

Maximum daily concentrations of the surface ozone in Minsk and their long-term trend

A.M. Liudchik, V.I. Pakatashkin, and S.K. Barodka

National Ozone Monitoring Research Centre, Laboratory of Atmosphere Physics, Minsk, Belarus (liudchikam@tut.by)

More than ten years of surface ozone monitoring in Minsk is characterized with a steady decline in its concentration resulted from increase of anthropogenic air pollution and climate features of Belarus. A negative long-term trend of observed average diurnal concentrations is typical for all seasons. However, in a series of measurements relating to the spring-summer period one has cases of abnormally high concentrations of ozone. Most often they are found in terms of time close to a daily maximum but depending on the meteorological conditions and air pollution it is possible to observe them in other periods of the day. A considerable number of anomalies exceeds a maximum allowable hourly concentration adopted in Belarus - 160 mg/m³.

Based on the results of measurements in Minsk during 2004 – 2015, maximum and extreme climatic normals of daily surface ozone concentration are determined. A modern concept of a "dynamic normal" (K.Y. Vinnikov, A. Robock, D.J. Cavalieri and C.L. Parkinson, Geophys. Res. Lett. (2002), 29, No. 9, 10.1029/2001GL014481) taking into account seasonal features and change in the normal over time is employed. Extreme values are defined as those exceeding the maximum normal.

Both the maximum and extreme normals have the spring and summer maxima in their cyclic components falling at the same span of time. However, the summertime maximum of the extreme normal is much higher than the corresponding maximum of the maximal normal and amounts to about 120 mg/m³. This indicates a greater amplitude of fluctuation of the maximum ozone concentrations in summer if compared to a spring period. As a result, the cyclic component of the extreme normal grows due to the fact that only positive deviations from the maximal normal are accounted for.

Changes in the annual variation of the maximum and extreme normals during the observation period differ significantly. The maximum normal decreases over years, and that is consistent with the negative long-term trend of average daily ozone concentrations. Reduction in summer occurs faster than in spring. By 2015, in summer the maximum normal has declined to a value of ~ 90 mg/m³. The extreme normal in spring increases with years, whereas in summer, remaining quite high, it decreases.

Seasonal long-term trends of the normals confirm the foresaid. A linear model of the trend is used because of the limited number of observations. The trend of the maximum normal is negative and approximately equals -3 mg/m³ per decade in the spring and -10 mg/m³ per decade in summer. The trend of the extreme normal is negative in summer (-4 mg/m³ per decade) and it is positive in spring (about 9 mg/m³ per decade).

Reducing the maximum normal during a period of observations is accompanied by increase in the amplitude of the short-term fluctuations of ozone concentration with respect to the normal in spring. This is what determines the springtime increase (the positive trend) of the extreme normal of daily ozone concentrations.