The Role for Climate Services in Handling Climate Change Risks: Contributions of UKCP18
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On the one hand, we have the weather. Meteorologists often use high-resolution regional models to perform forecasts aiming to predict weather changes on weekly time scales. Will it rain in an hour? Will it be sunny this weekend? We have an intimate awareness of weather as it affects our daily lives. On the other hand, we have climate. Climate is the superposition of weather patterns, where averages can be taken on any time scales, from months to centuries. As individuals, we only have limited intuition of climate. Aside from choosing to go on beach holidays in the summer or when to go on a ski trip, we typically do not make day to day decisions based on climatology. Yet, understanding the long-term evolution of weather is critical.

When climate changes, so does the weather. Understanding how climate change will reveal itself as local weather is one of the hardest questions; known as the "seamless prediction problem". What we need is the ability to forecast weather far into the future, but owing to the nonlinearities inherent to the climate system, the best we can do is to present a statistical assessment of what weather may look like. This fuzzy, statistical world, presents many challenges for potential users and policymakers. UKCP18 is a climate service that represents the latest effort to address the seamless prediction problem for the UK. UKCP18 attempts to perform weather forecasting on climate-relevant scales in a way that will help the UK plan for the effects of climate change in a meaningful way.

To explore the strengths and weaknesses of UKCP18, and to showcase examples of how these climate projections can be exploited, a dedicated RMetS meeting was held at Imperial College London in partnership with the Grantham Institute and the Met Office on 20 February 2019. Leading academics, policymakers and the public gathered to explore the role of climate services in handling climate change related risks.

As **Sir Brian Hoskins** (University of Reading and Grantham Institute) emphasised, the key philosophy underpinning UKCP18 is that for climate services to be meaningful, it must represent two-way interactions between users and model developers. Moving towards operational climate forecasting involves a spectrum of potential users that reach far beyond academia. Experiments and model architecture must therefore represent an intersection between technical prowess, user needs from scientific, governmental and industrial stakeholders, and the need for effective communication to capture the nuances in interpreting these complex model results.

The importance of user engagement was echoed by **Baroness Brown** (Chair of Adaptation Committee of CCC) who explained how climate services are used by policy-makers. For example, spatially resolved water supply demand projections help farmers across the UK make informed decisions. UKCP18 will be an invaluable tool for policymakers, as it forms the basis upon which metrics can be developed to calculate costs and benefits of policies. Ultimately, there is a need for expertise capable of translating climate science, especially locally, where it cannot be assumed that decision makers are able to understand climate science in depth. Simple, direct and locally relevant messages are needed; this is something UKCP18 can offer.

Jason Lowe (Met Office Hadley Centre) explained that UKCP18 encompasses three types of experiments. (1) Probabilistic projections, which represents 350 model runs, are used to constrain the uncertainties associated with socio-economic scenarios on annual time scales. (2) Global climate projections exist for 28 experiments for the RCP8.5 scenario running at 60 km resolution. These projections were made with a model version closely related to the UK's submission to CMIP6. (3) Finally, 12 regional projections were made with resolution enhanced to 12km over the European domain, using representative experiments from the set of global projections to provide the global context. Experiments with resolution enhanced further to 2.2 km will become available later this year.

These regional projections are intended for use in detailed impact assessments of the UK and case study analyses. Parallel marine projections are also available, which provide information about changes in mean sea level, storm surges, wave climate and tides.

UKCP18's results confirm a greater chance of warmer, wetter winters and hotter, drier summers. While the optimistic greenhouse gas emission scenario is compatible with the 2 degrees goal set by the Paris agreement, **James Murphy** (Met Office Hadley Centre) warns that other scenarios will require significant adaptation. The whole UK will experience warming, especially in summer, and precipitation will increase during winter, with storms expected to become more intense. On the marine side, **Matt Palmer** (Met Office Hadley Centre) explained that sea level rise will occur all around the UK, increasing flood risks and affecting local tidal characteristics, which will have important implications for the coastal infrastructure.

Regarding climate risks, **Suraje Dessai** (University of Leeds), **Liz Parkes** (Environment Agency) and **Prof Nick Pidgeon** (Cardiff University) highlighted that many sectors are sensitive to climate change, but since UKCP18 was designed with user needs in mind, it can help make climate change relevant to individuals. Even though climate change is a global problem, people, communities and businesses are the ones that will be affected and need to implement mitigation and adaptation schemes. The localisation of information and the ability to define specific impacts is vital for designing efficient mitigation and adaptation strategies. There is a need for people able to translate probabilistic climate forecast into local and actionable information. UKCP18's regional projections are key to this effort.

From the perspective of risk management, **Mike Morecroft** (Natural England) explained how UKCP18 projections can help manage ecological changes by protecting vulnerable species and build resilience into our natural landscape. With regards to water management, **Geoff Darch** (Anglian Water) showed how this information can be used to manage water supply and demand. UKCP18 will help answer questions such as what climate change means for water recharge and quality, and will inform the investments needed to make water infrastructure more resilient. Finally, **Dr Ella Howes** (CEFAS) outlined how climate services can be used for shoreline management, considering rising sea level, flood risks and storm surges.

Build with user engagement as a guiding principle, UKCP18 is quickly becoming the key tool to translate the climate science into effective climate mitigation and adaptation strategies appropriate to the lives of people, economic realities and infrastructures.