Engineering and Innovation Research Studentship 2024/2025

Project title:	**Tree greenhouse gas emissions in response to stress and environmental change**
Discipline	Environmental Science
Key words:	Greenhouse gases, trees, climate
Supervisory team:	Alice Fraser-McDonald, Pinar Karagoz, Stephen Peake
URL for lead supervisor's OU profile	https://www.open.ac.uk/people/afm274

Project Highlights:

- Biogeochemistry project with links to climate change consequences
- Practical project with potential for field and lab-based experiments.
- Impact on current GHG budgets and future emissions predictions.

Overview:

Atmospheric greenhouse gases (GHGs), such as methane (CH_4) and nitrous oxide (N_2O), have the capacity to contribute to the warming of the lower atmosphere and planetary surface. Atmospheric GHG concentrations have increased dramatically since the industrial revolution, causing a significant warming trend in the Earth's climate (IPCC, 2018). It is important to quantify natural and human-induced GHG emissions for the development of climate research and global GHG budgets. The overarching aim of this project is to investigate how GHG emissions from trees are affected by stress and environmental change (Figure 1).

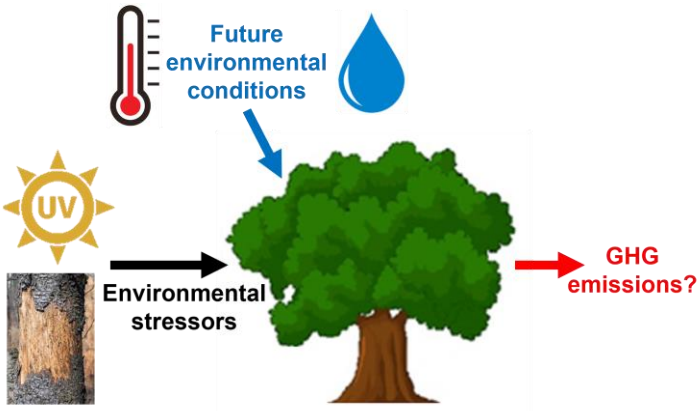

Figure 1. Graphical representation of the scope of the research project.

Plants directly release GHGs under aerobic conditions (Keppler *et al*., 2006), as well as indirectly providing an emission pathway for GHGs produced in anoxic soils (Pangala *et al*., 2015). Aerobic GHG production in plants can be caused by environmental stressors such as UV radiation, temperature, water, and herbivory (Bruhn *et al*., 2009; Gorgolewski *et al*., 2022). Evidence for aerobic methanogenesis caused by environmental stressors is either from laboratory studies rather than *in situ* measurements, or from the foliage and branches of trees rather than stems. This project would involve novel investigations into the effect of environmental stressors on the magnitude of GHG emissions from trees.

Under future climatic and atmospheric conditions, variations in environmental conditions are likely to alter the magnitude of GHG emissions from plants. The average global surface temperature from 2018-2100 is predicted to be higher than the 1850-1900 average by up to 1.8°C under the lowest GHG emissions scenario and up to 5.7°C under the highest emissions scenario. Variables such as temperature and moisture are known to affect GHG production and transport through trees over seasonal timescales (Pangala *et al*., 2015). However, the potential effects of changing environmental conditions due to predicted global warming on plant GHG emissions (from either aerobic or anaerobic GHG sources) have yet to be assessed. During this project, experiments will be developed to determine the expected changes in GHG emissions from plants under future climate and environmental scenarios.

Methodology:

This project would involve fieldwork, including measuring CH_4 and N_2O emissions from tree stems and plants. These measurements would likely be

conducted using a gas sampling method which uses a recirculating closed-loop system between gas flux chambers and a GHG analyser. There may also be the potential to measure larger fluxes using gas sensors affixed to a drone. These techniques can be used to measure GHG fluxes *in situ*.

Laboratory and mesocosm experiments would be developed to investigate how GHG emissions from plants may change under altered environmental conditions. The gas sampling method would be used in a laboratory setting to measure emissions from plants growing in controlled environment units. Data would be scaled up to provide estimates of national and international significance in terms of GHG budgets and a global warming context.

References & Further reading:

Bruhn, D. *et al.* (2009). Effects of temperature, ultraviolet radiation and pectin methyl esterase on aerobic methane release from plant material. *Plant Biology*, vol. 11 (S1), pp. 43-48. DOI: 10.1111/j.1438-8677.2009.00202.x.

Gorgolewski, A. *et al*. (2022). Overlooked sources of methane emissions from trees: Branches and wounds. *Canadian Journal of Forest Research*, vol. 52 (8), pp. DOI: 10.1139/cjfr-2021-028.

Keppler, F. *et al.* (2006). Methane emissions from terrestrial plants under aerobic conditions. *Nature*, vol. 439(12), pp. 187-191. DOI: 10.1038/nature04420.

Pangala, S. R. *et al.* (2015). The contribution of trees to ecosystem methane emissions in a temperate forested wetland. *Global Change Biology*, vol. 21, pp. 2642 - 2654. DOI: 10.1111/gcb.12891.

Further details:

The student should have a strong background and interest in environmental science, or a related scientific discipline. A proven ability to conduct experimental work and carry out statistical analyses would be desirable, but not essential. The successful applicant would work in the Environment and Sustainability team in the School of Engineering and Innovation. Resources available for the project include a portable greenhouse gas analyser and access to controlled environment laboratories. It is envisaged that field work can be carried out relatively locally (in the UK) where required.

For further information, please contact alice.fraser-mcdonald@open.ac.uk.

Applications should include:

- A 1000 word cover letter outlining why the project is of interest to you and how your skills match those required
- an academic CV containing contact details of three academic references
- an Open University application form, downloadable from: http://www.open.ac.uk/postgraduate/research-degrees/how-to-apply/mphil-and-phd-application-process
- IELTS test scores where English is an additional language

Applications should be sent to **STEM-EI-PhD@open.ac.uk** **by 16.02.2024**