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Assessing data assimilation and model boundary error strategies for high resolution ocean model downscaling in the Northern North Sea

Jesper Sandvig Mariegaard, Méven Robin Huiban, Jacob Tornfeldt Sørensen, and Henrik Andersson
DHI, Hørsholm, Denmark (jem@dhigroup.com)

Determining the optimal domain size and associated position of open boundaries in local high-resolution downscaling ocean models is often difficult. As an important input data set for downscaling ocean modelling, the European Copernicus Marine Environment Monitoring Service (CMEMS) provides baroclinic initial and boundary conditions for local ocean models. Tidal dynamics is often neglected in CMEMS services at large scale but tides are generally crucial for coastal ocean dynamics. To address this need, tides can be superposed via Flather (1976) boundary conditions and the combined flow downscaled using unstructured mesh. The surge component is also only partially represented in selected CMEMS products and must be modelled inside the domain and modelled independently and superposed if the domain becomes too small to model the effect in the downscaling model.

The tide and surge components can generally be improved by assimilating water level from tide gauge and altimetry data. An intrinsic part of the problem is to find the limitations of local scale data assimilation and the requirement for consistency between the larger scale ocean models and the local scale assimilation methodologies.

This contribution investigates the impact of domain size and associated positions of open boundaries with and without data assimilation of water level. We have used the baroclinic ocean model, MIKE 3 FM, and its newly re-factored built-in data assimilation package. We consider boundary conditions of salinity, temperature, water level and depth varying currents from the Global CMEMS 1/4 degree resolution model from 2011, where in situ ADCP velocity data is available for validation. We apply data assimilation of in-situ tide gauge water levels and along track altimetry surface elevation data from selected satellites. The MIKE 3 FM data assimilation model which use the Ensemble Kalman filter have recently been parallelized with MPI allowing for much larger applications running on HPC. The success of the downscaling is to a large degree determined by the ability to realistically describe and dynamically model the errors on the open boundaries. Three different sizes of downscaling model domains in the Northern North Sea have been examined and two different strategies for modelling the uncertainties on the open Flather boundaries are investigated. The combined downscaling and local data assimilation skill is assessed and the impact on recommended domain size is compared to pure downscaling.