

Spatial and temporal seasonal variation of CO₂ efflux from the soil surface in the boreal forests in Central Siberia

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In boreal forest ecosystems, soil CO₂ flux may account for 40–80 % of the total CO₂ release in forest ecosystems [4], and it is the main pathway of transferring carbon from terrestrial ecosystems to the atmosphere. The amount of CO₂ released to the atmosphere through soil respiration is ten times greater than that resulting from the burning of fossil fuels [3]. Taking into account the considerable amounts of C stored in boreal soils [1] even small changes in soil respiration may cause great fluctuation in atmospheric CO₂ concentrations. Therefore, better understanding of soil respiration dynamics in diverse boreal forests is essential for understanding the global carbon balance [2].

The objectives of the present study are: (a) to study the dynamic changes in soil CO₂ efflux from the soil surface during frost-free season; (b) to identify the impact of meteorological variables (factors) on soil CO₂ efflux. The research was conducted in the boreal forests in Central Siberia (60°N, 90°E), Russia. Sample plots were represented by the lichen pine forest, moss pine forest, mixed forest and a plot with mineral sandy soil without a plant cover. We used the automated soil CO₂ flux system based on the infrared gas analyzer –LI-8100 (Li-cor Biogeosciences Inc., USA) for measuring the soil efflux. Soil temperature was measured next to each collar at the time of the CO₂ efflux measurement with Soil Temperature Probe Type E (Omega, USA) in three depths –5, 10, 15 cm. Volumetric soil moisture was measured with Theta Probe Model ML2 (Delta T Devices Ltd., UK). The presence and type of ground cover substantially affects the value of soil respiration fluxes. In 2015, the flow of carbon dioxide from the soil surface averaged $5.4 \pm 2.3 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$. The lowest soil respiration for forest areas was observed in the moss pine forest ($1.14 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$). The lichen pine forest had the intermediate values (mean and SD) of soil respiration. A sandy soil plot without a plant cover demonstrated the lowest soil respiration ($0.12 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$). The maximum soil respiration values and seasonal fluctuations were obtained in the mixed forest ($29.62 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$).

The correlation analysis of dependence between soil temperature, soil moisture and soil CO₂ efflux showed that an increase of temperature and soil moisture at the beginning of the growing season (June) leads to inhibition of soil respiration processes. At the end of the growing season (September), we recorded a reduction in the impact of two climate factors (soil temperature and moisture) on soil respiration intensity. Nevertheless, the soil temperature appears to be the major driver controlling the soil CO₂ efflux during the frost-free season in analyzed Siberian boreal forests.

Literature:

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