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ABSTRACT

Active layer thickness and CO_2 efflux of frozen peatlands: relationship, spatial variability, trend of climate change (CALM R1, western Siberia, Russia).

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Global warming, recorded in recent decades in the North West Siberia, leads to a change in soils temperature regime, changing plant associations, gradual degradation of permafrost and changing landscape as a whole. Cryogenic ecosystems through a combination of the sporadic permafrost and significant reserves of organic matter as a peat, are unique indicators of climate change in the early stages.

The research CALM SITE R1 (Nadym Grid) is located in north of western Siberia (Russia, since 1997) within the zone of sporadic permafrost of north taiga. It is 1-ha (100m*100m) grid consists of a square array of permanent stakes separated by 10 m (121 data points per grid for all measurements). Permafrost is closely associated with frozen peatlands, bog and frost mounds. The typical soils are Turbic Cryosol of frozen peatland and Histosols of bog. For each point of CALM R1 site active layer thickness, carbon dioxide effluxes were measured in August 2013, 2014.

Active layer thickness and soil CO_2 effluxes are characterized by high spatial and temporal variability. Active layer thickness varies from 45 to 200 cm and more; average thickness is 136±10 cm (2013) and 166±8 cm (2014). Strong spatial variation of this parameter related with the different soil cover and the organic layers dimensions. Areas with deepest thaw (more than 200 cm) are developed in large sedge-moss pools within peatlands and in bogs and were not included in calculations. In general, soil carbon dioxide emission is low and does not differ from year to year (156 ± 21 – 2013; 132±17 – 2014) $mgCO_2m^{-2}h^{-1}$ (ranging from 10 to 450 $mgCO_2m^{-2}h^{-1}$). Based on the regression analysis among more than 10 characteristics (hydrothermal, geocryological, soil) for CALM R1 site was revealed a high and significant correlation soil carbon dioxide efflux only with the active layer thickness ($r=0,45$, p-level<0,05; $y=112+0,13*x$). We consider the main factor, which determine the soil carbon efflux is the depth of permafrost table; it determines the type of ecosystem in such transitional landscapes and organic matter transformation processes.

For last 17-years period of CALM R1 measurements was determined that active layer thickness is characterized by high spatial and temporal variability. It varies

widely from 45 to 185 cm (1997) and from 55 to 200 cm and more (2014) (variation coefficient is 27,0- 40,0 %). Area with small active layer thickness (<50 cm) decreased from 14% to 0% in this period. Average active layer thickness increase from 119±6 to 166±8 cm from 1997 to 2014.

The climatic record (weather station “Nadym”) indicates a progressive warming of annual air temperatures of ~2°C over the past 17 years (an average of -6°C to -4°C), due to increase in both summer and winter temperatures. The contribution of winter warming is ~2 times greater that of summer warming. Growth of active layer thickness is related with this.