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Determinants of calcite flux in planktonic foraminifera on seasonal and interannual time scales

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Planktonic foraminifera precipitate calcareous shells, which after the death of the organisms are exported from the sea surface to the sea floor, where they are preserved on geologically relevant timescales. The export flux of planktonic foraminifera shells constitutes globally up to a half, and in the studied region off Cap Blanc (Atlantic Ocean) about one third, of the marine pelagic calcite flux. Given their importance for the marine calcite budget and for the pelagic carbonate counter pump, which counteracts the biological pump in terms of oceanic capacity for intake of CO_2, it is crucial to gain an understanding of factors modulating the export flux of planktonic foraminifera calcite. In principle, variability in the export flux of planktonic foraminifera calcite could depend within one species on i) shell flux, ii) shell size and iii) calcification intensity, and where shell size and calcification intensity differ among species also on the species composition of the deposited assemblage. To assess the importance of these aspects in modulating the export flux of planktonic foraminifera calcite, we investigated two annual time series (from 1990-1991 and 2007-2008) from sediment traps moored in the Cap Blanc upwelling area. We assessed the predictability of foraminifera calcite flux variability on seasonal and interannual time scales, by determining the variability in species-specific shell fluxes, shell sizes and weights with bi-weekly resolution. We find a remarkable discrepancy in the contribution of the controlling factors between seasonal and interannual scales. On the seasonal time scale, 80% of the variability of the calcite flux is explained by shell flux. On the inter-annual time scale, on the other hand, variations in shell size and calcification intensity are key to explain the calcite flux, since the time series from 2007-2008 yielded 58% larger and 11% heavier specimens. These results imply that for the global estimate of planktonic foraminifera calcite flux, shell flux is likely the most relevant predictor. However, a prediction of the temporal evolution of the calcite flux will likely require estimates of changes in shell size and calcification intensity of the involved foraminifera species.

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