High resolution atmospheric forcing for the North Atlantic NEMO mesoscale experiment (1979+)

Alexander Gavrikov, Polina Verezemskaya, Natalia Tilinina and Sergey Gulev

Shirshov Institute of Oceanology
Nakhimovsky ave 36, Moscow, 117997, Russia
gavr@sail.msk.ru, +7 499 1247985

Bernard Barnier and Jean-Marc Molines

Equipe Modelisation des Ecoulements Oceaniques Multiechelles (MEOM)
Institut des Geosciences de l'Environnement (IGE), Grenoble, France

Eddy resolving ocean modeling being the biggest advantage of the recent decade is often performed with the low-resolution atmospheric forcing from global reanalyses or climate model outputs. The northern subpolar Atlantic is the key ocean climate formation region. Circulation and convective processes in this region are the results of the large and mesoscale ocean eddies interaction and a reaction on spatially and temporarily localized atmospheric forcing, expressed by intensive mesoscale processes, such as mesoscale cyclones, synoptic fronts and cold-air outbreaks. The intensity of these features is commonly underestimated in the reanalysis-based ocean model forcing, what leads to an inadequate representation of ocean circulation in the Subpolar North Atlantic.

In our study, we have developed the optimal configuration of the Weather Research and Forecast (WRF) atmospheric mesoscale model over the North Atlantic forced with ERA-Interim as an initial and boundary condition. The WRF model domain is centered at (45°N, 45°E), with 551 points in the east-west and north-south directions with a spatial resolution of 14 km, 51 vertical levels (starting from around 10-12m above the ocean's surface). The North Atlantic Atmospheric Downscaling (NAAD) numerical experiment was conducted for the period of 1979-2018 with a 3-hourly output and allows to resolve atmospheric mesoscale processes at different timescales and their influence on the ocean and wave dynamics. To keep the regional model from drifting the spectral nudging procedure has been applied. In order to provide adequate data for wave and ocean modeling, the NAAD validation procedure was focused on surface wind, water content, temperature parameters, and precipitation. The preliminary analysis showed good agreement with observational data.

To estimate the impact of high-resolution forcing on ocean dynamics the NAAD dataset was used as boundary condition for the NEMO ocean model. The NEMO domain covers the Northern Subpolar Atlantic (47 to 72N) with 1/12° spatial resolution and 75 vertical levels. Several numerical experiments with different atmospheric forcing have shown that higher forcing resolution leads to a better representation of surface ocean circulation as compared with surface drifters' data. The other advantage of the high-resolution atmosphere is a more adequate representation of temperature and salinity, while other simulations are tending towards saltier and warmer ocean, in comparison to observations. High-resolution forcing with stronger dynamical characteristics of mesoscale events significantly affects short-term (daily) heat, salt and density variations on the surface (up to 1˚ and 1-2 PSU) and depth of vertical mixing layer (by 400 m), that in total changes the deep convection intensity in the key regions.