

Interactive comment on “Controlled experimental aquarium system for multi-stressor investigation: carbonate chemistry, oxygen saturation, and temperature” by E. E. Bockmon et al.

Anonymous Referee #1

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The manuscript 'Controlled experimental aquarium system for multi-stressor investigation: carbonate chemistry, oxygen saturation, and temperature' describes the experimental setup of such a system. Furthermore, data on carbonate chemistry and oxygen stability is presented, gathered in two experiments of one and four weeks duration. The manuscript is well written, data presentation is clear and I have only a few comments and suggestions.

General comments and suggestions:

1: I am not sure whether the statement that the stability of the system presented here
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is better for shorter than longer experiments is true. If so, possible reasons should be discussed. Nevertheless, the larger variability in the four weeks experiment seems to be to a large extent by poorer temperature control. Also, the deliberate change in oxygen (O₂) and carbon dioxide (CO₂) concentrations in the air used for equilibration adds to this. In this respect, I would be interested to know why the change from 1500 to 1600 ppmv is just seen as a small pH drop on the same day while the change in oxygen is persistent from then on until the end of the experiment.

2: Another interesting observation is the unexplained pH drop in one of the 'ambient' replicates during the four weeks experiment. Also, at the beginning both of these replicates do show a pH off-set for a couple of days. Apparently something went wrong and it would be helpful to speculate about potential candidates, e.g. change in water turnover time, imperfect/different equilibration at the membrane interface...

3: It seems that target CO₂ and O₂ levels in air (these values should be reported for all treatments in both experiments) differ from the actual levels reached in seawater. For instance, in the four weeks experiment seawater pCO₂ at low pH was calculated to be about 1350 μ atm, while the air had a mixing ratio of 1600 ppmv. Potential explanations, such as CO₂ loss by out-gassing, or imprecise mixing by the mass-flow controllers should be discussed. Also, why do the 'ambient' treatments have higher pCO₂ than one might have expected (again please report the mixing ratios of the air used for equilibration).

4: Finally, I would like to see some recommendations/discussions on 1) a suitable biomass to water volume ratio (e.g. in μ mol organic C per L), avoiding significant biological impact on carbonate chemistry, and 2) on suitable combinations of seawater turn-over, replenishment and air-flow rates.

Specific comments:

1: P.3432, L.5 Why should ocean warming and deoxygenation complicate the anthropogenic impact on organisms. What is probably meant is that two combined stressors complicate the interpretation.

2: P.3432, L.14 What is meant with 'control results'?

3: P.3433, L.13 Next to 'bubbling' there are also other methods to perfectly mimic ocean acidification, e.g. combined additions of acid and sodium-(bi)carbonate.

4: P.3435, L.13 If the boron/salinity relation is mentioned here, influencing the calculations of carbonate from total alkalinity, inorganic nutrients such as phosphate and silicate should be mentioned as well.

5: P.3435, L.13 and below The discussion of controlling two parameters and assuming total alkalinity constant is a bit confusing. Regardless any changes in total alkalinity, target levels for pCO₂ and O₂ (ignoring small changes in solubility due to likely changes in salinity) are unaffected. For pH, of course, it matters.

6: P.3436, L.10 Dissolved inorganic carbon is also not affected by changes in temperature and is conservative with respect to mixing.

7: P.3436, L.23 What is meant with 'x 50 fiber'?

8: P.3437, L.20 'Quickly' is relative and depends on the biomass to seawater ratio.

9: P.3438, L.4 'In addition...', I did not understand what was meant here.

10: P.3438, L.20 and below Explain better, as now it seems that the increase in atmospheric pCO₂ would just have to be added on top of the natural fluctuations.

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11: P.3439, L.5 and below Maybe a few more details on the total alkalinity and pH measurements employed could be given.

12: P.3439, L.12 Why would an 'ambient' treatment be typical for a California coastal upwelling event? Under such conditions I would rather expect high CO₂ in combination with low O₂. In this respect I was also puzzled that the opposite combination of high CO₂ and high O₂ (low CO₂ and low O₂) was chosen in experiment S32. Which processes would lead to that unusual situation?

13: P.3439, L.25 Respiration decreases the pH. During night time, when I would expect the biggest effect of respiration on carbonate chemistry, pH, however, actually goes up.

14: P.3439, L.28 What is meant with 'the influence of outside factors on the carbonate chemistry'?

15: P.3440, L.16 Having a quick look at Nam et al. 2011, it seems that they describe a typical high CO₂ low O₂ environment (see also comment #12).

16: P.3441, L.22 Remove space within μatm .

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