Supp. Table 1. Summary table of the p-values obtained for the one-way ANOVA or Kruskal-Wallis comparisons between Rdaytime, Rnight and R24h estimated with the Max and the Most methods. SS refers to the comparison of the estimates integrated from sunrise to sunset, and PP those integrated over the production period. The *p*-values smaller than 0.05 were considered as significant and are presented in bold.

Estimate	Integration	Oct-1	Oct-2	Oct-3	Jun-1	Jun-2	Jun-3
Rdaytime	SS	**6.7×10^{-6}**	**2.1×10^{-6}**	**9.4×10^{-6}**	**6.7×10^{-6}**	**1.4×10^{-4}**	**9.5×10^{-5}**
	PP	**4.9×10^{-5}**	**4.1×10^{-5}**	**1.7×10^{-4}**	**4.1×10^{-5}**	**4.0×10^{-4}**	**6.9×10^{-5}**
Rnight	SS	0.62	**0.03**	0.14	**0.03**	0.07	**0.01**
	PP	0.59	**0.03**	0.32	**0.04**	0.09	**0.01**
R24h	SS	**9.3×10^{-3}**	**3.7×10^{-3}**	**0.01**	**1.7×10^{-4}**	**3.1×10^{-4}**	**7.0×10^{-4}**
	PP	0.08	**0.01**	**0.02**	**2.2×10^{-3}**	**9.1×10^{-4}**	**1.1×10^{-3}**

Supp. Table 2. Day-by-day differences between estimates obtained with the Max method and with the Most method. Comparisons were done between each value obtained with the Max method and the corresponding value obtained with the Most method (obtained for the same mesocosm and for the same day). n.a.: value not available

Mesocosm	Day	$\frac{RdaytimeMax - RdaytimeMost}{RdaytimeMost} * 100$ (%)	$\frac{RnightMax - RnightMost}{RnightMost} * 100$ (%)
Jun-1	2	91.86	-10.96
Jun-1	3	255.55	-21.86
Jun-1	4	166.78	-16.94
Jun-1	5	168.50	-20.52
Jun-1	6	105.96	-11.11
Jun-1	7	127.17	-14.36
Jun-1	8	86.21	-10.58
Jun-1	9	96.33	-12.43
Jun-1	10	109.96	-15.94
Jun-1	11	48.95	7.46
Jun-1	12	81.92	-9.86
Jun-1	13	45.76	11.47
Jun-1	14	35.15	11.14
Jun-1	15	54.54	10.97
Jun-1	16	65.07	-2.31
Jun-1	17	104.72	-8.75
Oct-1	2	95.97	-5.08
Oct-1	3	267.52	-10.07
Oct-1	4	100.63	-5.80
Oct-1	5	173.96	-11.74
Oct-1	6	110.84	-6.53
Oct-1	7	149.83	-9.18

Oct-1	8	197.39	-5.91
Oct-1	9	378.59	-14.85
Oct-1	10	90.58	-6.94
Oct-1	11	107.32	-7.31
Oct-1	12	396.78	-14.76
Oct-1	13	167.79	-8.63
Oct-1	14	485.44	-5.23
Oct-1	15	212.18	-7.46
Jun-2	2	108.31	-15.83
Jun-2	3	207.13	-19.33
Jun-2	4	119.28	-11.91
Jun-2	5	218.74	-21.92
Jun-2	6	94.49	-12.20
Jun-2	7	68.23	-8.04
Jun-2	8	101.47	-16.25
Jun-2	9	66.79	-7.62
Jun-2	10	118.54	-19.20
Jun-2	11	n.a.	n.a.
Jun-2	12	59.13	-7.34
Jun-2	13	57.70	12.95
Jun-2	14	34.84	12.10
Jun-2	15	47.32	32.42
Jun-2	16	55.22	-2.09
Jun-2	17	74.94	36.07
Oct-2	2	94.88	-5.05
Oct-2	3	296.31	-10.08
Oct-2	4	105.92	-5.86
Oct-2	5	186.89	-11.86
Oct-2	6	113.24	-6.16
Oct-2	7	156.36	-9.43
Oct-2	8	436.17	-7.48
Oct-2	9	754.91	-15.35
Oct-2	10	190.30	-15.09
Oct-2	11	171.10	-12.03
Oct-2	12	437.40	-17.01
Oct-2	13	247.38	-13.45
Oct-2	14	465.52	-7.02
Oct-2	15	-12.66	0.74
Jun-3	2	109.54	-17.03
Jun-3	3	196.16	-19.31
Jun-3	4	119.06	-12.30
Jun-3	5	186.73	-23.23
Jun-3	6	129.94	-12.42
Jun-3	7	132.34	-14.68
Jun-3	8	87.04	-9.50
Jun-3	9	97.79	-14.54

Jun-3	10	108.25	-14.36
Jun-3	11	57.35	1.72
Jun-3	12	77.13	-11.17
Jun-3	13	48.71	-0.54
Jun-3	14	55.88	-0.19
Jun-3	15	38.21	19.86
Jun-3	16	59.91	-3.77
Jun-3	17	39.47	16.09
Oct-3	2	65.22	-4.18
Oct-3	3	140.75	-6.97
Oct-3	4	206.28	-9.65
Oct-3	5	205.15	-12.17
Oct-3	6	101.39	-5.93
Oct-3	7	469.64	-19.02
Oct-3	8	457.29	-8.84
Oct-3	9	230.56	-9.68
Oct-3	10	218.97	-13.64
Oct-3	11	104.12	-7.29
Oct-3	12	352.56	-14.90
Oct-3	13	149.94	-8.42
Oct-3	14	n.a.	-3.64
Oct-3	15	463.95	-8.07

Supp. Table 3. Average duration of the Positive NCP period and of the periods of light-enhanced respiration in hour.

Mesocosm	Positive NCP period	From the start of the Negative NCP period to the maximal respiration	From the sunset to the maximal respiration
Oct-1	10.22	5.65	5.22
Oct-2	10.15	5.37	4.81
Oct-3	10.29	5.28	4.82
Jun-1	11.13	5.61	2.16
Jun-2	11.14	5.67	1.94
Jun-3	11.44	5.41	2.10

Supp. Table 4. Mean GPP estimates with standard deviations (gO_2 m^{-3} d^{-1}) obtained with the Max and the Most methods and integrated over the production period (PP) or from sunrise to sunset (SS).

Mesocosm	GPP-Max-PP (gO_2 m^{-3} d^{-1})	GPP-Most-PP (gO_2 m^{-3} d^{-1})	GPP-Max-SS (gO_2 m^{-3} d^{-1})	GPP-Most-SS (gO_2 m^{-3} d^{-1})
Oct-1	0.36 ± 0.11	0.25 ± 0.09	0.38 ± 0.08	0.26 ± 0.07
Oct-2	0.36 ± 0.14	0.26 ± 0.13	0.38 ± 0.09	0.26 ± 0.10
Oct-3	0.42 ± 0.18	0.28 ± 0.13	0.42 ± 0.13	0.29 ± 0.10
Jun-1	0.54 ± 0.19	0.41 ± 0.17	0.72 ± 0.19	0.54 ± 0.18
Jun-2	0.51 ± 0.21	0.38 ± 0.19	0.68 ± 0.24	0.51 ± 0.22
Jun-3	0.58 ± 0.21	0.43 ± 0.18	0.77 ± 0.25	0.58 ± 0.23

Appendix 1.

Sensor deployment duration and sampling frequency

In the present study, the data used wad obtained with a frequency of 1 measurement every minute. This measurement frequency or sampling frequency, which is the time period between two consecutive data acquisitions (Staehr et al. 2010a), has to be chosen wisely. Useful information from the DO data can be missed if the sampling frequency is too slow, leading to differences in metabolic estimates. On the other hand, a rapid sampling frequency might result in the generation of an extensive dataset, which is not necessary if it does not provide additional information. A sampling frequency of 30 min has been estimated to be sufficient to provide reliable daily metabolic estimates in field observations of lakes (Staehr et al. 2010a). In the same study, the required duration of sensor deployment to obtain powerful metabolic estimates (i.e., within 20% of the mean with a certainty of 80%) was calculated for various sampling frequencies (from 10 min to 4 hours).

As said before, in the present investigation, data were collected with a sampling frequency of 1min. To verify whether the duration of the experiments used in this work is sufficient to get powerful estimations of NCP using the new method described, the same power analysis was conducted with sampling frequency ranging from 1 to 60 min, using data from the Oct-1 mesocosm.

The Oct-1 data were collected with a 1-min SP (SP1) by the sensors. Data for SPs of 5, 10, 15, 30 and 60 min (SP5, SP10, SP15, SP30, SP60) were then obtained from the initial SP1 data. Then, the instantaneous and daily metabolic parameters were calculated with these 5 datasets. The results of the power analysis of the number of days that would be required for the Oct experiment with the tested sampling frequencies are presented in Supp. Table 5. The results showed that the 15 days of acquisition of data of Oct-1 obtained with a sampling frequency of 1 min greatly surpassed 0.8 days, which is the minimum required number of days to have powerful estimates of NCP in this case.

Supp. Table 5. Required duration of sensor deployment (in days) to obtain powerful NCP estimates (i.e. within 20% of the mean with a certainty of 80%) for the Oct-1 data at various sampling frequencies ranging from 1 to 60 min.

Sampling frequencies (minutes)	Required deployment time (days)
1	0.80
5	4.21
10	9.37
15	14.51
30	30.07
60	55.17

On a more general note, this power analysis highlights the fact that sampling frequency must be considered when designing a mesocosm experiment and when using automated sensors that can perform high-frequency measurements.

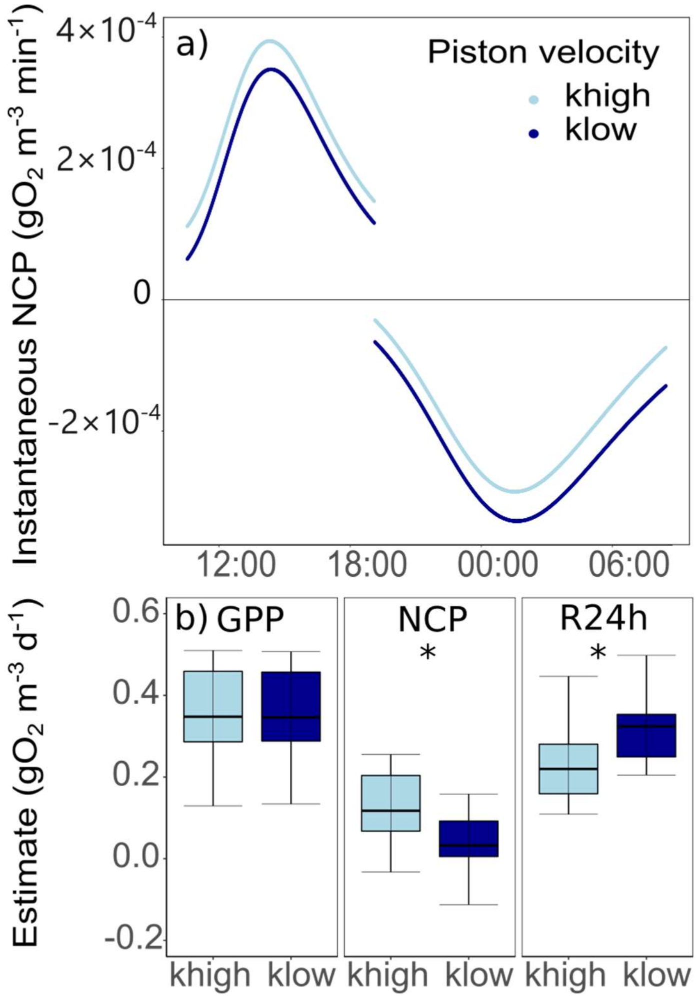
Appendix 2.

Sensitivity analyses of the method to the air-water exchange coefficient value

The rate at which oxygen is exchanged with the atmosphere over time can be approximated as being proportional to the oxygen deficit (e.g., the difference between DO and the oxygen saturation level) (Cox 2003). The piston velocity coefficient k, a proportional constant, is needed to estimate the transfer of oxygen between the atmosphere and the water surface. This parameter is related to surface turbulence, internal mixing, water viscosity and temperature. In the field, k can be calculated with the wind speed at 10 m above the water surface, but in enclosed mesocosms that are covered by a dome and therefore not directly subject to wind-induced turbulence, this calculation is not possible. However, despite the lack of direct wind effects, k cannot be considered equal to 0 in mesocosms because of the water mass movement in the mesocosm caused by the external waves surrounding the mesocosm and because of the mixing induced by the pump. An analysis of the sensitivity of the calculation method to the value of k was performed in Staehr et al. (2010), with a k value of 0.4 m d^{-1} (0.017 m h^{-1}). However, this analysis has never been done for an enclosed mesocosm situation, in which estimating k can be very challenging.

Therefore, in the present investigation, metabolic parameters estimated with low and high piston velocity values were compared. More precisely, the instantaneous NCP and the daily metabolic parameters (Eq. 6 & Eq. 10-Eq. 12) obtained for the Oct-1 mesocosm with 2 piston velocity values from Alcaraz et al. (2001) were compared. The choice to compare the dataset obtained in October is justified because the experiment was carried out under similar temperature and salinity conditions as in Alcatraz et al. (2001). Thus, a low piston velocity value was used (klow = 0.00936 m h^{-1}) that corresponded to the lowest value obtained under nonnull turbulent conditions, as we considered that turbulence would not be zero in the mesocosms due to the external waves and pumping effects, and a high piston velocity value was also tested (khigh = 0.02322 m h^{-1}).

The instantaneous metabolism seemed to be affected by the value of k used for its calculation (Supp Fig. 1a). For example, the instantaneous NCP was the highest using khigh during the Positive NCP period. On the other hand, the instantaneous NCP was closer to 0 using khigh during the Negative NCP period (Supp. Fig. 1a). The daily GPP values obtained with khigh and with klow were not significantly different (Supp. Fig. 1b) (ANOVA, $p = 0.98$), while the R24h value obtained with khigh was significantly higher than that obtained using klow (ANOVA, $p = 0.02$*). Consequently, the daily NCP, which is the difference between GPP and R24h, was significantly greater when khigh was used (ANOVA, $p = 0.01$*).



Supp. Figure 1. (a) Instantaneous positive and negative NCP on day 3 (C1-Oct) calculated with khigh = 0.02322 m.h-1 (light blue) and klow = 0.009326 m h-1 (dark blue). (b) Daily estimates of GPP, NCP and R calculated with khigh (dark blue) and klow (light blue). The levels of significance from ANOVA are indicated with * ($p < 0.05$ *, $p < 0.01$ **, $p < 0.001$ ***). For each box, the lower quartile, median, and upper quartile values are displayed with horizontal lines. Whiskers show the range of the data, from the minimum to the maximum.

The instantaneous NCP value during Positive and Negative NCP periods was increased and decreased, respectively, by a greater k value. This result explains why the daily GPP was not significantly affected, as it is estimated using data from both the Positive and Negative NCP periods. The effects of the piston velocity value on production were counterbalanced by its effects on daytime respiration, resulting in an almost unaffected GPP estimate. However, R24h is calculated using only the instantaneous NCP from the Negative NCP period. Hence, the magnitude of k affects R24h estimates in the same way that it affects instantaneous NCP estimates during Negative NCP periods.

To conclude, the present analysis highlights the fact that the method using high-frequency data to estimate metabolic parameter is sensitive to the air-water exchange coefficient value. This work underlines the need for a reliable estimation of the air-water exchange coefficient to obtain precise metabolic parameters. The dependence of the free-water method on an accurate estimation of the air-water exchange coefficient is one of the weaknesses of this method, and future research should focus on this topic. However, the aim of mesocosm experiments is to assess the effects of one or several simulated disturbance(s) on the studied system and therefore to compare control mesocosms with mesocosm(s) in which the disturbance(s) was applied. Hence, even if the air-water exchange is under- or overestimated, it will be estimated in the same way in all mesocosms. The comparison between the control and the other mesocosms will thus not be affected by the uncertainty related to the air-water exchange coefficient as long as the same coefficient is applied for all mesocosms and all mesocosms experience similar environmental conditions.