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Nitrogen dioxide and formaldehyde in atmospheric boundary layer: method and results of observations in Moscow Region

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A few instruments perform DOAS measurements in the visible and UV spectral region in polluted and clear areas of Moscow region. The measurements started in 2008. A new method for retrieval the NO_2 and HCHO contents in the atmospheric boundary layer (ABL) basing on these measurements was developed.

Nitrogen dioxide (NO_2) is one of key chemical components which also influence on radiative balance of the atmosphere. Anthropogenic sources of NO_2 produce about 2/3 of the total emissions of this impurity therefore NO_2 content in the atmospheric boundary layer (ABL) over major cities may exceed the natural background by orders of magnitude. Formaldehyde (HCHO) is the most abundant organic carbonyl compound in the atmosphere. This is a short-lived oxidation product of a large number of volatile organic compounds (VOCs). Its abundance can be closely related to VOC emissions of natural origin or from human activity.

The DOAS technique is based on measurements of the spectrum of the scattered solar radiation incoming from the zenith and/or the slant directions during daytime and twilight period in UV and visible wavelengths. Usage of twilight measurement allows retrieving accurately stratospheric NO_2 content. A new universal method is developed which may be used for both zenith and multi-axis DOAS observations. At the first step NO_2 and HCHO slant columns are determined. The conversion of the slant columns to the vertical columns uses the calculated air mass factors. The calculation of air mass factors is performed by radiative transfer model MCC++. The method may be applied for clear sky and overcast. Effects of the major factors, affecting the accuracy of the estimation, such as aerosol, clouds and albedo of the underlying surface, are analyzed. It is shown that in cloudless condition and with the cloud lower boundary located above the near-surface layer of gases, the determination of the integral ABL content is possible with random errors of 7–25%.

Developed method is used at two observational points located in Moscow as well as at Zvenigorod Scientific Station located at 35 km to the west from Moscow beginning from 2008. Performed observations allowed us to investigate NO_2 and HCHO emissions in Moscow including the hot summer of 2010.

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