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Biogeosciences
Discussions

Interactive comment on "The metabolic response of pteropods to ocean acidification reflects natural CO_2-exposure in oxygen minimum zones" *by* A. E. Maas et al.

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I would like to thank the reviewer for her/his constructive suggestions for our paper. Below, I respond to each of the reviewer's comments on a point by point basis. Reviewer comments are in plain text and author response is in bold.

L99–100: pH profiles were only calculated for 2008. Is there a great inter-annual variation in pH or is it rather constant between the different years? Typically, the whole carbonate system parameters are given in papers dealing with OA. Can the authors add these data in order to provide readers with more elaborate information on the prevailing abiotic conditions that the pteropods live in, i.e. aragonite saturation state?

DIC and alkalinity of the system were not properly measured. Our estimates of the carbonate system are based on the known alkalinity of the region, and upon temperature, salinity and our pH measurements. Text has been added to both the methods and discussion which better elaborate on our estimates of the carbonate chemistry of the system: "Profiles of pH in the ETP in 2008 were measured using the standard SOP for pH analysis with m-cresol purple (Byrne and Elliott, unpublished data). Carbonate chemistry of the region was estimated using WOCE alkalinity values (P-18 1994 and 2008), pH and profiles of salinity and temperature using the CO2sys developed by Lewis and Wallace (1998). WOCE alkalinity data from 200 m was relatively consistent at nearby latitudes between 1994 (2298 $\pm$ 9.2) and 2008 (2300.5 $\pm$ 4.5), suggesting that these values are reasonable estimates of OMZ alkalinity."

L 104–114: The same question as above applies to the respiration experiments. If 10–50 ml chambers were used, it should have been possible, although maybe not for all replicates, to take water samples in order to be able to determine the carbonate chemistry more detailed? And how much replicates were set up for each pH level?

The syringe based end-point respirometery methods, and the small volumes of water employed in this experiment, make it impossible to analyze the carbonate chemistry without exposing the experimental water to air or destroying the organism prior to weighing. The alkalinity of the trials would have been quite consistent as the water used in all experiments was treated in the same fashion. Text has been added to the methods section to provide further details about the pH measurements in the respiration chambers.

L173: "aragonite is thought to be undersaturated in this region" needs a reference or proof through own data

A paragraph has been added to the discussion as follows to contextualize the abiotic conditions with respect to aragonite: "Assuming an average salinity of

34.7, a temperature of 10° C and a depth of 200 m (CTD data) and incorporating the measured pH with the known alkalinity of the region, aragonite is undersaturated in the OMZ (CO2sys: seawater pH scale, Dickson KHSO4, and constants from Dickson and Millero, 1987; ΩAr $=$ 0.65)."

L184: The authors state these pteropods may be able to endure periods of acidosis either through buffering their cellular pH or the dissolution of their aragonitic shell. While the first possibility seems adequate to me, the second does not seem to be a good alternative since the shell of the pteropods is so markedly thin. Do the authors think, pteropods could withstand this and survive without their shell? I'd like the authors to accomplish on this point a bit more as this may constrict their chance to cope with increasingly hypercapnic conditions in the shallower, warmer, oxygenated end of their distribution.

"It has been shown that juveniles of the species Cavolinia inflexa survive seawater of pH 7.51 pH ($\sim$ 1,700 μatm CO2) for 5-13 days, although under these conditions they are completely shell-less (Comeau et al. 2010b). This study suggests that loss of the shell is survivable for some species of pteropods for a brief period of time. The swimming efficiency, defensive capacity and the energetic effect of this loss of shell has yet to be quantified, and it is likely that the long term effects would have some effect on population fitness. However, the amount of shell dissolution that would be required to buffer tissue acidification in the OMZ on a diel basis would be unlikely to cause complete dissolution of pteropod shells. Although their shells are delicate, the bodies of pteropods are quite small and buffering would not require too much dissolution."

L184: thRough

The typo has been fixed

Table 4 and Fig. 2+3, 5: The units should be consistently: μmol O2 g-1 h-1 and respectively μmoles O2 g-1 hr-1 and μmole O2 g-1 hr-1

Units have been made consistent throughout

Fig 5: In CRD 2007 the grey bar at 150 μmol and 300 m depth, to which species does it belong? Usually the grey bars stand left and the right bars right, so I think this bar rather belongs to C. pyramidata?

The bar does correspond with C. pyramidata. The figure has been fixed to make it consistent with the rest of the dataset

Figure legend of Fig. 5: (solid dark grey line? Should be black line, right?), the same for (dashed dark grey line).

The labels have been changed from "dark grey" to "black"

There are two references (Maas et al. in prep. for J. Plankt Res, and Seibel et al. PLoS One subm.) that are not yet accepted and therefore shouldn't be cited except as unpublished work. If these manuscripts are still not accepted in the final stage of the present ms, the authors should omit these from the reference list.

Seibel et al. is now in press. Maas et al. is still in prep. If it is not in press it will be removed from the final manuscript during the final stage of this manuscript.

Interactive comment on Biogeosciences Discuss., 8, 10295, 2011.