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Modelling the effect of large climatic changes over the Mediterranean on the Atlantic thermohaline circulation

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We investigate the impact of large changes to the surface freshwater fluxes (evaporation and precipitation) over the Mediterranean Sea, on the rate of exchange through the Strait of Gibraltar and on the structure of the thermohaline circulation in the Atlantic. The simulations were performed with a global Ocean General Circulation Model of a 2.25° by 3o resolution, which enables long-term climate simulations, whilst still resolving the seawater exchange between the Mediterranean and the Atlantic and producing a realistic exchange rate through the Strait of Gibraltar. A complete "shutdown" of the Mediterranean Outflow (MO) into the Atlantic has not produced any significant change to the North Atlantic Meridional Overturning Circulation (MOC) rate. This result supports a number of recent observational and modelling works that disprove the conventional belief that the Mediterranean water plays a crucial role in maintaining deep-water formation in the North Atlantic by contributing a source of salty water directly to the convection sites. Simulations of an extreme "wetter" Mediterranean, in which the precipitation rate exceeds the evaporation loss and net freshwater gain is approximately double the rate of today's loss, results in a reversal of the present-day circulation and drives an estuarine circulation in the Strait of Gibraltar. The relatively fresh Mediterranean outflow at the surface was found much less effective in weakening the MOC rate than a similar freshwater discharge, when located closer to the deep-convection sites. Extreme dry climate over the Mediterranean leads to a very strong and salty (>44) Mediterranean Outflow, which, despite transporting more than 10x106 kg s-1 of salt into Atlantic, has a very limited impact on the NADW production rate. However, the model clearly shows that this enhanced

MO contributes to the southward flow of the NADW into the South Atlantic and the Southern Ocean and therefore influences the thermohaline structure in these locations.