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Geoscientific Model Development Discussions

Interactive comment on "AMM15: A new high resolution NEMO configuration for operational simulation of the European North West Shelf" *by* Jennifer A. Graham et al.

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general comments:

The paper "AMM15: A new high resolution NEMO configuration for operational simulation of the European North West Shelf" describes the upgrade of the current operational NEMO setup AMM7 run at the UK Met Office. In addition to the higher horizontal resolution of 1.5 km compared to 7 km in AMM7 there are also changes in bathymetry, model domain and boundary conditions. A good description of all major changes is given and results from the old and the new setup are compared to some extent. The paper is very well structured and written! It is, however, missing some aspects and would benefit from addressing some central questions.

An analysis of ocean current, transport and eddy kinetic energy is missing. At least a subchapter on current should be added to complete the paper.

central questions:

What is the purpose of the model? (If it shall be used in operational ocean forecasting: What are the main applications? What kind of output is needed? At what level of quality?) Answering these questions would naturally contribute to answering the central question (Q1) to be answered for all models in operational use: Is it fit for purpose?

Another aspect that needs to be addressed is the downside of upgrading to higher resolution: higher computational demands, increase in needed storage capacity and transfer time and very important for an operational model: the increased effort to extract the needed information from an increasing amount of data on the customer side. A table which compares AMM7 and AMM15 regarding number of wet grid cells, CPU time and storage needed should be added. In addition to question Q1 above a 2nd question (Q2) should be addressed: Is the upgrade worth it? (What was the expectation when starting the upgrade process? Has it already been reached? What is left?)

specific comments:

CT1: Page 3, line 4: . . .'vertical cells can be masked . . .' How is this masking implemented? Percentage of cells masked?

CT2: Page 4, lines 3-5: Looking at Figure 1 it seems to be more natural to include the Bay of Biscay completely. Why was the southern open boundary chosen parallel to the Spanish coast?

CT3: Page 4, lines 7-10: This seems to be an argument to include the overflow regions in the high resolution model setup to overcome the problems of simulating overflows in coarse models.

CT4: Page 4, lines 11-14: To move the boundary inside the Baltic Sea has some implications: If boundary conditions from another model shall be used (in this case

from Gräwe et al., 2015) it must be ensured that both models show an equal resistance of the Danish Straits (meaning the same water level gradient across the Straits leads to the same volume and salt (!) transport, see, e.g., Mattson, 1996 a,b). Comparing the horizontal and vertical (!) resolution and the bathymetry of Gräwe et al., 2015 and the AMM15 setup and further looking at the results presented later on, this is obviously not fulfilled and should be addressed in future studies.

CT5: Page 4, lines 26-28: Not to include wetting and drying and to specify a minimum depth of 10 m seems to be contradictory to the high horizontal resolution and can, depending on the purpose of the model, present a severe drawback. Major improvements when going to a much higher horizontal resolution are expected due to the better representation of bathymetry and coastline. The model region has a substantial portion of shallow coasts including large tidal mud flats. A minimum depth of 10 m at a horizontal resolution of 1.5 km seems to be inappropriate in this case. It is intended by the authors to be improved in future versions of the model and should be in the focus.

CT6: Page 4-5: Chapter 2.3 is called 'Forcing and Initialization' but information on initialization is missing and should be provided for temperature and salinity at least. Was it the same for AMM7 and AMM15? (Figure 8 b ,d hints to differences in initialization.)

CT7: Page 5, lines 13-16: See CT4, the ratio of SSH difference across the straits and the volume transport should be checked.

CT8: Page 6, lines 24-26: The RMSE for amplitude in Table 1 shows an increase from AMM7 to AMM15 in all constituents but O1. Having the much higher resolution in AMM15 (and therefore much higher computational load) and that a new bathymetry was introduced (which is a major effort, when setting up a new model) in mind, a substantial improvement in reproducing tides should be expected; coming back to question Q2 (Is it worth it?). Especially the large increase in RMSE for M4 points to a severe problem, as M4 is much more influenced by the internal dynamics of the model as by the boundary conditions compared to all other constituents. Is seems that some fur-

ther adjustment of the bathymetry and/or boundary conditions is needed. (Some one year model runs where a fraction of the M2 tidal amplitude is added/subtracted from the bathymetry might be a starting point.) And comment CT5 has to be mentioned again: Probably the mismatch of horizontal resolution and handling of shallow water strikes harder in the AMM15 setup than it did in the coarser AMM7. To introduce drying and flooding in the model and get rid of the minimum depth should come with a major improvement of tides along the coast.

CT9: Page 9, line 10 & Page 10, line 28: The simulation of SST in an uncoupled model run is strongly dependent on the SST used as lower boundary condition in the atmospheric forcing, i.e. ERA-interim. Depending on the connection between the OSTIA SST product and the SST from the ERA-Interim product it might be helpful to introduce a 3rd row in Figure 3 showing the differences of ERA-Interim and OSTIA SST. It seems sensible not to expect smaller differences in the model than in the forcing data set (at least not on larger scales).

CT10: Page 10, line 21-24: See C4

CT11: Page 17, Figure 8 For the salinity in Figure 8 (b), (d) it seems that the AMM7 model is converging towards the AMM15 solution. Did both models start from the same initialization? If not, what are the differences?

CT12: Page 18, lines: 7-9 This should be concretized in the light of question Q1 and Q2. Is the improvement at the present stage sufficient to put the AMM15 into operation (having the much higher costs in mind)?

CT13: Page 18, lines: 9-11 This leads to the question: Why has, e.g., the vertical resolution not been improved from AMM7 to AMM15? This is easily done compared to changes in the horizontal resolution and doesn't lead to the same increase in the need for computational resources.

CT14: Page 18, line 20: The assessment of transport is for sure an important issue.

Before looking into this integrated quantity it would be advisable to look into the current. It can be expected that the step change in horizontal resolution from AMM7 to AMM15 has the largest impact on ocean current (and not on temperature and salinity). Despite the fact that there is a lack of observations for a proper validation on regional scale, it is therefore suggested to add a subchapter on currents. A comparison of mean surface and vertical integrated currents from AMM7 and AMM15 would already be a substantial contribution to the completeness of the paper. To add an estimate of eddy kinetic energy from both models would be perfect.

References:

Mattsson, J. (1996a), Analysis of the exchange of salt between the Baltic and the Kattegat through the Öresund using a three-layer model, J. Geophys. Res., 101(C7), 16,571–16,584.

Mattsson, J. (1996b), Some comments on the barotropic ïňĆow through the Danish straits and the division of the ïňĆow between the Belt Sea and the Öresund, Tellus, Ser. A, 48, 456–464.

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