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Belowground carbon dioxide efflux in the contrast ecosystems of the north West Siberia: partitioning into different sources

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In studies of the carbon cycle of terrestrial ecosystems, soils have received considerable interest because of their determinative role in the long-term storage of carbon sequestered. Increases in terrestrial ecosystem respiration as temperatures warm could create a positive feedback that causes atmospheric carbon dioxide concentration, and afterwards global temperature, to increase more rapidly. The major sources of carbon dioxide in the soil are plant root respiration (autotrophic) and soil microbial respiration (heterotrophic). Partitioning soil carbon dioxide efflux has received significant attention, as differential responses of these components to environmental change have profound implications for the ecosystem carbon balance. How autotrophic and heterotrophic respiration sources respond to climate change is especially important in ecosystems underlain by permafrost. Permafrost ecosystems contain vast stores of soil carbon and are located in northern latitudes where climate change is accelerated. At the same time, studies on the separation of carbon dioxide sources in northern ecosystems are not enough today.
The main objective of this study was to estimate belowground carbon dioxide efflux from different source components (autotrophic and heterotrophic) using different field and laboratory approaches (“shading”, “component integration”, “root exclusion”, “root mass regression”) in contrast ecosystems of north West Siberia. The study included mineral soils (boreal forest and arctic tundra) and peat soils (permafrost peatland).
Flux measurements indicate that areas without permafrost (boreal forest site) had the greatest carbon dioxide efflux, due to both a high proportion of autotrophic respiration (up to 50%) and high microbiological activity. The proportion of autotrophic respiration in the soils of tundra ecosystems varies widely due to variability of biotic and abiotic factors: from 7% in permafrost peatland site to 70% in arctic tundra with mineral soils. Despite the high storage of organic carbon in peat soils (up to 30 kg / square meter at permafrost peatland site), the production of carbon dioxide by these soils is extremely low. This is due to the small root biomass (about 250 g for square meter) and extremely low microbial respiration.
As a result of the research, it was shown that for different ecosystems different methodological approaches to separate determination of autotrophic and heterotrophic respiration are more acceptable. In forest ecosystems, all methods showed good comparable results, including the regression method. In the tundra ecosystems, because of the large variability of environmental conditions, most methods (for example, “root mass regression”) are unacceptable. For such conditions, the most suitable method is “the components integration” method.
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