VIIRS RIVER ICE MAPPING

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Outline

- Project overview
- Algorithm and product
- Recent enhancements
- Product verification
- Plans

Motivation

- Operational needs for river ice information
  - Water management, transportation, recreation, safety
- Current VIIRS products are insufficient
  - Inadequate algorithm, coarse land/water mask
- Better characterization of the river ice is possible with
  - Algorithm specifically focused on the river ice
  - More detailed and accurate land/water mask

Project Overview

- Objective:
  - Provide near real-time information on the state of the ice cover over rivers and coastal areas
    - Focus on wide (> 375m) rivers in Alaska and CONUS
    - Support for NOAA River Forecast Centers (RFCs) and US Coast Guard operations

- Funding: JPSS Risk Reduction

- Project started in 2014, Phase II started in 2016.

Team

Development and implementation

- Naira Chaouch (PI) , Marouane Temimi, Peter Romanov, Paul Alabi (all NOAA-CREST, CCNY, New York)

Operational support

- Jay Hoffman, Dave Santek (CIMSS/SSEC, UW Madison)

Users

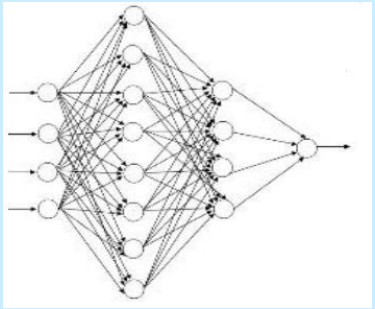
- Ed Capone (North East RFC), Mike DeWeese (North Central RFC), Erik Holloway, Tim Szeliga (Alaska-Pacific RFC), Aaron Bisig (US Coast Guard)

Technique

Initial ice identification
(Threshold-based decision-tree)
VIIRS R1, R2, R3, T5

Ice and water reflectance prediction
(ANN-based Band 2 BRDF model)

SatZenith
SatAzimuth
SolZenith
SolAzimuth



R_{ice}

R_{water}

Ice concentration estimate
(Linear unmixture technique)

$IceConc = (R_{ice}-R_{obs})/(R_{ice}-R_{water})$

Input:

VIIRS SDR (Bands 1-3,5)
VIIRS cloud mask
VIIRS geolocation
River Masks

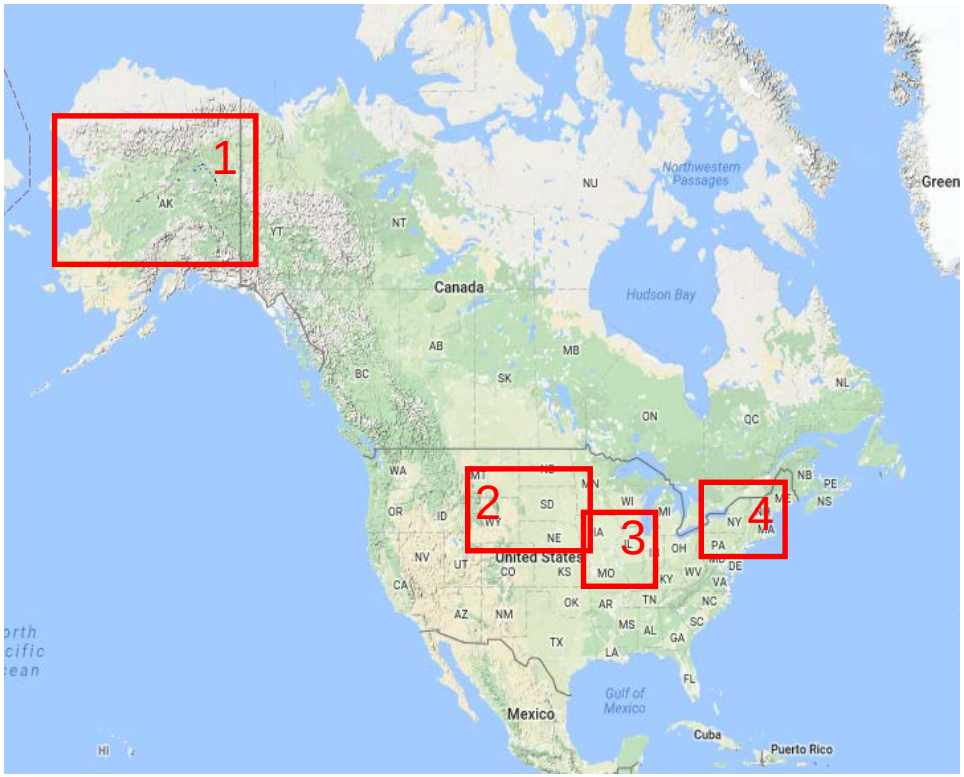
Algorithm is applied only to VIIRS observations over river channels

Output:

Ice concentration map

-Overpass-based
-Limited to selected rivers
-Geographic projection
~375m grid cell size

Geographical coverage



1. APRFC (Alaska-Pacific
2. MBRFC (Missouri Basin)
3. NCRFC (North-Central)
4. NERFC (North-East) & MARFC(Mid-Atlantic)

Rivers covered

Pre-2017	*Starting 2017*
Alaska	
Yukon	Yukon
Kuskokwim	Kuskokwim
	Tanana
	Sustina
North East	
Hudson	Hudson
Mohawk	Mohawk
Lake Champlain	Lake Champlain
	Merrimack
	Connecticut
	Androscoggin
	Penobscot
	Kennebec
	Piscataqua
	Great Bay
	Damariscotta
	Saco
North Central	
Mississippi	Mississippi
Illinois	Illinois
Missouri	
Missouri	Missouri

Product Generation and Accessibility

River Ice Concentration maps are routinely produced at CIMSS/SSEC, UW

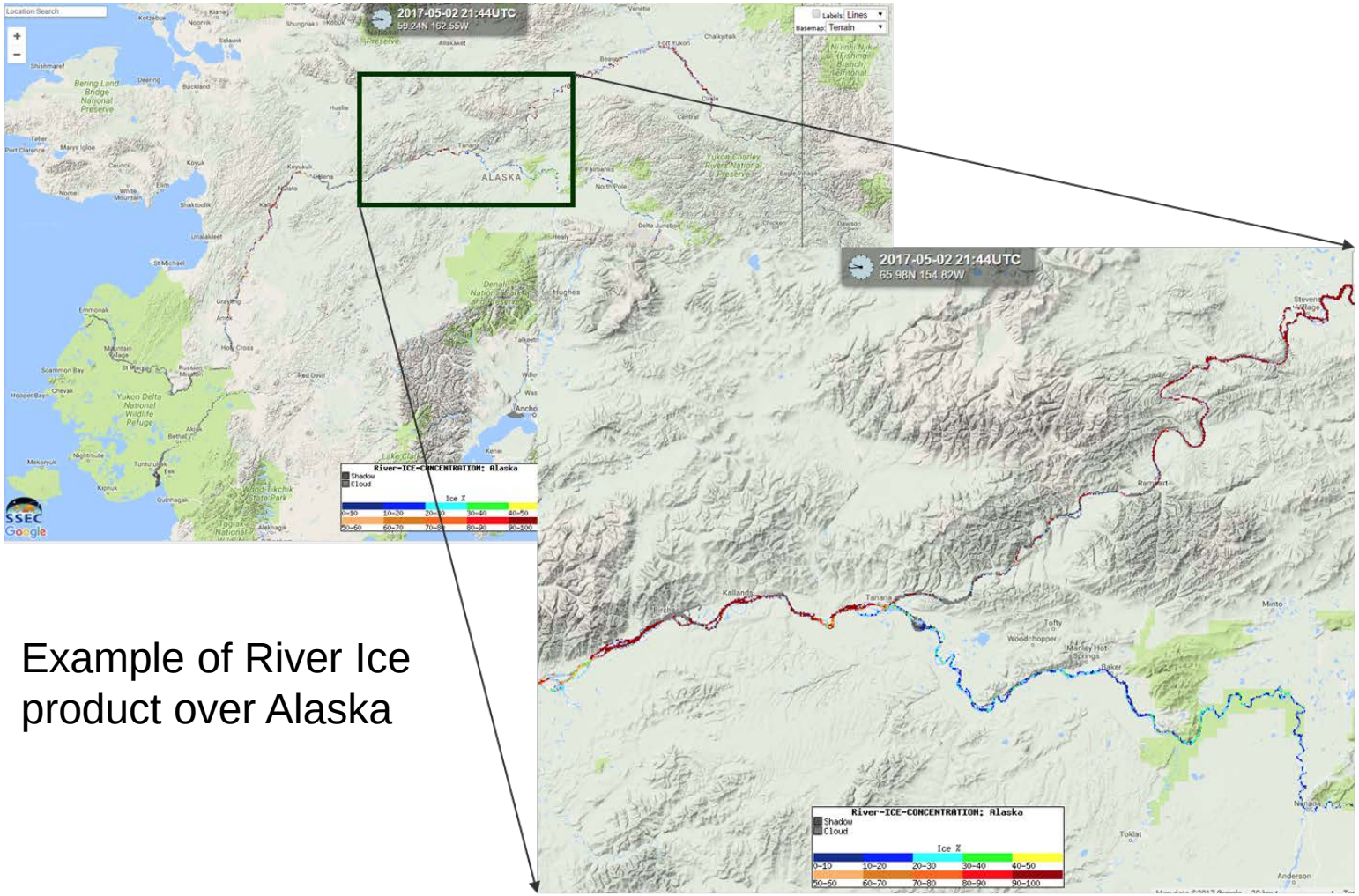
Maps are displayed on AWIPS II and SSEC Real Earth:

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

SSEC Real Earth display system

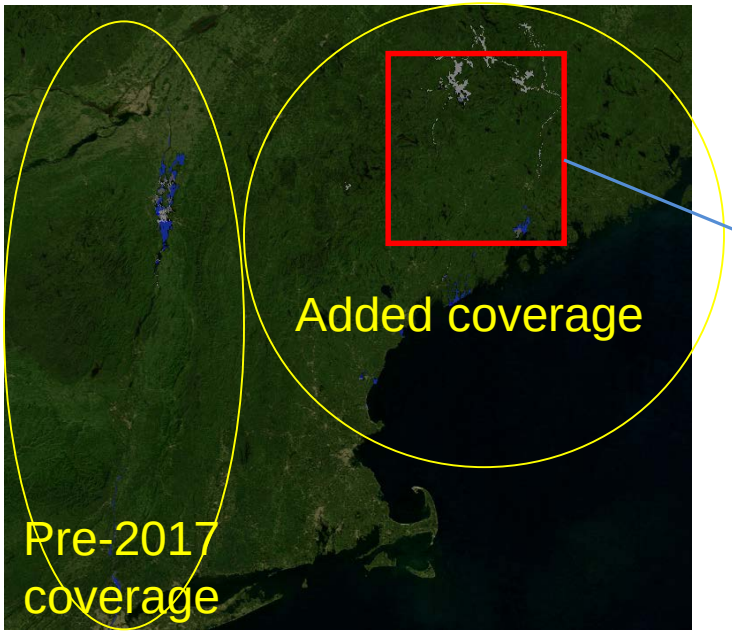
- Geographic projection
- Image selection by time/overpass
- Zoom in and out
- Background selection
- Overlay labels
- Create/Operate layers of images

Example of Product



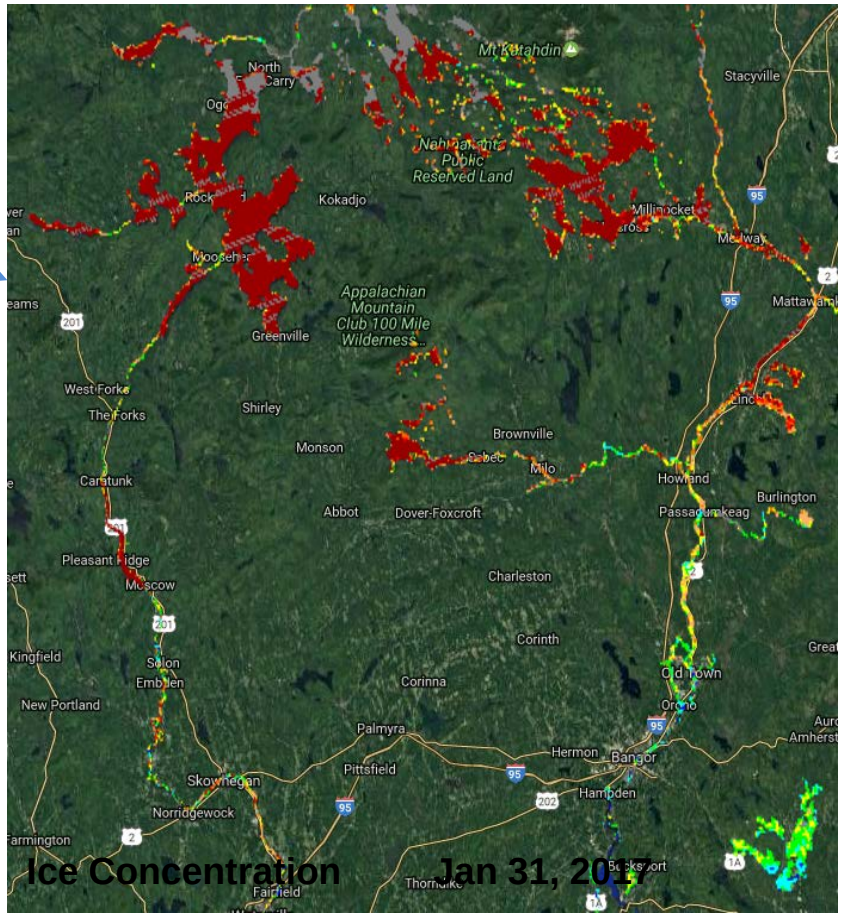
Example of River Ice product over Alaska

Example of Product



In 2017 the coverage in the North East was substantially expanded to cover coastal areas, rivers and lakes on the request of US Coast Guard.

North-East

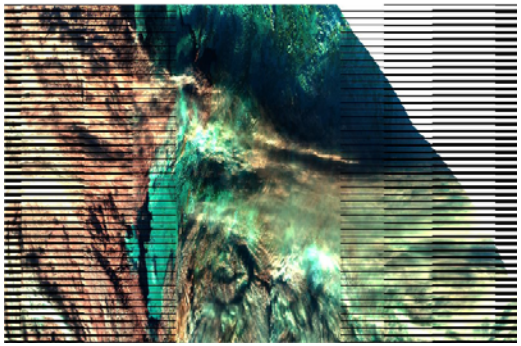


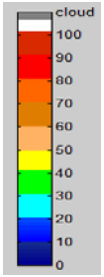
Recent Improvements: Cloud shadows

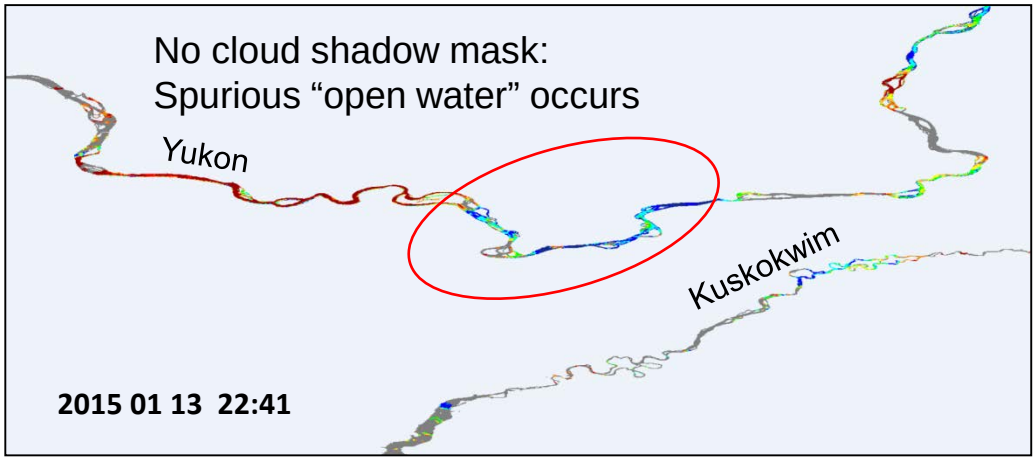
Why: - Unaccounted cloud shadows cause ice misses

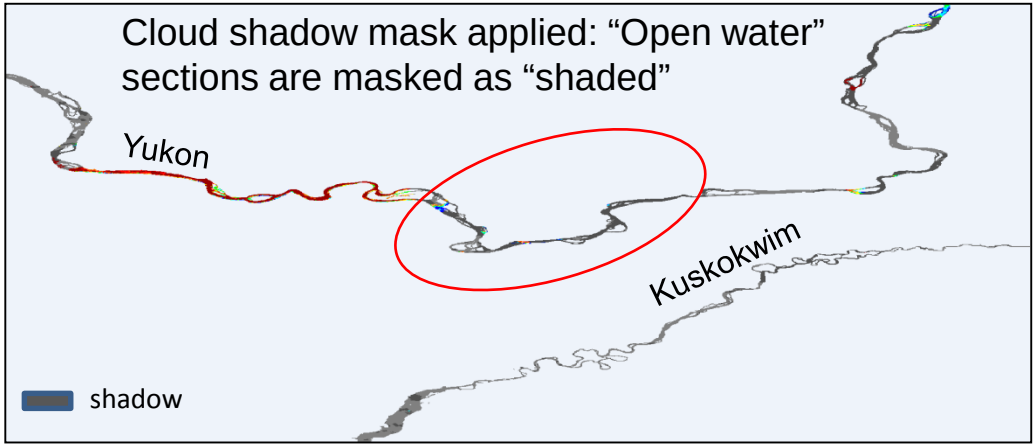
- VIIRS IDPS cloud shadows are derived at $\theta_{sol} < 75^0$

Algorithm: Geometry-based, fixed lapse rate for cloud height, $\theta_{sol} < 88^0$









Red: clouds, yellow: cloud shadow

Recent Improvements: Terrain shades

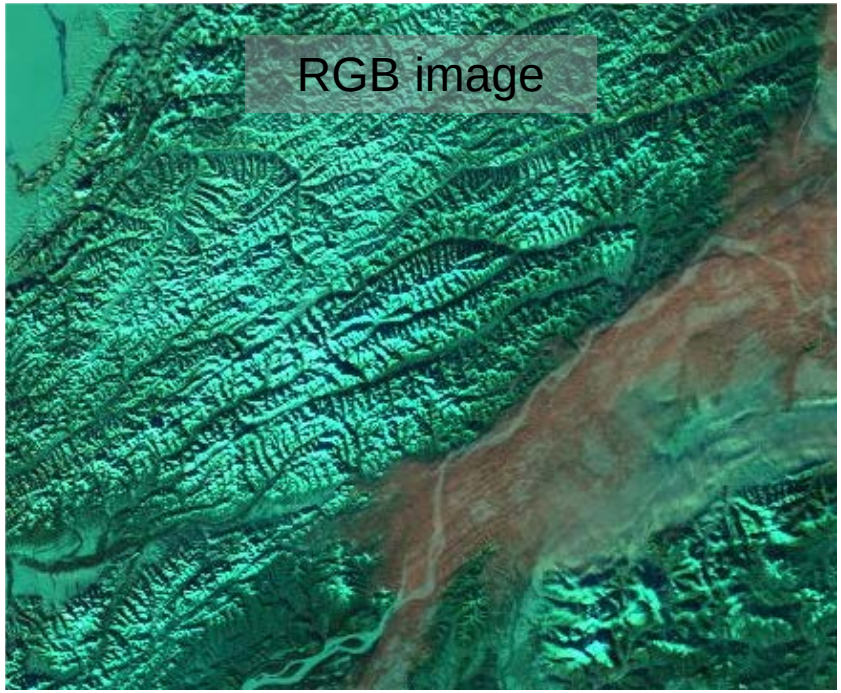
Motivation:

Cause underestimated ice concentration

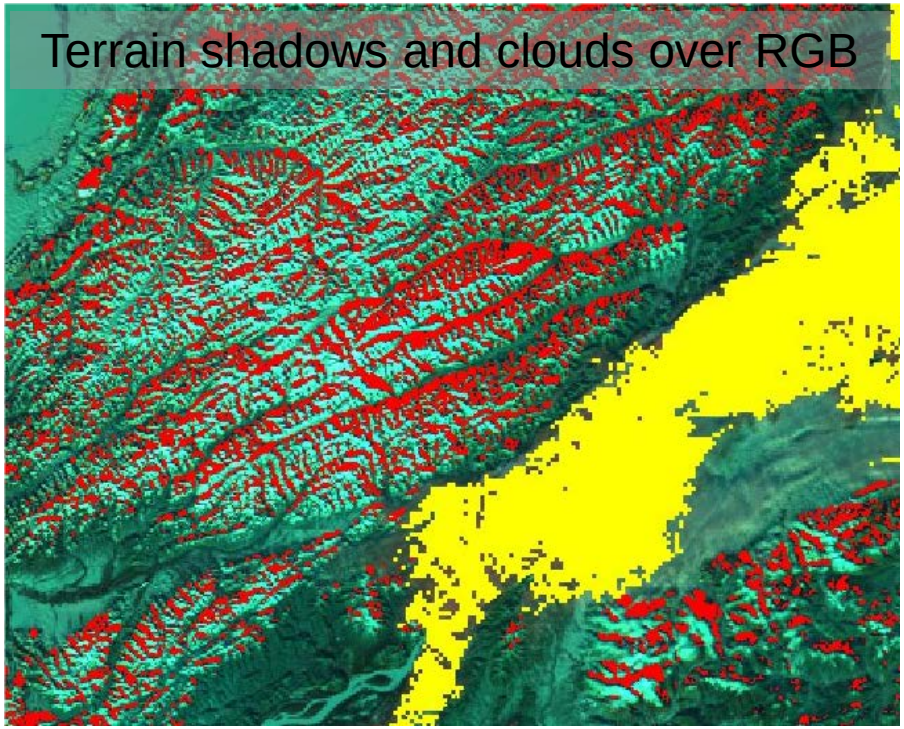
Not available in VIIRS IDPS EDRs

Algorithm:

Geometry-based, 200 m USGS elevation dataset used, up to 88^0 solar zenith

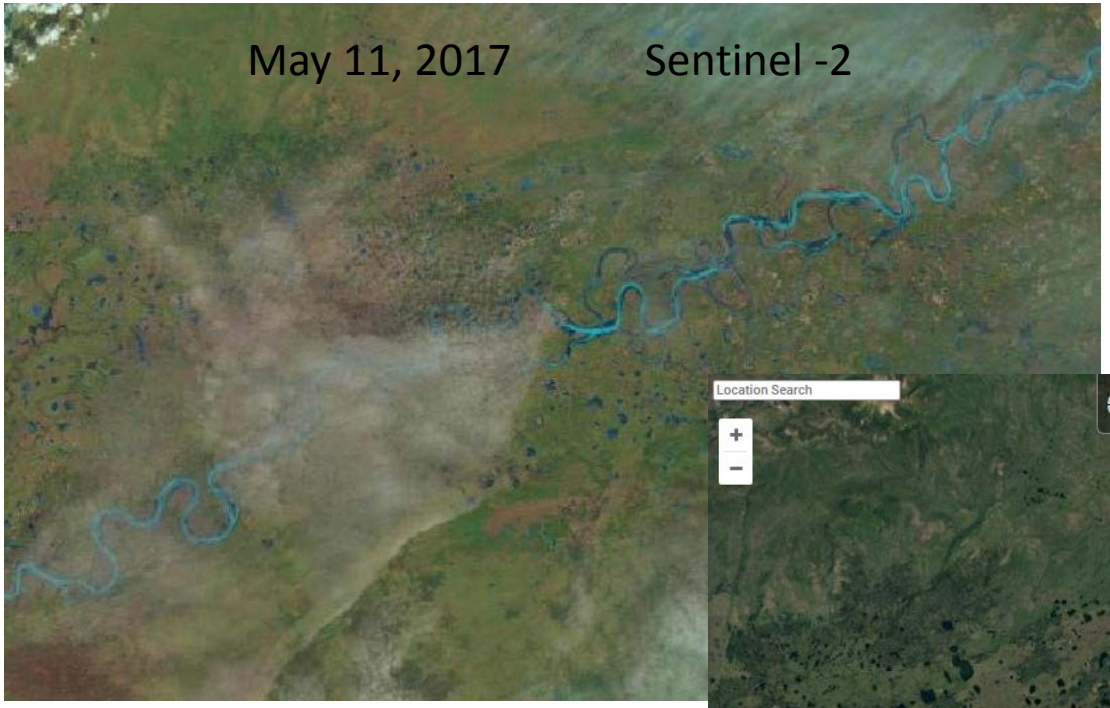


Feb 02, 2017

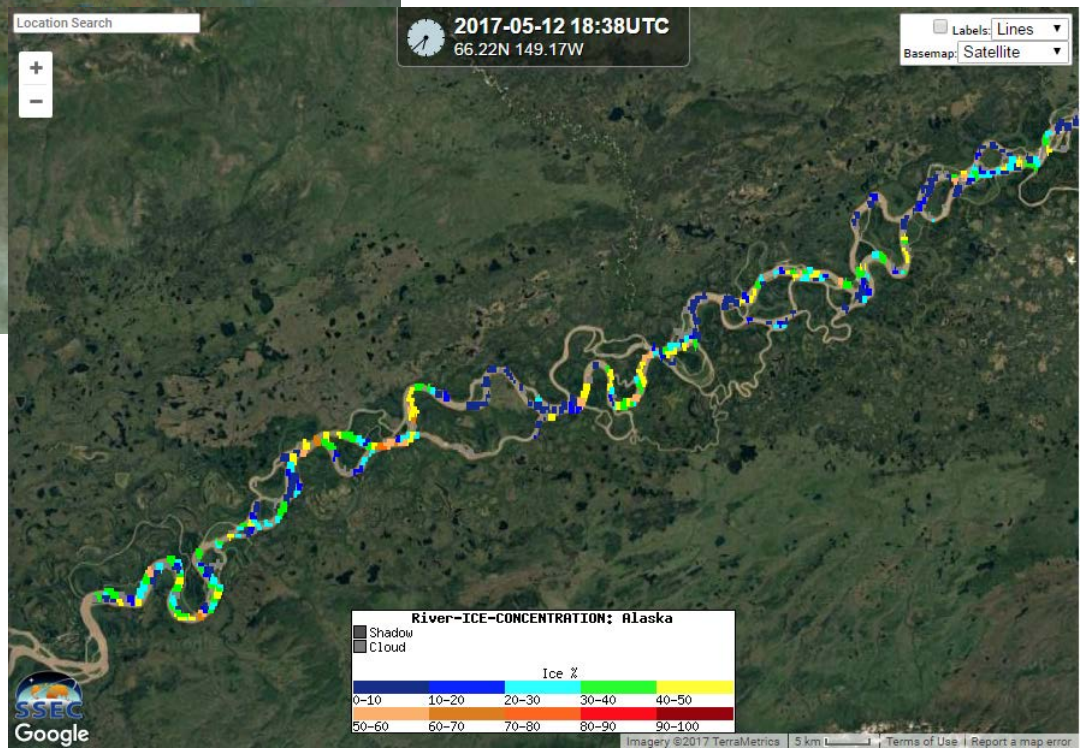


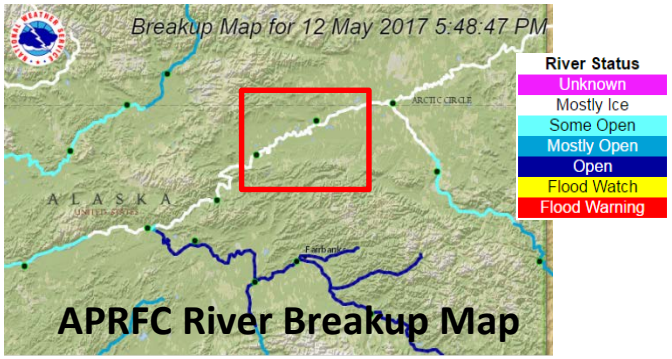
Yellow: Clouds
Red: Terrain shades

Product verification

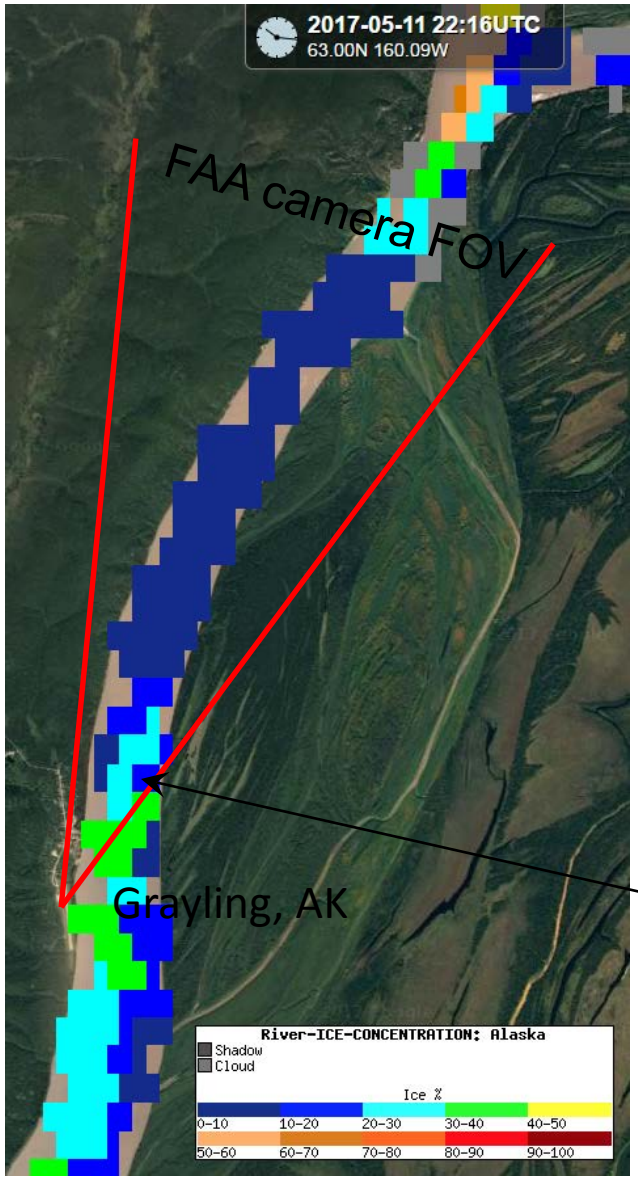


1. Qualitative comparison with high resolution imagery and operational river ice charts



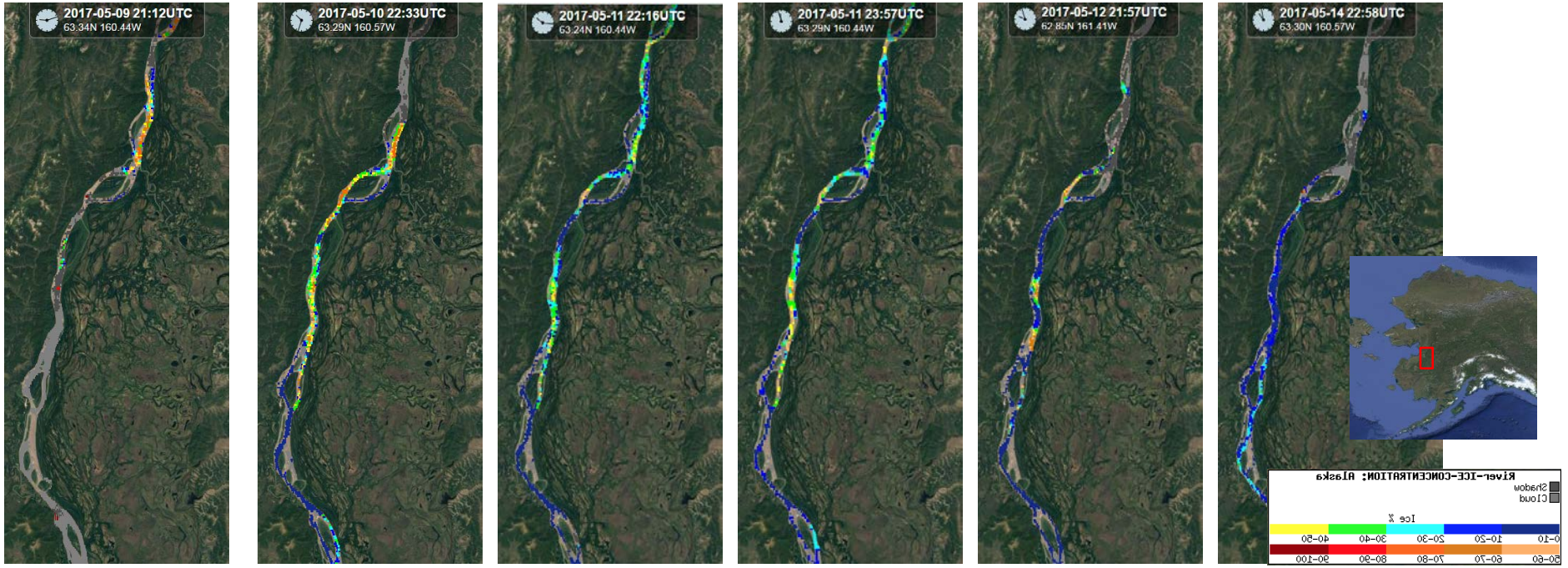


Product verification



2. With FAA, DOT web cameras, airborne imagery, surface reports

Monitoring River Ice Cover



Consecutive images provide information on the river ice dynamics

Clouds hamper continuous monitoring of the state of the river ice

What's next

- Expand the area coverage to the whole CONUS and Alaska area
- Extend the coverage to narrow rivers with less than 375m width
    - Need water fraction data at 375m
- Validation with all available in situ and remote sensing data
- Operational implementation at OSPO