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Elucidating the impact of Siberian biomass burning aerosol on the radiative balance in the Arctic: model analysis constrained by observations

Igor B. Konovalov¹, Nikolai A. Golovushkin¹, **Matthias Beekmann**², Guillaume Siour², Tatyana B. Zhuravleva³, Ilmir M. Nasrtdinov³, Victor N. Uzhegov³, Irina N. Kuznetsova⁴, Murat I. Nakhaev⁴, Solène Turquety⁵, and Florian Couvidat⁶

¹Institute of Applied Physics, Russian Academy of Sciences, Nizhniy Novgorod, Russia (konov@ipfran.ru)

²Université de Paris and Univ Paris Est Creteil, CNRS, LISA, F-75013, Paris, France

³V.E. Zuev Institute of Atmospheric Optics, Tomsk, Russia

⁴Russian Hydrometcenter, Moscow, Russia

⁵Laboratoire de Météorologie Dynamique (LMD), Sorbonne Université, École Polytechnique, École Normale Supérieure, CNRS, F-75005, Paris, France

⁶INERIS, F-60550, Verneuil-en-Halatte, France

Siberian wildfires inject into the atmosphere huge amounts of aerosol particles, part of which are transported into the Arctic. Once in the Arctic, biomass burning (BB) aerosol can contribute to the radiative balance and affect the climate processes in different ways, including the absorption and scattering of the solar radiation, changes in the albedo of the ice/snow surface cover, modification of the optical properties of clouds. However, quantitative knowledge of the role of Siberian BB aerosol in the Arctic is deficient, reflecting major uncertainties in available model representations of its emissions, chemical composition, and optical properties.

In this study, the CHIMERE v2020 chemistry transport model (<https://www.lmd.polytechnique.fr/chimere/>) coupled with the WRF meteorological model was used to examine the effects of aerosol-radiation interactions (the direct aerosol radiative effect and the associated semi-direct effects) due to the transport of BB plumes from Siberia into the Eastern Arctic. The analysis features the use of satellite and in situ observations to constrain the BB aerosol sources and optical properties. Furthermore, the simulations brought together new model representations of the optical properties and aging of the organic component of Siberian BB aerosol [1,2], which were also constrained by satellite and ground-based observations, and recent findings from aerosol chamber experiments [3]. The study focuses on the radiative effects associated with the strong fires that occurred in Siberia in July 2016.

It is found that weakly-absorbing Siberian BB aerosol exerted a strong cooling effect in the near-surface layer of the atmosphere and at the top of the atmosphere over large areas on land in the Eastern Arctic. However, the aerosol radiative effects over the ocean were found to be of a mixed character, which is partly due to semi-direct effects triggered by the aerosol absorbing

components (black carbon and brown carbon). Overall, our study results indicate that direct and semi-direct radiative effects caused by Siberian BB aerosol constitute a significant part of the evolving natural baseline of the Arctic radiative budget and need to be taken into accounts in analyses and predictions of the Arctic amplification of climate change.

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