Science, Technology, and Data Applications for Disaster Operations

2020 JPSS/GOES Proving Ground / Risk Reduction (PGRR) Summit

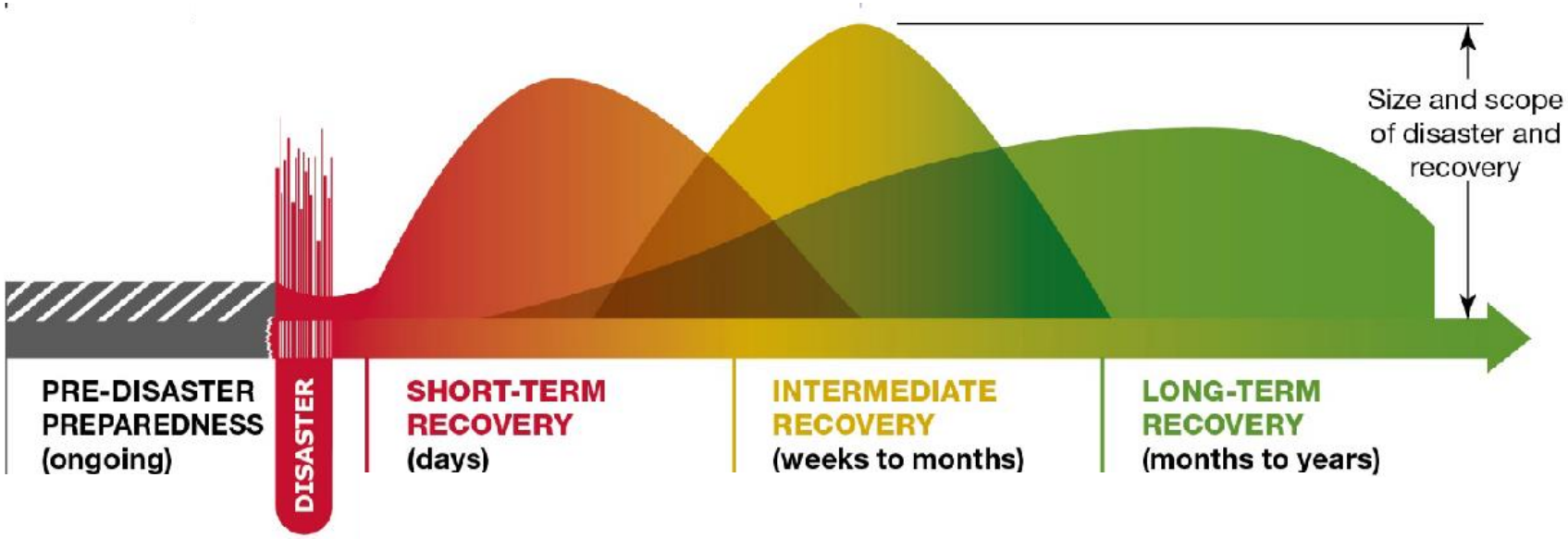
February 27, 2020

Adam Barker, PhD

Geospatial Analyst

Response Geospatial Office

Geospatial Analysis Informs Decisions throughout the Disaster Lifecycle



Geospatial analysis is typically delivered within days. Conventional approaches (e.g., site inspections) may take months

- Expedited rental assistance
- Help determine where to deploy Survivor Assistance teams
- Help determine where to locate Disaster Recovery Centers
- Help to allocate shelter and resource needs
- Prioritize and expedite debris removal
- May assist in the Presidential declaration process
- Force allocations and right-sizing

FEMA

HAZARD

- Flood
- Tornado
- Hurricane
- Earthquake
- Man-made

DATA

ANALYSIS

MODELING

- Impact Assessment
- Scripts

REMOTE SENSING

- UAS
- Satellites
- Planes

CROWD SOURCING

- Real-Time Situational Awareness

DISSEMINATION

- Dashboards
- Reports/ Infographics
- Mobile

GOAL

Provide Better Support for the Disaster Survivor

- Reduce Complexity
- Save Time
- Enhance Situational Awareness

STEADY STATE → ACTIVATION

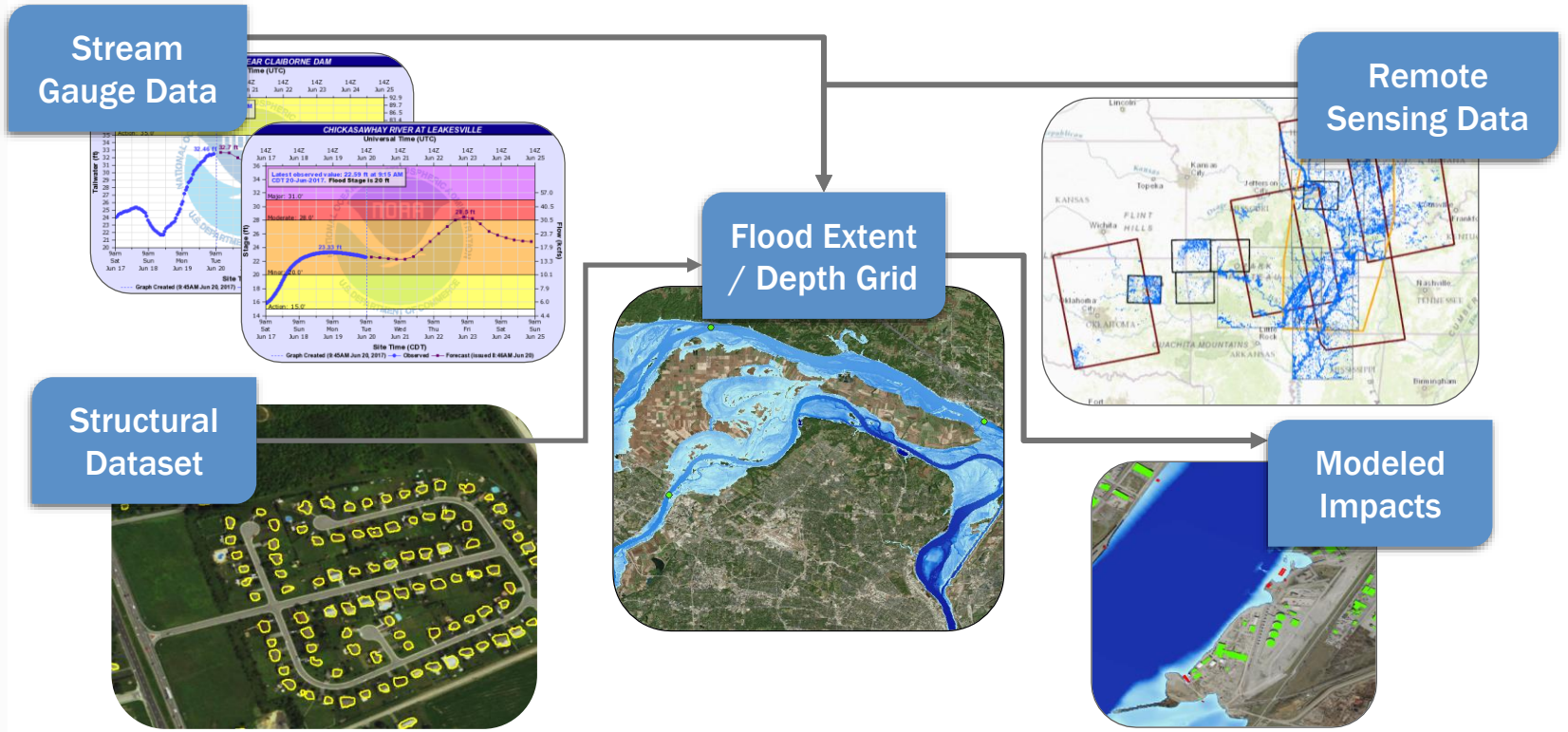
- Geo Coord Calls
- Interagency Participation
- Data Sharing

NEED:

- **PROGRAM REQUIREMENTS** (US&R, IA, PA)
- **SCHEMA STANDARDIZATION**
- **RISK TOLERANCE**

How do we identify damage?

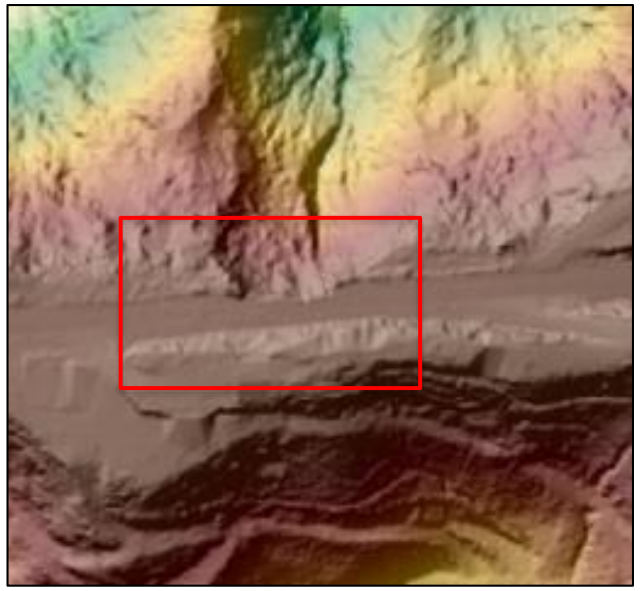
Modeling and imagery helps to determine level of damage



REMOTE SENSING | FOCUS AREAS

Debris Estimation

Transportation Impacts



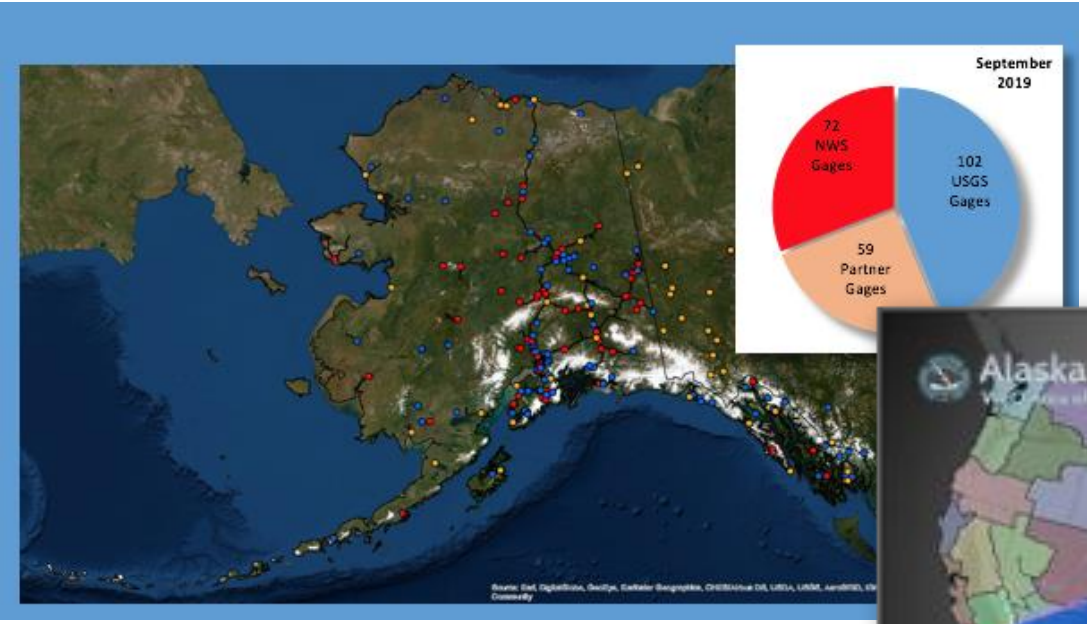
Damage Assessments

Proving Ground Summit

February 27, 2020

Eric Holloway - Emergency Services Branch, Alaska Region

What we have to work with...



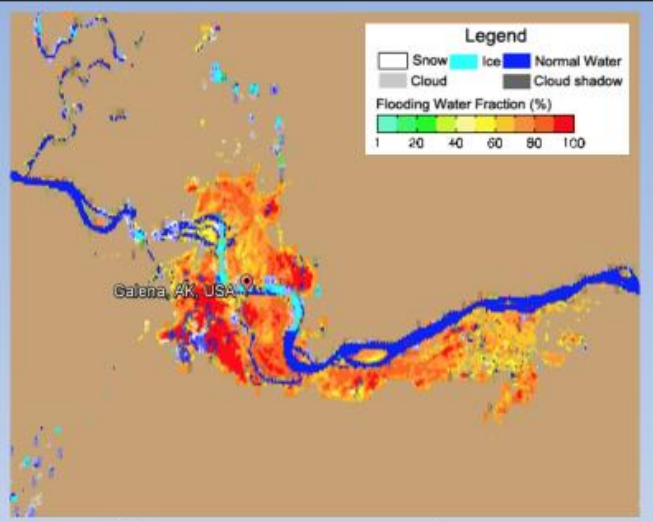
High Impacts from flooding in the state...

1. Ice jam floods
2. Fall sea storms and flooding
3. Building fires
4. Winter storms and flooding
5. Summer storms and flooding
6. Extreme cold/community utility freeze-ups
7. Wildfires
8. Generator/community power problems
9. Facility damage
10. All other, e.g., erosion, economic, Haz Mat, Windstorms, landslide/avalanches, earthquakes, volcanic eruptions, communication problems, etc.

Ice Jam flooding and Fall Sea storms account for a third of all declarations since 1978!

What we have engaged in...

May 29th 13:30 ADT VIIRS false-color image



May 29th 13:30 ADT – River Ice/Flood Detection

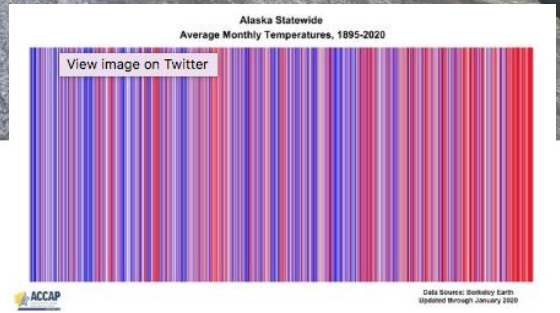
Ice Product...

ANCHORAGE DAILY NEWS

Alaska News | Alaska Life | Politics | Opinions | Sports | Talk to

Plowing push extends Kuskokwim River ice road to a whopping 355 miles

Author: Associated Press | Updated: 4 hours ago | Published 5 hours ago



ANCHORAGE DAILY NEWS

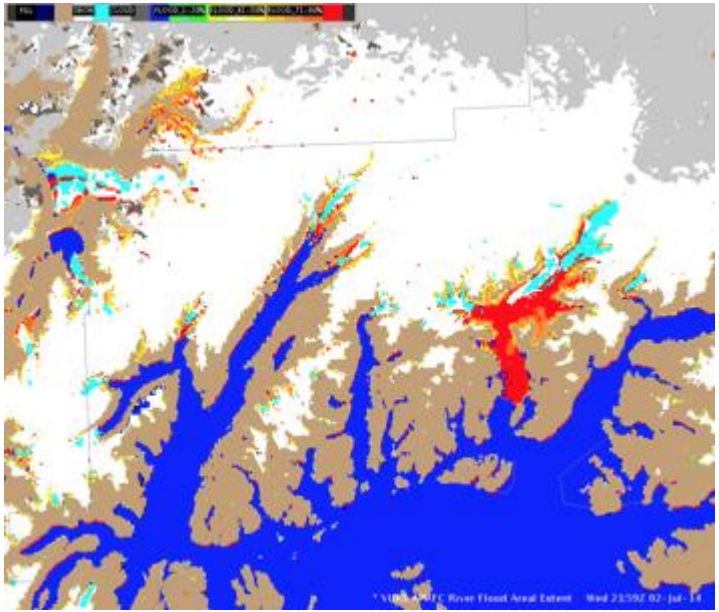
Alaska News | Alaska Life | Politics | Opinions | Sports | Talk to

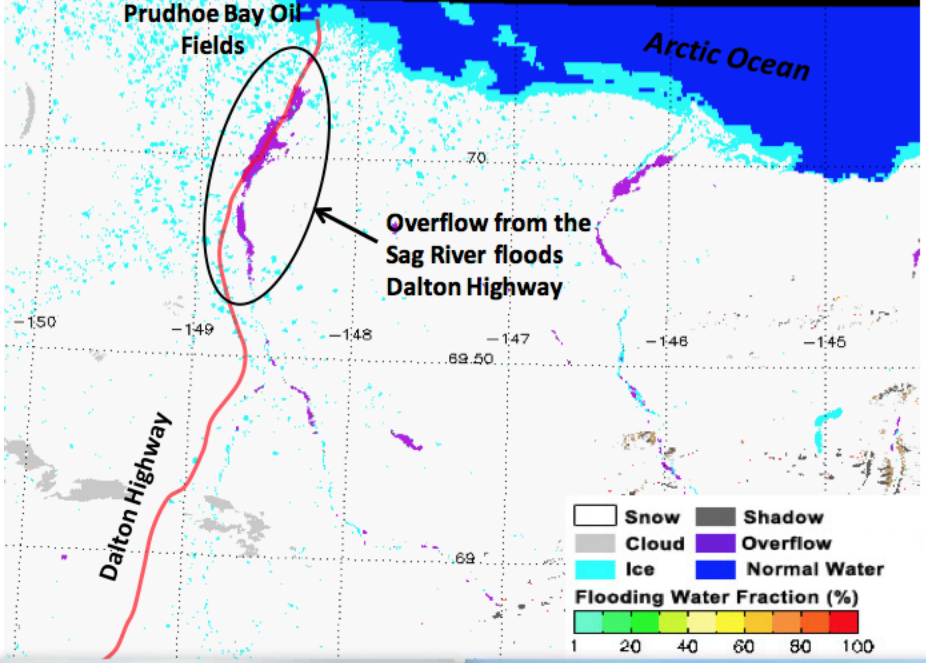
Rural Alaska

2 dead near Bethel when four-wheelers fall through river ice amid warnings to stay off

Author: Zaz Hollander | Updated: April 3, 2019 | Published April 1, 2019

Flood Product...





National Water Center Integrating Model and Remote Sensing Data for a Complete Hydrology

National Water Center

February 26, 2020

Shawn Carter
shawn.carter@noaa.gov

Stakeholder Priorities

NWC National Water Center

Flooding

Drought

Water Availability

Water Quality

Climate Change

Need integrated understanding of near- and long-term outlook and risks

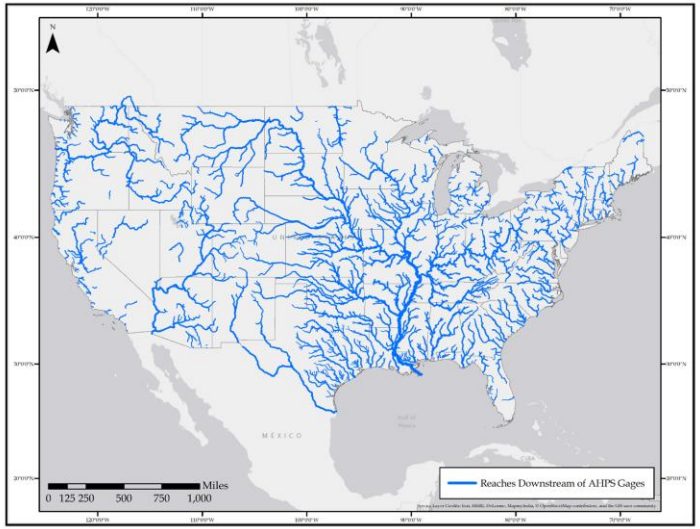
- Provide consistent, high resolution (“neighborhood-level”) analyses, predictions and data to address critical unmet information and service gaps
- Transform information into actionable intelligence by linking hydrologic, infrastructural, economic, demographic, environmental, and political data

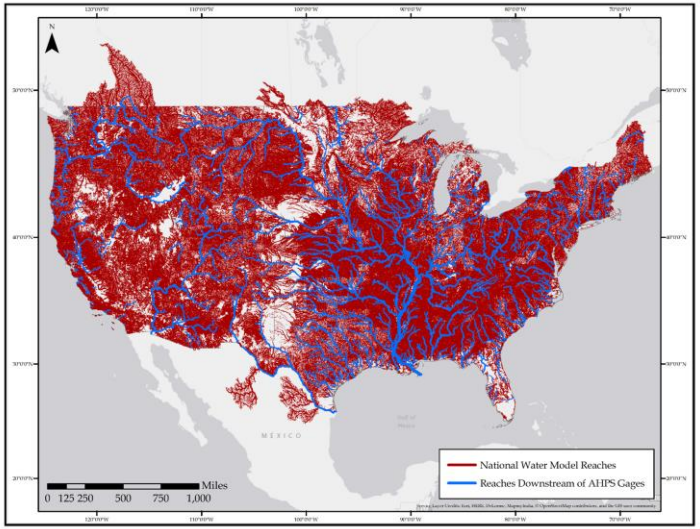
National Water Model

NWC National Water Center

V2.0 Implemented June 19, 2019

- **Continental-scale water resources model providing high resolution, spatially continuous estimates of major water cycle components**
- **Operational forecast streamflow guidance for currently underserved locations: ~110,000 River miles to nearly 5,000,000 River miles**





NWC Services

Routine services include, but are not limited to:

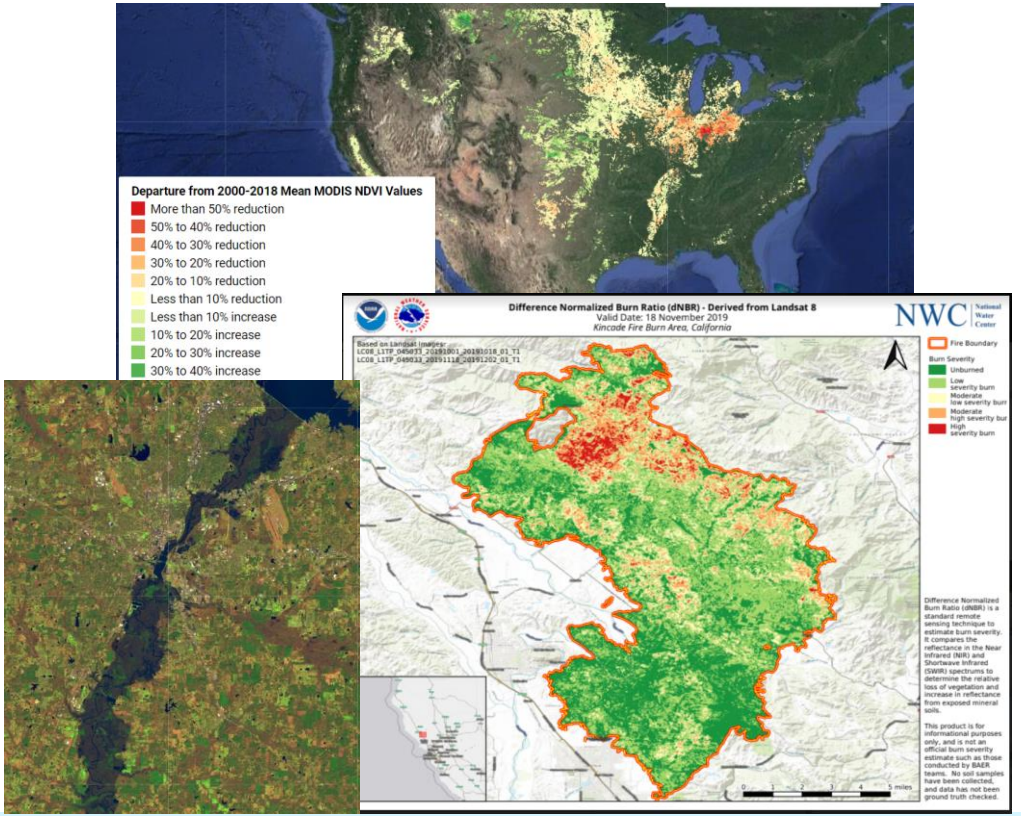
- Holistic monitoring of observations of current and forecast conditions, to assess potential flash and riverine flood
- Interpretation of hydrologic model-based guidance for parameters including streamflow and streamflow anomaly
- Generation of hydrologic model-based guidance for parameters including time to bankfull conditions and other high/low flow criteria
- Continental snow analysis and data assimilation
- Analysis of snowpack and water supply conditions
- Evaluation of forecast hydrologic models and model guidance and their derivatives
- Remote sensing analysis of snow and soil moisture state conditions
- Flood Inundation Mapping (FIM)

Episodic services include, but are not limited to:

- Flood Inundation Mapping (FIM)
- Dam/Levee Failure Analysis
- Remote sensing analysis
- Event-specific briefings

Remote Sensing of Hydrology

- Flood
- Fire
- Snow/Ice
- Soil Conditions
- Vegetation



Challenges

- VIIRS / ABI Flood/Ice
  - Cloud Cover
  - Daylight
  - Spatial Scale

Is Flood/Ice on AWIPS?

Mitigating Challenges

Supplement with high spatial resolution earth observing satellites

Incorporate SAR

Future Wants/Needs

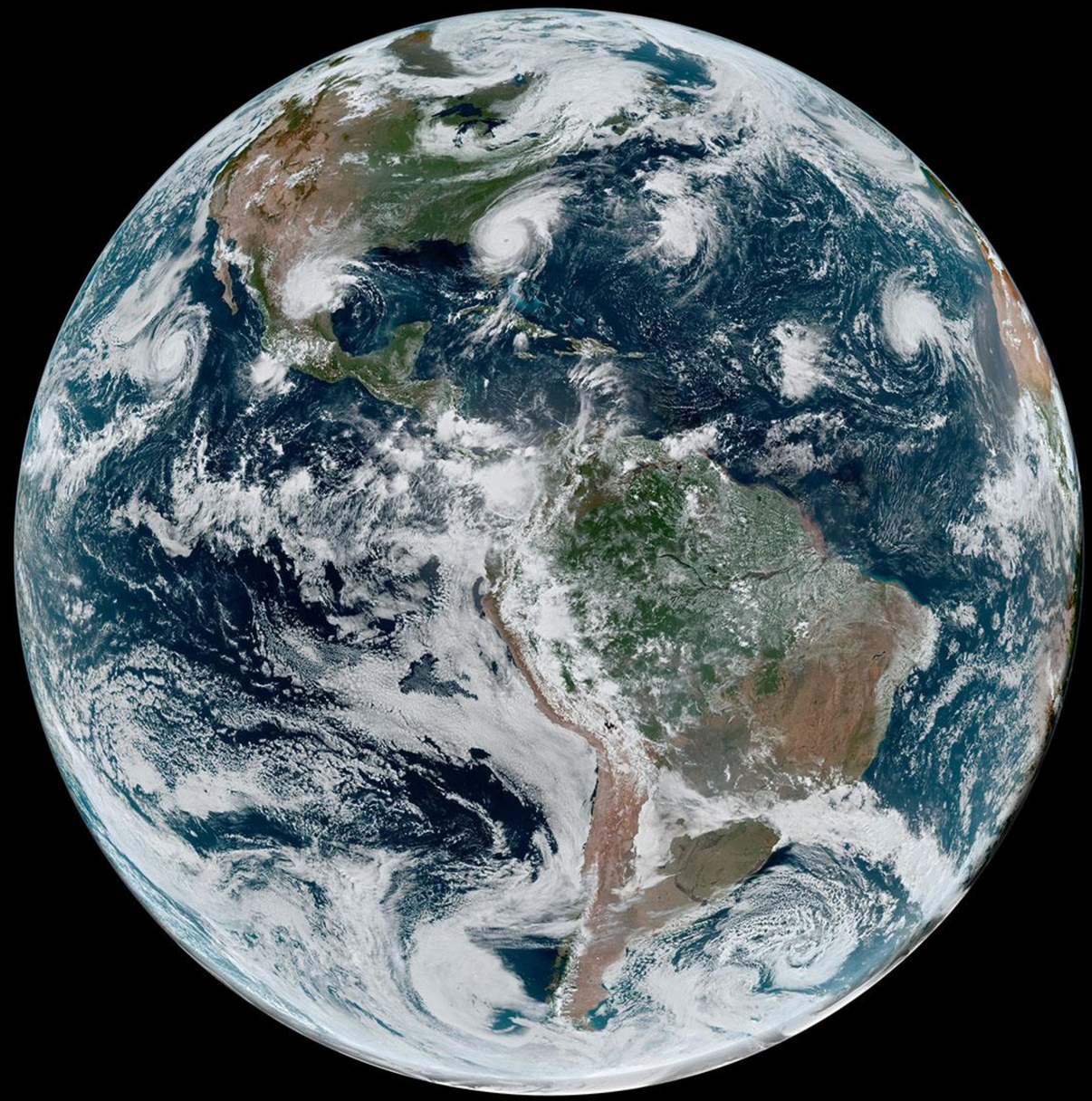
Downscale water fraction pixels to 10-30m

NWC could mitigate the processing requirement by maintaining downscale windows on specific areas for specific events (like GOES meso-floaters).

GROUP ON EARTH OBSERVATIONS

AmeriGEO
Earth Observations for the Americas

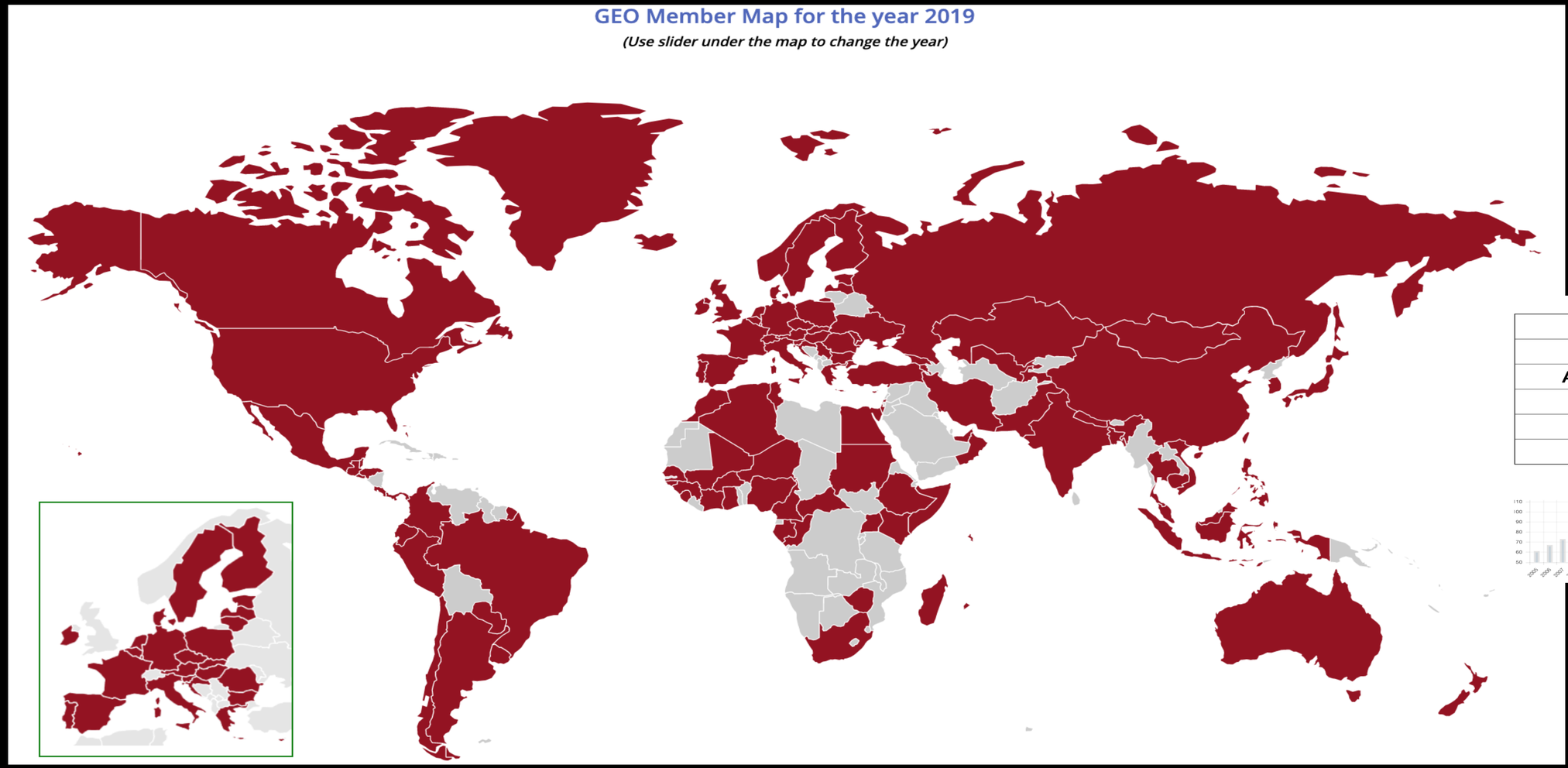
JPSS/GOES-R PG/RR Summit



Angélica Gutiérrez
On behalf of
- the Regional GEO – AmeriGEO
  Amerigeoss.org
- GEO-Global Water Sustainability (GEOGloWS)

Advancing the use of Earth Observations in the Americas

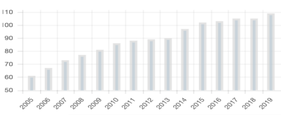
Group on Earth Observations



Number of Members (2019)

Africa:	28
Americas:	18
Asia/Oceania:	22
C.I.S.:	6
Europe:	35
Total:	109

Number of Members by year



What is AmeriGEO

Conceived in October 2014, launched in November 2015

Is a cooperative effort of the 16 GEO member countries in the Americas that:

Reflects ***local, national, and regional interests*** of the ***GEO country-members*** for short and long-term planning, development, and implementation aligned with GEO activities.

Is ***entrenched in the institutional and technical capabilities of its country members*** and in the resources of other global initiatives available for the benefit of the region.

Seeks to increase institutional and personal capacity and engage experts, stakeholders, and decision makers ***in the process of decision making.***

18 Member Countries
Observers: Bolivia, Nicaragua

What topics does GEO work on?

- Community
  - Decision Makers (National, State, and Local governments)
  - Academia, NGOs, Commercial
- Activities
  - Thematic (Flagships and Initiatives)
  - Foundational Activities (GNC-A, others).

GEO In Action:
Revolutionizing Our Understanding of Stream Flow on Every River in the World

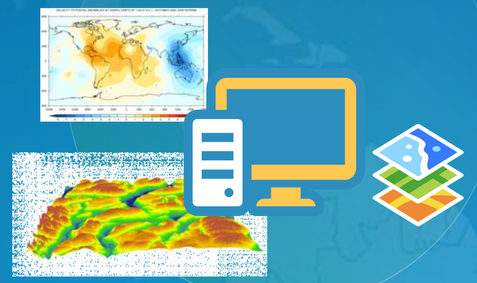
GEO Water Activities addressing streamflow and flood risks and forecasting:

Global Flood Awareness System (GloFAS) (JRC EU)
Global Water Sustainability (GEOGloWS) (NOAA – CNES)
Global Flood Risk Monitoring Community (NASA)

Global Streamflow Services – A Paradigm Shift

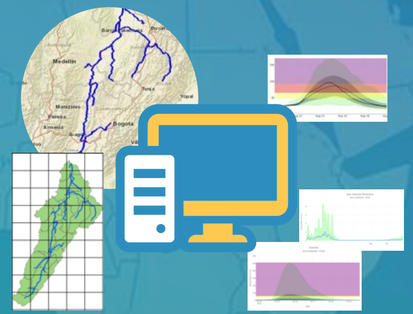
PAST – Individual Hydrologic Forecasting

DEM, Land Use, Meteorology



Global Data

Hydrologic Modeling



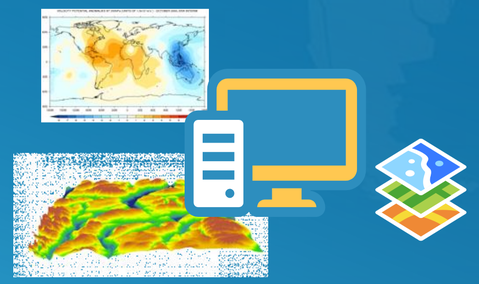
HydroMet Services

Local Governments

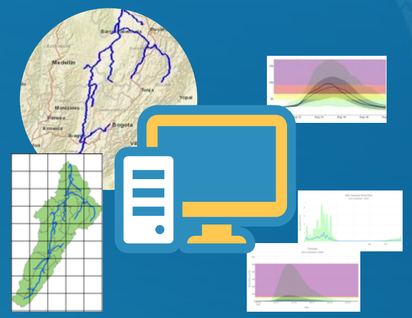
NGO’s and GEO Partners

NOW – Global Hydrologic Forecasting

DEM, Land Use, Meteorology



Hydrologic Modeling



Global Services

HydroMet Services

Local Governments

NGO’s and GEO Partners

GEOGLOWS

GLOBAL WATER SUSTAINABILITY

Scaling it up: a global service for local actions through high density forecasts for every river of the world

- Scaling tools to global service
- Migration of algorithms to ECMWF cyber infrastructure
- System to be implemented as quasi-operational service by mid 2020

Partnership Global Streamflow Forecast

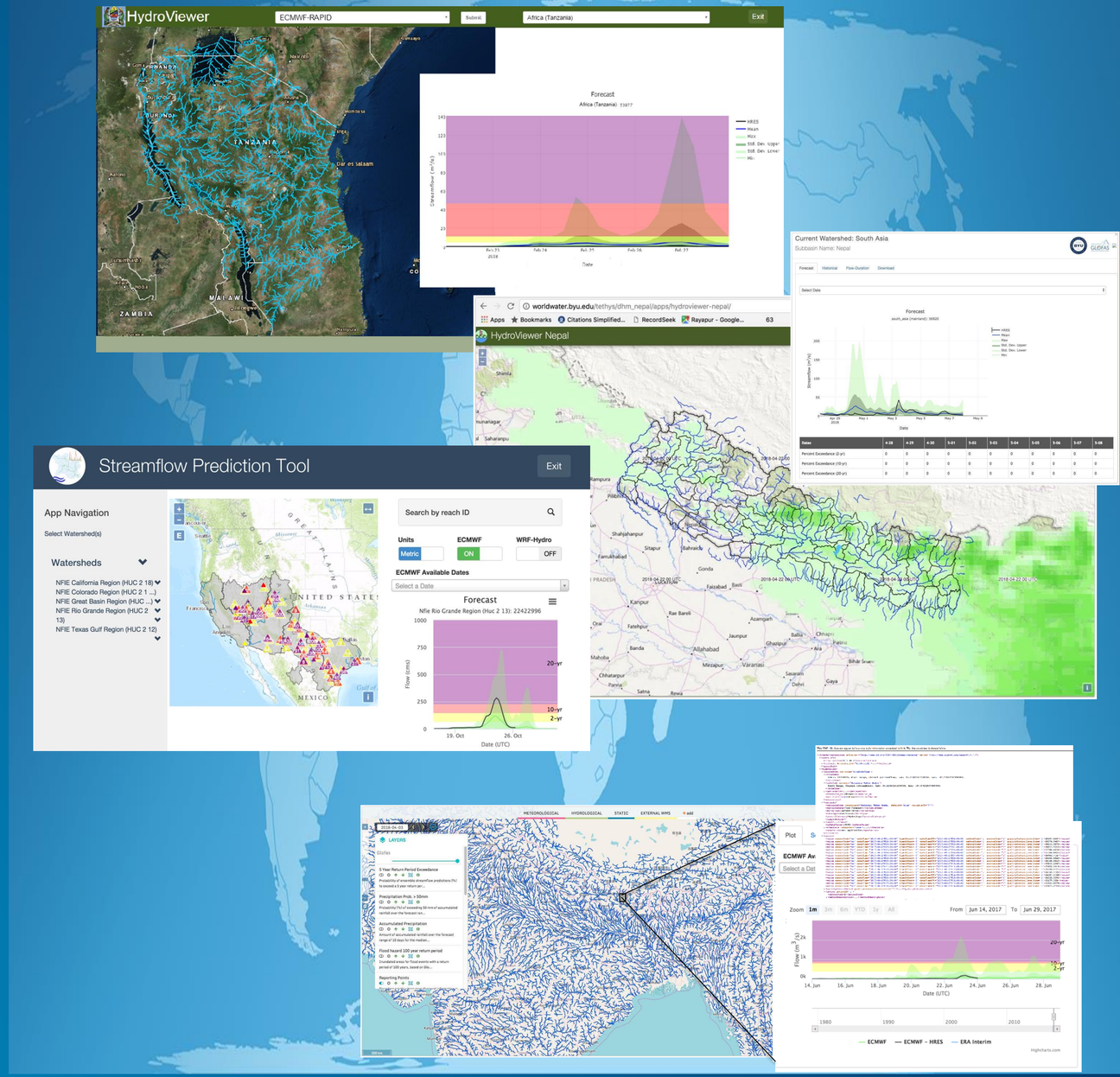
GEOGLOWS
GLOBAL WATER SUSTAINABILITY

Actionable information

Pilots and Implementation across the world: USA, Peru, Colombia, Dominican Republic, Brazil, SICA (8 countries in Central América); Ethiopia, Ivory Coast, Somalia, Tanzania; Bangladesh, Nepal, Kazakhstan, Uzbekistan, Kyrgyz Republic, Tajikistan, and Turkmenistan and Afghanistan.

- Driven by ECMWF ensemble forecasts
- Demonstrated in first pilot in US (2015)
- Many national-scale applications
- Data served through API access
- Custom view using webservices

NO FLOOD VISUALIZATION



NOAA’s Flood Mapping Service from Operational Polar and Geostationary Orbiting Satellites

https://iac2019-iaf.ipostersessions.com/Default.aspx?s=EC-84-59-56-43-27-07-34-1B-5D-81-4F-81-FB-D4-61

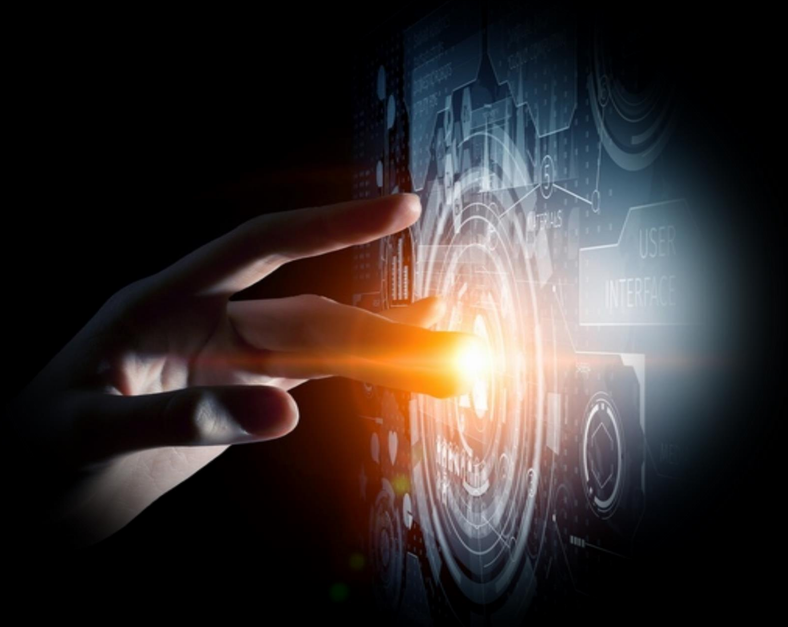
River Ice and Flooding Initiative PRODUCTS:

- **VIIRS Real time flood maps** http://realearth.ssec.wisc.edu/?products=RIVER-FLDglobal
- **VIIRA Daily Composites** https://realearth.ssec.wisc.edu/?products=RIVER-FLDglobal-composite1
- **VIIRA 5-Day Composites** http://realearth.ssec.wisc.edu/?products=RIVER-FLDglobal-composite
- **ABI Daily Composites** http://realearth.ssec.wisc.edu/?products=River-Flood-ABI
- **AHI Daily Composites** http://realearth.ssec.wisc.edu/?products=RIVER-FLD-AHI
- **Joint VIIRS/ABI** http://realearth.ssec.wisc.edu/?products=RIVER-FLD-joint-ABI
- **Joint VIIRS/AHI** http://realearth.ssec.wisc.edu/?products=RIVER-FLD-joint-AHI

The products can also be browse through REALEARTH APP for android and Apple

A Paradigm Shift is needed to harness the potential of space science and technology in the decision making process

- Investment to develop actionable tools and services
- Through pilot projects, demonstrate the ability to integrate JPSS/GOES-R PG/RR data with social, economic, environmental data to improve understanding and decision-making
- Data integration (Remote sensing and In-situ data, for Social, Economic, Health and Environmental issues)



- Higher resolution
- More frequent observations to get the accurate time accumulation and lower latency.

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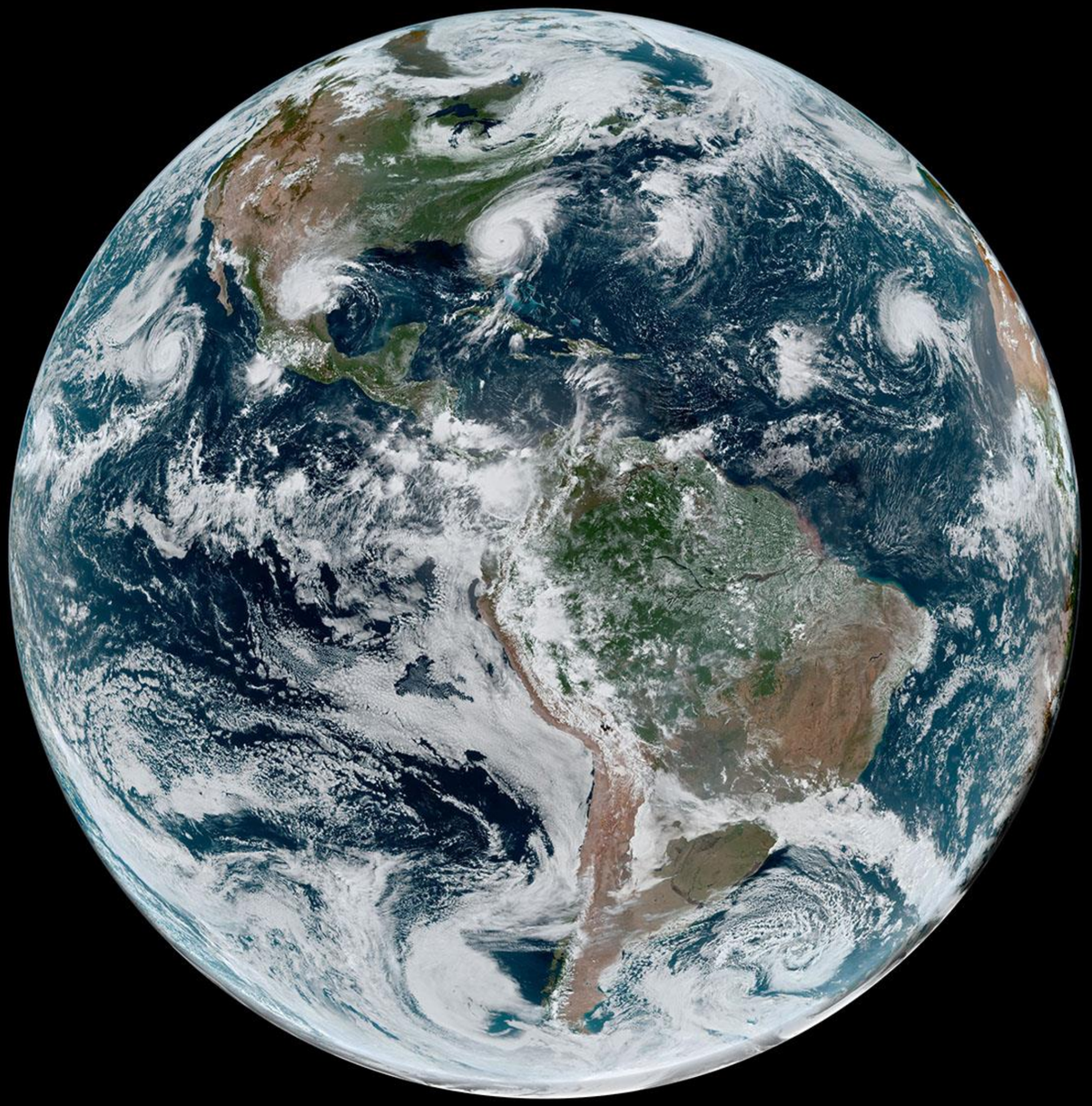

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Advancing the use of Earth Observations in the Americas




An Overview of the current GEO-LEO Flood Products and Future Development

Sanmei Li Donglian Sun
George Mason University, USA
Jay Hoffman William Straka
Space Science and Engineering Center, USA

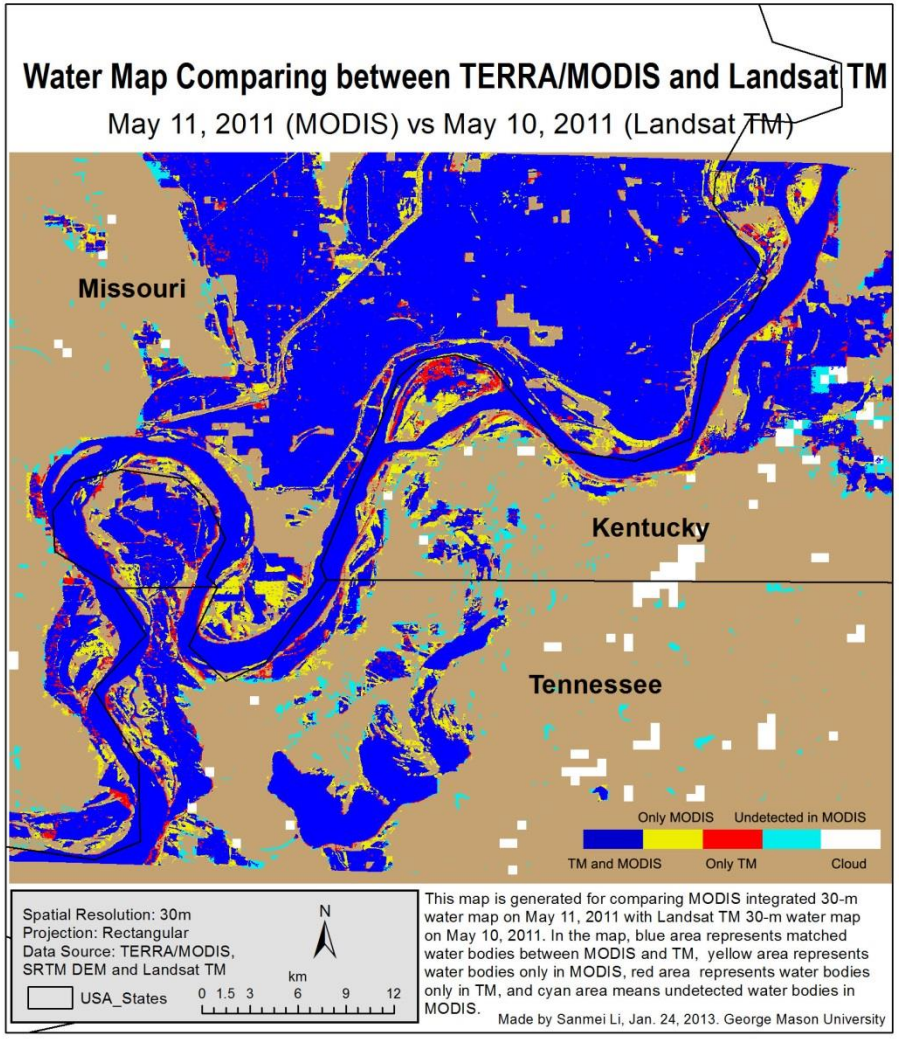
Feb. 27, 2020 College Park, MD

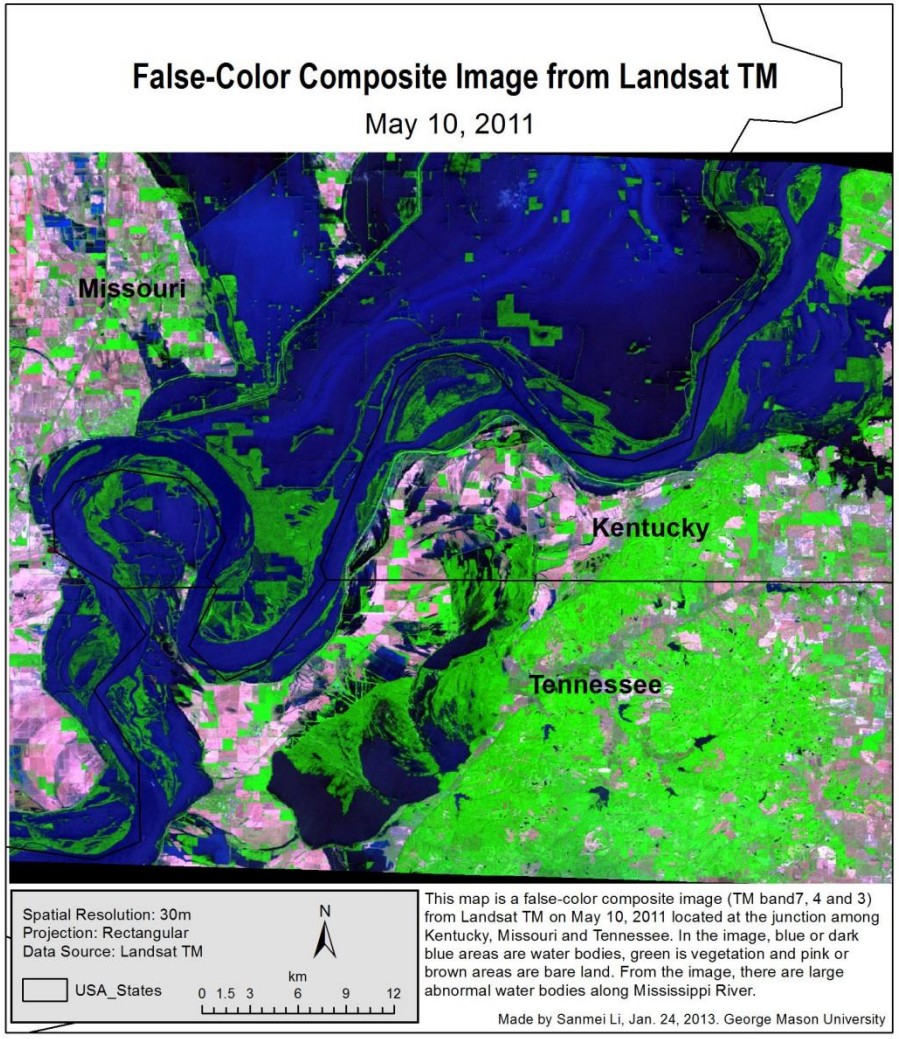
POWERED BY GINA www.gina.alaska.edu

Outline

- Background
- The current VIIRS/ABI/AHI flood products
- User support
- Focus on the development in the next period
- Future plan

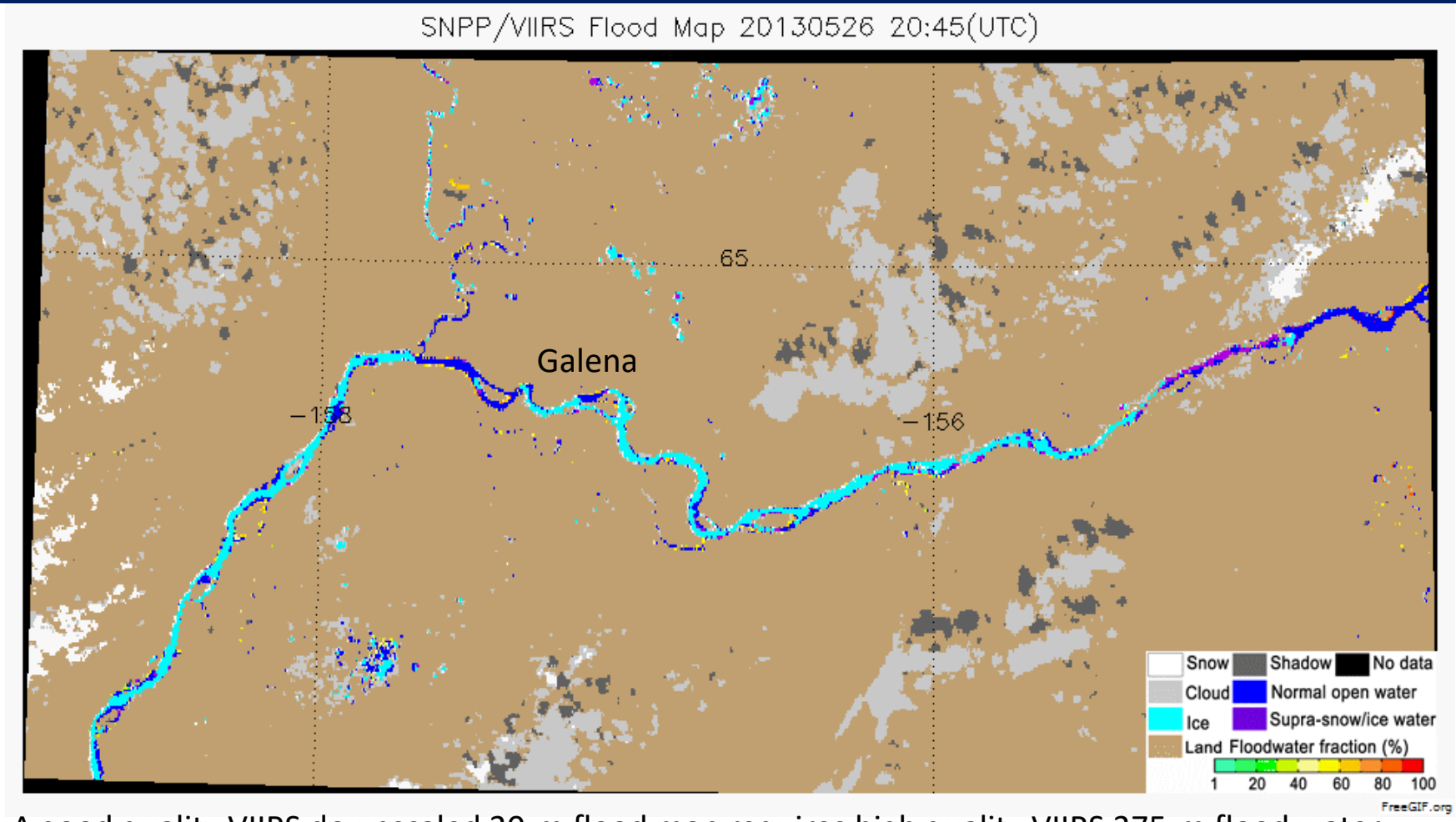
Background – Develop the downscaled flood maps





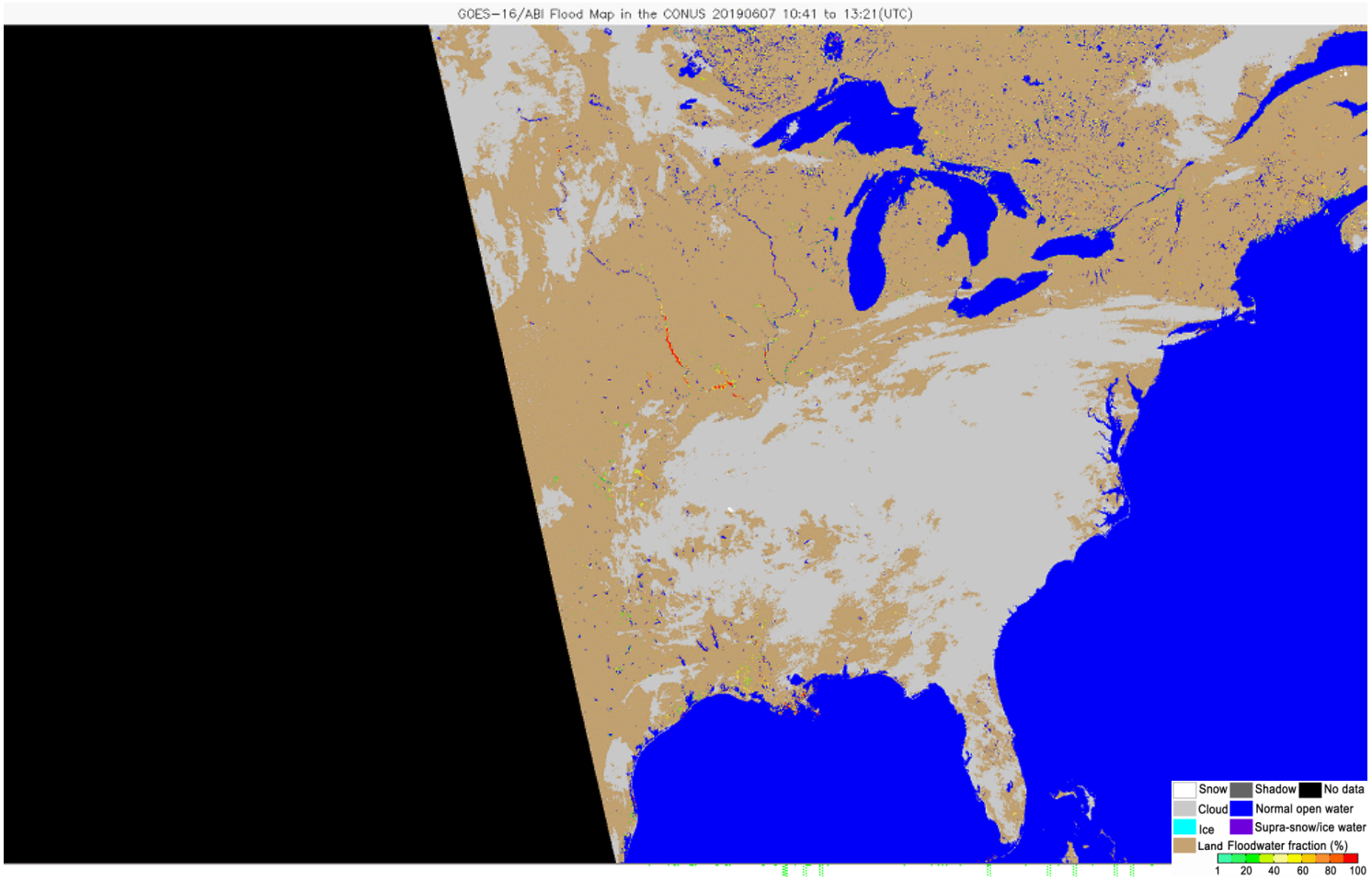
- In 2012, we generated a 30-m flood map by using a MODIS 500-m water fraction map and the SRTM/DEM data. The result was highly consistent to the Landsat TM result, which kicked off the development of the VIIRS downscaling model under the support from JPSS Program.

Background –Development of the VIIRS 375-m Flood Product



- A good quality VIIRS downscaled 30-m flood map requires high quality VIIRS 375-m flood water fraction product.
- The 2013's Galena ice-jam flood kicked off the development of VIIRS 375-m flood water fraction product under the JPSS's river ice and flooding initiative.
- At least five years' hard work, which somehow delays the development of the downscaling model…….

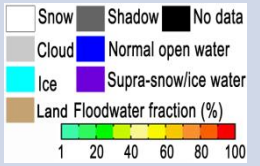
Development of the ABI/AHI and Joint VIIRS/ABI/AHI Flood Products



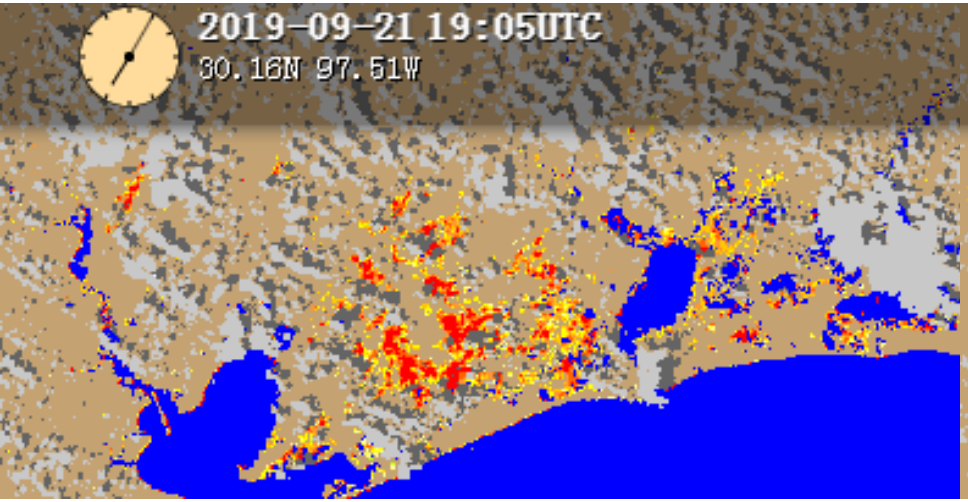
- During the development of VIIRS flood products, we realize the VIIRS imagery can be easily affected by clouds and cloud shadows.
- In 2017, with the support from GOES-R Program, we started integrating the ABI imagery in the flood mapping software to generate the ABI flood product.
- In 2019, Himawari-8/AHI flood product and the joint VIIRS/ABI/AHI flood product were also developed.

Lists of the current VIIRS/ABI/AHI Flood Products

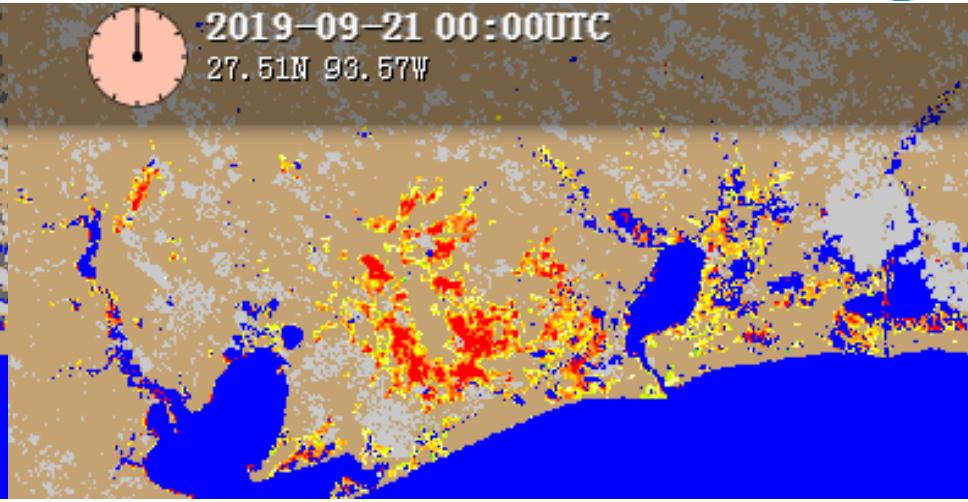
Products	Spatial resolution	Availability	Coverage	Production latency	Description
Suomi-NPP &NOAA-20/VIIRS near real-time flood product	375m	2-3 daytime passes for each satellite	Global land between 80° S and 80° N	Available 3 hours after pass	Daytime-only flood extent in water fractions (open water percentage in a satellite pixel)
Suomi-NPP &NOAA-20/VIIRS daily composited flood product	375m	Once per day	Global land between 60° S and 75° N	Available at 06Z	
Suomi-NPP &NOAA-20/VIIRS 5-day composited flood product	375m	Once per day	Global land between 60° S and 75° N	Available at 06Z	
GOES-16&17/ABI flood product	1-km	Every hour	Land in America (135° W ~ 17° W, 50.5° S ~ 50.5° N)	every hour	
Himawari-8&9/AHI flood product	1-km	Every hour	Land in East Asia and Oceania (90° E ~ 180° E, 47.5° S ~ 50.5° N)	every hour	
Joint VIIRS/ABI flood product	375m	Once per day	Land in America (135° W ~ 17° W, 50.5° S ~ 50.5° N)	Available at 00Z	
Joint VIIRS/AHI flood product	375m	Once per day	Land in East Asia and Oceania (90° E ~ 180° E, 47.5° S ~ 50.5° N)	Available at 12Z	



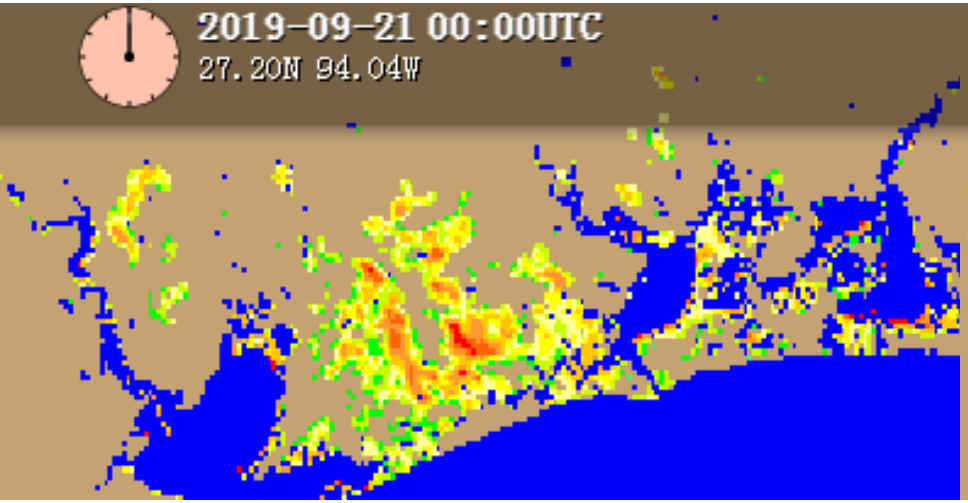
Application in flood detection



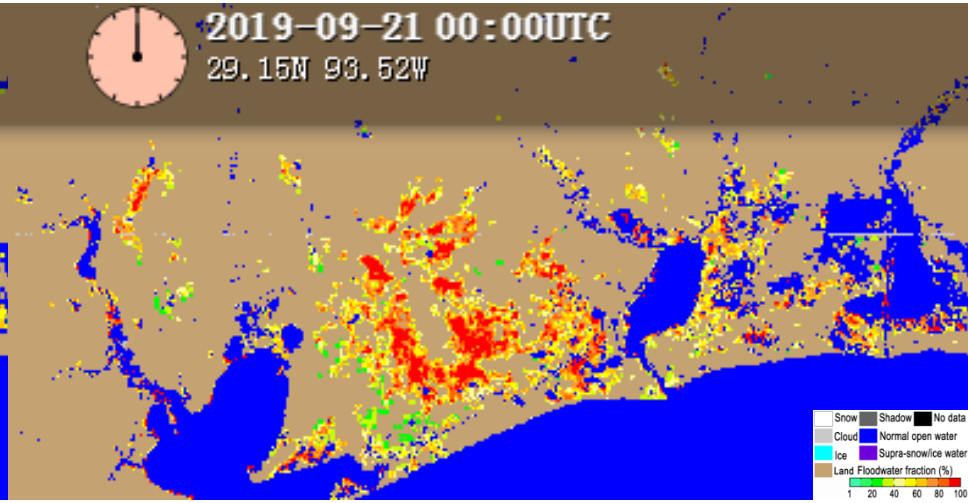
VIIRS near real-time: good time manner



VIIRS daily composites: less cloud and cloud shadows



ABI daily composites: maximal clear-sky coverage, good time manner, but coarse spatial resolution



Joint VIIRS/ABI: best results but more latency.

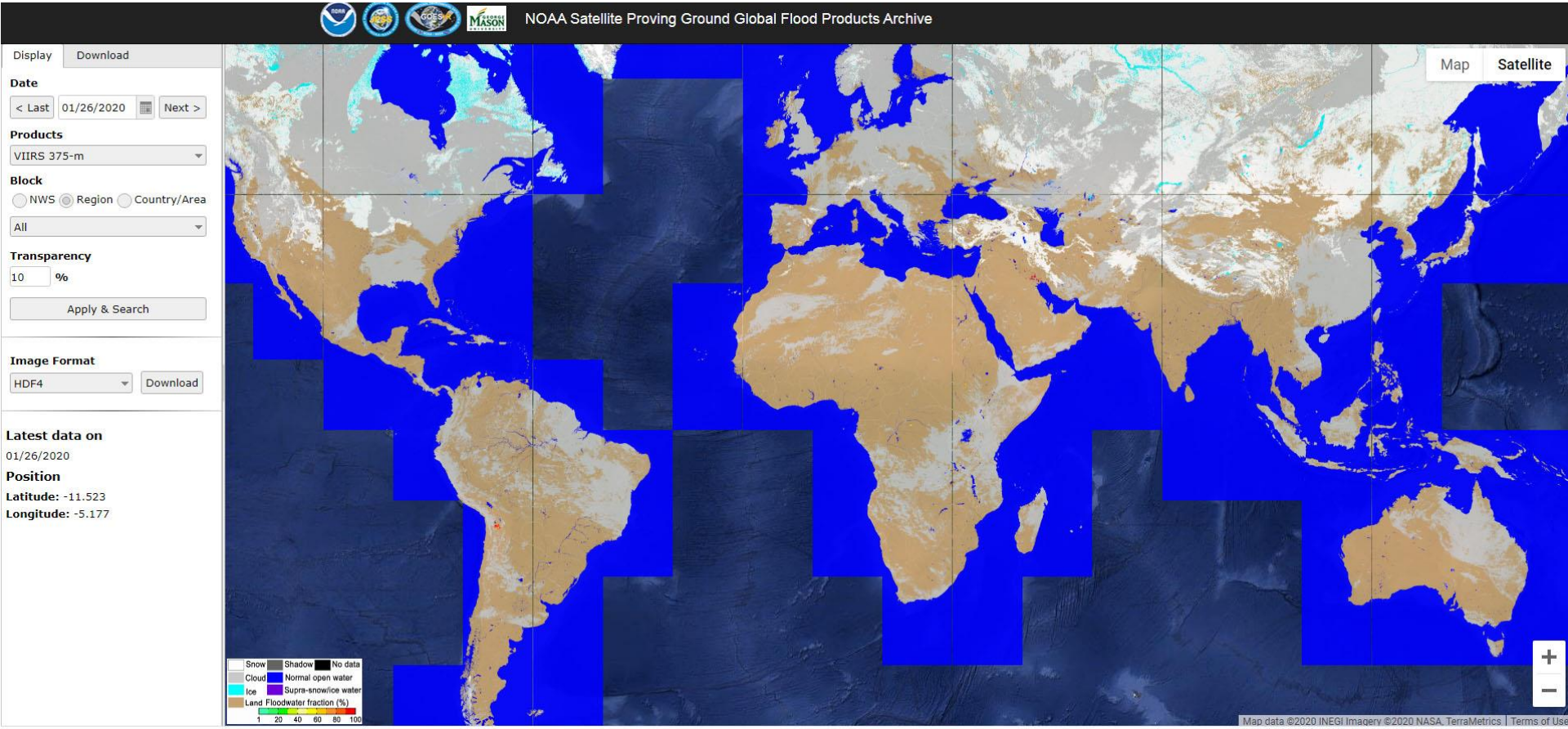
- Detecting floods using different flood products in the West Gulf region of USA indicates the different advantages of these products.

Accessability

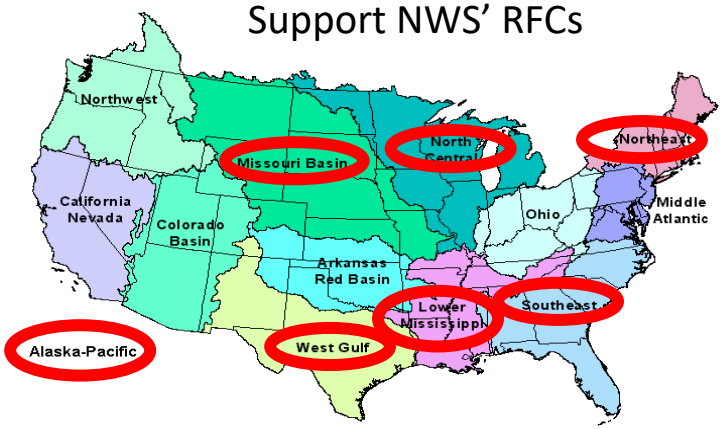
- SSEC RealEarth
  - ✓ Online visualization page : https://www.ssec.wisc.edu/flood-map-demo/flood-products/
  - ✓ Links to the single flood products:
    - VIIRS real-time flood maps: http://realearth.ssec.wisc.edu/?products=RIVER-FLDglobal
    - VIIRS daily composites: https://realearth.ssec.wisc.edu/?products=RIVER-FLDglobal-composite1
    - VIIRS 5-day composites: http://realearth.ssec.wisc.edu/?products=RIVER-FLDglobal-composite
    - ABI Daily composites: http://realearth.ssec.wisc.edu/?products=River-Flood-ABI
    - AHI Daily composites: http://realearth.ssec.wisc.edu/?products=RIVER-FLD-AHI
    - Joint VIIRS/ABI: http://realearth.ssec.wisc.edu/?products=RIVER-FLD-joint-ABI
    - Joint VIIRS/AHI: http://realearth.ssec.wisc.edu/?products=RIVER-FLD-joint-AHI
  - ✓ Also available on RealEarth App (available for Android and Apple)
- The latest 10-day global flood products are available in the ftp site: ftp://floodlight.ssec.wisc.edu

Archive and download system

- A global flood product archive and downloading system has also been developed for users to browse and download the flood products in hdf4, geotiff, png and shapfile formats.
- Website: https://jpssflood.gmu.edu



Support NWS' RFCs



Support FEMA

MDARNG

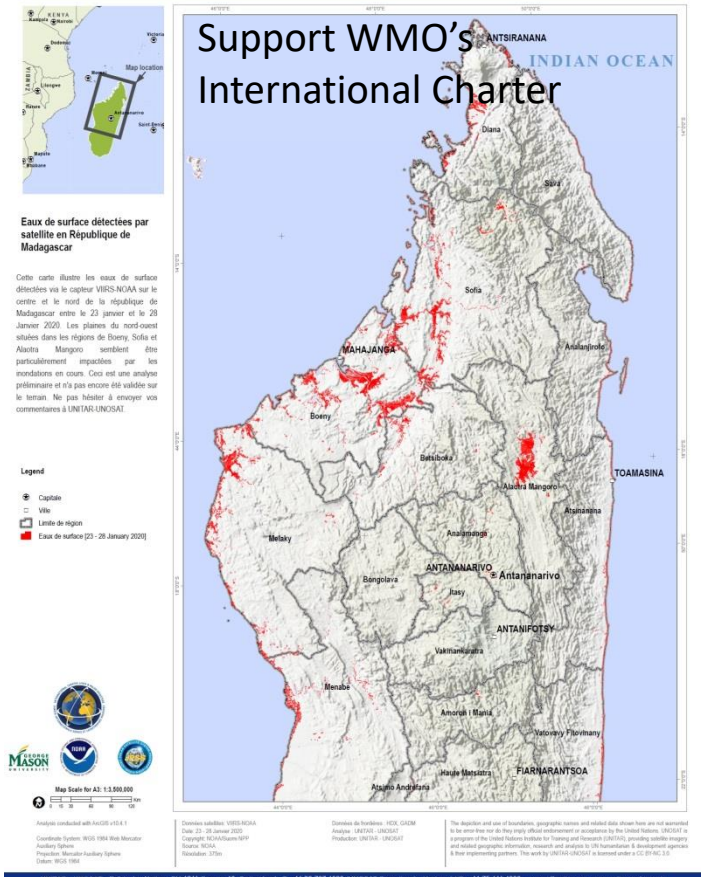
FEMA Collection Synchronization – Current Operational Period (02SEP)

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

Support WMO's International Charter



Support media

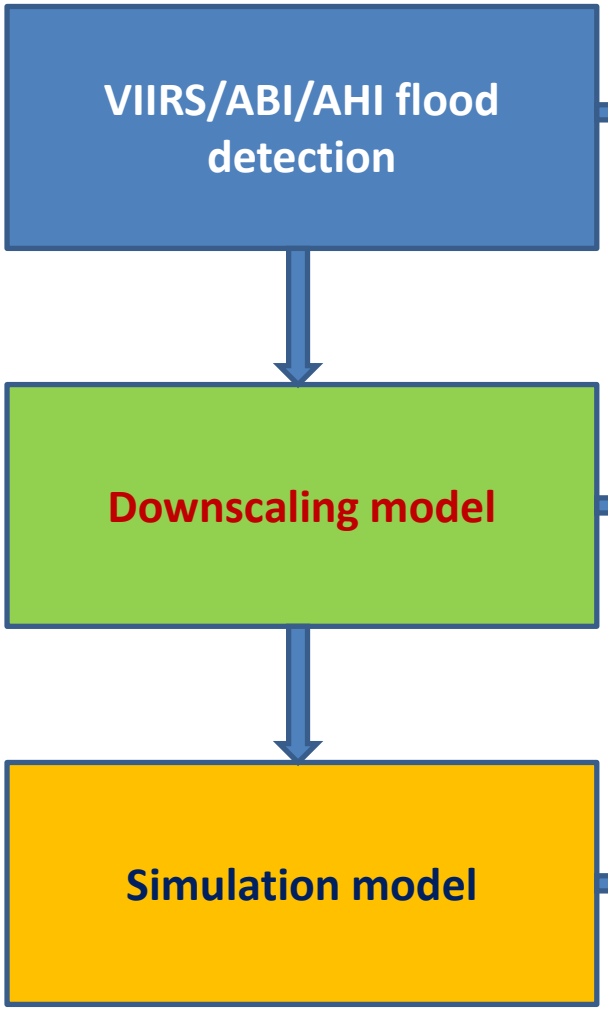
nytimes.com/interactive/2019/09/11/us/midwest-flooding.html

The New York Times

The Great Flood of 2019: A Complete Picture of a Slow-Motion Disaster

By Sarah Almukhtar, Blacki Migliozzi, John Schwartz and Josh Williams Sept. 11, 2019

Focus in the next period



- VIIRS/ABI/AHI flood water fraction products

For flood observation
(Almost done.)

- VIIRS 375-m and ABI 1-km flood water surface level
- VIIRS/ABI 30-m flood extent
- VIIRS/ABI 30-m flood water depth

For flood observation
(What we have been working with since 2012.)

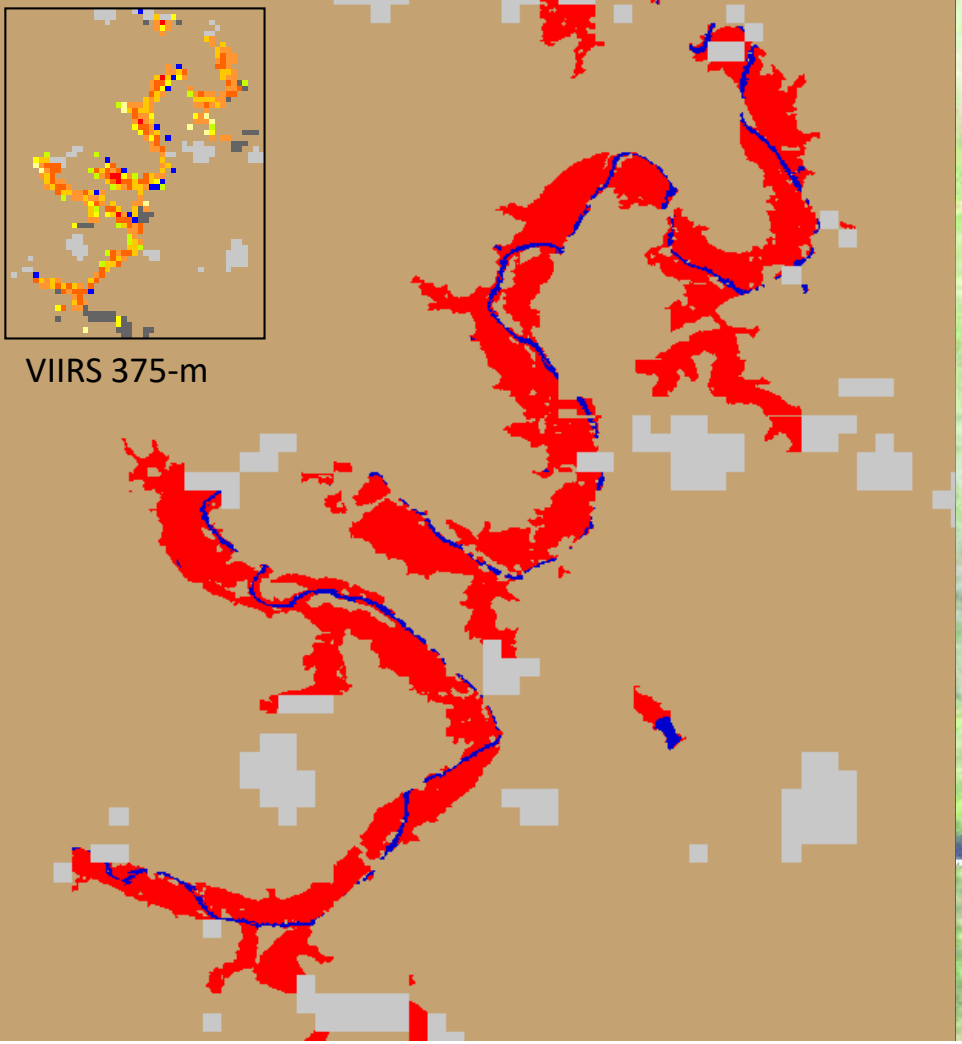
- VIIRS 30-m simulated flood extent

Forecast flood extent and re-build the entire inundation process
(What we plan to work with after the downscaling model becomes mature.)

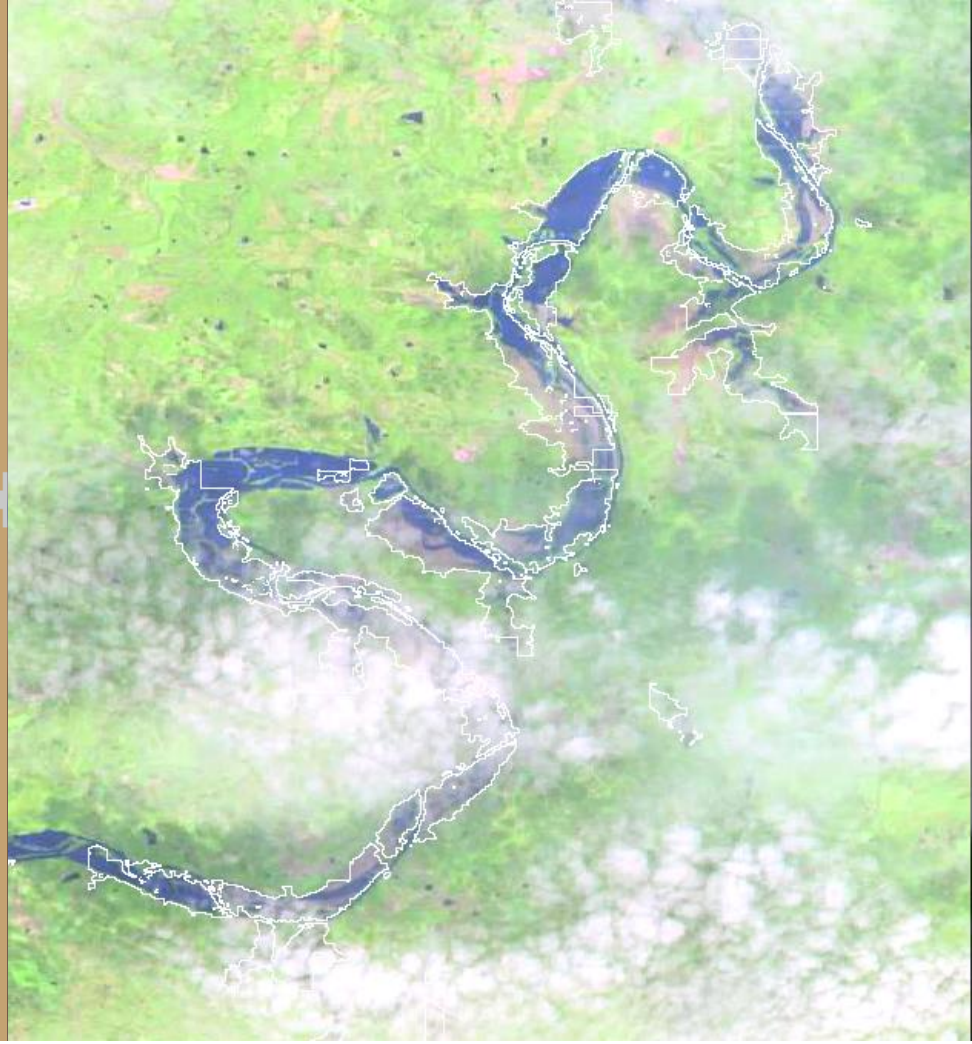
Downscaling model

- Develop the downscaling model to derive the 3-D flood maps from VIIRS/ABI flood water fraction products and 30-m SRTM/DEM :
  - ✓ 30-m flood extent product
  - ✓ 30-m flood water depth product
  - ✓ 375-m or 1-km flood water surface level product

	Spatial resolution	Swath width	Global coverage
VIIRS/ABI Imagery	375 m and 1-km	3000 km or full disk	every day
Downscaled VIIRS/ABI flood maps	30 m	3000 km or full disk	every day
Landsat-8 OLI imagery	30 m	189 km	16 days

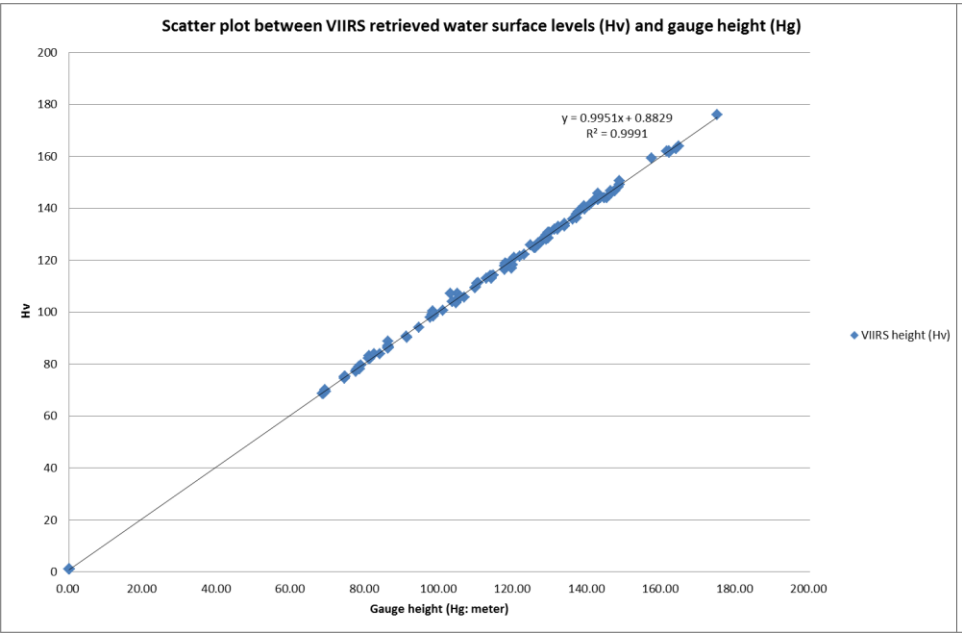


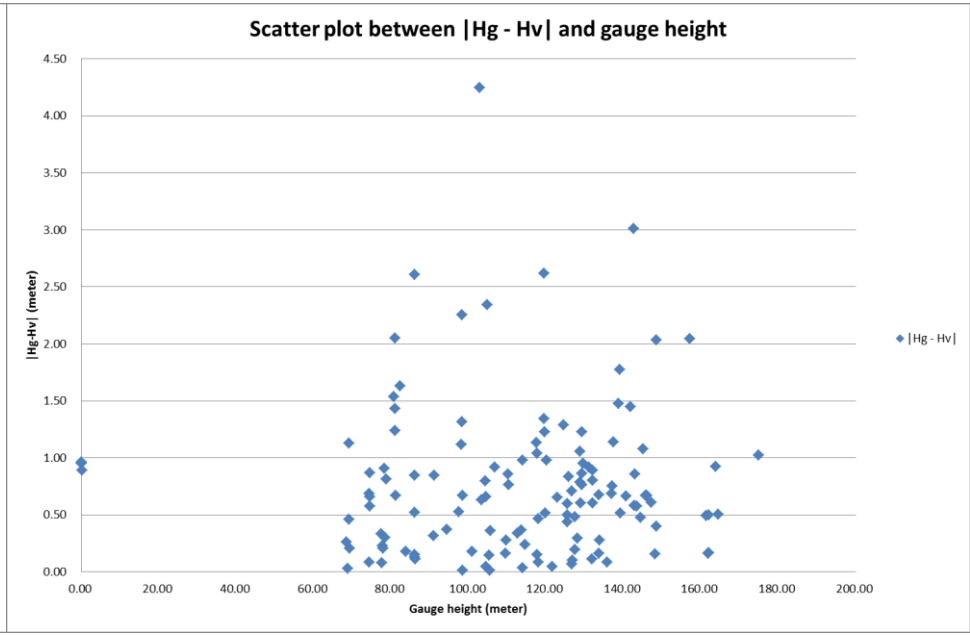
VIIRS 30-m downscaled flood map on May 02, 2017



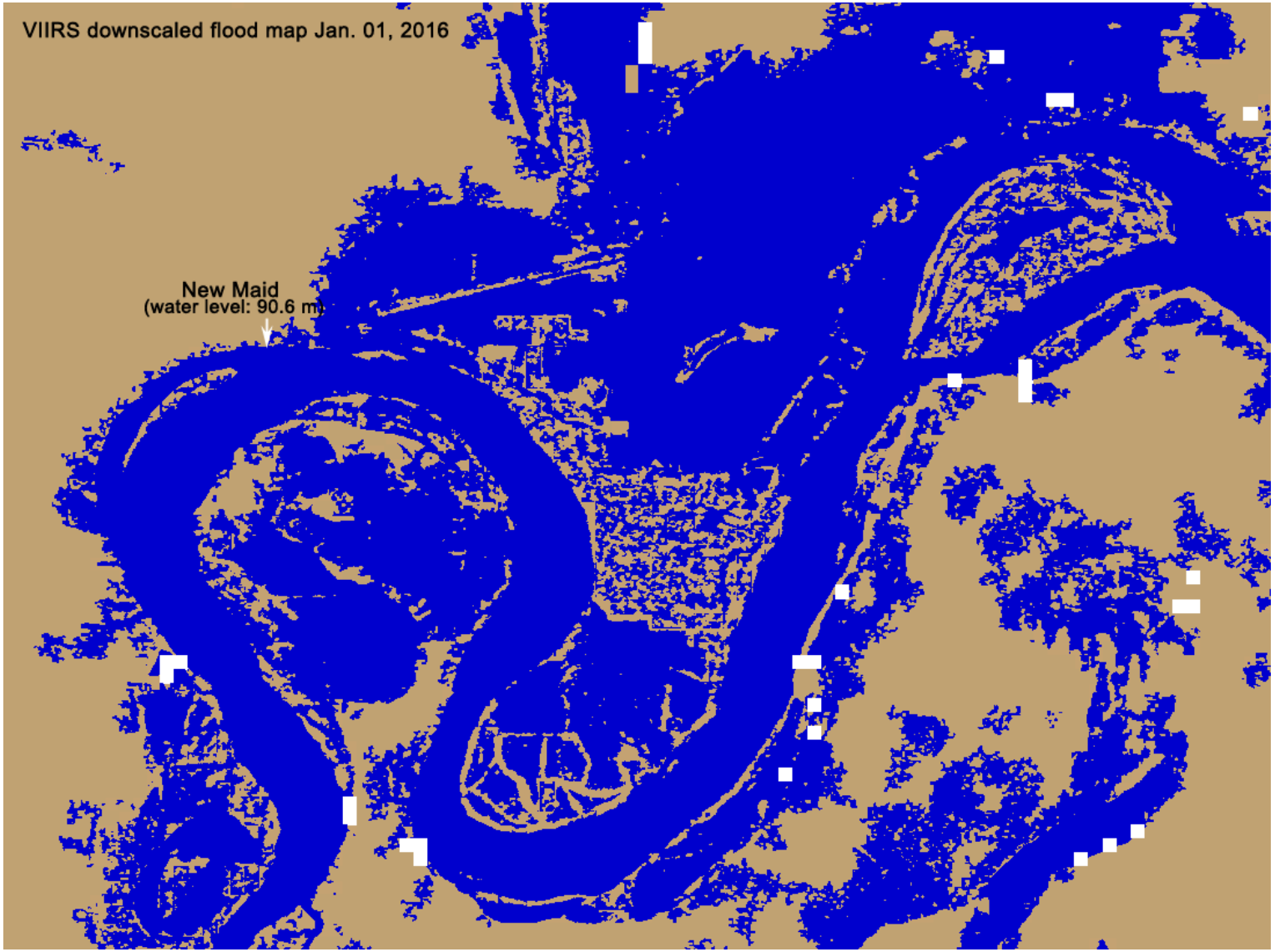
Landsat-8 OLI image on May 08, 2017 (white lines show the range of flooding water from VIIRS. Light pink region along the river should be the receded inundated water.)

Retrieval of Water Surface Level

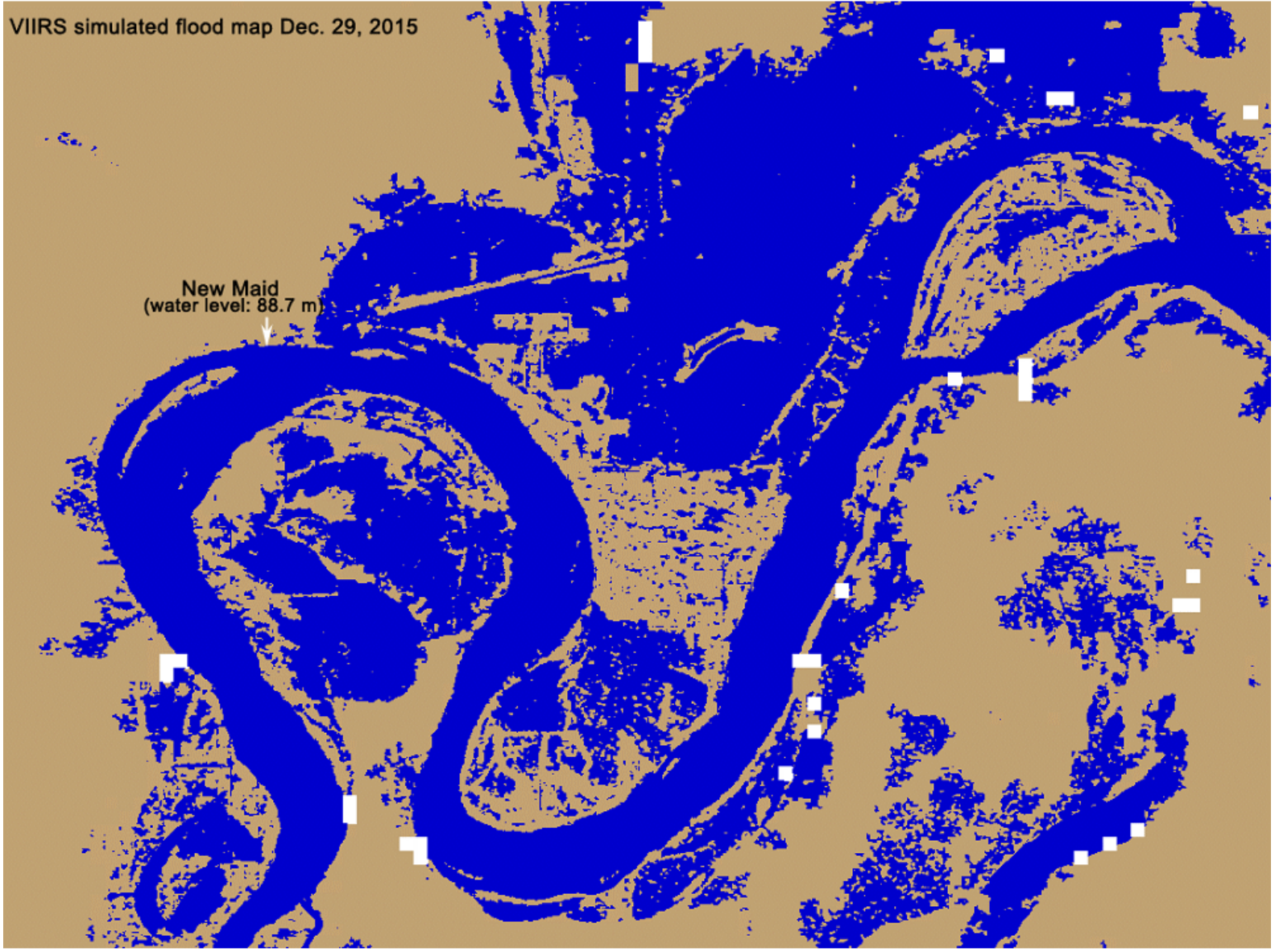




- Produce VIIRS/ABI flood water surface level product at 375-m or 1-km spatial resolution.
  - ✓ Could be a good supplementary resource for river observations, especially along ungauged rivers.
  - ✓ Provide potential application of flood extent simulation and prediction with hydraulic models
- The latest retrieved VIIRS water surface levels from SRTM/DEM show an average absolute difference about 0.82 m with a standard deviation about 0.78 m.



- Based on the downscaled flood products, a simulation model can also be developed to derive the flood extent, which can be used to forecast flood and rebuild the entire inundation process during a flood event.



- Based on the downscaled flood products on Jan. 01, 2016, the flood extent on Dec. 29 and 30, 2015, which were cloudy, could be simulated.

Future plan

- Validation and application of the VIIRS/ABI/AHI flood water fraction products:
  - Validate the VIIRS/ABI/AHI flood water fraction products.
  - Reprocess the historic VIIRS data since 2012 and build the long-term VIIRS global flood datasets.
  - Applications: Flood patter analysis with the long-term VIIRS flood datasets and flood hazard loss assessment.
- Development of the downscaled flood products:
  - Routinely produce the downscaled 30-m 3-D flood products from VIIRS and ABI in the CONUS.
  - Extend the downscaled model outside of the CONUS to produce global 30-m 3-D flood maps from VIIRS, ABI and AHI.
  - Apply the model with the 10-m NED in the CONUS to generate 10-m 3-D flood products from VIIRS and ABI.
- Development of the flood extent simulation model.

Thanks!

Operational River ice monitoring and forecasting over the US and the Globe using SNPP and NOAA-20 VIIRS data

Naira Chaouch, nchaouch@ccny.cuny.edu

Peter Romanov, Paul K. Aalabi, Reza Khanbilvardi, Marouane Temimi

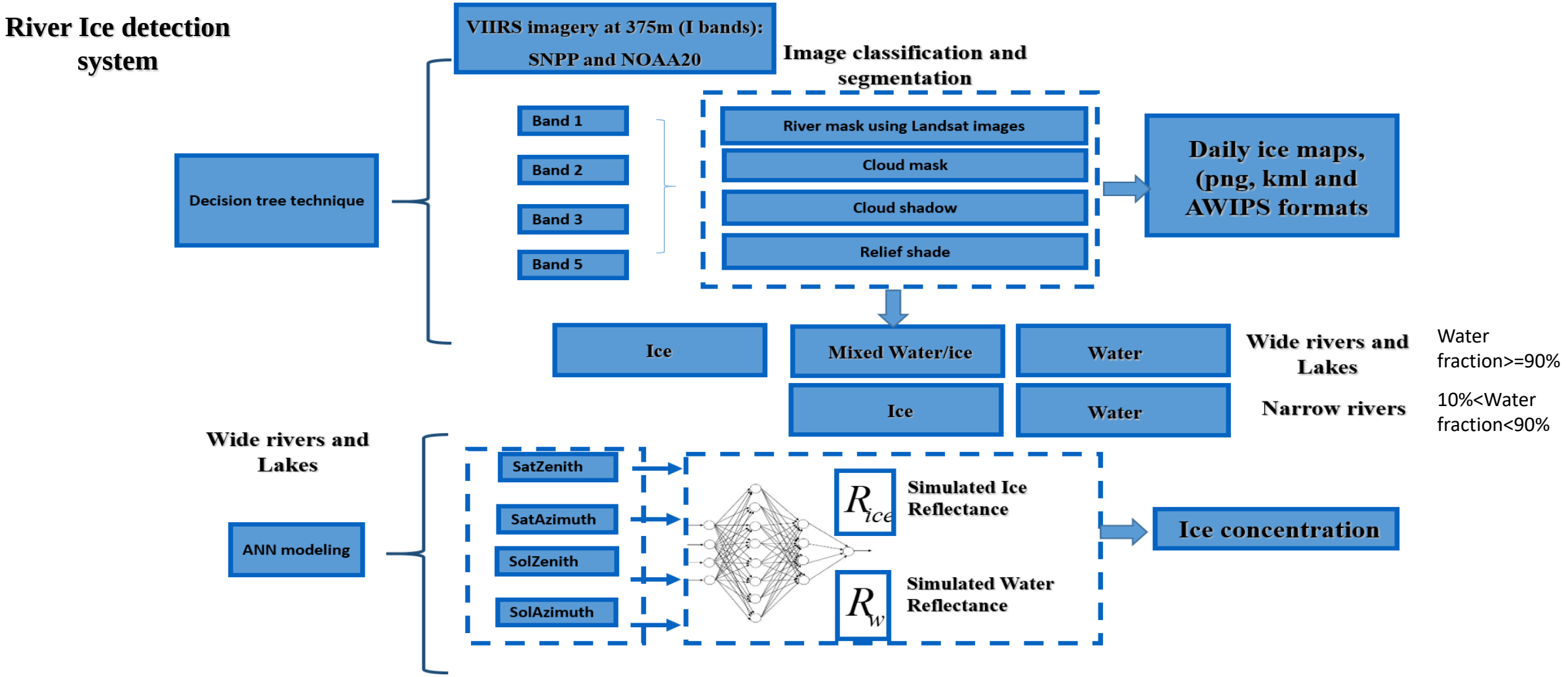
NOAA-CREST/ City College of New York

JPSS/GOES-R PGRR Summit

February 27th, 2020

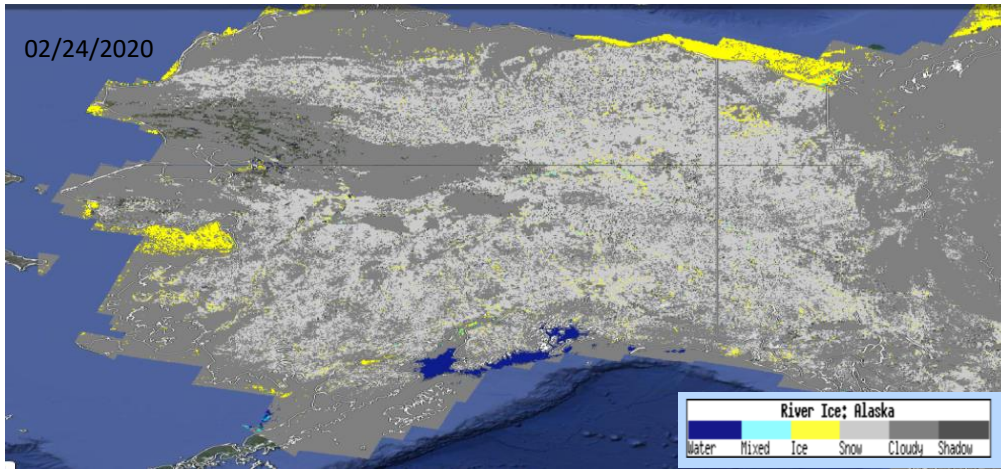
River Ice product: Current version

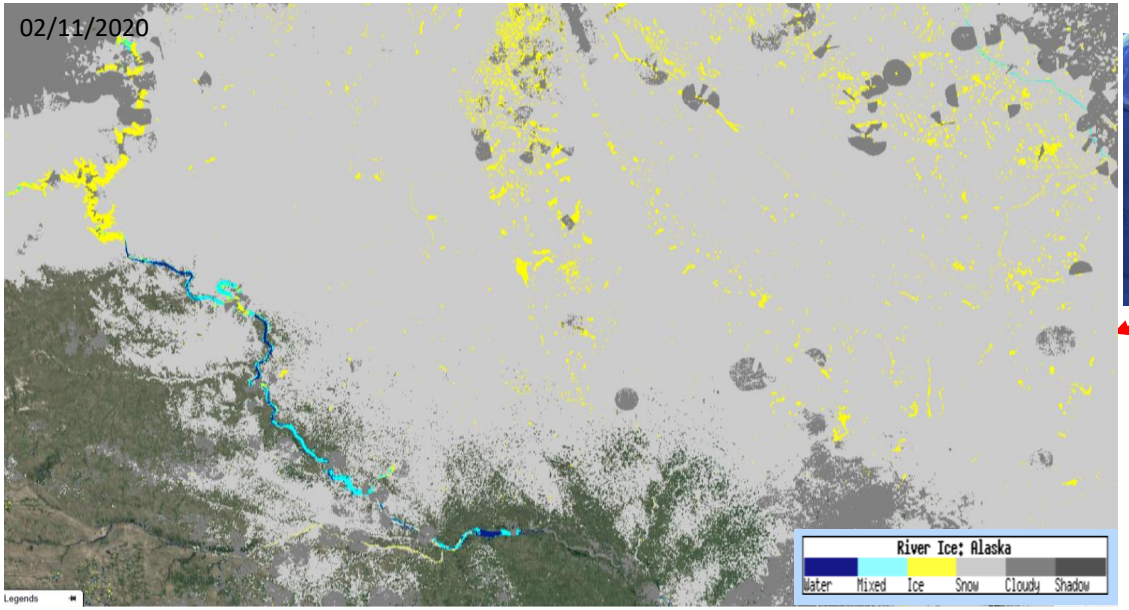
The river ice package is an operational river and lake ice VIIRS based detection and mapping system. It is a near real time product developed using SNPP and NOAA20 data at 375 m spatial resolution. The river ice product is displayed on AWIPS II and SSEC' Real Earth



The current version covers four RFCs domains (Alaska, Missouri Basin, North Central and North East river forecast centers).

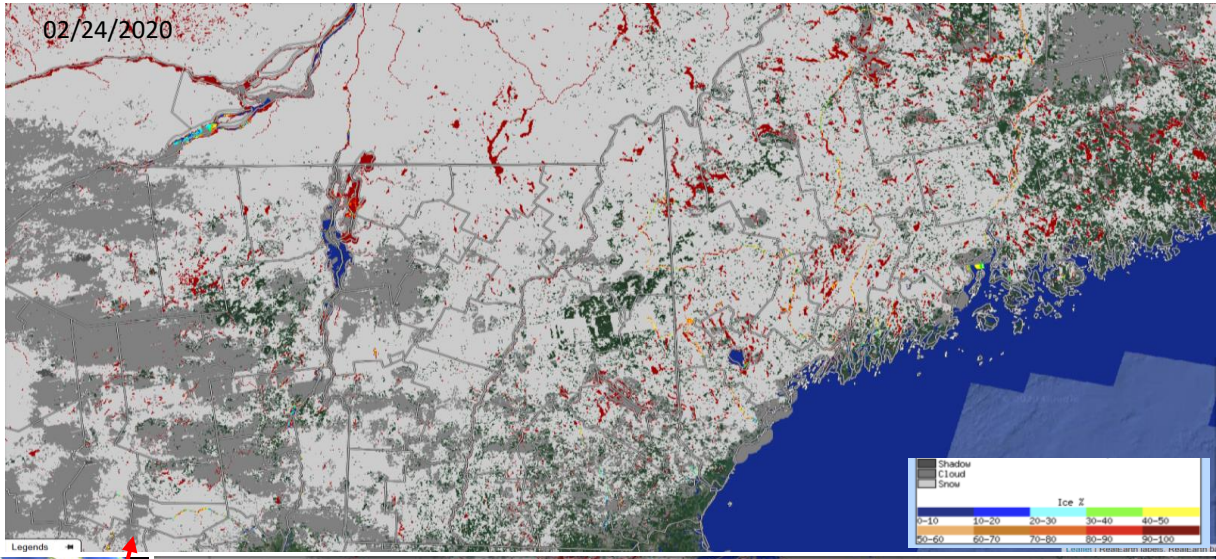
Ice product

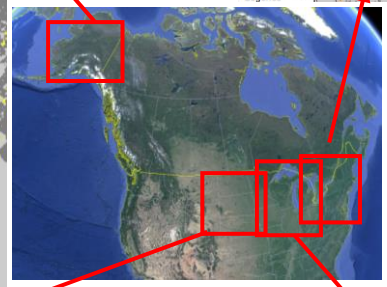


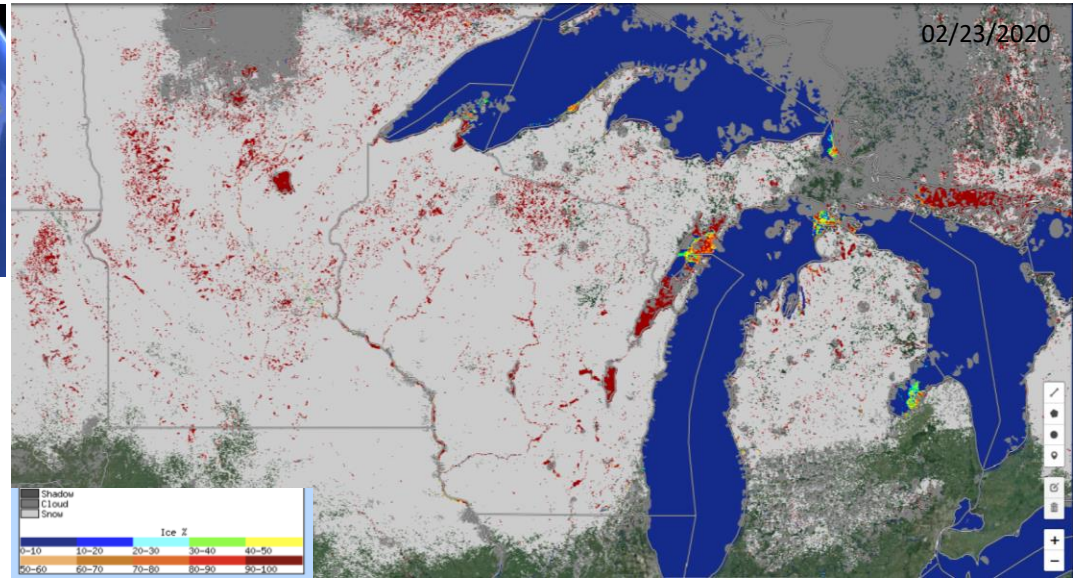


Alaska Pacific: https://floods.ssec.wisc.edu/?products=RIVER-ICE-AP
North East: https://floods.ssec.wisc.edu/?products=RIVER-ICE-NE
North Central: https://floods.ssec.wisc.edu/?products=RIVER-ICE-NC
Missouri Basin: https://floods.ssec.wisc.edu/?products=RIVER-ICE-MB

Ice concentration product







Alaska Pacific: https://floods.ssec.wisc.edu/?products=RVER-ICEC-AP
North East: https://floods.ssec.wisc.edu/?products=RVER-ICEC-NE
North Central: https://floods.ssec.wisc.edu/?products=RVER-ICEC-NC
Missouri Basin: https://floods.ssec.wisc.edu/?products=RVER-ICEC-MB

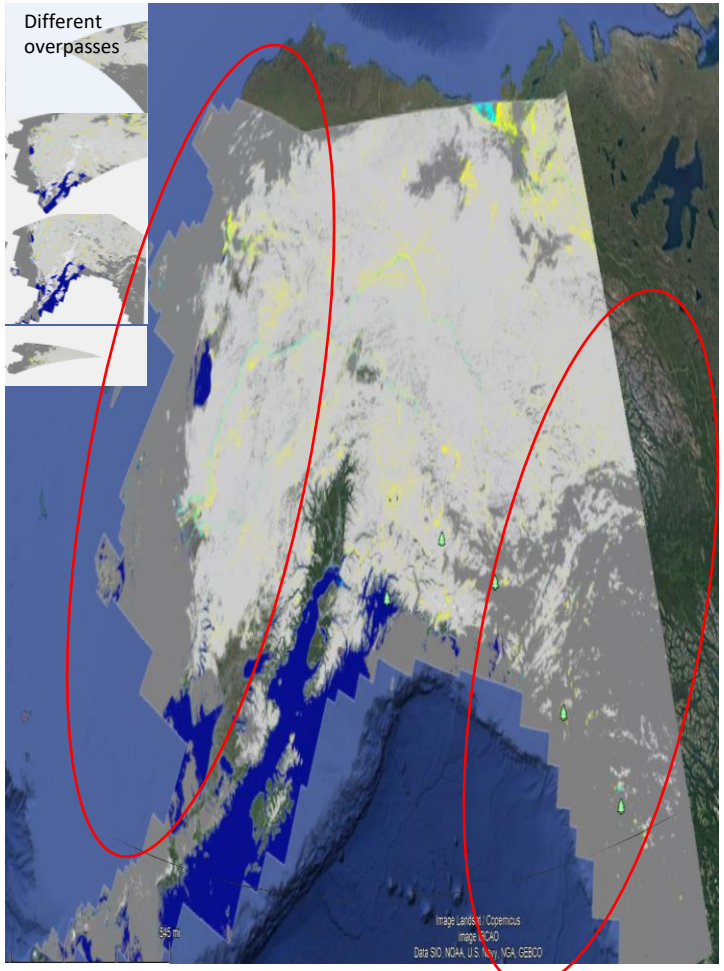
Composite River ice products

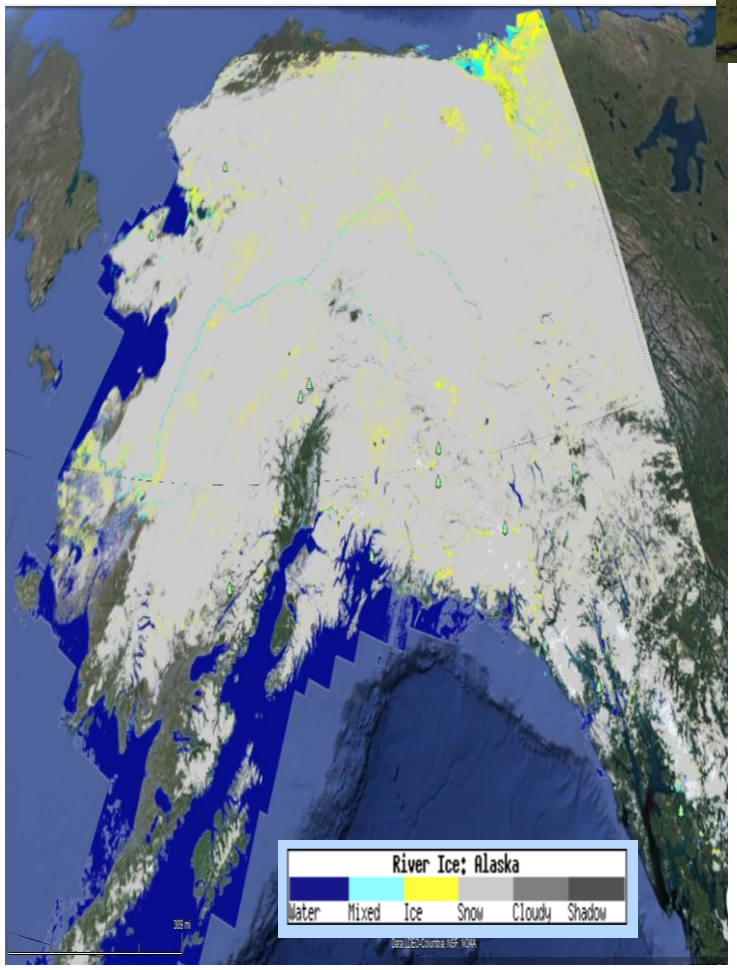
Daily product

Most frequent class

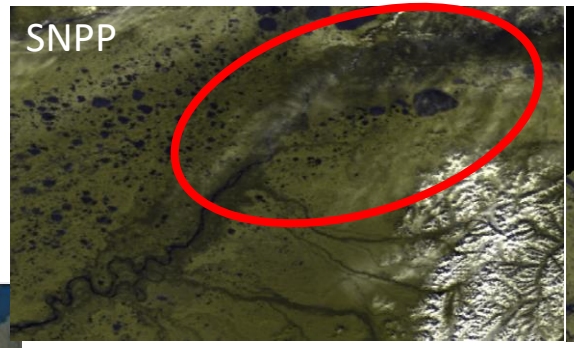
Running product

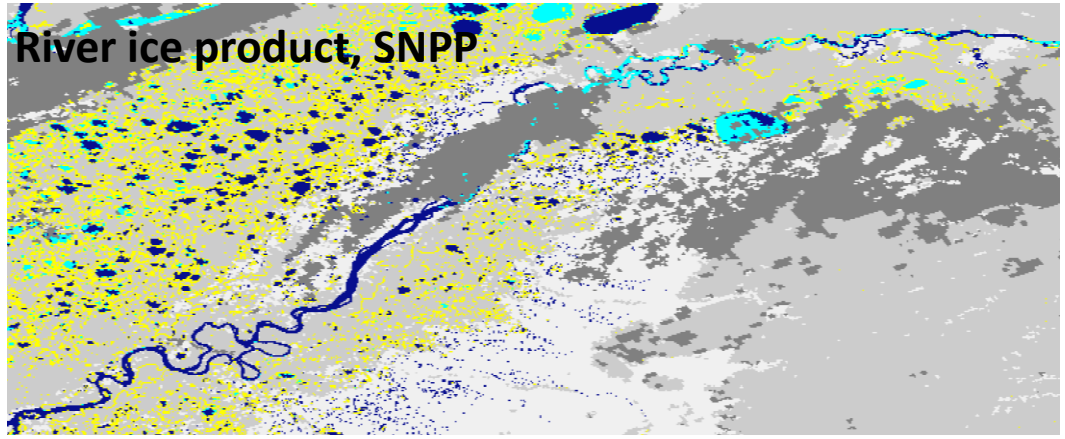
Updates the ice product with each overpass and Keep the latest cloud free pixel information within 7 days

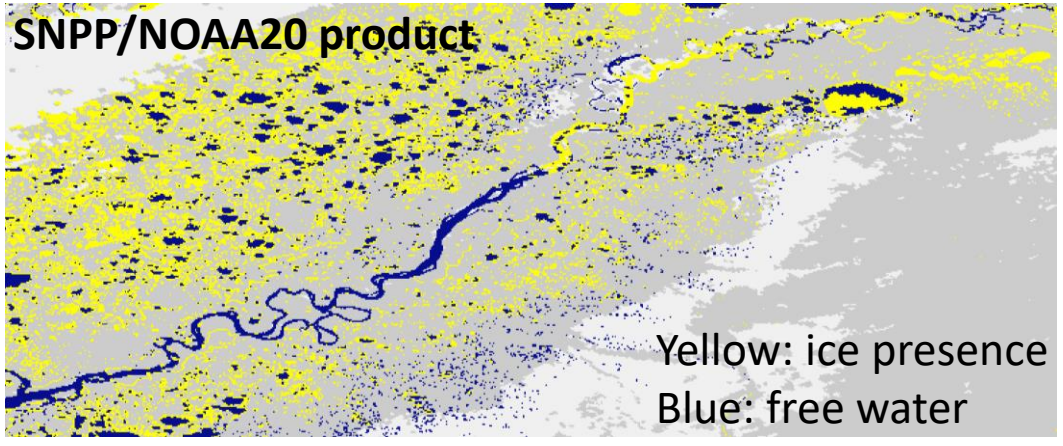




Composite SNPP/NOAA20 product





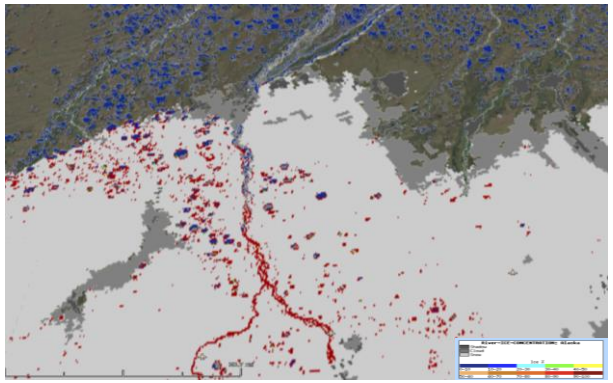


Challenges and Future versions

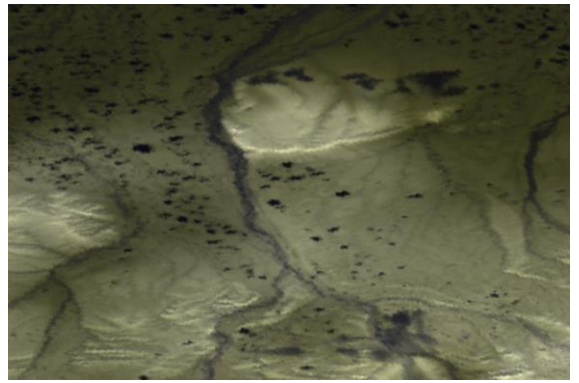
- Improvement of the retrieval over narrow rivers especially in the presence of snow on ground

- Text\email alert to be generated automatically using change detection of ice condition around certain points of interest

10/05/2019, sag River



VIIRS RGB



- Improvement of the consistency of the product by controlling the temporal variability of River ice concentration

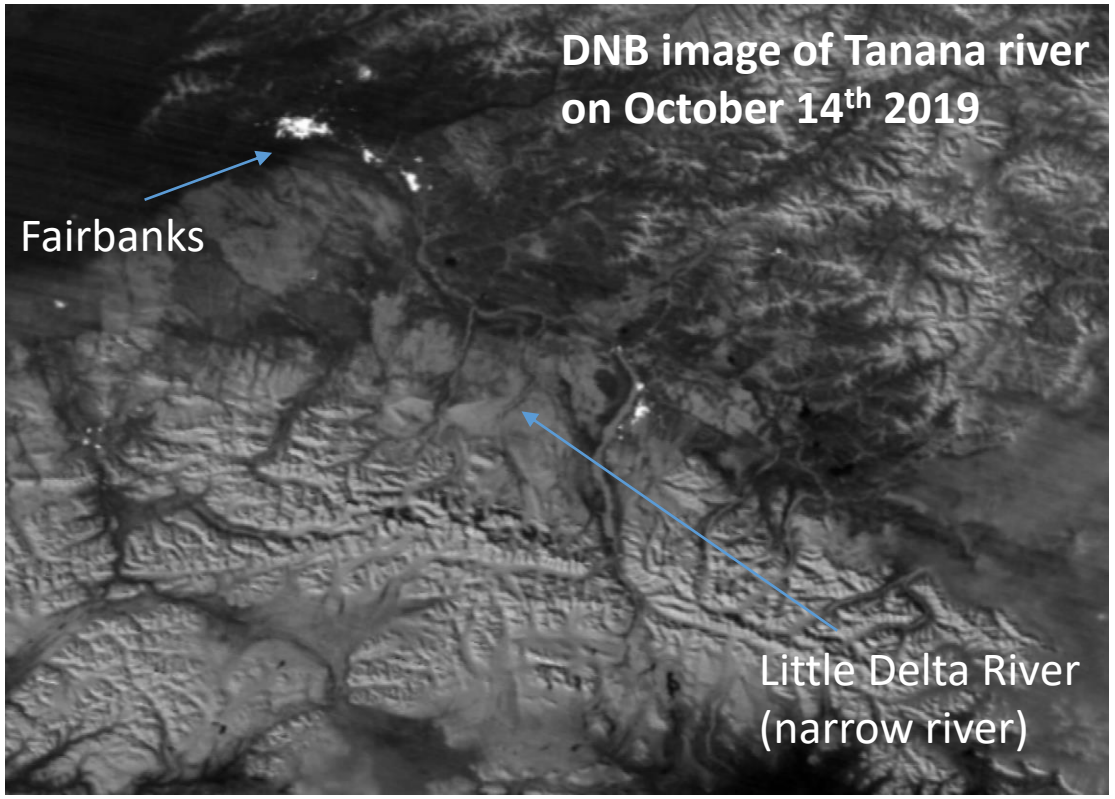
- Improvement of the cloud and cloud shadow determination and its impact on river ice retrieval : current version is using CLAVRX and IICMO cloud data. VICMO cloud product shows better cloud classification.

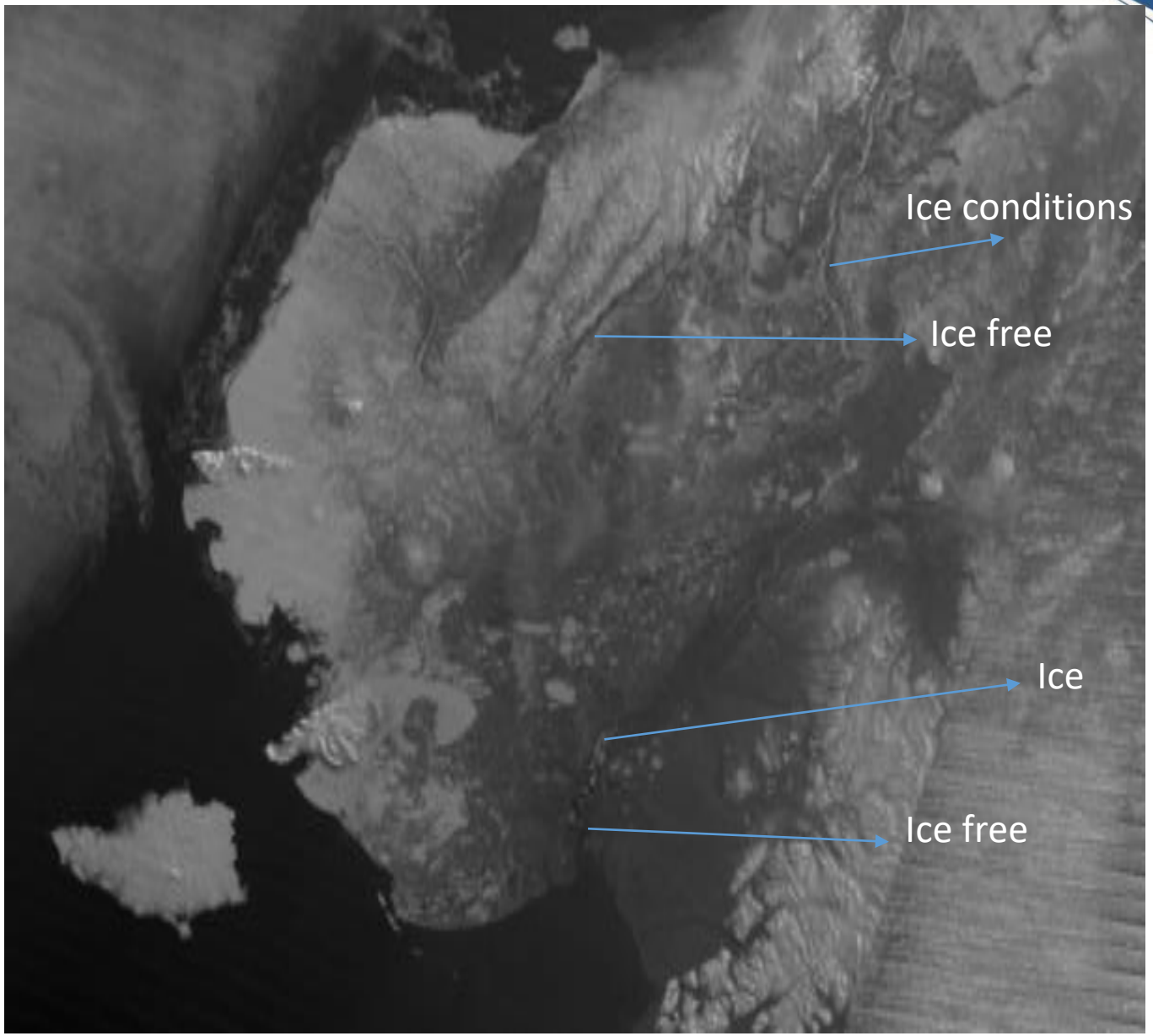
- Expansion of the ice product coverage toward global river ice mapping system

- Investigate the potential of using DNB for river ice detection

DNB VIIRS data

- DNB band shows a clear potential to monitor river ice condition during night time
- Blending I bands with DNB should provide better spatial and temporal coverage especially in case of fast evolving ice-flood events or for Alaska during winter between December and February where the day coverage is reduced because of the solar Zenith angle and limited day light coverage.



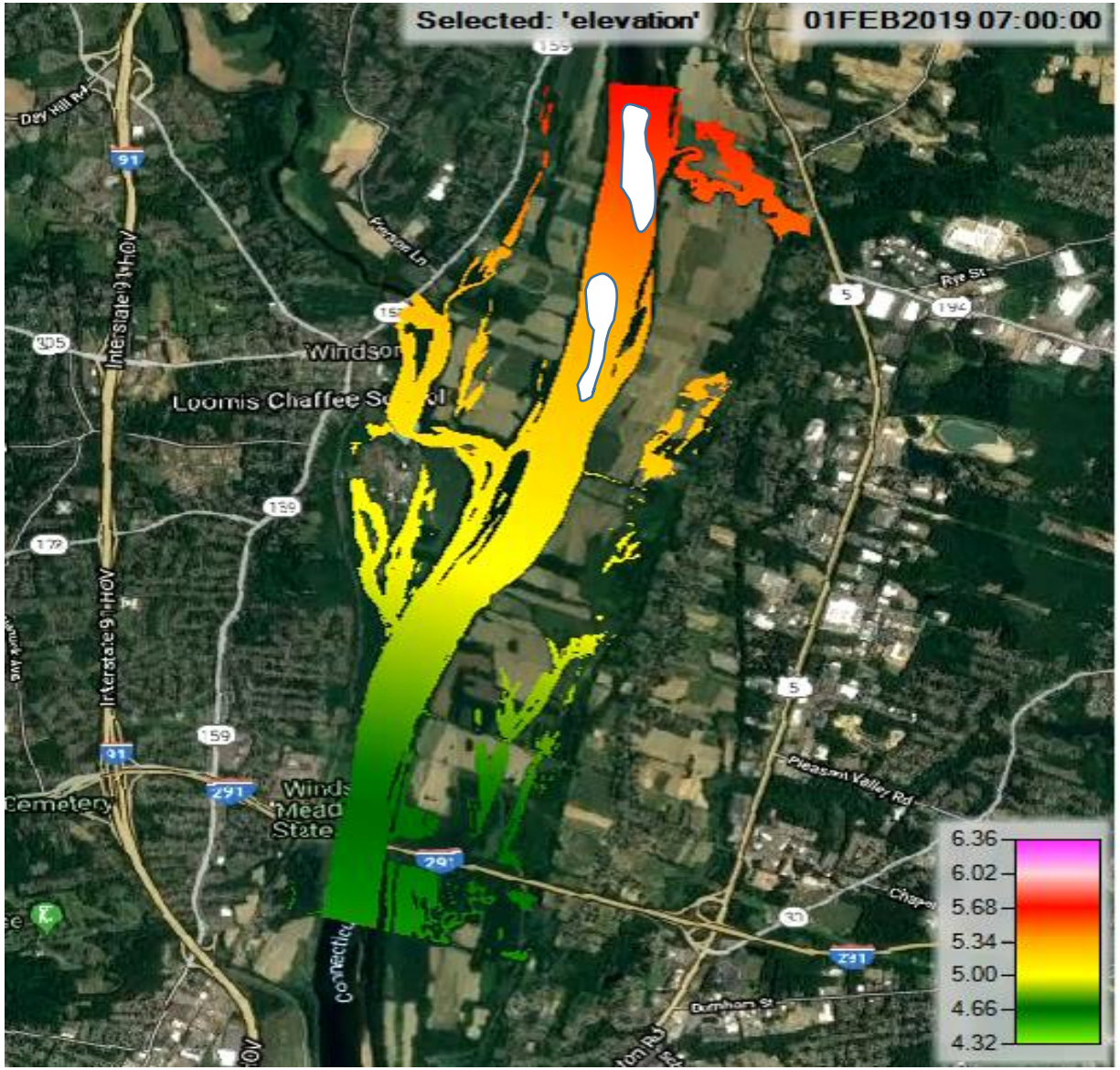


VIIRS DNB band showing a clear separation between ice and ice free conditions in the Yukon and Kuskokwim Rivers, 04/26/2019

Assimilation of JPSS river ice information in river hydraulic models to improve streamflow forecast

- The use of HEC-RAS model that is used by RFCs to integrate information on river ice.
- Cold region hydrological processes have not been included yet in the National Water Model (Alaska is not covered by the NWM yet). We will work on integrating VIIRS river ice in the flow routing in the NWM

Northern Vermont 0n 1/12/2018



Connecticut River with HEC RAS between Springfield MA and Hartford CT

Thank you