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Conceptualizing the seasonal and hydrological dynamics of riparian zone control on DOC in boreal headwater streams

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Dissolved organic material (DOM) plays a key role in many natural surface waters. Despite the importance of DOC for the hydrochemistry in boreal headwaters there are few models that conceptualize the controls on short-term variability in stream DOC. A relatively simple model has been proposed where the vertical profile of DOC in the riparian soil solution, serves as an instantaneous "chemostat" setting the DOC of laterally flowing groundwater just before it enters the stream. This paper considers whether the addition of seasonality (in the form of soil temperature) and antecedent flows can improve the predictions of daily DOC concentrations. The model was developed and tested using field data from the Krycklan catchment on the Svartberget Research Station in northern Sweden where a transect of soil solution sampling sites equipped with suction lysimeters and wells for monitoring groundwater level have been installed and monitored for over a decade. The field data showed an exponential correlation between depth and DOC concentration in the soil solution. There was also an exponential correlation between stream discharge and groundwater table position. The expressions for these two correlations (exponential functions) have been combined into a simple riparian DOC model. To simulate effects of seasonality and/or antecedent flow, modules for soil temperature evolution and/or groundwater flow were added and tested. The model was calibrated and tested against 8 years of data from the Västrabäcken headwater catchment in the Krycklan area. To estimate the uncertainty in the model and the observed data a Hornberger-Spear-Young sensitivity analysis together with a GLUE uncertainty analysis was performed.