Response to Associate Editor

Dear Emily Havard et al.,

Thank you for submitting your work to Biogeosciences. We have received two reports from external referees. Both commented on the potentially valuable contribution of your data set and work to the field, but they also raised critical points that require further attention and revisions. Key concerns include the relationships between G. bulloides and environmental parameters, comparisons between recent and older data sets, the effect of potential long-term changes in planktonic foraminifera size, and the discussion on the impact of ocean acidification, among others.

Based on the reviewer evaluations and your responses, I invite you to carefully consider the reviewers' comments and suggestions and make the necessary revisions. This is considered a major revision.

Additional notes the authors from review file validation:
"With the next file upload request, please number the tables and figures in the Appendix separately (Table A1 to Table A3 and Figure A1 to Figure A3)."

Best regards,
Yuan Shen
Associate Editor

Dear Yuan Shen,

We thank you and the reviewers for your feedback that has allowed us to improve our manuscript. After consideration of the reviewers' evaluations, we have provided responses to each of their comments. Here, we provide a line-by-line description of edits made to our manuscript based on the suggestions of the reviewers. Additionally, we have updated the data table of sediment trap particle flux, including carbonate and organic carbon, to include data through October 2021 (previously January 2021), to exactly match the dates of our foraminiferal assemblage record. We have updated calculated values and Fig. 10 panel c as appropriate, and we have added the table to the supplement.

Sincerely,

Emily Havard

On behalf of all authors

Edits in Response to Reviewer 1

We have clarified the description of the relationships between *G. bulloides* and environmental parameters.

Lines 452-456 "This species is further positively associated with surface dissolved oxygen, which has many possible drivers, including primary productivity, the properties of upwelled waters, and seasonal currents (Fig. 6). However, G. bulloides is negatively associated with environmental variables that are positively associated with upwelling (CUTI), including pH, organic carbon, nitrogen, and opal (Fig. 6). The negative association between G. bulloides and opal flux suggests that G. bulloides feeds on a variety of phytoplankton in SBB, rather than primarily on diatoms"

We have clarified that acidification is a hypothesis presented as a possible explanation for the results observed in our study.

Lines 467-469 "In the context of rapid acidification in the California Current system and an increase in local upwelling intensity, we hypothesize that the decrease in G. bulloides flux is most likely driven by ocean acidification such that conditions within SBB are moving beyond the range of tolerable conditions for this species."

Lines 622-623 "We hypothesize that this decrease in foraminiferal flux is driven by an increase in upwelling and the acidification of the California coastal upwelling system."

We have added to the methods a description of long-term environmental data availability in SBB and long-term data used in our study.

Lines 146-149 "Some environmental data from 1993-1998 in SBB was either non-existent or available at a temporal resolution too low to yield meaningful comparisons to the 2014-2021 environmental data. We thus discuss long term trends only in the available datasets of the Coastal Upwelling Transport Index (CUTI), foraminiferal flux, carbonate flux, and organic carbon flux."

We have added a discussion of prey availability.

Lines 456-459 "A change in prey availability could impact assemblage composition and foraminiferal flux, and more research is needed to determine the feeding dynamics of SBB species in detail. However, as G. bulloides is known to be an opportunistic feeder (Schiebel and Hemleben 2017), a shift in food type is unlikely to explain the extent of flux decrease observed in this study."

We have included the sediment trap particle flux data table in the supplement.

Edits in Response to Reviewer 2

We have included a discussion of potential decrease in foraminiferal size as a driver of assemblage change.

Lines 326-329 "Given the decrease in total flux, a potential decrease in foraminiferal size over time is important to consider. Between 1993-1998 and 2014-2021, the fluxes of the two smallest and most abundant species, T. quinqueloba and G. glutinata, remained consistent or increased slightly. Therefore, we conclude that a decrease in shell size to below the 125µm sieve size is not a major contributing factor for the observed decrease in total foraminiferal flux."

We have clarified the post-mortem preservation of the tests in the methods section.

Lines 126-129 "Sediment trap particles were preserved in a borate-buffered formalin solution (pH >8) in the sediment trap, minimizing interaction with the surrounding seawater. After trap recovery, samples were split, with a 1/16th split used for foraminiferal flux and species counts, excluding July-October 2015 and May-November 2020."

We added information about benthic foraminifera and local sediment movement.

Lines 188-189 "Benthic foraminifera contributed less than 0.5% of the total assemblage and there was no evidence of major resuspension events or landslides throughout the study period."

We have added an explanation of the CCA loadings and directions to the methods section.

Lines 160-162 "CCA loadings are the correlations between the canonical variables and environmental or species variables. For example, if a variable has a positive loading, it has a positive correlation with the canonical variable (CCA1 or CCA2) and is positively associated with other variables that have positive loadings on the same canonical variable."

We have clarified to acknowledge the array of environmental factors that influence pteropod distribution and shell formation in addition to carbonate chemistry.

Lines 66-71 "In addition to a variety of other environmental parameters such as salinity, oxygen, and temperature, pteropods are impacted by changes in carbonate chemistry (Bednaršek et al., 2019; Johnson et al., 2023; Mekkes et al., 2021). Modern (2016) pteropods, for example, *produce thinner aragonite shells in the more acidic, nearshore upwelling zones of the California coast compared to offshore, due to a decrease in calcification (Mekkes et al., 2021). Foraminifera also calcify thinner shells in response to ocean acidification (De Moel et al., 2009; Moy et al., 2009; Osborne et al., 2016; Pallacks et al., 2023).”*