UK Centre for Ecology & Hydrology

Quantifying carbon and water fluxes from lowland peat agriculture in the East Anglian Fens

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Introduction

- In their natural state, peatlands have the capacity to store vast quantities of carbon (C) in their soils. However, drainage for peat extraction, grazing, and agriculture can turn these ecosystems into C sources.
- In the UK, ~3% of the country's greenhouse gas (GHG) emissions come from drained agricultural lowland peat.
- Peat drainage also causes biodiversity loss, and uses large amounts of water and nutrients.
- Climate change will add more pressure on these systems, which could also put food security at risk.

Figure 1. Bog in Northern Ireland (Credit: Hollie Cooper, UKCEH).

In that context, **the main goal of this project was to measure C and water fluxes for the main crops produced in the fens.**

Methods

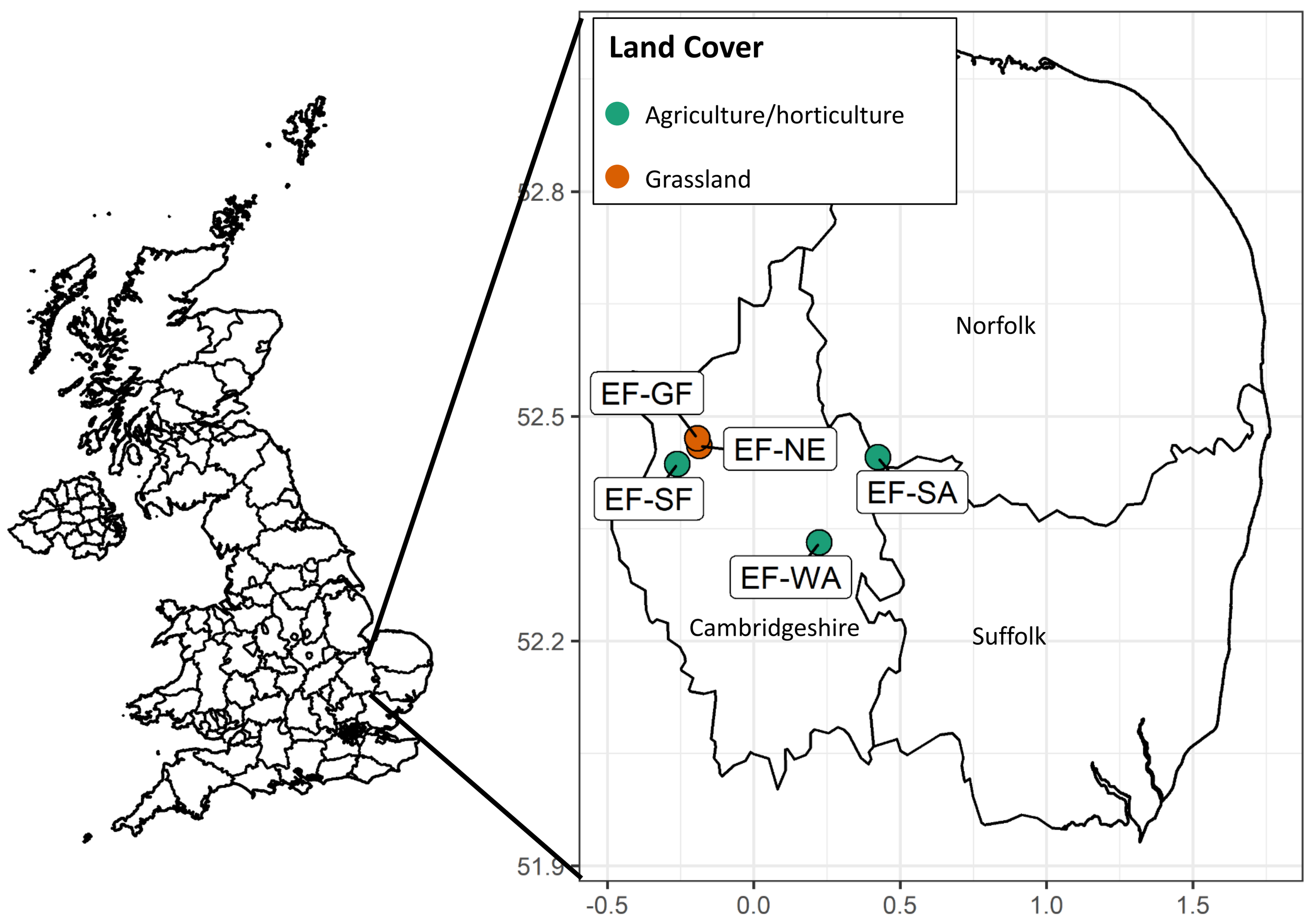

Figure 2. Location of the study sites

We used a network of **five eddy covariance (EC) flux towers located in grasslands (EF-GF, EF-NE) and agricultural fields (EF-SA, EF-SF, EF-WA) located in the East Anglian Fens.** These towers are part of the UK-wide network of EC towers (UK-Flux) led by the UK Centre for Ecology and Hydrology. **Each tower is equipped to measure the exchange of CO_2 and water (evapotranspiration, ET) between the land surface and the atmosphere**, as well as a **set of meteorological variables**, including net radiation, precipitation, water table depth, and air and soil temperatures.

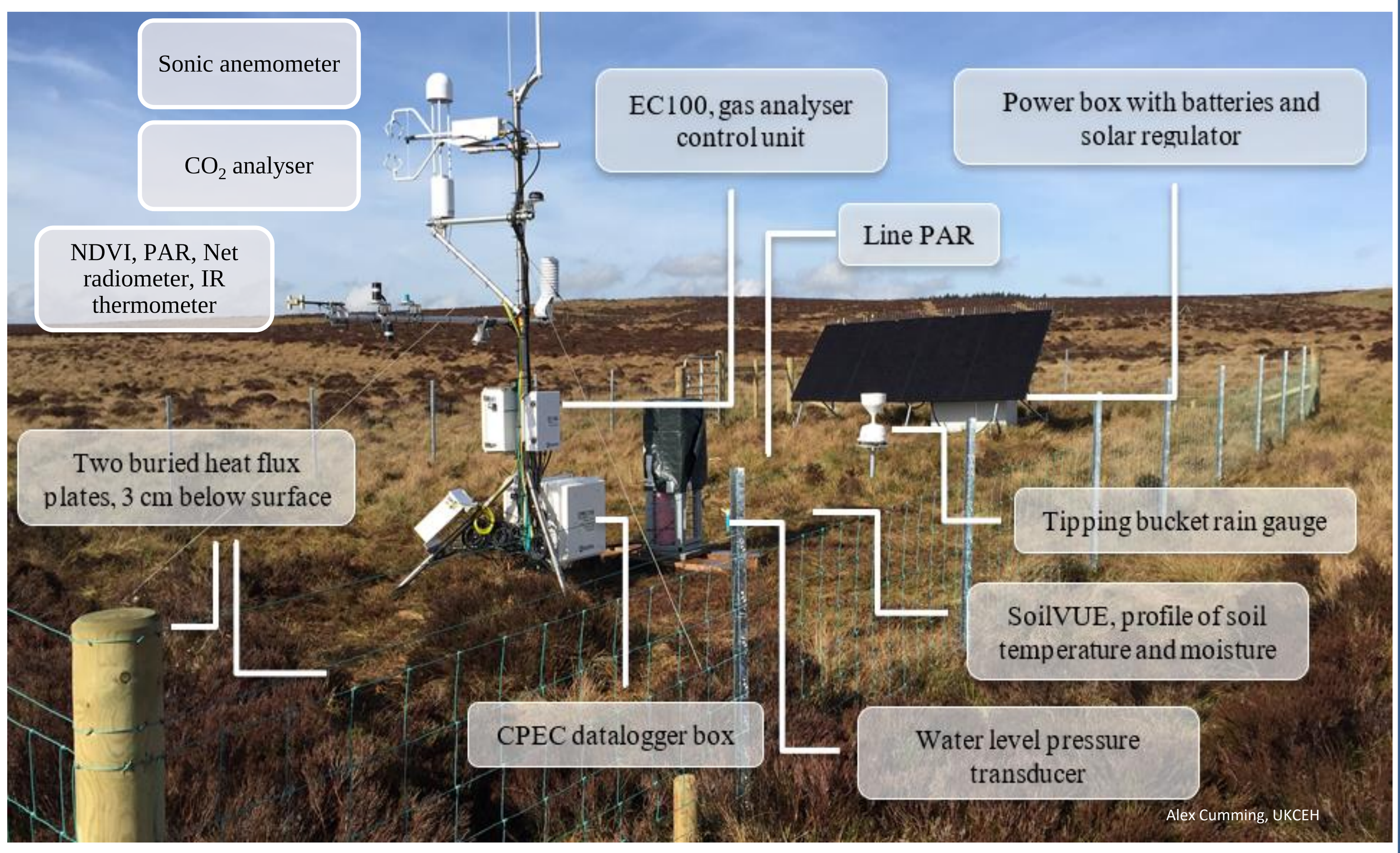

Figure 3. Experimental design at the study sites (Credit: Alex Cumming, UKCEH)

Results

Croplands

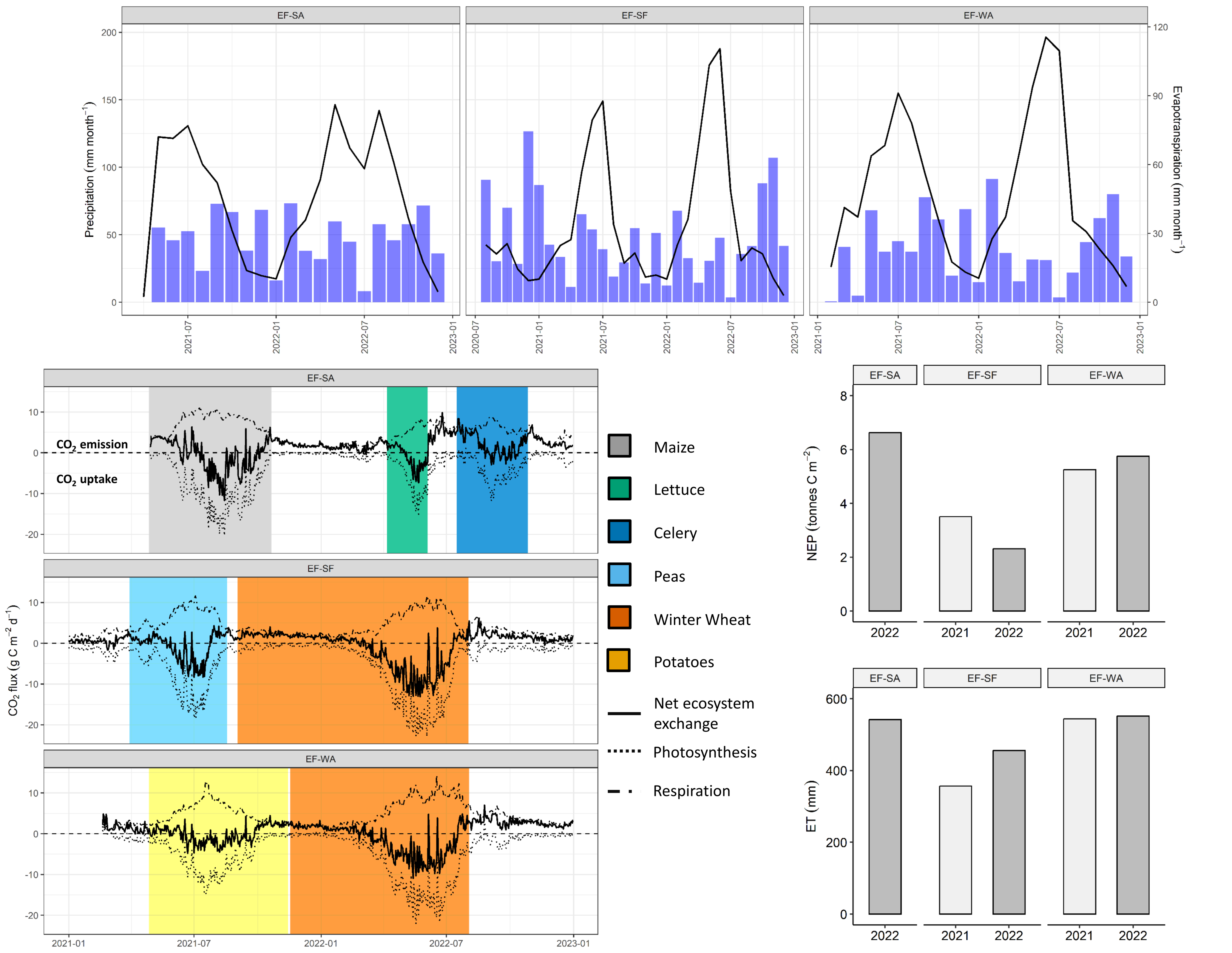

Figure 4. Top: Precipitation (mm month^{-1}) and Evapotranspiration (ET, mm month^{-1}) for each agricultural study site. Bottom left: Net ecosystem exchange (g C m^{-2} d^{-1}), Photosynthesis (g C m^{-2} d^{-1}), and Respiration (g C m^{-2} d^{-1}) for each crop grown at the three agricultural sites. Values above zero represent CO_2 emissions, and values below zero represent CO_2 uptake. Bottom right: Annual Net Ecosystem Productivity (NEP, tonnes C m^{-2}) and annual ET for each cropland.

Grasslands

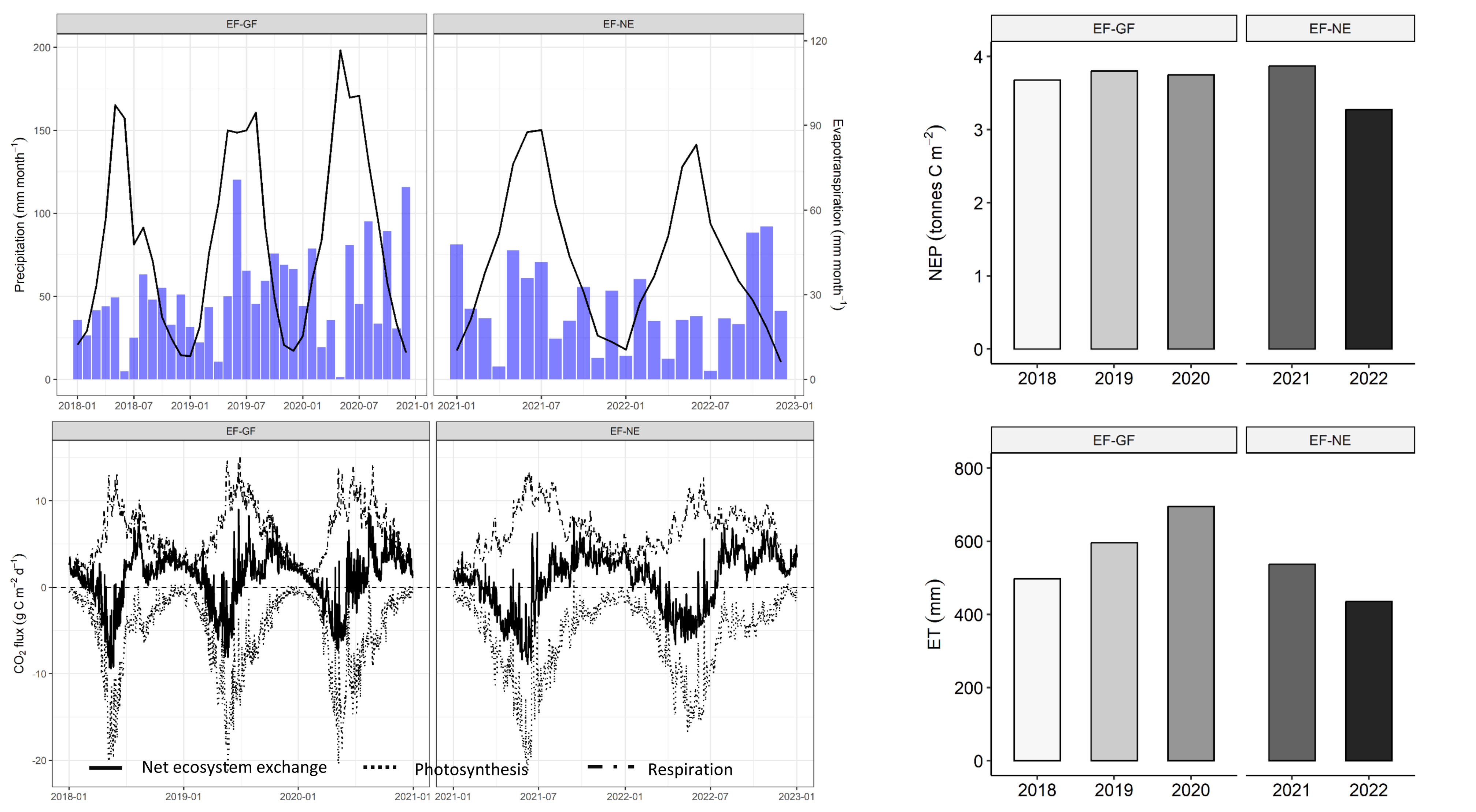

Figure 4. Top left: Precipitation (mm month^{-1}) and Evapotranspiration (ET, mm month^{-1}) for each grassland study site. Bottom left: Net ecosystem exchange (g C m^{-2} d^{-1}), Photosynthesis (g C m^{-2} d^{-1}), and Respiration (g C m^{-2} d^{-1}) for each crop grown at the three agricultural sites. Values above zero represent CO_2 emissions, and values below zero represent CO_2 uptake. Right: Annual Net Ecosystem Productivity (NEP, tonnes C m^{-2}) and annual ET for each grassland.

Conclusions

- All the measured ecosystems were sources of CO_2 to the atmosphere.
- Seasonal patterns of C fluxes varied with crop selection at the agricultural sites, with potatoes and winter wheat being the largest CO_2 emitters.
- ET exhibited similar seasonal patterns across sites, with large fluxes observed at the peak growth stage of the crop cycle, and lower ET values during the winter or during periods without vegetation (e.g., post-harvest)
- The results from this study are crucial to the development and implementation of land management practices and policies required to reduce GHG emissions and achieve net zero ambitions by 2050 or earlier, whilst maintaining agricultural output and meeting food security.

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Great Fen

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