

# "Ice-Track": Providing High-Resolution Sea Ice Type Forecast for Route Optimization

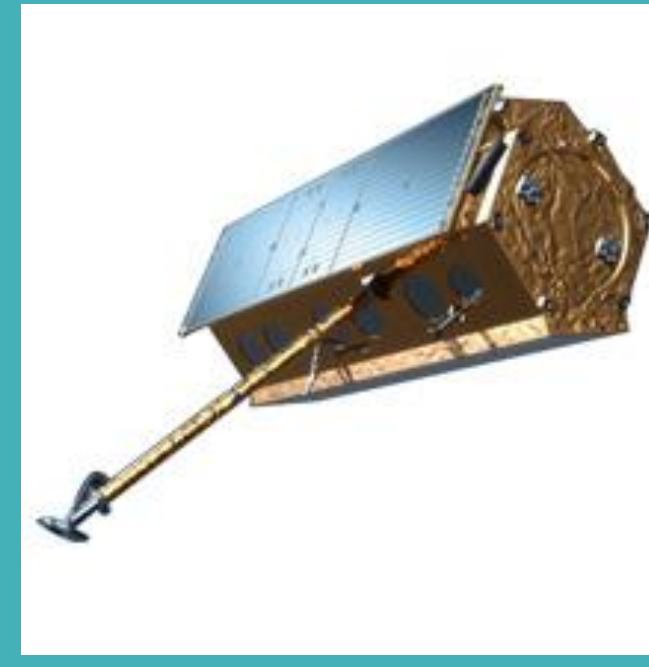
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## Introduction

In the FAST-CAST 2 project we aim to provide optimized routes through sea ice. For this, we derive route suggestions from dynamic ice maps. At this stage of development, the maximum velocities of a ship within different ice types are considered. Also, traveling shallow waters is avoided.



Sentinel-1 ©esa

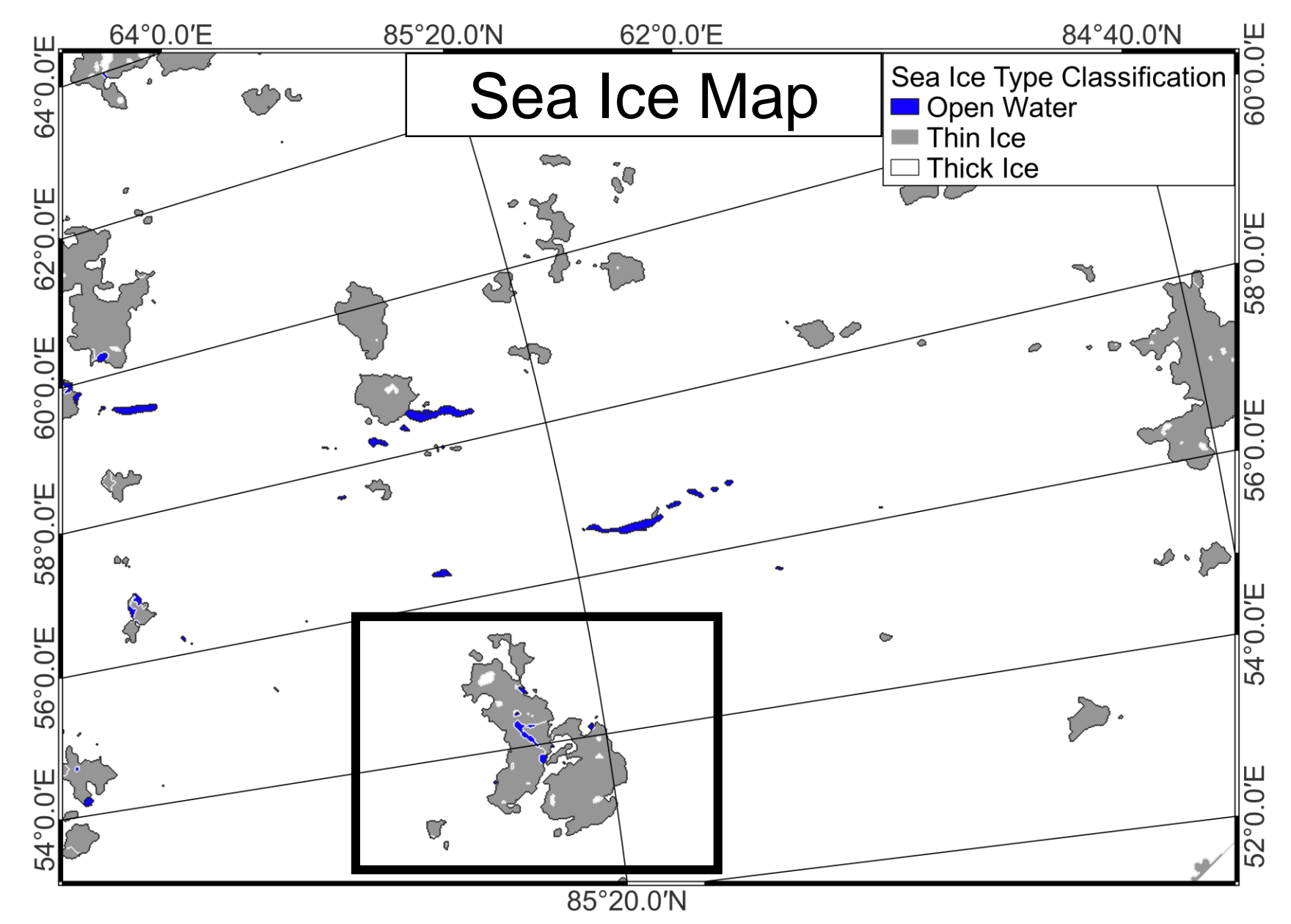


TerraSAR-X ©DLR

## Data and Use case

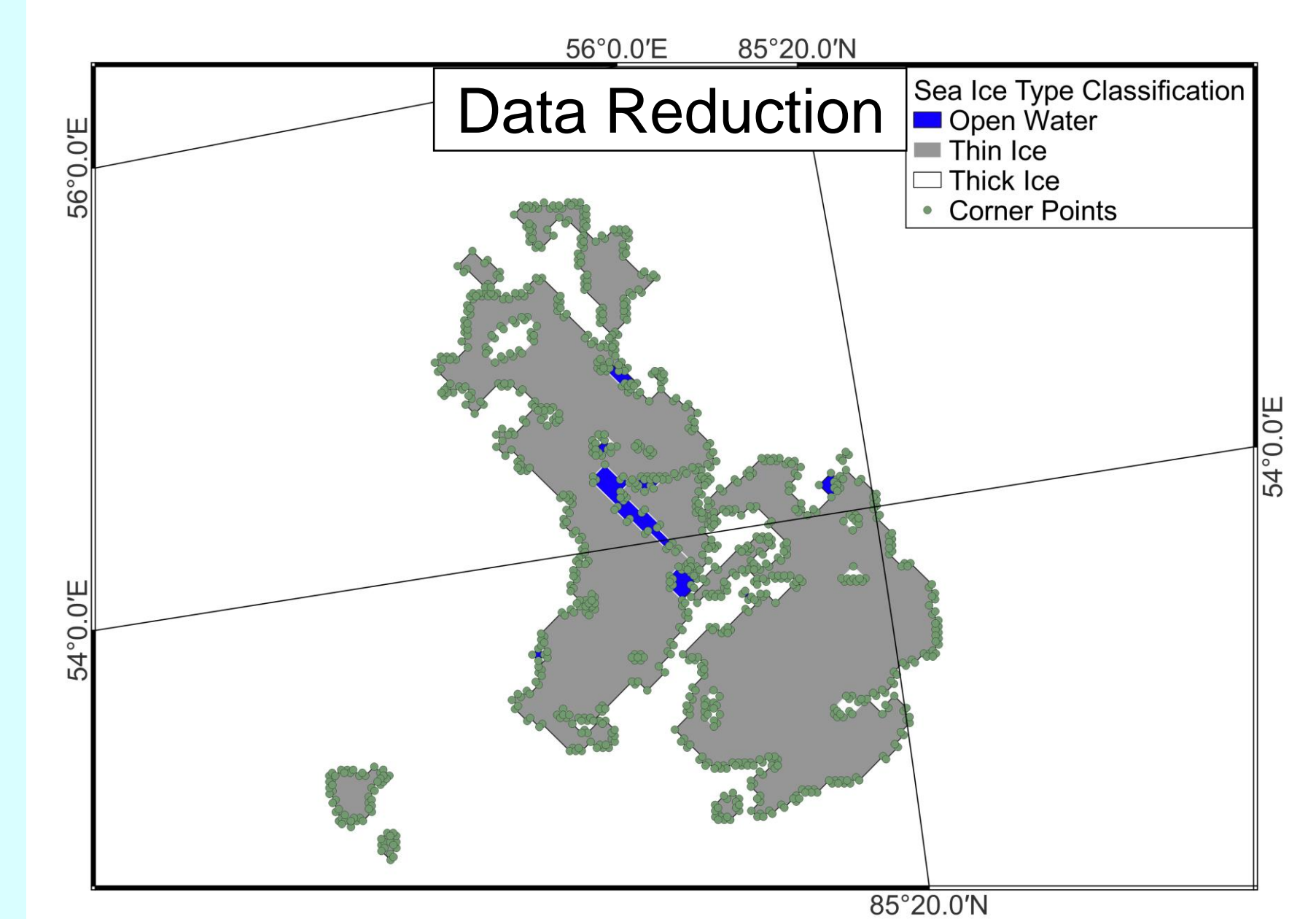
This is an operational application of the sea ice drift forecast provided on CMEMS [1, 2]. We derive ice maps from Sentinel-1 or TerraSAR-X synthetic aperture radar (SAR) data [3, 4]. We have tested our method in a two weeks trial during the ArcWatch 2 Campaign on RV Polarstern in early autumn 2024 (PS144).

Ice Map



## Sea Ice Map and Data Reduction

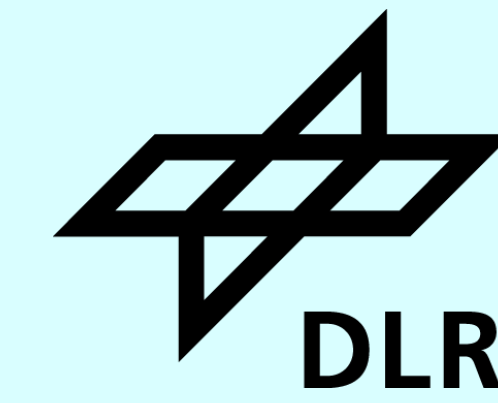
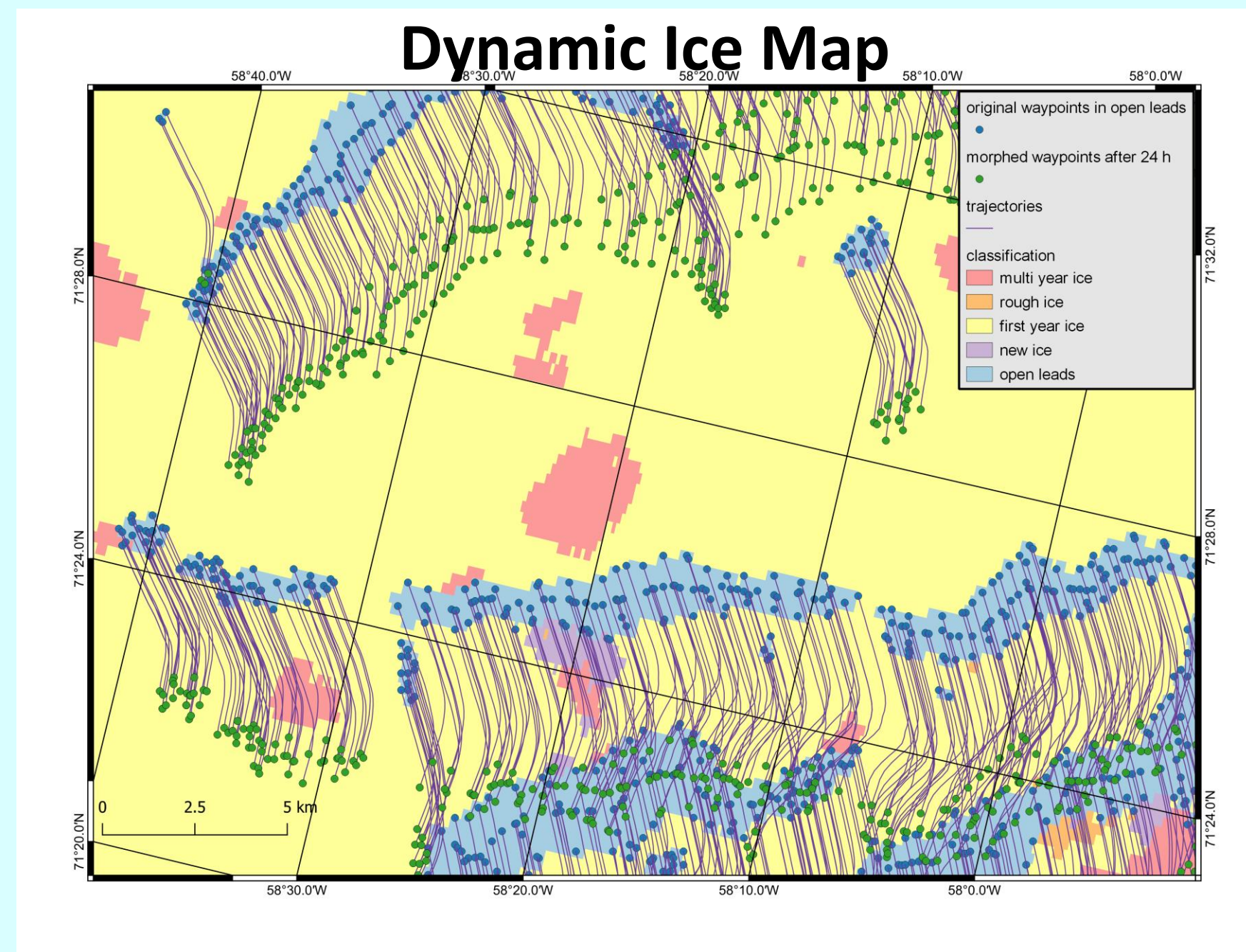
We use SAR-based sea ice type classification derived with AI for ice charting. Then we polygonise the ice map for data reduction. At this stage, two-dimensional routing is possible.



Morphing

## Adding Time Dimension

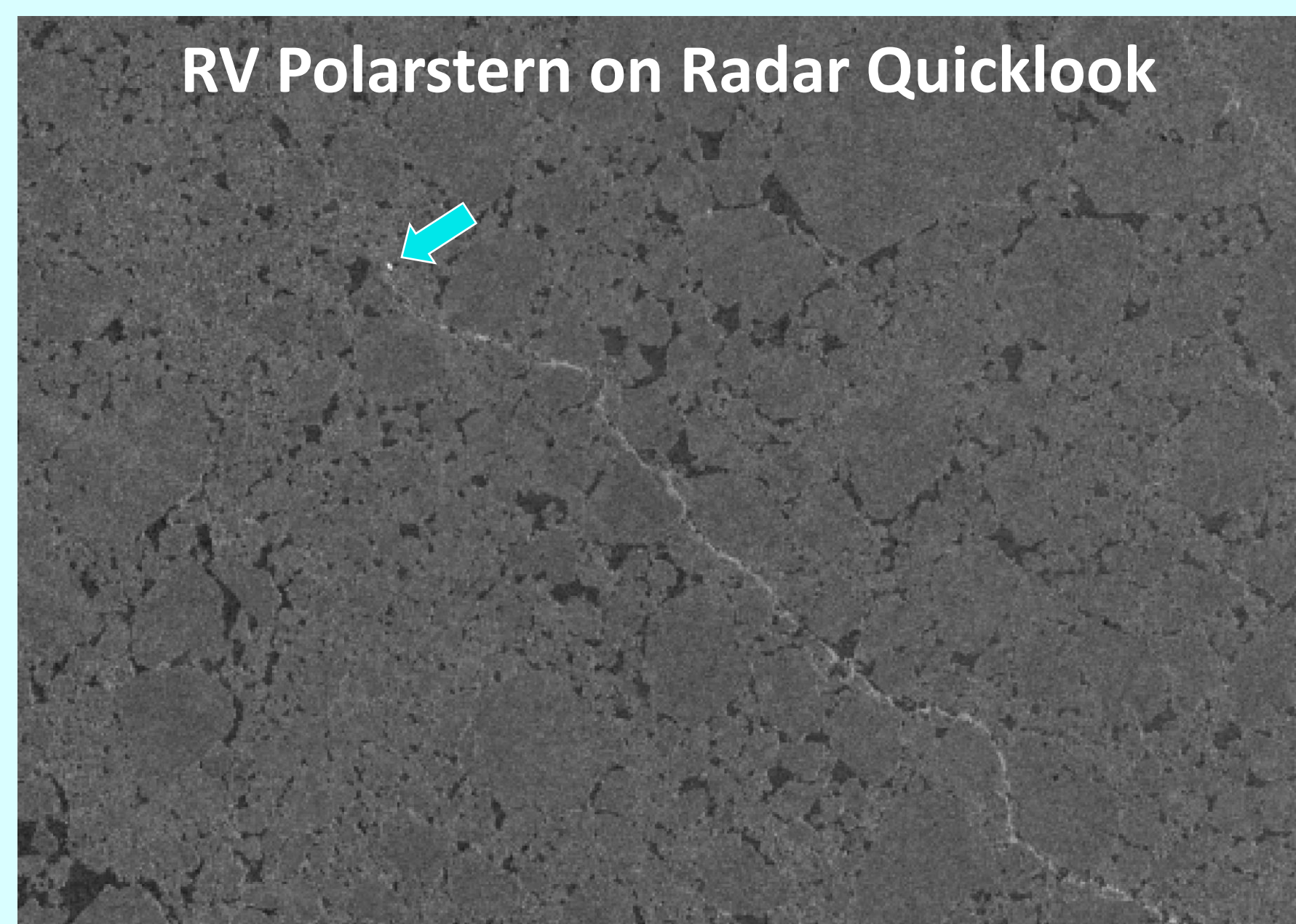
The core step: Performing a value adding procedure by combination of corner points and sea ice drift forecasts, e.g. TOPAZ5 [2]. We provide hourly slices of advected corner points. The result is a spatial-temporal ice map ready for routing.



Navigation Experience

## Routing

Even for distances of several hundred kilometres, the Anytime A\* variant offers solutions within a few minutes. Travelling in challenging ice classes is penalized, which leads to a time-optimized route suggestion. As arrival times for waypoints in routes are known, time-dependent ice conditions can be considered.



## Dynamic Routing Result for Actual PS144 Scenario



## Feedback from the Crew

The calculated routes were received with great interest by the crew of RV Polarstern and used together with other information to navigate through the ice. The tests carried out have confirmed the usefulness of the routes and shown that particularly longer routes through sea ice can benefit from the newly developed technology.

## References

[1] European Union - Copernicus Marine Service: neXtSIM-F: Arctic Ocean Sea Ice Analysis and Forecast, <https://doi.org/10.48670/moi-00004>, 2020. [2] European Union - Copernicus Marine Service: TOPAZ5: Arctic Ocean Physics Analysis and Forecast, <https://doi.org/10.48670/moi-00001>, 2015. [3] Kortum, K., S. Singha, and G. Spreen, 2022, Robust Multiseasonal Ice Classification From High-Resolution X-Band SAR: IEEE Transactions on Geoscience and Remote Sensing, 60, 1–12, <http://dx.doi.org/10.1109/TGRS.2022.3144731>. [4] Murashkin, D., and A. Frost, 2021, Arctic Sea ICE Mapping Using Sentinel-1 SAR Scenes with a Convolutional Neural Network, 5660–63, <http://dx.doi.org/10.1109/IGARSS47720.2021.9553206>.

## Acknowledgements

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Full routing video:

<https://www.dlr.de/en/latest/news/2024/pilot-project-provides-automated-shipping-routes-through-drifting-sea-ice-for-first-time>

