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Evaluation of anthropogenic influence on thermodynamics, gas and aerosol composition of city air

Nina Uzhegova (1), Boris Belan (1,2), Pavel Antokhin (1), Evgenii Zhidovkhin (1), Georgii Ivlev (1), Artem Kozlov (1), and Aleksandr Fofonov (1)

(1) Zuev Institute of Atmospheric Optics of SB RAS, Tomsk, Russian Federation (ninosh@mail.ru), (2) Tomsk State University, Tomsk, Russian Federation (bbd@iao.ru)

In the last 40-50 years there is a global tendency of urbanisation, which is a consequence of most countries' economical development. Concurrently, the issue of environment's ecological state has become critical. Urban air pollution is among the most important ecological problems nowadays.
World Health Organization (WHO) points out certain "classical" polluting agents: carbon monoxide (CO), nitric oxide (NO), nitrogen dioxide (NO2), sulphur dioxide (SO2), troposphere ozone (O3) (studied here), as well as lead, carbon dioxide (CO2), aldehydes, soot, benzpyrene and dredges (including dust, haze and smoke) [1].
An evaluation of antropogenic component's weight in the thermodynamical conditions and gas and aerosol composition of a city's atmosphere (by the example of Tomsk) is given in this paper.
Tomsk is located at the South of West Siberia and is the administrative center of Tomsk region. The city's area is equal to 294,6 km2. Its population is 512.6 thousands of people.
The overall number of registered motor vehicles in the city in 2008 was 131 700. That is, every fourth city inhabitant has a personal car. From 2002 to 2008 the number of motor vehicles in Tomsk has increased by 25 thousands units [2]. This increase consists mostly of passenger cars. There is also a positive trend in fuel consumtion by the city's industries and motor vehicles – from 2004 to 2007 it has increased by 10%.
Such a quick rate of transport quantity's increase in the city provides reason to suggest an unfavorable ecological situation in Tomsk.
For this study we have used the AKV-2 mobile station designed by the SB RAS Institute of Atmospheric Optics. The station's equipment provides the following measurements [3]: air temperature and humidity; aerosol disperse composition in 15 channels with a particle size range of 0.3-20 μm by use of the Grimm-1.108 aerosol spectrometer; NO, NO2, O3, SO2, CO, CO2 concentration.
This paper describes a single experiment conducted in Tomsk. Date of experiment: Thursday, 14.05.2009. Local time: 15:00-17:30. Weather: clear, no precipitation.
The measurements had been conducted on a "snake" route through the city including all of the main traffic arteries. Taking the wind rose into account, a background (clear) point had been selected for comparison with the city measurements.
Temperature: The measurements have shown that air temperature in the city is higher than in suburbs by 1–1.5 C on average. In the main traffic arteries the temperature difference between the city and suburbs (Δ) is largest and reaches 3.19 C.
Absolute humidity: The measurements have shown that the absolute humidity in the city is higher than the background value by 2.5 g/m3 on average. This suggests an additional source of water vapor in the city. Taking into account that the area of maximum Δ (3.16 g/m3) is located along one of the city's main streets, we can assume that the main source of water vapor in the city is automobile transport.
Gas composition: Judging by gas composition, the area for background measurements had been chosen correctly. Daily average MPC for the main polluting agents (except for ozone) did not exceed the normal values. Opposite situation has been observed in the city.
We have found out that the city is a "pollution island". Concentration of admixtures (NO, NO2, CO) in the city's center are considerably higher than in the background area. At the main traffic arteries daily average MPC has been considerably exceeded, as well as one-time MPC for certain pollution agents.
Ozone concentration value in the city's atmosphere is inversely proportional to the nitric oxide concentration,

because NO is involved in cycles leading to ozone destruction in the troposphere. Thus, a negative ΔO3 has been observed almost everywhere in the city.

Aerosol composition: Two areas of maximum values of aerosol bulk concentration have been delimited in different city parts. One is a source of fine aerosol (r < 0.9 μm), the other – of the coarse one (r > 0.9 μm).

Summary:

1. Apart from the obvious inflow of anthropogenic heat, an additional source of moisture has been discovered in the city. Apparently, it is automobile transport.
2. The measurements have discovered areas with significantly exceeded daily and one-time MPCs for such dangerous polluting agents as CO, NO, NO2. These are the areas with the most intensive car traffic.
3. A high level of ozone concentration has been discovered in the city's background area and the Academgorodok.
4. It is necessary to build up statistics for this type of studies and introduce this method into the air quality control methodology. As an addition to the practiced methods it will allow to achieve a more complete and correct picture of air pollution.

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