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Modelling Holocene climate trends: A model intercomparison

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For the paleomodel intercomparison, we compared the results from scenarios with identical forcing for the mid-to-late Holocene period: varying Earth's orbital parameters, fixed level of greenhouse gas concentrations, fixed land-sea mask and orography. 18 paleoclimate modelling groups are involved in this initiative, working on transient Holocene simulations. One major issue of both the modelling and reconstruction side were the quantification of uncertainties, and the evaluation of trend and variability patterns beyond a single proxy and beyond a single model simulation. The goal is to obtain robust results of trend patterns, seasonality changes, as well as transitions on a regional scale.

The major objective is to investigate the spatio-temporal pattern of temperature and precipitation changes during Holocene as derived from integrations with a set comprehensive global climate models (GCMs), Earth system models of intermediate complexity (EMICs), as well as conceptual-statistical models. In the conceptual-statistical model by Laepple and Lohmann (2009) a rigorous simple concept is proposed: The temperature response on astronomical timescales has the same function as the response to seasonal insolation variations. The general pattern of surface temperatures in the models shows a high latitude cooling and a low latitude warming. Our analysis shows common patterns of temperature changes, especially for the respective summer seasons. This is a common feature for all model considered. Due to strong differences in atmospheric dynamics and sea ice, we find significant differences in the winter patterns. The precipitation trends show a clear difference between GCMs and EMICs mainly because the treatment of the hydological cycle in the tropics. Most models show a southward movement of the ITCZ. Using statistical analysis of the model variability modes and their amplitude during the Holocene, we reveal a strong heterogeneity in temperature and precipitation pattern and no common response in trend and variability, although a tendency towards NAO- and SOI- (El Nino-like) is detected.

Our approach is to obtain, through ensemble runs for climate model output, a range of solutions that can be then compared and evaluated for their consistency with the range of uncertainty given by the palaeoclimate proxies. This approach allows a much more congruent way of comparison between proxy data and model result because both investigations will provide a range of possible climate change where the errors in the estimates are accounted for. We compare the ocean temperature evolution of the Holocene as simulated by climate models and reconstructed from marine temperature proxies. Independently of the choice of the climate model, we observe significant mismatches between modelled and reconstructed amplitudes in the trends for the last 6000 years.