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Optimizing chambers for stream carbon dioxide evasion estimates; results of a controlled flume experiment.

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Fluvial ecosystems have a huge potential to affect the global carbon budget. In particular, streams and rivers significantly contribute to carbon dioxide emissions. However, CO2 fluxes from streams to the atmosphere exhibit a marked spatial and temporal variability that is difficult to quantify. Spatio-temporal patterns of biogeochemical fluxes are the result of interconnected unsteady hydrological (e.g. discharge, stream's length and area, air-water gas exchange velocities) and biochemical conditions. Local estimates of carbon dioxide fluxes from a water body require the simultaneous knowledge of gas exchange coefficients and carbon dioxide concentrations. Different methods (e.g. tracer gas addition, oxygen time series, eddy covariance technique, flux chambers) have been recently developed to obtain point or spatially integrated measures of carbon fluxes under different environmental conditions. Here, we present the results of a flume experiment conducted in the Lunzer Rinnen facility in Lunz am See (Austria). The contribution discusses the dependence of the air-water gas exchange velocities on a set of relevant physical flow properties (i.e. slope, water velocity, discharge). The experimental setup is representative of low slope/velocity streams (flume energy dissipation rate less than 0.01). Gas exchange velocities were evaluated interpreting CO2 observations derived from a standard and an ad-hoc designed flexible-foil CO2 chamber under different deployment modes - anchored and drifting. Our data confirms that higher slopes and flow velocity enhance air-water gas exchange velocities; hence, CO2 outgassing rates in rivers. Moreover, the flexible foil chamber developed for this experiment is shown to be a useful tool for the estimate of local CO2 outgassing rates as it reduces the turbulence induced by the standard chamber on the streamflow. Given the flexibility/simplicity of the floating chamber its use can improve the ability to quantify spatio-temporal patterns of CO2 outgassing in streams.