Xylem sap dynamics of 175-year-old Quercus robur under *elevated* CO_2

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Baseline 2015/16 eCO_2 2017-2026

Free-Air Carbon-dioxide Enrichment (FACE)

3 no-infrastructure ambient-air (natural/ ghost arrays)

3 ambient-air infrastructure FACE rings

3 FACE treatments of +150 ppmv CO_2

https://www.birmingham.ac.uk/research/bifor/face/index.aspx

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Acknowledgements:
BIFoR FACE Operations Team and colleagues.

Research Question

How does elevated CO_2 influence plant water usage and transpiration?

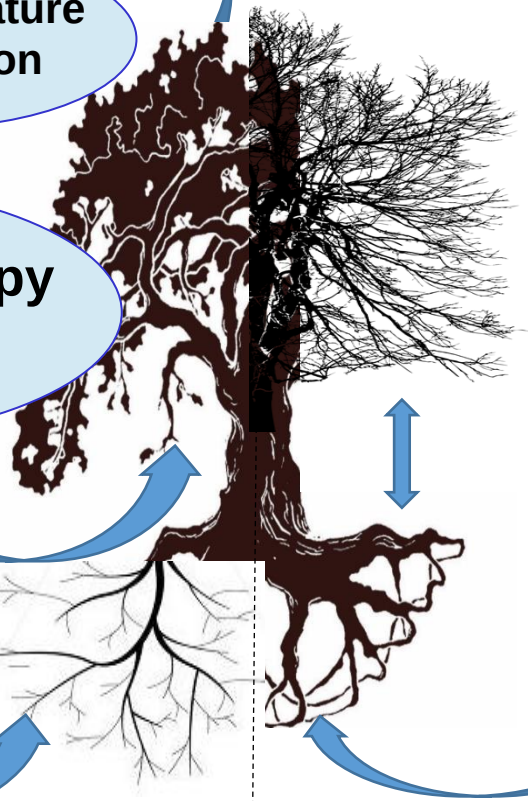
Key Measurements

Leaf temperature & transpiration

Sap flow & canopy transpiration

Soil moisture & temperature

Winter



Summer

Photo K M Hart

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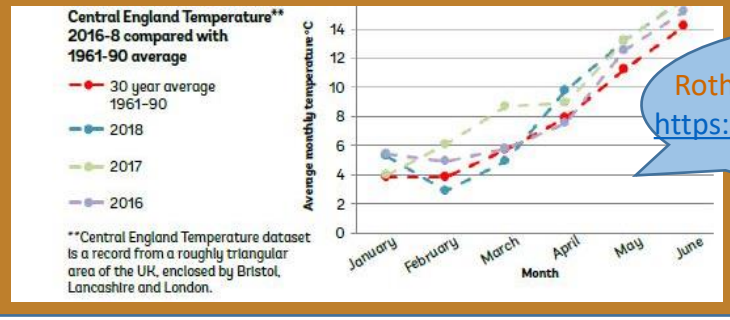
Sharing is encouraged

Measuring the trees Quercus robur

1 Phenology of Q.robur at BIFoR FACE 2016-2022

- Spring budburst & 1st leaf
- Autumn senescence



Based on figures from Rothamsted Research (2017) & https://naturescalendar.woodlandtrust.org.uk/

Confounding factors

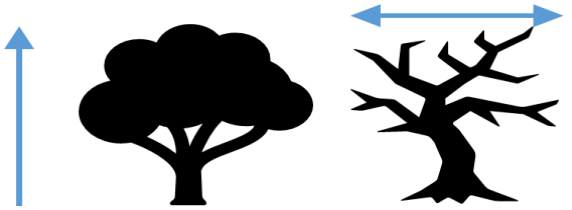
- phenology
- tree size
- sap speed
- wood characteristics
- xylem width
- wounding

2 At sap transducer installation

- Circumference/ diameter
- Install height
- Bark thickness
- Distance to logger & centre of treatment array

3 After installation

- Canopy spread and asymmetry
- Canopy height



4 For xylem sapflux calculation

- Woody matrix characteristics from incremental and micro cores

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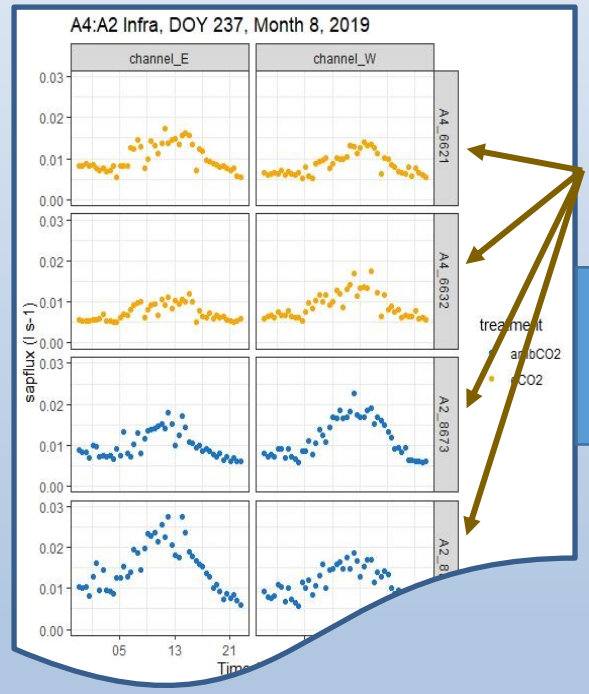
2019 Results of Xylem sap dynamics Q. robur

Quick et al. (in prep)

Photography not allowed

Sunny Summer's Day responses at BIFoR FACE



trees

Filter & Sum

Whole tree DOY water usage during daylight at BIFoR FACE

Data visualisation shows:

- **Tree size affects water usage (WU)**
- **Daily tree canopy transpiration estimated even during cloudy days**
- **Air temperature may influence WU**

NOTE
DOY for peak daylight WU does not correspond to DOY 237 of peak sapflux density.

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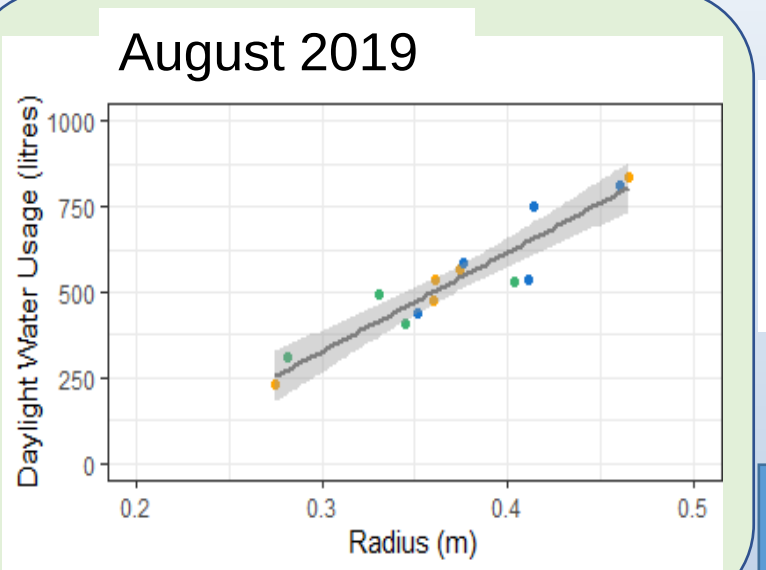
Tree size affects xylem sap dynamics Q. robur

Quick et al. (in prep)



Treatment
- none
- ambCO$_2$
- eCO$_2$

Whole tree monthly normalised water usage during daylight

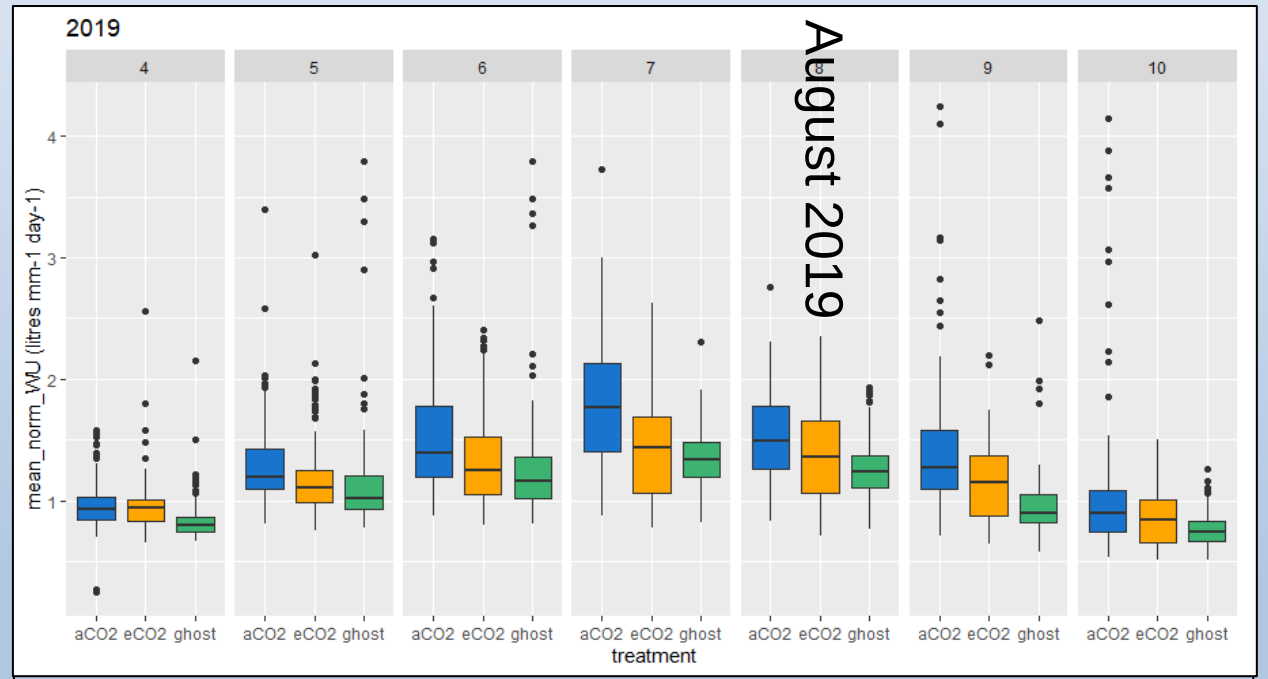


Fig. Boxplots 2019 show mean daylight daily water usage normalised for tree stem radius (litres mm-1 day-1)

We find that mean daily daylight oak tree water usage varies linearly with stem radius (∝DBH) by 2.9 litres per millimetre during August.

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Preliminary findings: Xylem sap dynamics Q. robur

Quick et al. (in prep)

How does elevated CO_2 influence plant water usage and transpiration?

SUMMARY

Elevated atmospheric CO_2 is expected to reduce daylight plant water usage – the water saving can be quantified following normalisation by tree radius.

FINDING

Normalisation of water usage by tree radius mostly accounts for water usage variation between trees.

Season, Canopy area and xylem area also affect WU

See supporting information [EGU].

NEXT STEPS

Further data analysis is in progress from Data 2019-2022 for oaks and other species.

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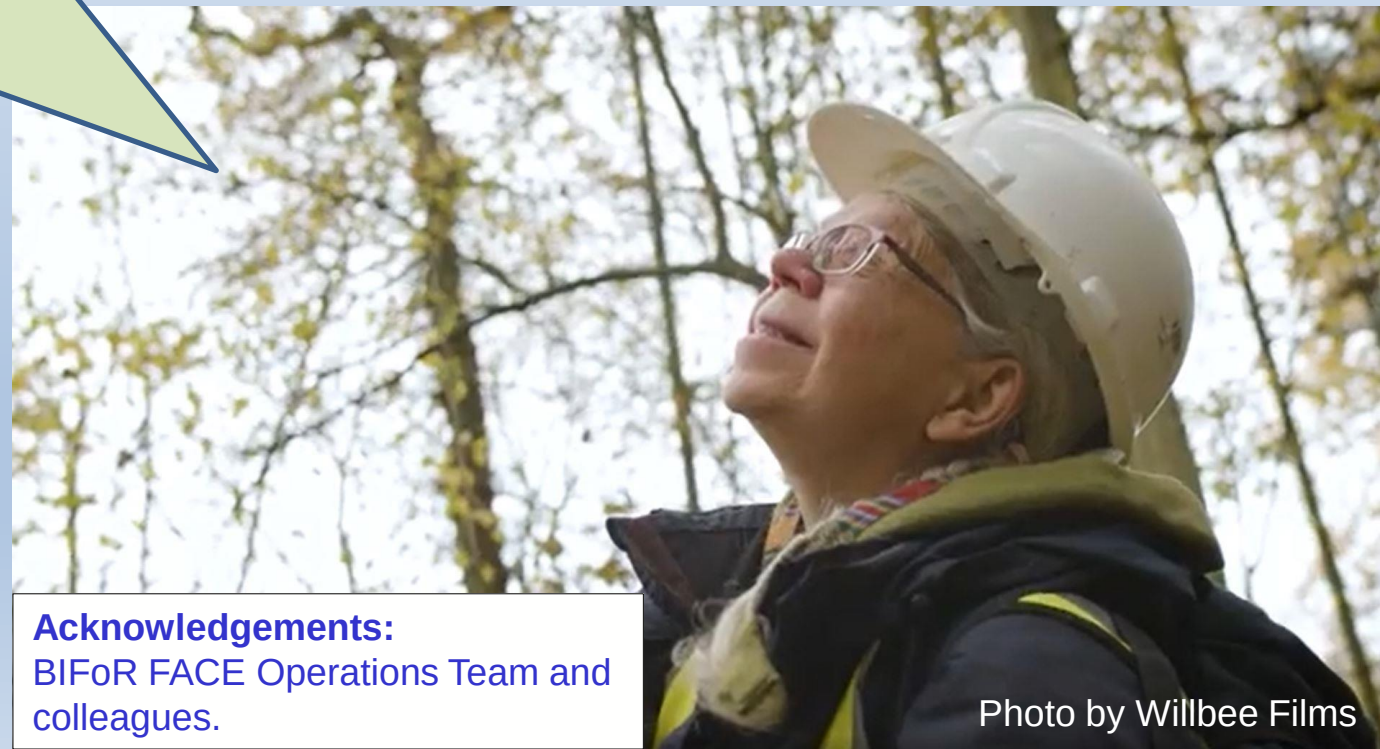
Thank you for listening,

Questions welcomed.

@SEQ616



Acknowledgements:
BIFoR FACE Operations Team and colleagues.

Photo by Willbee Films

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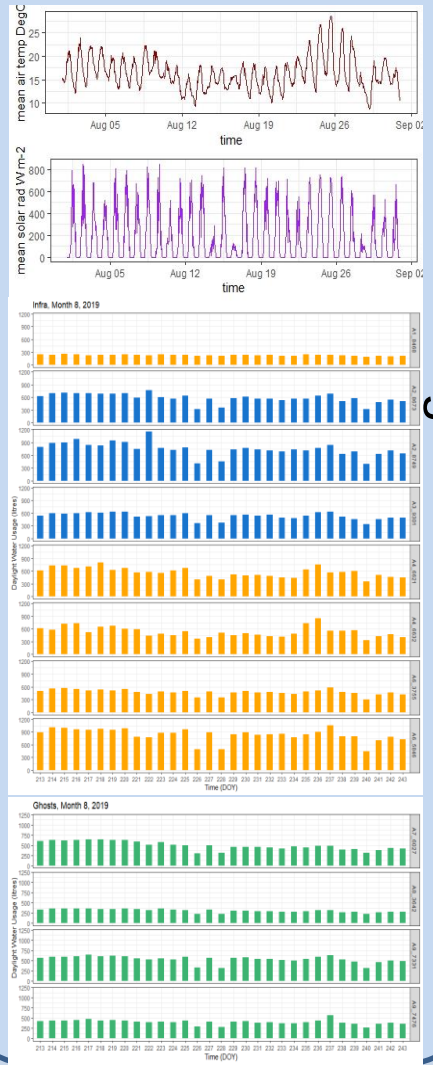
2019 Extra Results of Xylem sap dynamics Q. robur Quick et al. (in prep)

Photography not allowed

Whole tree DOY water usage during daylight at BIFoR

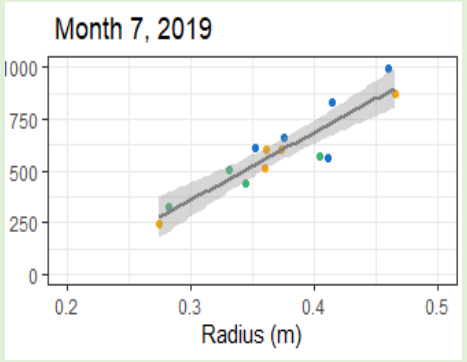


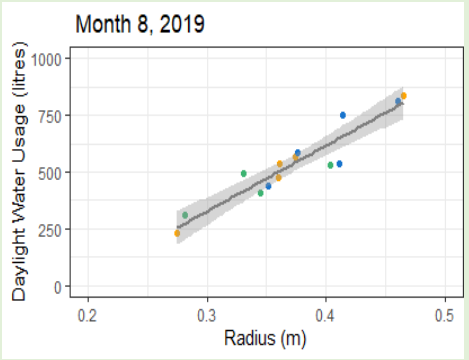
August 2019

trees

Treatment
- none
- ambCO$_2$
- eCO$_2$

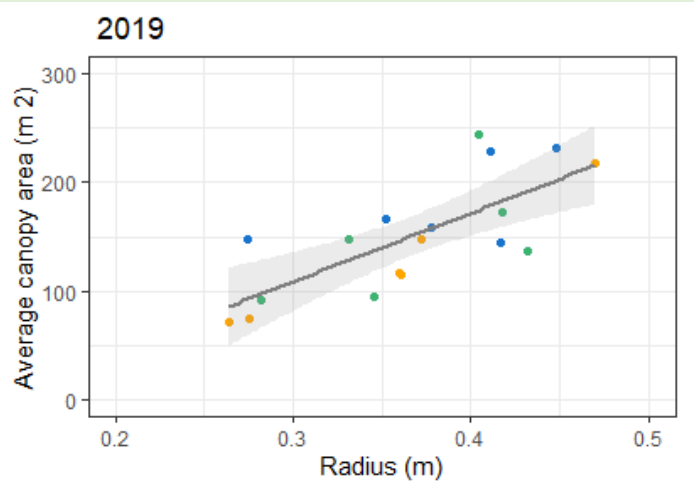
Summer 2019





We also find that daily daylight oak tree water usage varies linearly with stem radius (∝DBH) consistently across the summer season in 2019…

2017-2022



Canopy area (m²) also varies linearly with stem radius (∝DBH) across the project duration 2017-2022. circa 0.8 m² mm -1

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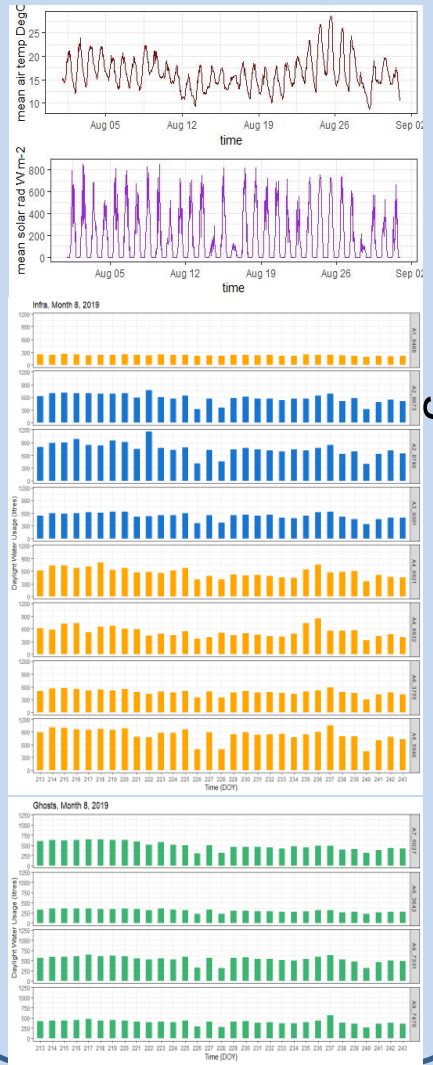
2019 Extra Results of Xylem sap dynamics Q. robur Quick et al. (in prep)

Photography not allowed

Whole tree DOY water usage during daylight at BIFoR FACE



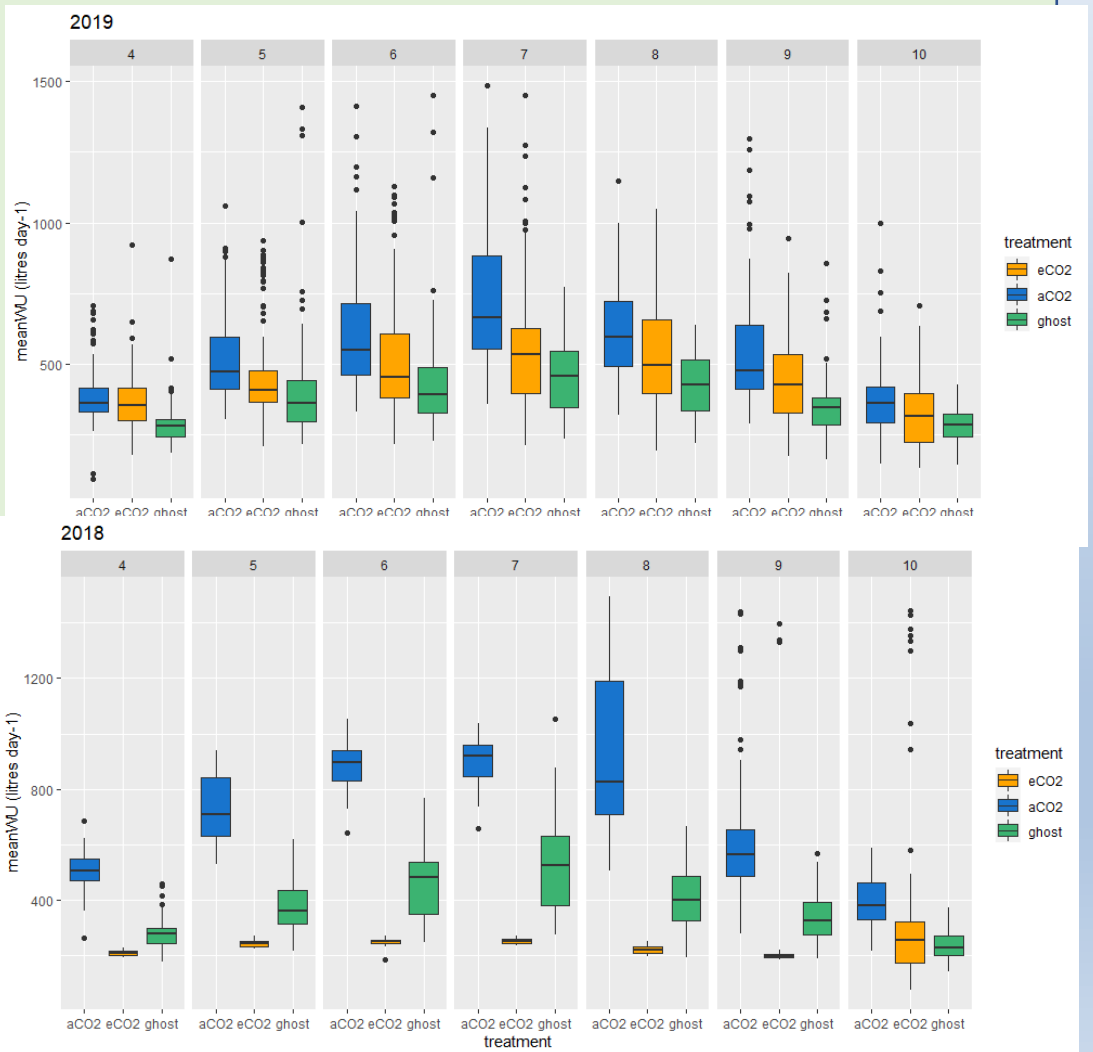
August 2019

trees

Treatment
none
ambCO$_2$
eCO$_2$

Treatment Season 2017-19

Whole tree daylight daily water usage during FACE treatment season



2017-2022

We have found that our sample of trees monitored for water usage, six per treatment, is adequate from 2019 onwards in the three treatments. Single FACE trees sampled e.g. in 2018 are insufficient to enable general conclusions.

Further data analysis is in progress for both oaks and other species.

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