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Evaluation of simulations of the Last Glacial Maximum with fire-enabled vegetation models from the FireMIP intercomparison project

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Fire-enabled vegetation models are an important component of earth system modelling. Understanding the sensitivity of vegetation and wildfire to climate change benefits from out-of-sample experiments, of which the Last Glacial Maximum (LGM; 21 ka BP) is a preferred test. Here, we compared wildfire simulations for the LGM made with four fire-enabled vegetation models using a standardized protocol and driven by a climate-model simulation of the response to known LGM changes in ice-sheet extent, atmospheric composition and insolation. We compare the resulting model output with inferred changes in fire based on charcoal records from the Reading Palaeofire Database (RPD).

All four models show a global decrease in fire at the LGM compared to the present day, consistent with the charcoal records which also record less fire. The simulated change in fire is driven principally by changes in vegetation cover at the LGM, particularly the shift from forest to more open vegetation. The simulated reduction in forest cover is consistent with pollen-based reconstructions of LGM vegetation. Despite this general agreement among models, there are differences between the simulated fire anomalies at a regional scale. The largest differences between the models occur in equatorial Africa, South America and East Asia where the amplitude and spatial extent of regions of increased fire (driven principally by the replacement of tropical trees by grassland); in some regions even the direction of change is not consistent. Comparison of the simulated changes with charcoal records from these regions identifies which model(s) perform best, but also make it clear that there is no one model that simulates observed patterns of change in fire across all of the regions.