How does JULES compare against observed traits & ecosystem monitoring at Mill Haft?

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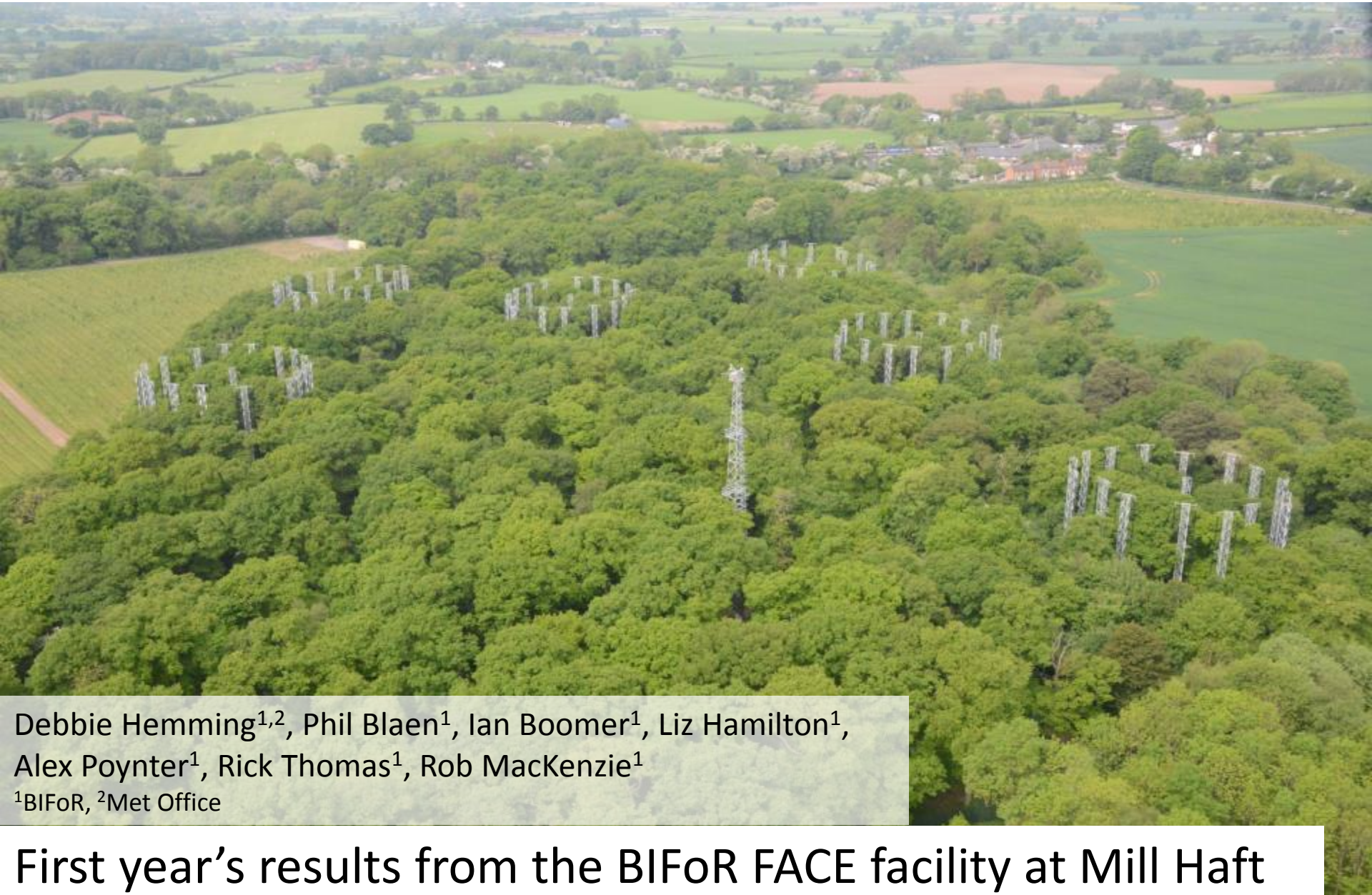

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[1]BIFoR, [2]Met Office

First year's results from the BIFoR FACE facility at Mill Haft

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biosphere-atmosphere interactions

Animal behaviour

Birds and free moving insectivores

Tertiary and quaternary feeding animals

Parasitic insects

Feeding insects

Microbial pathogens

Anti-microbial defence

Anti-herbivore defence

Leaf damage

VOCs - parasite attractants

Pollinator insects

Tissue damage

Trees, shrubs and ground plants

Plant Physiology

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

Leaf fall

Nutrient emissions in VOCs

Nutrient fixation

Leaf decomposition

Litter layer:
Invertebrate detritivores and nutrient cycling

Litter Layer

Detritivores (Invertebrate and microbial)

Water system

Rhizosphere
microbiology, nutrient fixation and cycling

Tree roots and rhizosphere symbiotic microbes

Nutrient flow through water systems (invertebrates and microbial)

Soil horizons

Nutrient flow through soil

Aquatic systems

Bed Rock

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Anti-micr...

Anti-herb...

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Pollinator insects

!!! See Poster 'BIFoR FACE update' by Rob MacKenzie et al...!!!

Physiology

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

Leaf fall

Nutrient emissions in VOCs

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Detritivores (Invertebrate and microbial)

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...microbiology, nutrient fixation and cycling

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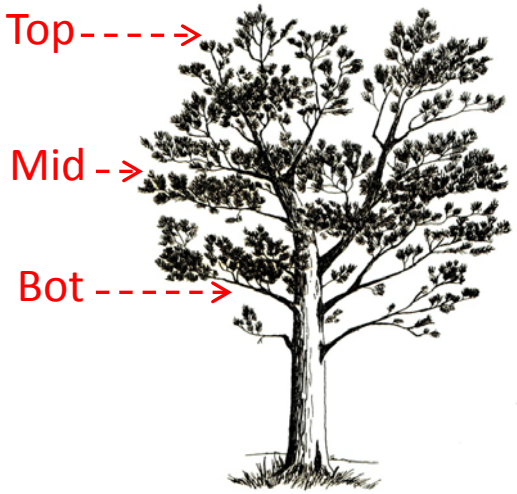
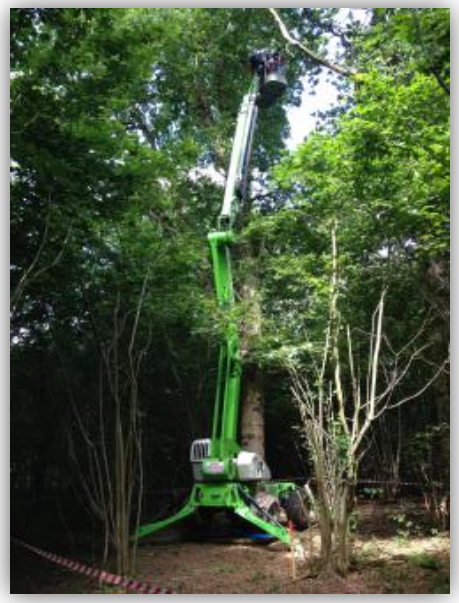
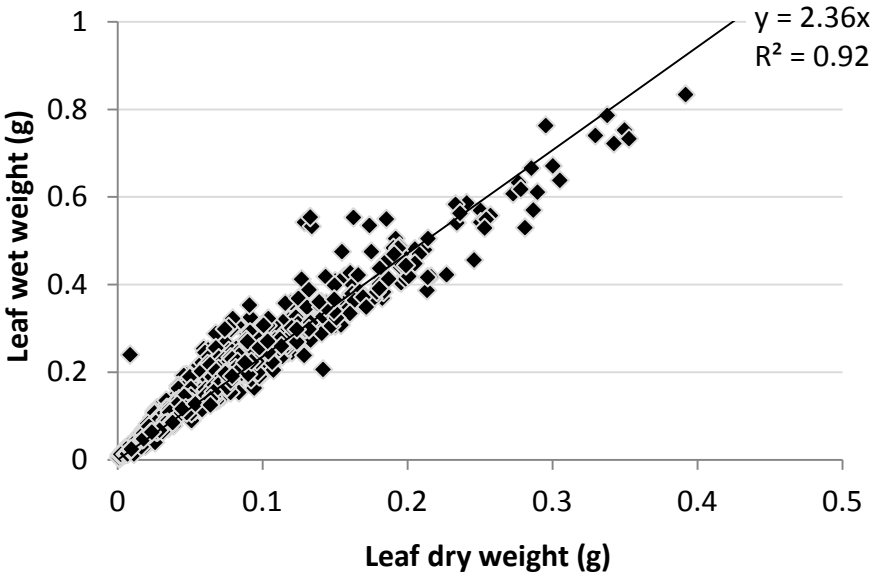
Overview of presentation



Leaf traits (*Q. robur*)	- wet & dry weight - leaf area & Specific Leaf Area - %N in leaf, twig, bud
Phenocam	- Greenness index
JULES runs	- modelled vs observations



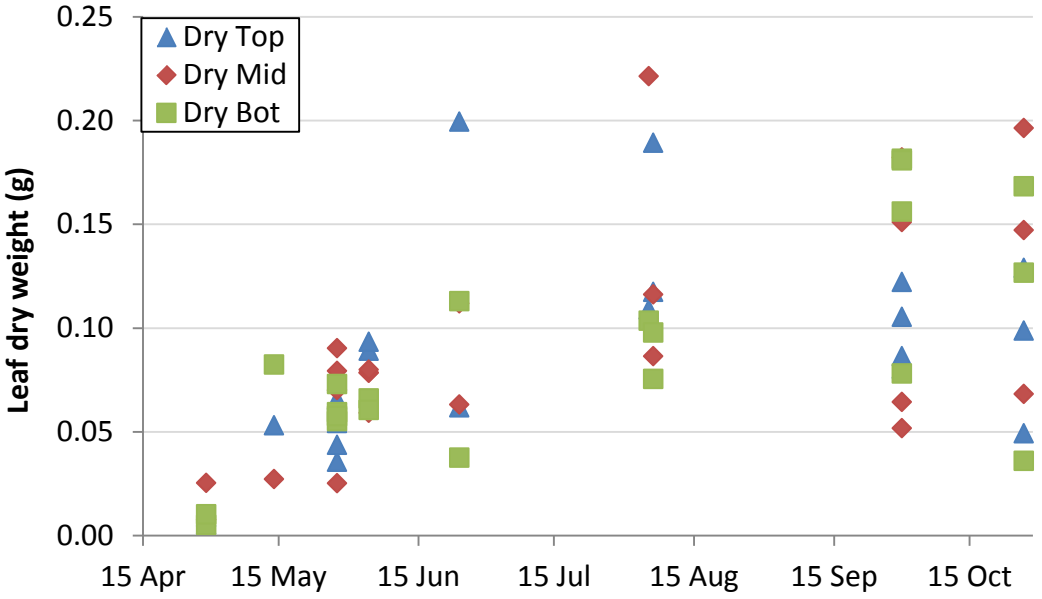
Leaf wet & dry weight



Leaf wet weight = 2.36 * Leaf dry weight

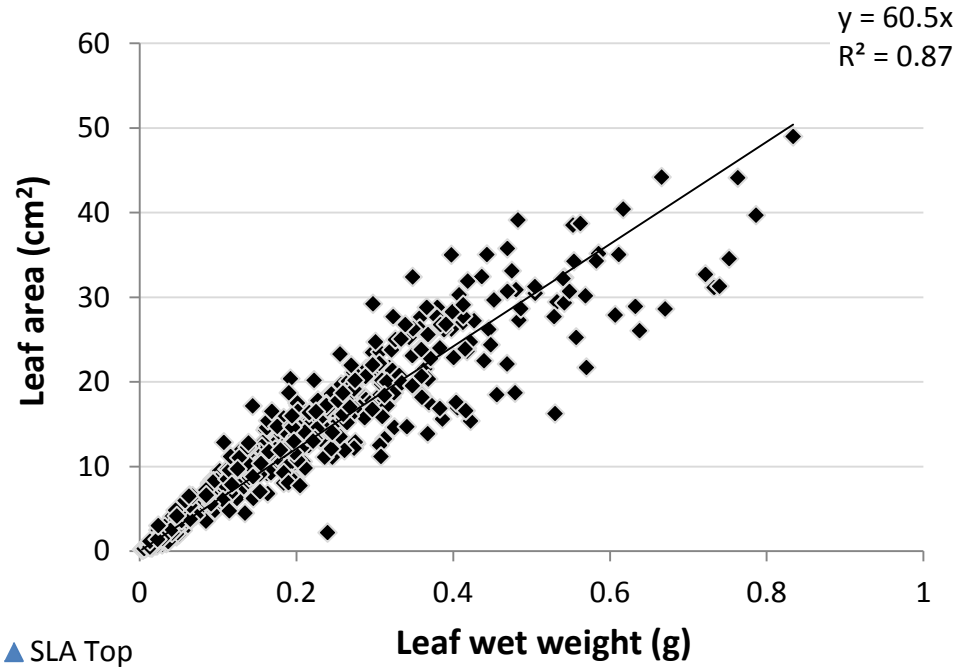
Leaf water content:
May ~80% → June ~60% → July-Oct ~50%

No clear relationship between leaf mass & canopy position

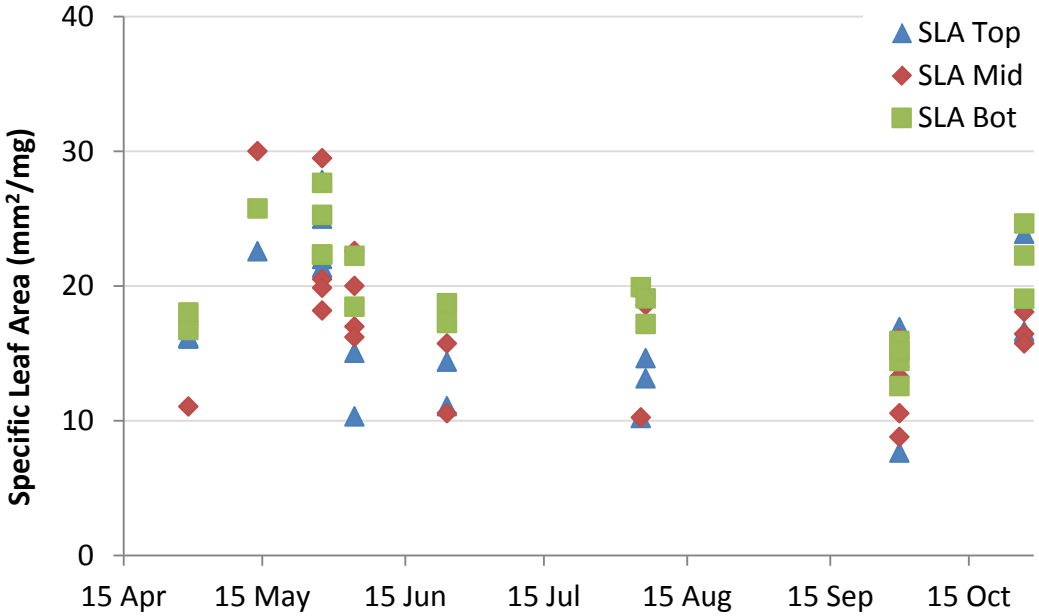


Leaf area & Specific Leaf Area

Leaf area (cm^2) = 60.5 * Leaf wet weight (g)



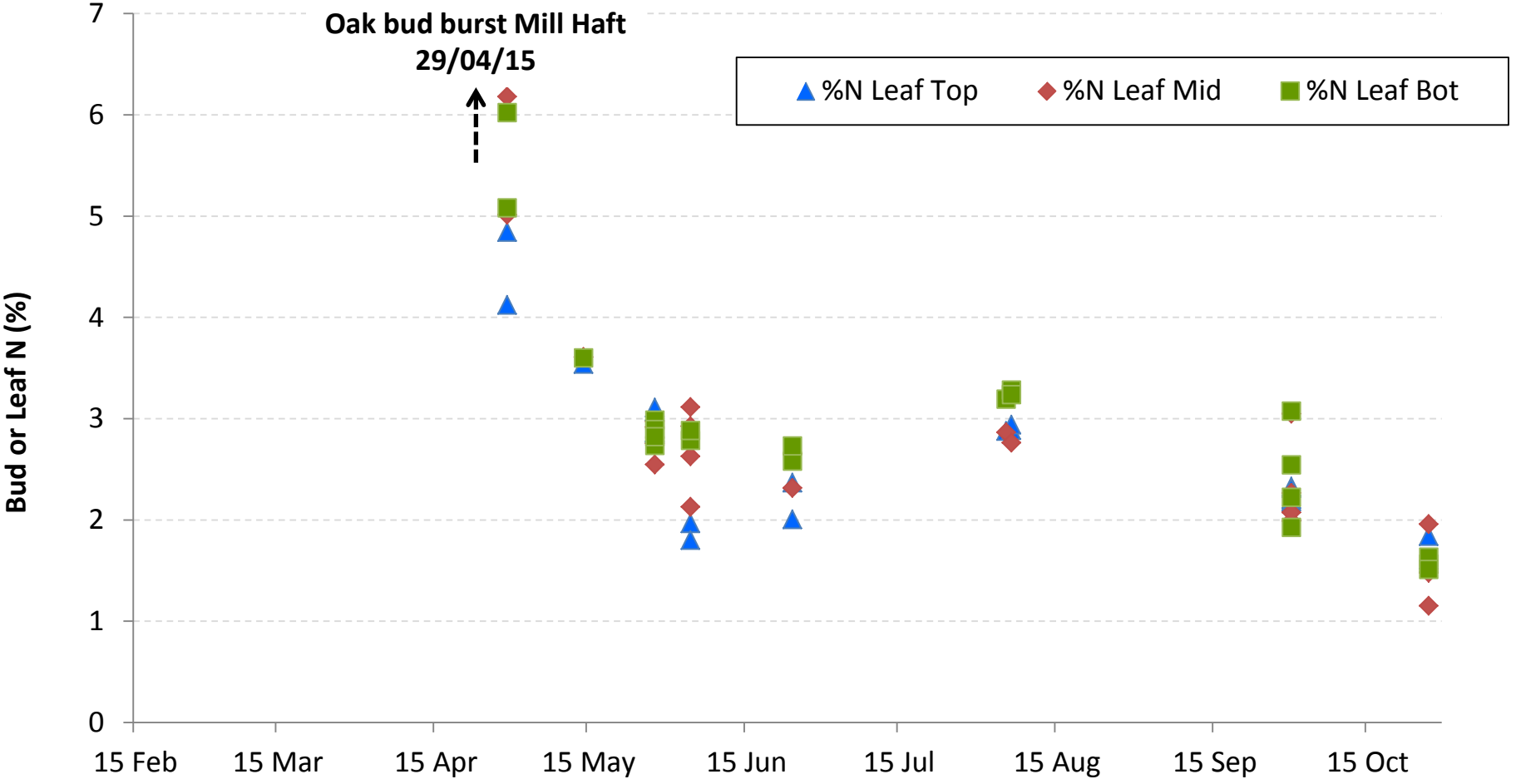
SLA (mm^2mg^{-1}) = Leaf Area (mm^2) / Leaf mass (mg)



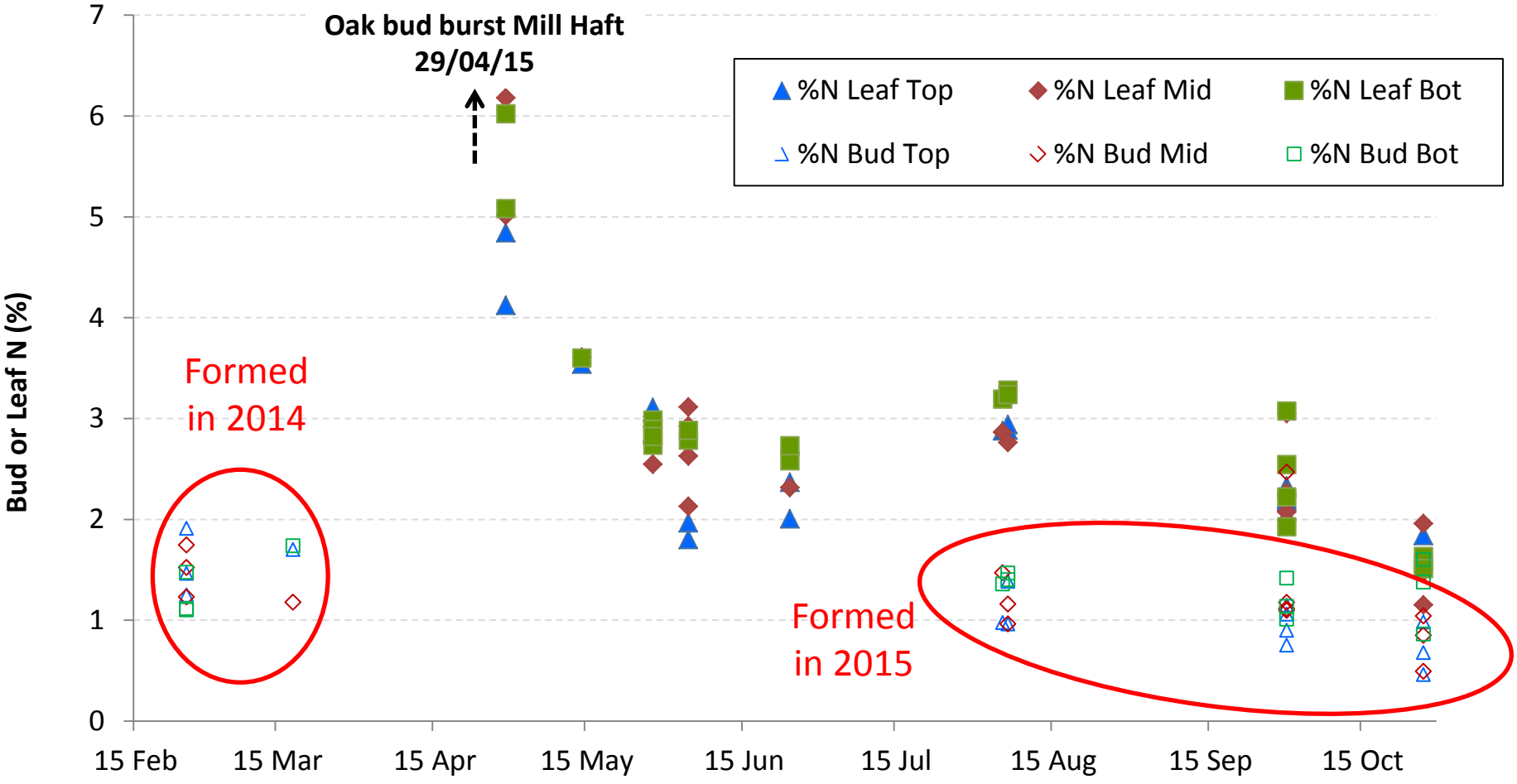
SLA increases with initial leaf growth then remains ~10-20 mm^2/mg

No clear relationship in SLA with canopy position

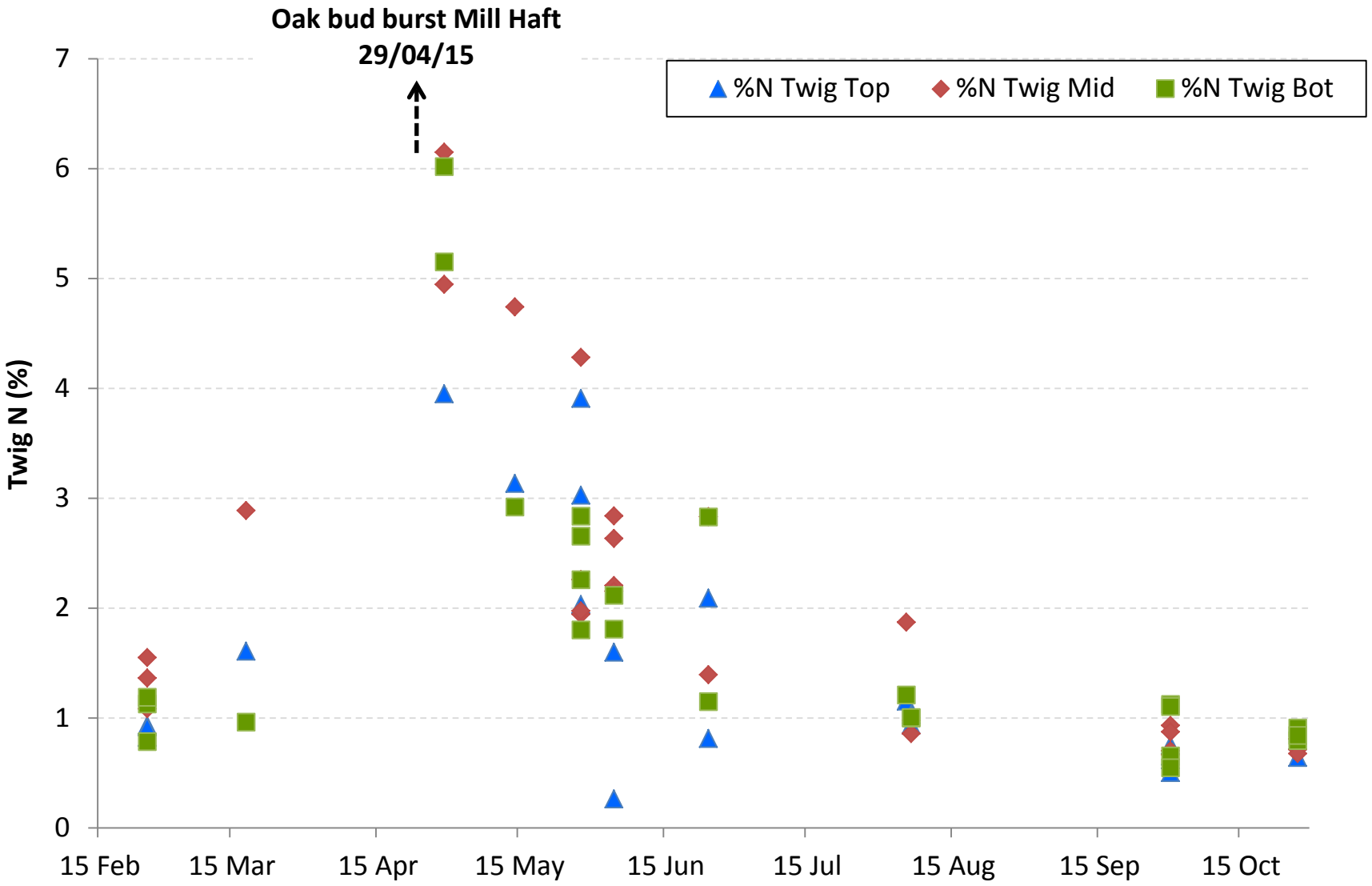
Average Leaf % Nitrogen by canopy position



Average Bud & Leaf % Nitrogen by canopy position



Average Twig % Nitrogen

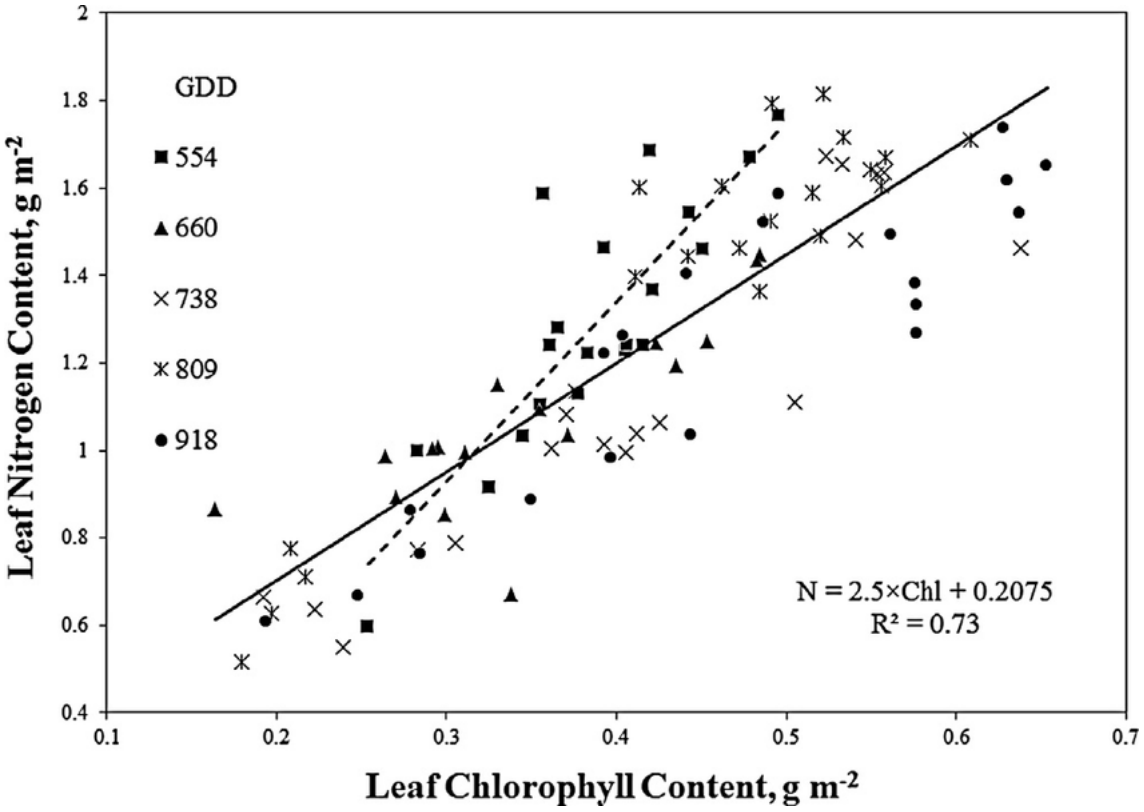


Influences on plant N content

Photosynthesis is known to be tightly correlated with leaf N
Main N containing molecules in plants:

- **RUBISCO – rate limiting enzyme of photosynthesis**
- **Chlorophyll (~6.3% N) – light-harvesting pigment**
- **Nucleic acids & proteins involved in cell regulation & respiration**

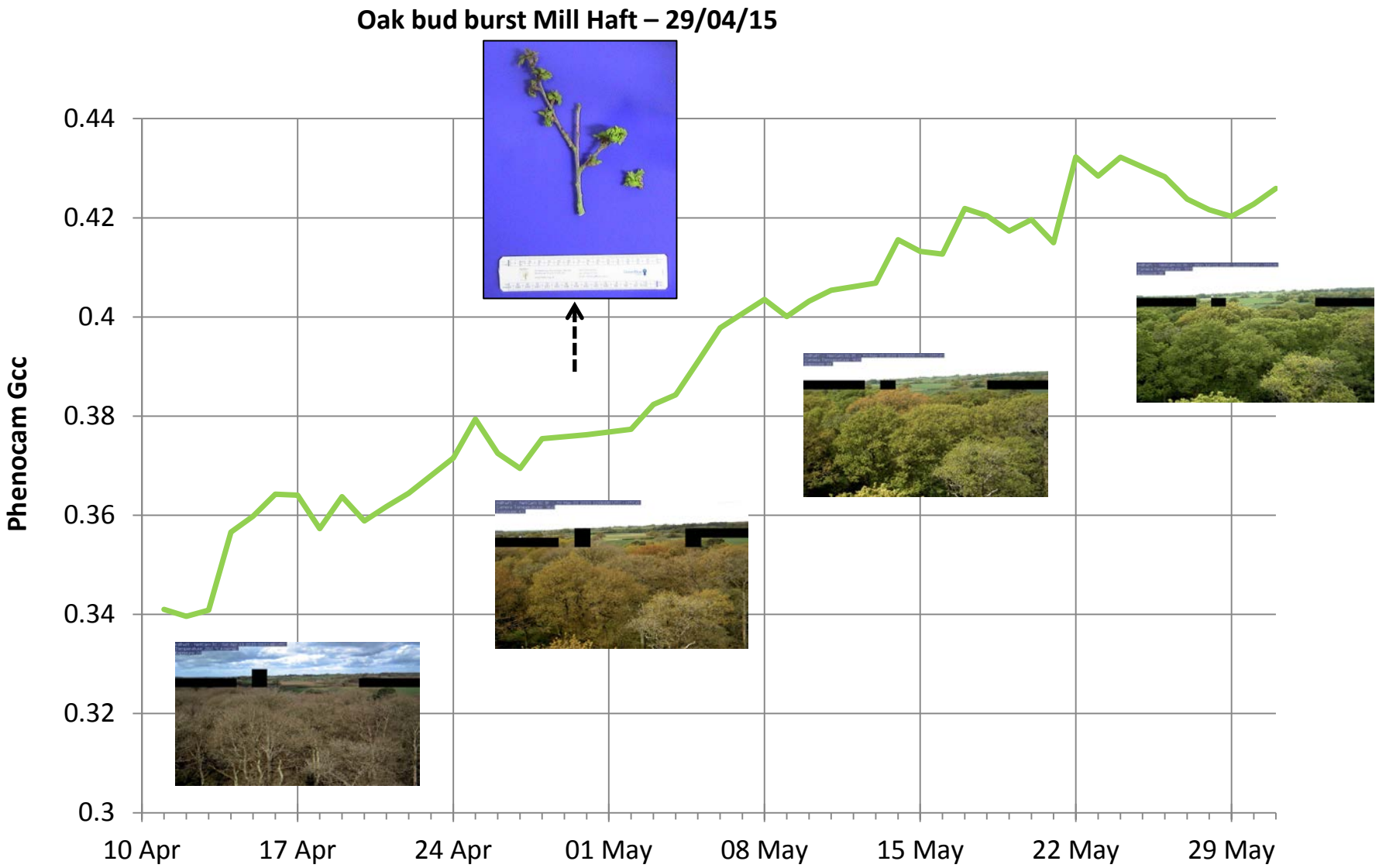
~75% of N in C3 plant leaves is in chloroplasts & involved in photosynthesis



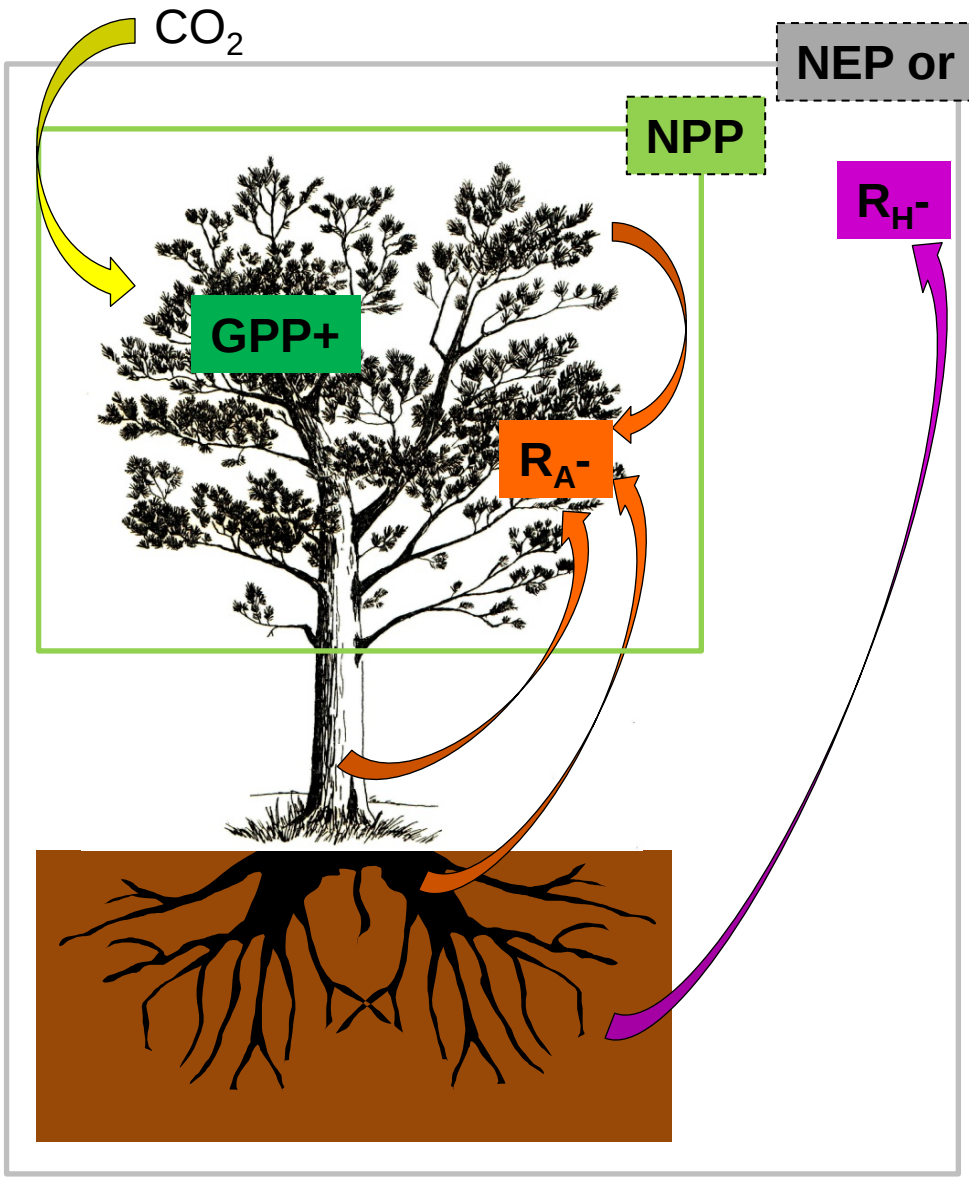
Relationship between leaf N and Chl content in maize leaves under different growing degree days (GDD) – Schlemmer et al 2013

Schlemmer et al. 2013. Remote estimation of nitrogen and chlorophyll contents in maize at leaf and canopy levels. Remote sensing

Phenocam – Green chromatic coordinate (Gcc index)



Schematic of plant/ecosystem CO_2 exchanges



GPP – Total CO_2 fixed per unit time

R_A – Rate of growth & maintenance respiration

NPP – Net rate of organic matter production

$$\mathbf{NPP = GPP - R_A}$$

R_H – Rate of heterotrophic respiration

NEE – Net instantaneous measure of CO_2 influx/output within ecosystem

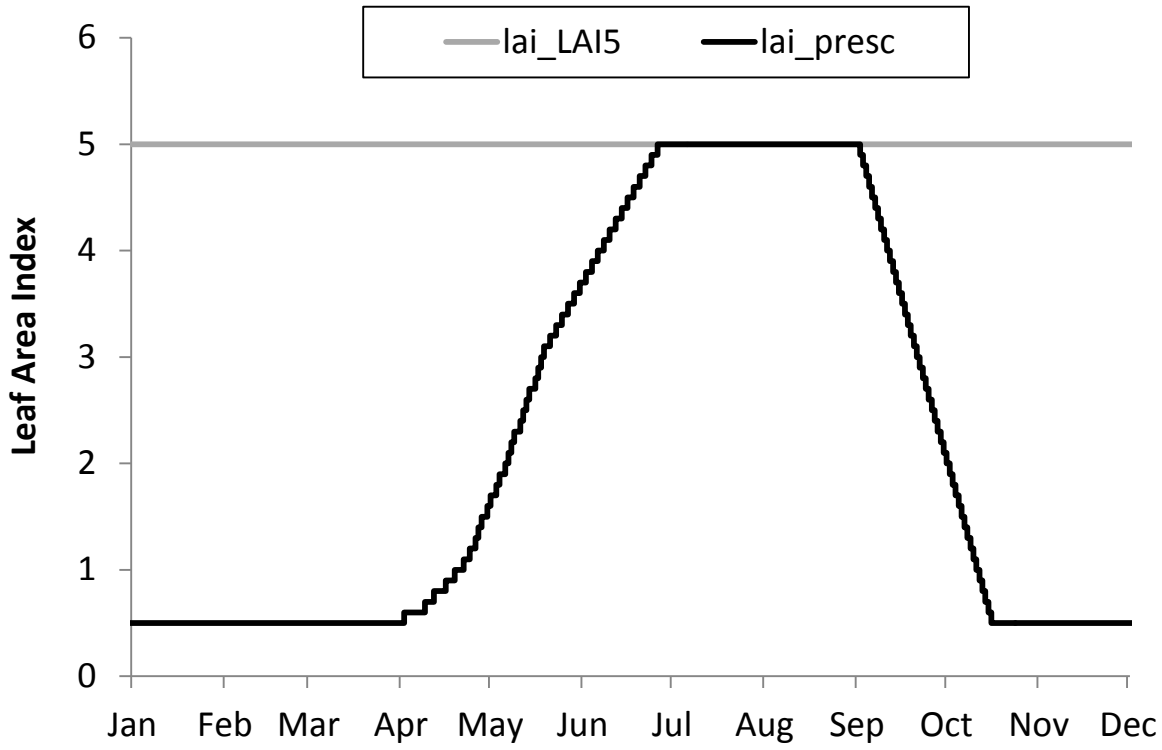
NEP – Net rate of organic matter accumulation in ecosystem (over time)

$$\mathbf{NEE} \text{ or } \mathbf{NEP = GPP - R_A - R_H}$$

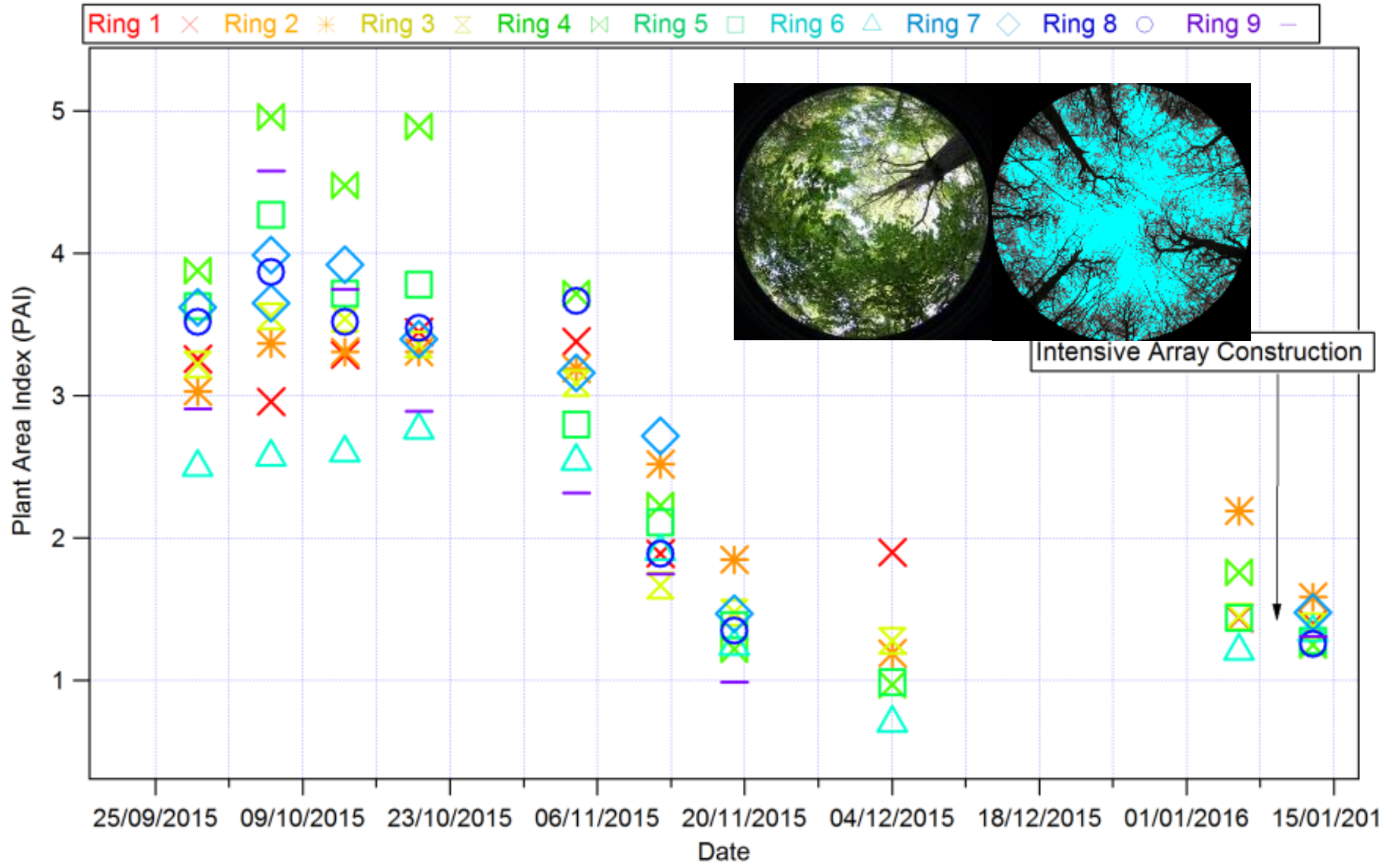
JULES runs

JULES vn4.2 point location forced with hourly Shawbury meteorological station data

Fixed LAI = 5
Prescribed LAI = from obs at Mill Haft
Phenology OFF, CanRadMod 6

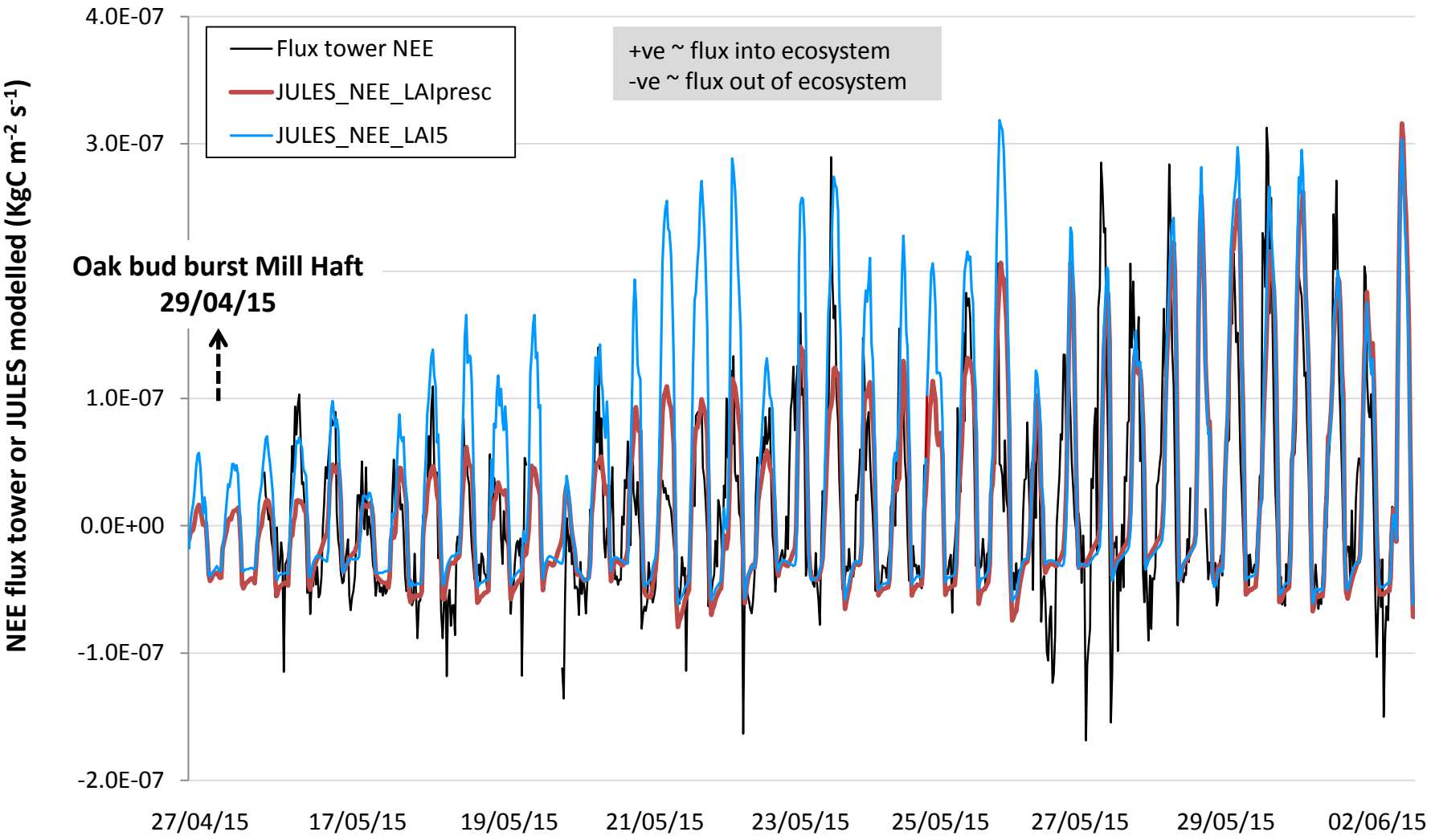


Observed Leaf/Plant Area Index (LAI/PAI)

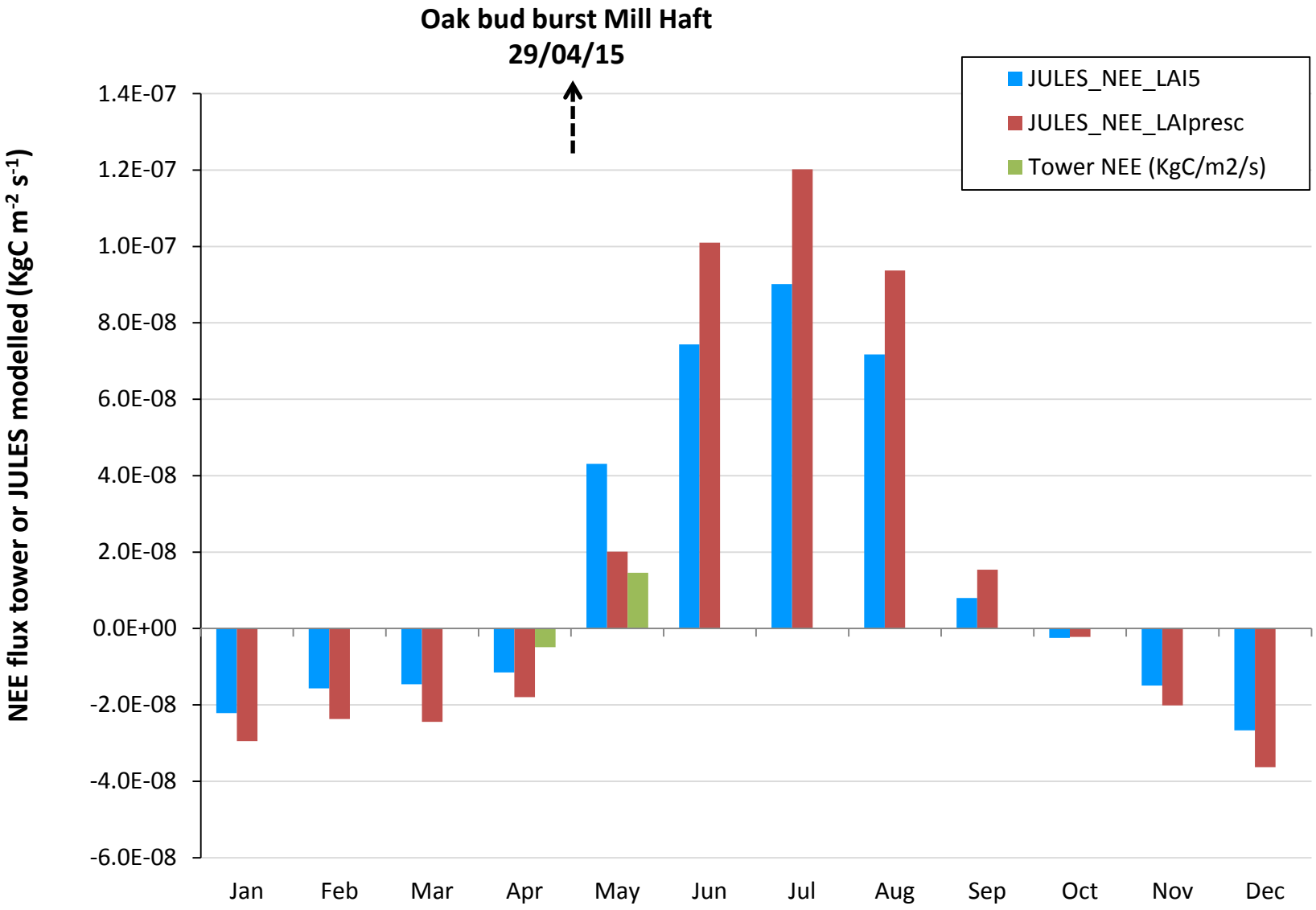


NEE from Mill Haft fluxes & JULES model (KgC m^{-2} s^{-1})

JULES vn4.2 point location forced with hourly Shawbury meteorological station data

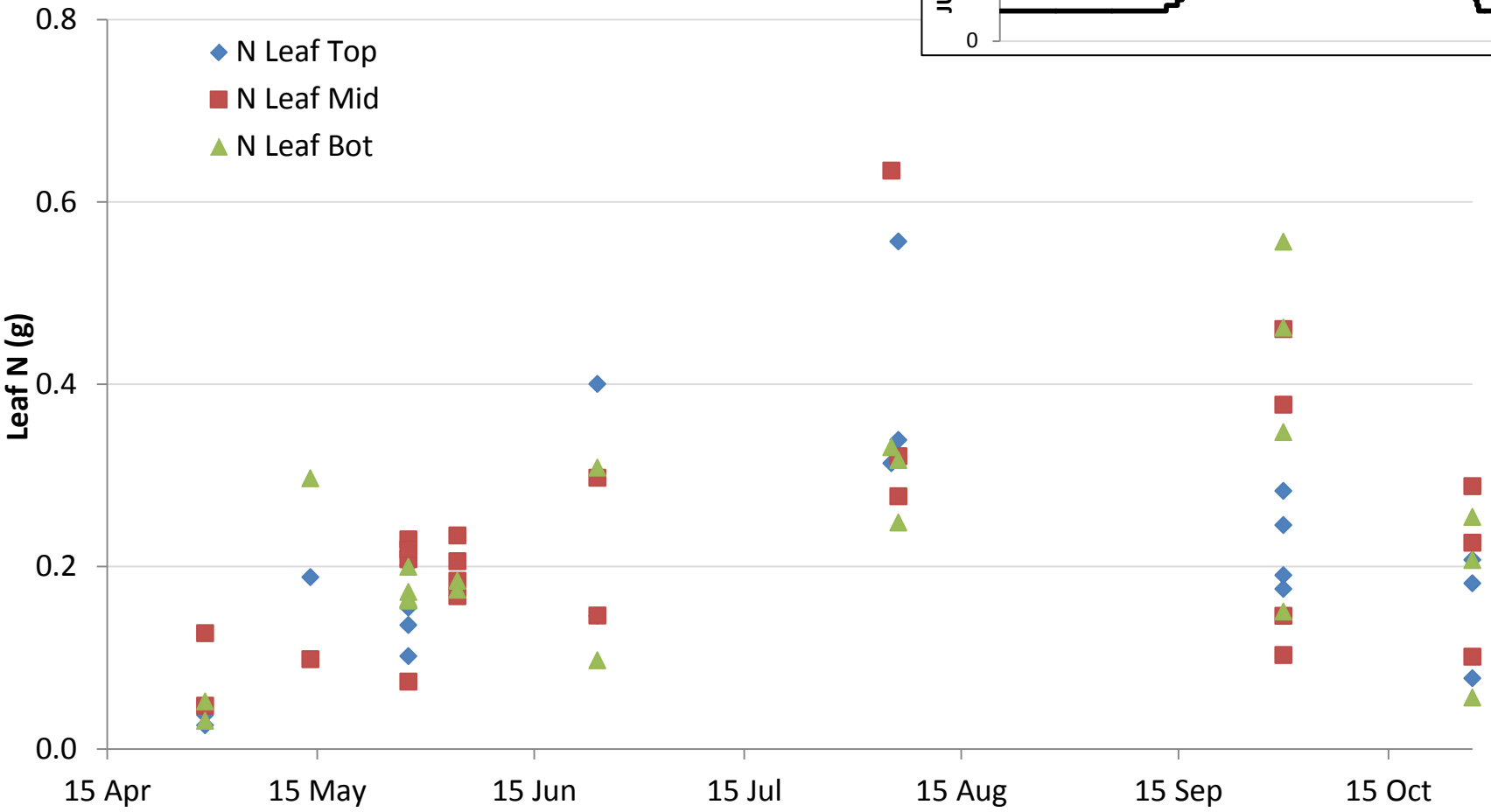


NEE monthly averages 2015



Average Leaf Nitrogen (g) by canopy position

Leaf N (g) = Leaf N (%) * Dry Leaf mass (g)




Thanks, Questions ?

Measuring the response of leaf photosynthesis to CO_2

Characterize this response across the woodland under ambient conditions

Derive two key photosynthetic parameters (V_{cmax} and J_{max}) use to model photosynthesis

Hazel and Sycamore -understory

Measured a total of
31 Response curves

Oaks:
Top, mid and low canopy