PROJECT TITLE: Unlocking the scaling puzzle in forest carbon and water fluxes

DTP Research Theme(s): Living World, Changing Planet

Lead Institution: University of Bristol

Lead Supervisor: Associate Professor Martin De Kauwe, Department of Biological Sciences, University of Bristol

Co-Supervisor: Associate Professor Tristan Quaife, Department of Meteorology, University of Reading

Co-Supervisor: Dr Emily Lines, Department of Geography, University of Cambridge

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Project keywords: carbon cycle, leaf-to-canopy scaling, remote sensing, evaporation

Alice Holt flux tower

Eddy covariance instruments on the Alice Holt flux tower

Project Background

The global terrestrial carbon and water cycles are inextricably linked, dominated by leaf-scale processes (*e.g*. photosynthesis and stomatal conductance). Consequently, we construct global vegetation models using leaf-level understanding of plant responses to environmental cues. However, when we evaluate model prediction at ecosystem scales (~km^2), we find critical discrepancies in estimated and observed carbon and water fluxes, signifying an important gap in our understanding of leaf-to-ecosystem scaling. Furthermore, datasets derived at leaf-, canopy- and ecosystem- scales are rarely consistent. Our inability to explain these biases in both models and observations limits our capacity to accurately predict vegetation responses to future climate.

Project Aims and Methods

The student will have the opportunity to develop novel hypotheses to examine why leaf, canopy, and ecosystem-scale fluxes differ. The student will leverage ecosystem modelling alongside a suite of evidence streams including: leaf-level photosynthesis; sap flow (to monitor individual tree water use); cutting-edge canopy solar-induced chlorophyll fluorescence (SIF) measurements (proxy for canopy-scale photosynthetic activity); eddy-covariance; and LiDAR (to quantify canopy structural variability). In particular, the student will deliver new process-orientated insight into how the exchange of carbon and water varies at contracting time scales (*e.g*., seasonal, annual), as well as during summer temperature extremes. This project draws together supervisory expertise that bridges ecophysiology, model-data fusion, vegetation modelling and remote sensing. The PhD will split into achievable milestones, allowing the student to work clearly towards targets (including scientific papers), while still maintaining intellectual freedom to refine project directions. The project will focus on Forest Research's Alice Holt (Hampshire), an 80-year old lowland oak plantation eddy covariance (H_2O/CO_2) flux site.

Candidate requirements

A strong background in biology, mathematics, physics, atmospheric science, engineering or a similar quantitative science are encouraged to apply. Programming experience with C/C++, Fortran 90, Python or R is highly desirable, but not essential. A strong drive to understand the dynamics of plant ecosystems is essential. We welcome and encourage student applications from under-represented groups. We value a diverse research environment.

Project partners

The team at Forest Research have long standing collaborations with the co-supervisors at Reading and Cambridge, including taking novel observations or the forest, and previous CASE PhD support. This project will bring GW4 into that collaboration and pave the way for future research.

The student will also have the opportunity to interact with the Alan Turing Institute (via Co-S Lines), and the EnvSensors project, a cross-institutional project about scaling sensors from ground to satellite using Machine learning. (https://www.turing.ac.uk/research/research-projects/environmental-monitoring-blending-satellite-and-surface-data).

Training

The student will have the opportunity to run and develop their chosen modelling tool (either stand-scale; MAESPA/DART or land surface; JULES/CABLE). They will have the opportunity to do UK-based fieldwork, learning about micrometeorology (eddy covariance) and stand-scale water fluxes (sapflow) and the analysis of eddy covariance data. They will also be exposed to cutting edge remote sensing data (LiDAR, solar-induced chlorophyll fluorescence).

Background reading and references

Medlyn et al. (2017), How do leaf and ecosystem measures of water-use efficiency compare? *New Phytologist*, 216: 758-770

Useful links

http://www.bristol.ac.uk/biology/courses/postgraduate/

NERC GW4+ DTP Website:
For more information about the NERC GW4+ Doctoral Training Partnership please visit
https://www.nercgw4plus.ac.uk

Bristol NERC GW4+ DTP Prospectus:
http://www.bristol.ac.uk/study/postgraduate/2022/doctoral/phd-great-western-four-dtp/

How to apply to the University of Bristol:
http://www.bristol.ac.uk/study/postgraduate/apply/

The application deadline is Monday 10 January at 2359 GMT.
Interviews will take place during the period 23 February – 9 March 2022.

General Enquiries:
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