

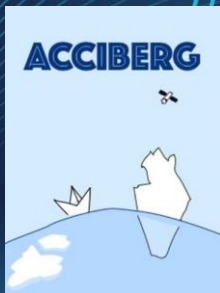
COPERNICUS MARINE 8th GENERAL ASSEMBLY

● ACCIBERG

Arctic Cross-Copernicus forecast products
for sea Ice and iceBERGs

L. Bertino, NERSC

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101081568





Copernicus
Marine Service



ACCIBERG facts

Consortium (7): NERSC, MET Norway, ECMWF, Mercator Ocean, DMI, CNR, ITUNOVA

Duration: 01.01.2023 – 31.12.2026

Funding: 3 M€

EC Grant Agreement: No. 101081568

Project coordinator: Laurent Bertino

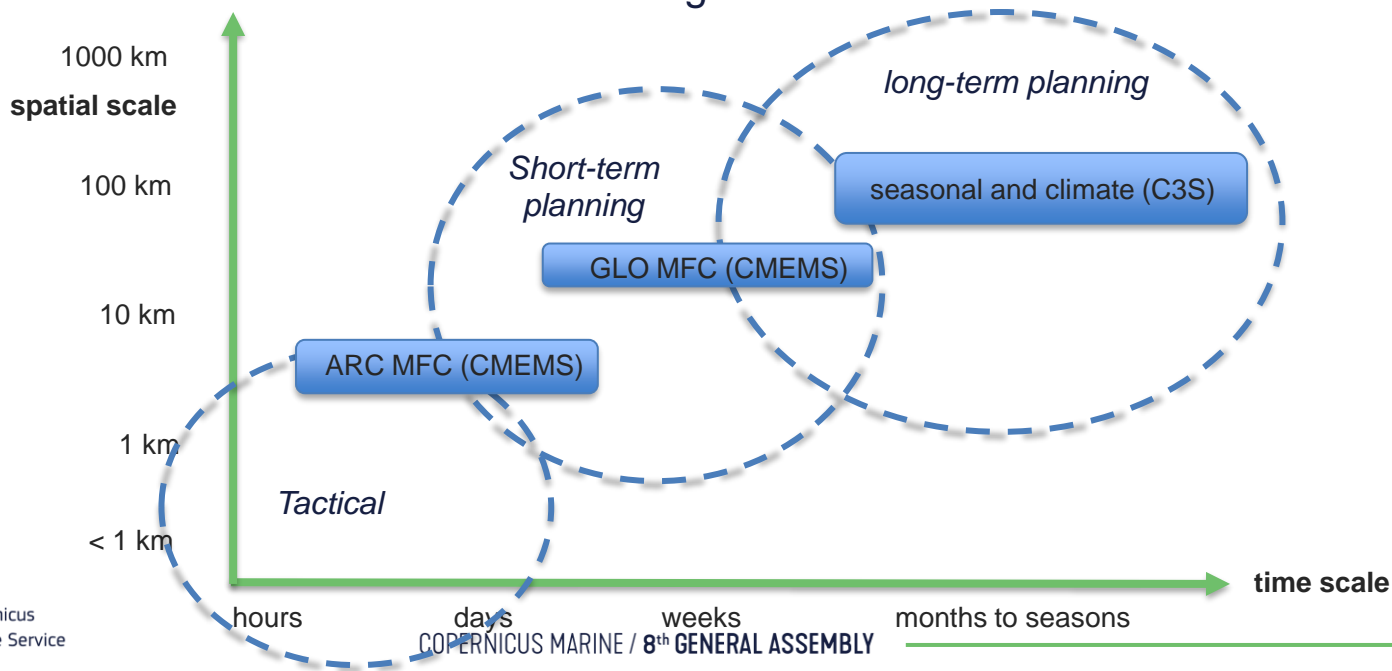
<http://acciberg.nersc.no>



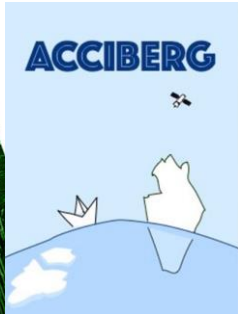
NERSC
NANSEN ENVIRONMENTAL
AND REMOTE SENSING CENTER
THE NANSEN CENTER · BERGEN · NORWAY

Motivation

- Sea Ice forecasts not precise enough for sea ice navigation
- Consistency between Copernicus Marine and Climate Change Services
- Lack of information about icebergs



Mission

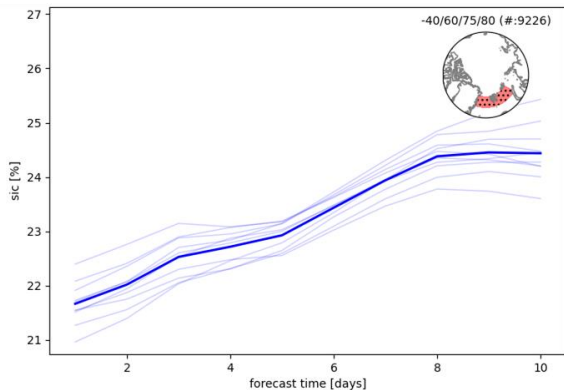


- ACCIBERG will improve the **forecasts of sea ice** and Arctic ocean parameters and their uncertainties in **both the Copernicus Marine and Climate Change Services**, extending the coverage of the satellite detection of icebergs and developing a **new iceberg forecast service**.
- It will deliver more reliable and accurate sea ice forecasts, accompanied by **uncertainty estimates** and user-targeted quality measures
- Iceberg forecasts will be automated and aim to be implemented in the **Copernicus services**.

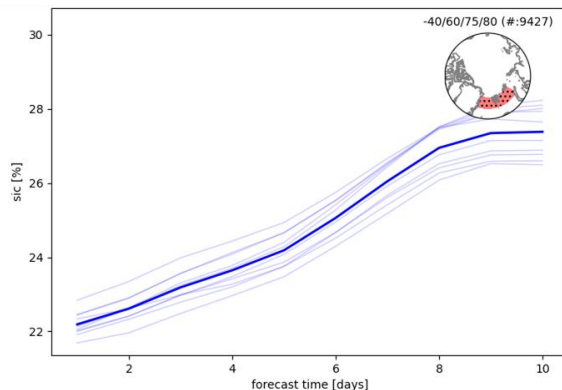
Ensemble spread in TOPAZ4/5 and ECMWF forecasts

Sea ice concentrations

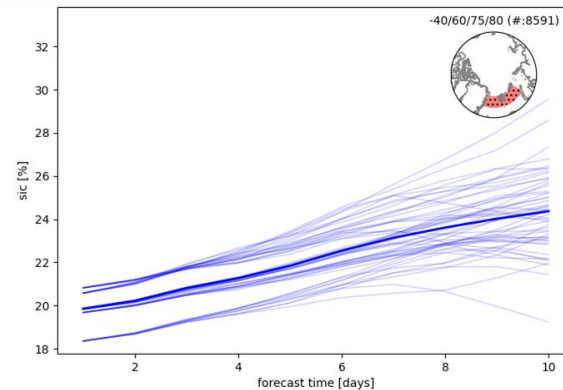
TOPAZ4 (old)



TOPAZ5 (new)



ECMWF 48r1



- Select arbitrary regions and forecast bulletins, compare forecast systems
- Evaluate growth of uncertainties, compare to satellite observations

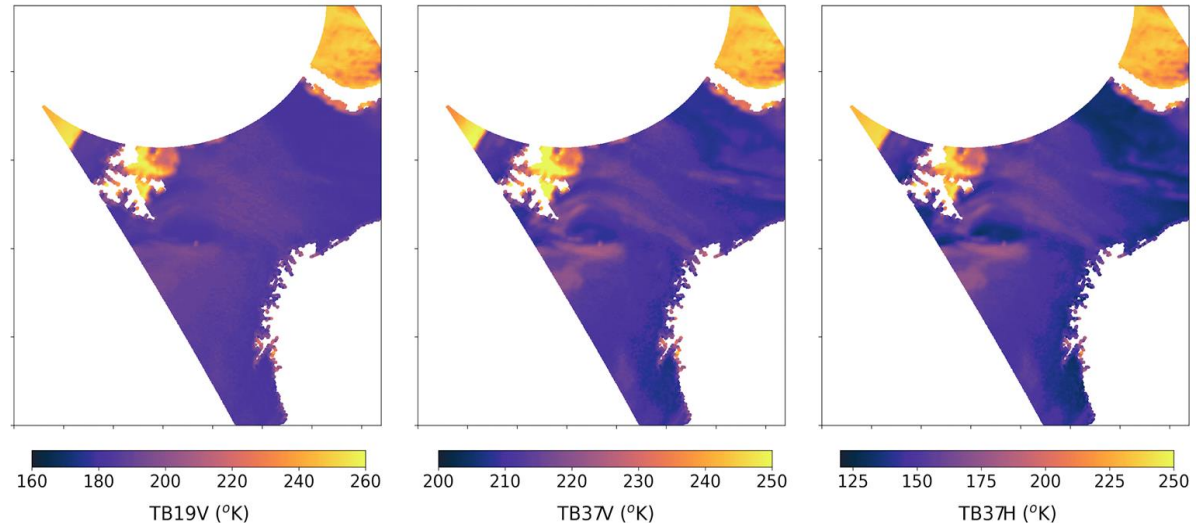
(24.10.-15.11.2023 only)

Open-source ICECAP code: <https://git.ecmwf.int/users/nedb/repos/icecap/browse>

Assimilation of sea ice concentrations

- Modified EnKF for assimilation of Level-2 SIC from PMW (Duran-Moro et al. TC, 2024)
- Modified EnKF for assimilation of Level-1 Tb data (ongoing)

Simulated TB using Wentz model
Satellite pass on 2023-02-24 01h02m22



Iceberg modelling: a true cross-Copernicus target

Framework: OpenDrift (Dagestad et al., MET Norway)

- Open-source Python, containerized, smart subsetting, EDITO-friendly
- Used for critical operations (search and rescue, oil spills ...)

Physics:

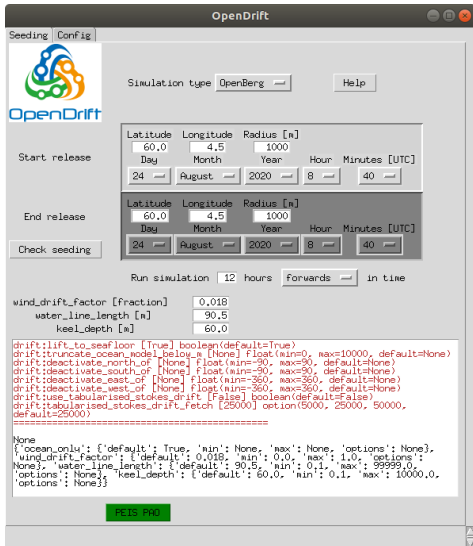
- Winds (10 m, log vertical profile)
- Ocean currents (3D currents)
- Waves (Radiation + Stokes drift)
- Sea ice (concentration, drift)
- Melting and roll-over: wave erosion, ocean temperatures
- Grounding: bathymetry, tidal heights
- Calving: Glaciers mass loss

$$M \frac{d\mathbf{u}}{dt} = \mathbf{F}_{AT} + \mathbf{F}_W + \mathbf{F}_C + \mathbf{F}_{SS} + \mathbf{F}_{SI}$$

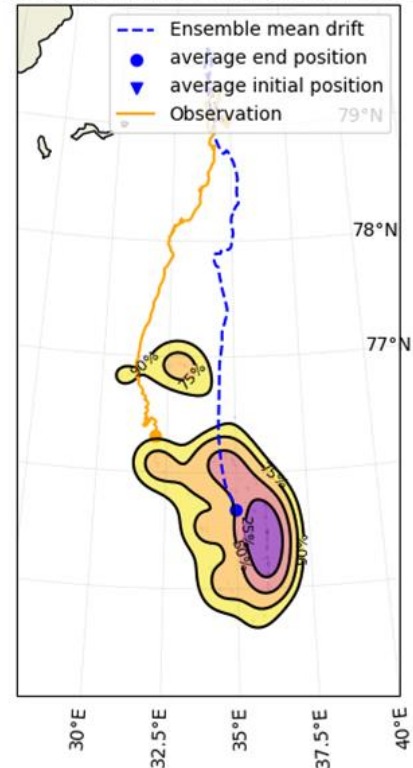


Iceberg forecasts on-demand concept

- Deploy MET Norway's GPS buoy on an iceberg
 - Check the Safety Sheet first!
- Use the IceWatch app to order a forecast
- Receive the forecast trajectory on your phone



Density Distribution and Ensemble Mean





Summary

- Main project innovations
 - 1- First open-source iceberg forecasts: New products for Copernicus
 - 2- Assimilation of Level-1 sea ice data from PMW: improving forecasts
 - 3- Validated ensemble sea ice forecasts: informed uncertainties
- Main project challenges:
 - Validation data: few observed iceberg trajectories
 - Ocean currents accuracy is location-dependent
- Next research priorities
 - No-download operations: trajectories, validation, data assimilation
 - Beyond the ice edge: Dynamics of multi-year sea ice
 - Exploit CIMR and ROSE-L optimally.