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Surprises from stream greenhouse gas emissions estimated at high resolution in a catchment

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Streams represent environments where terrestrial and aquatic habitats meet and has recently been recognized as disproportionally large emitters of CO_2 in landscapes. However, previous estimates are often based on measurements with low resolution in time and space, and frequently CO_2 concentrations are also estimated indirectly from alkalinity and pH measurements adding to the uncertainty. The capacity of streams to emit CH4 is presently also poorly understood. In this study, we performed regular and spatially distributed measurements of CO_2 and CH4 water concentrations and gas exchange rates in a headwater stream network, aiming to resolve spatial and temporal variability in flux patterns. Multiple supplementary methods including tracer injections, CO_2 sensor networks, drifting flux chambers, and stream section mass balances were performed. A locally validated spatiotemporal model with high accuracy and resolution was developed. The observed variability was high revealing high fluxes very locally or during short periods in time related to rapid hydrological events, highlighting the need to consider spatiotemporal variability in detail. Stream CH4 emissions were also surprisingly high compared to CO_2 emissions.