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Heterogeneous reactions on biomass burning aerosol: the case study of the 2010 mega fire event in Russia

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Results of recent laboratory studies [1,2] indicated that heterogeneous reactions of ozone and nitrogen dioxide on the surfaces of aerosol consisting of humic acids or humic like substances (HULIS) may significantly affect the chemical budget in biomass burning plumes, where HULIS is an important contributor to the aerosol composition. To achieve better understanding of potential role of these reactions in the atmosphere, we considered them together with other processes in the framework of the state- of- the- art CHIMERE chemistry transport model applied to the case of the 2010 mega fire event in western Russia. It had been shown earlier [3] that this model adequately reproduces the measured variability of the key air pollutants (O_3, PM10, CO) in the Moscow region during the period when the atmospheric composition was strongly affected by numerous wildfires (e.g., up to 1 mg/m3 of daily mean PM10 concentration was detected by air pollution monitors). Using the experimental data, the heterogeneous reaction rates were parameterised as a function of actinic fluxes, reactant concentrations and relative humidity. The actinic fluxes were calculated using the on-line TUV model and aerosol optical depth data retrieved from the MODIS measurements. Results of the numerical experiments indicate that heterogeneous loss of ozone during the considered episode could be considerable (reaching several tenths of percent). They show also that although wildfires provide large reactive surface for the heterogeneous processing of ozone and nitrogen dioxide on biomass burning aerosol, at the same time they strongly inhibit these reactions by attenuating actinic fluxes through the "shielding" aerosol effect. Accordingly, the maximum impact of heterogeneous reactions on concentrations of ozone and other reactive species is estimated to be at the upper part of the boundary layer. The obtained estimates of effects of heterogeneous reactions are found to be sensitive to uncertainties in aerosol composition and reaction rate parameterisations, thus calling for new experimental and modelling studies.

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