

Supplement of

Stratification-induced hypoxia shapes greenhouse gas dynamics in ponds

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Supplementary methods

Temperature profiles collected during each sampling occasion showed strong overall agreement between the measurements collected with Aqua TROLL and the ones recorded by the Hobo temperature loggers, despite the low accuracy of the last ones. A strong overall agreement was then found between the two types of measurement in defining the occurrence of stratification: in 58 of 60 cases. In the two cases where there was a mismatch, a coherent definition between the two kinds of measurements was found if using the daily mean of temperature, instead of the closest recorded measurement in time (Figs. S1, S2).

Wind speed data were obtained from the Danish Meteorological Institute (DMI). The dataset provides daily mean wind speed at 10 m height. The data are reported on a regular grid with a spatial resolution of 20×20 km, where each value represents the area-averaged wind speed within a grid cell. Data documentation is available at: <https://www.dmi.dk/friedata/dokumentation/meteorological-observations-data>

Supplementary results

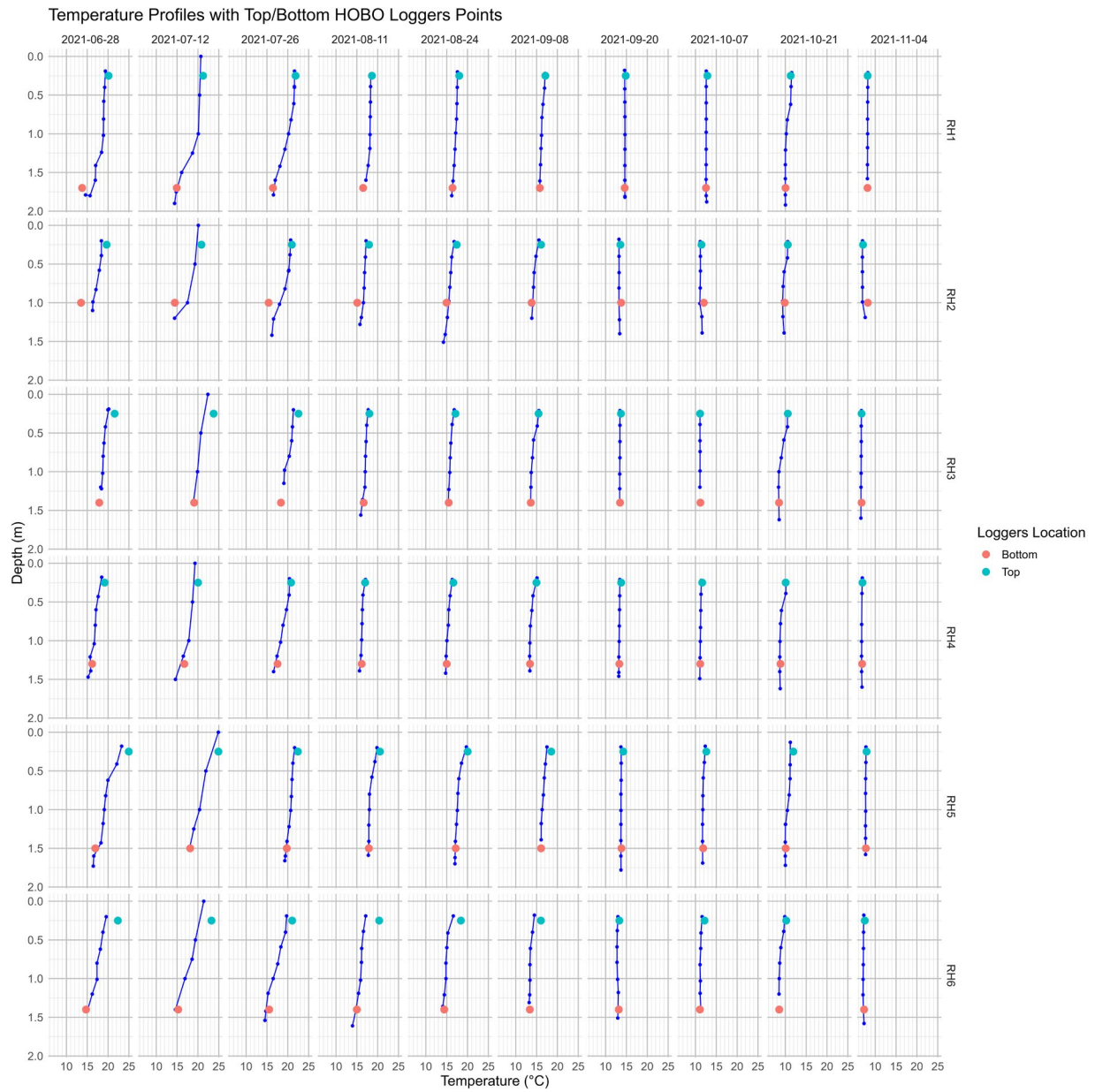


Figure S1 Water temperature profiles expressed by the depth of the water column (y axis) and the temperature recorded (x axis) by Aqua TROLL sensor (dark blue points and line) and temperature measurements in top (light blue points) and bottom (red points) waters recorded by HOBO. The measurements represent the data from the six ponds (noted RH1-6) measured from 28 June to 4 November 2021



Figure S2 Comparison of mixed (in blue) and stratified (in red) patterns recorded by Aqua TROLL sensor (circles) and HOBO loggers (triangles). The measurements represent the data from the six ponds (noted RH1-6) measured from 28 June to 4 November 2021

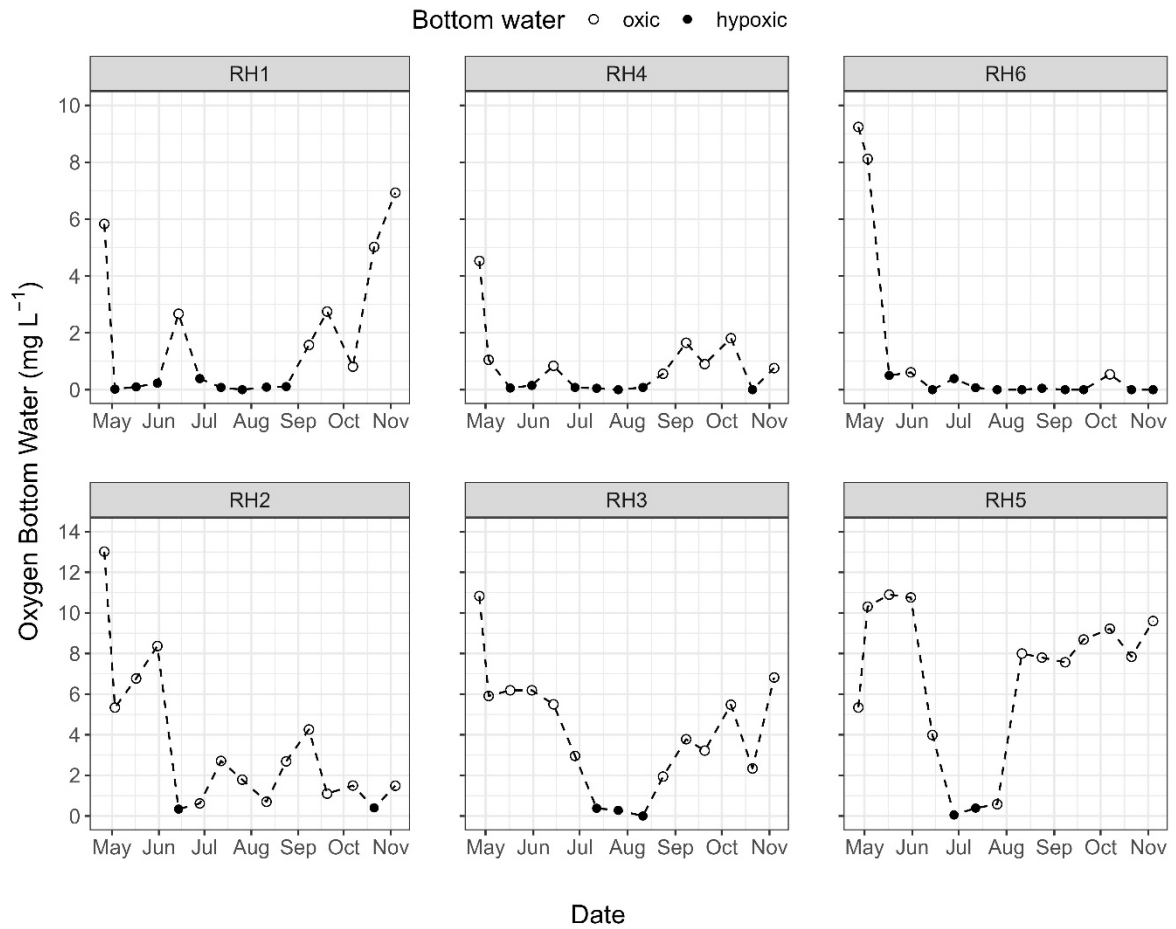


Figure S3 Dissolved oxygen concentrations (mg L⁻¹) in the bottom water in the six ponds (RH1-6) for 192 days, from 27 April to 4 November 2021. Full dots are periods of stratification and hypoxia (oxygen concentrations ≤ 0.5 mg L⁻¹), empty dots are periods of fully mixed water column (bottom-water oxygen concentration > 0.5 mg L⁻¹).

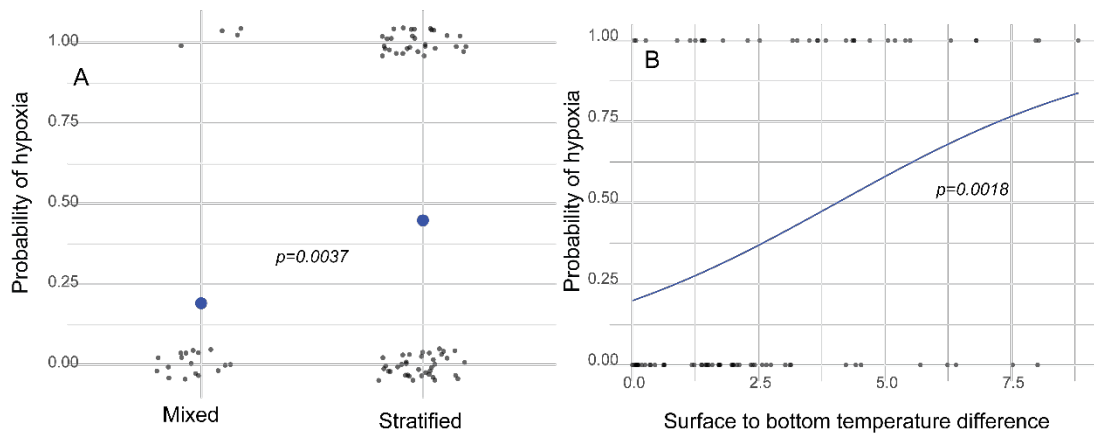


Figure S4 Logistic regression results for A) the probability of hypoxia ($\text{DO} < 0.5 \text{ mg l}^{-1}$) in the bottom water as a function of whether the pond is mixed or stratified. The filled dots are jittered observations showing the occurrence of hypoxia or not in a thermally mixed versus stratified state and the larger blue dots represent the probability of hypoxia in each state. There is a weak significant increase in likelihood of hypoxia with stratification ($p=0.037$), but with a $< 50\%$ chance of hypoxia in the stratified state and; B) the probability of hypoxia as a function of the difference between surface and bottom temperature, as the temperature difference increase there is a significantly higher chance of hypoxia.

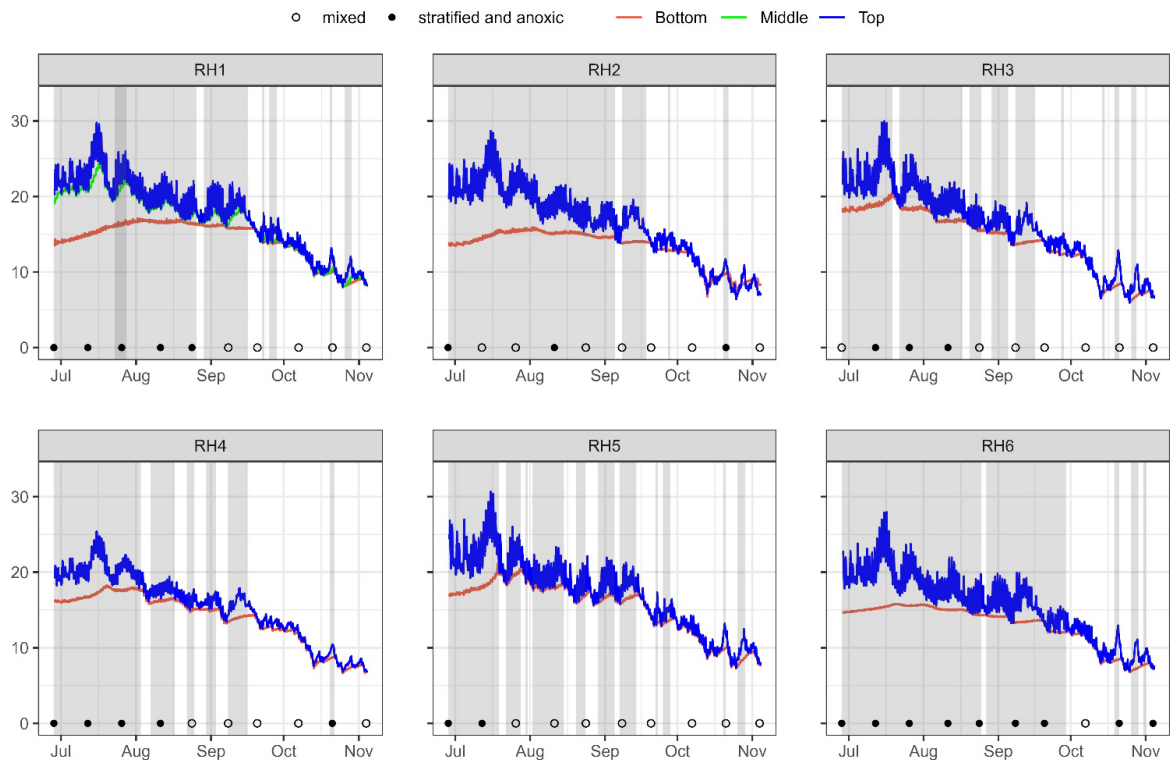


Figure S5 Plots showing water temperature measured daily from 28 June to 4 November 2021 in surface and bottom water in six ponds (noted RH1-6). For RH1, temperature was also measured with a sensor placed in the middle of the water column. Red lines represent temperature measured at the bottom water, green lines the middle water and blue lines the surface water. Shaded areas correspond to pond stratification (based on surface-bottom temperature). Darker shaded areas correspond to stratification between surface and middle water (surface-middle temperature).

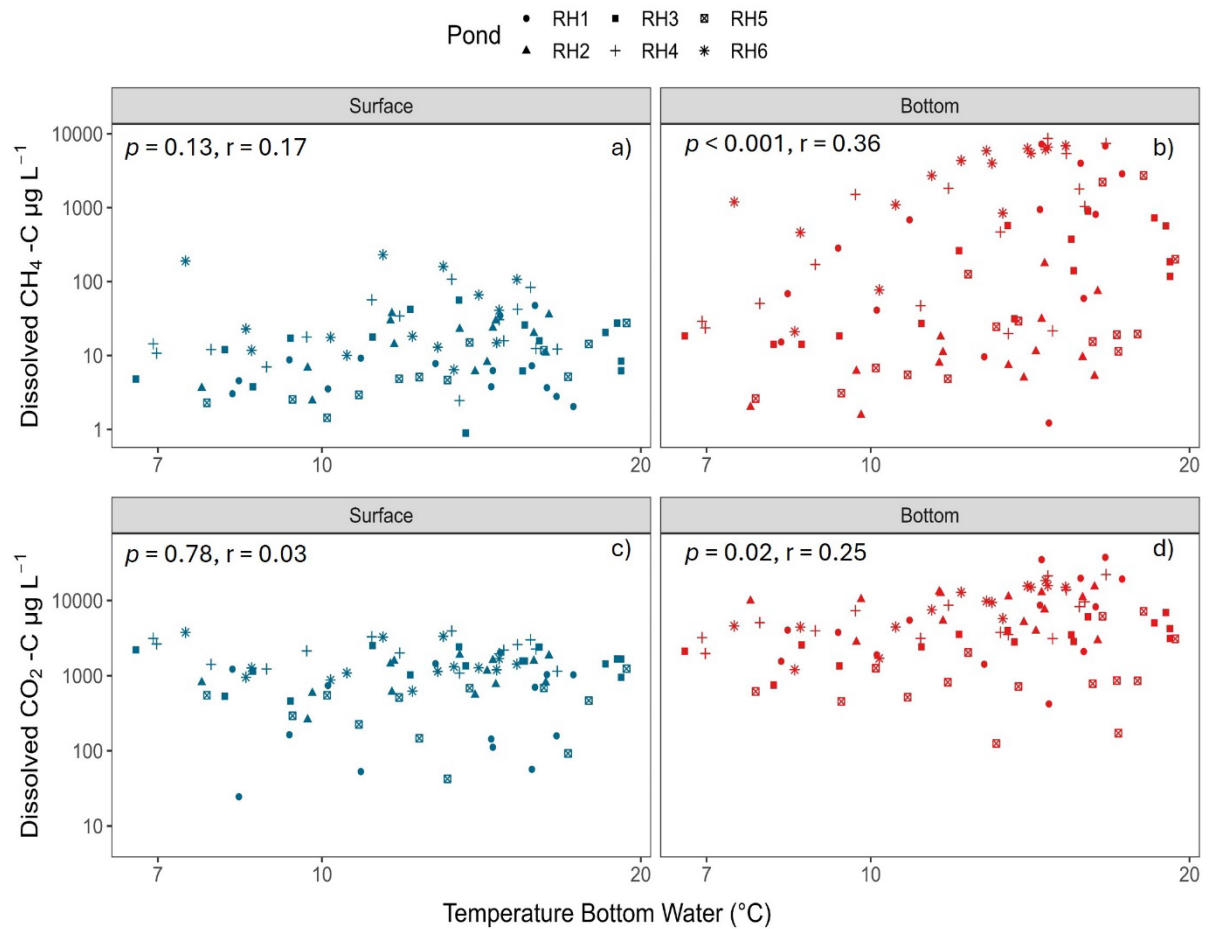


Figure S6 Concentrations of dissolved CH₄ (a, b) and dissolved CO₂ (c, d) in bottom (red points) and surface (blue points) water in all the ponds, in relation to the temperature in the bottom water (°C) at the sampling moment. Different shapes correspond to different ponds. The *p*- values and *r*-values correspond to the results from the Pearson correlation test between the response variable (left y axis) and the temperature in the bottom water (°C).

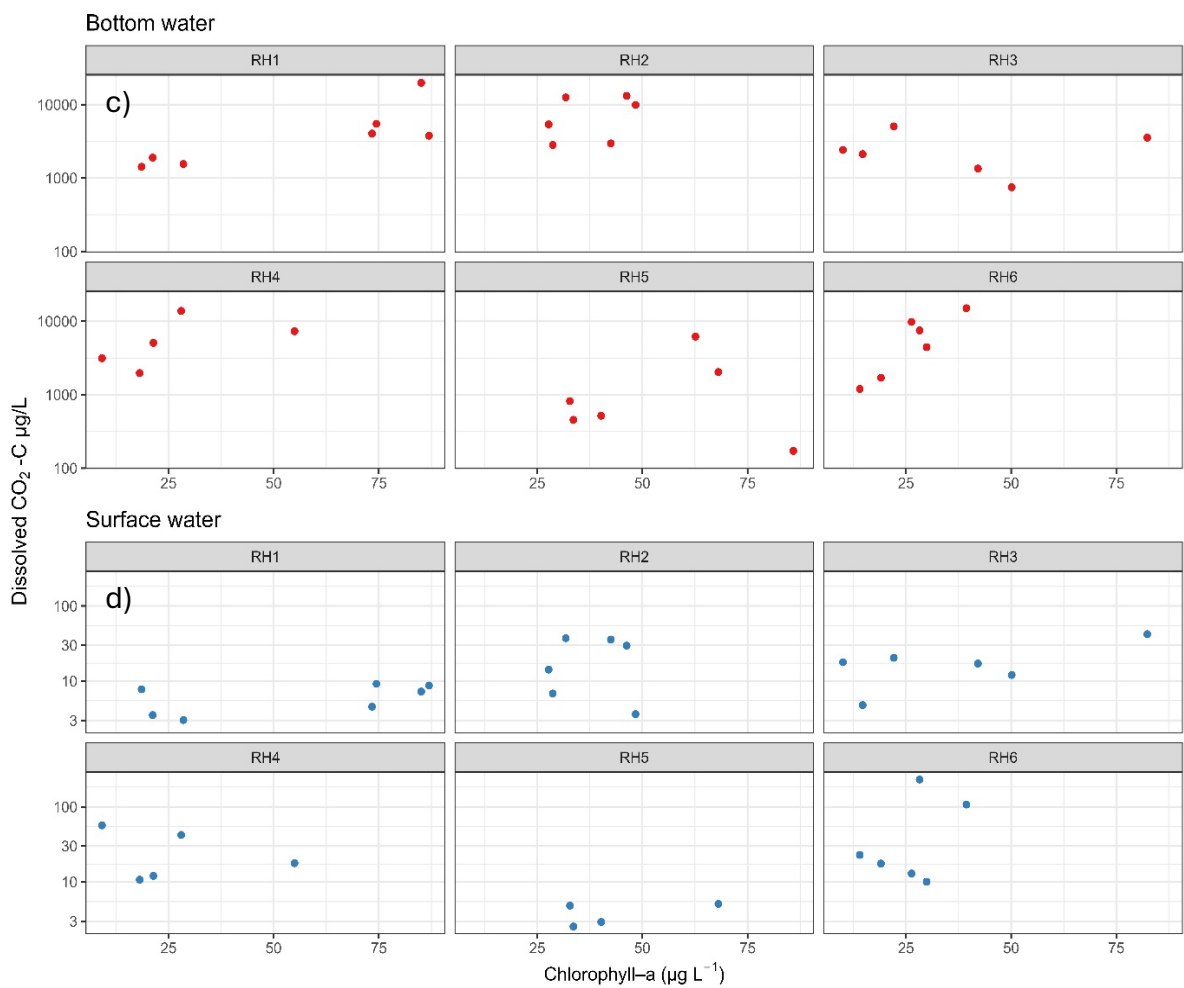
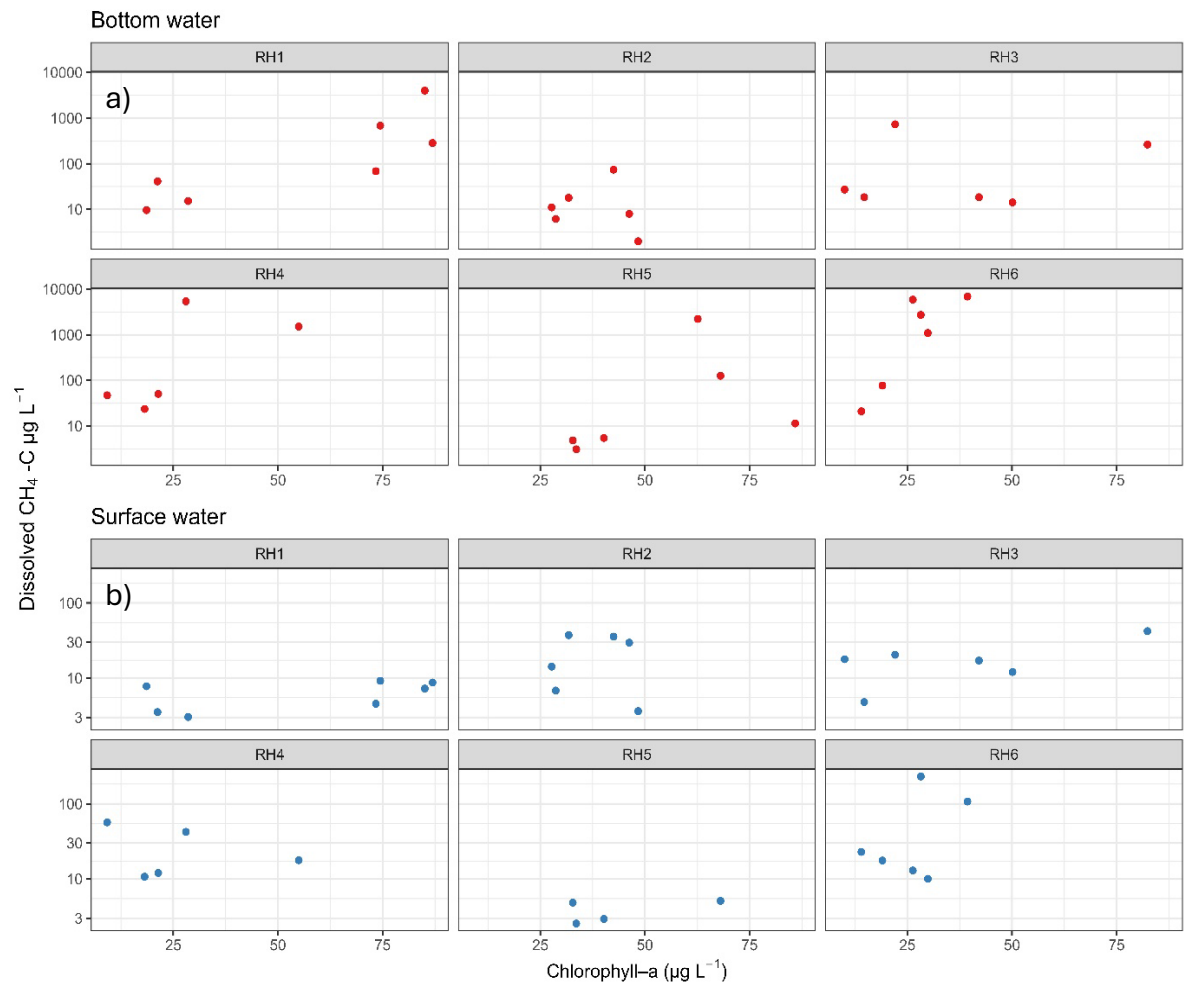


Figure S7 Dot plots showing the concentrations in bottom and surface water of dissolved CH₄ (a, b) and dissolved CO₂ (c, d) in the six ponds (RH1- RH6) by their level of chlorophyll *a* in the water column. Blue dots represent values of CH₄ or CO₂ in the surface water, while red dots indicate values of CH₄ or CO₂ in the bottom water

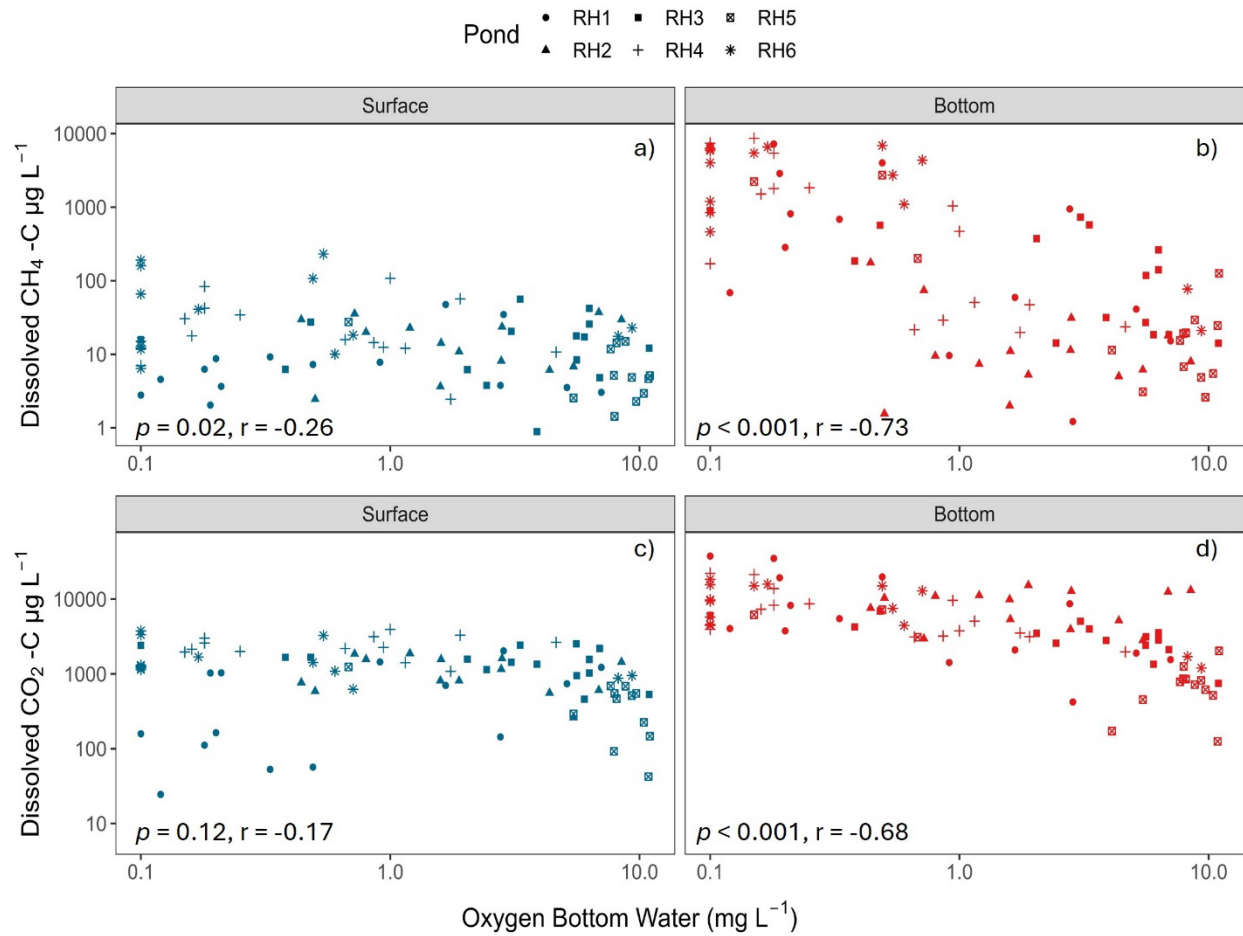


Figure S8 Concentrations of dissolved CH₄ (a, b) and dissolved CO₂ (c, d) in bottom (red points) and surface (blue points) water in all the ponds in relation to the concentration of oxygen in the bottom water (mg L⁻¹) at the sampling moment. Different shapes correspond to different ponds. The *p*- values and *r*-values correspond to the results from the Pearson correlation test between the response variable (left y axis) and the concentration of oxygen in the bottom water (mg L⁻¹).

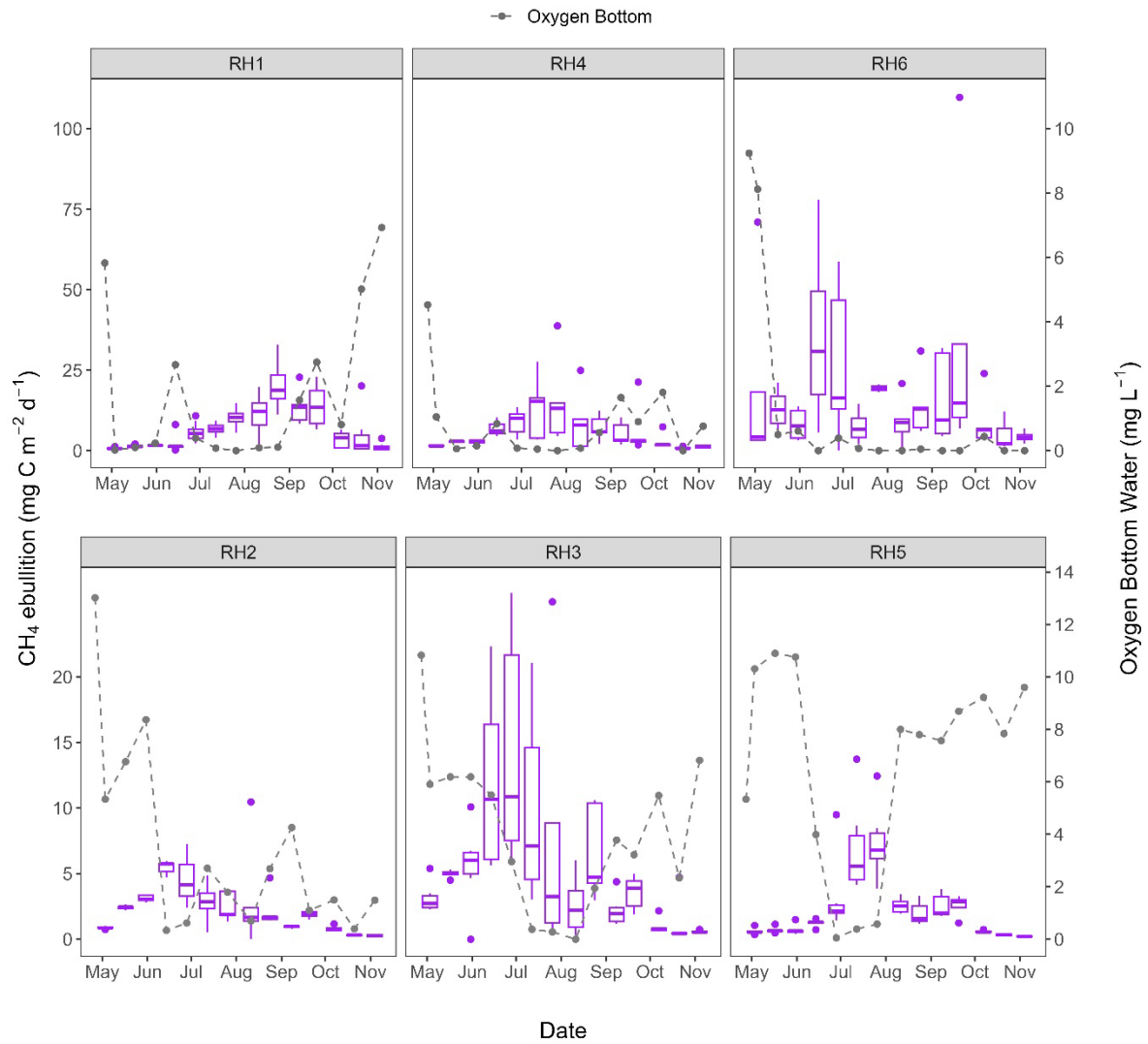


Figure S9 Boxplots showing the fluxes of CH₄ ebullition (mg C m⁻² d⁻¹) among the chambers for each pond (RH1-6) from 27 April to 4 November 2021. The median and interquartile range (IQR) are given, and whiskers indicate minimum and maximum values, excluding outliers (calculated as box limits $\pm 1.5 \times \text{IQR}$). On the right y axis, the dashed lines correspond to the bottom water dissolved oxygen concentrations (mg L⁻¹). Note the different scales used on the y axes.

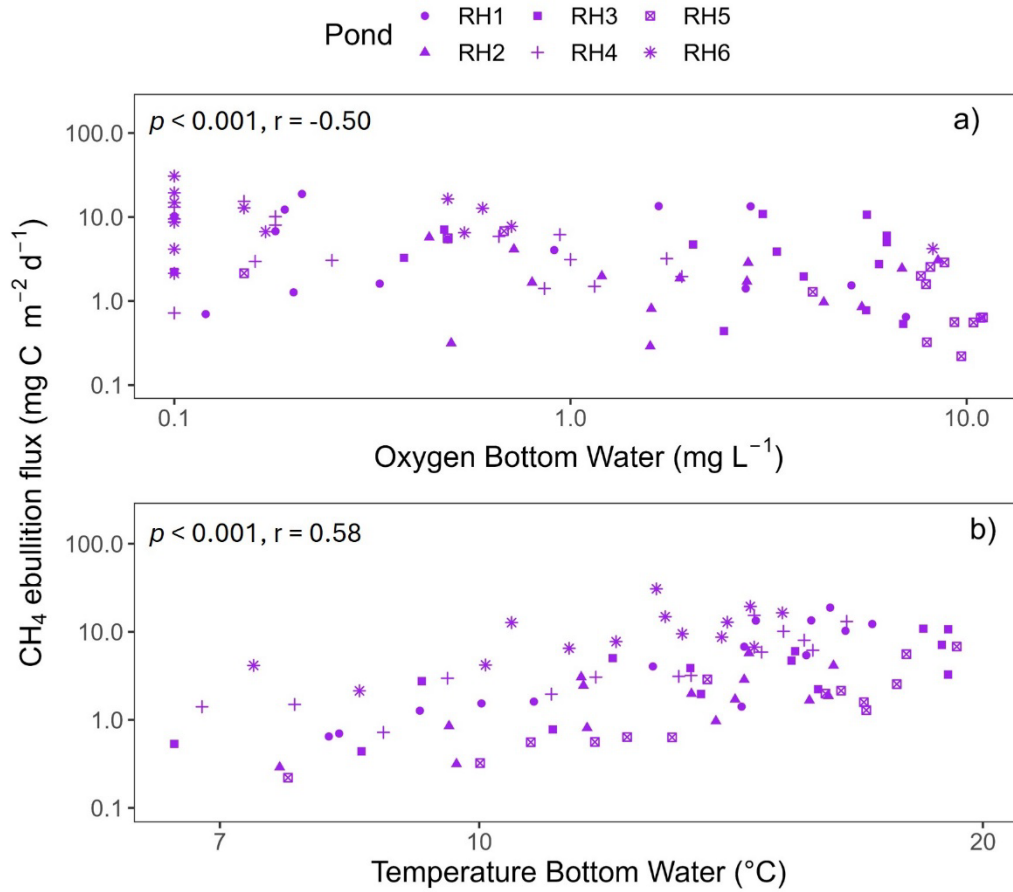


Figure S10 Fluxes of CH₄ ebullition (mg C m⁻² d⁻¹) in all the ponds according to the concentration of oxygen (mg L⁻¹, Fig. S8a) and temperature in the bottom water (°C, Fig. S8b) at the sampling moment. Different shapes correspond to different ponds. The p -values and r -values correspond to the results from the Pearson correlation test between the response variable (left y axis) and the concentration of oxygen in the bottom water (a) or the temperature in the bottom water (b).

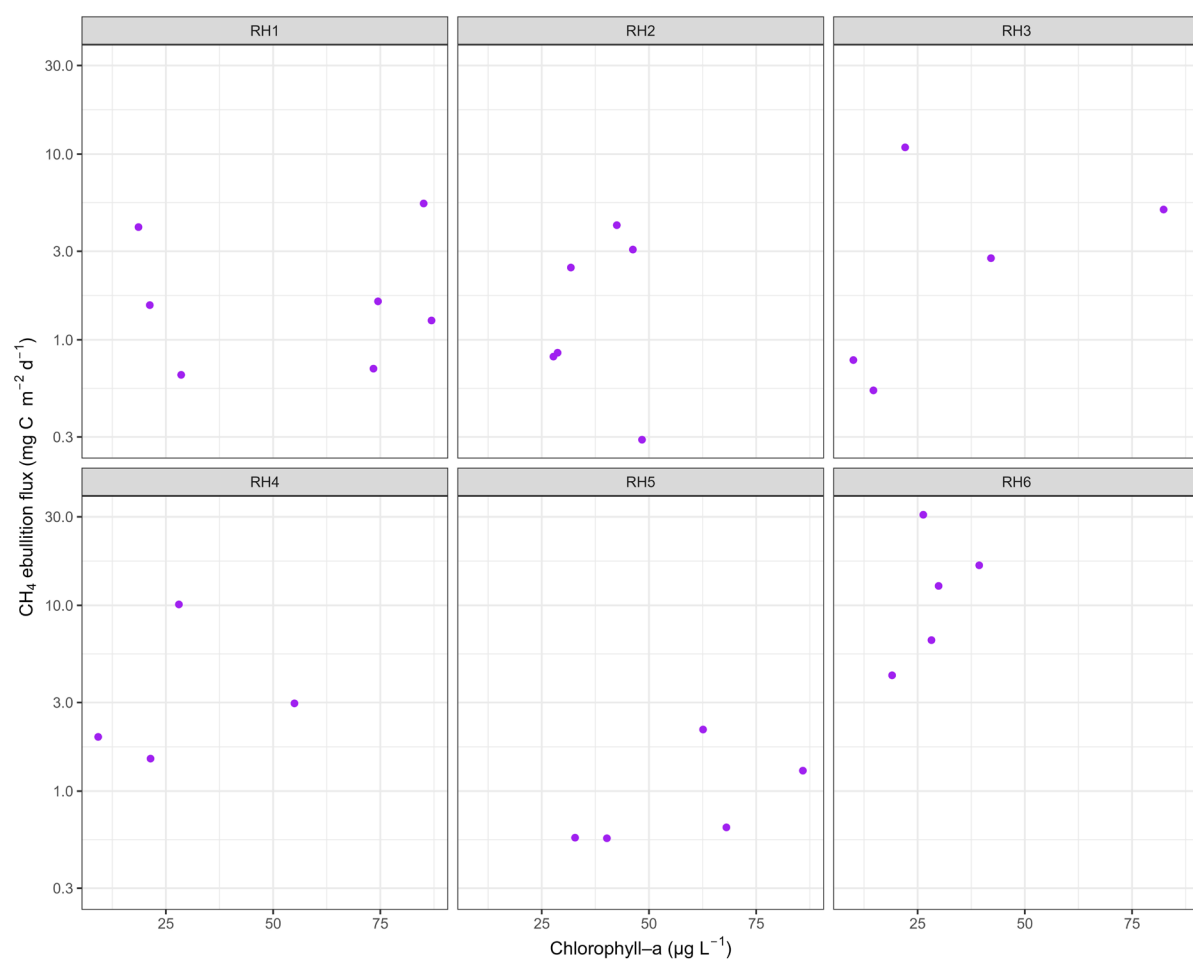


Figure S11 Dot plots showing the fluxes of CH_4 ebullition (mg C m⁻² d⁻¹) among the chambers for each pond (RH1-6) by their level of chlorophyll *a* in the water column.