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The response of Mediterranean thermohaline circulation to climate change: a minimal model

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Abstract. Physics-based understanding of the effects of paleoclimate and paleogeography on the thermohaline circulation of the Mediterranean Sea requires an ocean model capable of long integrations and involving a minimum of assumptions about the atmospheric forcing. Here we examine the sensitivity of the deep circulation in the eastern Mediterranean basin to changes in atmospheric forcing, considered a key factor in the deposition of organic-rich sediments (sapropels). To this extent we explore the setup of an ocean general circulation model (MOMA) with realistic (present-day) bathymetry and highly idealized forcing. The model proves able to qualitatively capture some important features of the large-scale overturning circulation, in particular for the eastern basin. The response to (i) a reduction in the imposed meridional temperature gradient, or (ii) a reduction in net evaporation, proves to be non-linear and, under certain conditions, of transient nature. Consistent with previous model studies, but now based on a minimum of assumptions, we find that a reduction in net evaporation (such as due to an increase in freshwater input) may halt the deep overturning circulation. The ability to perform long model integrations allows us to add the insight that, in order to have the conditions favourable for sapropel formation persist, we must also assume that the vertical mixing of water properties was reduced. The "minimal" model here presented opens the way to experiments in which one truly follows the basin circulation into, or out of, the period of sapropel formation and where forcing conditions are continously adjusted to the precession cycle.

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