PROJECT TITLE: Forests on the edge: examining the vegetation's recovery following climate extremes

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: Professor Lina Mercado, Department of Geography, University of Exeter

Co-Supervisor: Dr Eddy Robertson, Met Office

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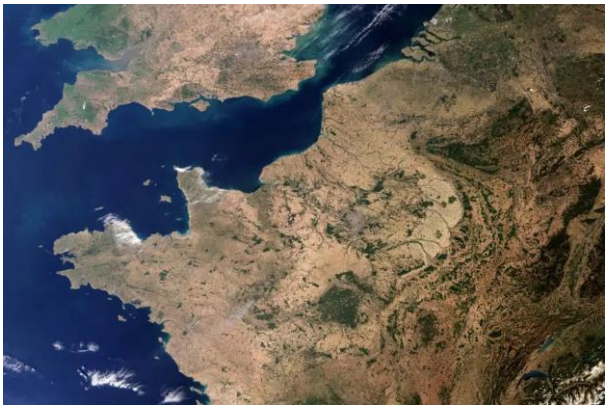
Project keywords: carbon cycle, water cycle, drought, heatwaves, evaporation, photosynthesis, climate change



A satellite image from the summer of 2022 showing the effect of high temperature and drought on Europe. Image credit: European Union, Copernicus Sentinel-3 imagery

Example of extensive canopy die-back during a drought in South-East Australia, 2019. Image credit: Rachael H. Nolan

Project Background

Climate change is rapidly altering the growing conditions of terrestrial ecosystems, with widespread evidence of more frequent, more intense, and longer-duration droughts and heatwaves. Examining the response and recovery of forests to droughts and heatwaves provides valuable insight into the species resilience we may anticipate from climate change. Thus, an improved understanding of the response of trees as conditions become more extreme is fundamental to our capacity to accurately simulate future changes in the carbon/water cycles and predict associated changes in species distributions.

This project will focus on the post-stress recovery dynamics of trees. The student will deliver new process-orientated insight into the mechanism by which trees recover from drought and heat stress. By integrating observations (eddy covariance, experiments, satellite data) with novel model-based hypotheses (*e.g.*, the role of stored carbohydrates, the legacy of hydraulic damage, *etc*) this PhD will ensure that future predictions accurately capture forest responses to changes in temperature, humidity, and water availability.

Project Aims and Methods

The project will focus on developing novel hypotheses that will be embedded into JULES, the UK's community land surface model in the Met Office Unified Model. The project will use the improved model to explore the response of trees to projected future droughts and heatwaves. This project will draw on supervisory expertise that bridges ecophysiology, hydrology, vegetation modelling, and climate science. 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 be based on the development of the JULES model (https://jules.jchmr.org/). JULES has actively developed by a wide community of UK researchers, coordinated by the UK Met Office and UK Centre for Ecology & Hydrology (UKCEH).

Candidate requirements

Candidates with 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 have long-standing and complementary research interests, and both Universities are part of the Met Office's Academic Partnership. The student will have the opportunity to interact with the CASE partner, the UK Met Office (via Dr Roberson) and spend extended periods at the Met Office site in Exeter to network and develop their skillset. The student will also have the opportunity to work alongside research teams working on two recently funded NERC projects on drought (De Kauwe) and temperature extremes (Mercado).

Training

Training and support will be provided by the team throughout the PhD and the student will have the opportunity to develop a wide range of transferable skills including: communication; data analysis; statistical (potentially including machine learning); and programming skills. The student will have the opportunity to run and develop the JULES land surface model; https://jules.jchmr.org/.

Background reading and references

De Kauwe, M.G., Sabot, M.E.B., Medlyn, B.E., Pitman, A.J., Meir, P., Cernusak, L.A., Gallagher, R.V., Ukkola, A.M., Rifai, S.W. and Choat, B. (2022), Towards species-level forecasts of drought-induced tree mortality risk. New Phytol, 235: 94-110. https://doi.org/10.1111/nph.18129

De Kauwe, M.G., Medlyn, B.E. and Tissue, D.T. (2021), To what extent can rising [CO_2] ameliorate plant drought stress?. New Phytol, 231: 2118-2124. https://doi.org/10.1111/nph.17540

Useful links

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

Bristol NERC GW4+ DTP Prospectus:

https://www.bristol.ac.uk/study/postgraduate/research/great-western-four-doctoral-training-partnership-nerc/

How to apply to the University of Bristol:

http://www.bristol.ac.uk/study/postgraduate/apply/

Please note: If you wish to apply for more than one project please contact the Bristol NERC GW4+ DTP Administrator to find out the process for doing this.

The application deadline is Tuesday 9 January 2024 at 2359 GMT. Interviews will take place from 26 February to 8 March 2024.

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

General Enquiries:

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