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A model/proxy comparison study of the upper ocean climate of the Mediterranean: focus on the Holocene Insolation Maximum and the Last Glacial Maximum

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The Mediterranean region used to experience strong climate fluctuations in the past, well recorded by marine sediments. To assess the impact of the "Holocene Insolation Maximum" and the "Last Glacial Maximum" on the Mediterranean sea ocean climate, we use a regional ocean general circulation model forced by atmospheric input derived from global simulations.

Focusing first on the 9000 years BP time slice or "Holocene Insolation Maximum", this modeling study analyzes the change of the eastern Mediterranean upper-ocean hydrography under climate conditions with higher seasonal cycle of insolation rate. We investigate the patterns characteristic for this type of climate and validate the results from our simulations for the early Holocene with sea surface temperatures reconstructed from abundance of foraminifera in marine sediment cores. The stronger seasonal cycle is reproduced by the model which shows a relatively homogeneous winter cooling and an enhanced near-surface vertical temperature gradient during summer. The resulting temperature anomalies show a warming at the surface and a cooling at depth. This makes the comparison with proxy-derived temperature estimates non-trivial. The traditional approach to compare SST reconstruction and model is likely to be inappropriate. A model data comparison should take the preferred living-depth habitat of the foraminifera used for the reconstructions into account.

The comparison of modeled SST and reconstructions does indeed show large discrepancies. Using vertically integrated temperatures (0 - 30 m) improves the agreement between model and proxy-derived summer temperatures. In winter the vertical temperature gradient is very small and thus the results are not very sensitive to the depth considered.

For the Last Glacial Maximum, the model reproduces essentially the reconstructed pattern with slight cooling in the Levantine and strong cooling in the Gulf of Lion (maximal in summer), but the model slightly underestimates the horizontal temperature gradient. The summer temperature signal in the Gulf of Lion shows a strong depth dependence.