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Controls on fire activity simulated for the last 6000 years – fuel availability versus fuel moisture

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Fire is an important natural disturbance factor, which significantly impacts vegetation dynamics. Fire activity depends on climate and information on fire history can, as such, be interpreted in climatic terms. However, the fire-climate relationship is often highly non-linear, as fire occurrence is controlled via several climate controlled factors, such as fuel availability and fuel moisture. Higher drought stress, for example, will decrease fuel moisture but can also impact fuel availability. In more recent times, fires are in addition strongly influenced by anthropogenic factors, which might mask any given natural fire-climate relationship.

Here we present results from a process-based fire model (Arora and Boer, 2004) implemented into the vegetation model JSBACH as part of the Earth System Model of the Max Planck Institute for Meteorology (MPI-ESM). The model is forced with meteorological data from a fully coupled simulation of the MPI-ESM covering the last 6000 years, which show a small decrease of the surface temperature and a decline in precipitation. The resulting land carbon storage undergoes a significant decrease. Due to the changes in the orbital parameters with time, regionally the effect on precipitation and temperature is stronger, which results in a shift of the tropical rain belt combined with changes in vegetation. Striking is for example a reduction in the vegetation cover in central East Asia over the last 6000 years with a subsequent decreasing trend in land carbon storage.

Simulated changes in fire activity are compared paleo fire reconstructions. In addition, we used the model for sensitivity experiments in which we keep either fuel availability or fuel moisture constant. This factor separation study allows us to interpret the fire-climate relationship in terms of the dominant driving forces.