Neu U, Akperov MG, Bellenbaum N *et al.* 2013. IMILAST: a community effort to intercompare extratropical cyclone detection and tracking algorithms. *Bull. Am. Meteorol. Soc.* **94**: 529–547.

Parton G, Dore A, Vaughan G. 2010. A climatology of midtropospheric mesoscale strong wind events as observed by the MST radar, Aberystwyth. *Meteorol. Appl.* **17**: 340–354.

Schenkman AD, Xue M. 2016. Bow-echo mesovortices: a review. *Atmos. Res.* **170**: 1–13.

Schultz DM. 2001. Reexamining the cold conveyor belt. *Mon. Weather Rev.* **129**: 2205–2225.

Schultz DM, Browning KA. 2017. What is a sting jet? *Weather* **72**(3): 63–66.

Slater TP, Schultz DM, Vaughan G. 2015. Acceleration of near-surface strong winds in a dry, idealized extratropical cyclone. *Q. J. R. Meteorol. Soc.* **141**: 1004–1016.

Smart DJ, Browning KA. 2014. Attribution of strong winds to a cold conveyor belt and sting jet. *Q. J. R. Meteorol. Soc.* **140**: 595–610.

Weisman ML. 2001. Bow echoes: a tribute to TT Fujita. *Bull. Am. Meteorol. Soc.* **82**(1): 97–116.

Wheatley DM, Trapp RJ, Atkins NT. 2006. Radar and damage analysis of severe bow echoes observed during BAMEX. *Mon. Weather Rev.* **134**(3): 791–806.

Supporting Information

Table S1. Description of extreme surface gusts causing features during extra-tropical cyclones (following Earl *et al*. 2017).

Table S2. Sites used in study with all-time ranks, percentage and features for the 28, 29 and 30 September 2016. N/A represents not information on direction or timing of the gust, meaning that the feature could not be identified.

Correspondence to: N. Earl

nearl@unimelb.edu.au

doi:10.1002/wea.3384

Meeting report

Building a UK climate impacts and risk assessment community

On 14 January 2019, the first Climate Impacts and Risk Assessment National Meeting took place at the University of Bristol. It was a successful conference, with a total of 117 delegates representing 52 institutions across the UK, including the Met Office, National Centre for Atmospheric Science and the Committee on Climate Change (Figure 1).

The meeting provided a new platform for the UK climate impacts community within which to meet and discuss their latest research. It welcomed scientists from both social and physical disciplines; however, there was a greater attendance of physical scientists at the initial meeting. It, therefore, offered a new and necessary forum for building the science evidence-based research conducted in the UK regarding climate impacts and risk assessments for the upcoming Intergovernmental Panel on Climate Change (IPCC) AR6 report and the third UK Climate Change Risk Assessment (CCRA3). Currently, similar meetings, for example, the UK National Climate Dynamics Meeting and the Dynamics of Rotating Fluids Meeting, are being conducted for different research communities such as climate modelling, health impacts or climate dynamics. A connection between these types of groups, branching further than academia, would be beneficial in developing cross-disciplinary research. Specifically, more attendees from industry would be welcome at future meetings to help facilitate the translation of climate resilience into practice. The meeting's scope was similar to that of the IPCC Working Group 2, and although the initial meeting focused on science within the UK, it welcomed research of a global nature.

Dann Mitchell and Hayley Fowler, together with Richard Betts and Andy Challinor, formed the first organising committee of the Climate Impacts and Risk Assessment National Meeting, and the meeting's funding gratefully came from the Natural Environmental Research Council (NERC) Half a degree of Additional warming Prognosis, and Projected Impacts (HAPPI-Health) project.

The conference welcomed 23 speakers, some of whom were PhD students, and seven poster presentations from both industry and academia. Speakers gave presentations on their work relating to one of three themes: Climate Processes, Projections and Uncertainty (I); Integrated Impacts (II); and Risks and Adaptation (III). There were also two panel discussions that allowed space for ideas, questions and comments to be brought forward, addressing some of the key points raised during the day.

The conference was opened by Prof. Jens Marklof, Dean of Science at the University of Bristol, and the first session commenced with a talk by keynote speaker Kathryn Brown, Head of Adaptation at the Committee on Climate Change (CCC). Kathryn introduced the priorities of the CCC, an independent advisory organisation to the UK government, which monitors progress in meeting emissions targets and provides analysis on climate change science and policy. With the call for papers for CCRA3 fast approaching, Kathryn outlined the evidence gaps in current research and asked: '*Do academics feel their research is being used effectively?*' Many academics highlighted that there was a delay in published findings being translated into policy or being applied by industries. In response, one proposed solution was having an earlier collaboration with stakeholders from the initial stages of projects.

Modelling projections

Future climate scenarios will have impacts, both positive and negative, on all critical national infrastructures, including utilities and transport. As such, utilising the capability of generating very large ensembles of plausible future extreme events, in conjunction with impact models, is essential for understanding these possible futures. Sarah Sparrow, University of Oxford, spoke of *climateprediction.net* (CPDN) – an initiative that uses the computing power of a network of home computers for climate modelling. CPDN offers a unique facility to generate these large climate datasets, which include the most damaging events at the longest return times. These can be (and have been) used to drive a variety of impact models so that statistically significant statements can be made.

Projecting future climate is both complex and carries huge uncertainties. Pathways describe different climate futures, all of which represent possible changes in future anthropogenic emissions and aim to represent their atmospheric concentrations. Simona Pedde, Centre for Ecology & Hydrology, spoke on the development of five shared UK Socioeconomic Pathways for climate change impact and risk assessment. These pathways, which were made relevant for stakeholders via stakeholder workshops, incorporate a wealth of socioeconomic factors, including changes in technology and behaviour, and are used for testing policies and risks according to different drivers.

Figure 1. Pictures show those who attended the first Climate Impacts and Risk Assessment National Meeting at the University of Bristol, 14 January 2019.

When modelling projections, it is important to be aware of the methodologies used for generating climate scenarios, for example, aerosol concentrations can vary temporally between scenarios with different methodologies. Dann Mitchell, of the University of Bristol, spoke on the different methodologies, such as pattern scaling, climate model sampling and stabilisation at particular levels of warming, and highlighted the importance of knowing one's data inside-out.

Extreme rainfall and flooding

Hayley Fowler, Professor at Newcastle University, gave her talk on the projected increases in the intensity of short-duration rainfall extremes, while Haider Ali concluded that such extremes are very sensitive to air temperature in his poster. Hayley's work linked to a discussion on the simplified and out-dated use of academic findings with regard to flood defence design, which was brought up by Consultant Louise Parry and Senior Engineer Miguel Piedra from Arup. They called for the assessment and communication of up-to-date information to help bridge the gap between science and policy. In his poster, Stephen Blenkinsop of Newcastle University elaborated on the recent development of a quality-controlled hourly rainfall dataset, CONVEX, for the UK, which provides a useful resource for engineers to assess current natural hazards associated with flooding and pollution following periods of intense rainfall.

The impact of extreme weather on plant-services colonisation was presented by Simon Smart, Centre for Ecology and Hydrology, who discussed how flooding could result in vacant niche space and lead to colonisation failure. James Morrison of Forest Research, was concerned with the risks posed to UK woodland and forestry from extreme events. He outlined the need for improved modelling of the UK wind climate and a new individual tree model to improve the evaluation of adaptation in climate change wind risk assessments.

With 2.7% of their land at risk of flooding, the National Trust are committed to understanding the impacts of climate change by better integrating science into their organisation. Sally Brown of the University of Southampton, spoke of her time there and highlighted that education and coherent delivery of information are possible solutions in tackling their question: '*How do we communicate coastal management to the public?*'

The hydrological cycle

Kate Halladay, a Climate Impacts scientist at the Met Office, spoke about the projected reduction in Amazonian evapotranspiration with a doubling of CO_2 compared to pre-industrial levels. Using three simulations from CMIP5, her study found that a non-linear decrease in evapotranspiration change was mainly due to decreased stomatal conductance, a decreased canopy water gradient and an increased moisture gradient.

Afterwards, in her talk on estimating changes in future streamflow, Marie Ekström of Cardiff University expressed a concern for how the end user might interpret scientific findings in areas where there is large variation in outputs from studies using differing methodologies. She emphasised the need to communicate the real value of a regional climate projection with transparency and guidance as climate change can be very contextual, and special care is required in its use/interpretation.

Alison Kay, a mathematical modeller at the Centre for Ecology and Hydrology, then presented the impacts of climate change on river flows as part of the MaRIUS project (Managing the Risks, Impacts and Uncertainties of drought and water Scarcity). Models suggest that both droughts and floods could worsen under climate change but that their impacts will vary spatially with significant uncertainties in their magnitude, derived from a range of sources. Stakeholder engagement plays a large role in the project, which uses a risk-based approach to the management of droughts and water scarcity and assesses how risk metrics can be used to inform management decisions.

Heatwaves

Heatwaves are becoming increasingly common, with urban areas particularly at risk. In her Integrated Impacts talk, Clare Heaviside, University of Oxford, presented findings that anthropogenic climate change increased the risk of heat-related mortality in London by –20% during the 2003 European heatwave. Helen Macintyre from Public Health England discussed urban heat island mitigation techniques and suggested that painting roofs white in urban areas could reduce the heat-related mortality contribution of urban heat islands by 18%.

Chetan Deva, University of Leeds, spoke on his investigation into whether the structure and magnitude of agricultural heatwaves are affected by irrigation. The main finding was that high-temperature events are spatially coherent in both the vegetative and ripening periods of the main Indian rice-growing season but not in the reproductive period. An additional finding was that irrigation interrupts the spatial coherence of high temperature events in all phases of the main Indian rice-growing season.

Urban planning and infrastructure

Oliver Heidrich of Newcastle University illustrated in his poster that mitigation plans far outnumber adaptation plans across

European cities and stressed that thoughtful guidance is needed to provide effective adaptation of infrastructure.

An example of such guidance came from Michael Sanderson of the Met Office who spoke on the Natural Hazards Project, funded by the Energy Technologies Institute. This series of high-quality, peer-reviewed reports summarises the key natural hazards for UK energy infrastructure in a way that makes it accessible to those responsible for high-value energy infrastructure.

Food security

It is vital that agricultural systems transform in order to effectively support development and ensure food security in a changing climate (Lipper *et al.,* 2014). Climate-smart agriculture (CSA) is an approach that helps guide the actions needed for such a transformation and seeks to sustainably increase productivity and incomes, adapt and build resilience to climate change and concurrently reduce/remove greenhouse gas emissions where possible.

Stewart Jennings of the University of Leeds, spoke on his exploration of modelling climate-smart, food-secure pathways in sub-Saharan Africa. He developed a modelling framework, driven by stakeholder inputs, to help deliver policy-relevant, sustainable agricultural futures in sub-Saharan Africa. His early results show that the maize model (GLAM) has a high skill in simulating yields.

The evidence related to CSA demonstrates the pertinence of scaling up the practices framed under such an approach. However, there is no replicable measure of climate smartness that captures its trade-off between adaptation, mitigation and productivity simultaneously, and often, the interpretations of climate smartness could easily turn subjective. Additionally, Laura Arenas-Calle, a PhD student at the University of Leeds, presented a replicable Climate-Smartness Index (CSI), combining normalised water productivity and greenhouse gas intensity – which has been designed to offer a single quantitative metric of climate smartness for systems that use water management to adapt to climate change.

Ben Parkes, University of Manchester, highlighted the importance of selecting the appropriate weather dataset when estimating crop yield response due to huge variations observed between studies. Ioannis Droutsas, a PhD student at the University of Leeds, explained a dynamic crop modelling methodology: the Simultaneous Equation Modelling Approach for Annual Crops (SEMAC). It is used for simulating crop growth and development, and it was implemented in the GLAM crop model, resulting in the new version: GLAM-Parti. The new version improves upon the simulation of drought stress effects on wheat due to an improved biomass partitioning scheme, reduced parameterisation requirements and improved internal model consistency.

Pete Falloon, Met Office, addressed the challenges regarding considerable variation in crop responses in food security impact studies, suggesting that there is a need to bring together models, indices, datasets and research. Further ideas were sparked at this stage when contemplating the possibility of using a modular modelling framework, introduced in a talk by Nans Addor of the University of East Anglia.

Health

The World Health Organisation (2017) reports that vector-borne diseases cause more than 700 000 deaths annually, accounting for over 17% of all infectious diseases. With climate change regarded as a principal driver of the northward movement of certain species, for example, ticks carrying Lyme disease within Europe (European Environment Agency, 2016), understanding the risks vector-borne diseases pose to the UK is therefore of great importance.

Ana Vicedo-Cabrera, London School of Hygiene and Tropical Medicine, discussed a framework for impact modelling the effect of climate change projections on human health, in relation to the air temperature and mortality, and indicated that the uncertainty comes from climate projections and exposure–response functions.

Malaria is a widespread disease with a significant health burden, and its distribution relies on the state of the climate, as well as the local capability to control the disease. It is expected that there will be a global increase in climate suitability for Malaria-carrying mosquitos and an increase in the population at risk; however, these findings are not without their uncertainty. Andy Morse, University of Liverpool, raised this issue in his talk on assessing the risk of vector-borne diseases using climate model output and the impact of climate change. He attributed it to uncertainty within the disease models or their responses and called for further impact model development in this area in order to reduce these uncertainties.

Final discussion

A final panel discussion concluded the meeting with calls to further the conversation about secondary impacts of climate change, especially regarding the UK. Comments were raised as to whether more could be done regarding the engagement with city councils to develop an understanding a sense of climate urgency. The consensus opinion of the meeting was for a more rapid and efficient translation of academic findings into climate action. It was clear that there were missing links with social science and industry, and so, future meetings would benefit from having more representatives from these groups.

Next steps

The first Climate Impacts and Risk Assessment National Meeting was very popular, showing the gap in current meetings in this area. It is hoped to continue the meetings on a biannual basis. The next conference is scheduled to take place across 2 days, on the 11th and 12th of September 2019, at the University of Leeds. It will focus on climate risks, impacts and resilience planning across the UK, aiming to address some of the points raised during the initial meeting with the aims to (a) gather evidence for the Working Group 2 report for IPCC AR6; (b) gather evidence for the working papers being developed for the third UK Climate Change Risk Assessment (CCRA3); and (c) contribute to a special issue of an international journal focussed on UK Climate Impacts, Risk and Resilience Assessment. Please contact Louise Beveridge (eelb@leeds.ac.uk) or visit the event page (http://climate.leeds.ac.uk/events/climate-impact-and-risk-assessment-national-meeting/) for further information.

References

Lipper L, Thornton P, Campbell BM *et al.* 2014. Climate-smart agriculture for food security. *Nat. Clim. Change* **4**: 1068–1072, https://10.1038/nclimate2437.

World Health Organisation. 2017. Vector-borne diseases [online]. World Health Organisation. https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases (accessed 4 June 2019).

European Environment Agency. 2016. Vector-borne diseases [online]. European Environment Agency. https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016 (accessed 11 July 2019).

Correspondence to: E. Vosper

emily.vosper@bristol.ac.uk

doi:10.1002/wea.3592