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Atmospheric temperature inversions and their influence on atmospheric composition in Moscow

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Both surface and elevated atmospheric temperature inversions have been studied on base of continuous observations in Moscow as they are important for air mixing in atmospheric boundary layer and contaminants accumulation. Data for 2011-2013 including parallel measurements of temperature profile in 0-600 m layer by MTP-5 instrument and of main trace gases (3, NO, NO_2, CO, CO_2, CH4, NMHC, SO_2) surface concentrations by automated set of equipment including ambient air analyzers of world level producers (Thermo, Horiba, Dasibi) have been taken into consideration. Observations were performed by group of A.M. Obukhov Institute of Atmospheric Physics RAS on the territory of the Meteorological Observatory of Lomonosov Moscow State University in the southwestern part of Moscow. Additionally, data on CO total content measured at OIAP in center of Moscow and on wind speed in ABL from meteorological station at Russian Exhibition Center have been used.
The statistical analyses of inversions included their seasonal distribution by intensity, duration and height. Most of inversions had an intensity within 1-5[U+F0B0]. In winter, unlike other seasons, there were more intense inversions up to 11[U+F0B0]C with duration up to several days. In spring, summer and autumn quite a large number of inversions were surface (from 25% to 40% of the total number) while winter inversions were mainly elevated. The share of surface inversions was about 10% of the total number.
Correlation coefficients were calculated to find the dependencies that may occur between the intensity (or duration) of inversion and the excess of concentrations above the average daily norm. For O_3, there was a negative correlation between the intensity and duration of inversion conditions and ozone concentrations. Under inversion there is a significant accumulation of pollutants, which destroy ozone and, therefore, the ozone concentration decreases. Other gases are commonly accumulated under inversion conditions. NO, NO_2, CO and CO_2 concentrations under inversions grow greater than concentrations of CH4, NMHC, and SO_2. It is likely to be related with main source intensity (traffic). The accumulation of trace gases are higher in wintertime under low temperatures and more intense and long inversions. As a rule, an increase in duration and intensity of inversions leads to growth of trace gas concentration, while the dependence of concentration excess on the height of the lower boundary of the inversion has not revealed.
Analyses of long-term observations of wind speed since 2005 showed stable decrease of calm days amount by about 7% per year that correlates with inter-annual dynamics of some pollutants (for example, CO). Apparently, local climate changes may contribute to both ABL structure and air pollution in Moscow but this aspect needs further investigation.