Changing Dissolved Organic Carbon in Yukon and Mackenzie River Basins

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Mobilization and transport of dissolved organic carbon (DOC) in Arctic watersheds under a changing climate will impact the terrestrial and marine carbon cycles, potentially increasing greenhouse gas production and promoting a harmful positive feedback. Two of these watersheds are the Yukon and Mackenzie River basins, which discharge into Arctic coastal waters. To constrain the release of DOC into these basins, we use an enhanced pan-Arctic Permafrost Water Balance Model (PWBM) to determine permafrost soil, and active layer DOC yields from 1981 to 2010. Over a 30-year period, the mean annual DOC yields from the Yukon and Mackenzie River basins were 2140 mgC/m2 soil and 977 mgC/m2 soil, respectively. Spatially, greater DOC yields were observed along rivers, with particularly high levels associated with the Mackenzie River, ranging from 2445 to 4975 mgC/m2 soil. This enhanced DOC yield within the Mackenzie River basin is due to higher soil organic carbon contents within the watershed, supplying the production of DOC. Seasonally, DOC export is 2-3 times higher in spring and summer compared to autumn and winter, agreeing with field studies. The continual increase in temperature and precipitation since 1981 also leads to a progressive increase in DOC release rates on the order of 1.2 mgC/m2/yr and 3.3 mgC/m2/decade for the Yukon and Mackenzie River basins respectively. As continued warming persists, DOC concentrations are anticipated to rise significantly in the future. This research provides a foundation for understanding carbon export to coastal waters and for assessing the impacts of an intensifying hydrological cycle and permafrost thawing amid ongoing warming in the Arctic.