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Interactive comment on “Air-sea exchange of CO₂ at a Northern California coastal site along the California Current upwelling system” by H. Ikawa et al.

Anonymous Referee #1

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The authors studied air-water exchange of CO₂ in a coastal upwelling site by using eddy covariance technique in summer 2007 and fall of 2008, and a SAMI-pCO₂ sensor in November 2010 and March to July in 2011. They then discussed the effects of upwelling on CO₂ fluxes, and concluded that the coastal area off the Bodega Bay was a source of CO₂ to the atmosphere. Overall, the paper is very well written, and the discussion seems to be reasonable. Unfortunately, I am struggling to find any major contributions of this paper to the study of carbon cycle except for the method of using eddy covariance technique to study air-water exchange of carbon dioxide itself.

Traditionally, air-water exchange of carbon dioxide is calculated based on the gradients

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of pCO₂ between the atmosphere and the water, and the gas transfer velocity. The problem is that even though pCO₂ gradients can be determined reasonably accurately, the gas transfer velocity has to be derived roughly based on wind speeds. The eddy-covariance technique, on the other hand, is more of a direct CO₂ flux measurement. It calculates vertical turbulent fluxes based on parameters within the atmospheric boundary layers. However, after reading the manuscript, I have a feeling that this technique will bring about large uncertainties. As an oceanographer who knows little about eddy covariance technique, I hope the manuscript will also be reviewed by at least one atmospheric scientist, to make sure the authors get an unbiased review.

Other comments:

- 1) SAMI-pCO₂ sensors have some known issues and suffer from biological fouling. Please provide more details of the calibration, and its uncertainties.
- 2) Derivation of DIC based on pCO₂ that was calculated from SST, salinity (ignoring the biological processes), and pH that was measured in another area (Central California coast) will bring about tremendous uncertainties. Ideally, the two parameters that are used to calculate DIC need to be measured accurately, and from the same body of water.
- 3) West coast of the United States features strong CO₂ sinks. The conclusion that the upwelling site is a CO₂ source is not necessarily wrong, but extrapolation of data from one longitude latitude point to a large area needs to be done very carefully.
- 4) The conclusion that the ocean is leaning more towards a source of carbon dioxide during early upwelling period than during upwelling relaxation period is nothing new. The early upwelling period is mainly a physical warming process, where the cold high CO₂ deep water is warmed up in the surface, raising pCO₂. The relaxation period is mainly a biological uptake process, where the high nutrient upwelled water, combined with light in the stratified surface layer, generates strong biological activities, lowering down pCO₂.

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