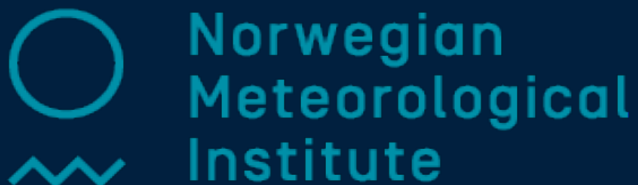


# SvalMIZ field campaigns for coupled NWP evaluation

Sarah Keeley,  
Malte Müller, Jean Rabault, (NMI)  
Josh Kousal, Lorenzo Zampieri (ECMWF)

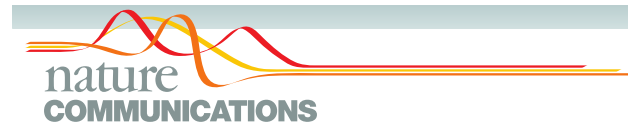
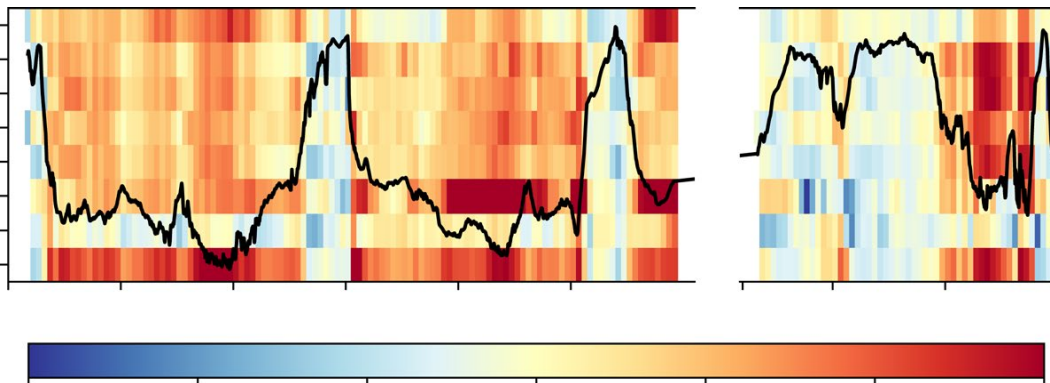
[sarah.keeley@ecmwf.int](mailto:sarah.keeley@ecmwf.int)



# Modelling limitations – until May 2026

- **uniform ice thickness**
- **no snow accumulation in the atmospheric model**
- Substantial temperature biases over sea-ice surfaces
- Implications for ice growth at longer forecast time

Biases of different reanalysis surface temperature against in-situ observations



ARTICLE

<https://doi.org/10.1038/s41467-019-11975-3>

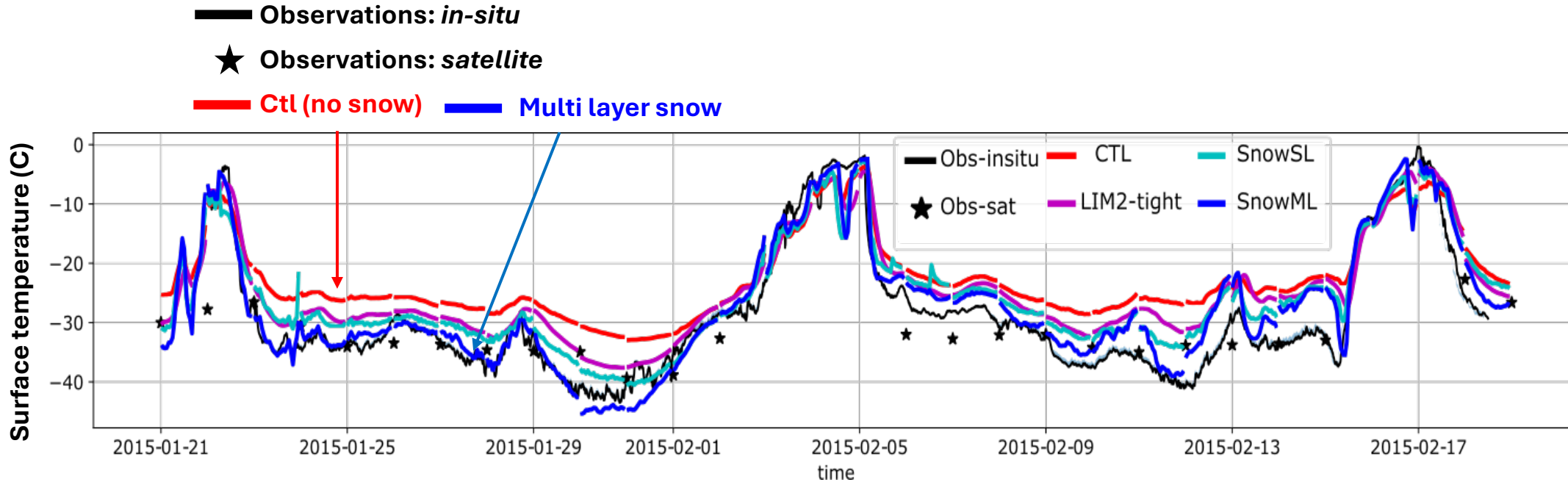
OPEN

On the warm bias in atmospheric reanalyses induced by the missing snow over Arctic sea-ice

Yurii Batrak<sup>1</sup> & Malte Müller<sup>1</sup>

# Evaluating the impact of snow over sea-ice in the ECMWF IFS – in situ & satellite

Evaluation using *in situ* observations from **N-ICE2015** campaigns and co-located CMEMS satellite observations, Jan/Feb 2015



**APPLICATE.eu**  
Advanced prediction in  
polar regions and beyond

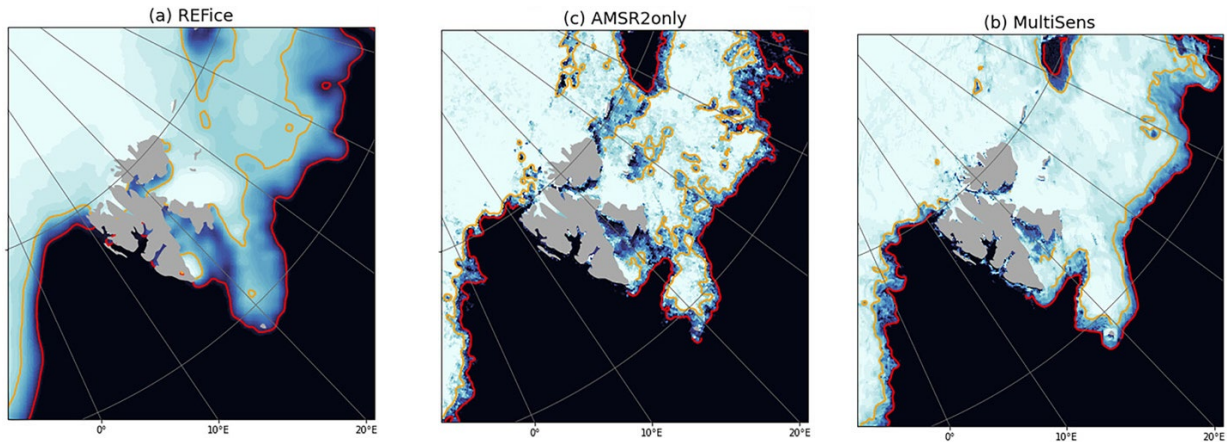
- Improved surface temperature of short-range FC
- Variability of satellite surface temperature much lower than in-situ

Arduini, G., Keeley, S., Day, J. J., Sandu, I., Zampieri, L., & Balsamo, G. (2022). On the importance of representing snow over sea-ice for simulating the Arctic boundary layer. JAMES., <https://doi.org/10.1029/2021MS002777>

# Importance of accurate sea-ice for weather forecasting

## Arctic Cyclone case 15th March 2019:

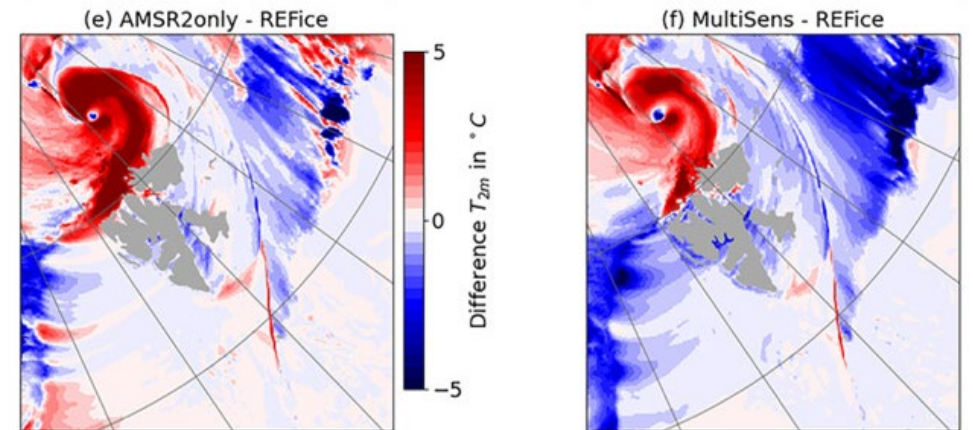
Different sea-ice products :



Cyclone North of Svalbard

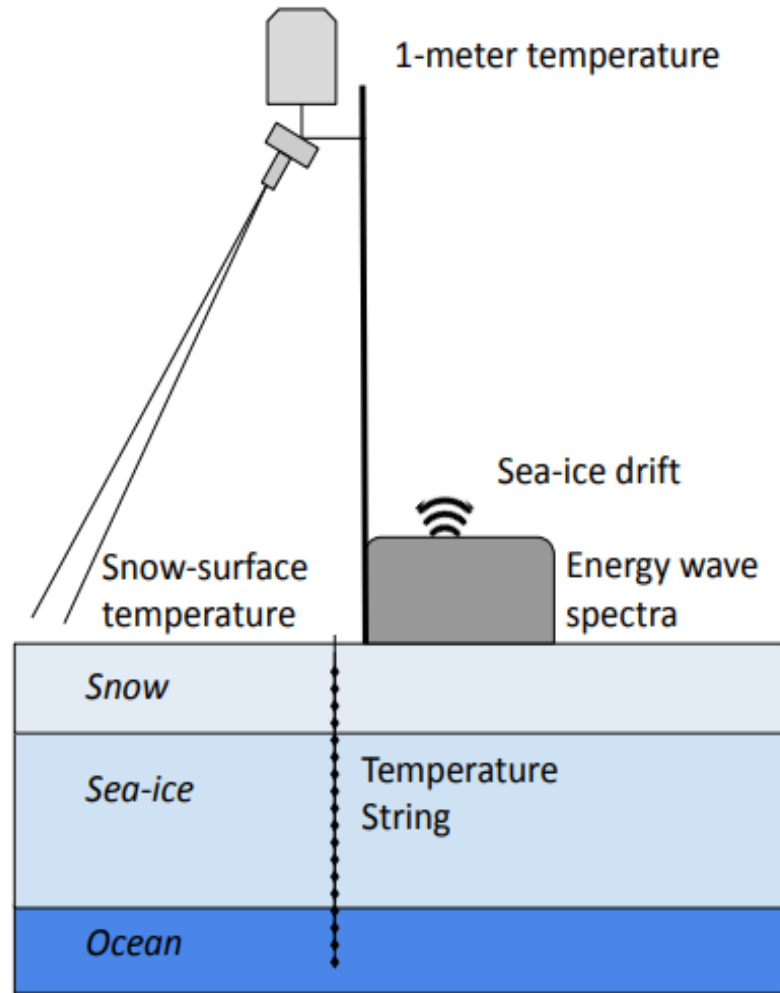
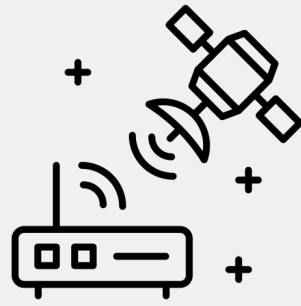


Induced differences in temperature by only changing the sea-ice product



Müller et al. 2023, Weather Forecasting

# OpenMetBuoy



# Svalbard Marginal Ice Zone Campaign - 2024

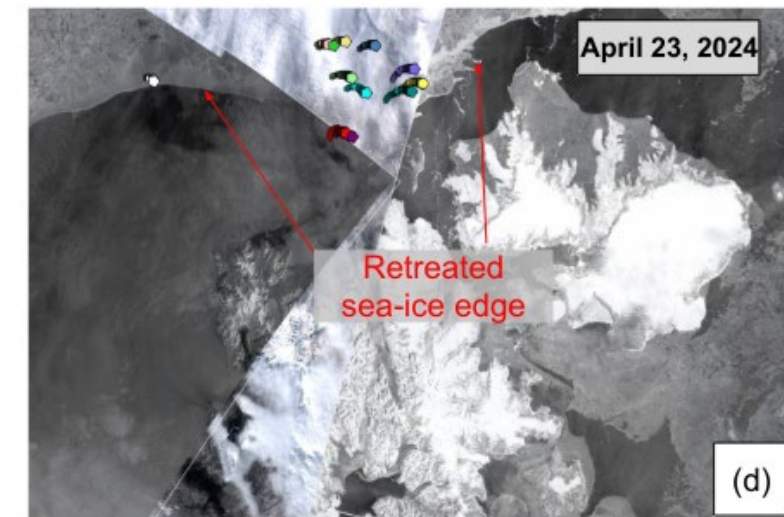
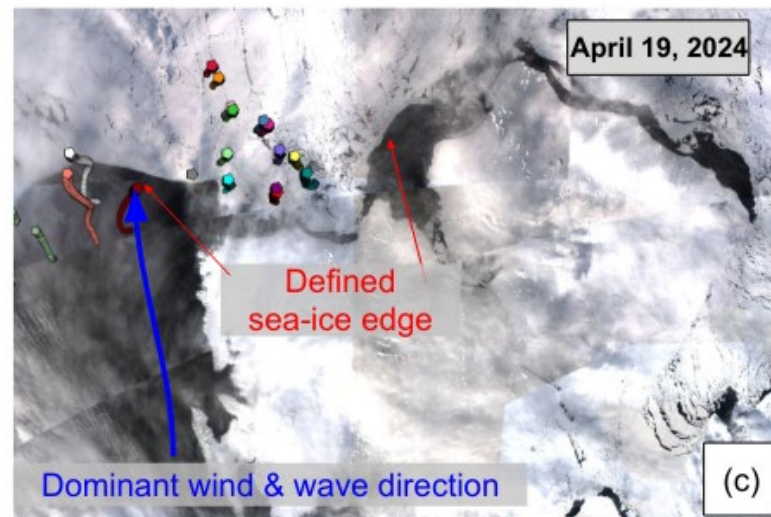
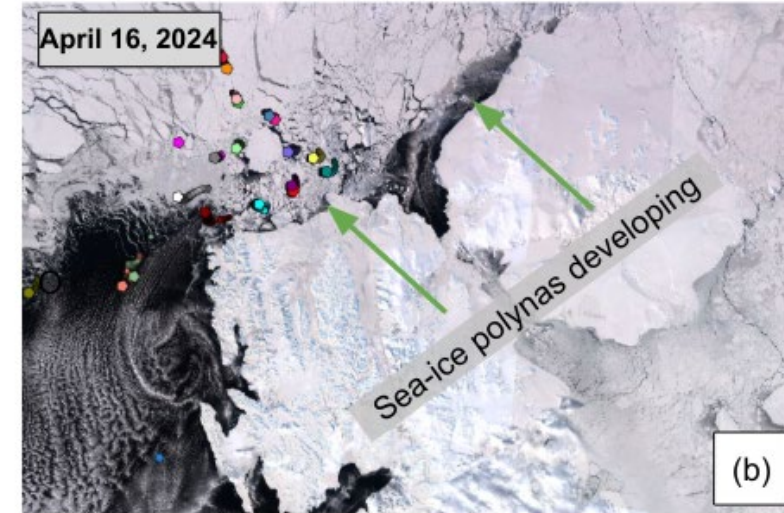
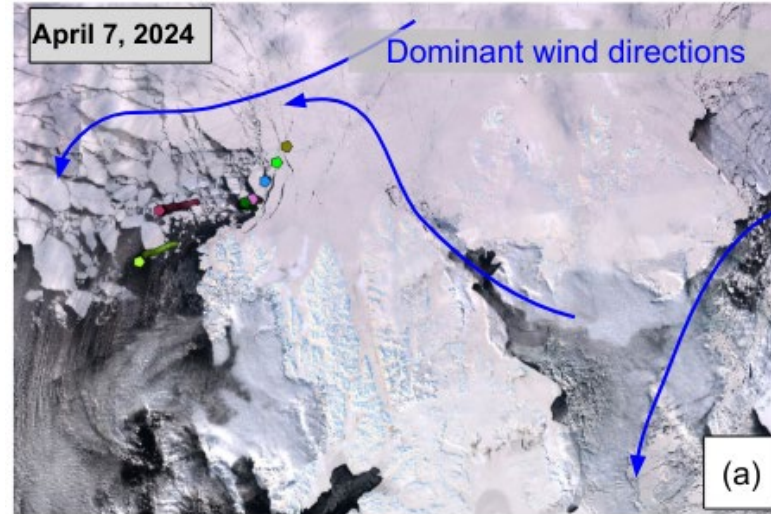
Coupled atmosphere-ice-wave system during the measurement period:

A: Persistent cold air outbreak, turning toward easterly winds

B: Sea-ice break-up north of Svalbard

C: Storm system from the south with strong southerly winds and large waves

D: Retreat of the sea-ice. Sea-ice edge very defined



# Model intercomparison: Weather / Sea-ice and Wave prediction systems

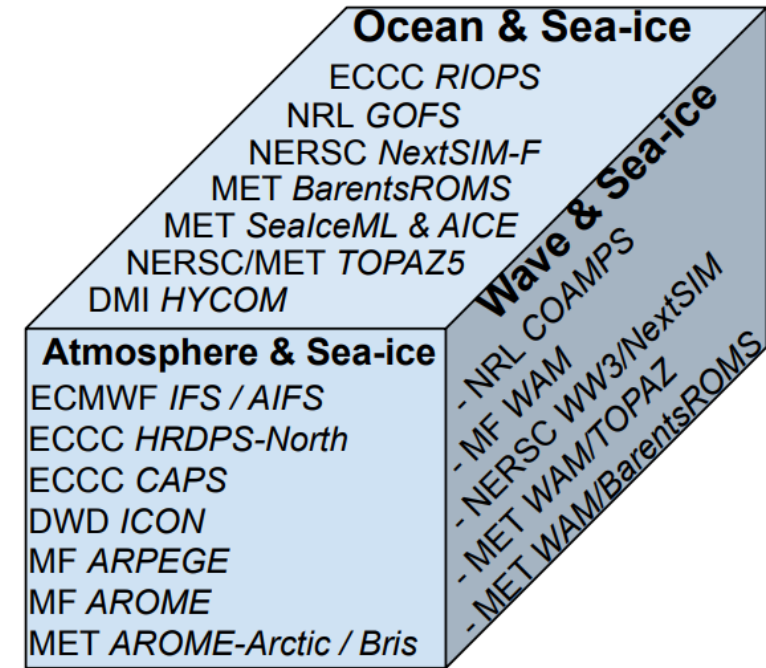
## Forecast model intercomparison

**Category A:** Coupled *atmosphere-sea ice* models  
*7 dynamical models + 2 ML-based models*

**Category B:** “Stand-alone” *sea-ice* (drift) models  
*6 dynamical models + 1 ML-based model*

**Category C:** Coupled *wave-sea ice* models  
*5 dynamical models*

45 Researchers from North America and Europe met in Oslo to discuss how to use the campaign data in their forecasting systems





# Model Tuning - SvalMIZ 2024

## Implementation of waves-in-ice in the ECMWF operational system (50r1)

### Newsletter

Number 185 - Autumn 2025

Published in October 2025

#### NEWS The introduction of waves in sea ice

Josh Kousal, Jean Bidlot, James Steer (all ECMWF),  
Jean Rabault (Norwegian Meteorological Institute),  
Malte Müller (Norwegian Meteorological Institute and The University of Oslo)

Over the last few decades, the polar regions have become an increasing focus for the weather and climate science community, and there is clear evidence that the interactions between waves and sea ice are important across various time scales.

In the present and past ECMWF operational forecasting systems, wave-sea ice interaction has not been represented. In the ECMWF Ocean Wave Model (ecWAM), waves are simulated only up to 30% sea ice cover (SIC). Beyond this limit, they are instantly attenuated (i.e. set to 0), and most model output variables are masked, thereby providing no wave information in areas with higher levels of ice cover.

[View all Newsletters](#)

#### Editorial

A milestone year and a moment of reflection

#### News

Code for Earth 2025: innovation, collaboration and impact

Thermal Trace: health-related weather and climate monitoring

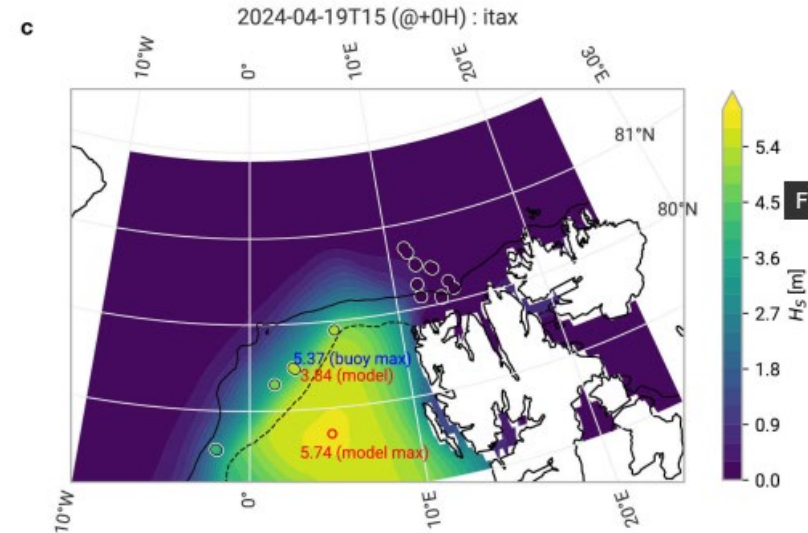
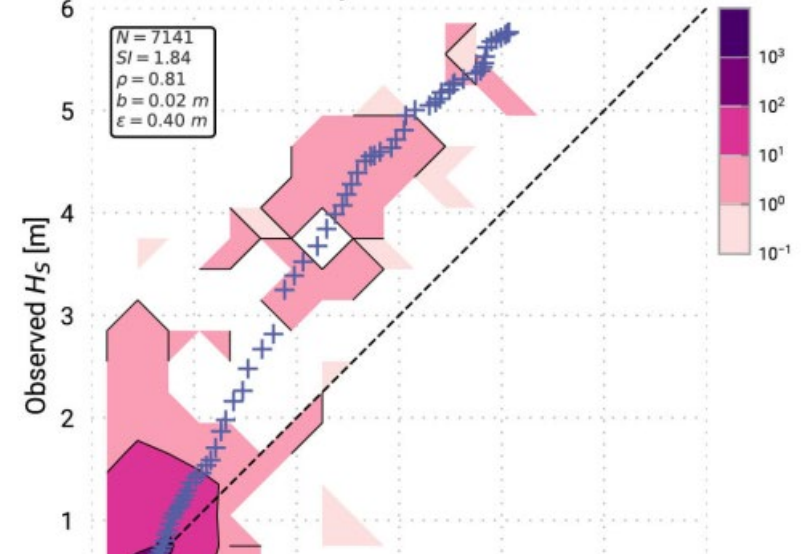


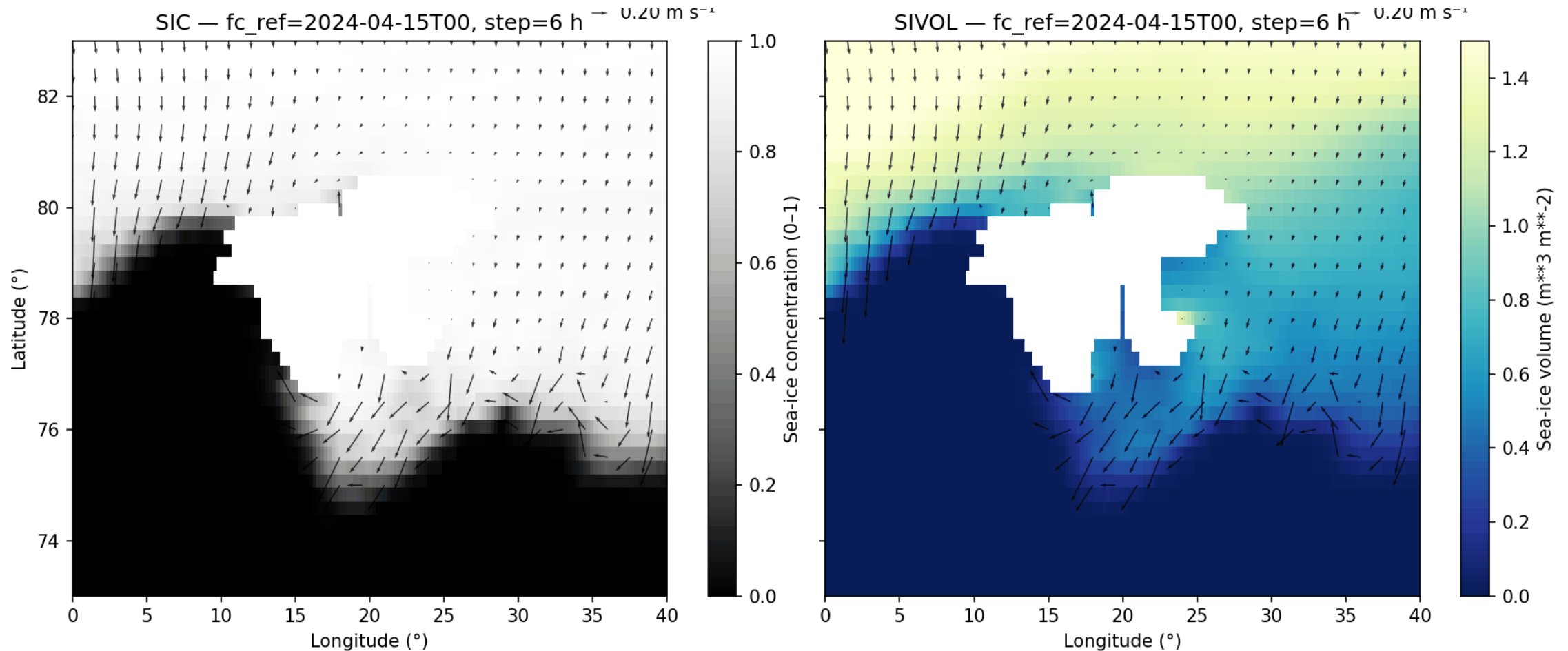
Fig 1c

With recent advances in hardware and software, wave buoys have reduced in cost. This has enabled the Norwegian Meteorological Institute (Meteorologisk Institutt), which has largely been

d itax.wave\_ext.an.swh.buoy.2024.04.01\_2024.05.31.sval.scats



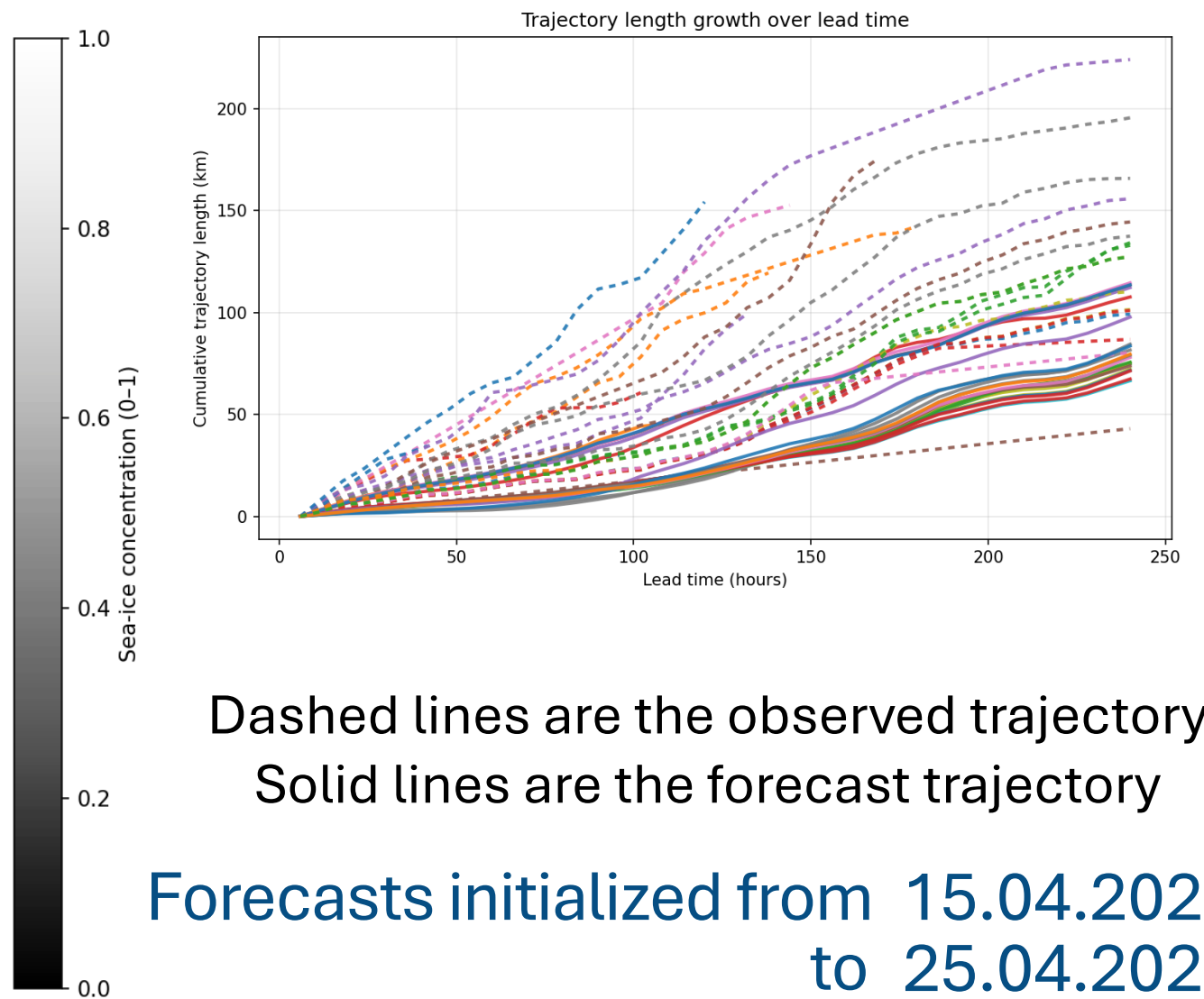
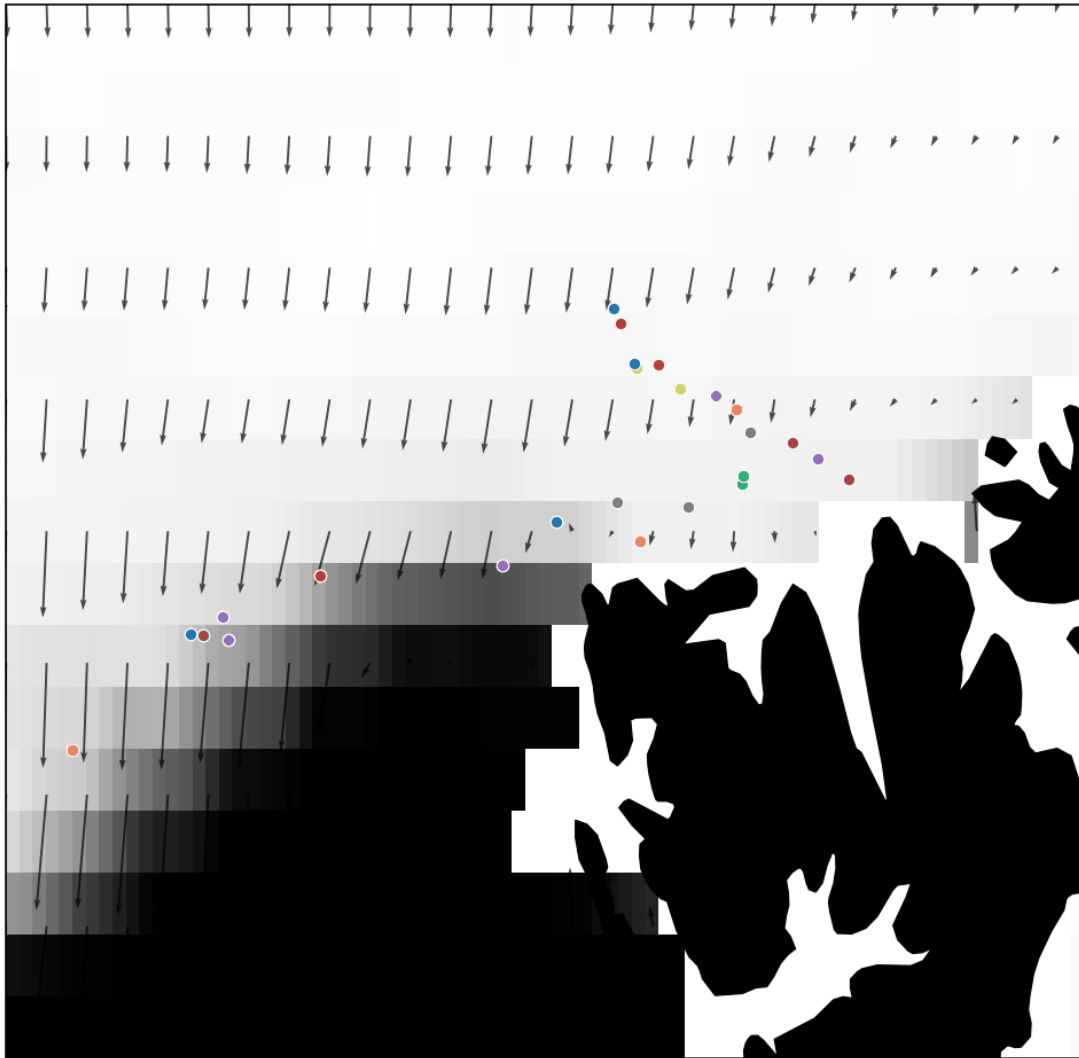
# Assessment of data driven models: sea ice forecasts during SvalMIZ-24



Forecast initialized on: 15.04.2024

# AI model of sea ice drift evaluation during SvalMIZ-24

Forecast vs Buoys — fc\_ref=2024-04-15 00Z, step=6 h



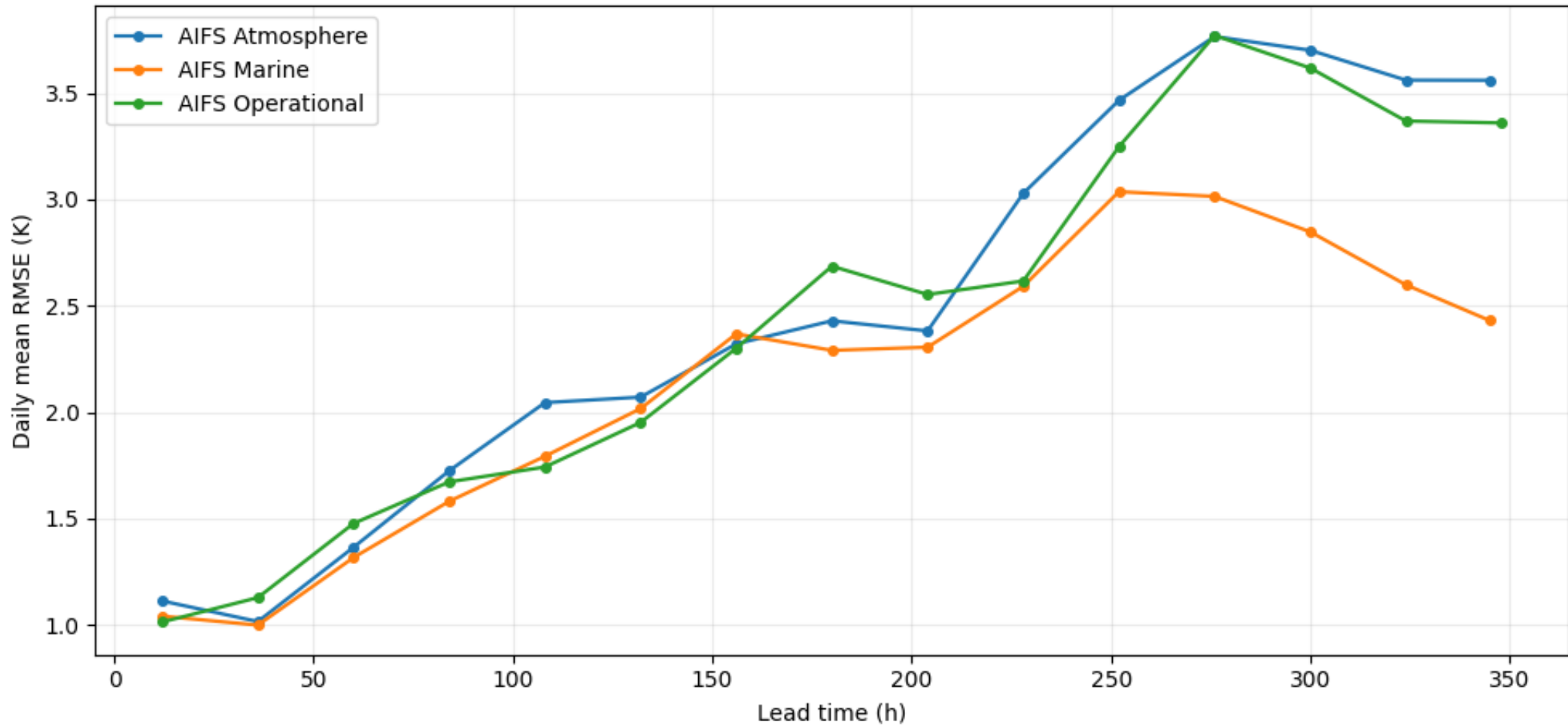
Dashed lines are the observed trajectory  
Solid lines are the forecast trajectory

Forecasts initialized from 15.04.2024  
to 25.04.2024

# Examples of relevant model evaluation against in-situ observations

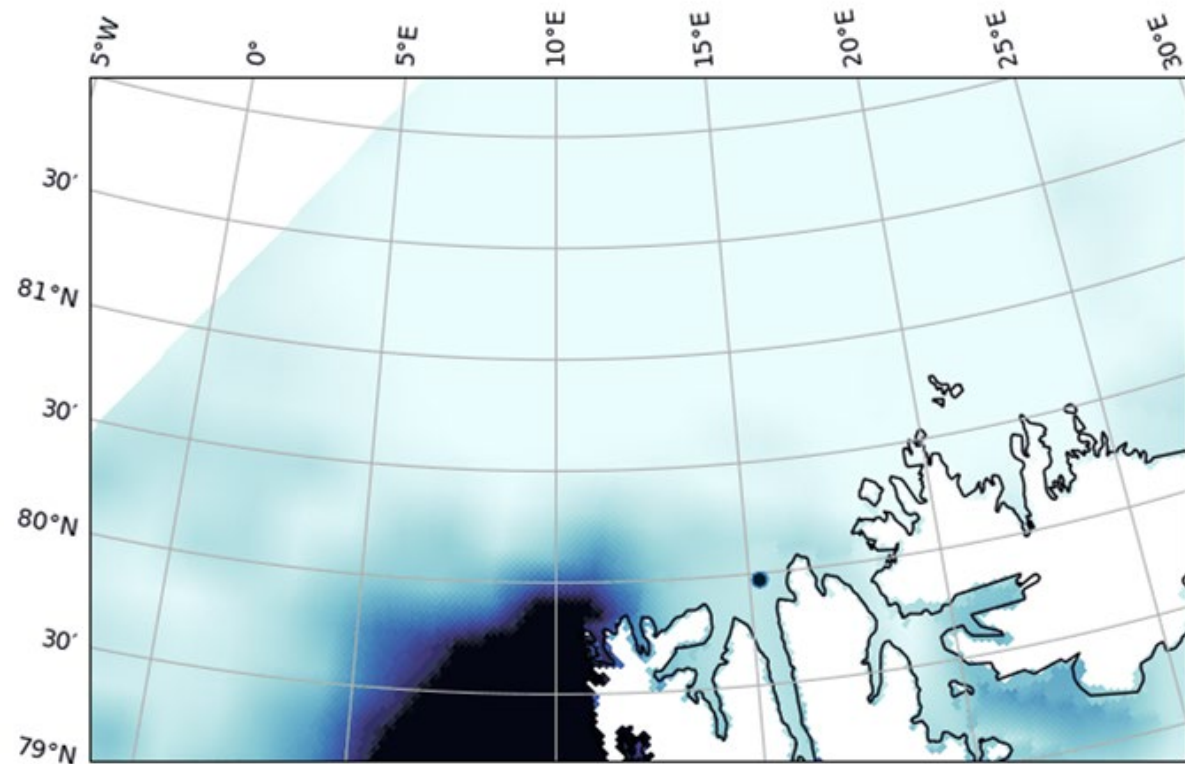
## *Near surface temperature evaluated against SvalMIZ-25*

2 m temperature RMSE — daily averages



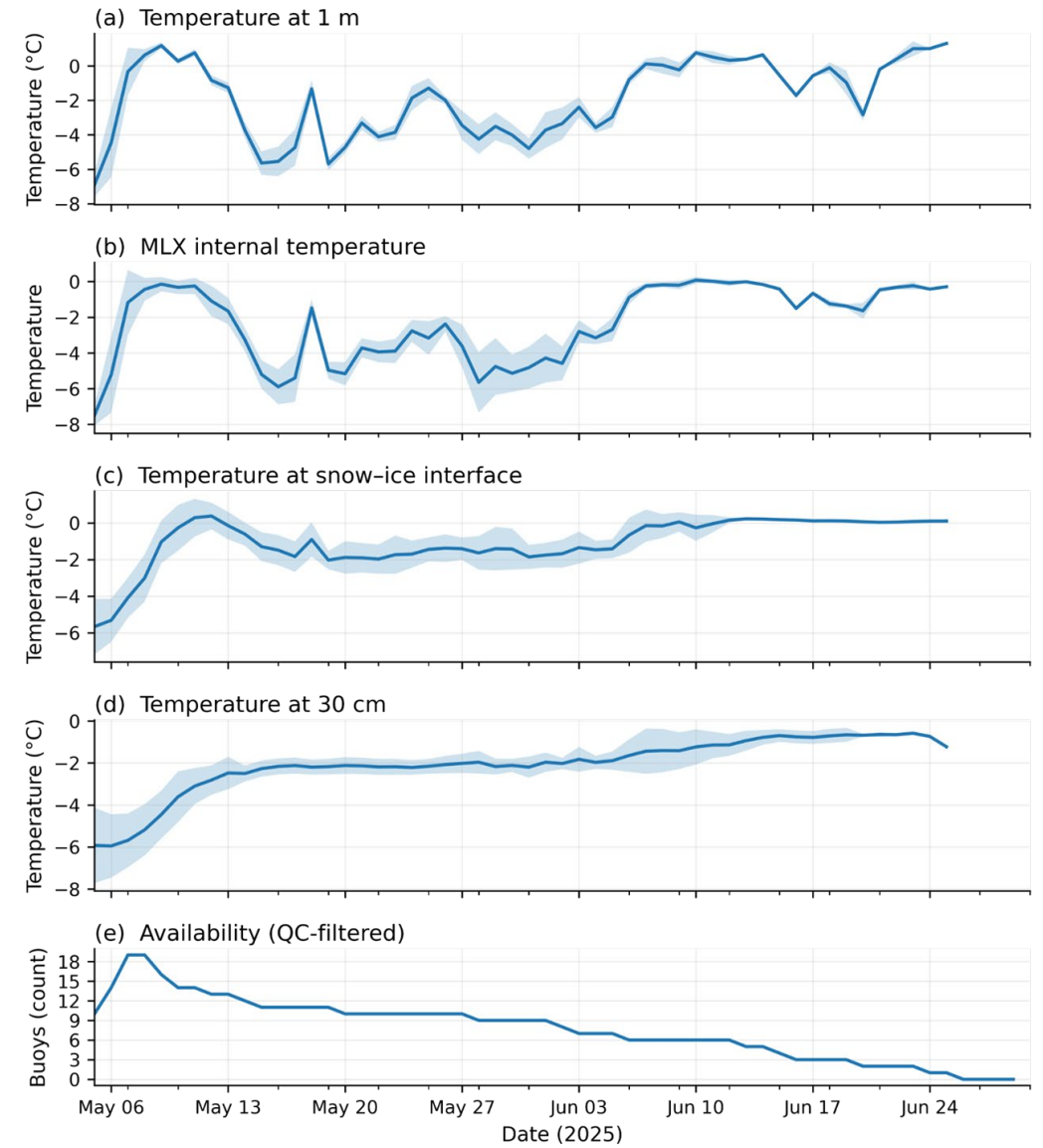
# SvalMIZ 2025

## Deployment of 21 buoys north of Svalbard

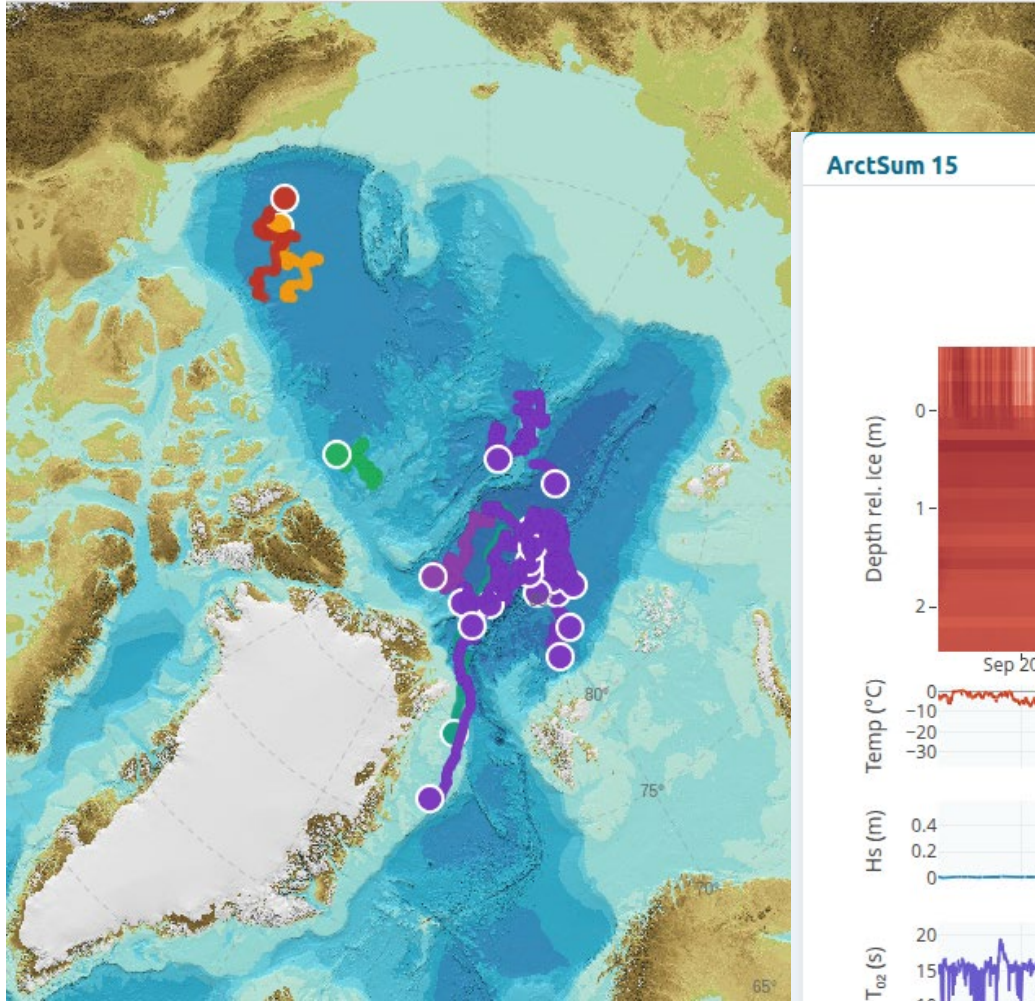


<https://odl.bzh/GyGURNvb>

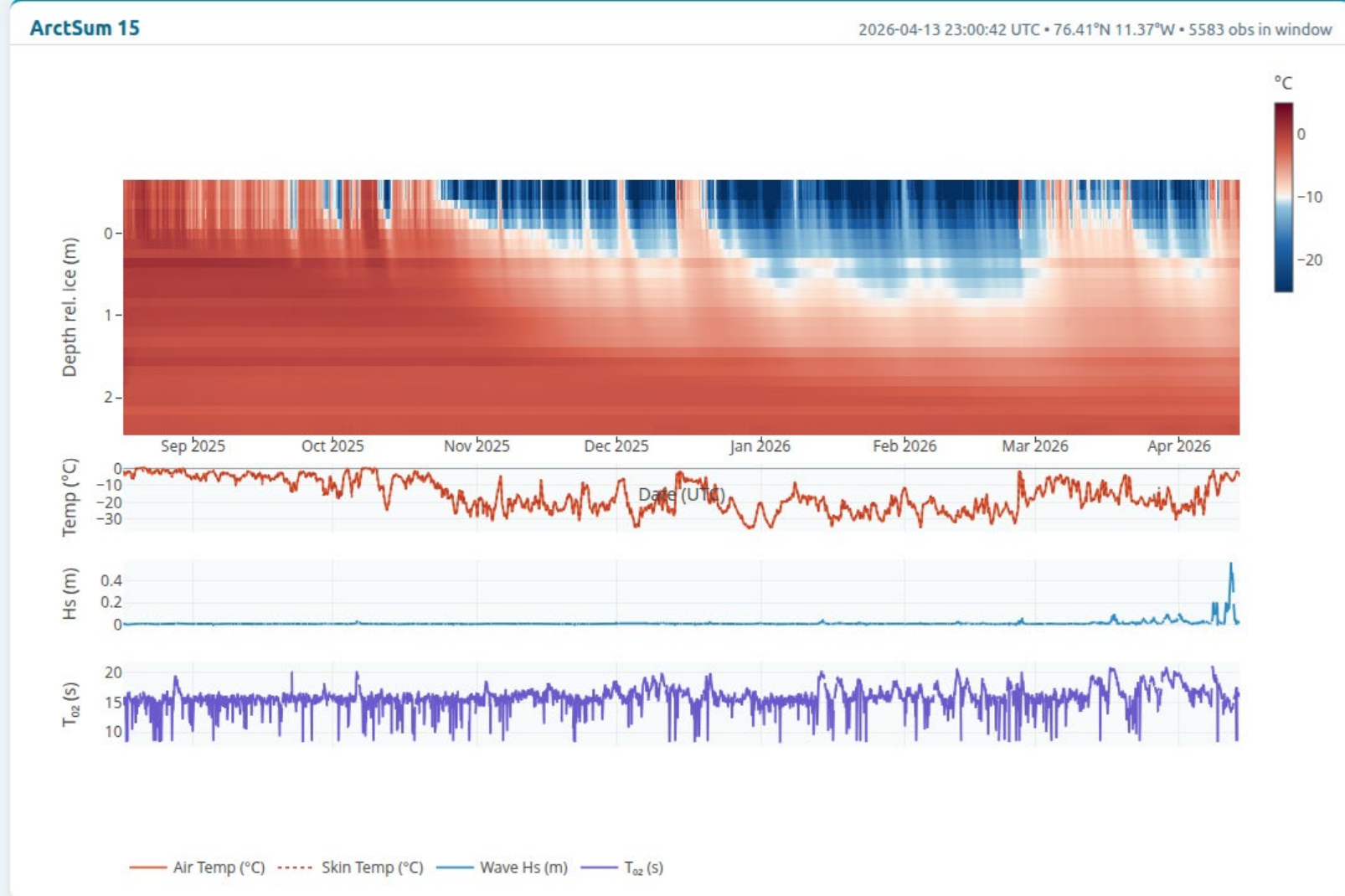
SvalMIZ-25 Buoy temperatures (mean  $\pm 1\sigma$  across buoys) and availability



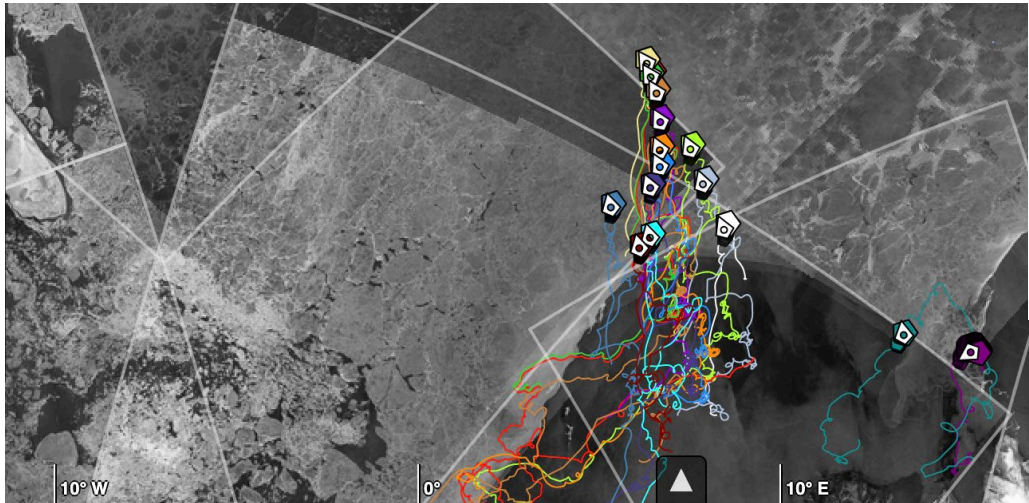
# ArctSum 2025



## Deployment of 19 buoys in the central Arctic



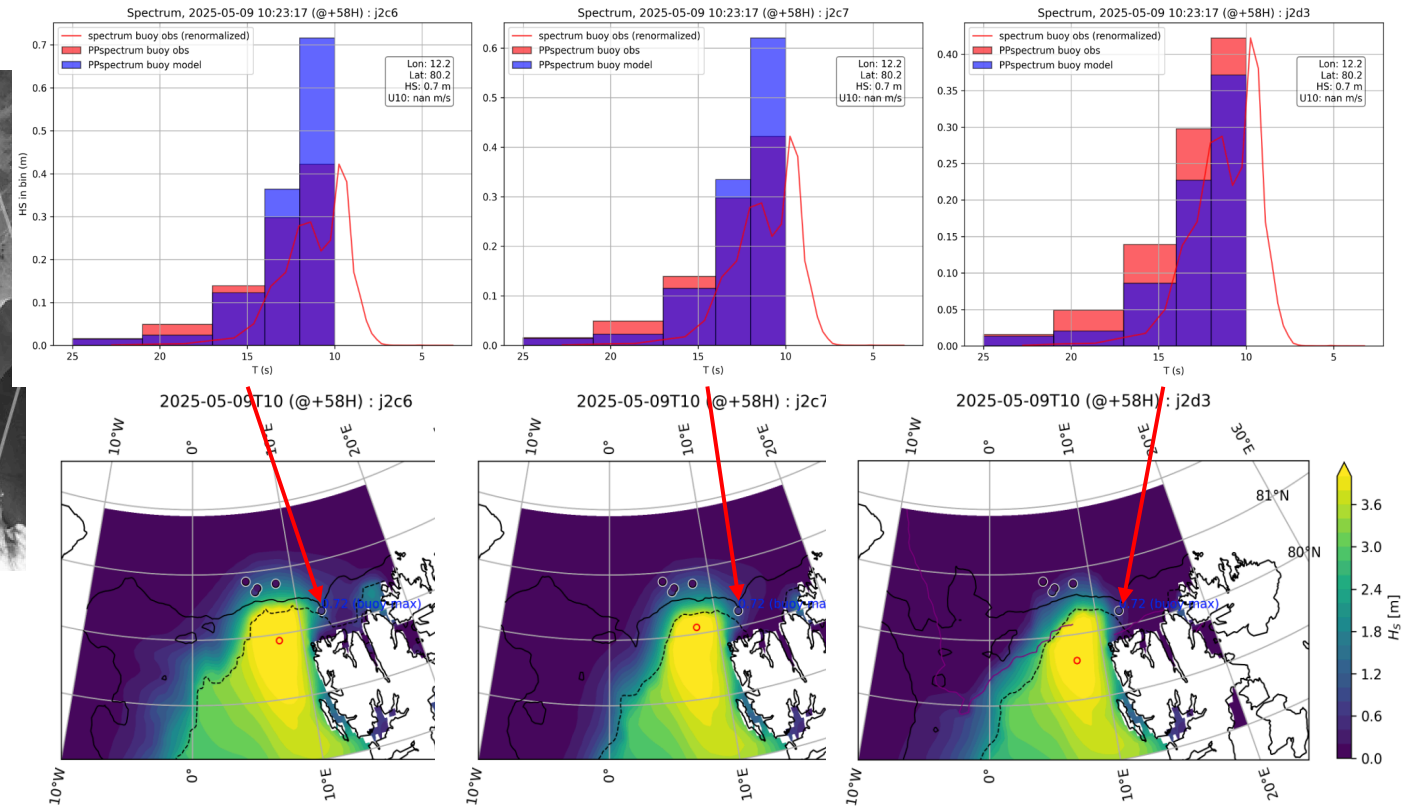
# Gaining more understanding of model performance: Spectra example



50r1

~51r1

ice break prototype

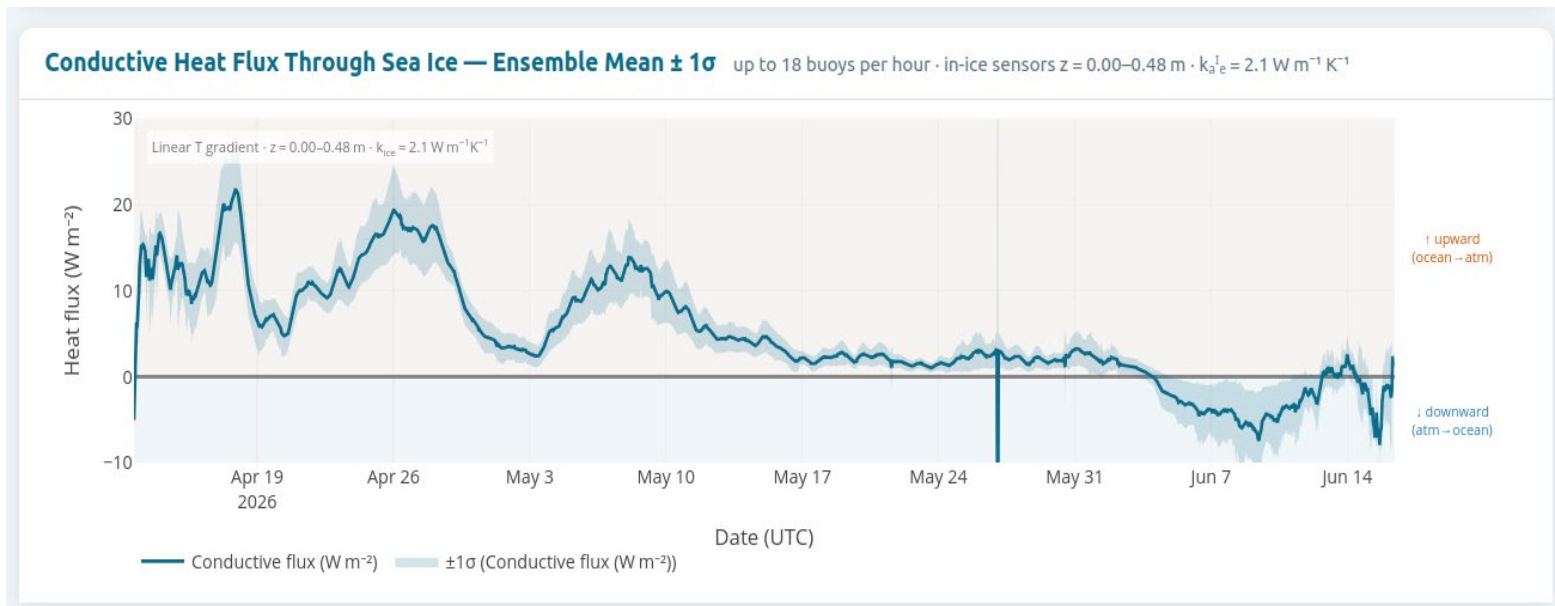
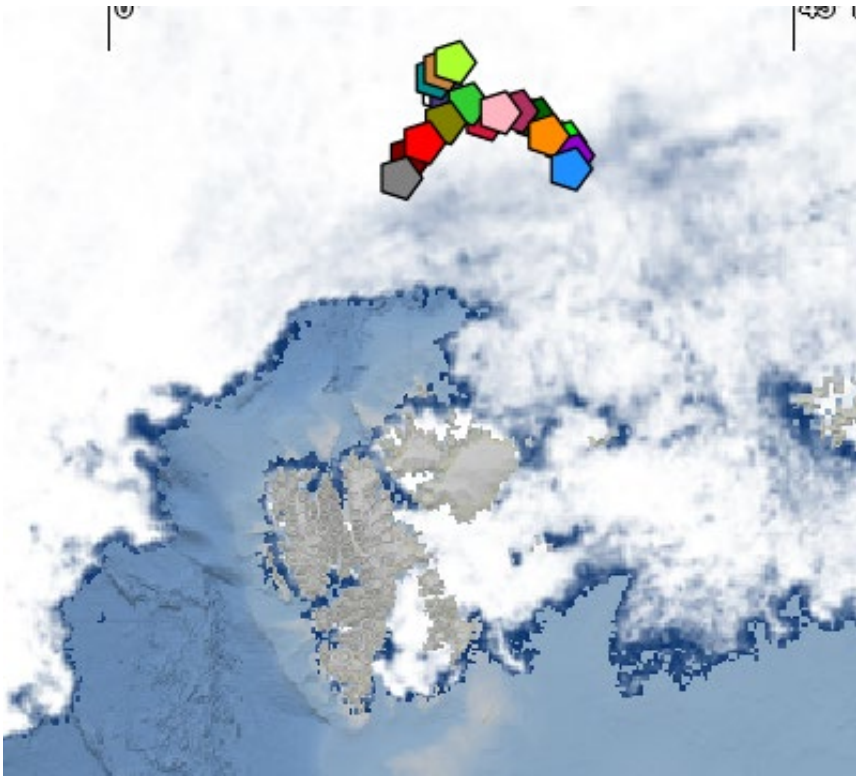


# SvalMIZ 2026

Deployment of 18 OMBs North of Svalbard

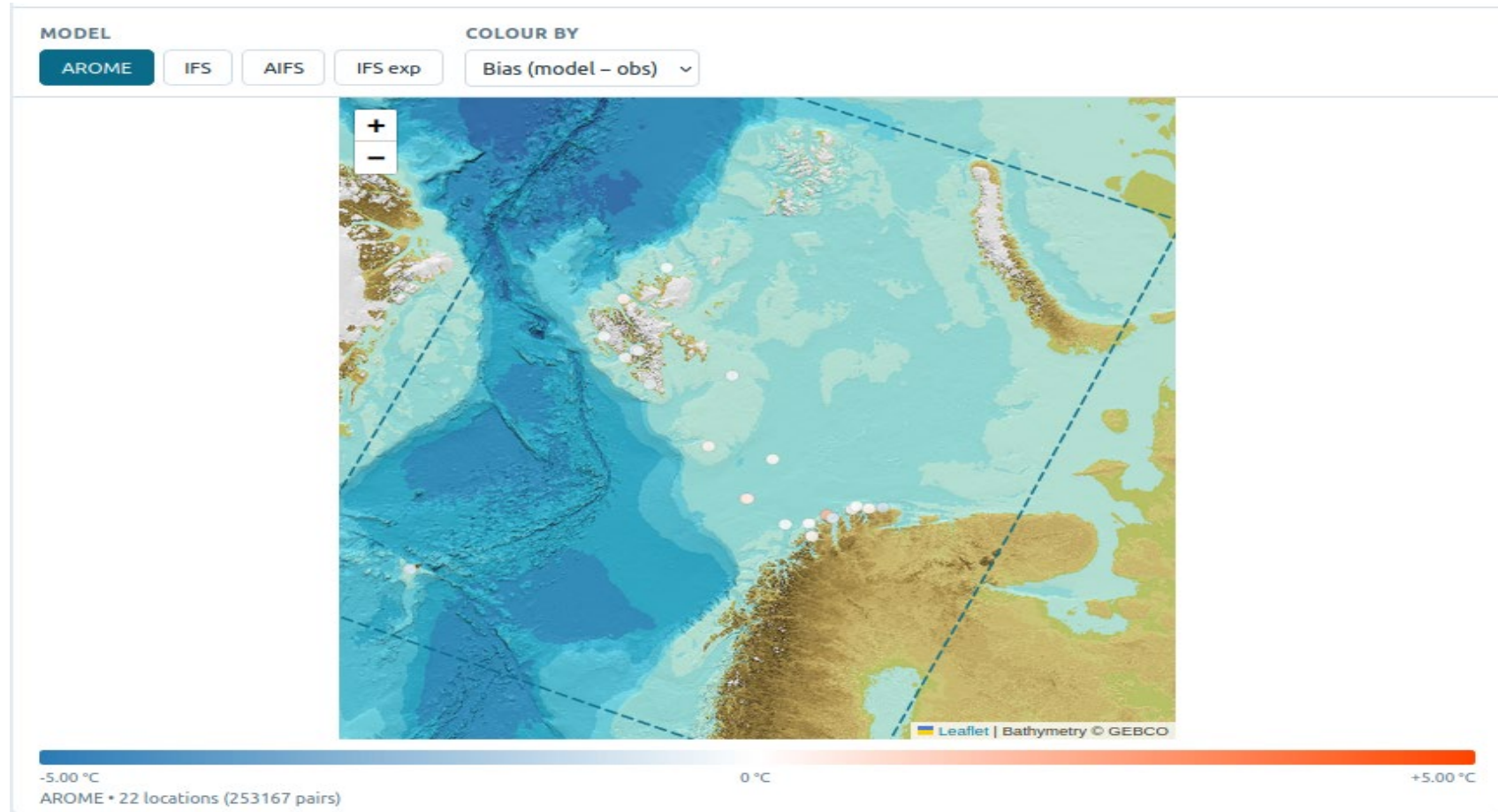
More than 6 weeks of data from 14+ buoys!

Bulk energy flux and conductive heat flux estimates possible for the region.

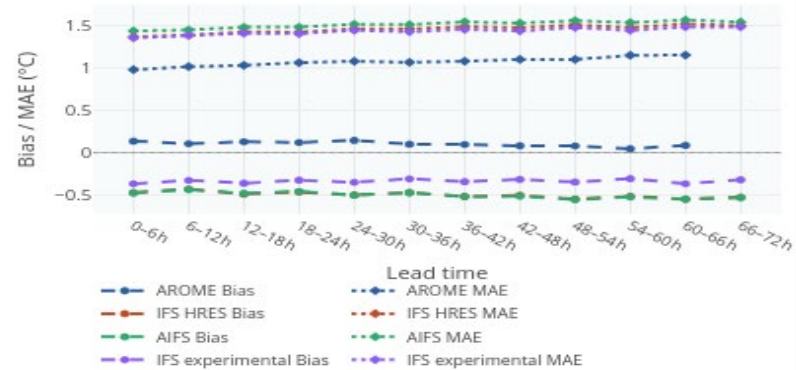


# SvalMIZ 2026

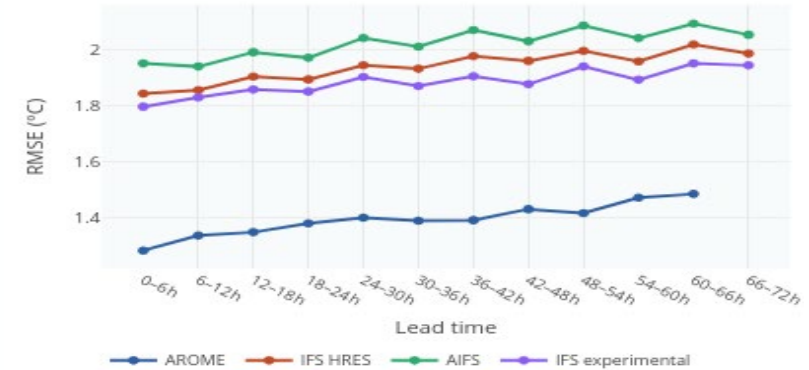
- Assessment of models in NRT



Bias & MAE by lead time



RMSE by lead time



# Conclusions

- SvalMIZ campaign data is providing a rich source of in situ data to compare models with a range of situations
- Benefit from the good collaboration with the data providers to help us understand the data quality
- The low operating costs means multiple deployments which are helpful for capturing different synoptic situations and reduces chance of over fitting data to a particular situation.
- Provides a focal point for operational centres to assess model performance across a range of different systems.

# Planned: ArctSum 2026



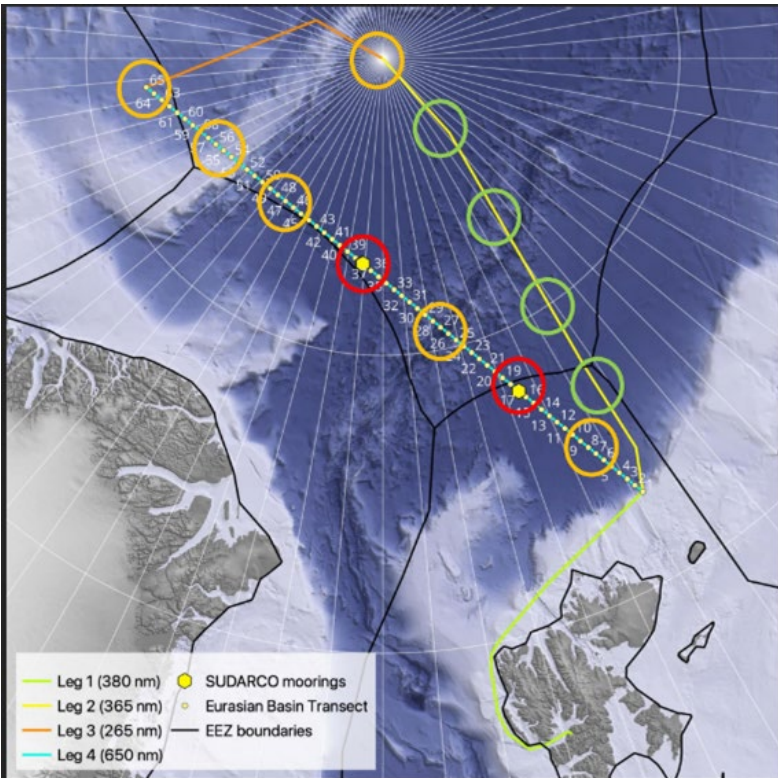
**Kronprins Haakon**  
**Polhavet2050 Cruise**



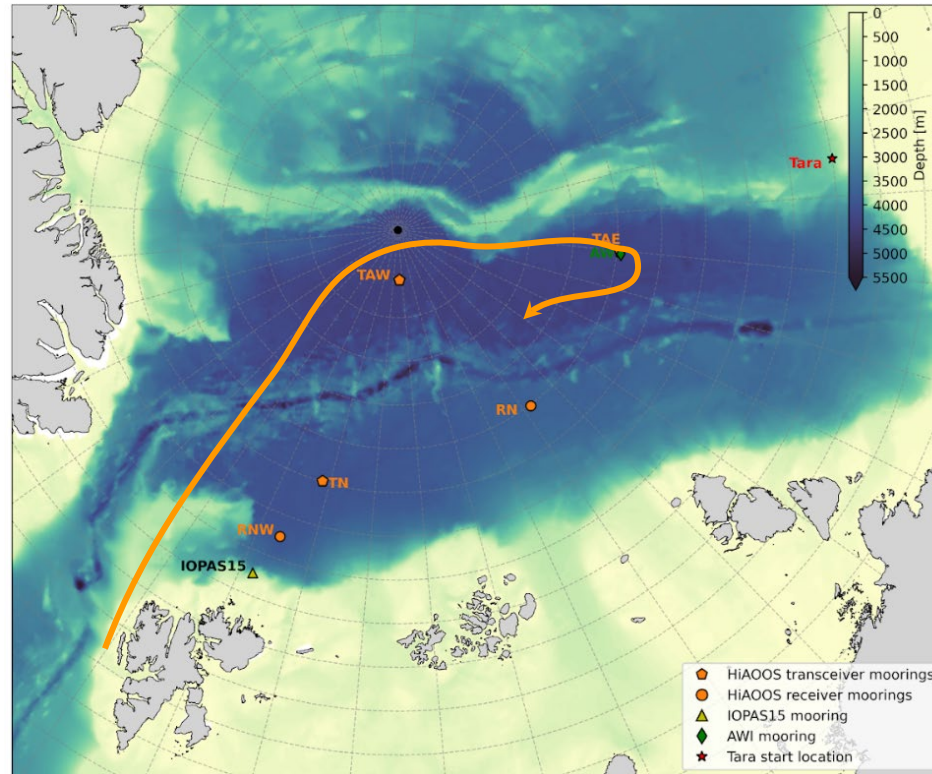
**KV Svalbard HiAOOS Cruise**



**Oden Cruise**  
*3 Buoys*



*10 Buoys*



*20 Buoys*

# SvalMIZ 2026

## Spatial variogram — temperature variability vs. distance

Empirical semivariogram  $\gamma(h) = \frac{1}{2} \cdot \text{mean}[(T_i - T_j)^2]$  computed from all observation pairs in each lead-time window. Observations (dashed) are the reference.

