



A decade of continuous NEE measurements at a Scottish peatland

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Big science questions

- Few long-term studies of net ecosystem exchange (NEE) in peatland systems.
- What is the carbon sequestration rate of peatlands?
- What is the year to year variability?
- What are the drivers of inter-seasonal and inter-annual variability?
- Can we predict changes?

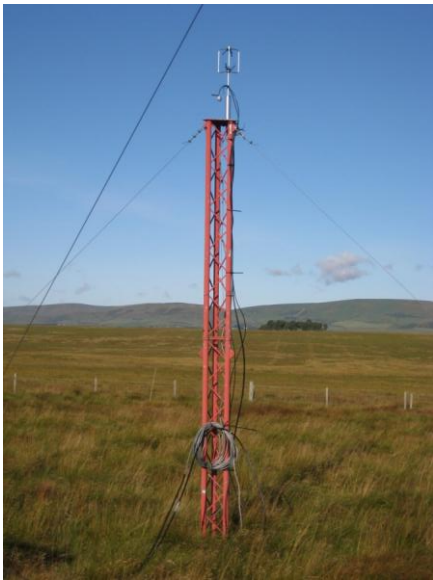
Site description

- Auchencorth Moss (55° 47' N, 03° 14' W) is a relatively flat, low-lying, ombrotrophic peatland in SE Scotland.
- The site was drained more than 100 years ago (drainage ditches now disused and overgrown).
- Land-use is primarily low intensity sheep grazing
- Peat depth ranges from <0.5 m to >5 m
- Vegetation consists of a patchy mix of grasses and sedges covering a primarily *Sphagnum* base layer on a typical peatland hummock/hollow microtopography.
- Mean water table depth is -12.5 cm, ranging from below -55 cm to +4.5 cm above the peat surface
- Auchencorth Moss is a CEH aquatic carbon catchment site (4 in the UK)

(Aquatic fluxes are presented session BG2.1, at PICO Spot 4, 8 April)



Site description: instrumentation



Prevailing wind direction:
S-W (ca. 70% of the time)



100 m

Eddy-covariance system (continuously since 2002):

- Gill Windmaster Pro ultrasonic anemometer
- Licor 7000 closed-path CO₂/H₂O analyser
- Measurement height 3.4 m
- Uniform fetch to North, West and South (several km)

Meteorological measurements include:

- Air and soil temperature
- Rainfall
- Radiation (total solar, PAR, net radiation)
- Water table depth

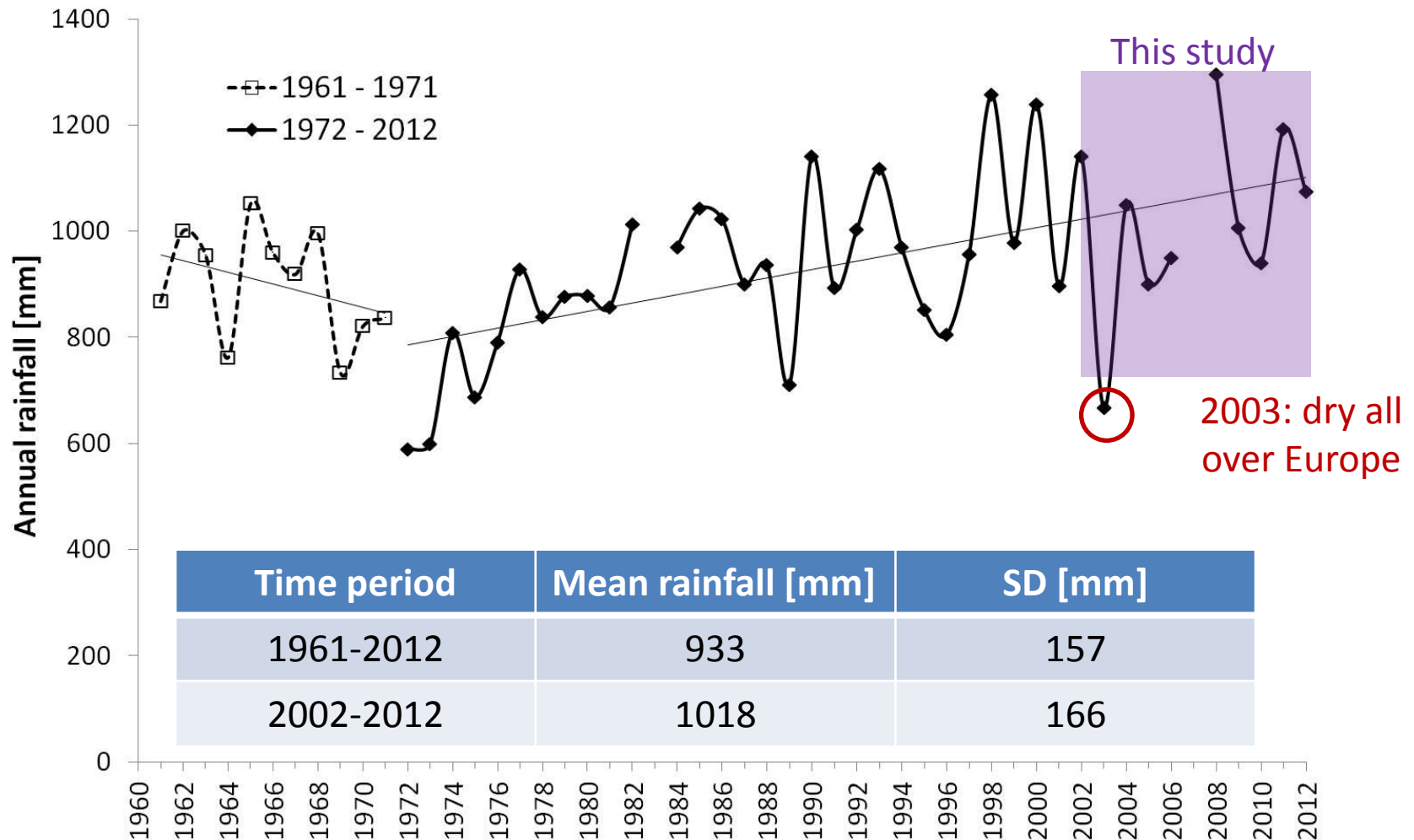
Image © 2013 Getmapping plc

Google earth

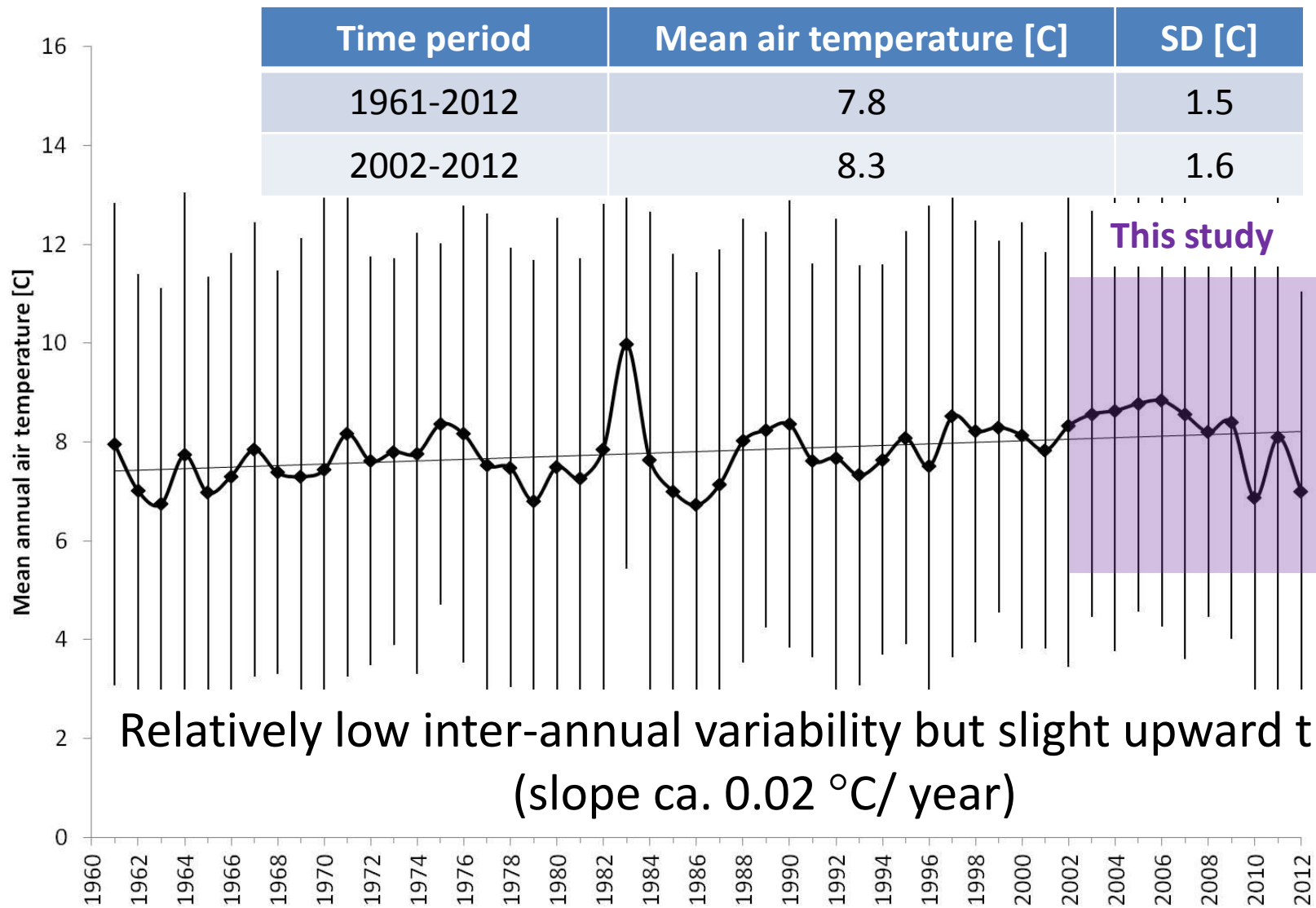
Imagery Date: 1/1/2007 55°47'32.19" N 3°14'35.42" W elev 267 m eye alt 834 m

Local climate - precipitation

Overall upward trend despite large inter-annual variability

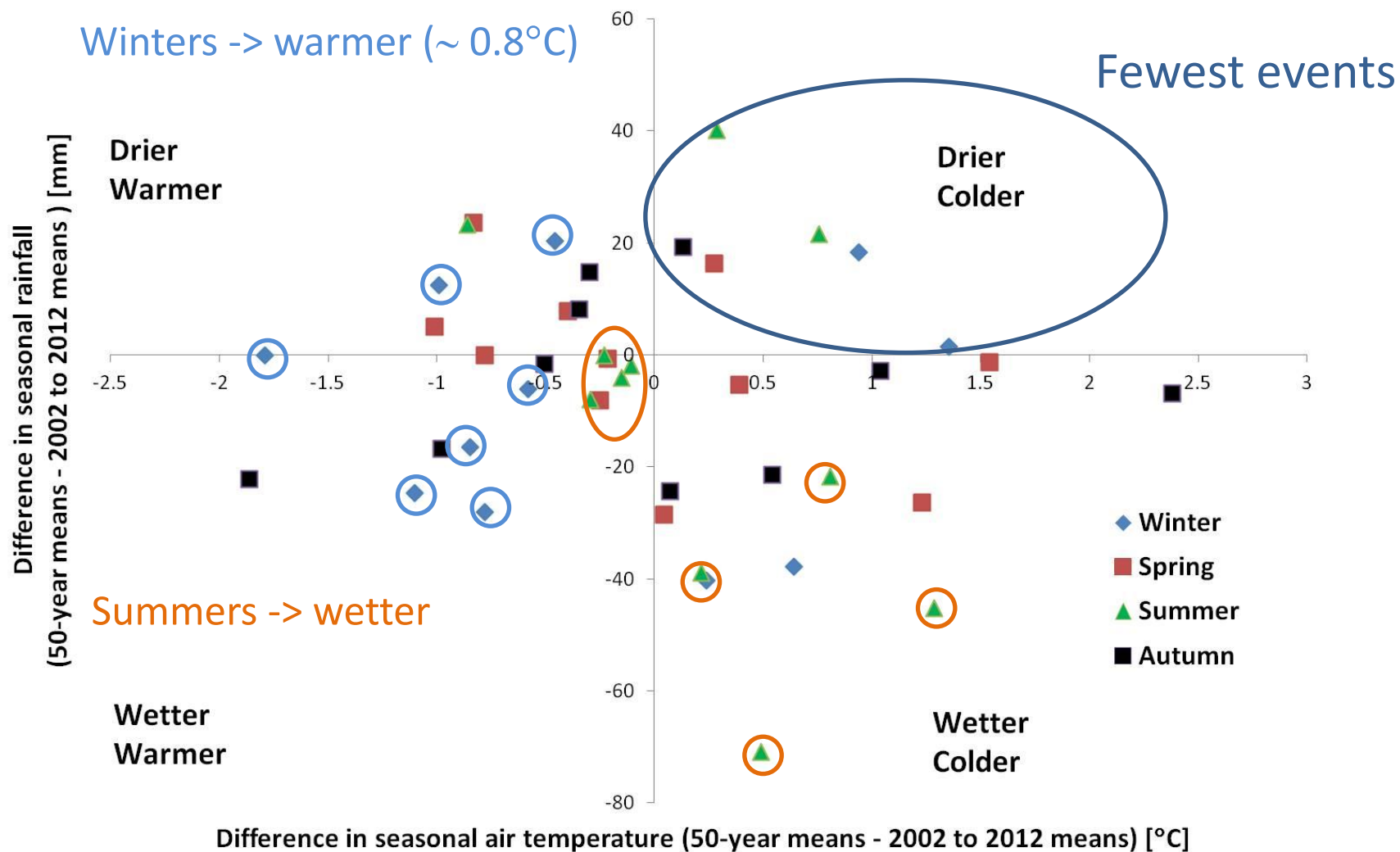


Local climate - temperature

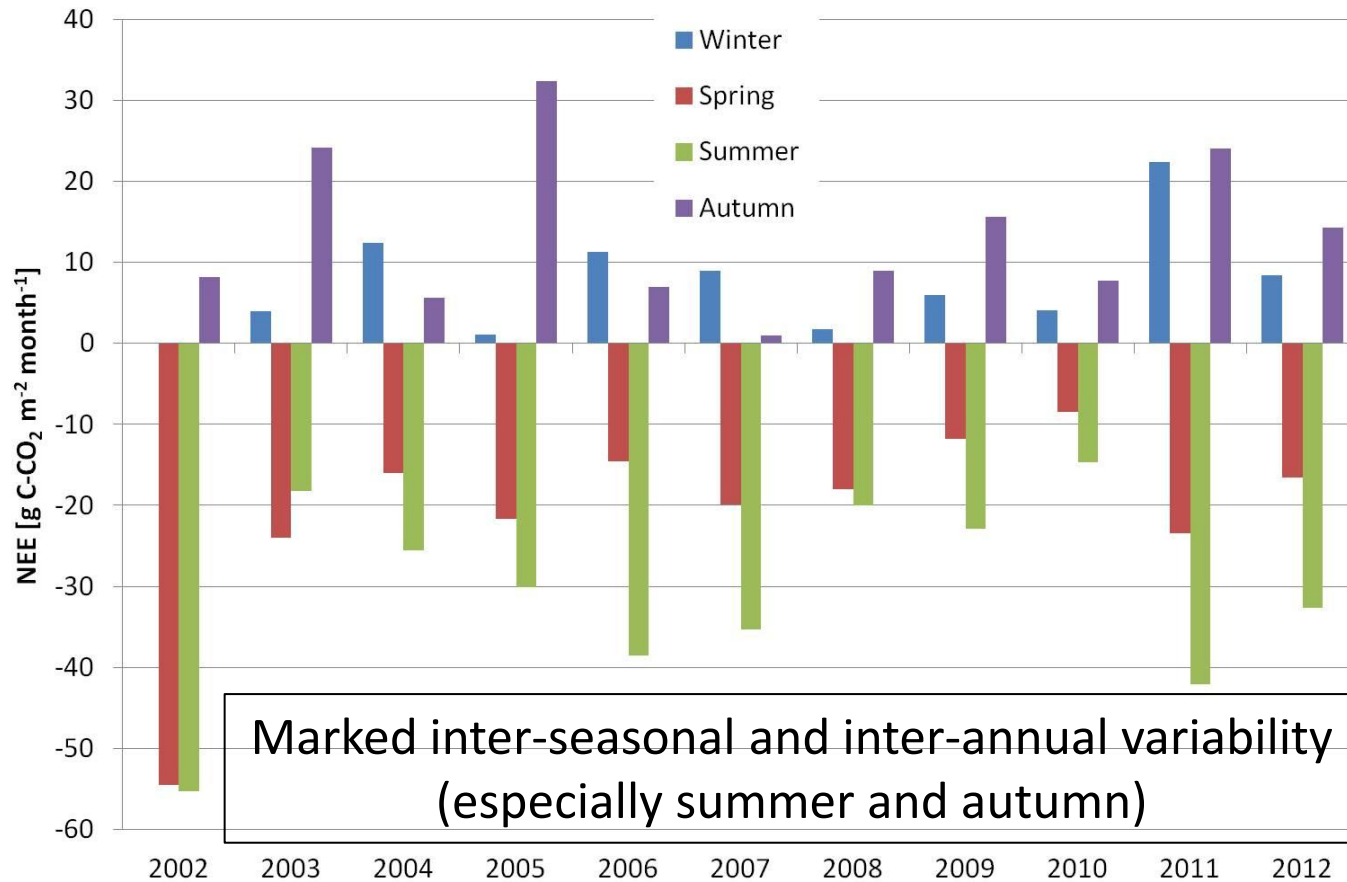


Local climate – overall trends

2002-2012 climate compared to 50 yr mean



Seasonal Net Ecosystem Exchange (NEE)



Winter: January - March

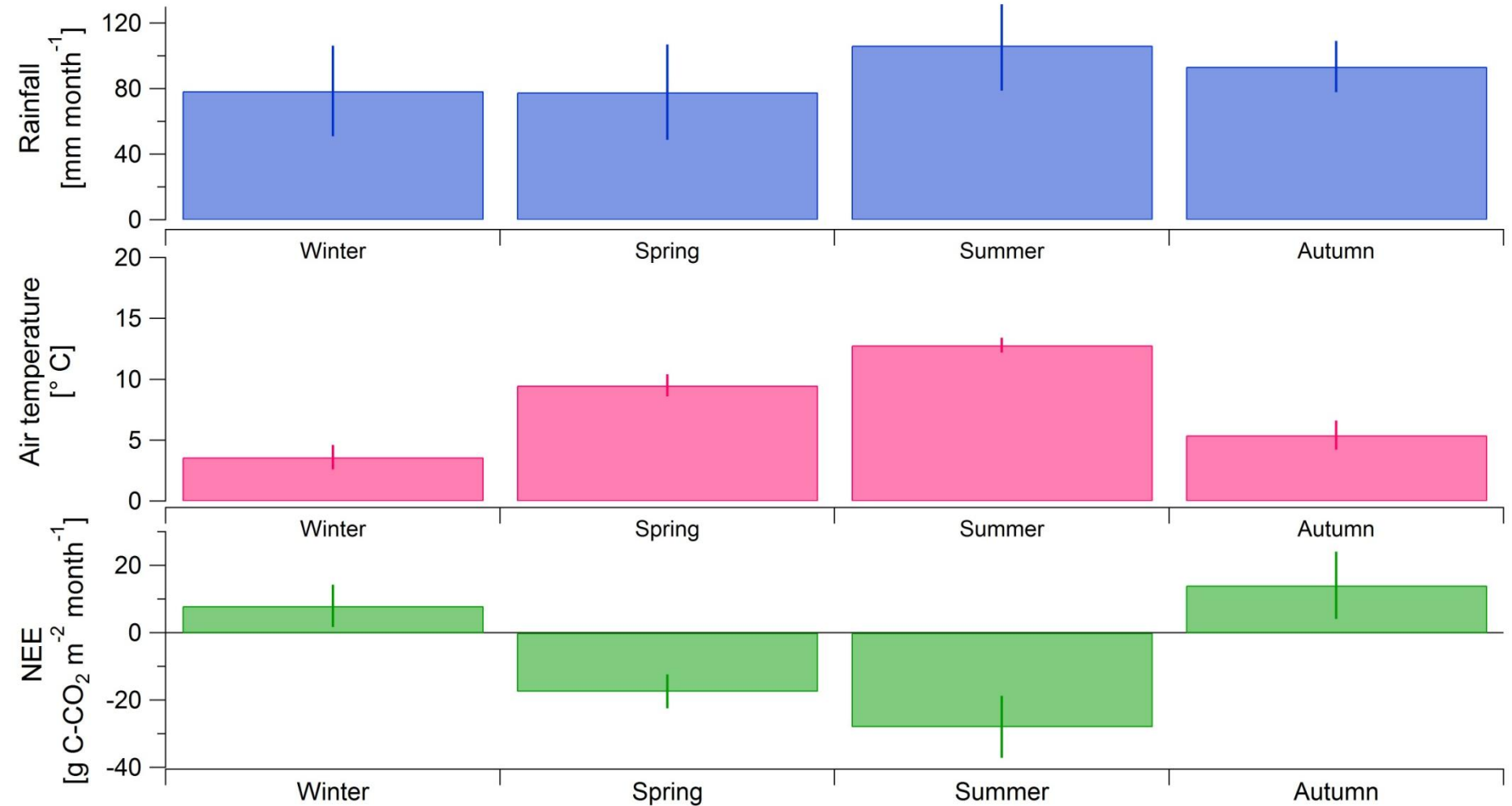
Spring: April - June

Summer: July - September

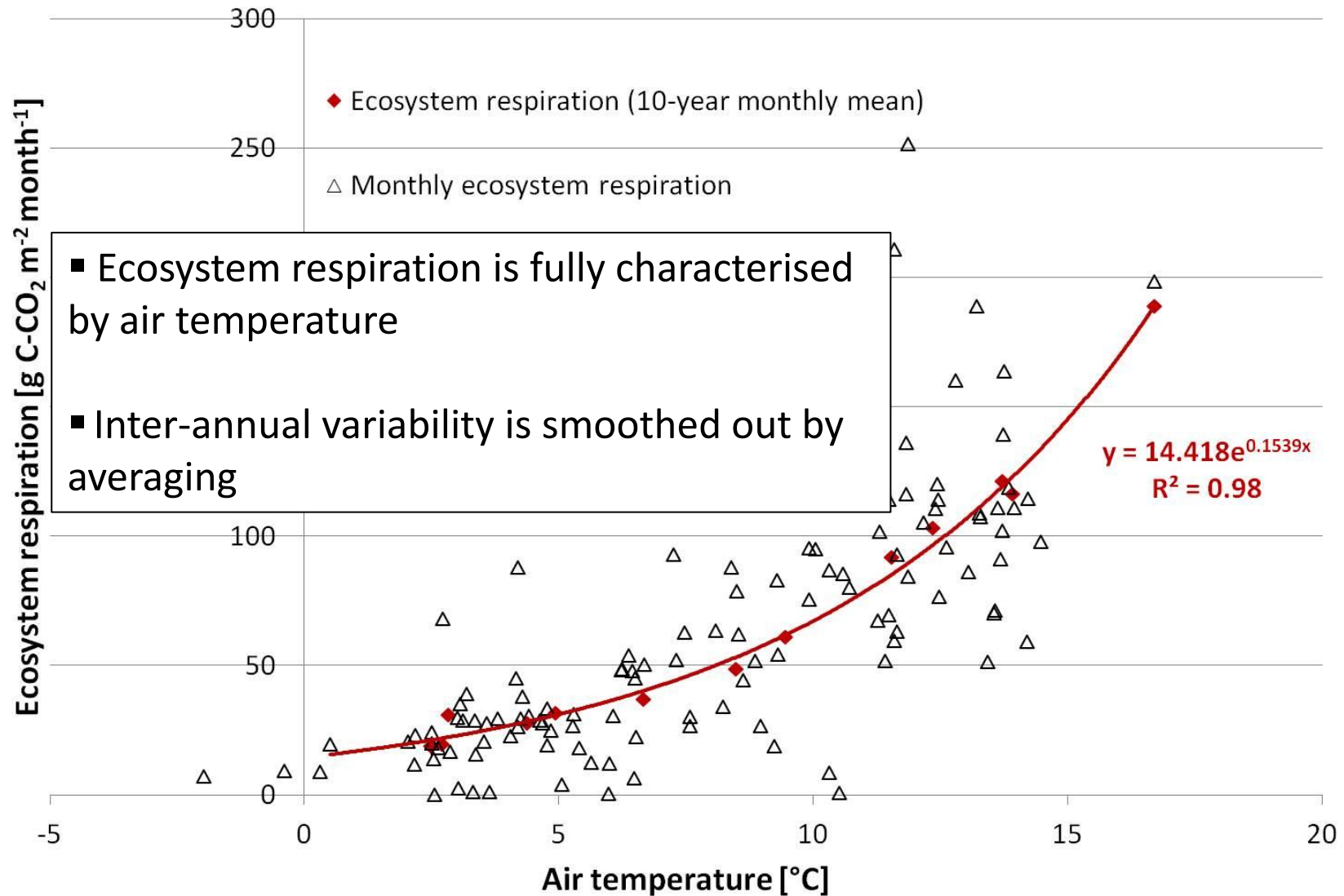
Autumn: October - December

Seasonal NEE, air temperature and rainfall

Largest CO₂ drawdown in summer (warmest and wettest season)

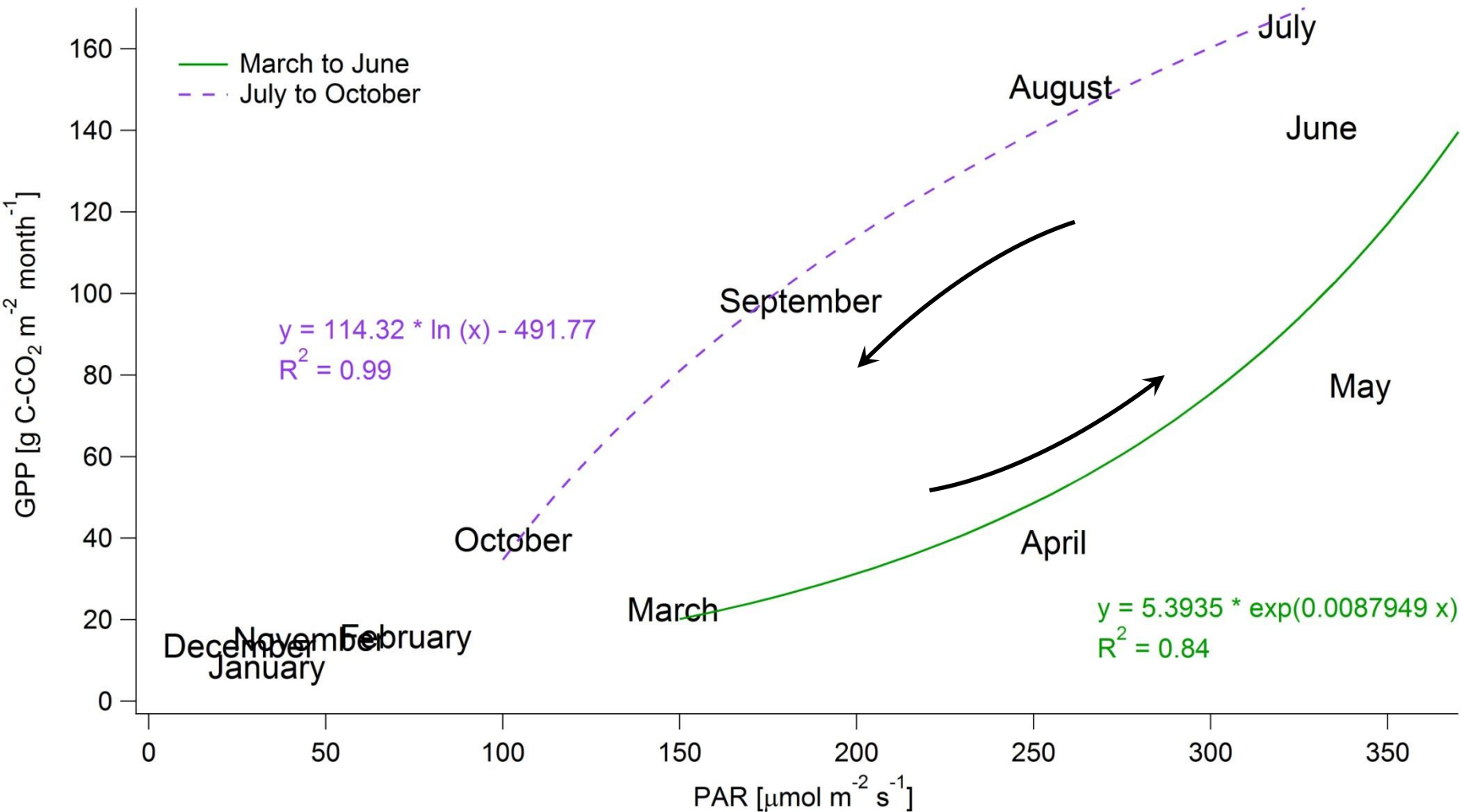


Ecosystem respiration (R_{eco})



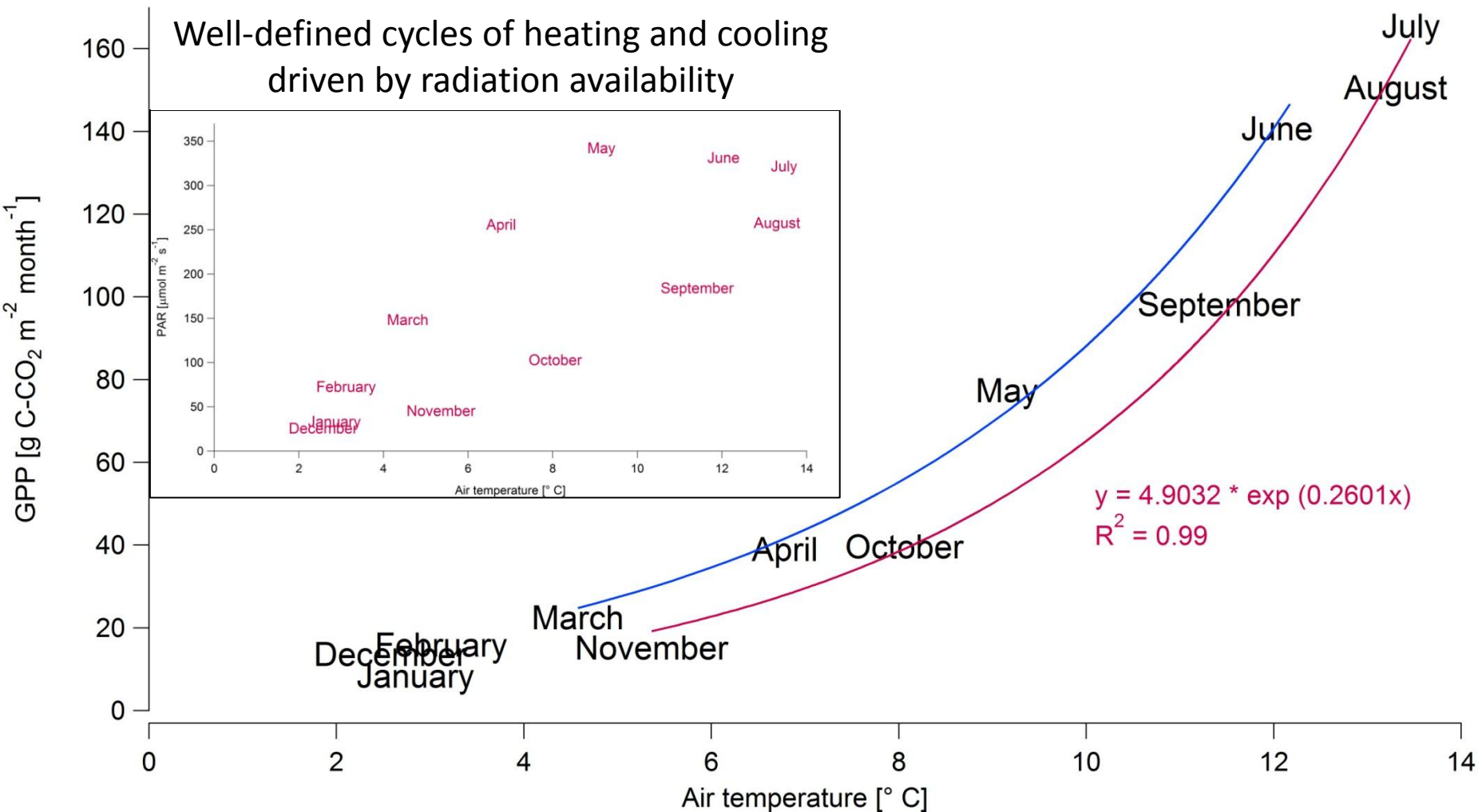
Gross Primary Production (GPP)

“Hysteresis” of GPP during growing season (culminating around summer solstice)



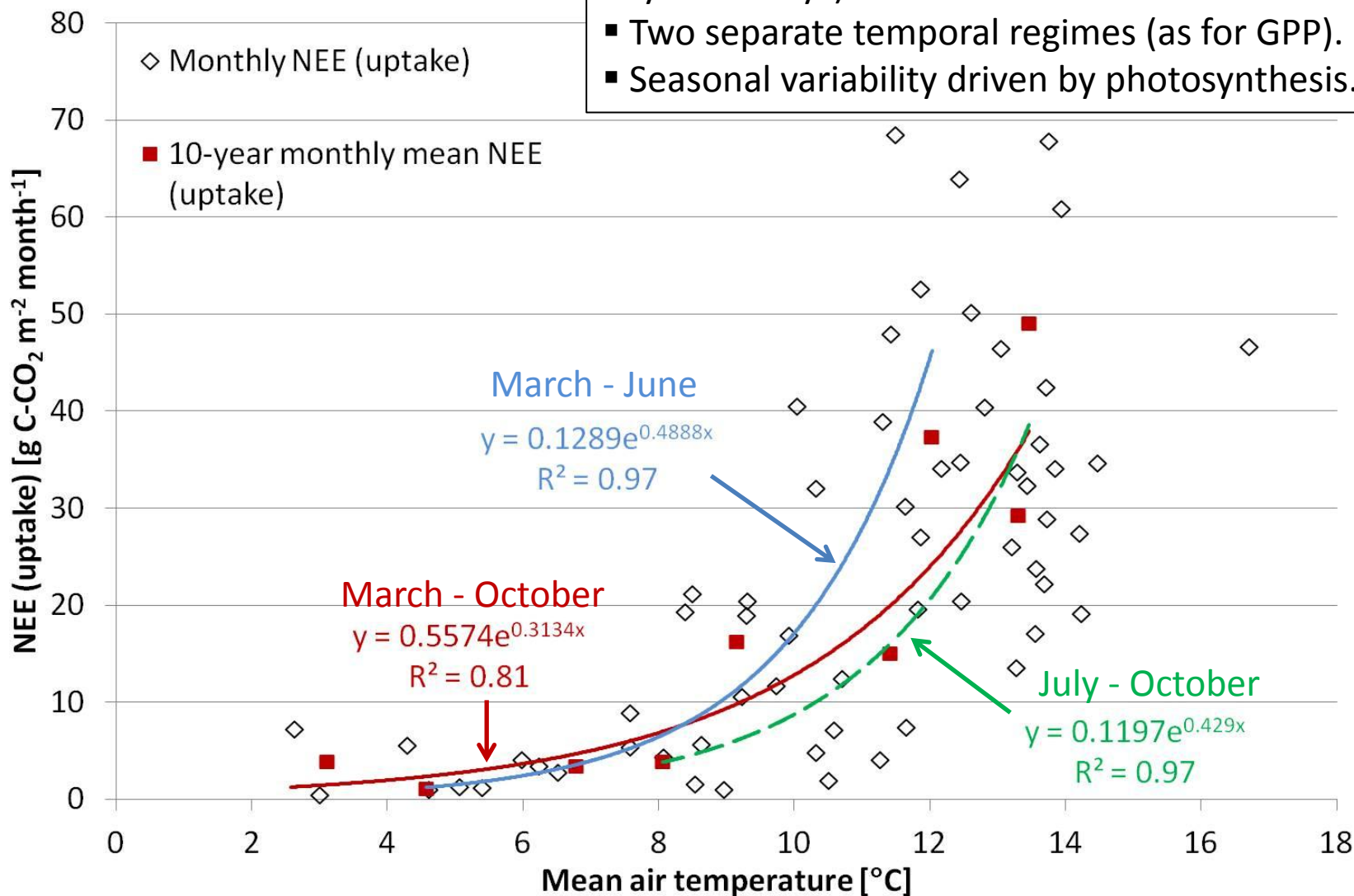
Gross Primary Production (GPP)

GPP is strongly correlated to air temperature but there are two (temporal) growth regimes

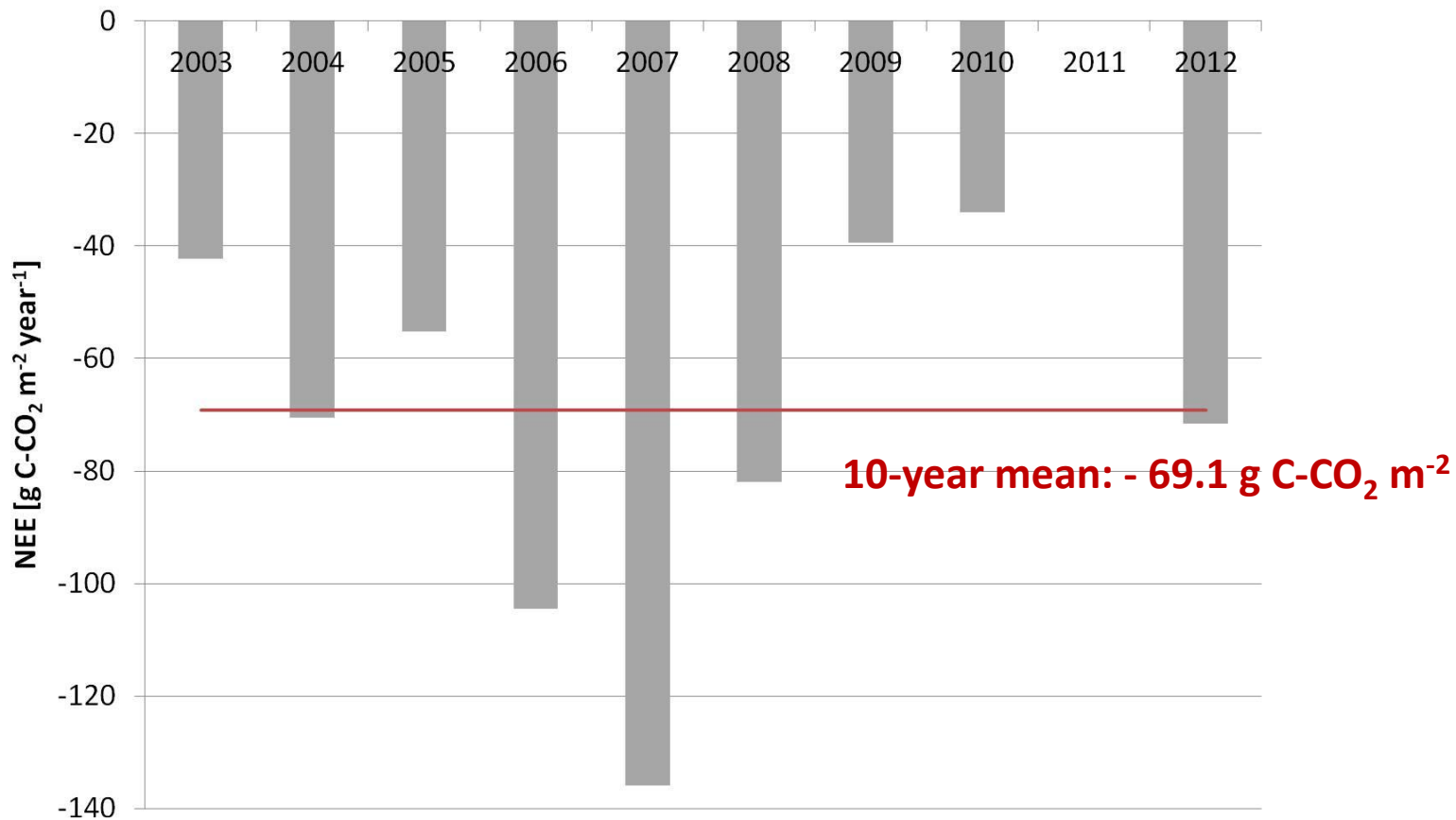


CO₂ uptake

- Air temperature is the best descriptor for NEE during the growing seasons (average length 247 days \pm 24 days).
- Two separate temporal regimes (as for GPP).
- Seasonal variability driven by photosynthesis.



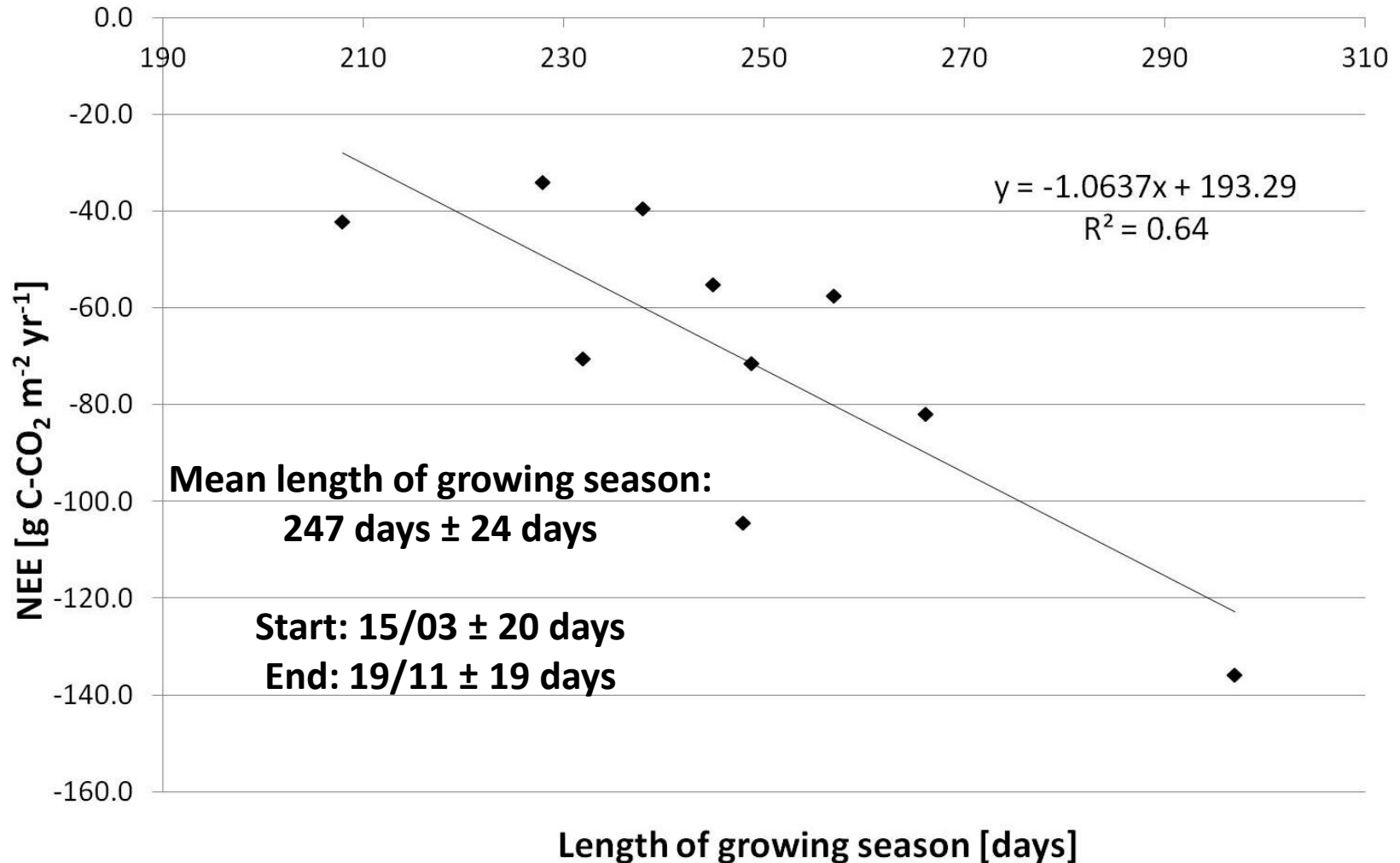
Annual CO₂ budget



Site	Duration [years]	Min NEE [g C-CO ₂ m ⁻²]	Max NEE [g C-CO ₂ m ⁻²]	Mean NEE [g C-CO ₂ m ⁻²]
Auchencorth Moss (this study) ²	9	-34.1	-135.9	-69.1 ± 33.6
Mer Bleue ³	6	-2	-112	-40.2 ± 40.5
Glencar ⁴	6	-12.5	-84	-47.8 ± 30.0
Degerö ⁵	2	-42	-55	-51.5 ± 4.9

NEE: Inter-annual variability

The annual NEE is closely linked to the length of the growing seasons



Conclusions

- Auchencorth Moss is a net sink of CO₂ (average -69.1 ± 33.6 g C-CO₂ m⁻² year⁻¹)
- This value is at the high end of other recent studies as is the inter-annual range of NEP (-31.4 to -135.9 g C-CO₂ m⁻²).
- Air temperature is a strong predictor for NEE, GPP (growing season) and R_{eco} on a monthly and seasonal basis.
- Inter-annual variations in NEE are strongly linked to the length of the growing seasons.

References

- ¹ UK Met Office - MIDAS Land and Marine Surface Station Data
- ² *A decade of continuous NEE measurements at a Scottish peatland.* Helfter et al. (in prep.)
- ³ *Contemporary carbon balance and late Holocene carbon accumulation in a northern peatland.* Roulet et al., GCB (2007).
- ⁴ *How strong is the current carbon sequestration of an Atlantic blanket bog?* Koehler et al., GCB (2011).
- ⁵ *Contemporary carbon accumulation in a boreal oligotrophic minerogenic mire – a significant sink after accounting for all C-fluxes.* Nilsson et al., GCB (2008).