Observation of sea ice drift and landfast ice boundaries in the Baltic Sea based on spaceborne SAR image time series

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Source: Sarah Airriess

Drift ice floats on the ocean surface and is driven and deformed by winds and ocean currents.

Landfast ice (also called **fast ice**) is sea ice that is "fastened" to the land. Landfast ice may either grow in place from the sea water or by freezing pieces of drifting ice to the shore or other anchor sites. Different to drift ice, landfast ice does not move.

For ships, landfast ice is an obstacle. For the people living in the Arctic and sub-Arctic coastal regions, the landfast ice is part of the infrastructure. Extending the land, it forms the basis for travel between islands and the mainland. In the Baltic Sea, ice routes replace ferries every winter. These ice routes are used for commercial transportation of people and goods, and are more economical than ferries.

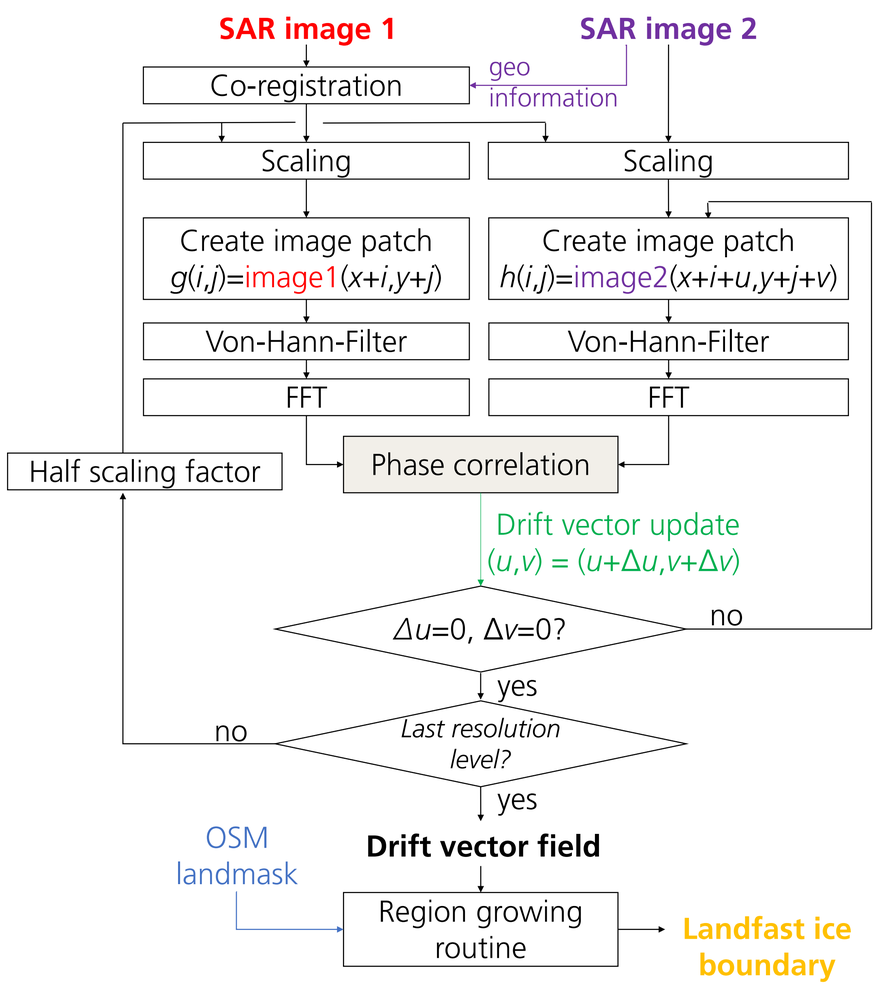
Synthetic Aperture Radar (SAR) satellites such as Sentinel-1A are equipped with an active radar antenna, which provides images of the Earth's surface regardless of cloud cover and solar illumination. This all-weather capability is particularly advantageous for observing polar waters.

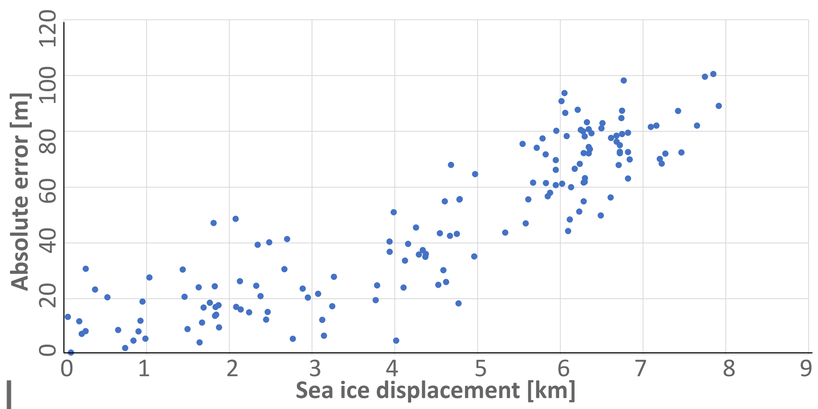
Sentinel-1 acquisitions taken on 2nd March 2018 over the Baltic Sea

Sea ice drift retrieval and landfast ice detection

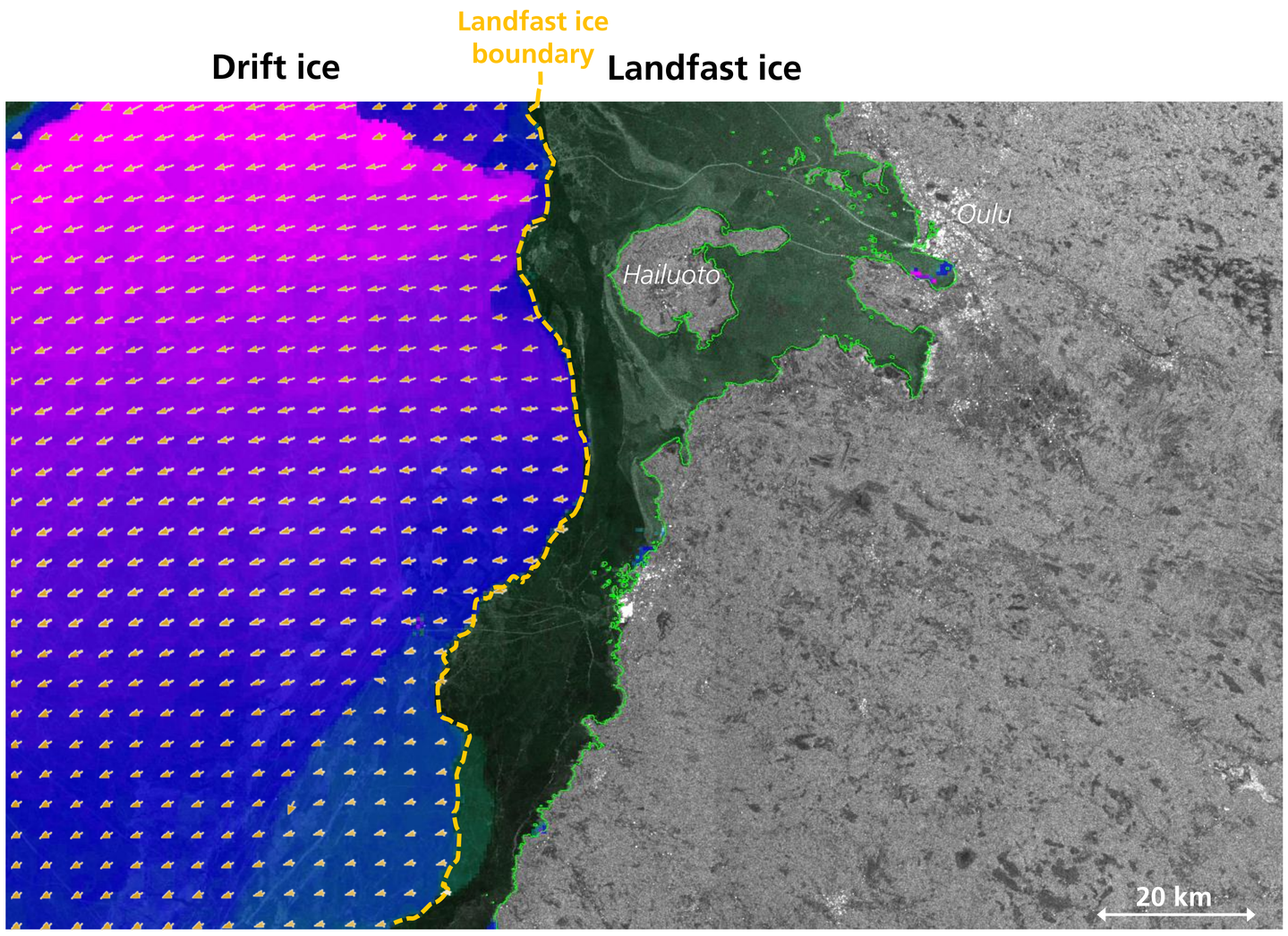
A software processor for the retrieval of high resolution sea ice drift vector fields from subsequent SAR images has been developed [1].

The generated drift vector fields reveal small variations within the sea ice motion, i.e. allow to detect landfast ice extent [2].

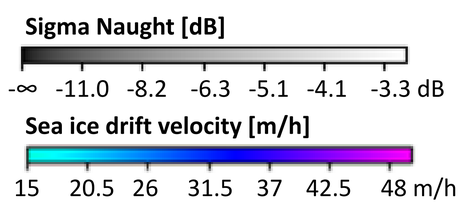




Accuracy of sea ice drift retrieval measured with drift buoys



Section of a Sentinel-1 acquisition taken 4th March 2018 over the northeastern part of the Baltic Sea showing landfast ice and drift ice. Overlaid colors represent the retrieved sea ice drift velocity in 500 m resolution and arrows illustrate sea ice drift direction (4 km spacing). The retrieval is based on the SAR acquisition in the background and another co-located SAR acquisition taken on 2nd March 2018.



[1] Frost, A., Wiehle, S., Singha, S., & Krause, D. (2018, July). Sea ice motion tracking from near real time SAR data acquired during Antarctic circumnavigation expedition. In IGARSS 2018-2018 IEEE International Geoscience and Remote Sensing Symposium (pp. 2338-2341). IEEE.
[2] Frost, A.; Schnupfhagn, C.; Pegel, C.; Ramanath, S. On the Localization Accuracy of Deformation Zones Retrieved from SAR-Based Sea Ice Drift Vector Fields. Remote Sens. 2025, 17, 2801. https://doi.org/10.3390/rs17162801

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