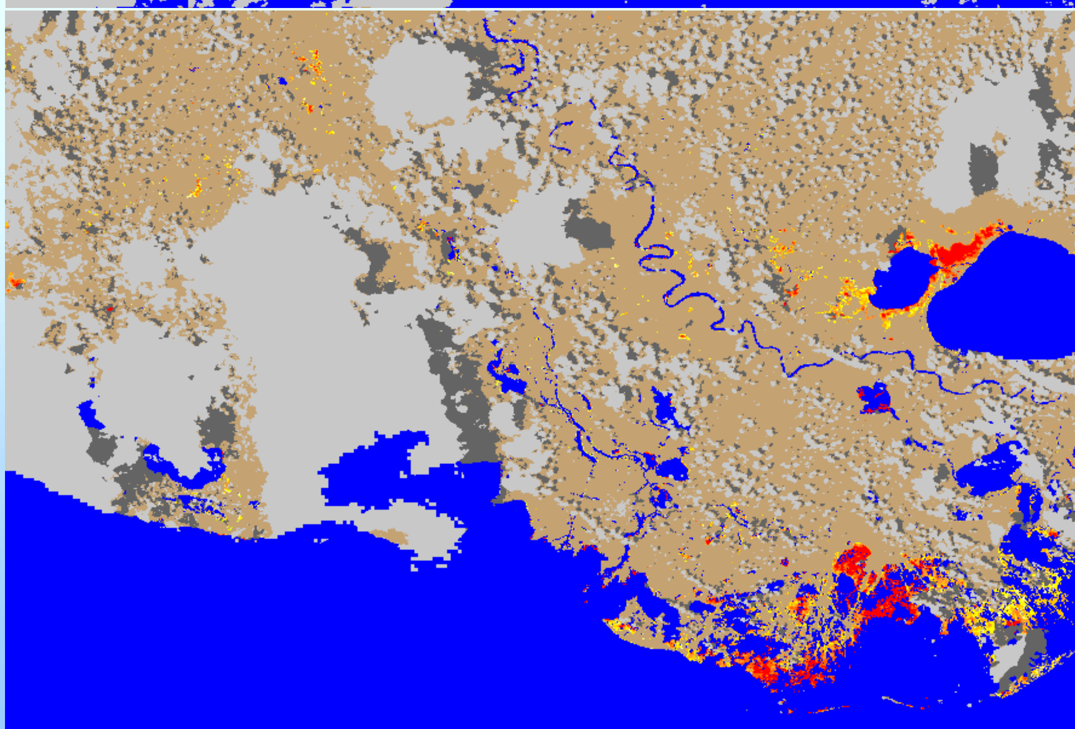
Key Results/Accomplishments

- Issues with the current version 1.0 algorithms:
  - About 10% Cloud shadows remain unremoved.
  - RFCs complain about the detection of supra-snow/ice water or mixed ice&water may not be detected accurately.
  - Water detection and fraction retrieval under complex conditions such as sun-glint-contaminated water surface.
  - IICMO does not work well in complex situations.
- Algorithm improvement on the version 1.0 algorithms:
  - Improve the cloud shadow removal algorithm
  - Improve the detection of the supra-snow/ice or mixed ice & water
  - Improve the classification algorithms on detecting cloud, snow cover and water surface

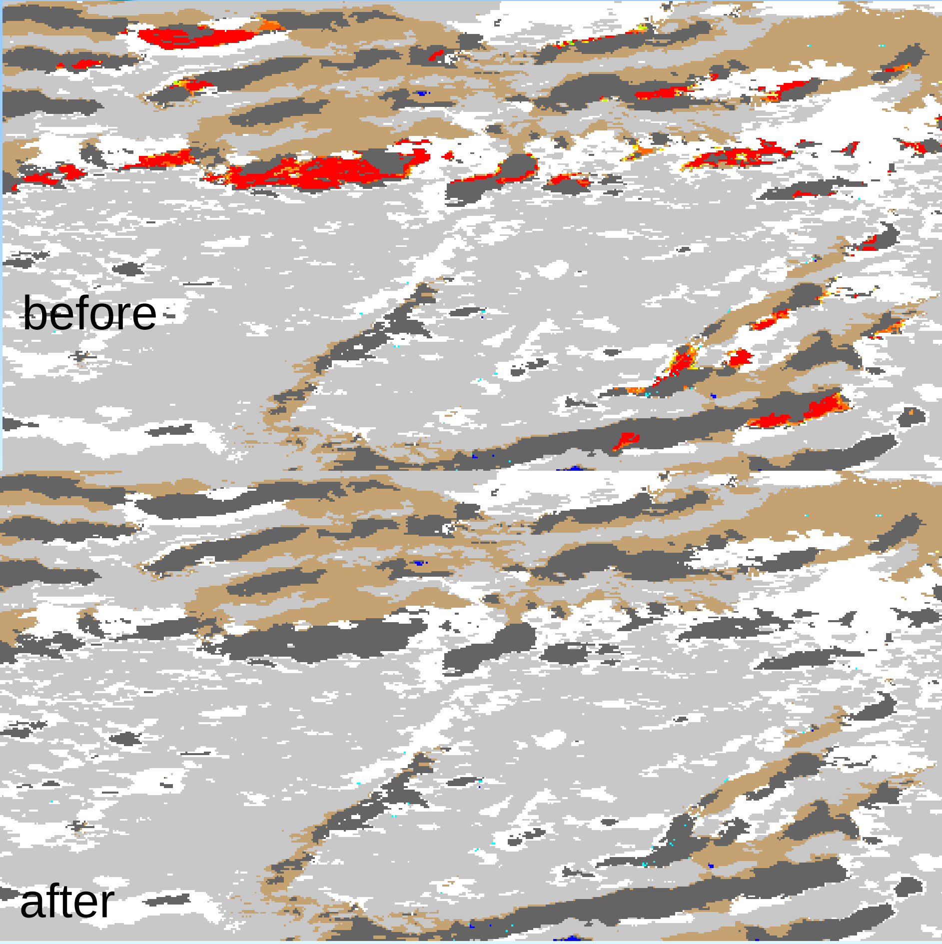


before

- Overall, the new cloud shadow fixes three issues existing in the current version 1.0 algorithms:
  - Shadows along the edges.
  - Shadows cast over snow surface.
  - Shadows cast by thin clouds.



after



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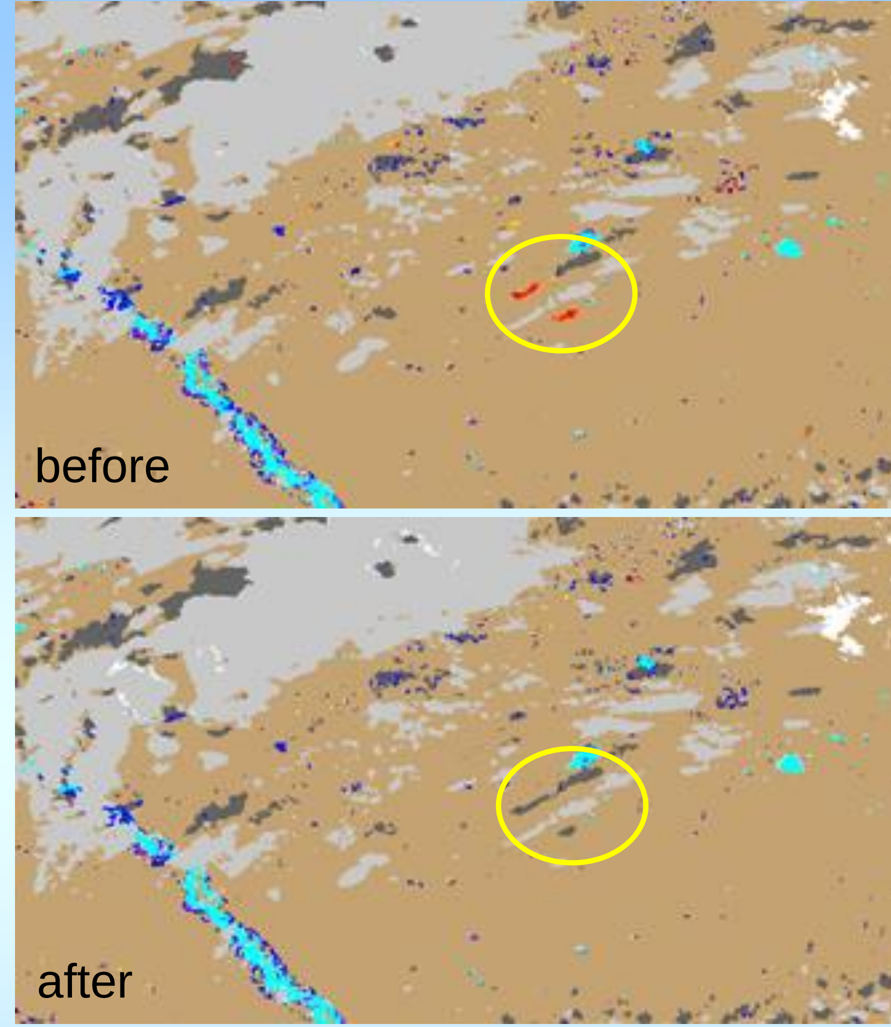
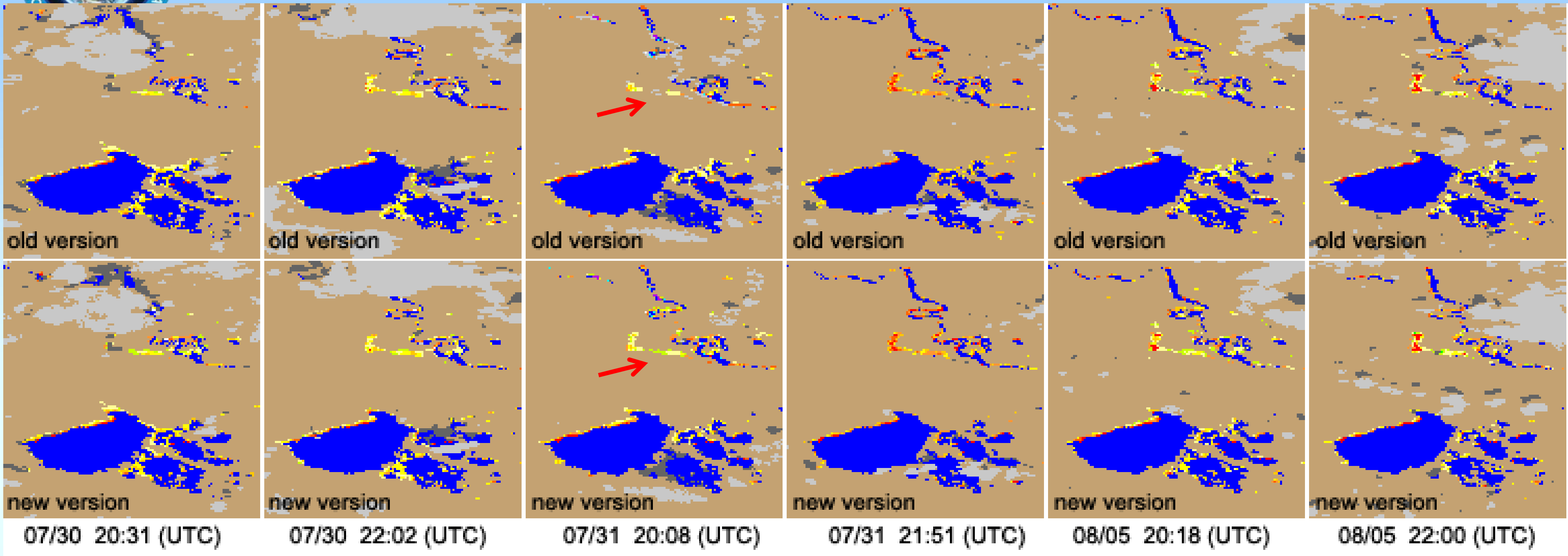


- Cloud shadows cast over snow surface that were not removed have been removed with the new algorithm.

- Cloud shadows cast by thin clouds that were not removed have been removed with the new algorithm.

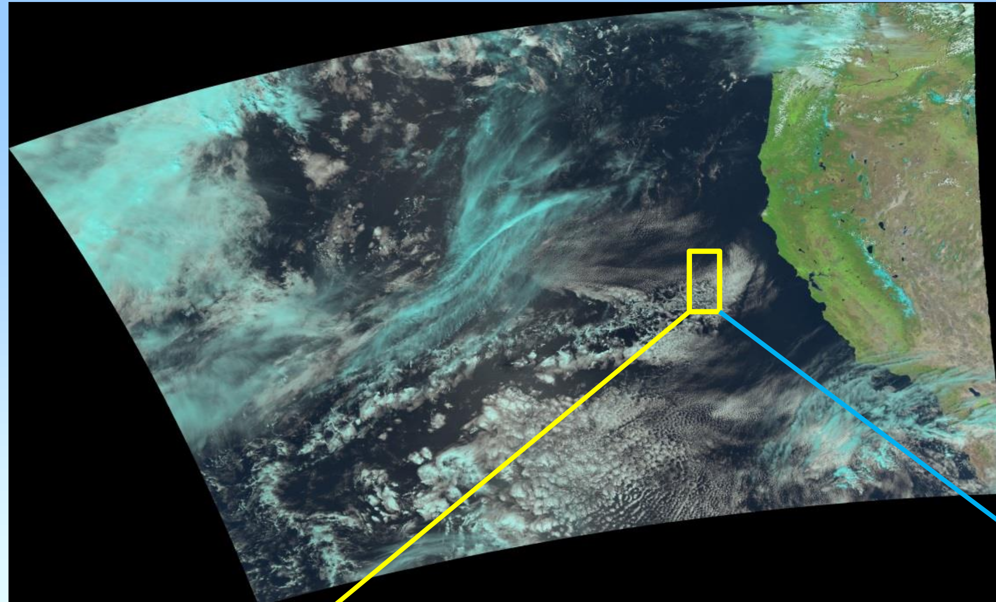


Tetlin flood in Alaska, July 2017

- The new algorithm shows more consistent water detection results by improving the classification algorithm among cloud cover, snow cover and water surface.

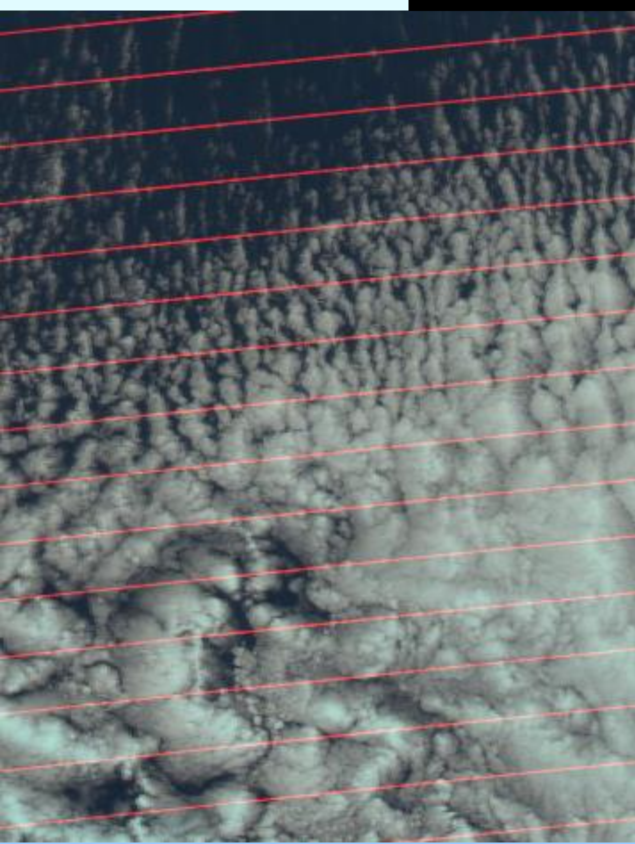
Key Results/Accomplishments

- NOAA-20/VIIRS data has been integrated into the flood software
  - De-striping on the Imager band 3
  - Adjustments to the algorithms and software have been made to process NOAA-20/VIIRS data
  - Software test has been done globally to check the quality of NOAA-20/VIIRS flood maps.



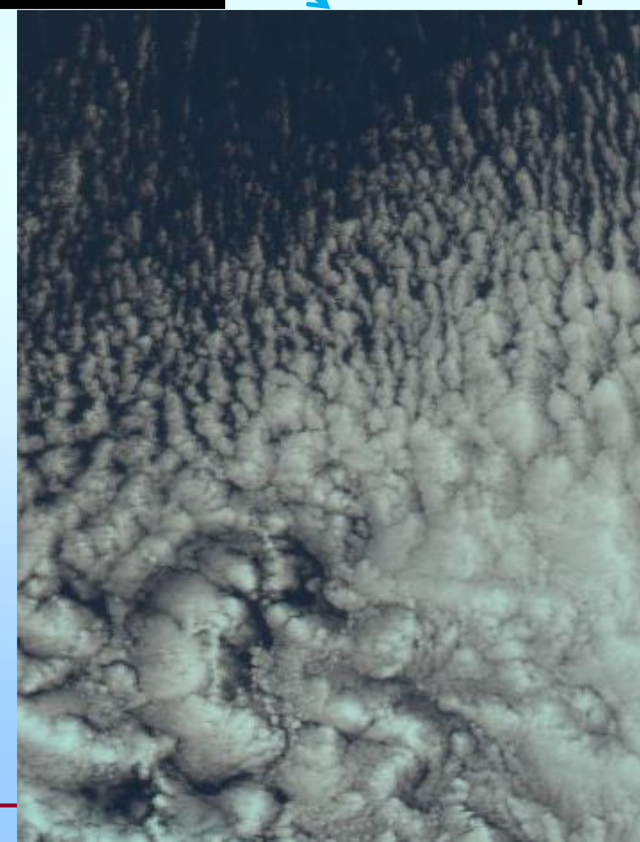
NOAA-20/VIIRS image on April 21, 2018 at 21:45 (UTC) with de-striping process on the SDR data

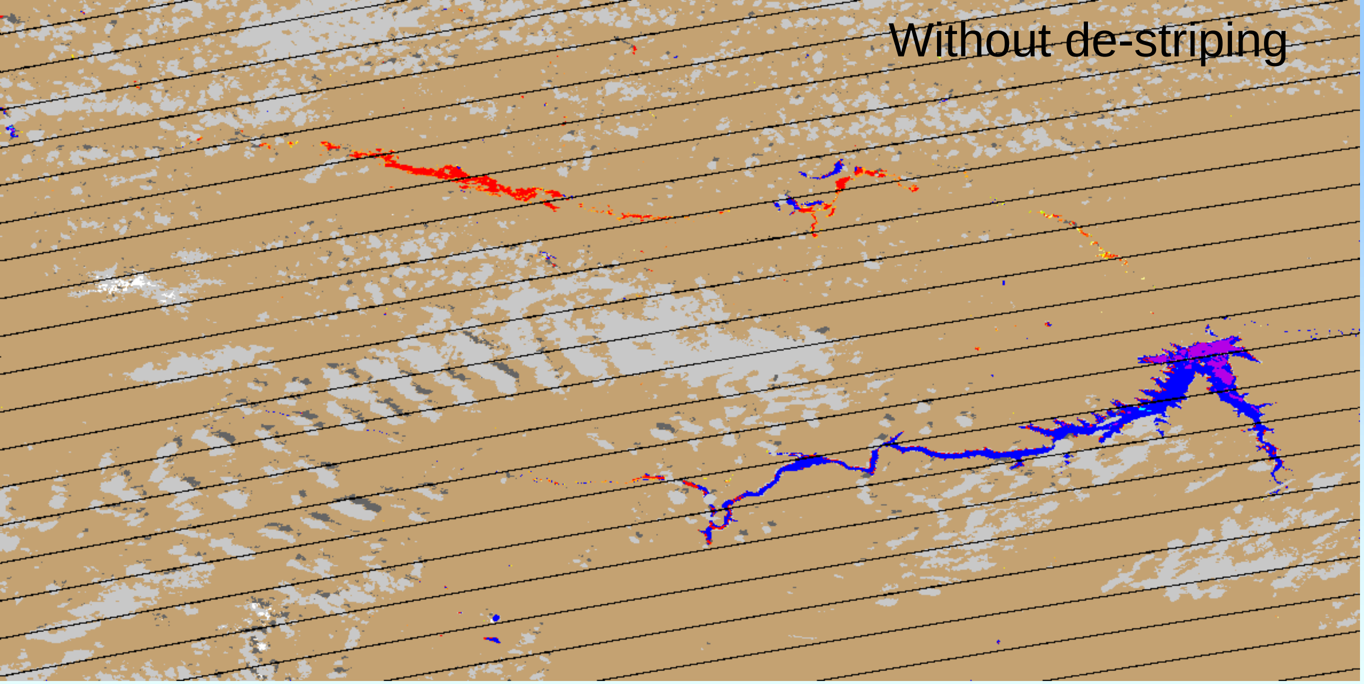
Before de-striping

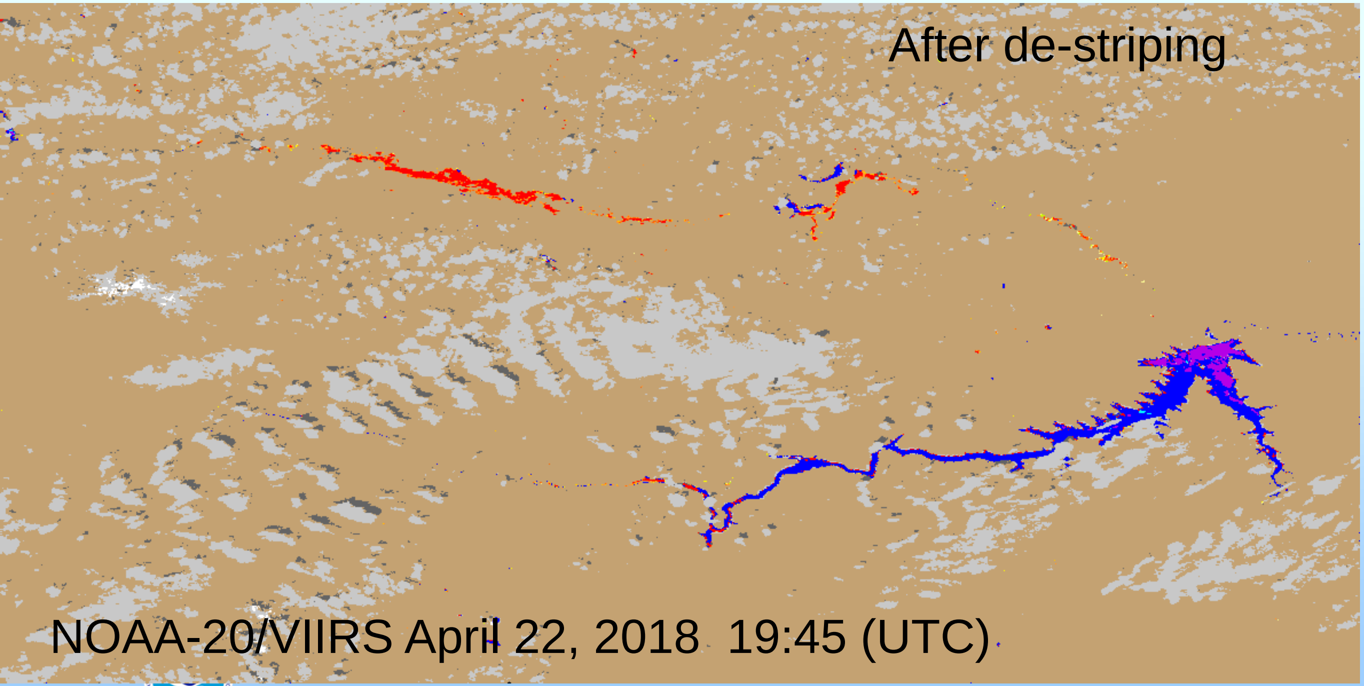


De-striping on the NOAA-20/VIIRS SDR data.

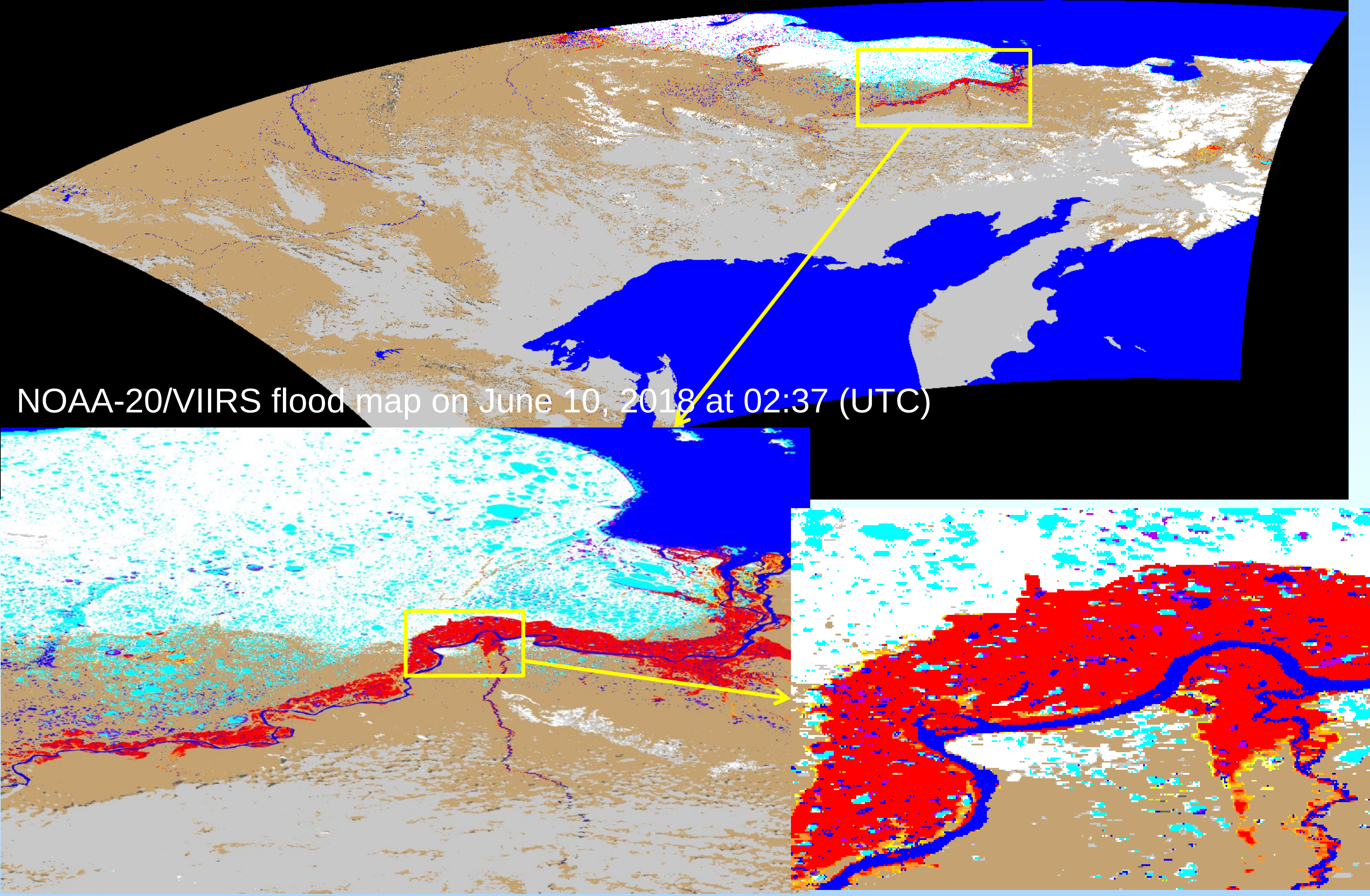
After de-striping





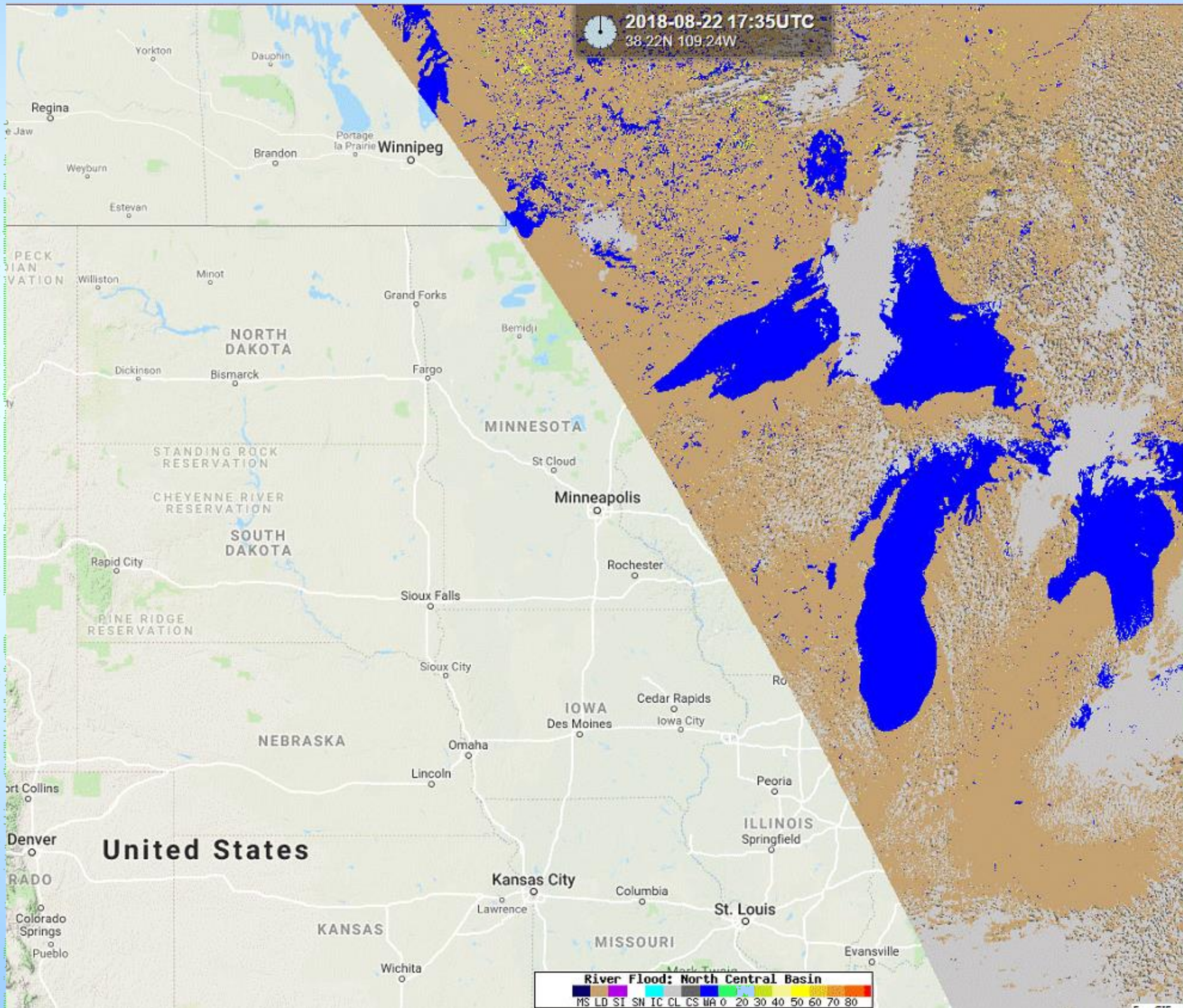


- The de-striping process on NOAA-20/VIIRS Imager band 3 produces flood maps with better quality.

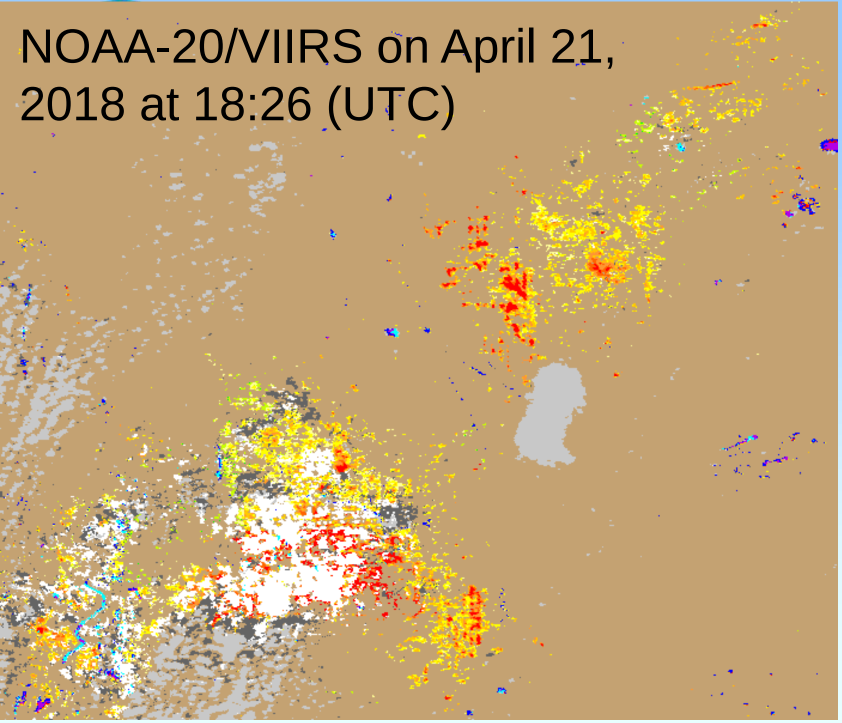


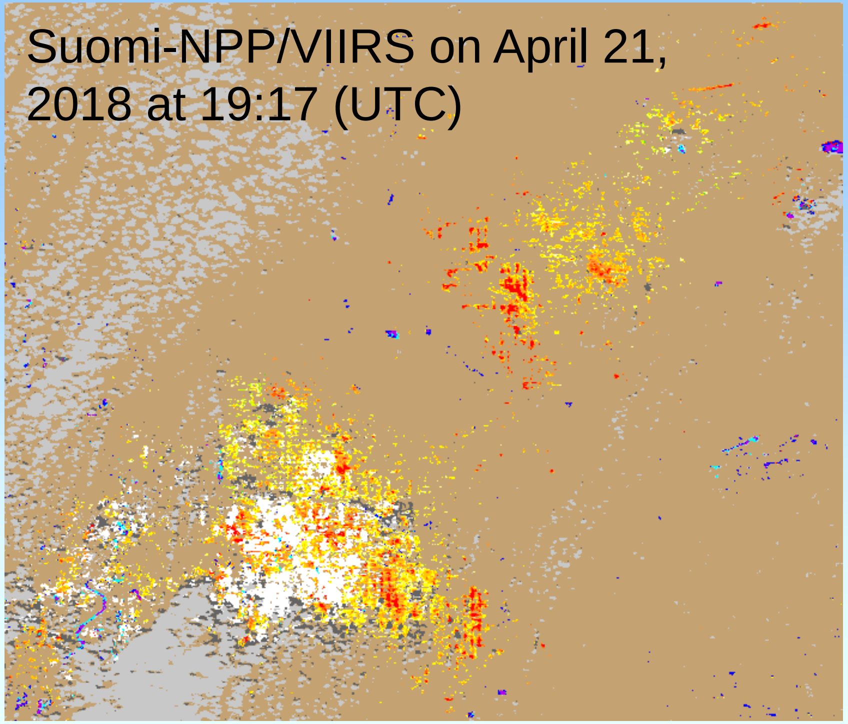
- Global test on NOAA-20/VIIRS flood maps shows reasonable results.

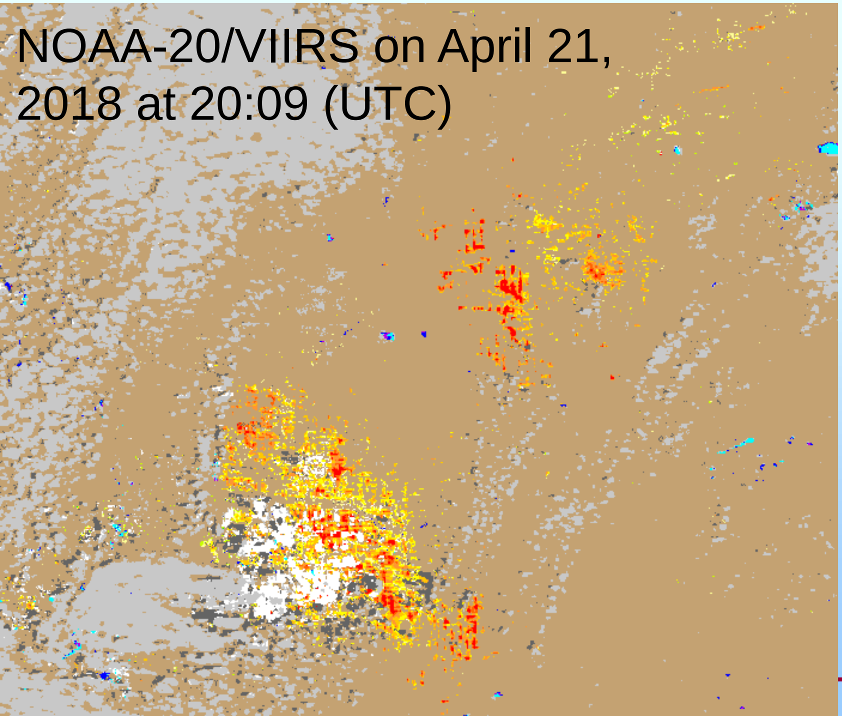
Key Results/Accomplishments



- New release in July 2018:
  - We released a new version of VIIRS flood mapping software with the improvements on the algorithms as well as new data source from NOAA-20/VIIRS.
  - In mid-latitudes, at least three observations are available for flood mapping from SNPP & NOAA-20/VIIRS.

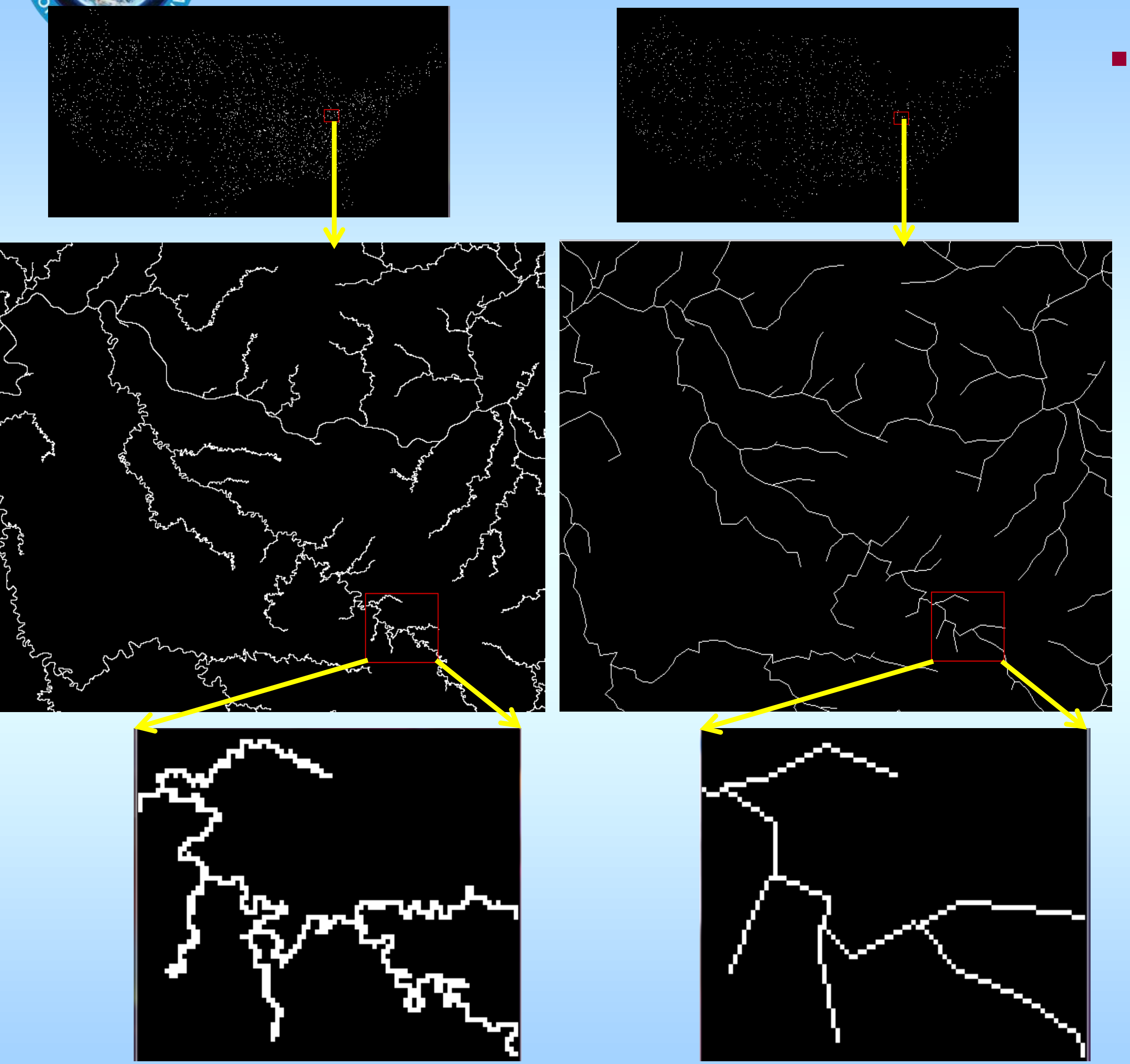






– With the new version which processes NOAA-20/VIIRS and Suomi-NPP/VIIRS imagery, VIIRS flood observations have been doubled than before. And thus, the doubled observations allows more dynamic detection on the water flow due to snow-melting in the north central region.

Key Results/Accomplishments

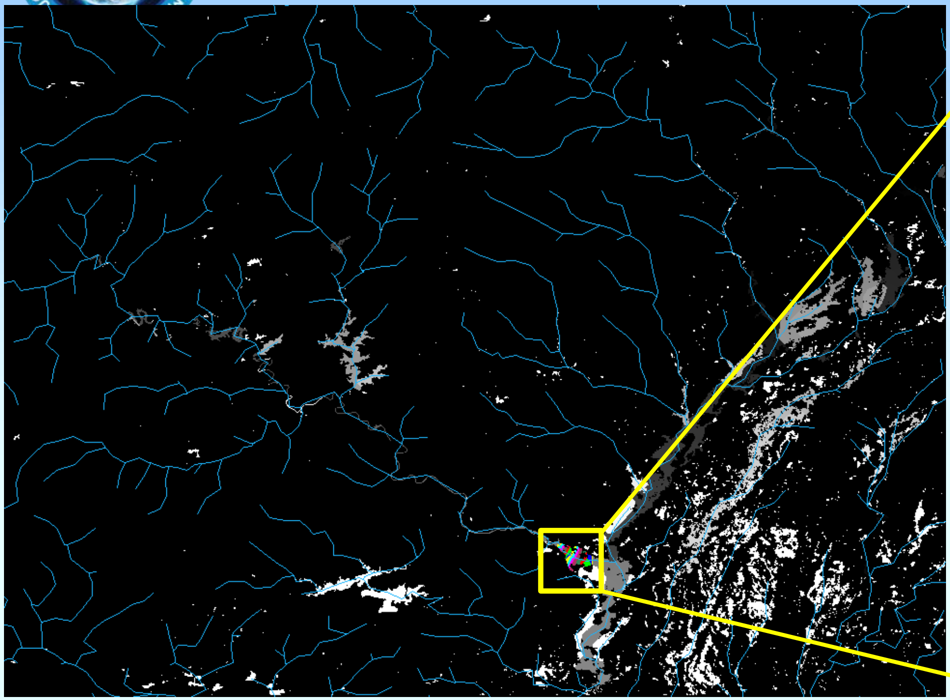


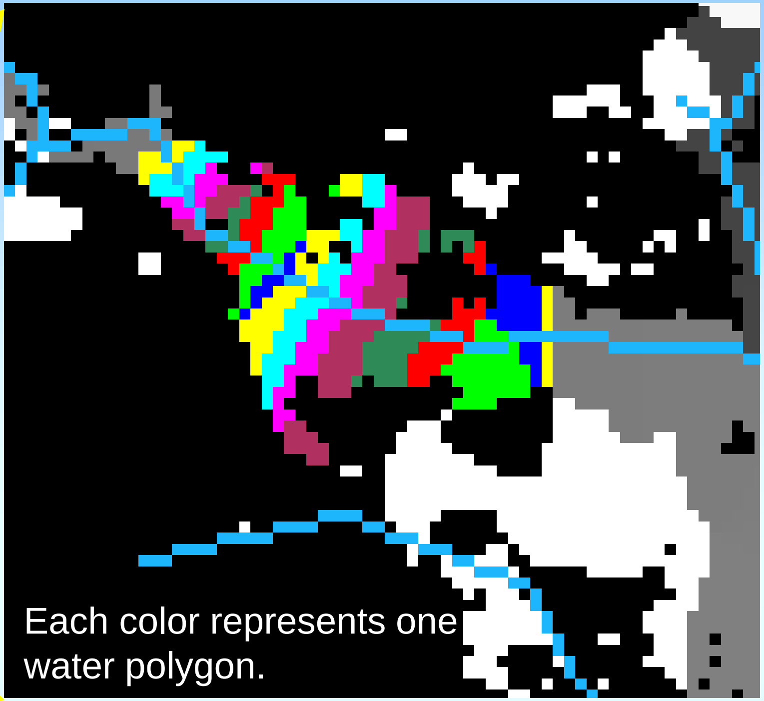
Original 375-m river lines

filtered 375-m river lines

- Apply NHD Plus V2.0 data in the downscaling process. Several datasets have been generated in the CONUS based on the original NHD Plus V2.0 dataset :
  - 375-m filtered river line dataset with river link attributes (upstream and downstream)
  - 375-m river/lake normal water level dataset
  - 375-m river line distance dataset (distance to the starting point of a river)

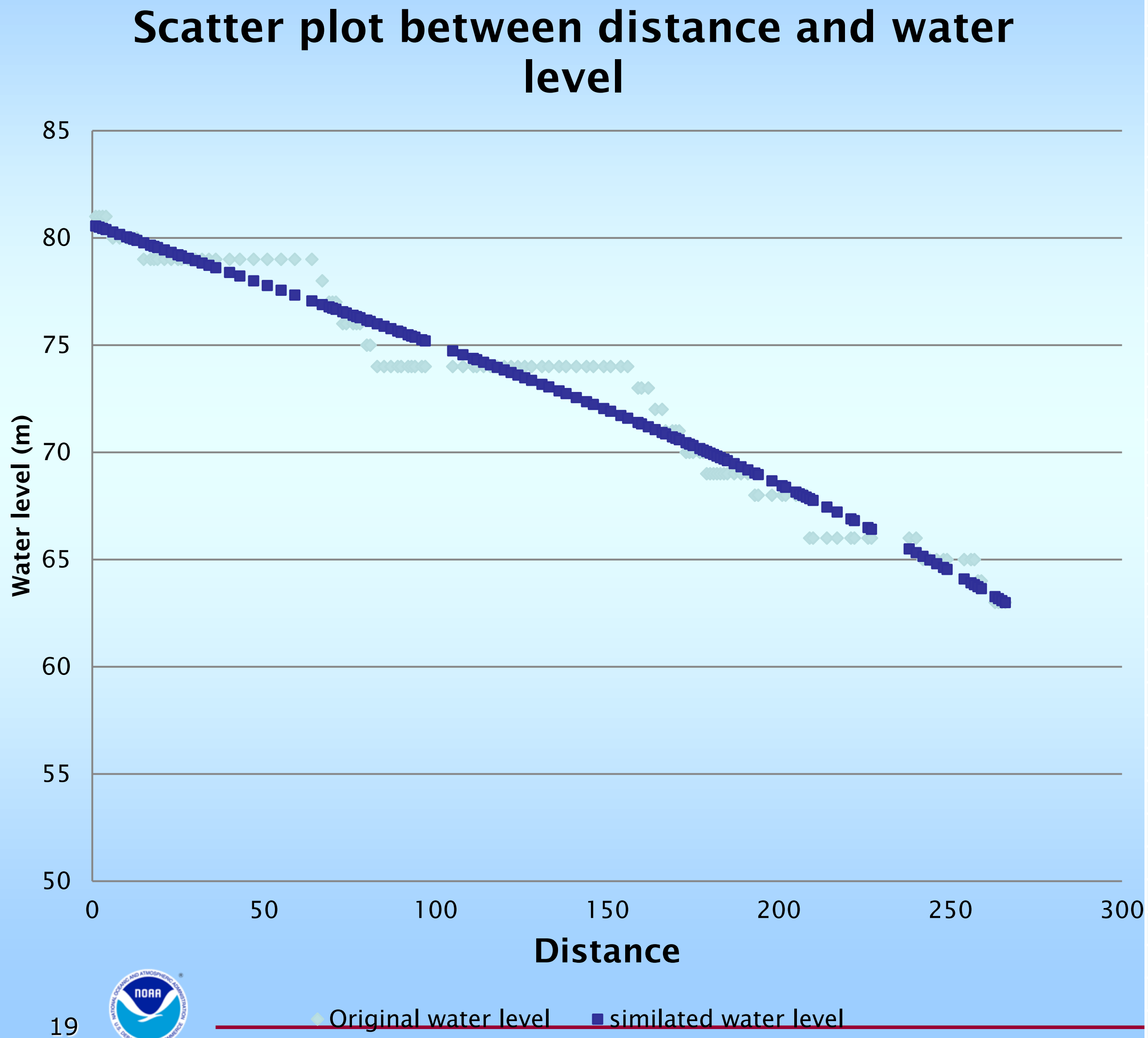
Pixel clustering and river network construction





- Floodwater pixels are clustering into different water polygons according to four factors:
  - the adjacency among pixels
  - hydrologic Unit Code level-8 (HUC8)
  - distance to the most upstream point of a river
  - flow direction.
- Calculate water levels by using moving average and least square error methods.

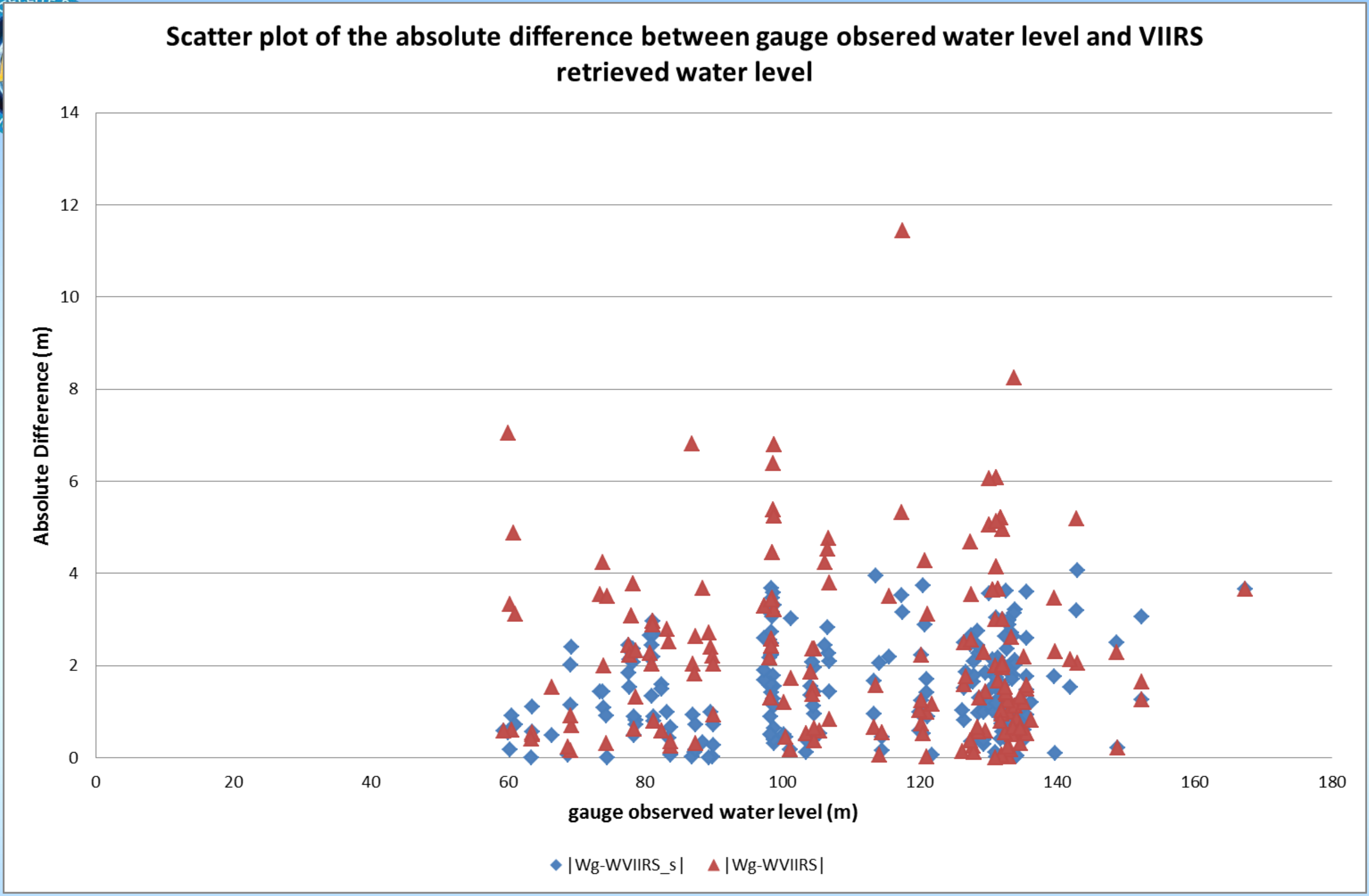
Water level simulation



Distance	adjusted polygon water level	similated water level
1	81	80.55619
2	81	80.49986
3	81	80.44359
4	81	80.38738
6	80	80.27511
8	80	80.16306
10	80	80.05119
11	80	79.99532
12	80	79.93951
13	80	79.88373
15	79	79.77229
17	79	79.66101
18	79	79.60542
19	79	79.54987
21	79	79.43886
23	79	79.32796
25	79	79.21716
26	79	79.1618
28	79	79.05113
30	79	78.94054
32	79	78.83001
34	79	78.71952
36	79	78.60908
40	79	78.38825
43	79	78.22263
47	79	78.00172
51	79	77.78066
55	79	77.55933
59	79	77.33762
64	79	77.05985
67	78	76.89275
69	77	76.78115
70	77	76.72528
71	77	76.66937
73	76	76.55741

Gauge	gauge observed water level	simulated water level	water level without simulation	Date
Mississippi River @ New Madrid, MO	88.324944	88	92	20170502
Mississippi River @ New Madrid, MO	89.300301	89.3	92	20170505
Mississippi River @ New Madrid, MO	89.605103	90.6	92	20170506
Mississippi River @ New Madrid, MO	89.787987	89.8	92	20170507
Mississippi River @ New Madrid, MO	89.970863	89.7	92	20170509
Mississippi River @ New Madrid, MO	89.919044	89.2	89	20170508

Gauge	gauge observed water level	simulated water level	water level without simulation	Date
Ohio River @ Cairo,IL	97.292	95.6	94	20170502
Ohio River @ Cairo,IL	98.161	96.6	96	20170505
Ohio River @ Cairo,IL	98.298	97.8	97	20170506
Ohio River @ Cairo,IL	98.42	96.9	96	20170507
Ohio River @ Cairo,IL	98.46	95.4	95	20170508
Ohio River @ Cairo,IL	98.42	97	95	20170509

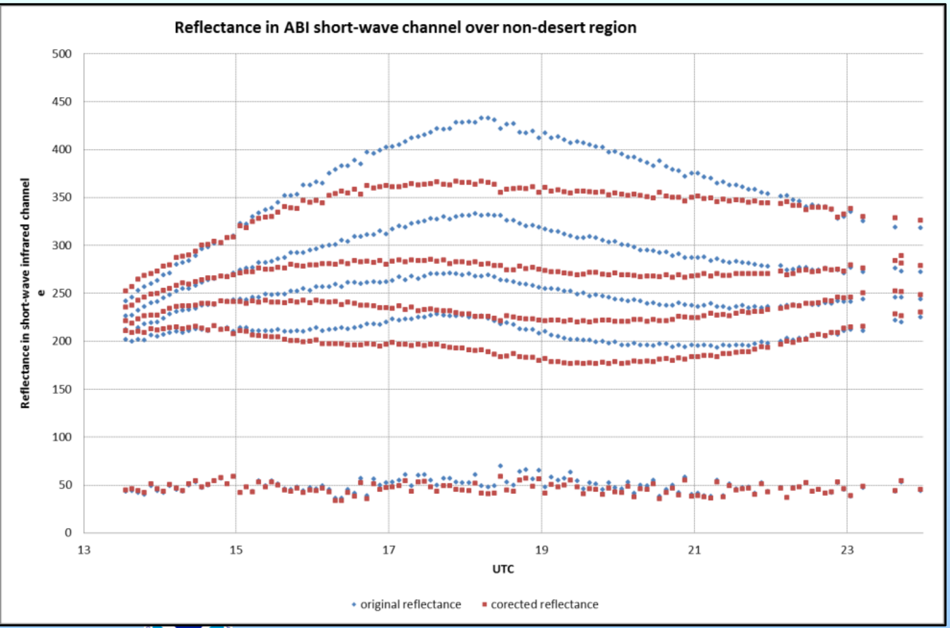


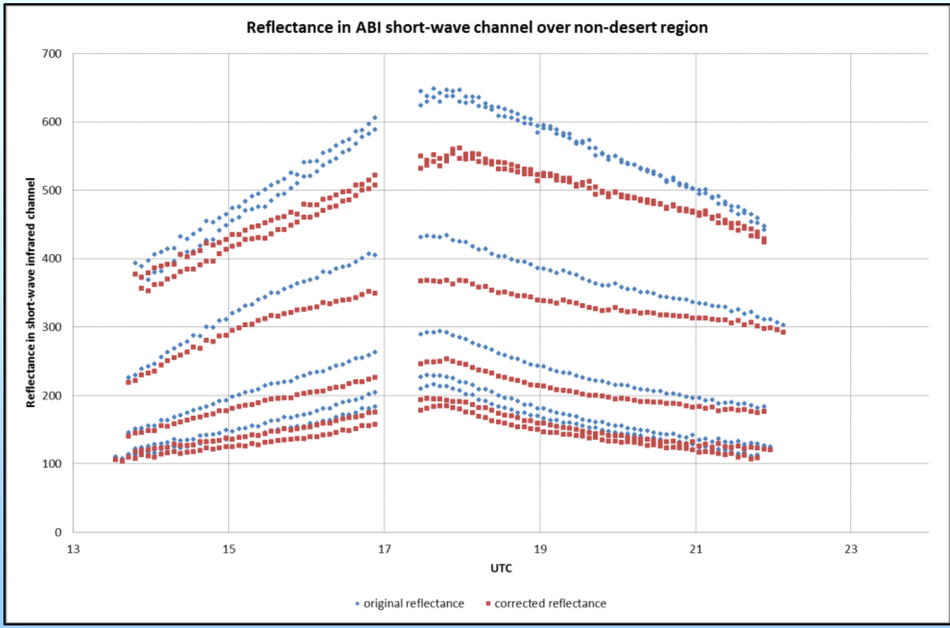
Average absolute difference between gauge observed water levels and VIIRS retrieved water levels of the 249 samples:

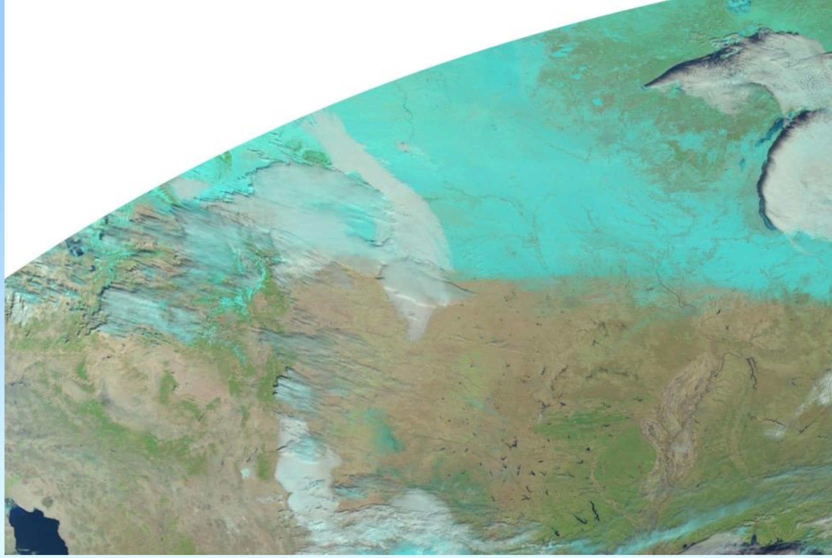
$\overline{|W_g - W_{VIIRS_s}|}$ = 1.48m $\overline{|W_g - W_{VIIRS}|}$ = 2.2m

Key Results/Accomplishments

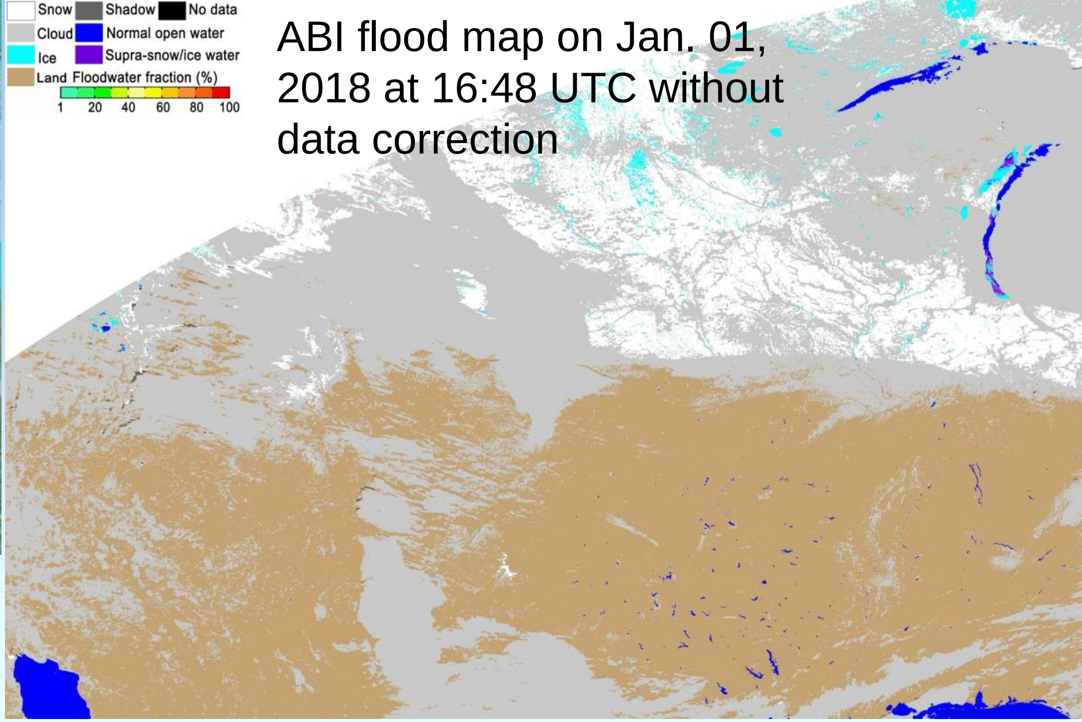
- GOES-16/ABI flood mapping algorithm and software development
  - GOES-16/ABI imagery have been integrated in the flood mapping software: projection, data correction, detection, visualization



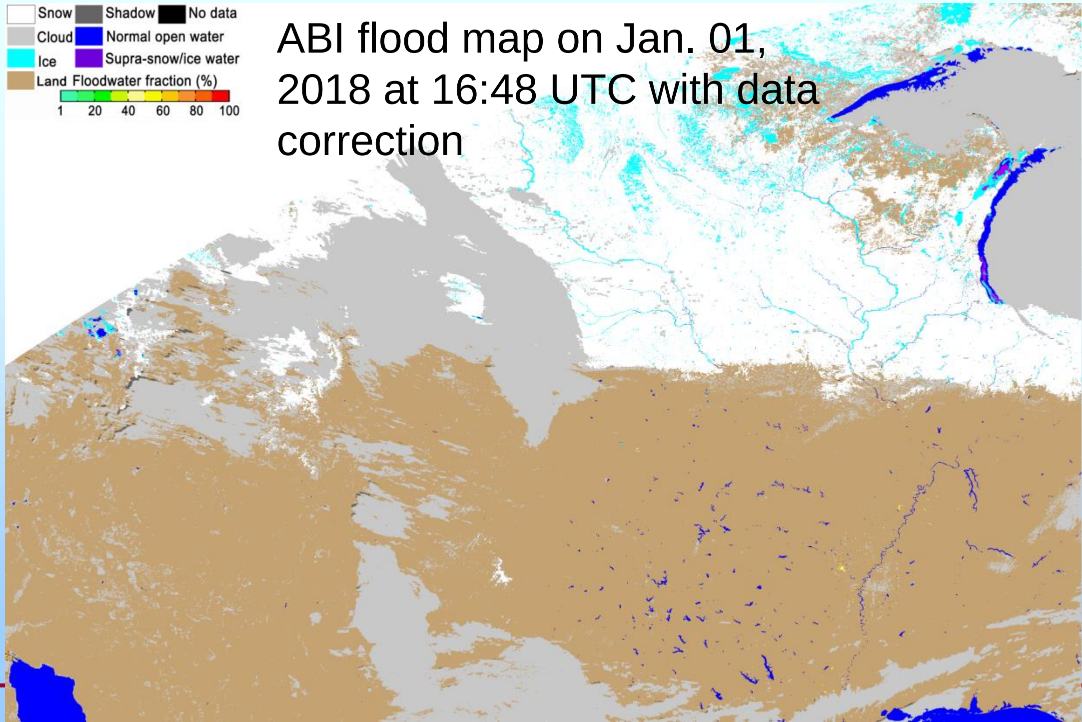




ABI false-color image on Jan. 01, 2018 at 16:48 UTC



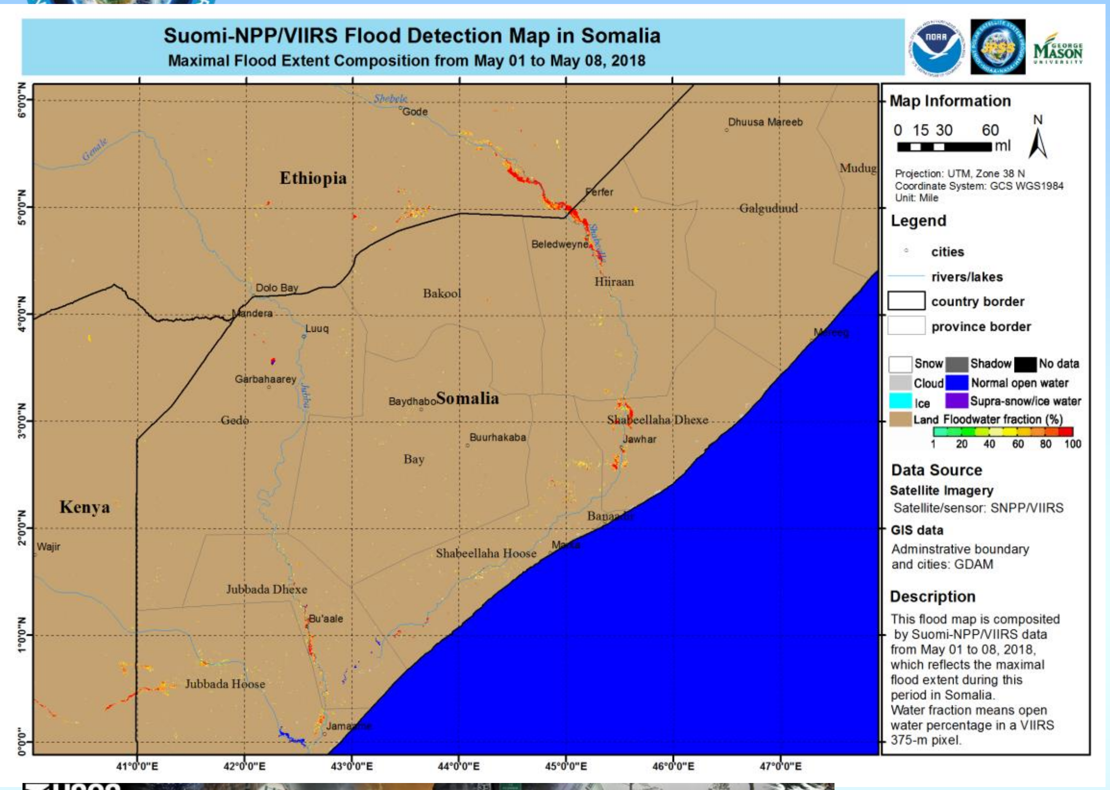
ABI flood map on Jan. 01, 2018 at 16:48 UTC without data correction

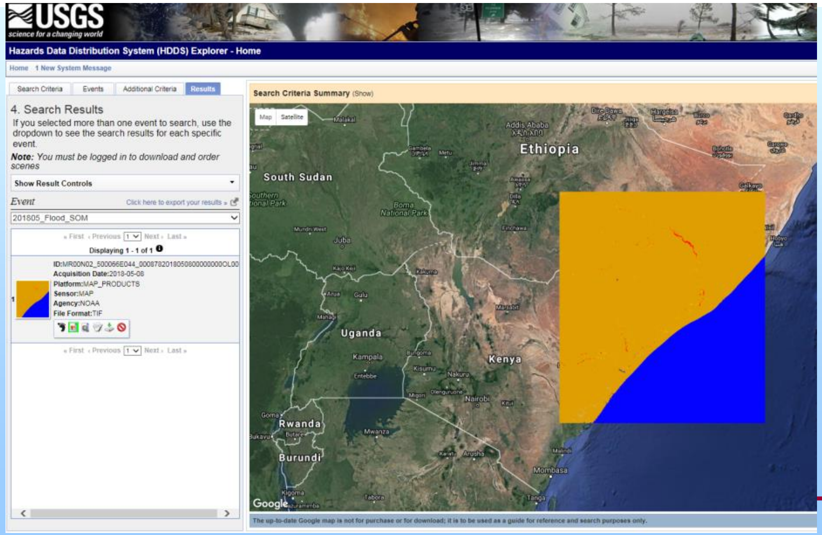


ABI flood map on Jan. 01, 2018 at 16:48 UTC with data correction

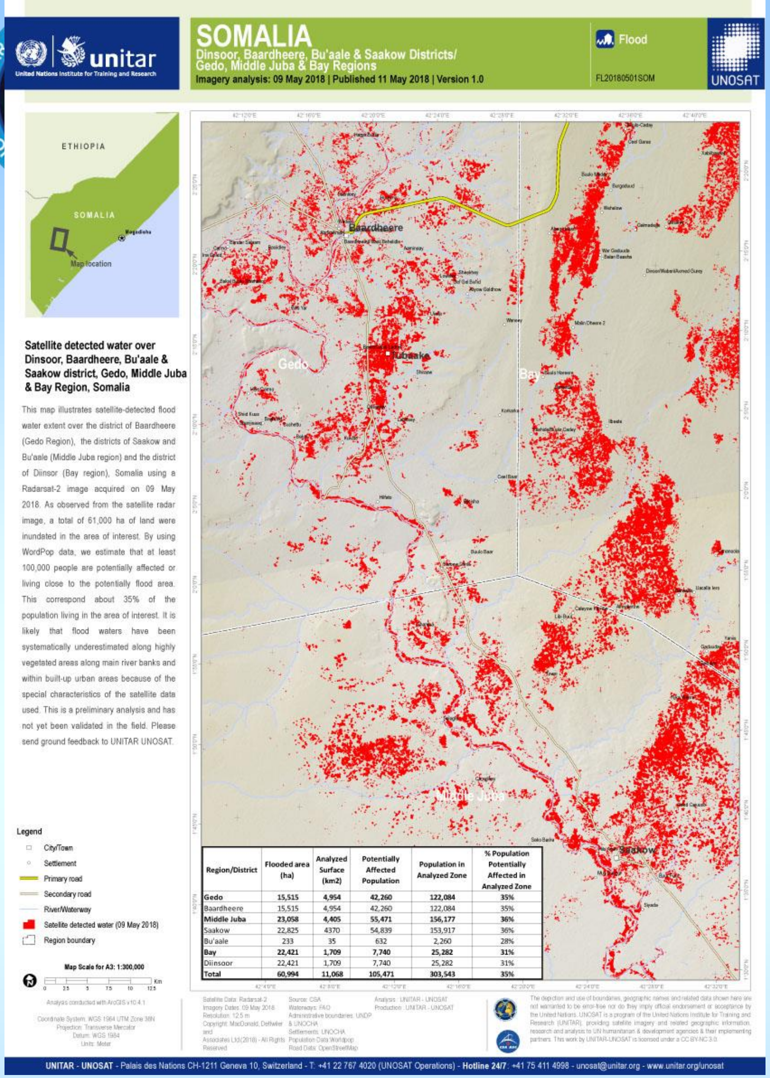
- ABI imagery shows different diurnal change patters on the surface reflectance over different land cover types.
- An correction method on the data has been developed to stabilize the flood detection performance.

Key Results/Accomplishments



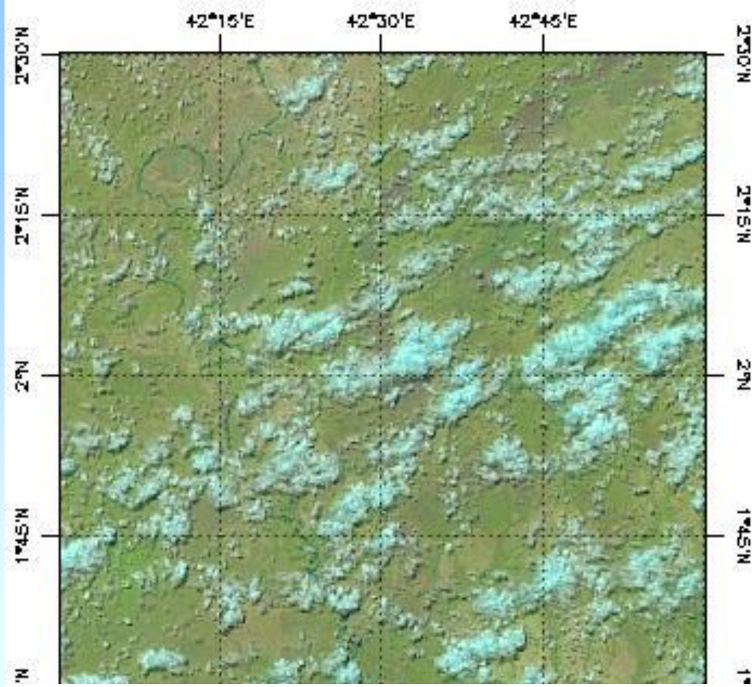


- Develop connections with WMO's International Charter to use VIIRS flood maps for flood activations' response.
  - VIIRS flood maps are generated to respond the flood activations distributed by the coordinators of Disaster Charter in NOAA and USGS.
  - Since Aug. 2016, we have responded more than 15 flood activations from International Charter.

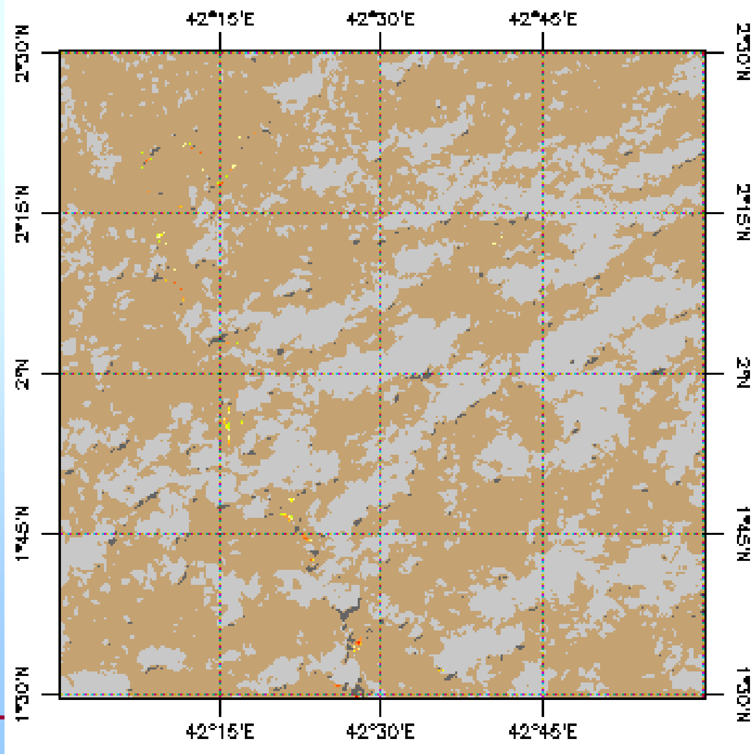


Region/District	Flooded area (ha)	Analyzed Surface (km2)	Potentially Affected Population	Population in Analyzed Zone	% Population Potentially Affected in Analyzed Zone
Gedo	**15,515**	**4,954**	**42,260**	**122,084**	**35%**
Baardheere	15,515	4,954	42,260	122,084	35%
Middle Juba	**23,058**	**4,405**	**55,471**	**156,177**	**36%**
Saakow	22,825	4370	54,839	153,917	36%
Bu'aale	233	35	632	2,260	28%
Bay	**22,421**	**1,709**	**7,740**	**25,282**	**31%**
Diinsoor	22,421	1,709	7,740	25,282	31%
Total	**60,994**	**11,068**	**105,471**	**303,543**	**35%**

UNOSAT flood map on May 09, 2018

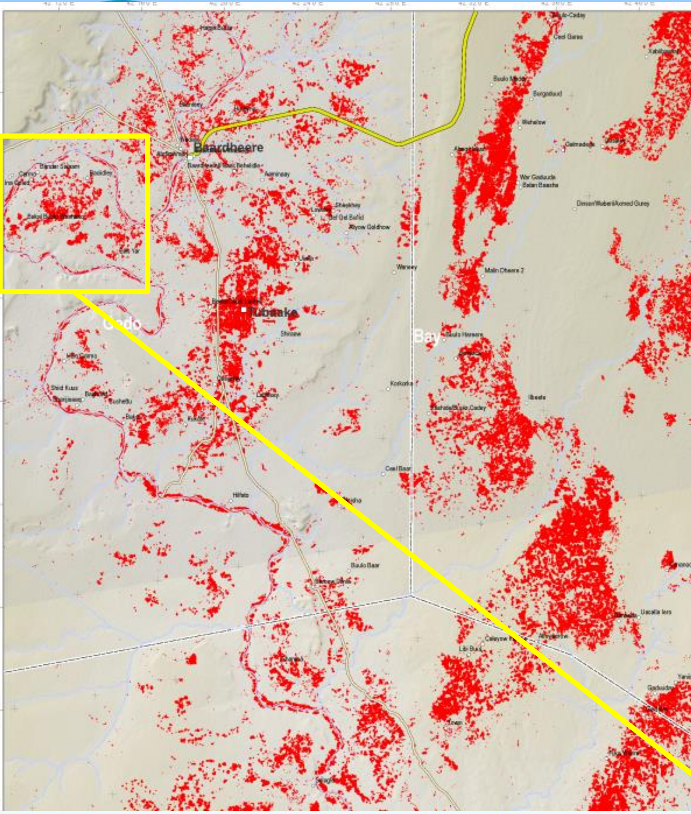


VIIRS false-color image on May 07, 2018 10:33 (UTC)



VIIRS flood map on May 07, 2018 10:33 (UTC)

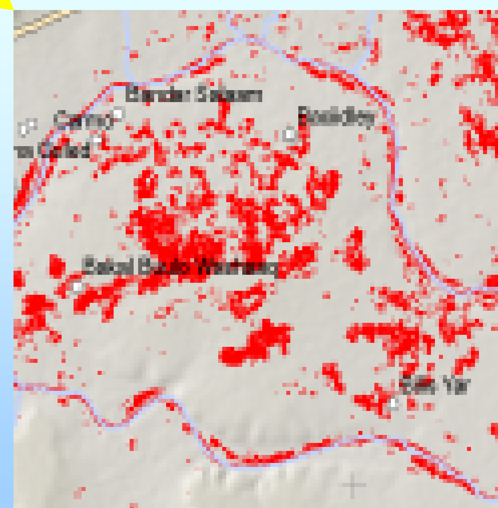
- Compare VIIRS results (no significant flooding) with Radarsat flood results (major flooding) on Somalia flood.



UNOSAT flood map
on May 09, 2018

Sentinel-2B image
on May 08, 2018

Sentinel-2B May 08, 2018



Sentinel-2B May 03, 2018

- VIIRS can still help even though the flood mapping has been dominated by radar satellite imagery.

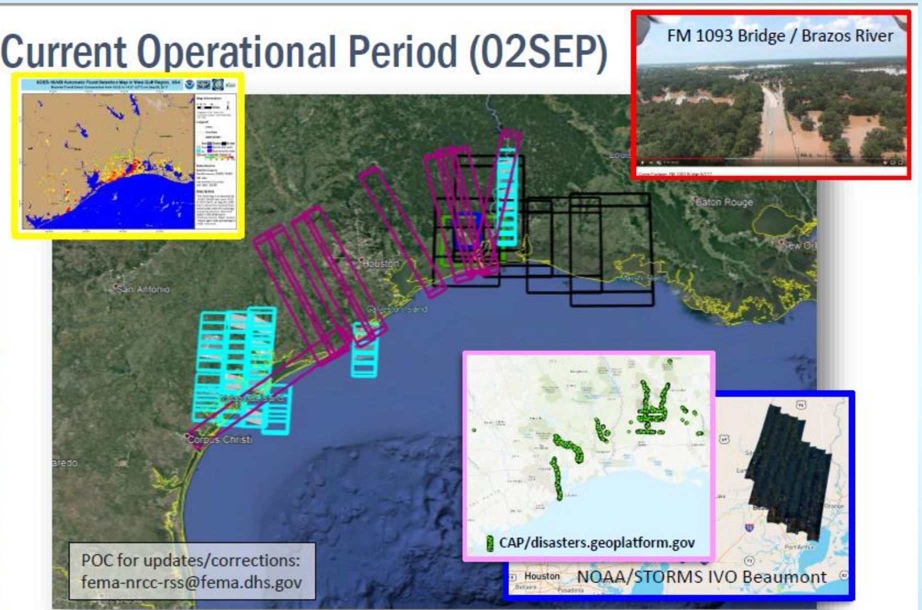
Key Results/Accomplishments

- Develop connections with FEMA and deliver flood products routinely to them for emergency response and disaster mitigation.

FEMA MDARNG **Collection Synchronization – Current Operational Period (02SEP)**

PIR #	Description
1	What are the locations of personnel in distress?
2	How many residences have been impacted and to what degree have they been impacted?
3	How has critical infrastructure been impacted (including list of critical sites, oil rigs, power, transportation, chemical spills)?
4	What are the flood extents of reservoirs and rivers in the AOI?
5	What is the impact of the Arkema chemical facility explosion?

Satellite Platforms	PED	Collection Information	PIR
COSMOSKYMED	Copernicus	1 SAR Product Available	2
RADARSAT-2	NASA/JPL	No Action	2
PALSAR	NASA/JPL	No Action	2
TERRASAR-X	NASA/JPL	No Action	2
WORLDVIEW-1	UNKNOWN	No Action	2
WORLDVIEW-2	UNKNOWN	No Action	2
WORLDVIEW-3	UNKNOWN	Over 100 MSI/PAN Collects	2
WORLDVIEW-4	UNKNOWN	No Action	2
SENTINEL-1	NASA/JPL	No Action	2
SENTINEL-2	NASA/JPL	No Action	2
SPOT-6	NASA/JPL	32 MSI/PAN Collects	2
LANDSAT-7	UNKNOWN	No Action	2
LANDSAT-8	UNKNOWN	No Action	2
GEOEYE-1	UNKNOWN	No Action	2
UKDMC-2	UNKNOWN	No Action	2
GOES-16 & JPSS	NOAA & GMU	Flood Detection	2



Airborne Platforms	PED	Collection Information	PIR
Civil Air Patrol	FEMA/States	Operational (Cumulative Imagery Displayed Above)	4
NOAA (N68RF King Air)	FEMA/States	Operational	2
NOAA (N48RF Twin Otter)	FEMA/States	No Action	2
NASA/JPL (UAVSAR)	NASA/JPL	Operational	2
National Guard (3X RC-26)	TX NG	Operational (focused on SAR)	1
EPA (ASPECT)	EPA	Operational	5
DOI BLM (Small UAS)	Unknown	Operational	1

Future plan

- Release of GOES-16/ABI flood detection software
- Development of Himawari-8/AHI flood detection software
- Development of the blended algorithm to merge VIIRS, ABI and AHI flood products together to produce a blended 375-m flood product
- Development of the downscaling model with the NHD Plus V2.0 datasets
- Development of a website for VIIRS/ABI/AHI flood products distribution
- SPSRB process to make the VIIRS flood product operational in NESDIS if possible

Summary

- A new update of VIIRS flood Version 1.0 software has been released, in which algorithm improvements have been made and NOAA-20/VIIRS data has been integrated.
- VIIRS global flood maps are now available and distributed by CSPP group through SSEC's Real Earth.
- NHD Plus V2.0 dataset has been implemented in the downscaling model and helps improve the accuracy of water level retrieval.
- VIIRS flood product have been applied for emergency responses under the developed interactions with WMO's International Charter and FEMA.
- GOES-16/ABI flood software is under development and will be available soon. A geostationary-JPSS flood product will be developed with the availability of VIIRS, ABI and AHI flood products.

Thanks!

VIIRS Surface Type Products

Presented by Xiwu Zhan, NESDIS/STAR

Chengquan Huang and Rui Zhang, UMD Geography

Date: 2018/08/28

VIIRS Surface Type Product Team

Name	Organization	Major Task
Xiwu Zhan	NESDIS-STAR	Government Lead
Chengquan Huang	UMD Geography	Technical Lead
Rui Zhang	UMD Geography	Algorithms and Production Lead
Marina Tsidulko	STAR-AIT	Land Data Processing
Ivan Csiszar	NESDIS-STAR	VIIRS Land Team Lead
Lihang Zhou	NESDIS-STAR	STAR-JPSS Program Manager

Outline

- Why Surface Type?
- VIIRS Annual Surface Type 2017 Product
  - Compositing Algorithm Improvement
  - VIIRS AST2017 to be delivered
- Surface Type Change Product
  - Needs for Daily Surface Type Data
  - Change detection algorithm testing
- Summary and Path Forward

Why Surface Type

ST-EDR/AST Requirements from JPSS L1RD

Attribute	Objective
Geographic coverage	Global
Vertical Coverage	
Vertical Cell Size	N/A
Horizontal Cell Size	1 km at nadir
Mapping Uncertainty	1 km
Measurement Range	17 IGBP classes
Measurement Accuracy	70% correct

- Evergreen Needleleaf Forests
- Evergreen Broadleaf Forests
- Deciduous Needleleaf Forests
- Deciduous Broadleaf Forest
- 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
- Water Bodies

Why Surface Type

Surface Type Plays Important Roles in Many Climate Processes

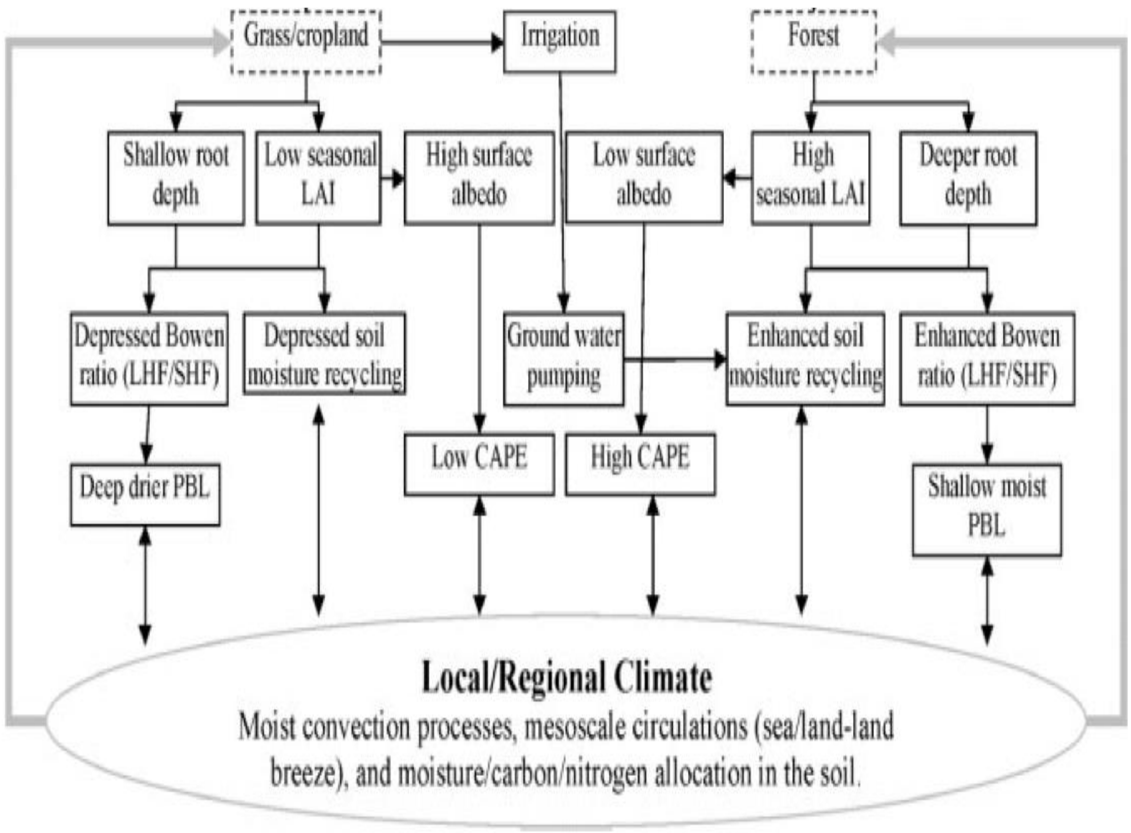
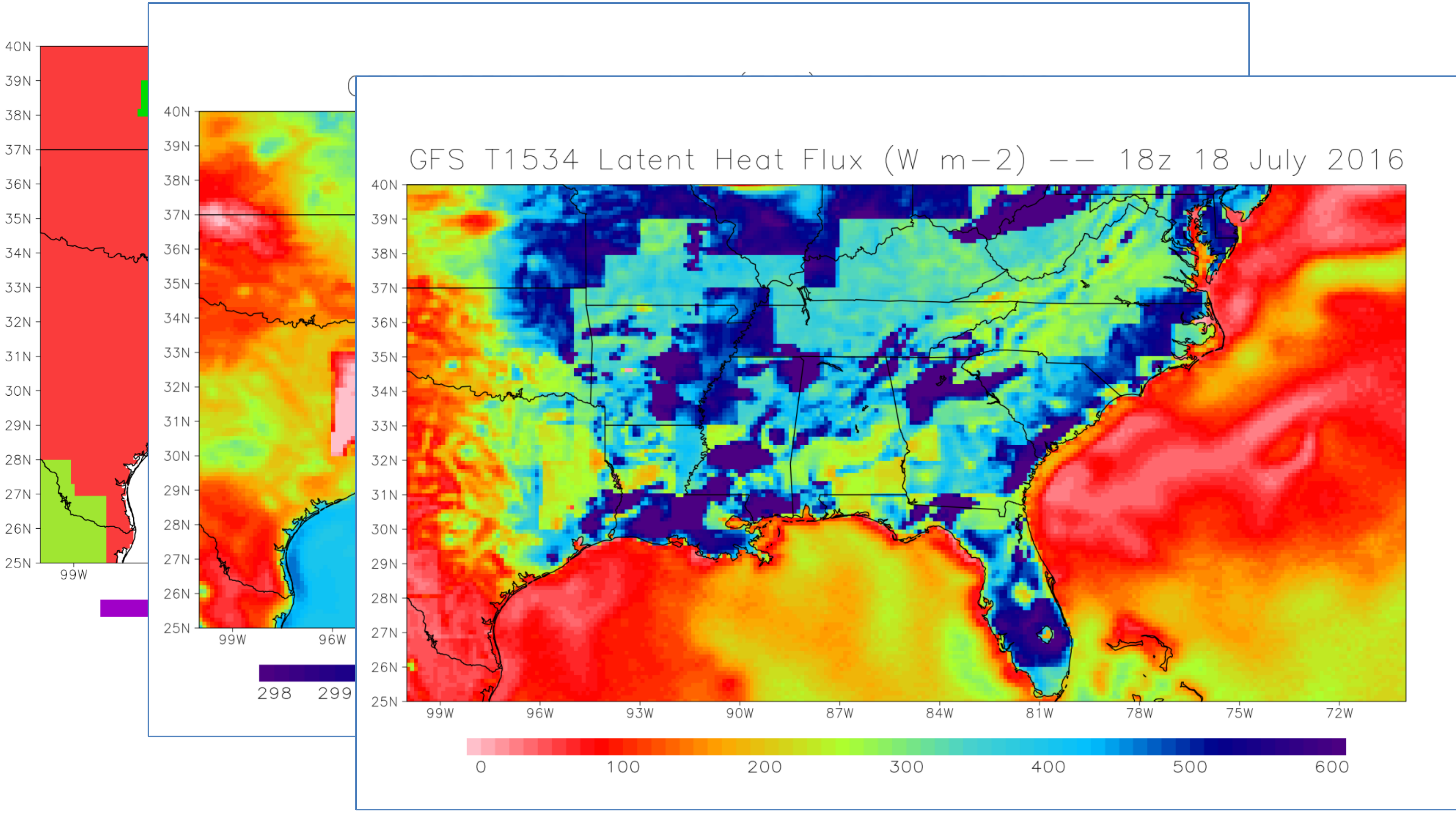


Figure 2. Conceptual model of the impacts of LCC on local and regional climate (Source: Pielke *et al.*, 2007).

Mahmood, R., Pielke, R.A., Hubbard, K.G., Niyogi, D., Dirmeyer, P.A., McAlpine, C., Carleton, A.M., Hale, R., Gameda, S., Beltrán-Przekurat, A., Baker, B., McNider, R., Legates, D.R., Shepherd, M., Du, J., Blanken, P.D., Frauenfeld, O.W., Nair, U.S., & Fall, S. (2014). Land cover changes and their biogeophysical effects on climate. *International Journal of Climatology, 34, 929-953.*

Why Surface Type

Surface Type Plays Important Roles in NWP models



Why Surface Type

- GLDAS is tested using either old AVHRR ST or newer MODIS/VIIRS QST IP
- Root-zone soil moisture estimates based on MODIS/VIIRS ST have better agreement with in situ measurements

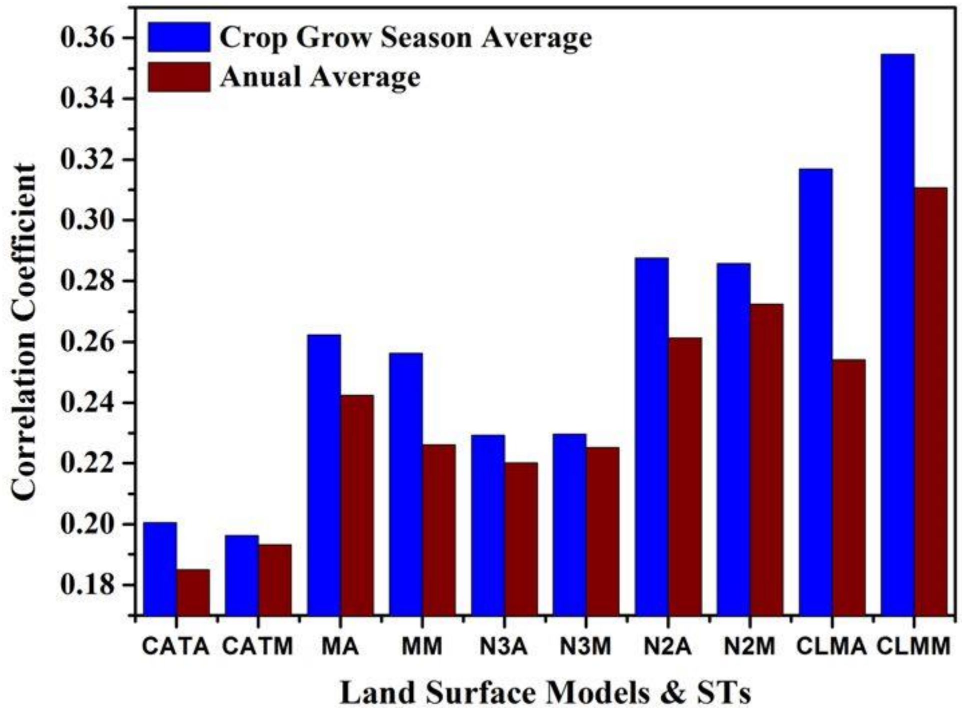
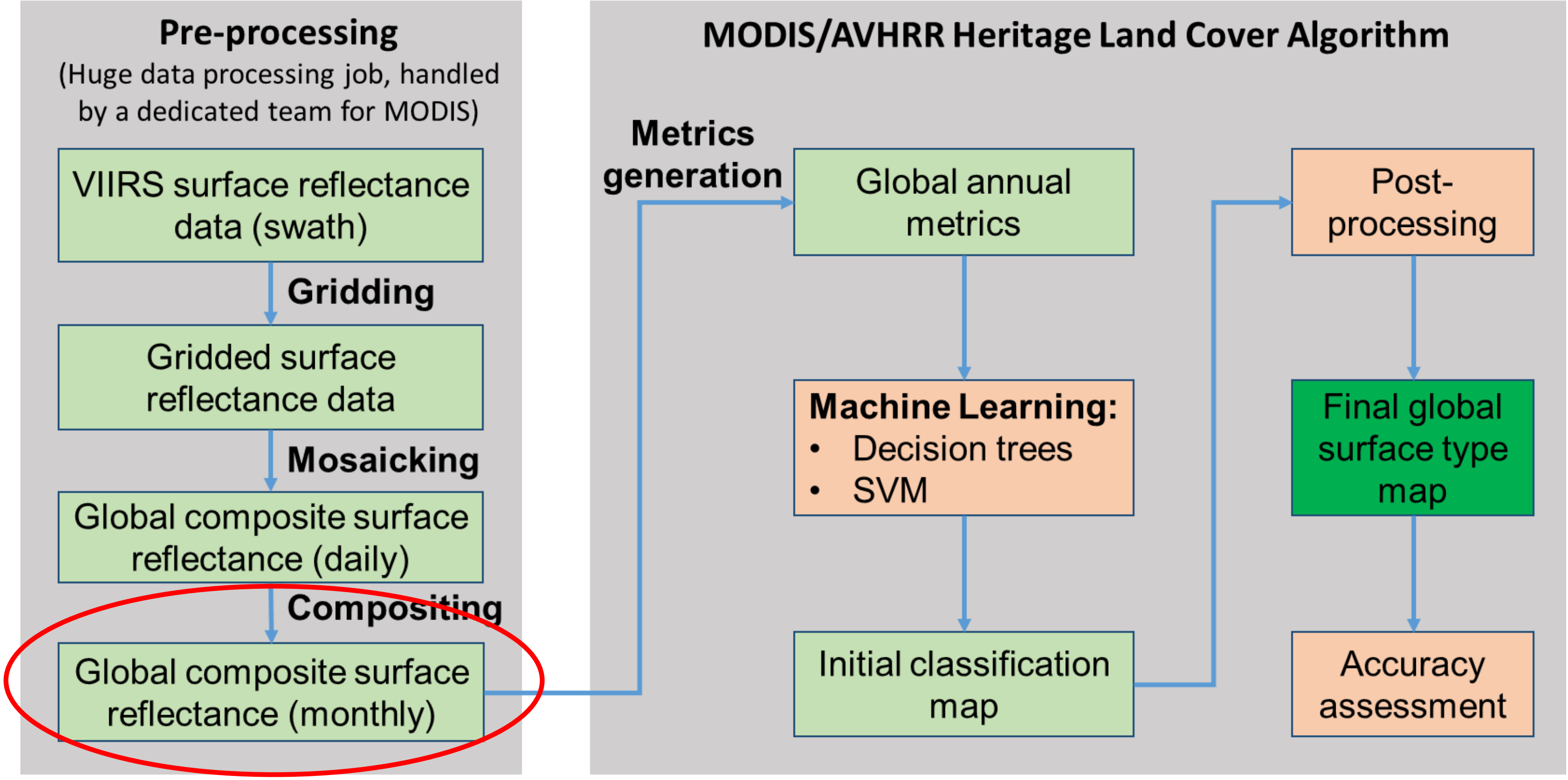


Fig. 1. The relationship between in-situ observational relative soil moisture of 108 stations and soil moisture simulated by land surface models with AVHRR and MODIS land cover over China mainland from January 2011 to December 2012. For each month, the sample size is 324, consisting of 108 stations data for every ten-day observation time interval. If correlation coefficients are more than o.16, 0.22 and 0.29, they are significant with credibility level 0.05, 0.01 and 0.001 separately. Crop grow season is from April to September in 2011 and 2012. The symbols of CATA, CATM, MA, MM, N3A, N2A, N2M CLMA and CLMM indicate Catchment, Mosaic, Noah3.2, Noah2.7.1 and CLM2.0 land surface models (LSM) implemented in LIS respectively. ST is surface type.

Jifu Yin, Youfei Zheng, Xiwu Zhan, Christopher R. Hain, Qingfei Zhai, Changchun Duan, Rongjun Wu, Jicheng Liu & Li Fang (2015) An assessment of impacts of landcover changes on root-zone soil moisture, *International Journal of Remote Sensing*, 36:24, 6116-6134, DOI: 10.1080/01431161.2015.1111539

VIIRS Annual Surface Type 2017

- Improve compositing algorithm
- Generate AST product with 2017 VIIRS Data



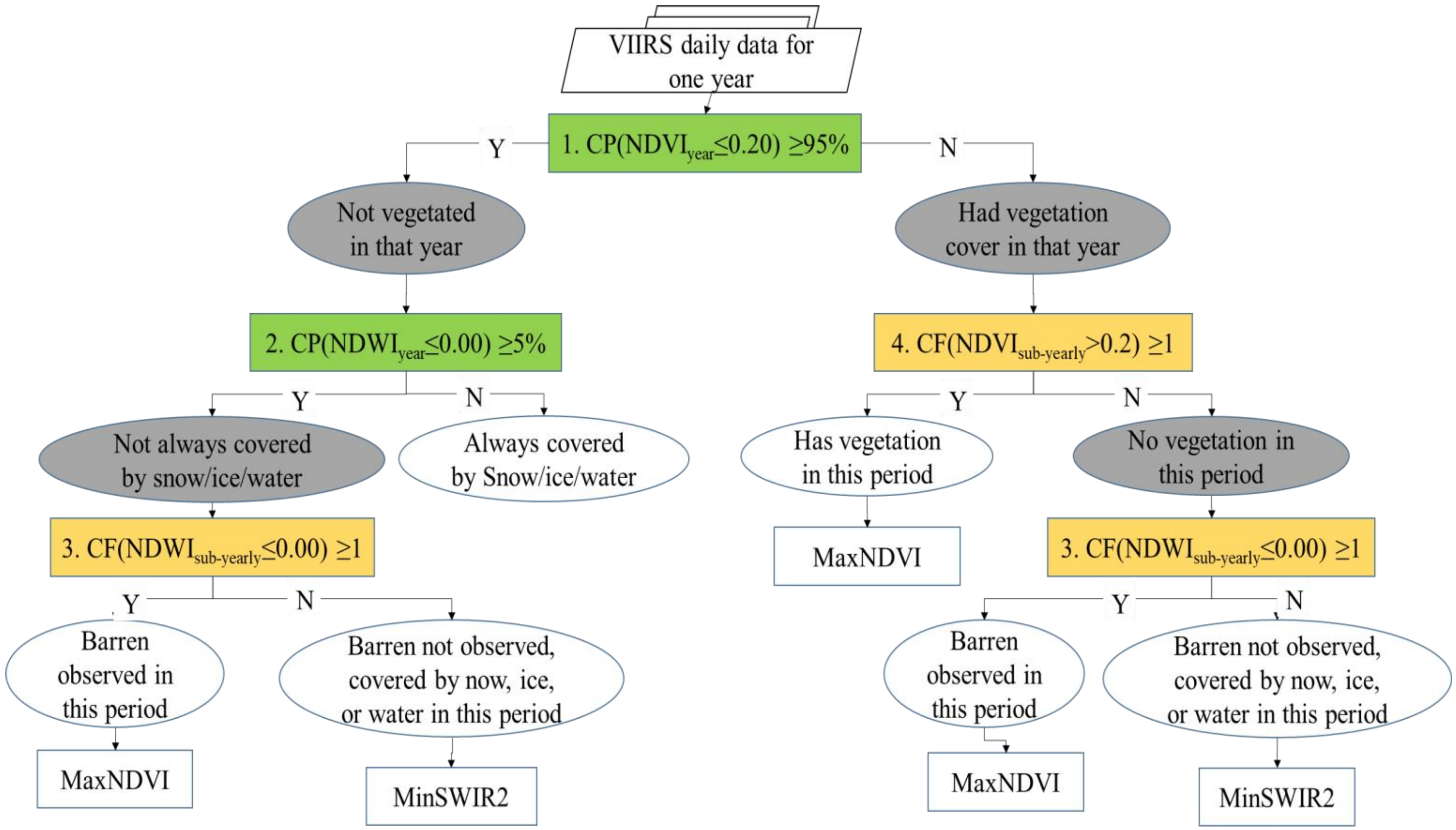
VIIRS Annual Surface Type 2017

A New Self-Adaptive Compositing (SA-Comp) Algorithm

- Previous compositing algorithms:
  - Limitations: Good at one aspect, bad for others
  - MODIS algorithm requires cloud mask/QA flags
- Automated surface cover condition determination
  - Vegetated
  - Water
  - Snow/ice
  - Other
- Different method for different surface conditions
- Major improvements over
  - Barren
  - Water
  - Snow/ice
- Published by ISPRS Journal of P&RS

VIIRS Annual Surface Type 2017

A New Self-Adaptive Compositing (SA-Comp) Algorithm



Bian, J., Li, A., Huang, C., Zhang, R., & Zhan, X. (2018). A self-adaptive approach for producing clear-sky composites from VIIRS surface reflectance datasets. *ISPRS Journal of Photogrammetry and Remote Sensing, 144, 189-201.*

VIIRS Annual Surface Type 2017

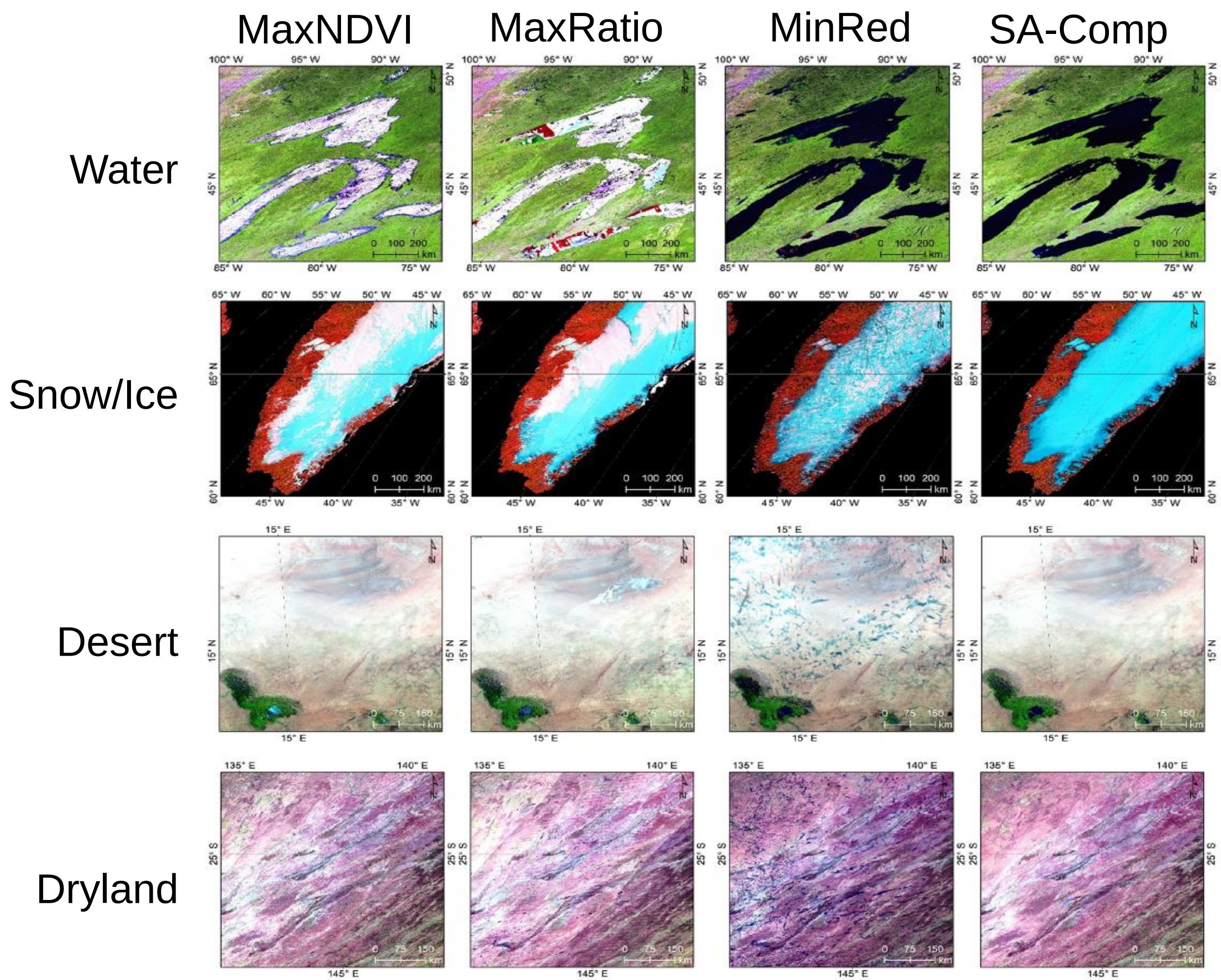
A New Self-Adaptive Compositing (SA-Comp) Algorithm

Better Than

Single-

Criterion

Methods



VIIRS Annual Surface Type 2017

A New Self-Adaptive Compositing (SA-Comp) Algorithm

Better Than

MODIS

Heritage

Methods

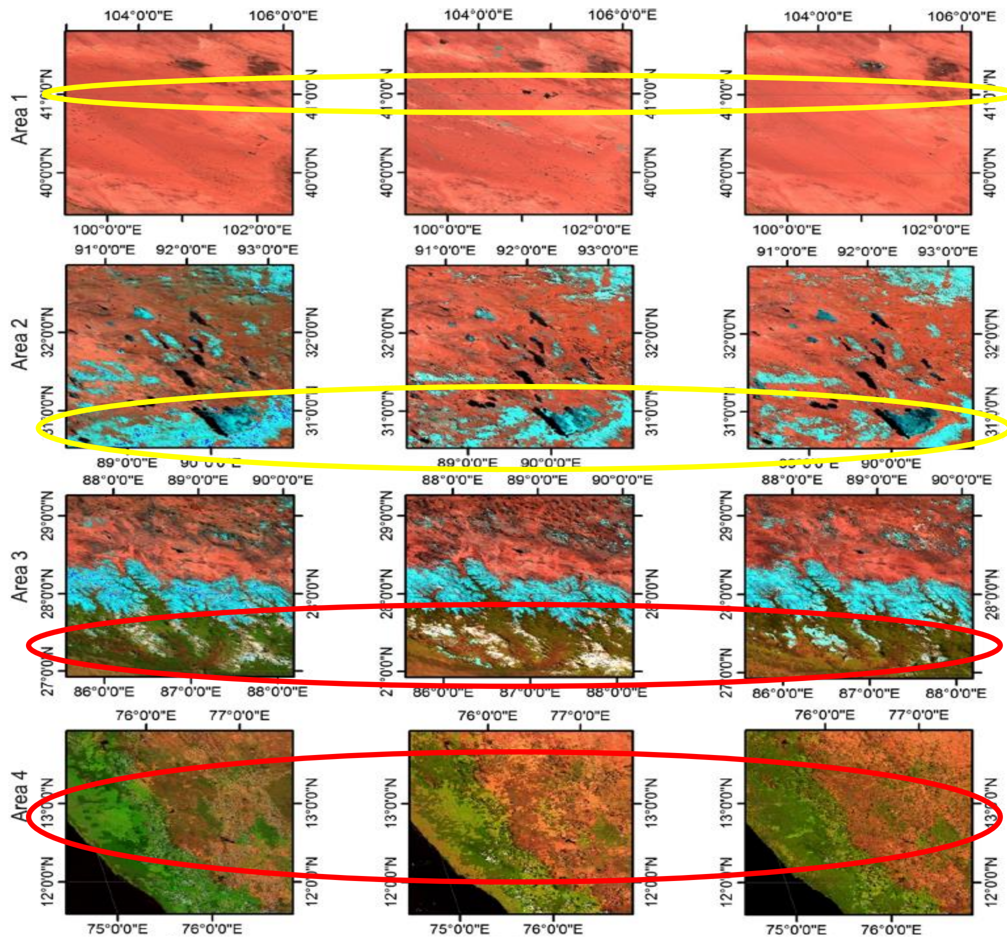
Less shadow

Non-snow selected when exist

Less cloud

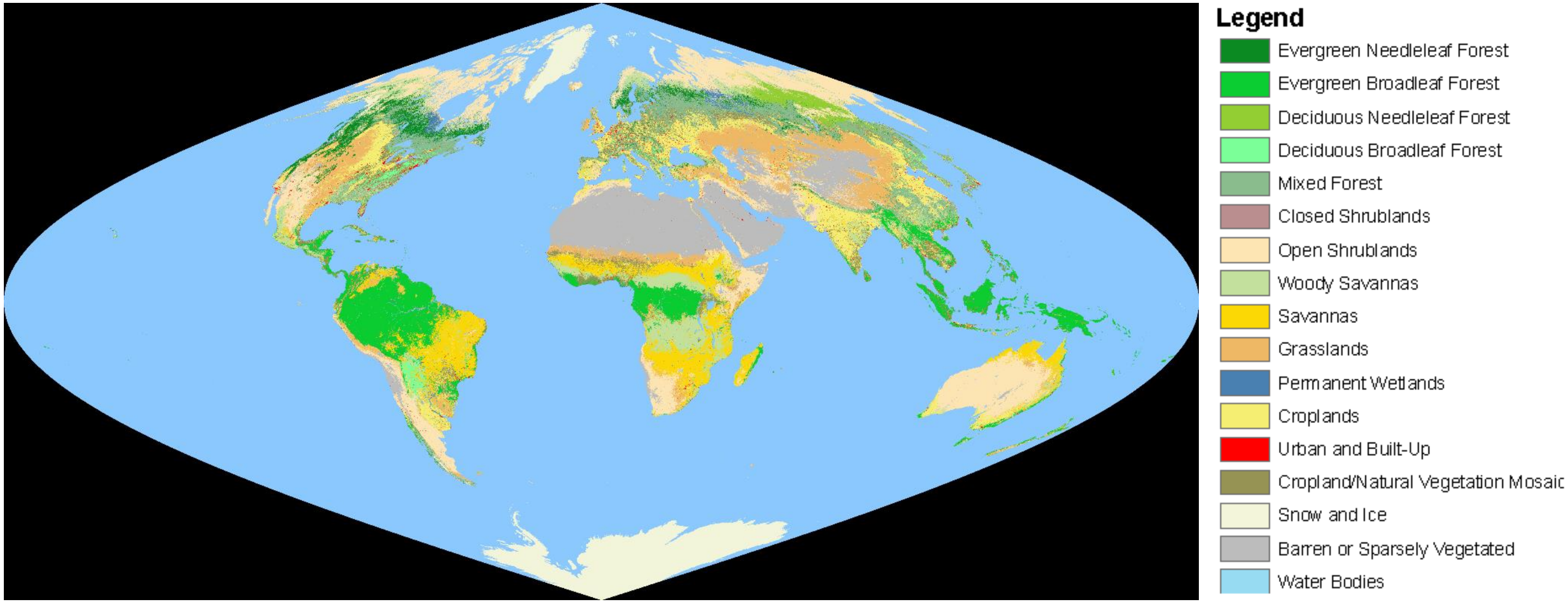
Smoother results over vegetated and non-vegetated areas

MOD09A1 | NASA VNP09A1 | SA-Comp



VIIRS Annual Surface Type 2017

- Generated using 2017 VIIRS data acquired between:
  - 1/1/2017 – 12/31/2017
- Available in two projections:
  - Sinusoidal
  - Lat/long
- FTP download:
  - ftp://vct.geog.umd.edu/ST/S-NPP_VIIRS_GST_IGBP_2017.zip
  - ftp://vct.geog.umd.edu/ST/S-NPP_VIIRS_GST_IGBP_2017_30arcsec.zip



Validation of 2017 VIIRS AST Product

		Reference																	Total	User's	Producer's
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	(%)	accuracy (%)	accuracy (%)
Map	1	1.86	0	0.06	0.04	0.29	0	0.01	0.21	0.04	0.04	0	0	0	0.01	0	0	0.02	2.6	71.7±2.9	70.7±3.5
	2	0	8.52	0	0.09	0.12	0	0	0.42	0.09	0.03	0	0.05	0	0.06	0	0	0	9.39	90.7±1.2	93.1±1.1
	3	0.05	0	0.97	0	0.11	0	0.05	0.11	0	0	0.04	0	0	0	0	0	0	1.33	73.2±3.9	66.6±4.8
	4	0	0	0.01	0.77	0.04	0	0	0.09	0.03	0	0	0	0	0.01	0	0	0	0.94	81.7±3.0	34.4±3.1
	5	0.19	0.12	0.29	0.74	3.64	0.03	0	0.63	0.15	0.02	0.02	0	0.02	0.27	0	0	0.02	6.12	59.4±2.6	77.1±2.5
	6	0	0	0	0	0	0.04	0	0	0	0	0	0	0	0	0	0	0	0.06	77.8±5.7	3.1±0.6
	7	0.21	0	0.05	0.07	0.17	0.6	11.78	0.52	0.41	1.48	0.21	0.41	0.02	0.17	0	0.55	0.02	16.67	70.7±1.7	84.8±1.7
	8	0.27	0.16	0.04	0.31	0.13	0.06	0.24	5.06	0.59	0.12	0.05	0.07	0.01	0.39	0	0	0.02	7.5	67.4±1.9	58.4±2.2
	9	0	0.21	0.03	0.05	0.05	0.43	0.32	0.85	4.63	0.21	0.03	0.21	0	0.56	0	0	0	7.59	61.1±2.9	67.8±2.7
	10	0.03	0	0.01	0.01	0.06	0.23	0.69	0.24	0.26	6.31	0	0.58	0.01	0.2	0	0.23	0	8.85	71.3±1.7	67.2±2.4
	11	0.01	0.03	0	0	0.01	0	0.07	0.04	0.05	0.01	0.54	0	0	0	0	0	0	0.77	69.6±6.2	60.1±7.3
	12	0.01	0.01	0	0.02	0.03	0.03	0.09	0.07	0.16	0.42	0.01	6.85	0.05	0.61	0	0	0.02	8.38	81.8±1.2	79.2±1.7
	13	0	0	0	0	0	0	0.01	0.03	0	0.01	0	0.07	0.52	0.04	0	0	0	0.69	75.0±3.6	80.6±5.4
	14	0	0.1	0.02	0.12	0.06	0.01	0.07	0.4	0.4	0.18	0	0.37	0.01	2.77	0	0.01	0	4.51	61.4±2.1	54.0±2.7
	15	0	0	0	0	0	0	0.17	0	0	0.17	0	0	0	0	10.06	0	0	10.41	96.7±2.3	100.0±0.0
	16	0	0	0	0	0	0	0.4	0	0	0.35	0	0.04	0	0.04	0	12.21	0	13.06	93.6±1.4	94.0±1.0
	17	0	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0	1.11	1.13	98.3±1.7	91.4±3.1
	Total	2.63	9.16	1.46	2.24	4.72	1.43	13.89	8.66	6.83	9.39	0.89	8.65	0.64	5.13	10.06	13	1.21	100		

Overall accuracy is 77.6 ± 0.6%.

Surface Type Highly Dynamic

- Conversions
  - Deforestation
  - Urban sprawl
  - Desertification
  - Revegetation
  - Other type conversions
- Short term changes
  - Vegetation phenology
  - Seasonal snow cover
  - Flooding/short term inundation
  - Wildfire burning

VIIRS Surface Type Change Product

Needs for Surface Type Change/Daily Surface Type Product

- Surface Type Change Can Result in changes in Key Climate Variables

  Li, F., Lawrence, D.M., & Bond-Lamberty, B. (2017). Impact of fire on global land surface air temperature and energy budget for the 20th century due to changes within ecosystems. *Environmental Research Letters, 12, 044014.*

- ET Varies with Inundation Level Changes

  Zhao, X., & Liu, Y. (2016). Evapotranspiration Partitioning and Response to Abnormally Low Water Levels in a Floodplain Wetland in China. *Advances in Meteorology, 2016, 11.*

- Local Surface Temperature and Precipitation Change from Deforestation

  Winckler, J., Reick, C.H., & Pongratz, J. (2017). Robust Identification of Local Biogeophysical Effects of Land-Cover Change in a Global Climate Model. *Journal of Climate, 30, 1159-1176.*

- Consistency check of land surface status (e.g. albedo, LST, GVF, fires, etc) requires near real time surface type data

VIIRS Surface Type Change Product

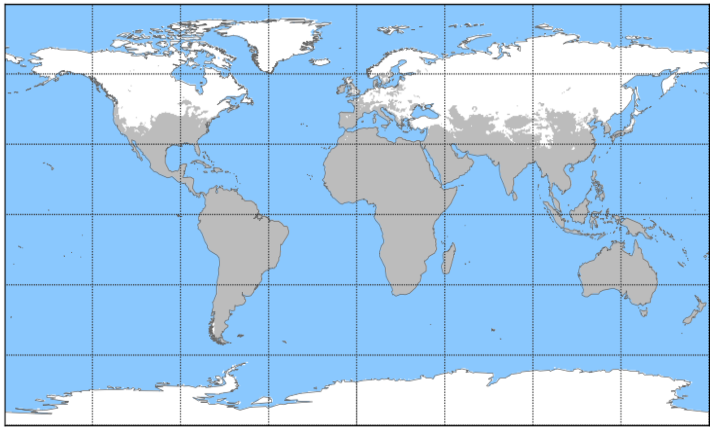
Feasibilities of Mapping Surface Type Change Using VIIRS

- Longer term surface type conversions should have been captured by AST
- Shorter term changes need to be detected or brought in, e.g.
  - Snow -> seasonal snow cover change
  - Flooding -> short term inundation
  - Fire/burned area -> fire driven changes
- Need to bring all these together in a single product suite – daily surface type product for users convenience

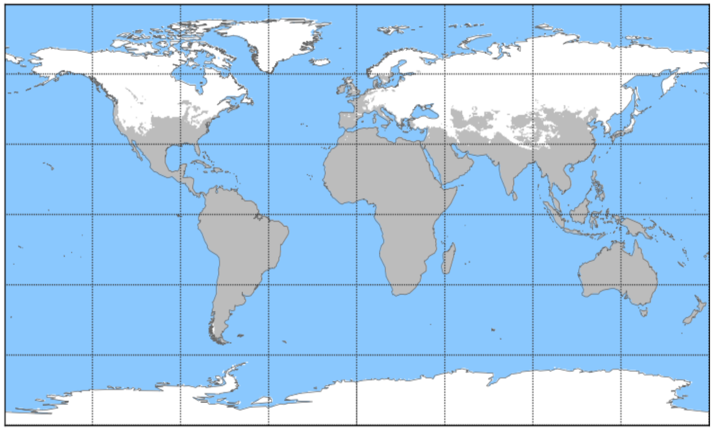
VIIRS Surface Type Change Product

Daily Snow Coverage Has Already Been Available from VIIRS Snow Product Team

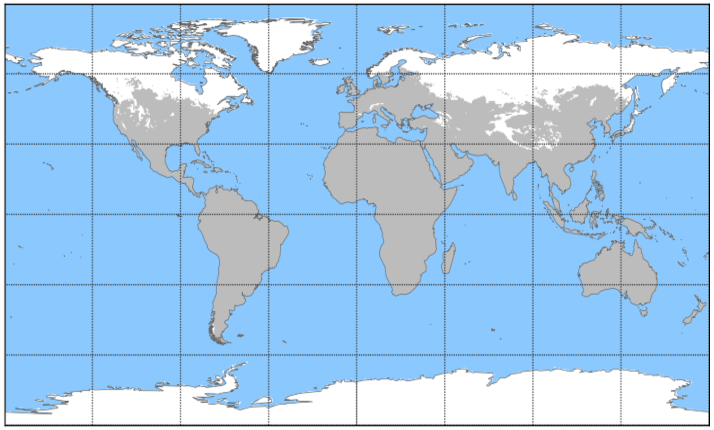
1 Jan 2017



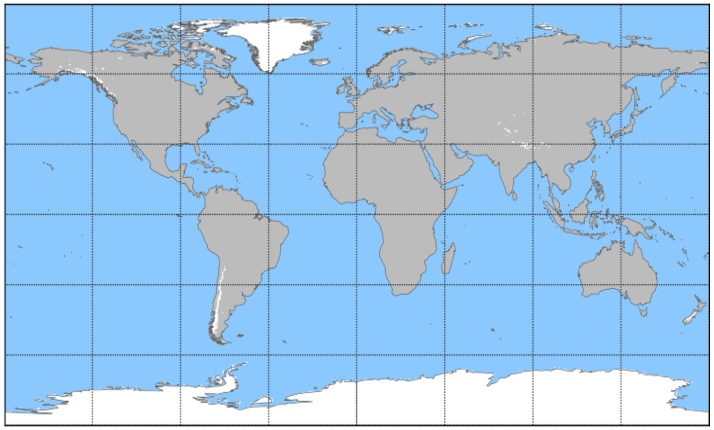
1 Feb 2017



15 Apr 2017



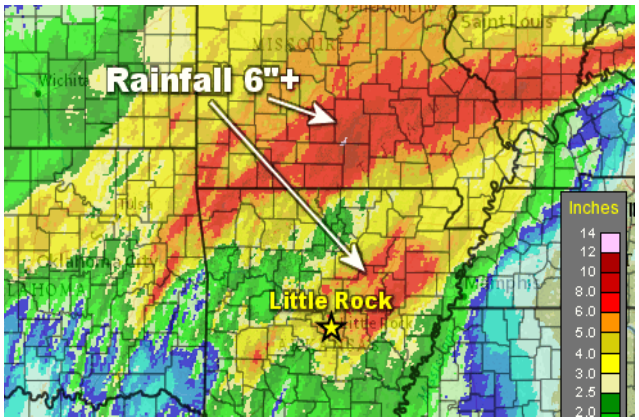
1 Aug 2017



VIIRS Surface Type Change Product

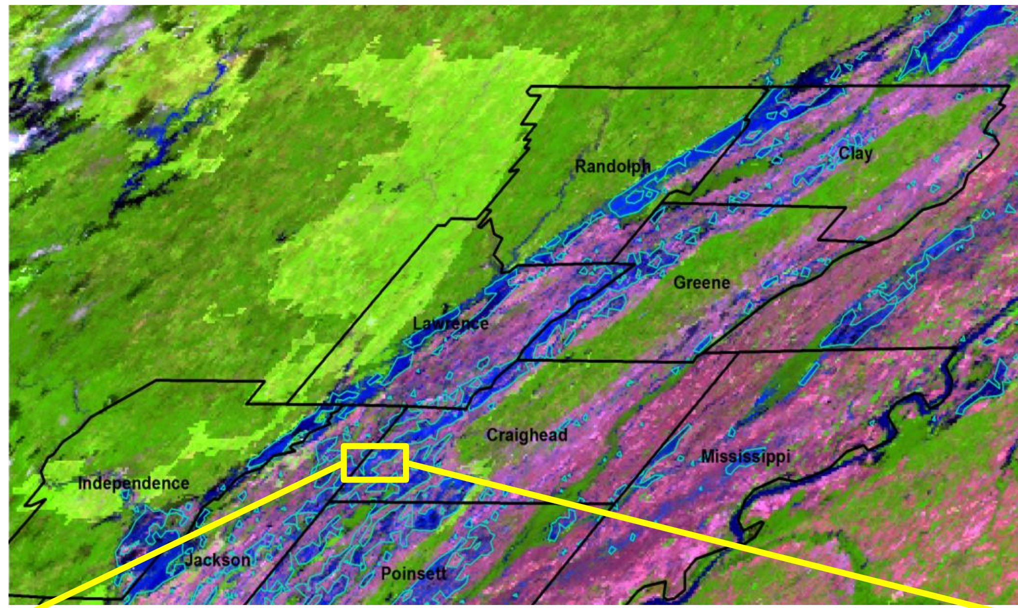
Flood Can Be Mapped When Cloud Free Observations Are Available

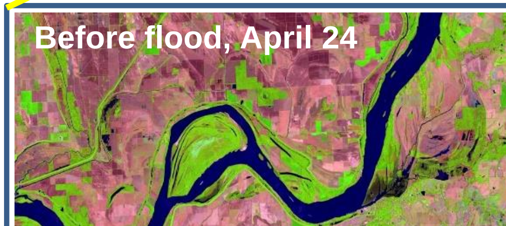
1. Heavy Rains on April 29-30, 2017



2. Levee Breach on May 3, 2017

3. Widespread flooding in Arkansas observed by SNPP satellite



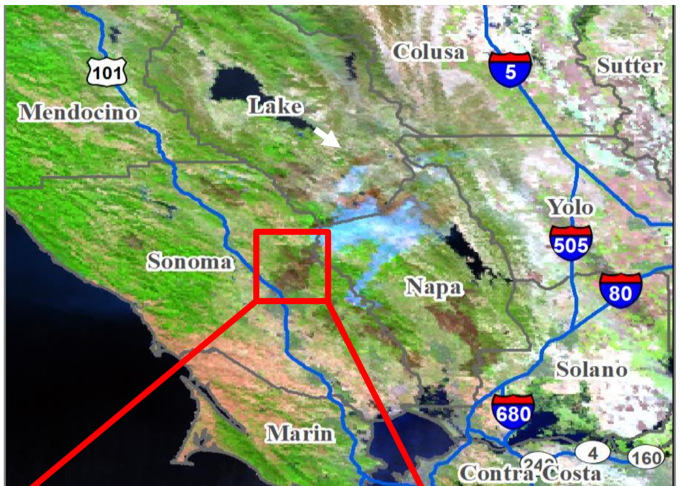


4. Detailed verification by Landsat

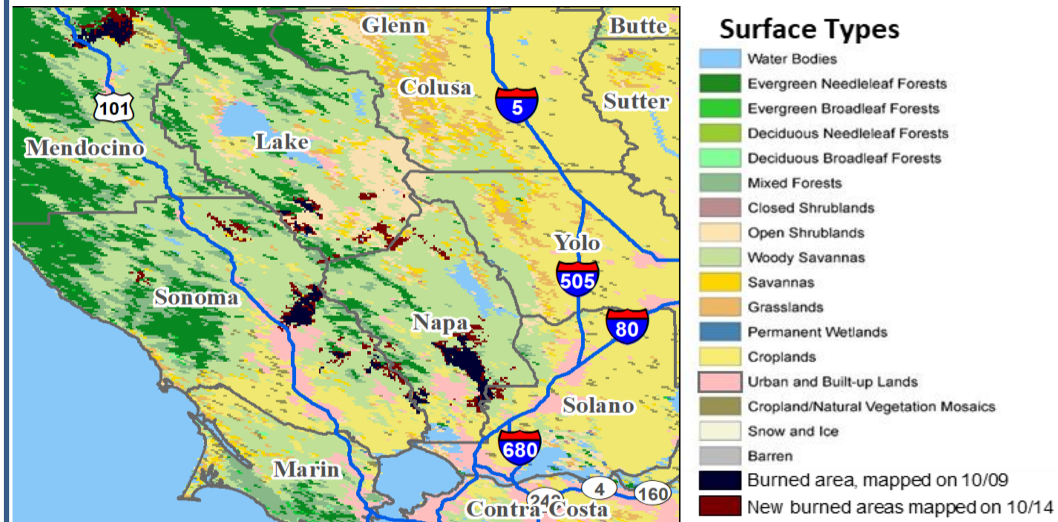
VIIRS Surface Type Change Product

Prototype Mapping of Burned Area Using VIIRS

VIIRS image showing multiple fires in CA, October 14, 2017

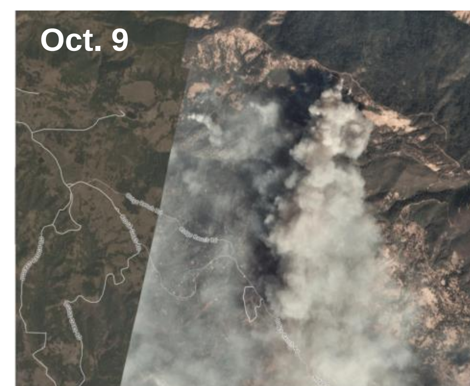


Surface type map showing new burned areas, Oct. 14



Landsat image showing fire and burned area, Oct. 11, 2017 (left)

High resolution images showing smokes of fire (right)



Summary & Path Forward

- *Surface type is an important **input parameter** for many **NWP** and other land surface models*
- *A **self-adaptive compositing algorithm** has been used for compositing VIIRS 2017 surface reflectance and surface type classification metrics*
- *The new **VIIRS Annual Surface Type 2017** product has been generated and validated, will be delivered to NCEP users and distributed to other users through STAR-JPSS website*
- *A global gridded **daily surface type product** is needed to provide dynamic daily surface type information for users*
- *Team starts to work on VIIRS Annual Surface Type 2018 from both S-NPP and NOAA-20 and will continue to explore approaches/feasibilities toward the Daily Surface Type product*

JPSS Vegetation Index & Green Vegetation Fraction Products

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IMSG/STAR

Tomoaki Miura
Univ of Hawaii

Outline

- ❑ Cal/Val Team Members
- ❑ VIIRS NVPS* Production Overview
  - NDE VI & GVF Algorithm
  - Performance Overview
  - NOAA-20 VI Product Status
  - Long Term Monitoring
- ❑ A concern on input data consistency
- ❑ Interactive communication with users
- ❑ Summary and Path Forward

**NVPS = NDE Vegetation Product System*

Cal/Val Team Members

	Name	Organization	Major Task
STAR/ EMB	Ivan Csiszar	NOAA/NESDIS/STAR	Land Lead
	Yunyue Yu	NOAA/NESDIS/STAR	EDR Lead, algorithm development/improvement, calibration/validation, team management
	Feng Zhao	NOAA Affiliate, IMSG	Product validation and assessment,
	Mingshi Chen	NOAA Affiliate, IMSG	Algorithm development/improvement, product monitoring
	Zhangyan Jiang	NOAA Affiliate, IMSG	Algorithm development/improvement, product monitoring
	Yuxiang He	NOAA Affiliate, IMSG	Product visualization, monitoring
STAR/ OPDB	Walter Wolf	NOAA/NESDIS/STAR	STAR ASSIST Lead
	Valerie Mikles	NOAA Affiliate, IMSG	STAR ASSIST, Algorithm System integration
	Michael Wilson	NOAA Affiliate, IMSG	STAR ASSIST, Algorithm System integration
U. Hawaii	Tomoaki Miura	U. Hawaii	Scientific support on validation and improvement

Overview -- VI

- VIIRS VIs are inherited products from **MODIS VI** and **AVHRR VI**
- VIIRS VIs consists of TOA NDVI, TOC NDVI and TOC EVI

$$NDVI^{TOA} = \frac{\rho_{I2}^{TOA} - \rho_{I1}^{TOA}}{\rho_{I2}^{TOA} + \rho_{I1}^{TOA}}$$

$$NDVI^{TOC} = \frac{\rho_{I2}^{TOC} - \rho_{I1}^{TOC}}{\rho_{I2}^{TOC} + \rho_{I1}^{TOC}}$$

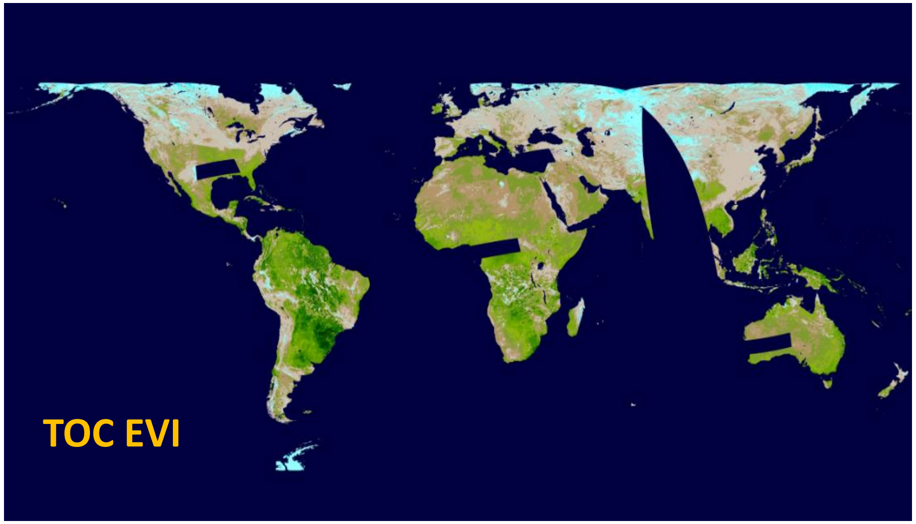
$$EVI = (1 + L).\frac{\rho_{I2}^{TOC} - \rho_{I1}^{TOC}}{\rho_{I2}^{TOC} + C1.\ \rho_{I1}^{TOC} - C2\ .\ \rho_{M3}^{TOC} + L}$$

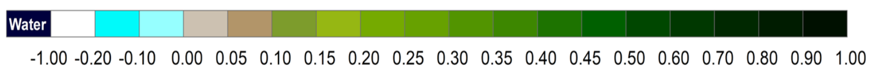
- Coverage: Daily, weekly and biweekly at global (4 km) and regional level (North America,1 km)

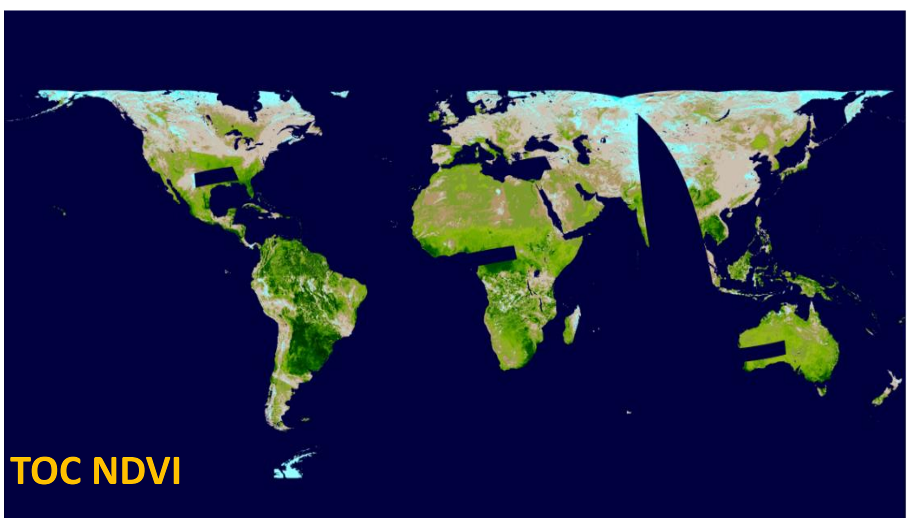
NDE VI algorithm output

Temporal Scale	Spatial Scale	Format	File Name (samples)
Daily (DLY)	Global (4km)	netCDF4 (*.nc)	VI-DLY-GLB_v1r2_npp_s20171226_e20180110_c201803161653550.nc
	Regional (1km)		VI-DLYL-REG_v1r2_npp_s20171226_e20180110_c201803161740430.nc
Weekly (WKL) 7-day	Global (4km)		VI-WKL-GLB_v1r2_npp_s20171226_e20180110_c201803161653550.nc
	Regional (1km)		VI-WKL-REG_v1r2_npp_s20171226_e20180110_c201803161740430.nc
BiWeekly (BWKL) 16-day	Global (4km)		VI-BWKL-GLB_v1r2_npp_s20171226_e20180110_c201803161653550.nc
	Regional (1km)		VI-BWKL-REG_v1r2_npp_s20171226_e20180110_c201803161740430.nc

Overview -- VI

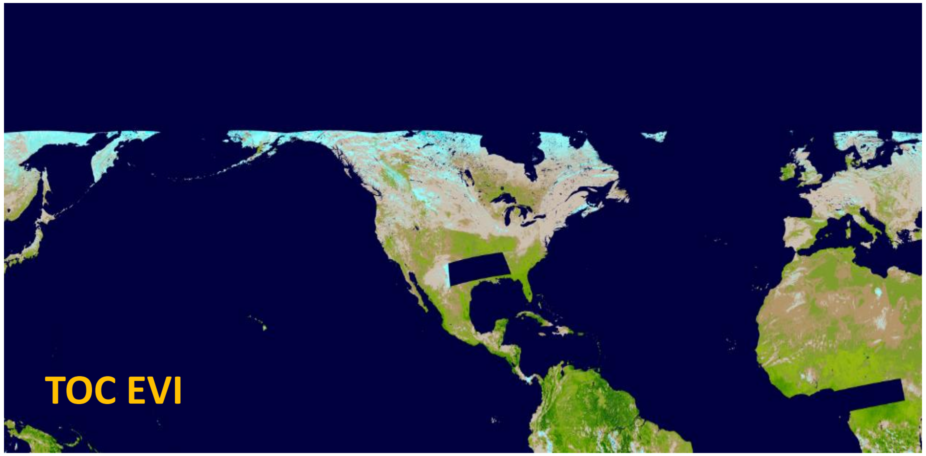


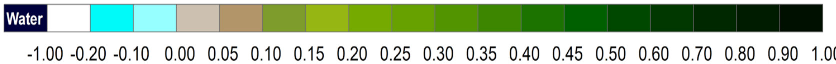


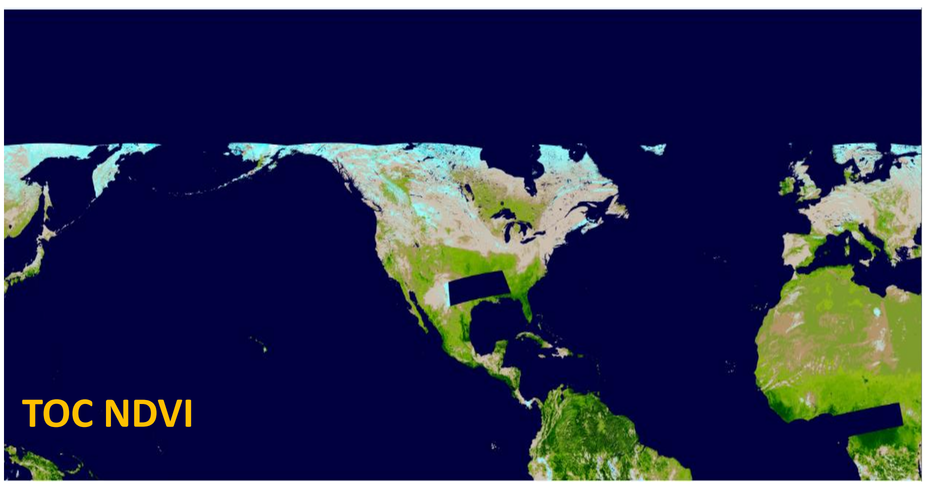


NDE *Global Daily* VIs on 01/04/2018

Overview -- VI







NDE *Regional Daily* VIs on 01/04/2018

Overview -- GVF

- Green Vegetation Fraction (GVF) is defined as fraction of a pixel covered by green vegetation if it were viewed vertically
- GVF EDR provides continuity with NOAA 16-km weekly AVHRR GVF
- GVF estimation is based on the Enhanced Vegetation Index (EVI)

$$GVF = \frac{EVI - EVI_0}{EVI_M - EVI_0}$$

Where EVI_0 and EVI_M, the global minimum and maximum EVI, are algorithm parameters determined experimentally, and need to be calibrated.

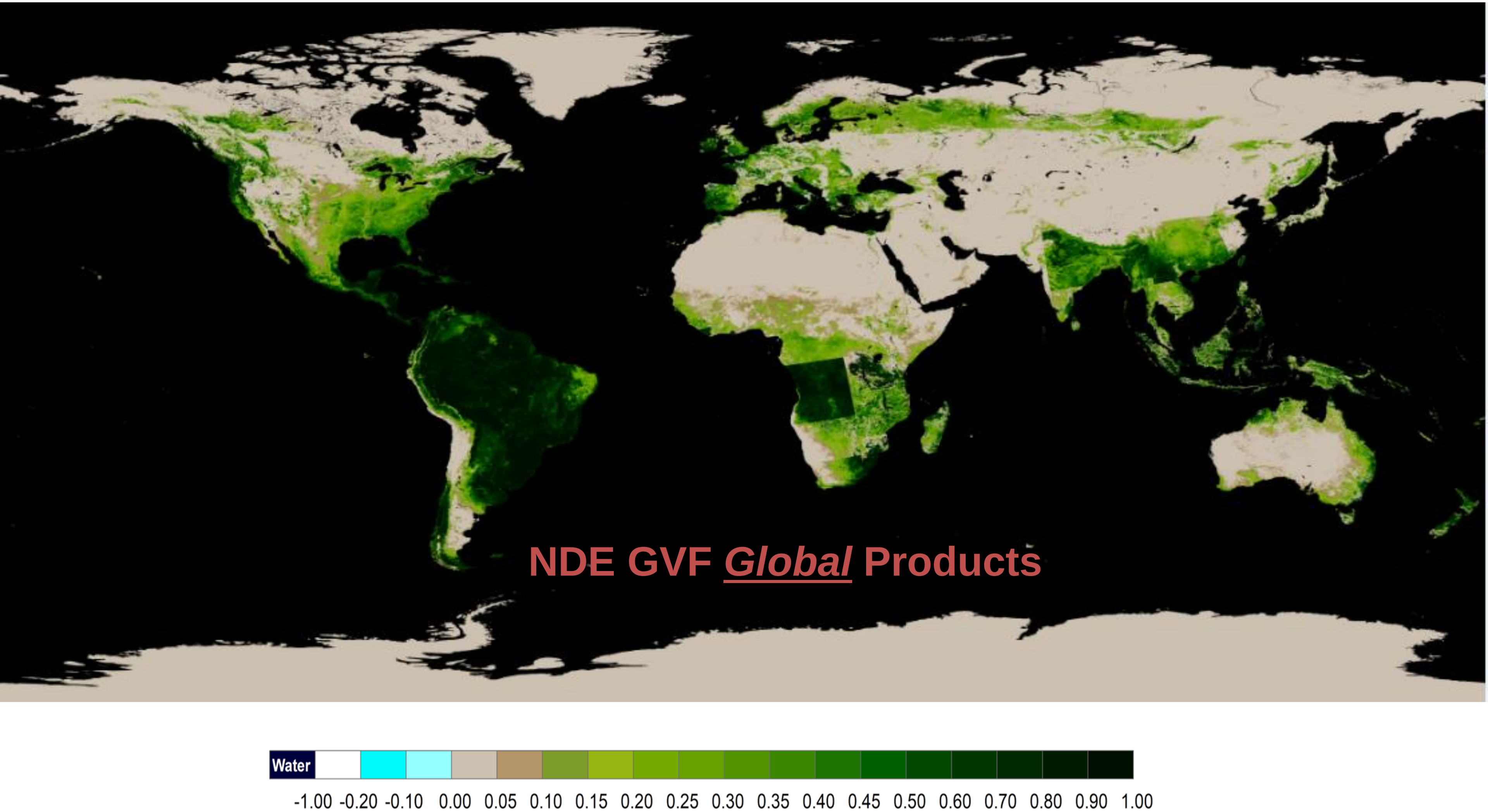
- Coverage: weekly at global (4 km) and regional level (North America,1 km)

NDE GVF algorithm output

Temporal Scale	Spatial Scale	Format	File Name (samples)
Weekly (WKL) 7-day	Global (4km) (GLB)	netCDF4 (*.nc)	GVF-WKL-GLB_v2r1_npp_ s20180103_e20180109_c201803191655370.nc
	Regional (1km) (REG)		GVF-WKL-REG_v2r1_npp_ s20180103_e20180109_c201803191657490.nc

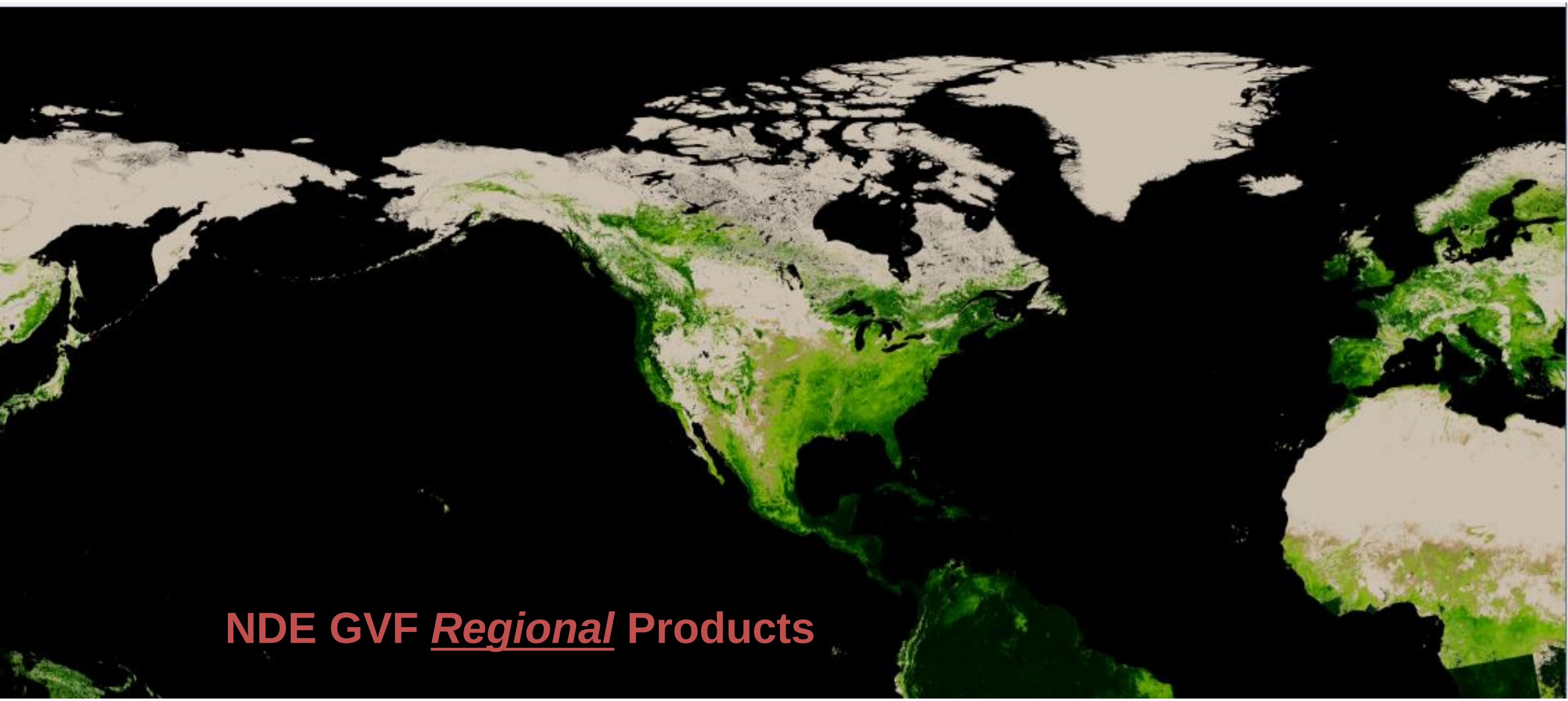
Overview -- GVF

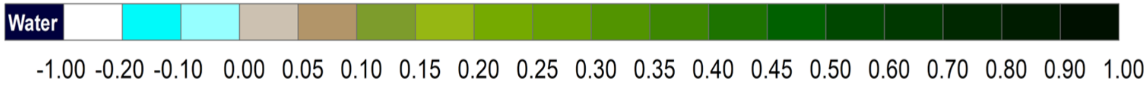
GVF on 01/03/2018 ~ 01/09/2018



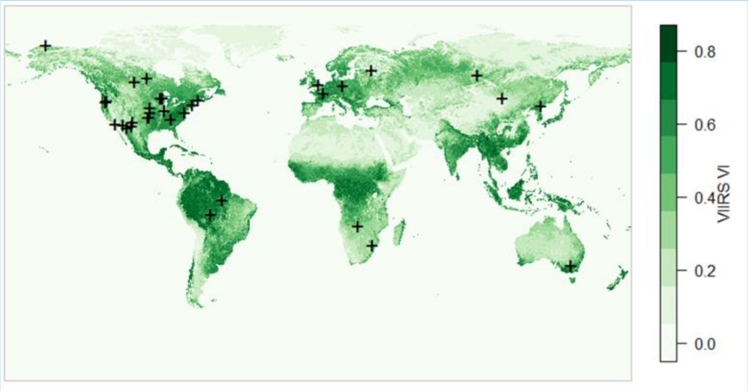
Overview -- GVF

GVF on 01/03/2018 ~ 01/09/2018



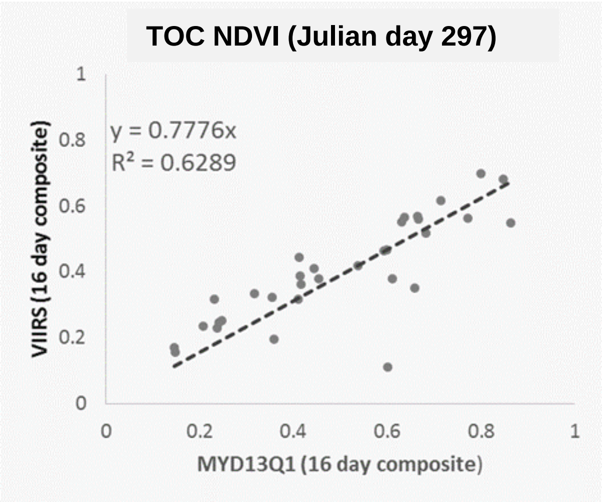


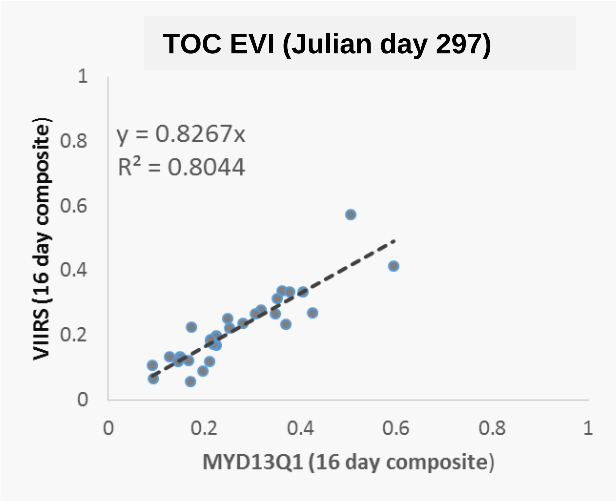
Product Performance Overview - VIs

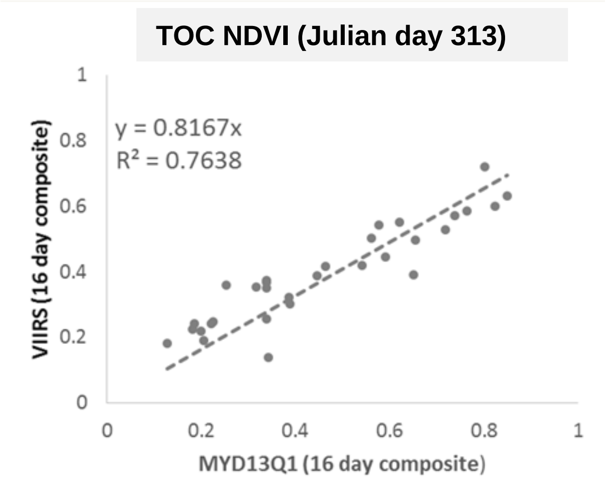


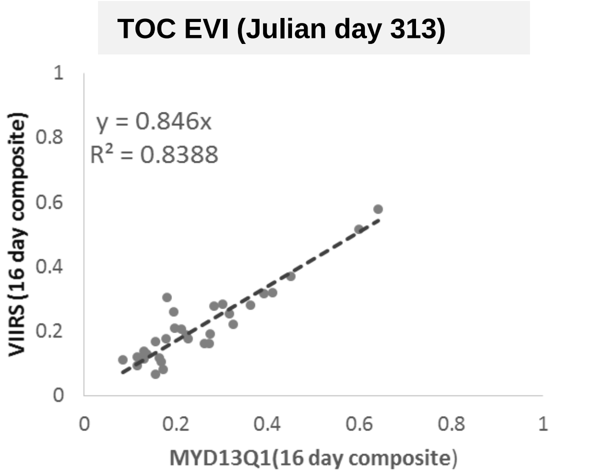
VI Product	Accuracy
NDVI TOC EVI TOC	-0.04 -0.02

35 Flux Tower sites (EOS Land Validation Core Sites)





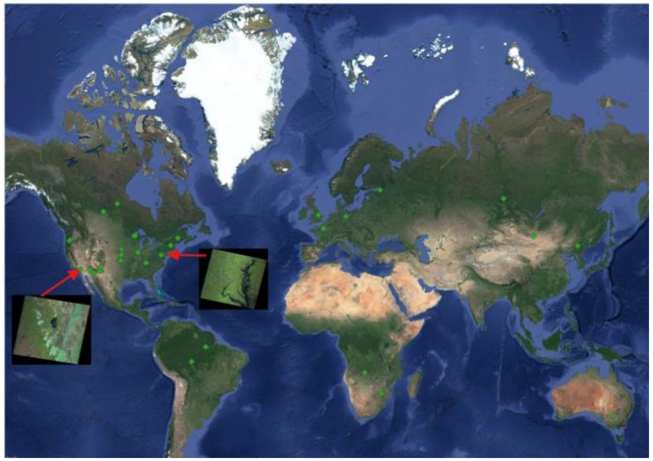




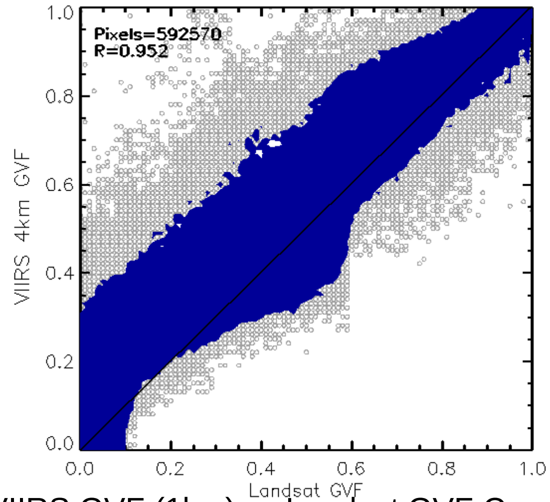
Product Performance Overview - GVF

VIIRS GVF vs. Landsat Derived GVF

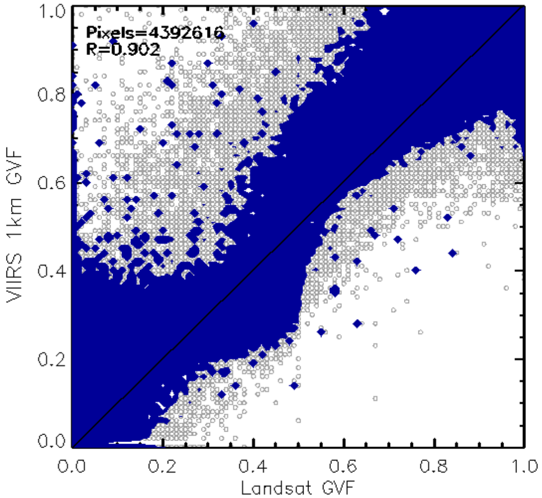
EOS Land Validation Core Sites



VIIRS GVF (4km) vs Landsat GVF Cross-plots



VIIRS GVF (1km) vs Landsat GVF Cross-plots



Global APU Estimates

Attribute	Threshold	Observed/validated
Measurement Accuracy		
1) Global	0.12	0.080
2) Regional	0.12	0.071
Measurement Precision		
1) Global	0.15	0.084
2) Regional	0.15	0.070
Measurement Uncertainty		
1) Global	0.17	0.116
2) Regional	0.17	0.100

Product Performance Overview - GVF

VIIRS GVF vs. Google Earth Derived GVF

Sample site (Park Falls, WI, USA)

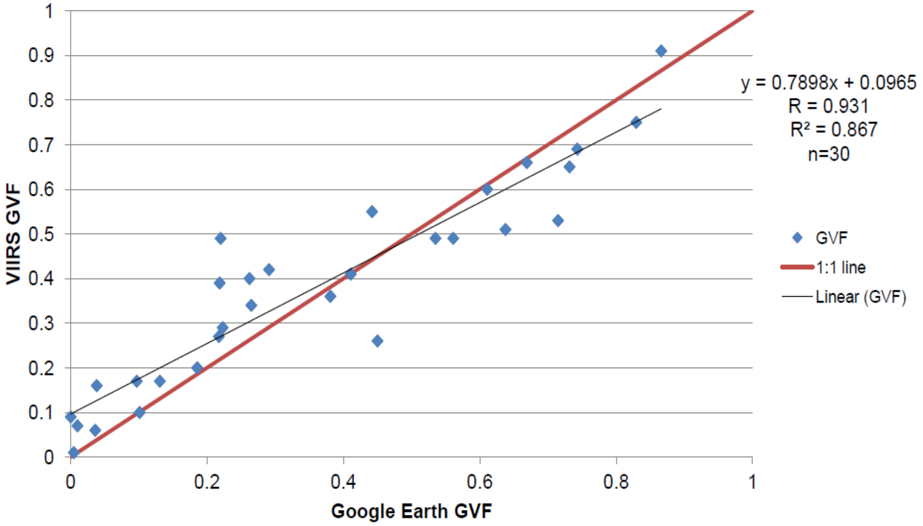
Google Earth image over a 0.036°x0.036° VIIRS GVF pixel

Classified image (vegetated pixels: bright green)

(5/10/2013)

Google Earth GVF=0.38
VIIRS GVF=0.36

VIIRS GVF (4km) vs Google Earth GVF – Scatterplot



APU Summary Table

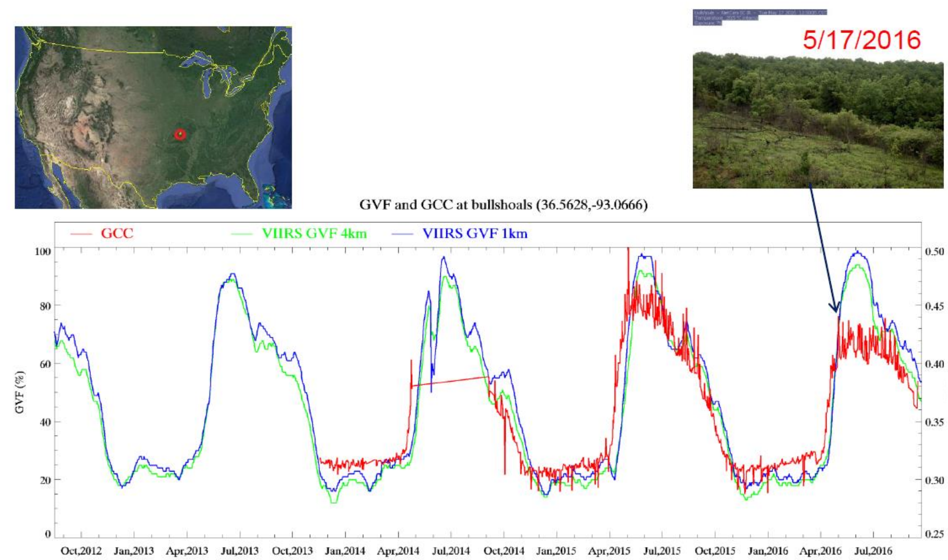
Attribute	Threshold	Calculated
Accuracy	0.12	0.0202
Precision	0.15	0.1010
Uncertainty	0.17	0.1014

Product Performance Overview - GVF

VIIRS GVF vs. PhenoCam GVF

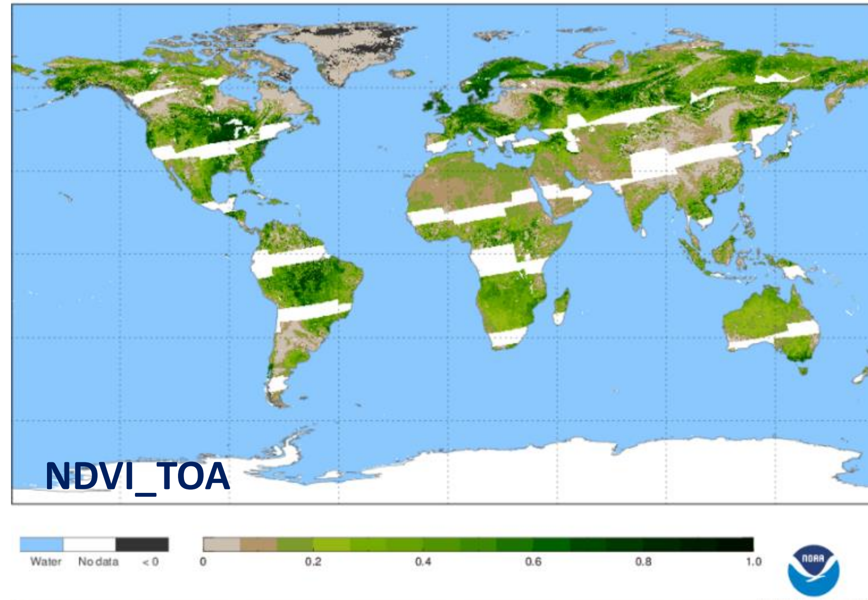
PhenoCam images collected every half hour

Sample site (Bull Shoals, Mo, USA)

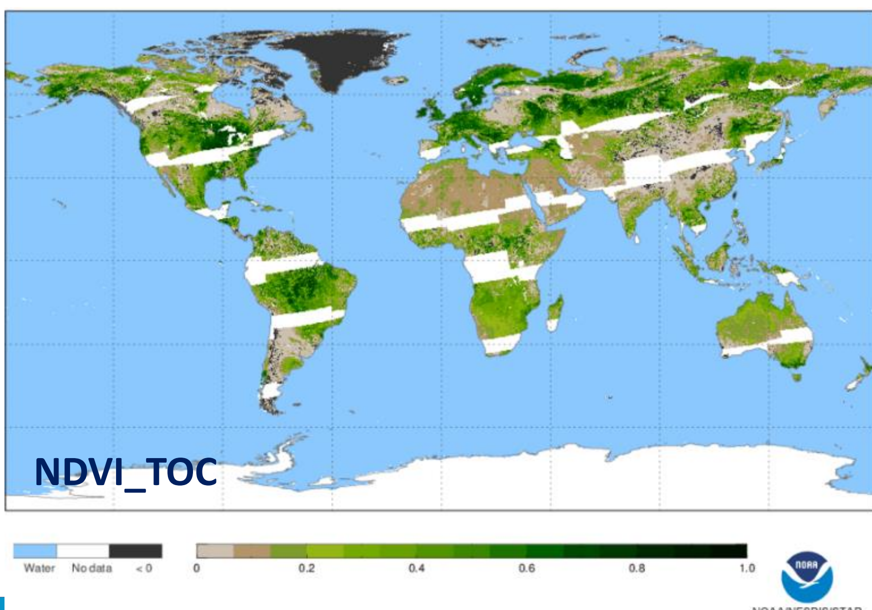


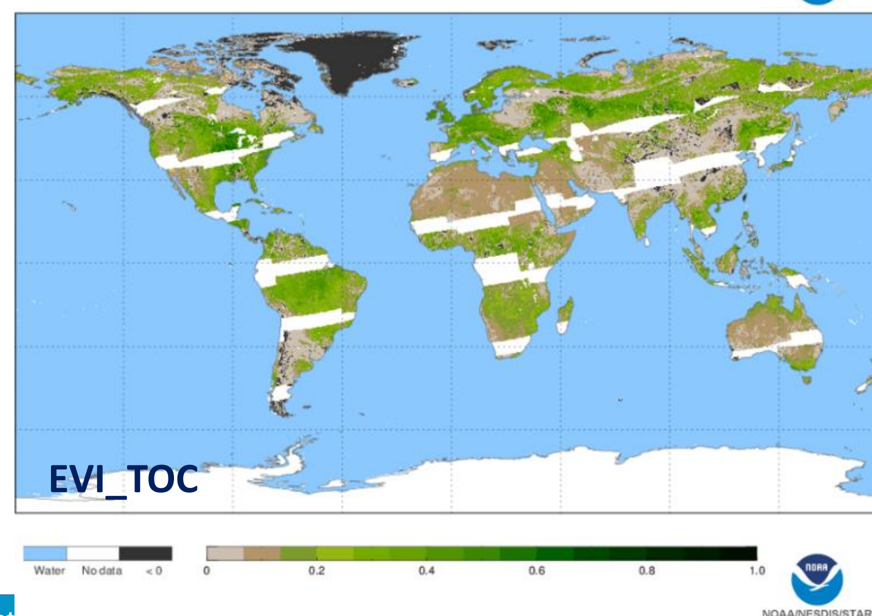
NDE NOAA-20 Status - VI

- The NDE SNPP algorithms are applied for NOAA-20 VI & GVF production (NDE)
- Beta maturity Review was done on Aug. 22., 2018
- Calibration and validation is on the way for Provisional maturity (Feb 2019)



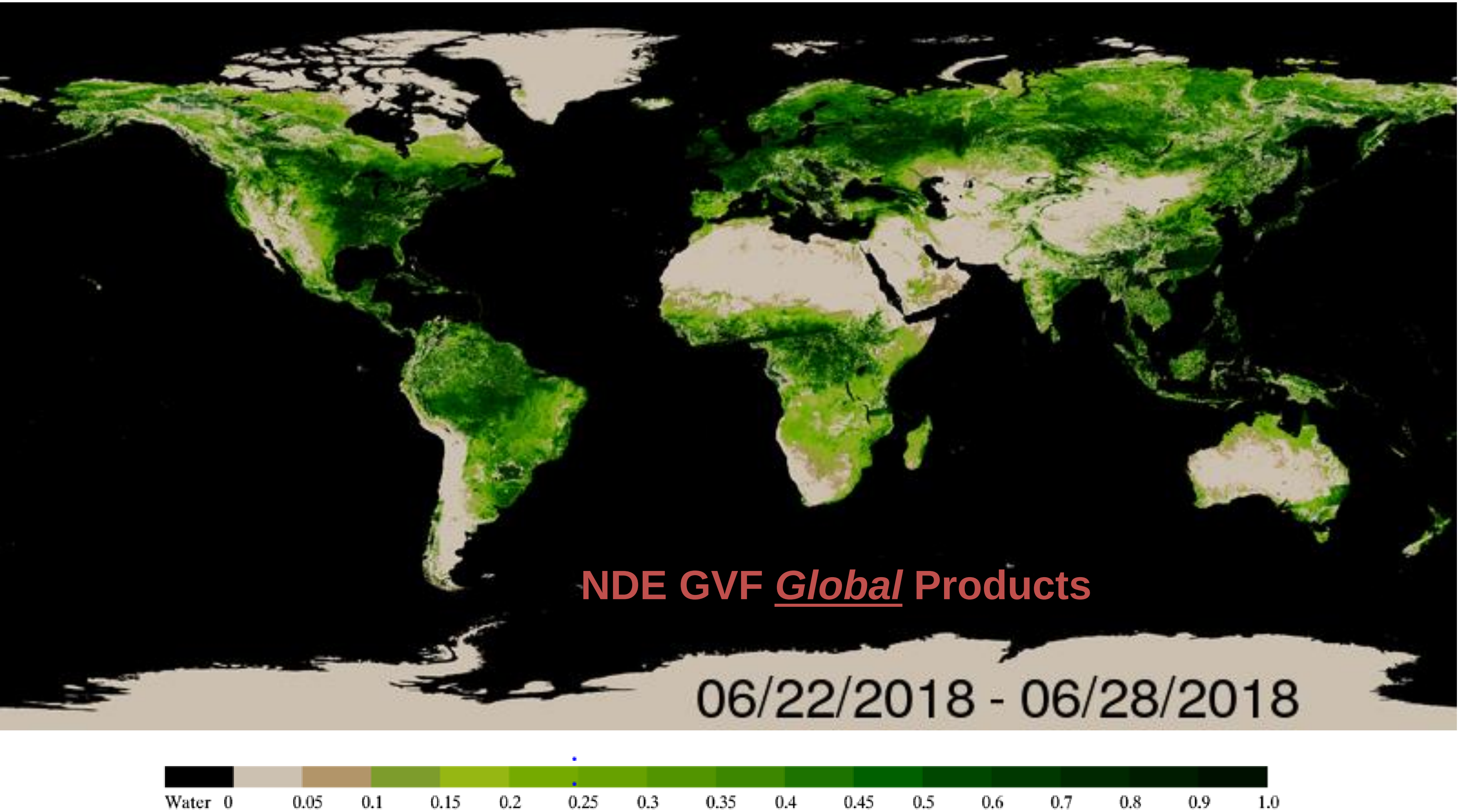
NDE NOAA-20 VI *Global* Products 07/02/2018



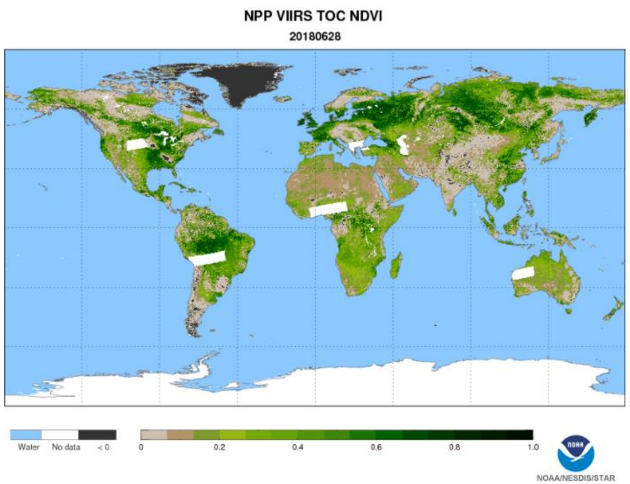


NDE NOAA-20 Status - GVF

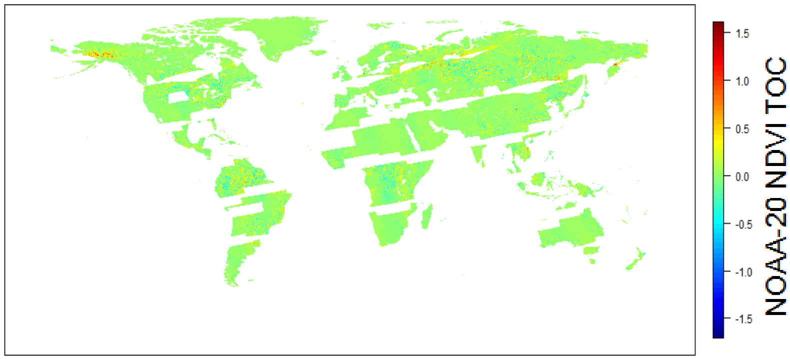
Jun 28, 2018 – July 20, 2018



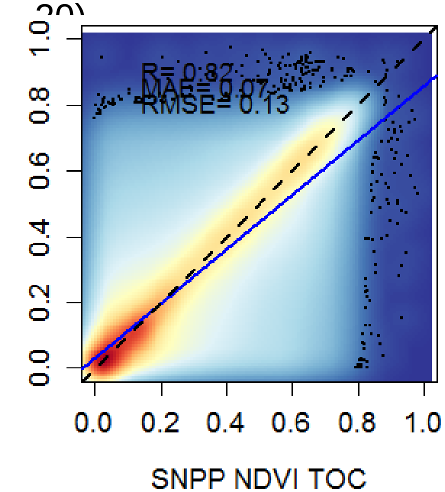
TOC NDVI Cross-comparison: NOAA-20 VS. SNPP

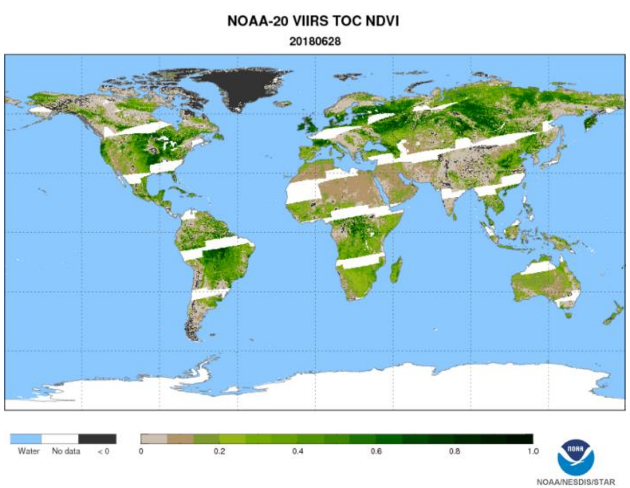


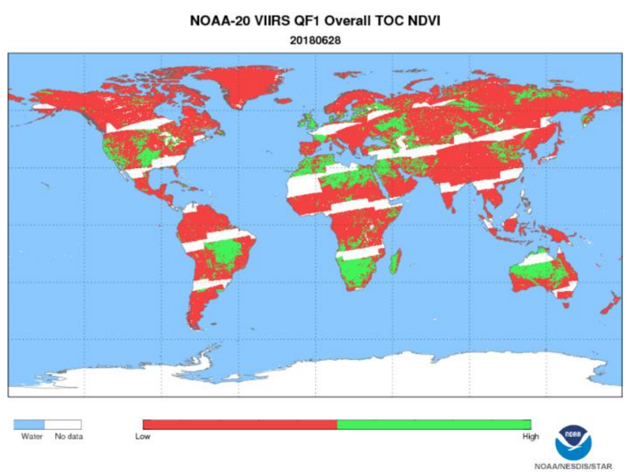
SNPP-NOAA-20

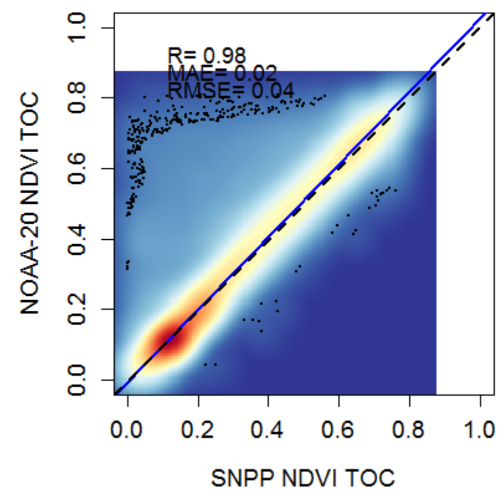


Scatterplot(SNPP-NOAA-20)

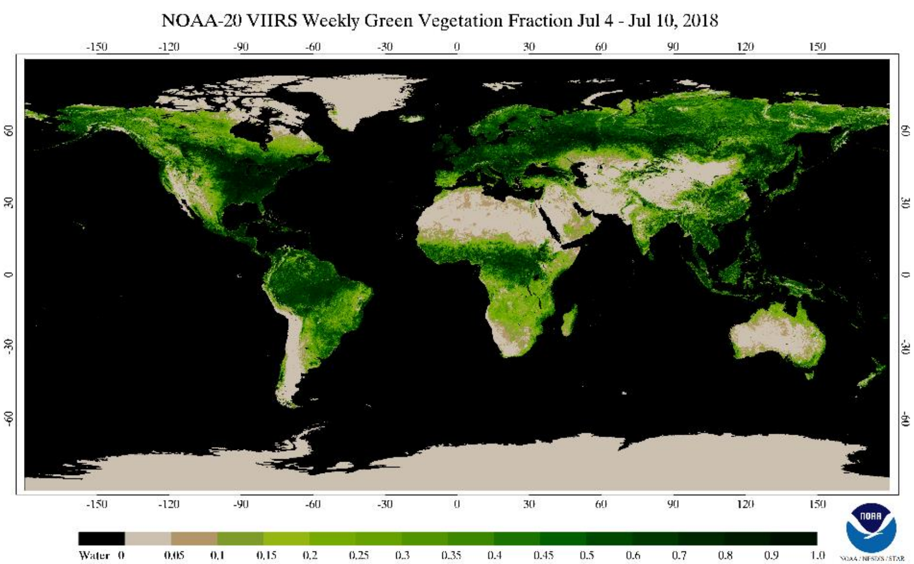


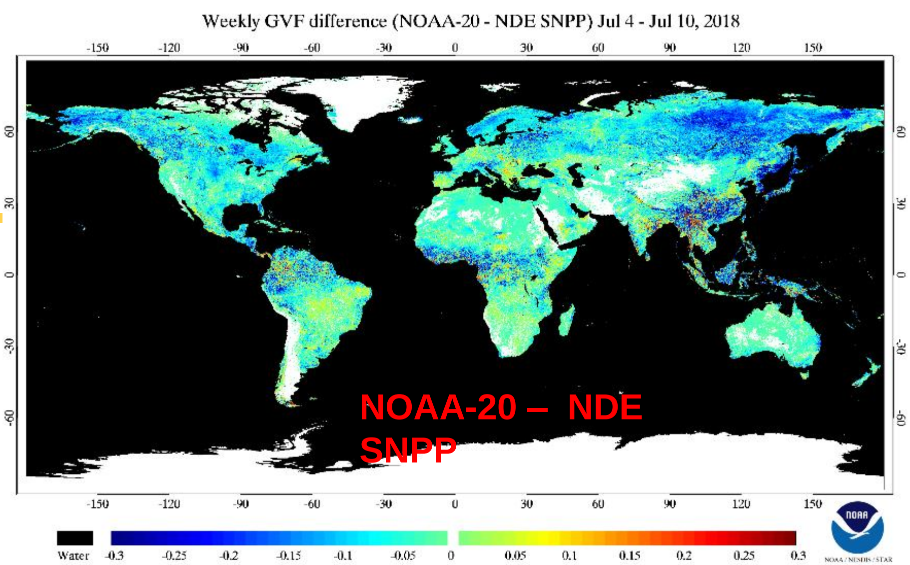


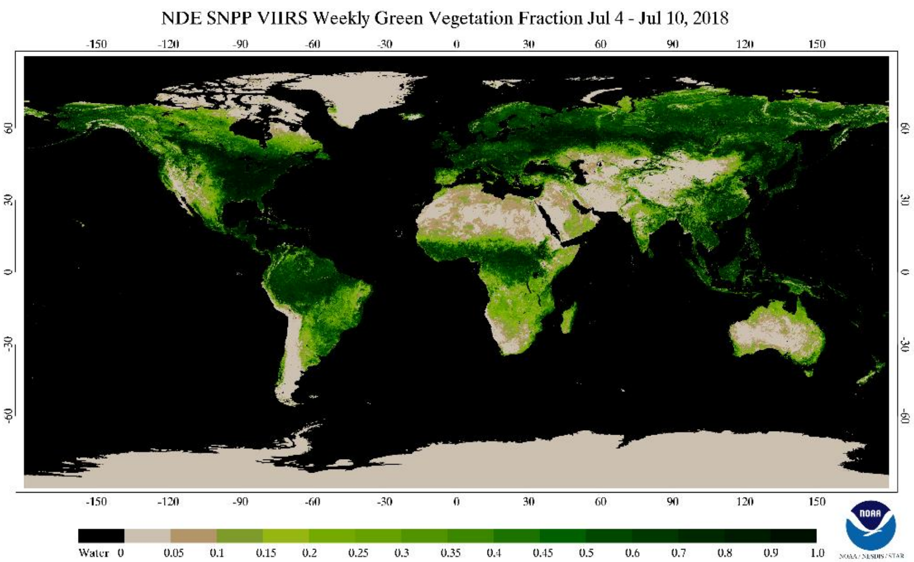


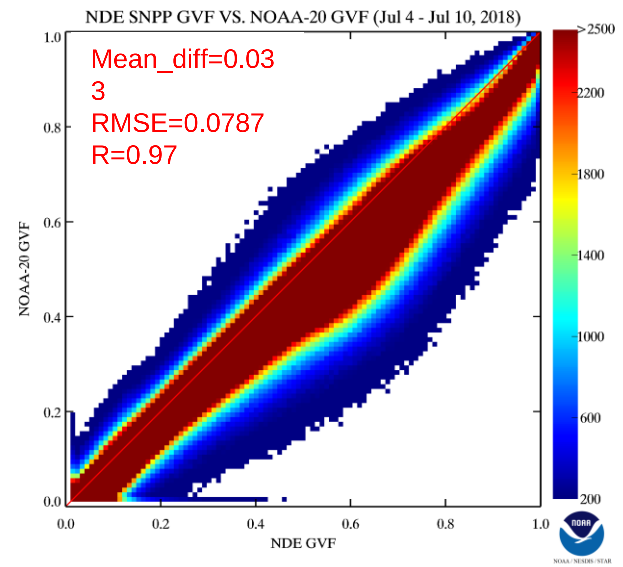


NOAA-20 GVF vs. SNPP GVF





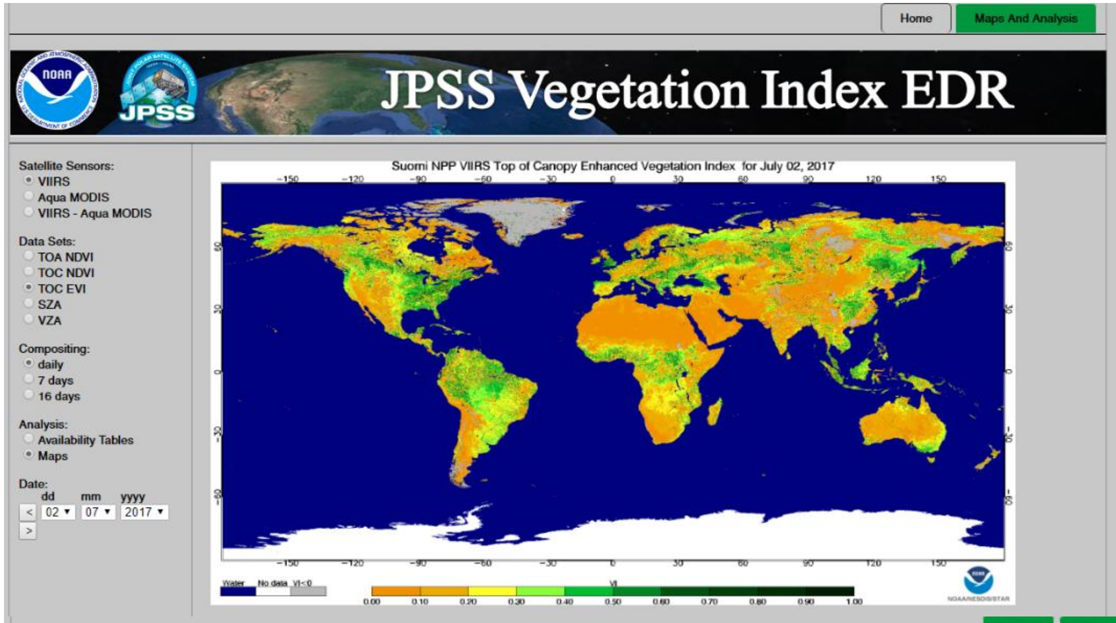


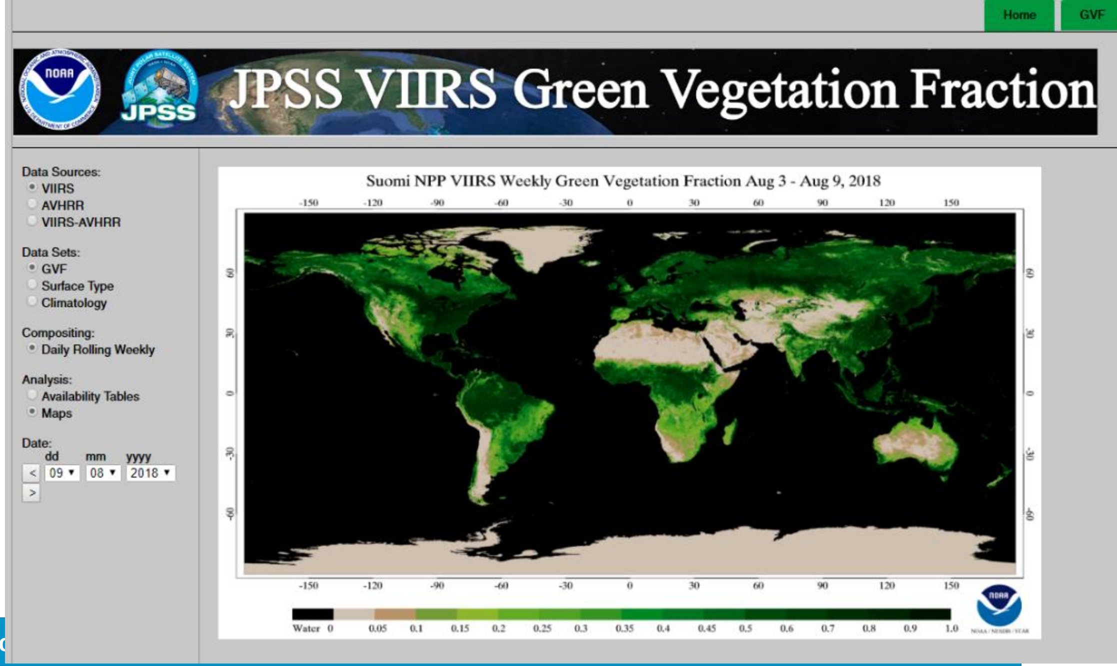


VIIRS VI Long-term Monitoring

Developing a long-term monitoring tool

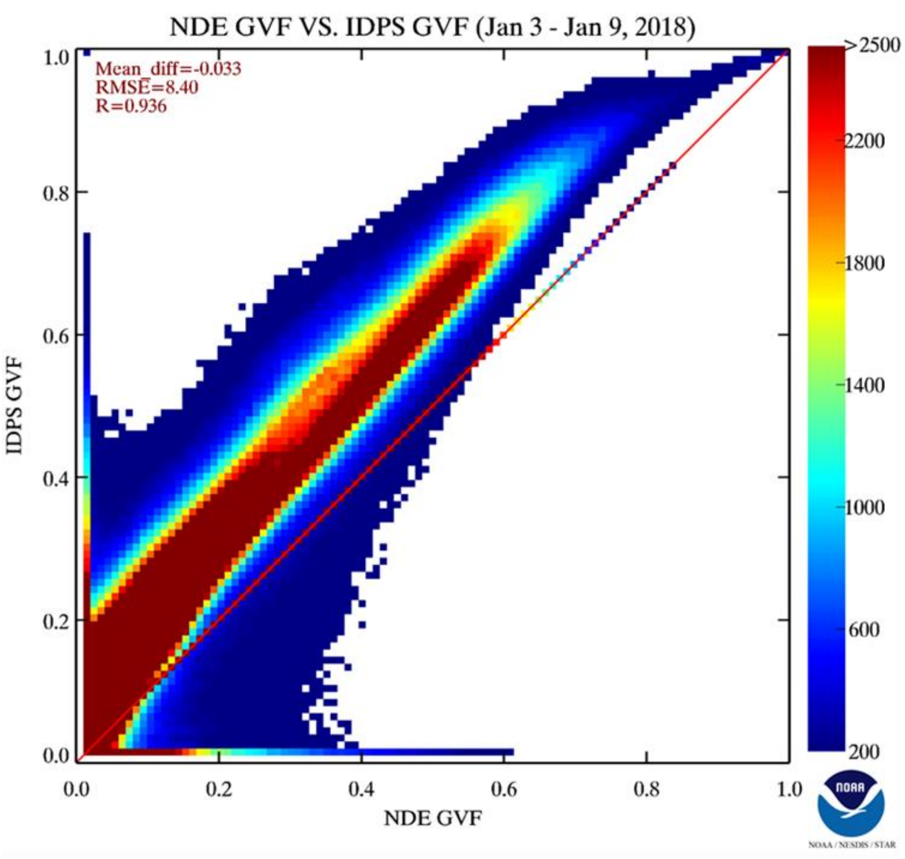
- Send alerts when abnormal results occurs;
- Automatically validate against field measurements;
- Update maps through WWW
- https://www.star.nesdis.noaa.gov/smcd/viirs_vi_web/landwatch/index.php

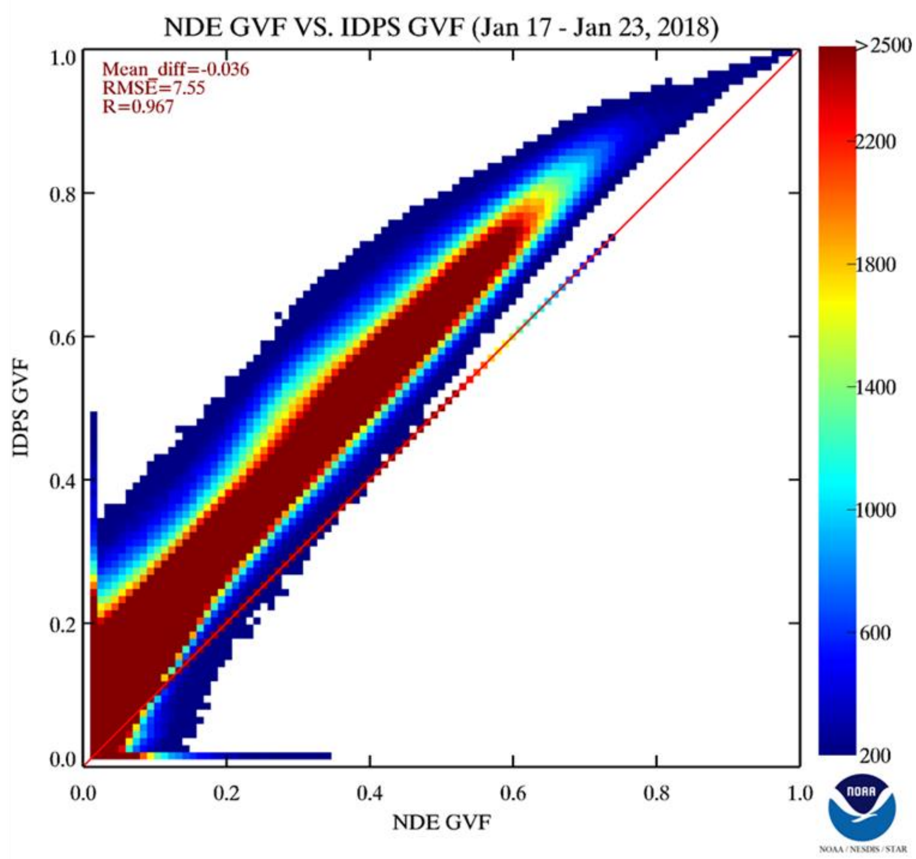




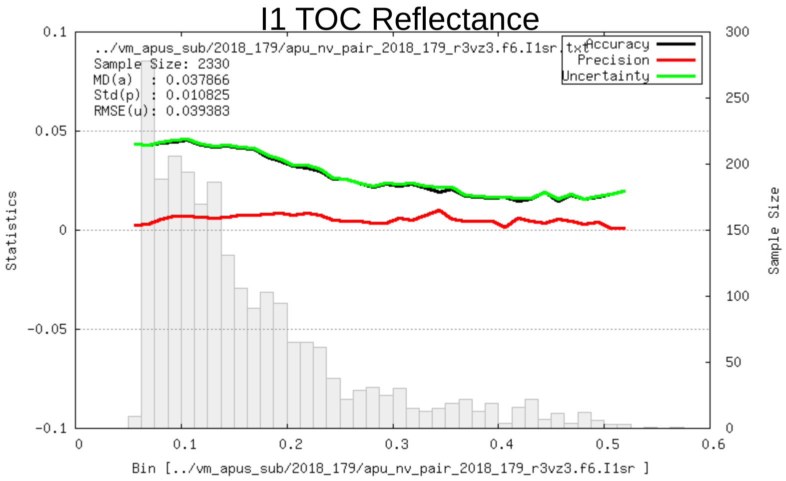
Issue under investigation: Input SR Diff to IDPS

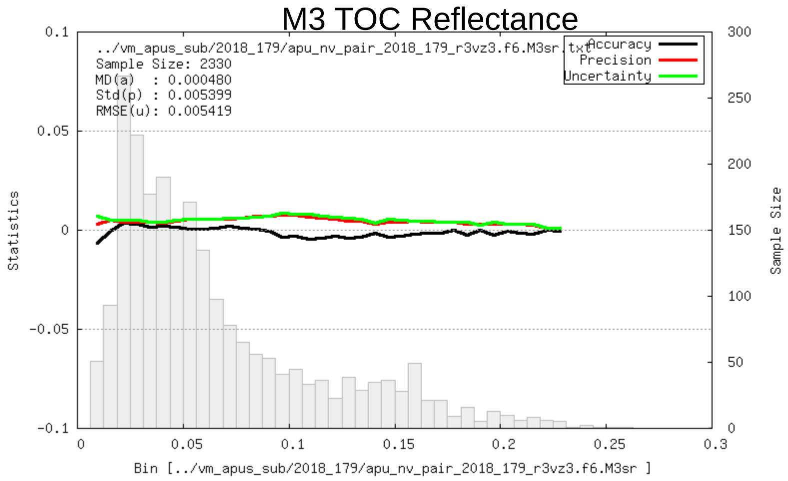
GVF Comparison: NDE vs. IDPS input

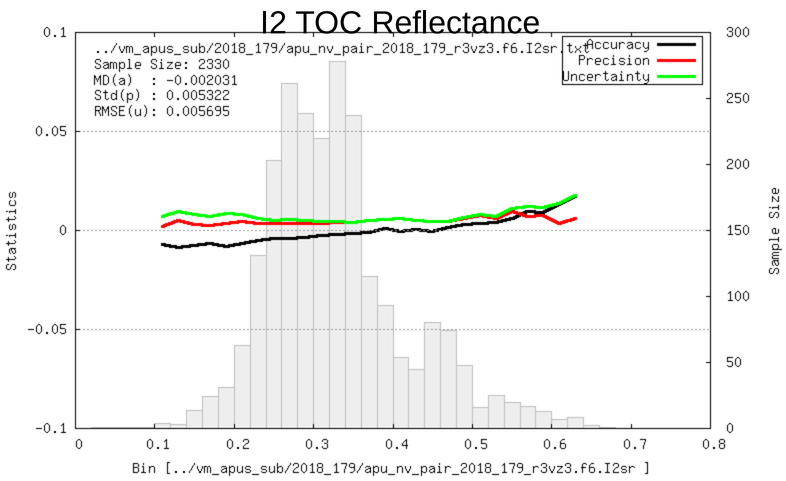




NVPS vs. IDPS: TOC Reflectance (55º – 62.5º for backward)

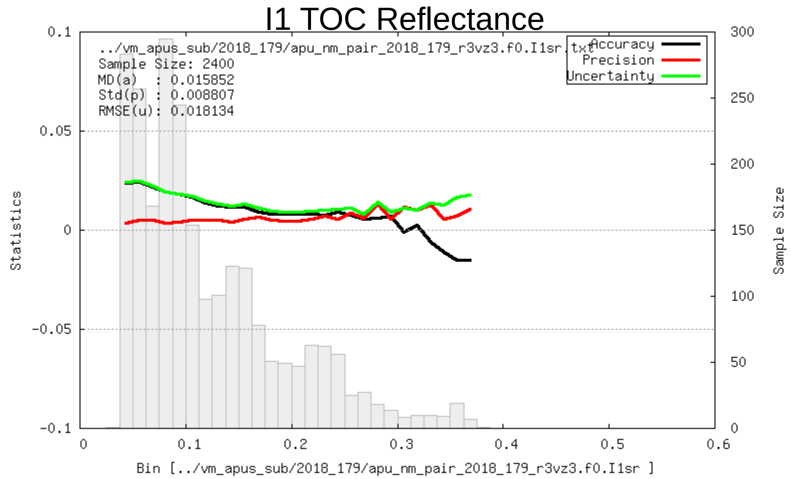


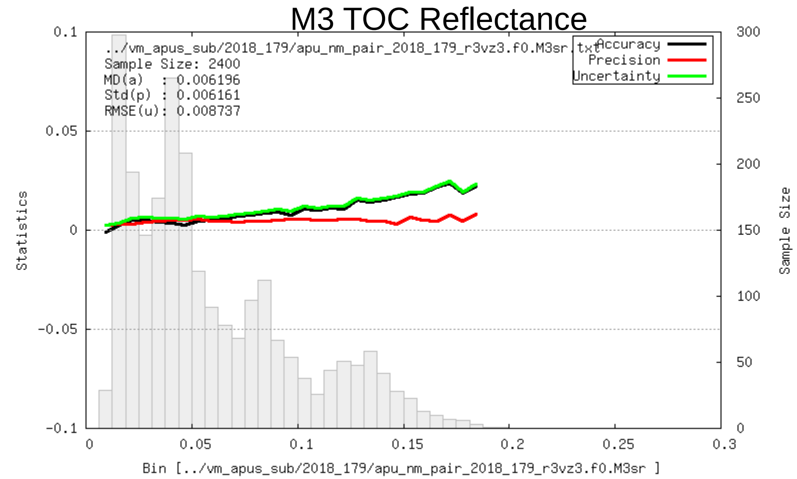


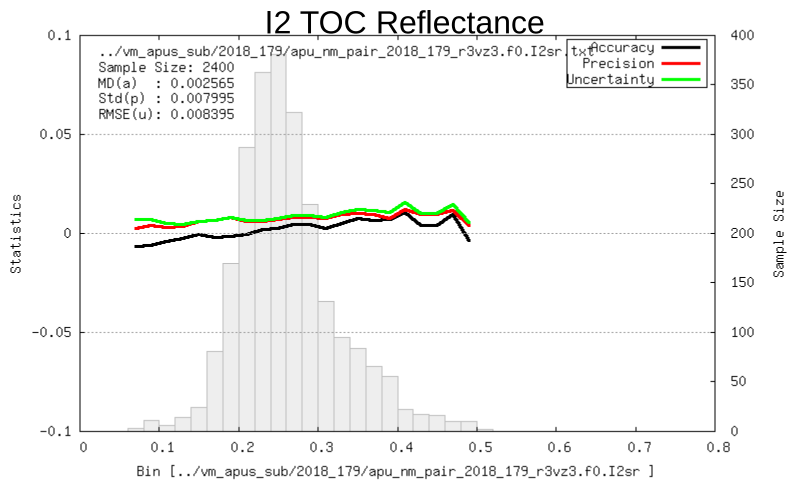


NOAA NASA

NVPS vs. MODIS: TOC Reflectance (0º – 7.5º for forward)



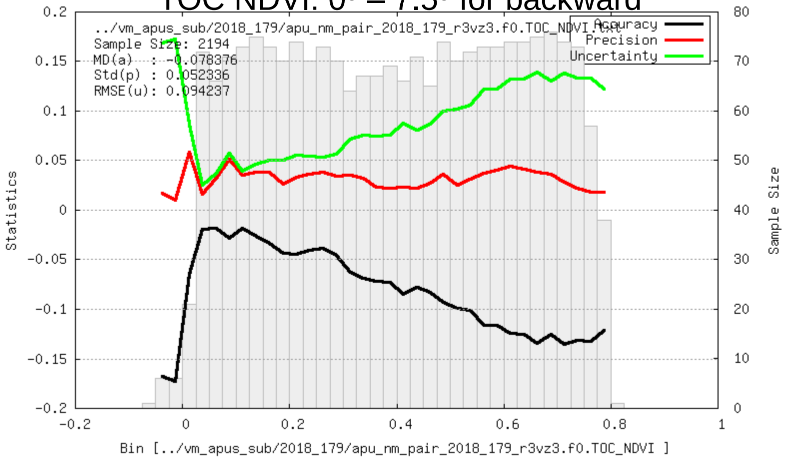




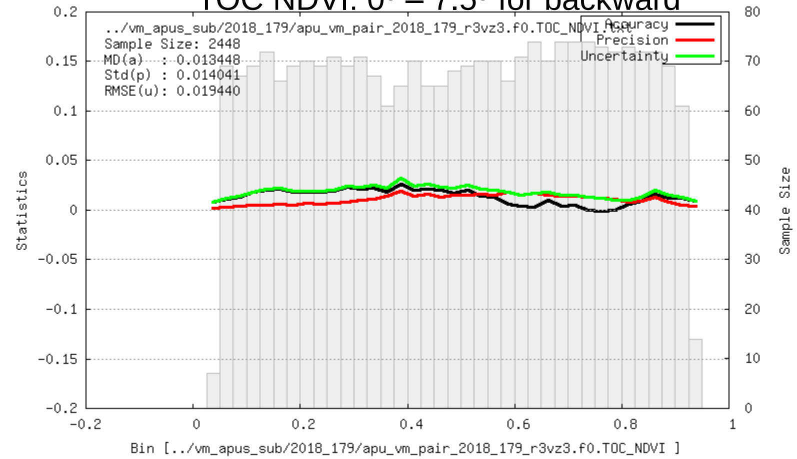
NVPS vs. MODIS

IDPS vs. MODIS

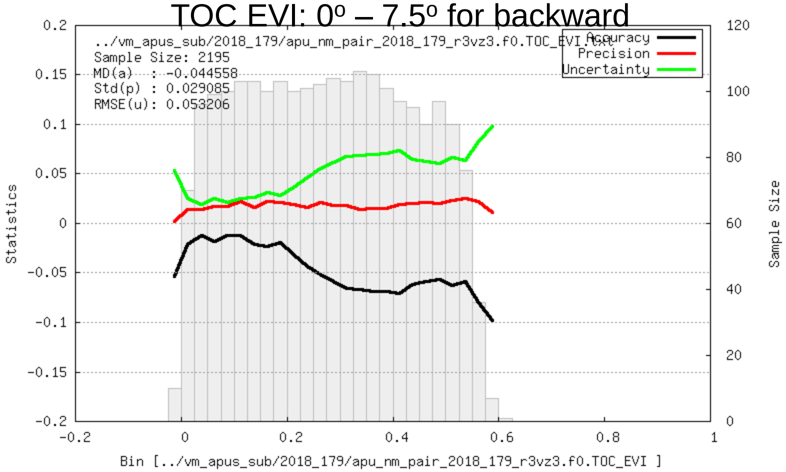
TOC NDVI: 0º – 7.5º for backward



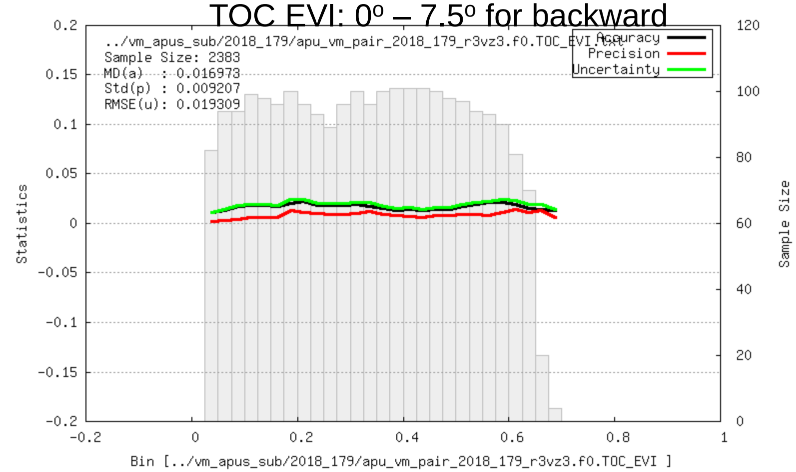
TOC NDVI: 0º – 7.5º for backward



TOC EVI: 0º – 7.5º for backward



TOC EVI: 0º – 7.5º for backward



Interactive communication with users

Current NVPS Primary Users:

- NOAA Earth System Research Lab/GSD, HRRR (Stan Benjamin)
- NCEP/EMC, Land Model (Jack Kain’s group)
- NESDIS/STAR, SMOPS (Xiwu Zhan)
- NDE Downstream products VIIRS LSE/LSA

Summary

- Enterprise VI and GVF algorithms were developed and implemented for operational production on the NDE system.
- The VI and GVF data from SNPP are operational ready
- The VI and GVF data from NOAA-20 are in the NDE test environment
- Performance of the NVPS meets the requirement, though further evaluation using in-situ data is needed
- NCEP HRRR, SMOPS, and LSE are using the NVPS GVF data
- Significant VI/GVF difference observed when input data are not consistent

Path Forward

- The NVPS improvements
  - Code efficiency and robustness
  - data layer re-arrangement, redundant removal
  - QF upgrade
- Comprehensive validation will be perform using in-situ data, as well as other reference data
- Conduct provisional readiness for NOAA-20 VI and GVF production
- Significant upgrade on validation and monitoring tool is necessary
- Interactive communication with users

JPSS Land Surface Temperature Product

Yunyue Yu
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Yuling Liu, Peng Yu, Heshun Wang
UMD/ESSIC

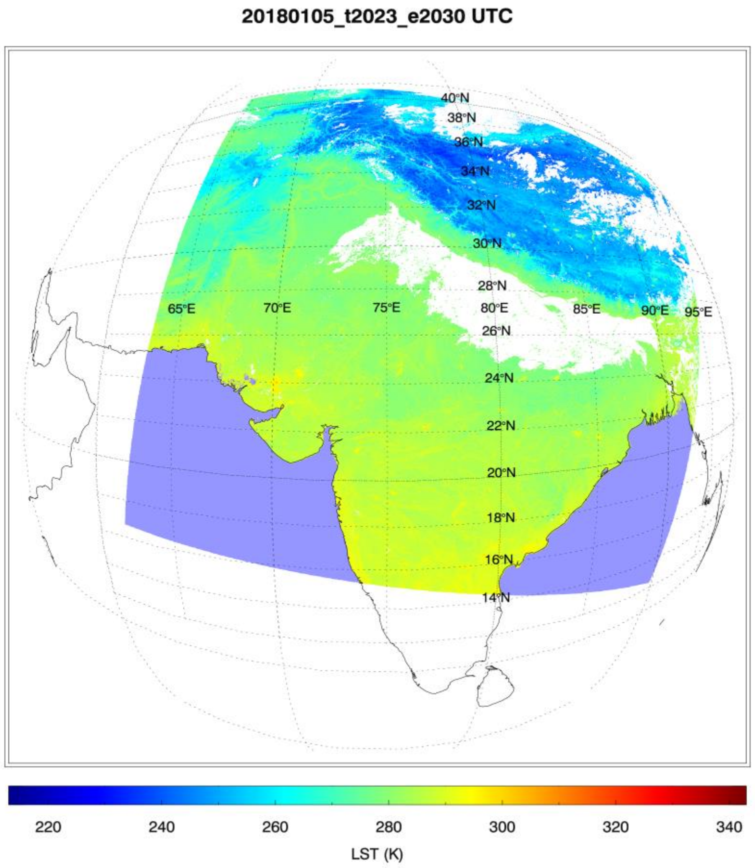
Outline

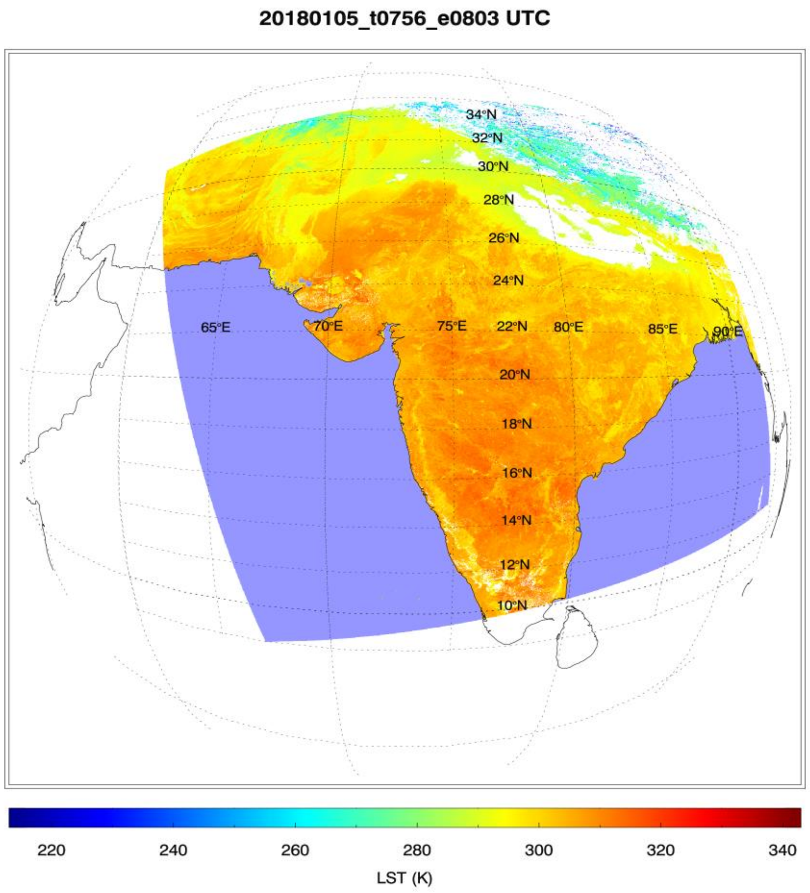
- ❑ Cal/Val Team Members
- ❑ JPSS LST Production Overview
  - Enterprise LST algorithm for NDE
  - NOAA 20 LST status
  - Gridded VIIRS LST product development
  - Emissivity development
  - Long Term Monitoring
- ❑ Interactive communication with users
- ❑ Summary and Path Forward

Cal/Val Team Members

PI	Organization	Team Members	Roles and Responsibilities
Ivan Csiszar	NOAA/NESDIS/SATR		Land Lead, Project Management
Yunyue Yu	NOAA/NESDIS/SATR		EDR Lead, algorithm development, validation, team management
		Yuling Liu	product monitoring and validation ; algorithm development
		Heshun Wang	algorithm improvement, emissivity development
		Peng Yu	product validation tool, monitoring, applications
Walter Wolf	NOAA/NESDIS/SATR		System Integration, Transition
		Valerie Mikles	System Integration, Transition
		Marina Tsidulko	STAR IT support
Jack Kain	NOAA/EMC/NCEP		User readiness
		Weizhong Zheng	User readiness : Model LST verification
		Yihua Wu	User readiness : Model LST verification

Enterprise LST Algorithm





Regression Form: $Ts = A_0 + A_1 T_{11} + A_2(T_{11} - T_{12}) + A_3\varepsilon + A_4\varepsilon(T_{11} - T_{12}) + A_5\Delta\varepsilon$

Status:

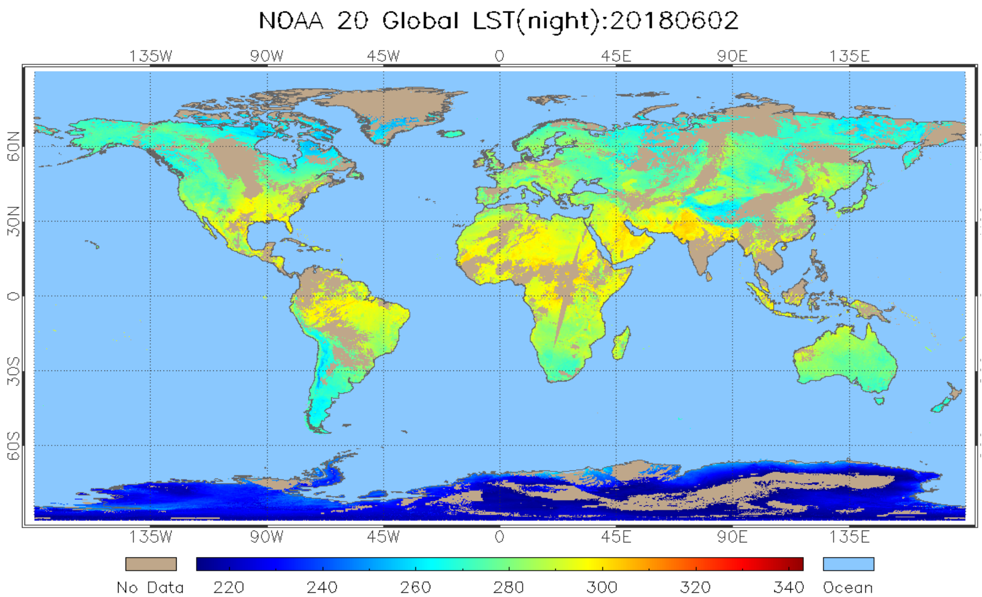
- The ASSIST Near Real Time (NRT) run of the enterprise LST has been started from end of June 2018
- The NDE Operational Readiness Review is scheduled in Sept 2018, operational run about one month afterward.
- The LST ATBD is Updated accordingly

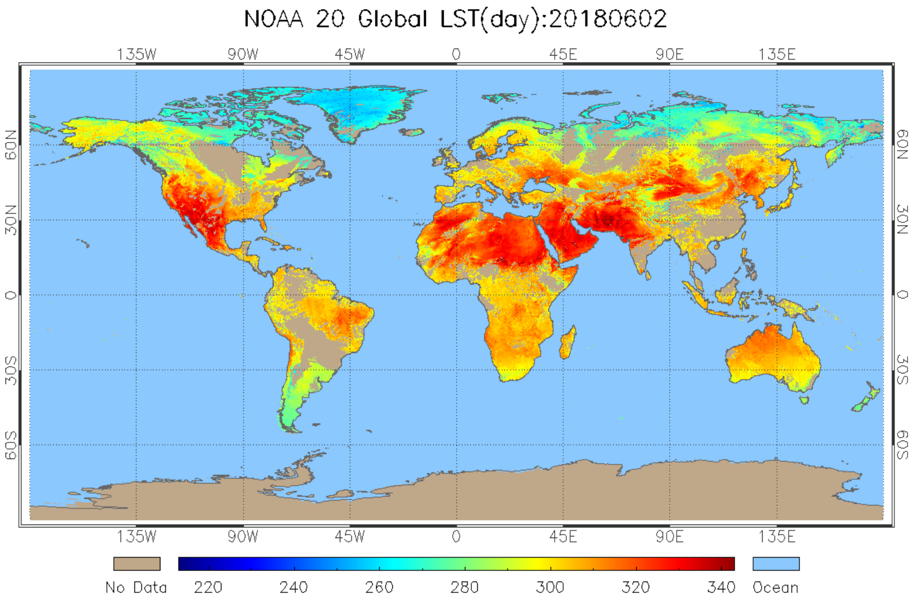
Performance Overview

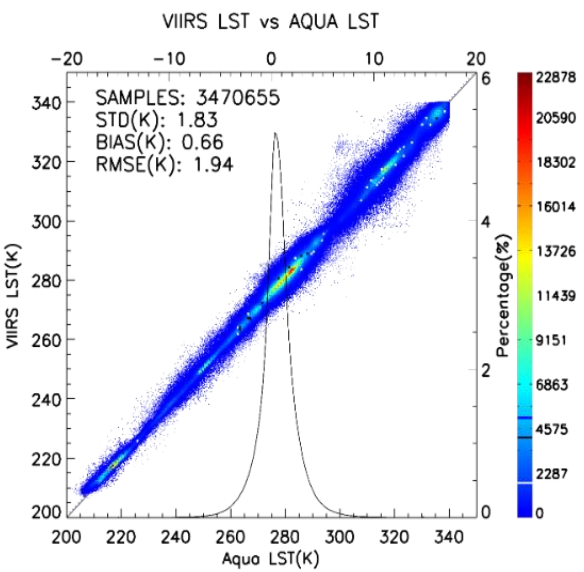
Validation method	Summarized Results* Bias (STD)	Notes
Comparisons with ground measurements	SURFRAD: -0.08(2.26) sxf: -0.48(2.50) tbl:-0.16(1.54) gwn:-0.91(3.35) psu:-0.25(1.62) dra:-0.83(1.69) fpk:-0.44(1.56) bon:-0.72(2.46)	Statistics of the differences are based on the enterprise VIIRS LSTs against ground LST estimates from 7 **SURFRAD** sites, 1 GMD site and 2 BSRN sites, for a time period of total 7 weeks in four seasons. The results are constrained by ground data quality control, cloud filtering procedure and upstream data quality.
	GMD over SUM -0.25(1.12)	
	BSRN over CAB -0.63(1.73) BSRN over GOB -1.23(1.52)	
Cross satellite Comparison	0.01(2.49) -0.18(2.80): daytime 0.46(1.43): nighttime	The cross comparisons are performed between enterprise VIIRS LSTs and MODIS AQUA LSTs. The results are constrained due to regional sampling limitation, i.e. over Africa, US, South America, Australia and Canada. It is also constrained due to temporal sampling limitation, sensor difference, and observation angle difference etc.

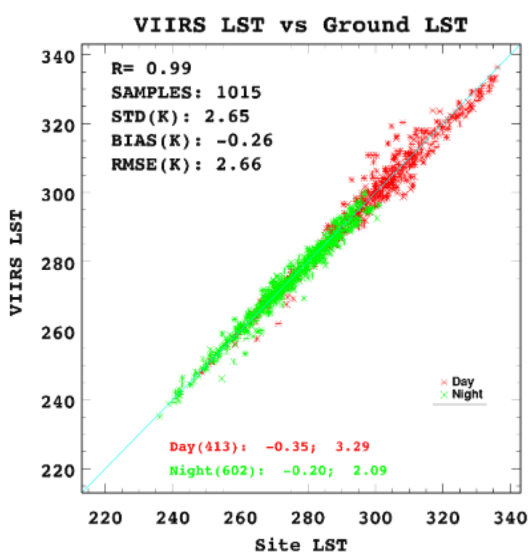
**Bias (STD) of L1RD threshold: 1.4 (2.5K)*

NDE NOAA-20 LST Status



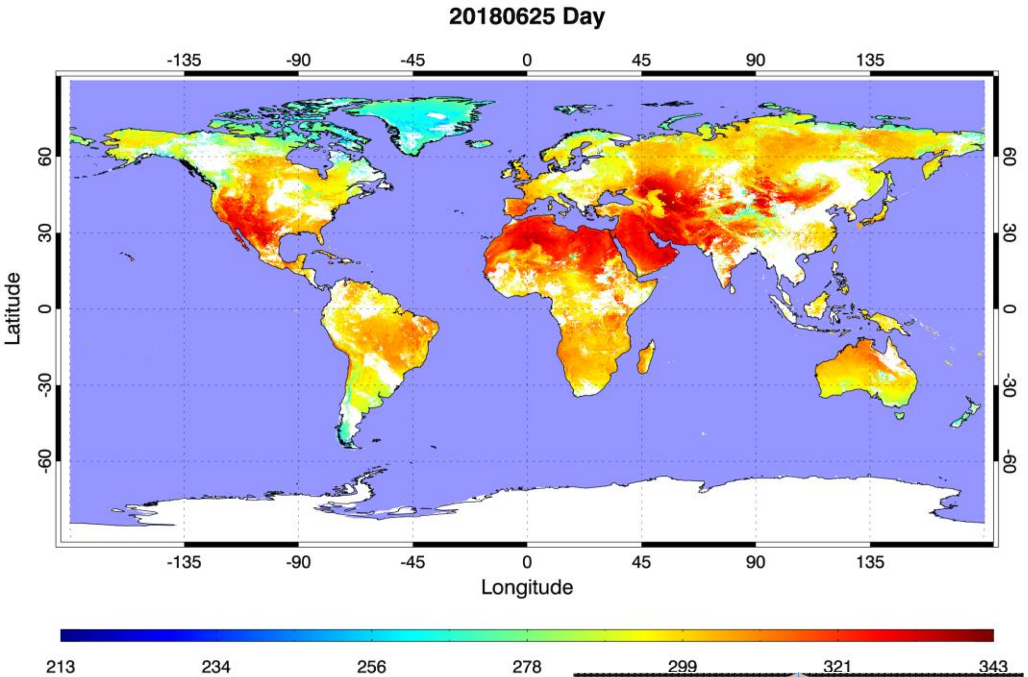


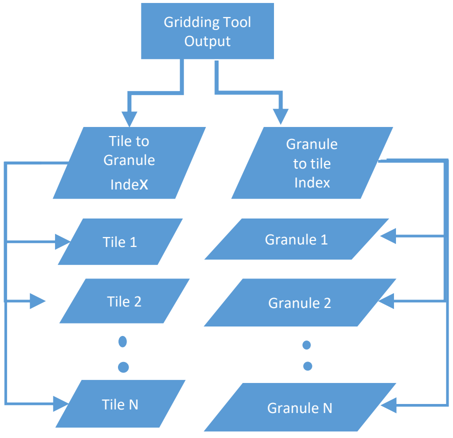




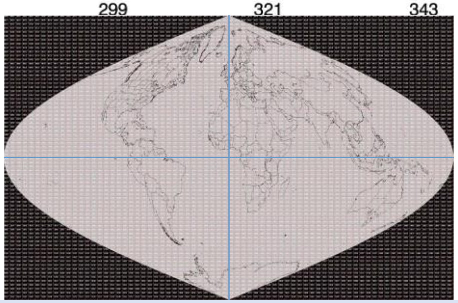
- The enterprise LST algorithm is applied for NOAA-20 LST production (NDE)
- Beta maturity Review was done in July 2018
- Calibration and validation is on the way for Provisional maturity (Dec 2018)

Gridded LST product development

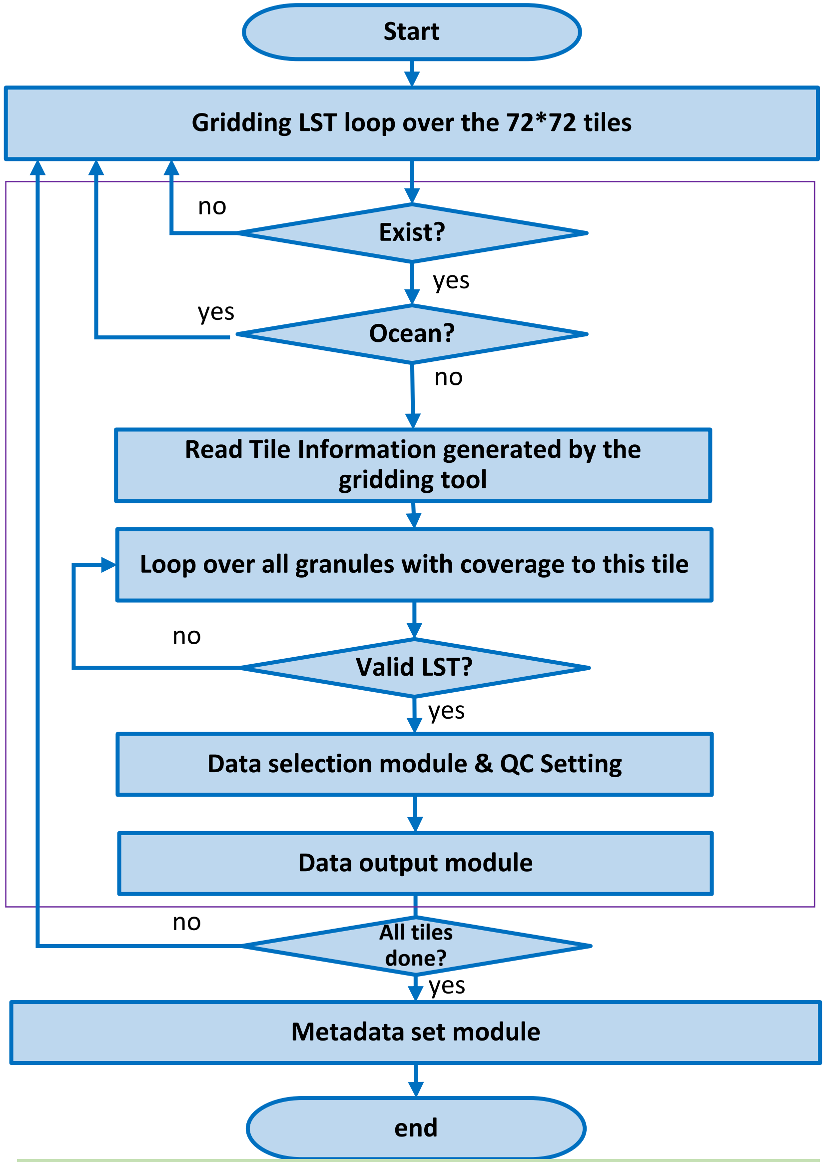




Gridding tool output structure



- A gridding tool generates grid-pixel mapping IPs which are used as input for the gridded LST production
- The gridded LSTs are computed tile by tile
- A tool will be provided to convert the tile dataset to the final LST product.



High level flow chart of gridded LST using the gridding tool

Emissivity Data Development

LSE Product Main Features

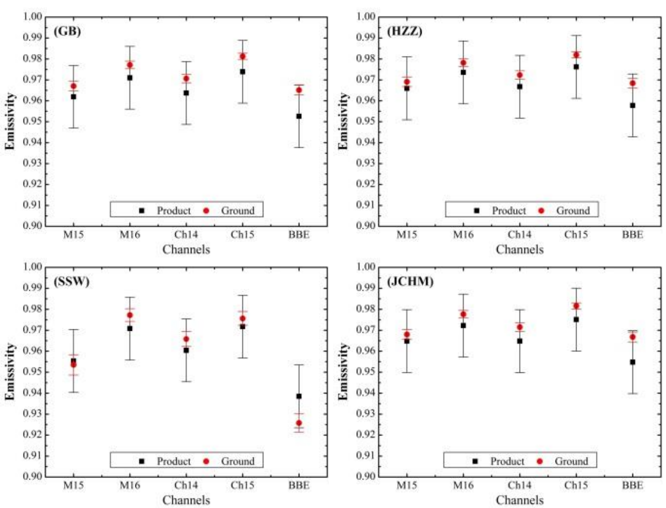
- Daily product with global coverage at 0.009 degree grid.
- Including 5 bands: VIIRS and ABI split window channels and 8-15um broadband.
- Pixel by pixel quality flag, grouping LSE uncertainty into four level and vast majority with an error of less than 1.5%.

Ground LSE Measurements

- Four bare sites at northwest of China measured by BOMEM MR340 FTIR.
- Sand Samples from Three deserts measured using Nicolet iS50 FTIR.

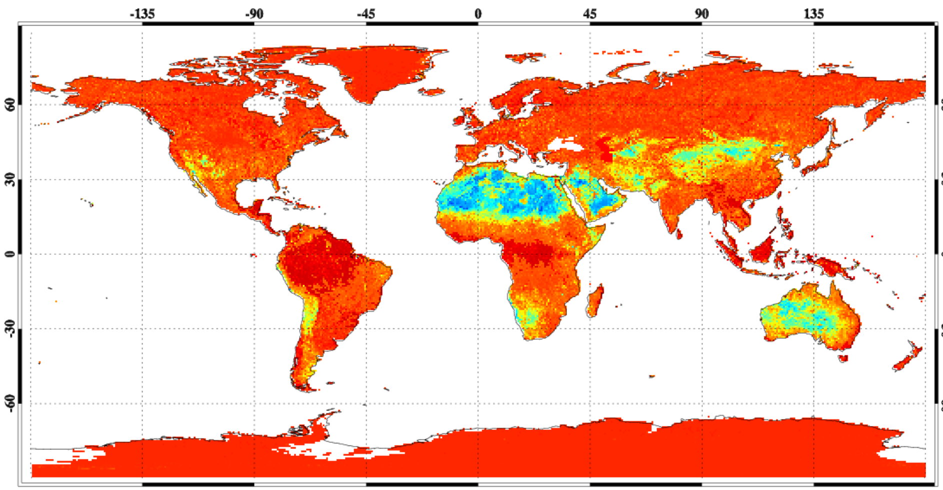
Validation Results

- Split-window channel LSE uncertainty within 0.6%
- Broadband LSE uncertainty within 1.2%.

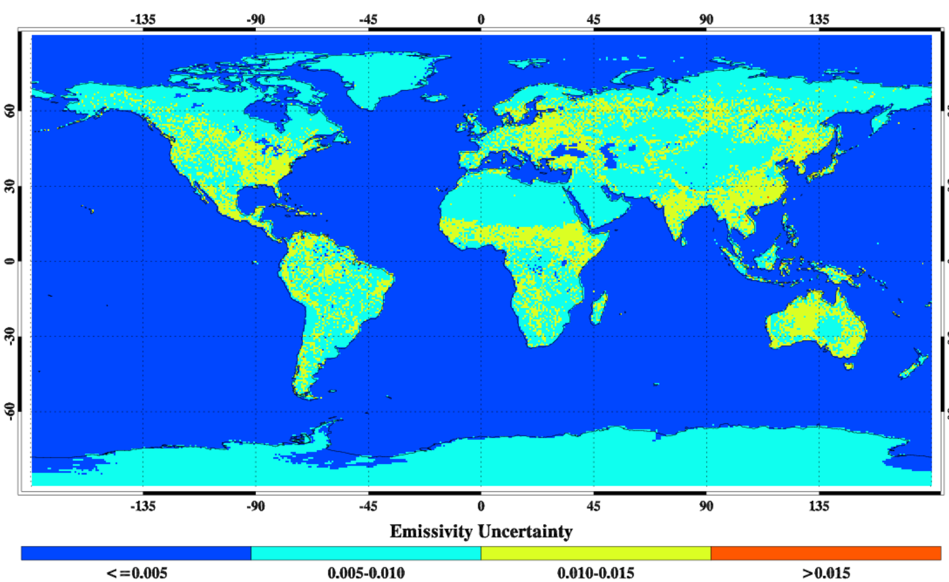


4-site validation Results

8.0-13.5 micron BBE @20161220



S-NPP VIIRS Emissivity Uncertainty @ 20170331



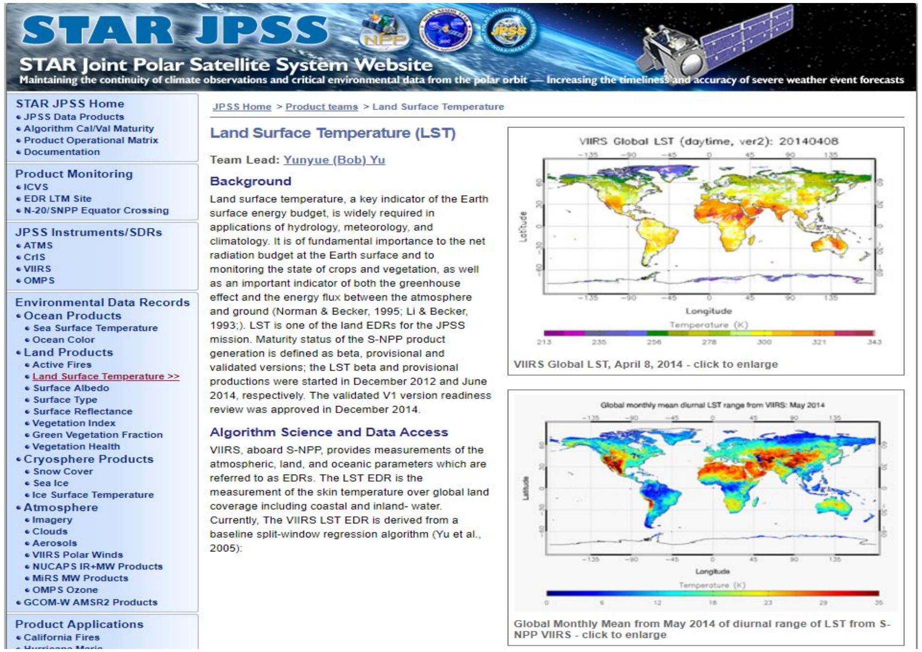
Long-term monitoring

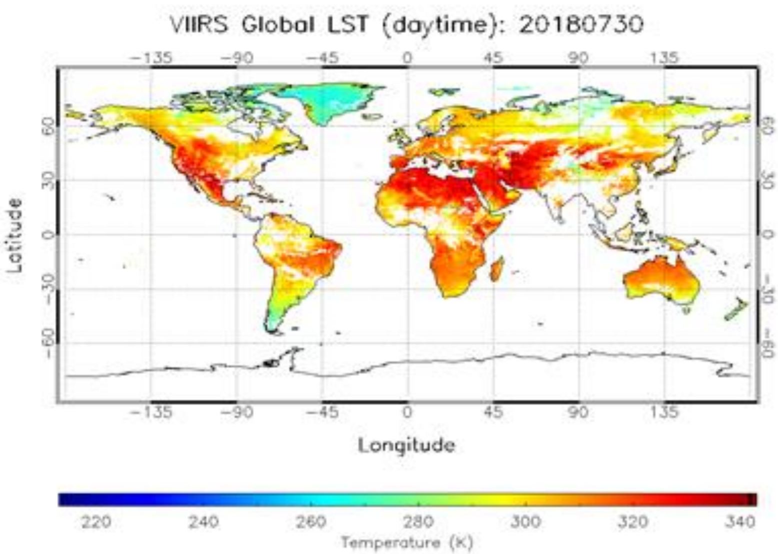
- **Monitoring/Validation tool maintenance and extension**

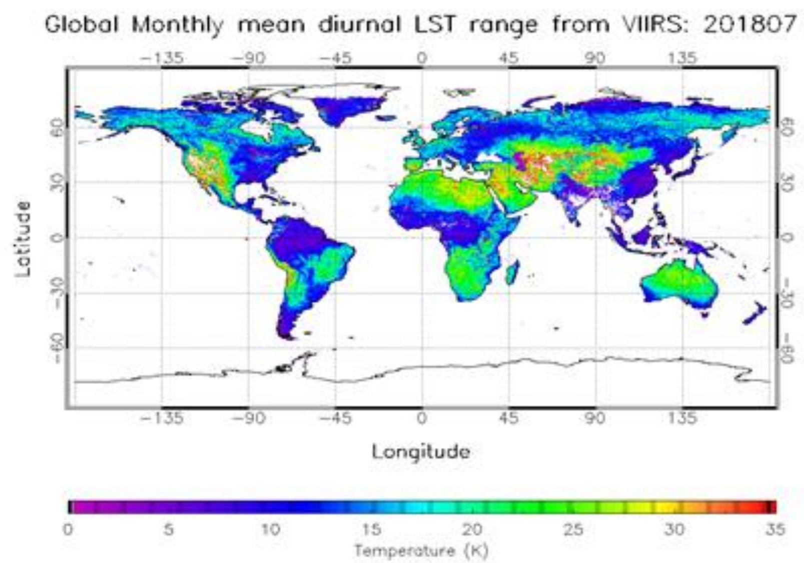
✓ The monitoring tool routinely generates daily global VIIRS LST maps, and the diurnal temperature range (DTR) from the operational VIIRS LST EDR data and validation with SURFRAD data.

✓ NOAA 20 data has been added into the monitoring system.

✓ ftp site for image distribution and notification is working routinely. The data is available at ftp://ftp.star.nesdis.noaa.gov/pub/smcd/emb/pyu/VIIRS_monitoring/.







Interactive communication with users

External Users

– USDA Agricultural Research Services(Martha Anderson)

-- USDA Forest Service (Brad Quayle)

– Academy – Univ. of Maryland (Konstantin Vinnikov, Shunlin Liang, Cezar Kongoli)

– Army Research Lab (Kurt Preston)

– EUMETSAT LSA SAF LST group (Isabel Trigo, Project Manager)

– ESA/ESRIN, Italy (Simon Pinnock & Olivier Arino)

– Univ. Of Edinburgh, UK (Chris Merchant)

– OBSPM, and LSCE, France (Catherine Prigent & Carlos Jimenez, and Catherine Ottlé)

– Universitat de les Illes Balears, Spain (Maria Antonia Jimenez Cortes)

– eLEAF, The Netherlands (Henk Pelgrum & Wim Bastiaanssen)

– Centre for Ecology and Hydrology, UK (Rich Ellis)

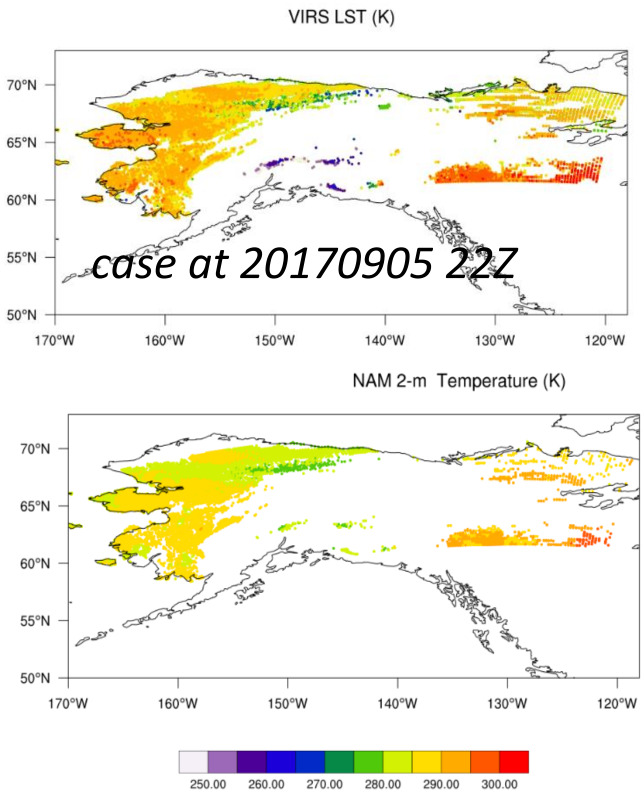
– Institute of Geodesy and Cartography, Poland (Katarzyna Dabrowska-Zielinska)

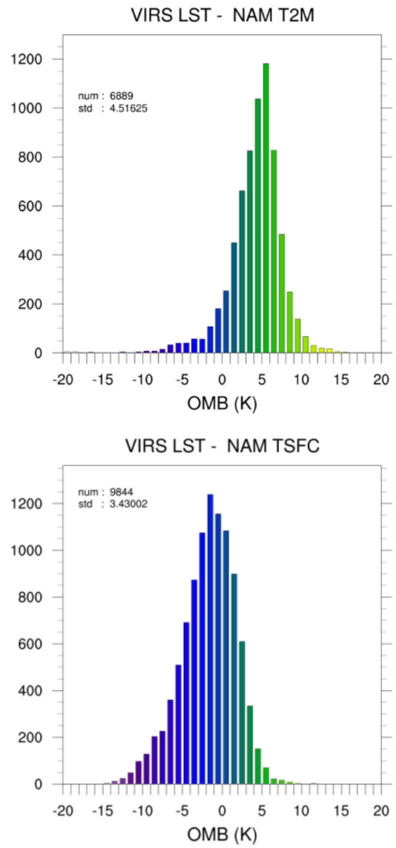
Provide test datasets for

- NCEP/EMC weather forecasting model output verification
- NCEP/EMC land surface air temperature prediction model

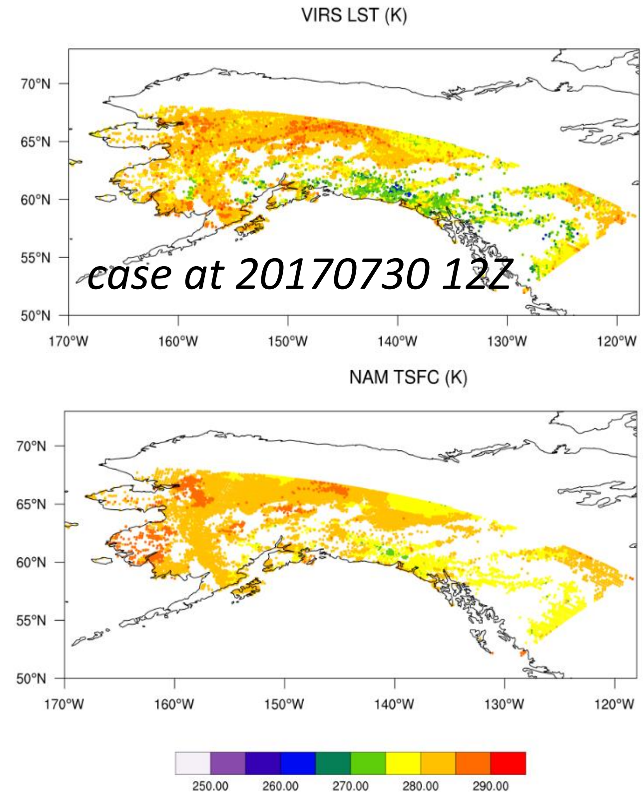
Current Users feedback

VIIRS LST vs Model 2m Temp





VIIRS LST vs Model TSFC



- EMC requested the granule VIIRS LST for studies on assimilating VIIRS LST into RTMA/URMA to improve air temperature prediction over Alaska area.
- The preliminary results are very encouraging therefore EMC is going to subscribe the VIIRS LST data

Summary

- Enterprise LST algorithm progress
  - The enterprise LST algorithm will be run in NDE by Oct 2018.
  - Local ent-LST dataset is available upon request
  - Daily emissivity dataset is available also
- NOAA 20 LST beta maturity reviewed
- Gridded LST design and development
  - CDR will be conducted in Sept/Oct 2018
  - Daily product, grid size 0.009.
  - Quality flags and metadata are available.
- Long-term monitoring – fairly matured for the science team
- Active communication with users

Future Plans/Improvements

- Comprehensive validation, Alg Calibration
- QF improvement
- Product maturity Progress
- Emissivity Data evaluation
- Operational Gridded LST done by Sept 2019
- Extension of the cross satellite LST comparison e.g. Sentinel 3.
- International collaboration on the ground data collection for LST validation.
- Users interactive communication

JPSS Land Surface Albedo

Yunyue Yu
NOAA/NESDIS/STAR
Yunyue.Yu@noaa.gov

Shunlin Liang, Dongdong Wang,
Yuan Zhou, Jingjing Peng
UMD/CICS

Outline

- ❑ Cal/Val Team Members
- ❑ VIIRS LSA Production Overview
  - New LSA algorithm for NDE
  - NOAA-20 LSA status
  - Algorithm Performance
- ❑ NDE Gridded LSA Product
- ❑ Updates to Sea Ice Surface Albedo Algorithm
- ❑ User feedbacks
- ❑ Summary

Cal/Val Team Members

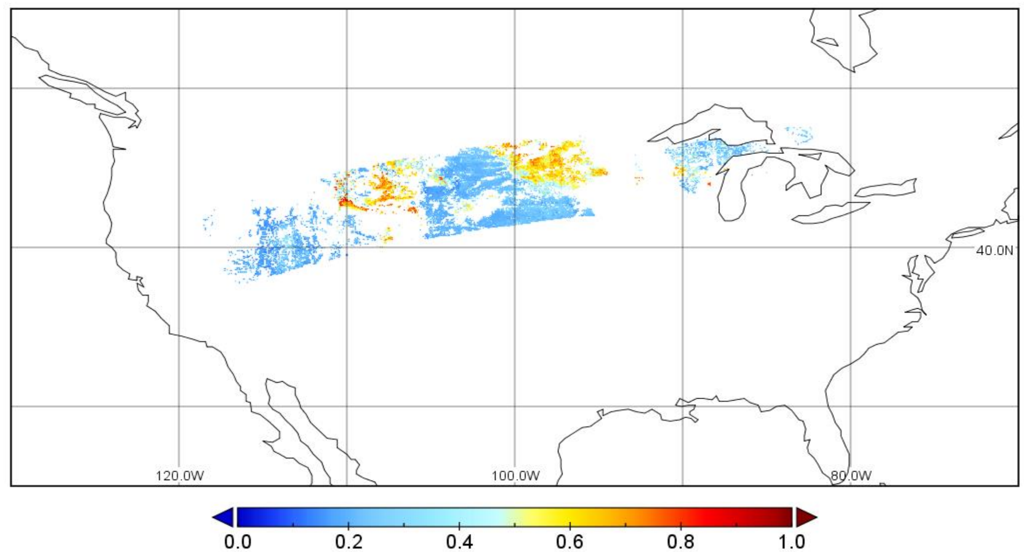
PI	Organization	Team Members	Roles and Responsibilities
Ivan Csiszar	NOAA/NESDIS/SATR		Land Lead, Project Management
Yunyue Yu	NOAA/NESDIS/SATR		EDR Lead, algorithm development, validation, team management
		Jingjing Peng	Algorithm development, validation, monitoring
Shunlin Liang	UMD/CICS		Algorithm development, validation
		Dongdong Wang	Algorithm development, validation, monitoring
		Yuan Zhou	Algorithm development, validation, monitoring
Walter Wolf	NOAA/NESDIS/SATR		System Integration, Transition
		Valerie Mikles	System Integration, Transition
		Marina Tsidulko	STAR IT support
Jack Kain	NOAA/EMC/NCEP		User readiness
		Weizhong Zheng	User readiness : Model albedo application, verification
		Yihua Wu	User readiness : Model albedo application, verification

VIIRS NDE LSA Product

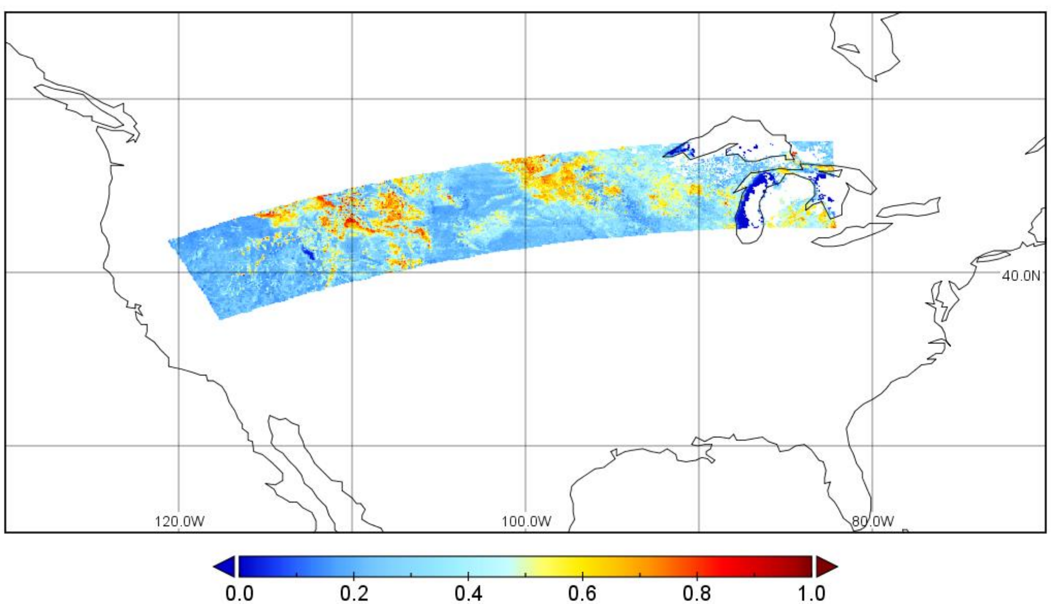
Status:

- The ASSIST Near Real Time (NRT) run of the NDE LSA has been started from end of June 2018
- The NDE Operational Readiness Review is scheduled in Sept 2018, operational run about one month afterward.
- The LSA ATBD is Updated accordingly

SNPP VIIRS Albedo Product (IDPS) (Jan 22th, 2015)



SNPP VIIRS Albedo Product (NDE) (Jan 22th, 2015)



Issues of IDPS LSA product

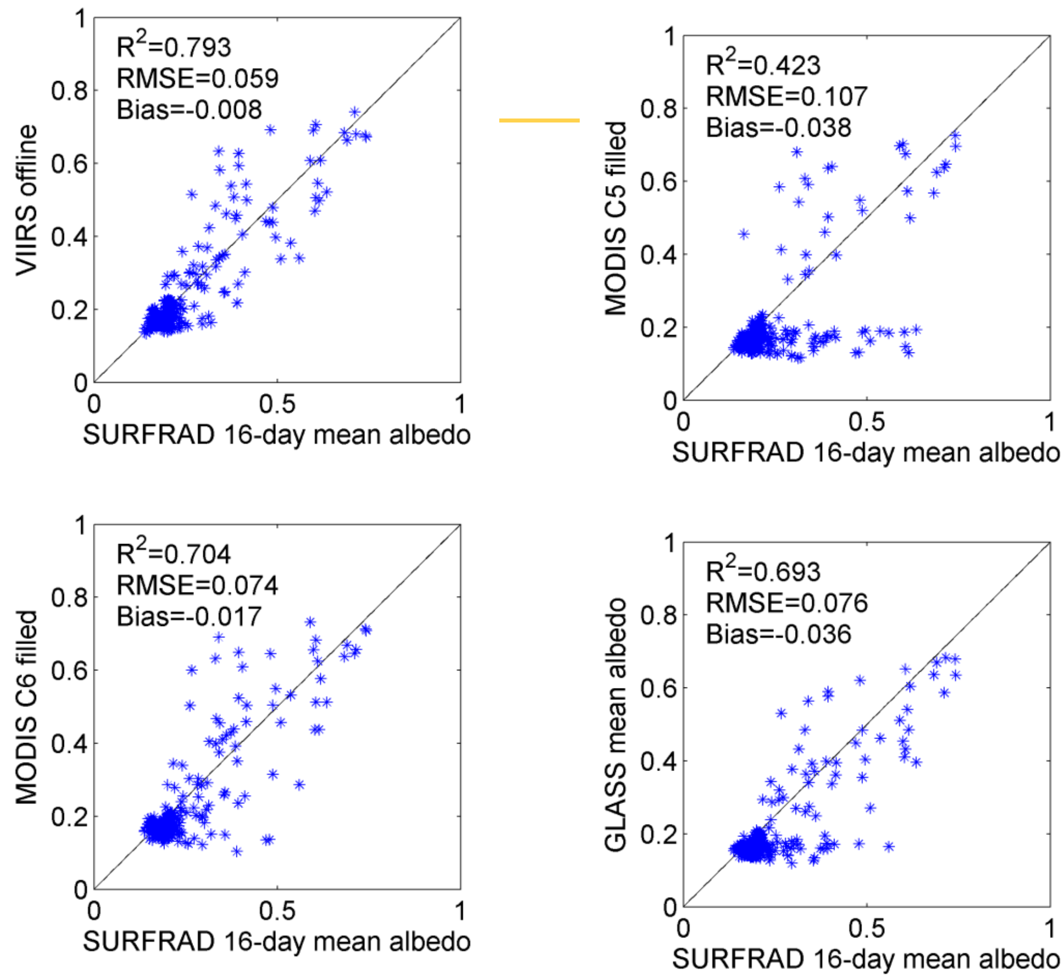
- Missing values
- Uncertainties from a single observation

Feature of NDE LSA product

- Gap-filled
- Noise-reduced

Performance Overview

- Surface-specific LUTs were developed
  - Generic
  - Desert
  - Snow
  - Sea-ice
- Climatology of albedo was used to fill data gaps and reduce retrieval uncertainties
- Validation results suggest the VIIRS NDE algorithm is accurate

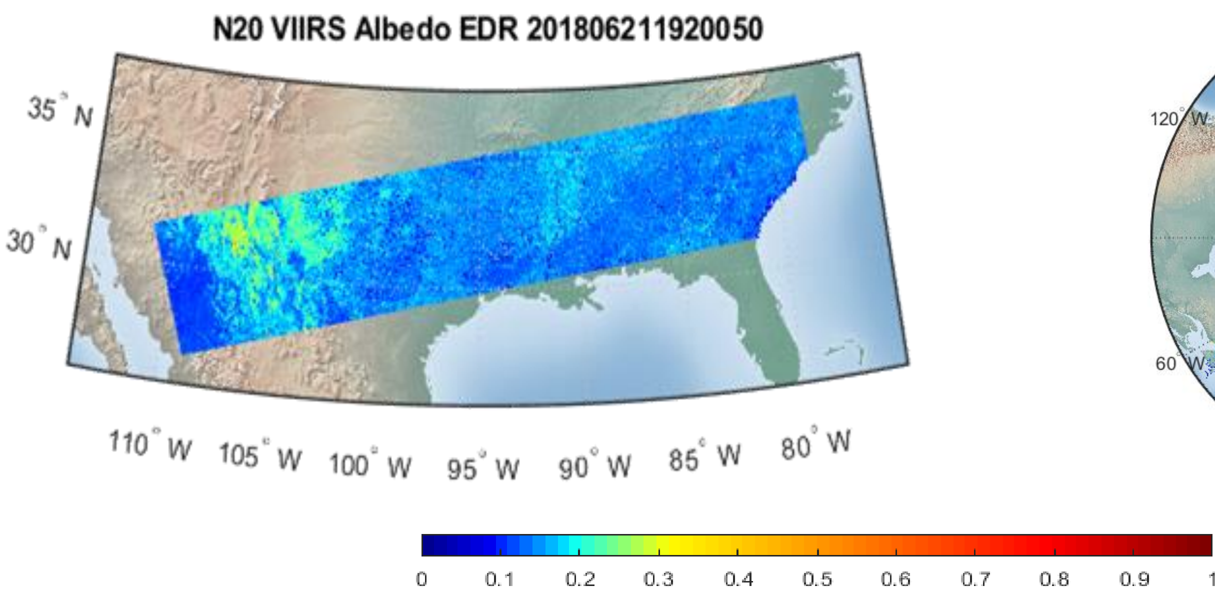


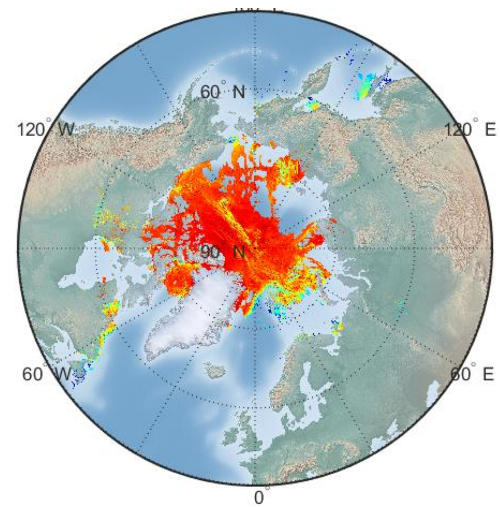
Validation results of 16-day mean albedo from VIIRS and MODIS by comparing against SURFRAD measurements

	Reqs.	Pre-TRR validation		Post-TRR validation	
		land	sea ice	SURFRAD	Ozflux
Accuracy	0.08	0.008	0.028	-0.005	0.02
Precision	0.05			0.05	0.035

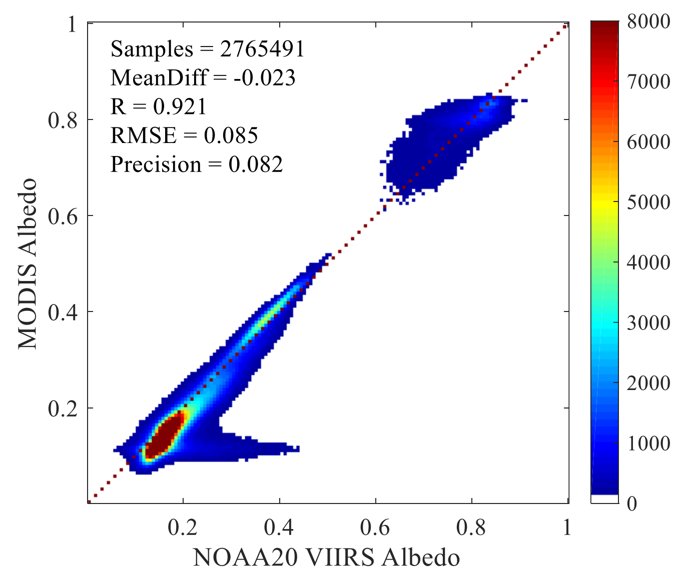
TRR: Test Readiness Review

NOAA-20 VIIRS Albedo Status





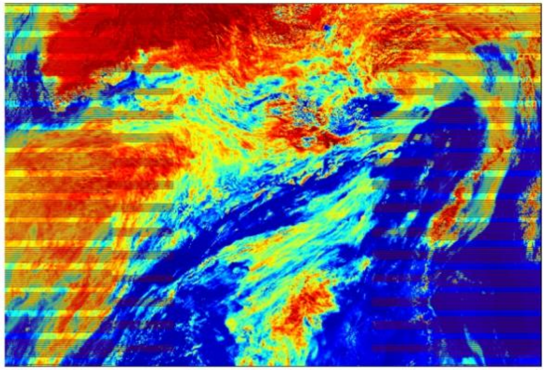
Summer Case: 20180609



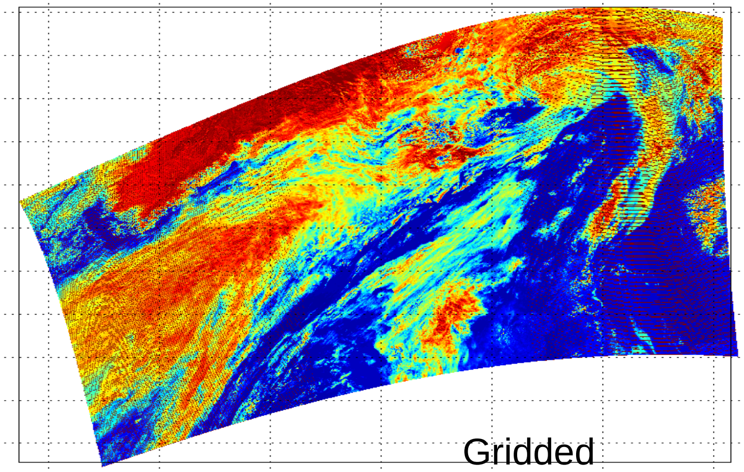
- The NDE SNPP LSA algorithm is applied for NOAA-20 LSA production (NDE)
- Beta maturity Review was done in July 2018
- Calibration and validation is on the way for Provisional maturity (Dec 2018)

Gridded LSA Product Development

(GranuleID, i, j) ------ (TileID, x, y)

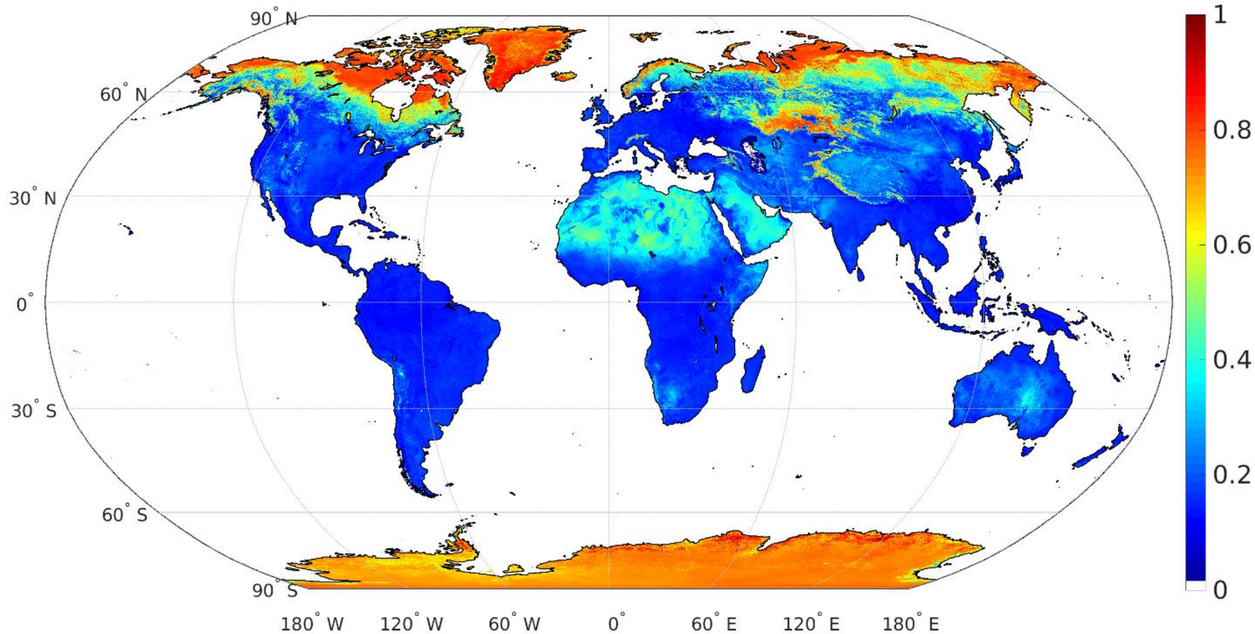


Granule



Gridded

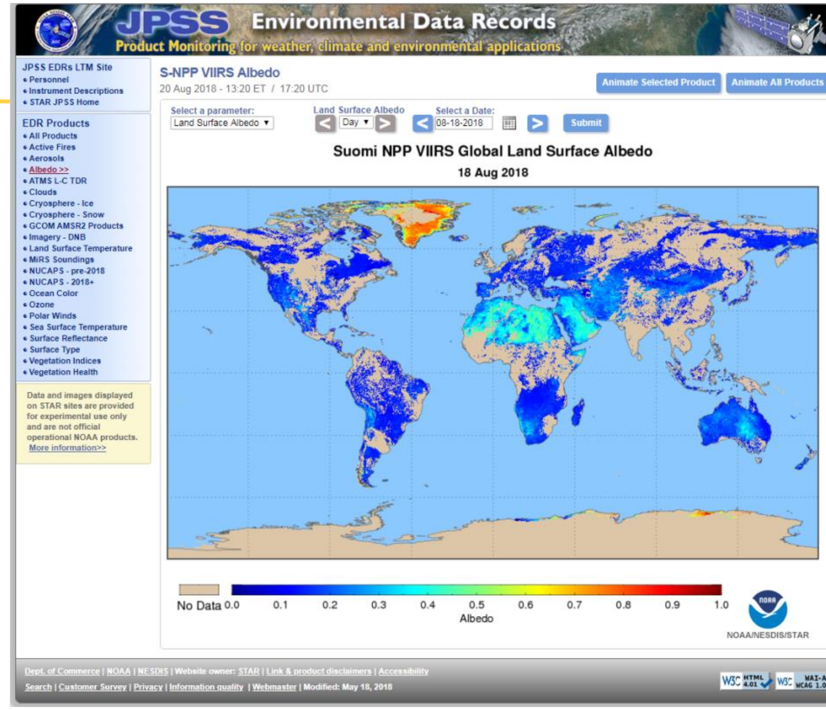
- A gridding tool generates grid-pixel mapping IPs which are used as input for the gridded LSA production
- The gridded LSAs are computed tile by tile
- A tool will be provided to convert the tile dataset to the final LSA product.

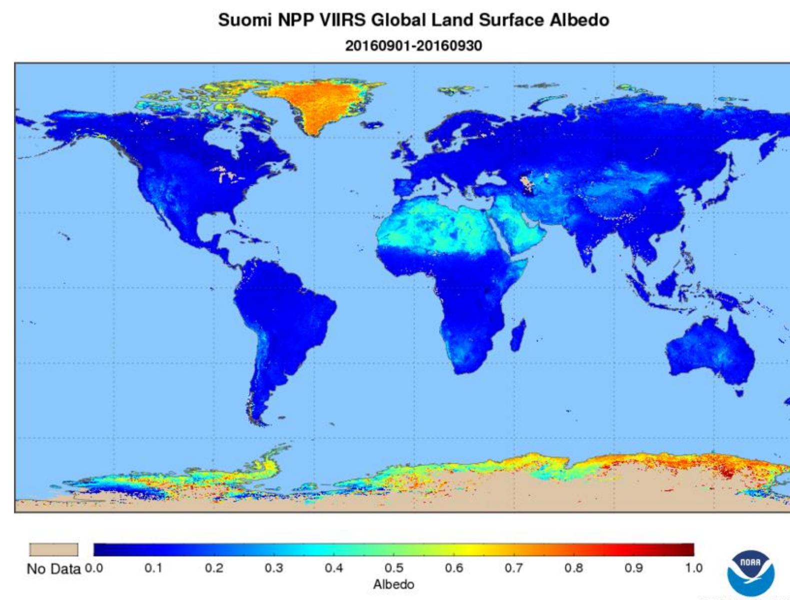


VIIRS LSA Long-term Monitoring

Developed a long-term monitoring tool

- Automatically validate against field measurements;
- Generate global composite maps on a regular basis ;
- Send alerts when abnormal results occurs;
- Update maps through WWW
- http://www.star.nesdis.noaa.gov/jpss/EDRs/products_Albedo.php





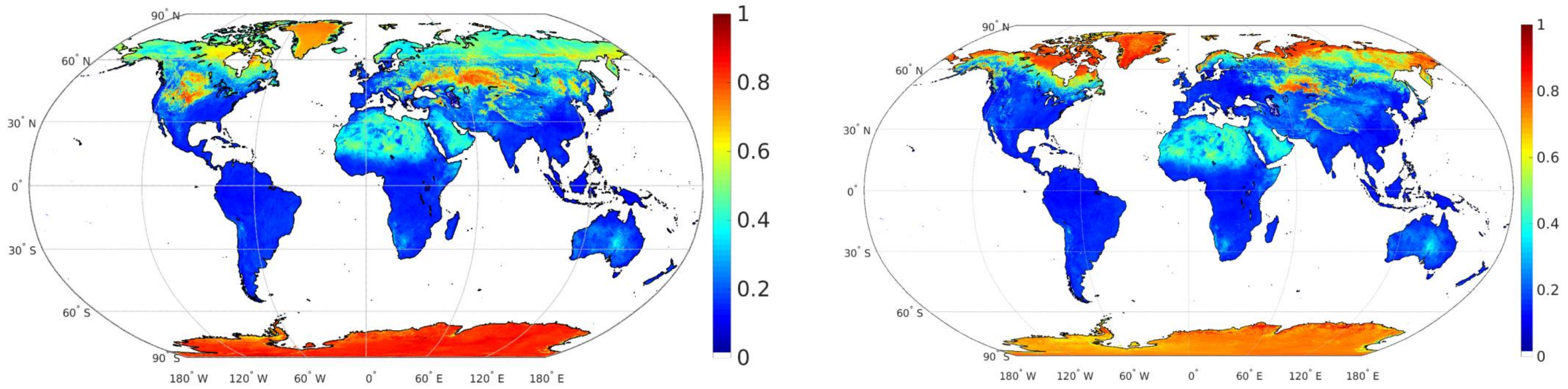
A global map of land surface albedo composite with VIIRS products of Sept, 2016

Interactive communication with users

- **U. S. Users:**
  - NOAA National Weather Service Environmental Modeling Center (Michael EK, Jesse Meng, Weizhong Zheng)
  - USDA Agricultural Research Services(Martha Anderson)
  - USDA Forest Service (Brad Quayle)
  - NOAA/NESDIS Center for Satellite Applications and Research (Jerry Zhan)
  - NOAA/NESDIS National Climate Data Center (Peter Thorne)
  - Academy -- University of Maryland (Konstantin Vinnikov, Shunlin Liang, Cezar Kongoli)
  - Army Research Lab (Kurt Preston)
- **Foreign Users**
  - EUMETSAT (Yves Govaerts)
  - Météo France (Jean-Louis Roujean)
  - Academy: Italy IASMA Research and Innovation Centre (Barbara Marcolla), Beijing Normal University (Qiang Liu)

Interactive communication with users

- The new gridded, gap-filled, noise-reduced product is developed to meet the requirements of modeling team and data analysis.
  - Working with the NCEP modeling team to test the application of new product
  - Customized the codes to generate tailored data sets.



Examples of albedo data customized for modeling team

Summary

- NDE Albedo Algorithm progress
  - The NDE Albedo algorithm will be run by Oct 2018
  - Feature: gap-filled, noise-reduced, sea-ice albedo
- NOAA-20 LSA beta maturity reviewed
- Gridded LSA design and development
  - CDR will be conducted in Sept/Oct 2018
  - Daily product, grid size 0.009.
  - Quality flags and metadata are available.
- Long-term monitoring – fairly matured for the science team
- Active communication with users

Future Plans/Improvements

- ❑ Comprehensive validation, Alg Calibration
- ❑ Operational Gridded LSA done by Sept 2019
- ❑ Product maturity Progress
- ❑ Albedo data reprocessing and evaluation
- ❑ Monitoring, validation tool at STAR environment
- ❑ Users interactive communication

Applications of Land Remote Sensing in NOAA's NWP

Yihua Wu[1,2], Weizhong Zheng[1,2]

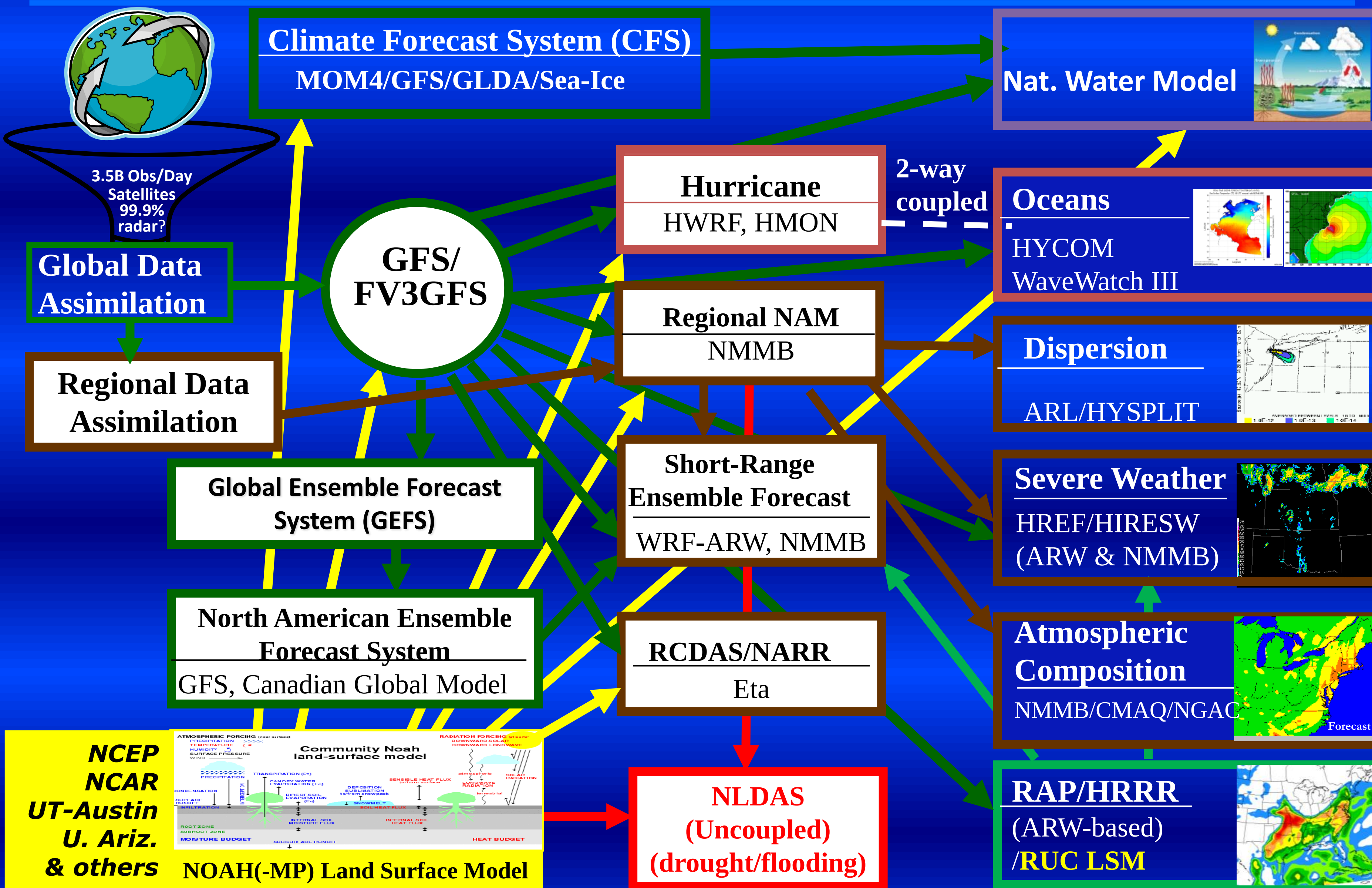
Jiarui Dong[1,2], Helin Wei[1,2], Jack Kain[2]

[1]I. M. Systems Group
[2]NCEP/EMC

Background

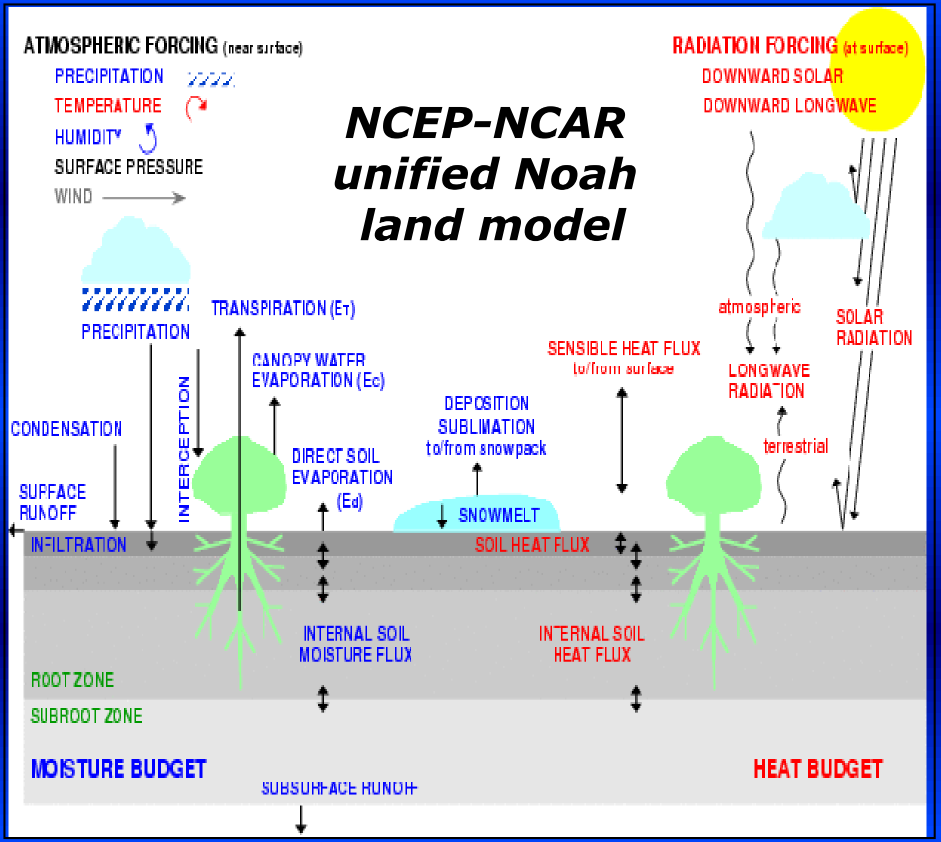
- The land surface model (LSM) is an essential component of modern weather and climate forecasting systems.
- Accurate and detailed land surface information is critical for environmental modelling, risk assessment and decision making.
- The parameters used in LSMs are partly poorly constrained due to sparse land surface observations.
- Novel satellite-derived datasets can improve LSM configuration, and hence can contribute to the improvements of environmental modelling, weather predictability, risk assessment and decision.

Noah(-MP) Land Model Connections in NOAA's NWS Model Production Suite



LSM's Role and Requirements

- Close surface energy & water budgets,
- Determine **heat**, **moisture**, and **momentum** exchange between surface & atmosphere,
- Provides surface boundary conditions to parent atmospheric model, e.g. NAM, GFS, CFS, FV3GFS.



- ○ Appropriate **physics** to represent land-surface processes,
- ○ **Atmospheric forcing** to drive land model,
- ○ **Initial land states**, e.g. soil moisture/ice and snow, analogous to initial atmospheric conditions, though land states may carry more "memory", especially deep soil moisture, similar to SSTs,
- ○ **Land surface physical property data sets**, e.g. land use/land cover (vegetation type), soil type, surface albedo and emissivity, and associated parameters, e.g. surface roughness, soil and vegetation properties.

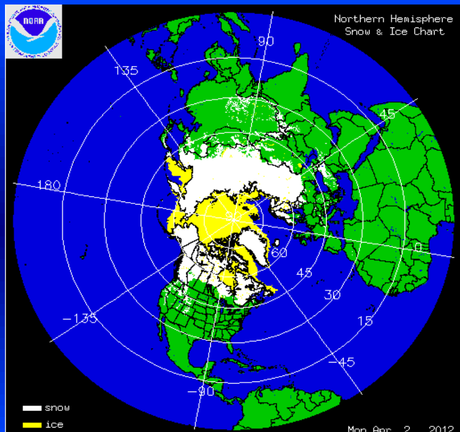
Land Surface Remote Sensing Products

- land cover change monitoring
  (land use type)
- Vegetation mapping and monitoring
  (vegetation type, cover area (GVF), plant density (LAI), plant height, plant phenology)
- Soil type (mostly relied on ground-based surveys)
- Soil moisture mapping
  (drought detection, flood monitoring, modeling)

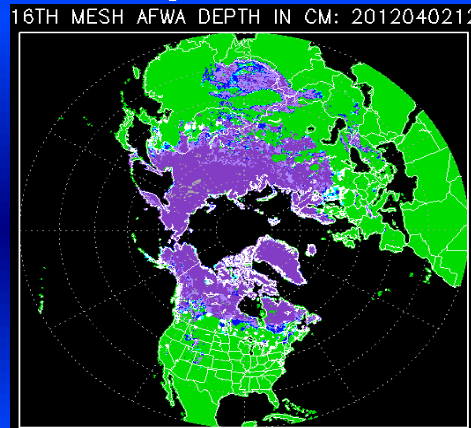
- Surface albedo and emissivity
- Snow cover and depth
- Wild fire monitoring
- Land surface temperature
- Determination of evapotranspiration
- Lake surface temperature
- Precipitation
- Urban surface physical parameters

Snow Products

Initial land states: 02 April 2012

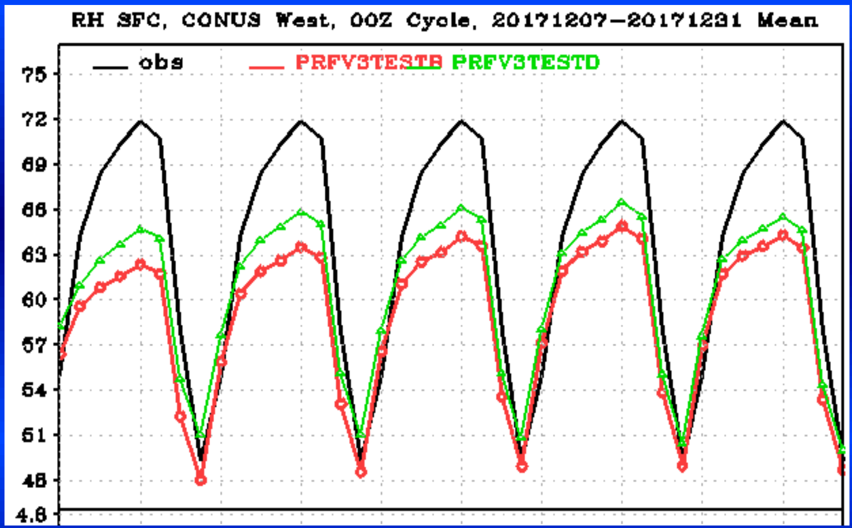


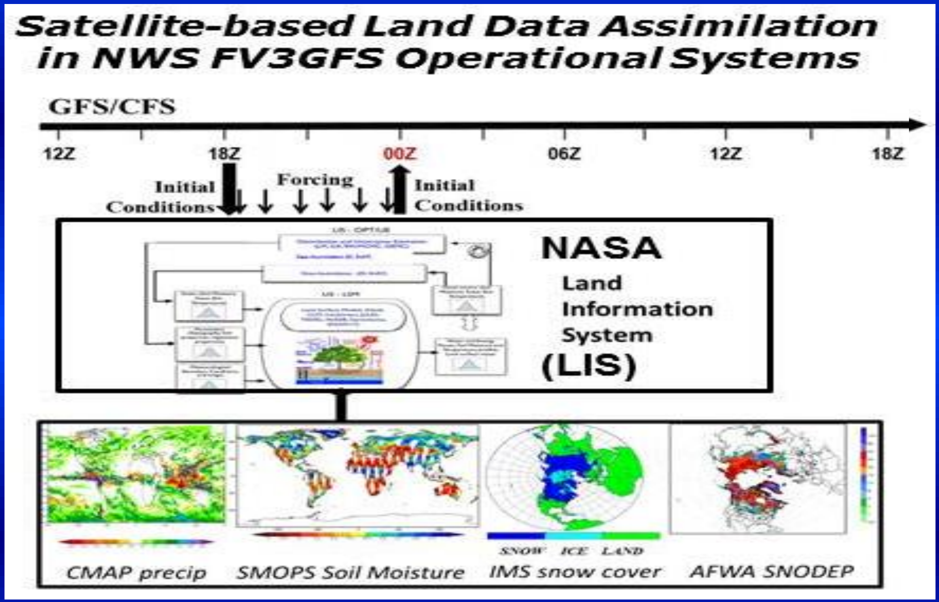
4-km Snow Cover (daily integrated NIC IMS product)

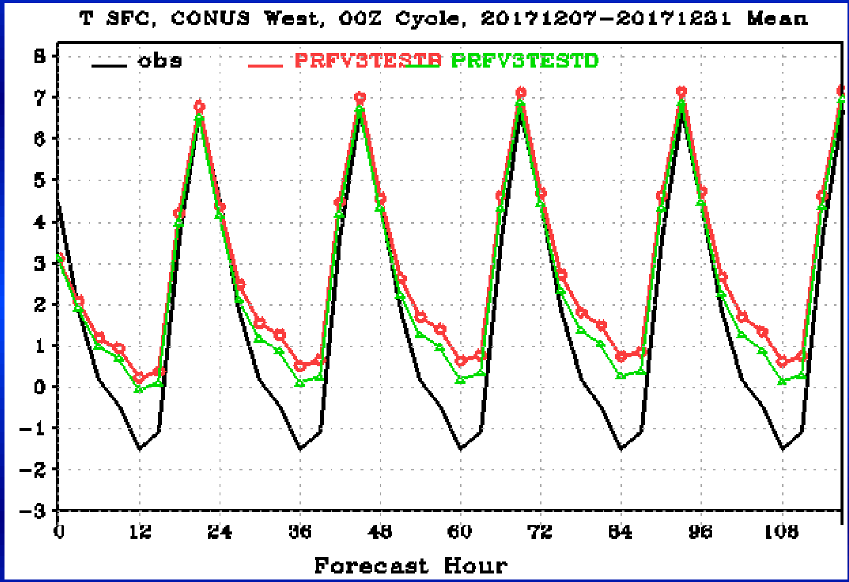


24-km Snow Depth (daily integrated AFWA product)

Snow Depth Effects in Data Assimilation

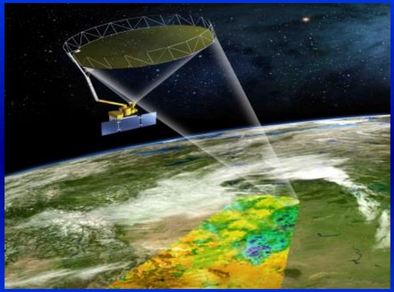




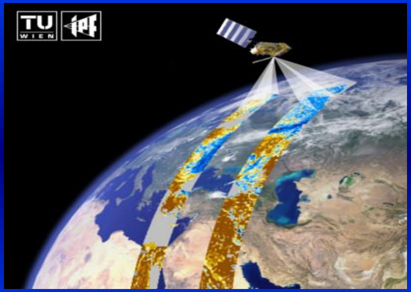


SMAP Soil Moisture

Initial land states

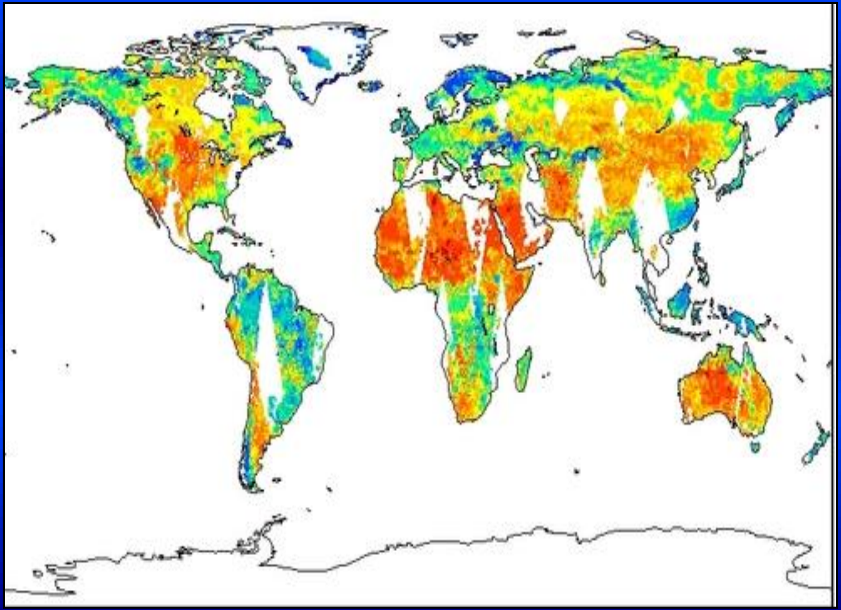


ESA SMOS



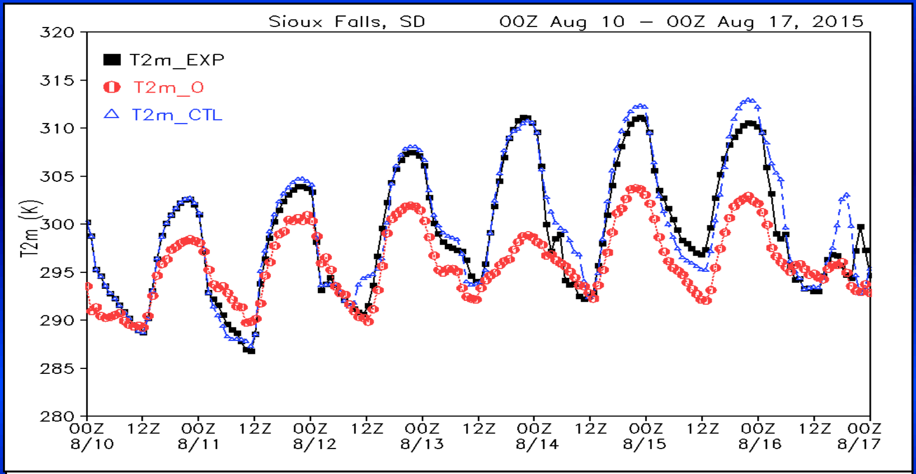
NASA SMAP

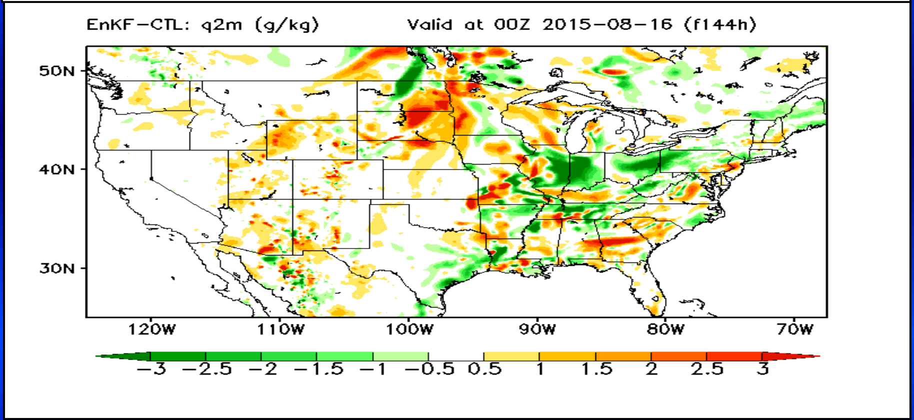
(Oct 2014 launch)



SMOPS Blended Daily Soil Moisture

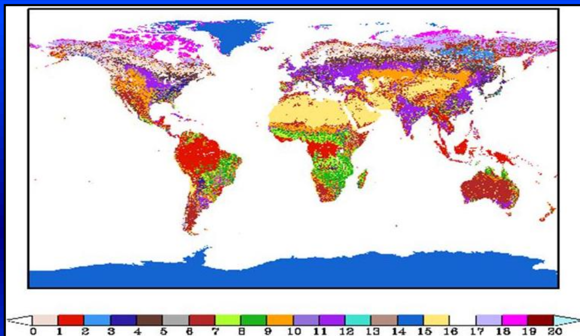
Data Assimilation



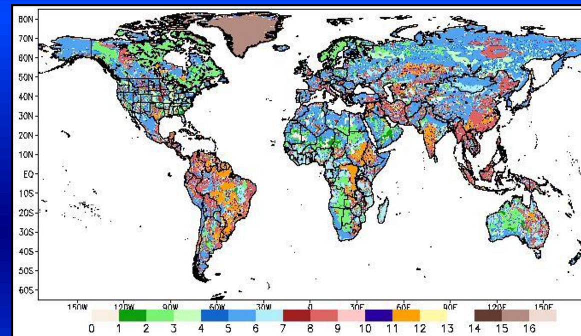


- ***Assimilating SMAP SM for a case (Aug 10, 2015) can reduce some warm biase T2m forecast in the GFS;***
- ***Impact of 2-meter specific humidity varies significantly spatially.***

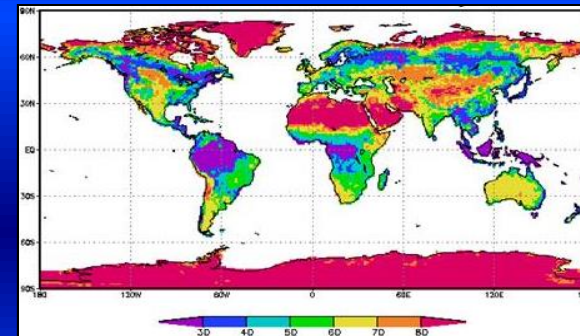
Land Data Sets *(NAM ~12/4/1-km)*



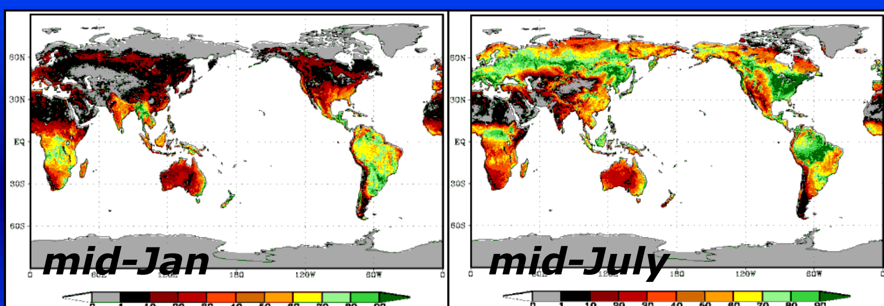
Vegetation Type
(1-km, IGBP-MODIS)



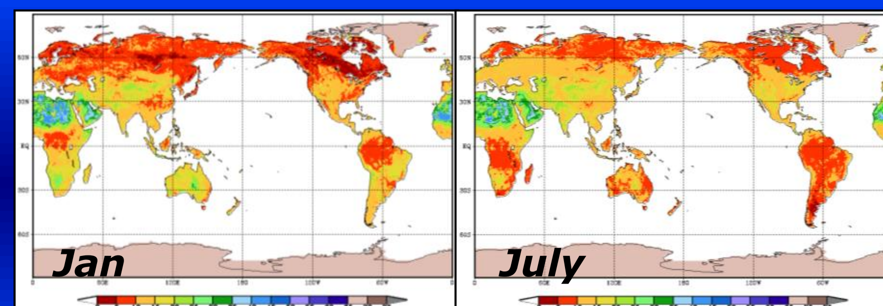
Soil Type
(1-km, STATSGO-FAO)



Max.-Snow Albedo
(1-km, UAz-MODIS)



Green Vegetation Fraction
(monthly, 1/8-deg, AVHRR)

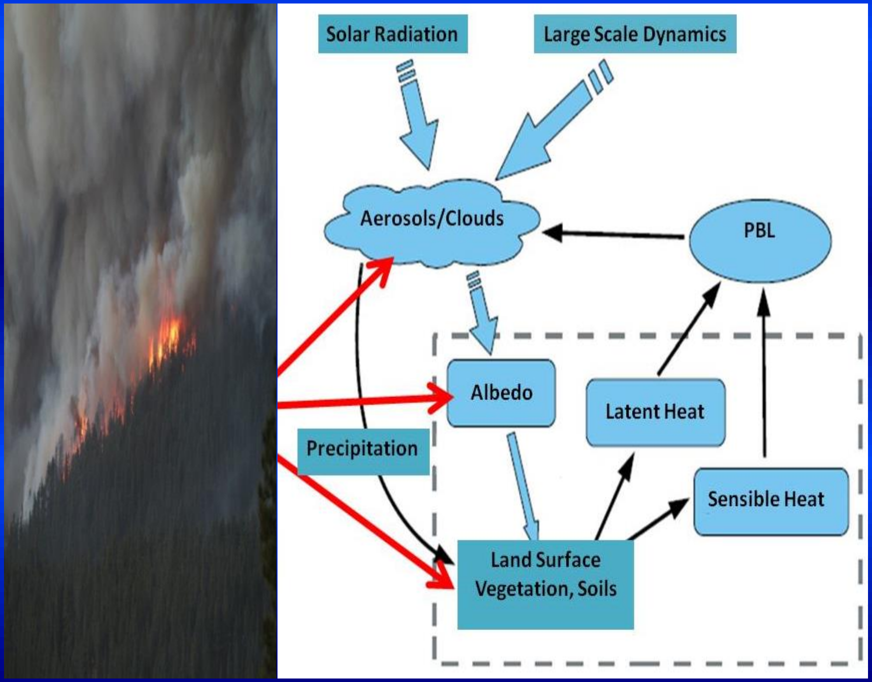


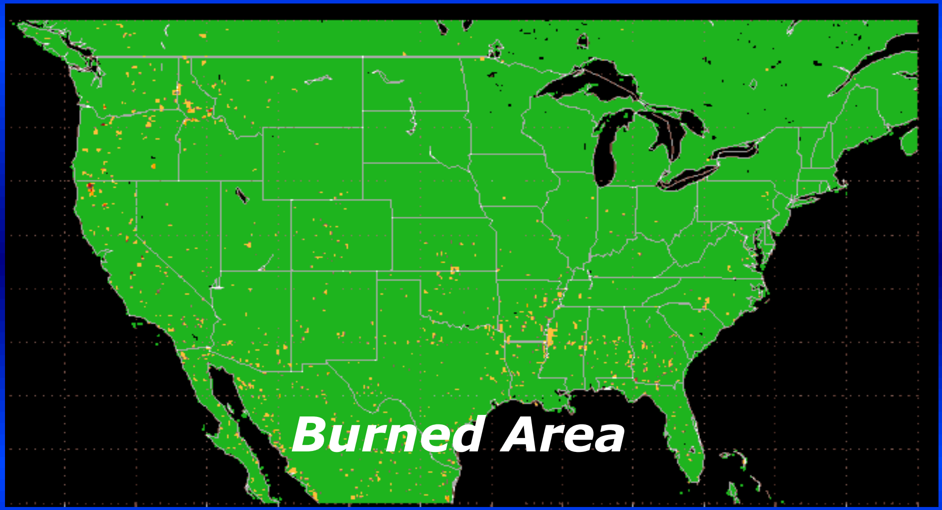
Snow-Free Albedo
(monthly, 1-km, BU-MODIS)

- Most are fixed annual/monthly/weekly climatologies.
- **Near real-time are better than fixed values.**

Land Conditions: Wildfire Effects

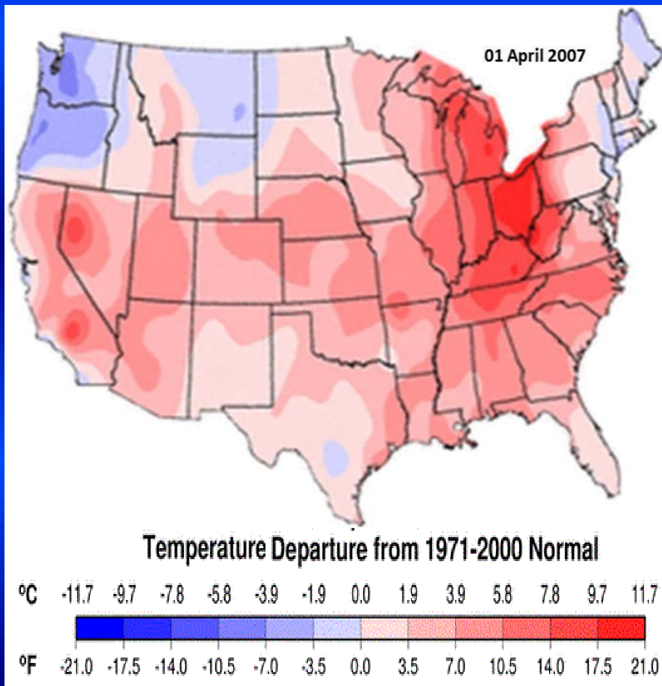
Wildfires affect weather/climate systems:
(1) atmospheric circulations
(2) aerosols and clouds
(3) **land surface states** (green vegetation fraction, albedo and surface temperature etc.) --> impact on surface energy budget, boundary-layer evolution, clouds & convection.



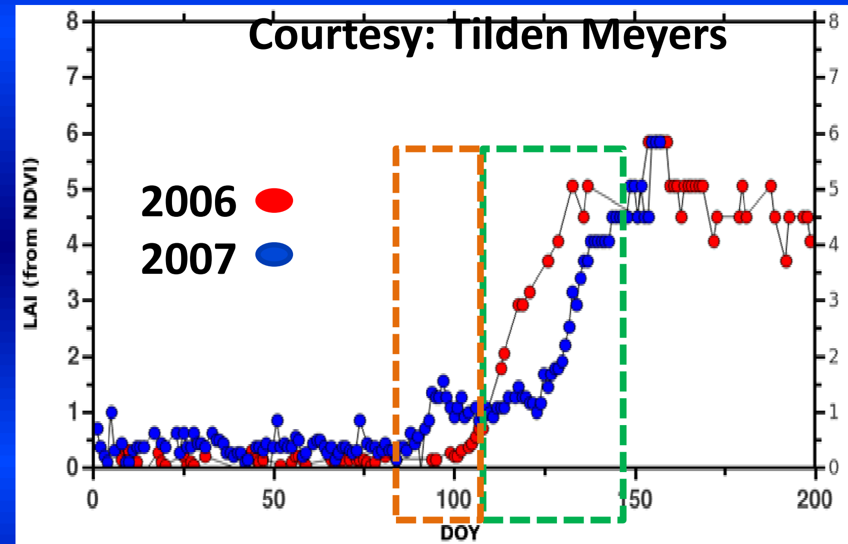


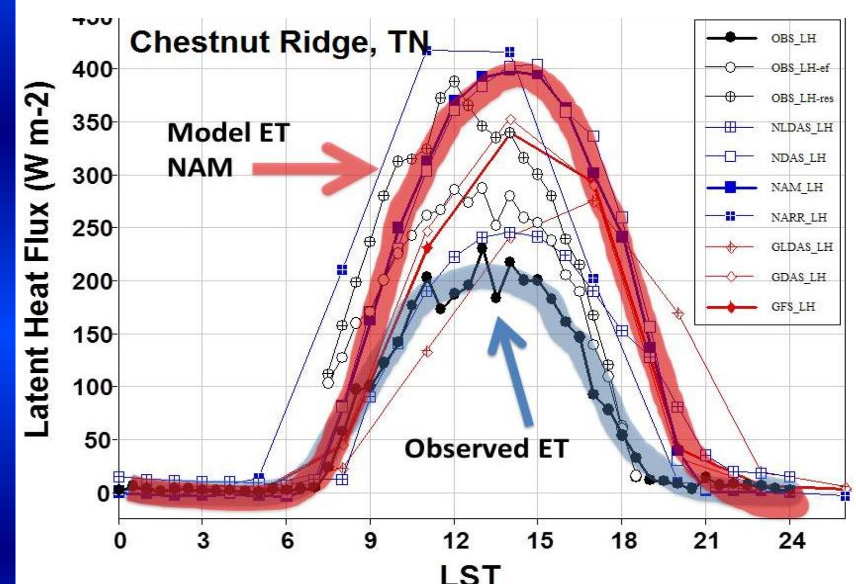
Burned Area (NESDIS/STAR): Near Real time burned area product was tested & used in operational NAM.

LAI Reduced by the Easter Freeze of April 2007



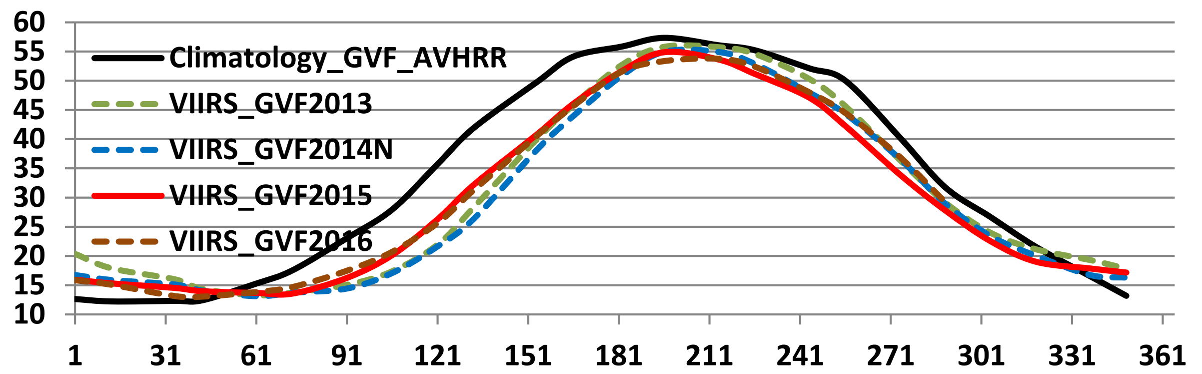
- In March 2007, unseasonably warm weather over the eastern half of the US prompted early growth of many crops.
- In early April (4-10), an Arctic cold hit the same region. Air temperatures in many locations were well below 25°F.
- The widespread freeze extensively damaged agriculture in 18 states in the region. Many farmers lost about 90% or nearly all of their crops.
- It also caused problems in NOAA weather forecast.



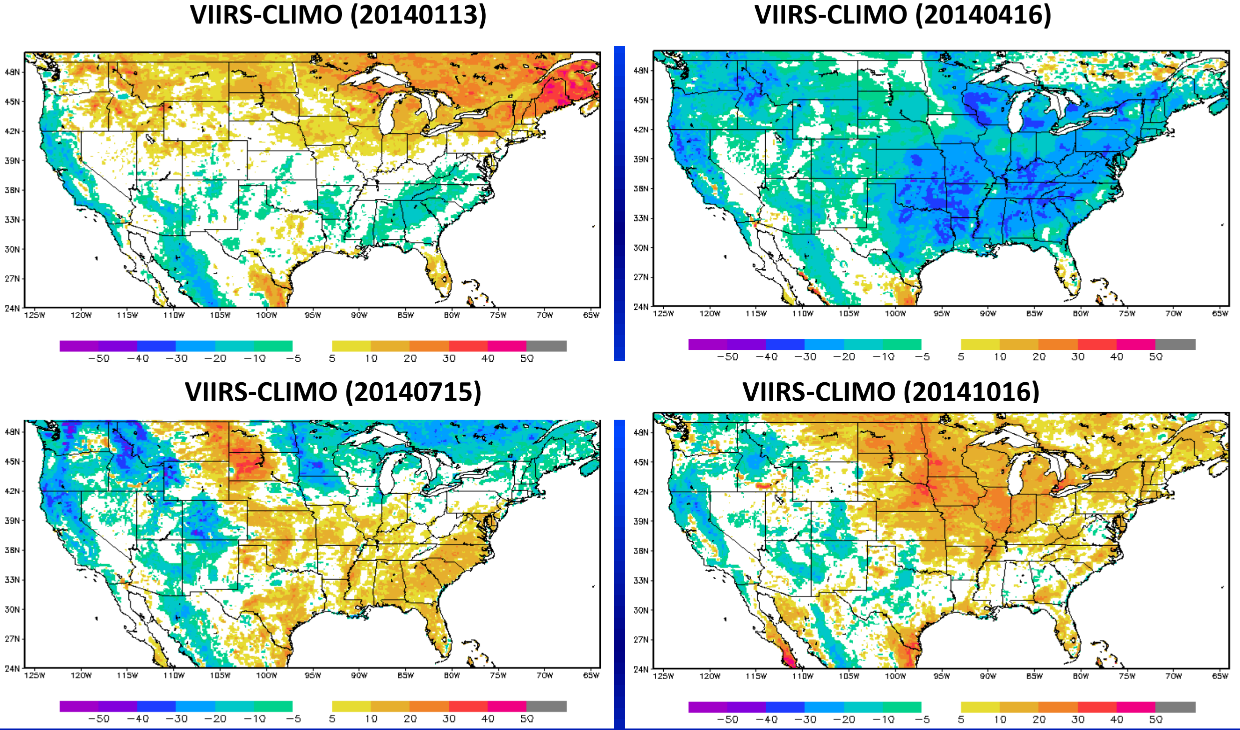


Near Realtime VIIRS GVF *vs.* AVHRR GVF Climatology

Annual Cycles of GVF over CONUS



GVF differences over CONUS in 2014 (VIIRS-AVHRR CLIMO)



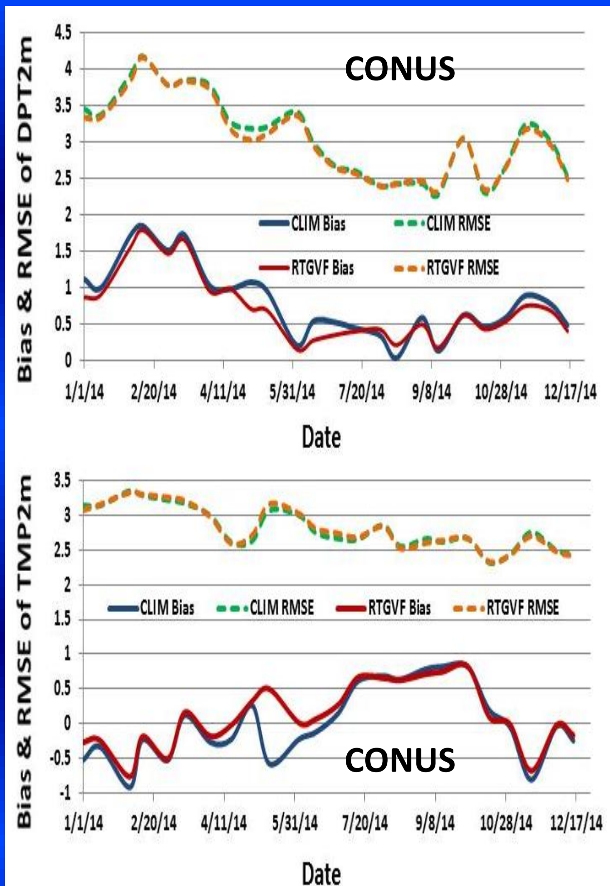
- Climatology GVF green up earlier
- Climatology GVF is higher most of a year

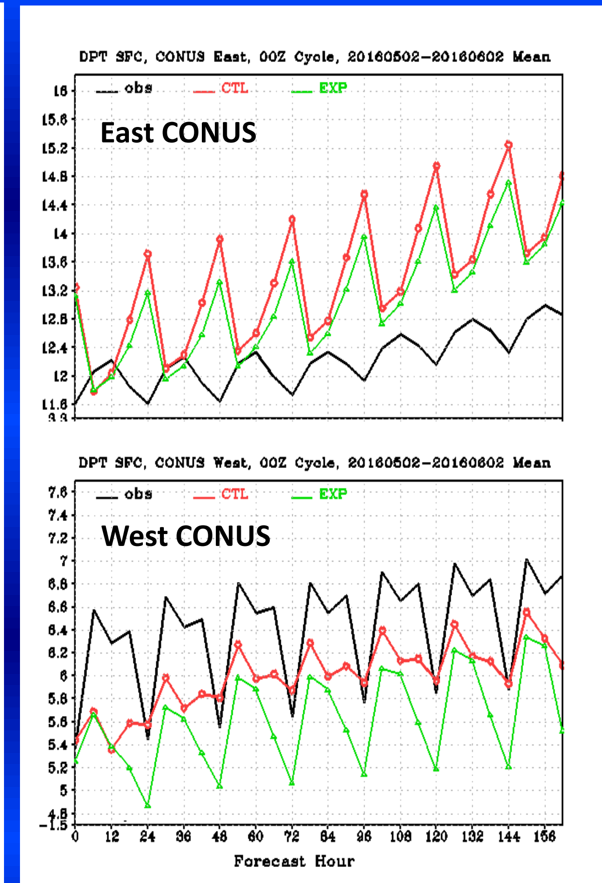
- VIIRS GVF is higher at high latitude in January
- VIIRS GVF is much lower over the entire USCONUS in April
- VIIRS GVF is higher in southeast US in July
- VIIRS GVF is higher over the eastern US in October

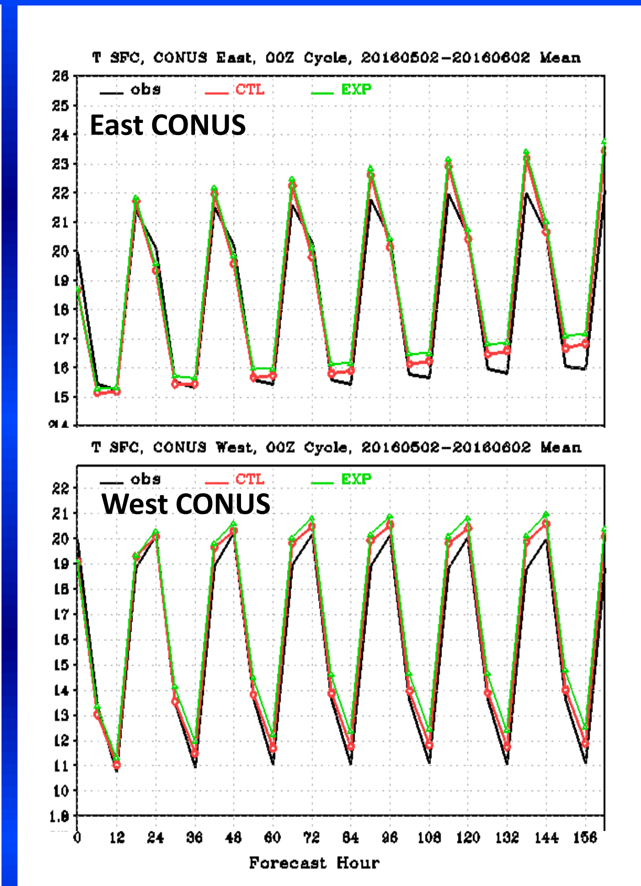
Tests of the Near-Real Time GVF in NAM and GFS

GVF Tests in NMA 2014

GVF Tests in GFS 5/02-6/02, 2016







Reduce the bias of DPT2m and T2m in 2014

East CONUS:
Reduce wet bias and RMSE.
West CONUS:
Increase dry bias and RMSE.

Increase warm bias and RMSE

Summary

- Real time, high spatial resolution, consistent remote sensing products can improve NWP.
- Consistency between all products, e.g. a “burned area product” also reflected in green vegetation fraction (GVF), albedo, emissivity, surface temperature, soil moisture, etc.
- Consistent use between NCEP global and regional models (global and regional FV3GFS).
- Future: account for lakes, wetlands, water bodies.
- Land data assimilation in LSM & UNLDAS will use NASA Land Information System (LIS), i.e. snow, soil moisture, GVF (Noah-MP with dynamic/growing vegetation).
- Several satellite data sets developed recently (e.g., GVF, snow, albedo, LST,) have been tested in the NCEP models. We will continue our efforts, and work together with several research teams including NESDIS to improve satellite data quality, utilization and data assimilation, and then improve NCEP NWP.

Thank you very much!