Microplastic concentrations and transport in the Baltic Sea and Arctic sea ice

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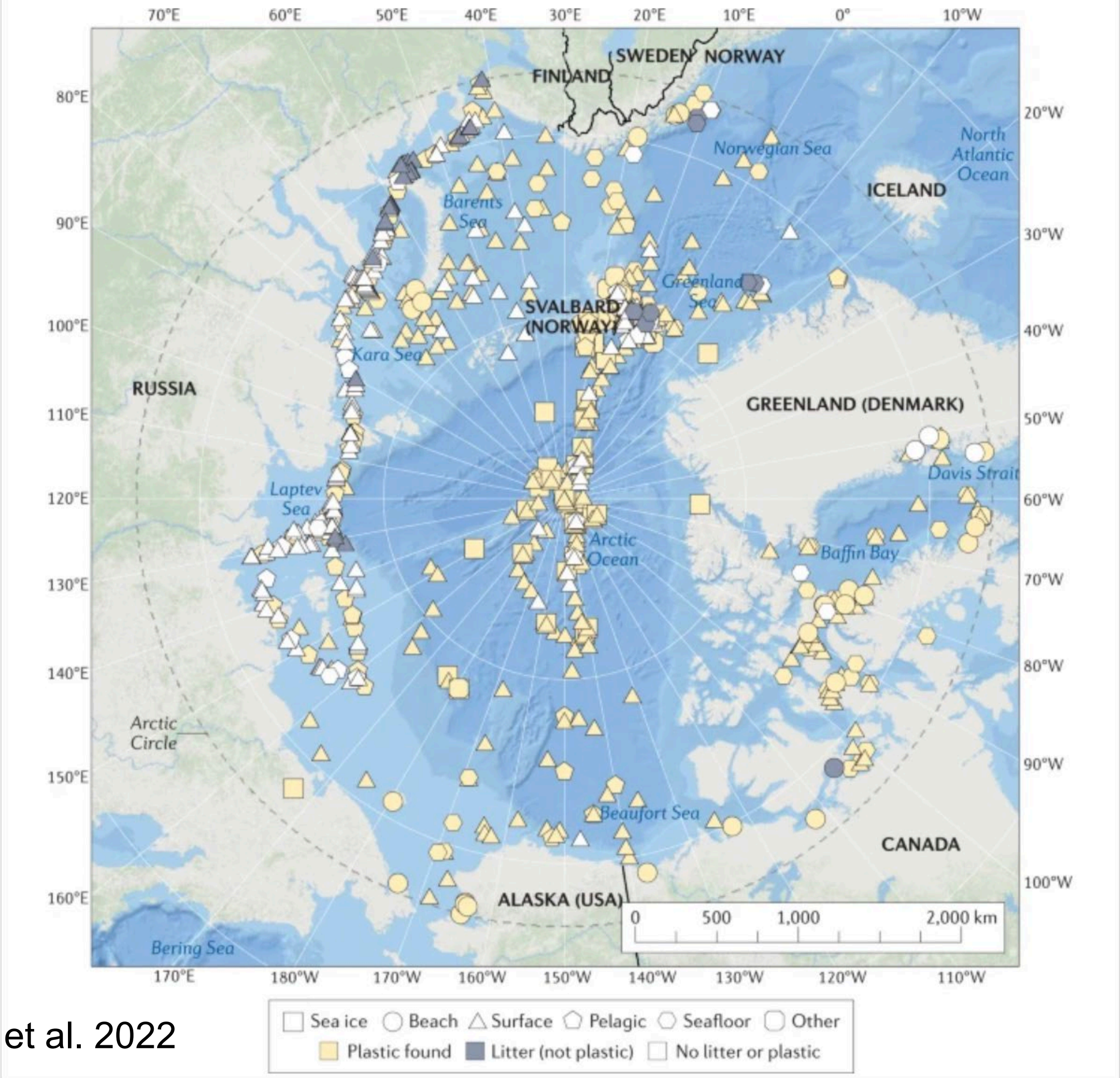
Background and rationale

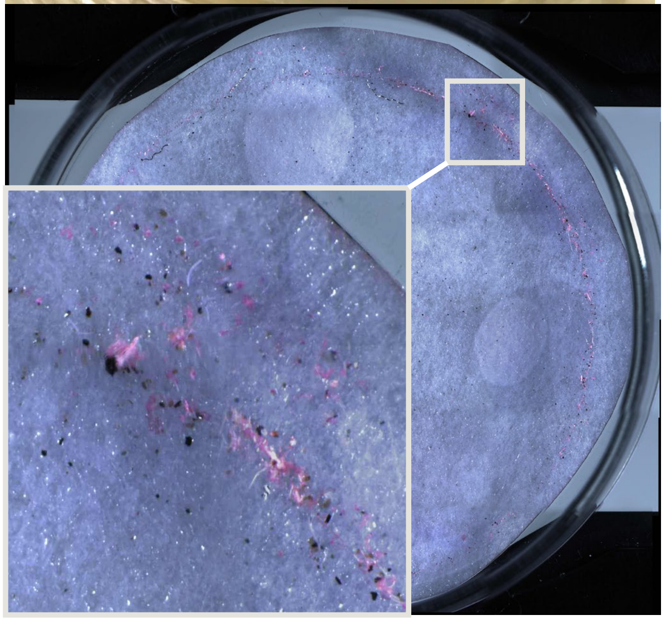
- Sea ice has high microplastic concentrations and acts as a vector across the Arctic
- In this work we studied microplastic in Baltic Sea fast ice and underlying water with comparison to Fram Strait pack ice.
- Also microplastic transport potential of Baltic sea ice was estimated by drift modelling

Fig. 3: Plastic pollution recorded in different Arctic ecosystem compartments.



Bergmann et al. 2022

Methods



- Sampling ice: ice saw or core auger (Fram Strait), underice water 20 um plankton net.
- Ice melted immediately, filtration on 20 um metal mesh. Volumes ice 7-14 L, snow 6-7 L , water 3.2 m^{3}.
- Stepwise enzymatic digestion protocol after Löder et al. (2017).
- Automated detection, counting and classification with fluorescence microscopy on nylon filters following a nile red stain.
- Samples below LOD discarded
- FTIR on selected samples
- Drift modelling using OpenDrift software and NEMO Nordic reanalysis

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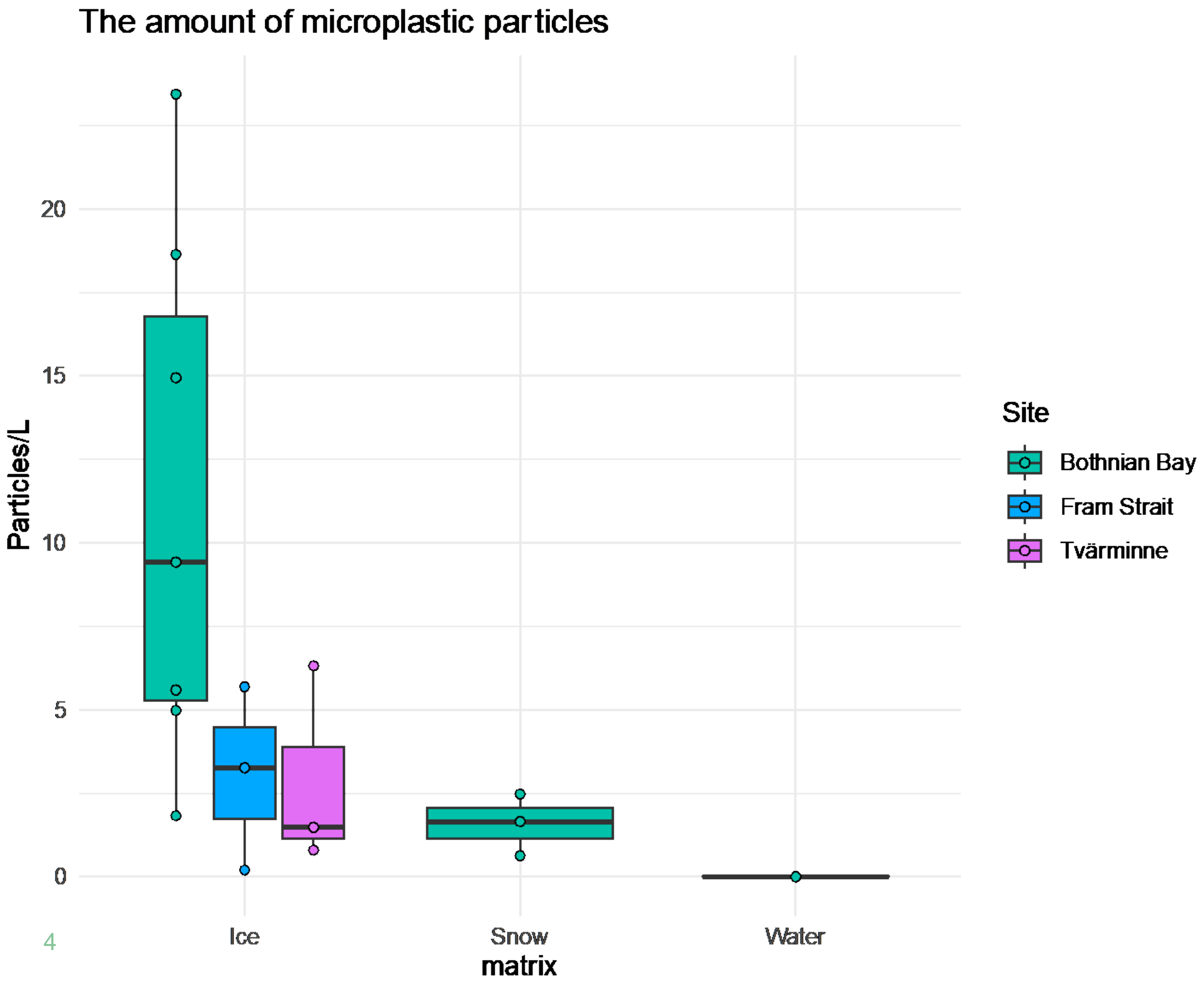
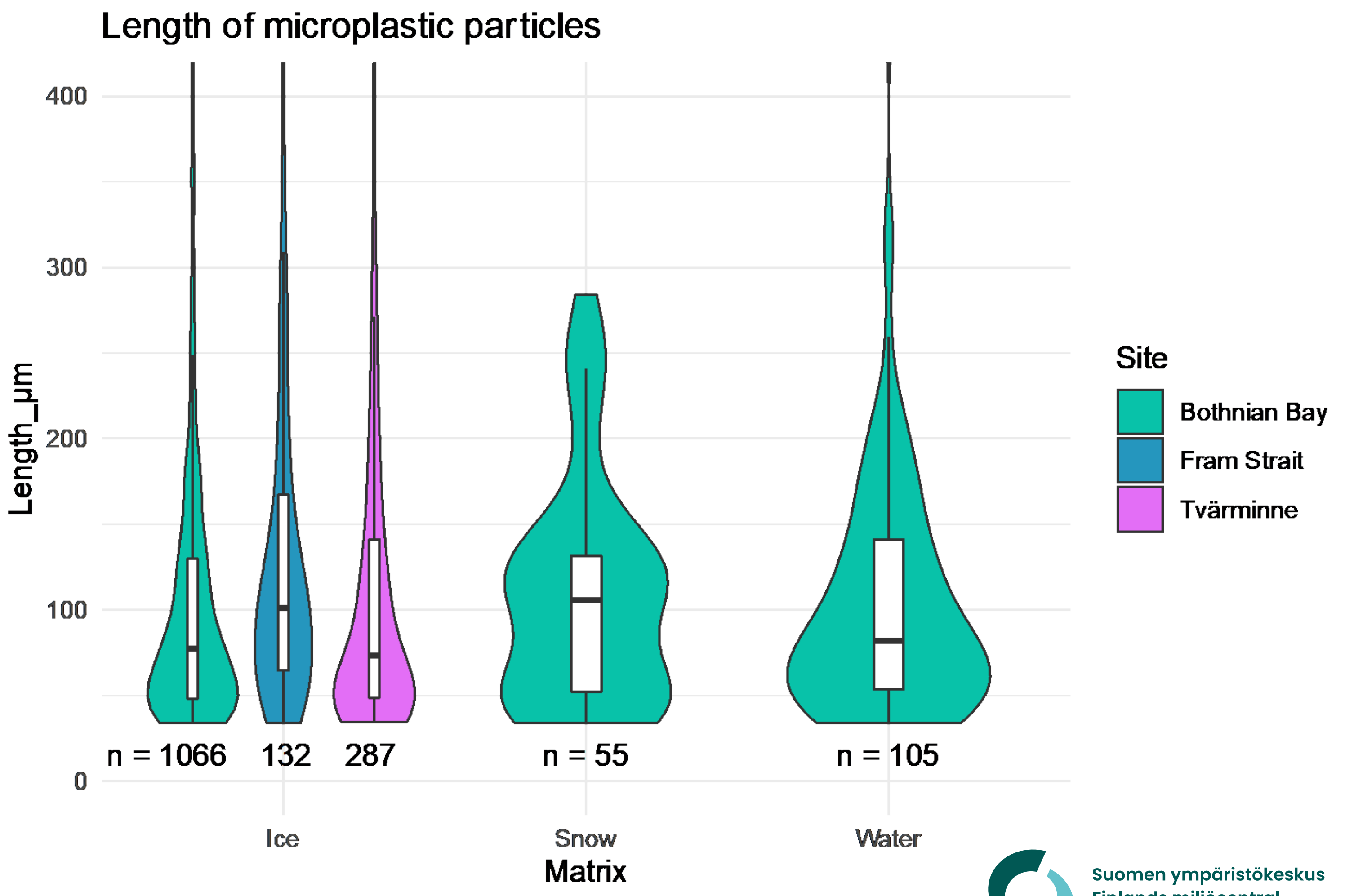
Microplastic particle concentration



- MP concentrations were higher in ice, in Bothnian bay site highest
- The range in ice close to Geilfus et al. 2019 (8-41 p/L) in Bay of Bothnia
- Fram Strait values correspond to Kanhai et al. 2020 for Central Arctic but 2 orders of magnitude lower than in Peeken et al. 2018

Microplastic particle size

- Most particles small, size range was wide
- Size distribution differed between Arctic and Baltic Sea ice
- Snow had clear upper limit of particle size
- Water and sea ice size distribution were similar



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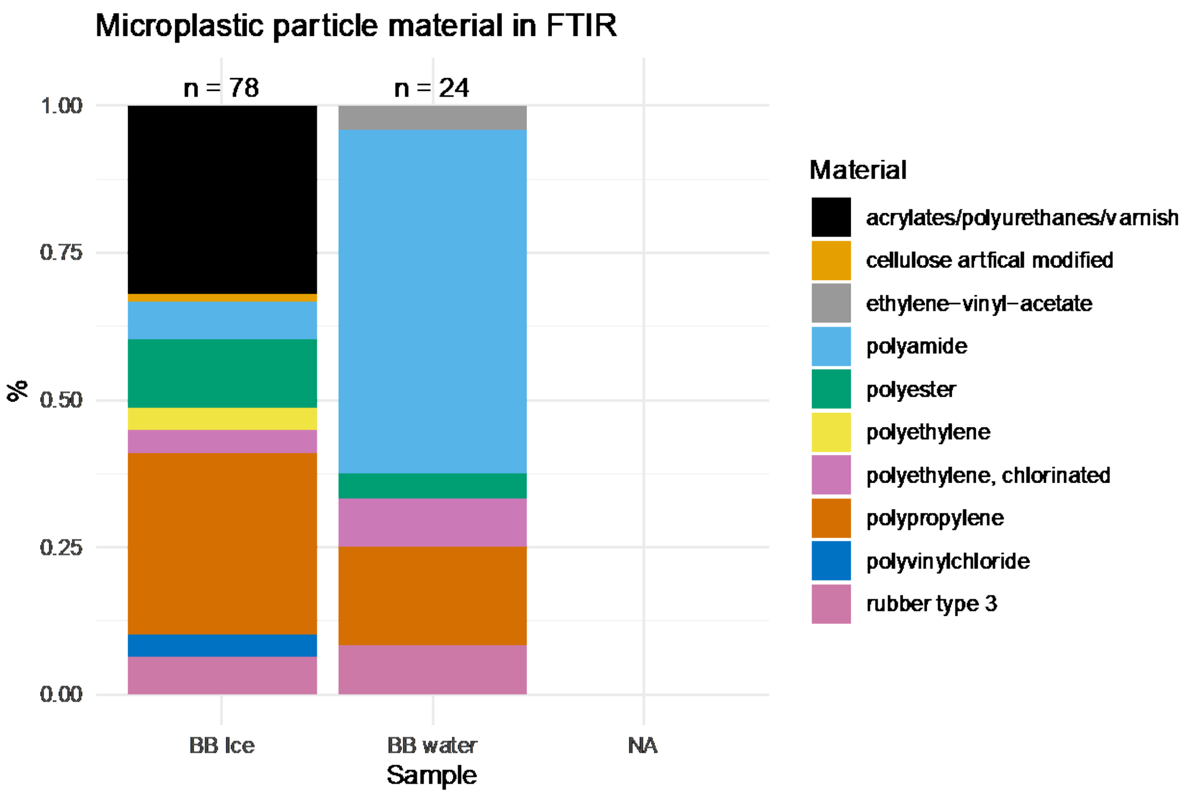
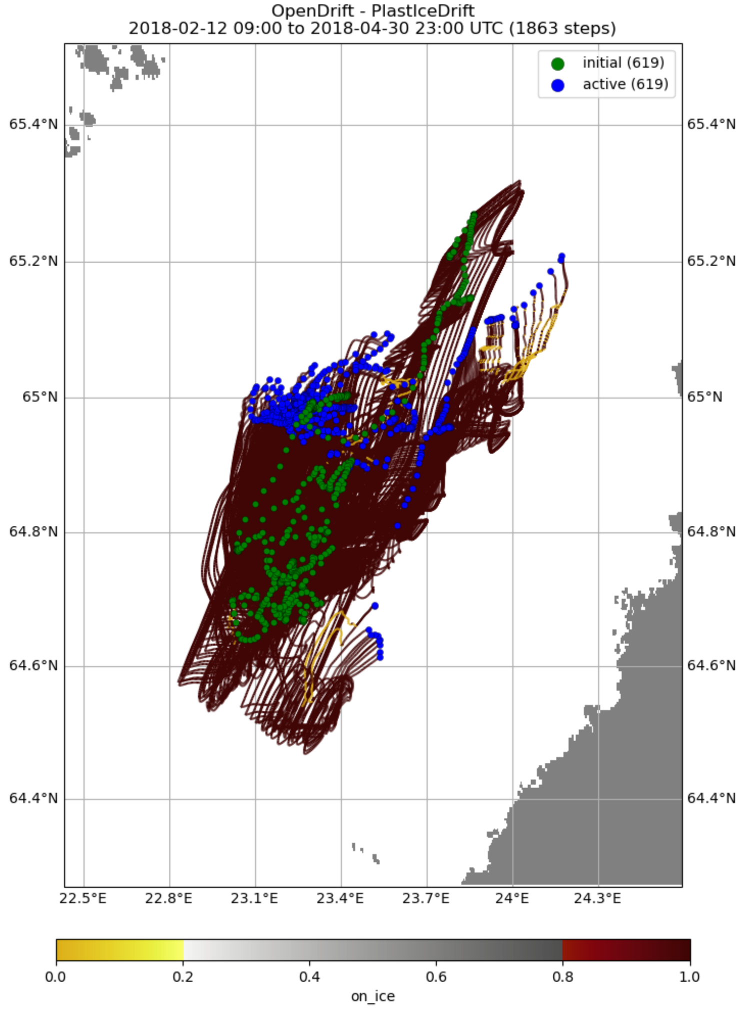
What plastic materials are found?



- Common plastic materials
- Water and ice had differing material profiles
- Polyamide most common in water, in ice polypropylene
- Small amount data on plastic material types limits possible conclusions on sources

The origin of microplastic in Baltic Sea fast ice?

- Drift modelling suggests that microplastic particles are transported only short distances while in fast ice.
- Incorporation and release spatially close, particle storage rather temporal than ice acting as a vector.



Point of origin
Endpoint
Trajectory in ice
Trajectory in open water

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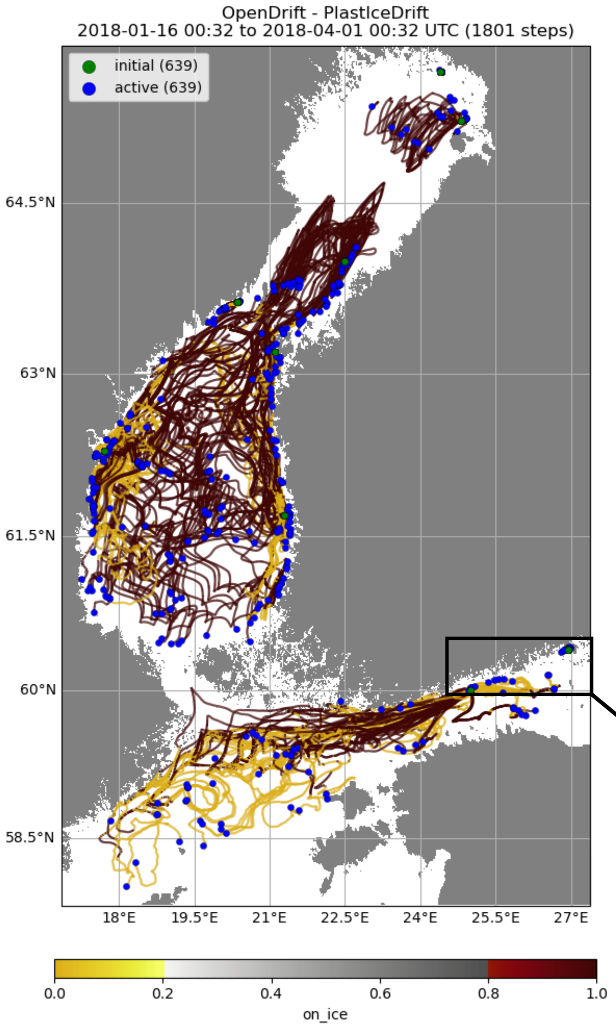
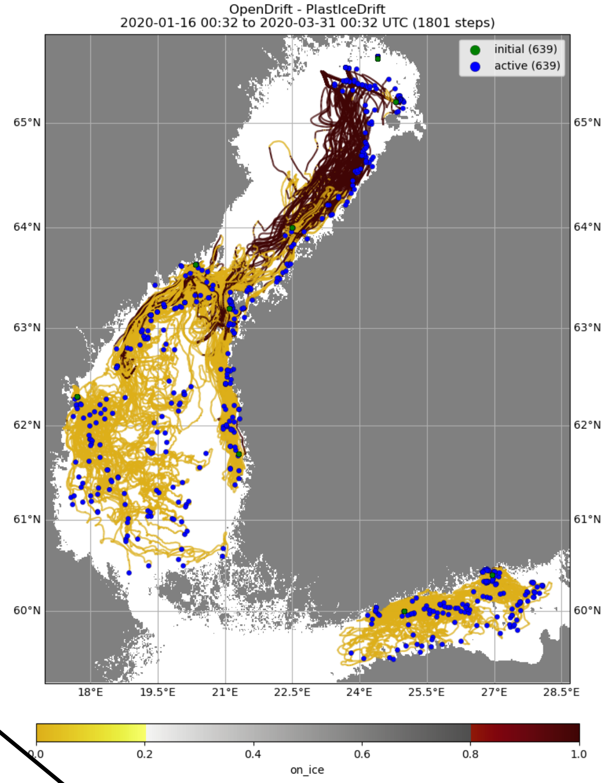
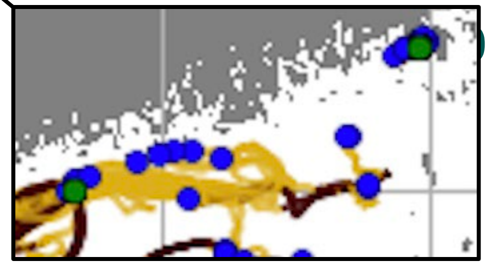
Pack ice can act as a vector in Baltic Sea too



Average ice winter 2018





- Particles were introduced outside major cities (sources) in the Northern Baltic Sea throughout two differing winter seasons
- The modelling results point to significant capacity for pack ice as a vector for microplastic particles in the Baltic sea

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Conclusions

- The Baltic sea fast ice has microplastic concentrations comparable to Arctic sea ice, concentrations were higher in ice than in snow or water.
- Particle size distribution point to air- and waterborne sources.
- Fast ice can act as a temporary reservoir, whereas pack ice can be also a vector for transport.

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