



Shelf seas forecasting using the NEMO model

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Overview

The Met Office provides real-time forecasts of marine conditions for the North-West European shelf using a system which is currently based on the POLCOMS model (Holt and James, J. Geophys. Res. 106(C7) (2001)), but is being transitioned to use the NEMO model (Madec G. 2008: "NEMO ocean engine". Note du Pole de modélisation, Institut Pierre-Simon Laplace (IPSL), France, No 27 ISSN No 1288-1619). Here we show results of initial validation tests of NEMO set up in a Shelf Seas configuration compared to a similar configuration of the POLCOMS model. For tides-only tests the two models show very similar RMS scores against in-situ data, with NEMO showing slightly better overall scores. Initial tests including winds and pressure forcing have also given encouraging results.

Operational Shelf Seas forecasting at the Met Office

Operational forecasting for the North-West European Shelf is currently based on the three model domains shown in Figure 1: a 12km resolution Atlantic-Margin model (AMM), a 6km resolution continental shelf (MRCS) and a 1 nautical mile model of the Irish Sea. The AMM model is driven at lateral boundaries by fields from the FOAM North Atlantic configuration and also by 15 tidal harmonics. Surface forcing is provided by the Met Office NWP models at up to hourly frequency. The MRCS model is coupled to the ERSEM biology model (Baretta, Ebenhöh and Ruardij, Netherlands J. Sea Res. 33 (1995)) to provide real-time forecasts of visibility.

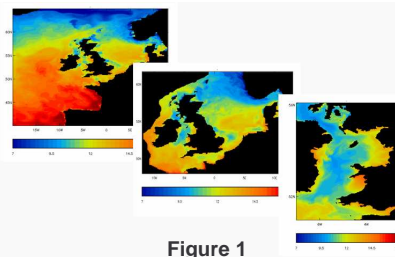


Figure 1

The Shelf Seas forecasting models are currently based on the POLCOMS model (Holt and James, J. Geophys. Res. 106(C7) (2001)), but they are being transitioned to use the NEMO code (Madec G. 2008: "NEMO ocean engine". Note du Pole de modélisation, Institut Pierre-Simon Laplace (IPSL), France, No 27 ISSN No 1288-1619). The NEMO code was originally developed as a deep ocean model and a number of developments have been made by partners in the MERSEA IP European project to facilitate its use for shelf seas modelling, for instance s-coordinates in the vertical, variable-volume grid cells and the incorporation of the GOTM turbulence modelling code (Burchard, Bolding, and Villareal (1999), "GOTM - a general ocean turbulence model. Theory, applications and test cases", Tech. Rep. EUR 18745 EN, European Commission)

Tides-only tests with NEMO and POLCOMS

A NEMO configuration was set up using the same domain and resolution as the POLCOMS-AMM model. The NEMO and POLCOMS AMM configurations used the same bathymetries, apart from the fact that the coastlines were recalculated for NEMO to take account of the fact that it uses a C-grid staggering in the horizontal instead of the B-grid used in POLCOMS. Both models were set up with 31 σ -levels in the vertical and had a fully non-linear free surface with variable-volume grid-cells through the full depth of the water column.

Tides-only experiments with uniform temperature and salinity fields were run for one year, with forcing at the lateral boundaries with 15 tidal components. Each model was run once using its native TKE scheme (different for each model) and once with the GOTM model (the k- ϵ option - Canuto, Howard, Cheng and Dubovikov, J. Phys. Ocean 31 (2001)). The models were validated against in-situ tide gauge data and satellite altimeter data.

Here we show validation results for the M2 tidal component for the versions of the models using the GOTM turbulence scheme. In general for these tides-only tests there was little difference between the results using the native TKE scheme and the results using GOTM.

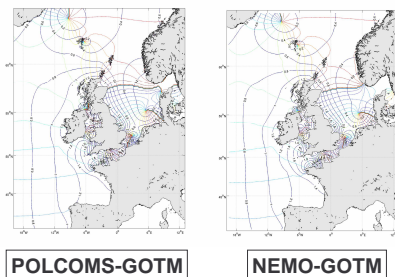


Figure 2

Figure 2 shows co-tidal plots for the M2 tidal component. The solid black contours show the amplitude of the tide in metres and the dashed coloured contours show the phase. The two models give similar results with small differences near the west coast of Norway and south-east of the UK. Detailed comparison with the observations shows that NEMO is slightly better in these areas.

Tides-only tests with NEMO and POLCOMS (continued)

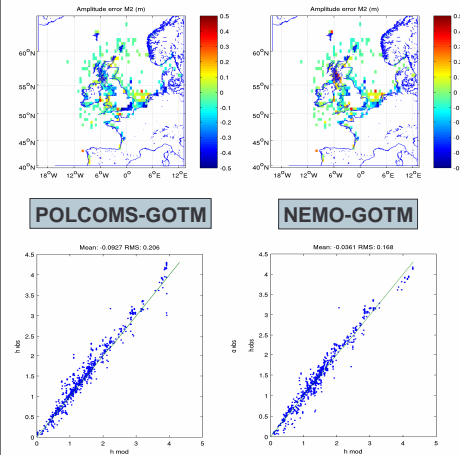


Figure 3 shows results of verification of the amplitude of the M2 tidal component against in-situ tide gauge measurements, showing POLCOMS on the left and NEMO on the right. The top plots show RMS errors plotted on a colour scale for each buoy location. The errors are typically of order 10cm or less, with POLCOMS and NEMO showing very similar errors. The bottom plots show scatter plots of the M2 amplitude for each location with the observed amplitude along the vertical axis and the modelled amplitude along the horizontal axis. Again both models show good agreement with the observed values. When average RMS errors for all observations are calculated NEMO gives slightly lower RMS values than POLCOMS, perhaps due to the use of the C-grid.

Figure 3

Figure 4 shows comparison of the model results with satellite data: the TPXO dataset derived from TOPEX-POSEIDON data (Egbert and Erofeeva J Atmos. Ocean. Technol. 19 (2002)). Again the comparison is for the amplitude of the M2 component. The models show errors of a similar magnitude. In general NEMO appears to slightly overestimate the amplitudes while POLCOMS underestimates them.

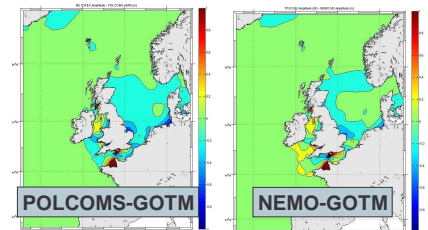


Figure 4

Tests with winds and pressure forcing

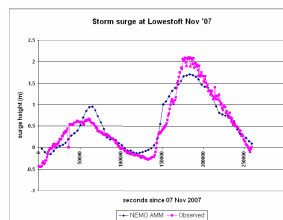


Figure 5

Tests have been performed with the NEMO-AMM configuration including the wind forcing and the pressure forcing ("inverse-barometer effect"). Figure 5 shows an example of verification against a tide gauge at Lowestoft on the east coast of the UK for the exceptional storm surge event of 9th November 2007 in the North Sea. NEMO slightly overestimates the first peak and underestimates the main peak, but captures the timing of the main surge quite well.

Future Work

A fully baroclinic version of NEMO-AMM is in the process of being tested. It is planned to set up a 7km resolution model covering the AMM domain with increased vertical resolution, to replace the current AMM and MRCS models. This will be coupled to the ERSEM biology model. A new river outflow scheme is being developed for NEMO to enable the river input to be applied over the full water column instead of just at the surface as is presently done. We are looking at the possibility of using the general curvilinear grid in NEMO to allow grid stretching and focussing of the horizontal resolution in near-shore waters. Another possibility that the use of NEMO opens up is the introduction of data assimilation using the NEMOVAR system. The first application of this is likely to be for the assimilation of satellite SST data.