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Forecast uncertainty and ensemble spread in surface currents from a regional ocean model

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Introduction

surface currents: important ocean state variable for applications in marine ecosystems, offshore industries, and shipping

regional ocean model *Barents-2.5* EPS: we assess surface currents from *Barents-2.5* by validating them against HF-radar observations

main question: To what extent do we expect predictability in surface currents from **regional ocean models** that do not assimilate currents or have few observations of currents?

Barents-2.5 EPS *model*

Grid

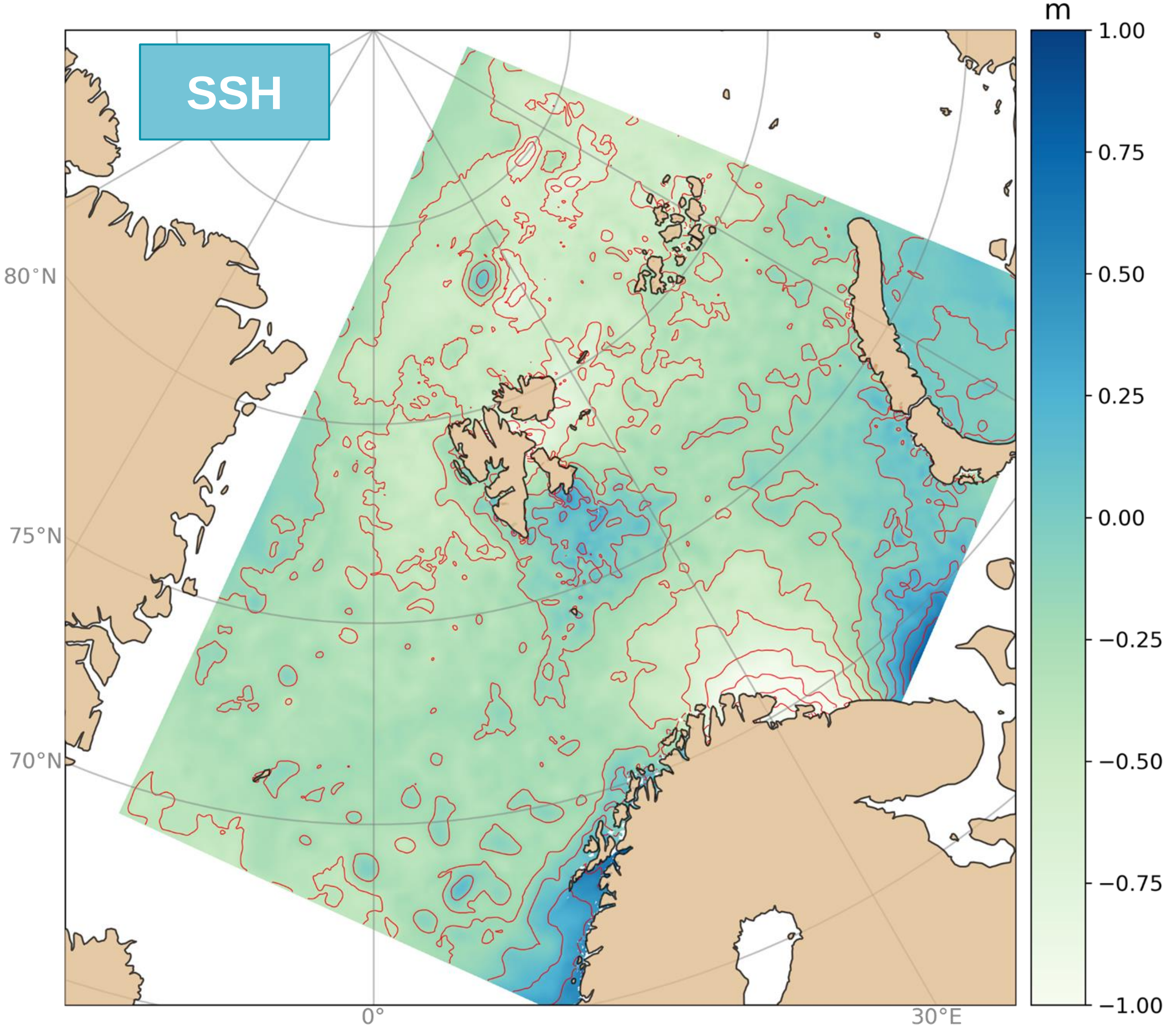
- 2.5 km horizontal resolution
- 42 vertical layers

Barents-2.5 EPS

- 24 members
  4 members: AROME-Arctic
  20 members: ECMWF
- **66 hours** forecast length

Data assimilation

- method:
  Ensemble Kalman filter
- observations:
  sea-surface temperature, sea-ice concentration based on AMSR-2 (SIRANO), *in-situ* temperature and salinity



Röhrs et al. (2023), Barents-2.5km v2.0: An operational data-assimilative coupled ocean and sea ice ensemble prediction model for the Barents Sea and Svalbard, GMD, doi: 10.5194/gmd-2023-20.

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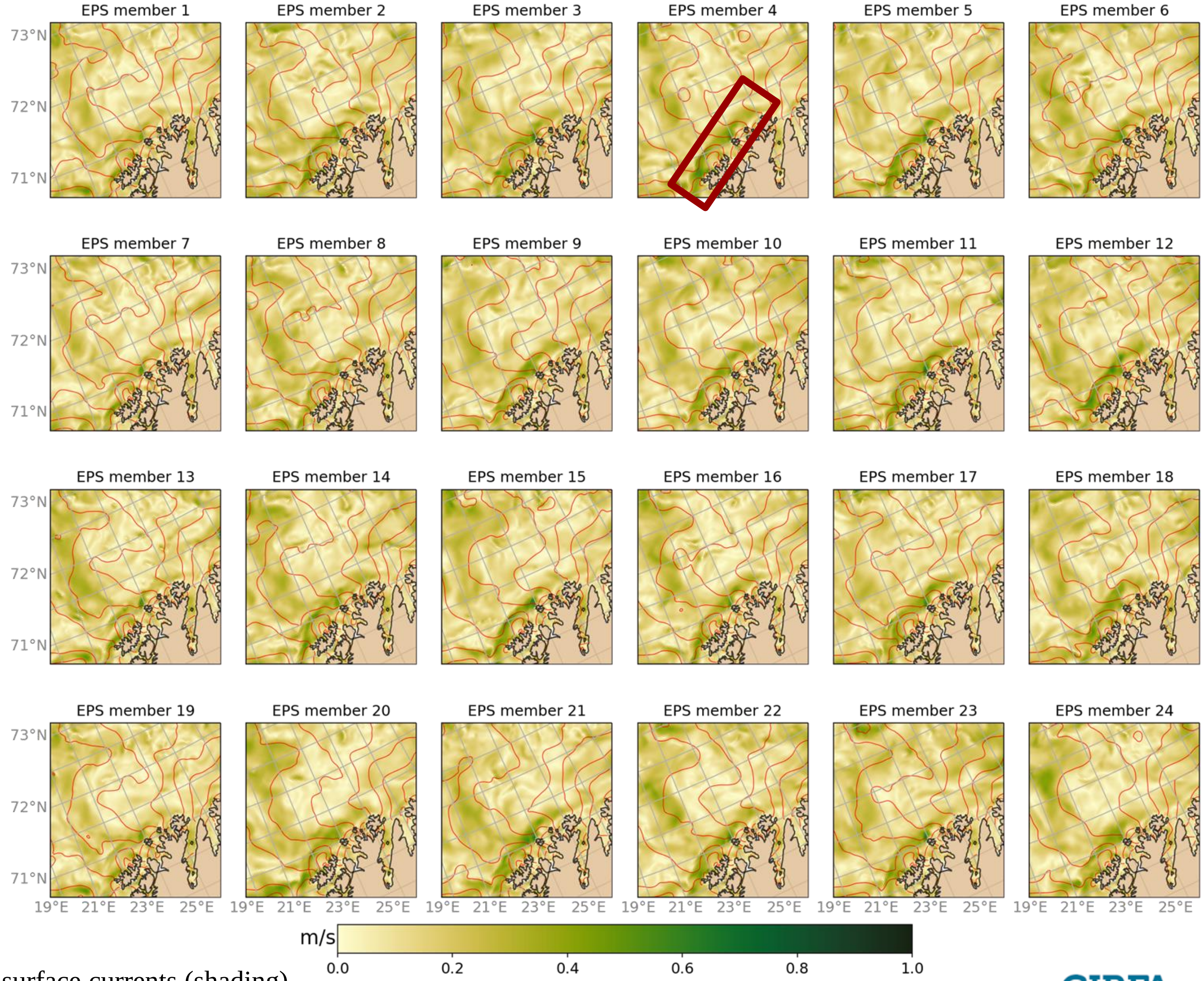
Barents-2.5 **EPS** *members*



surface currents (shading)
sea surface height (red contours)

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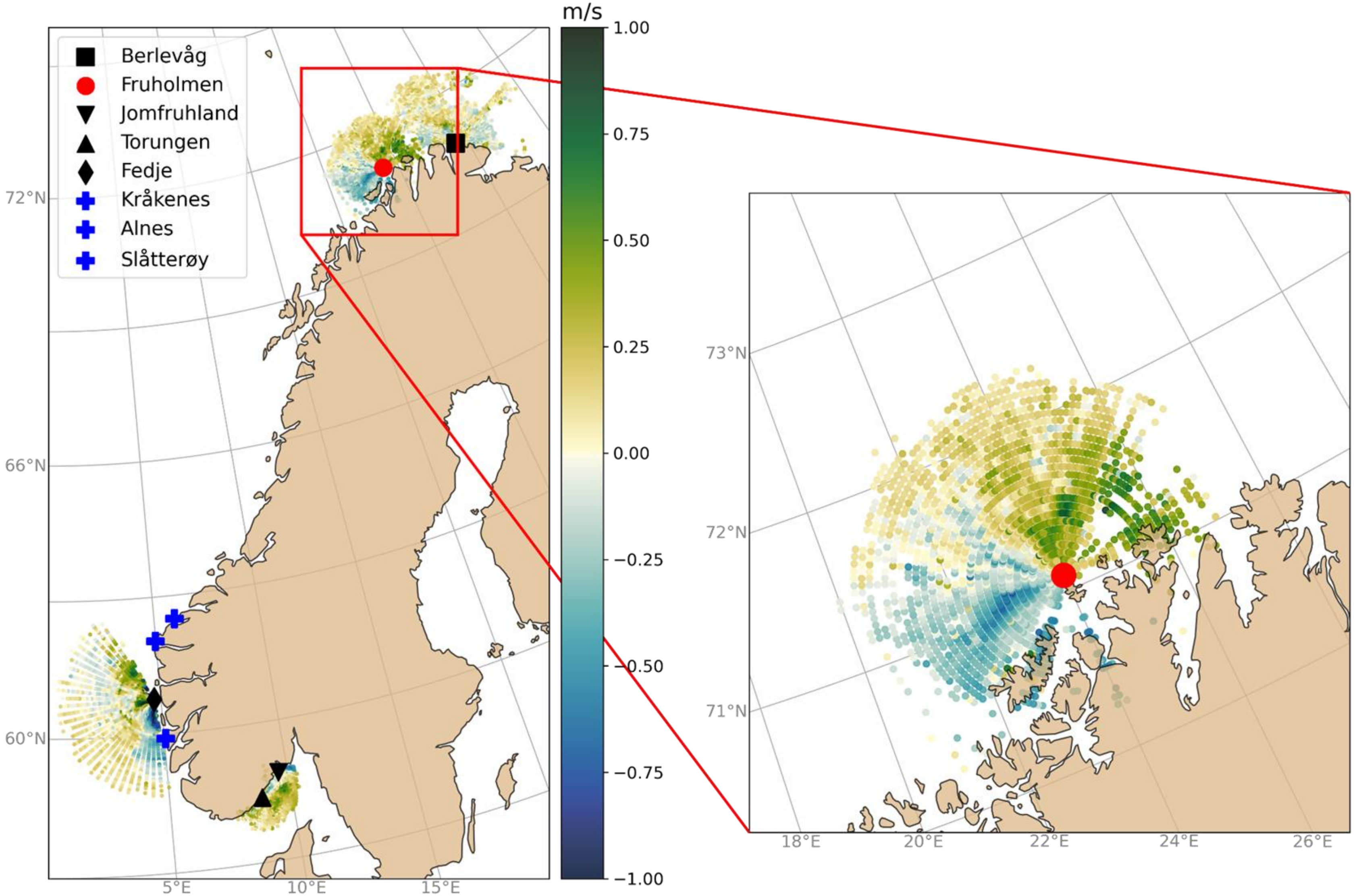
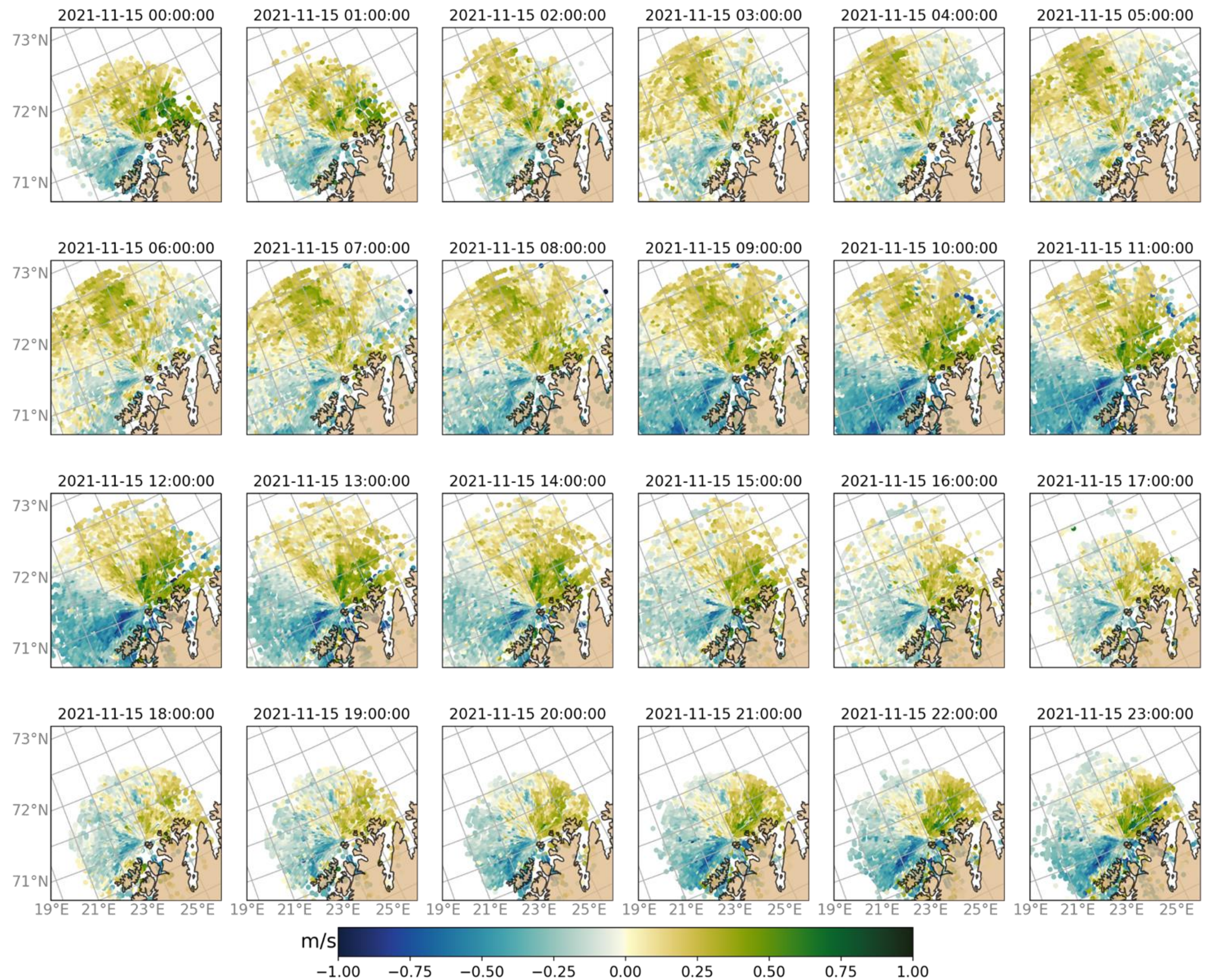
HF radars *Norwegian coast*



NOFO-HF project: *HF-radar data available at* [*https://thredds.met.no/thredds/catalog/remotesensinghfradar/catalog.html*](https://thredds.met.no/thredds/catalog/remotesensinghfradar/catalog.html)

HF radars *Fruholmen*



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Barents-2.5 EPS vs. HF radar

- data processing:
  - model smoothing: 2.5 km → 5 km
  - modeled *u*, *v* rotated from model grid onto north/east directions and interpolated to observed HF-radar positions
  - *u*, *v* projected onto HF radar's bearing direction
  - here, only the radial current component was considered
- validation period:
  - start date = 2021-11-15
  - end date = 2021-12-31
- three time spans:
  - 0h – 24h →+24h
  - 24h – 48h→+48h
  - 48h – 66h →+66h
- we looked into:
  - skill in surface current forecasts
  - prediction of uncertainty in surface currents

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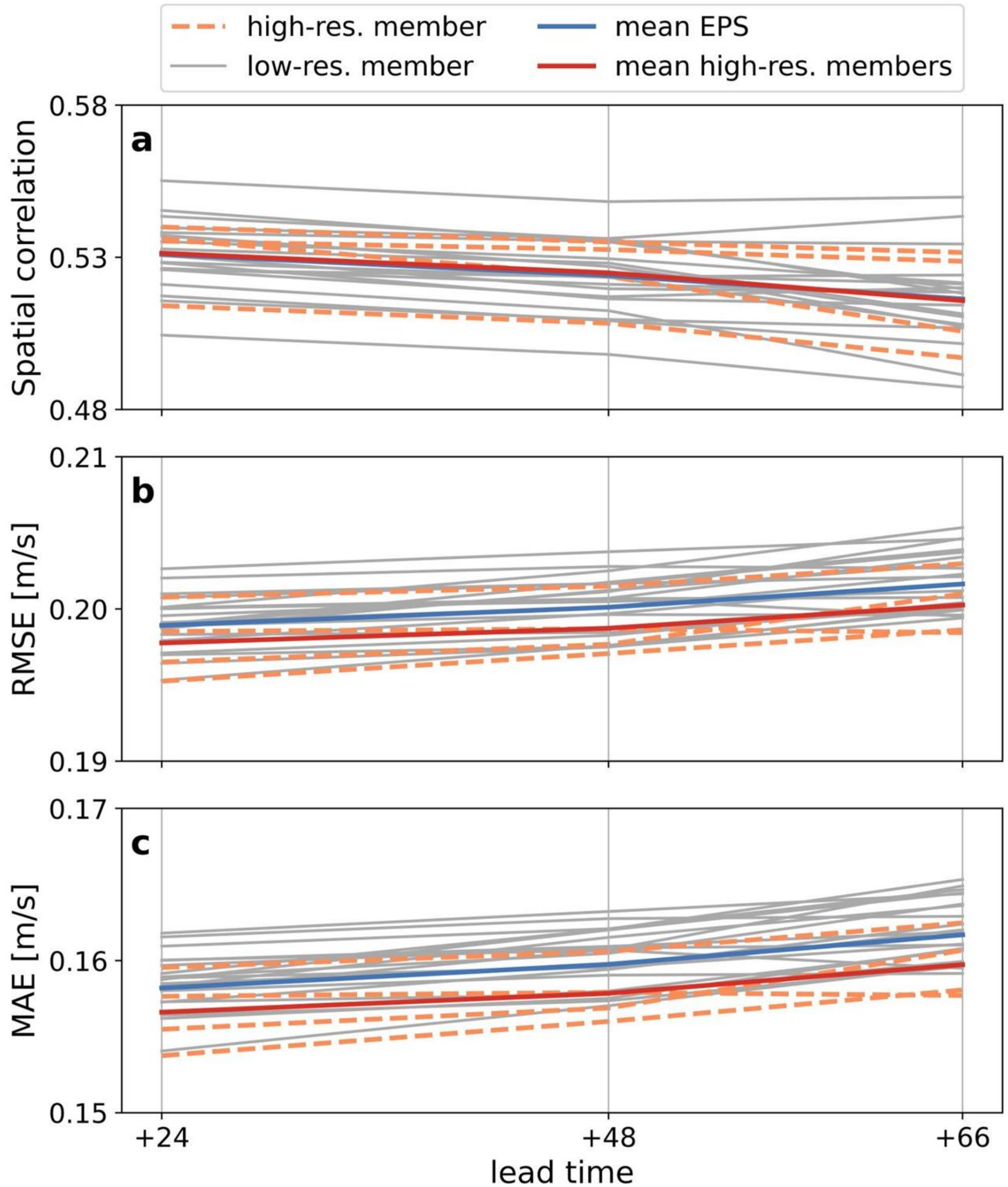
Skill in surface current forecasts



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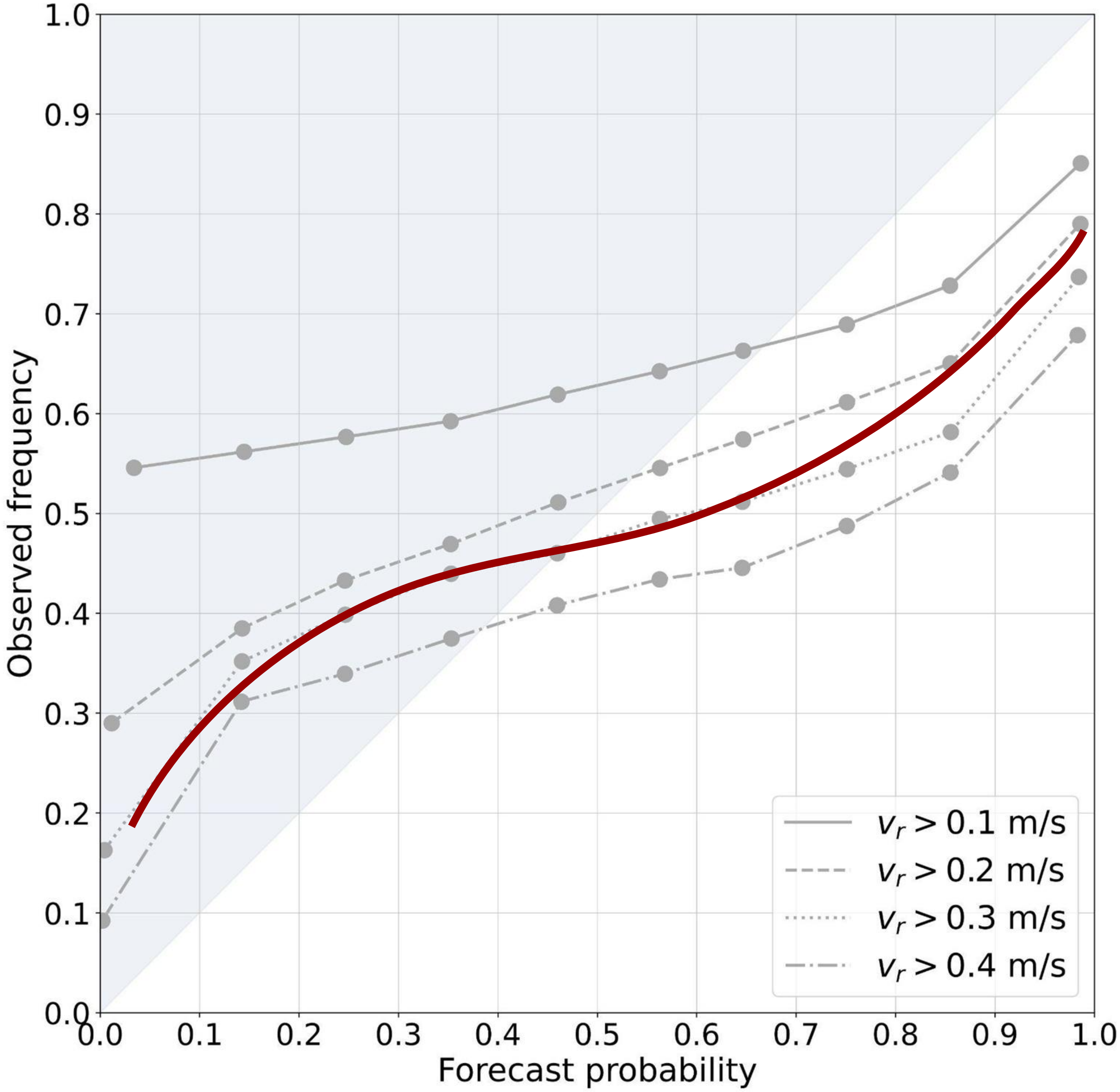
Prediction of uncertainty in surface currents



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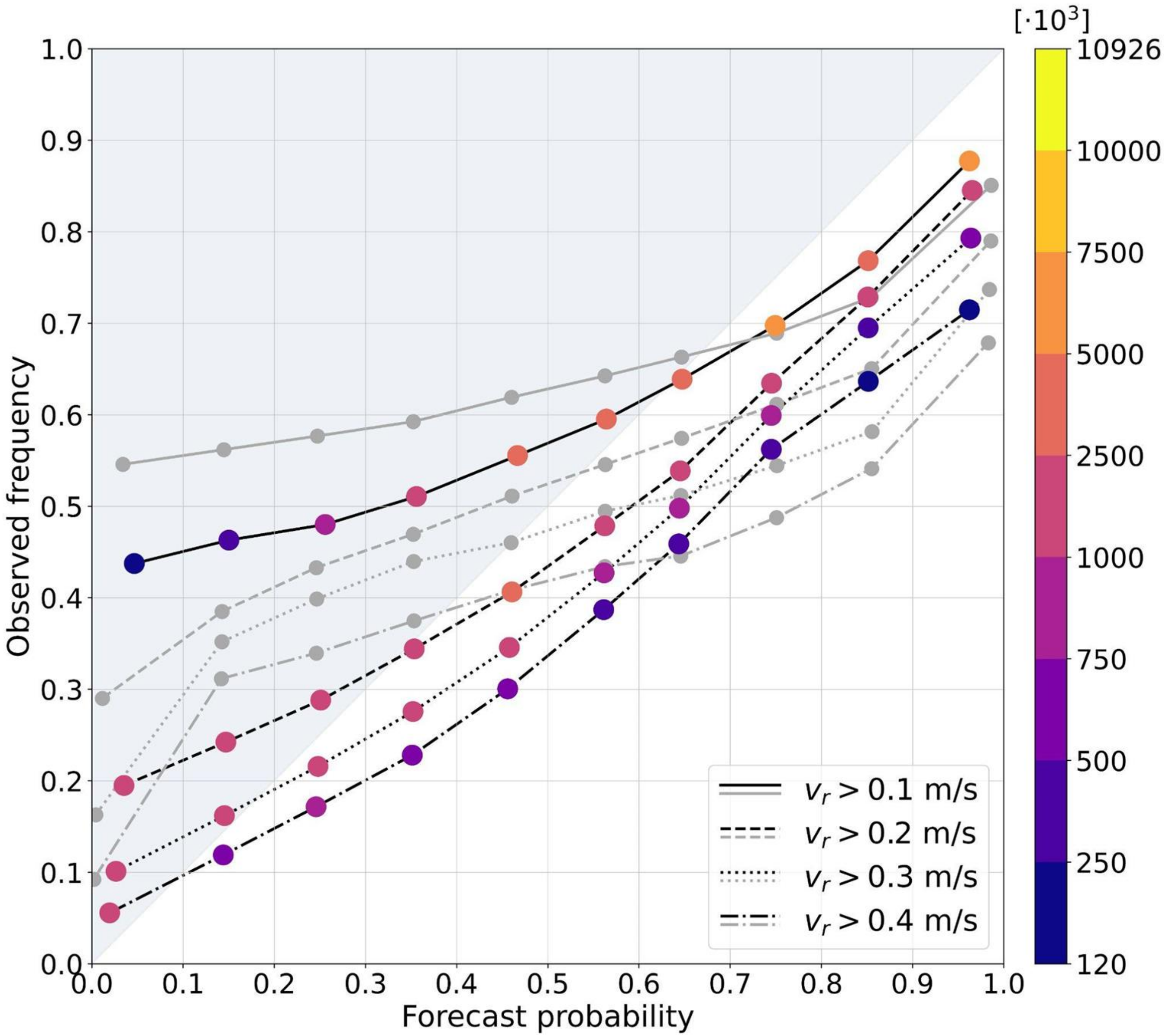
Prediction of uncertainty in surface currents



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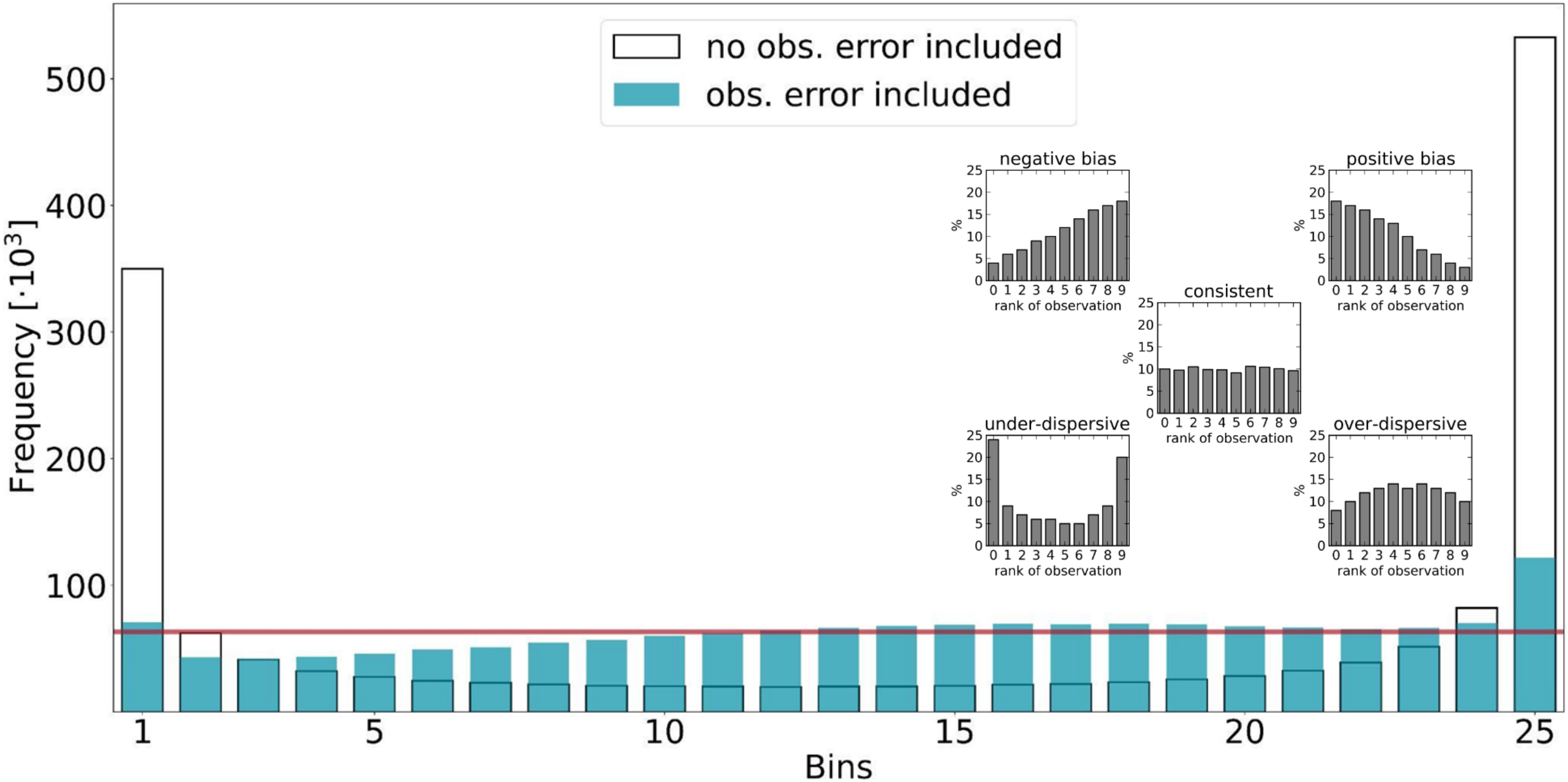
Prediction of uncertainty in surface currents *con't*



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Concluding remarks on regional ocean modeling

- promising abilities of *Barents-2.5* EPS to predict surface currents and their uncertainty

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- with increasing lead time
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AROME-Arctic

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- low predictive skill - to be improved by data assimilation of satellite altimetry and HF radars (ongoing work)

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AROME-Arctic

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Thank you for your attention!

Questions? Comments?

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Idžanović, M., E. Rikardsen, and J. Röhrs: Forecast uncertainty and ensemble spread in surface currents from a regional ocean model, in review for *Frontiers in Marine Science*, 2023.

References

Harlan, J., E. Terrill, L. Hazard, C. Keen, D. Barrick, C. Whelan, S. Howden, and J. Kohut (2010), The integrated ocean observing system high-frequency radar network: Status and local, regional, and national applications, *Marine Technology Society Journal*, **44**(6), doi: 10.4031/MTSJ.44.6.6.

Paduan, J.D. and H.C. Graber (1997), Introduction to high frequency radar: Reality and myth, *Oceanography*, **10**(2).

Röhrs, J., G. Sutherland, G. Jeans, M. Bedington, A. K. Sperrevik, K.-F. Dagestad, Y. Gusdal, C. Mauritzen, A. Dale, and J. H. LaCasce (2021), Surface currents in operational oceanography: Key applications, mechanisms, and methods, *Journal of Operational Oceanography*, doi: 10.1080/1755876X.2021.1903221.

Wilks, D. S. (2019), Statistical Methods in the Atmospheric Sciences, Elsevier, Amsterdam, Netherlands.

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