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Projected changes in variability of fire weather in boreal regions under different levels of global warming

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Recent years have seen unprecedented fire activity at Arctic latitudes, leading to severe consequences including unhealthy air quality in high latitude towns and cities. While wildfire occurrence and severity result from a complex interplay between natural and anthropogenic factors, weather is a key factor.

Weather conditions that promote high wildfire risk are characterized by the combination of high temperatures, little precipitation and low humidity, and often high winds. All of these can be affected by human-induced climate change and evidence is emerging that wildfire risk is already increasing in many regions. Such changes not only manifest as shifts in the means and extremes of the weather variables but can also be changes in the shape of their distributions. The importance of the full, regional Probability Density Functions (PDFs) of individual and aggregated variables, which contain information on expected weather not apparent from the distribution mean or tails, but through changes to their overall shape, for understanding climate risk has been broadly discussed in the literature. Furthermore, while simulations with regional climate models to derive such information are costly and time consuming, the advent of large ensembles of coupled climate model simulations has recently opened new opportunities.

Here we present a detailed characterization of the distribution and variability of weather variables conducive to wildfire risk across five high-latitude boreal regions in North America, Scandinavia and Russia. Building on methodology developed in Samset et al. (2019), we quantify the PDFs of daily data for a broad set of individual variables, as well as for the aggregate change expressed using the Canadian Fire Weather Index. Using ensembles of coupled simulations from two climate models (CanESM5 and MPI-ESM1-2) and two CMIP6 scenarios (the Shared Socioeconomic Pathways SSP1-2.6 and SSP5-8.5), we consistently quantify the changes of regionally and seasonally resolved PDFs under different levels of global warming.

Our results provide a comprehensive picture of the potential future changes in drivers of fire weather and wildfire risk in the pan-Arctic region and demonstrate the difference between regions. We also show how statistical descriptions combined with emulation of Earth System Model (ESM) information can offer an alternative pathway to resource demanding model runs, for rapidly translating science to user-oriented information.