PhD Project Title: ***Wildfires and the evolution of the global climate system***

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Smoke plumes from wide-spread fires in the US (http://spaceflight.nasa.gov).

Background: Wildfires are a key process in the Earth system. There is a strong link between the magnitude and frequency of wildfires and climate change. It has been shown that projected warmer and dryer future conditions in some regions could lead to increases in the area burnt by wildfires. Also, wildfires are a major source of gases and aerosols in the atmosphere. Emitted species range from CO_2 and methane to aerosols, and also include reactive compounds such as nitrogen oxides (NO_x) and carbon monoxide (CO), all very important for atmospheric composition, air quality, and climate. However, the studies of the effects of wildfires on climate via atmospheric composition changes have been very limited.

Aim and methodology: In this project, we aim to systematically explore the contributions of wildfire emissions to variability and trends in the climate system. We will study how the perturbations in the abundances of important gases and aerosols in the atmosphere due to wildfires affect radiative forcing, atmospheric, and ocean dynamics, and what are the impacts of such perturbations on regional climate (e.g. temperature and precipitation). This will be done initially for the recent decades for which extensive observations exist (1990-present). The main tool for this work will be the UK Earth System Model, the primary tool used in the UK for global climate change studies. A variety of observations will also be used to constrain model processes, with an emphasis on satellite information. Seasonal and interannual variability will be the primary foci of this initial stage. We will examine the interplay between wildfires and underlying modes of natural climate variability such as the El Niño Southern Oscillation (ENSO), as well as the interactions between the tropics and the extratropics (e.g. how tropical fire emissions affect mid-latitude climate). We will explore whether wildfire emission forcing affects the evolution of the climate system from year-to-year, and what are the implications for seasonal weather predictability. The role of atmospheric and ocean dynamics will be examined in detail. This hindcast analysis will be followed by future simulations using the fire emissions prepared for the forthcoming IPCC assessment in order to explore wildfire impacts on future atmospheric composition, radiative forcing, and climate. Implications for decadal and multi-decadal global/regional climate prediction will be examined.

Importance and synergies: This project aims to provide the first systematic analysis of wildfire effects on global and regional climate, exploring both past and future effects, and involving both atmospheric and oceanic dynamics in the analysis. Therefore, it is expected to be a significant contribution to the understanding of potentially important interactions in the Earth system. It will also provide synergies with other ongoing projects in the group, including studies of how regional aerosol emissions affect the global climate system, studies of the drivers of global fire activity, and the effect of fires on air quality and health etc. Furthermore, the PhD student will interact frequently with colleagues from the UK Met Office and specifically with the Atmospheric Composition and Climate Group, as well as the University of Exeter, due to our ongoing collaborations with these teams on related topics. Simultaneously, the project is expected to involve interactions with collaborators from the NASA GISS institute in New York who have a strong interest in the topic.

Project start date: **October 2019**

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