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Impacts of external forcing and internal variability on the evolution of hydroclimate during the last millennium

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Evidences from climate reconstructions and model simulations show that climate experienced important changes during the Last Millennium (LM). These changes can be associated with external forcing factors, such as cycles of solar activity, changes in the concentration of greenhouse gases in the atmosphere, volcanic eruptions, changes in orbital parameters, or changes in the land use and land cover, or with a redistribution of energy as part of climate internal variability. Both external forcing and internal variability contributed to alter temperatures, ice extent and atmospheric dynamics, with impacts on the hydroclimate in different parts of the world. The LM was characterised by a period of higher radiative forcing during the Medieval Climate Anomaly (MCA; ca. 950-1250), a period of lower radiative forcing during the Little Ice Age (LIA; ca. 1450-1850), and a rapid increase of the radiative forcing during the industrial era.

This work analyses simulations of the LM from the Paleoclimate Modelling Intercomparison Project (PMIP3 and PMIP4); grids of reconstructed data based on tree rings from the Drought Atlases of Europe (OWDA), North America (NADA) and Asia (MADA); data assimilation-based products like the Paleo Hydrodynamics Data Assimilation product (PHYDA) and the Last Millennium Reanalysis (LMR); as well as individual reconstructions based on tree rings, marine and lake sediments, speleothems, ice cores and documentary information, with the main objective of analysing the hydroclimate variability from interannual to multicentennial timescales from a global perspective, how these changes impacted tropical and extratropical regions, their relation to changes in temperatures and atmospheric dynamics, and the impact of external forcing and internal variability on their occurrence.

These analyses show coordinated changes in the hydroclimate of separate regions, both in extratropical and in tropical areas. These changes can be linked in extratropical areas to alterations of extratropical modes like the North Atlantic Oscillation (NAO), the Northern Annular Mode (NAM) and the Southern Annular Mode (SAM) and in tropical areas to alterations of the Intertropical Convergence Zone (ITCZ).

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