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Transport of planktic foraminifera by ocean currents in the Uruguayan margin

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Fossils of planktic foraminifera are found in marine sediments and are widely used as a proxy for past ocean conditions. The habitat of these unicellular marine zooplankton ranges from tropical to polar regions and is mostly located in the upper mixed layer of the ocean. The foraminifera form a calcium carbonate 'shell' around their cell during their lifespan. When they die, foraminifera lose their ability to control their buoyancy and their shells sink to the ocean floor. It is often assumed that the proxies which are derived from the shells in sediment cores represent ocean conditions above the location of deposition. However, foraminifera are transported by ocean currents, both during and after their lifespan. Hence, the paleoclimatic conditions recorded from their shells may originate far from the core site, generating large footprints in foraminifera-based paleoclimatic proxies.

In this project, we quantify the influence of the transport by ocean currents on the proxy signal of foraminifera found at core sites in the Uruguayan margin of the Punta del Este basin. This is a region where two western boundary currents meet: The southward flowing Brazil current and the northward flowing Malvinas current. We use a high resolution (0.1° horizontally) ocean general circulation model to track virtual sinking particles and the local oceanic conditions along their pathways. These model results are compared to proxy- and species analysis from the core sites. We found that offsets in modelled proxy signals due to transport in the Uruguayan margin are strongly linked to the relative position of the core site to the Brazil-Malvinas confluence. These offsets are most pronounced in the tails of the temperature distributions where they can reach up to +/- 7°C at sites located in the confluence zone. Species analysis from core tops taken slightly north of this region show more cold water species than reflected by the modelled temperature distributions, suggesting biological activity and nutrient availability not taken into account in the model play an important additional role in the relative abundances of species.
Our model simulations have provided both a first order insight into the potential proxy-signal offsets in highly dynamic ocean regions and show that understanding of the interplay between transportation effects and the biological activity of foraminifera is crucial for the interpretation of these proxies.