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The effect of abrupt climate changes and climate background conditions in Southern Europe during the last glacial

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The last glacial period is characterized by abrupt and large temperature shifts in Greenland and the North Atlantic realm. Pollen and sediment data from Lago Grande di Monticchio (MON) have demonstrated a clear imprint of these fluctuations operating at millennial time-scales. Interestingly, basic mean environmental condition changes with respect to temperature and precipitation occurred during MIS4, separating warm and dry conditions during MIS5 from relatively cold and humid conditions within MIS3. This general climate background shift is superposed by distinct millennial-scale variability at MON.

Using a fully coupled atmosphere-ocean general circulation model applying boundary conditions at 32 ka BP and pre-industrial conditions as a surrogate for MIS3 and MIS5, we have simulated and analysed characteristic changes in Southern Europe during the last glacial. We find that changes in the mean state at MON are mainly related to a partial shift of the North Atlantic deep water (NADW) convection sites from the Nordic Seas to South of Iceland, the presence of the Fennoscandian ice sheet and lower greenhouse gas concentrations. These background characteristics provide the basis for enhanced zonal moisture transport from the eastern North Atlantic to Middle and Southern Europe. Furthermore, simulations of abrupt climate change scenarios show that a deactivation of the convection sites South of Iceland during MIS3 leads to cooler and dryer conditions at MON. Such temperature and precipitation changes are thought to provide a counter-acting effect on woody vegetation and associated pollen signals at MON. This is in contrast to the impact of abrupt climate perturbation scenarios during MIS5, where no significant precipitation changes are detected. Hence, the simulated changes and underlying mechanisms are largely consistent with the recorded proxy evidence with respect to both, mean state and millennial-scale changes.