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Seasonal dynamics of soil CO_2 efflux and soil profile CO_2 concentrations in arboretum of Moscow botanical garden

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To analyse and predict recent and future climate change on a global scale exchange processes of greenhouse gases - primarily carbon dioxide - over various ecosystems are of rising interest. In order to upscale land-use dependent sources and sinks of CO_2, knowledge of the local variability of carbon fluxes is needed. Among terrestrial ecosystems, urban areas play an important role because most of anthropogenic emissions of carbon dioxide originate from these areas. On the other hand, urban soils have the potential to store large amounts of soil organic carbon and, thus, contribute to mitigating increases in atmospheric CO_2 concentrations. Research objectives: 1) estimate the seasonal dynamics of carbon dioxide production (emission – closed chamber technique and profile concentration – soil air sampling tubes method) by soils of Moscow State University Botanical Garden Arboretum planted with Picea obovata and Pinus sylvestris, 1) identification the factors that control CO_2 production.

The study was conducted with 1-2 weeks intervals between October 2013 and November 2015 at two sites. Carbon dioxide soil surface efflux during the year ranged from 0 to 800 $mgCO_2/(m^2hr)$. Efflux values above 0 $mgCO_2/(m^2hr)$ was observed during the all cold period except for only 3 weeks. Soil CO_2 concentration ranged from 1600-3000 ppm in upper 10-cm layer to 10000-40000 ppm at a depth of 60 cm. The maximum concentrations of CO_2 were recorded in late winter and late summer. We associate it with high biological activity (both heterotrophic and autotrophic) during the summer, and with physical gas jamming in the winter. The high value of annual CO_2 production of the studied soils is caused by high organic matter content, slightly alkaline reaction, good structure and texture of urban soils. Differences in soil CO_2 production by spruce and pine urban forest soils (in the pine forest 1.5-2.0 times higher) are caused by urban soil profiles construction, but not temperature regimes. Seasonal dynamics of CO_2 production are the same for both soils and associated with seasonal changes in climatic parameters (temperature and moisture). CO_2 efflux in the annual cycle correlates well with the soil temperature at a depth of 10 cm (r^2 = 0.7). In the dry summer months, efflux largely depends on soil moisture. Soil CO_2 efflux decreased by 1.5 - 2 times during the dry season.