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Coordinated changes in the hydroclimate of the last 1000 years

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This work analyses the evolution of hydroclimate during the last millennium, based on data from climate simulations and reconstructions, with the aim of identifying coordinated responses in different regions. The Medieval Climate Anomaly (MCA; ca. 950-1250) and the Little Ice Age (LIA; ca. 1450-1850) were characterized by temperature changes in many regions of the world, partially explained by changes in external forcing. However, it is unclear whether analogous coordinated changes existed in hydroclimate.

To assess the response of hydroclimate at interannual to multicentennial scales, last millennium simulations from the Paleoclimate Model Intercomparison Project (PMIP3/CMIP5) have been analysed. In particular, simulated temperature, surface wind, sea level pressure, precipitation and soil moisture have been used to perform epoch and principal component analyses and comparisons of composites for the MCA and LIA. These analyses show coordinated changes in several regions, mainly in extratropical areas that could be affected by expansions and contractions of the Hadley cell and latitudinal displacements of westerlies.

Similar analyses have been performed with the information provided by three drought atlases, gridded datasets based on tree-ring reconstructions for Europe (OWDA), North America (NADA) and Asia (MADA). Even if drought atlases for other regions exist, these are the only ones that span over most of the last millennium. As the drought atlases do not provide global coverage, the simulations have been masked to the spatial regions of the atlases. This allows for a more meaningful comparison of temporal and spatial patterns of reconstructed drought and simulated soil moisture during the last millennium. Results support the existence of large-scale coordinated hydroclimate changes in both simulations and reconstructions, with a consistent spatial pattern of large-scale hydroclimate variability. However, the simulated temporal responses suggest an influence of external forcing that is not evident in the drought atlases.