Research experience placements at the University of Reading or CEH, summer 2019

The Natural Environment Research Council has a scheme aimed at encouraging undergraduate students who are doing a degree in a quantitative discipline to consider a career in environmental research.

http://www.nerc.ac.uk/funding/available/postgrad/advanced/experience/

The SCENARIO DTP has two placements in this scheme this year, based at the University of Reading department of Meteorology. This scheme is therefore an excellent opportunity to get experience of working in a thriving research environment before considering applying for a PhD next year (whether with SCENARIO or elsewhere).

Students would receive £8.88/hr, 30 hours per week for 7 weeks of work this summer. The eligibility criteria are strict. They must:

- Be studying for a degree in a quantitative discipline (e.g. mathematics, statistics, computing, engineering, physics)
- Be undertaking the placement in a different department to their undergraduate degree
- Be in the middle of their first degree studies (or integrated Masters)
- Be expected to obtain a first or upper second class UK honours degree
- Be eligible for subsequent NERC PhD funding (UK, EU or right to remain in the UK)

Four possible areas of study are given on the following pages. Please note that all of these topics will require computing skills to perform, in terms of data handling and presenting your results – hence, a willingness to learn how to use the appropriate software is essential.

If you are interested in applying for one of these placements, please email Prof Bill Collins (w.collins@reading.ac.uk) by Friday 17th May 2019, providing a brief application (no more than 2 sides of A4) that should

(a) Explain how you meet all of the above criteria
(b) Provide information on A-levels grades (or equivalent), and on the marks you have received on your University course so far.
(c) Any experience with data processing software (Python, Matlab, R, etc.)
(d) Indicate, in order of preference, the three topics you would like to work on.
(e) Provide a short statement, in around 250 words, on the origin and nature of your interest in environmental science. Include any relevant work or project experience.

1. **Determining meteorological drivers of urban air quality using Doppler lidar observations**

Air quality in cities is controlled by several factors: pollutant emission strength and location, high background concentrations and city microclimate. Air pollution
episodes tend to occur when windspeed is low, and the lowest layer of the atmosphere – the Boundary Layer – is shallow, trapping pollutants. The Urban Boundary Layer (UBL) has special characteristics compared to rural surroundings as winds are generally lower due to friction caused by buildings. The UBL depth can be higher as the urban surface heats the atmosphere more, causing hot air to rise and pollution to be dispersed. While surface measurements of air pollutants are common, observations of the UBL are not, requiring sophisticated instrumentation. This project will exploit new observations of London’s boundary layer using Doppler lidar to analyse which boundary layer conditions cause poor air quality episodes. A Doppler lidar is similar to a radar, but instead of radio waves a pulse of near-visible light is emitted which scatters back from pollution particles in the air. The instrument senses the Doppler shift in light due to particle motion, thus measuring the wind velocity out to several kilometres from the instrument. It can be used to derive UBL depth as well as observing particulate pollution layers. This instrument is currently deployed as part of the MAGIC project (www.magic-air.uk) in central London. The student would have opportunity to analyse data as it comes in, visit the experimental site and discuss findings with project partners. Data would be interpreted using statistical analysis, aided by use of simple models.

2. Assessment of skill of ensemble prediction systems at forecasting wind power production in Mexico

The wind-energy industry in Mexico is developing rapidly, with a projected increase in installed capacity by 2030 to 15 GW from 3.8 GW in 2016. Numerical weather prediction (NWP) is useful not only for the planning of new wind farms, but also for their operation: multidecadal datasets of atmospheric conditions can help to assess the suitability of a given site for wind energy production while medium-range forecasts can provide valuable data for the day-to-day operation of installed farms. However, NWP is largely underutilised by the industry in Mexico. This project aims to address this gap by investigating the capability of current NWP models to predict wind-energy generation, and associated economic benefits, in Mexico. Previous work has shown that on average the Ensemble Prediction System (EPS) of the European Centre for Medium-range Weather Forecasts is skilful at forecasting wind power production for at least five days. In this project, a more detailed analysis will be conducted by comparing EPSs from other forecasting centres and by looking at the forecasting skill of these EPSs at predicting specific events such as ramps (the relatively rapid loss or surge in wind power production over a short period of time). In addition to the numerical gridded datasets of wind data from the ensemble forecasts, you will analyse observational datasets of wind and wind power from a real wind farm located in southern Mexico.

This project is part of a wider collaboration with scientist of the Renewable Energy Institute of the National University of Mexico and therefore you will have an opportunity to interact with international collaborators. Furthermore, you will have the opportunity to visit the Reading University Atmospheric Observatory, where you will learn about the variables measured, the instruments used and the physics underlying the measurements, including a weather balloon launch. You will gain experience obtaining and analysing model and observational data, collaborating with others, writing a scientific report and potentially contributing to a publication.
3. **Assessment of thermobaric energy in the ocean**

An important feature of the ocean is that its equation of state for density is a strong nonlinear function of three variables: salinity, temperature and pressure. One particularly important aspect of the nonlinearity is related to ‘thermobaricity’, that is the strong pressure dependence of the thermal expansion coefficient (which controls the response of sea level to global warming, among other things). Thermobaricity, when coupled with density-compensated temperature/salinity anomalies created by the surface patterns of heat and freshwater fluxes, introduces a new form of energy in the system, called thermobaric energy. Most of the time, thermobaric energy represents a ‘dormant’ form of energy that most often plays little role in ocean dynamics. It has been hypothesized, however, that circumstances may occasionally arise that would cause thermobaric energy to be suddenly released, thus potentially explaining some past abrupt climate change induced by changes in the ocean circulation. Progress in our understanding has been limited, however, by the lack of an appropriate theoretical framework to define and quantify thermobaric energy precisely. The main objective of this project will be to test a couple of possible definitions of thermobaric energy arising from the analysis of the problem in terms of the theory of available potential energy developed by the supervisor. The next step will be for the student to collect climatological data of temperature and salinity from existing sources (from the web) in order to quantify thermobaric energy in the actual ocean and its temporal variations in the past 50 years or so. In addition, an afternoon will be devoted to visit Reading university weather station in order for the student to better appreciate what kind of variables are measured, the physical principles underlying such measurements, and where the data are collected and analysed.

You will gain experience analysing complex datasets and learn about current research in atmospheric dynamics.

4. **The Impact of Cloud and Saharan Dust on Solar Energy Generation in the UK**

To meet the world’s growing energy needs, research into the efficiency of renewable energy sources, such as solar energy, under a variety of environmental conditions, is required. Solar energy generation is affected by the amount of solar radiation entering the atmosphere, but it can also be affected by clouds and aerosols (small particles in the atmosphere), since they reduce the solar radiation reaching ground level. Saharan dust is one type of aerosol which can be transported to the UK and Europe.

This project will use case studies of Saharan dust events reaching the UK to assess the relative importance of clouds and dust on surface solar radiation and therefore solar energy generation. Satellite and ground-based remote sensing observations will be used to quantify dust and cloud properties. The student will run an atmospheric radiation model using the different cloud and dust observations, and will examine their impact on surface solar radiation and hence solar energy generation.

The student will benefit from observational satellite and ground-based data collection and analysis, running and adjusting a radiation model, scientific data analysis (including data visualisation), and report-writing. The student will have the opportunity of a tour of the Reading University Atmospheric Observatory including
solar radiation observations, and the opportunity to accompany a meteorological observer.