



SEA ICE LEADS

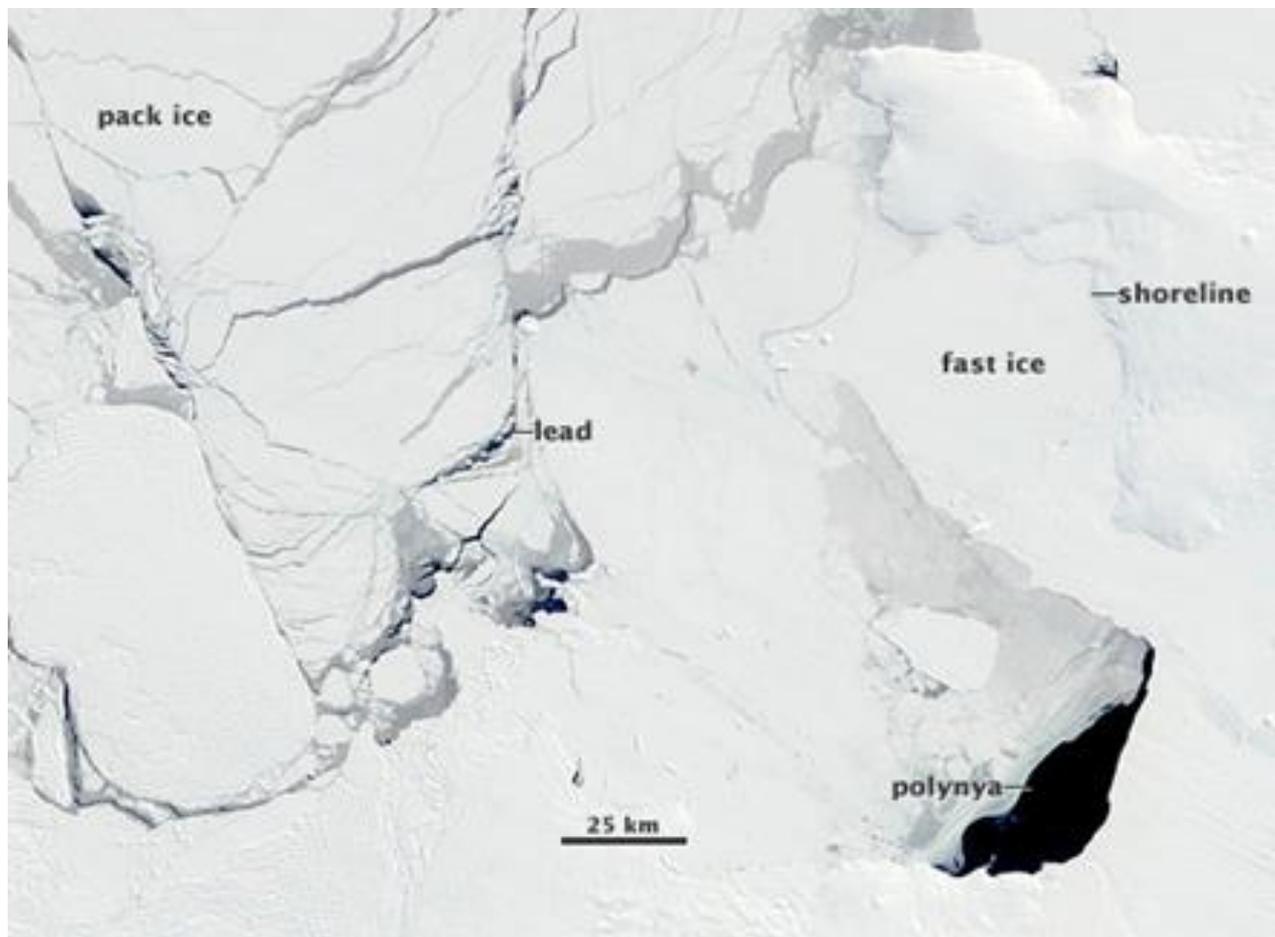
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¹Cooperative Institute for Meteorological Satellite Studies

²NOAA/NESDIS Madison, WI

Background

- Leads are elongated fractures in the sea ice cover. They form under atmospheric and oceanic stresses (Smith et al., 1990).
- Leads provide a source of heat and moisture to the Arctic atmosphere (Alam and Curry 1995, Maykut, 1987).



(From earthobservatory.nasa.gov)

Objective

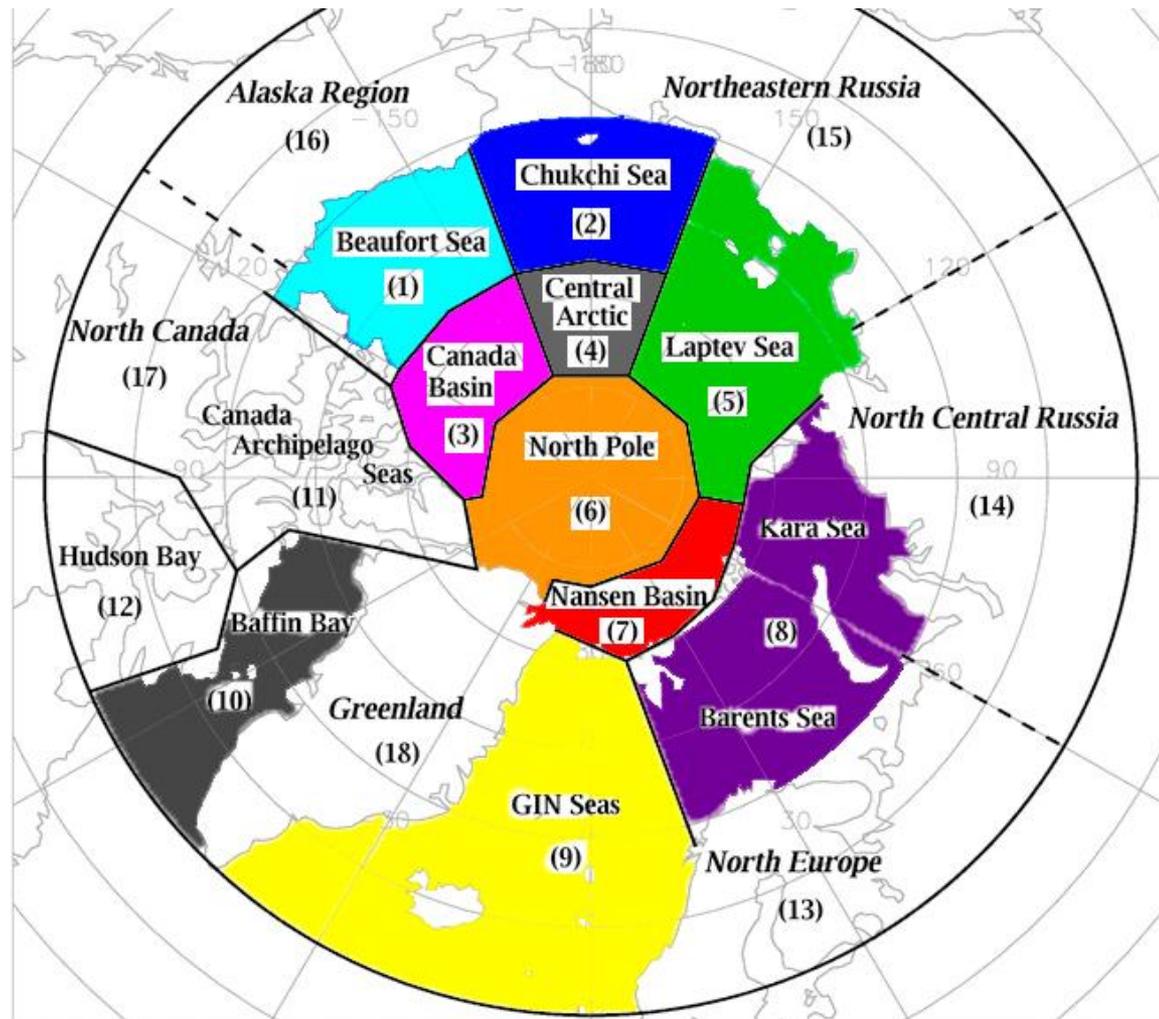
- Identify the spatial and temporal distributions of sea ice leads (fractures) in the Arctic
- Generate near-real-time sea ice leads product in the Arctic using VIIRS



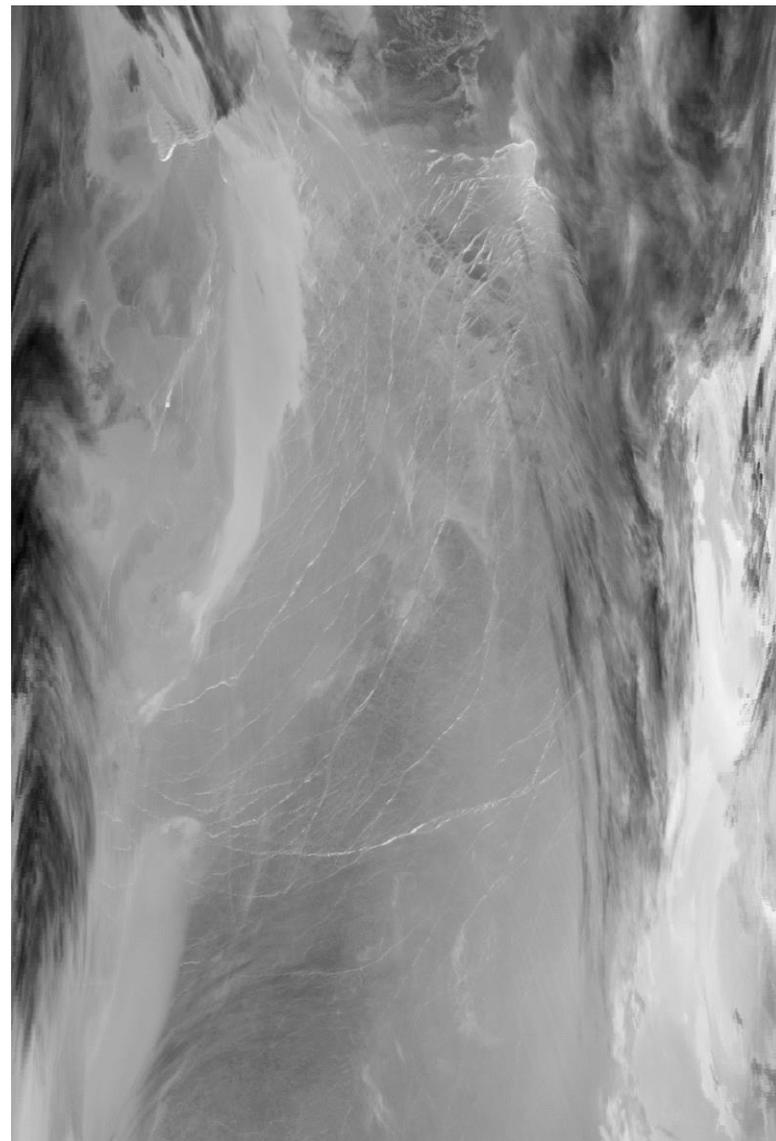
Image credit: National Ice Center

Arctic:

- 10 polar regions
 - Beaufort Sea
 - Chukchi Sea
 - Canada Basin
 - Central Arctic
 - Laptev Sea
 - North Pole
 - Nansen Basin
 - Kara & Barents Sea
 - GIN Seas
 - Baffin Bay



- Leads are identifiable by thermal contrast; warmer than the surrounding ice
- With more consistent along-swath resolution, leads detection is possible for a larger swath from VIIRS than MODIS



MODIS-TERRA BT31 image on 15 February 2018 at 0545UTC. Leads are readily apparent as bright (warm) features relative to the darker (colder) ice and clouds.

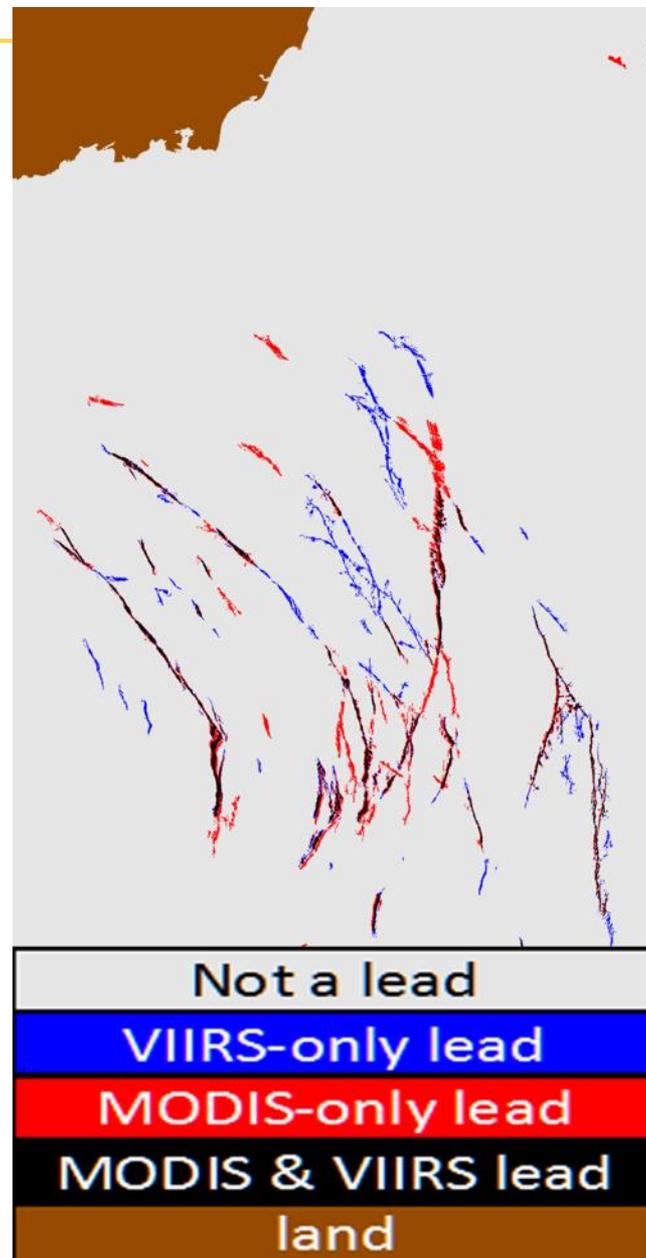
- MODIS-TERRA cloud mask image from 15 February 2016, at 0545UTC.
- The original cloud mask defines clouds as all non-black areas
- A spatial filter is applied to remove thin features from the mask and orange in the figure reprints clouds removed



Leads Detection

- VIIRS and MODIS leads detections have some similarities and differences
- VIIRS has better constrained pixel size and a wider swath.
- With JPSS-1 more increase the chances for cloud-free overpasses; similar to MODIS (AQUA & TERRA)

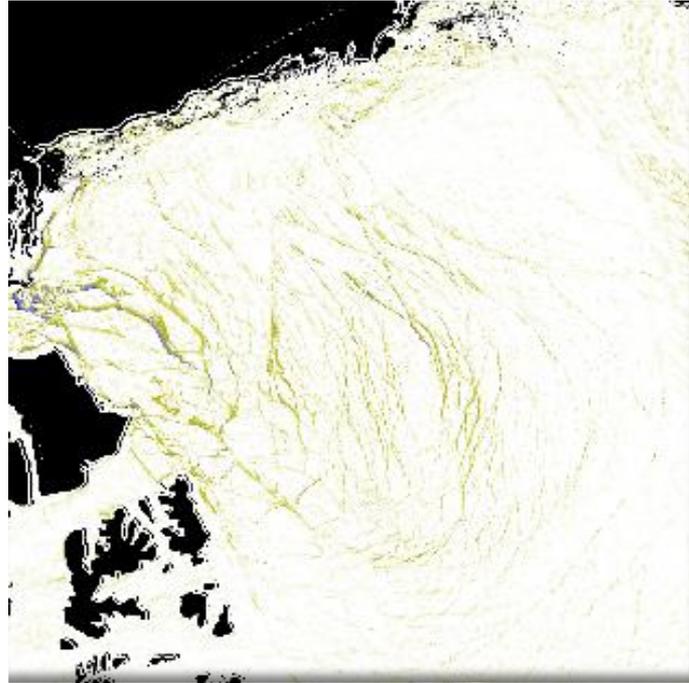
Leads detected in MODIS and VIIRS on 15 February 2018.



Why VIIRS ?

VIIRS's wider swath and consistent along-swath resolution results in better ice leads retrievals

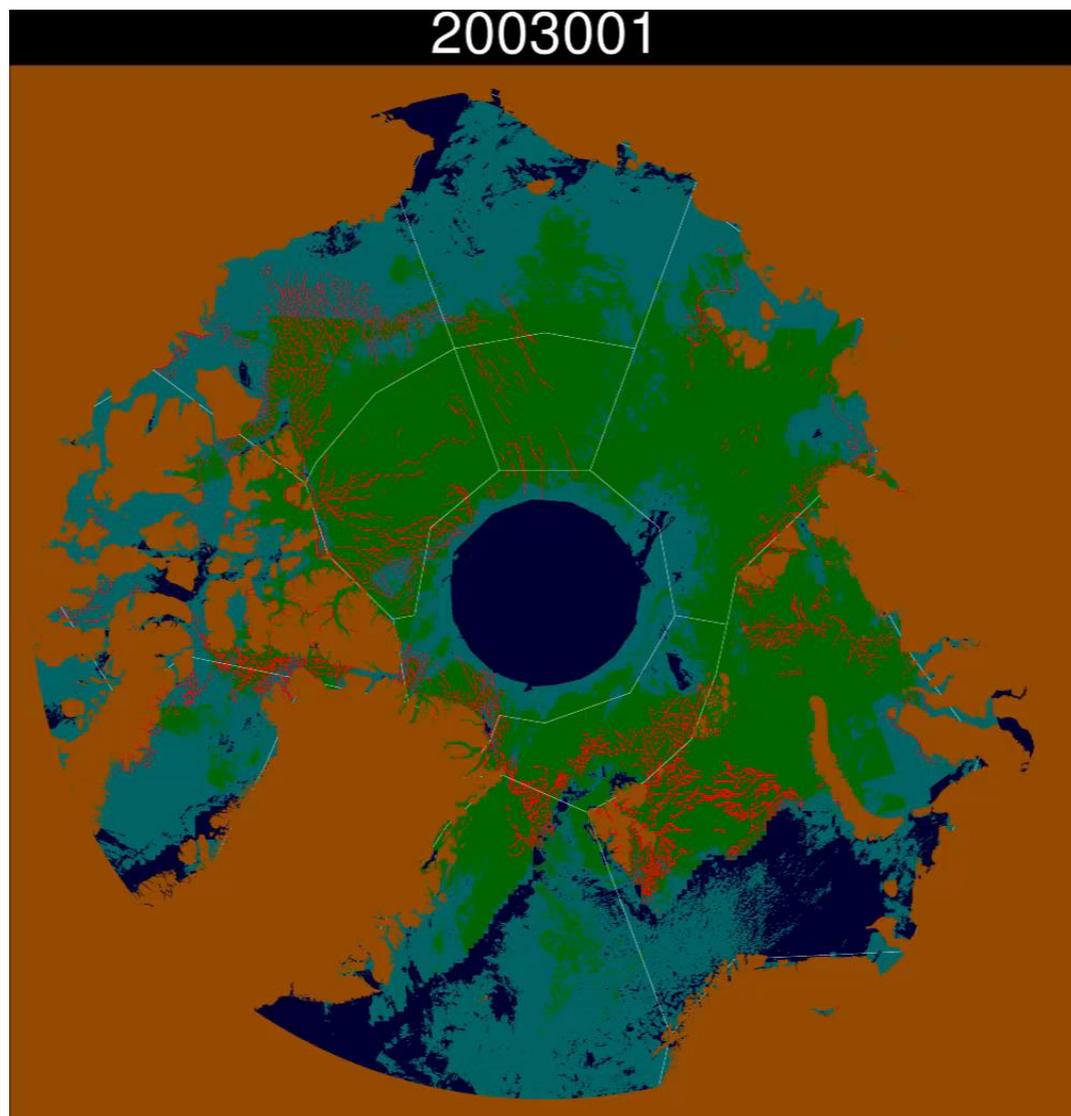
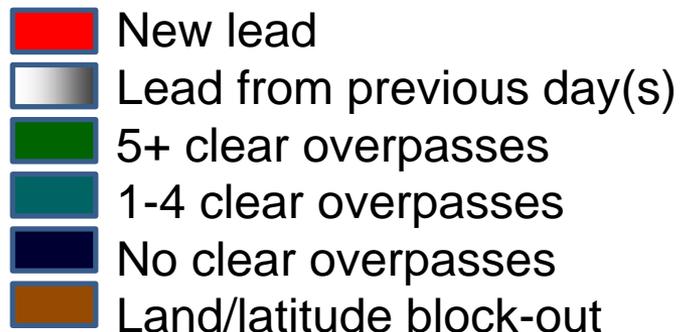
- More detail in thermal contrast in more leads detected
- VIIRS detects more leads in regions where MODIS scan angles are greater than 30°



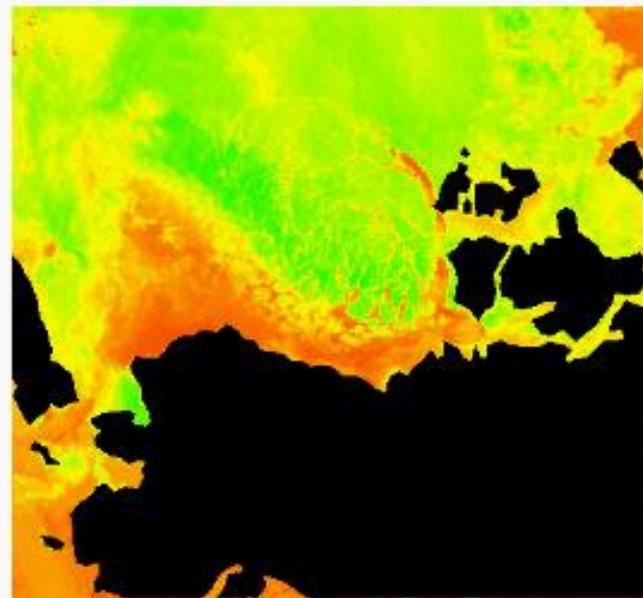
Feb 9, 2016
Sea Ice
Concentration
← VIIRS
MODIS



- Sea ice leads algorithm has been developed for MODIS
- Future steps
 - Extend algorithm to VIIRS
 - Real-time product using VIIRS



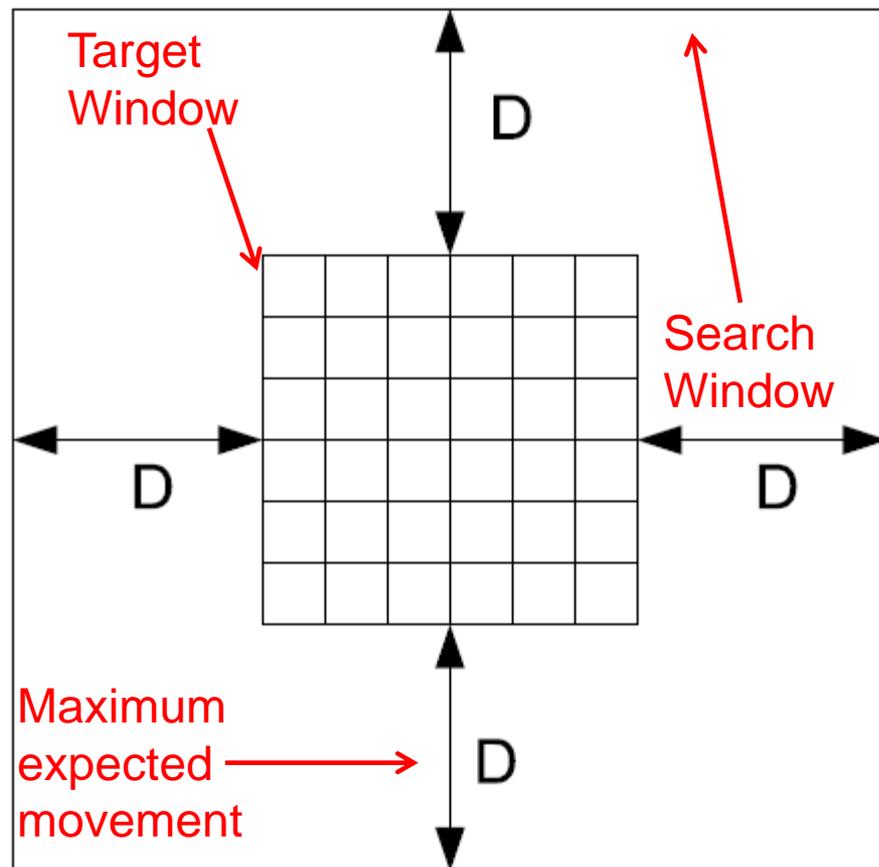
- Ice motion computes displacement between features in two separate satellite images
- Currently generated from :
 - AMSR2 (89 GHz)
 - VIIRS infrared window (M15)
 - Blended AMSR2+VIIRS(IR)
 - VIIRS day-night band (DNB)



AMSR2 89GHz Brightness
Temperatures, April 24-May 26, 2016

Sea Ice Motion, Algorithm

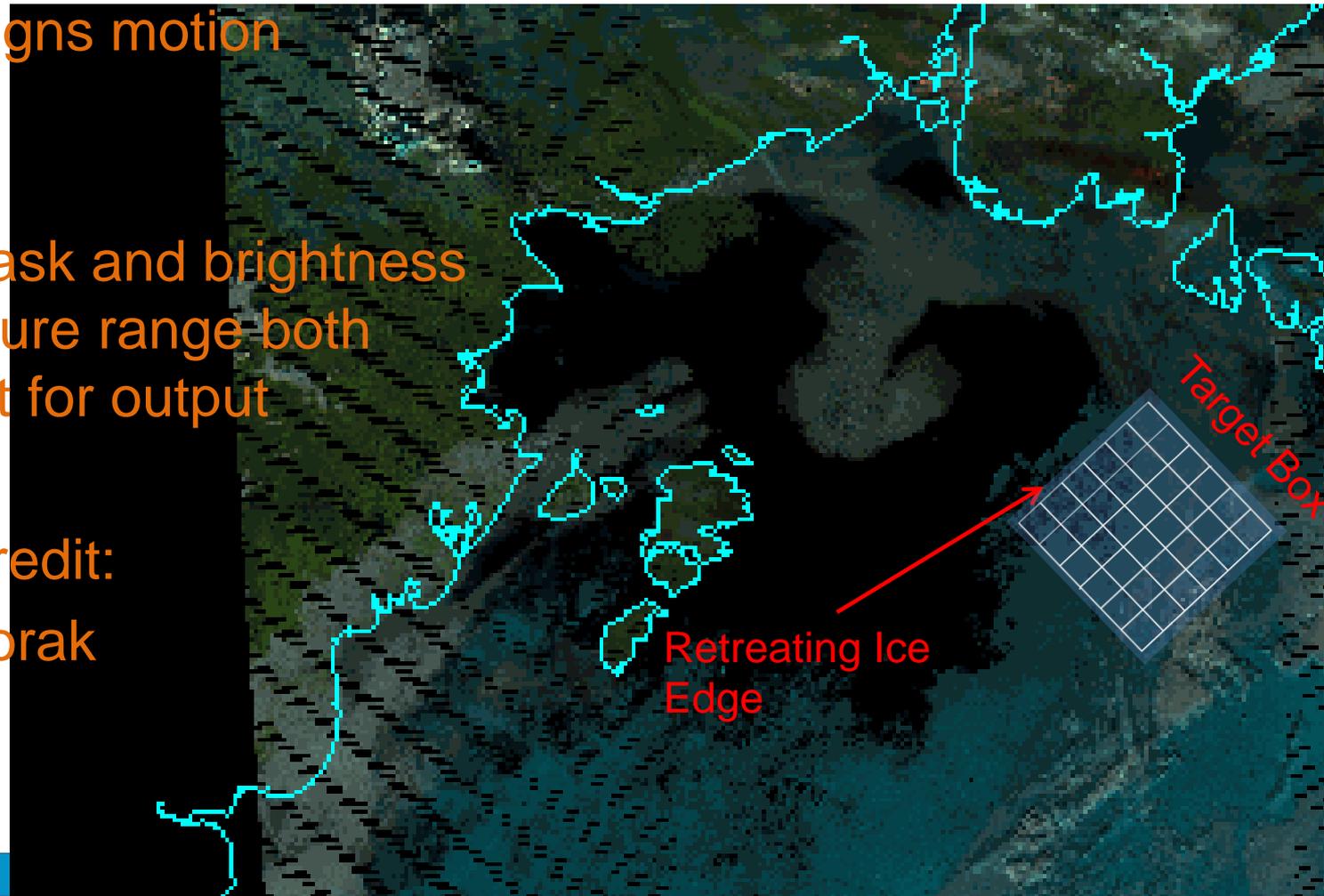
- Automated, maximum cross-correlation (MCC) procedure is used to features within the target window
- Target window size, search range, and time between images can be edited
- Imagery must be placed on similar grid for consistency



Sea Ice Motion, Algorithm

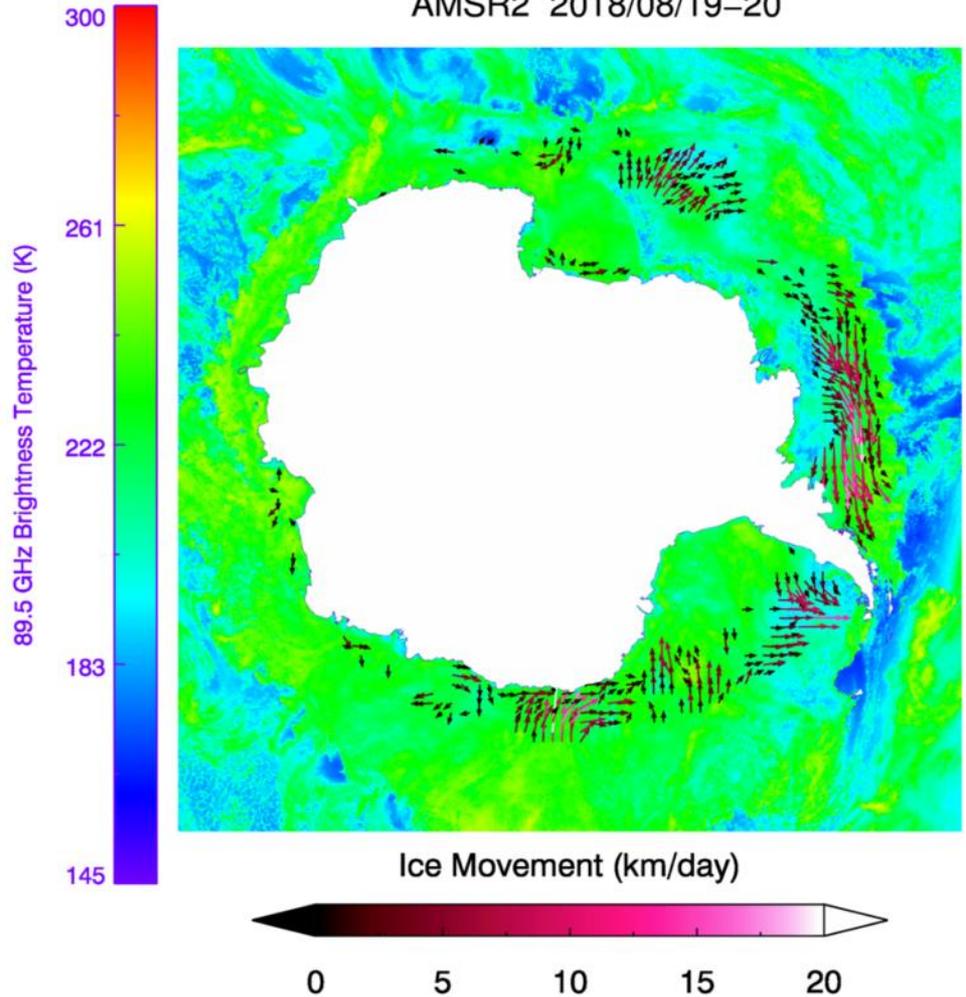
- Algorithm searches for changes in the target box then assigns motion vectors
- Cloud mask and brightness temperature range both important for output
- Image Credit: Rich Dworak

Image Credit: Rich Dworak, CIMSS

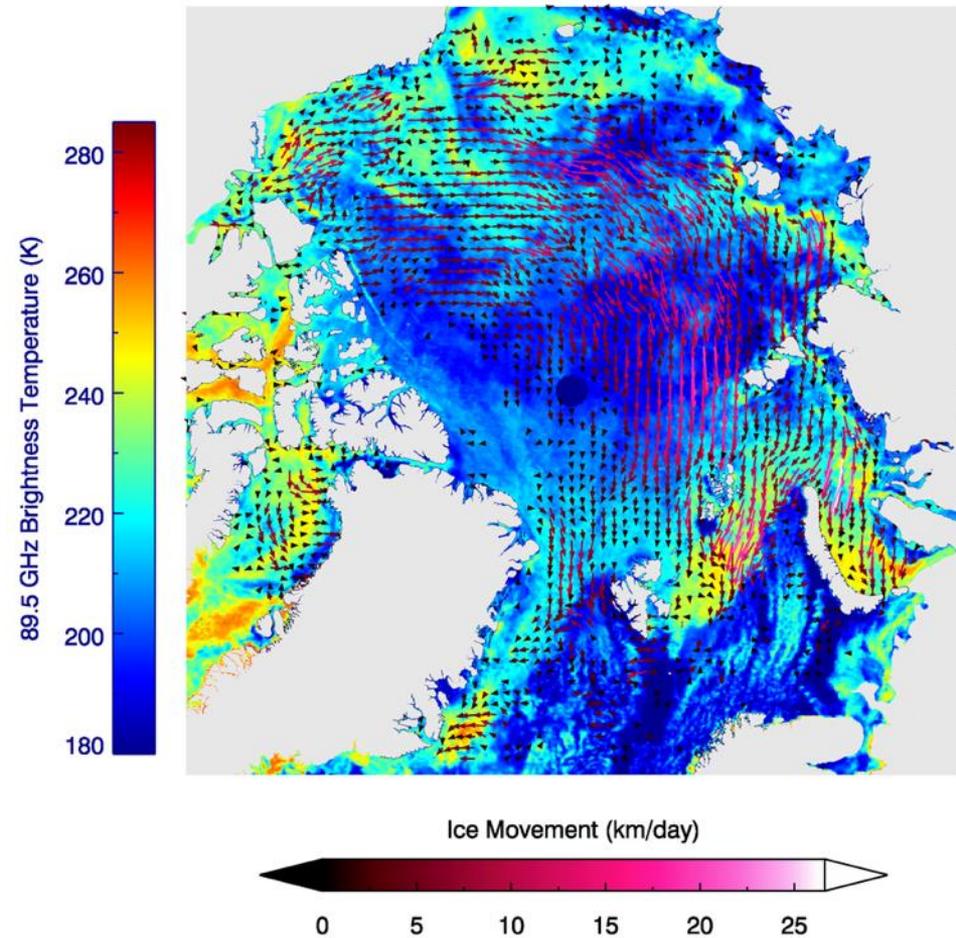


Sea Ice Motion

AMSR2 2018/08/19-20



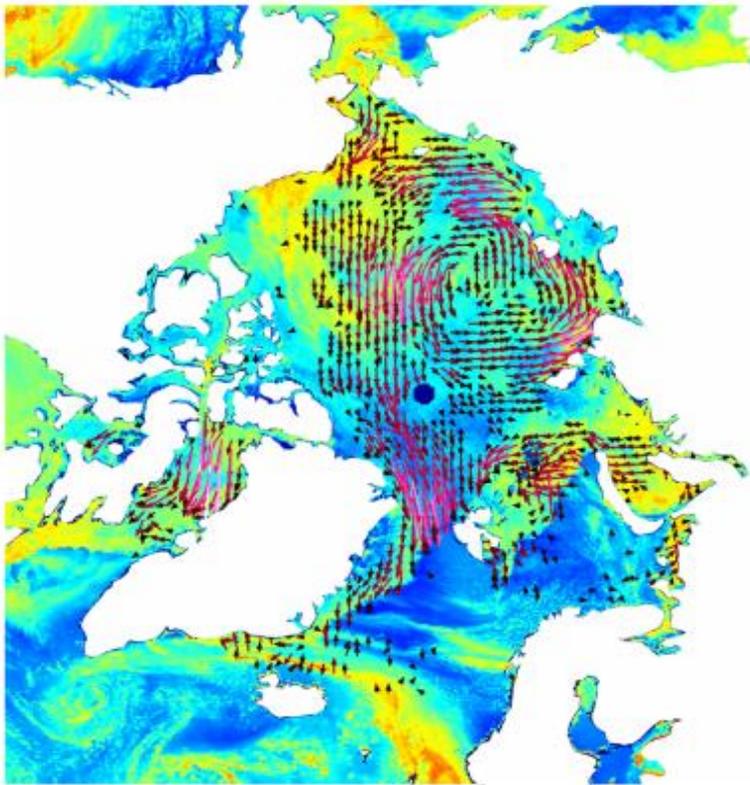
Blended Ice Motion 2017/05/08-09



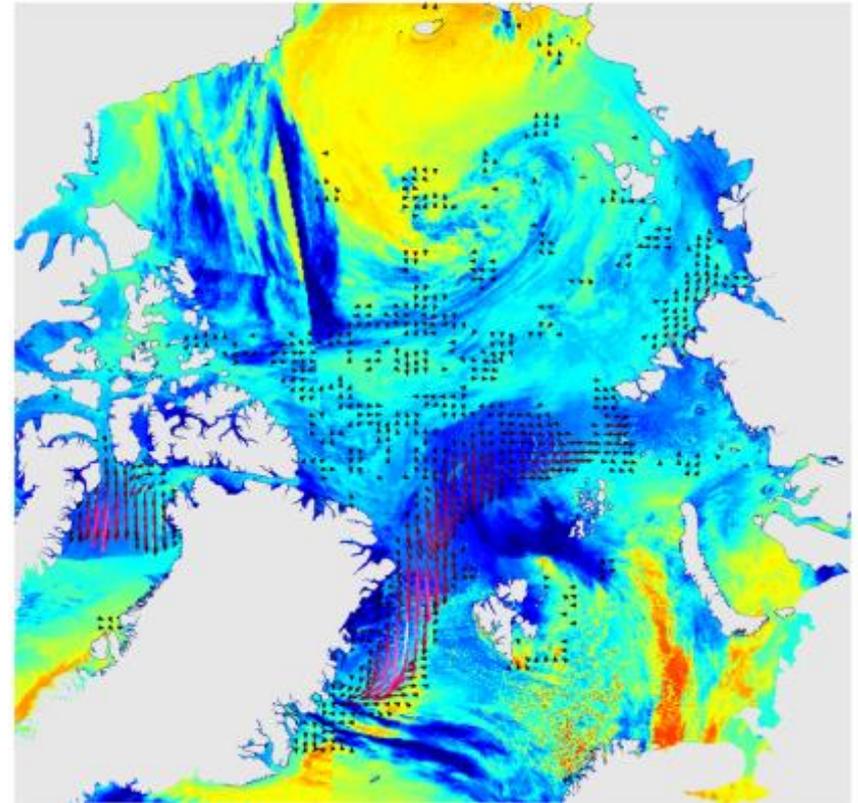
Daily generation over Arctic and Antarctic with more precise motion available for areas of interest

Blended Sea Ice Motion

AMSR2 2017/03/10-11



VIIRS_M15_10-11



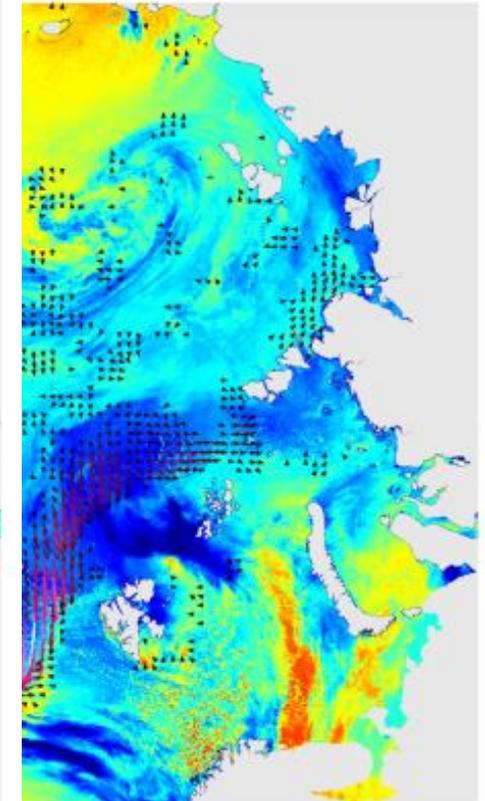
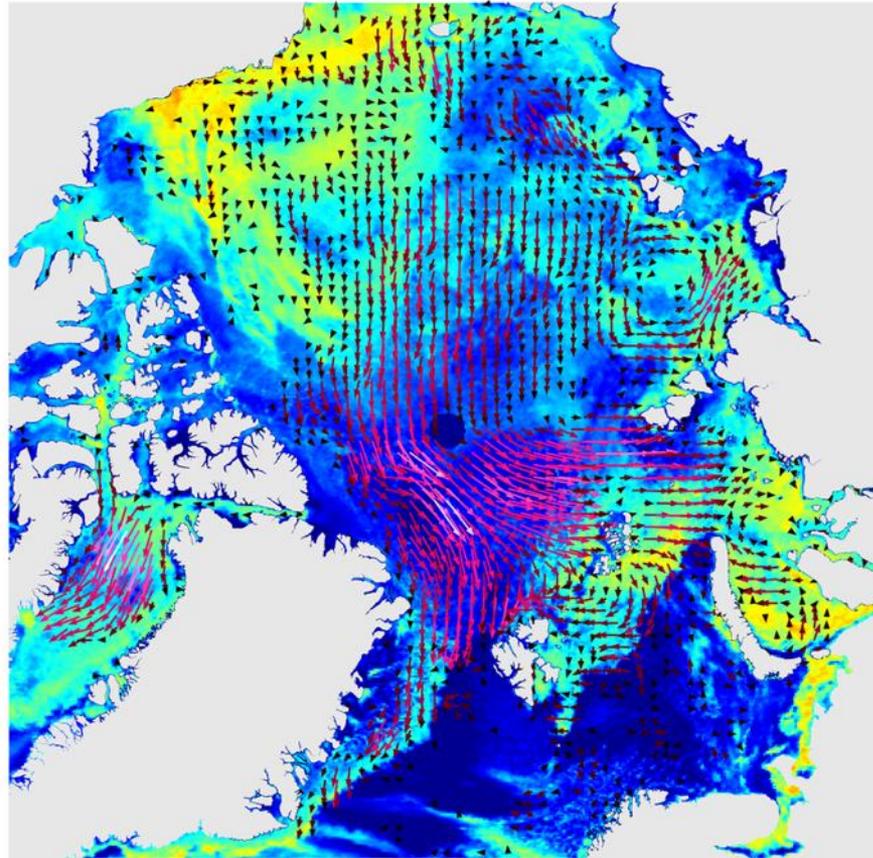
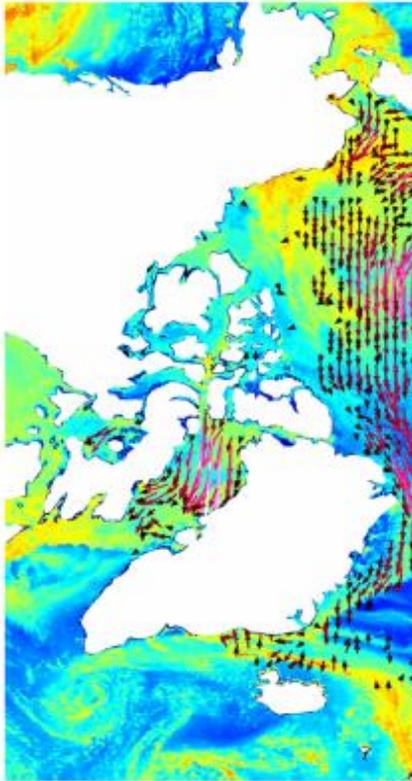
Motion from all-weather AMSR2 may be combined with high-resolution (but cloud-sensitive) VIIRS

Blended Sea Ice Motion

AMSR2 2011

Blended Ice Motion 2017/03/10-11

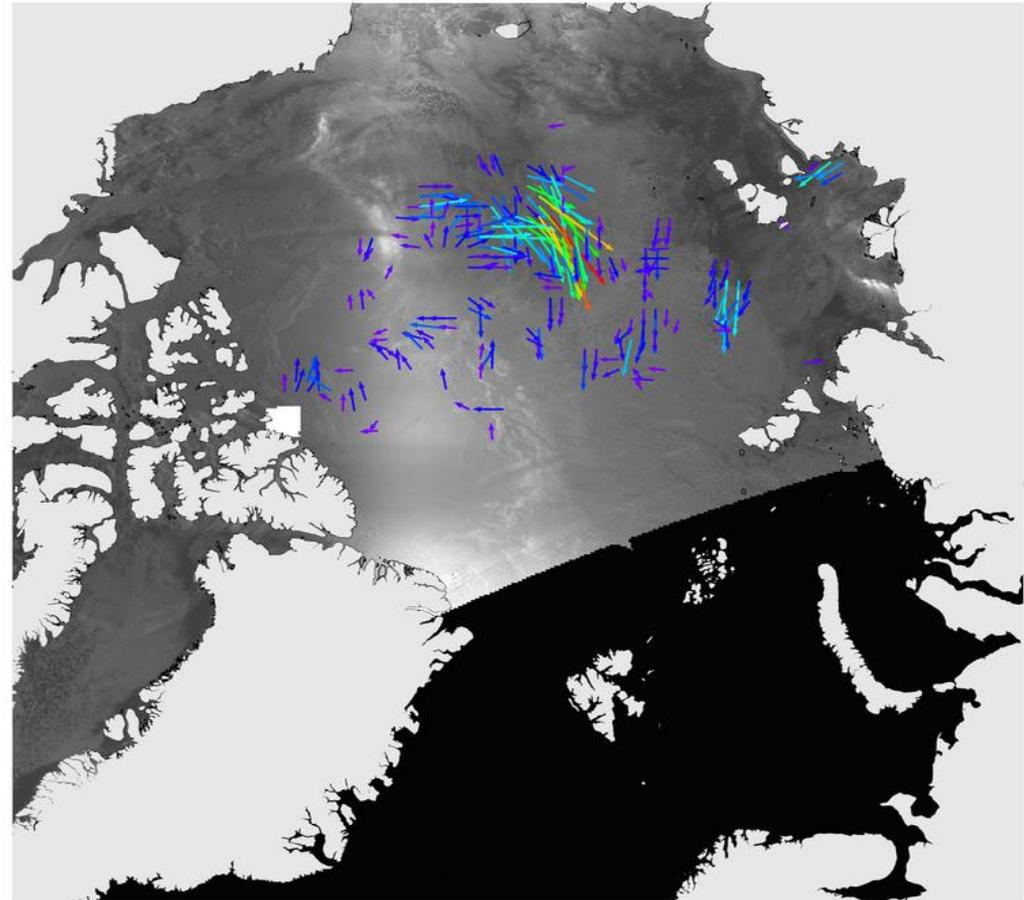
A15_10-11



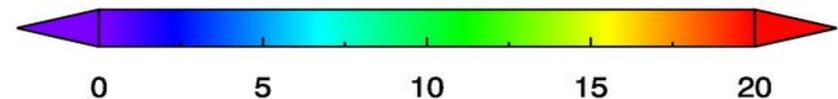
Blended product provides high spatial resolution under all-weather conditions

- High spatial resolution (750m) compared to AMSR2
- Not limited to daytime overpasses
- No additional processing for blending with other VIIRS M bands

VIIRS_NCC_10/11-12

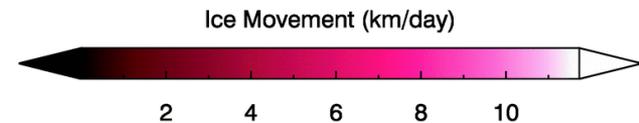


Ice Movement (km/day)

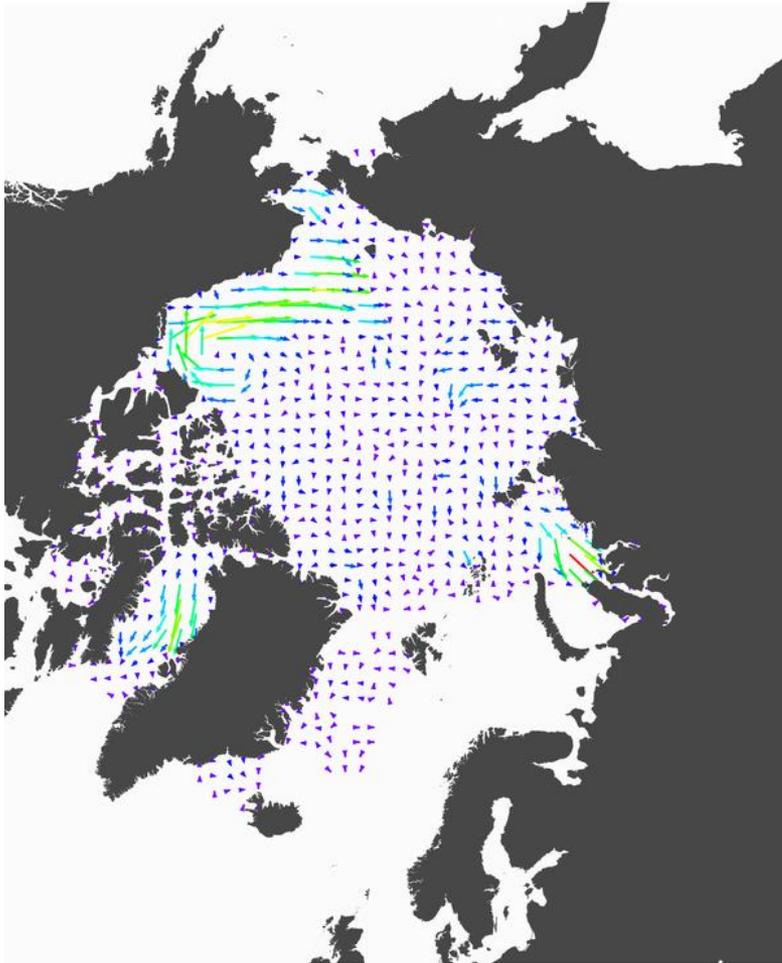


- Provided blended AMSR2+VIIRS sea ice motion over the Alaskan Region
- Daily updates provided 24-hour motion vectors to Alaskan Sea Ice Program analysts
- Experimented with “near real-time” ice motion that updates every 3 hours

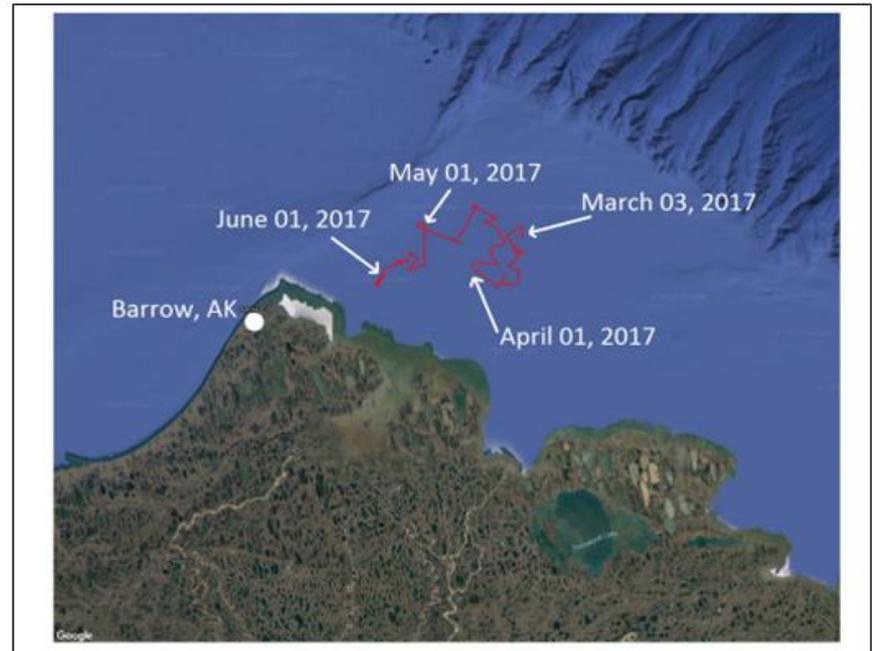
Blended Ice Motion: 2018/05/01-02



VIIRS M15 Ice Motion: 20180107 - 20180113



Lagrangian Tracking



Daily changes in ice position off of Barrow, Alaska, derived from the blended sea ice motion product.

Monthly/Seasonal Ice Motion