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Quantitative assessments of natural and anthropogenic factors determining near-surface ozone variations in the Northern Eurasia

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We propose the results of analyses of near-surface background ozone (O_3) variability in remote area of Central Siberia as seen from Zotino Tall Tower Observatory (Zotino Tall Tower Observatory, 60.26 N, 89.24 E) continuous measurements conducted since March 2007 till present. These observations, being part of complex measurements of air composition including NO_x, CH4, and CO, are intended to improve current understanding of the impact of strong anthropogenic plume formed by upwind climatically important sources of pollutants (Europe and highly urbanized territories of South Siberia) onto the near-surface ozone balance downwind across the North Eurasia.
The quantitative description of the seasonal variability of O_3 at station is performed for maximal daily ozone on a monthly base from the 2007–2015 dataset. Observed ozone concentration reaches its maximum in spring (40-45 ppbv) and minimum (15-20 ppbv) in autumn-winter. Annual concentration is about 30 ppbv that corresponds to the background conditions. Enhanced concentration is observed in March-April which is due to increased stratospheric-tropospheric exchange. Strong wildfires over the adjusting territories in Siberia are the most important factor of the observed ozone disturbances at synoptic scale, whereas severe wildfire seasons in West and East Siberia (summer 2011 and 2012) are found to be the most important factor of regional ozone enhancement (up to 50 ppbv daily averaged in July 2012) on sub-seasonal scale.
Numerical experiments with GEOS-Chem v.10-01 CTM were conducted to assess the sensitivity of lower-troposphere background chemistry to the anthropogenic sources NO_x and local biogenic emissions of VOC (in warm period) in terms of ozone production rates by reducing various emission sources by 50 and 100% for 2007. The results show anthropogenic influence is more significant than biogenic, but the impact of all these emissions is not prevailing: its contribution to surface ozone concentration is about 15-17%. The ozone reduction (OR) reaches its maximum in summer for all scenarios with 100% NO_x emissions reduction: 5 ppbv with full and 50% reduced BVOC emissions and 6 ppbv with 100% reduced BVOC emissions. OR with full anthropogenic and reduced biogenic emissions does not exceed 2.5 ppbv. In winter the influence of anthropogenic factor is also significant: for all scenario with full NO_x emissions OR is near zero, but with reducing anthropogenic emissions for 50% and 100% it reaches -2 and -4.5 ppbv respectively. These results are important for analysis of further observations and for better understanding of the influence of various natural and anthropogenic factors on air composition in the boreal zone of Siberia.
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