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High frequency measurements of CO₂ and CH₄ in a temperate peatland dominated by *Molinia caerulea*

Adrien Jacotot^{1,2,3}, Sébastien Gogo^{1,2,3}, Laurent Perdereau^{1,2,3}, Jean-Baptiste Paroissien^{1,2,3}, Christophe Guimbaud^{4,5,6}, Fatima Laggoun-Déforge^{1,2,3}

(1) Université d'Orléans, ISTO, UMR 7327, Orléans, France, (2) CNRS, ISTO, UMR 7327, Orléans, France, (3) BRGM, ISTO, UMR 7327, BP 36009, Orléans, France, (4) Université d'Orléans, LPC2E, UMR 7328, Orléans, France, (5) CNRS, LPC2E, UMR 7328, Orléans, France, (6) CNES, LPC2E, UMR 7328, Orléans, France



1. Context & research objectives

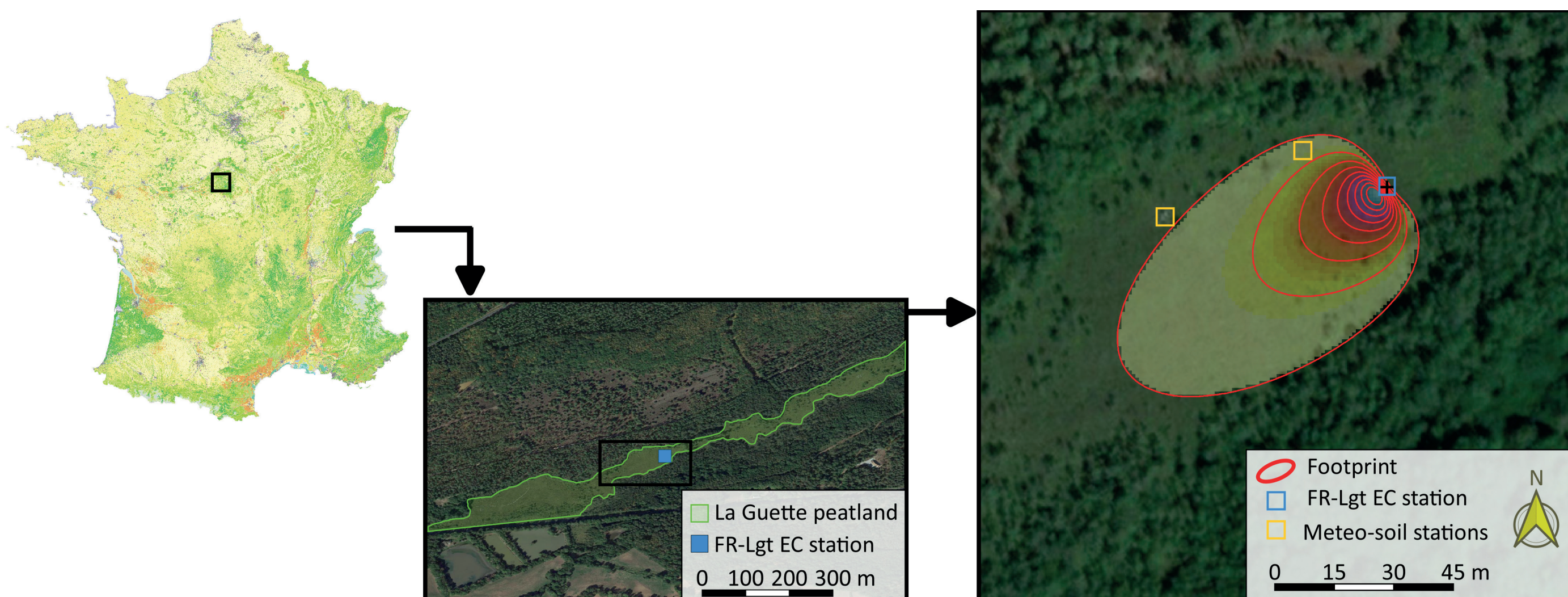
Peatlands are sensitive ecosystems that act as a powerful carbon (C) sink. Due to their fragility, they could be strongly impacted by future natural and anthropogenic global changes. We can anticipate a direct effect of these changes, which can modify for example the functioning or the species distributions of peatlands, therefore altering the valuable role of this ecosystems in C sequestration and thus in climate change mitigation.

In such a context, we initiated in early 2017 a long-term observation of CO₂ and CH₄ fluxes in a temperate peatland. The main objectives of this installation are to (i) evaluate the seasonal and inter-annual variability of the fluxes (ii) calculate the C budget of the ecosystem, and (iii) determine the fluxes sensitivity to biotic and abiotic factors.

2. Study site & fluxes measurements

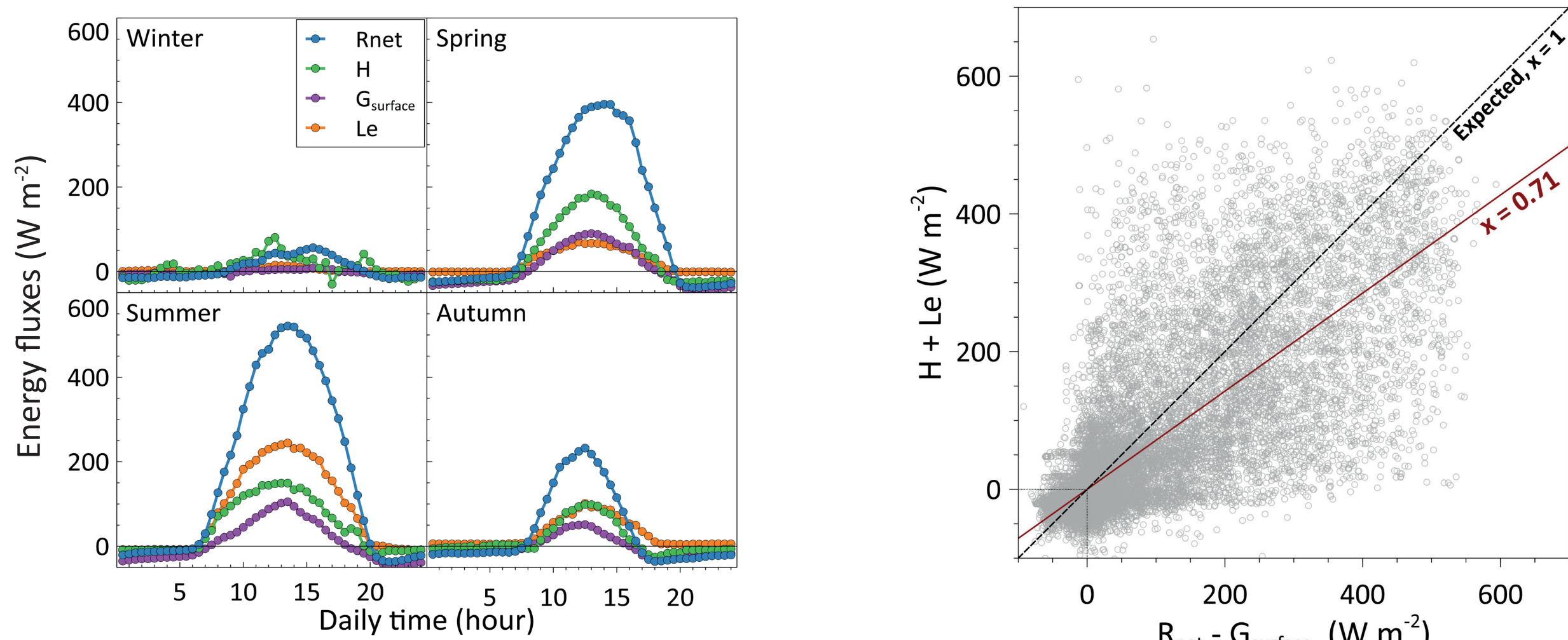
La Guette peatland (FR-LGt) is an acidic fen located in the center of France. Due to an anthropogenic disturbance (road construction across the peatland), the drainage of the fen was accelerated, allowing the ecosystem to be colonized by a graminoid, *Molinia caerulea*. In 2014, restoration work has been undertaken to limit this drainage and to decrease the water table depth.

In early 2017, an Eddy covariance station was implemented in the peatland to continuously monitor CO₂ and CH₄ exchanges between the ecosystem and the atmosphere. Two meteo-soil stations were also installed to support the EC station. Fluxes are recorded at 20 Hz, and micrometeorological parameters every minutes.



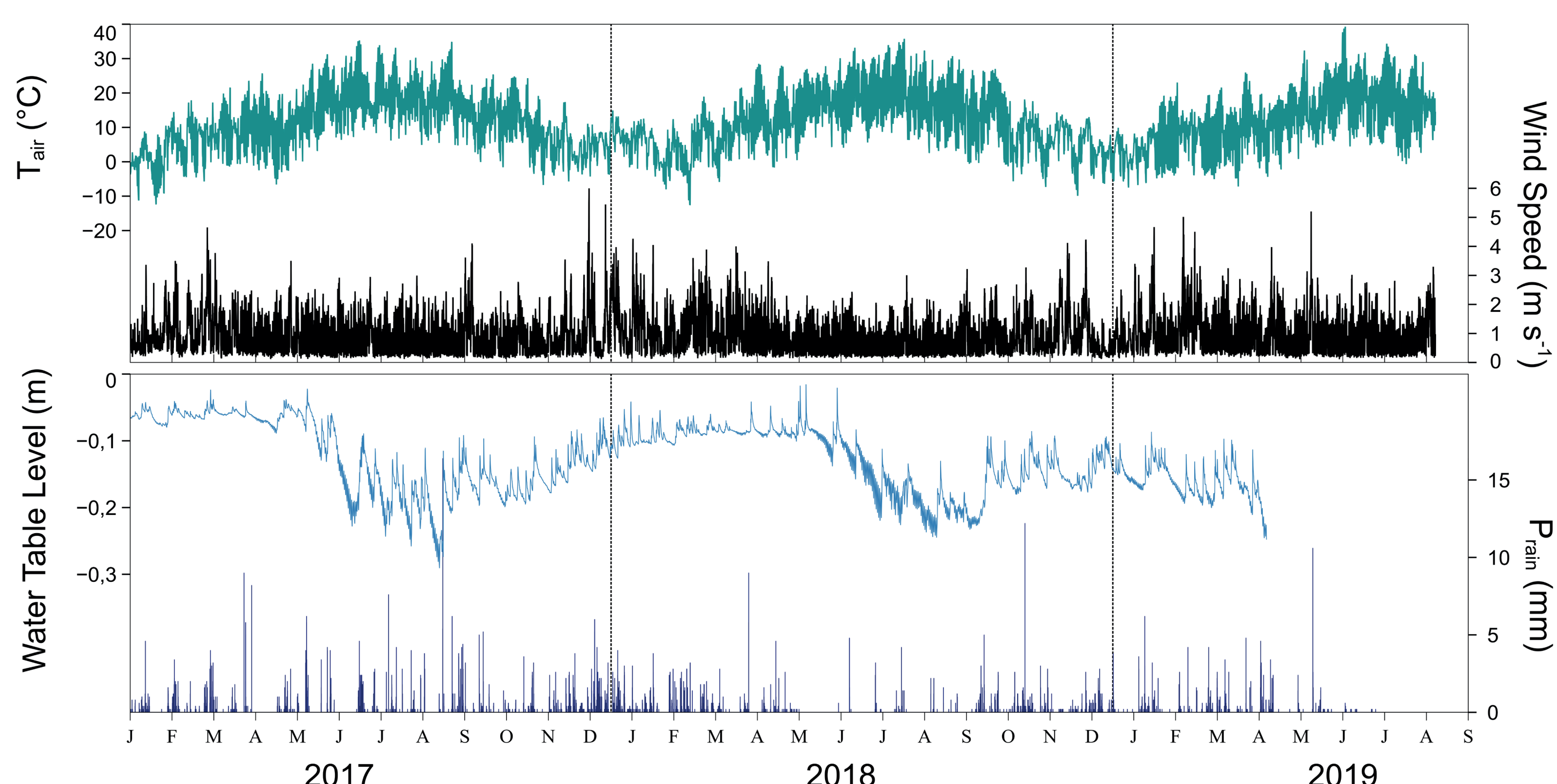
Location of La Guette peatland, and illustrations of the tower and its associated meteo-soil station.

3.1 Results: Energy balance closure



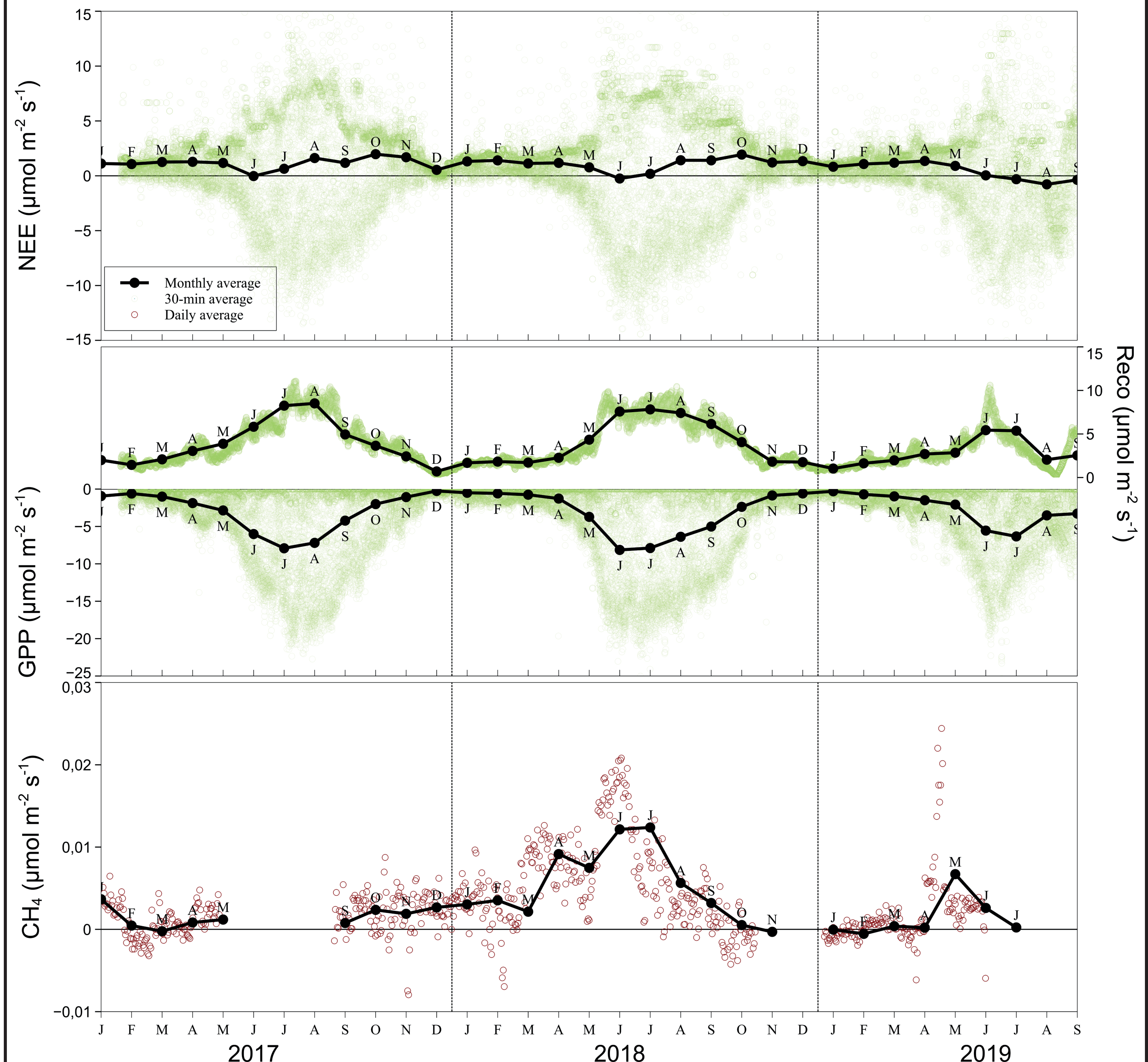
Left: Diurnal variations of Net Radiation (Rnet), Sensible heat (H) and Latent heat (Le) fluxes and soil ground fluxes (G) (n=4300). Right: Evaluation of the Energy Balance closure of the system.

3.2 Results: Micrometeorology



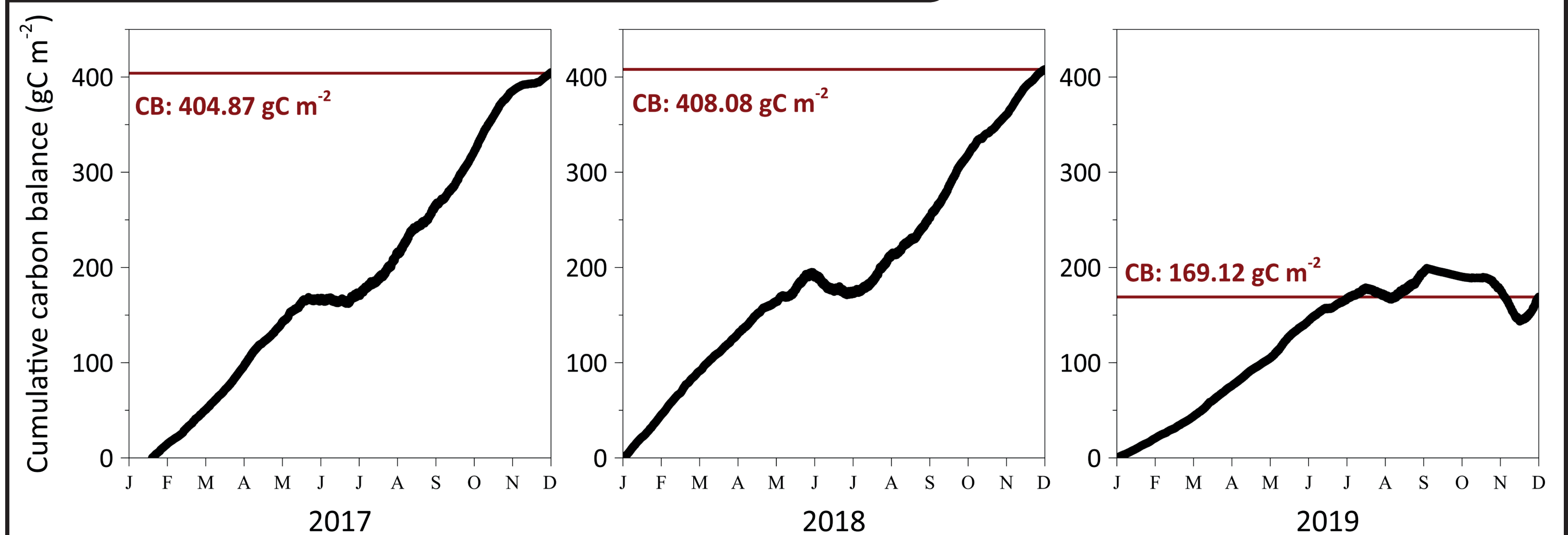
Hourly variations of air temperature (°C), wind speed (m s⁻¹), water table level (m from the soil surface) and precipitations (mm) from January 17 to September 19.

3.3 Results: Carbon fluxes



Half-hourly, daily (n=48) and monthly (n=1440) averages of Net Ecosystem Exchange (NEE), Gross primary production (GPP), Ecosystem Respiration (Reco) and Methane fluxes (CH₄).

3.4 Results: Carbon balance (CO₂ + CH₄)



Cumulative carbon balance (CO₂ and CH₄) for 2017, 2018 and 2019.

4. Conclusions

Mean Net Ecosystem Exchange was 1.13, 1.08 and 0.44 μmol m⁻² s⁻¹ for 2017, 2018 and 2019, respectively. Considering CO₂ and CH₄, the carbon balance for the peatland was 404 gC m⁻² for 2017, 408 gC m⁻² for 2018 and 169 for 2019 (until September). For these three years, the total carbon balance of the peatland was 982 gC m⁻². Therefore, these results show that La Guette peatland acted as a source of C for the atmosphere in 2017, 2018 and 2019.

This functioning, at the opposite of what we expect for a peatland, is suspected to result from the drainage of the ecosystem for the road construction, and also by the colonisation by *Molinia caerulea*. *Molinia* roots can penetrate deeply in the soil, favorizing oxygen penetration that increases the organic matter decomposition rates.

However, EC measurements will continue over the long term to determine if the restoration works undertaken in 2014 will decrease the water table depth and reverse the functioning of the fen. More investigations are also needed to identify the biotics and abiotics factors that control the fluxes.

5. Eddy covariance stations of the SNO-Tourbières

In a larger scale, the FR-LGt Eddy covariance station is part of the French Peatland Observatory Service (SNO-Tourbières; <http://www.sno-tourbières.cnrs.fr>), and is included in a network of three EC stations deployed in three contrasted French peatlands where the other two are Landemarais in Britain, and Frasné in the Jura mountains. This network will provide important data that will help to understand the evolution of the carbon balance in temperate peatlands with global changes. In addition, the SNO-Tourbière is part of the Research Infrastructure OZCAR for the Observation of the Critical Zone (Application and Research).

FR-LGt Eddy covariance station is in the process of ICOS (Integrated Carbon Observatory System) certification as an associated site.



Contact information:
Adrien Jacotot, CNRS Orléans, France. E-mail: adrien.jacotot@cnrs-orleans.fr