Developing high precision D/H measurements in ambient atmospheric CH$_4$ for understanding the global methane problem

Supervisors: Dr Rebecca Fisher, Dr James France, Dr Tim Arnold (NPL) & Dr Dave Lowry

Project Description:

Scientific background

Methane concentrations in the atmosphere are rising, and the reasons are not well understood – is it because of rising fossil fuel emissions, shale gas development, agriculture, waste, or climate feedbacks causing increasing natural wetland emissions?

The stable isotopic composition of methane ($^{13}$C/$^{12}$C and D/H ratios) can help us to constrain the distribution of sources emitting methane to the atmosphere. This is because different sources have very specific isotopic signatures. The ability to isotopically fingerprint a methane source from samples taken at some distance from the emission location is thus an important tool for pin-pointing where the methane is coming from.

RHUL has long multi-site records of δ$^{13}$C in methane and is now embarking on an exciting new approach – to develop measurement of D/H in methane. To succeed, the database of D/H signatures for methane sources, which currently has many gaps, will need to be filled. We also anticipate improving the coverage of measurements, particularly from latitudinal (pole to pole) gradients of methane and its isotopologues, to help constrain the global distribution of sources.

Targets to reduce methane emissions can be more successfully achieved if we have greater understanding of the global distribution of emissions – these reductions are essential to meet net-zero carbon emissions and for the 2015 Paris Agreement to succeed.

Research methodology

The PhD student will continue the development of the D/H trace gas measurement system at Royal Holloway with co-supervision from the National Physical Laboratory (Dr Tim Arnold). The student will make and interpret measurements of methane and other greenhouse gases from air samples sent to RHUL from different latitudes around the Atlantic Ocean region, such as Spitsbergen, Ascension Island, Falkland Islands and Halley Bay, Antarctica. Fieldwork of opportunity will be offered to collect whole air samples (utilising our strong links with the British Antarctic Survey, University of New South Wales, Facility for Airborne Atmospheric Measurement and others) to better characterise the isotopic signature of major sources, e.g. wetland, fire, fossil fuel, waste and agriculture.

Sampling collection methodologies will range from long-term continuous measurements, mobile sampling (using the new RHUL mobile laboratory and potentially aircraft campaigns) and targeted source sampling campaigns. Isotopic ratios of methane in air samples will be measured by isotope ratio mass spectrometry (IRMS).

Measured signatures will be compared with that expected from inventories. The work will be developed into a D/H signature database (along with the limited existing literature) to allow a first attempt at a global D/H - δ$^{13}$C – CH$_4$ model in collaboration with partners at Cambridge University.
Training

Training in field sampling, greenhouse gas analysis, stable isotope analysis, GIS and data interpretation will be given at RHUL. The student will also gain experience in laboratories at NPL and experience in fieldwork planning and execution. Work with Cambridge will develop the coding and numerical modelling skills. The student will be expected to participate in group meetings for ongoing synergistic projects of the greenhouse gas research group and present findings at international conferences.

Person specification

A good science or engineering degree (or expected), preferably with some knowledge of atmospheric science, coding and laboratory experience. A willingness to travel would be beneficial.

Deadline for applications

Applications for this PhD need to be with Rebecca Fisher by Friday 20th March 2020. Please apply through: http://bit.ly/2EBdFqs and cite “College funded Phd-Studentship - Earth Sciences” as the source of funding. Interviews for college funded PhD studentships in Earth Sciences will be held Friday 3rd April.

References:


Please contact the lead supervisor directly for further details