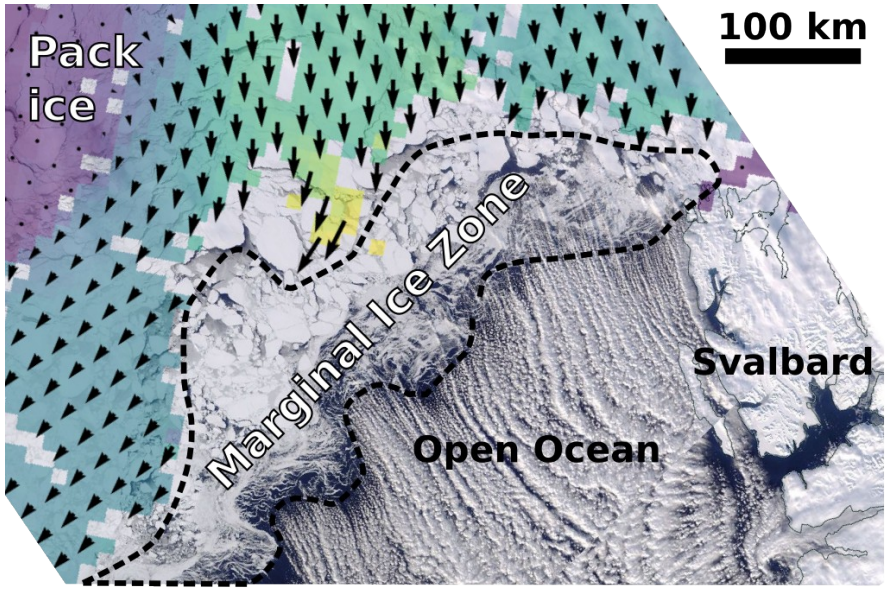
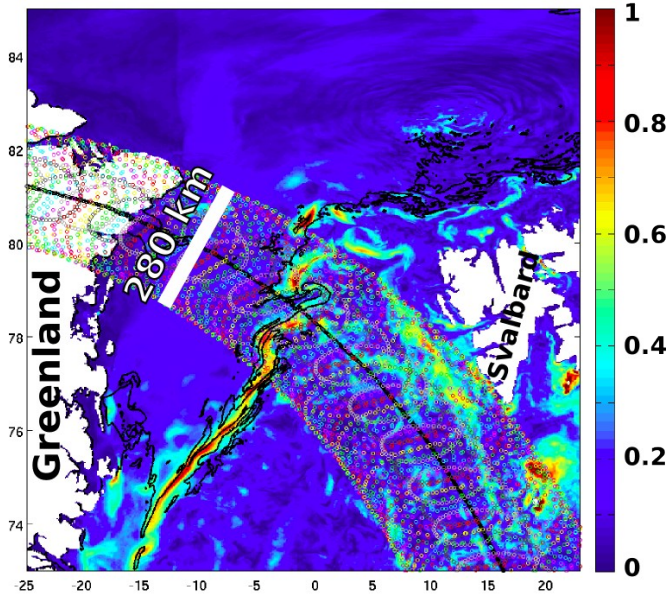
Doppler Oceanography from Space
From science to technology and applications
10 -12 October 2018 Brest (France)

SEA ICE AND NEAR- SEA ICE APPLICATIONS





Johnny A. Johannessen[1], Harald Johnsen[2], Anton Korosov[1], Jeong-Won Park[1], Thomas Kræmer[2], Camilla Brekke[2], Geir Engen[2], Morten W. Hansen[1], Mohamed Babiker[1]

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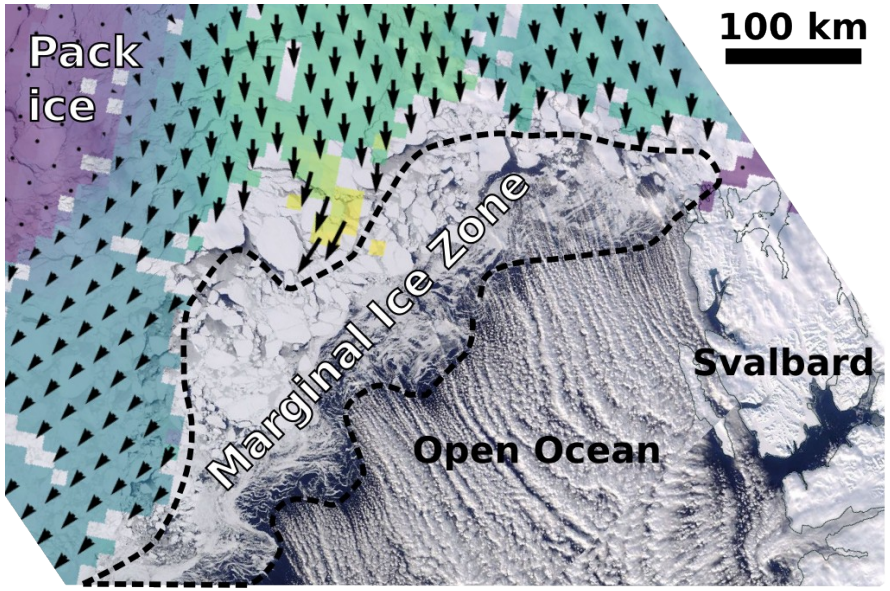

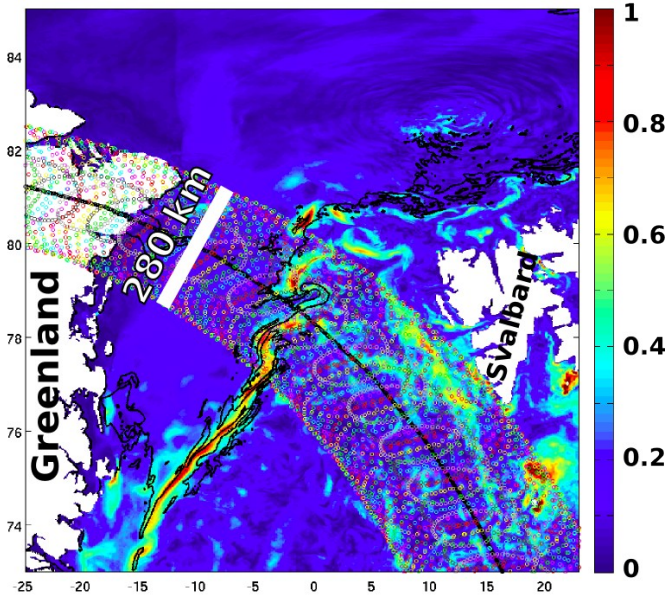

Table of Content

- Background
  - Large scale circulation
  - Lead fraction and MIZ characteristics
- Doppler shift retrievals over sea ice
  - Assesment
- Summary

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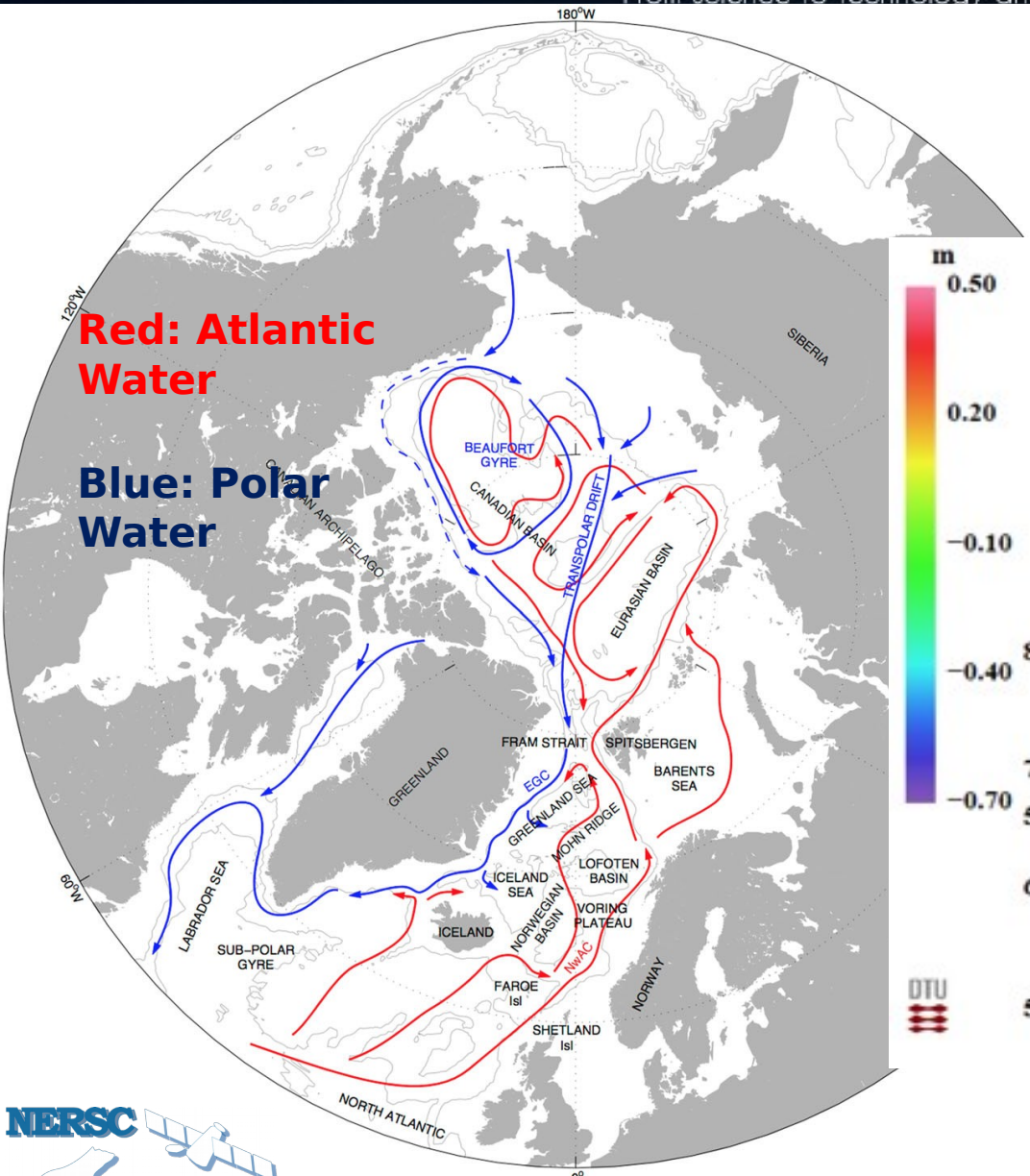
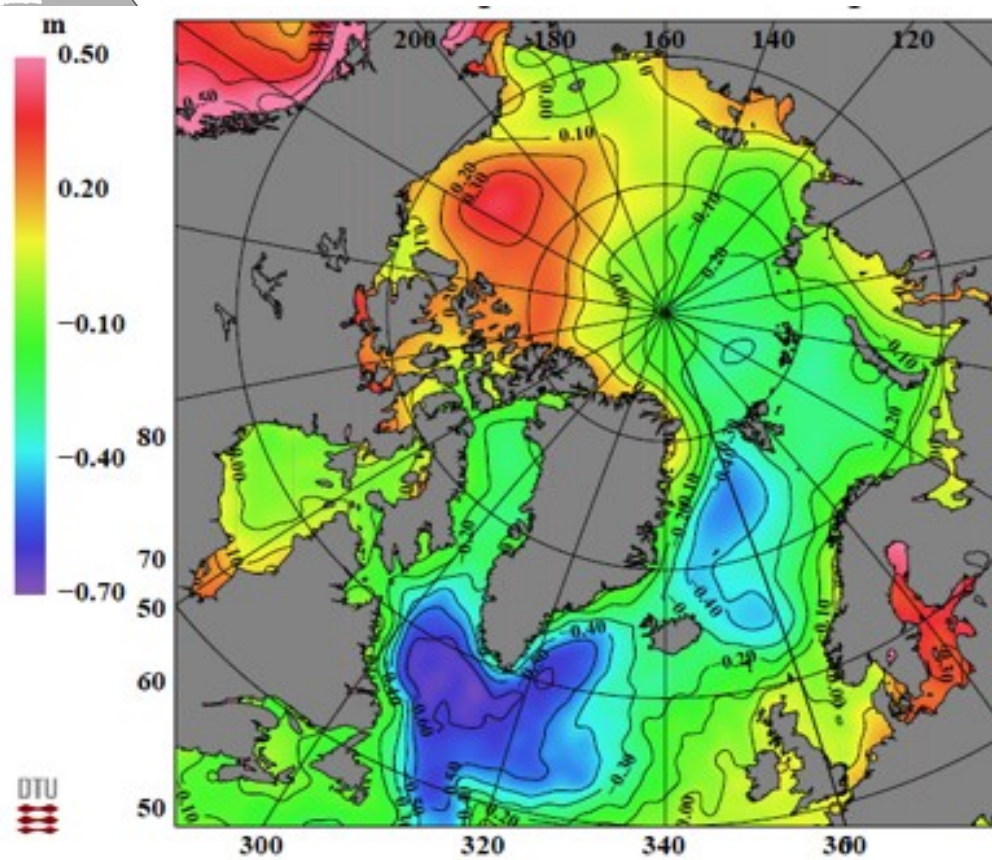
Large scale ocean circulation



Red: Atlantic Water

Blue: Polar Water



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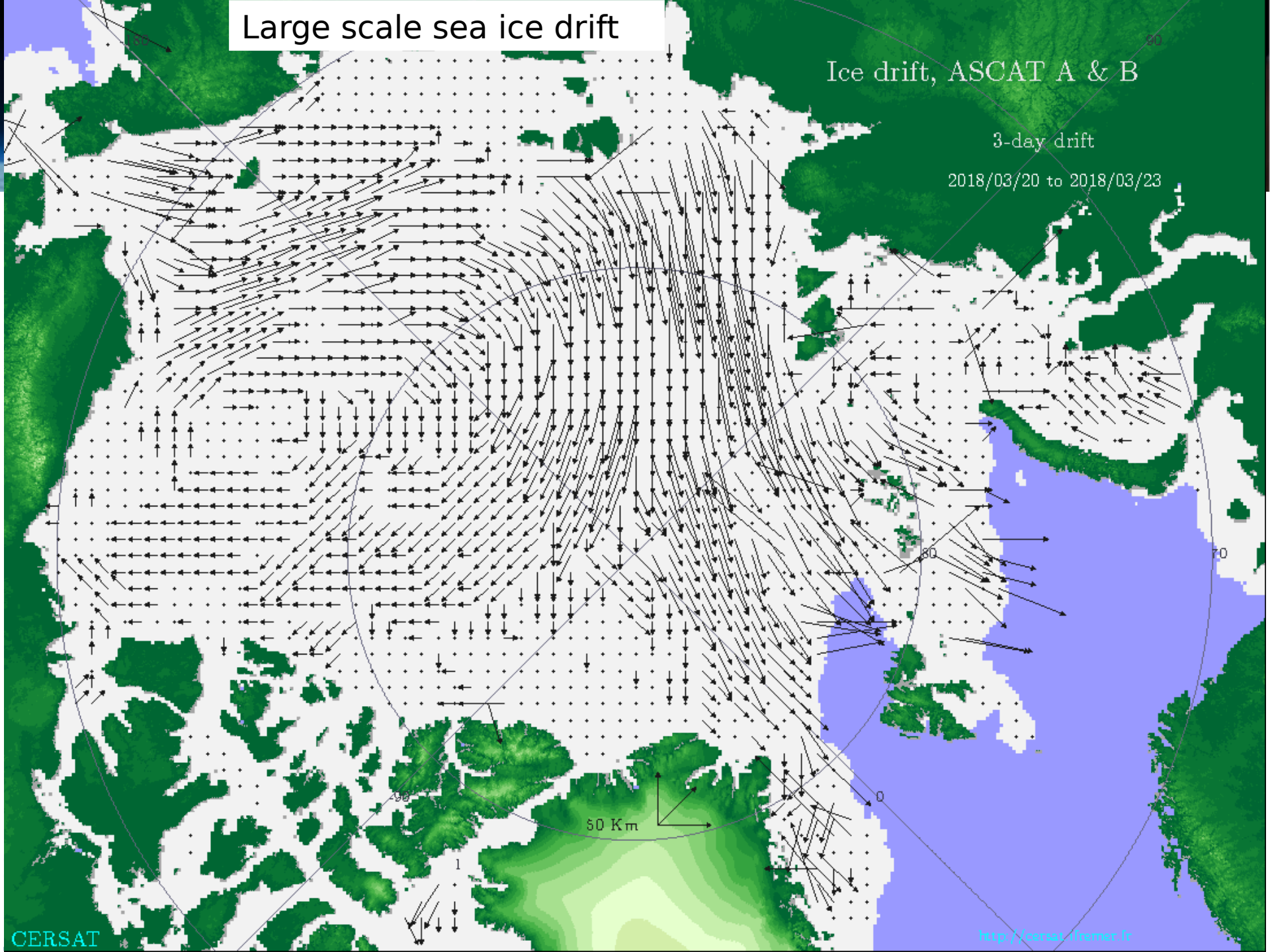
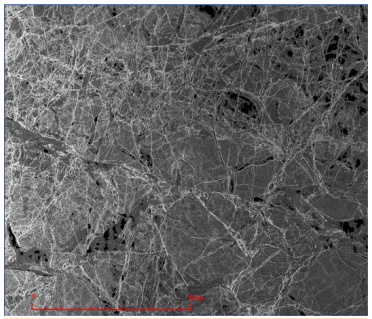
Large scale sea ice drift

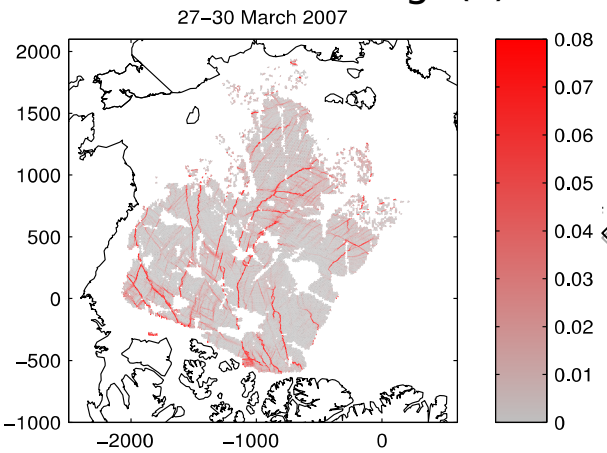


LEAD FRACTION AND SHEAR/DIV ZONES

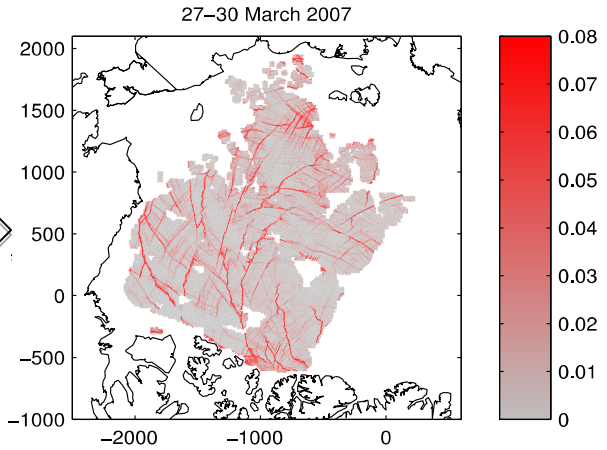
SAR image(s)



From SAR image(s)



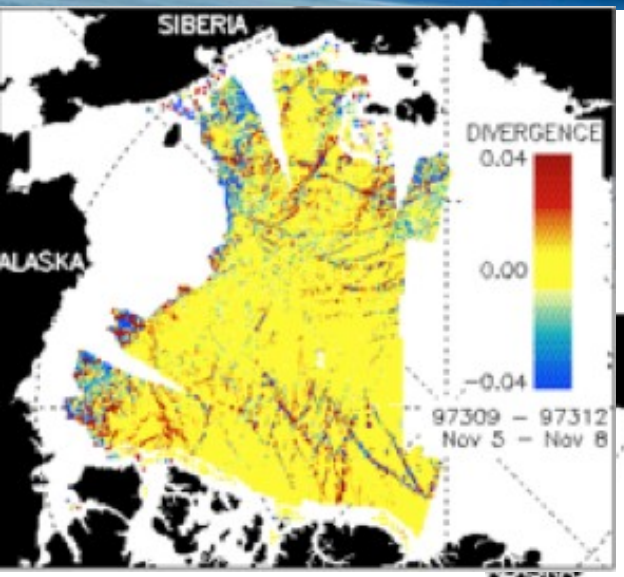
Elasto-Brittle model



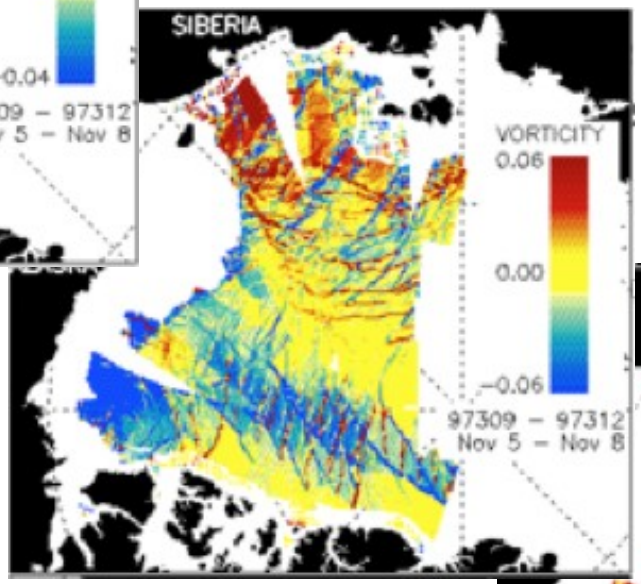
Sea Ice Deformation

The deformation of a 10 km by 10 km cell over a 41-day period is shown from RADARSAT.

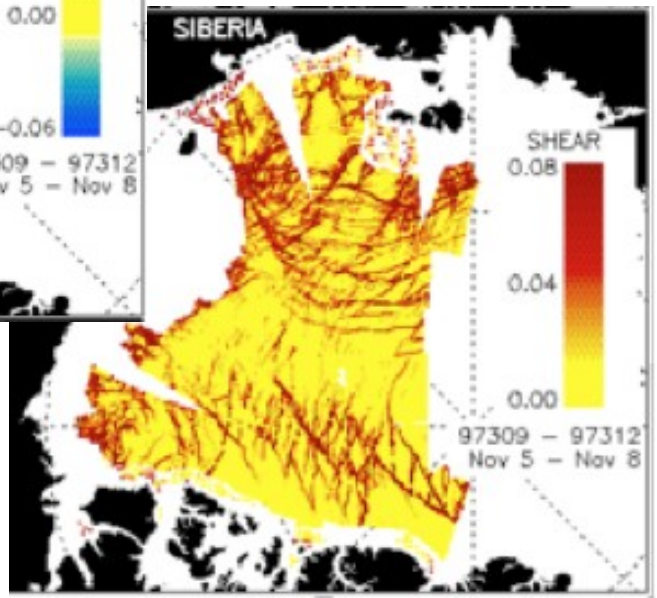
The record of area change reflects the opening of the lead running through the cell.



Divergence



Vorticity



Shear

Courtesy Ron Kwok

MIZ characteristics

The marginal ice zone is known to undergo complex Ocean - Sea Ice - Atmosphere interactions that are manifested both in the structure of the ice edge and in the sea ice motion. Among these are:

- Upwelling
- Mesoscale eddies
- Ice jets
- Wave refraction and attentuation
- Ice bands and internal waves

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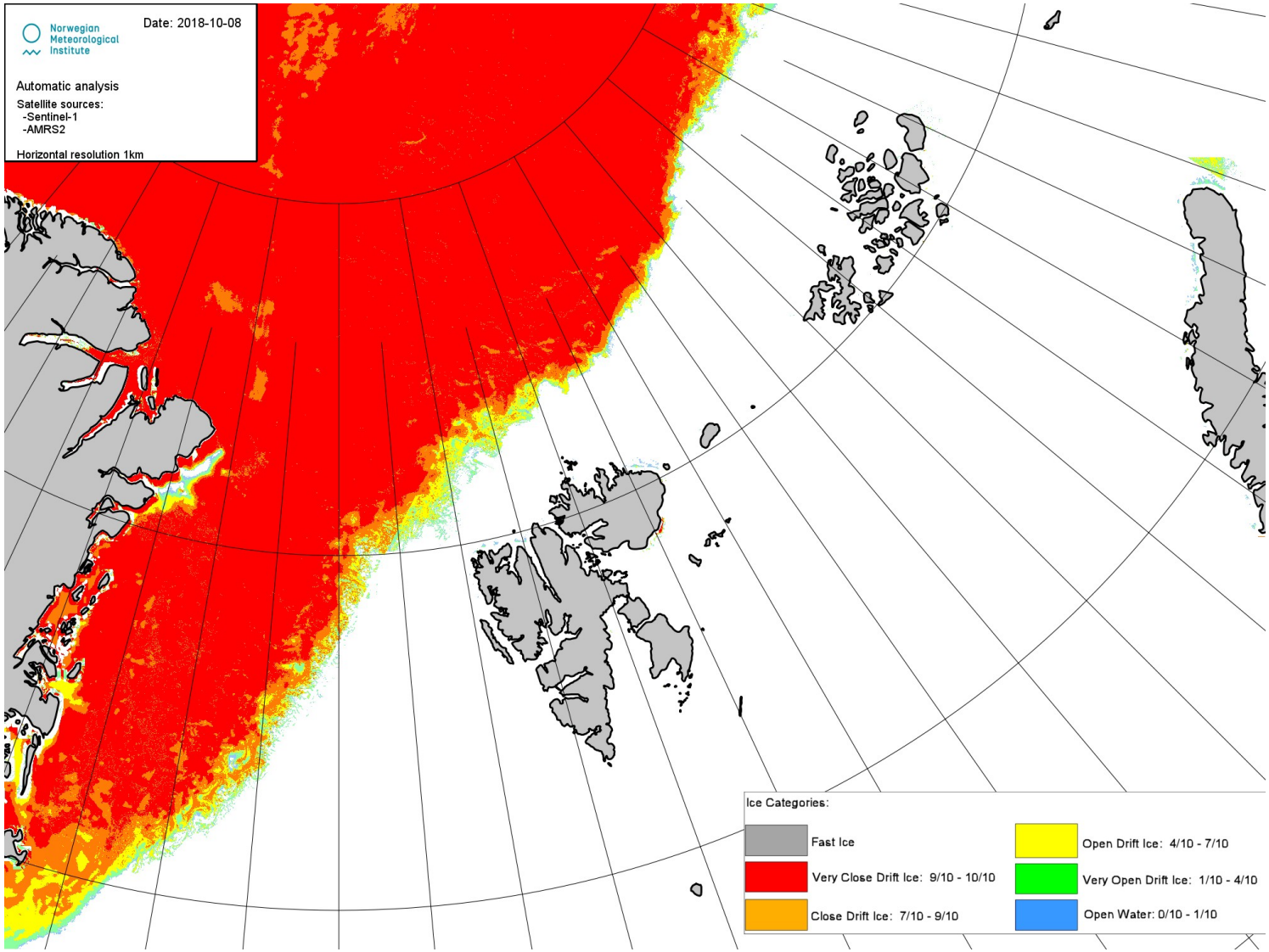

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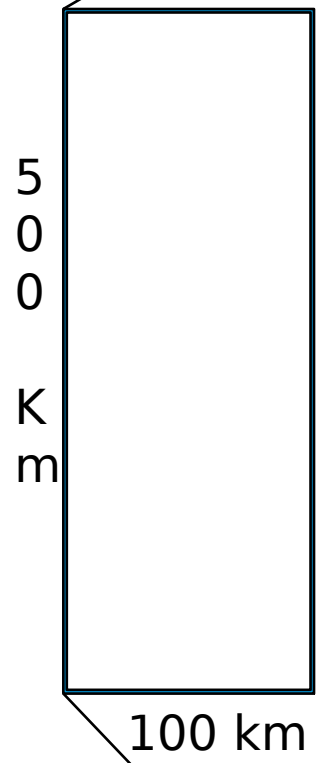

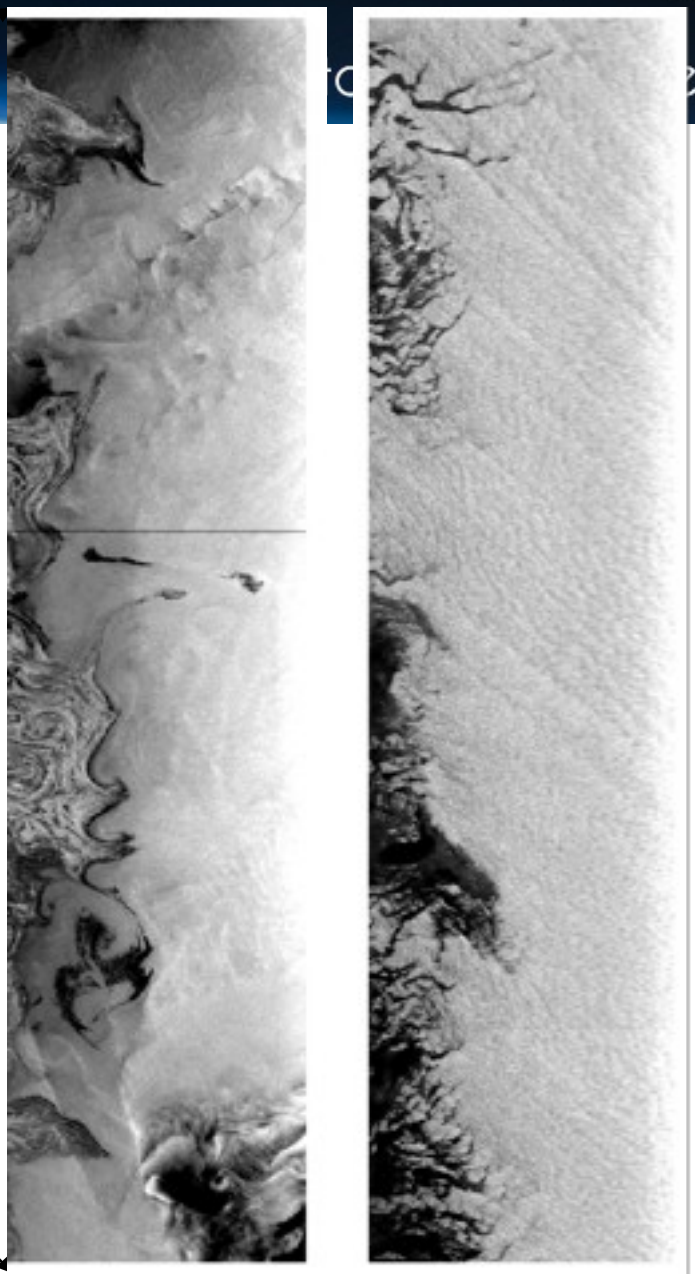

ERS-1 SAR image of a 500 km area along the MIZ in the Greenland Sea from 13 January 1992.

Same area imaged by ERS-1 on 16 January 1992.

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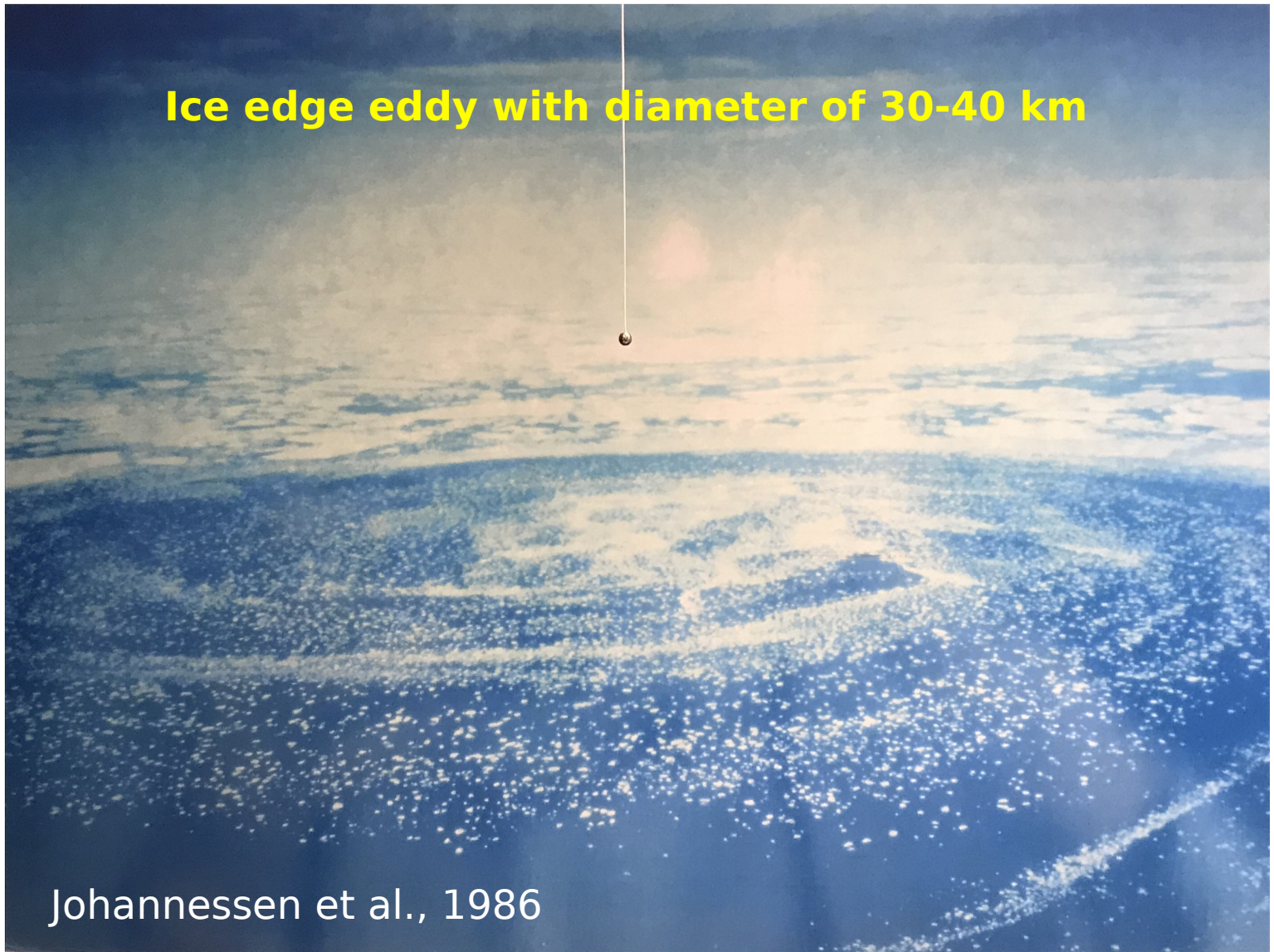
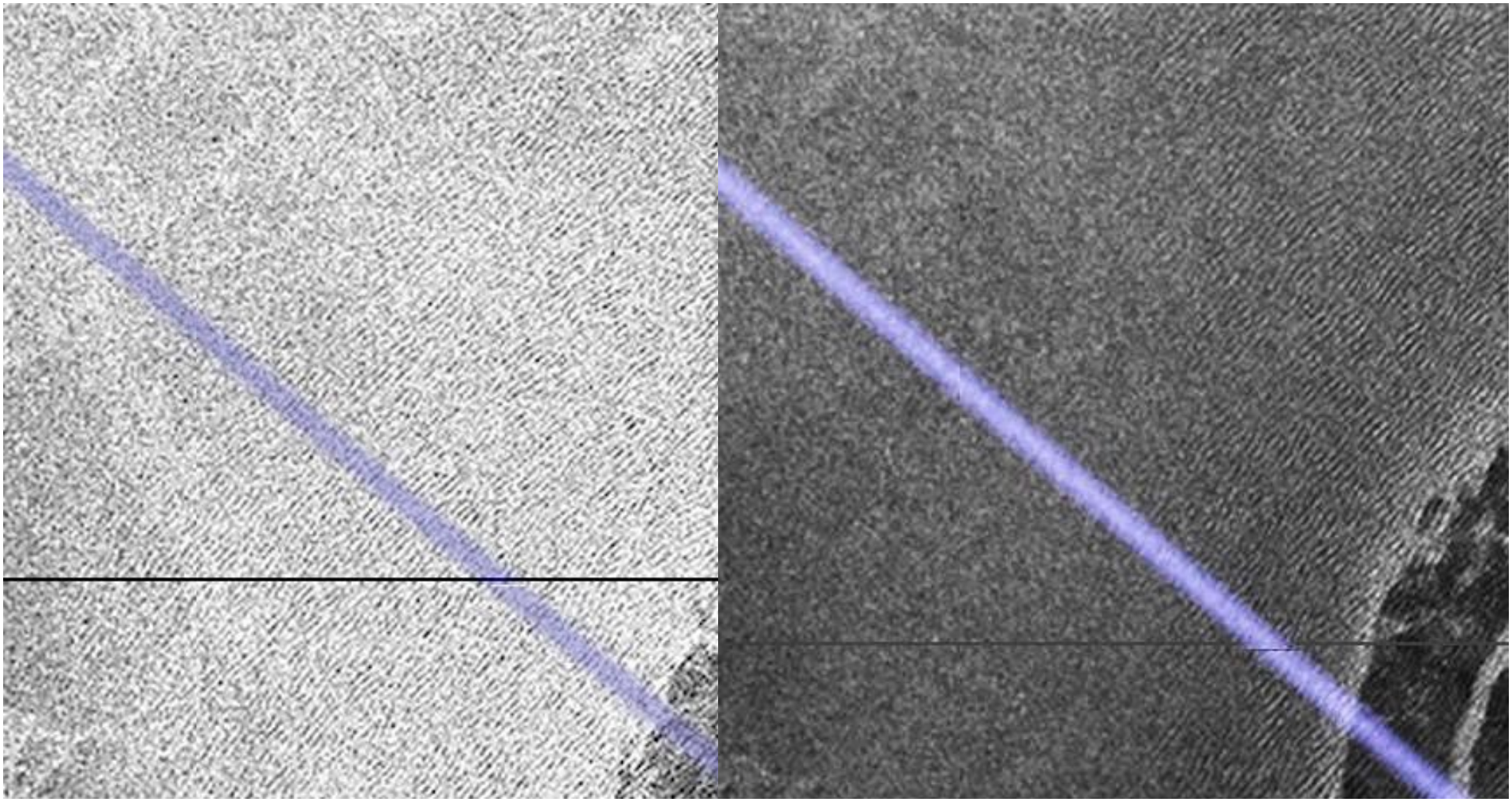
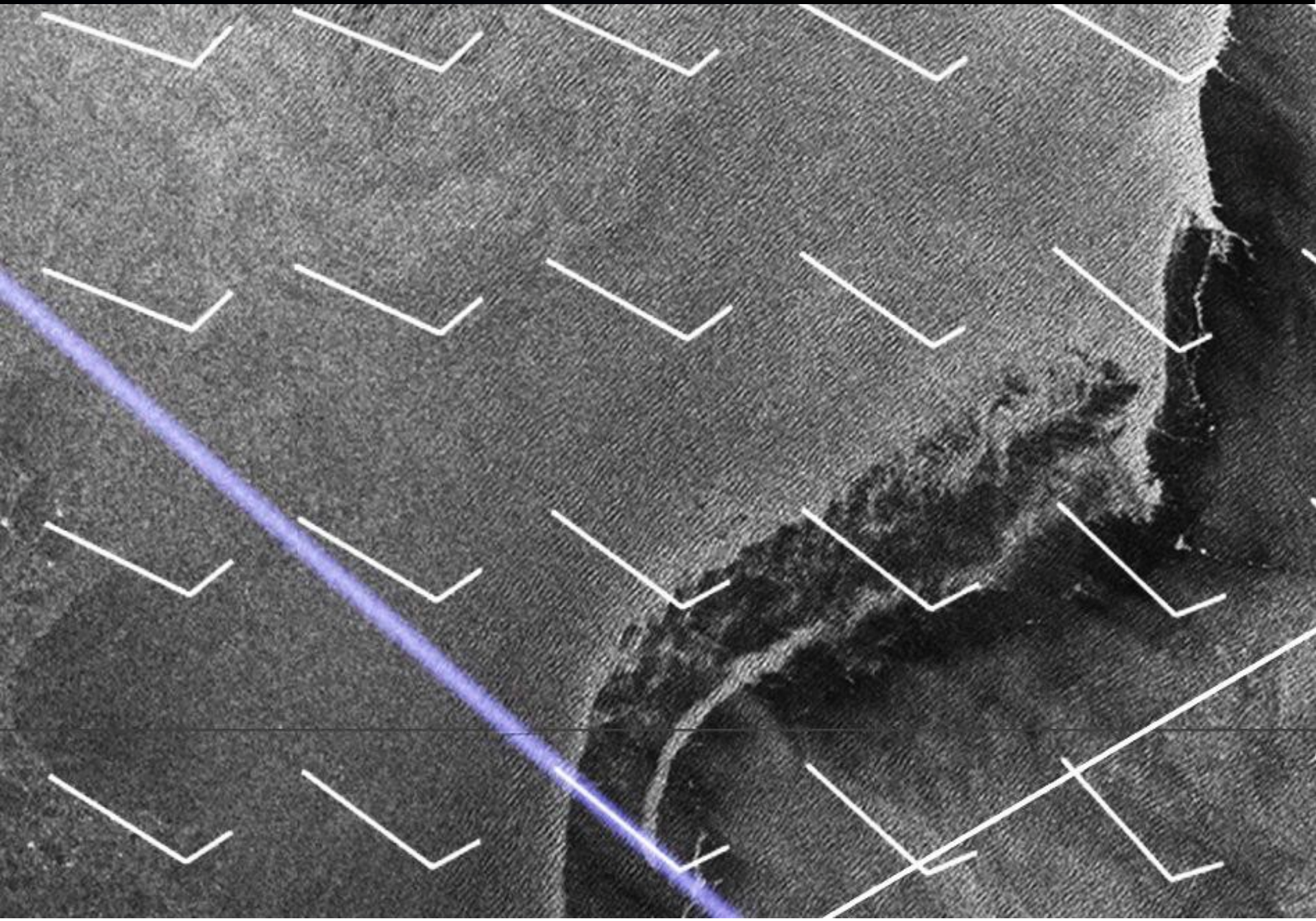

Ice edge eddy with diameter of 30-40 km
Johannessen et al., 1986



Waves in the ice on 5 October 2014 from S1 (courtesy SWARP Project)



Waves in the ice (courtesy SWARP Project)

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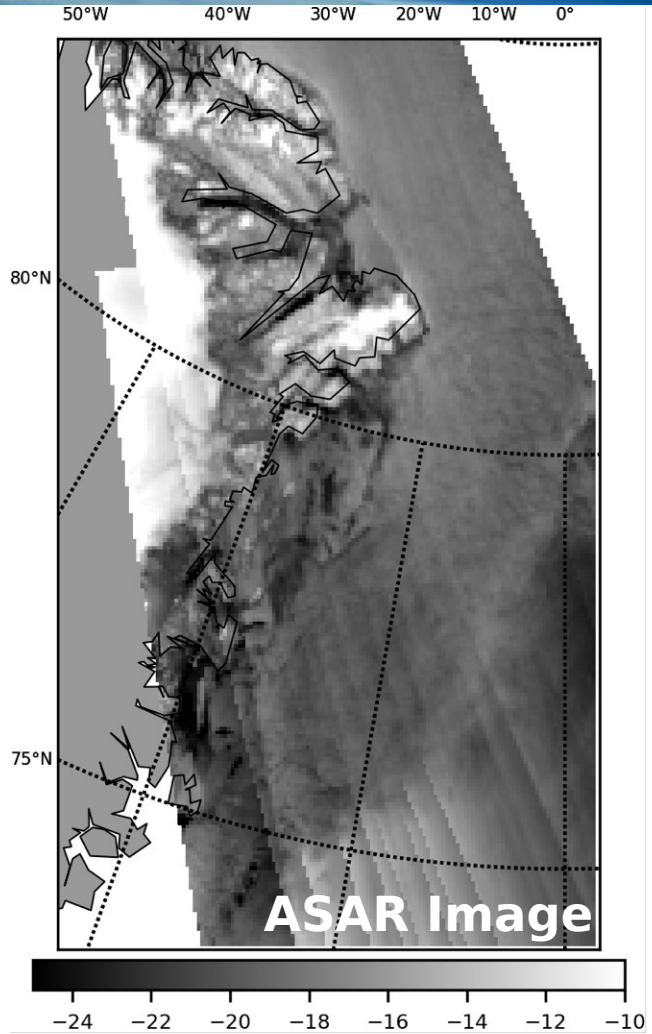
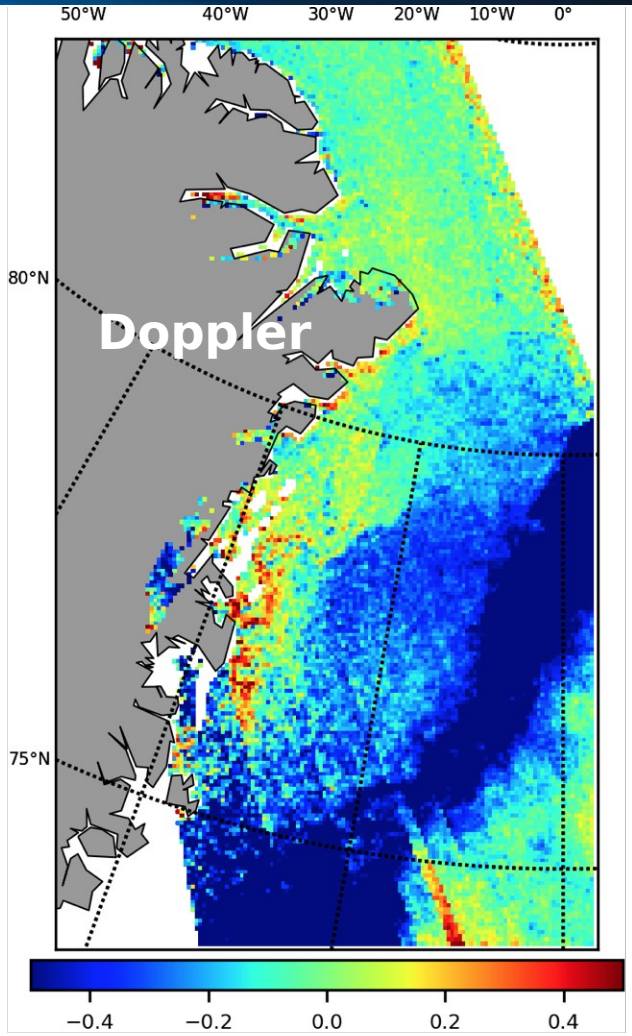
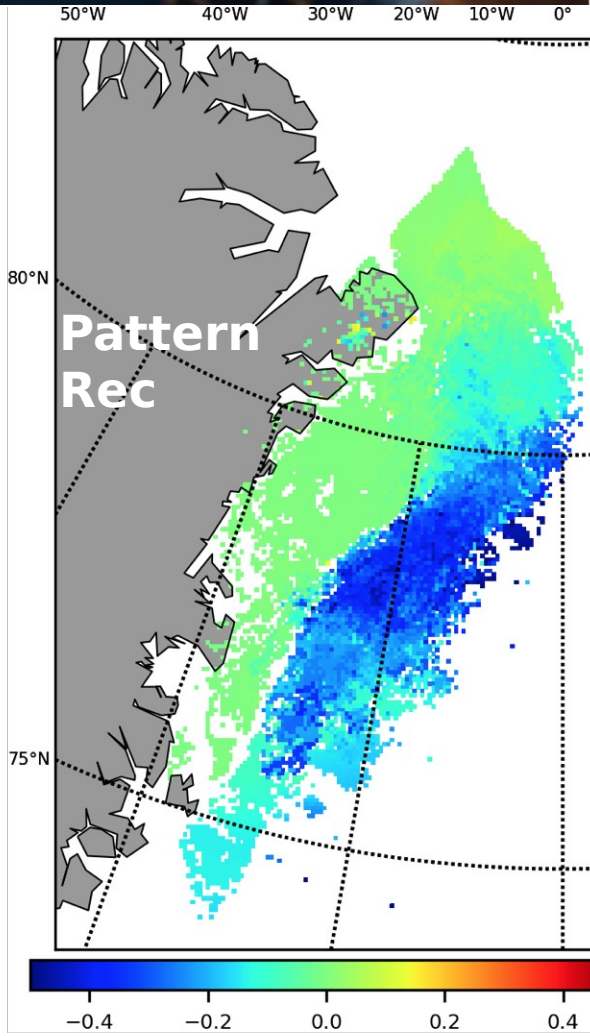


(a)



(b)



(c)

Doppler based velocities and Pattern recognition

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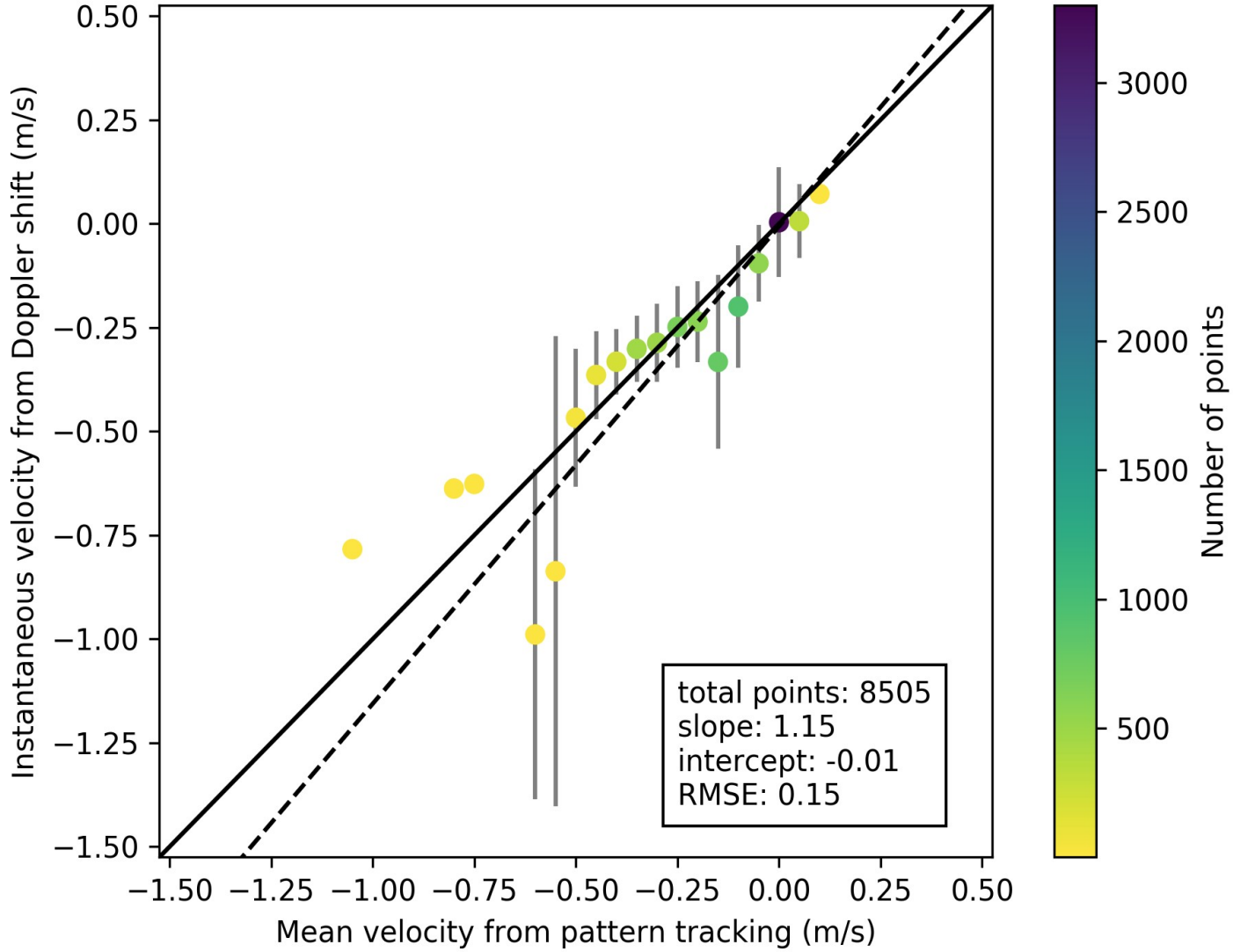
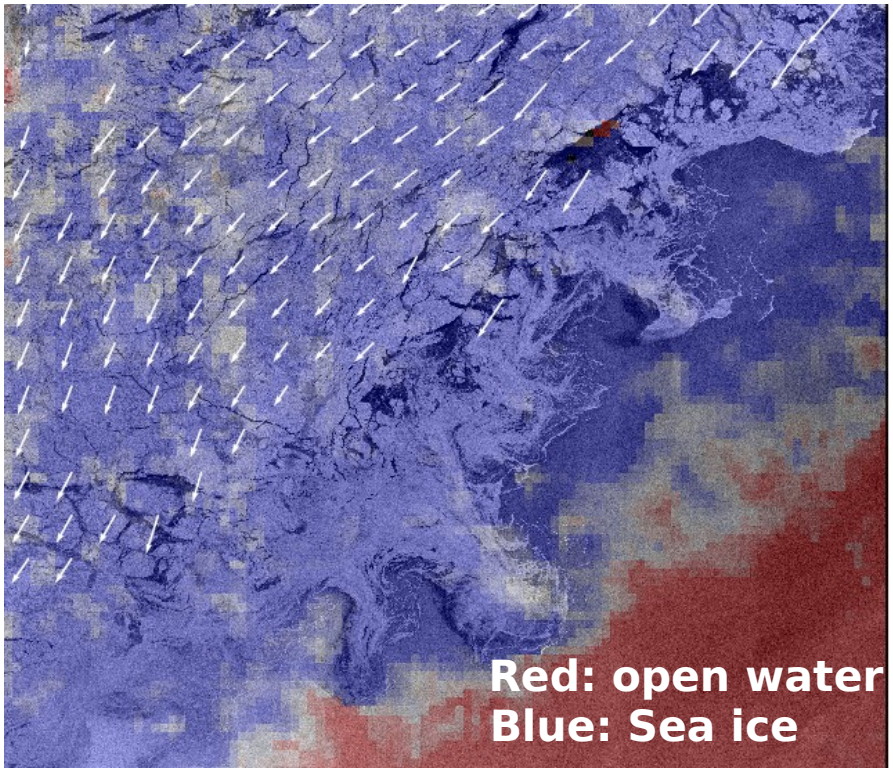


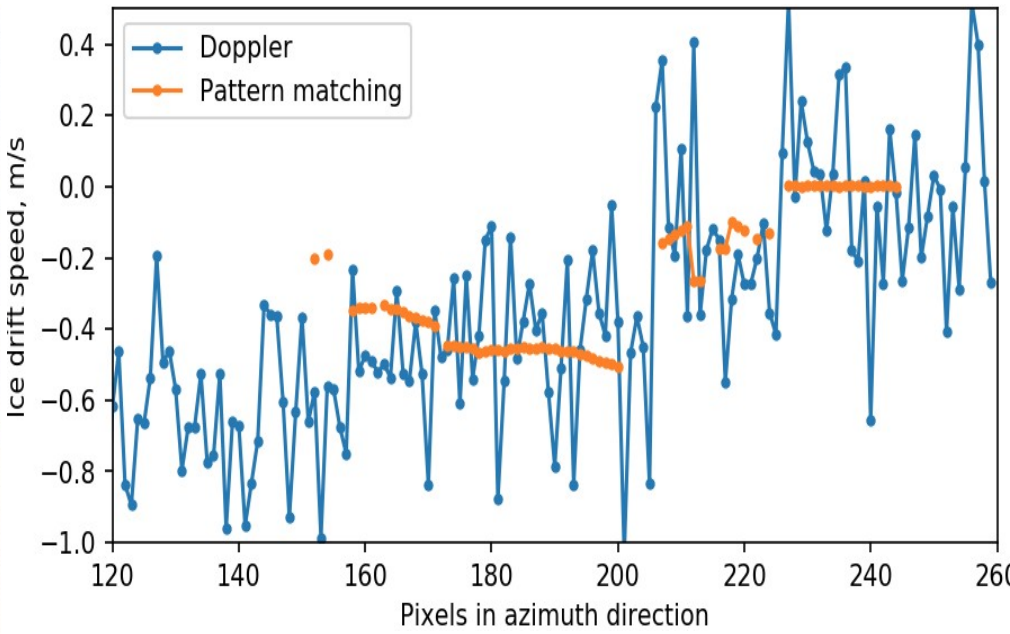
ASSESSMENT

Time averaged velocity fields from Doppler derived instantaneous velocity and pattern matching based mean velocity.

Envisat SAR image from the Fram Strait from 1 January 2010.

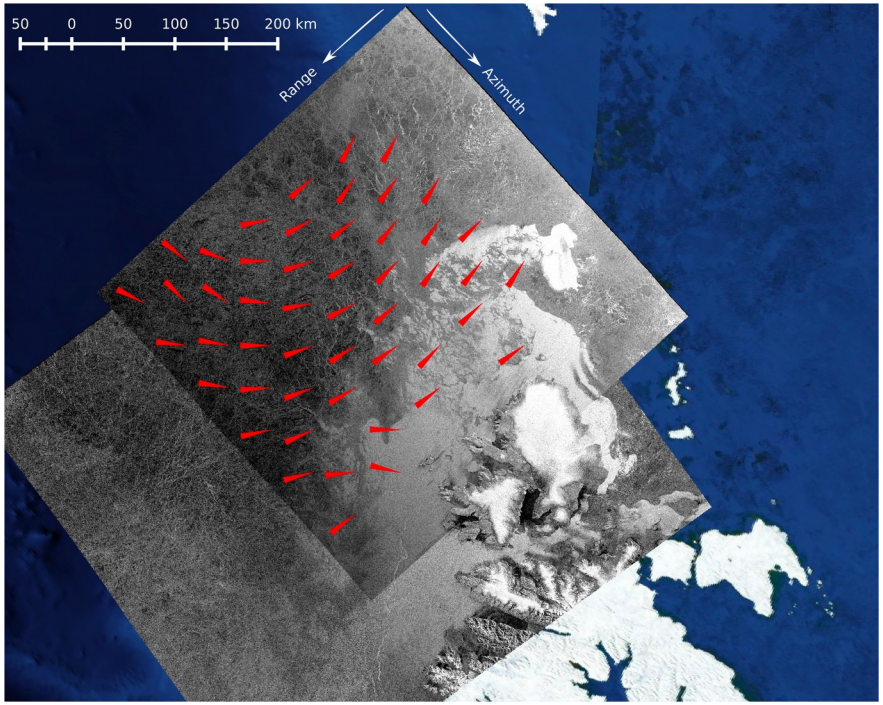


Sea ice drift vectors derived from combined pattern recognition and Doppler shift estimation.

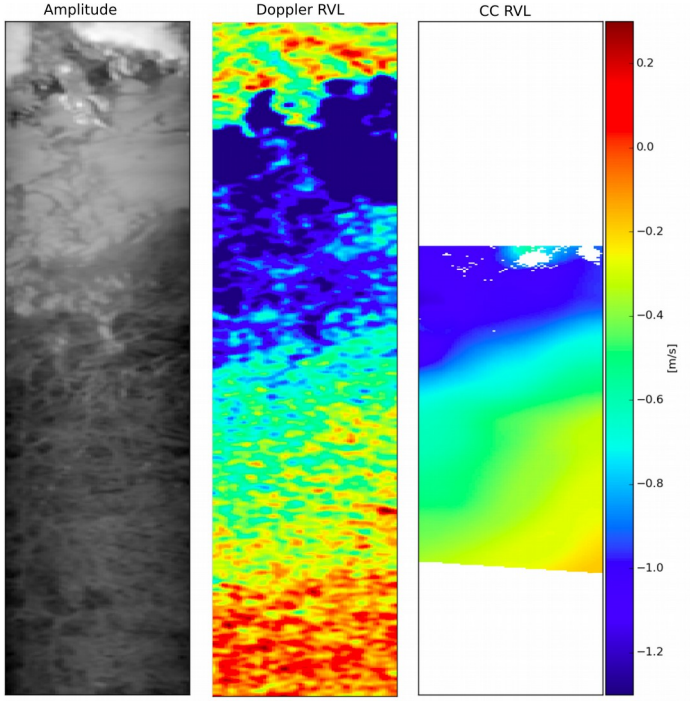


Values of sea ice drift speed from pattern matching (orange line) and Doppler shift.

Sentinel-1 TOPS Doppler & Sea Ice Drift



Collocated (25 min time separation) RSAT-2 and S1a EW with estimated sea ice drift vectors overlaid. Area: North West of Svalbard



S-1 intensity image (left), Doppler radial velocity (mid) and cross-correlation (CC) radial velocity (right).

T. Kræmer, H. Johnsen, C. Brekke, Engen G., "Comparing SAR-Based Short Time-Lag Cross Correlation and Doppler-Derived Sea Drift Velocities" IEEE Trans. Geoscience and Remote Sensing, Volume: 56 Issue: 3, ISSN: 1558-0644, DOI: 10.1109/TGRS.2017.2769222, 2017

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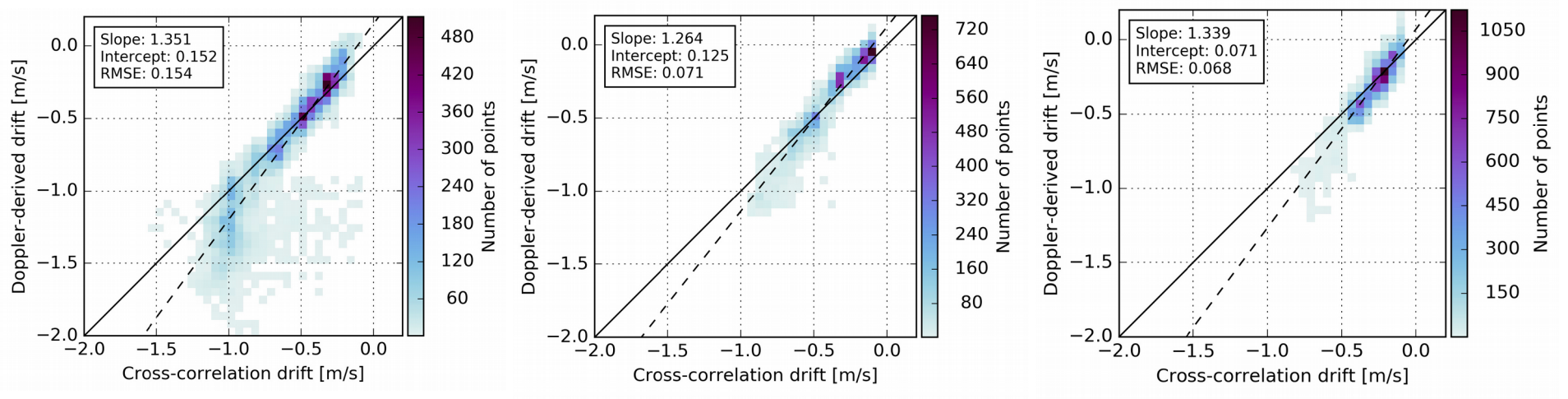

Scatterplot of cross-correlation (RSAT-2 and S1a) radial velocity versus S1a Doppler radial velocity. Left: EW3, Mid: EW4, Right: EW5. All estimates are averaged to around 10km x 10km.

The main source of the bias comes from imperfect compensation for antenna DC bias over swaths.

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Summary

- ✓ Doppler based velocity retrievals over sea ice are feasible.
- ✓ Larger incidence angles are favorable. Will it be possible at 12 degrees?
- ✓ Coupling with conventional pattern recognition is promising in order to recover a more homogeneous 2-D estimates.
- ✓ 2-D estimates with finer spatial resolutions < 10 km will be challanging.
- ✓ The attentuation of waves in the ice correlates with the ice deformation field.
- ✓ Application in sea ice models (elasto-brittle) and coupled sea ice-ocean models need deformation estimates.

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Thank You!

.....and please hurry up .....
sea ice may be gone in a not too far future

Photo by Espen Storheim

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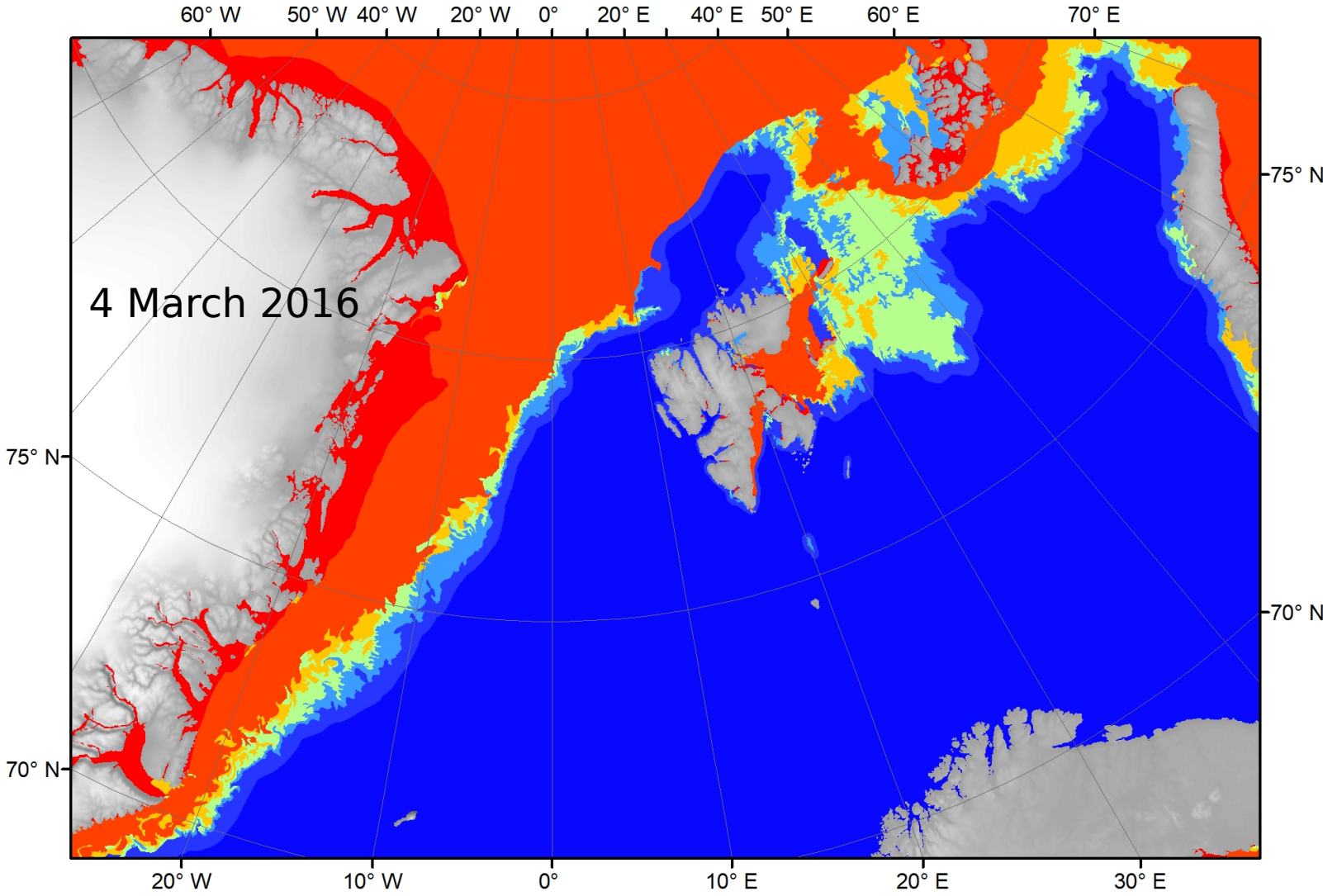

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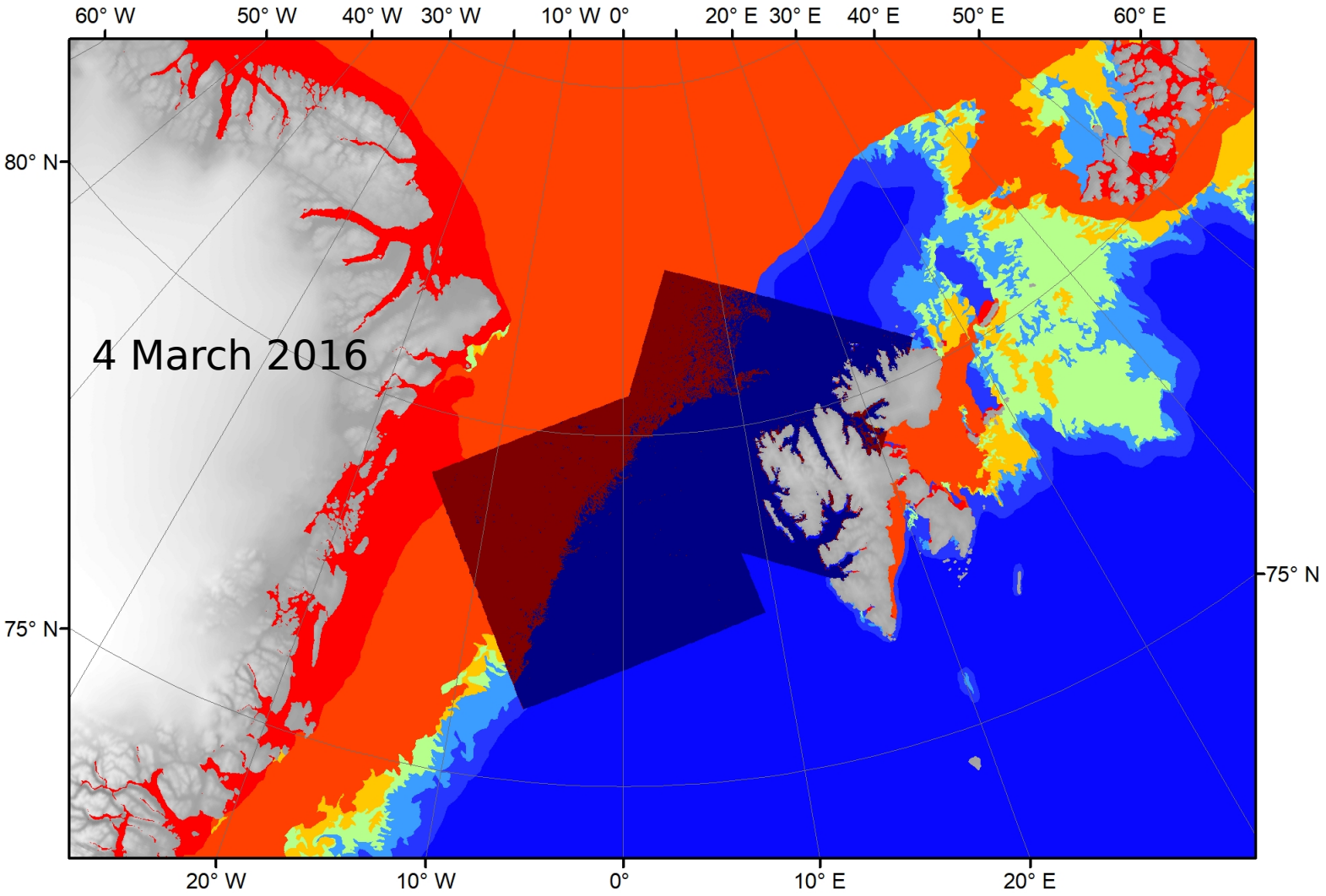

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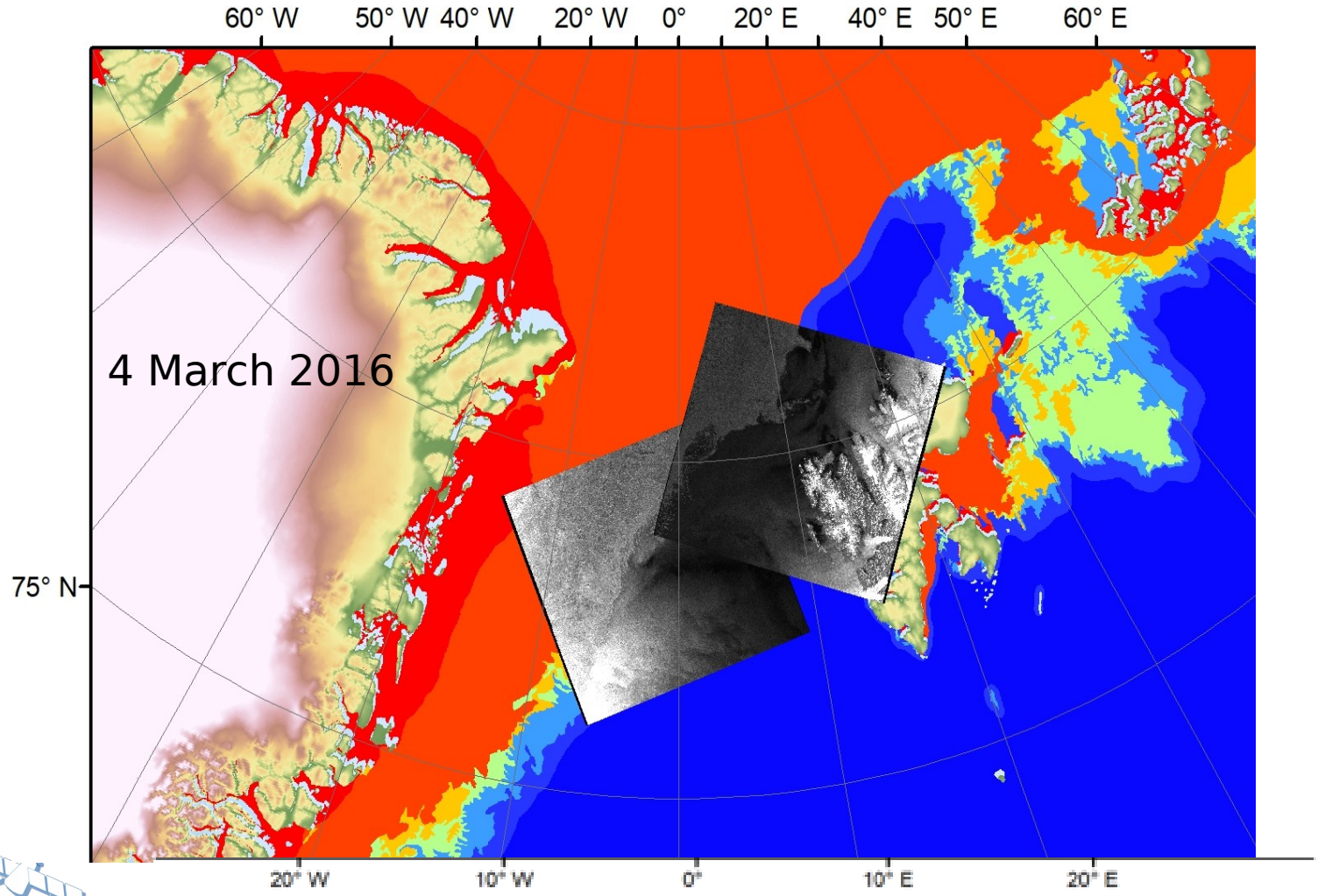

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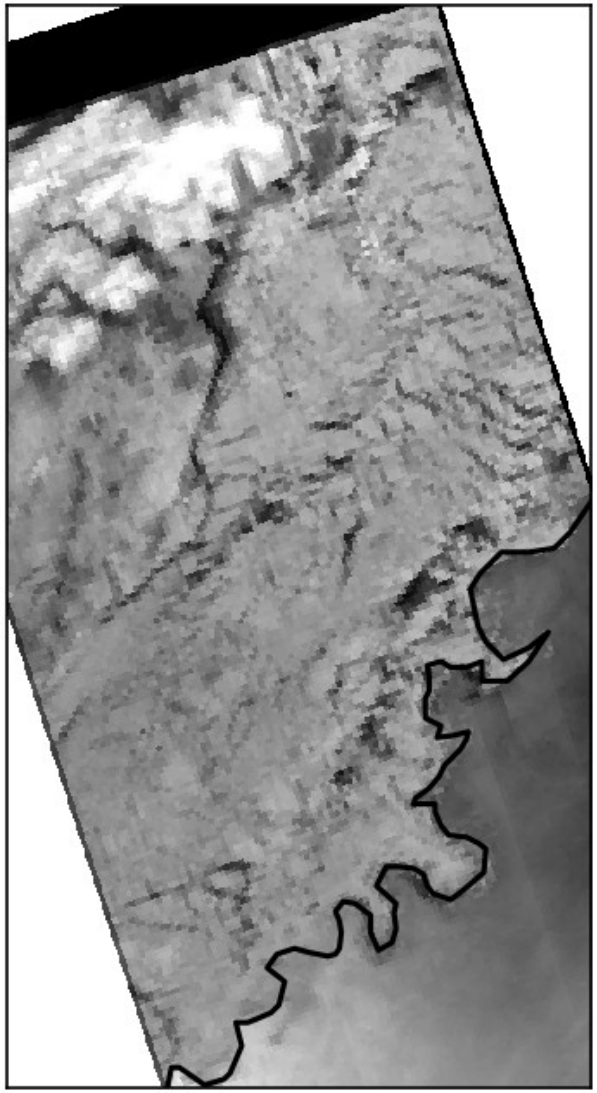

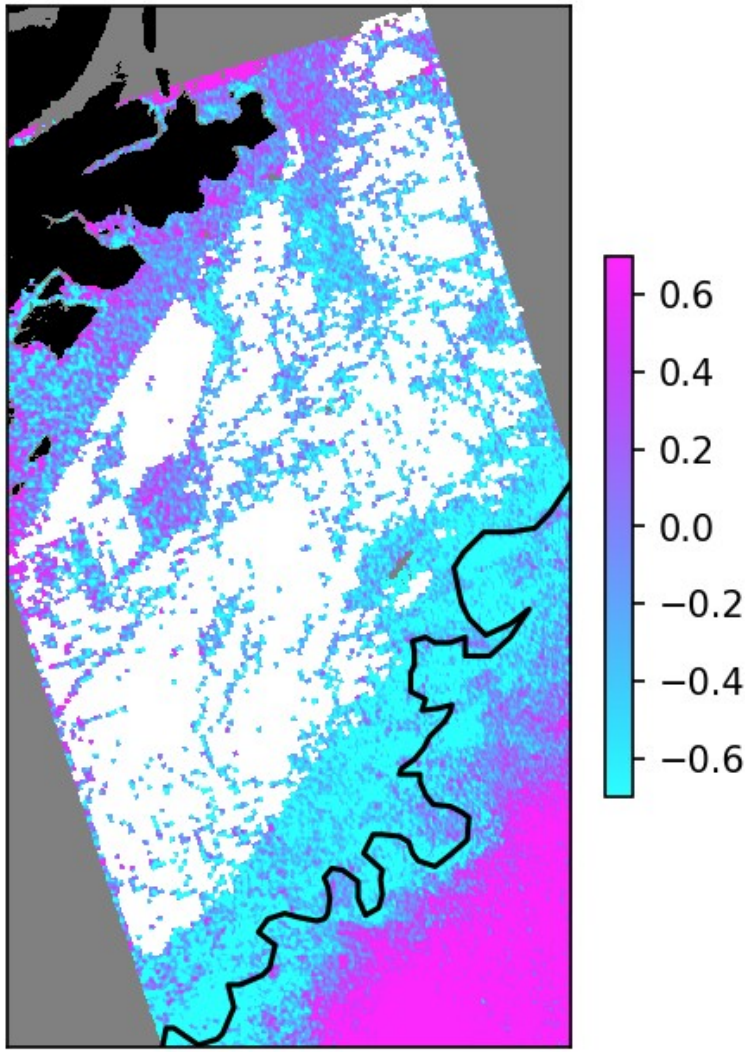

Normalized radar backscatter (grayscale image), sea ice edge (black line) and Doppler derived instantaneous velocity (colored image, m/s).

The white area indicate good agreement between the pattern recogn. & SAR Doppler.

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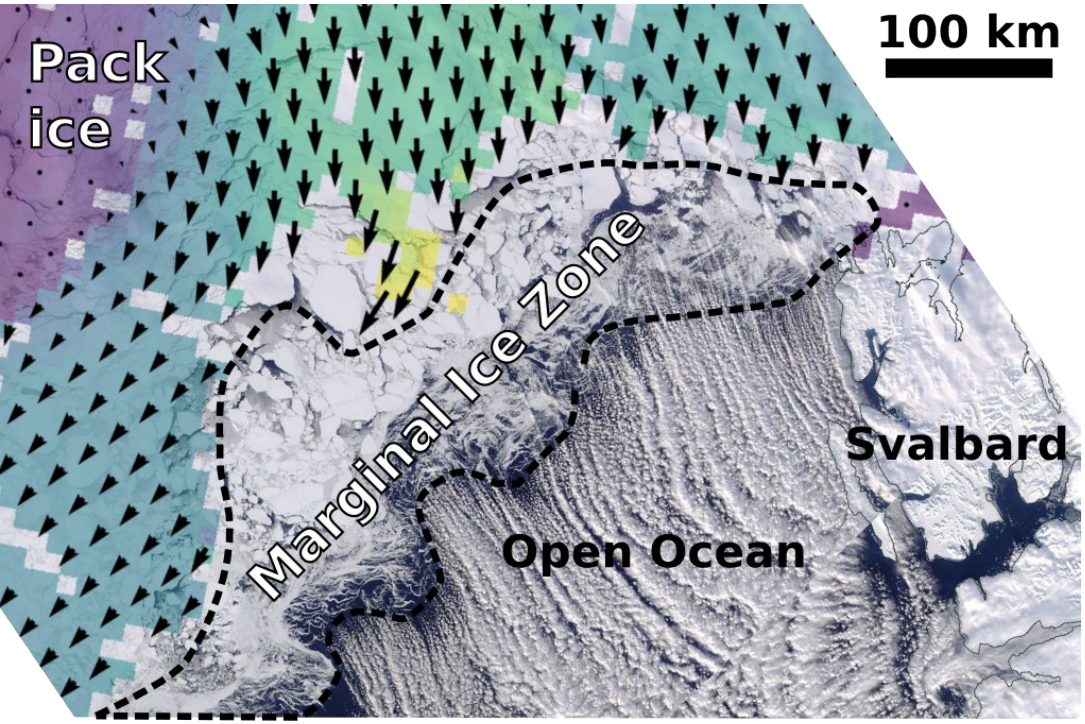

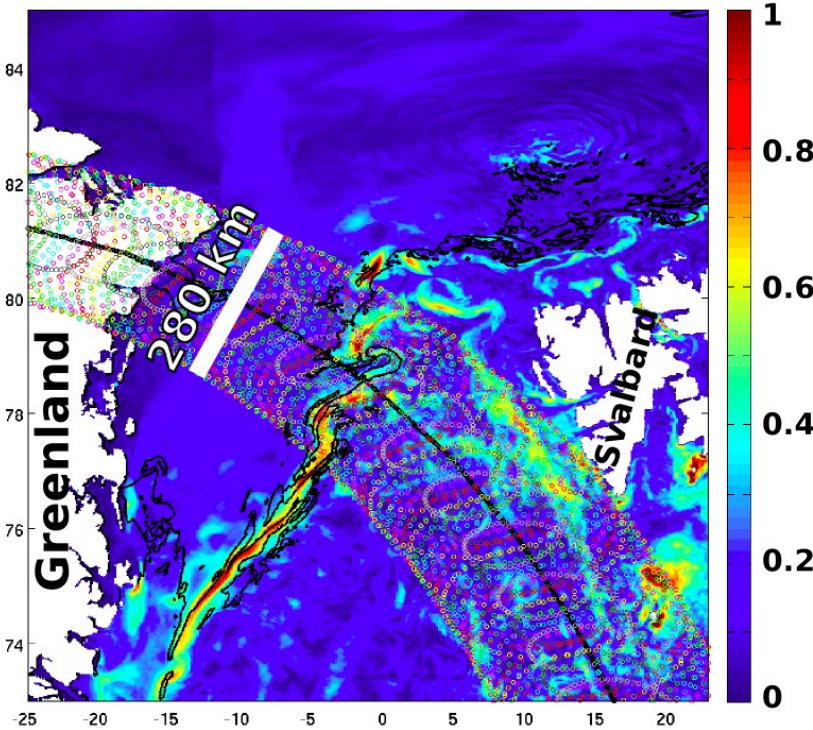

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