Arctic Cross-Copernicus forecast products for sea Ice and iceBERGs

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ACCIBERG Project Newsletter

Upcoming: ACCIBERG Stakeholder Workshop:

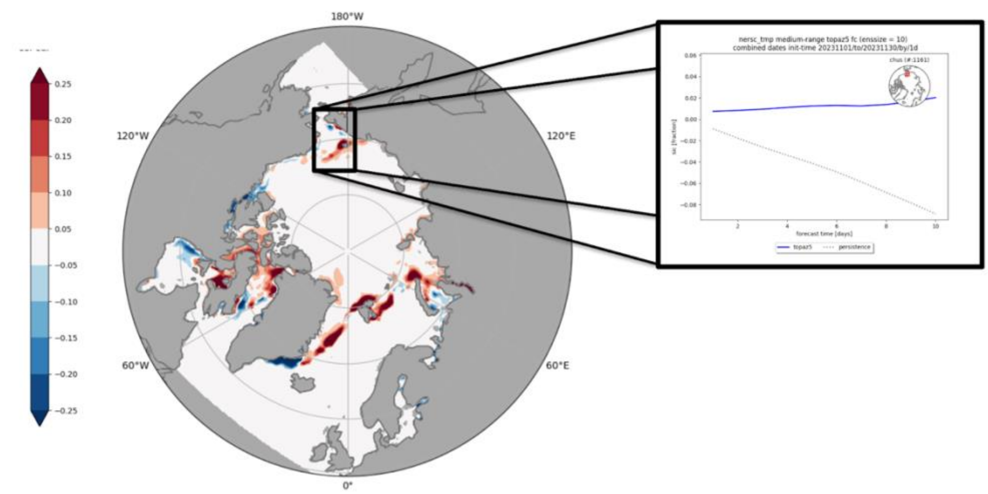
9am – 12:30pm, 8th November 2024, CNR ARTOV, Frascati, Italy

The ACCIBERG project is organising a stakeholder workshop in Frascati back-to-back with the 12th IICWG-DA meeting. We warmly invite all IICWG-DA participants interested in the outputs of ACCIBERG to extend their stay in Italy to join us. Online participation is also possible for those unable to travel.

The workshop will include practical demonstrations by partners from ECMWF, NERSC, MET Norway, and Mercator Ocean International on the project and related tools. This includes the recent work done on validation of ensemble sea ice forecasts from the Copernicus Marine and Climate Change Services with the ICECAP package, along with demonstrations of how to run iceberg simulations with the OpenDrift package (OpenBerg). There will also be a demonstration of OpenBerg on the EDITO platform and an overview of the Copernicus Marine Services for the WHITE ocean and Arctic Hub. In addition, there will be opportunities to discuss any feedback, views and questions on project plans that you might have, with the project partners. Please register here to attend the meeting, either online or in person.

ICECAP software development

The ICECAP software has been developed in the project to evaluate and calibrate sea-ice forecasts from CMEMS and C3S and create sea ice forecast products with uncertainty quantifications.



Example of plots that ICECAP can generate: sea ice concentration bias for 10-day forecasts in an ARC MFC prototype for November 2023, displayed both as a pan-Arctic map and a regional mean over the Chukchi Sea.

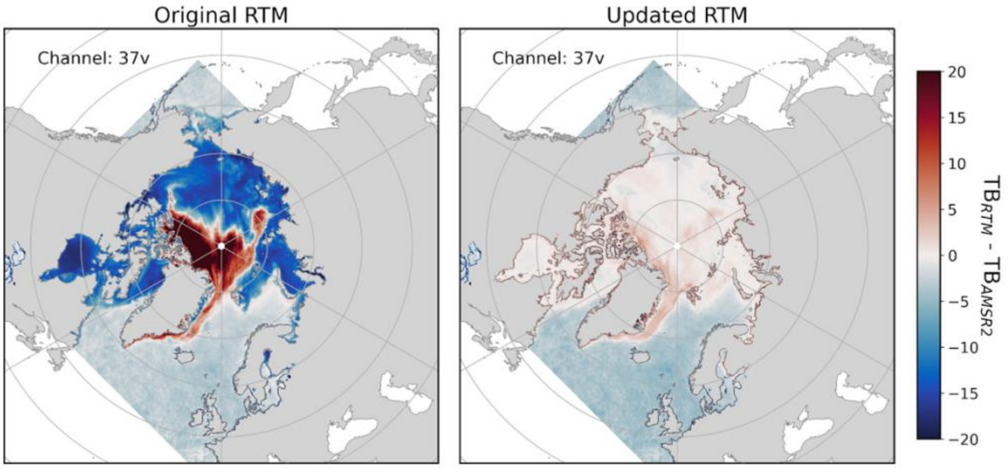
The software currently handles medium-range sea ice forecasts from the CMEMS ARC-MFC system and ECMWF, extended-range forecasts from ECMWF, and seasonal forecasts from the C3S seasonal forecasts. More systems will be added as they become available through the operational data portals of the providers.

Investigations to assess the quality of ensemble forecasts of the different systems have already demonstrated the utility of the software to the developers of forecast systems, as it provides a quick and easy-to-use tool to evaluate forecast quality. Work on end-user products such as forecasts of the distance of the ice edge to a given location, or freeze-up and break-up dates is progressing well and has been showcased to several stakeholders. Now, the focus is on refining the useability and portability of the software, deciding on calibration methods and the first version of end-user product prototypes in collaboration with the project partners, and finalising the documentation and end-user jupyter notebook interface. More thorough analyses will be ready for the ACCIBERG stakeholder workshop in November.

Microwave satellite simulator development

The work to introduce the assimilation of raw (Level-1b) satellite EO data for improving the forecasts of sea-ice concentration and sea-ice type is progressing well. ACCIBERG is developing dynamic calibration of the satellite simulators for integration into the data assimilation system of the Arctic CMEMS forecast system. Improvements are being made to the original Radiative Transfer Model (RTM), which was retrieved and tested using AMSR2 and ERA5 data. The early results showed significant errors over the sea-ice areas, with both an over-estimation of brightness temperatures over multi-year ice and under-estimation over first-year ice areas. The RTM has then been modified to account for the type of sea ice, providing a more realistic ice emissivity field to the RTM. This has allowed a significant improvement of the simulated brightness temperatures (see figure below). We have now started to use the updated RTM for direct assimilation of brightness temperatures (Level-1b) instead of sea-ice concentration (Level-2). We are thus building upon previous work that demonstrated the advantage of assimilating Level-2 rather than Level-4 sea-ice concentration (Durán Moro et al. 2024).

Durán Moro, M., Sperrevik, A. K., Lavergne, T., Bertino, L., Gusdal, Y., Iversen, S. C., and Rusin, J.: Assimilation of satellite swaths versus daily means of sea ice concentration in a regional coupled ocean–sea ice model, The Cryosphere, 18, 1597–1619, https://doi.org/10.5194/tc-18-1597-2024, 2024



Difference between simulated and observed TB37v. TB37v is simulated with (left) the original RTM and (right) the updated RTM. AMSR2 and ERA5 data are used as input in the RTM simulation. Period of simulation is January 2024.

Next-generation Ensemble Data Assimilation System (NEDAS)

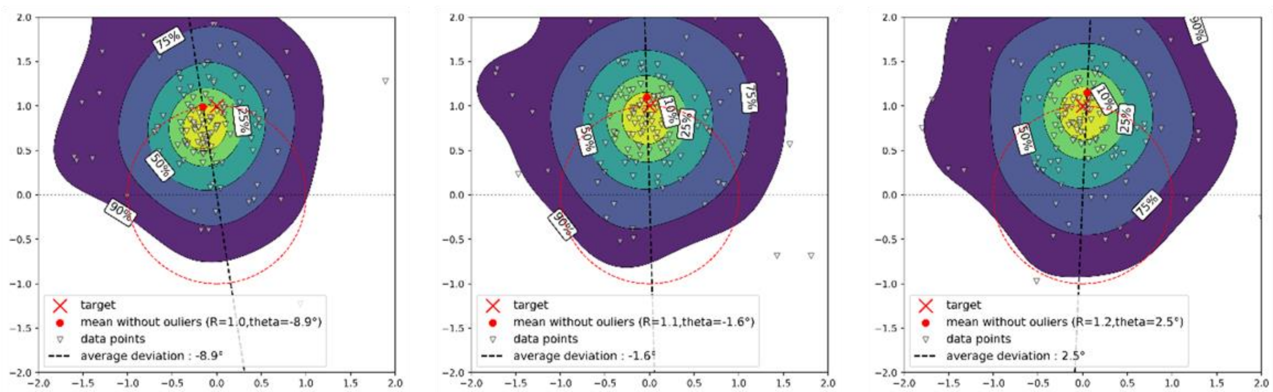
NEDAS, a new open-source EnKF assimilation software entirely in Python, has been developed as part of the project in order to accelerate the development and testing of novel data assimilation methods, such as the assimilation of brightness temperatures from satellites. It provides a light-weight Python solution to the ensemble data assimilation (DA) problem for geophysical models. It allows DA researchers to test and develop new DA ideas early-on in real models, before committing resources to full implementation in operational systems. NEDAS is armed with parallel computation (mpi4py) and pre-compiled numerical libraries (numpy, numba.njit) to ensure runtime efficiency.

The modular design allows the user to add customized algorithmic components to enhance the DA performance. It offers a collection of state-of-the-art DA algorithms, including serial and batch assimilation approaches, making it easy to benchmark new methods – like the assimilation of Level 1 passive microwave data – with the classic methods in the literature before jumping into operationalisation. For anyone wishing to try a new data assimilation method, but without the hassle of operational codes, then the NEDAS source code is publicly available on: https://github.com/nansencenter/NEDAS

Iceberg monitoring and forcasting

The satellite detection algorithm has been modified to remove ships based on their AIS data, and the false detection of sea ice as icebergs has been improved thanks to an automated new sea ice concentration product by DMI. Further developments use additional sensors and thermal noise removal, which show a high level of agreement.

The latest version of the Open Drift software now has most dynamical and thermodynamical components of the iceberg drift model implemented and early results look promising. Still the results can vary from one area to another, so the ACCIBERG team has been searching for additional iceberg trajectories, welcoming new members into our Advisory Board in the process. The implementation of Open Drift on WEkEO has gone smoothly and has been highlighted by the EDITO Model Lab project. The OpenBerg module is thus the first open-source iceberg simulation code to our knowledge. The code is available here with an example: https://opendrift.github.io/gallery/example_openberg.html



Above: One-day long simulations of 10 icebergs in the West Greenland Sea using three different inputs for ocean currents and represented in scaled polar coordinates (speed and veering angle). When icebergs are further than 20 km from the coast, the simulations are able to simulate the speed (distance from the center close to 1) and the direction of the drift (angle compared to the vertical direction).

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