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Ocean currents generate large footprints in marine palaeoclimate proxies

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Fossils of marine organisms like planktic foraminifera found in ocean sediments are one of the cornerstones of palaeoclimatological studies. An underlying assumption in their interpretation is that foraminiferal shells – and signals derived from these – are representative of water properties overlying the location of their deposition. Planktic foraminifera, however, are carried by ocean currents. Depending on the species, they grow their shell over weeks to months, with the potential to incorporate ocean conditions from far away. Here, we use high-resolution ocean circulation models to assess the footprint of planktic foraminifera. We validate our method with proxy analyses from two sediment cores. Our results show that the palaeoclimatic signal derived from foraminifera may originate from areas up to several thousands of kilometers away. Temperature reconstructions derived from proxy records therefore may represent distant conditions, often significantly different from those at the site. In the eastern equatorial regions and extensions of the western boundary currents, this difference may add up to 1.5°C for species living for a month, and up to 3.0°C for longer-living species. Consideration of the full-lifespan foraminiferal core footprint and oceanic transport appear crucial aspects in the interpretation of proxy signals.