Project: **1549**

Project title: **FESOM-FUTURO: Development and application of a high-resolution configuration for the upwelling systems off West Africa**

Principal investigator: **Stephan Juricke**

Report period: **2025-11-01 to 2026-10-31**

Configuration development

In response to requirements from our West African partners and further collaborators, the mesh design was revised substantially (Figure 1). FUTURO-ATL has a base resolution of 25 km, refined to 12.5 km in the Southern Ocean and the Arctic, to 10 km in the North Atlantic and to 5 km in the tropical and South Atlantic, so that the same configuration serves a broader community. In FUTURO-CV, the refinement to 0.8 km now covers the West African coast from the Canary Islands to the Gulf of Guinea. This increased the number of surface vertices to 2,597,218 for FUTURO-ATL and to 8,160,865 for FUTURO-CV, almost twice that of the original CV mesh. Because vertical resolution strongly affects submesoscale dynamics and the vertical distribution of upwelling-related biogeochemical tracers, both configurations use 120 levels, 20 of them in the upper 50 m. Together, these choices substantially increase the computational cost per simulated year.

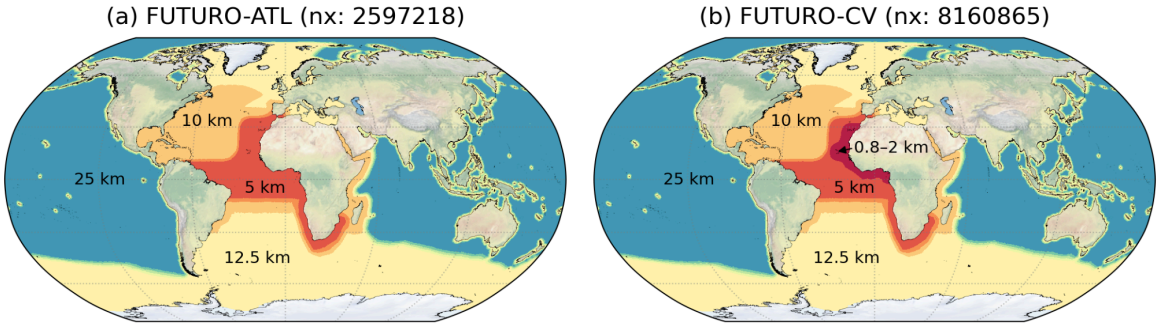


Figure 1: Horizontal resolution of (a) FUTURO-ATL and (b) FUTURO-CV; nx is the number of surface vertices.

Tuning and evaluation of FUTURO-ATL and FUTURO-CV

Following the recommendation of the 2026 review, the two configurations were developed sequentially. FUTURO-ATL was tuned first, with sensitivity experiments on the vertical mixing scheme, the air–sea transfer coefficients, the Redi diffusivity and the albedo, evaluated with respect to the seasonal cycle of the West African upwelling, the global SST RMSE, the AMOC and sea ice. The tuned configuration reproduces the seasonal cycle of the upwelling and filament structures finer than those resolved by satellite products, as well as the large eddy observed near the Cabo Verde archipelago (Figure 2). Building on the calibrated ATL configuration, FUTURO-CV was then tested and integrated for a three-year hindcast. Compared with ATL, CV shows stronger eddy activity and pronounced small-scale wave signals around the West African coast and the archipelago. As the project has grown, the long-term CV hindcast is carried out with computing time granted separately at NHR@Göttingen.

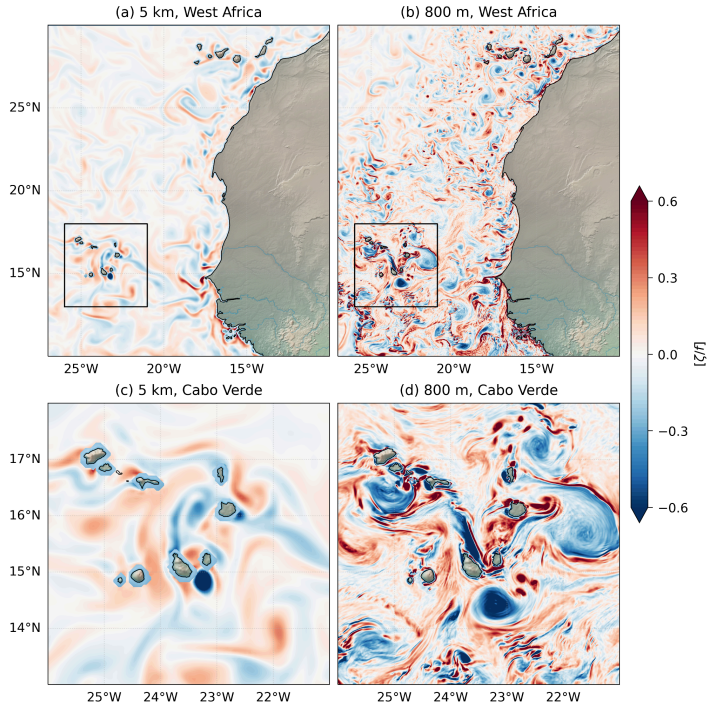


Figure 2: Surface relative vorticity normalised by the Coriolis parameter (ζ/f) in (a, c) FUTURO-ATL (5 km) and (b, d) FUTURO-CV (800 m) off West Africa (a, b) and around the Cabo Verde archipelago (c, d).

The calibrated configuration is currently integrated over one 66-year cycle of JRA55-do forcing. The resulting physical state is the starting point of the coupled FESOM2-REcoM3 simulations requested for 2027.

Use of resources

By the end of 2026, about 88% of the granted computing time will have been used. About 5% expired in the first quarter, when the mesh design had to be agreed with several partners before the experiments could start, and about 7% in the third quarter because of a three-week maintenance of Levante and the subsequent slow queue.

Outreach and outputs

- [Outreach] The results motivated the regular FUTURO Modelling Meeting, which we initiated with international experts in ocean modelling and coastal upwelling; it currently brings together more than 30 scientists from six countries.
- [Poster] Chen, L. and Juricke, S. (2026). FESOM-FUTURO: km-scale modeling of West African Upwelling Systems. km-Scale Global Modelling Summit 2026, Hamburg.
- [Master thesis in progress] Kone, J. G.: Validation and Assessment of FESOM Ocean-Only Simulations of the Northwest African Upwelling System. WASCAL programme from Cabo Verde school, supervised by L. Chen.
- [Funding] Chen, L. and Xue, T. FUTURO-BIO (GEOMAR Postdoctoral Activities Call 2026): coupling of REcoM3 to the FUTURO configurations, building on this project.