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Using low cost CH4, CO_2 sensors in a Digimesh network on lakes to study aquatic CH4 and CO_2 gases flux.

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Aquatic ecosystems are major sources of greenhouse gases (GHG). Robust measurements of natural GHG emissions are important for evaluating regional to global carbon budgets and for assessing climate feedbacks on natural emissions to improve climate models. Diffusive and ebullitive (bubble) transport are two major pathways of gas release from surface waters. To capture the high temporal variability of these fluxes in a well-defined footprint, we designed and built an inexpensive device that includes an easily mobile diffusive flux chamber and a bubble counter, all in one. Besides a function of automatically collecting gas samples for subsequent various analyses in the laboratory, this device utilizes a low cost CH4 sensor (Figaro, Japan) and CO_2 sensor (SenseAir, Sweden) to measure GHG fluxes in the chamber. CH4 sensor and CO_2 sensor have linear responses in range from atmospheric level to about 25 ppm and 5000 ppm, respectively, that are comparable to a GC-FID and a spectrometric gas analyzer (Los Gatos Research Inc.; DLT 100). The bubble counter uses a pressure sensor to measure bubble volume in range 2 - 30 mL. The flux chamber and the bubble counter are automatically opened/closed by a diaphragm pump and two 3-way valves. To measure the spatial variability of emissions, each of the devices is equipped with an XBee module that enables local radio communication (DigiMesh network), time synchronization, and data readout at a server-controller station on the lakeshore. Software of this server-controller is operated on a low-cost Raspberry Pi computer which has a 3G/4G connection for remote control and monitor functions from anywhere in the world. The networks have been deployed over summer in small lakes in Abisko, Umeå and Linkoping, Sweden. This study shows the potential of a low cost automatic sensor network system to study GHG fluxes on remote lakes with high temporal and spatial resolutions.