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Gaseous composition of surface air in Moscow during the extreme heat and fires in summer 2010

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Summer 2010 was extremely hot for the European territory of Russia (ETR). The heat was caused by very intensive and stable blocking anticyclone that established in Moscow since June, 18 till August, 18. Anticyclone of such strength has been never observed before. During these 2 months troposphere over ETR was almost closed for western winds. Hot weather led to numerous forest and peat fires (about 29,000 cases) with total covered area about 12,000 km2. Such situation caused quite dramatic economic, social and ecological consequences for Russia. One of aftermaths was significant change of atmospheric composition. Many cities and settlements were covered by dense haze when they had been impacted by plumes from fires. Evident presence of high amount of aerosol in the ambient air caused anxiety and application of safeguards. Meanwhile, less obvious increase of concentrations of trace gases (including toxic CO, NO, NO2, O2, VOCs) was very high as well and made great contribution to air quality deterioration.

This report presents results of observation of atmospheric gaseous composition over Moscow and Moscow region in summer 2010 and during previous years (2002-2009) performed at Moscow and partly at Zvenigorod(40 km from Moscow) scientific stations of A.M. Obukhov Institute of Atmospheric Physics . Moscow station is equipped with up-to-date instruments that are used on GAW WMO network and calibrated according to international standards.

Summer 2010 was characterized by very favorable conditions for trace gases accumulation in low atmosphere. During 33 days in succession surface air temperature exceeded 30ºC. Because of active evaporation of fuels, varnishes, dyes and other products as well their photochemical transformation the common for Moscow atmospheric composition changed drastically. In addition products of wood, grass and peat burning were transported to Moscow with eastern and southern winds. The strongest haze was registered on August, 6-10 when concentrations of almost all trace gases jumped far above maximum permissible thresholds. Thus, hourly average concentrations for 3 reached 134.2 ppb, for – 15.8 ppm, for 2 - 548.4 ppm, and for 4 – 3.9 ppm.

Data on trace gases surface concentrations have been compared with NO2 total content in vertical column of the troposphere that measured at both sites and at the centre of the city. Highest NO2 content in troposphere was observed during calm and NE winds, and sometimes its peaks were not coincide with ones in surface layer. In general concentrations of short-lived species like nitrogen oxides in Moscow were 2-3 times higher comparing with Zvenigorod station that is 40 km westward from Moscow. Long-lived species like CO have less vivid daily variations and are removed from Moscow megacity mostly due to horizontal advection and transport to free troposphere.

Aggregate effect of dynamic and photochemical factors as well as man-made emissions is clearly indicated as trace gases weekly cycle. NO, NO2 and CO are dependent on traffic and industrial activity. O3 weekly variability reflects its destruction in reactions with nitrogen oxides and formation after CO and NMHC oxidation. Long-lived species demonstrated gradual growth during the week and lower daily variations.

Beyond any doubts heat and smog in summer 2010 severely impacted human health. According to official statistics death rate in Moscow in July- August increased by over 50% compared with 2009. Extreme situation of summer 2010 should push government structures and society to pay more attention for improving system of air composition observations and air quality forecast.

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