Fires of the future: Mathematical modelling and statistical inference for wildfire dynamics

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Wildfires are a disturbance to a variety of ecosystems, and vulnerability is likely to increase in areas which are not adapted to these disturbances due to climate change. The occurrence of wildfires requires the influence of several factors, since these dynamics tend to be affected by abrupt shifts in environment, even small changes in the drivers can cause large changes in the system – making predictions difficult. Mathematical models can theoretically aid to find thresholds for spread and predict how abrupt shifts in drivers are affecting overall burnt areas and the rate of spread. For such complex, multi-scale, spatio-temporal systems we propose a coupled convection-reaction-diffusion system and computational techniques for close to real-time simulations to be of use in emergency situations. Due to recent events, the vulnerability of the UK regarding wildfire events has raised awareness and highlighted the potential for environmental damage and loss of property and key infrastructure. Most UK wildfires are a result of inadvertent or deliberate human action, but the environmental conditions depend on antecedent and current weather. With the use of Geographic Information Systems, meteorological data, and historic fire event data from Global Wildfire Information System, the Department for Environment, Food and Rural Affairs and local drone footage collected from moorland heather burning season we will use statistical techniques, emulator-based methods and GPU implementation for Bayesian techniques, to validate the model by testing its ability to predict unseen data and infer parameters. Thus, the model can then be used to predict future events, improve management strategies, and aid decisions on climate change effects such as outlying weather patterns that may influence fire behaviour.