Nemo-NAA10km : A Nemo based ocean modelling configuration for North Atlantic & Arctic

Overview :

Nemo-NAA10km is a NEMO based regional ocean modelling configuration. Its domain covers the North Atlantic ocean from a latitude of about 35°N, the Nordic Seas, the Arctic Ocean & a piece of Pacific Ocean. Its resolution is about 10km, with increased resolution up to 8km in the Arctic. Its interaction with the atmosphere works in forced mode only, and it has two open boundary conditions (one in the Northern Atlantic and one in the Northern Pacific). Nemo-NAA10km is not a climate model, but an ocean process model aimed at studying the underlying physics of processes, and process changes. For this purpose Nemo-NAA10km is designed to provide realistic results without any form of data assimilation or restoring. Its only form of control on temperature or salinity is made at its open boundary conditions. And it is through a thorough representation of each physical process, that it achieves a realistic representation of temperature and salinity fields within its domain, even if long term simulations of more than 50 years are considered.
Nemo-NAA10km works in hindcast mode, forced by re-analysis (ERA5 for the atmosphere and GLORYS for the ocean for example), or in climate downscaling mode forced by climate model outputs (NorESM or EC-Earth for example).

The design of Nemo-NAA10km started in 2018, and used the Nemo-Nordic setup as inspiration (https://gmd.copernicus.org/articles/12/363/2019/). Nemo-NAA10km was first based on NEMO v3.6, and is now based on NEMO v4.2.2. Switching to new versions of NEMO permits to profit from the most recent scientific and technical developments of the NEMO ocean engine.

Recent developments made on Nemo-NAA10km include the online coupling with the biogeochemical model PISCES, and the use of the AGRIF tool to increase locally the resolution up to 1km. These two developments were demonstrated to work together. The analysis of these simulation is ongoing.

The NEMO ocean engine is a ocean modelling toolbox used, develloped and maintained by a huge community of researchers, engineers and technicians worldwide (https://www.nemo-ocean.eu/).

Evaluation Procedure :

The evaluation procedure of Nemo-NAA10km is based on the long experience of physical oceanography of IMR researchers, associating both experts in observations and ocean modelling. The first validation step is sea level (SSH), for which a good representation is the sine qua non condition for an ocean model to be realistic. This validation is made against tide gauges at high frequency to ensure the representation of barotropic waves, which carry energy in the model, at different velocities. Validation is made against tide gauges along the Norwegian coast, using hourly output over several years. Correlation and RMSE are computed with and without tidal signals included. The correlation of SSH including tides reaches more than 95 %, and more than 80 % without tides. Baroclinic validation, sea ice cover and trends are described based on several campaign of observations, and are still updated as these lines are written. Please refer to [11] and its appendix for further details.

Source Files :

Hindcast and downscaling simulations can be found at the following URL

https://ns5001k.web.sigma2.no/ROBINSON_DIRECTORIES/NEMO-NAA10KM-SIMULATIONS/

List of peer reviewed publications using Nemo-NAA10km (Ref. 11 can be considered as a validation reference) :

1. Revisiting the parameterization of dense water plume dynamics in geopotential coordinates in NEMO v4.2.2 *Geosci. Model Dev., 19, 2677–2690, https://doi.org/10.5194/gmd-19-2677-2026, 2026. Robinson Hordoir, Jarle Berntsen, Magnus Hieronymus, Per Pemberton, and Hjalmar Hatun*

2. Barents Sea atlantification driven by a shift in atmospheric synoptic timescale, 2026, *Nature Climate Change volume 16, pages 179–186, Robinson Hordoir, Vahidreza Jahanmard, Pål Erik Isachsen, Ulrike Löptien, Heiner Dietze, Anne Britt Sandø & Vidar S. Lien*

3. Future poleward distribution shifts of community and functional groups in the Barents Sea modelled under different climate and fisheries scenarios, 2025, *Marine Ecology Progress Series, DOI: 10.3354/meps14868, Marcela C. Nascimento, Filippa Fransner,* Robinson Hordoir, *Morten D. Skogen, Raul Primicerio, Torstein Pedersen*

4. Barotropic Trends Through the Barents Sea Opening for the Period 1975–2021, 2025, *Journal of Geophysical Research: Oceans 130(1), DOI: 10.1029/2024JC021663, Vahidreza Jahanmard, Ulrike Löptien, Anne Britt Sandø, Andrea M.U. Gierisch, Heiner Dietze, Vidar S. Lien, Nicole Delpeche-Ellmann, and Robinson Hordoir*

5. A multi-scenario analysis of climate impacts on plankton and fish stocks in northern seas, 2024, *Fish and Fisheries 25(4), DOI: 10.1111/faf.12834, Anne Britt Sandø, Solfrid S. Hjøllo, Cecilie Hansen, Morten D. Skogen, Robinson Hordoir, and Svein Sundby*

6. *Koseki, M., Sandø, A. B., Ottersen, G., Årthun, M., and Stiansen, J. E. 2025. Exploration of short-term predictions and long-term projections of barents sea cod biomass using statistical methods on data from dynamical models. PLOS ONE, 20: 1–28. URL https://doi.org/10.1371/journal.pone.0328762.*

7. *Ma, S., Huse, G., Ono, K., Nash, R. D. M., Sandø, A. B., Nedreaas, K., Sætre Hjøllo, S., et al.Recruitment regime shifts and nonstationarity are widespread phenomena in harvestable stocks experiencing pronounced climate fluctuations. Fish and Fisheries, n/a. URL https://onlinelibrary.wiley.com/doi/abs/10.1111/faf.12810.*

8. Trivial gain of downscaling in future projections of higher trophic levels in the Nordic and Barents Seas, 2023*, Fisheries Oceanography 32(5), DOI: 10.1111/fog.12641, Ina Nilsen, Filippa Fransner, Are Olsen, Jerry Tjiputra, Robinson Hordoir and Cecilie Hansen*

9. dos Santos Schmidt, T. C., Slotte, A., Olafsdottir, A. H., Nøttestad, L., Jansen, T., Jacobsen, J. A., Bjarnason, S., et al. 2023. Poleward spawning of Atlantic mackerel (Scomber scombrus) is facilitated by ocean warming but triggered by energetic constraints. ICES Journal of Marine Science, p. fsad098. URL https://doi.org/10.*1093/icesjms/fsad098.*

10. *Falconer, L., Ytteborg, E., Goris, N., Lauvset, S. K., Sandø, A. B., and Hjøllo, S. S. 2023. Context matters when using climate model projections for aquaculture. Frontiers in Marine Science, 10. URL https://www.frontiersin.org/articles/10.3389/fmars.2023.1198451.*

11. Changes in Arctic Stratification and Mixed Layer Depth Cycle: A Modeling Analysis, 2022*, Journal of Geophysical Research: Oceans 127(1), DOI: 10.1029/2021JC017270, Robinson Hordoir, Øystein Skagseth, Randi B. Ingvaldsen, Anne Britt Sandø, Ulrike Löptien, Heiner Dietze, Andrea M. U. Gierisch, Karen M. Assmann, Øyvind Lundesgaard and Sigrid Lind*

12. Pan-Arctic suitable habitat model for Greenland halibut, 2021, ICES Journal of Marine Science, 2021*, 78(4), DOI: 10.1093/icesjms/fsab007, Mikko Vihtakari, Robinson Hordoir, Margaret Treble, Meaghan D. Bryan, Bjarki Elvarsson, Adriana Nogueira, Elvar H. Hallfredsson, Jørgen Schou Christiansen, and Ole Thomas Albert*