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# Characterizing seasonal variability of storm events based on very high frequency monitoring of hydrological and chemical variables: comparing patterns in hot spots and hot moments for nutrient and sediment export

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Storm events are critical hot moments of emission for several dissolved and particulate chemical species at major stake for water quality (e.g. dissolved organic carbon DOC, suspended sediments, phosphorus). During such events, the solutes or particles are exported from heterogeneous sources through various pathways to stream leading to specific integrated signals at the outlet characterized by very short dynamics. This is merely true in headwater catchments where the total duration of such events ranges over 10h to 3 days, with very quick variations in stream flow and concentrations at the outlet occurring in a few hours. Thus for investigating properly event processes, high frequency monitoring of flow and water quality is required. We analysed 103 storm events in a 5 km2 agricultural headwater catchment, part of the AgrHys Observatory, on the basis of a 3-year-long data set which combined meterological (Rainfall), hydrological (flow and piezometry), and water quality (turbidity, conductivity, DOC and $NO_3$ concentrations) data recorded at very high frequencies (from 1 to 20 min) thanks to dedicated sensors. We proposed a range of quantitative storm descriptors for characterizing input (rainfall), antecedent and initial conditions (groundwater levels and saturated area), and stream response in terms of level and dynamics of flow (Q), groundwater levels, and concentrations (C) but also the C-Q relationships. Three intra annual periods have been previously defined for base flow dynamic according to shallow groundwater table variations so that they correspond to different connectivity status in the catchment. The seasonal and inter-annual variability of the storm events have been analysed using the descriptors and based on these predefined periods. Results show that the hydrological flowpaths and the consequent storm chemistry were controlled by the hydrological base flow regime rather than by the rain input characteristics. This highlights that the exports of $NO_3$, DOC and sediments during storms may be either synchronized or desynchronized depending on the season. This temporal dynamic of the ratios between species may be at major stake for the aquatic ecosystems response and structure.