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Editorial: Climate and ocean dynamics at the Brazilian margin – Past and present

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Editorial on the Research Topic
Climate and ocean dynamics at the Brazilian margin - Past and present

Continental margins account for only about one-third of the surface covered by the oceans, but are responsible for more than 80% of the carbon sequestration in marine sediments. Tropical continental margins receive some of the largest terrestrial organic and inorganic fluxes to the marine realm. In particular, the Brazilian continental margin is located in a crucial region of the global oceanic conveyor belt and is central to the interaction between climate and ocean dynamics in low latitudes. Despite decades of research, it is not yet clear whether and how the highly vulnerable marine and terrestrial ecosystems in that region will respond to climate change. To better understand potential future climate scenarios and how they will alter the Brazilian margin, an important strategy is to reconstruct past climate and ocean dynamics. This research theme brings together synergistic research efforts from different Earth system disciplines to improve our understanding of the Brazilian margin as a key compartment of the (sub)tropical climate system and South Atlantic Ocean dynamics.

This Research Topic includes studies from the Brazilian margin that reconstruct past tropical climate and associated changes in precipitation patterns, land-sea interaction, changes in river discharge, changes in sea surface productivity, water mass properties, sediment diagenesis and geochemistry, and micropaleontological methods using foraminifera and coccolithophores.

In a very detailed investigation of marine isotope stage (MIS) 5, the study by Venancio et al. shows that foraminiferal Ba/Ca ratios can be used to to detect changes in fluvial discharge, which in turn can be linked to movements of the Intertropical Convergence Zone (ITCZ). Furthermore, the study shows that these precipitation changes were related to rapid Dansgaard/Oeschger (D/O) stadials.

Fluvial discharge from MIS 5 (and also MIS 6) is also reconstructed by Arndt et al. In this study, clay mineral compositions of deep-sea sediments are used to identify changes in the drainage basin of the Doce River caused by changes in the South Atlantic Convergence Zone (SACZ). The dominant temporal control on clay mineral composition (kaolinite and gibbsite versus illite, quartz, and albite) here appears not to be the short-term D/O cycles, but changes in Earth's orbit, particularly the precession cycle (21 ka), which causes variations in tropical seasonality.

The coupling of the terrestrial and marine domains during the late Pleistocene and Holocene is studied by Dauner et al. They show that organic matter (OM) composition (terrestrial versus marine) exhibited increased marine productivity between 50 and 39 ka BP and shifted to a more terrestrially dominated OM regime between 30 and 20 ka BP. Such changes may be associated with variations in upwelling and fluvial nutrient supply, as well as changes in surface water masses.

Sea surface paleoproductivity off the Brazilian margin is also reconstructed by Pedrão et al. They use a combination of coccolithopore assemblages and bulk sediment geochemistry showing that marine productivity was higher during the LGM and lower during the Holocene. The authors conclude that this was due to changes in sea level that under glacial conditions resulted in an exposed shelf and increased continental nutrient input to the ocean.

Interestingly, the feedback mechanism described above can also be observed during periods of Northern Hemisphere cooling, such as Heinrich Stadial 1 (HS1) (~18.5-15 ka). Meier et al. have collected several data sets based on biomarkers, foraminifer and sedimentary geochemistry. This very comprehensive approach clearly shows that HS1 can be considered an exceptional period during the last deglaciation. During HS1, they described pronounced hydroclimatic gradients leading to an extreme climate characterized by oceanic warming, extreme precipitation, and subsequent nutrient input.

The relation between terrestrial input and deep ocean properties during the last glacial on the Brazilian margin is shown by Suarez-Ibarra et al. They combined micropaleontological (benthic and planktonic foraminifera, ostracods), geochemical (stable carbon isotopes on benthic foraminifera), and sedimentological (carbonate and bulk sand content) data in order to link insolation to sea surface productivity and how the subsequent marine snow effects deep-sea carbonate dissolution. This study nicely shows that our knowledge in benthic-pelagic coupling is still somewhat limited.

The origin of deep-sea sediments on continental slopes is an important topic for the reconstruction of past climates. In their study, Sousa et al. use rare earth elements (REE) to identify the sources of deep-sea sediments. Their data clearly show that rivers can be the main source of REE in sediments of the western South Atlantic and that Fe minerals produced by continental weathering can be the major carriers of REE.

Deep-sea sediments on continental margins not only contain detrital material, but also calcareous organisms such as benthic foraminifera that have been investigated by Saupe et al. Along three subtropical transects the authors show that benthic foraminiferal assemblages are controlled by hydrodynamic conditions opening the opportunity to reconstruct current regimes with benthic foraminifera. In addition, benthic foraminifera are also influenced by the quantity and quality of organic matter flux as well as substrate properties.

Between the deep-sea and the surface, strong currents often prevent a continuous sedimentation and therefore paleoceanographic reconstructions are limited or even lacking. One possibility to circumvent this problem is to use cold-water corals (CWC). Endress et al. studies the scleractinian CWC *Solenosmilia variabilis* from the Bowie Mound as an archive for temperature reconstructions using Li/Mg ratios. They show that, especially during periods of Northern Hemisphere cooling such as HS4 and HS6, the intervening water masses warmed significantly, which may provide evidence for bipolar seesaw dynamics.

Overall, this set of studies improves our understanding on the interrelations between the terrestrial and marine realms on the Brazilian continental margin. They especially stress the importance of ITCZ and SACZ dynamics during Heinrich Stadials fostering new conceptual models while strengthening research synergies across various disciplines.

Author contributions

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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