

Interactive comment on “A year in the life of a central California kelp forest: physical and biological insights into biogeochemical variability” by David A. Koweek et al.

Anonymous Referee #2

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This manuscript nicely describes spatial and temporal variation in carbon system variables in a kelp forest in Central California. The data presented are the first to report high frequency measurements of carbon system variables made at small spatial scales across an entire annual cycle within a kelp forest. The data reveal substantial depth-dependent, spatial, and seasonal differences. The authors suggest mechanisms that could be responsible for creating the observed variation. Sampling design, sample collection, and analytical methods all appear appropriate to the research questions posed. The organization of the paper is logical, the writing is clear, and the graphics are appropriate and informative.

Below I offer specific comments intended to strengthen the manuscript.

C1

Page 2, line 8: more clearly stated as “Calcification and dissolution of kelp-associated organisms, especially shelled invertebrates, can modify water chemistry. . .”

Page 2, line 16: better stated as “ Despite the recognized importance of the kelp forest. . .”

Page 2, line 16: I searched but did not find reference to kelp as an “ecosystem architect”. The earlier use of the term “foundation species” is more consistent with the ecological literature.

Page 2, lines 25-27: Important points are made here. It would be helpful to clearly return to these in the discussion section.

Section 2.4 Satellite derived estimates: Estimating kelp canopy biomass is notoriously difficult. The authors have done a good job estimating relative changes in biomass over time but I found no indication in the text or figures to indicate error in this estimate. The inclusion of error estimates would be helpful.

Section 3.4: Carbon systems variables differ between surface and bottom, consistent with the intrusion of CO₂ enriched water at bottom and photosynthetic activity at the surface. Here or in the discussion it could be helpful to mention that the observed surface-to-bottom variation suggests that benthic calcifiers appear neither to be influencing TA nor do they appear to be benefitting from the effects of photosynthesis on water chemistry, which seem to be confined to surface waters. Moreover, understory seaweeds, which can achieve substantial biomass in kelp forests, don't appear to affect water chemistry appreciably (tho this was not tested). A fuller discussion of these considerations could be helpful.

Section 4.2: The discussion of “space-for-time substitutions” is reasonable, but in my opinion is less compelling than other arguments that can be made concerning kelp forest ecosystems in an era of global change. I'd encourage the authors to open the discussion with the most compelling inferences that can be drawn from their data.

C2

Page 11, lines 10-18: The discussion of refugia could be refined. Assuming that photosynthesis within the canopy modulates stress due to high CO₂/low pH, it's difficult to think of very many organisms (especially calcifying organisms) that can take advantage of this. These are likely to be limited to epibionts on kelp blades and perhaps a few canopy-associated fish species. A much larger number of calcifying taxa are associated with the benthos, where water conditions are likely to be less conducive to calcification and growth when omega is low. Consequently, the potential refugium created by the canopy is spatially unassociated with the bulk of benthic species. Moreover, the persistence of refugia in such a dynamic system is questionable.

Page 11, lines 25-34: Comments about water quality criteria are reasonable: for instance, it's important to point out that the variability observed in this study exceeds that of water quality criteria now in existence. However, the paragraph doesn't seem particularly nuanced, beyond references to Boehm et al, Weisberg et al, and Chan et al. I encourage the authors to more fully consider the implications of their data for water quality criteria.

Page 11, line 28: replace "supervising agencies" with "regulatory agencies".

Page 12, line 8: distinguish between "fully constrained" and "over-constrained" with respect to carbon system variables.

Page 12, line 18: replace "harvesting" with "kelp harvesting".

Page 12, line 20: should read "effects of the kelp canopy".

Page 12, line 22: replace "chemically homogenize" with "reduce gradients in".

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