Woodland resilience to climate change:

assessing tree-soil-water relations under elevated atmospheric CO_2

Susan Quick (SEQ616@student.bham.ac.uk, Stefan Krause[1], Giulio Curioni[1], Neil. J. Loader[3], Alan G.Jones[4], Phil Blaen[1,2], Carolina Mayoral[1] and A.Rob MacKenzie[1].

1. Birmingham Institute of Forest Research [BIFoR], University of Birmingham, UK 2. now at Yorkshire Water, UK
3. Geography Department, University of Swansea, UK 4. Earthwatch Institute, Oxford, UK

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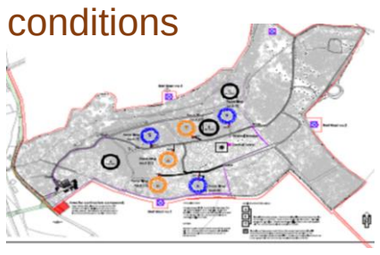
1 What is **BIFoR FACE ?**

This CO_2 time machine experiment, in 170-yr old mature temperate UK oak forest, predicts how forests will respond to 2050 climate conditions

http://www.birmingham.ac.uk/research/activity/bifor/index.aspx



- 3 Treatment → FACE rings +150 ppmv CO_2
- 3 Control → FACE ring infrastructure ambient-air
- 3 Ghosts → no FACE infrastructure

Baseline 2015/16; eCO_2 2017-2026

Sun's radiation determines when plants use and lose water at leaf level.

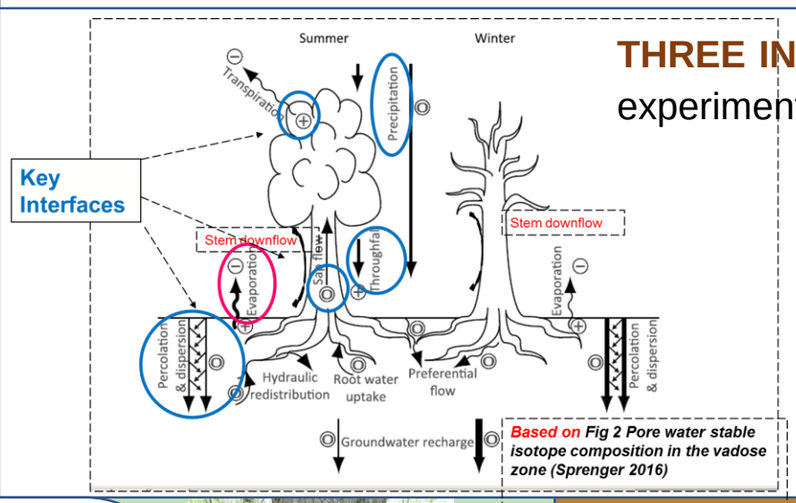
Air temperature and humidity also affect the trees' water-carbon cycle.

2 **ECO-HYDROLOGICAL PROJECT**

Tree-soil-water relations under elevated CO_2

This project investigates how water and water vapour, cycling through Soil-Plant-Atmosphere continuum affects CO_2 sequestration. It will inform climate change models and help predict future forest resilience.

3 **METHOD**



THREE INTERFACES are chosen to determine the WATER flow relations across experimental patches

ATMOSPHERIC-WATER

PLANT-WATER

SOIL-WATER

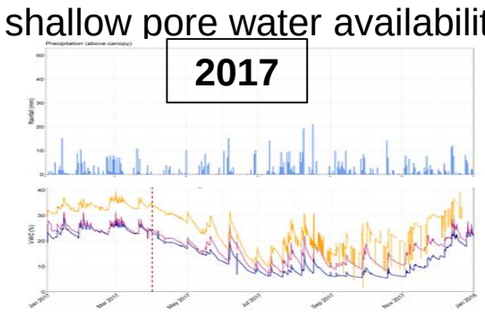
Meteorological conditions

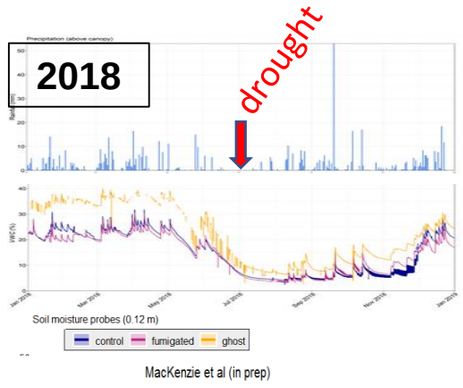
Dominant/ subdominant tree species xylem flow and transpiration

Spatial & temporal variability of soil moisture

4 SOIL-WATER

SOIL MOISTURE (to 100cm depth) is remotely measured, across the 9 research patches. WATER INPUT (precipitation) across the forest strongly influences shallow pore water availability.





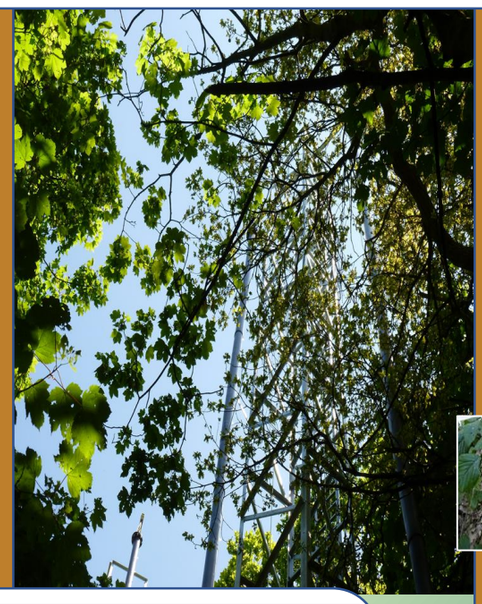
MacKenzie et al (in prep)

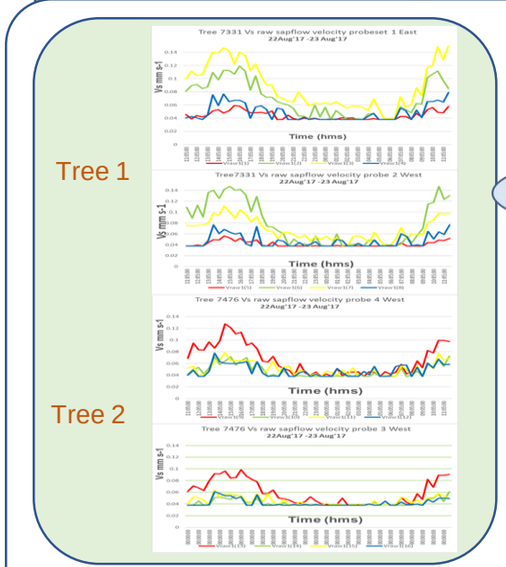
Ghosts patches wetter. Very heterogeneous, but no clear CO_2 influence yet.

5 PLANT-WATER

XYLEM SAPFLOW measured in. 21 trees ***Quercus robur*** (18) & *Acer pseudoplatanus* (3).

Sapflux characteristics vary due to sap speed, tree dimensions, heat characteristics and xylem width, in response to leaf demand





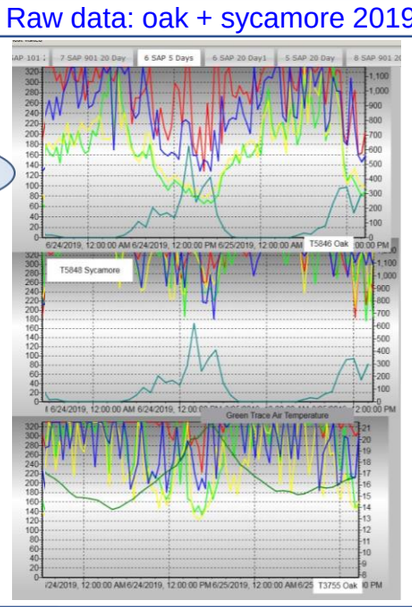
Oak Sap Velocity Data 2018

Xylem sapflow heatpulse probes

Key: probe depth mm
10
25
40
55
PAR µmol/s
Air temp °C

PAR = Photosynthetically Active Radiation

Raw data: oak + sycamore 2019

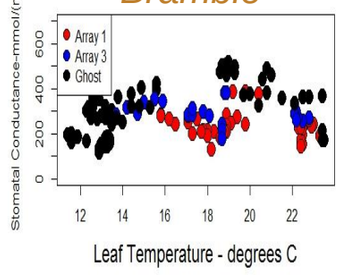


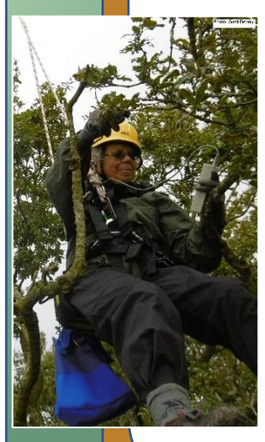
6 TRANSPIRATION

Using STOMATAL CONDUCTANCE from porometry. Understorey plants *Rubus fruticosus/ bramble* contribute to the water flux as well as ***Quercus robur/ oak.***

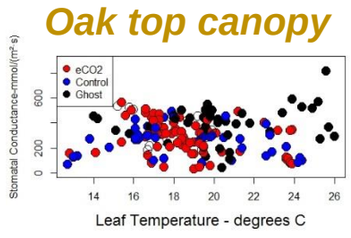
Transpiration relates to water vapour moving out of the stomata

Bramble





Oak top canopy



Oak leaves have more varied leaf temperature effects

8. EARLY FINDINGS SUMMARY

- Xylem flow varies by tree/ understorey species *Quercus robur/ oak, Acer pseudoplatanus /sycamore,*
- Stomatal closure strategies to prevent leaf wilt and transpiration in *Rubus fruticosus* / bramble show eCO_2 effects for a given leaf temperature
- Shallow (12cm) volumetric water content data is heterogeneous across forest

9.NEXT STEPS 2019-2020

- Full oak xylem sapflow analysis related to water balance & availability.
- Analyse ***Quercus robur*** **2019** canopy transpiration time domain data in all 3 treatment types to correlate with sapflow velocity and flux

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