Estimating and attributing regional methane emissions using innovative atmospheric measurements

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Methane (CH$_4$) is the second most important greenhouse gas contributing to climate change, and emissions of CH$_4$ also contribute to air pollution. Reduction of CH$_4$ emissions comprised a substantial part of the overall greenhouse gas mitigation achieved over 2008-12 by the UK as part of the 2008 Climate Change Act, and CH$_4$ emissions mitigation is likely to play a significant role in various policies responding to the 2015 Paris Agreement of the UN Framework Convention on Climate Change.

The primary anthropogenic sources of CH$_4$ are from the agricultural and fossil fuel industries, whilst natural emissions from wetlands are also a large source of CH$_4$. Other sources include landfills, wastewater, and biomass burning. Identifying the contributions of different CH$_4$ source types is essential for evaluating anthropogenic CH$_4$ emissions and validating mitigation policies, as well as for understanding the response of wetland ecosystems to climate change.

New atmospheric observations of CH$_4$ and the isotopic composition of CH$_4$ are being developed at Imperial and NPL/Edinburgh in order to better quantify and separate different sources of CH$_4$. This student project will develop links between the two groups and investigate how different types of measurements can be combined to help define regional sources of CH$_4$ in the UK. The student will be involved with measurement development, fieldwork, and data analysis including atmospheric modelling. The student will be part of ongoing projects at Imperial and NPL, including an ERC Starting Grant project.

This project will advance the use of stable isotopes and radiocarbon (14C) in atmospheric CH$_4$ to distinguish CH$_4$ emissions. Since fossil-derived carbon has lost all its 14C over millions of years of radioactive decay, fossil fuel-related emissions have a distinct signature in 14C measurements. Different types of emissions also vary in

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their stable isotopic composition, for example CH$_4$ emitted by biomass burning is more enriched in carbon-13 than CH$_4$ emitted from the natural gas industry. The use of 14C together with stable isotopic tracers to identify regional CH$_4$ sources is an innovative and potentially powerful technique, but more observations and the development of modelling frameworks to exploit the observations are needed.

The student will participate in atmospheric measurements conducted in the UK and perform atmospheric model simulations using the Met Office Numerical Atmospheric-dispersion Modelling Environment (NAME). Using the atmospheric model, the student will simulate the atmospheric CH$_4$ concentration and isotopic composition over the UK for different emission scenarios. The simulations will help to evaluate the constraints on methane sources that could be provided by the new isotopic data for different observational networks in the UK. Emission scenarios and sensitivity studies will focus on specific CH$_4$ mitigation measures from the UK Committee on Climate Change and the Coupled Model Intercomparison Project (CMIP5 and CMIP6).