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Relevance of wildfires on dust emissions via interaction with near-surface wind pattern

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Mineral dust is a key player in the Earth system and shows diverse impacts on the radiation budget, cloud microphysics, marine and terrestrial ecosystems. Eventually, it also affects our modern way of life. Not only dust emissions from barren or unvegetated soil surfaces like deserts or uncultivated croplands are important sources of airborne mineral dust. Also, during fire events dust is entrained into the atmosphere and appears to contribute noteworthy to the atmospheric dust burden.

The underlying process, which drives dust entrainment during fires, is the so-called pyro-convection. The high temperatures in the center of a fire result in an upward motion of the heated air. Subsequently, air flows towards the fire replacing the raising air. The resulting accelerated winds are able to mobilize soil and dust particles up to a size of several millimeters, depending of both the size and the strength of the fire. Several measurements have shown that up to 80% of the mass fraction of the emitted particles during natural or prescribed fires is related to soil or dust particles. The particles are then mixed externally with the combustion aerosols into the convective updraft and were finally inject into altitudes above the planetary boundary layer where they can be distributed and transported over long distances by the atmospheric circulation.
To investigate the impacts of such fires on the near-surface wind pattern and the potential for dust emissions via exceeding typical threshold velocities, high resolved Large-Eddy Simulations (LES) with the All Scale Atmospheric Model (ASAM) were executed. In the framework of this study, the influences of different fire properties (fire intensity, size, and shape) and different atmospheric conditions on the strength and extent of fire-related winds and finally their relevance for dust emissions were investigated using sensitivity studies.

Prescribed fires are omnipresent during dry seasons and pyro-convection is a mechanism entraining dust particles into boundary layer. As the quantity of dust emitted during fire events is still unclear, the results presented here will support the development of a parameterization of fire-related dust entrainment for meso-scale models. This will allow an estimation of such fire-related dust emissions on a continental scale and can finally reduce the uncertainty in the aerosol-climate feedback.