Meeting report

Bringing real-world problems into climate models – RMetS Weather and Climate conference workshop

Most of us will experience climate change through impacts to our lives, such as increases in risk of heat-related illness, water scarcity or changes in the spread of vector-borne and infectious diseases. Our supply and quality of food might be affected by changes in crop yields and biodiversity, and economic consequences may be felt through damage to infrastructure from extreme weather. To better prepare and respond to future climate change, detailed understanding of future climate-related risks and the impacts they may pose to natural and human systems is needed. Here we present findings of a workshop in the UK to explore the challenges and opportunities of this topic.

Understanding the impacts of climate change

The global climate is changing, with global mean temperatures already at 1.3°C above pre-industrial levels,[1] and 1.5°C over land (IPCC, 2023). In the UK, summers have become warmer and winters have become warmer and wetter, with the 2023 annual average temperature 1.66°C above 1961–1990 levels and the past decade's winters 24% wetter compared to the same baseline (Kendon *et al.*, 2024). What will happen in the UK under increasing climate change? One way to answer this question is to describe possible future changes in mean and extreme temperature, the frequency and intensity of rainfall and sea-level rise. Thanks to the rapid improvements in global climate models and the development of local climate projections, such as UKCP18,[2] we have projections in the UK for these factors. We can also derive these estimates for different emission scenarios, thanks to the strong but complex relation between greenhouse gas emissions and changes in the climate.

However, if we want to understand how we can take action to respond to increasing risks, we need to understand how changes in hazards, such as rising temperature and changes in precipitation, translates to changes in societal impacts. For example, what are the effects on our health and communities from a 40°C heatwave? The impacts from this hazard both now and in the future not only depend on the changes in the weather risk, but also on other factors such as vulnerability of people and systems, how our society acts to adapt to changes in extreme weather, as well as changes in the potential population exposed, demographics and socio-economic distribution.

Workshop setting

The UKHSA Centre for Climate and Health Security organised a workshop hosted at the RMetS Annual Weather and Climate conference which was held on 8–10 July 2024. The aim of this workshop was to explore ideas from the weather and climate community on how to address the challenging task of impact modelling. With a special focus on health, the workshop was centred around two questions considering the associated challenges and opportunities:

1. How can climate projection data and impact models be extended to account for multiple adaptation and mitigation scenarios based on evidence? And how do we improve estimation of uncertainties, particularly when multiple sources of uncertainty are included in an impact model?
2. How can climate projections and socio-economic projections (such as the United Kingdom shared socio-economic pathways (UK-SSPs)) be combined to generate a dataset incorporating changes in both climate and society?

To provide inspiration and background to these questions, the workshop started with presentations from *Katie Jenkins* (Tyndall Centre for Climate Change Research at the University of East Anglia) and *Michael Sanderson* (Met Office). Katie spoke about learnings from the OpenCLIM project[3] and highlighted some of the real challenges of incorporating adaptation into quantitative models in a robust way. A key aim of OpenCLIM was to provide an integrated assessment of climate risks for the UK and ensure accessibility and usability of models and data. More specifically, an example was given for the modelling of heat-related mortality, where steps were taken to incorporate adaptation via structural changes and acclimatisation. The modelling was limited by a lack of quantitative data describing how populations could acclimatise over time, resulting in a need to oversimplify this behaviour within the model. Challenges of representing adaptation become more significant when focusing on local scales, where socio-economic conditions such as levels of deprivation and building characteristics will influence levels of vulnerability to heat. Importantly, the modelling emphasised how small changes in the way adaptation is represented in the model will have a large influence on the outcome, bringing in additional uncertainty to the model chain.

Michael provided an overview of the characteristics of climate, health and socio-economic data and why there are some major challenges in combining them all in a model. For example, weather stations record information at a given location and time, whereas climate models simulate average meteorological conditions over a predefined area. Some health data are available as averages or totals for postcode areas, which are irregular in shape. These different datasets need to be combined to allow impacts of historical and projected climate events to be assessed. Michael's talk illustrated several different methods of varying complexity to do this, which could produce different values of climate variables, such as temperature, rainfall and humidity.

Following the presentations, the workshop attendees were split into small groups to discuss the two posed questions. Participants were encouraged to highlight any learnings from other sectors or areas of work which could potentially be transferable. For many, this was the first time they had to consider how to measure and model impacts and how social factors are equally important to weather factors. Nevertheless, all groups went into lively discussions to try and come up with a solution in 60 min (Figure 1).

Ideas from participants

A common theme that emerged was the need for more and better impact data (such as improved coverage, including in space and time, and coverage of outcomes such as non-fatal health impacts), ideally held in an easily accessible database so researchers can identify and access the data collected. To gather more data on observed impacts, some participants suggested crowdsourcing (e.g. a system for people to report local flood impacts that might not be captured by official statistics) and to make use of detailed data collected during Covid. Others suggested that better ways are needed to monitor unseen events (e.g. if the hazard occurred but without noticeable impacts) to better understand when events of a certain magnitude have significant societal impacts or not. Another common theme was the need for cross-disciplinary and cross-sector collaborations. As many of the participants were unfamiliar with both health and socio-economic data, they were unsure of the format, availability and scale of the data that

[1] https://climateactiontracker.org/global/cat-thermometer.

[2] https://www.metoffice.gov.uk/research/approach/collaboration/ukcp.

[3] https://tyndall.ac.uk/projects/openclim/.

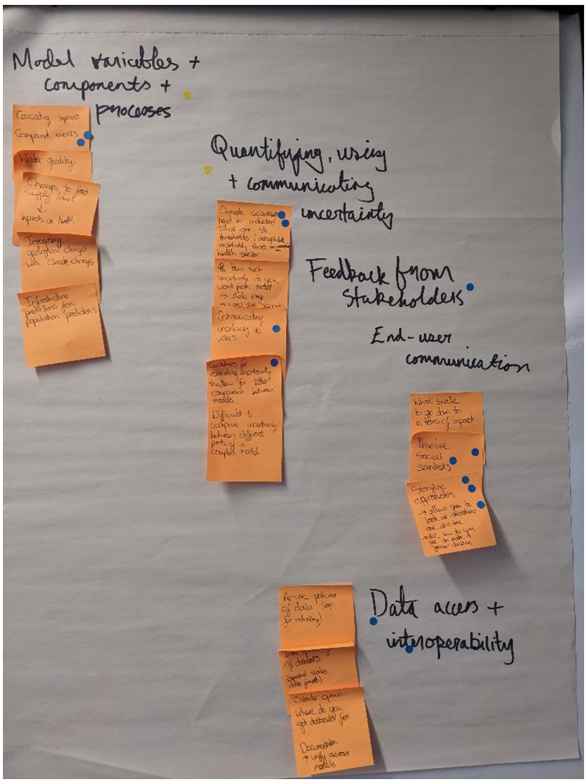

Figure 1. Ideas from one of the discussion groups.

could be used. Most agreed that it would be highly valuable for those working in the weather and climate science fields to work together with researchers from other fields, such as social science, to better understand the requirements for making weather and climate data more useful for different users.

To start tackling these complicated tasks, several groups proposed to use scenarios, storyline or case study approaches. Storylines, or narratives, involve creating scenarios of plausible chains of events to investigate what would happen under these assumptions. Applying these methods could help to reduce the uncertainties involved in each step as certain well-defined assumptions can be made that are relevant for the users and populations considered. They can also help with communicating complex issues to a range of users with varying priorities. Another suggestion was to try to estimate and prepare for the worst-case scenario in terms of hazard occurrence, frequency and magnitude and their associated impacts. This can help focus efforts through reducing the number of options and uncertainties to be considered. However, as worst-case scenarios can be highly uncertain, there is a risk of leading to expensive over-adaptation or maladaptation to a different type of event that may occur instead, again highlighting the benefits of cross-sectoral collaboration.

Other significant points included the importance of climate scientists understanding the level of uncertainty that is acceptable by users to better know what resources and developments are needed and how to communicate limitations. It would also be useful to know who (e.g. which sectors or policymakers) are already using what data for adaptation and decision-making and impact assessments, what the most important features of this data are for this type of decision-making and where the gaps are. Guidelines for estimating uncertainty, particularly when combining models and datasets, would be useful to support better comparisons between different studies and estimates.

Wrapping up discussions

In the full group discussion at the end, there was a general feeling that these questions are difficult to tackle, and it will be essential for people from different fields to come together to develop suitable methods. Some reflected on the need for data providers to work more closely with users to understand specific needs and ensure the data produced are relevant, as there may be limited understanding of the many challenges that users of climate and weather data experience when applying and using these data.

The need to better understand impacts and the complexity of integrating adaptation within models was raised in several talks throughout the conference covering various sectors, indicating that this is a high-priority research area where people from different applications and disciplines could come together and pool resources and knowledge to drive innovation and development (such as the new UK adaptation hub[4]). These discussions will be essential given the continued need for organisations sensitive to climate change to adapt at local scales, to both current and future risks and the urgency of which actions need to be identified and implemented in practice.

[4]https://www.kcl.ac.uk/news/new-5m-collaboration-to-help-uk-prepare-for-climate-change.

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Author contributions

Jennifer Israelsson: Conceptualization; writing – original draft; writing – review and editing. **Helen L. Macintyre:** Writing – review and editing. **Katie Jenkins:** Writing – review and editing. **Michael Sanderson:** Writing – review and editing.

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