

Responses to Reviewer #1's comments

First of all, the authors would thank the reviewer for giving practical comments. We have revised our manuscript based upon all your comments. Below are our responses to the comments:

Response to major comments

1) *I am suggesting major revisions largely due to the discrepancies between the modeled and observed results. I think there needs to be more discussion as to why the model doesn't pick up the short term variability, and how that impacts your conclusions about when thresholds will be met. The models seem to do a good job predicting average seasonal variability, but there is a lot of variation over shorter timescales that may push oysters to experience harmful pH and oxygen conditions over shorter timescales. In the discussion, I think you need to focus less on the modeled outcomes, and more on the observations. What are the conditions now, and what timescales do they vary over? How will that impact oysters? Please revise the discussion to focus on your observations instead of the model output.*

→ Thank you for the practical comments. The current structure of Section 4 is a result of addressing another reviewer's previous comment to move future projection results from Section 3 to Section 4. Therefore, the reviewer may have felt that this section focuses more on model results rather than the observations. To take the present comments into account, the authors would like to refer the reviewer to Section 3, in which observed results are already described in detail. Moreover, in 4.2, we have also referred to observation-based estimated start and end dates of Pacific oyster spawning periods before discussing the projected start and end dates for the future (in Lines 396-398 in the revised manuscript).

As the reviewer pointed out, the model did not reproduce well the observed short-term fluctuations in biogeochemical parameters, which may affect the accuracy of future projection results. This was mainly because the temporal resolution of the model output is 6 hours, insufficient to resolve significant short-term fluctuations in biogeochemical processes predominantly caused by biological activities, i.e., photosynthesis by phytoplankton, eelgrass, and seaweeds during the day and respiration of marine organisms at night. Although the spatial resolution of the model (2 km) is relatively high for downscaling climate model outputs, it is insufficient to reproduce spatial differences in biogeochemical-parameter values among the four monitoring sites in Hinase and Shizugawa. Also, the model-observations mismatch for TA and DIC values, especially the failure to reproduce sudden decreases, likely resulted from insufficient input of freshwater from rainfall and riverine water into the model. These have been described in Lines 331-338 in the revised manuscript.

Considering the reviewer's comment, i.e., to focus more on our observations rather than our model outputs, the authors have added the observed short-term fluctuations of Ω_{arag} to modeled Ω_{arag} (Figure S1 below and in the revised manuscript). As a result, the simulated or projected number of days on which Ω_{arag} values are below the threshold of acidification for Pacific oyster larvae (1.5) has been modified from 0 days to 3 days for the present, from 0 days to 5 days with the RCP 2.6 scenario, and from 204 days to 256 days with the RCP 8.5 scenario in Hinase. In Shizugawa, the simulated or projected number of days have been modified from 0 days to 7 days for the present and with the RCP 2.6 scenario, and from 244 days to 322 days with the RCP 8.5 scenario (Table 3). The results show that consideration of the short-term variations may push oysters to experience harmful pH and Ω_{arag} conditions, as the reviewer pointed out. Unfortunately, we could not estimate the modified number of days on which DO concentrations are below $203 \mu\text{mol kg}^{-1}$ by considering the observed short-term

fluctuation of DO concentration due to the lack of continuous DO observations in this study. As previous reviewers commented that our manuscript has relatively many figures already, we did not add a new figure to the main text but instead have added one as supplementary material (Fig. S1) in the revised manuscript, and have modified Table 3 to reflect what was mentioned above.

Making the above-mentioned modifications following the reviewer’s comments have also stressed to the authors the need to describe more clearly the discrepancy between the scientific findings and the fact that no specific impacts of ocean acidification on Pacific oyster larvae have so far been detected in the study sites, even they occasionally experience the critical level of ocean acidification proposed by a previous study ($\Omega_{\text{arag}} < 1.5$; Waldbusser et al., 2015). The relevant descriptions have also been added to Lines 435-439 in the revised manuscript.

These modifications do not change the overall purpose of this study. However, the following description, which was part of the Abstract in the previous manuscript, has been deleted from the revised manuscript, because if we take the short-term fluctuation in DO concentration into account, the description is not appropriate:

“On the other hand, no significant impact of surface-water deoxygenation on Pacific oysters was identified at present nor was projected for the future in both sites.”

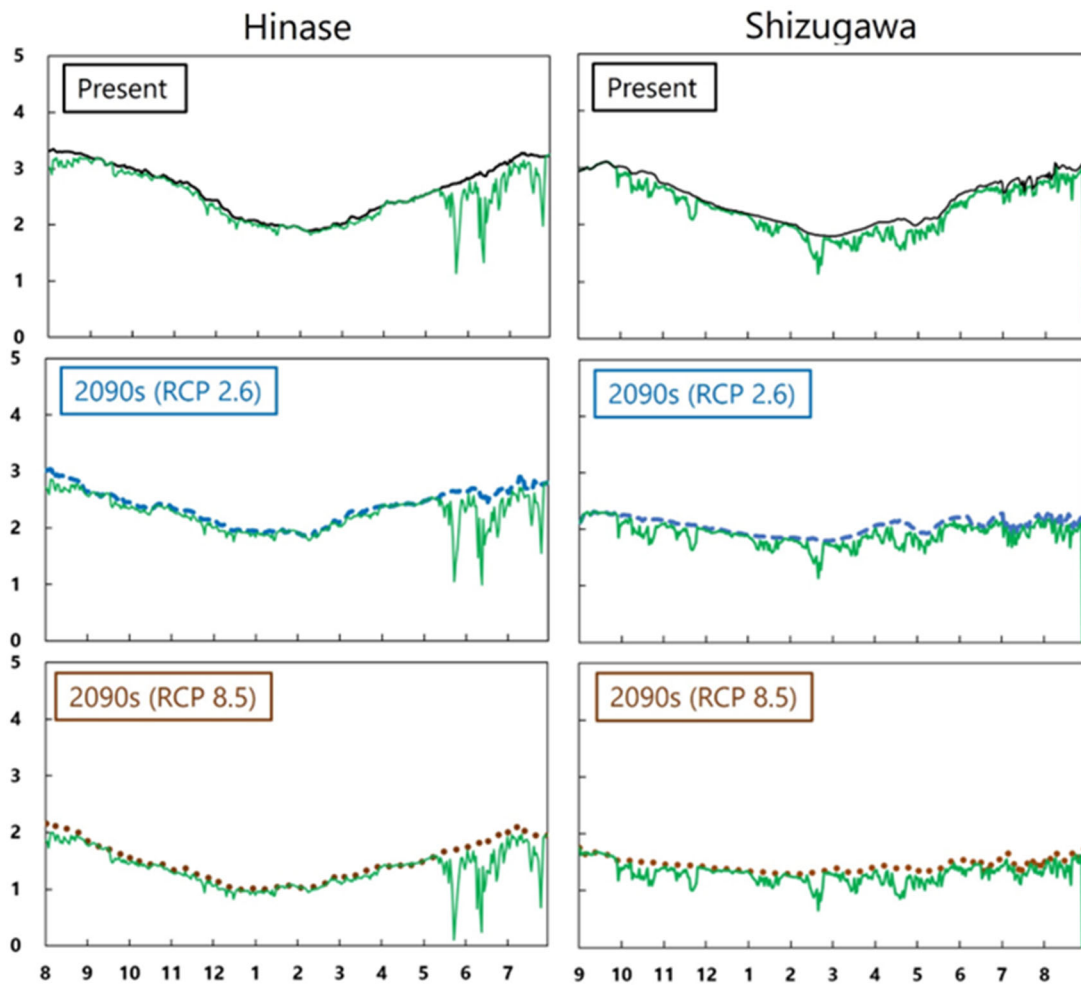


Figure S1. Simulated or projected Ω_{arag} in Hinase from August to July (left) and in Shizugawa from September to August (right) for the present (top), for the 2090s with the RCP 2.6 scenario (middle), and for 2090s with the RCP 8.5 scenario (bottom). Solid black lines, dashed blue lines, and dotted brown lines are identical to results shown in Figures 15(g) and 16(g). Solid green lines denote modeled daily Ω_{arag} minima if present day observed daily Ω_{arag} fluctuations are included.

Responses to specific comments

2) L 47 and 50: *I don't think 'leached' is the correct word here. I would say CO₂ is absorbed by the oceans from the atmosphere.*

→ The term “leached into” has been replaced with “absorbed by” (in Lines 45 and 48 in the revised manuscript).

3) L127 (and throughout): *Please refer to 'Chapters' as 'sections' instead.*

→ The terms “Chapters” have been replaced with “sections” in the entire text (in Lines 108 and 110 in the revised manuscript).

4) L179: *Should 'alkaline' be 'alkalinity' here?*

→ Thank you for the comment. That should be “alkalinity” and has been modified accordingly (in Line 156 in the revised manuscript).

5) L206: *You correct for the drift of the sensor, not the 'observed value'*

→ The reviewer is right, and we have modified the text accordingly (in Lines 163-164 in the revised manuscript).

6) L248: *'biochemical' should be 'biogeochemical'; check manuscript for other instances*

→ The term “biogeochemical” has been replaced with “biogeochemical” (in Line 207 in the revised manuscript). We have also checked the entire manuscript and have confirmed that there are no other instances.

7) L333: *replace 'vicinal' with 'nearby'*

→ The term “vicinal” has been replaced with “nearby” (in Line 272 in the revised manuscript).

8) L413: *replace 'creatures' with 'organisms'*

→ The term “creatures” has been replaced with “organisms” (in Line 334 in the revised manuscript).

9) L439/443: *replace 'contributed to by' with 'controlled by'*

→ The term “contributed to by” has been replaced with “controlled by” (in Lines 360 and 364 in the revised manuscript).

10) L548: *Change section name to 'Conclusions'*

→ We have changed the section name to “Conclusions” (in Line 457 in the revised manuscript).