



Measuring CO₂ Exchange over Restored and Forested Scottish Peatlands

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Introduction

A critical policy question concerns the tradeoff, in net greenhouse gas emissions terms, between forest plantations on peat and their restoration to bog.

As part of the Scottish GHG Flux network, data from past research at a forested site, measurements over the same site after restoration, and two new towers on secondary plantation are being managed and analysed. The systems now include methane exchange to give a fuller picture of the carbon budget. These measurements should give us a unique perspective on the transition from forestry back to peat bog or replanting.

*The flux towers discussed here all use standard instrumentation and methodologies for eddy-covariance.

Forestry CO₂ Flux Towers

DYKE (UK_DKE, Forsinard): May 2016 – Nov 2017 tall tower at Dyke in RSPB Forsinard Reserve, part of the Flow Country in Caithness & Sutherland (Figure 1), measuring over forest before it was harvested and the restored peatland. Measurements are ongoing over the restored area with the addition of a methane analyser.

The flux footprint in Figure 2 shows the average areal extent observed by the tower. Overall CO₂ flux data capture was 47%, reduced to 35% after QAQC. The standard model for gapfilling, REddyProc (Wutzler *et al* 2018) was applied (Figure 3), analysis is ongoing to fill the larger gaps using a different model and give a fully attributed budget.



Figure 1 Forested peatland eddy-covariance flux towers locations and instruments (from left to right, Dyke, Elchies and Racks Moss)

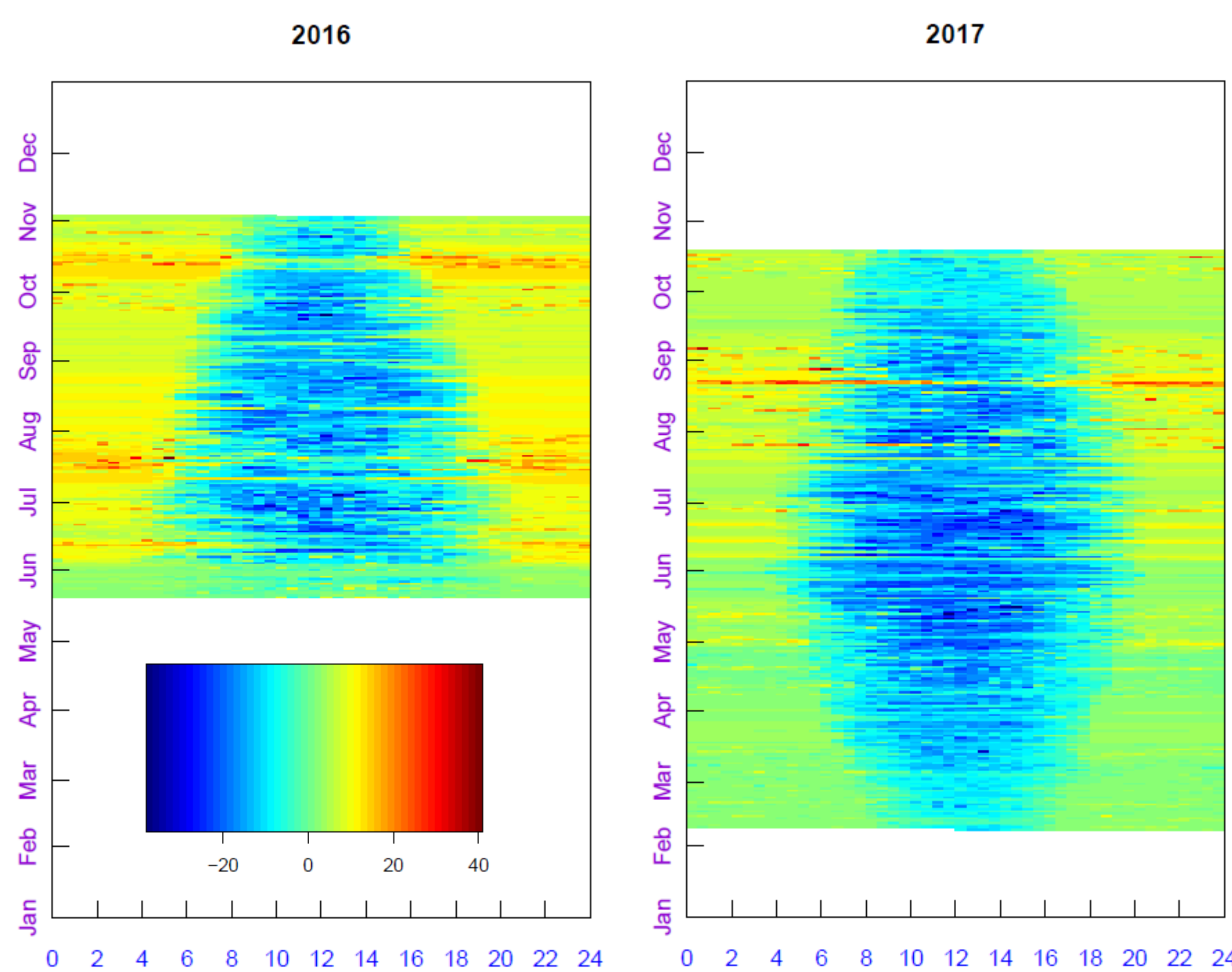


Figure 3 Gapfilled NEE ($\mu\text{mol m}^{-2}\text{s}^{-1}$) over a mature plantation of deep peat at Dyke, Forsinard, from the REddyProc model

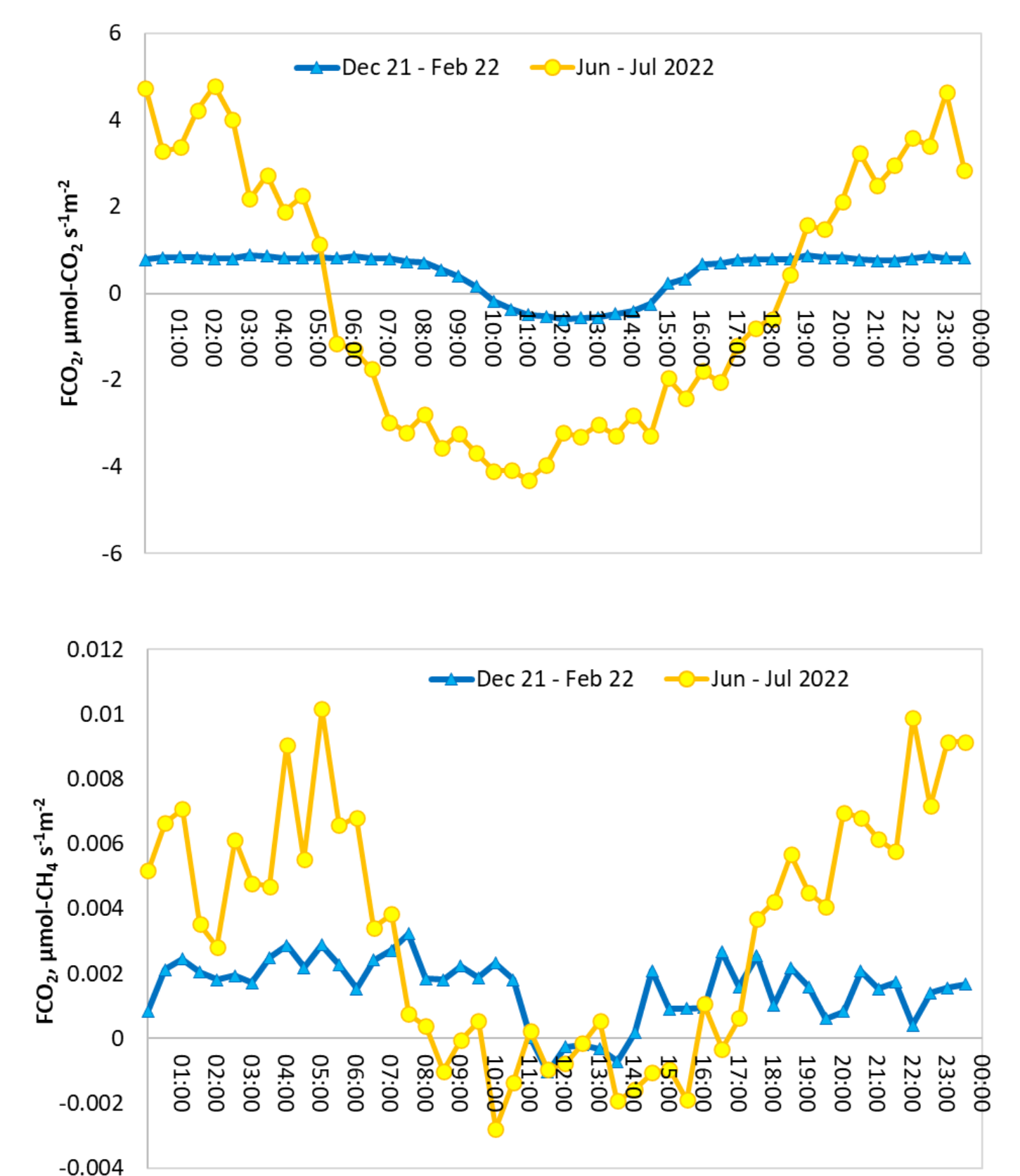


Figure 5 Median diel cycles of CO₂ and CH₄ exchange over a young secondary plantation on peat at Elchies, for winter and summer months in 2021 and 2022.

ELCHIES (UK_ECH, near Dufftown, Moray, Figure 1):

from October 2021 ongoing, young secondary plantation, trees ≤ 1 m tall. Up to July 2022 the raw data capture of CO₂ and CH₄ data was 44% and 41% respectively, after initial QAQC. Figure 4 shows the flux footprint with the area SW of the tower. The site should be in place for at least another three years, providing a useful dataset to examine the early growth of a secondary plantation on peat.

The plots in Figure 5 show the median diel cycle of CO₂ and CH₄ exchange over the winter (Dec-Feb) and summer (Jun-Jul) from realtime calculations of the flux. The site is a small sink in the summer (-14 kg-C ha⁻¹) and source over the winter (40 kg-C ha⁻¹). The CH₄ exchange is small and close to the instruments detection limit, further analysis will be performed to ensure the best quality results are used to estimate the net carbon budget. With such a young plantation the exchange rates are an order of magnitude smaller than those at the mature forest on Dyke.

RACKS MOSS (Dumfries and Galloway): installation is in planning for completion in spring 2023 (lead by UKCEH and CCC), a tall scaffolding tower (~ 40 m) is being installed over a mature secondary plantation. The site will be instrumented for CO₂ and CH₄ exchange as well as being a potential platform for additional measurements of forest-atmosphere exchange of trace gases and aerosols.

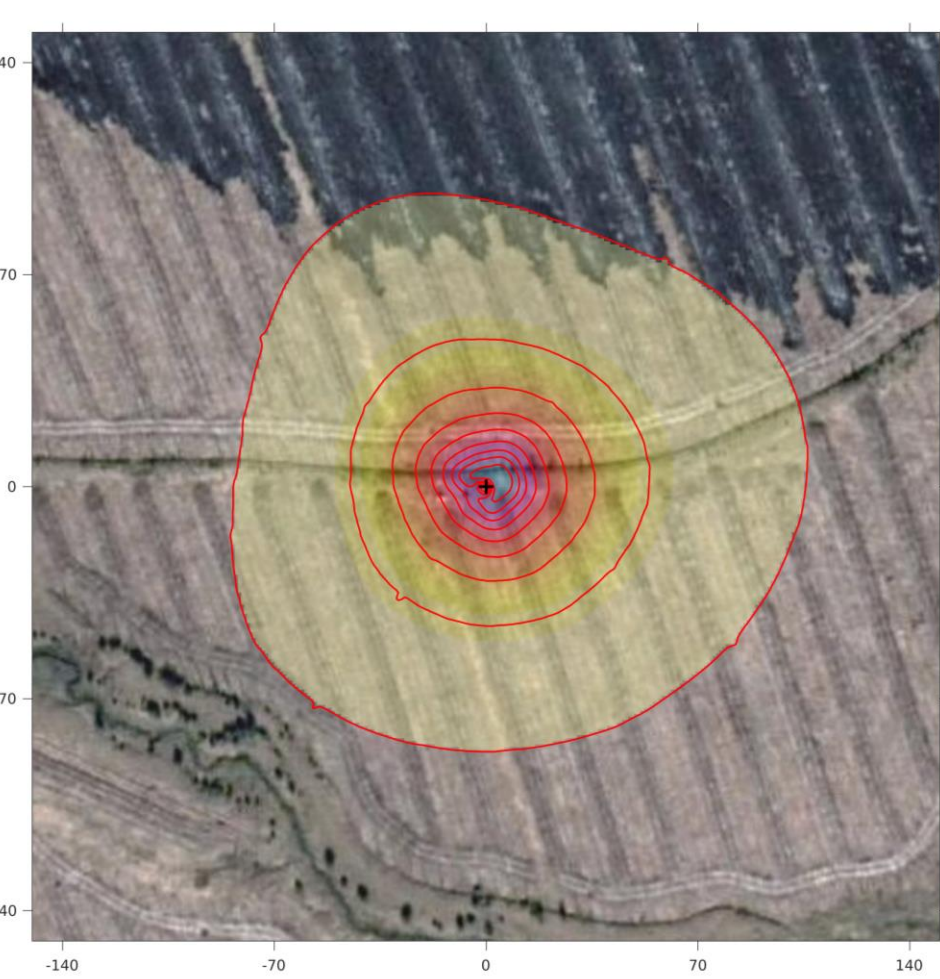


Figure 2 Flux footprint for the forest tower showing the average extent of the measurements (background satellite image is from 2020, after harvest and a wildfire)

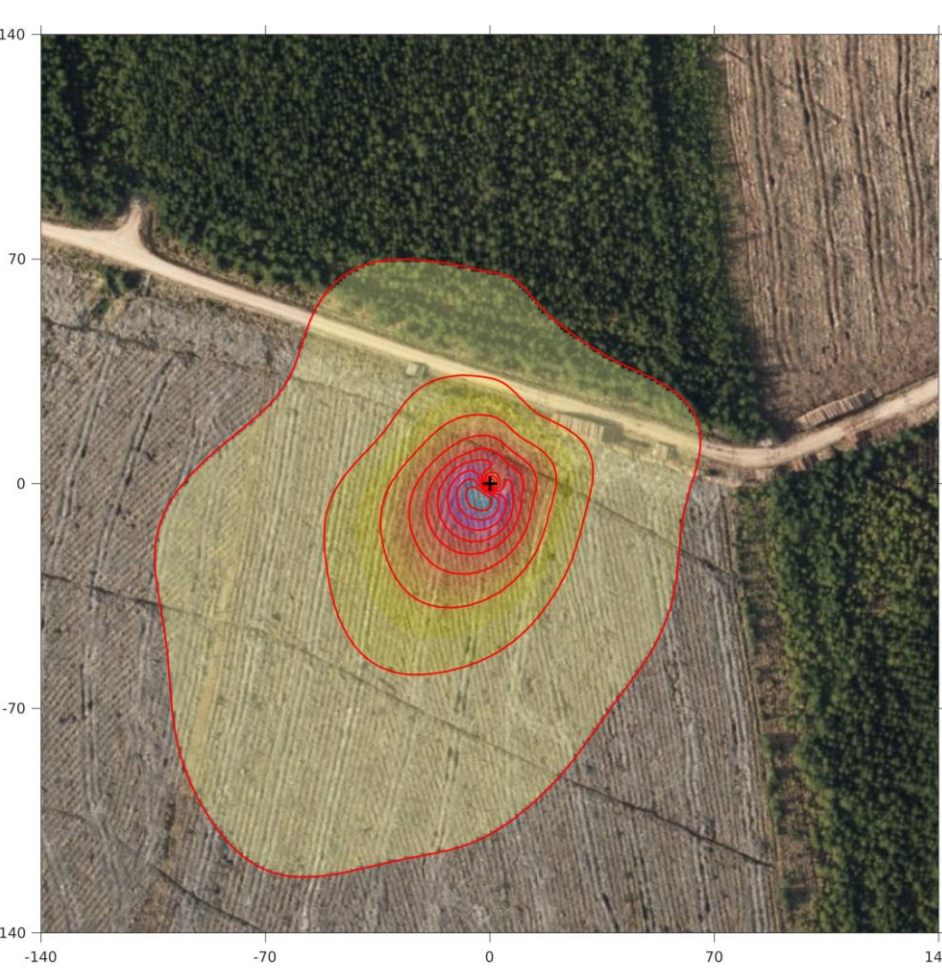


Figure 4 Flux footprint showing the average extent of the measurements over the young secondary plantation on peat.



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Wutzler T, Lucas-Moffat A, Migliavacca M, Knauer J, Sickel K, Sigut, Menzer O & Reichstein M (2018) Basic and extensible post-processing of eddy covariance flux data with REddyProc. Biogeosciences, Copernicus, 15, doi: 10.5194/bg-15-5015-2018



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