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Spatial Correlation of Soil Organic Matter and Pedogenic Oxides in Permafrost-Affected Soils of Northern Siberia at the Profile Scale

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The organic carbon (OC) and nitrogen (N) of permafrost-affected soils are highly vulnerable to warming brought on by climate change. Detailed research on the pedogenesis and soil properties of permafrost-affected soils plays a key role in characterizing and quantifying the terrestrial carbon and N cycles.

This study was carried out in northern Siberia, at the Little Grawiika Creek catchment (67°28.933' N, 86°25.682' E) that is located on the eastern riverside of the Yenisei River, Krasnoyarsk Krai, Russian Federation. The aim of the study was to conduct research focused on the spatial distribution and relationship of OC and N in permafrost-affected soils that were divided into four groups based on the depth of permafrost table. 13 pits were opened to the depth of their respective permafrost table and the spatially referenced soil samples were collected, each within an 80 cm wide grid and 10 cm mesh size to obtain a high spatial resolution.

In order to quantify the spatial distribution and spatial correlation of OC and N stocks in permafrost-affected soils at the profile scale, geostatistical approaches such as simple kriging, ordinary kriging, universal kriging and ordinary cokriging were applied and compared by cross validation. Spatial analysis of pH, content of pedogenic oxides, soil structure and vegetation data were used to determine their influence on the distribution of OC and N stocks at the profile scale.

The quality of the OC and N distribution maps is enhanced considerably by cokriging as compared to distribution maps which use simple, ordinary or universal kriging approaches; this is demonstrated by distinctly lower root mean square errors. The nugget-to-sill ratio decreases with an increase in active layer depth, which confirms that vertical variability of soil OC and N stocks decreases with permafrost thaw. Moreover, the range of autocorrelation of OC and N stocks increases considerably with active layer depth.