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Carbon cycle of permafrost transect: main terrestrial and hydrological ecosystems of Eastern Siberia

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Almost 65% of Siberian forests and 23% of tundra vegetation grow in permafrost zone. According to our estimate, carbon stocks in the soils of forest and tundra ecosystems of Yakutia (Eastern Siberia, Russia) amount to 17 billion tons (125.5 million hectares of forest and 37 million hectares of tundra in total) that is about 25% of total carbon resource in the forest soils of the Russian Federation.
This presentation is compiled from the results of many years time series investigations conducted on the study of carbon cycle in permafrost-dominated forests with different productivity and typical tundra and along Great Lena river basin including Aldan and Viluy tributaries.
Seasonal photosynthesis maximum of forest canopy vegetation in dry years falls into June, and in humid ones – into July. During the growing season the woody plants of Yakutia uptake from 1.5 to 4.0 t C ha^{-1} $season^{-1}$ depending on water provision. Night respiration is higher in dry and extremely dry years (10.9 and 16.1% respectively). The productive process of tree species in Eastern Siberia is limited by endogenous (stomatal conductance) and exogenous (provision with moisture and nutrients, nitrogen specifically) factors. The increase of an atmospheric precipitation after long 2-3 annual droughts accompanied with strong surge in photosynthetic activity of forest plants is almost 2.5 times.
The temperature of soil is a key factor influencing soil respiration in the larch forests. Average soil respiration for the growing season comes to 6.9 kg C ha^{-1} day^{-1}, which is a characteristic of Siberian forests. Annual average soil emission is 4.5±0.6 t C ha^{-1} yr^{-1}.
As our multi-year studies showed, there is significant interannual NEE variation in the Central Yakutia larch forest, while in the Southern Yakutia larch forest and tundra ecosystem variation is more smooth, because the climatic conditions in these zones (close to the mountain and sea) are less changeable than in sharply continental Central Yakutia.
According to our long-term eddy-correlation data, the annual uptake of carbon flux (NEE) in the high productivity larch forest of South eastern Yakutia, 60N – 2.43±0.23 t C ha^{-1} yr^{-1}, in the moderate productivity larch forest of the Central Yakutia, 62N makes 2.12±0.34 t C ha^{-1} yr^{-1} and in the tundra zone, 70N – 0.75±0.14 t C ha^{-1} yr^{-1}.

Interannual variation of carbon fluxes in permafrost forests in Northeastern Russia (Yakutia) makes 1.7-2.4 t C ha^{-1} yr^{-1} that results in the upper limit of annual sequestering capacity of 450-617 Mt C yr^{-1}. In connection with climate warming there is a tendency of an increase in the volume of carbon sequestration by tundra and as opposed to decrease by forest ecosystem in the result of prolongation of the growing season and changing of plant successions. This is also supported by changes in land use as well as by CO_2 sequestration in the form of fertilizer.

According our biogeochemical investigation annual flux of carbon from main in Eastern Siberia Lena river hydrological basin is almost 6.2 Mt C yr^{-1} including 28% at Aldan and 14% at Viluy rivers.