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Biogeochemical changes in the eastern Mediterranean Sea during the early Holocene

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During the early Holocene, a series of changes in the conditions of the Mediterranean hydrography, and corresponding its biogeochemistry, occurred. This led to the formation of sapropels, which are the result of an increased accumulation of organic matter that has been attributed to a better preservation of organic carbon due to oxygen depletion and/or to higher biological production that enhances the carbon flux to the seafloor. This study aims to identify plausible scenarios leading to sapropel formation.

For this purpose, we set up a regional version of the general ocean circulation model MPI-OM for the Mediterranean (26 km horizontal resolution, 29 levels) coupled to the biogeochemical model HAMOCC. The model is forced with atmospheric data derived from equilibrium time slice simulations for pre-industrial conditions and 9000 B.P with the atmosphere-ocean-dynamical vegetation model ECHAM5/MPI-OM/LPJ. For the identification of scenarios leading to sapropel formation, we simulated a 9 kyr B.P. baseline simulation and two sensitivity experiments, one with enhanced riverine nutrient input and one with stagnating deep water circulation.

Results show that a 3x increase in riverine nutrient input leads to an enhanced particulate organic carbon export production. The corresponding increased oxygen utilization, however, is not sufficient to induce an anoxic state. In the stagnating deep water circulation perturbation experiment there is no further ventilation of the deep water, while the continuous utilization of oxygen through organic matter reminearlization stays unvaried. When extrapolating the oxygen utilization rate, it would take millennia to reach an anoxic state, which suggests that the onset of the stagnating deep water circulation was during the period of deglaciation.

In the future experiments we will test both a combination of the stagnating deep water with enhanced riverine nutrient input, as well as the initialization with glacial conditions.