11. DOC in streams and soils in forested watershed underlain by continuous permafrost: a seasonal pattern

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Abstract

Dissolved organic matter has significant contribution to carbon and nitrogen cycling in high latitude terrestrial ecosystems and link terrestrial and aquatic environment. In laboratory experiments quality of organic material, temperature and moisture content of organic soil horizons are important factors in the control of DOC production. Meanwhile, abiotic leaching of DOC from its source is driven by amount and frequency of precipitation. These factors together influence soil microbial activity, rates of leaching, and thus the net release of DOC from the forest floor into soil solution, transport through mineral soil and export to aquatic ecosystems. In permafrost affected environment progressive melting of frozen ground during frost-free period determines specific seasonal combination of soil temperature and moisture.

In current study we have attempted to quantify seasonal changes in DOC concentrations and fluxes. The experimental watershed was located in central Siberia (64° N, 100° E) with continuous permafrost distribution. Forest floor leachates, soil solutions and stream water were sampled continuously from June to September in 2003, 2004 and 2005.

Concentrations of DOC in forest floor leachates have had significant spatial variations. There was influence of aspect and hummock topography within a site. In general, almost two-fold higher DOC concentrations (ca 100 mgC/l) and fluxes (up to 2 g/m²/day) from forest floor were found on the south-facing slope comparatively to the north-facing one. Soil solutions demonstrated considerably lower concentrations of DOC: 20-40 mgC/l in top 5 cm and 10-20 mgC/l in 20 cm depth. It suggests removal of DOC by microbial decomposition or sorption on both slopes. However, the decrease of DOC concentrations with soil depth was more apparent in warmer south-facing slope.

Seasonal changes included the increase of DOC concentrations and fluxes in forest floor from June to September with further sharp decrease up to 20-40 mgC/l depending on time of freezing. However, on inter-annual basis amount of precipitation played the crucial role in a production, release and transport of DOC to soil and adjacent streams. Mid-summer droughts inhibited DOC production, and little precipitation limited abiotic leaching.

Concentrations of DOC in stream have demonstrated overall decrease during frost-free season from 20-30 mgC/l in spring period to 10-15 mgC/l in fall. Progressively increasing active soil layer is thought to control DOC export from terrestrial ecosystems through the increased sorption capability. Meanwhile, intense precipitation occurred throughout frost-free period may significantly alter DOC input to streams. DOC appeared in stormflow is originated primarily from organic rich soil layers escaping mineral soil and consequently removal from a solution. Moreover, qualitative content of stream DOC vary significantly among hydrological phases and seasons.