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Impacts of Boreal wildfire emissions on Arctic tropospheric ozone: a multi-model analysis

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Observations suggest that the Arctic has warmed rapidly in the past few decades compared with observed global-mean temperature increases. Model calculations suggest that changes in short-lived pollutants such as ozone and aerosol may have contributed significantly to this warming. Arctic tropospheric budgets of short-lived pollutants are impacted by long-range transport of gases and aerosols from Europe, Asia and N. America, but also by Boreal wildfires in summer. Our understanding of how Boreal fires impact Arctic budgets of climate-relevant atmospheric constituents is limited, and is reliant on sparse observations and models of tropospheric chemistry. In particular, the role of Boreal fires in the Arctic tropospheric ozone budget is poorly constrained, and has been the subject of some controversy, with different studies suggesting both minor and major roles for fires as a source of Arctic ozone. A better understanding of Boreal fire influence on Arctic ozone and aerosol is essential for improving the reliability of our projections of future Arctic and Northern Hemisphere climate change, especially in light of proposed climate-fire feedbacks which may enhance the intensity and extent of high latitude wildfire under a warming climate.

Here we use results from the POLARCAT Model Intercomparison Project (POLMIP) and observations collected in the Arctic troposphere as part of International Polar Year in 2008, to evaluate simulated Arctic tropospheric ozone and how it is influenced by Boreal fire emissions in a series of state-of-the-art global atmospheric chemical transport models. By following large plumes exported from Siberian and North American Boreal fire regions in both the models and observations, we show that different models produce a wide range of influence on Arctic tropospheric ozone from fires, despite using identical emissions and having broadly consistent transport patterns. We demonstrate that the different models display highly varied NO_y partitioning and abundances of oxygenated hydrocarbon compounds in air influenced by Boreal fires, with important consequences for ozone production efficiency. We conclude that differences in the treatments of tropospheric chemistry between models are key drivers of diversity in modelled Arctic ozone response to fire emissions, with organic chemistry effects on model NO_y partitioning playing a significant role.