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New insights into physical and chemical atmospheric transformations of biomass burning aerosol from wildfires in Siberia

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Wildfires in Siberia are a major source of aerosol in Northern Eurasia. Biomass burning (BB) aerosol can significantly impact the Earth's radiative balance through absorption and scattering of solar radiation, interactions with clouds and changes of surface albedo due to deposition of black and brown carbon on ice and snow. There is growing evidence that atmospheric aging of BB aerosol can be associated with profound but diverse chemical and physical transformations which, in most cases, are not adequately represented in chemistry-transport and climate models that are widely used in assessments of radiative and climate effects of atmospheric pollutants.

An idea of this study is to identify changes in the optical properties of aging BB aerosol using absorption and extinction aerosol optical depths (AAOD and AOD) retrieved from the OMI and MODIS satellite observations and to elucidate key processes behind these changes using the Mie-theory-based calculations along with simulations with chemistry-transport and microphysical box models involving representation of the evolution of organic particulate matter within the VBS framework. The study focuses on a major outflow of BB plumes from Siberia into the European part of Russia in July 2016. The analysis of the satellite data is complemented by the original results of biomass burning aerosol aging experiments in a large aerosol chamber.

The results indicate that the BB aerosol evolution during the first 10-20 hours features strong secondary organic aerosol (SOA) formation resulting in a substantial increase in the particle single scattering albedo. Further evolution is affected by the loss of organic matter, probably due to evaporation and oxidation. The results also indicate that although brown carbon contained in the primary aerosol is rapidly lost (consistently with available independent observations) due to evaporation and photochemical destruction of chromospheres, it is partly replaced by weakly absorbing low-volatile SOA.

In general, this study reveals that aging BB aerosol from wildfires in Siberia undergoes major physical and chemical transformations that have to be taken into account in assessments of the impact of Siberian fires on the radiative balance in Northern Eurasia and the Arctic. It also

proposes a practical way to address these complex transformations in chemistry-transport and climate models.

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