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The Holocene perspective of Northern Hemisphere temperature evolution

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The average surface air temperature of the globe has increased by about 0.5°C since the middle of the nineteenth century. Regarding the climate changes observed during the 20th century, it is of particular importance to identify and quantify the environmental changes to put the recent warming in relationship with the natural climate variations at different timescales. Considering the relatively short period of the available instrumental data, the use of paleoclimate records in combination with model simulations proves to be very useful for the estimation of past climate variability. Here we analyse the Holocene temperature evolution of the past 6000 years as well as the recent and projected future climate evolution. For our analysis, we use the output of an ensemble of general circulation models for the mid-Holocene (PMIP II project) and for recent and projected future (CMIP 3 project), complemented by transient simulations over the mid-to-late Holocene. The model data are also compared to observations and proxy data. The general structure of the Northern Hemisphere appears to have a “Hockey Stick” shape: The Northern Hemisphere cooling during the mid-to-late Holocene (neoglaciation) has been partly compensated during the past century. The reason for the Holocene trend lies in the astronomical forcing in conjunction with climate feedbacks whereas the recent and projected future warming trend can be attributed to anthropogenic influence on greenhouse gas concentrations in the atmosphere plus climate feedbacks. It is important to detect regional differences: At low latitudes and over large parts of the open ocean, the present climate is already warmer than that of the mid-Holocene during boreal summer, whereas at mid and high latitudes (especially over land and parts of the Arctic Ocean) the mid-Holocene values will be reached within the next 20-80 years. Seasonality and regional circulation and temperature anomalies are discussed. It is argued that the Holocene hockey stick appears as a robust feature in models and data, much easier to interpret than the time evolution covering the last millennium when the relative importance of the forcing factors and internal variability is less known.