Response to Associate Editor

Dear Emily Havard et al.,

We have received an additional evaluation of your revised manuscript and responses. As the two original reviewers were unavailable, we invited a third reviewer to assess your submission. Overall, the reviewer recognized the potential value of your data and work, as well as the quality of the revised manuscript and your responses.

However, they also expressed concern regarding the insufficient explanation of the influence of environmental variables on foraminiferal fluxes, as well as the interannual comparison between the 2014–2021 and 1993–1998 periods.

I suggest that the authors carefully review the manuscript once more and make the necessary revisions to address these recurring concerns.

Best regards,
Yuan Shen
Associate Editor

Dear Yuan Shen,

We thank you and Reviewer 3 for your feedback on our manuscript. Here, we provide a line-by-line description of edits made in response to the suggestions of Reviewer 3.

Sincerely,

Emily Havard

On behalf of all authors

Edits in Response to Reviewer 3

We have revised and elaborated throughout section 4.1 to further clarify the discussion of potential drivers of shorter-and longer-term flux. We have also included additional information about multi-decadal temperature and carbonate chemistry trends spanning the 1993-2021 time period.

Lines 431-439, "The decrease in the median flux of G. bulloides (-58.8%) between 1993-1998 and 2014-2021 is the biggest contributor to the decline in total foraminiferal flux (-37.9%) (Fig. 7). Despite their decrease in numbers, G. bulloides has remained relatively abundant, inhabiting SBB year-round with a high degree of interannual variability, showing a lack of seasonal peaks when averaged over multiple years (Kincaid et al., 2000; Black et al., 2001; Figs. 2, 3, and 4). During 2014-2021, the species is positively associated with surface dissolved oxygen, which has many possible drivers, including primary productivity, the properties of upwelled waters, and seasonal currents (Fig. 6). Interestingly, G. bulloides is negatively associated with environmental variables that are positively associated with upwelling (CUTI), including pH, organic carbon, nitrogen, and opal flux (Fig. 6)."

Lines 441-443, "Few environmental datasets span the full 1993-2021 time period in SBB. However, available, nearby records of carbonate chemistry and temperature combined with particle and foraminiferal flux data from the SBB sediment trap allow us to make some reasonable inferences of possible drivers of the decrease in foraminiferal flux."

Lines 449-451, "At CalCOFI station 90.90, located on the western edge of the southern California Current, carbonate chemistry has been measured since 1983 (Wolfe et al., 2023). The measurements show a trend of decreasing pH by 0.0015 yr^{-1} and decreasing carbonate ion concentration by 0.41 µmol kg^{-1} yr^{-1} (Wolfe et al., 2023)."

Lines 457-460, "In contrast to changing carbonate chemistry, daily SST measurements taken in the Santa Barbara harbor show little change between 1993 and 2021. The mean SST from 1993-1998 was 16.3 ºC, while the mean SST from 2014-2021 was 16.8 ºC, with no apparent trend (Carter et al., 2022). Nor is warming evident at CalCOFI station 90.90 (Wolfe et al., 2023)."

Lines 467-477, "Environmental drivers such as acidification could also impact the broader ecosystem including prey species. However, G. bulloides is an opportunistic feeder (Schiebel and Hemleben, 2017), an inference which is further supported in SBB by its year-round presence despite differing availability of prey species (Catlett et al., 2021). Thus, while a change in prey

availability between the 1990s and 2020s cannot be entirely ruled out as a factor in assemblage composition, it is unlikely to be a primary driver of the decrease in foraminiferal flux. We hypothesize that both the negative association of G. bulloides with active upwelling indicators on short times scales as well as the long-term decrease in observed flux reflect the growing challenges of ocean acidification in this environment. Given the documented association between low pH and reduced calcification and stress in G. bulloides (Davis et al., 2017; Osborne et al., 2020), it may be that conditions within SBB are more frequently moving beyond the optimal range for this species."

We have added a summary line to highlight a key implication of decreasing foraminiferal flux.

Lines 499-501, "Although a decrease in calcification has negative consequences for calcifying organisms, a medium to long-term impact of a continued decrease in the observed carbonate flux may be an increase in the buffer capacity of the surface ocean, which may already be providing a stabilizing feedback to atmospheric CO_2 inputs."