Challenges and potential solutions to measuring greenhouse gas emissions from mesocosm experiments

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ABSTRACT

Emissions of greenhouse gases (GHG) from fresh waters are significant but often poorly constrained, in part due to the paucity of measurements. Accurately characterizing GHG, in this case carbon dioxide (CO_2) and methane (CH_4), dynamics in lakes is challenging due to highly variable emissions in time and space. Furthermore, a large proportion of methane (CH_4) may be released sporadically as ebullition, or bubble flux. This has led to a desire for an increased frequency of measurements. There is an increasing range of reliable GHG monitors (e.g. LGR, Picarro, Licor) that run through smart automatic chambers to measure mesocosms in sequence, but applying such to a larger system of 24 mesocosms is very expensive. Here we outline the development, testing and results from an alternative approach using chambers containing low-cost sensors. Here we measure CH_4 (Figaro TGS 2611 metal oxide sensors) and CO_2 (Sensiron scd30) along with temperature and relative humidity across the 24 mesocosms of the lake warming mesocosm experiment (LWME) at Aarhus University. A simple flushing system lifts the chambers 6 times a day, which allows the estimation of diffusive and ebullitive flux at a four-hour resolution. Such high resolution, continuous data provides a reliable quantification of GHG dynamics in shallow lake ecosystems. From such data, it is possible to assess the most parsimonious approach to sampling in the absence of a system capable of high frequency measurements. In the case of the LWME this allows the investigation of the role of eutrophication and temperature in shaping GHG dynamics in shallow lakes. The system has a relatively low power consumption and can therefore be applied at mobile mesocosm systems with a solar power setup, allowing off grid application.

KEYWORDS: GHG, High frequency measurement, low cost sensors, automation, eutrophication