Distribution of trace gases and aerosols in the Siberian air shed during wildfires of summer 2012

*Sergey Borisovich Belan[1], Jean-Daniel Paris[2], Phillip Nedelek[3], Pavel Antokhin[1], Victoriya Arshinova[1], Mikhail Arshinov[1], Boris Belan[1], Denis Davydov[1], Georgii Ivlev[1], Alexander Fofonov[1], Artem Kozlov[1], Tatyana Rasskazchikova[1], Denis Savkin[1], Denis Simonenkov[1], Tatyana Sklyadneva[1], Gennadii Tolmachev[1]

1. V.E. Zuev Institute of Atmospheric Optics Russian Academy of Sciences, Siberian Branch, 2. Laboratoire des Sciences du Climat et de l'Environnement/IPSL, CNRS-CEA-UVSQ, 3. Laboratoire d'Aerologie, CNRS-UPS

During the last two decades, three strong biomass burning events have been observed in Russia: two of them in 2002 and 2010 in the European part of Russia, and another one in 2012 in West and East Siberia. In this paper we present results of the extensive airborne study of the vertical distribution of trace gases and aerosols carried out during strong wildfire event happened in summer 2012 in Siberia. For this purpose, the Optik TU-134 aircraft laboratory was used as a research platform. A large-scale airborne campaign has been undertaken along the route Novosibirsk–Mirny–Yakutsk–Bratsk–Novosibirsk on 31st of July and 1st of August, 2012. Flight pattern consisted of a number of ascents and descents between close to the ground and 8 km altitude that enabled 20 vertical profiles to be obtained. Campaign was conducted under the weather conditions of low-gradient baric field that determined the low speed transport of air masses, as well as the accumulation of biomass burning emissions in the region under study.

Highest concentrations of CO_2, CH_4 and CO over wildfire spots reached 432 ppm, 2367 ppb, and 4036 ppb, correspondingly. If we exclude from the analysis the data obtained when crossing smoke plumes, we can find a difference between background concentrations measured in the atmosphere over regions affected by biomass burning and clean areas. Enhancement of CO_2 over the wildfire areas changed with altitude. On average, it was 10.5 ppm in the atmospheric boundary layer (ABL) and 5-6 ppm in the free troposphere. Maximum CO_2 enhancements reached 27 ppm and 24 ppm, correspondingly. The averaged CH_4 enhancement varied from 75 ppb in the boundary layer to 30 ppb in the upper troposphere, and a little bit lower than 30 ppb in the middle troposphere. Maximum CH_4 enhancements reached 202 ppb, 108 ppb, and 50-60 ppb, correspondingly. The averaged and maximum enhancements of CO differed by an order of magnitude. Thus, in the ABL the maximum difference in concentration between clean and wildfire areas reached 2300 ppb, while averaged one was 170 ppb. In the middle troposphere maximum enhancements varied from 1000 to 1700 ppb.

The vertical distribution of ozone has its own peculiarities. Ozone concentration decreased in the layers with enhanced aerosol concentration and it increased in the areas with lower aerosol content. At the same time, photochemical production ozone was observed at the plume edges in the zone of fresh air entrainment.

This work was supported by the Russian Foundation for Basic Research (grant No 17-05-00374).

Keywords: Atmosphere, Aerosol, Greenhouse gases, Wildfires

