The influence of large-scale circulation on the dispersal of gases from Northern Hemisphere Sea Oil and Gas platforms

Background

The impacts of climate change are occurring faster and more strongly than originally thought, the sea levels are rising, the world is warming while our atmosphere is more polluted than ever. As climate change will alter local meteorological conditions the dispersion mechanisms, as well as trajectories, of essential air pollutants need better understanding. Although is expected that global emissions of atmospheric anthropogenic gases will decrease strongly throughout the remainder of the 21st century such pollutants will cause unintended climate consequences with potential impacts on atmospheric circulation (McGregor et al. 1995, Webber 2017 PhD Thesis). In particular, there is a lot of uncertainty regarding both the quantification of emission (e.g. CO2, CH4 and NOx) emitted during the extraction and burning of fossil fuels, in addition to their remote impacts via atmospheric transport away from the source.

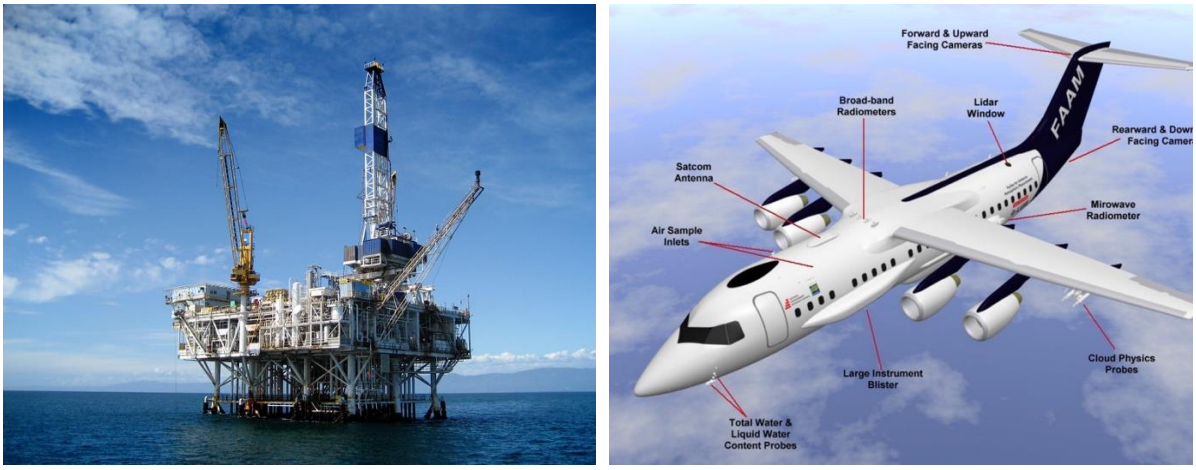

Figure 1. Offshore Oil Platform (left) and FAAM aircraft and the instrumental design on the aircraft (right).

Aim

The aim of this project is to use data analysis and modelling to understand key physical mechanisms by which the **interaction of oil platform emissions with weather systems in the North Sea impact the regional and large-scale redistribution of pollutants and potentially the climate**. Whilst this project will primarily consider the effect of changes in weather patterns on the fate of North Sea emissions, the final part of the project will use the findings to consider how the effect of emissions on a much larger scale may altered by changes in climatic conditions, including weather patterns.

How will you work

You will use a combined approach of observations and modelling along with data analysis to understand how atmospheric circulation patterns over the Northern Hemisphere transport and interact with pollutants emitted by oil and gas platforms (in

the North Sea). The project will also have an excellent field work component opportunities – flying for collecting your own data during research campaigns aboard the the Facility for Airborne Measurements Aircraft (Figure 1, right, https://www.youtube.com/watch?v=UnLBG_JsVm0). You will have the opportunity to work in a team of modellers, observational scientists as well as data analysts who will guide and develop your already existent skills along with new ones. NCAS will offer also the opportunity for you to take part to outreach activities, national and international conferences as well as meet Oil and Gas industry partners if useful for the project.

You will have access to supercomputing facilities for the part of your work involving modelling.

Methodology

The project will make use of a range of observational datasets for present-day analyses, including three-dimensional atmospheric and reanalysis, surface observations, and satellite data as well as FAAM aircraft data (https://www.faam.ac.uk/). For studying climate change impacts the project will utilise a suite of available global climate model (GCM) experiments, such as those from the IPCC CMIP5/6 archives (http://www.ipcc-data.org/). Also, the project will use the established NCAR WRF model to design and perform a set of sensitivity experiments by varying the magnitude and temporal evolution of oil-platforms emissions. Using WRF along with chemical gas dispersion and transport models (i.e GEOS) will be done extensively in order to understand how and where the gases emitted by the platforms are transported. WRF as well as GEOS-CHEM have been used previously to address important questions related to regional and global climate. An example of such a transport of pollution between continents is given Figure 2 (taken from Li et al. 2002).

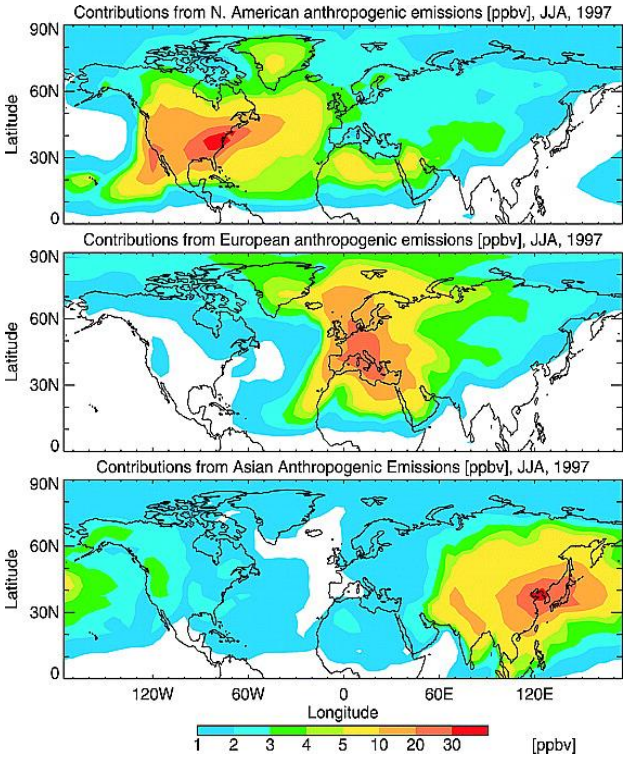

Figure 2: Example of sensitivity of simulated surface ozone concentrations in June–August 1997 to anthropogenic emissions in the individual continents. The plots show the mean decreases in concentrations when anthropogenic emissions from (top) North America, (middle) Europe, and (bottom) Asia are shut off separately. “Surface ozone” refers to the lower mixed layer (0–100 m), i.e., the lowest layer of the model (Li et al. 2002).

Key research questions

- What are the spatio-temporal effects of oil platforms emission remotely, for the near-future climate?
- What is the footprint of changing emissions on large-scale climate and circulation in the North Atlantic Sector?
- What is the sensitivity of the response to the range of possible emission scenarios?
- To what extent oil-platforms drive changes interact with other forcings (e.g.., GHG from other sources)?

Research Team

You will benefit of the guidance and work closely with a team of modellers, data and instrumental scientists from the National Centre for Atmospheric Science (NCAS). You will be able to develop collaborations with chemists from the Wolfson Atmospheric Chemistry Laboratories (WACL) in York and have the chance to meet industry project partners from the Oil and Gas Industry. You will gain an excellent base of data analysis as well as modelling and mechanistic understanding of atmospheric and climate related processes.

Requirements

The project would suit a student who must have a strong mathematical and physics background, excellent familiarity with programming, and a keen interest in atmospheric and climate science as well as data analysis.

Links and References

FAAM Aircraft: https://www.youtube.com/watch?v=UnLBG_JsVm0

McGregor, G.R. & Bamzelis, D. Theor Appl Climatol (1995) 51: 223. https://doi.org/10.1007/BF00867281

Chris Webber: http://centaur.reading.ac.uk/73249/1/18015122_Webber_thesis.pdf

IPCC data: http://www.ipcc-data.org/

FAAM data: https://www.faam.ac.uk/

Li, Q., D. J. Jacob, I. Bey, P. I. Palmer, B. N. Duncan, B. D. Field, R. V. Martin, A. M. Fiore, R. M. Yantosca, D. D. Parrish, P. G. Simmonds, and S. J. Oltmans, Transatlantic transport of pollution and its effects on surface ozone in Europe and North America, *J. Geophys. Res.*, 107(D13), doi: 10.1029/2001JD001422, 2002.