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Stream CO_2 concentration dynamics in an agricultural headwater catchment – biological and hydrological controls

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Fluvial systems (streams and rivers) are globally suggested to dominate the inland water CO_2 source to the atmosphere. However, this estimate relies on a number of assumptions and the data scarcity makes the estimate highly uncertain. One of the critical knowledge gaps is the lack of directly sampled and temporally resolved data from agriculture dominated areas. Agriculture land is heavily managed by humans (drainage, nutrient addition, soil cultivation etc.), while magnitude and dynamics of stream CO_2 are likely very different compared to areas of other land-use (e.g. forest and wetland). Here we present high-frequency stream CO_2 concentration data collected from a Swedish agricultural headwater catchment covering more than a year of open water including periods of snowmelt, drought as well as rain storms. The stream displayed high but at the same time very variable CO_2 concentrations (median = 3.4 mg C L-1, IQR = 3.3 mg C L-1). The high dynamics were both controlled by the rapid hydrological response to precipitation but also to high biological activity causing diel cycles in CO_2 with amplitudes of < 3.2 mg C L-1. Also, rain storm events following periods of drought caused elevated stream CO_2 concentrations. The high diel dynamics and the short-term events would have been missed with standard snapshot sampling. Furthermore, the stable isotopic composition of the DIC pool suggests a mixture of geogenic and biogenic inorganic C sources indicating that geogenic C might be used in primary production. The study highlight the need for further studies of stream CO_2 in agricultural areas and where high-frequency measurements will be a requirement for capturing the dynamics.