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Soil temperature synchronisation improves estimation of daily variation of ecosystem respiration in *Sphagnum* peatlands

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Ecosystem respiration (ER) is a key process in the global C cycle and thus, plays an important role in the climate regulation. Peatlands contain a third of the world soil C in spite of their relatively low global area (3% of land area). Although these ecosystems represent potentially a significant source of C under global change, they are still not taken into account accordingly in global climatic models. Therefore, ER variations have to be accounted for, especially by estimating its dependence to temperature.s The relationship between ER and temperature often relies only on one soil temperature depth and the latter is generally taken in the first 10 centimetres. Previous studies showed that the temperature dependence of ER depends on the depth at which the temperature is recorded. The depth selection for temperature measurement is thus a predominant issue. A way to deal with this is to analyse the time-delay between ER and temperature. The aim of this work is to assess whether using synchronised data in models leads to a better ER daily variation estimation than using non-synchronised data.

ER measurements were undertaken in 2013 in 4 *Sphagnum* peatlands across France: La Guette (N 47°19'44", E 2°17'04", 154m) in July, Landemarais (N 48°26'30", E -1°10'54", 145m) in August, Frasne (N 46°49'35", E 6°10'20", 836m) in September, and Bernadouze (N 42°48'09", E 1°25'24", 1500m) in October. A closed method chamber was used to measure ER hourly during 72 hours in each of the 4 replicates installed in each site. Average ER ranged from 1.75 μmol m^{-2} s^{-1} to 6.13 μmol m^{-2} s^{-1}. A weather station was used to record meteorological data and soil temperature profiles (5, 10, 20 and 30 cm).

Synchronised data were determined for each depth by selecting the time-delay leading to the best correlation between ER and soil temperature. The data were used to simulate ER according to commonly used equations: linear, exponential with Q_{10}, Arrhenius, Lloyd and Taylor. Models comparison was performed using RMSE (goodness-of-fit) and AIC (goodness-of-fit and model complexity) as indicators to assess their relative quality.

Both indicators showed a wide variation between sites. However, for each site differences between synchronised and non-synchronised data were larger than the differences between models equations. According to the AIC, models using synchronised data produced better ER estimations than models using non-synchronised data, at all depth. RMSE support this result for all sites for superficial peat layer. In some locations, mainly Frasne, synchronised data at 5 cm depth provide better estimation than air temperature, i.e. 25.0 vs. 26.4 for RMSE and 337.1 vs. 379.8 for AIC, respectively. The equation of the most appropriate model varies between sites, but the differences between them are small.

At a daily scale, data synchronisation in Sphagnum peatlands improves ER estimation regardless of the model used. Moreover, to estimate ER flux, the use of synchronised data at 5 cm depth seems the most adequate method.