Review report

Understanding the resilient carbon cycle response to the 2014–2015 Blob event in the Gulf of Alaska using a regional ocean biogeochemical model

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Summary of the manuscript

The manuscript uses a high-resolution MITgcm to analyze the response of surface pCO_2 to the 2014–2015 marine heatwave event, commonly known as "The Blob," in the Gulf of Alaska. Surface ocean warming is generally expected to enhance surface pCO_2 as warmer water has lower CO_2 solubility, leading to a reduction in the oceanic uptake of atmospheric CO_2 or even outgassing. In this case, however, the 2014–2015 Blob exhibited the opposite behavior at the Gulf of Alaska, showing a moderate reduction in surface ocean pCO_2. The authors use the MITgcm to demonstrate that this reduction results primarily from the impact of vertical transport: the suppression of upwelling of DIC-rich subsurface waters during the winter of 2013 had a stronger effect than the subsequent warming-induced increase in surface pCO_2.

Main Review

The manuscript is generally well written. The authors present their ideas clearly, making the text easy to read and understand. They address an interesting question and use an appropriate tool i.e., the high-resolution regional MITgcm simulation to investigate the CO_2 response to the 2014–2015 Blob.

That said, the attribution and mechanistic explanation (lines 266–287) of the main findings need to be strengthened. First, the explanation of the respective roles of horizontal and vertical transport is brief and unclear. As this is a key point of the study, it deserves a clearer discussion.

Second, the main finding also relies heavily on stratification changes due to warming. Although the effect of warming on stratification is somewhat obvious, it would be helpful to include an explicit analysis, perhaps in the supplementary material showing the upper-ocean density gradient or a related metric. This may not require much additional effort but would enhance the mechanistic understanding and make the manuscript more self-contained regarding attribution.

Third, Supplementary Figure S2 appears to be central to the study, as it shows changes in surface transport. To make the analysis more complete, I suggest reducing the number of panels and moving a modified version of this figure into the main text. If there are restrictions on the number of figures, Figures 6 and 7 could be combined, this might also be visually more effective and the freed space could then be used for Figure S2. This is, of course, only a suggestion.

Finally, it would be helpful to strengthen the link to Ekman dynamics and entrainment discussed at the beginning of the Discussion section. The authors could support this point with additional literature or include a supplementary plot of wind stress curl to clarify the connection.

Overall, this is an interesting and valuable study. The authors have most of the essential analyses in place but would benefit from refining the mechanistic explanations and reinforcing the main argument.