



*Supplement of*

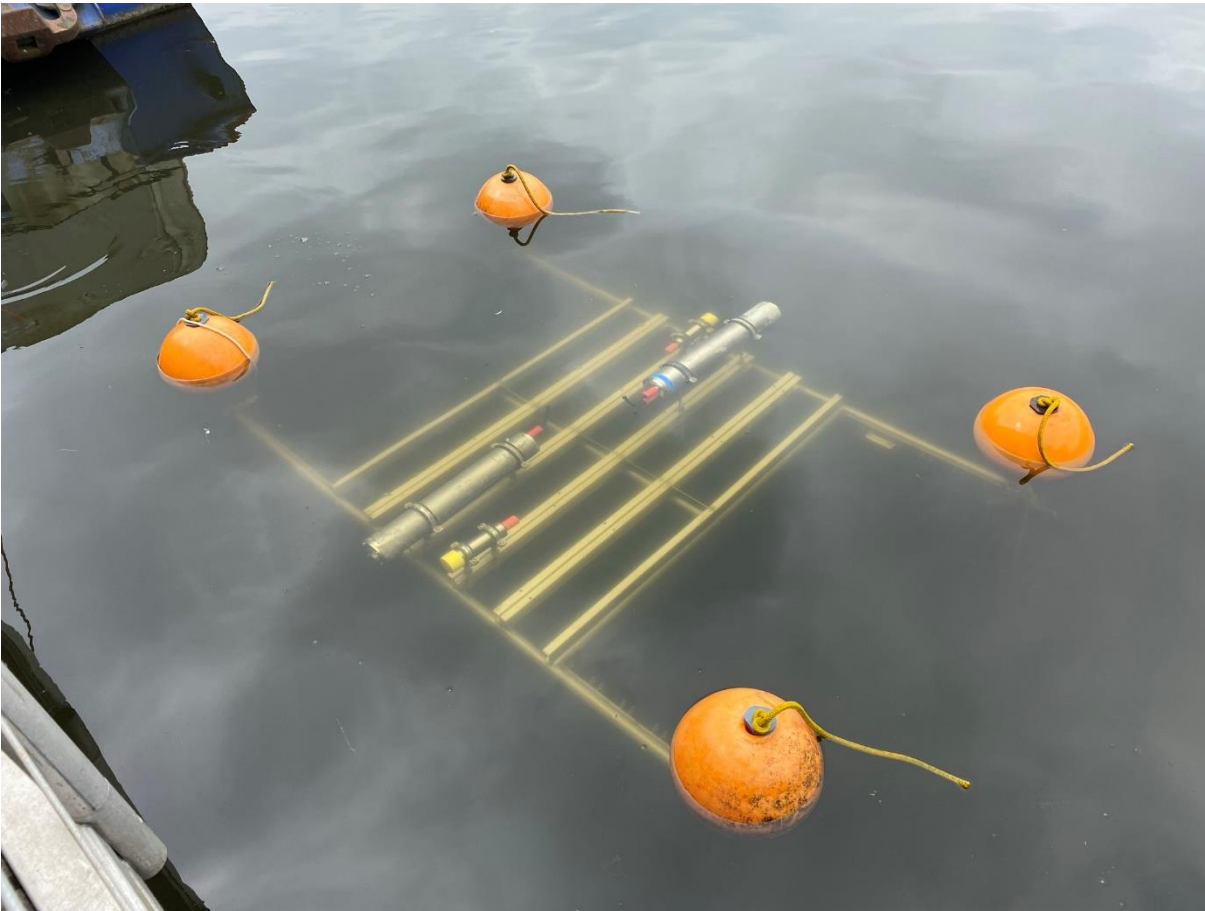
## **Surface CO<sub>2</sub> gradients challenge conventional CO<sub>2</sub> emission quantification in lentic water bodies under calm conditions**

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## S1 Setup and calibration of probes for dissolved gases



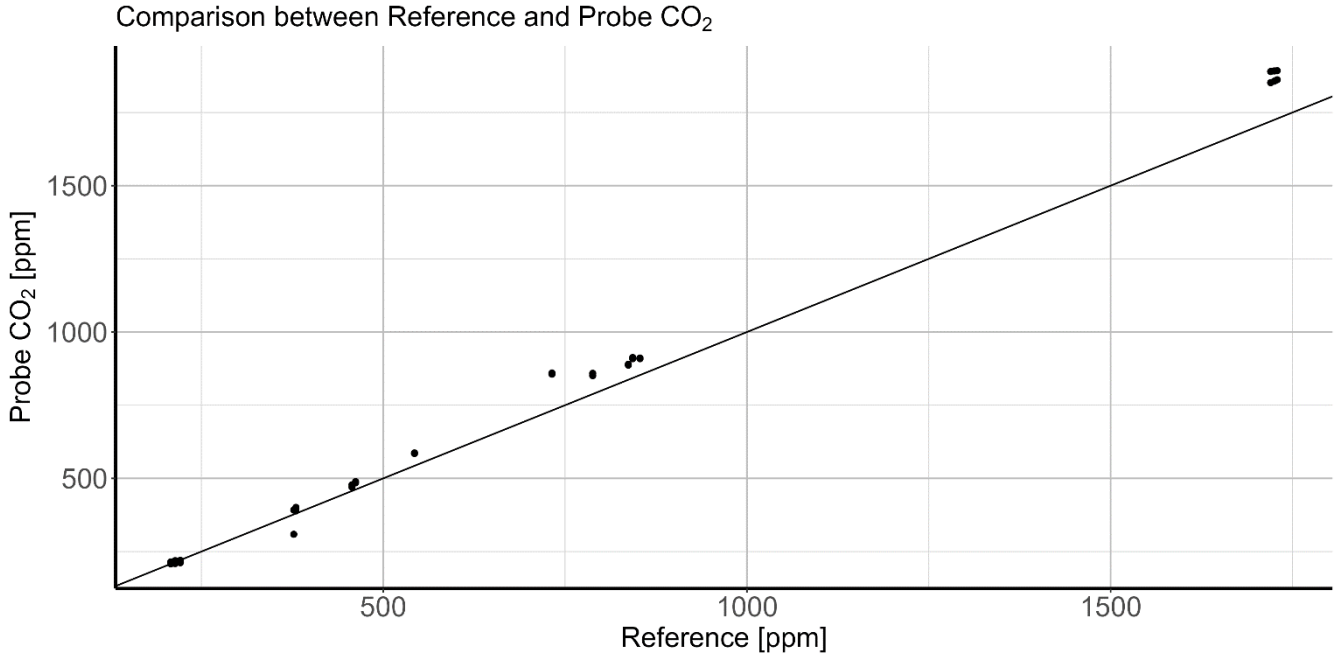
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**Figure S 1: Photograph of the CO<sub>2</sub> sensors (large metallic probes, Contros HydroC, -4H- JENA engineering, Germany) installed on the floating frame. The mounts of the probes could be extended to adjust the distance between the probes to 20 cm, and the ropes on the buoyancy bodies could be extended to lower the entire frame. By that, the depth of the probes could be adjusted to allow measurements in 5 cm and 25 cm depth.**

- 15 Two CO<sub>2</sub> probes (CONTROS Hydro-C CO<sub>2</sub>, 4H Jena Engineering, Germany) were set to measurement cycles of 1400 minutes, followed by 3-minute zero measurement, and 37-minute flushing. During internal zero a blank measurement is performed, which is used to recalibrate measurements in the post-processing procedure. After these zero measurements, a flush period creates quality flags in the dataset, because the CO<sub>2</sub> concentration in the sample volume of the detector cell might be influenced by the zeroing. Those flagged measurements were discarded before data analysis.
- 20 The Contros CO<sub>2</sub> probes came with a factory calibration in the range of 100 ppm to 3500 ppm. In addition we performed a cross validation by running both probes in a water filled sink and an infrared gas analyser (EGM-5, PP-Systems, USA) coupled to a membrane contactor (MiniModule, Liqui-Cel, USA) as a reference system (as in Koschorreck et al., 2021; Figure S 2).

The validation in the laboratory was done in a range of 208 ppm to 1729 ppm, where the mean relative error (following equation) was 6.1 % and 4.6 % for probe 1 (0.05 m depth) and probe 2 (0.25 m depth), respectively (Figure S 2).

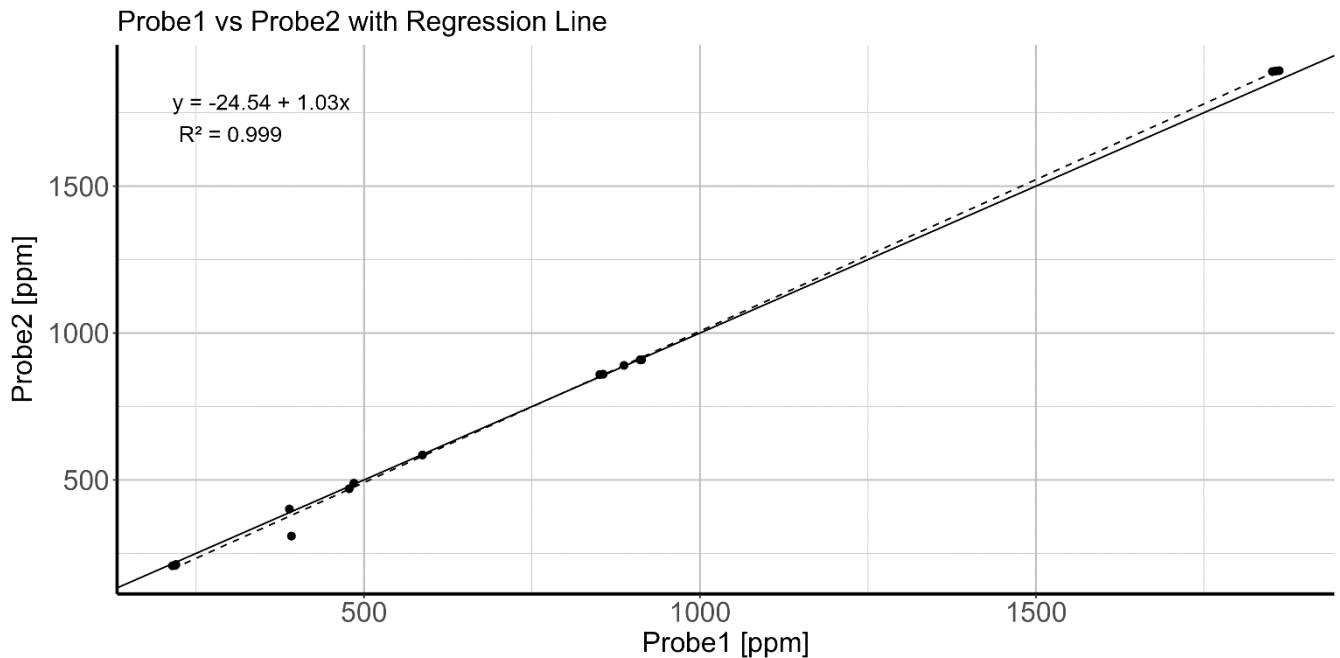
$$25 \quad MRE = \frac{(Probe_{CO_2} - Reference_{CO_2})}{Reference_{CO_2}} * 100$$



**Figure S 2: CO<sub>2</sub> measurement comparison between the two CO<sub>2</sub> probes and the Reference. Dots indicate measurements and the solid line shows  $y = x$ . CO<sub>2</sub> Probe calibration was performed in a water filled sink with both probes being deployed at the same time. The probe measurements align well to each other with a correlation coefficient of 0.99. In addition, an infrared gas analyser (EGM-4, PP-Systems, USA) coupled to a membrane contactor (MiniModule, Liqui-Cel, USA) was used as a reference system to quantify probe errors. The mean absolute errors of CO<sub>2</sub> were 55.4 ppm and 66.2 ppm for Probe1 and Probe2, respectively. Relative errors were -6.14 % and -4.6 % for Probe1 and Probe2, respectively.**

The two probes did not differ significantly when compared with each other ( $R^2 = 0.999$ , Figure S 3). This comparison is of particular importance because the differences in concentration between the two depths were analyzed in the field experiment.

35 The good agreement between the two probes confirms the robustness of the measured gradients in the lake.



40 **Figure S 3: CO<sub>2</sub> measurement comparison between the two CO<sub>2</sub> probes. Dots indicate measurements, dashed line is a linear regression ( $y = 1.03x - 24.54$ ), and the solid line shows  $y = x$ . CO<sub>2</sub> Probe calibration was performed in a water filled sink with both probes being deployed at the same time. The probe measurements align well to each other with a correlation coefficient of 0.99.**

Oxygen sensors were checked using oxygen-free (treated with sodium sulfite) water and air-saturated water before deployment (constant bubbling with air). After deployment, the sensors were put in 100 % air saturated water to measure possible drifts. However, no significant drift was detected after the sampling period.

45 To measure the influence of surface stratification on oxygen concentrations, we installed an additional O<sub>2</sub> Sensor in 0.25 m depth. Unfortunately, that sensor failed to log data and we could not analyze those effects.

## S2 Data analysis

50 Data derived from concentration measurements was analysed using R (R Core Team, 2024). Day and night averages were calculated using sunrise and sunset times determined using the *is.day* function.  $U_{10}$  was calculated from wind speed at 2 m height using the *wind.scale* function, which is based on a logarithmic wind speed profile. Gas transfer velocities were calculated from  $U_{10}$ , using the *k.cole.base* function, referring to the parametrization explained in Cole and Caraco (1998). Gross primary production (GPP) and respiration (R) were calculated using the *metab* function. All those functions are part of the LakeMetabolizer package (version 1.5.5; Winslow et al., 2016).