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**Biogeosciences Discussions**

# *Interactive comment on* "High temporal and spatial variability of dissolved oxygen and pH in a nearshore California kelp forest" *by* C. A. Frieder et al.

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This is a very nice and carefully carried out study on the variability in DO and pH in a near shore kelp forest ecosystem at the California coast. The paper is timely, as there is little high resolution data available on coastal fluctuations in pH and DO. Such data is needed to understand the sensitivity of coastal organisms to ocean acidification. The data has been analyzed carefully and the paper is written well, I have only minor comments that are more conceptual in nature. I believe that the authors could make a greater effort to discuss more examples from the recent literature on coastal pH variability. Otherwise, this is a very nice paper. Good job!



General comments:

1) The authors should keep in mind that for most marine metazoans, CO2 and O2 partial pressures are the most important parameters that impact biological processes. Gas exchange of both carbon dioxide and oxygen is based on diffusion of dissolved CO2 and O2, increases in environmental pCO2 thus lead to equivalent increases in pCO2 in the organisms' extracellular fluids (blood, coelomic fluid or hemolymph) in order to maintain fluxes of respiratory CO2 out of the organism. Body fluid pH is altered passively by the need to maintain higher pCO2 (e.g. in mussels), while in some other organisms (e.g. fish) blood pH is stabilized at an increased pCO2 by actively accumulating bicarbonate ions (see e.g. Melzner et al. 2009 Biogeosciences for a discussion of some concepts). This also implies that a change in pH by 0.2 units can have very different impacts on marine animals depending on whether one considers a change from e.g. 8.3 to 8.1 or one from 7.7 to 7.5, as the change in pCO2 is very different between these two intervals. Hence, I would recommend to add a figure / table on estimated changes in pCO2 calculated from measured alkalinity / dissolved inorganic carbon and / or pH.

2) Future changes in pCO2 in CO2 enriched habitats will be greater than in the open surface ocean. This has been highlighted by Brewer & Peltzer (2009 Science), Cai et al. (2011 Nature Geoscience), Thomsen et al. (2010 Biogoeosciences). The authors might include some calculations on the magnitude of change in pCO2 / pH to be expected in the future based on estimated increases in future dissolved inorganic carbon. For more details and some calculations for coastal systems see also: Melzner et al. (2012) Marine Biology, in press, DOI : 10.1007/s00227-012-1954-1.

Minor comments:

P4115, line 26: for many species that are poor at controlling extracellular pH it is clear that rapid changes in seawater pCO2 rapidly translate into changes in extracellular pCO2 and pH. E.g., mussels cannot control extracellular pH (Thomsen et al. 2010

Biogeosciences), sea urchins (Strongylocentrotus droebachiensis, Stumpp et al. 2012 Aquatic Toxicology) need several days (4-10) to adjust to a new extracellular acid-base status when exposed to seawater acidification. Many fish and decapod crustaceans are able to rapidly regulate extracellular and intracellular pH (within hours, see e.g. Larsen et al. 1997 Marine Biology, papers by Heisler).

Figure 9 should be expanded to reflect full range of pH / pCO2 changes observed in this study and should reference published examples of process sensitivity to the pH / pCO2 / pO2 changes depicted in the figure.

Papers that could be discussed:

Cai et al. 2011 Nature Geoscience (coastal pH / pO2 variability) Feely et al. 2010 Estuarine Coastal Shelf Science (coastal pH / pO2 variability) Haynert et al. 2011 Mar Ecol –Prog Ser (coastal pH / pO2 variability, foraminifera) Thomsen et al. 2010 Biogeosciences (coastal pH / pO2 variability, mussels) Bechmann et al. 2011 J. Toxicol. Env. Heal. A (Mytilus early life stage sensitivity) Gazeau et al. 2010 Biogeosciences (Mytilus early life stage sensitivity) Sunday et al. 2011 PLoS ONE (mussel adaptation potential to OA) Brewer & Peltzer 2009 Science (non-linear increase in future pCO2 in CO2 enriched regions)

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Interactive comment on Biogeosciences Discuss., 9, 4099, 2012.