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A model-data comparison of the Holocene global sea surface temperature evolution

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We compare the ocean temperature evolution of the Holocene as simulated by climate models and reconstructed from marine temperature proxies. We use transient simulations from a coupled atmosphere-ocean general circulation model, as well as an ensemble of time slice simulations from the Paleoclimate Modelling Intercomparison Project. The proxy dataset comprises a global compilation of marine alkenone- and Mg/Ca-derived sea surface temperature (SST) estimates. Independently of the choice of the climate model, we observe significant mismatches between modelled and estimated SST amplitudes in the trends for the last 6000 yr. Alkenone-based SST records show a similar pattern as the simulated annual mean SSTs, but the simulated SST trends underestimate the alkenone-based SST trends by a factor of two to five. For Mg/Ca, no significant relationship between model simulations and proxy reconstructions can be detected. We tested if such discrepancies can be caused by too simplistic interpretations of the proxy data. We therefore considered the additional environmental factor changes in the planktonic organisms' habitat depth and a time-shift in the recording season to diagnose whether invoking those environmental factors can help reconciling the proxy records and the model simulations. We find that invoking shifts in the living season and habitat depth can remove some of the model-data discrepancies in SST trends. Regardless whether such adjustments in the environmental parameters during the Holocene are realistic, they indicate that when modeled temperature trends are set up to allow drastic shifts in the ecological behavior of planktonic organisms, they do not capture the full range of reconstructed SST trends. These findings challenge the quantitative comparability of climate model sensitivity and reconstructed temperature trends from proxy data.