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Ocean Science Discussions

Interactive comment on "Validation of the NEMO-ERSEM operational ecosystem model for the North West European Continental Shelf" *by* K. P. Edwards et al.

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We believe that the paper as presented (with some clarification and changes) is suitable as a validation paper for the operational ERSEM system and represents a continuation from O'Dea et al (2012) which focussed on the physics in the new operational system. This reviewer makes several interesting and valid points and begins by questioning the novelty of the paper. It is important to note that the presented modelling system has emerged from previous systems and work that have suggested substantial changes to the operational set-up which we are elaborating here (for example see Siddorn et al, 2007 which describes the MRCS-PE system). These suggested changes

included: extension of the domain, improvement of the boundary and initial conditions, improvements of the circulation model including data assimilation, and change in parameterisation of the biogeochemical model. This work has confirmed that these suggested changes are indeed improvements which have a significant impact on the model quality.

In the new domain off-shelf areas were included to improve the dynamics on the shelf and the shelf-break exchange. It is clear, that this domain with large impacts of highly dynamic and weakly constrained open boundaries is not suitable for a detailed description of the off-shelf waters, but was designed in order to improve the representation of the continental shelf. A further extended domain of the North-Atlantic, necessary for an appropriate description of the off-shelve areas (see also Holt et al. 2012), at this spatial resolution is currently out of scope for an operational system of the marine ecosystem, but is subject of on-going research programs (e.g. EUROBASIN) and may be considered for the next generation of the operational modelling suite. We need to make clear that while the model domain has been extended, our main area of interest has not – we are still mainly interested in the on-shelf (MRCS) region shown in Figures 1 and 2. Such that even if the representation of the off-shelf dynamics is far from perfect, the inclusion of these areas has significant positive impact on the on-shelf dynamics. The AMM7-NE system is not simply being used as a research model but is being run operationally to meet the needs of customers such as the UK Ministry of Defence (MOD) and, as such, is designed in part to meet our customer requirements and the validation provided is designed with this in mind.

The reviewer makes the point that the model only compares with surface data values and mainly at seasonal scales. We address the problem regarding surface data below, but want to point out that while the paper does mainly provide statistics at seasonal scales, we did review statistics at both monthly and seasonal scales for the WOA nutrients and at daily, weekly, monthly and seasonal for the chlorophyll. Since the WOA nutrients are provided monthly, it does not make sense to compare against shorter time

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scales in the model – both the monthly and seasonal values are provided in Table 1. Tables 3 and 4 along with Figures 7, 8 and 10 provide daily statistics for the chlorophyll (based on log10 values) for the entire two year period. We also compared statistics on weekly, monthly and seasonal averages which generally show improvement from the daily to longer time scales. We are happy to include an additional table in the paper (or to expand Table 3) if that would provide more clarity.

The reviewer also makes the point that one major problem is the unrealistic winter chlorophyll maximum west from Iberia. We believe that this is caused primarily from the use of boundary conditions for the nutrient fields and not for the phytoplankton or chlorophyll fields. We plan to add text to address this in the paper and to explain that, again, the modelling of the deep Atlantic (as off the Iberian Peninsula) is not the aim of this work and that these areas merely serve to drive the improved on-shelf dynamics, which is our focus. This is a difficult area in our model due to its proximity to both the southern and western boundaries and we are currently exploring several options for improved boundary conditions within ERSEM including climatological chlorophyll fields and fields from a global biogeochemical model.

The reviewer points out the obvious problems along the shelf slope that we addressed in the paper. He says “but to me the unrealistic excess nutrients on the slopes is a clear sign of excess spurious diapycnal mixing on the slope, which is likely to come from the physical model configuration. Although spurious diapycnal mixing is a characteristic of fixed level models, and cannot be eliminated, it can be reduced and it seems it is not the case in this configuration.” There is too much diapycnal mixing in the physical model which may be made worse in ERSEM through the use of the MUSCL advection scheme which is very diffusive. There is some discussion of the problems with the physics along with the corrections that were made to help minimize these problems in O’Dea et al (2012). Further work is being undertaken to improve the model results along the shelf break. We will expand this description in the paper to make it more clear what has been and is being done to address this issue.

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Finally, we understand the importance of comparing our model with subsurface observations and, as mentioned on page 761 lines 20-27, are working closely with several agencies including AFBI, IMR, Cefas and SAHFOS to get appropriate data to make these comparisons. In the meantime, we do not believe the problem is as bad as the reviewer seems to think. As stated by the reviewer, "these nutrients are of high biological relevance since central waters reach the surface with upwelling, especially to the south of the domain." We accept that this is true, but if the subsurface nutrients were being upwelled to the surface in too great a concentration, we would expect the surface chlorophyll to be much too high in most of the southern part of the domain. Instead, we see improvement in most of the southern regions (see the Taylor plot in Figure 8) along with a great improvement in both the nutrient and chlorophyll values at L4 in the English Channel (Figure 6). Also, the bias for the on-shelf region is almost zero (0.009) in the AMM7-NE model (Table 3) indicating that the model has approximately the correct amount of chlorophyll on the shelf over the two-year period. However, more work is being done to investigate this problem within the physics and we are looking at the use of a less-diffusive advection scheme for the tracers.

Interactive comment on Ocean Sci. Discuss., 9, 745, 2012.