Nowcasting the risks of wildfire

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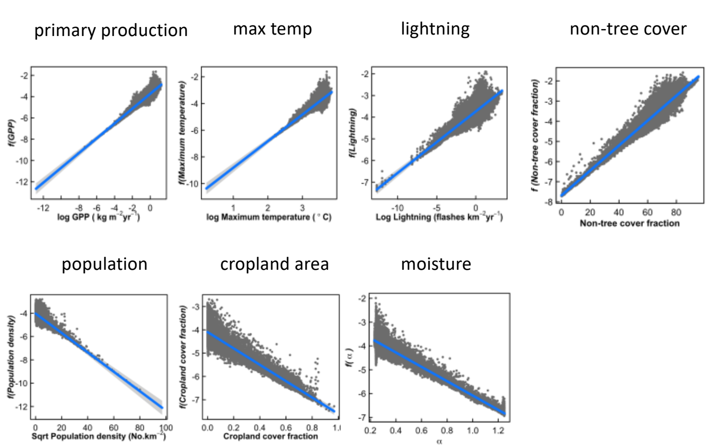
Wildfire represents an increasing risk to people and property. There is concern that if present trends continue, the risks to insurance and re-insurance companies will become unsustainable, and property in fire-prone regions will become uninsurable. The problem arises because historic data, on which insurance pricing generally depends, are no longer a reliable guide to wildfire risk. Palaeodata provide evidence that biomass burning, regardless of greater or lesser human intervention, is highly sensitive even to small (< 1˚C) regional temperature shifts. Severe fire seasons during the past year in southeastern Australia, California and Siberia reflect unprecedentedly high temperatures, combining with specific atmospheric circulation patterns, to create extreme fire risks.

There is thus an urgent need to develop a **new approach to the spatially detailed assessment of wildfire risk in the present and the near future** that takes account of the non-stationary nature of climate, together with current understanding of the meteorological, ecological and human influences on fire. The project will demonstrate the feasibility of mapping present and near-term wildfire risk using a combination of climate and wildfire models.

The project will exploit the availability of **large ensembles and long runs of leading climate models,** including state-of-the-art models used by the UK Met Office (Exeter) and the EC-Earth model, which is based on the European Centre for Medium-range Weather Forecasts (Reading) forecast model and used for climate prediction in several countries. Instead of focusing on long-term projections, as much of the "climate impacts" literature does, this project will focus on the present. The idea is to represent the present climate probabilistically, based on model ensembles that represent alternative realizations of the climate, all consistent with the present composition of the atmosphere. This work will also quantify climate 5-10 years into the future. This can be done with reasonable confidence because different scenarios of future carbon emissions do not produce noticeably divergent climates until 20 or more years hence.



The other key element of this research will be a **global wildfire model**. Current "process-based" vegetation-fire models are based on a still-limited quantitative understanding of the processes, and do not perform to the standard required. On the other hand, **remotely sensed data on fire occurrence, burnt area and fire radiative power** are abundant, publicly available, and improving. Empirical models can therefore be developed, relating wildfire (as seen from space) to its multiple controls. The Figure (left) shows an example based on annual burnt-area statistics on a coarse (0.5˚C) global grid. The panels are partial residual plots based on a generalized linear model.

The wildfire model will also be probabilistic. Information on the locations of actual fires will inform a model based on physical, biological and human predictors, which in turn will be used to quantify location-specific wildfire risks for the near future. Improved global wildfire modelling based on remote-sensing data, using both statistical and machine-learning approaches, is a highly active area of current research in the Leverhulme Centre. The project will build on this activity to develop and apply a suitable model at the spatial resolution required.

By combining probabilistic modelling of both climate and wildfire, this project is therefore expected to achieve a substantial advance in the state of global fire modelling; while also providing a proof-of-concept for a new scientific approach to the quantification of this increasingly important risk.

Training opportunities:

The student will be embedded in the Leverhulme Centre for Wildfires, Environment and Society and have the opportunity of regular interdisciplinary science meetings and training with the cohort of fire scientists working in the Centre. More specifically, they will join a growing cohort of wildfire modellers, some working in cooperation with the UK Met Office, who exchange experience through (and outside) of the Centre's monthly Earth Systems Fire Group meetings.

The student will have access through the Centre to world-leading capability in the remote sensing of fire (Martin Wooster's group at Kings College London) and data science. Rosella Arcucci's group in the Data Science Institute at Imperial College includes a new activity on wildfire data assimilation.

Since the project is partially funded from the Land Ecosystem Models based On New Theory, obseRvations, and ExperimEnts (LEMONTREE) project, an international consortium working on new approaches to modelling the terrestrial biosphere, the student will also attend monthly (virtual) science meetings of that project and thereby interact with ecosystem scientists, including a large cohort of PhD students, in seven countries.

The PhD programme will include a three-month secondment to AXA XL, where the student will develop context for the implications of the work for (re-)insurance, and present project findings.

Student profile:

This project requires, above all, well-developed quantitative skills, including a good mathematical background, competence in programming in R or Python, and applications of statistical and/or machine learning software. Suitable degree subjects would include physics, engineering, applied mathematics, meteorology or economics.

Funding particulars:

The project will be funded 50% from the Leverhulme Centre component of the LEMONTREE project.

https://research.reading.ac.uk/scenario/