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Soil carbon dioxide emissions of the cities of European Russia across bioclimatic zones

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Soil emission is the largest component of Gross Respiration in terrestrial ecosystems, including cities. Field measurements of soil carbon dioxide emission allow us to evaluate and compare the state of the underground layer and the entire ecosystem in different functional zones of a single city with different types of vegetation, as well as in cities located in different bioclimatic zones. During the two growing seasons of 2020 and 2021, monitoring studies of air temperature, soil temperature and moisture and CO_2 emissions from urban and natural soils for six cities of the European Russia (12 sites, 120 points, from 8 to 18 measurements per season) were performed in the zonal series: forest tundra (Murmansk) – northern taiga (Apatity) – southern taiga (Moscow) – broad-leaved forests (Pushchino) – forest-steppe (Kursk) – steppe (Rostov-on-Don). CO_2 emissions from urban and background soils were determined by a combination of factors: soil properties (primarily organic carbon content) and the seasonal dynamics of hydrothermal conditions. From north to south, the temperature increased, and soil moisture decreased. At the same time, for all cities except Rostov-on-Don, the average soil temperature in the city was higher than in the background soil. While for the conditions of dry steppe, the background soils were drier and warmer in comparison with the urban soils of Rostov-on-Don. For all cities (except Kursk), average annual CO_2 emission of urban soils was higher than of the natural soils, and the difference increased from north to south, reaching 110% for Rostov-on-Don. The maximum mean annual emission was shown for Rostov-on-Don (0.95±0.59 $mgCO_2$ m-2 h-1), which was almost twice as high as for Murmansk.

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