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DOC concentration peaks driven by water table increases at the outlet of mountainous peatlands

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Peatlands in mountains are small and patchy. However, they are biogeochemical hotspots for carbon cycle, and disproportionally contribute to organic carbon transfer to headwater streams. In a harsh mountainous climatic and hydrologic context, this study aims at identifying parameters controlling DOC concentration fluctuations at the outlet of peatlands.

In the French Pyrenees, the variability of the DOC concentration was investigated at the outlet of a fen site (1343 m.a.s.l., 4,7 ha) for four years, and at the outlet of a bog site (706 m.a.s.l, 5,3 ha) for a year and a half. High frequency (30 min) in situ fDOM (fluorescence of dissolved organic matter) sensors were deployed as proxies for DOC concentration. To identify controlling factors on DOC concentration, high frequency data including meteorological parameters and stream discharge were collected at both sites. Water table level and the water temperature were also monitored at a high frequency in piezometers wells at different representative locations in each peatland.

High frequency monitoring reveals a strong variability in DOC concentration at both sites. Most of this variability is related to short ($\sim$30 hours) DOC concentration peaks initiated by precipitation events. Lower mean DOC concentration (1.8 mg.L^{-1}) but stronger DOC increases (5,1 times mean concentration) are observed at the fen site compared to the bog site (mean concentration of 5.9 mg.L^{-1}, and increases of 1,8 times). At both sites, DOC concentration increases are not proportional to the discharge increases observed at the outlet. However, peak analysis reveals that DOC concentration increases are linearly correlated to the averaged water table rises of the whole site. The slope of the linear models differs between sites. Master recession curve analysis was used to classify water table signals from each piezometer well depending on their hydraulic conductivity. This highlights clear differences in hydraulic conductivity between the bog and the fen sites, explaining their different DOC concentration peak models. Fen are flashy systems, characterized by low baseline DOC and strong peaks, when bog sustain higher baseline DOC concentrations but weaker peaks. Whatever peatland types, this study shows that re-wetting of the non-saturated peat layer is a key factor in the DOC transfer processes from peatland to stream in mountainous watersheds.