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European moisture fluxes during the Last Glacial Maximum

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In recent years, several works have explored the role played by Atmospheric Rivers (ARs) in the occurrence of extreme precipitation events in Europe under current climate conditions. ARs are relatively narrow regions responsible for anomalous integrated water vapor transport (IVT), contributing to the moisture transport and convergence to a particular area, thus enabling one of the pre-conditions for heavy precipitation.
The question arises on the role of ARs for extreme precipitation under different climate conditions. We examine a 30-year climatology of the IVT in the North Atlantic during the Last Glacial Maximum, using a dynamically downscaling with the Weather Research and Forecast Model (WRF), using boundary conditions from the MPI-ESM-P global model. Simulations (Ludwig et al., 2017) considering distinct greenhouse gas concentration, orbital parameters, sea level and ice sheets realms were conducted for two distinct time periods: 1) Pre-Industrial period (PI); 2) Last Glacial Maximum (LGM). For the LGM, two different Sea Surface Temperature (SST) settings were considered, including the Multiproxy Approach for the Reconstruction of the Glacial Ocean surface (MARGO). This revised data significantly reduces model biases in European temperature and precipitation patterns, since most unrevised GCM simulations overestimate SSTs. Pre-Industrial simulations were compared to present climate reanalysis from the NCEP and ERA-Interim datasets.
Results show a decrease of the mean IVT over the UK in the MARGO simulation, associated with the revised lower SST in this area, which presents its maximum difference southwest of this region. As a result, unrevised SST based IVT fluxes towards the UK tend to be higher. Nevertheless, these differences are small in magnitude when compared to the differences between the PI and LGM simulations (considering both revised and unrevised SST versions). During the glacial period, IVT fluxes towards the European continent were significantly smaller throughout the year. The areas of larger differences follow the meridional solar cycle, and are primarily relevant for Southwestern (Northwestern) Europe during winter (summer).
The IVT fluxes along regional coastlines were compared for the different periods in: 1) Iberian Peninsula; 2) France; 3) UK; 4) Scandinavia. This analysis demonstrates that the PI simulation has a positive bias when compared to the NCEP and ERA-Interim reanalysis, and confirms the significantly reduced western moisture flux towards Europe during the LGM. Very low moisture fluxes towards northern Europe (particularly in Scandinavia) during the LGM illustrate the striking impact of the extensive ice sheet on the European climate, its feedback with reinforced blocking at high latitudes, and a consequent southern migration of the Jetstream and cyclone activity.

Ludwig P, Pinto JG, Raible CC, Shao Y (2017), Impacts of surface boundary conditions on regional climate model simulations of European climate during the Last Glacial Maximum, Geophys. Res. Lett., 44, 5086–5095, doi:10.1002/2017GL073622

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