Geophysical Research Abstracts
Vol. 18, EGU2016-8286, 2016
EGU General Assembly 2016

Carbon fluxes in an acid rain impacted boreal headwater catchment

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Terrestrial carbon export via inland aquatic systems is a key process in the budget of the global carbon cycle. This includes loss of carbon to the atmosphere via gas evasion from rivers or reservoirs as well as carbon fixation in freshwater sediments. Headwater streams are the first endmembers of the transition of carbon between soils, groundwater and surface waters and the atmosphere. In order to quantify these processes the experimental catchment Uhlirska (1.78 km^2) located in the northern Czech Republic was studied. Dissolved inorganic, dissolved organic and particulate organic carbon (DIC, DOC, POC) concentrations and isotopes were analyzed in ground-, soil -and stream waters between 2014 and 2015. In addition, carbon dioxide degassing was quantified via a stable isotope modelling approach. Results show a discharge-weighted total carbon export of 31.99 g C m^{-2} yr^{-1} of which CO_2 degassing accounts 79 %. Carbon isotope ratios (δ^{13}C) of DIC, DOC, and POC (in ‰ VPDB) ranged from -26.6 to -12.4 ‰ from -29.4 to -22.7 ‰ and from -30.6 to -26.6 ‰ respectively. The mean values for DIC are -21.8 ±3.8 ‰ -23.6 ±0.9 ‰ and -19.5 ±3.0 ‰ for soil, shallow ground and surface water compartments. For DOC, these compartments have mean values of -27.1 ±0.3 ‰ -27.0 ±0.8 ‰ and -27.4 ±0.7 ‰Mean POC value of shallow groundwaters and surface waters are -28.8 ±0.8 ‰ and -29.3 ±0.5 ‰ respectively. These isotope ranges indicate little turnover of organic material and predominant silicate weathering. The degassing of CO_2 caused an enrichment of the δ^{13}C-DIC values of up to 6.8 ‰ between a catchment gauge and the catchment outlet over a distance of 866 m. In addition, the Uhlirska catchment has only negligible natural sources of sulphate, yet SO_4^{2-} accounts for 21 % of major stream water ions. This is most likely a remainder from acid rain impacts in the area.