How can we reduce the numbers of people exposed to particulate matter in the UK?
PhD project for the PANORAMA DTP to be hosted at the Wolfson Atmospheric Chemistry Laboratories of the University of York, supervised by Profs. Evans and Lewis.

Background

Air quality in the UK has received increasing attention over the last decade. The government is drafting a new air quality strategy (https://goo.gl/rfSqGc). This challenges the UK to improve its air quality over the next 25 years. One of the most difficult aspects of this new strategy is a policy is to half the number of people living in areas with an annual average atmospheric concentration of small particles of greater than 10 micrograms per cubic meter, the World Health Organization's (WHO) air quality standard. One key question here is how much of this concentration can be controlled by regulation of industry, transport, domestic activates and agriculture; how much is transported in from Europe and the rest of the world; how much is from natural sources (such as sea salt or from trees and soils)? This project will use computer model of atmospheric chemistry and transport together with observations from the ground and from space to try to understand this and other questions relating to UK air quality.

Project

You will use the internationally recognized open-source GEOS-Chem computer transport model in its global, regional, adjoint and forecast modes to understand UK air quality (www.geos-chem.org). The model is used and supported by a large number of people around the world and acts as the chemistry component of NASA's GEOS atmospheric system. You combine the model output with local observations from the new UK air quality supersites in London, Manchester and Birmingham (https://nerc.ukri.org/press/releases/2018/02-air/); with the DEFRA air quality monitoring network (https://uk-air.defra.gov.uk); satellite data notably from the new TropOMI instrument (http://www.tropomi.eu/). This will allow an evaluation of model performance for a number of key air quality species. This aspect of the work is designed to find flaws with the emissions or processes in the model and to produce an evaluation suit for the model over UK. Improvements in the model will flow into the NASA air quality forecasting framework. Machine learning techniques current in development by the Atmospheric Chemistry Model Group could be used to enhance this area of research.

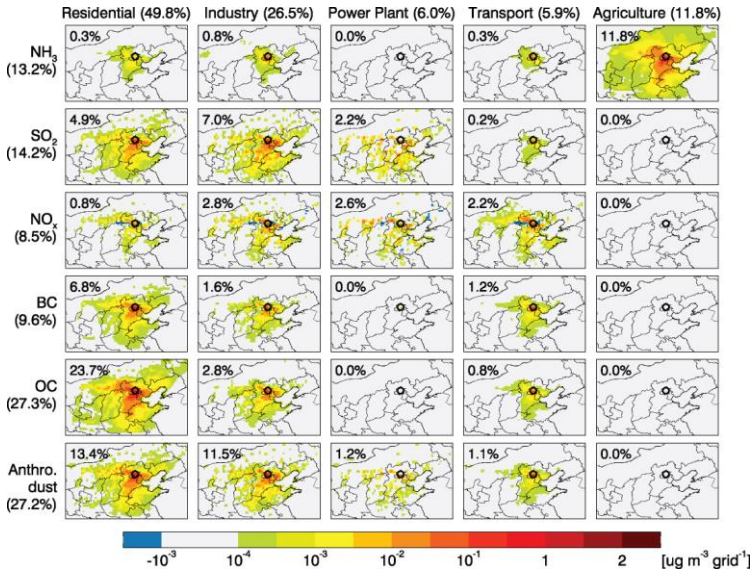

Figure taken from Zhang et al., Source attribution of particulate matter pollution over North China with the adjoint method, 2015. This shows the different contributions to the different types of particulate matter found over Beijing from different sources. This project would aim to reproduce these kinds of figures for key cities in the UK.

Once we are happy that the model emissions are suitable, we will turn our attention to evaluating the sources of particles and gases in the model. To do this we will use the adjoint of the GEOS-Chem model which allows us to unpick the different sources (transport, industry, domestic, natural, European etc) contributing to the particulate matter over the UK. We will do this in conjunction with Prof Daven Henze at the University of Colorado who leads the global development of the GEOS-Chem adjoint. A visit to the University of Colorado will allow the student to gain familiarity with working with the model adjoint. The key questions here will be how much of the pollution over the UK can be reduced by different strategies and how much forms part of the background (whether natural or from emissions sourced from outside of the UK) and so whether it would be possible to implement policies to half the number of people living in areas in violation of the WHO standard.

Training.

The student will be based within the Atmospheric Chemistry Modelling team at the University of York's Wolfson Atmospheric Chemistry Laboratories (WACL) and would work with Prof Mat Evans and Prof Ally Lewis. They would benefit from the training in both specific technical and in transferable skills provided by the PANORAMA DTP and that offered by the University of York's Chemistry Department. They would be expected to spend some time at the University of Colorado, Boulder with the project partner Prof. Daven Henze.

Skills

The student will use the GEOS-Chem model for the project. This will be run on the University of York's new £2.5M computer cluster. Suitable students could come from a variety of backgrounds. The student will need to use FORTRAN and Python for developing, running and evaluating the model. Thus, a knowledge of scientific programming would be a benefit but not necessary for the project – training is provided by the university, and in house at WACL. Similarly, some understanding of atmospheric chemistry would be a benefit but not necessary for the project. Suitable candidates could range from a chemist with an interest in computational science to a physicist with an interest in environmental issues.

Informal inquires to Mat Evans (mat.evans@york.ac.uk).