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Simulations of historical burned area: A comparison of global fire models in FireMIP

Lina Teckentrup (1), Gitta Lasslop (2), Dominique Bachelet (3), Matthew Forrest (2), Stijn Hantson (4), Fang Li (5), Joe R. Melton (6), Chao Yue (7), Almut Arneth (4), Sandy P. Harrison (8), and Stephen Sitch (9)

(1) Land in the Earth System, Max Planck Institute for Meteorology, Bundesstrasse 53, 20146 Hamburg, Germany, (2) Senckenberg Biodiversity and Climate Research Centre, Frankfurt am Main, Germany, (3) Biological and Ecological Engineering, Oregon State University, Corvallis, OR 97331, USA, (4) Karlsruhe Institute of Technology, Institute of Meteorology and Climate Research, Atmospheric Environmental Research, 82467 Garmisch-Partenkirchen, Germany, (5) International Center for Climate and Environmental Sciences, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, China, (6) Climate Research Division, Environment Canada, Victoria, BC V8W 2Y2, Canada, (7) Laboratoire des Sciences du Climat et de l'Environnement–Institute Pierre Simon Laplace, Commissariat à l'Énergie Atomique et aux Énergies Alternatives (CEA)–Centre National de la Recherche Scientifique (CNRS)–Université de Versailles Saint Quentin, Unive, (8) School of Archaeology, Geography and Environmental Sciences (SAGES) , Reading University, Reading, RG6 6AB, UK, (9) College of Life and Environmental Sciences, University of Exeter, Exeter EX4 4QF, UK

There are large differences in model projections of the response of fire to future climate change; the causes of these differences are being investigated as part of the Fire Model Intercomparison Project (FireMIP). The nine FireMIP models have different magnitude of annual and seasonal global burned area, and in the geographic patterns in burned area. We diagnose the cause of these differences using a series of sensitivity experiments in which the potential individual drivers of fire, specifically CO_2, population density, land-use change, lightning and climate, are kept constant.

CO_2 is shown to either increase burned area due to CO_2 fertilization in fuel-limited regions, or decrease burned area in regions where tree density increases and changes in the hydrological cycle occur. In models where the number of ignitions is linked to population, burned area increases in initially sparsely populated regions. However, in densely populated regions, the effect of anthropogenic ignitions is outweighed by fire suppression and the increased fragmentation of the landscape by anthropogenic land use. The response to land-use change depends on how fires in cropland and pastureland are treated in each model. Only CLM allows fire in croplands; some models treat pastures as if they were natural grasslands, while others suppress fire in pastures. When neither croplands nor pastures are allowed to burn, burned area decreases as a result of land-use change; when pastures are treated as grasslands and allowed to burn, then burned area increases globally. Increasing lightning ignitions are found to increase burned area in regions that are limited by ignitions and aridity or by ignitions and fuel availability. Climate influences burned area directly by changing fire weather and indirectly by changing fuel availability. Changes in CO_2, land use, and population density are important in determining the long-term trends in burned area. Land-use changes and, to a lesser extent, population density are the dominant drivers of these trends. In contrast, variability in lightning ignitions and climate are the cause of interannual differences in burned area.