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Comparison of simulations and reconstructions of the past hydroclimate

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The evolution of the past climate can be mainly assessed with information from climate simulations and from reconstructed data. Climate simulations allow to analyse global phenomena with a large number of variables that constitute a complete representation of the climate state. However, they are affected by large uncertainties, due to limitations in the realism of the physical models, errors in the reconstructions of external forcing used as boundary conditions, and to the role of internal variability in the evolution of climate. Reconstructions provide information about the actual evolution of past climate, but they also have uncertainties due to errors in the proxy data, their partial representation of past climate, calibration uncertainties and the fact that they are only available for certain regions. To achieve robust conclusions about the mechanisms defining the evolution of hydroclimate, both simulations and reconstructions are therefore needed.

In this work, information from the last millennium simulations of the Paleoclimate Model Intercomparison Project (PMIP3/CMIP5) and from the reconstructed drought atlases for Europe (OWDA), North America (NADA) and Asia (MADA) has been analysed, to assess the evolution of hydroclimate in different regions and how external forcing and internal variability may have influenced changes in past drought. In particular, principal component and epoch analyses have been performed, to identify the modes of variability existing in model simulations and reconstructed data, and to analyse the reponse of hydroclimate after volcanic events. The results of these analyses show that long-term trends in hydroclimate in response to external forcing clearly appear in most of the model simulations, while they are not so clear in the reconstructed data. The alteration of hydroclimate as a result of volcanic events is present both in model simulatons and in reconstructed data, but the magnitude of this alteration differs. The combination of both sources allows to obtain a more complete view of the physical mechanisms defining the evolution of hydroclimate. Model simulations suggest an intercontinental response to external forcing, with discernible long-term trends during the last millennium. Drought reconstructions do not show a long-term response to external forcing, but they also show large-scale intercontinental changes.