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Impacts of 2010 Russian wildfires on atmospheric composition: integrating satellite and ground based observations with regional model simulations

Igor B. Konovalov (1,2), Matthias Beekmann (2), Irina N. Kuznetsova (3), Anatoliy M. Zvyagintsev (4), and Alla Yurova (3)

(1) Institute of Applied Physics, Russian academy of Sciences, Nizhny Novgorod, Russia (konov@appl.sci-nnov.ru), (2) Laboratoire Inter-Universitaire de Systèmes Atmosphériques, CNRS, Université Paris-Est and Université Paris 7, Créteil, France, (3) Russian Hydrometcenter, Moscow, Russia, (4) Central Aerological Laboratory, Dolgoprudny, Russia

Wildfires play an important role in the chemical and thermal balance of the atmosphere providing significant source of greenhouse and reactive gases. They are also known to contribute significantly to air pollution in many regions of the world. In particular, the extreme air pollution level and strongly reduced visibility were observed in Central European regions of Russia during the intensive wildfire events in European Russia in summer of 2010. Such episodes provide a critical test for the current understanding of many related processes, including transport and chemical transformation of air pollutants, radiative processes, evolution of wildfires and pyrogenic emissions of chemical species and aerosols.

The goal of this study is to analyze the impact of wildfires on the chemical composition of the atmosphere during the 2010 heat wave in Russia by integrating available ground based and satellite measurements with results of meso-scale modeling. In particular, we investigate the feasibility of using standard dataproducts retrieved from the MODIS measurements as a primary source of information on pyrogenic emissions of air pollutants. A key idea of our method is to optimize major uncertain parameters of the algorithm which derives fire emission estimates from satellite measurements of fire radiative power by assimilating data of ground measurements of atmospheric composition (such as the data from air pollution monitoring network in Moscow) into the regional chemistry transport model (CTM). This approach insures the consistency of the simulations with the measurements, and it also provides a general framework for obtaining measurement-based estimates of emissions from wildfires. These estimates can further be used in global atmospheric composition and climate models.

We use the state-of-the-art CHIMERE CTM, which enables simulations of three-dimensional evolution of major gaseous and aerosol constituents over Europe and which was earlier validated for the European part of Russia under "normal" atmospheric conditions. Having performed modifications needed to adequately address the considered extreme situation, we found that the optimized model reproduces independent ground and satellite observations (such as, e.g., MOPITT CO measurements which were not used in the optimization procedure) quite adequately, and that inclusion of fire emissions into the model significantly improves its performance. While measurements of atmospheric composition in Russia are very sparse, the model consistent with the available observations becomes an indispensable tool for assessing the extent of perturbations in atmospheric compositions over Russia and neighboring states caused by wild fires and abnormal meteorological situation. The results of our analysis identifying the role of Russian wildfires in the evolution of atmospheric composition over Europe in summer 2010 will be presented.