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Possible future changes in extreme events over Northern Eurasia

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In this study, we investigate possible future climate change over Northern Eurasia and its impact on extreme events. Northern Eurasia is a major player in the global carbon budget because of boreal forests and peatlands. Circumpolar boreal forests alone contain more than five times the amount of carbon of temperate forests and almost double the amount of carbon of the world's tropical forests. Furthermore, severe permafrost degradation associated with climate change could result in peatlands releasing large amounts of carbon dioxide and methane. Meanwhile, changes in the frequency and magnitude of extreme events, such as extreme precipitation, heat waves or frost days are likely to have substantial impacts on Northern Eurasia ecosystems. For this reason, it is very important to quantify the possible climate change over Northern Eurasia under different emissions scenarios, while accounting for the uncertainty in the climate response and changes in extreme events.

For several decades, the Massachusetts Institute of Technology (MIT) Joint Program on the Science and Policy of Global Change has been investigating uncertainty in climate change using the MIT Integrated Global System Model (IGSM) framework, an integrated assessment model that couples an earth system model of intermediate complexity (with a 2D zonal-mean atmosphere) to a human activity model. In this study, regional change is investigated using the MIT IGSM-CAM framework that links the IGSM to the National Center for Atmospheric Research (NCAR) Community Atmosphere Model (CAM). New modules were developed and implemented in CAM to allow climate parameters to be changed to match those of the IGSM.

The simulations presented in this paper were carried out for two emission scenarios, a "business as usual" scenario and a 660 ppm of CO_2-equivalent stabilization, which are similar to, respectively, the Representative Concentration Pathways RCP8.5 and RCP4.5 scenarios. Values of climate sensitivity and net aerosol forcing used in the simulations within the IGSM-CAM framework provide a good approximation for the median, and the lower and upper bound of 90% probability distribution of 21st century climate change. Five member ensembles were carried out for each choice of parameters using different initial conditions. With these simulations, we investigate the role of emissions scenarios (climate policies), the global climate response (climate sensitivity) and natural variability (initial conditions) on the uncertainty in future climate changes over Northern Eurasia. A particular emphasis is made on future changes in extreme events, including frost days, extreme summer temperature and extreme summer and winter precipitation.