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Interactive comment on "Heterogeneity of impacts of high CO_2 on the North Western European Shelf" *by* Y. Artioli et al.

Anonymous Referee #2

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General Comments:

This manuscript uses a coupled oceanographic-ecosystem model to study the combined impacts of climate change and ocean acidification (OA) on the marine ecosystem in a shelf-sea environment, and reveals the heterogeneity of the model responses from near shore to open oceanic waters. A series of model experiments are set up to test model responses to 3 drivers: climate change, enhanced primary production to increasing CO2 and reduced nitrification to OA (lower pH). I particularly like the results showing the interactions among different climate change and OA drivers, and also the underlying causes for the spatial heterogeneity in a shelf sea with high environmental gradients. The paper is in general clear and well-written. But the paper need major revisions as suggested below before it can be published. But more details should be

added to make the paper more complete. The test for climate change was done by run the model under present-day condition and future condition in end of this century. As stated in the paper, the climate change impacts the ecosystem through temperature, mixing and nutrient supply. The paper should include result comparison of these three modeled variables (using figures), and also briefly list the parameterisation of the impacts of these three variables (such as those in section 2.2). I also do not fully support the inclusion of the test for the pH-dependent nitrification. The paper does not have a clear background information for the ecological significance of the nitrification in marine ecosystems. For the impact of the pH-dependent nitrification, the paper mostly only show the modeled NH4:DIN ratio. But the ecological importance of this ratio is not discussed and it is unclear how this ratio would change the ecosystem in the model (such as smaller phytoplankton would get advantage over larger ones with higher NH4:DIN and the community composition could be changed?). As shown by the paper, the NH4:DIN even largely follows PP not pH: this pH-dependent nitrification mechanism barely impacts model performance. In addition, the parameterisation for the pH-dependent nitrification is based on one single study, while nitrification can be impacted by both environmental condition as well as the bacterial community composition. With limited knowledge of ecological impacts, it is unclear if the nitrification is a key process in marine ecosystem under changing climate. Without much of mechanisms built into the model, as stated in the paper, it is not surprise that the modeled impact of nitrification is mostly very small for PP, biomass and pH. Thus I suggest to remove the test for the pH-dependent nitrification from the paper. It is not very useful and can distract the reader from the main points of the paper. Showing the spatial heterogeneity of ecological response from climate change and enhanced primary production is sufficient for the paper.

Specific Comments: p9390, line 12: in four different configuration p9392, line 2-6: not quite relevant, considering removal. p9393, line 15: 1/9o latitude is about 12km but 1/12o longitude is about 6-7 km in this area. p9394: as discussed above, can the authors also show the parameterisation of climate change (temperature and nutrient

concentration) on biological species? p9394-9395, Equation (1) and (4): these two parameterisation uses two sets of constants (0.0005, 0.6111 and 3.8889); but these constants are based on limited studies. Have the author tested the model sensitivity to these constants? Can the sensitivity tests been shown in some way? p9394, Equation (3), first variable on the right hand, "act.resp"? p9395, line 4: nitrification rate in absolute value, not depending on ambient ammonium/ammonia concentration? p9395, section 2.2.3: suggest to use a table to more clearly show the scenario setup. p9395, line 12: Scenario 1 is named "PDnit". But in many places throughout the paper, "PD" is used to represent Scenario 1. Please correct. p9395, line 13-14: change to "with nitrification dependent on pH but with no primary production enhancement ..." p9395, line 15: remove duplicate "for the" p9395, line 19-20: "with nitrification dependent on pH but with no primary production enhancement ..." p9395, line 23-24: "with neither nitrification dependent on pH nor primary production enhancement on CO2" p9398, line 6-9: this explanation is not quite persuasive to me. Figure 3b shows difference in total zooplankton (micro+meso) biomass. Shift in zooplankton community can increase mesozooplankton biomass, but not total zooplankton biomass. Even considering lag, increase in mesozooplankton may not compensate for the loss of microzooplankton. p9398, line 23: Here and other places, the paper mentioned the impact from riverine discharge. Can the author consider to show a comparison of riverine input in PDnit and A1Bnit? p9398, line 25: As shown in Equation (1)-(3), CO2 increase PP and respiration in same rate. Why the response of phytoplankton groups are different? p9399, line 8: "to only climate change." p9399, line 14: A1Bnit, nit should be subscript. p9401, last line: "used in this work is perliminary" p9402, line 12-13: again, why increase in picophytoplankton is higher than others? Table 1, the comparison between A1Bnit and PDnit: considering high spatial heterogeneity in both positive and negative differences (figure 3), the mean cross the whole domain does not make much sense. Maybe separate results for the inner shelf sea and the open oceanic waters? Table 1: why the change in zooplankton is generally much higher than those of phytoplankton? Fig. 1B: consider to use different color scale? Fig. 2: Caption "mean values of the monthly

mean minimum" is awkward and unclear to me. Fig. 3 Caption: line 1: ecosystem add "(A1Bnit minus PDnit scenarios)" at the end of first sentence. Fig. 4 Caption: change text in the first parentheses to "(A1Bnit,pp minus A1B scenarios)"

Interactive comment on Biogeosciences Discuss., 10, 9389, 2013.