**PhD studentship Project information**

**Funding Source:** CENTA DTP

**Proposed start date:** 25th September 2023

**Closing date for applications:** 11th January 2023

**Eligibility:** UK/International

**Department/School:** Physics (NCEO)

**Supervisors:** **PI: Dr Jeremy Harrison (National Centre for Earth Observation and University of Leicester, email: jh592@leicester.ac.uk)**

**Co-I: Prof John Remedios (NCEO)**

**Project Title:** Supporting the Montreal Protocol: monitoring long-lived halogenated species with atmospheric nadir sounders

**Project Description (max 700 words):**

**Project Highlights:**

* Produce some of the first long-term global datasets of halogenated species derived from measurements by atmospheric nadir sounders
* Monitor halogenated species in support of the Montreal Protocol
* Investigate whether there is evidence for illegal emissions around the world, e.g. from East Asia.

**Overview:**

Chlorofluorocarbons (CFCs) were first developed in the 1930s as safe, reliable, and non-toxic refrigerants for domestic use. This explosion in use led to a steady increase in their atmospheric abundances. However, while inert in the troposphere, it was this stability which enabled them to reach the stratosphere, where dissociation by ultraviolet (UV) radiation released chlorine atoms catalysing the destruction of the stratospheric ozone layer which protects us from harmful UV radiation.

It will be many years before stratospheric ozone levels return to pre-1980 levels because these species and their replacements, the majority of which are regulated by the Montreal Protocol, are generally very long-lived in the atmosphere. Continued monitoring of these species is crucial to ensure abundances are decreasing as expected. For example, atmospheric monitoring was able to quantify recent illegal emissions of CFC-11 from eastern China [Rigby et al., 2019].

Over recent decades, monitoring these species, which are also very strong greenhouse gases, from orbit has been the domain of infrared (IR) limb sounders. The only active limb sounder now measuring these species regularly is the ACE-FTS (Atmospheric Chemistry Experiment – Fourier Transform Spectrometer) which has been operating since 2004 [Bernath, 2017]. With the golden age of limb sounding coming to an end, one question is whether hyperspectral nadir IR sounders can fill the satellite monitoring gap.

A number of atmospheric nadir sounders, with low radiometric noise and high spectral resolution, measure top-of-atmosphere radiances in the thermal IR; these include IASI (Infrared Atmospheric Sounding Interferometer) and CrIS (Cross-track Infrared Sounder). From the atmospheric spectra recorded by these instruments we can determine the concentrations of a range of trace gases, such as methane, water, and carbon dioxide. These instruments have the potential to provide monitoring of halogenated species, and early work has shown the promise of using IASI for monitoring eight such species [De Longueville et al., 2021]. The advantage of using CrIS is that it possesses superior signal-to-noise, thus providing the prospect of more robust trends and the monitoring of additional species that IASI cannot observe.

**Methodology:**

The student will primarily use data from IASI on MetOp-B (launched in 2012) and CrIS on Suomi-NPP (launched 2011). A whitening transformation will be applied to averaged spectra, thereby removing most of the climatological background, and leaving a residual that contains the spectral signatures of trace gases that depart from normality [De Longueville et al., 2021]. These spectral aberrations can be attributed to changes in the abundance of trace species, and will be used to identify the detectable halogenated species such as chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), and other related species such as SF6, CF4, and CCl4. The student will then develop an algorithm to map the whitened signals of the identified halogenated species into robust total columns and trends, and compare these with ACE-FTS and ground observations, and the outputs of atmospheric models such as SLIMCAT. The student will also investigate any evidence for illegal emissions on a regional scale.

**References:**

Bernath, P. The Atmospheric Chemistry Experiment (ACE). JQSRT, 186, 3-16 (2017). https://doi.org/10.1016/j.jqsrt.2016.04.006

Bernath, P., et al. Sixteen-year Trends in Atmospheric Trace Gases from Orbit. JQSRT, 253, 107178 (2020). https://doi.org/10.1016/j.jqsrt.2020.107178

De Longueville, H., et al. Identification of short and long-lived atmospheric trace gases from IASI space observations. Geophysical Research Letters, 48, e2020GL091742 (2021). https://doi.org/10.1029/2020GL091742.

Rigby, M., et al. Increase in CFC-11 emissions from eastern China based on atmospheric observations. Nature, 569, 546–550 (2019). https://doi.org/10.1038/s41586-019-1193-4

WMO (World Meteorological Organization), Scientific Assessment of Ozone Depletion: 2018, Global Ozone Research and Monitoring Project–Report No. 58, 588 pp., Geneva, Switzerland, 2018. https://csl.noaa.gov/assessments/ozone/2018/downloads/2018OzoneAssessment.pdf

**Funding details:**

NERC CENTA studentships are for 3.5 years and are funded by NERC. In addition to the full payment of your tuition fees, you will receive the following financial support:

* Annual stipend, currently set at £ 17,668 (2022/3 – new figures to be confirmed spring 2023)
* Research training support grant £8,000 (RTSG)

\* If you do not meet the criteria for UK Fees you will need to fund the difference between UK and International fees for the duration of your studies.

\* A limited number of top up studentships to fund the difference between UK and International fees may become available but are not guaranteed.

For more details of the CENTA consortium please see the CENTA website: www.centa.org.uk.

**Entry requirements:**

Applicants are required to hold/or expect to obtain a UK Bachelor Degree 2:1 or better in a relevant subject or overseas equivalent.

The University of Leicester [English language](https://le.ac.uk/study/research-degrees/entry-reqs/eng-lang-reqs) requirements apply where applicable.

**Application advice:**

To apply please refer to

<https://le.ac.uk/study/research-degrees/funded-opportunities/centa-phd-studentships>

With your application, please include:

* CENTA Application form - available to download on the How to Apply section of the above link
* CV
* Personal statement explaining your interest in the project, your experience and why we should consider you
* Degree Certificates and Transcripts of study already completed and if possible transcript to date of study currently being undertaken
* Evidence of English language proficiency if applicable
* In the reference section please enter the contact details of your two academic referees in the boxes provided or upload letters of reference if already available.

In the funding section please specify that you wish to be considered for Ref CENTA2-NCEO1-HARR

In the proposal section please provide the name of the supervisors and project title (a proposal is not required)

**Project / Funding Enquiries to:** [**CENTA@le.ac.uk**](mailto:CENTA@le.ac.uk) **or** [jh592@leicester.ac.uk](mailto:jh592@leicester.ac.uk)

**Application enquiries to** [**pgradmissions@le.ac.uk**](mailto:pgradmissions@le.ac.uk)

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