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Temporal variations of atmospheric pollutants in the Moscow megacity and estimate of their emissions

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In the late 1990s, at the initiative of the Moscow government a monitoring system (Mosekomonitoring, MEM) of urban environment was created. In particular, it includes automatic stations for measuring the concentration of pollutants in the surface layer of the atmosphere (the MEM stations network). MEM stations are located in the territories of various functional purposes: near highways, residential areas, urban background areas, and outside the metropolitan area. For 20 years, the measurements provided at 60 stations, however a part of sites carried out only episodically observations during this time-period. All observation data from all stations were used to analyze the diurnal pollutants fluctuations. 35 MEM stations during of 2005-2014 conducted continuous observations. The data of surface NO, NO_2, CO, SO_2, CH4, and PM10 concentrations from these stations were used to analyze the longer-term variability of pollutants concentrations.
The weekly cycles (WC) obtained by the method of superimposed epochs and the inverse Fourier transforms characterize variations in surface concentrations of urban air pollutants during the average week for 10 years. The largest magnitude equal to 22 $\pm$ 6%, has the WC of NO_2. The WC magnitudes of CO, NO and PM10 are respectively equal to 12$\pm$6 %, 14$\pm$7 % and 13$\pm$9 %. Fluctuations in CH4 and SO_2 concentrations are not significant for large-scale territorial averaging.
The emission fluxes of CO, NO_x, SO_2, and CH4 and their integral emissions from Moscow megacity have been estimated using multiyear measurements of their surface concentrations, vertical air temperature and wind stratification. The decrease of CO, NO_x and CH4 annual integral emissions with the rate respectively -1.9$\pm$0.3, -1.7$\pm$0.4 and -7.8$\pm$3.1 %/yr and growth of SO_2 with the rate of +3.3$\pm$2.3 %/yr were found for 2005-2014. Obtained emissions estimates and their long-term trends reflect the changes mainly in the urban transport system and industry. The means of integral annual pollutants emissions from Moscow differ slightly from the same characteristics of other world megacities. The calculated CO emissions coincide with their EDGAR v4.2 inventory values interpolated to the territory of Moscow. However, the EDGAR v4.2 values of NO_x, SO_2 and CH4 significantly exceed their calculated values.
Additionally the characteristics of CO total column (CO TC) and aerosol optical depth (AOD) over Moscow and outskirts obtained using ground-based OIAP and AERONET observations as well as orbital AIRS, MOPITT (CO TC) and MODIS (AOD) data were analyzed for improvement of weekly and seasonal variations of anthropogenic emissions.