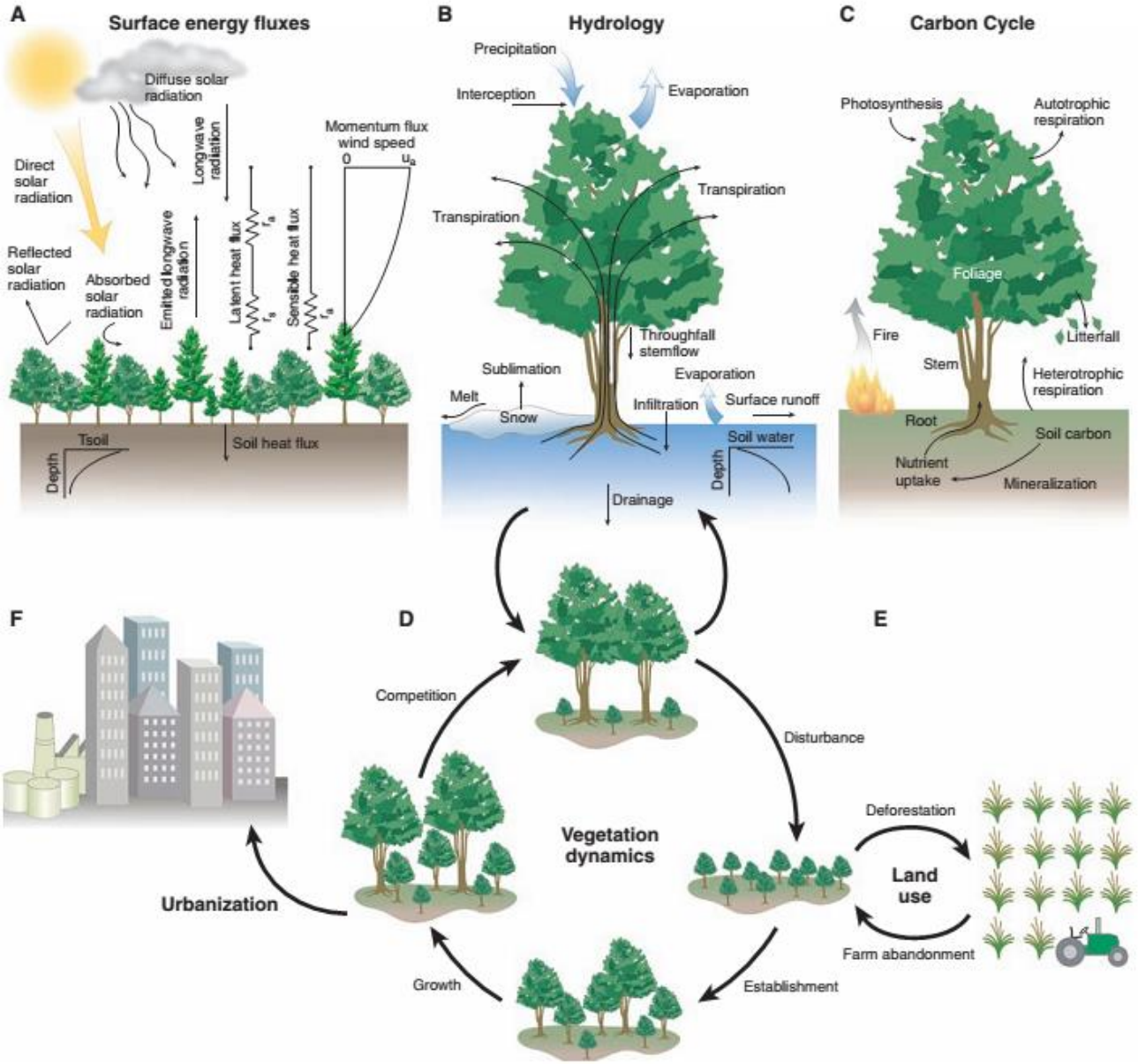
UKCEH GHG Flux Network

- Observing land-atmosphere processes
- Flux towers and their importance
- Virtual field trip
- The network and data

Hollie Cooper & Alanna Bodo, Ross Morrison, Alex Cumming, Brenda D'Acunha, Daniel Rylett, Katie Journeaux, Simon Oakley, Niall McNamara, Chris Evans, Jonay Jovani Sancho, Dafydd Crabtree, Nick Cowan, Jenny Rhymes and others

UK Centre for Ecology & Hydrology



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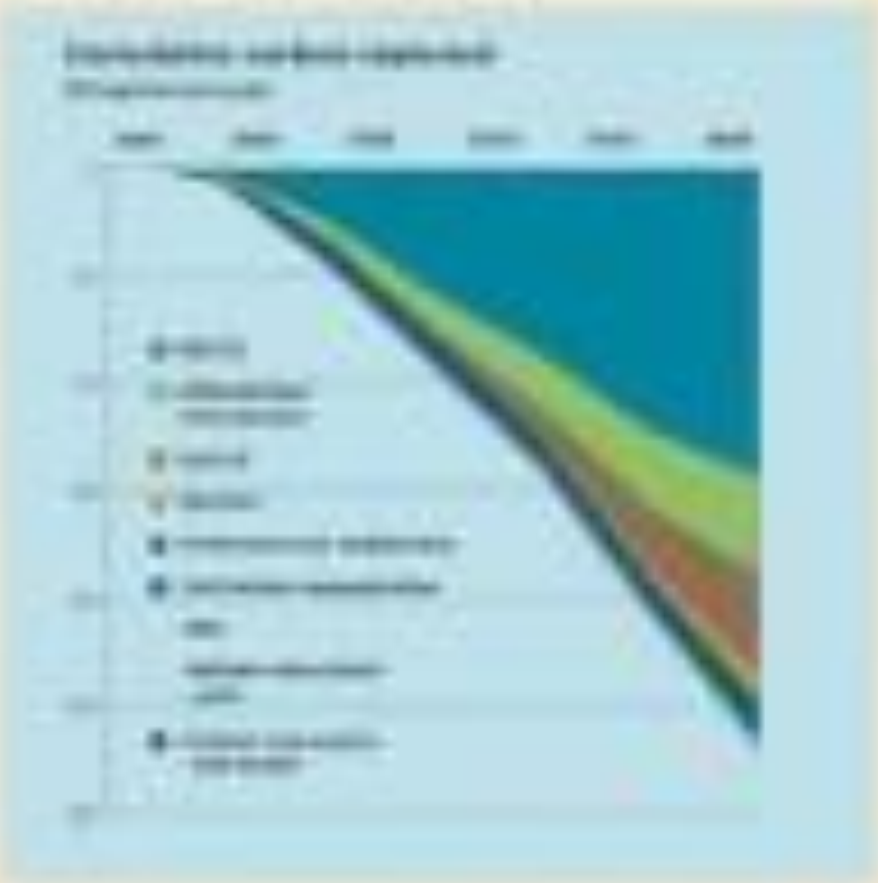
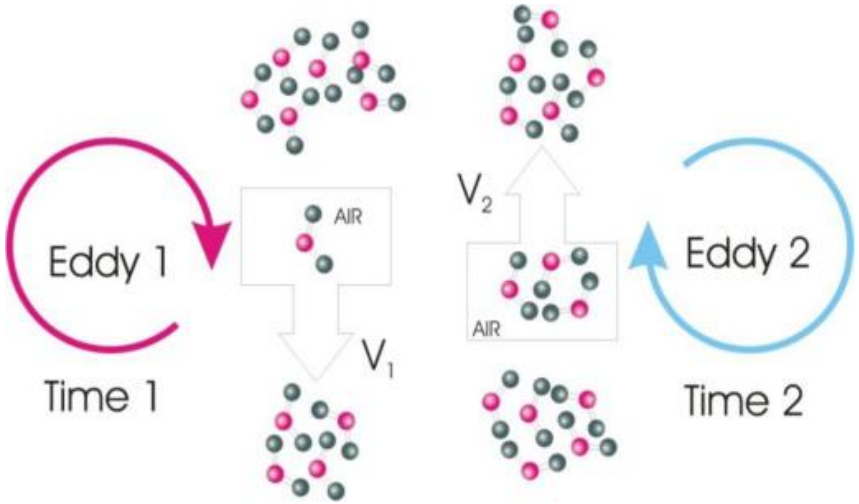
Source: Bonan, 2008. Science

Our evidence helps the government and society make informed decisions about future land management options, to help us reach net zero.



Eddy covariance 101



- Turbulent transport of energy and mass in atmospheric boundary layer
- Direct, continuous observations of ecosystem flux dynamics at c. hectare scale
- Ecosystem processes - underpins land based carbon & greenhouse gas accounting

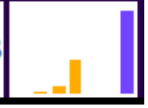
Source: Global CCS Institute

UK Commitment to Net Zero

Table 2
Key metrics for actions in the Balanced Pathway to meet the Sixth Carbon Budget

		2019	2025	2030	2035	2050	Trend
UK greenhouse gas emissions	UK greenhouse gas emissions ($MtCO_2e$)	522	445	316	191	0	
	UK greenhouse gas emissions per person (tCO_2e/capita)	7.8	6.5	4.5	2.7	0	

...

Land	UK woodland area	13%	14%	14%	15%	18%	
	Energy crops (kha)	10	23	115	266	720	
	Peat area restored	25%	36%	47%	58%	79%	
	Land-based carbon sinks ($MtCO_2$)	18	18	20	23	39	
Removals	Greenhouse gas removals ($MtCO_2$)	0	<1	5	23	58	

https://www.theccc.org.uk/publication/sixth-carbon-budget/

Peatlands

- Account for ~12% of land cover in the UK and are the UK's largest terrestrial carbon store
- When degraded, they become a net source of greenhouse gas emissions
- 86% of peatland emissions comes from degraded lowland peat
- UK government dedicated to peat restoration, woodland creation and management
- Legislation to end managed burning on protected blanket bog

UK Net Zero Strategy: Build Back Greener (2021)

Overriding water table control on managed peatland greenhouse gas emissions

C. D. Evans, M. Peacock, A. J. Baird, R. R. E. Artz, A. Burden, N. Callaghan, P. J. Chapman, H. M. Cooper, M. Coyle, E. Craig, A. Cumming, S. Dixon, V. Gauci, R. P. Grayson, C. Helfter, C. M. Heppell, J. Holden, D. L. Jones, J. Kaduk, P. Levy, R. Matthews, N. P. McNamara, T. Misselbrook, S. Oakley, S. E. Page, M. Rayment, L. M. Ridley, K. M. Stanley, J. L. Williamson, F. Worrall & R. Morrison — Show fewer authors

Nature **593**, 548–552 (2021)

"Halving [the mean annual effective water table depth] in all drained agricultural peatlands, for example, could reduce emissions by the equivalent of over 1 per cent of global anthropogenic emissions."

Agriculture

- ~12% of UK net GHG emissions are from Agriculture, Forestry or Other Land Uses (AFOLU)

1% from forestry, peatlands and soils

11% from agriculture

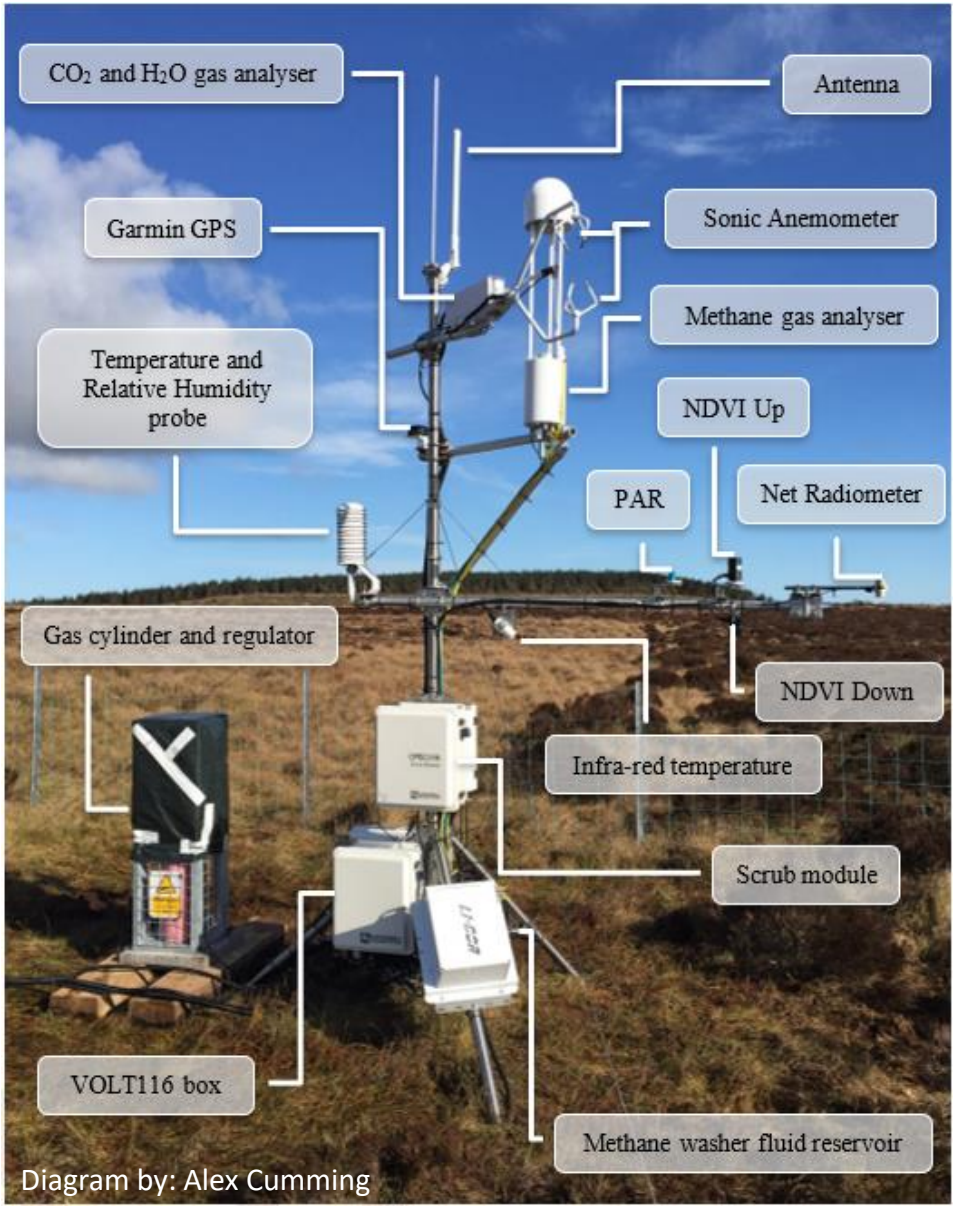
- Potential to use land for multiple new purposes, such as bioenergy
- Land use challenges exacerbated by the impact of climate change on the availability of productive land and water
- Lowland Agriculture Peat Taskforce

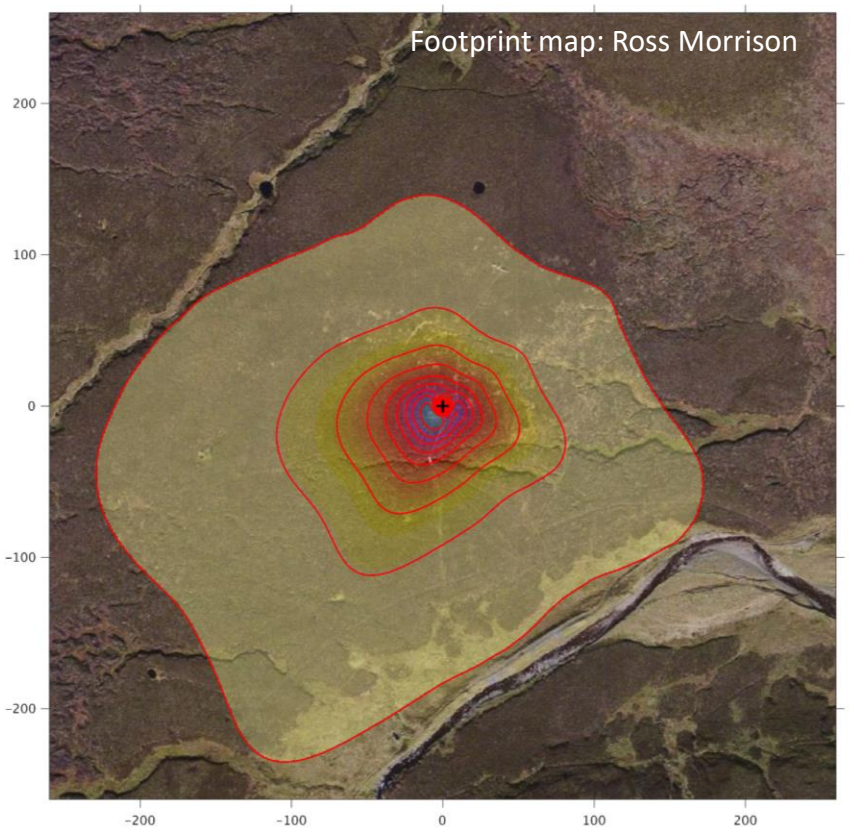
UK Net Zero Strategy: Build Back Greener (2021)

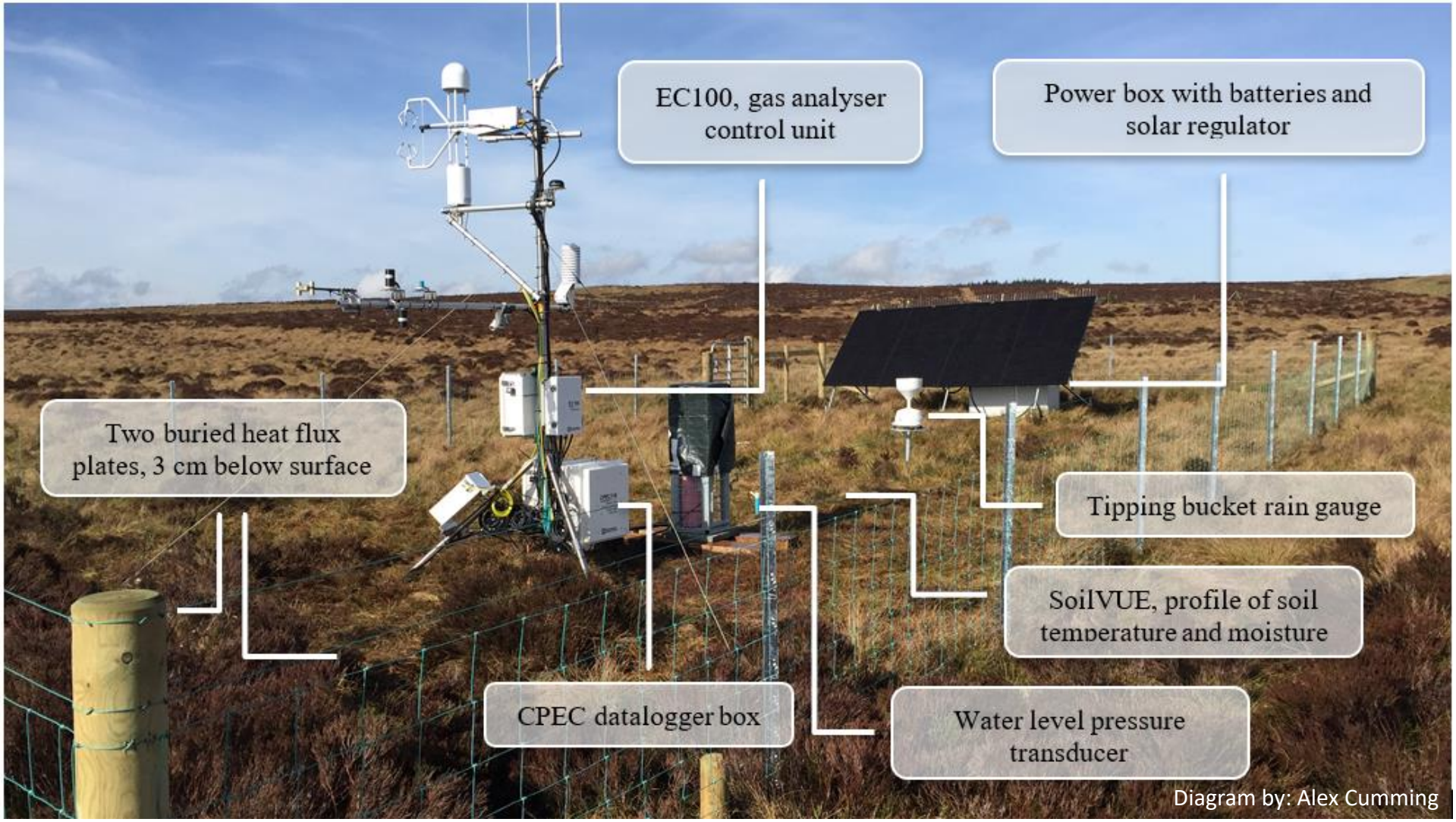
Flux observations in the net zero world

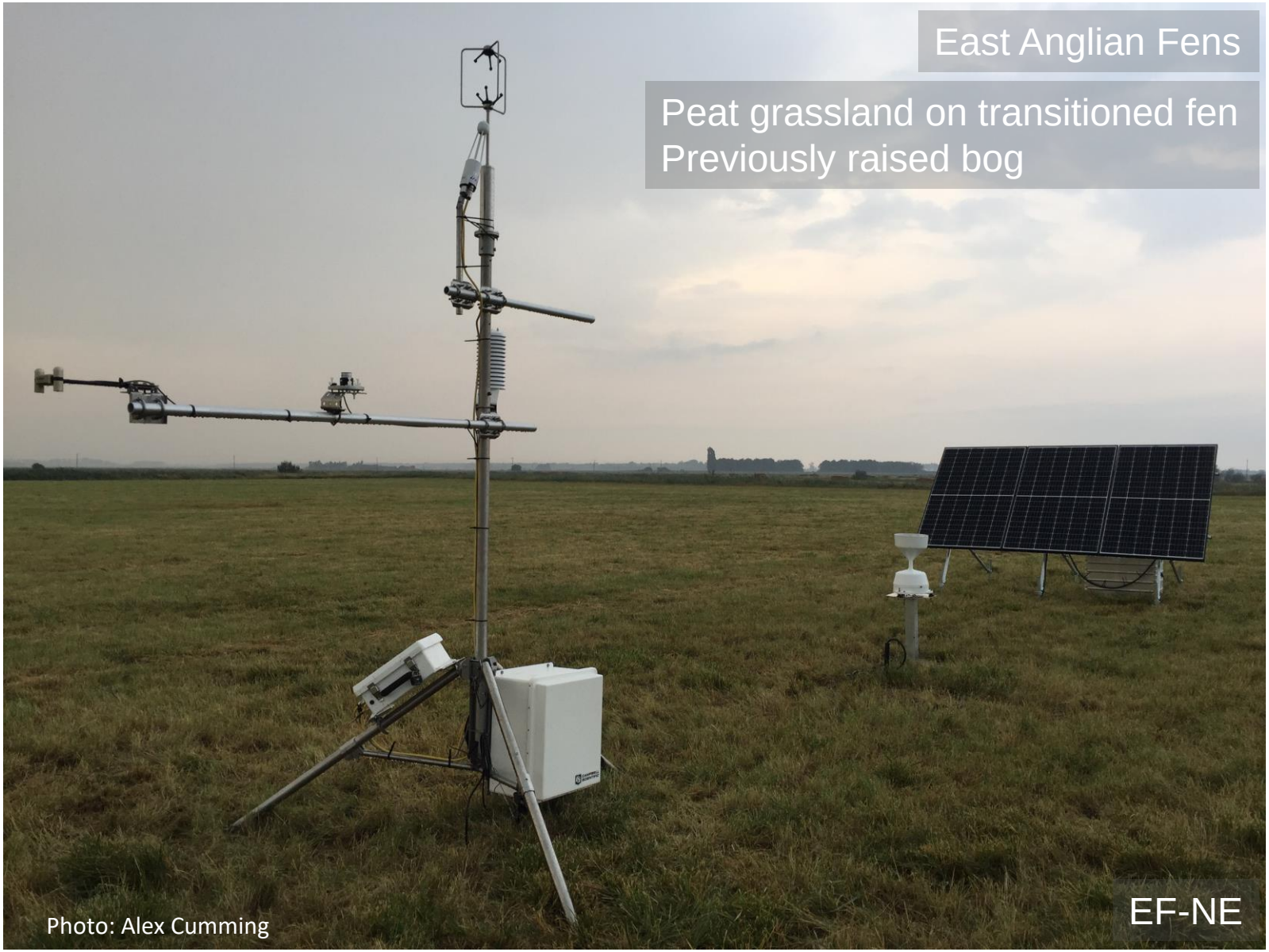
- What is the greenhouse gas balance of the land surface, how is it changing, what are the drivers of change?
- Can ecosystems be managed for enhanced C storage and/or decreased GHG emission? What are the co-benefits and/or trade-offs?
- How will environmental change impact carbon and water dynamics on various temporal scales now and in the future?


Photo: Alex Cumming


CO_2 and H_2O gas analyser
Antenna
Garmin GPS
Sonic Anemometer
Methane gas analyser
Temperature and Relative Humidity probe
NDVI Up
PAR
Net Radiometer
Gas cylinder and regulator
NDVI Down
Infra-red temperature
Scrub module
VOLT116 box
Methane washer fluid reservoir
Diagram by: Alex Cumming

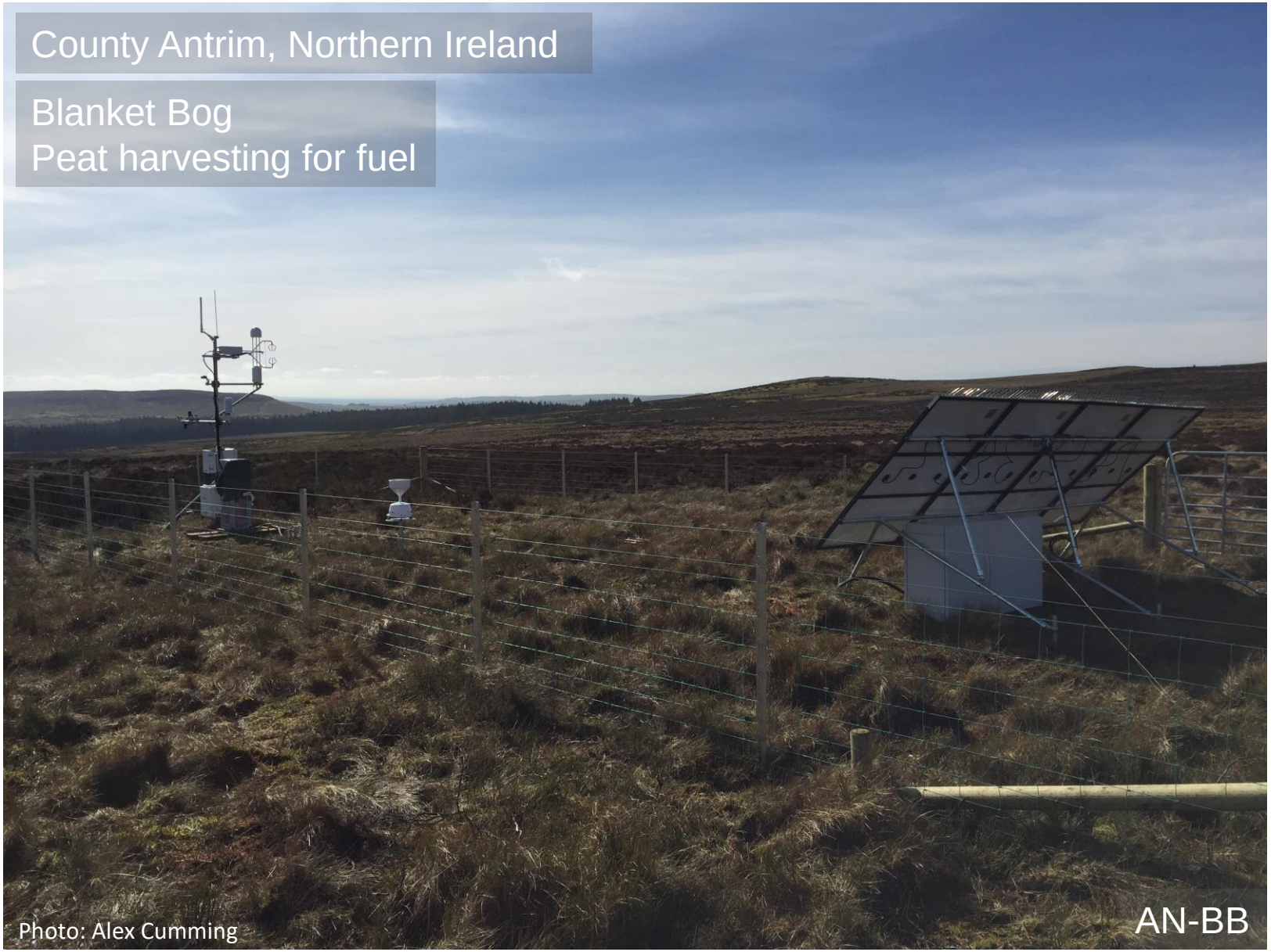

Footprint map: Ross Morrison
200
100
0
-100
-200
-200
-100
0
100
200


EC100, gas analyser control unit
Power box with batteries and solar regulator
Two buried heat flux plates, 3 cm below surface
Tipping bucket rain gauge
SoilVUE, profile of soil temperature and moisture
CPEC datalogger box
Water level pressure transducer
Diagram by: Alex Cumming


East Anglian Fens
Peat grassland on transitioned fen
Previously raised bog
Photo: Alex Cumming
EF-NE


East Anglian Fens
Transitioning to restoration
Photo: Hollie Cooper
EF-RF


Cors Caron, Wales
Lowland raised bog
Restoration
Photo: Jonay Jovani Sancho
WA-RB

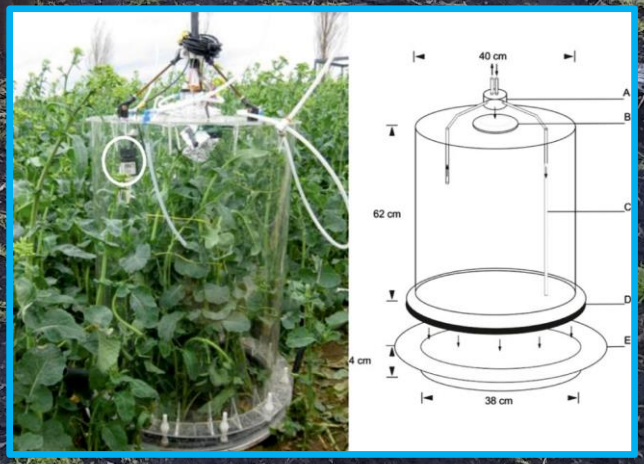

County Antrim, Northern Ireland
Blanket Bog
Peat harvesting for fuel
Photo: Alex Cumming
AN-BB


Lancaster, England
Willow bioenergy with paired system
Photo: Hollie Cooper
LA-WB

Water level experiment

defra
Department for Environment Food and Rural Affairs

CO_2, CH_4, N_2O

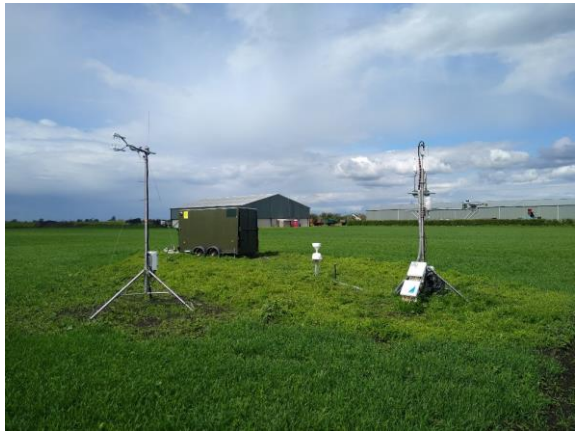


Wet agriculture (‘paludiculture’) trials

- CO_2 & CH_4 balance of Sphagnum moss farming
- Water level manipulation experiment
- Engagement with farming community & The Fens UNESCO Biosphere Vision

BEIS Wasted agricultural peatlands

- GHG emissions (CO_2 & N_2O) from degraded arable peatlands represents a major gap in the UK GHG Inventory
- Mobile flux laboratories
- Aerodyne Quantum Cascade Laser (QCL) + climate control
- Eddy covariance test site with four EC systems

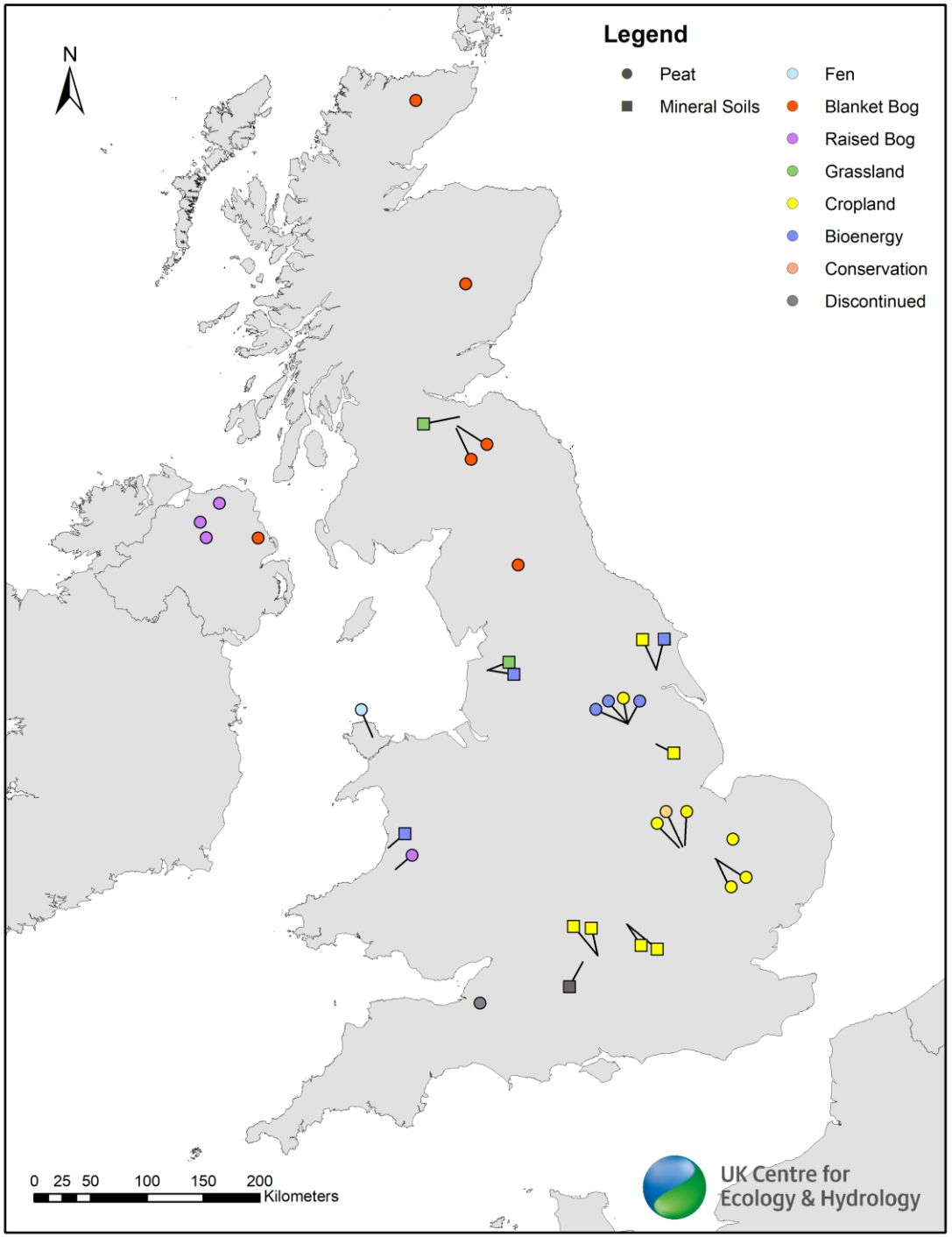


Agricultural control and test systems

- Paired ‘climate-smart’ treatments (cover crops, organic matter, grass strips) versus conventional controls

Summary of UK GHG flux network

- ~30 active eddy covariance (EC) flux sites
- ~35 EC systems (e.g. paired measurements)



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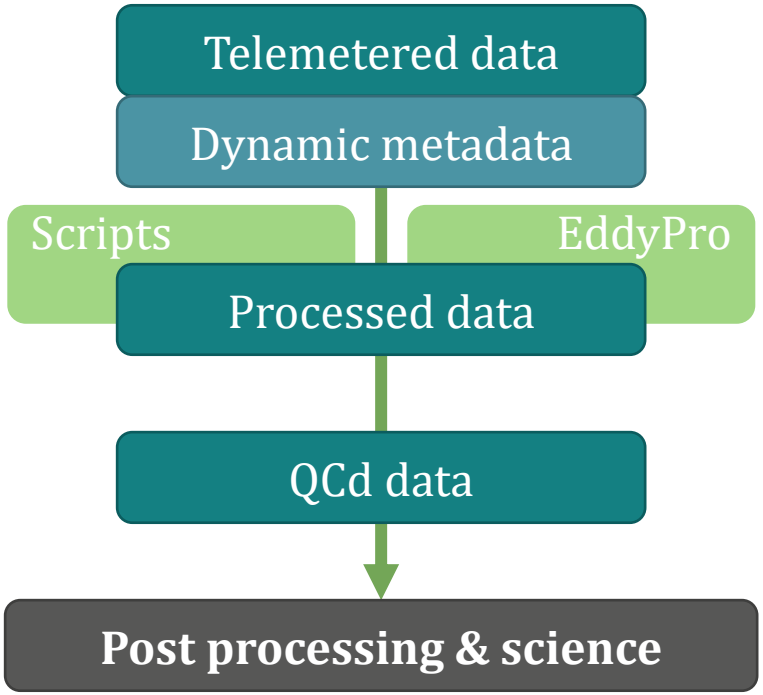
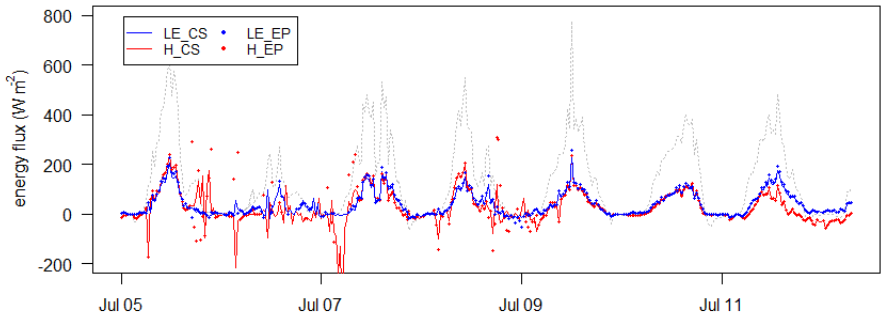
Hollie Cooper

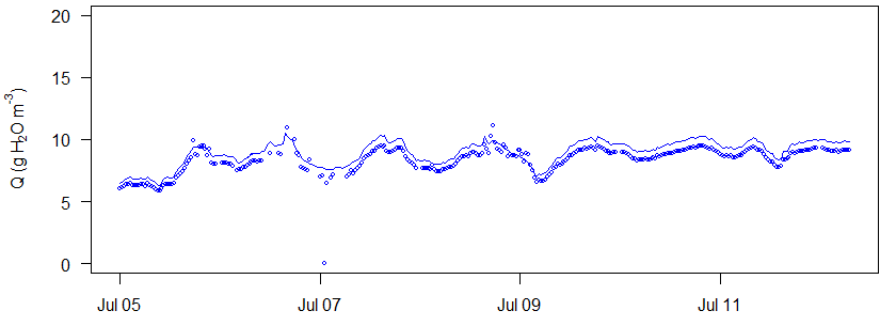
Autonomous observation & data systems

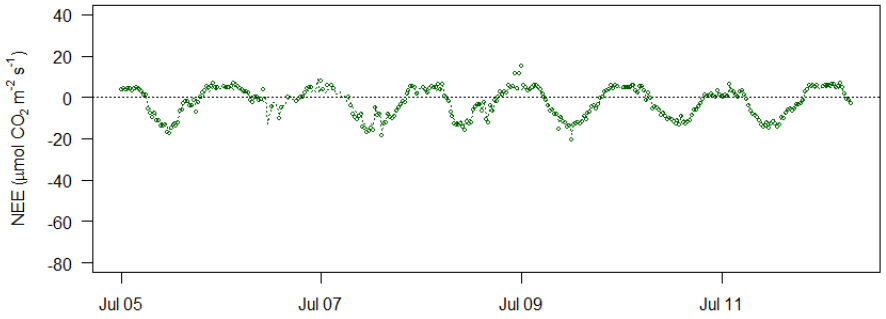
- Data collection from sites across UK
- Automated data processing and quality assurance
- Automated delivery of data and graphs to affiliate site hosts
- Near-real time data for science applications
- More autonomous hardware design means more variables measured and the ability to accommodate more sites

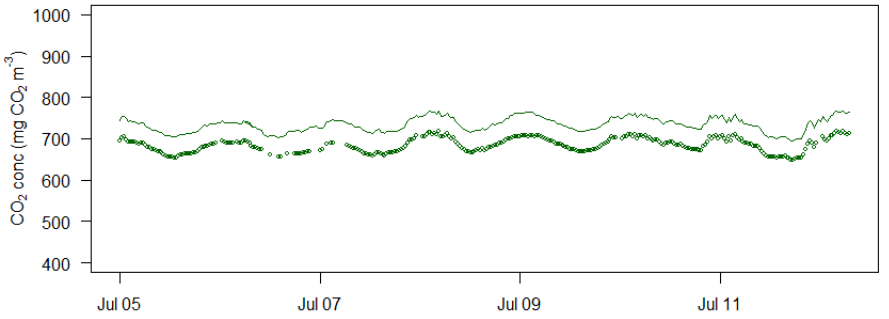


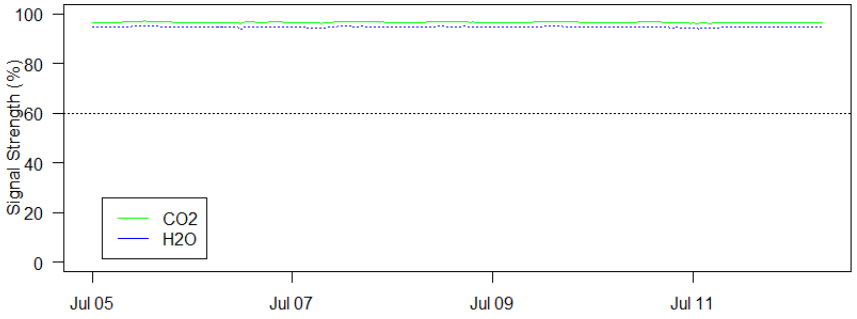
Autonomous observation & data systems





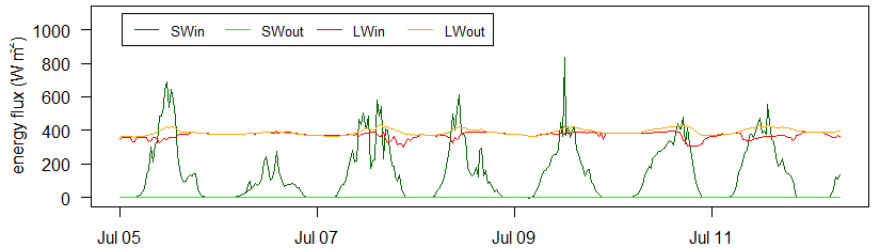


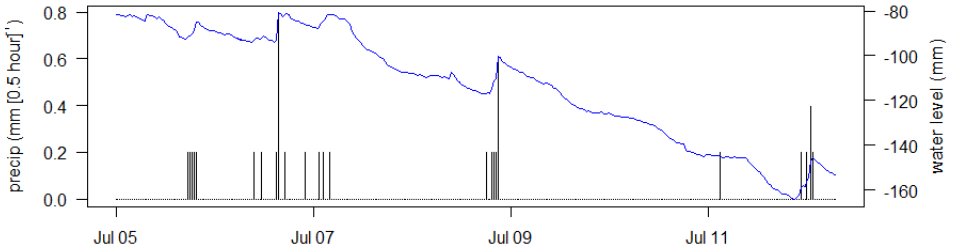


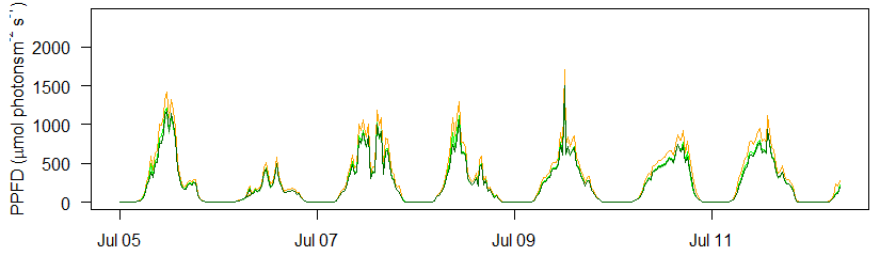


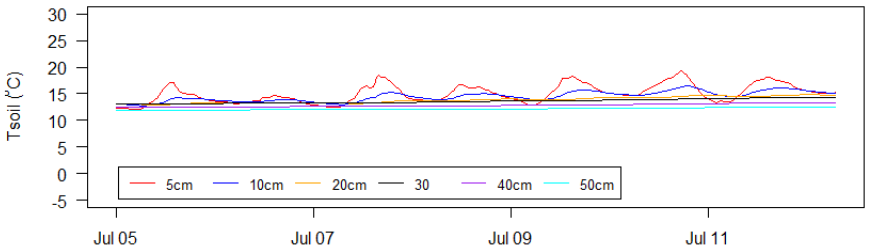
NEE = GPP - TER

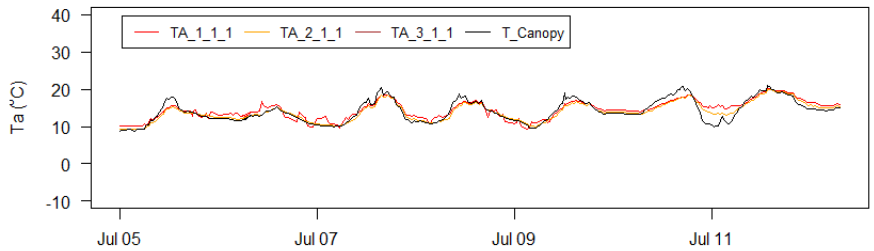
Autonomous observation & data systems

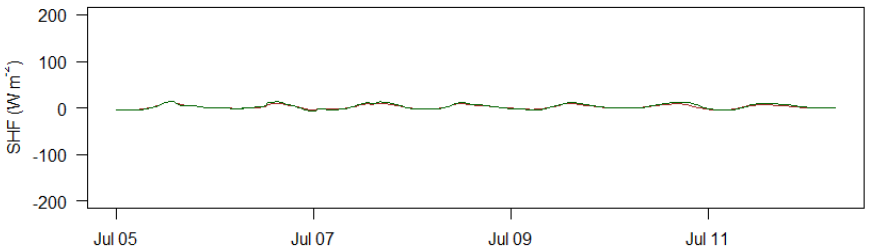


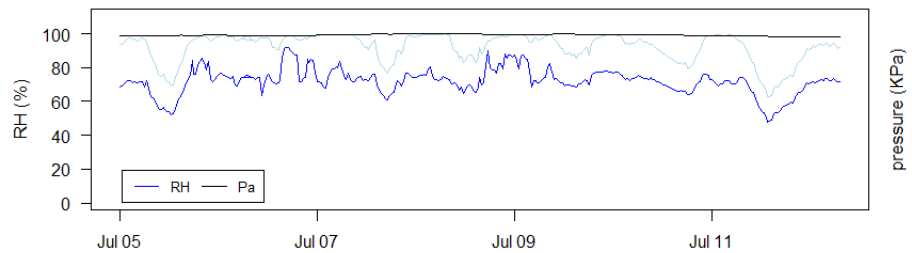


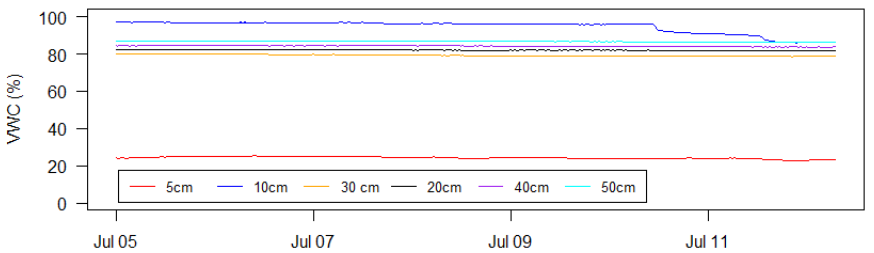




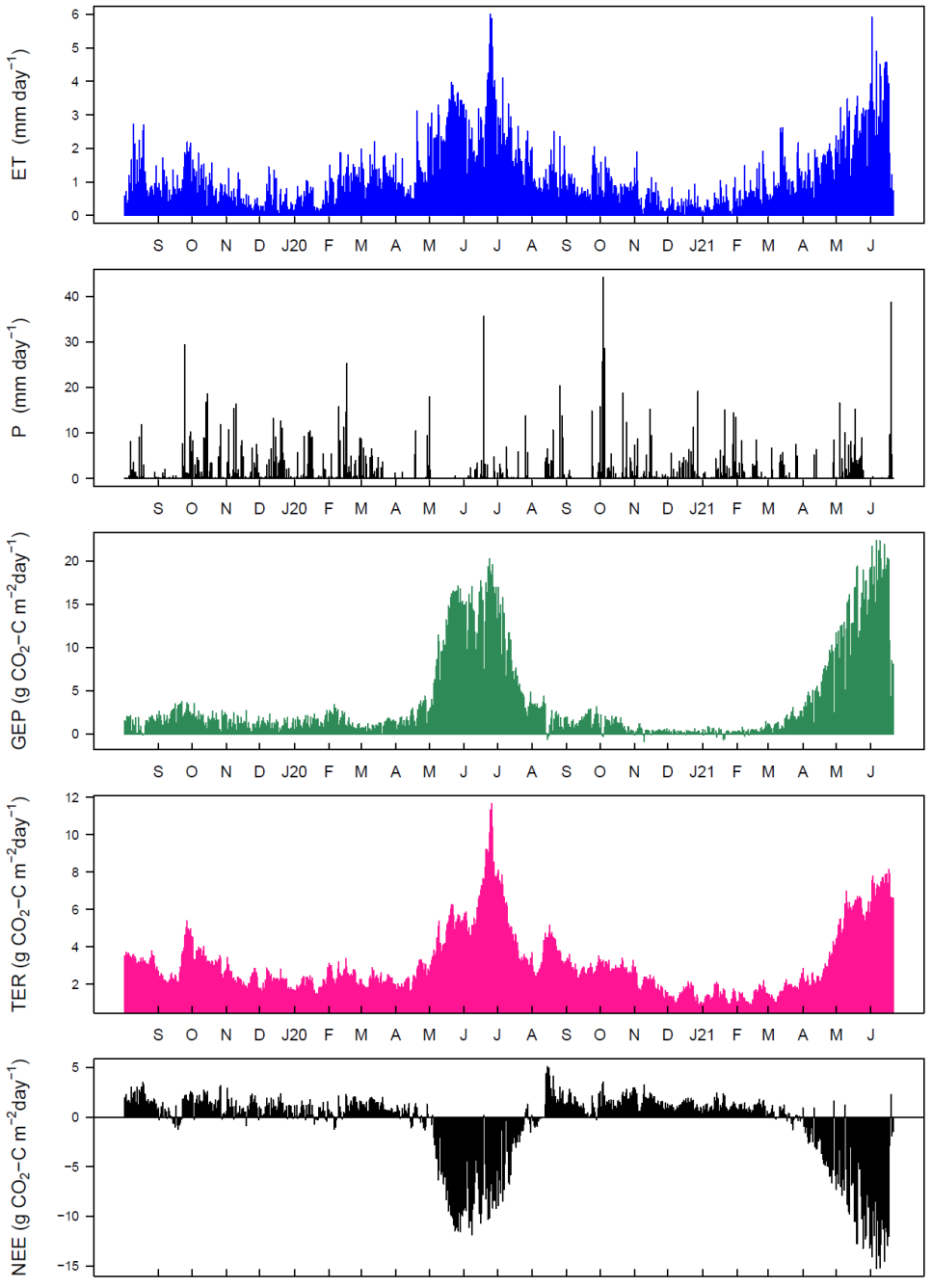




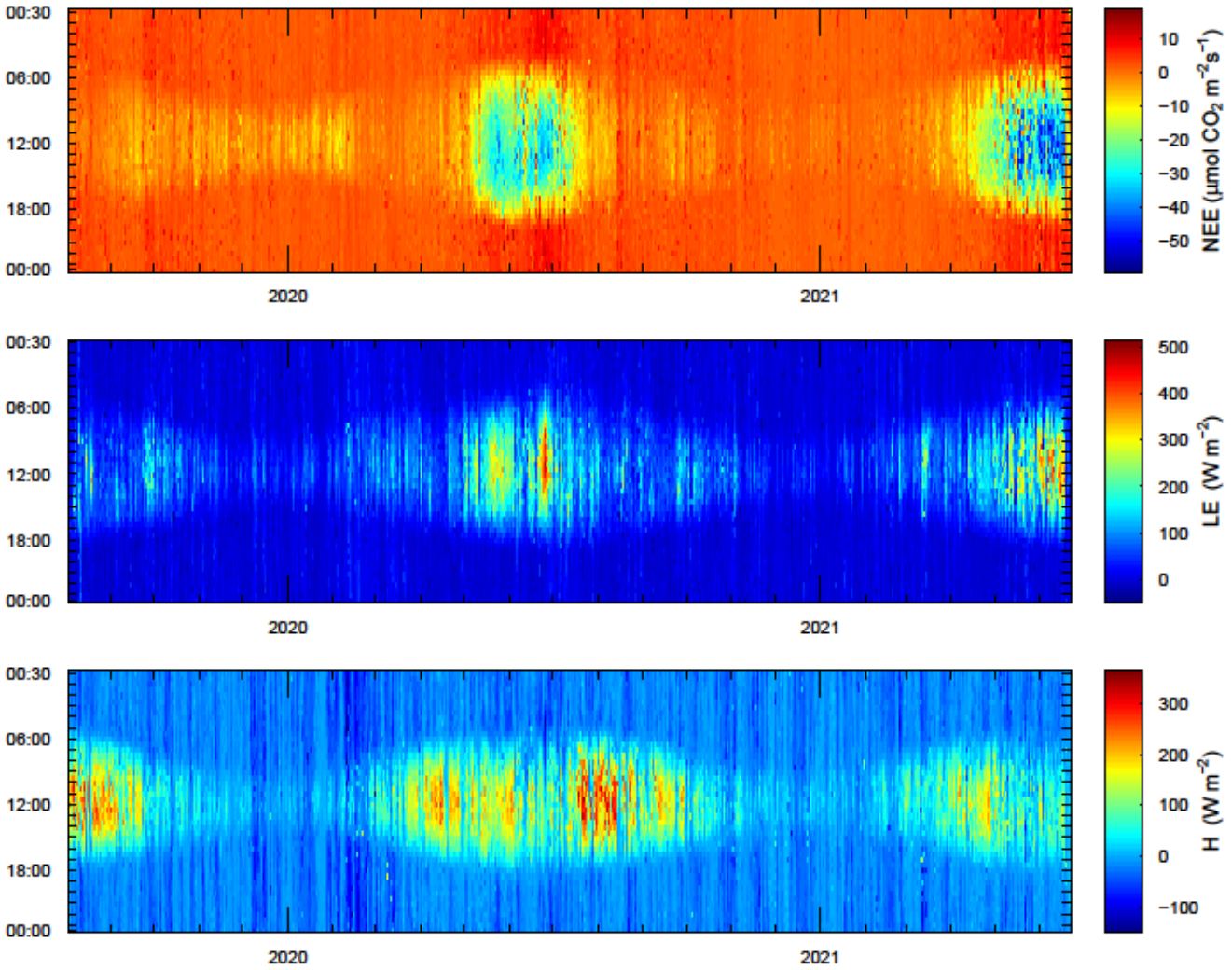




Processed Data

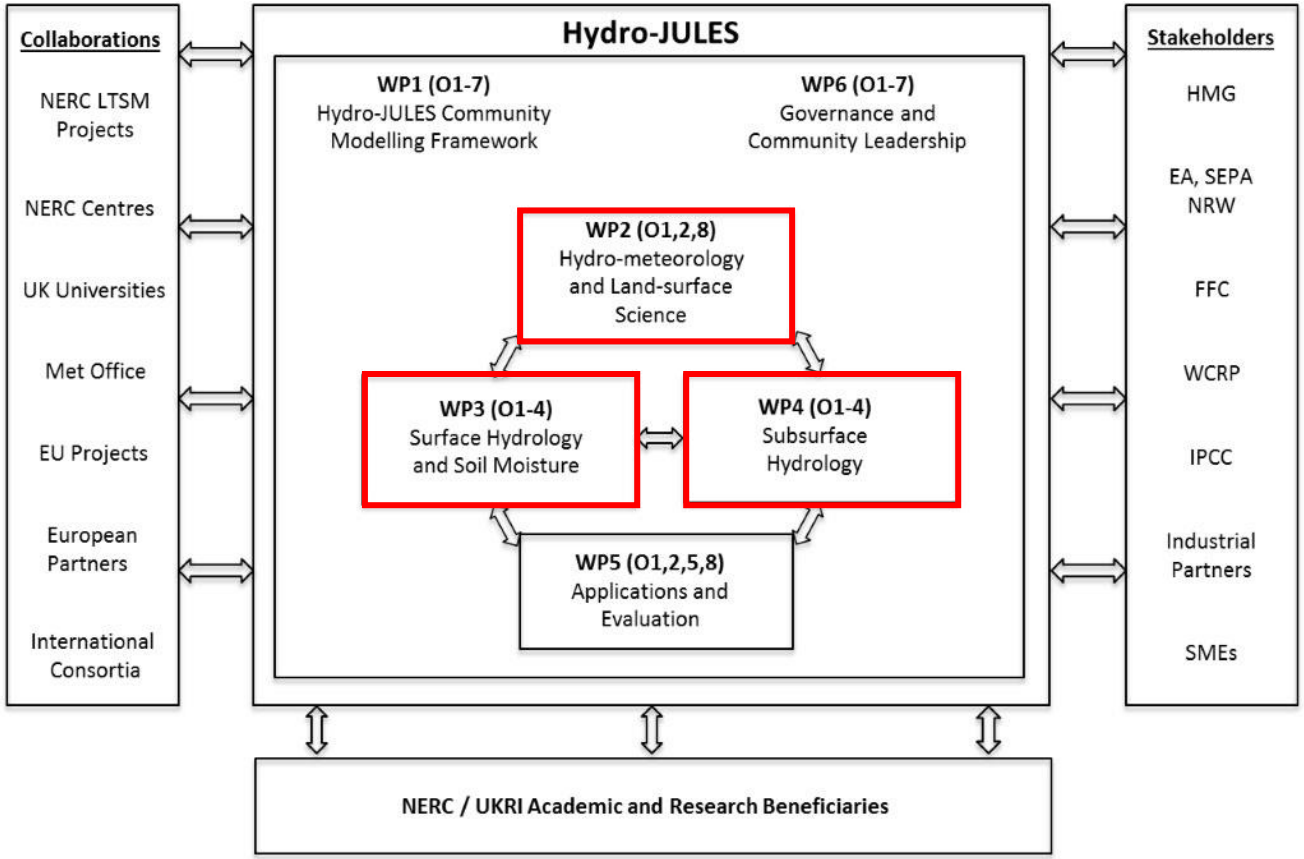


Mass & energy fluxes, CO_2, water, heat



Ross Morrison

Contribution to Hydro-JULES



AGU Advances

Research Article | Open Access

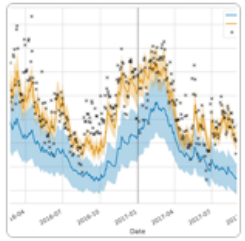
Land-Atmosphere Interactions Exacerbated the Drought and Heatwave Over Northern Europe During Summer 2018

Paul A. Dirmeyer, Gianpaolo Balsamo, Eleanor M. Blyth, Ross Morrison, Hollie M. Cooper

First published: 15 April 2021 | https://doi.org/10.1029/2020AV000283 | Citations: 10

This article is a companion to Orth (2021), https://doi.org/10.1029/2021AV000414.

Improving soil moisture prediction of a high-resolution land surface model by parameterising pedotransfer functions through assimilation of SMAP satellite data



Ewan Pinnington[1], Javier Amezcua[1], Elizabeth Cooper[2], Simon Dadson[2,3], Rich Ellis[2], Jian Peng[5,6], Emma Robinson[2], Ross Morrison[2], Simon Osborne[4], and Tristan Quaife[1]

Contact Us

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GHG Flux Fieldtrip Discussion

- How might you use flux tower data in your work?

- Where would you put an EC system and why?
  - Follow up: What challenges might you encounter when designing your research project?

- What questions do you still have about EC? Micrometeorology? Other?