

Keeping an eye on the carbon balance

Photo courtesy of Jake Bryant@envirofoto.com



Alice Holt, UK

Team Effort

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Phenological
Eyes
Network

IMECC

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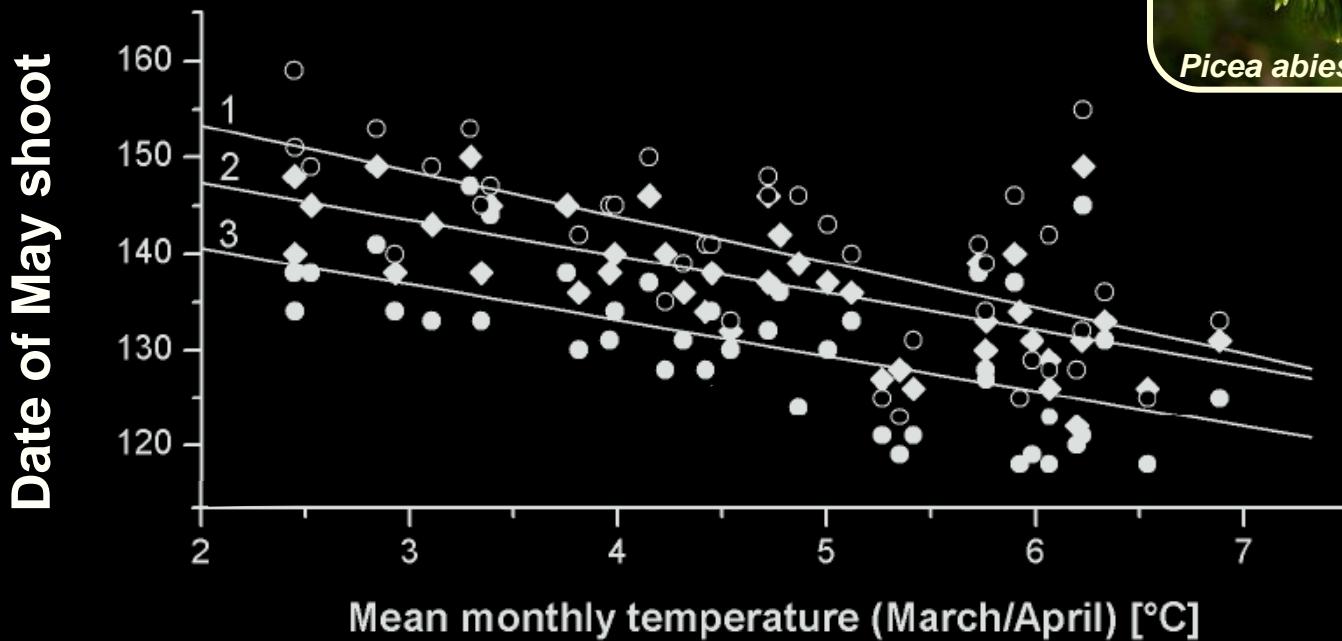


Photo courtesy of Jake Bryant @envirofoto.com



Classical approach to recording start of growing season

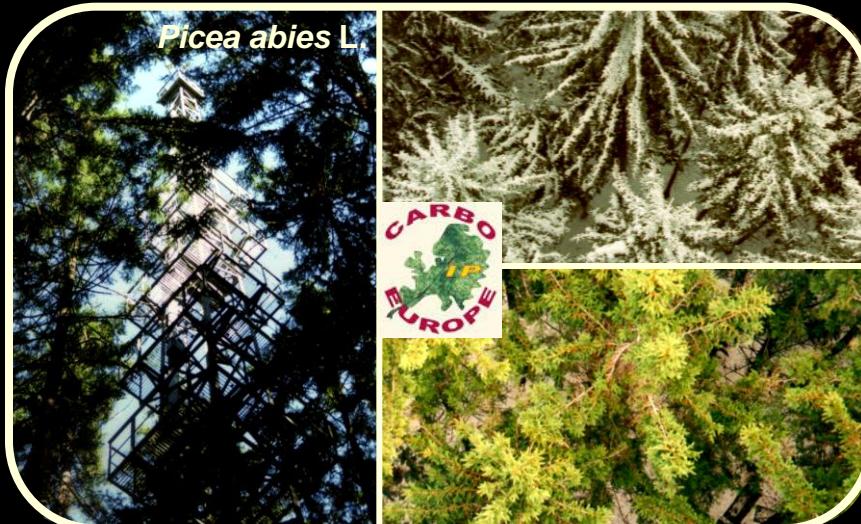
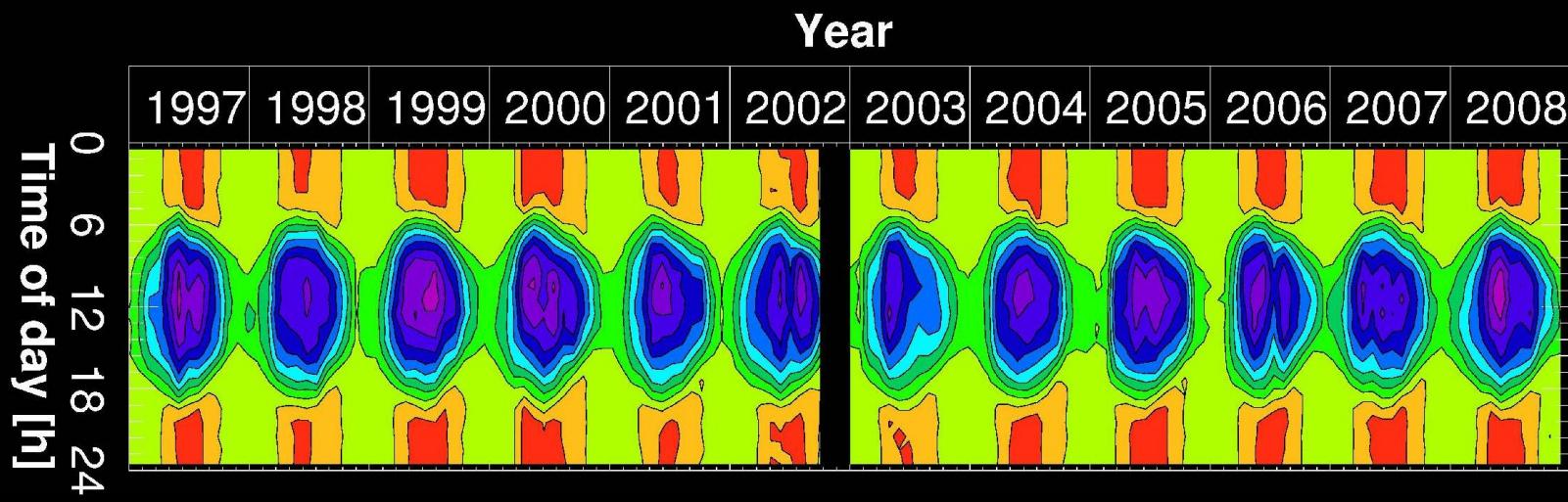
Phenological monitoring since 1962



Tharandt
International Phenological Garden

Niemand et al., 2005
Köstner et al., 2005

Alternative approach to investigate forest ‘growth’ variability

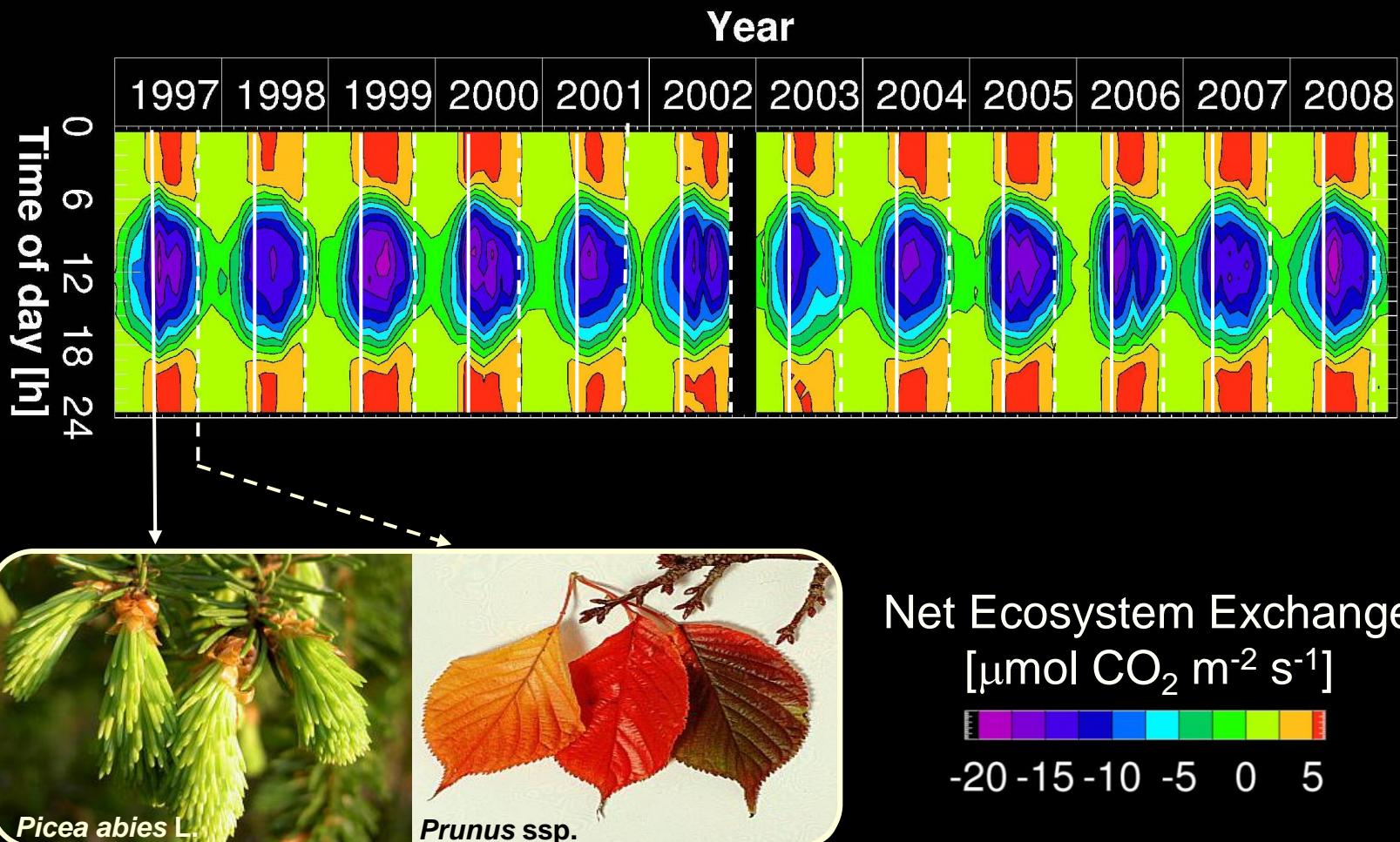


Tharandt CarboEurope Tower, Dresden, Germany

Net Ecosystem Exchange
[$\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$]

-20 -15 -10 -5 0 5

Together new possibilities to study ‘functional phenology’



Tharandt
International Phenological Garden

Niemand et al., 2005
Köstner et al., 2005

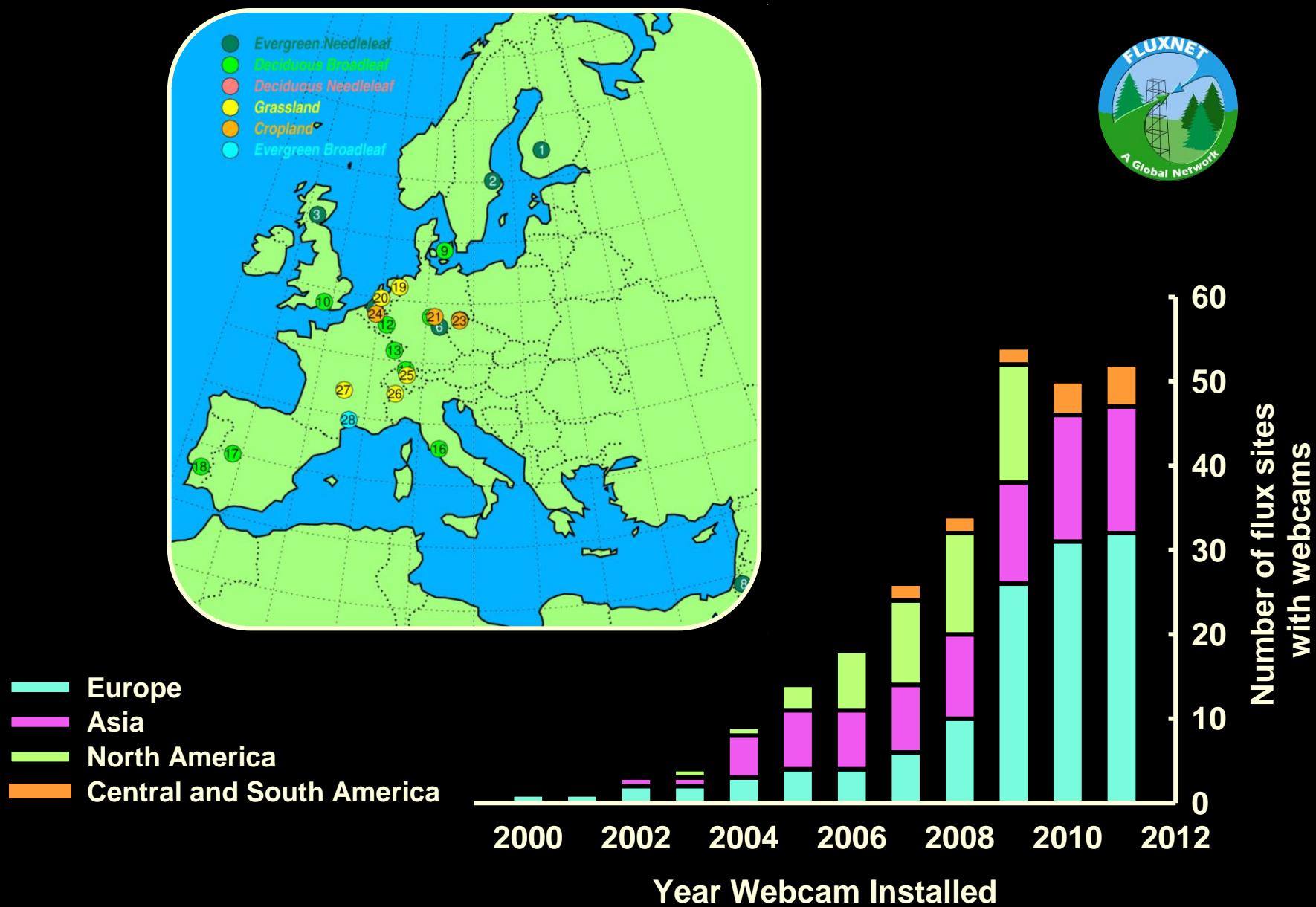
FLUXNET sites encouraged to mount webcams on towers

hmmm, we need
more cameras
like this on
flux towers...



Dennis Baldocchi et al., 2005

Growing webcam network at European FLUXNET sites



Extracting a colour signal from digital images

'digital number-DN'



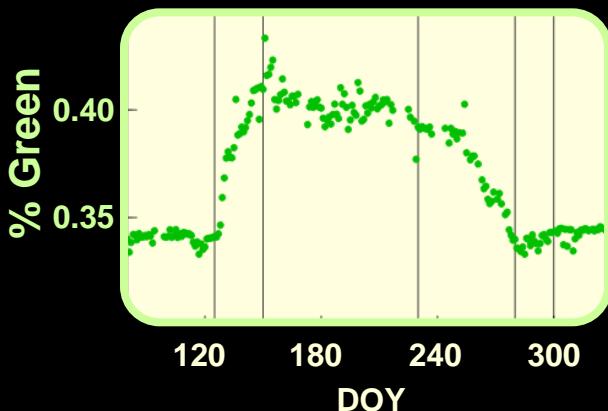
Richardson et al., 2007, 2009



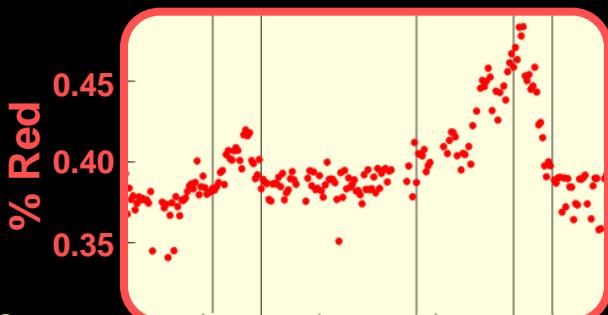
Bartlett Deciduous Forest Ameriflux Tower, New Hampshire, USA

Strong seasonality in colour signal

Relative Channel Brightness ← ‘digital number-DN’



Green Dn
Total Dn



Red Dn
Total Dn

Richardson et al., 2007, 2009

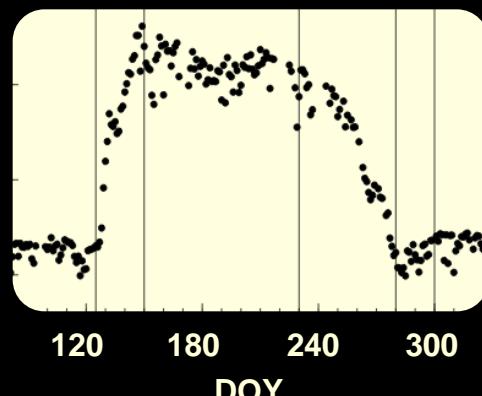


Bartlett Deciduous Forest Ameriflux Tower, New Hampshire, USA

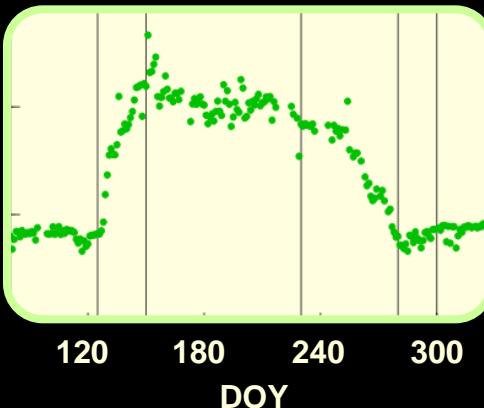
Strong seasonality in colour signal

Green Excess Index ← Relative Channel Brightness ← ‘digital number-DN’

2Green DN - (Red DN + Blue DN)



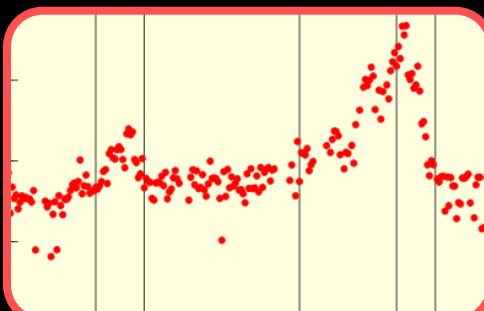
% Green



Green Dn
Total Dn



% Red



Red Dn
Total Dn

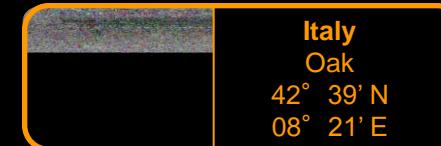
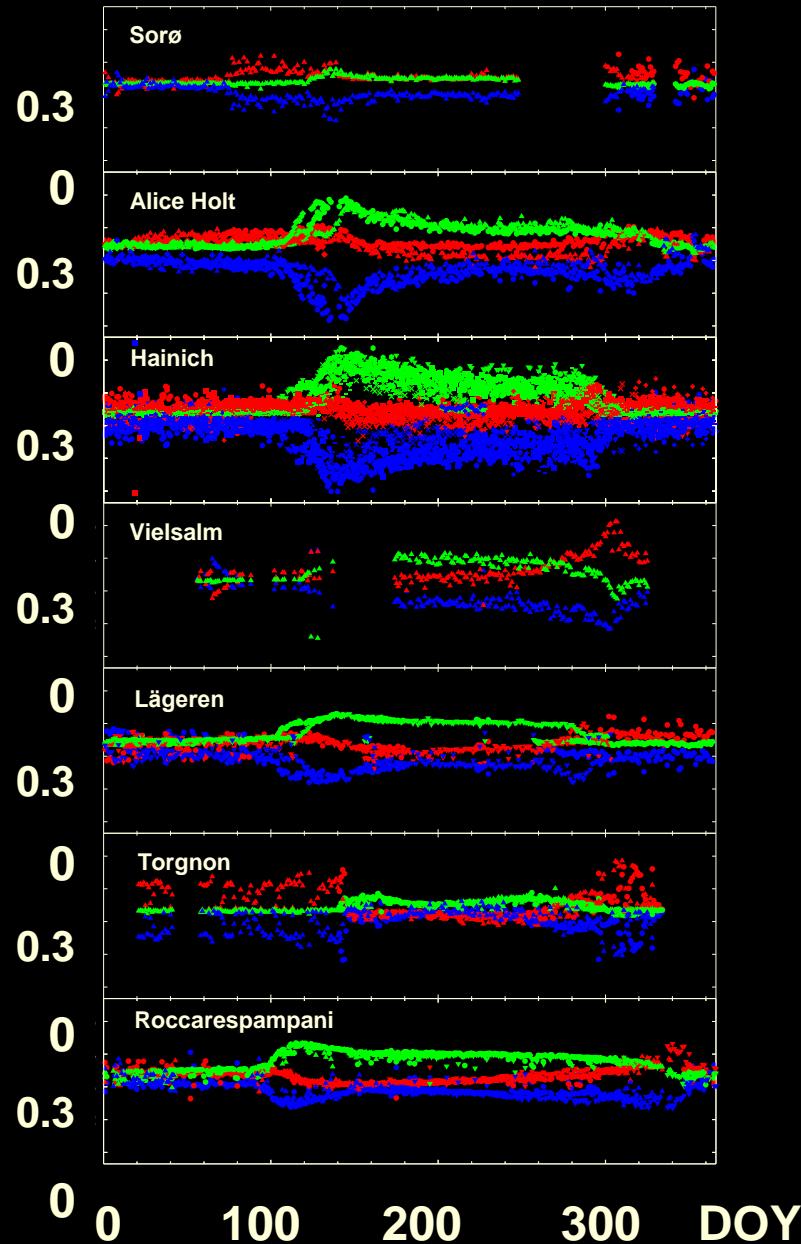
Richardson et al., 2007, 2009



Bartlett Deciduous Forest Ameriflux Tower, New Hampshire, USA

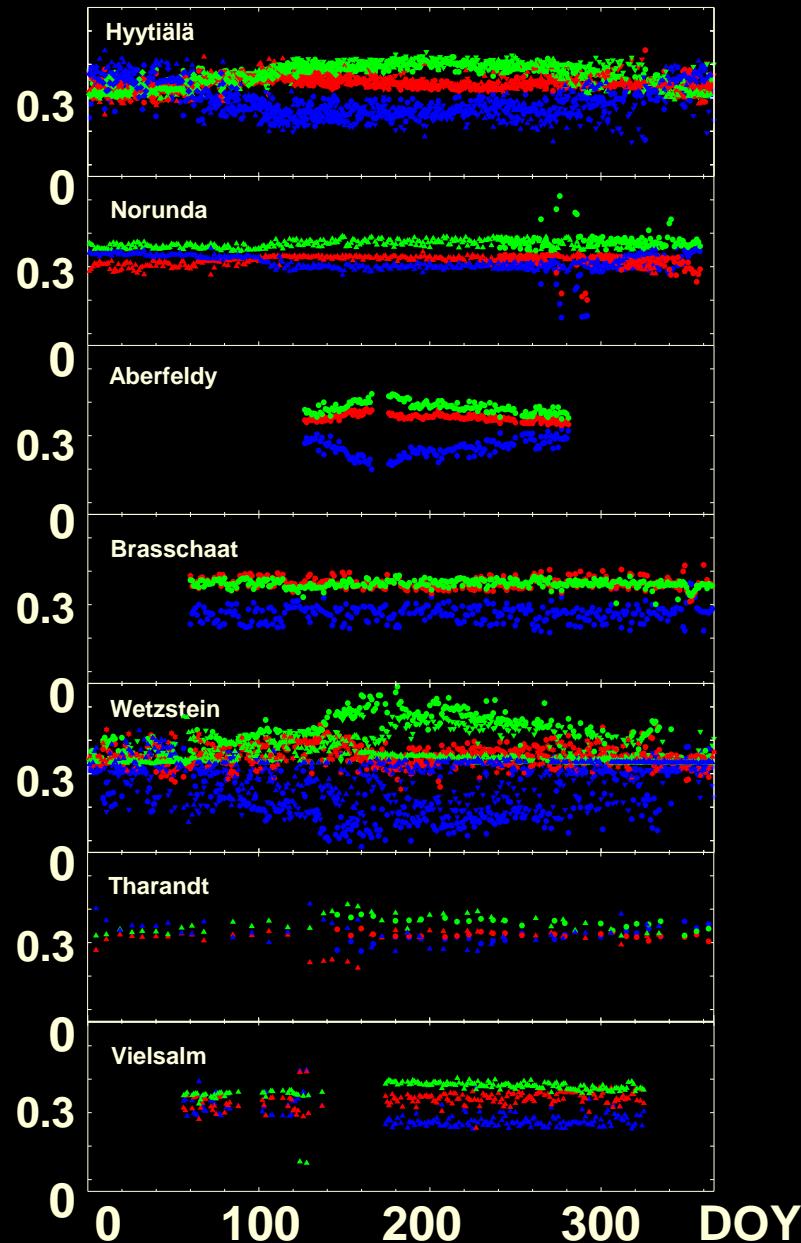
Latitudinal distribution of webcams in deciduous flux sites

Colour Fraction
in Red, Green & Blue Channels



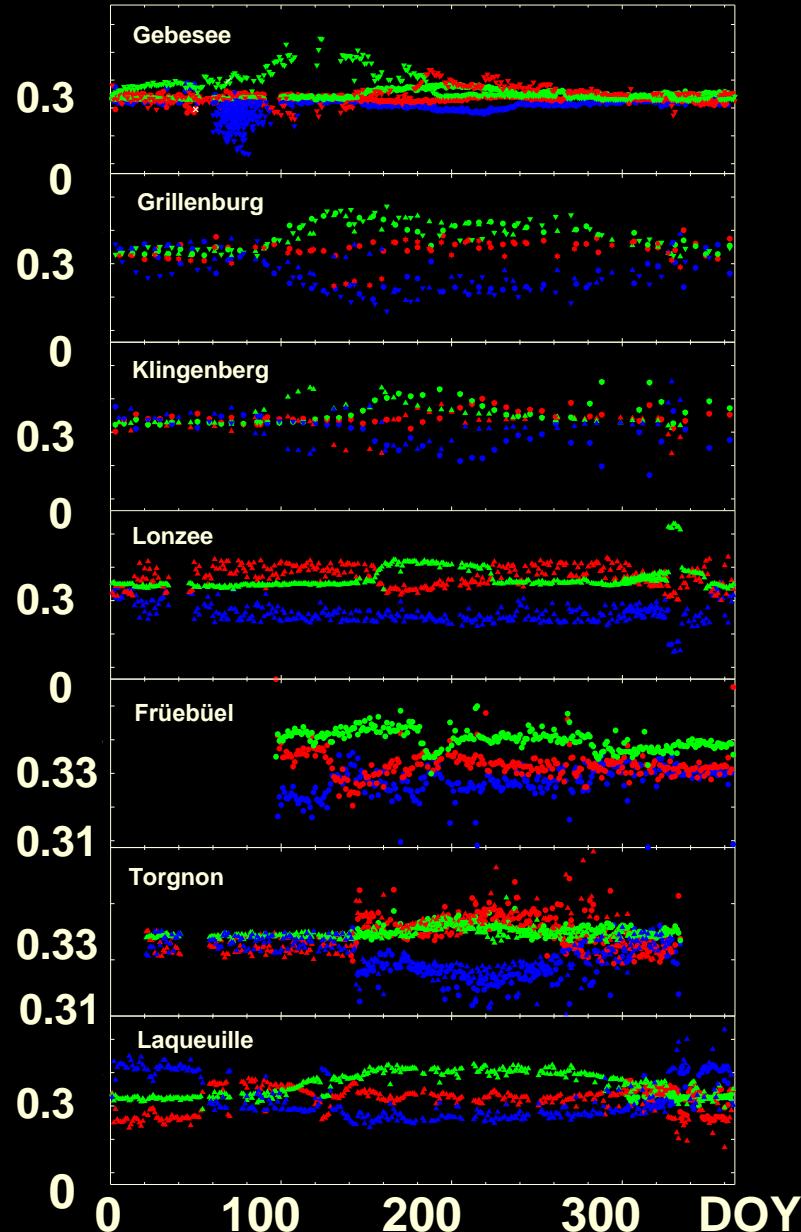
Latitudinal distribution of webcams in evergreen flux sites

Colour Fraction
in Red, Green & Blue Channels

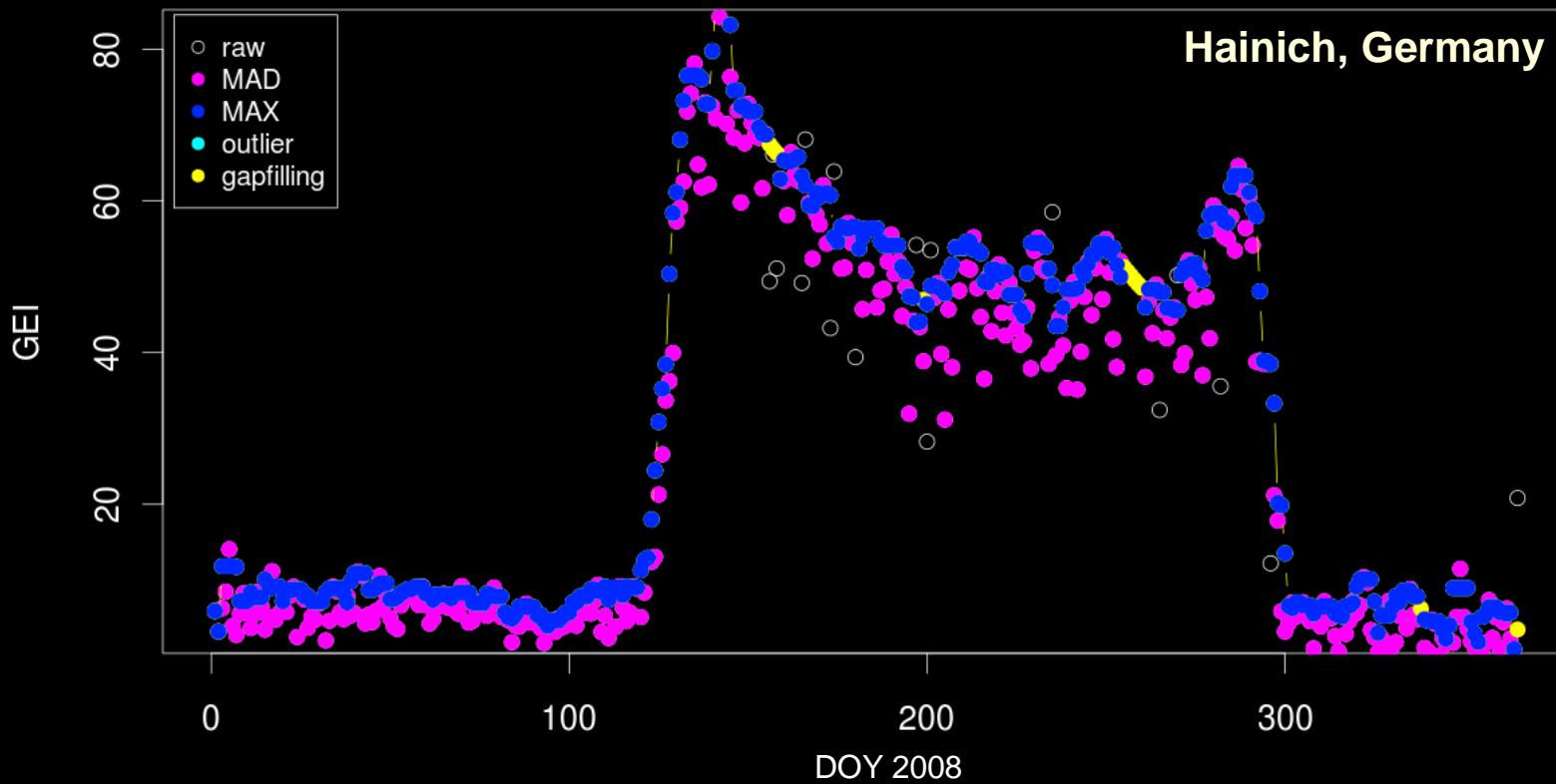


Webcams in grass and cropland flux sites

Colour Fraction
in Red, Green & Blue Channels



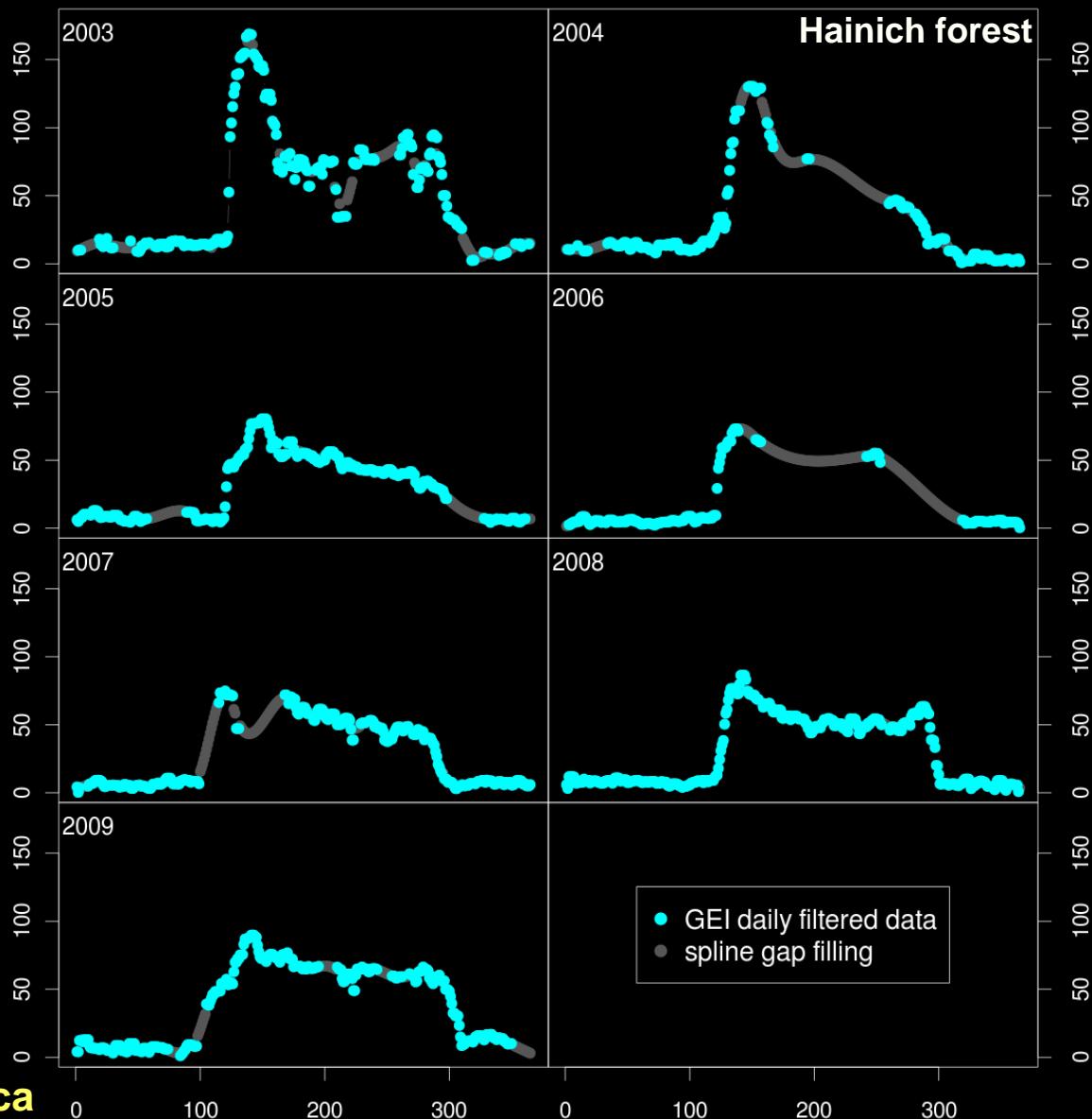
Filtering and extracting phenological metrics



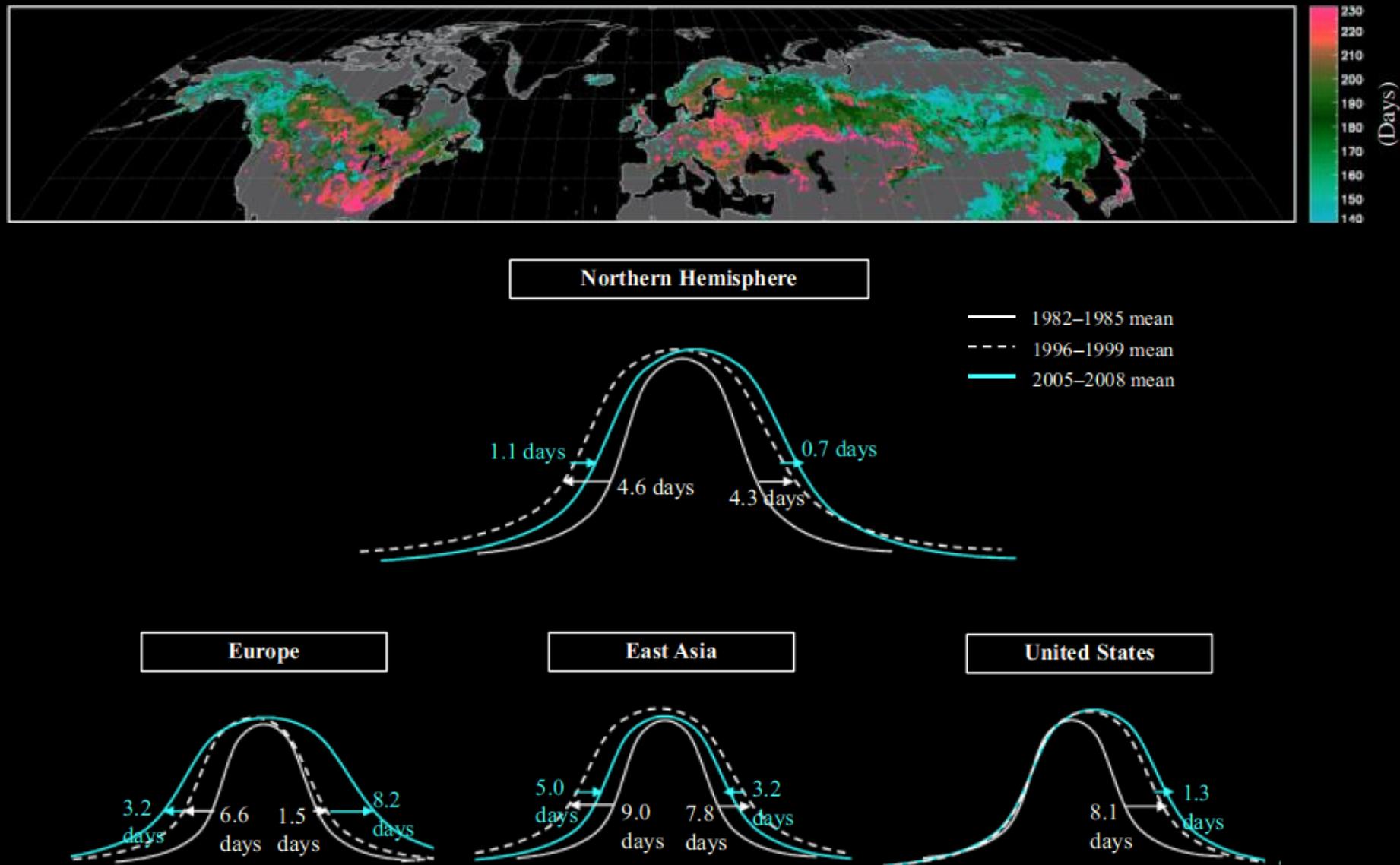
*Remove unrealistic data Green Fraction <0.2 and Excess <-40
Median of Absolute Deviation for the median (Papale et al., 2006)
MAX value filter over 5-day window (Sonnentag et al., AGU, 2006)*

Filtering and extracting phenological metrics

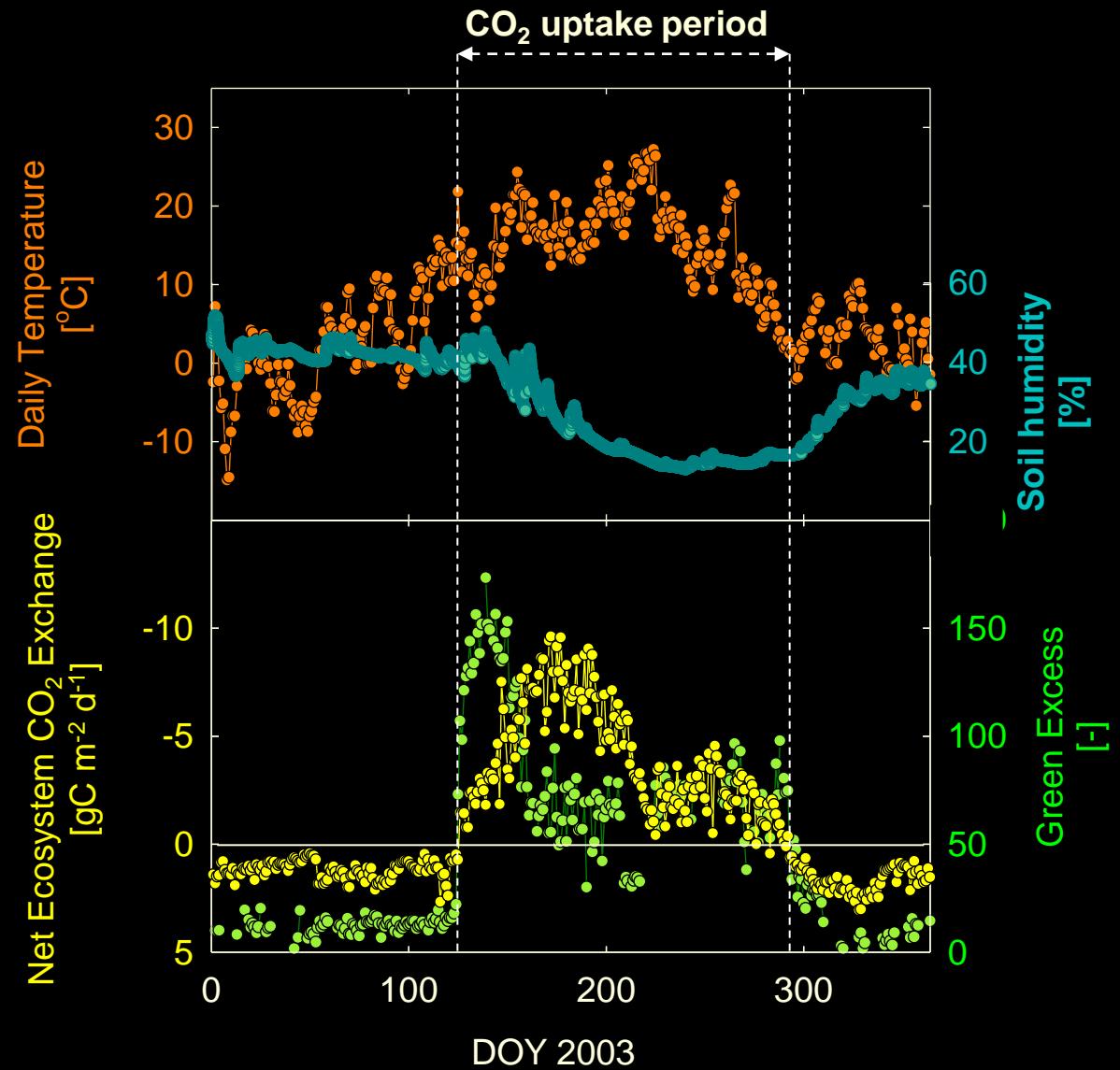
*Gapfill by fitting
a spline to
MAD MAX
filtered data
(d.f. = length (data)/8)*



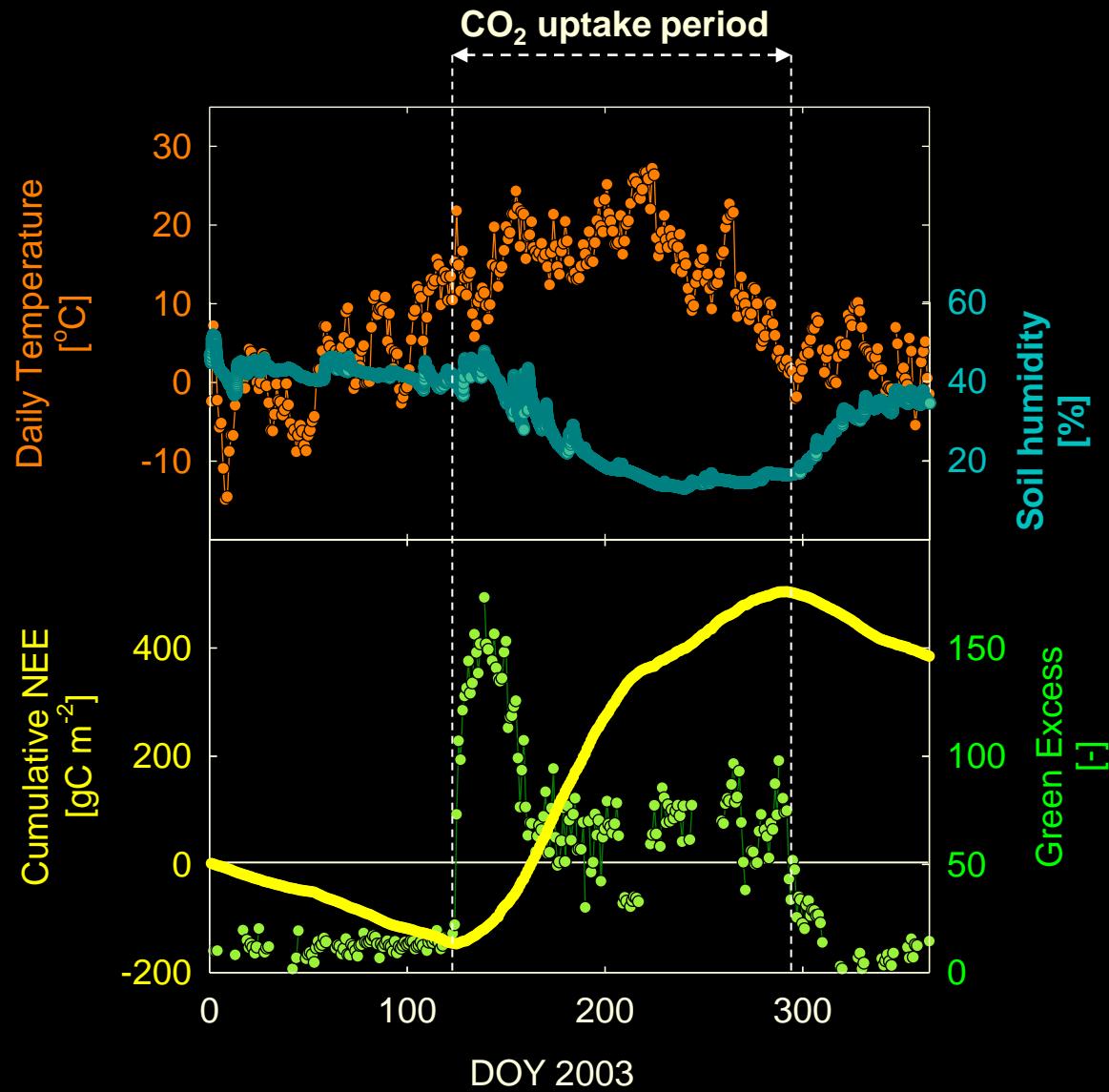
Growing season length often retrieved from NDVI products



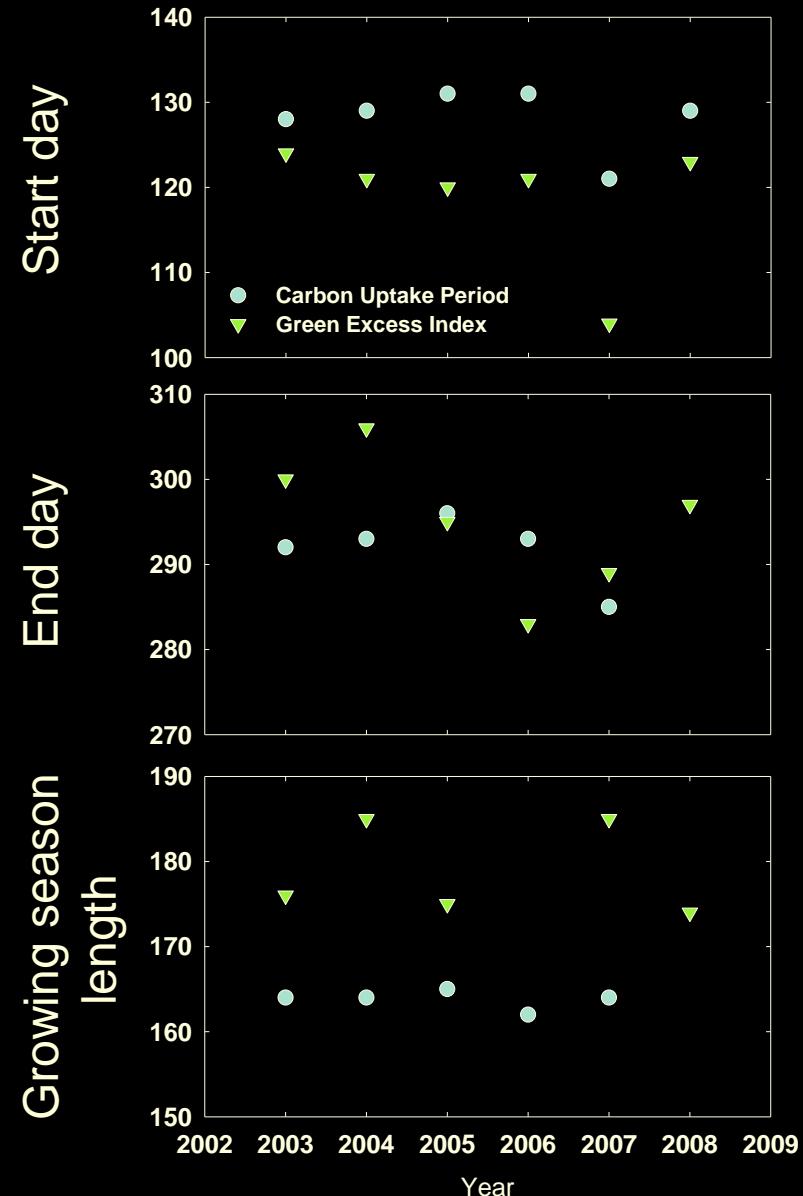
Carbon uptake period and green signal consistent



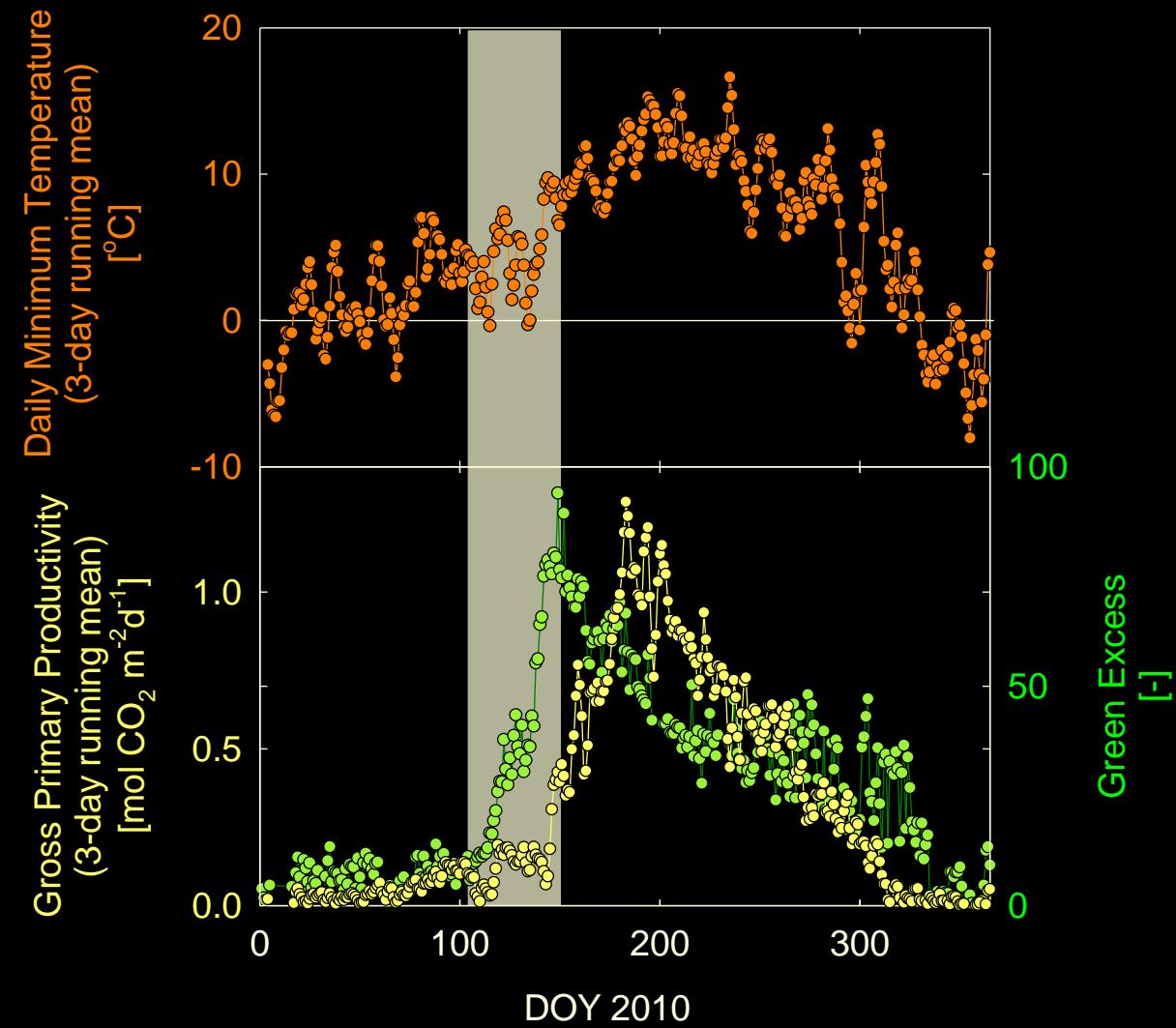
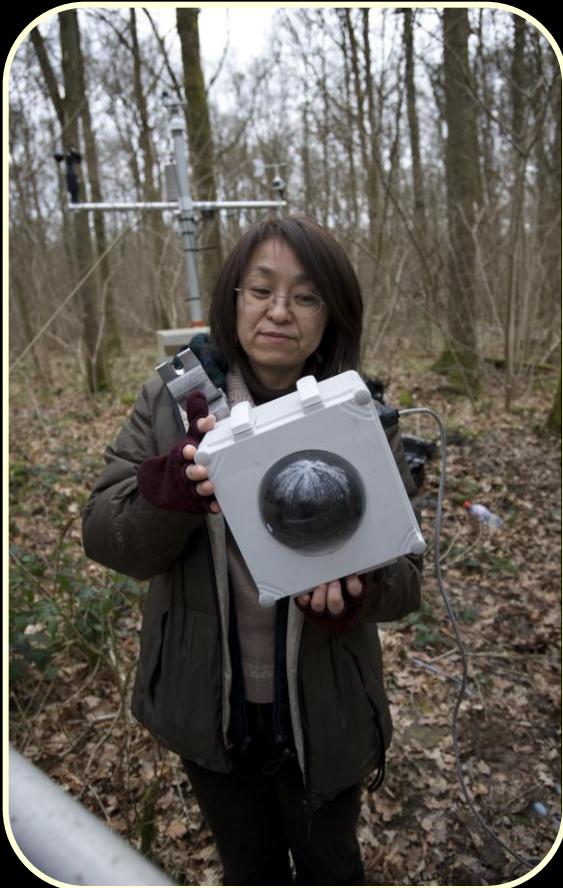
Carbon uptake period and green signal consistent



Interannual variability in growing season length



Frost events impact green signal and CO₂ uptake

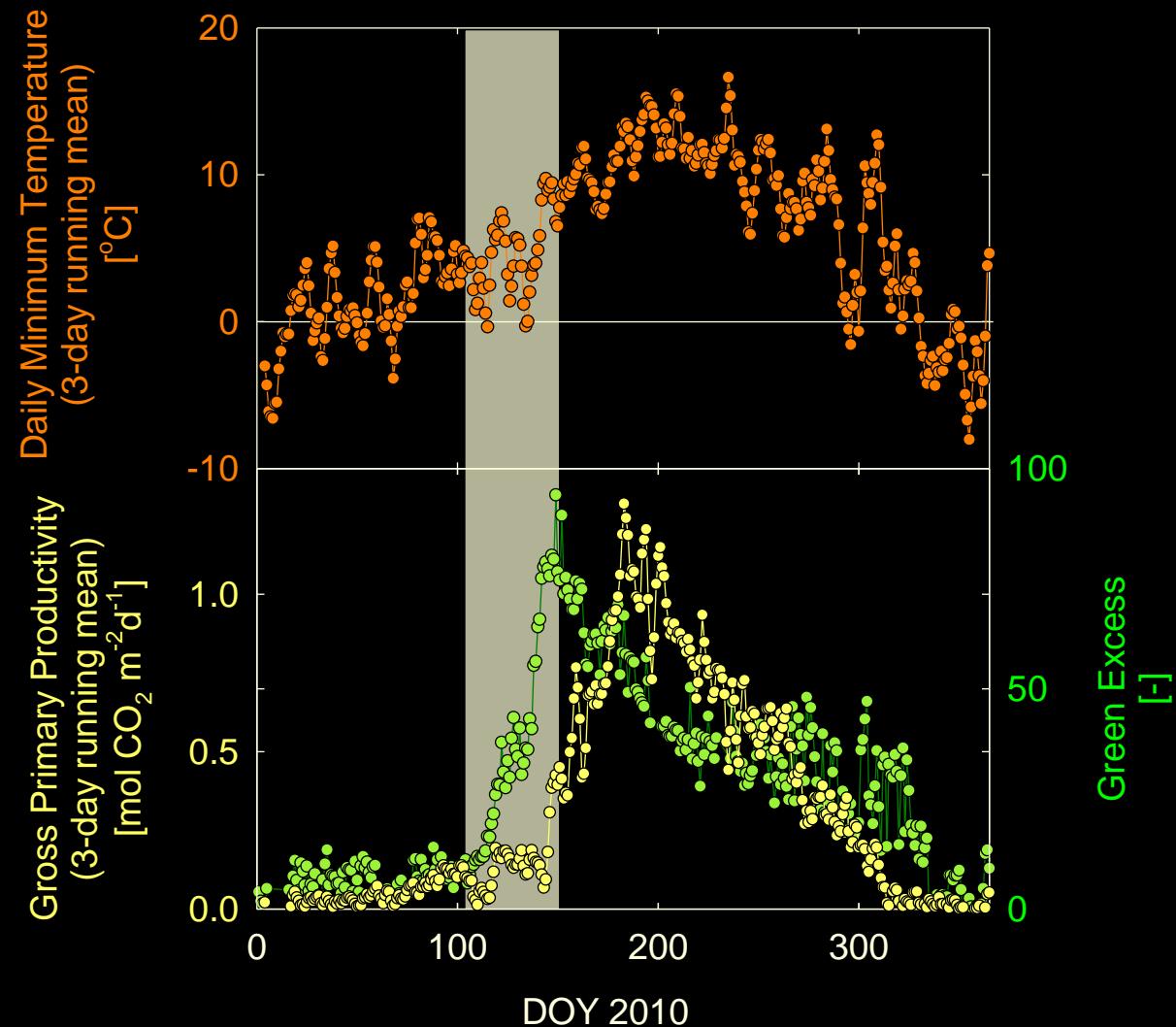


Alice Holt, England

Courtesy of Mizinuma, Wilkinson & PEN

Frost events impact green signal and CO₂ uptake

*Frost damaged
Ash leaves*

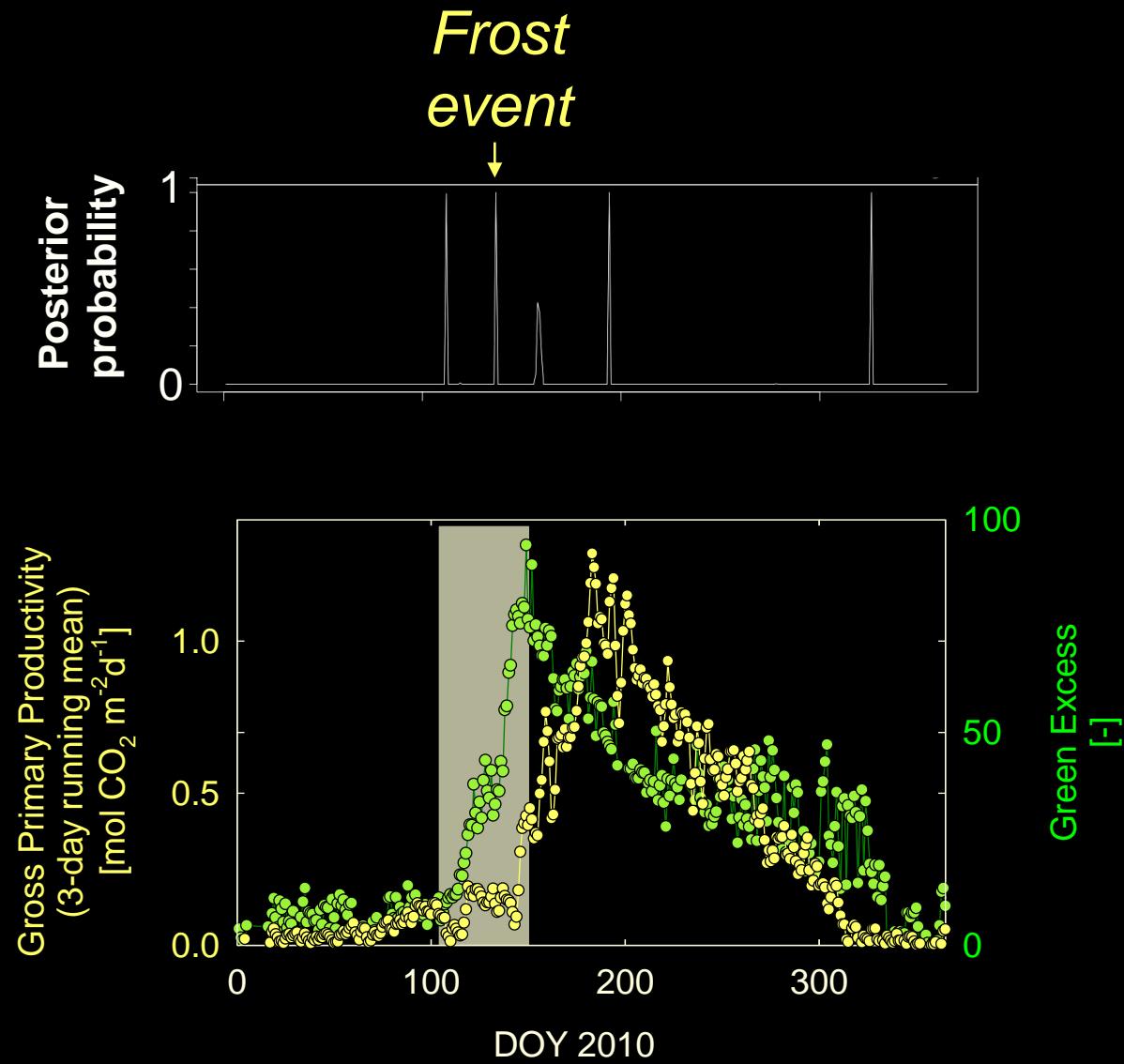


Alice Holt, England

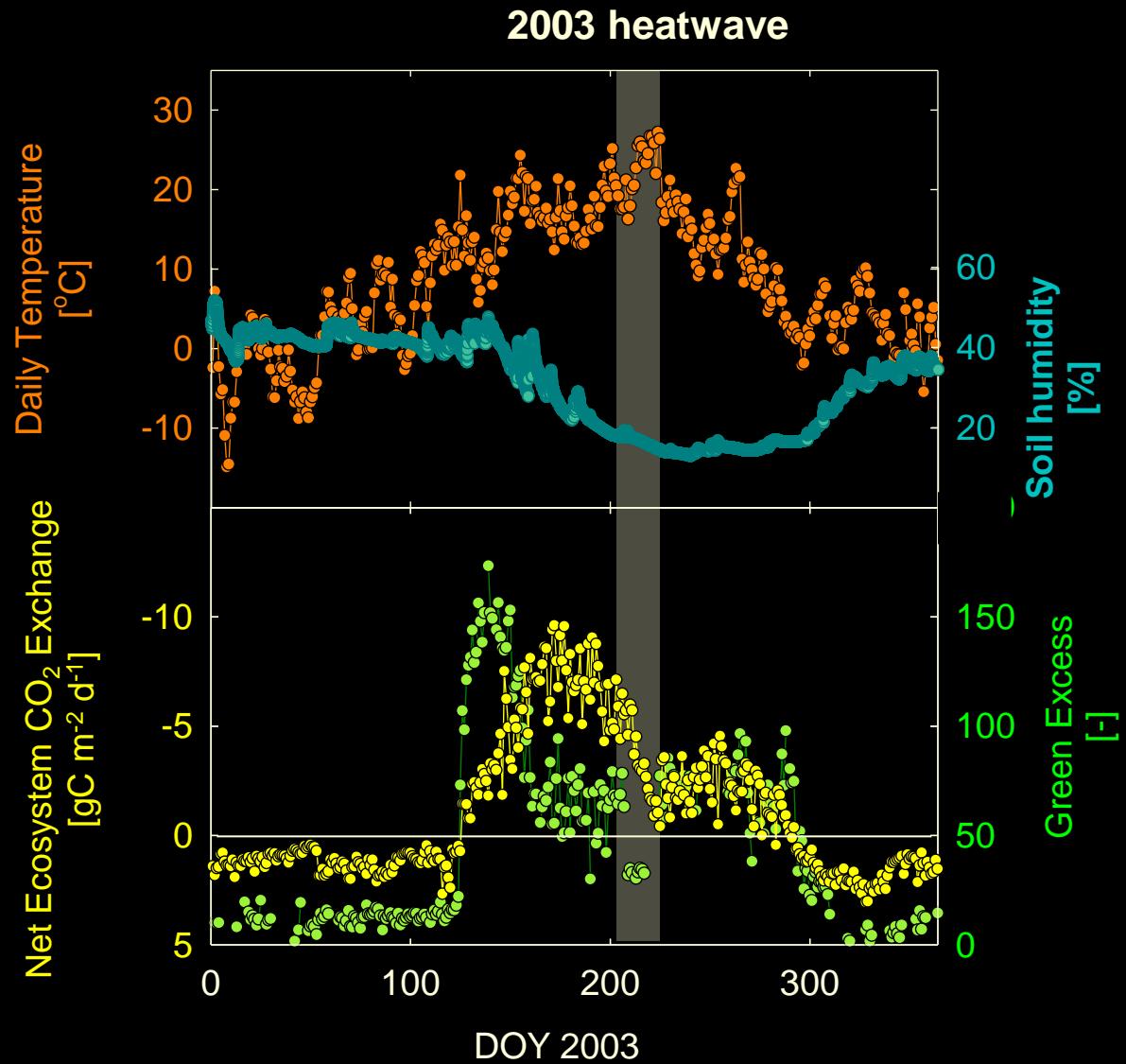
Courtesy of Mizinuma, Wilkinson & PEN

Frost events impact green signal and CO₂ uptake

*Frost damaged
Ash leaves*



Colour signals affected by extreme events?



Conclusions



Webscams are a cheap and simple way to obtain dynamic information on canopy state

Rich detail in the image signal that can be linked to weather events affecting growing season length



Carbon uptake does not always coincide with the green up signal

The webcam network at flux sites can help us monitor and probe large scale vegetation responses to climatic shifts



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