



Methane exchange in forests

Methane exchange from tree stems and forest soils

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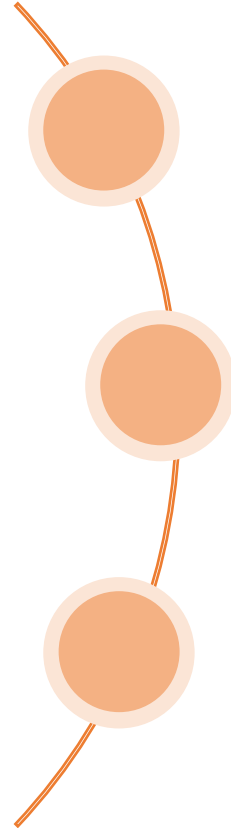
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Research aim and objectives

To unravel the difference of tree stem CH_4 flux in tree species and intra-species, this research aims to determine the variations of tree stem CH_4 and CO_2 fluxes within two tree species from temperate, managed forests with mineral soils in the UK.



To determine the interspecific variation of tree stem CH_4 and CO_2 fluxes: English oak and Japanese larch.

To determine the intra-species variation of tree stem CH_4 and CO_2 fluxes.

To determine temporal variation and comparison of CH_4 and CO_2 fluxes from tree stem and soils.

Experimental design

- Field site: Wheldrake Wood (53°54'48"N, 0°59'39"W), UK
- Tree species: English oak (*Quercus robur*) and Japanese larch (*Larix kaempferi*) (n=12 per tree species)
- Manual chamber measurements of CH₄ and CO₂ fluxes from tree stems and soils in each stand (n=3 per tree) were taken three times in March and June 2020 using a cavity-ring down gas analyser
- Measurements of environmental variables : soil moisture, soil temperature, air temperature



Fig. 1 Rigid tree stem chambers installed (45 cm above surface) on English oak (left) and Japanese larch (right).

Results

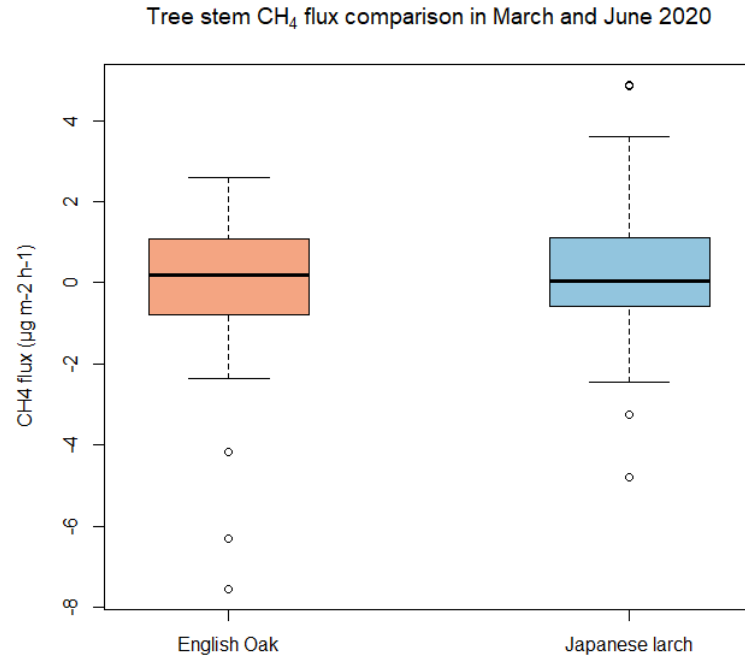


Figure 2. Effect of tree species on tree stem CH₄ flux in March and June in 2020 (Mann-Whitney U test). The data of March and June were combined, as both oak and larch tree stem CH₄ fluxes data were not significantly different between months (Repeated ANOVA).

- Tree stem CH₄ fluxes were not significantly different between the two tree species in March and June ($P=0.748$).
- Tree stem CO₂ emissions were significantly higher from Japanese Larch than from English oak in March ($P<0.001$) and June ($P<0.001$).

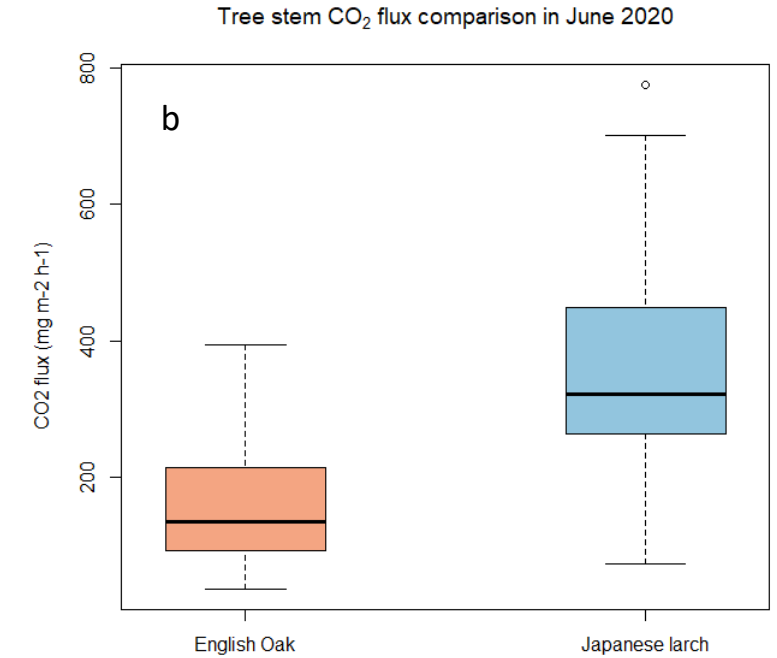
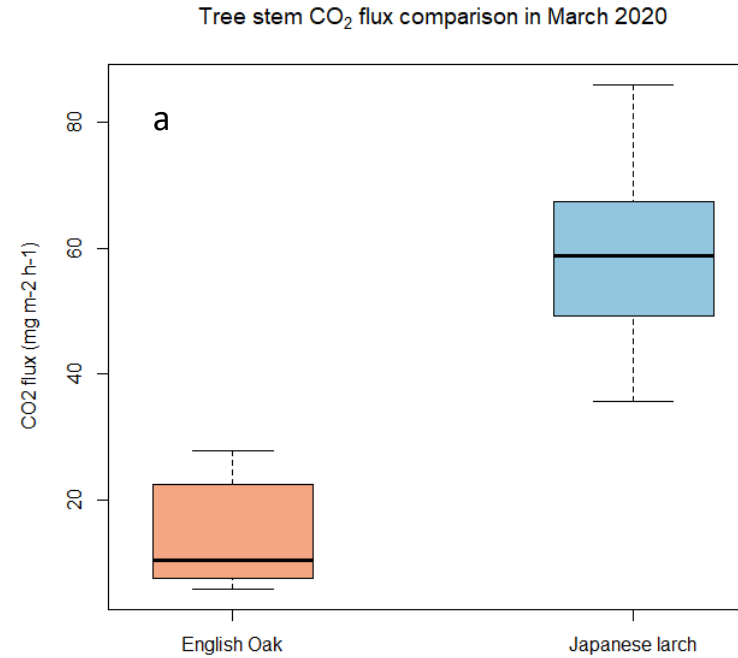


Figure 3. Effect of tree species on tree stem CO₂ flux in March (a) and June (b) in 2020 (Independent T- test). The data were compared differently by month, as both oak and larch tree stem CO₂ fluxes data showed significantly different between March and June (Repeated ANOVA).

Results

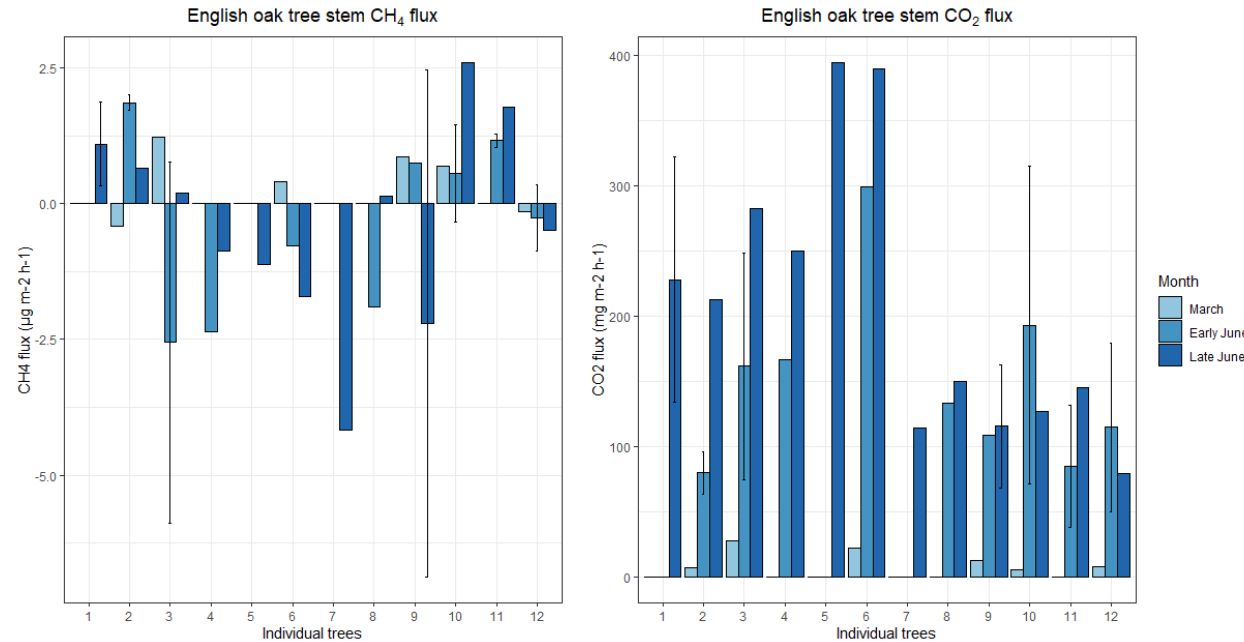


Fig. 4 The variation of tree stem CH₄ (left) and CO₂ (right) fluxes on English oak.

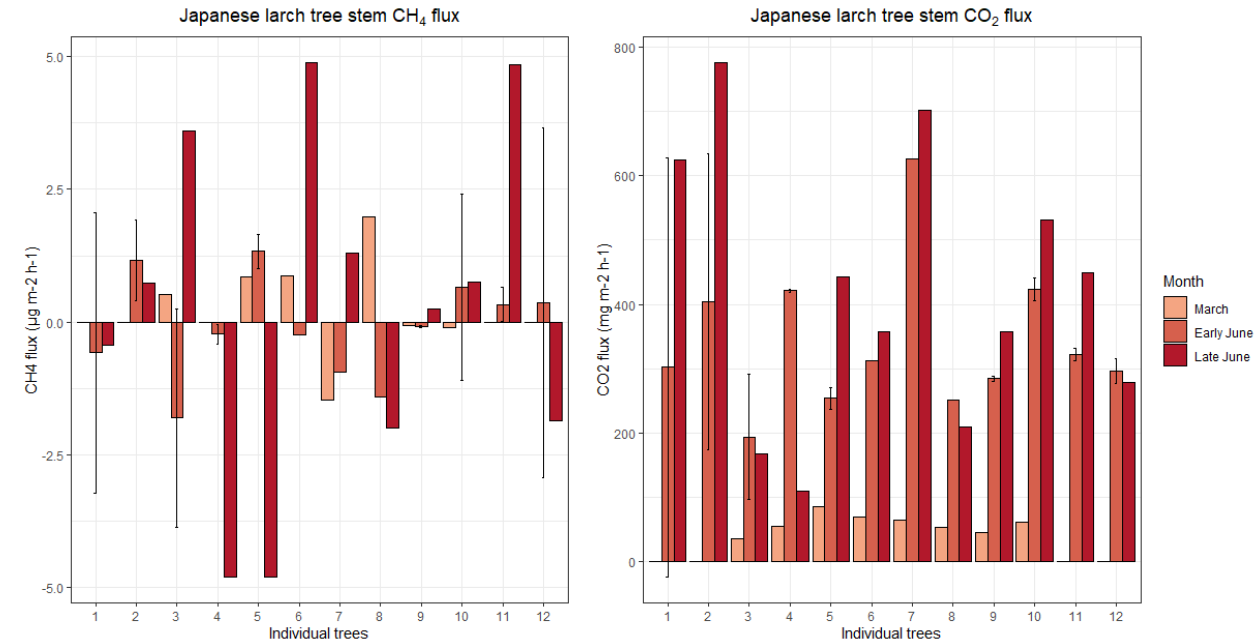


Fig. 5 The variation of tree stem CH₄ (left) and CO₂ (right) fluxes on Japanese larch.

- English oak showed tree stem CH₄ emissions with 53.8% and tree stem uptake with 43.6%, and 2.6% of the tree stem CH₄ fluxes did not meet the minimum detectable fluxes (MDF) criterion.
- Japanese larch showed tree stem CH₄ emissions with 50.0% and tree stem uptake with 45.2%, and 4.8% of the tree stem CH₄ fluxes did not meet the MDF criterion.
- Temporal effect was not observed in tree stem CH₄ fluxes on both tree species.

Results

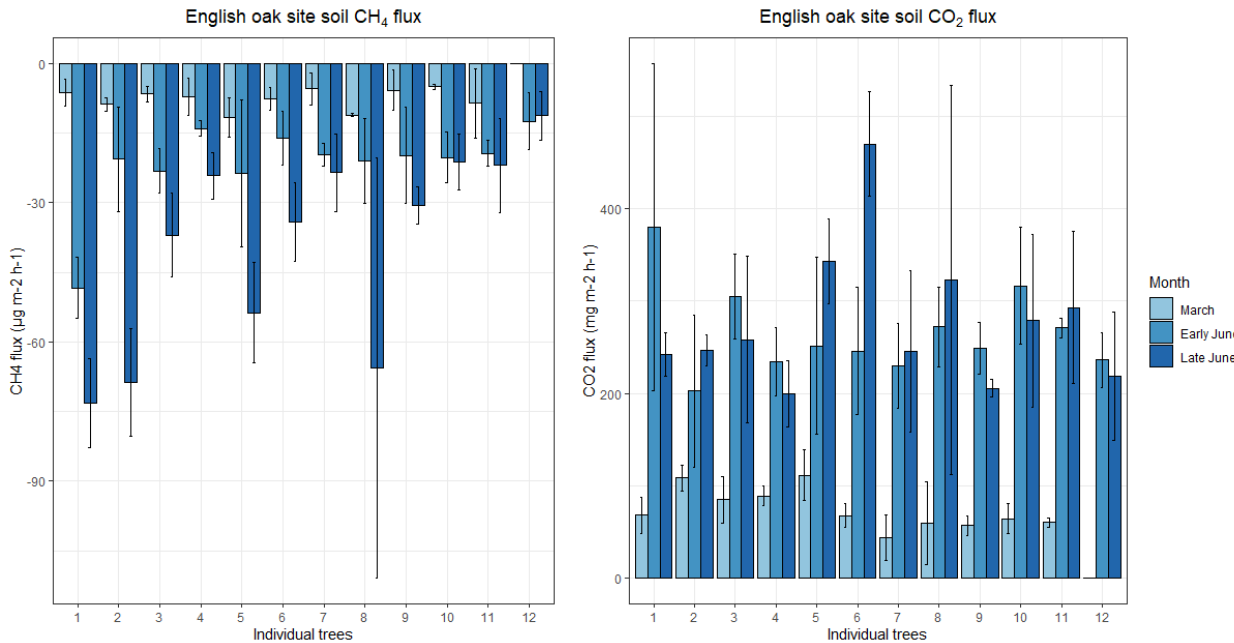


Fig. 6 The variation of soil CH₄ (left) and CO₂ (right) fluxes on English oak site. The comparison of CH₄ and CO₂ fluxes between oak tree stem and soils were tested by month (Independent T-test/Mann-Whitney U test). Temporal effect on soil CH₄ an CO₂ fluxes were tested by Friedman test and Wilcoxon signed-rank test.

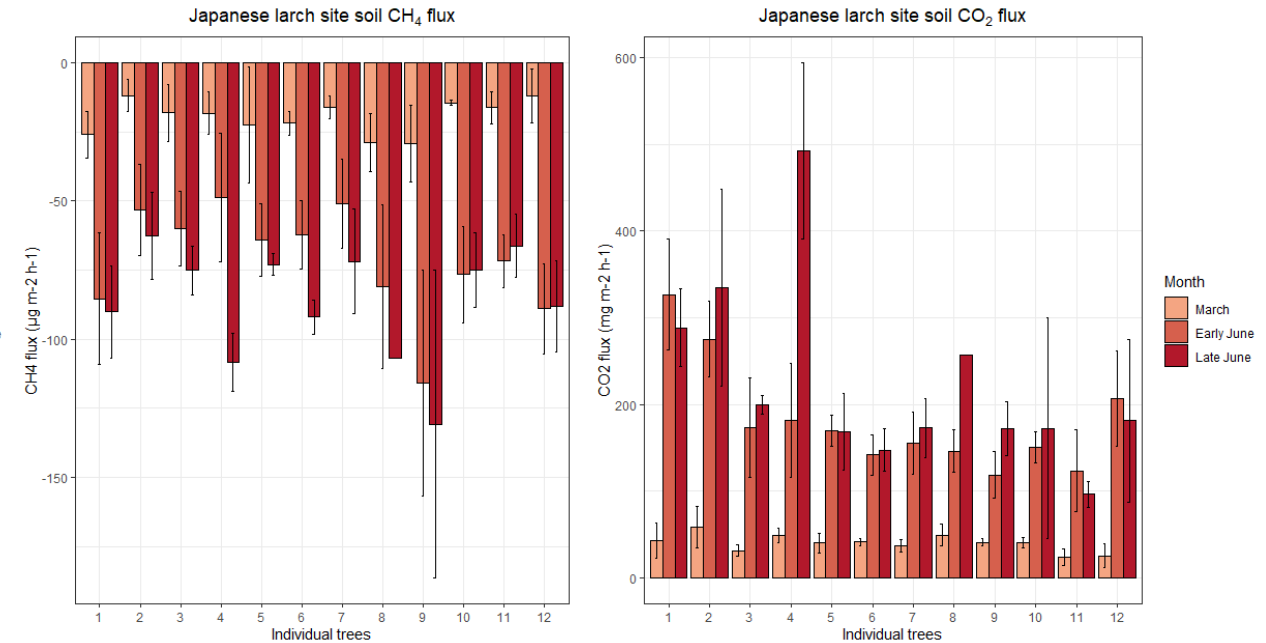


Fig. 7 The variation of soil CH₄ (left) and CO₂ (right) fluxes on Japanese larch site. The comparison of CH₄ and CO₂ fluxes between larch tree stem and soils were tested by month (Independent T-test/Mann-Whitney U test). Temporal effect on soil CH₄ an CO₂ fluxes were tested by Repeated ANOVA.

- Mineral forest soil CH₄ fluxes were significantly lower than tree stem CH₄ fluxes at both English oak ($P < 0.001$) and Japanese larch sites ($P < 0.001$).
- Mineral forest soil CH₄ and CO₂ fluxes showed significantly temporal effect at both oak (CH₄ and CO₂ fluxes, $P < 0.001$) and larch sites (CH₄ and CO₂ fluxes, $P < 0.001$).

Highlights

- Tree species did not have significant effect on tree stem CH₄ flux, but on tree stem CO₂ flux ($P < 0.001$).
- Large intra-species variations of tree stem CH₄ fluxes were observed from English oak (-7.55 – $2.60 \mu\text{g CH}_4 \text{ m}^{-2} \text{ h}^{-1}$) and Japanese larch (-4.80 – $4.88 \mu\text{g CH}_4 \text{ m}^{-2} \text{ h}^{-1}$).
- Mineral forest soils only showed CH₄ uptake at both oak site (-5.00 to $-73.20 \mu\text{g CH}_4 \text{ m}^{-2} \text{ h}^{-1}$) and larch site (-11.98 to $-130.76 \mu\text{g CH}_4 \text{ m}^{-2} \text{ h}^{-1}$).
- It is hard to estimate tree stem CH₄ fluxes from measurements once or twice each month due to high variability.

Next steps

- Study high-frequency (15 times/chamber/day) measurements of tree stem and soil CH₄ and CO₂ fluxes in temperate forests with mineral soils using automated chambers.
- Study the potential drivers and mechanisms of tree stem CH₄ exchange.

Acknowledgements

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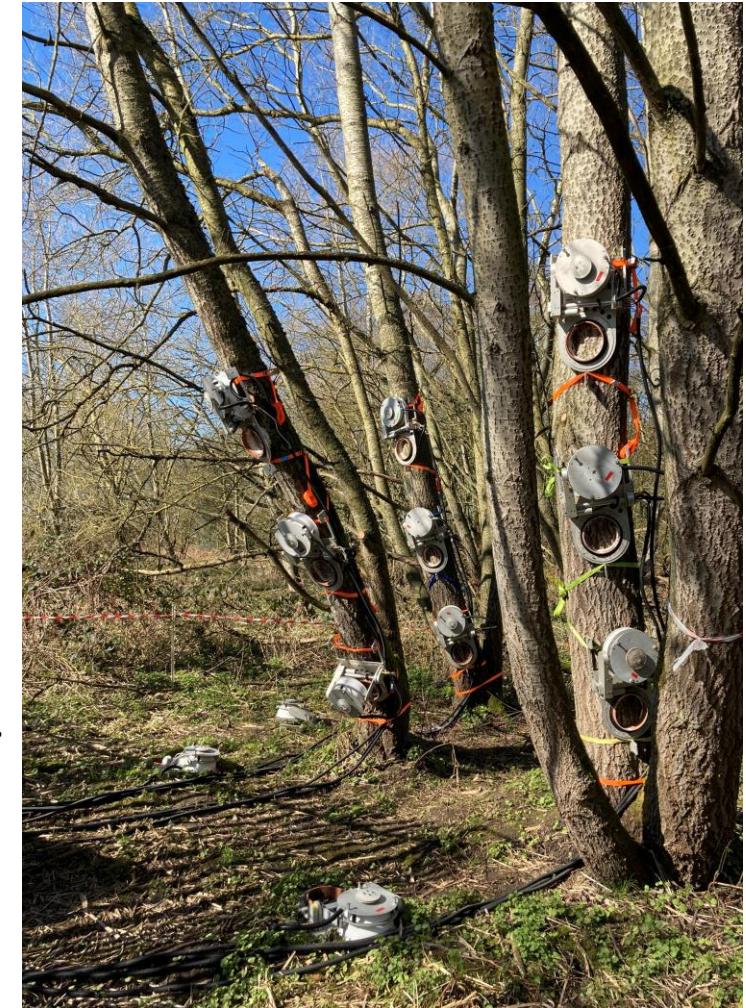


Fig. 8 Automated chambers install on Aspen (*Populus tremula*) tree stems and soils.