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Hydrographic changes along the western Iberian margin: The need to reconstruct and understand regional climate responses for glacial climate record integration

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The western Iberian margin is a key region for studying glacial abrupt climate change events because its surface water signals reflect oxygen isotope and temperature variations recorded in the Greenland ice core records while its deep water – below 3000 m – changes follow the Antarctic ice core climate curves (e.g., Shackleton et al., 2000; Paleoceanogr.) allowing for interhemispheric comparisons. In addition, the southern edge of the North Atlantic's ice-rafted debris (IRD) belt, the so called Ruddiman belt, intercepts with the margin. During major ice-rafting events, i.e. the Heinrich events, this southern limit is associated with the Polar Front (e.g., Eynaud et al., 2009, GCubed).

Here we present planktonic stable isotope, IRD, % N. pachyderma (s), and sea surface temperature records covering the last 50 ka for a latitudinal core transect along the western Iberian margin. The transect spans from core SU92-03 at 43°N via core MD95-2040 at 40.5°N and cores MD95-2042, -2041 and MD01-2444 at 38°N to core MD99-2339 at 36°N in the central Gulf of Cadiz. By combining the records of these cores we are able to establish gradients in intensity and duration – assuming that our age models are correct – of the millennial-scale climate variability typical for Marine Isotope Stage 3. The data clearly reveals that a boundary, most likely linked to the southern limit of the IRD belt, existed at about 39°N (Salgueiro et al., in press; QSR). North of this boundary cooling/ ice-rafting events had a stronger impact than south of it with % N. pachyderma (s) levels during most Heinrich event exceeding 80%, while off Sines at 38°N only 55% are reached during Heinrich event 4 and in the central Gulf of Cadiz just 16%. This reduction in % N. pachyderma (s) clearly highlights the reduced impact of the Polar Front and the associated subpolar waters the further south a site is located. From the northern sites, core MD95-2040 has the higher resolution and its records show that each cooling event – Heinrich events and Greenland stadials (GS) – led to significant cooling including IRD deposition. In comparison to the southern sites, especially to MD99-2339 at 36°N, cooling episodes lasted longer, mainly because cooling started earlier in the north, in agreement with the Polar Front reaching this region first. Comparison between cores MD01-2444 (38°N) and MD99-2339 (36°N) reveals that for most of MIS 3 their temperature evolution was similar, including no cooling associated with GS 11. However, impacts of some events differed between the sites. Thus GS 12 led to >5°C cooling at the Sines site, but had no impact in the central Gulf of Cadiz and GS 10, 9, and 7 and to a lesser extend also Heinrich event 4 had a stronger temperature response at 38°N than at 36°N.

The differences in the climatic response along our core transects clearly reveal that on the western Iberian margin – and in other regions where positions of atmospheric and hydrographic fronts varied strongly with the abrupt climate change events – more than one site is needed to understand the full spectrum of the climate change and to potentially trace response delays because these delays will play an important role in integrating marine records not just between themselves but also with ice core and terrestrial records.