LINKAGES BETWEEN NORTH ATLANTIC SURFACE WATER CIRCULATION PATTERNS AND MEDITERRANEAN OUTFLOW VARIABILITY ON THE WESTERN IBERIAN MARGIN: EXAMPLES FROM MARINE ISOTOPE STAGES 3 AND 12 TO 10

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The Mediterranean Outflow (MOW) plays a major role in shaping the hydrography and sedimentological patterns within its flow depth (500-1400 m) along the western Iberian margin. Several studies along the southern margin showed that the MOW flowed at greater depths – as deep as 2000 m – during the last glacial maximum (LGM; ca. 21 ka ago). In order to understand the MOW's response to millennial-scale climate variability (Dansgaard-Oeschger cycles) during the last 50 ka, we performed a multi-proxy study on IMAGES core MD99-2339 from 1200 m water depth in the western Gulf of Cadiz; a site which today is marginally influenced by the lower MOW core. During the glacial interval covered by the sediment sequence (47 to 12 ka ago; MIS 3-2), the grain size and physical property records reveal periodic occurrences of contouritc layers indicating a strengthening of the bottom water current (Voelker et al., 2006; EPSL). Intensification of the deeper MOW core was contemporary with cooling of the surface waters in the Gulf of Cadiz and in the western Mediterranean Sea and with colder temperatures above Greenland, i.e. stadial periods. They, furthermore, coincided with increased Western Mediterranean Deep Water (WMDW) formation in the Gulf of Lions (Sierro et al., 2005; Paleoceanography). The coupling between WMDW formation and deeper MOW flow strength was so tight that even the short-termed cessations of WMDW formation due to Heinrich event related incursions of fresh, subpolar surface waters into the western Mediterranean Sea led to a reduction in MOW flow strength. Incursions of subpolar surface waters, however, were short and also occurred only during parts of the Heinrich events. In general, temperate to subtropical surface waters prevailed in the western Gulf of Cadiz indicating a persistent influence of the Azores current and its paleo-counterpart and thus a strong coupling to the North Atlantic's subtropical gyre circulation.

Further back in time (480 – 330 ka ago) evidence for MOW variability on the mid-depth western Iberian margin is arising from Calypso core MD03-2699 retrieved at 1900 m water depth from the western edge of the Estremadura Spur north of Lisbon. The time interval discussed encompasses the most extreme glacial period of the last 800 ka, MIS 12 (475 – 420 ka, and interglacial MIS 11.31 (408 – 396 ka), which is often seen as a potential "analog" for the current interglacial. Today and during the MIS 11 interglacial period the study site is/ was under the influence of North Atlantic Deep Water (NADW). After 396 ka, however, when continental ice built-up increased and climate started to deteriorate, the benthic stable isotope values at site MD03-2699 begun to diverge from known NADW records. The excursions to lighter benthic $\delta^{18}O$ values – indicating a warmer and/ or less saline water mass – were accompanied by grain size maxima (increased bottom current strength) and often also coincided with cold spells in the surface waters. As this scenario is so similar to the pattern observed in the Gulf of Cadiz during MIS 3, the benthic isotope and grain size records are interpreted as a deepening of MOW to water depths similar to the LGM and thus an increased MOW influence at the study site. Grain size maxima also occurred during the glacial maxima of MIS 12 and 10, but the isotope evidence is not so conclusive. Terminations 5 and 4 – the transitions from MIS 12 to 11 and 10 to 9, respectively – are, on the other hand, marked by $\delta^{18}O$ minima that could be linked to a warmer (MOW?) intermediate depth water mass. Trace element analyses on benthic foraminifera shells are currently done to reconstruct bottom water temperatures that should help in the future to distinguish between MOW and NADW/ LSW related signals.

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