# ‘Sci Fi Forest’ – propelling an English oak woodland to 2050

**Rob MacKenzie**
**on behalf of the BIFoR team**

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Photo credit: A. Priest Photograph

# FACE – Free Air $CO_2$ Enrichment

- Scientific background – rising carbon dioxide in the atmosphere ($CO_2$)
- Mature forest FACE experiment
- The unique opportunity – getting involved

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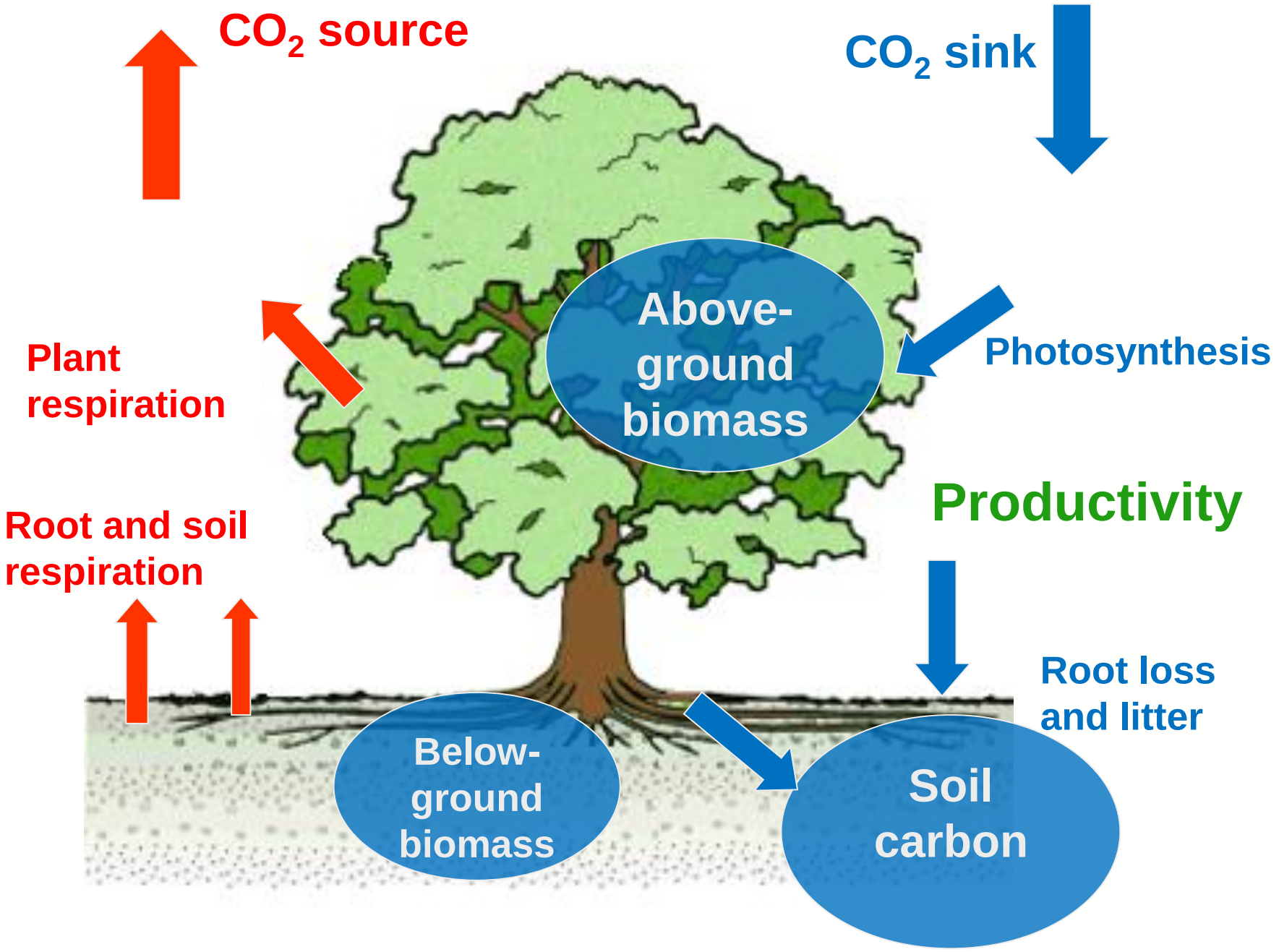
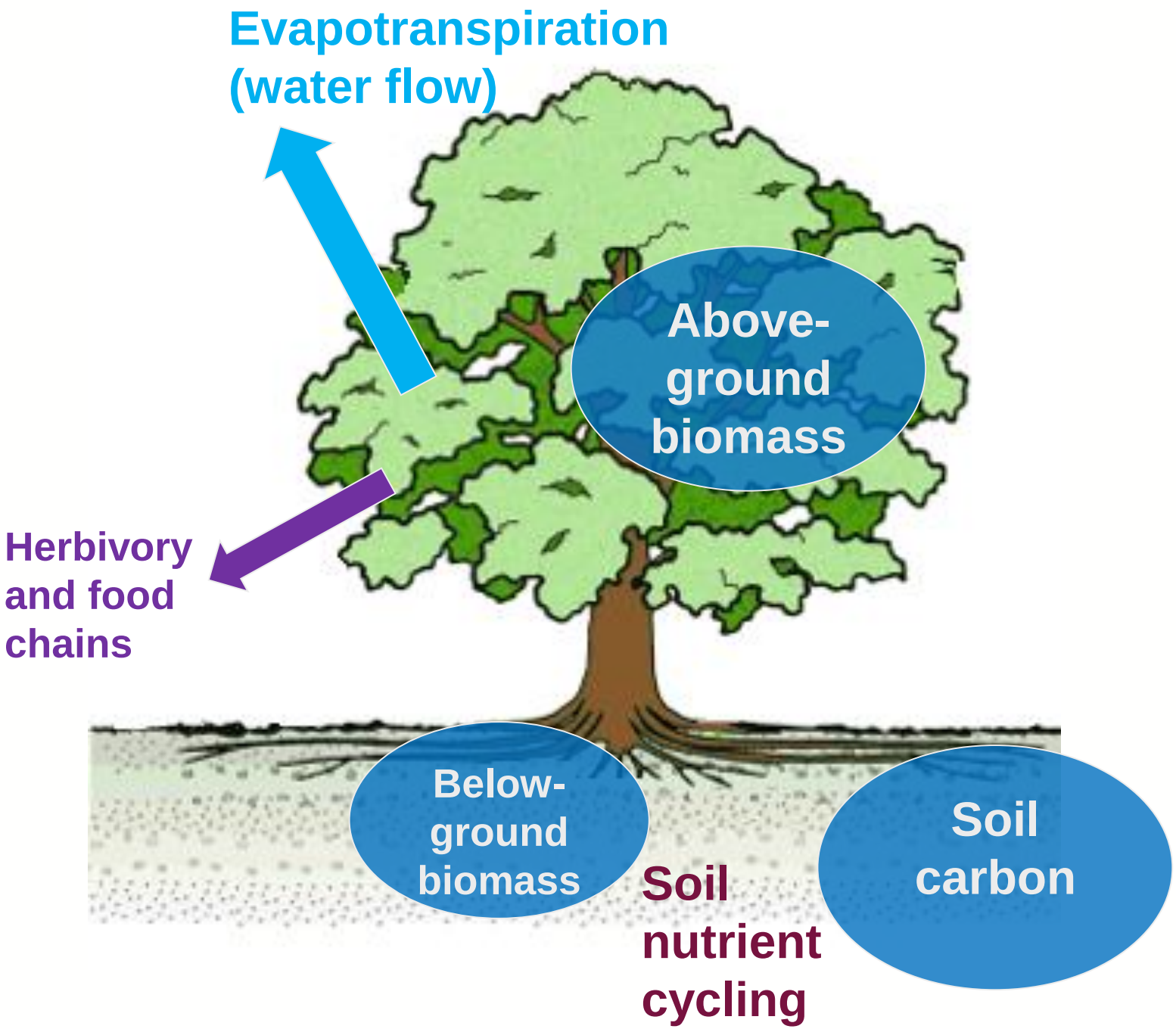

$CO_2$ source
$CO_2$ sink
Above-ground biomass
Plant respiration
Photosynthesis
Productivity
Root and soil respiration
Root loss and litter
Below-ground biomass
Soil carbon


Evapotranspiration
(water flow)
Above-
ground
biomass
Herbivory
and food
chains
Below-
ground
biomass
Soil
carbon
Soil
nutrient
cycling

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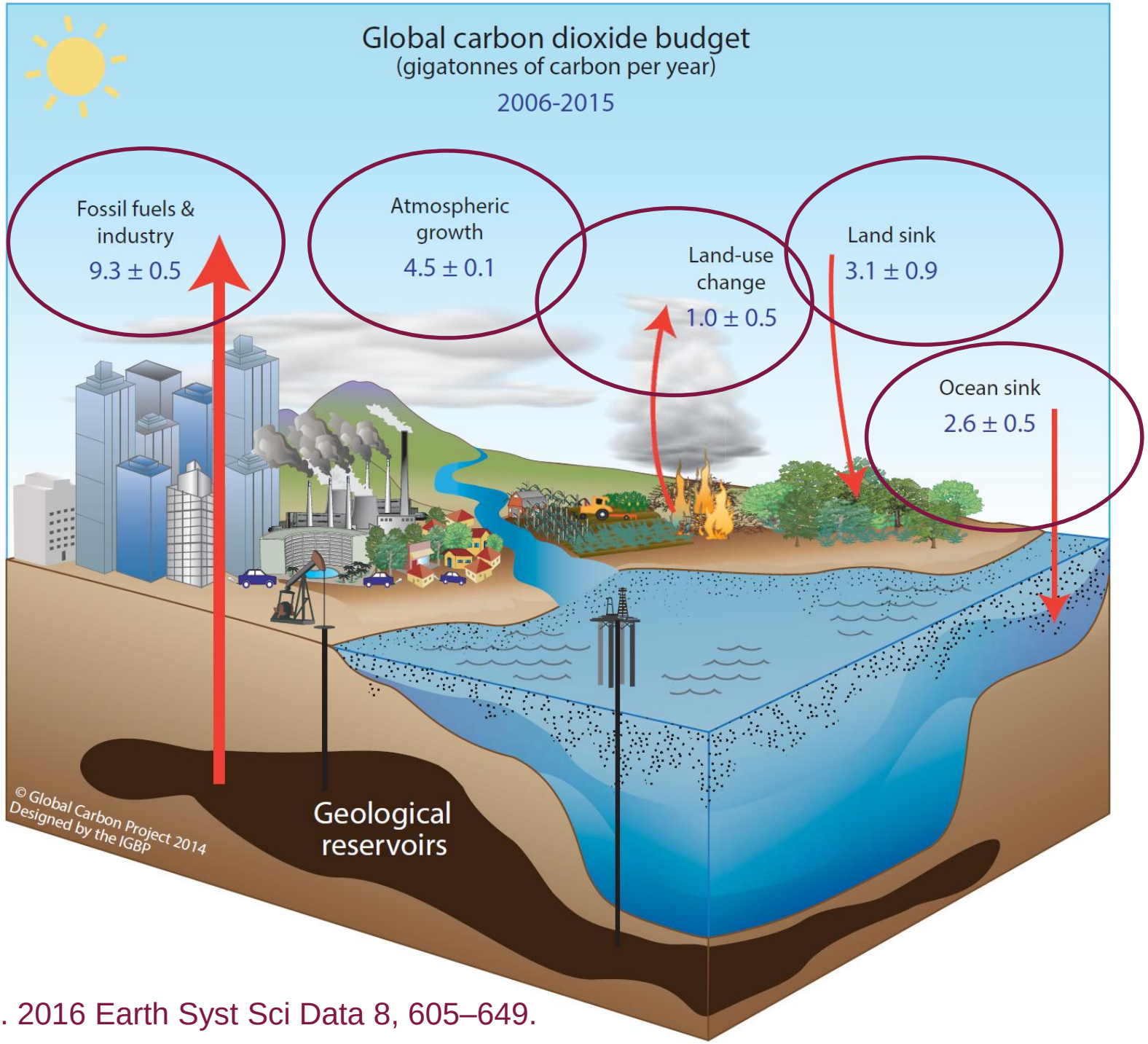
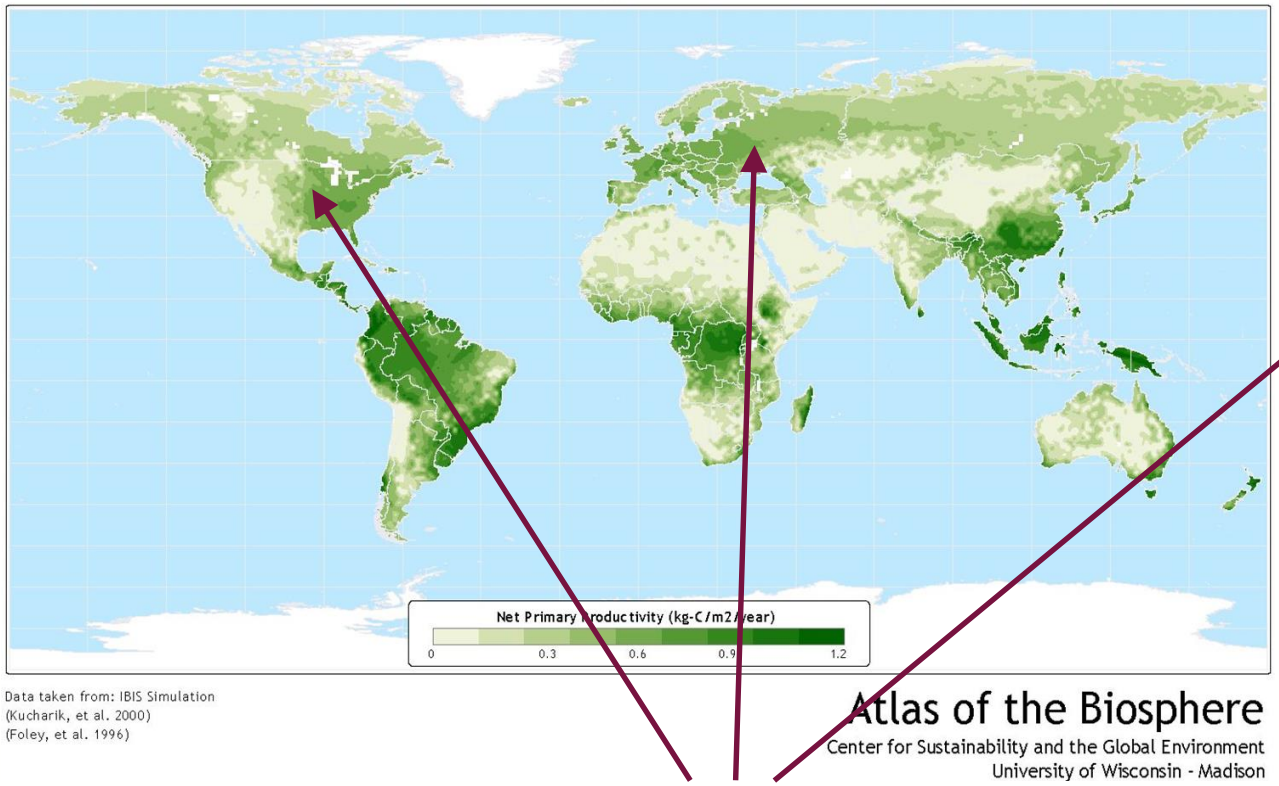
# Science Background

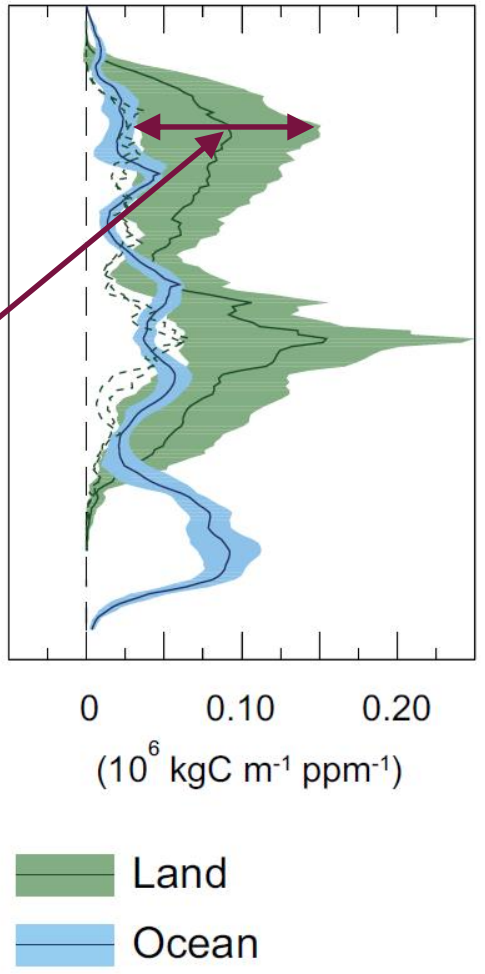
# The importance of temperate forests




Quéré et al. 2016 Earth Syst Sci Data 8, 605–649.

# Uncertainty!




**Northern Hemisphere Temperate Forests**

**Extra carbon per unit land area per unit increase in $CO_2$**

Ciais et al 2013. In: Climate Change 2013. The Physical Science Basis. Cambridge Univ Press. (Fig 6.22)

# Temperate forests matter!

Current net land C sink located primarily in northern hemisphere[1].

old-growth (i.e. mature) forests dominate the sink[2].

Globally, temperate forest living biomass holds a stock of ~48GtC [3,4],

(plus ~15GtC in dead wood and litter,

and ~57GtC in temperate forest soil[4]).

Temperate forests absorb ~0.7GtC $y^{-1}$ ref. 4

≅ annual EU-28 emissions ref.5

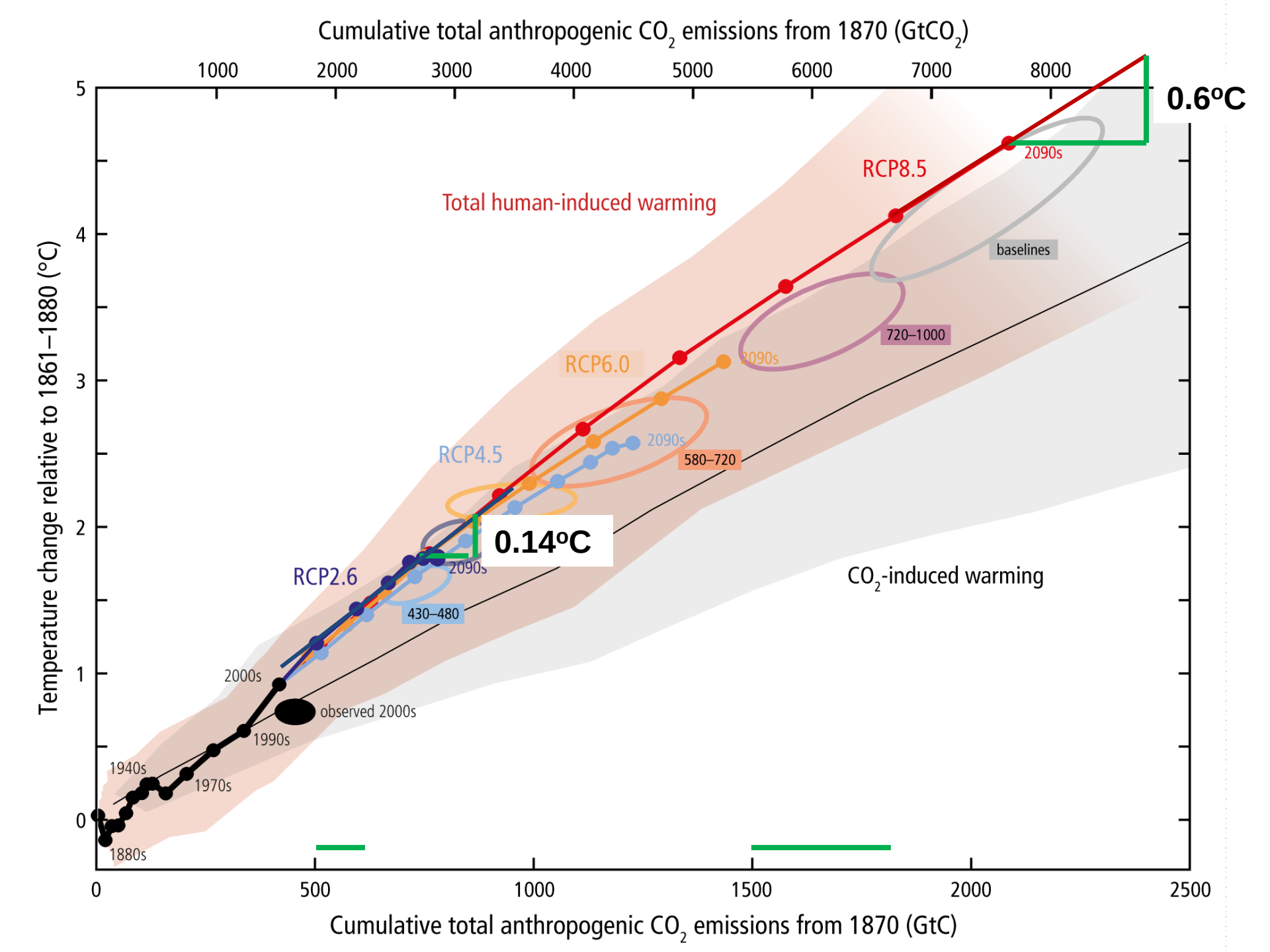
Temperate forests sink/stock ratio ~1.5% $y^{-1}$.

Four times more efficient C sink per unit living biomass than rainforest

(sink/stock ~0.4% $y^{-1}$ ref. 4).

References in Notes view.

Cork harvest in Portugal


Cumulative total anthropogenic $CO_2$ emissions from 1870 ($GtCO_2$)
1000
2000
3000
4000
5000
6000
7000
8000
0.6°C
RCP8.5
2090s
Total human-induced warming
baselines
720–1000
RCP6.0
2090s
RCP4.5
2090s
580–720
0.14°C
RCP2.6
2090s
430–480
$CO_2$-induced warming
2000s
observed 2000s
1990s
1940s
1970s
1880s
Temperature change relative to 1861–1880 (°C)
0
1
2
3
4
5
0
500
1000
1500
2000
2500
Cumulative total anthropogenic $CO_2$ emissions from 1870 (GtC)

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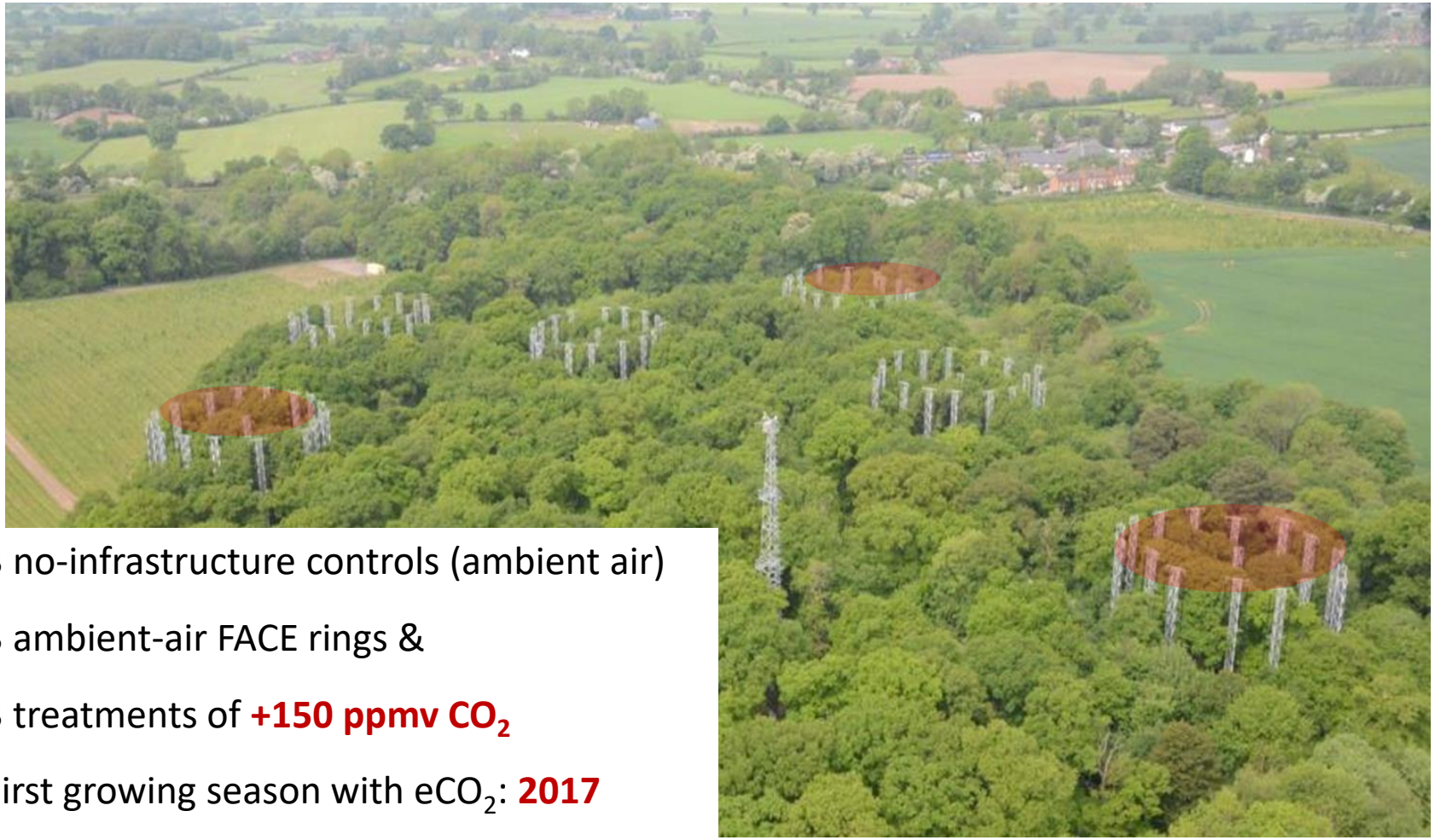
# BIFoR FACE

# Overview and taster

# …2nd Generation forest FACE are in mature forests – e.g. 150-yr old oak and hazel in BIFoR FACE



3 no-infrastructure controls (ambient air)

3 ambient-air FACE rings &

3 treatments of **+150 ppmv $CO_2$**

First growing season with $eCO_2$: **2017**

2015/16 baseline; $eCO_2$ **2017-2026**

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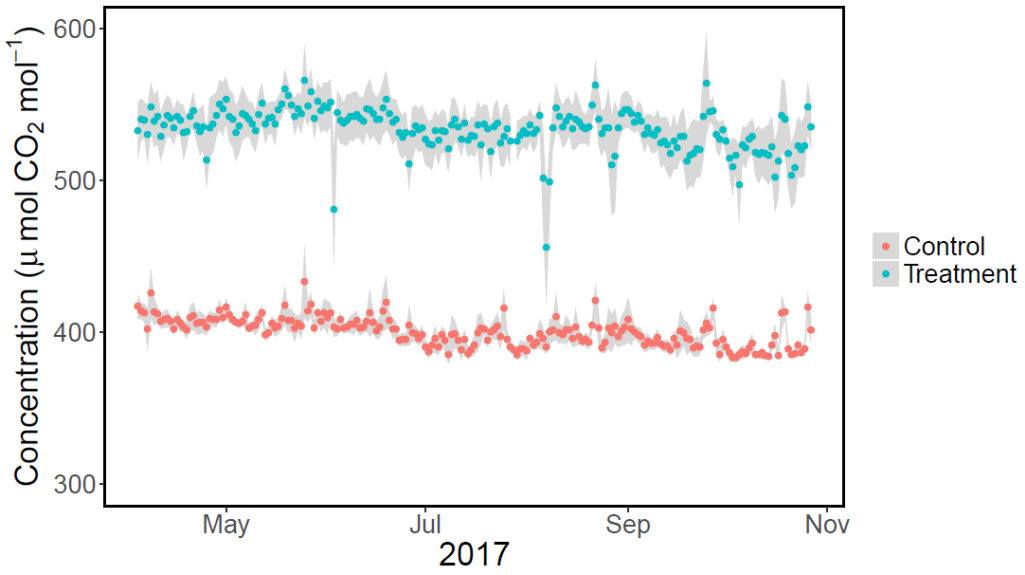
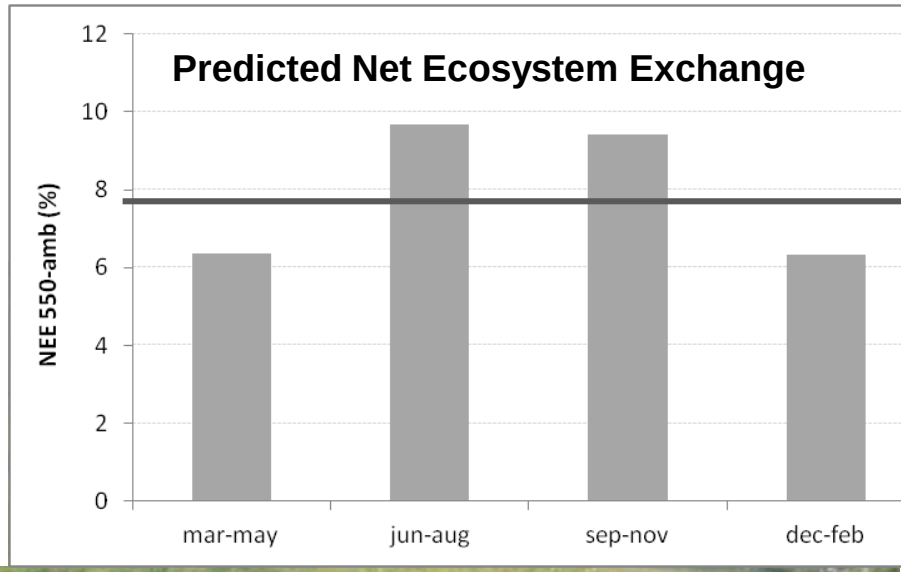
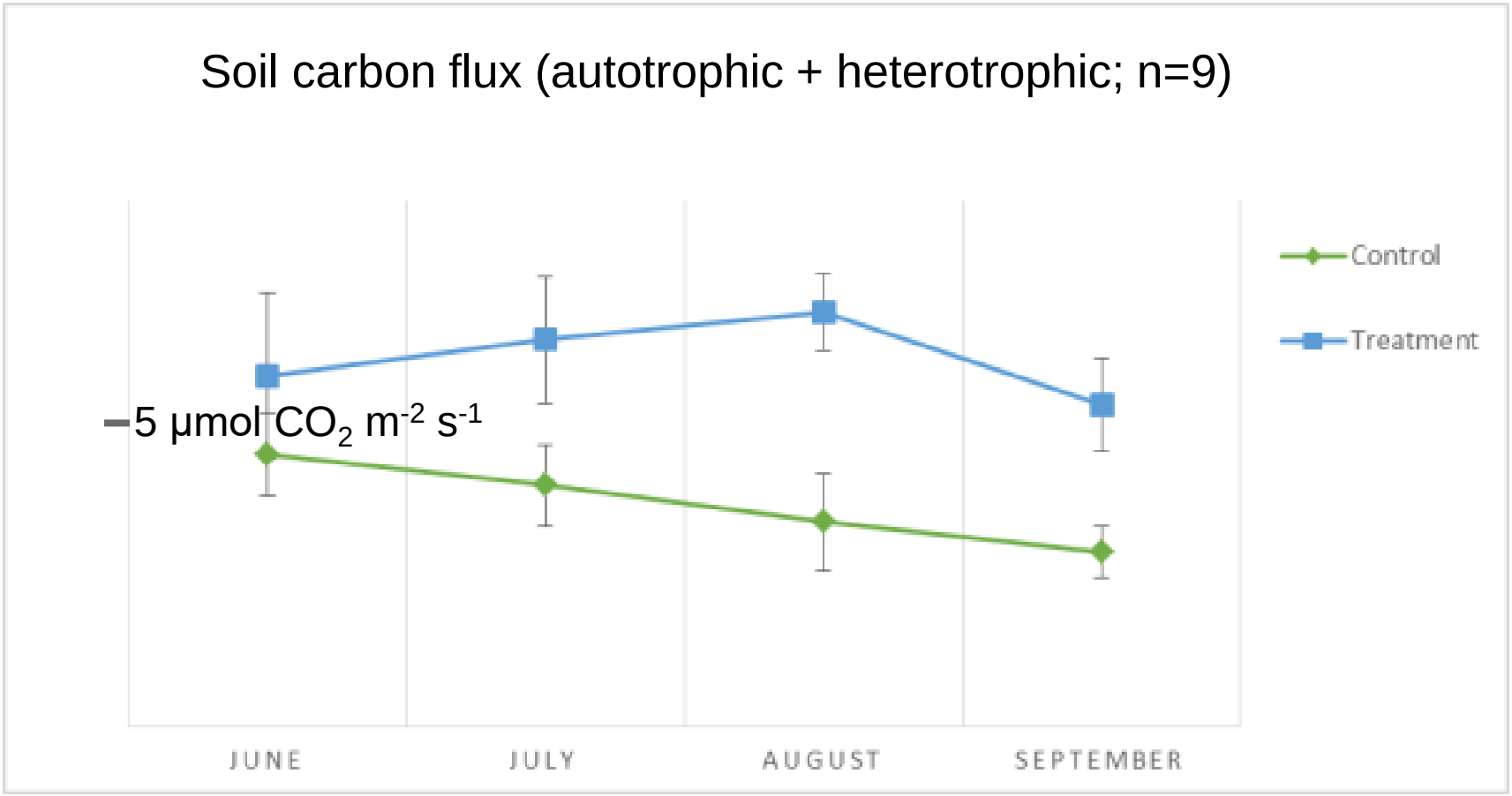

Concentration (µ mol $CO_2$ $mol^{-1}$)
600
500
400
300
May
Jul
Sep
Nov
2017
Control
Treatment


Predicted Net Ecosystem Exchange
NEE 550-amb (%)
12
10
8
6
4
2
0
mar-may
jun-aug
sep-nov
dec-feb

# First season results show more carbon in…& more carbon out…

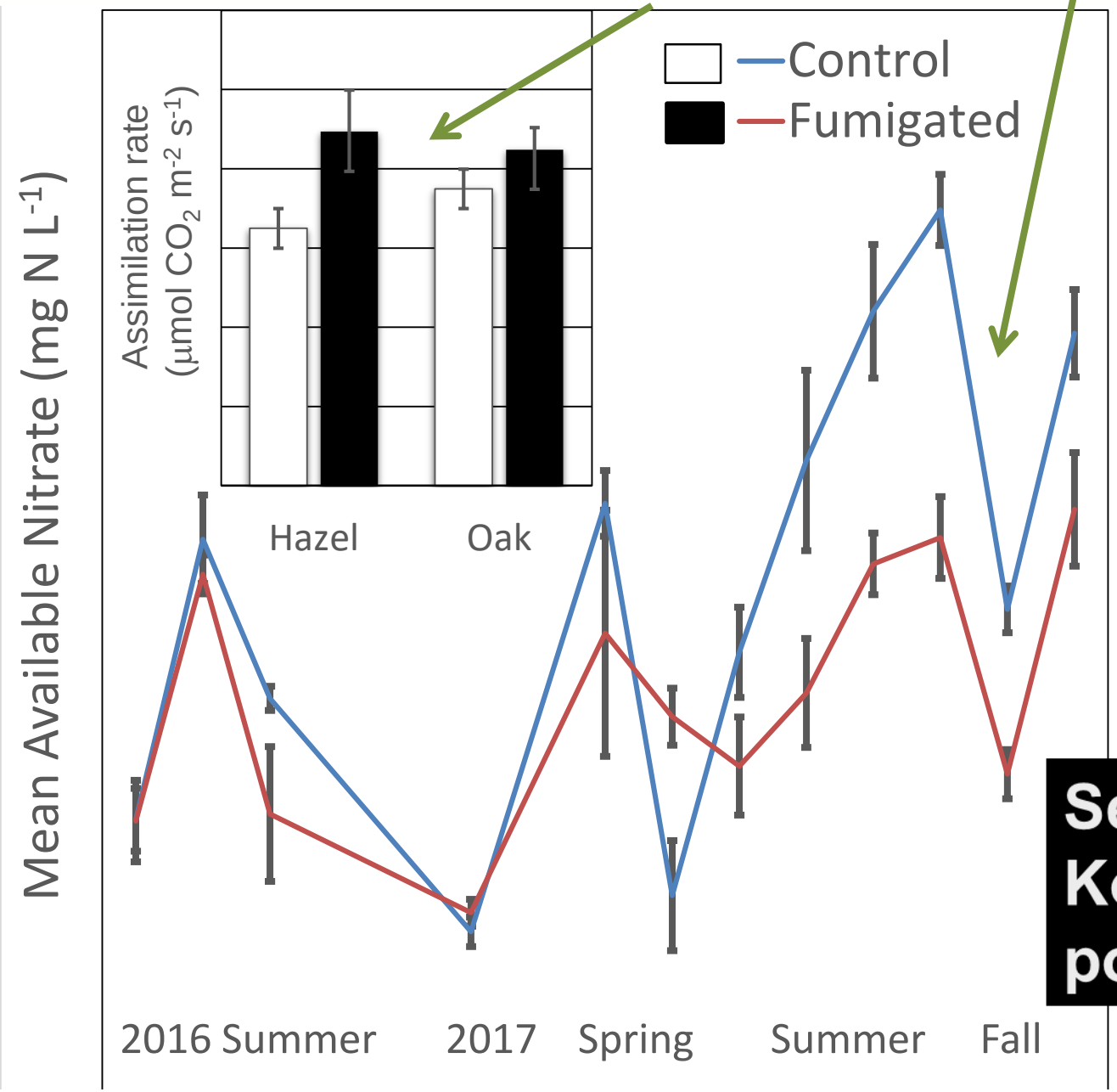



Angeliki Kourmouli: soil respiration (unpublished)

Clare Ziegler root panorama: https://kuula.co/post/7ltkV

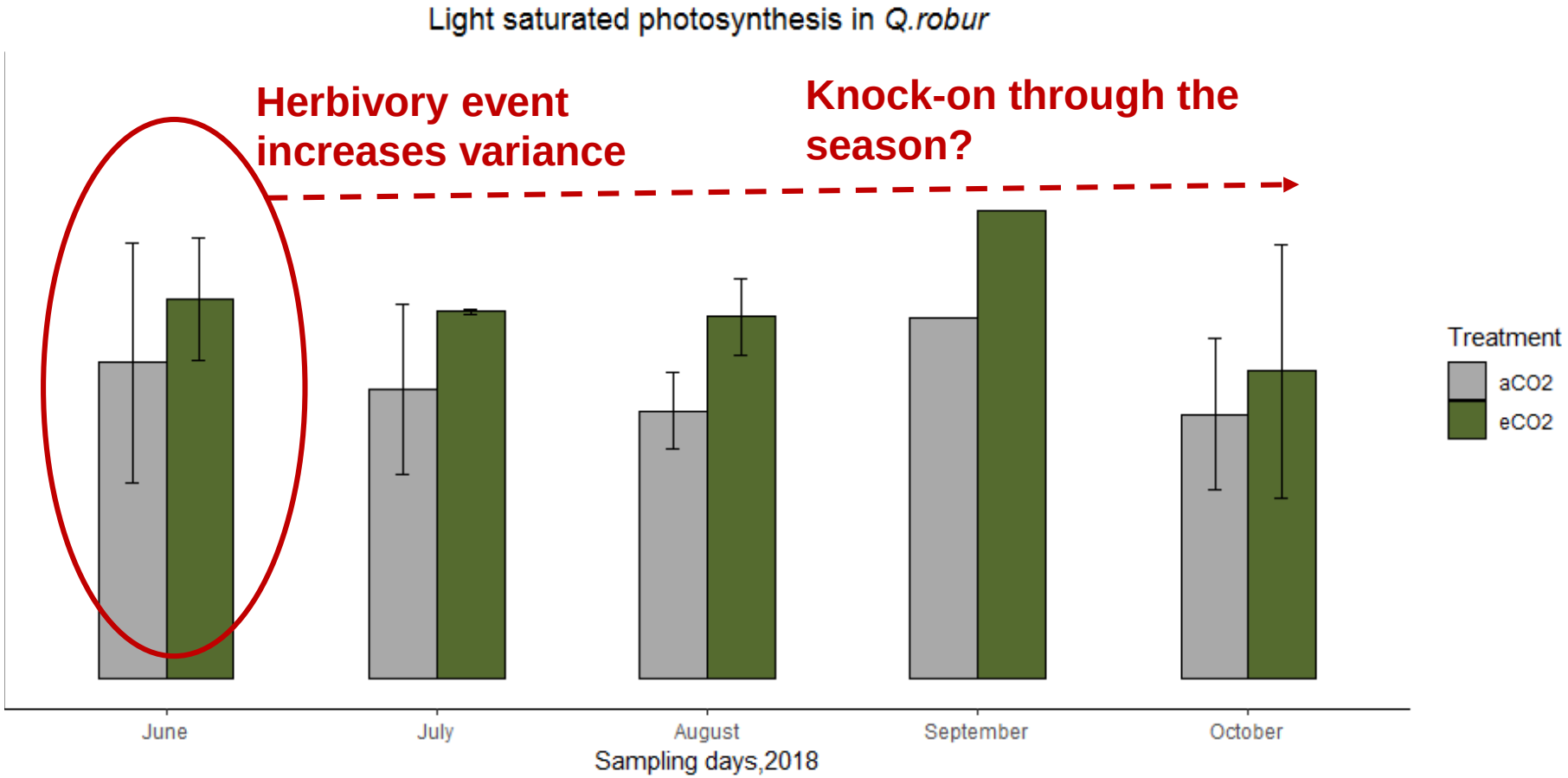
**See Angeliki Kourmouli's posters**

# First season results show more carbon in…& more nutrients taken up…



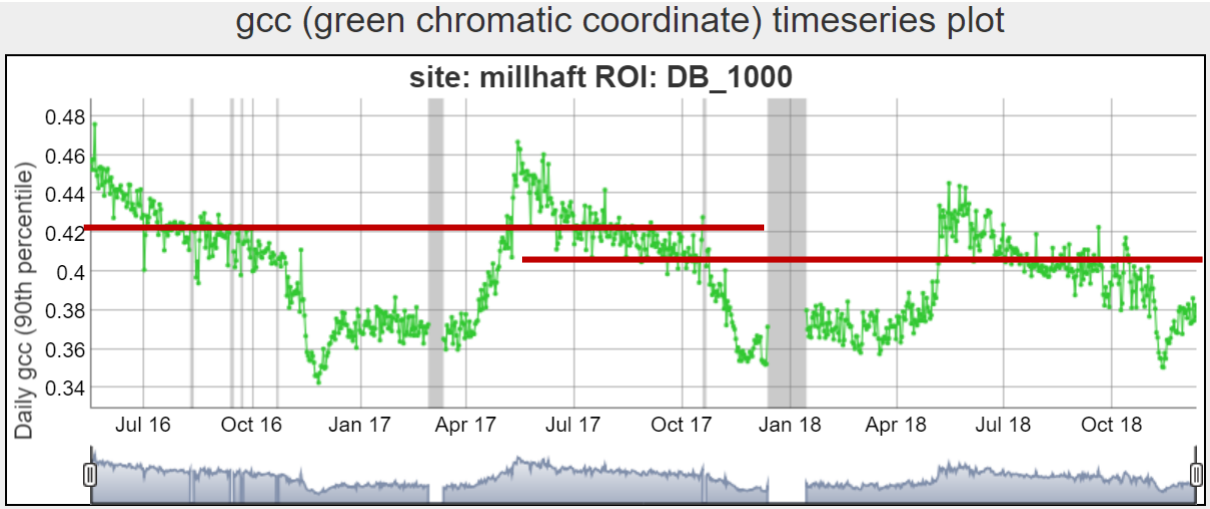

**See Angeliki Kourmouli's posters**

Sabine Tausz-Posch: assimilation; Angeliki Kourmouli: nitrate assimilation – all unpublished



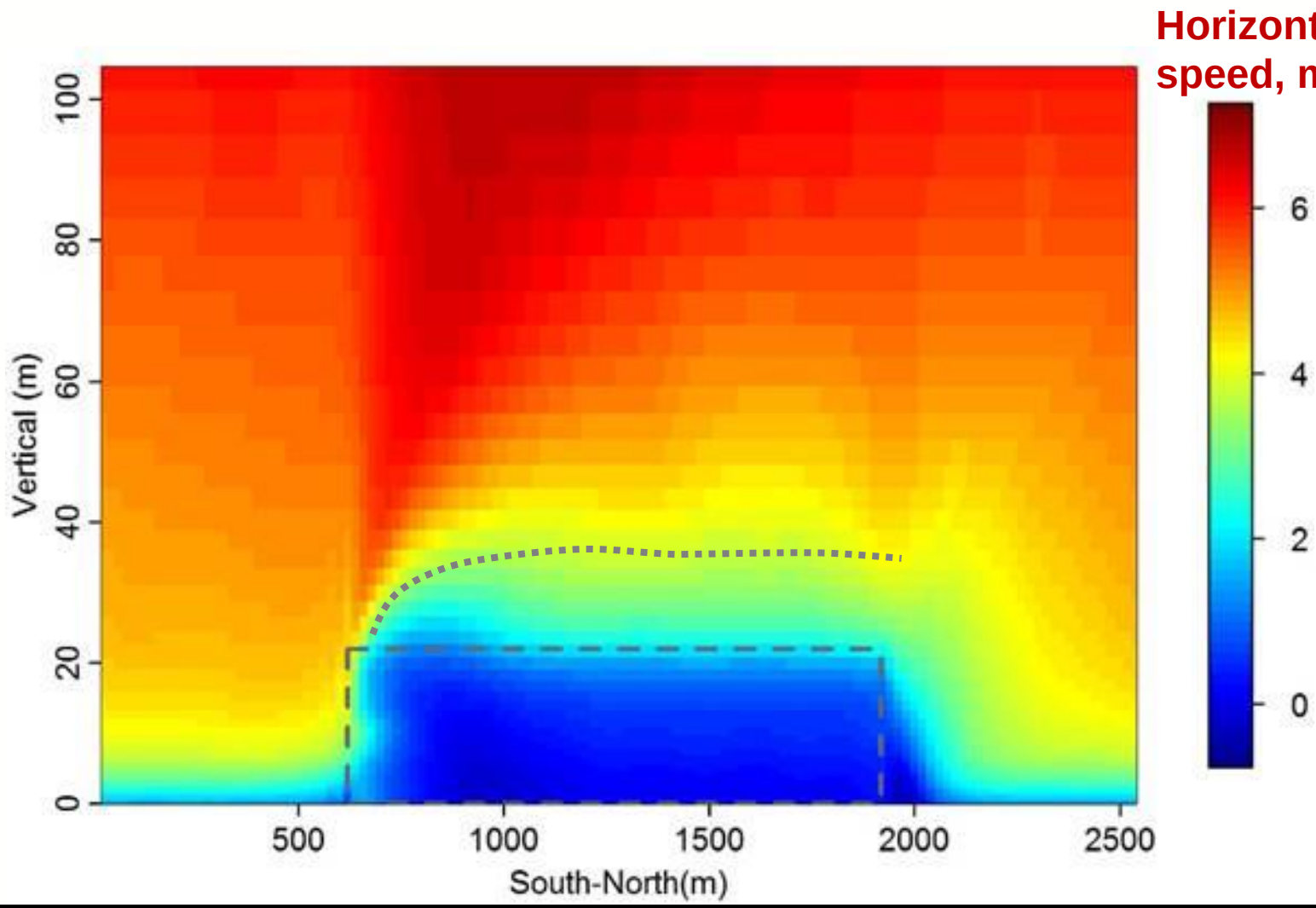

Anna Gardner, Michael Tausz, Jerry Pritchard, Rob MacKenzie, unpublished data

**Canopy measurably less green in 2018**




**See Anna Gardner's poster**

**Wind flow model output: strong and unsteady winds at the leading edge of forest patches; boundary layer forms above the patch; implications for insect mobility/energy budgets?**




**See posters by Ed Bannister and Eric Casella**

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# BIFoR-FACE

## Access and collaboration

# BIFoR-FACE

- University of Birmingham supported by the JABBS Foundation established infrastructure, leases the site, and provides support for the FACE technology (incl. $CO_2$ costs, FACE engineer and technical site support)
- Research costs need to be sourced
- Access cost model

# Facility fees model

Use of BIFoR FACE varies from the requirement for **small numbers of tissue samples** from treatment and control plots, to **long-term instrumental monitoring** of physical, chemical or biological parameters away from the FACE facility but making use of the broader infrastructure and research support the facility provides → implications for charging model

| Duration | Category A | Category B | Category C |
|---|---|---|---|
| Days | 4,425 £ per day | 2130 | 200 |
| Months | 32,000 £ per calendar month | 24,000 | 1,800 |
| Years** | 67,500 £ per year | 50,000 | 2,200 |

A = Mature fEC grant-funded studies; group rates for institutional membership by agreement.

B = Studies to support specific grant applications and/or near-to-submission 4* research outputs supporting UoB REF return; grant-funded studies not utilizing the FACE infrastructure; group rates for doctoral training cohorts by agreement.

C = Exploratory studies and special applications, including individual student access by agreement.

# Collaborations

32 projects so far

- Documented through project forms
- Scientific Access Committee
- IP and data sharing agreement

**Open** science but clear rules for first-use of data

- Currently only two comparable facilities in operation worldwide
- National and International scientific facility
- Collaboration - get involved!

# More Information

**Web: www.birmingham.ac.uk/bifor**

**Email: bifor@contacts.bham.ac.uk**

**Twitter: @BIFoRUoB**