Fine scale motion tracking of sea ice over central Arctic using TerraSAR-X data

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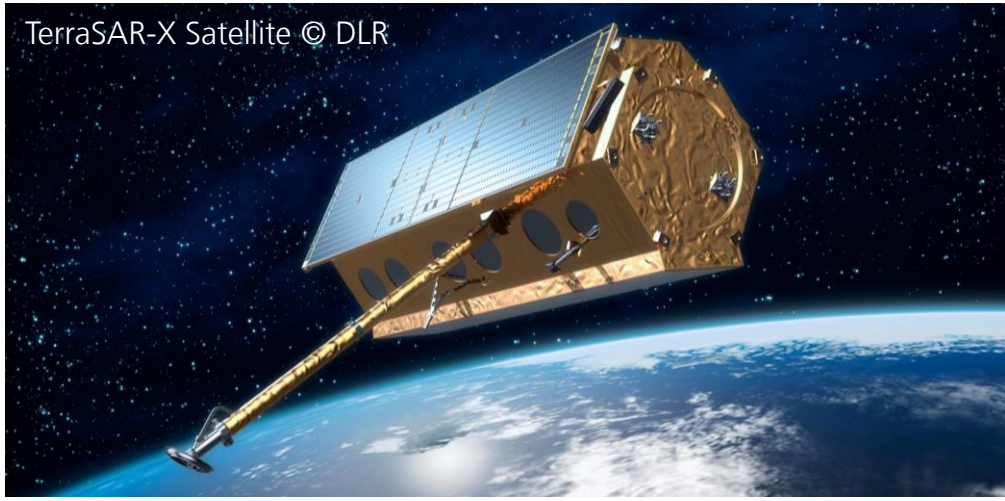
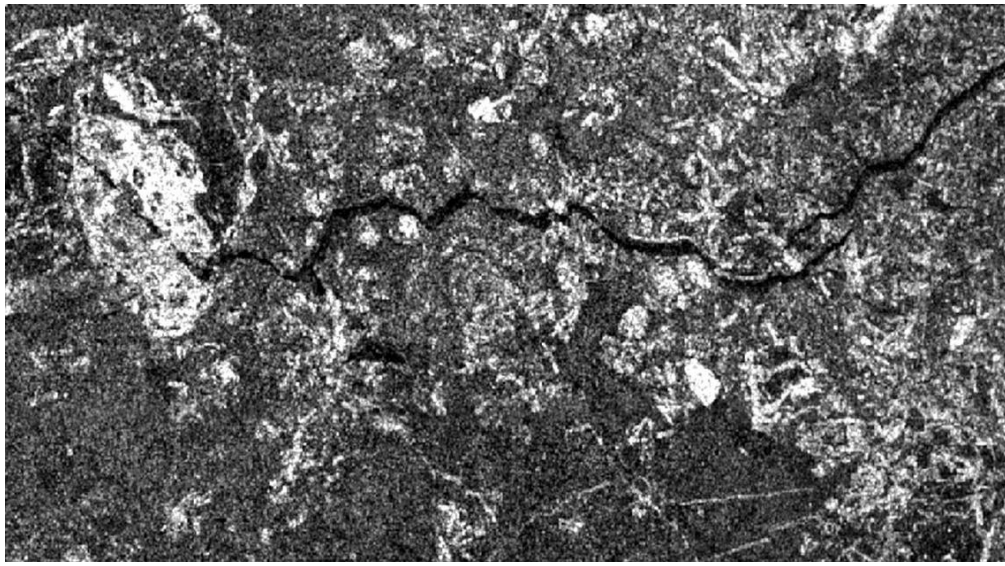
DLR
German Aerospace Center

MOSAiC: Multidisciplinary drifting Observatory for the Study of Arctic Climate

In recent years, sea ice in the Arctic Ocean has undergone significant changes. Multiyear ice has been replaced by seasonal ice, and ice covered areas have been replaced by lead areas, partially [1].

To better understand the impact of the Arctic to the global climate, Alfred Wegener Institute (AWI) initialized the MOSAiC expedition. On 20 Sept 2019, the research icebreaker *Polarstern* departed from Tromsø in Norway to spend a year drifting with the sea ice across the central Arctic. To support the expedition, the DLR provides space borne Synthetic Aperture Radar (SAR) images acquired by the satellite TerraSAR-X over the study area around *Polarstern* [2].



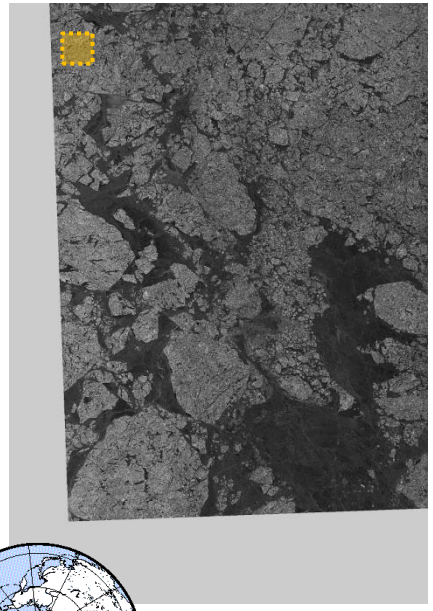


TerraSAR-X radar satellite image from 17 Nov 2019, showing a major fracture zone after a major storm event

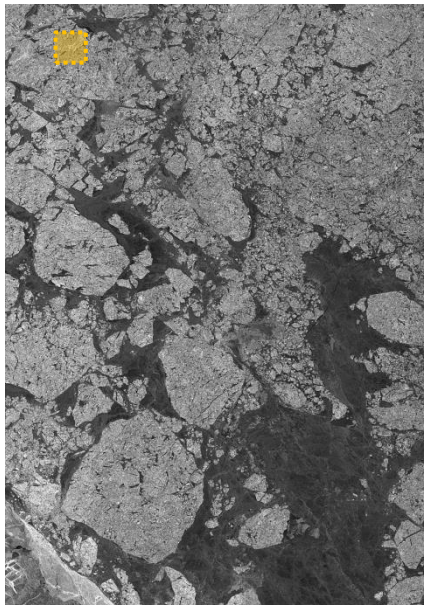
[1] C. Planck, D. K. Perovich, B. Light, 2017
[2] Link: https://www.dlr.de/eoc/en/desktopdefault.aspx/tabid-13247/23165_read-59590/

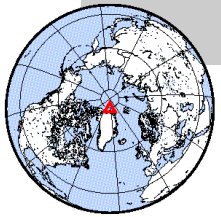
Basic principle of sea ice motion tracking

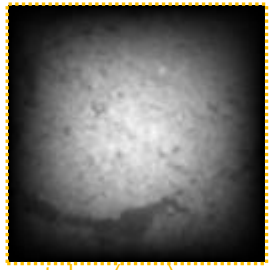
Co-registered TS-X ScanSAR
24.03.2018 17:11 UTC



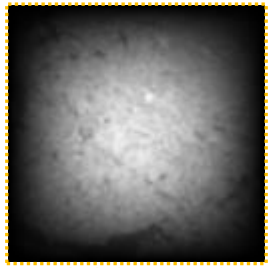
TerraSAR-X ScanSAR
26.03.2018 16:36 UTC





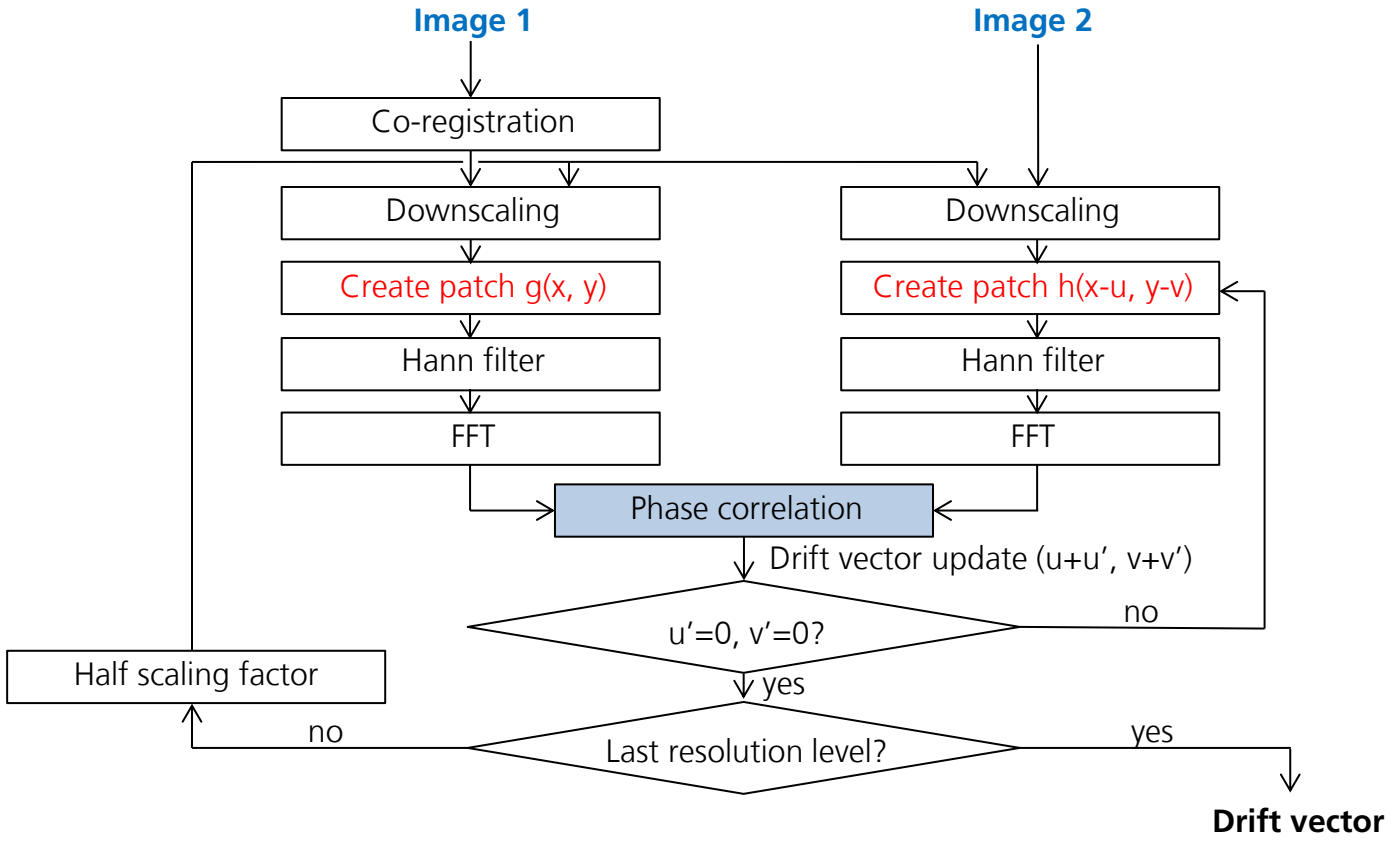


patch g(x, y)
after Hann filter



patch h(x-u, y-v)
after Hann filter

- Aim: Observe fine scale discontinuities in sea ice motion fields, i.e. convergence and divergence zones
- Apply phase correlation within a resolution pyramid[3]:



[3] A. Frost, S. Jacobsen, S. Singha, 2017

Basic principle of sea ice motion tracking

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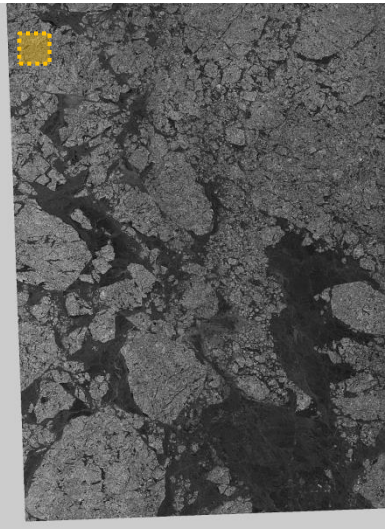
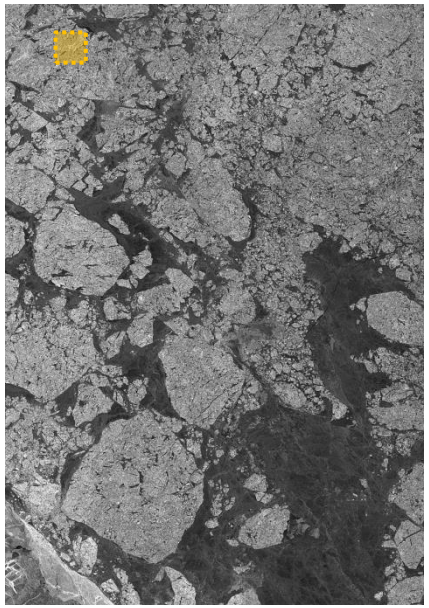
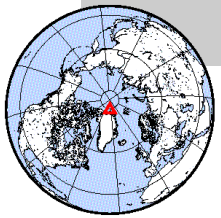
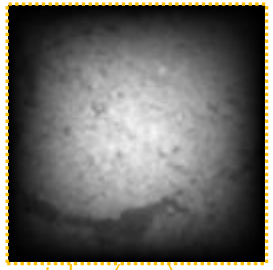


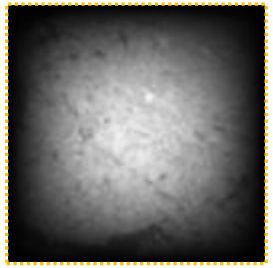
TerraSAR-X ScanSAR
26.03.2018 16:36 UTC





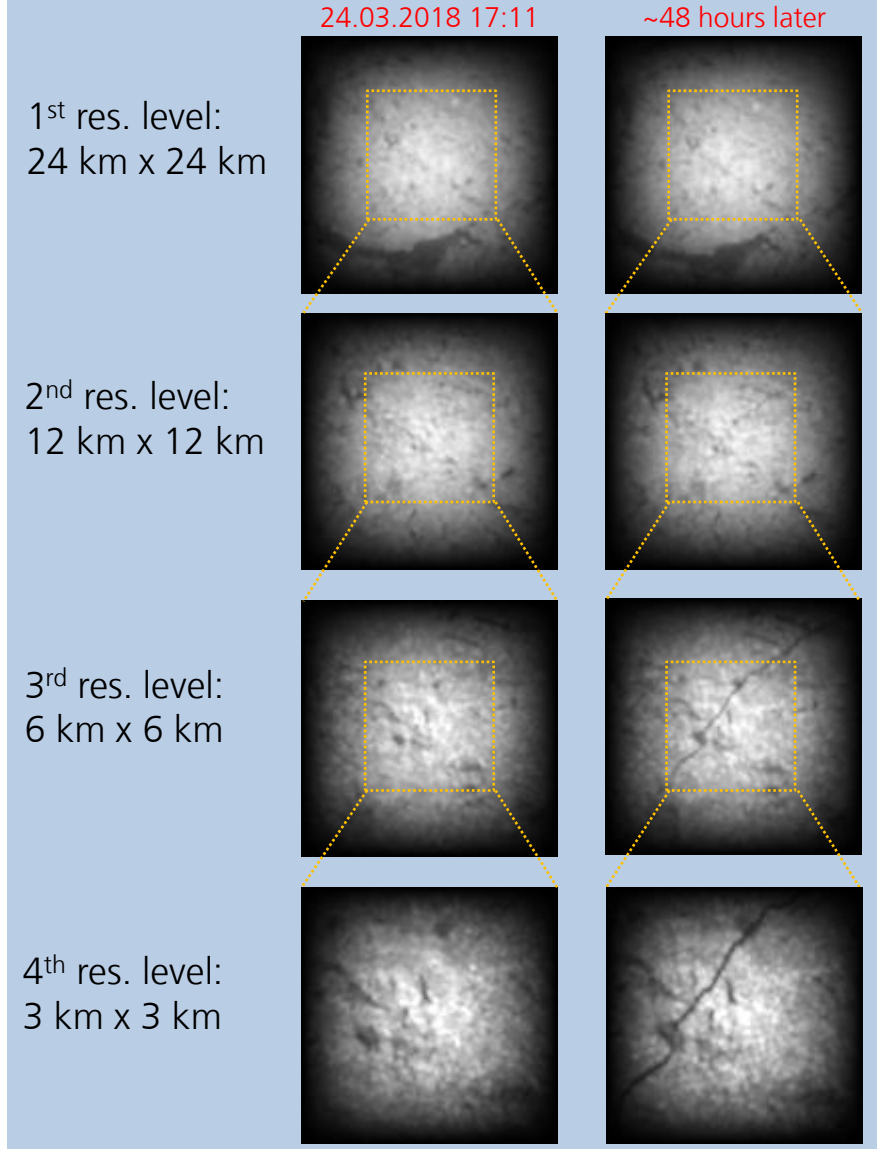


patch g(x, y)
after Hann filter



patch h(x-u, y-v)
after Hann filter

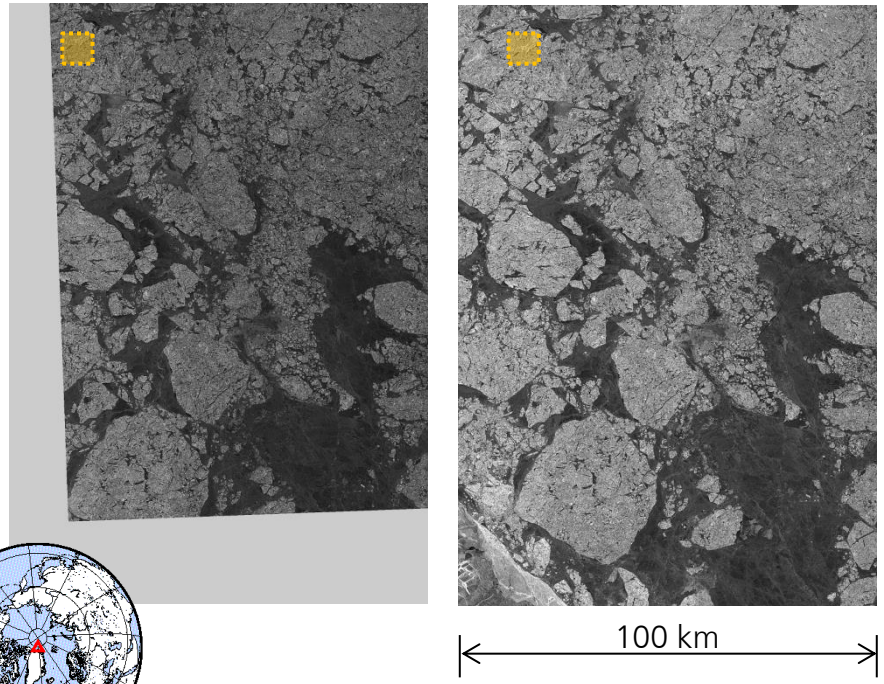
MOTION ESTIMATION

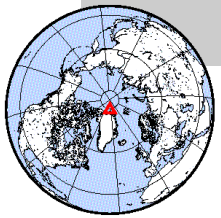


Basic principle of sea ice motion tracking

Co-registered TS-X ScanSAR
24.03.2018 17:11 UTC

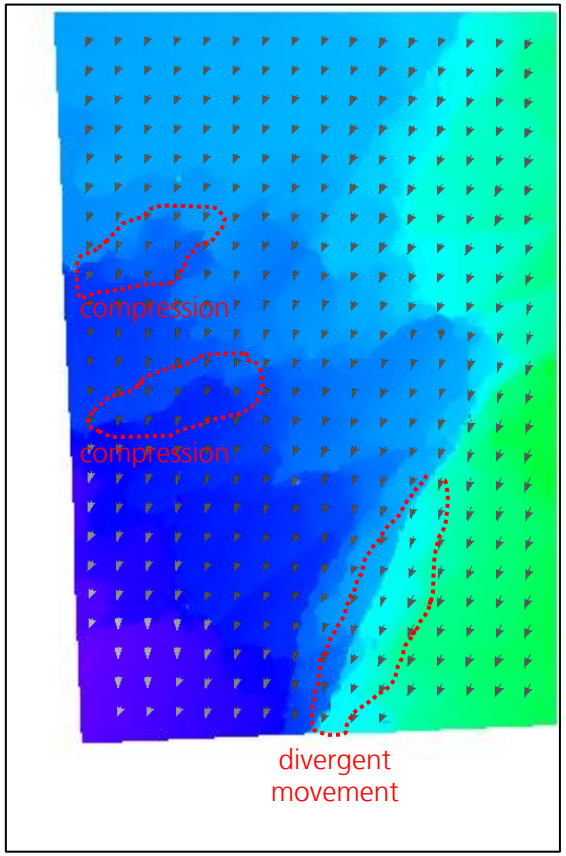
TerraSAR-X ScanSAR
26.03.2018 16:36 UTC



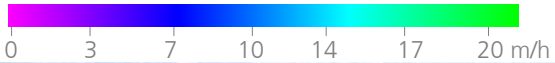


100 km

Drift vector field
extracted from the image pair on the left
Resolution: 300 m x 300 m



Sea ice velocity



The analysis of drift fields allows to assist navigation in polar waters by:

- Localizing converging and diverging ice areas,
- Identifying regions of compressing ice, which might form ice ridges,
- Identifying open water leads that are likely to open up or close.

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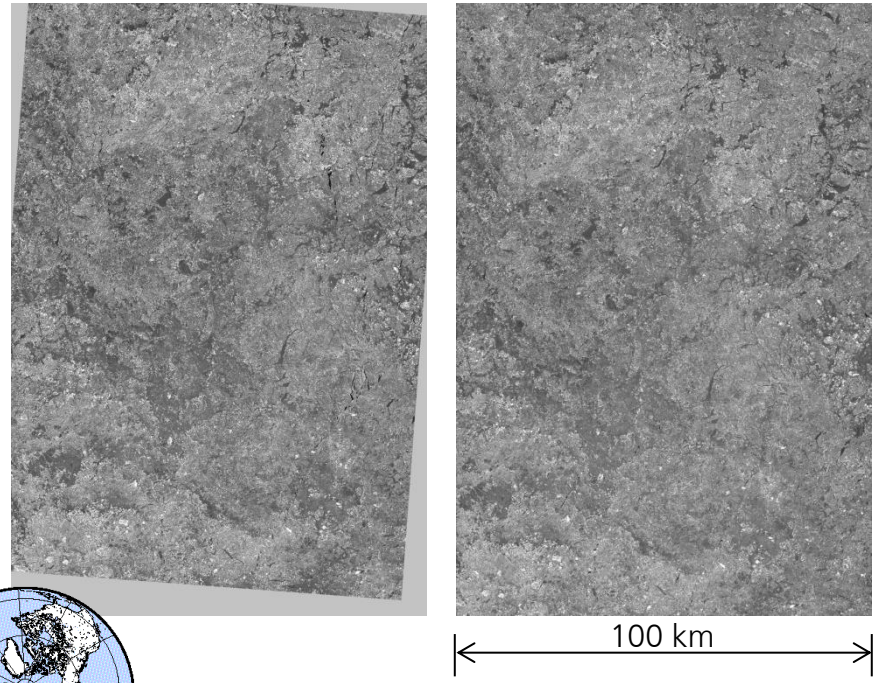
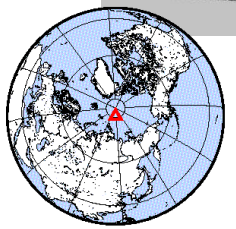
Co-registered TS-X ScanSAR
19.11.2019 04:33 UTC

TerraSAR-X ScanSAR
20.11.2019 04:15 UTC

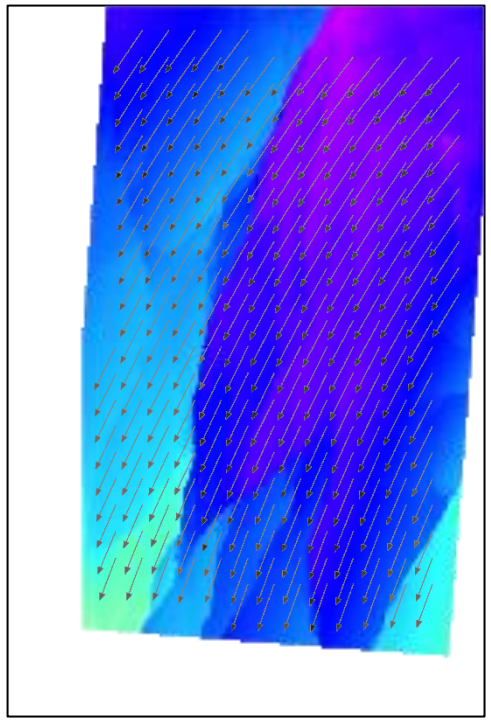


100 km



The authors would like to thank to the MOSAiC Remote Sensing team.
Data were acquired through TerraSAR-X data account suman_OCE3562.

Drift vector field
extracted from the image pair on the left
Resolution: 250 m x 250 m



Sea ice velocity

360 375 390 405 420 435 450 m/h

On the first view:

- Approx. 100% ice coverage
- Homogeneous drift of homogeneous ice
- Average sea ice drift: 400 m/h

Looking more detailed into it:

- Multiple small scale discontinuities i.e. convergence and divergence zones
- These discontinuities become visible due to the high resolution of the underlying image (17 m) and the drift field (250 m)

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