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The Eemian climate simulated by two models of different complexities

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The Eemian period, also known as MIS-5, experienced warmer than today climate, reduction in ice sheets and important sea-level rise. These interesting features have made the Eemian appropriate to evaluate climate models when forced with astronomical and greenhouse gas forcings different from today. In this work, we present the simulated Eemian climate by two climate models of different complexities, LOVECLIM (LLN Earth system model of intermediate complexity) and CCSM3 (NCAR atmosphere-ocean general circulation model). Feedbacks from sea ice, vegetation, monsoon and ENSO phenomena are discussed to explain the regional similarities/dissimilarities in both models with respect to the pre-industrial (PI) climate. Significant warming (cooling) over almost all the continents during boreal summer (winter) leads to a largely increased (reduced) seasonal contrast in the northern (southern) hemisphere, mainly due to the much higher (lower) insolation received by the whole Earth in boreal summer (winter). The arctic is warmer than at PI through the whole year, resulting from its much higher summer insolation and its remnant effect in the following fall-winter through the interactions between atmosphere, ocean and sea ice. Regional discrepancies exist in the sea-ice formation zones between the two models. Excessive sea-ice formation in CCSM3 results in intense regional cooling. In both models intensified African monsoon and vegetation feedback are responsible for the cooling during summer in North Africa and on the Arabian Peninsula. Over India precipitation maximum is found further west, while in Africa the precipitation maximum migrates further north. Trees and grassland expand north in Sahel/Sahara, trees being more abundant in the results from LOVECLIM than from CCSM3. A mix of forest and grassland occupies continents and expand deep in the high northern latitudes in line with proxy records. Desert areas reduce significantly in Northern Hemisphere, but increase in North Australia. Tropical Pacific sea-surface temperature (SST) annual cycle, modeled by CCSM3, suggests a minor shift towards an El Nino. However, the SST variability in our LOVECLIM simulations is particularly small due to the overestimated thermocline's depth. The simulated large-scale climate change during the Eemian compares reasonably well with proxy data, giving credit to both models and climate reconstructions.

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