UNIVERSITY OF BIRMINGHAM

A new multi-disciplinary institute of forest research

Rob MacKenzie

on behalf of the nascent BIFoR team

BIFOR

BIRMINGHAM INSTITUTE OF FOREST RESEARCH

Trees in the UK

FOREST VALUE

UK forest industries - £4.2bn Gross Value Added per annum
11,000 direct jobs and ~100,000 downstream jobs.

TRADE GAP

1M tonnes of hardwoods (oak, ash, beech, sycamore, walnut) are imported annually.

Annual UK trade deficit in wood-based construction materials is ~£1bn

→ Zero-carbon UK housing difficult - requires responsible sourcing and transport offsetting

SKILLS GAPS

50-80% of UK woodland and forest unmanaged (any managed sustainably?)

"Most Wanted" skills: plant pathology, taxonomy, soil science, environ. microbiology

SKILLS LEADS

Climate, bioscience (esp. medical),

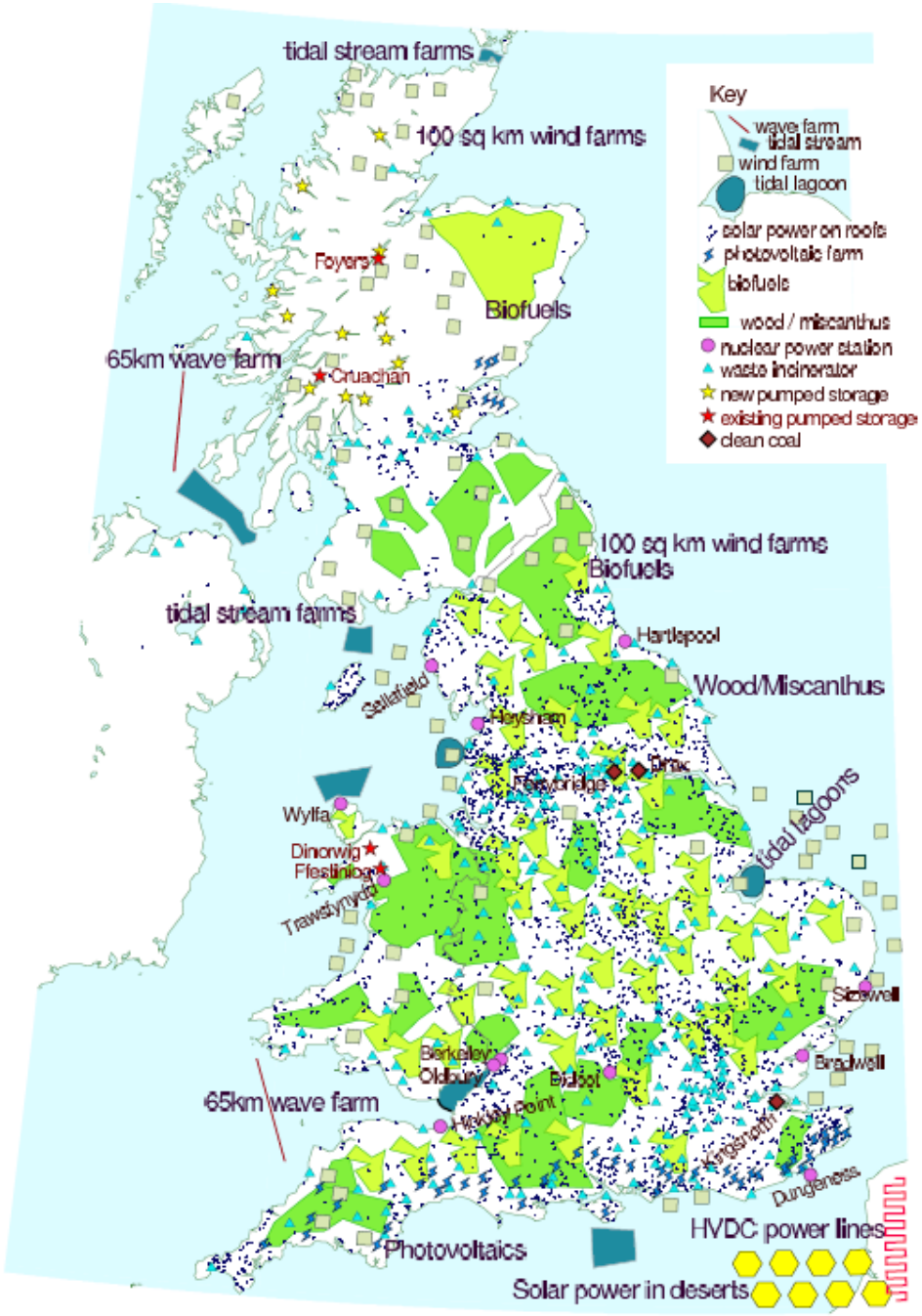
KNOWLEDGE GAPS

Value Capture Frameworks

and one-world living

Carbon sink – mature woodlands inc. soil

Resilience to biotic and abiotic challenge



Visions of a sustainable UK include substantial areas of managed woodland

Sustainable
Energy/water/food/biodiversity

Forestry Commission Strategy:
Protect
Improve
Expand

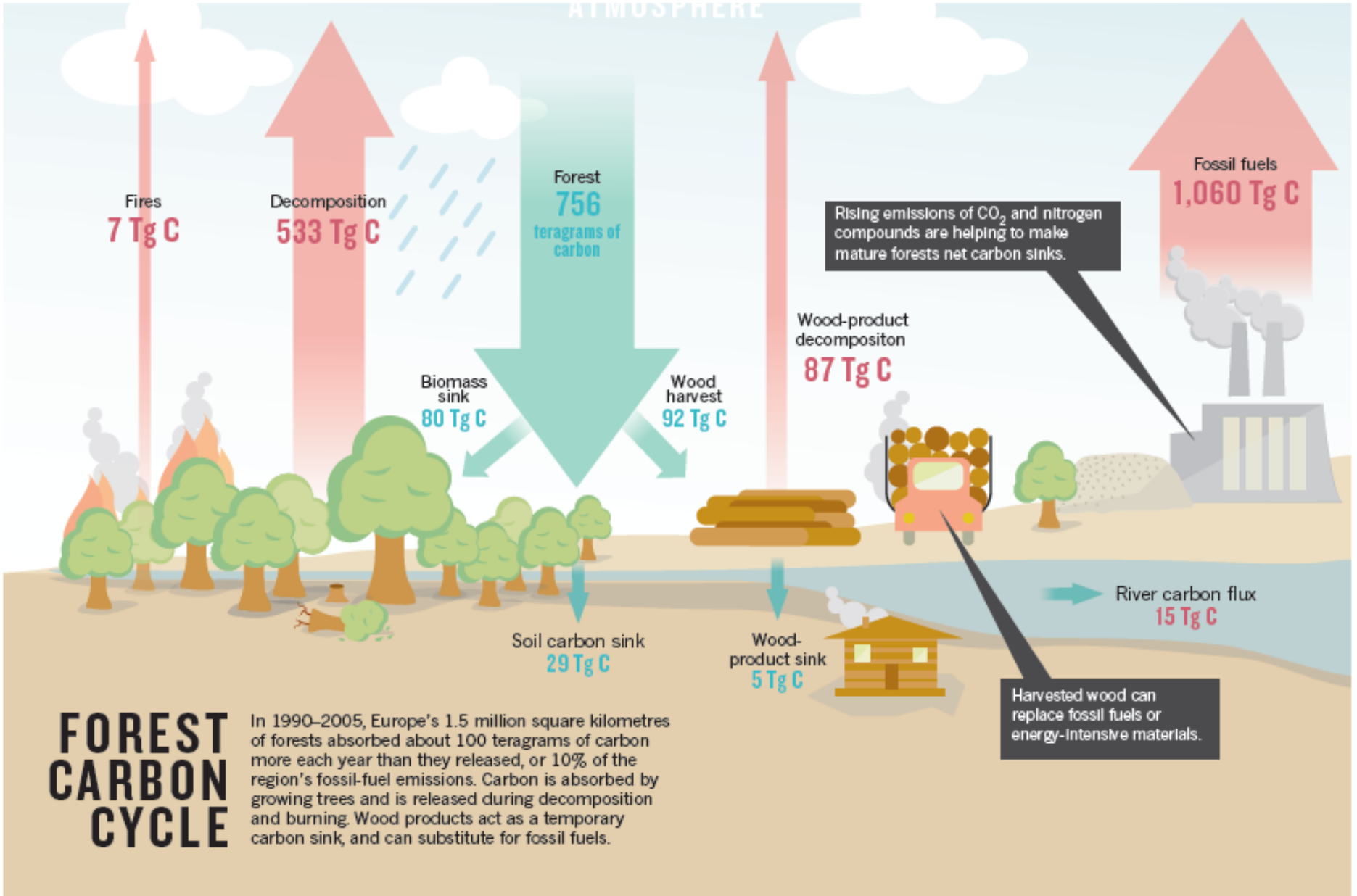
MacKay, 2009: Sustainable Energy Without the Hot Air, UIT, Cambridge, UK

Green areas: woods and short-rotation coppice

Yellow-green areas: biofuel cropping

Mature forests are a carbon sink – because of elevated CO_2 and nitrogen deposition

(Odum's Framework is 1-dimensional - makes no sense in most of UK)



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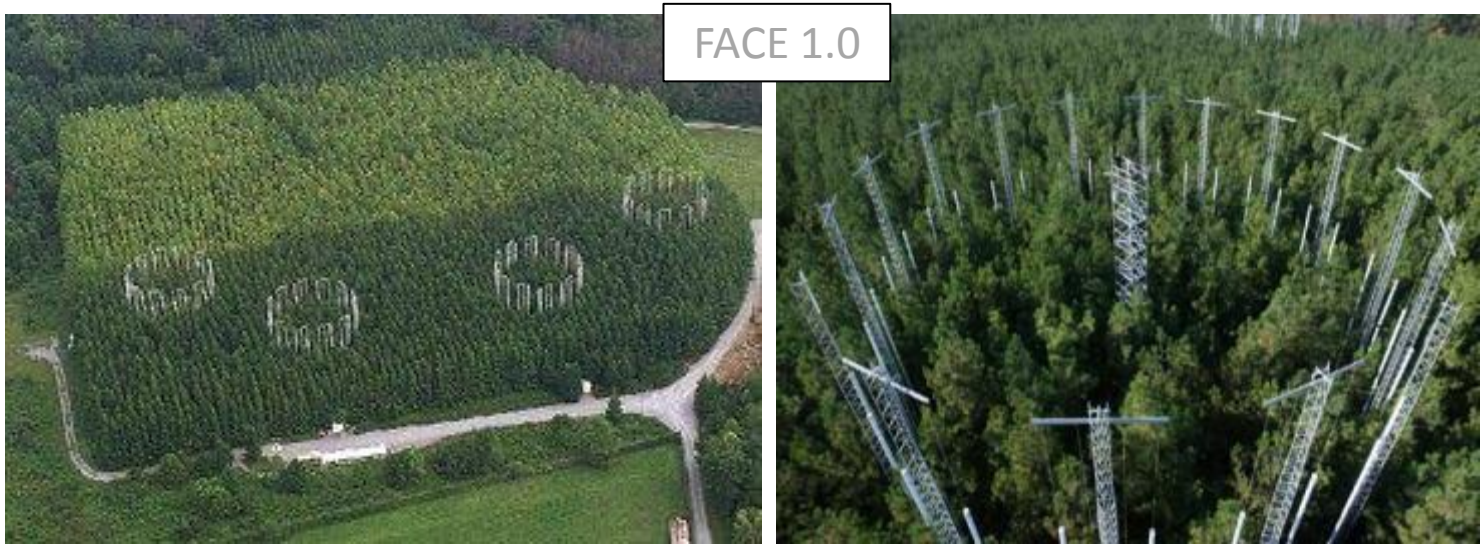
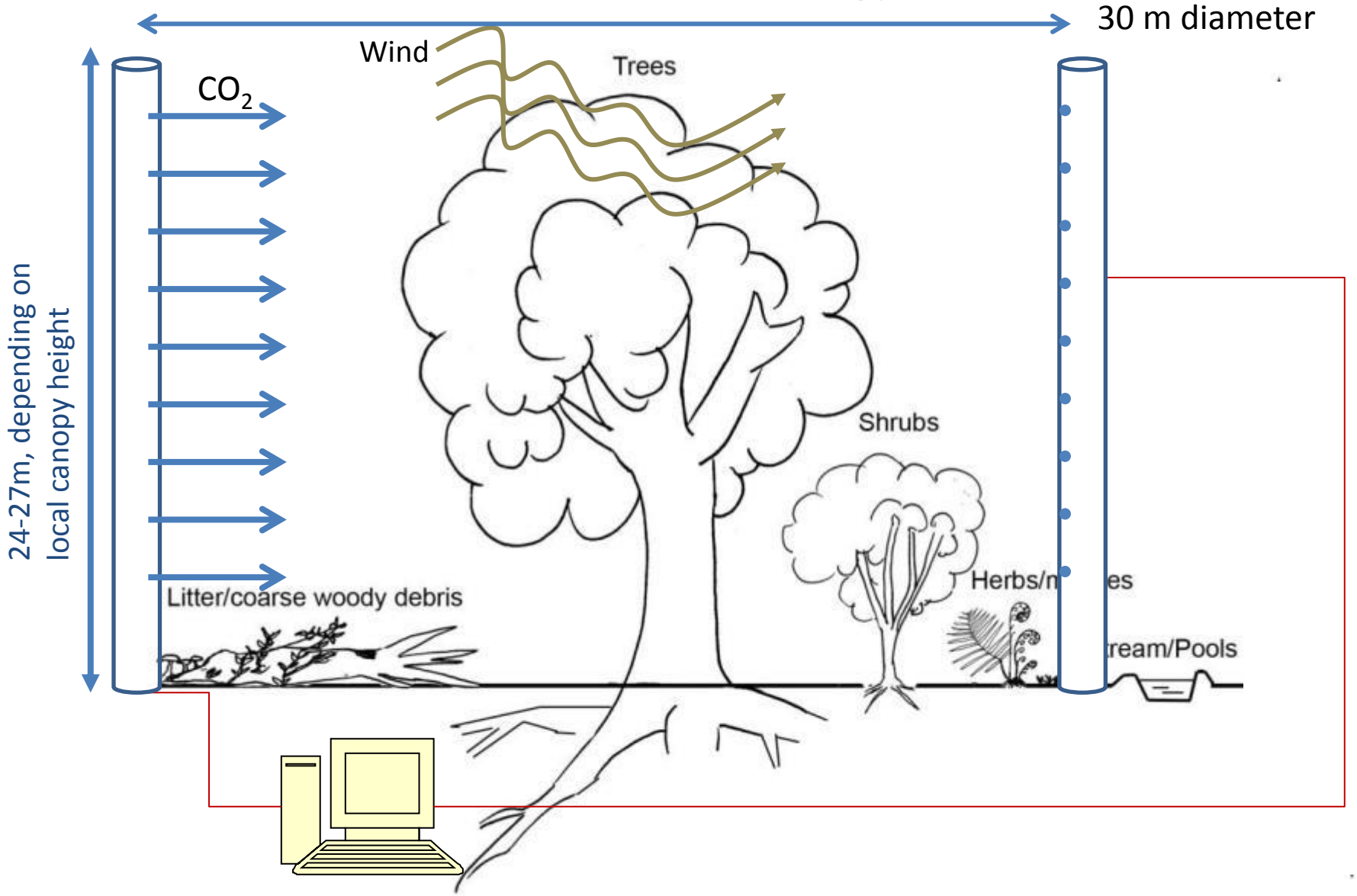
BIFoR FACE top-level research questions



1. Does elevated CO_2 increase the **carbon storage**?
2. Do other **macro- or micro-nutrients** limit the uptake of carbon?
3. What aspects of **biodiversity and ecosystem structure-and-function** alter?
4. How can lessons learnt be **generalised** to other woodlands and forests? (Global Network of second-generation Forest FACE experiments)

Global Facility for research and research translation

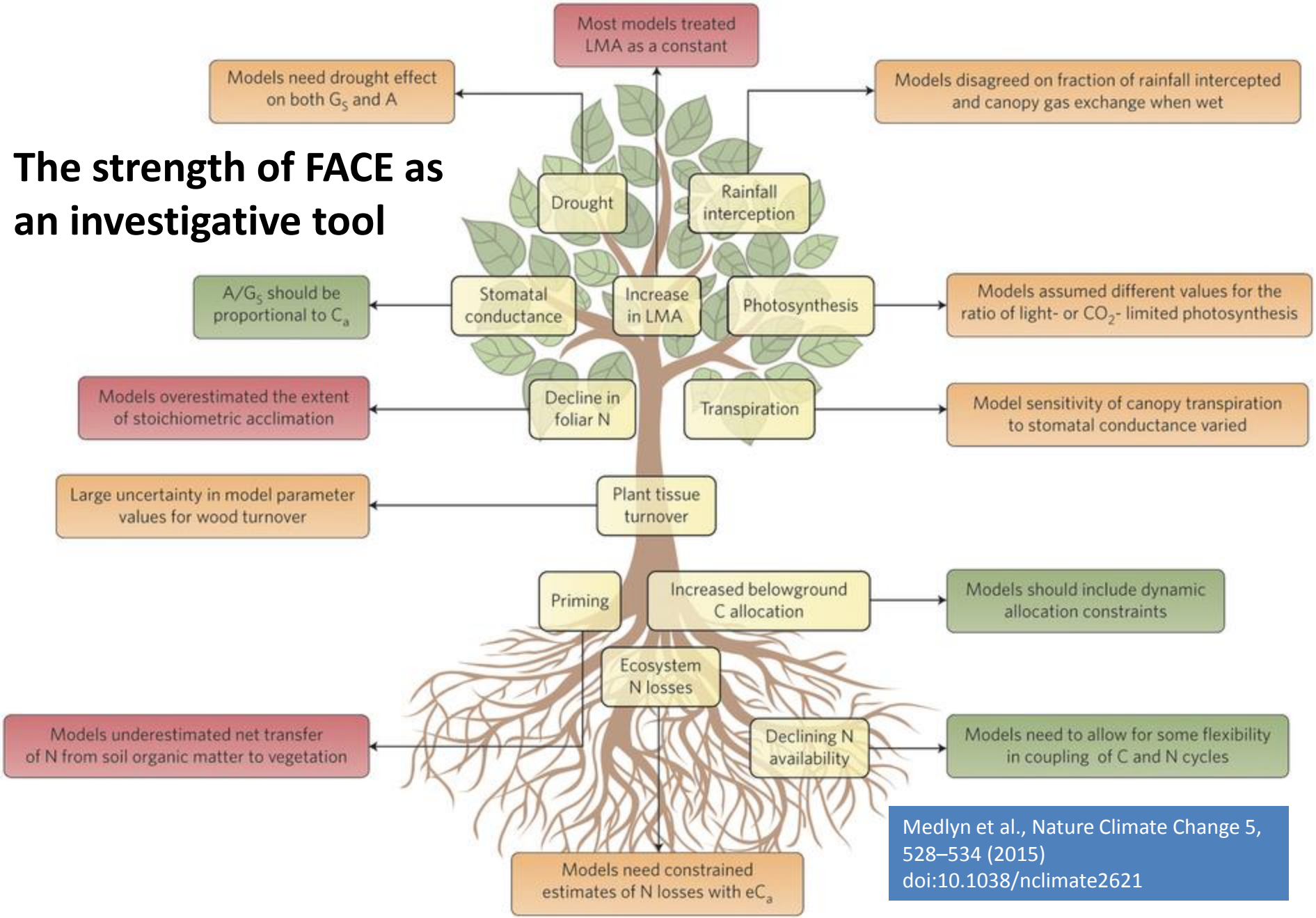
FACE Methodology



Aim to run experiment for 10 years +

"The ecological equivalent of the Large Hadron Collider"

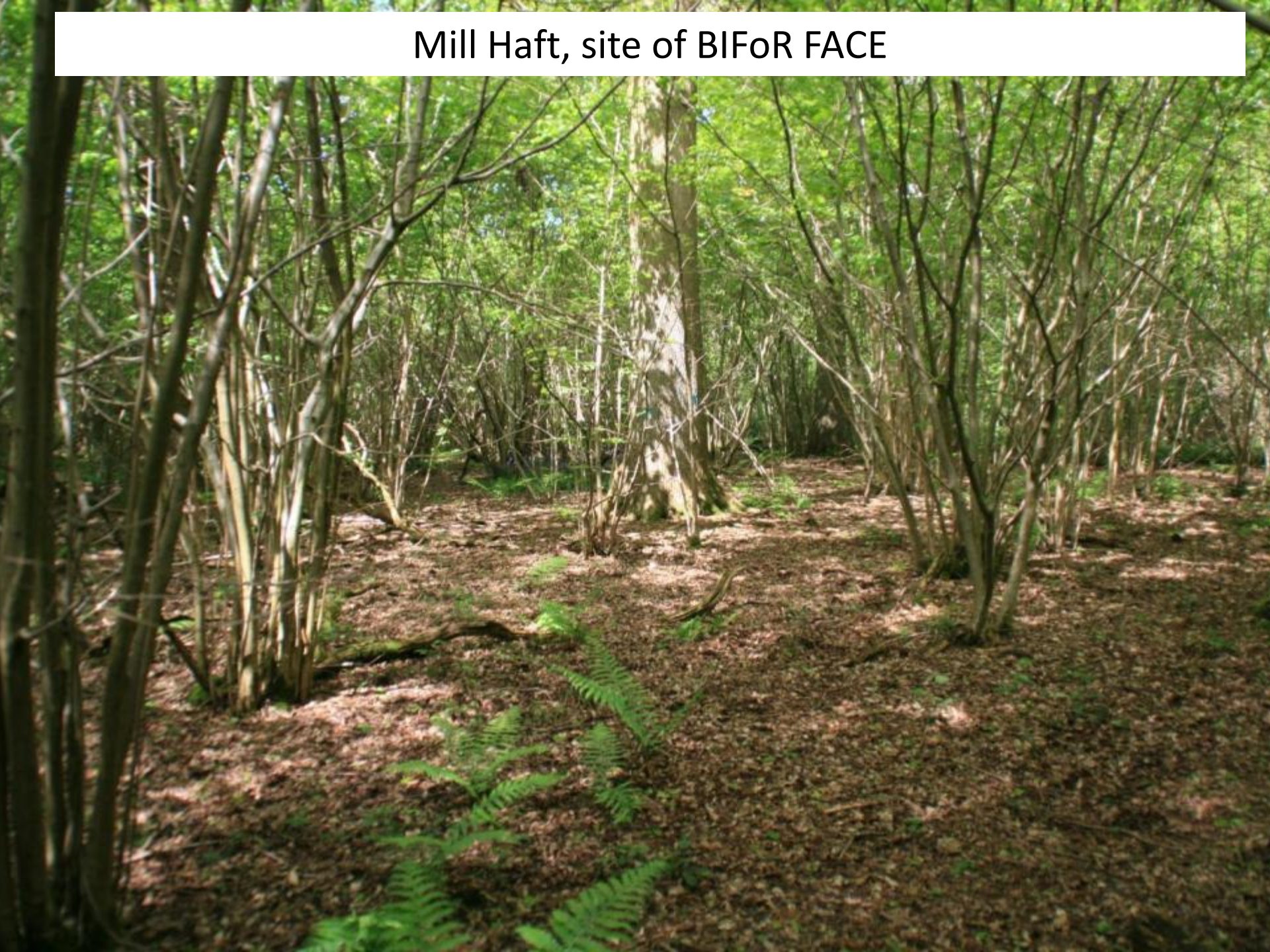
The strength of FACE as an investigative tool



Medlyn et al., Nature Climate Change 5, 528–534 (2015) doi:10.1038/nclimate2621

Green: processes where FACE data sets allowed discrimination among alternative model assumptions; red: processes where FACE data sets identified missing or wrong model assumptions; orange: processes where additional data are needed to discriminate among model assumptions. A, assimilation; Gs; stomatal conductance.

Mill Haft, site of BIFoR FACE



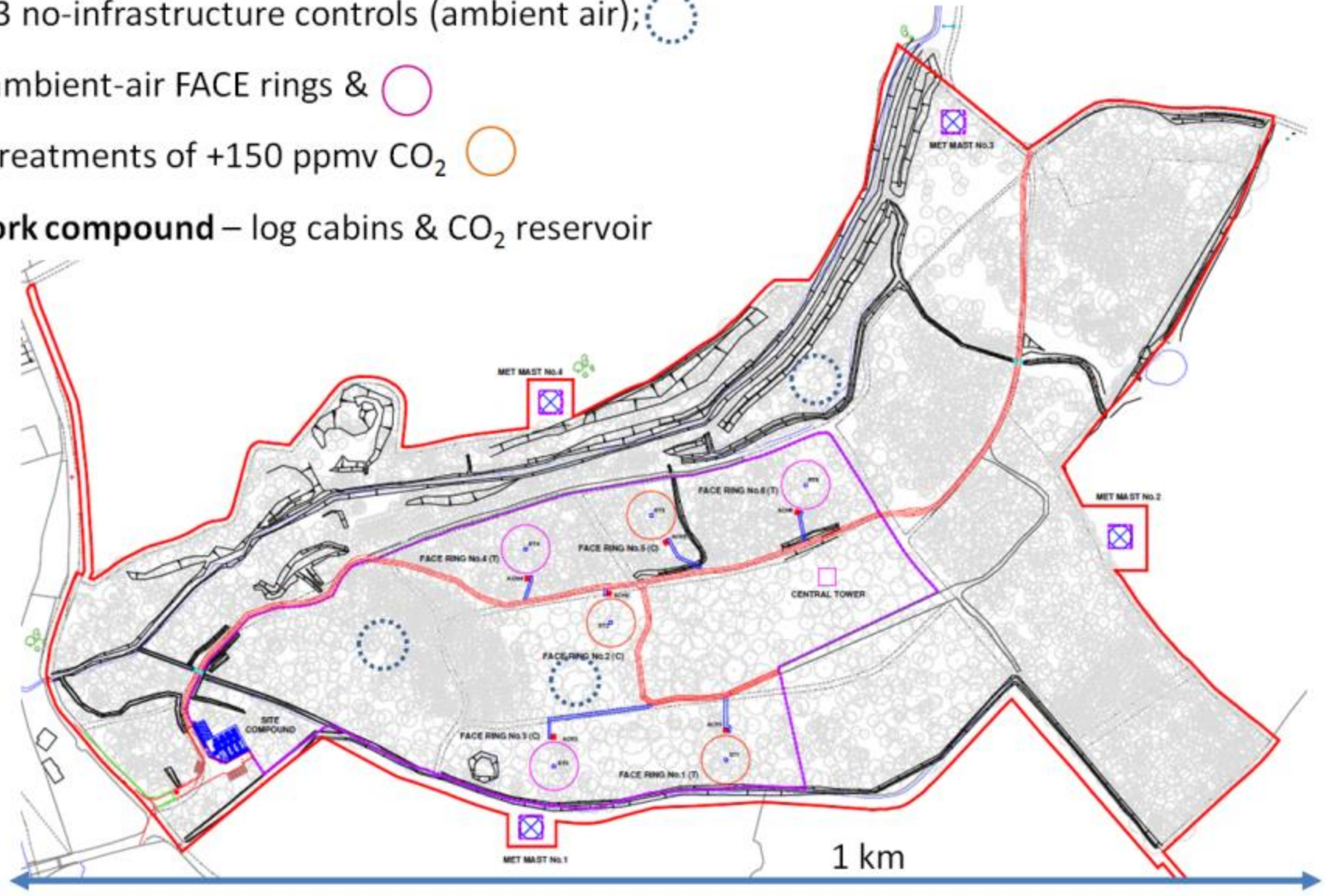
The BIFoR FACE facility

FACE – 3 no-infrastructure controls (ambient air);

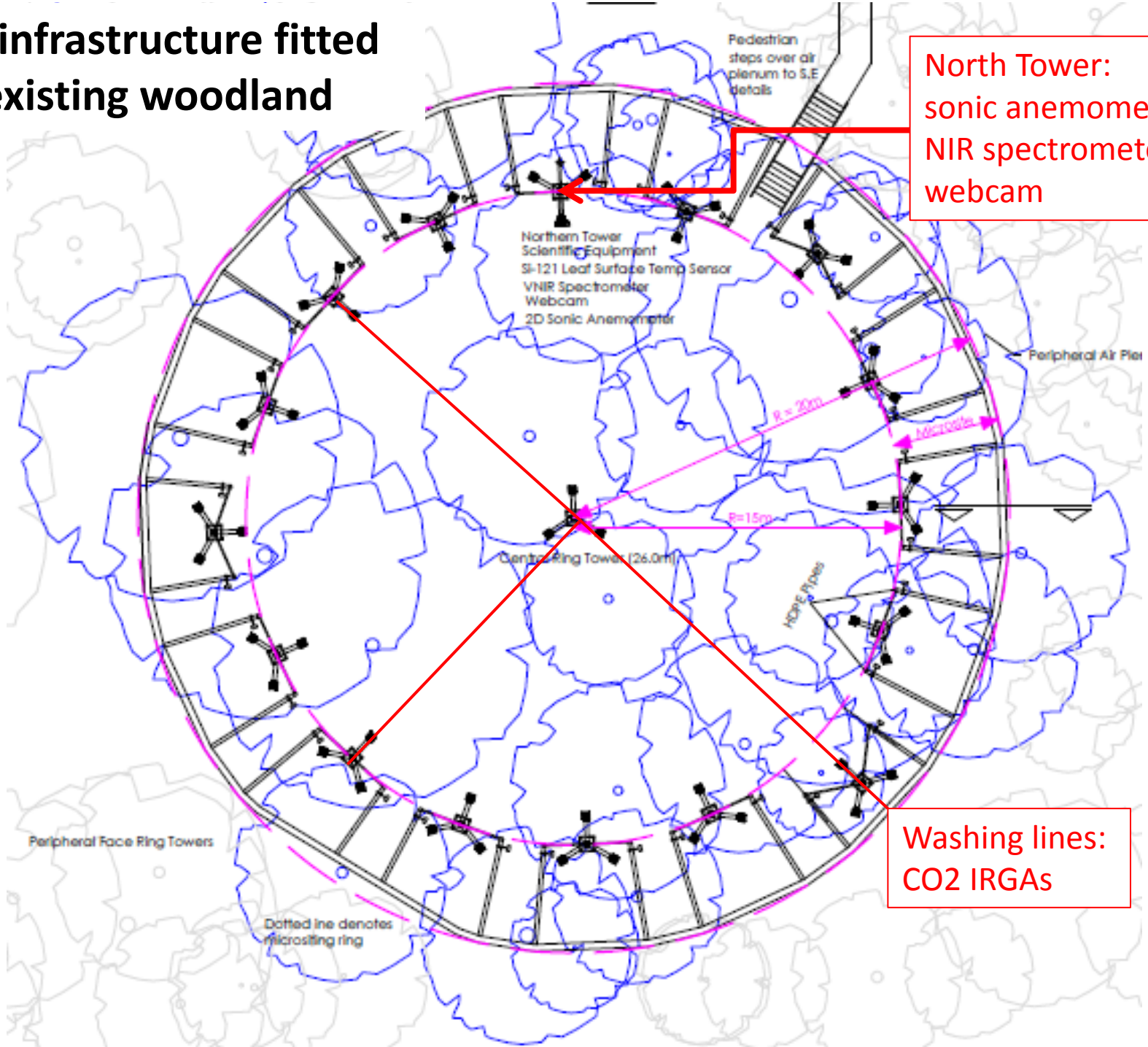
3 ambient-air FACE rings &

3 treatments of +150 ppmv CO_2

Fieldwork compound – log cabins & CO_2 reservoir



FACE infrastructure fitted into existing woodland

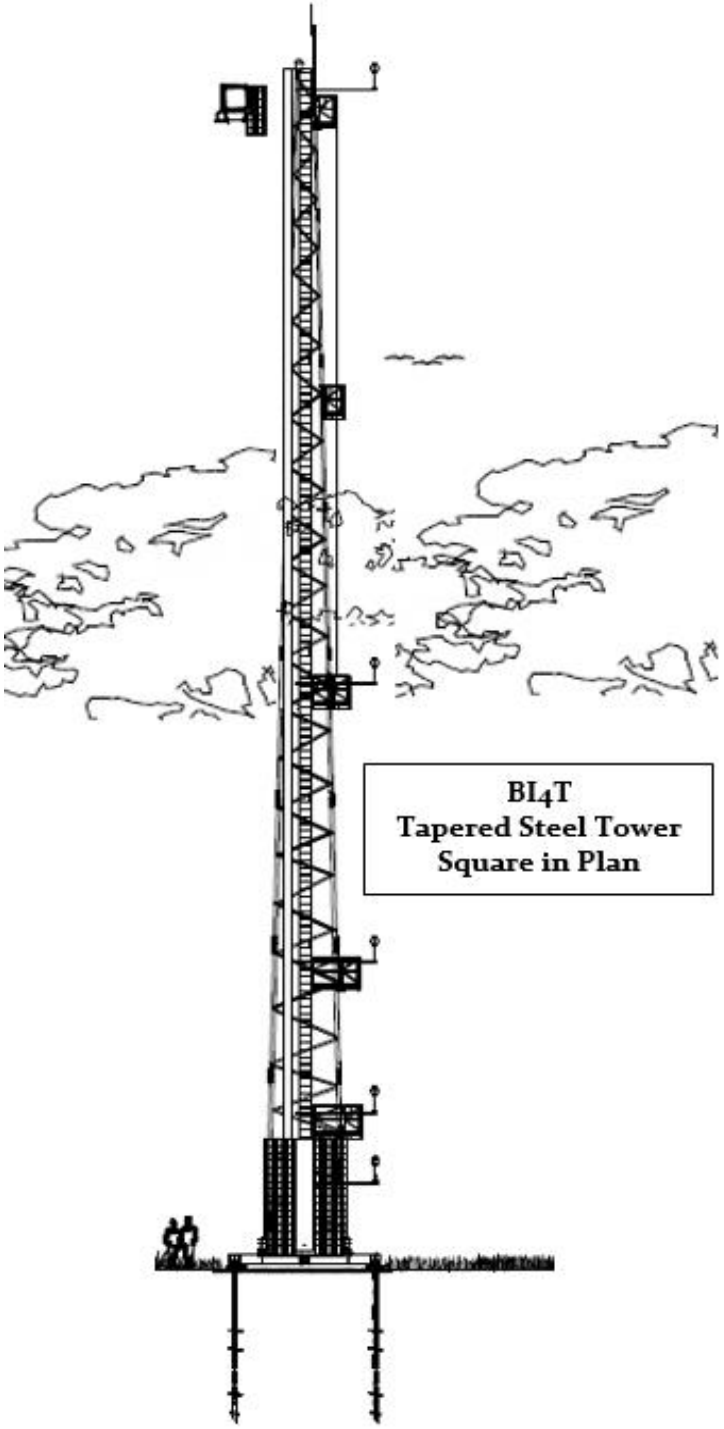


BIFoR FACE: tall tower and stream monitoring

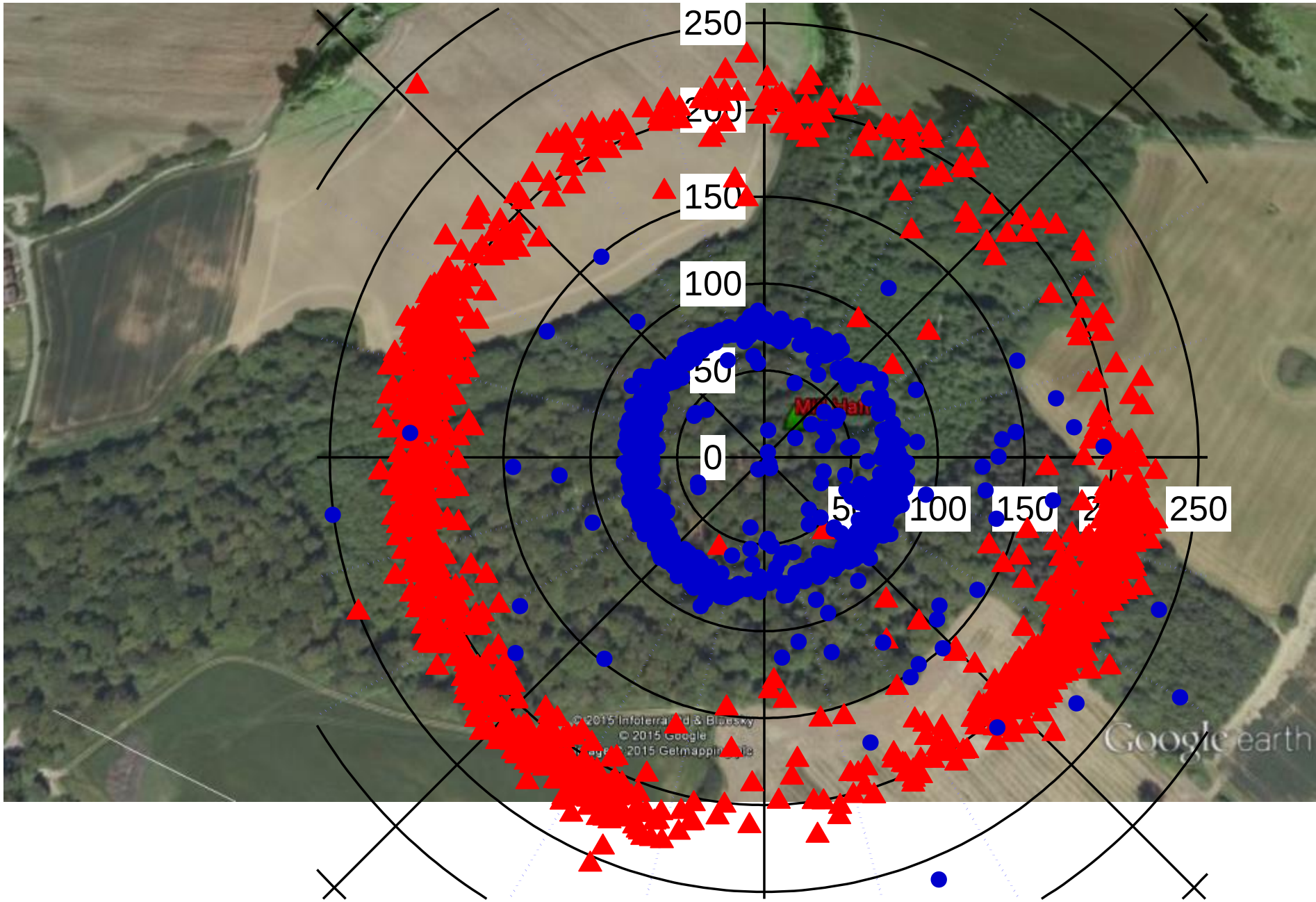
Capturing flows into/out of experimental plot: N, P, C, trace nutrients

40m

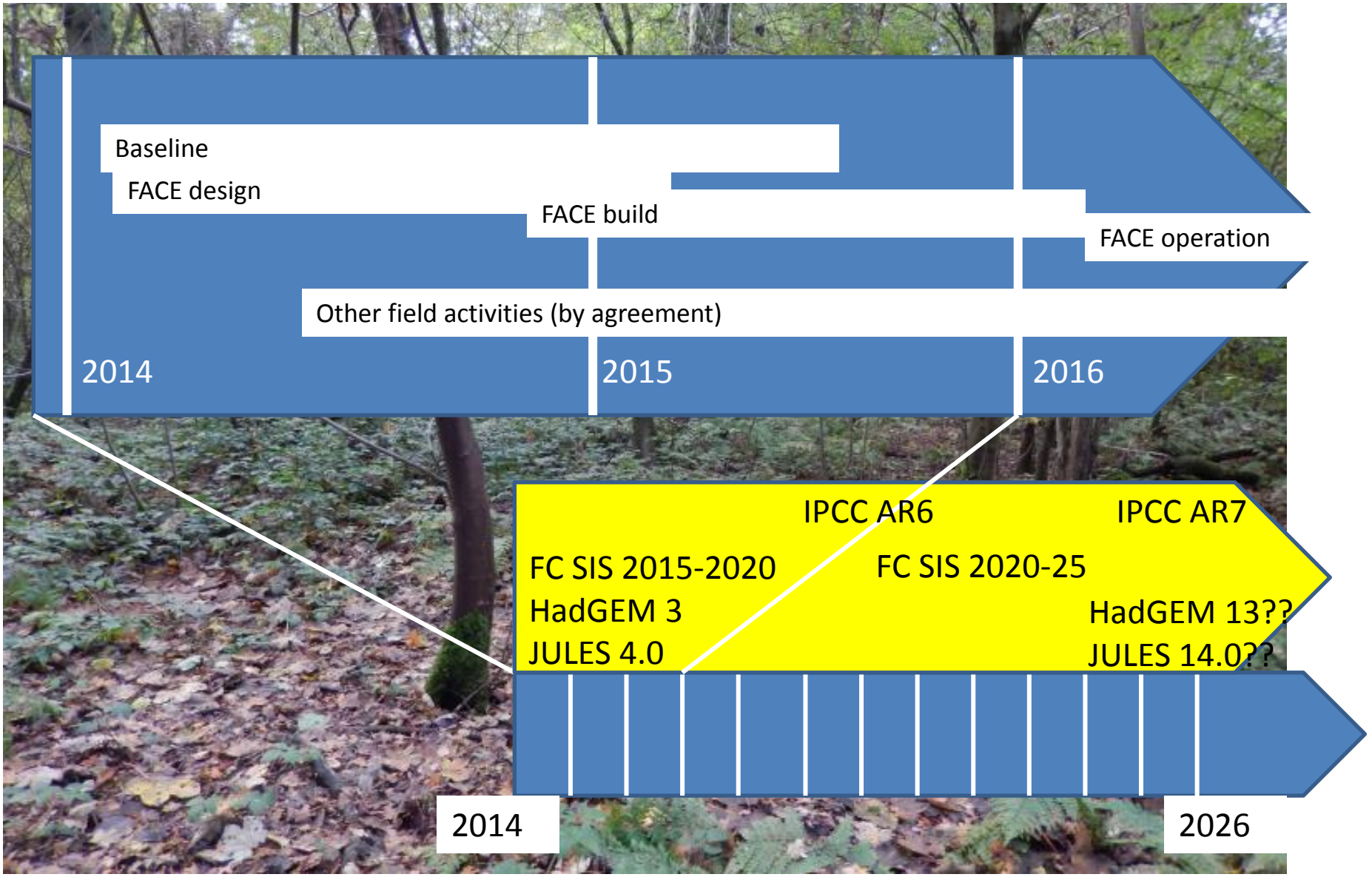
25m



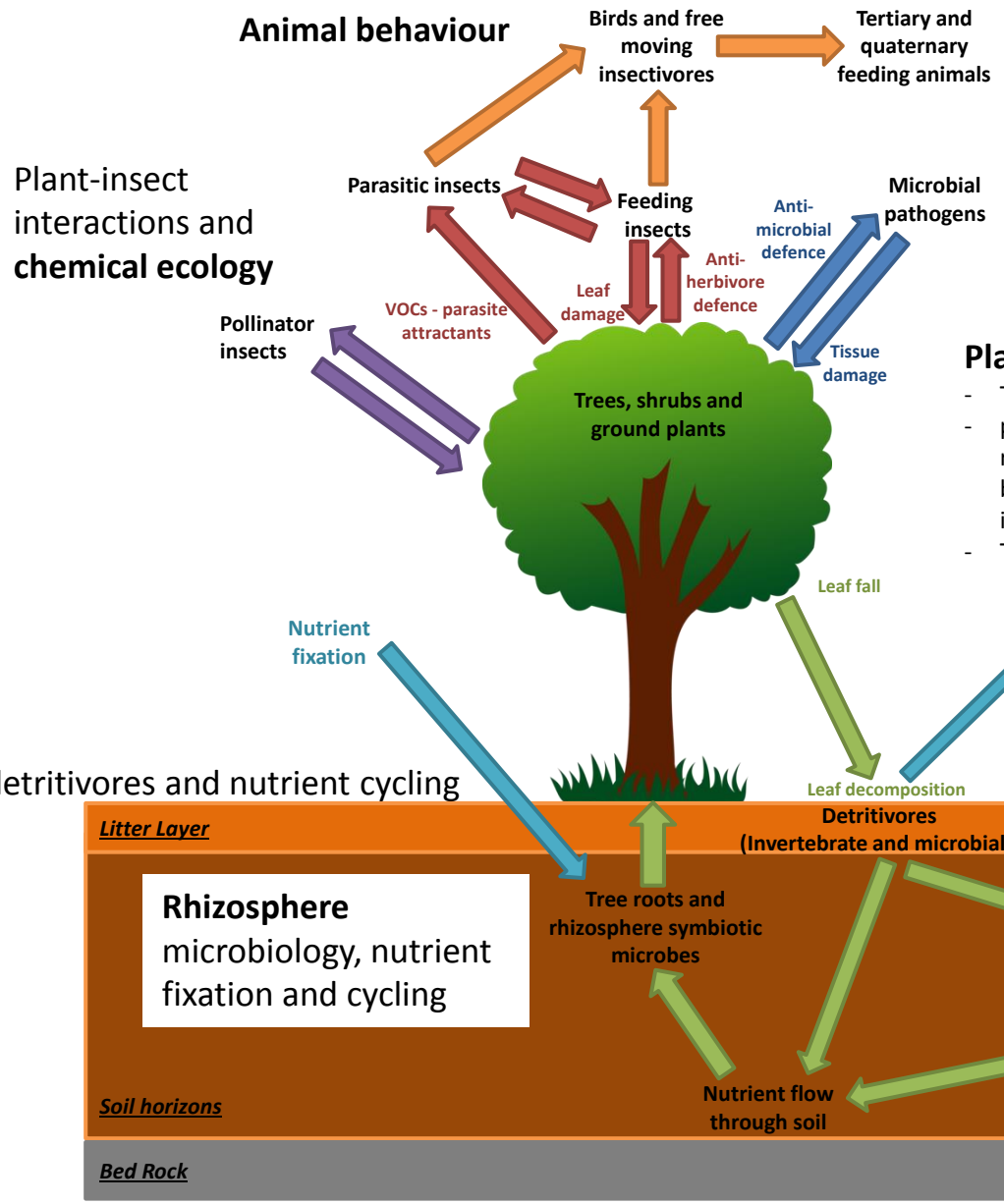
https://sites.google.com/site/millhaftstream/


Flux Footprint Estimates
90% distance (m)
Peak (m)
250
150
100
50
0
100
150
250
© 2015 Google
Google earth

BIFoR Field Facility: Timeline



FACE 2.0 …SEX AND DEATH



Plant-insect interactions and **chemical ecology**

Plant-pathogen molecular interactions

- Current tree pathogens
- Which pathogens will emerge or cause most devastation in the changing environment?

Plant Physiology

- Tree growth
- photosynthesis and respiration (Which trees will be the winners under increased CO_2?
- Trees role in C and N cycles

Litter layer:
Invertebrate detritivores and nutrient cycling

Aquatic zoology and animal behaviour

Core Measurements at Mill Haft

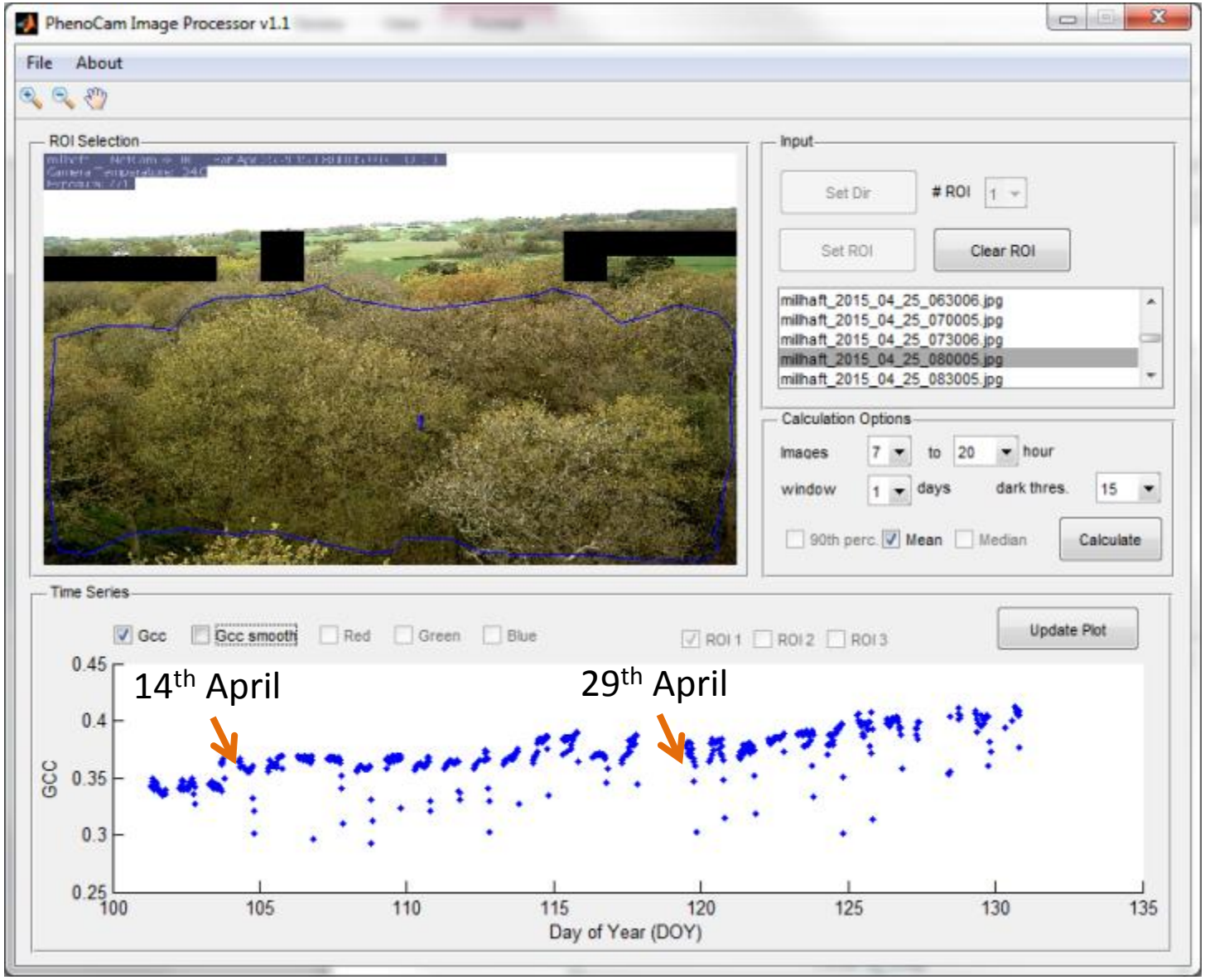
Underway

- LAI - via hemispherical photography
- Stream Monitoring (Discharge,Water temperature, pH, Turbidity, Dissolved oxygen, Nitrate & Nitrite, Dissolved organic carbon
- Eddy covariance flux measurements (CO_2, H_2O, CH_4)
- Phenocam
- Met kit
- Plant tissue sampling
- Invertebrate sampling
- Litter traps
- Soil sampling
- Dendrometers

Pending

- Soil gas fluxes
- Minirhyzotrons

Phenology Camera



http://phenocam.sr.unh.edu/data/latest/millhaft.jpg

None of this matters if nobody does anything…

BIFoR aims to provide **fundamental science, social science and cultural research** of direct relevance to forested landscapes anywhere in the world.

We will make the case for forests as part of one-planet living:

Bioeconomy and innovation;

Non-extractive value-capture;

The "triple bottom line".

WORLD VIEW

A personal take on events

Emerging powers need a more-inclusive science

Fast-growing economies can learn from the West's mistakes and couple social and 'hard' sciences to address their own societal needs, says **Colin Macilwain.**

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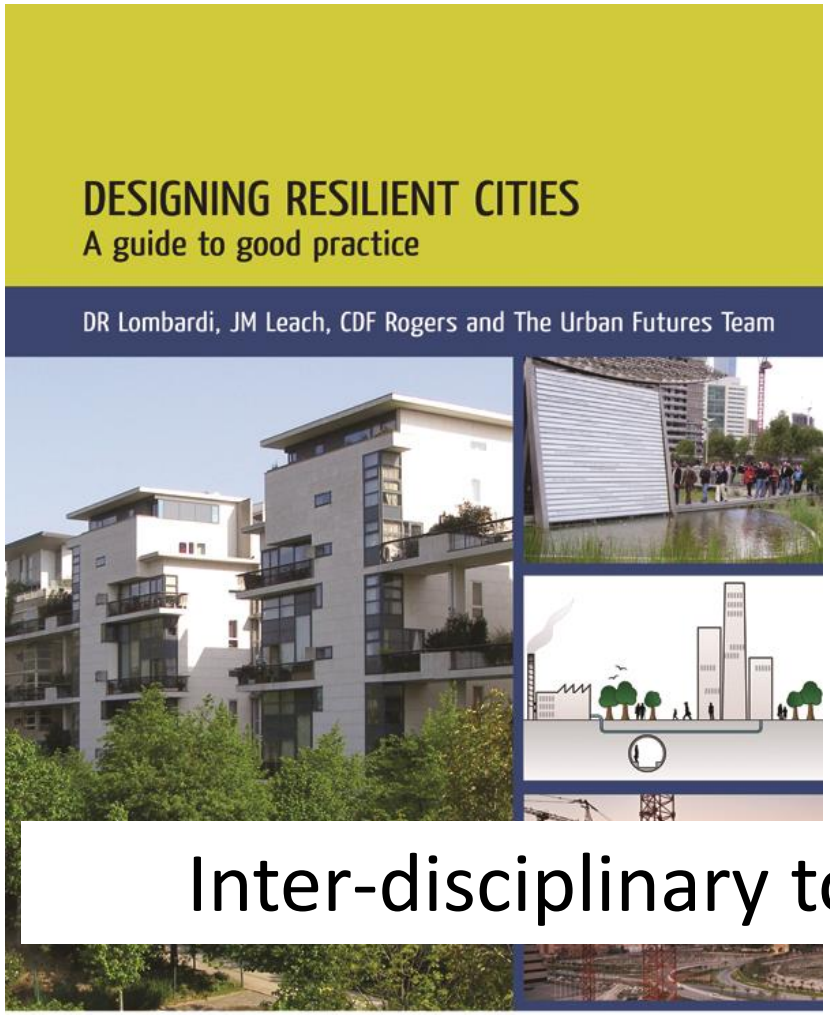
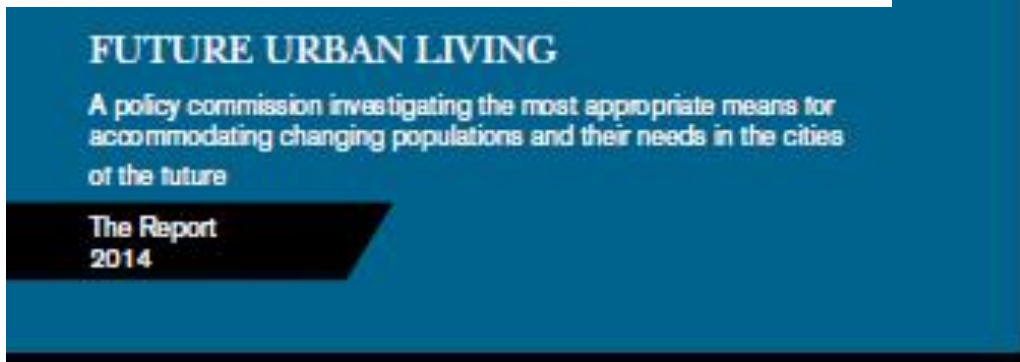


Inter-disciplinary tools for urban forestry



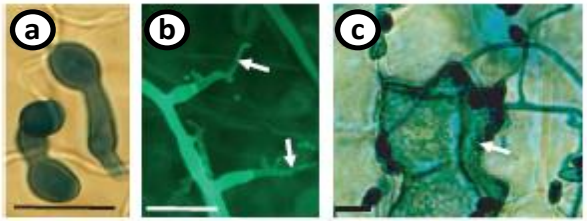
No vision is sustainable if the trees are dead:

UK: low woodland cover, and what remains is under serious threat from disease

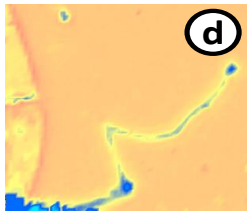
– e.g., phytophthera, ‘ash dieback’, acute oak decline.

Novel technologies for disease management

1. **identify disease resistant trees** - *discover genetic markers and suites of metabolic markers indicating host has generated a programmed resistant response against pathogen*
2. provide tools for **disease detection** at the early stages of infection - *discover pathogen genetic and metabolic markers (hyperspectral imaging, metabolomics and RNA transcript profiling).*
3. **identify targets for anti-fungal compounds** *(by identifying key metabolic and transcript control points)*.
4. **discover novel anti-fungal compounds** produced in nature (fungal co-culture and metabolomics).



Hyperspectral image: FT-IR (mid IR) image of *Phytophora infestans* emerging from a potato leaf cell



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