Modelling dissolved organic carbon response to changing hydroclimate in a Subarctic watershed

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Hydroclimatic regime shifts associated with climate change can be expected to alter freshwater availability and quality. In the far north, where vast quantities of carbon are stored terrestrially, explaining landscape-scale carbon (C) budgets is necessary for understanding the impact of changing hydroclimatic regimes. We simulated streamflow, DOC concentration, and DOC export in a northern Canadian catchment that has undergone notable climate warming using a dynamic modelling approach. The Integrated Catchment model for Carbon (INCA-C) was successfully calibrated to a multi-year period (2012–2016) that represents a range in hydrologic conditions. To assess the potential future response, 30-year periods representing baseline and two future climate scenarios were simulated. Annual discharge is predicted to decrease over the long-term under an elevated temperature scenario (22–27% of baseline) but increase (116–175% of baseline) under an elevated temperature and precipitation scenario. Our results suggest that the current nival hydroclimatic regime will shift to a combined nival and pluvial regime under elevated temperature and precipitation. Average DOC flux is predicted to decrease (24–27% of baseline) under the elevated temperature scenario, as higher DOC concentrations are offset by lower runoff. In contrast, results suggest an increase in carbon export of 64–81% above baseline where both temperature and precipitation increase in the future, owing to greater catchment connectivity. Predicted changes in DOC export (notably in early winter), particularly under a climate that is wetter and warmer could be part of larger ecosystem change requiring additional monitoring efforts in the region.