PROJECT TITLE: Atmospheric data and machine learning for national emissions evaluation

DTP Research Theme(s): Changing Planet

Lead Institution: University of Bristol

Lead Supervisor: Prof. Matt Rigby, University of Bristol, School of Chemistry

Co-Supervisor: Dr. Pete Levy, Centre for Ecology and Hydrology

Co-Supervisor: Prof. Simon O'Doherty, University of Bristol, School of Chemistry

Project Enquiries: matt.rigby@bristol.ac.uk

Project keywords: greenhouse gas, emissions, carbon dioxide, climate, machine learning

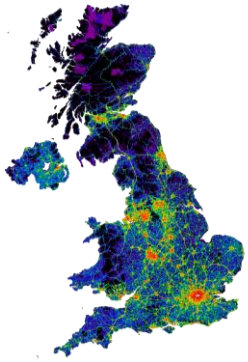

Figure 1: The UK's carbon dioxide emissions inventory.

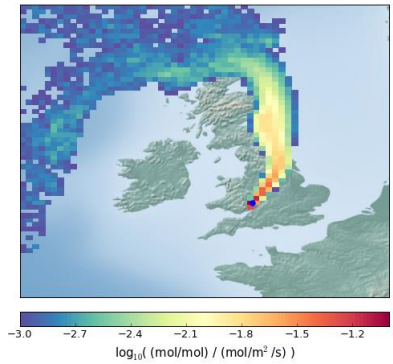

Figure 2: Numerical simulation of the "air history" of a measurement at the Ridge Hill DECC network site (Met Office NAME model).

Project Background

How do we know a country's greenhouse gas (GHG) emissions? According to international treaties such as the United Nations Framework Convention on Climate Change (UNFCCC), the requirement is only that nations estimate and report their own emissions based on economic activity data. However, the UK has pioneered an alternative approach that aims to improve transparency and accuracy: GHG concentrations are measured in the air, and atmospheric models and Bayesian methods are employed to infer emissions from the surrounding regions. The Bristol-led DECC network and DARE-UK project underpin the UK's world-leading "top-down" emissions reporting system. This expertise is now central to the recently announced prototype "operational" UK emissions evaluation system, GEMMA. This project will help develop and use next-generation atmospheric modelling and machine learning tools for estimating national GHG emissions in the UK and around the world.

Project Aims and Methods

Through projects such as DARE-UK and GEMMA, we are developing novel techniques to evaluate a country's greenhouse gas emissions (e.g., Figure 1). These methods have traditionally involved using atmospheric models to simulate the flow of GHGs to ground based GHG measurement sensors (Figure 2). In the last few years, a new generation of in situ remote sensing measurements and GHG satellites have come online. Furthermore, new measurements of co-emitted tracers are becoming available. These systems open the possibility of understanding the UK's emissions at the source-sector level (e.g., Ramsden et al., 2022). However, the challenge now is to develop the modelling tools that can effectively make use of these novel datasets to go beyond evaluating national total emissions. To achieve this, you will need to develop new modelling, machine learning and statistical methods, working closely with ongoing projects funded by NERC, DESNZ and Google. The project can accommodate a range of interests in this field, and we encourage students to contact the supervisory team to discuss options.

Candidate requirements

You must have, or expect a degree in physical sciences, mathematics, or computing. You must have excellent communication and interpersonal skills. If you wish to be involved in making atmospheric measurements, you must have previous laboratory experience. If you are primarily interested in developing modelling approaches, a strong background in Mathematics or computing is essential, but no experience in Chemistry is required. We welcome and encourage student applications from under-represented groups. We value a diverse research environment.

Collaborative partner

The Centre for Ecology and Hydrology are world leading in the estimation of GHG fluxes using measurements and bottom-up (process-based) models. Dr. Pete Levy has over 20 years' experience in the field and leads the UKCEH GHG Flux Network. The student will work with Dr. Levy on interpreting the UK GHG emissions inventory and using atmospheric data to inform sector-level emissions estimates.

Training and external collaboration

You will be trained by Prof. Rigby and ACRG and Met Office staff to use the UK Met Office NAME model. Training will be provided in Bayesian statistics and machine learning by Prof. Rigby and Dr. Levy. If desired, you will be trained in cloud computing and can participate in the OpenGHG initiative. Students will be encouraged to participate in measurement site visits and field campaigns under the supervision of Prof. O'Doherty. You will have the opportunity to present your work at international conferences and collaborate with our extensive network of national and international partners (e.g., through projects such as DARE-UK, AGAGE, ICOS, etc.).

Background reading and references

Ramsden, et al., Atmos. Chem. Phys., 22, 3911–3929, https://doi.org/10.5194/acp-22-3911-2022, 2022.

Rigby, M., et al., *Nature*, 569(7757), 546–550, doi:10.1038/s41586-019-1193-4, 2019.

White, E. D. et al., *Atmos. Chem. Phys.*, 19(7), 4345–4365, doi:10.5194/acp-19-4345-2019, 2019.

Useful links

https://www.bristol.ac.uk/chemistry/postgraduate/
https://www.bristol.ac.uk/chemistry/research/acrg/
https://openghg.org

Bristol NERC GW4+ DTP Prospectus:
http://www.bristol.ac.uk/study/postgraduate/2024/sci/phd-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: Bristol NERC GW4+ DTP Administrator
Email: bristol-nercgw4plusdtp-admin@bristol.ac.uk