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Fire and ice: a comparison of interglacial fire activity within the MPI-ESM and ice core proxies

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One of the controlling factors of net ecosystem exchange that is highly sensitive to changes in climate is fire activity. A model study to describe these controlling factors is validated using multiple proxies to understand fire activity on a continental scale. We present results form a transient integration with the fully coupled Earth System Model (ESM) ECHAM5/MPI-OM1/JSBACH of the Max-Planck-Institute for Meteorology covering the last 6000 years. The model comprises dynamical components for atmosphere, ocean, and biosphere including an approach to simulate fire dynamics. The simulation is analyzed with a focus on land carbon and fire dynamics. A range of observational products are used to constrain the models ability to simulate fire distribution and changes in fire regimes over the course of the last 6000 years.

On the global land scale, the model run shows a small decrease of the global mean temperature and a decline in annual precipitation. For the land carbon storage there is 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. Related to climatic changes the fire activity is changing as well. We simulate a reduction of 5% in annual global burned area within the last 6000 years. Regionally, the simulation points out trends in the fire activity corresponding to the changes in vegetation shifts: e.g. there is an increase of 15% in central East Asia and a reduction of about 20% in tropical West Africa in burned area mainly a result of the redistribution of fuel abundance.

Simulated changes in fire activity are compared to fire activity records reported in the global charcoal database (Power et al., 2008) and levoglucosan values out of ice cores. As the charcoal data and levoglucosan data show opposite trends, we demonstrate the sensitivity of the modeled and observed trend to the chosen grid boxes of the model domain. Whereas the charcoal sites are biased to North-America and show an opposite trend than the ice-core data from Kilimanjaro, the investigation of levoglucosan data out of remote ice cores (EPICA or NEEM) are additional used to get a global view on the trend in fire activity.