Scenario DOCTORAL TRAINING PARTNERSHIP

NERC SCIENCE OF THE ENVIRONMENT

# Next-generation representation of plant water stress in land-surface models

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The processes that link the cycles of water and carbon are fundamental, and largely govern the (observed and simulated) dynamics of ecosystems and climate. To a larger extent than in the ocean, terrestrial sources/sinks are regulated by highly variable surface-atmosphere interactions, largely via plant physiology. In this context, soil moisture drought is a key driver, for both mean and extreme response: understanding the extent to which ecosystems can adapt to, else are vulnerable to soil drought is a key requirement for predicting global change impacts, while remaining one of the largest uncertainties in state-of-the-art process models (Peters...Vidale, Verhoef et al., 2018).

**The principal aim** of this project is to develop a new, consistent approach to representing biophysical complexity in land surface models (particularly JULES), with a focus on plant water stress, over multiple time scales (minutes to decades). This will be achieved by exploiting recent theoretical advances relating to optimality concepts and the role of the soil-plant hydraulic continuum (soil- and xylem hydraulic properties) in the context of drought. **The main science question** is whether vegetation will in the future sequester more carbon from the atmosphere, enhancing its use of water, or else downregulate and optimise its use of water.

**By developing and using the JULES model, the student will:**

- Evaluate a range of novel ways to represent plant water stress, using large, diverse sets of surface observations: e.g. leaf trait and gas exchange data, soil moisture, net ecosystem exchange and evapotranspiration at FLUXNET sites.
- Complement these data by Earth Observation time series of e.g. green vegetation cover, sun-induced fluorescence (an indicator of GPP) and land surface temperature (an indicator of evapotranspiration), to allow for up-scaling.
- Conduct model comparisons, verification and sensitivity studies

This project will provide the student both with the opportunity to learn about cutting edge advances in modelling plant physiology and land surface hydrology, and with hands-on experience on pulling these developments through to established modelling infrastructures (e.g. via JULES). The ultimate application will be in weather and climate predictions, which are used for impact studies that inform national to international policies.

**Training opportunities:** the student will have access to Reading and Imperial post-graduate training programmes, as well as NERC-funded advanced courses, e.g. the NCAS Climate Modelling Summer School. The student will also receive bespoke training in land surface modelling, as well as in data and uncertainty analyses. There will be opportunities to undertake placement(s) and additional training at UKMO in Exeter.

**Student profile:** this project would be suitable for students with a degree in physics, mathematics or a closely related environmental or physical science, and should be able to demonstrate experience of scientific programming.

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