Geophysical Research Abstracts,
Vol. 11, EGU2009-7211-3, 2009
EGU General Assembly 2009

The Mediterranean Sea: physical and ecological processes and their significance in a global perspective

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The Mediterranean Sea is involved in global processes by (1) water exchange with the open ocean and (2) by recording at an enhanced sensitivity (and hence, amplitude) climatic developments of the wider North Atlantic and African monsoon domains. Palaeoceanographic studies have demonstrated the Mediterranean´s role in and response to global climate changes of the past. Fine-scale records of surface water variability directly mirror the variability of North Atlantic climates as seen in Greenland ice cores, some extending the palaeoclimatic profiles beyond the reach of the ice cores and alluding to the close linking with the Atlantic MOC. From the biological point of view, though the modern Mediterranean is generally characterized by low primary productivity and organic-deficient sediments, the late Pleistocene deposition of sapropels (organic carbon- rich sediment layers) demonstrates that dramatically different conditions periodically occur and coincide with changes in global and regional climate.

One aspect of Mediterranean palaeo-research is focussing on the outflow of salty waters (Mediterranean Outflow Water, MOW) as this affects the haline budget of the upper North Atlantic with potential consequences for the Meridional Overturning Circulation (MOC). Under glacial conditions the MOW settled at greater depths, below 1.6 km, hence not significantly influencing the deep overturning in the North Atlantic. Shoaling and strengthening of the MOW during the glacial-interglacial transition then potentially provided momentum for shifting the Atlantic MOC to its interglacial mode, possibly in conjunction with increased salt imports from inter-ocean transport through the Indian-Atlantic ocean gateway in the south.

Importantly, sapropels constitute test cases for assessing the response of the Mediterranean´s oceanography and ecology to orbitally driven fluctuations in the (African) summer monsoon, via enhanced river discharge along the North African margin. Instructive in this respect are the records for the last interglacial period when a distinct maximum in the boreal summer insolation triggered a dramatic monsoon-fuelled freshwater flooding centred on the open eastern Mediterranean. This positive shift in the basin's freshwater budget led to collapse of the deep water circulation and substantial weakening of the intermediate water formation, with oxygen depleted conditions extending towards the photic layer. This hydrographic change, possibly complemented by enhanced export of primary productivity to the seafloor, resulted in very high organic carbon concentrations (sapropel 5) in the eastern Mediterranean deep-sea records.

The above suggests that Mediterranean sediment records are key to unraveling past large (hemispheric) scale climate reorganizations. In addition, this basin represents a natural laboratory to advance our understanding on the ecosystem dynamics in the open ocean. Concerning the Mediterranean contribution to global ocean changes, however, evidence is still sparse and emphasis must be on the role of the MOW in the MOC, notably the abrupt resumptions of the Atlantic MOC that marked the end of perturbed states during the last glacial cycle.