Proposed Studentship

Identifying best practice methodology for location, characterisation and emission estimation of methane fluxes using a range of ground-based mobile measurement instrumentation.

Supervisors: Dr Dave Lowry, Dr James France, Dr Rebecca Fisher

Scientific background

The race toward net zero is hampered by poor understanding of many greenhouse gas sources and their emissions, and how to scale these up spatially and temporally from flux calculations. To mitigate emissions, it is crucial to locate and characterise emissions. Currently, much of the assessment of CH_4 from sources in the UK (and other nations) is based on "desk-study" inventories, which are often determined from emission factors, simple models, or self-reporting. Much regulation and policy rely on inventories, but these inventories lack the direct measurement required to fully understand the real spatial or temporal distribution of emissions. Measurements have traditionally taken place at known sources or at fixed continuous measurement sites, but the introduction on laser-based spectroscopy has in the last decade been used more and more for mobile measurements on a wide range of platforms from aircraft to vehicles, allowing targeted measurement of expected emission sites. However, the use of instruments with varying capabilities, differing measurement protocols and data processing methods can lead to widely varying emissions estimates for the same source. Building confidence in emissions estimates derived from direct measurements requires definition of the best practice protocols under a range of scenarios with different instruments.

Research methodology

The RHUL GHG group has a state-ot-the-art mobile measurement facility (MIGGAS). It has 4 vehicle-mounted and portable laser spectrometer systems with GPS for location and sonic anemometer for wind data. These measure CH_4, CO_2 and C_2H_6 emissions and ^{13}C-isotopic signatures of CH_4 across different landscapes that consist of a range of source types from ground area sources such as landfill sites and pastureland ruminants, to elevated point sources, such as vents, pipes and chimneys. Instruments have different response rates and cell sizes that result in different emission peak shapes, heights and widths, with measurement frequencies varying between 0.1 and 3 seconds and response times from 1 second to 1 minute. These peak responses are further exacerbated by vehicle and wind speeds, and the characteristics of the atmospheric boundary layer.

A range of different identified methane sources in southern England, both as isolated emissions and as complex overlapping plumes, will be chosen for detailed survey using 4 different instruments, all capable of CH_4 measurement. Emissions will be measured on multiple occasions under differing meteorology and seasonality using a range of measurement protocols. Large harmonised datasets will be compiled to assess consistency of measurements and to develop a "best practice toolkit" for calculation of emission rates from mobile greenhouse gas measurements. The work will also investigate the usefulness of additional proxies, such as C-isotopic measurement, ethane:methane and CO_2:methane ratios in the characterisation of source types. Isotope ratio mass spectrometry will be used to measure $\delta^{13}C$ in samples for comparison with mobile data. More information on the techniques employed by the RHUL greenhouse gas laboratory can be found at: https://www.royalholloway.ac.uk/research-and-teaching/departments-and-schools/earth-sciences/research/research-laboratories/greenhouse-gas-laboratory/).

Training

Training will be provided in project planning, field sampling, greenhouse gas and stable isotope analysis, data interpretation, statistical and spatial analysis and modelling. The student will attend synergistic project meetings, help formulate research strategies, present / publish their findings. The student will be encouraged to develop software for in-survey data processing for near instantaneous source type characterisation.

Person specification

Applicants should have an appropriate highly numerate science degree, including mathematics, computer science, biology, chemistry, physics, geoscience, environmental science, but ideally should have some field and laboratory experience. A valid UK driving licence is desirable.

References:

Bakkaloglu, S., Lowry, D., Fisher, R., France, J., Brunner, D., Chen, H. & Nisbet, E., (2021), Quantification of methane emissions from UK biogas plants, Waste Management, 124, 82–93, https://doi.org/10.1016/j.wasman.2021.01.011

France, J. L., Bateson, P., Dominutti, P., Allen, G., Andrews, S., Bauguitte, S., Coleman, M., Lachlan-Cope, T., Fisher, R. E., Huang, L., Jones, A. E., Lee, J., Lowry, D., Pitt, J., Purvis, R., Pyle, J., Shaw, J., Warwick, N., Weiss, A., Wilde, S., Witherstone, J. & Young, S., (2021), Facility level measurement of offshore oil and gas installations from a medium-sized airborne platform: method development for quantification and source identification of methane emissions, Atmos. Meas. Tech., 14, 71–88. https://doi.org/10.5194/amt-14-71-2021.

Lowry, D., Fisher, R. E., France, J. L., Coleman, M., Lanoisellé, M., Zazzeri, G., Nisbet, E. G., Shaw, J. T., Allen, G., Pitt, J. & Ward, R. S., (2020), Environmental baseline monitoring for shale gas development in the UK: Identification and geochemical characterisation of local source emissions of methane to atmosphere, Science of the Total Environment 708, 134600 https://doi.org/10.1016/j.scitotenv.2019.134600.

Nisbet, E., Fisher, R., Lowry, D., France, J., Allen, G., Bakkaloglu, S., Broderick, T. J., Cain, M., Coleman, M., Fernandez, J., Forster, G., Griffiths, P. T., Iverach, C. P., Kelly, B. F. J., Manning, M. R., Nisbet-Jones, P., Pyle, J. A., Townsend-Small, A., al-Shalaan, A., Warwick, N., Zazzeri, G., (2020). Methane mitigation: methods to reduce emissions, on the path to the Paris agreement. *Reviews of Geophysics,* 58, e2019RG000675. https://doi.org/10.1029/2019RG000675.

Nisbet, E.G., Manning, M.R., Dlugokencky, E.J., Fisher, R.F., Lowry, D. & 18 others (2019), Very strong atmospheric methane growth in the 4 years 2014–2017: Implications for the Paris Agreement. Global Biogeochemical Cycles, 33, 318–342. https://doi.org/10.1029/2018GB006009

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