CONVEX EXTREME RAINFALL WORKSHOP: SUMMARY

http://research.ncl.ac.uk/convex/

This document is a summary of the first CONVEX (CONVective EXtremes) workshop held on the 17th and 18th April 2012 at Reading University. It provides a summary of the main themes and discussion points from the workshop and is split into 3 short sections. The first two reflect the aims of CONVEX, the first looking at how the scientific community might best meet the needs of users of climate information, attempting to bridge the gap between the climate modelling community and the end users of climate information. The second section addresses the state-of-the-art in our understanding of extreme rainfall events and how they might change in the future. A third section summarises how CONVEX plans to act on the information gathered at the workshop.

If you are interested in reading the more detailed minutes of the meeting an additional document is available from Dr. Stephen Blenkinsop (s.blenkinsop@ncl.ac.uk) and some of the presentations from the workshop are now available online from the CONVEX web site at http://research.ncl.ac.uk/convex/outputs/convex2012workshop/.

1. Providing user-relevant outputs from climate research

The first day of the workshop focussed on the interaction between researchers and end users. It started by introducing the project and providing an overview of current climate modelling capabilities - explaining where we currently have confidence (or lack of) in results and how this provides the rationale behind developments CONVEX is making in high resolution climate modelling. The day also saw presentations from Heather Lammas (Worcestershire County Council) and Juliette Daniels (London Climate Change Partnership). Heather presented information on how extreme events impact the region with attention to the economic and social impacts of the 2007 floods whilst Juliette discussed the practical challenges associated with using climate information and models for stakeholder engagement. A need to move beyond the delivery of results to an active two-way information exchange with users was a clear message that emerged from these discussions which provided an extremely useful backdrop for several discussions on the application of climate model outputs and how CONVEX might improve on existing knowledge and practice.

The first discussion session sought to identify **the minimum and ideal requirements from climate models and their projections for users of climate information**. Some of the significant points raised during the discussion were:

- Requirements for hydrological modelling depend on catchment and event type. Data on hourly timescales are required, especially for flash flooding or transport drainage. For persistent drought, the number of dry/wet days needs to be accurately represented and hence may benefit from 1.5km climate modelling.
- Quantitative information from models was seen as essential but some use for qualitative information was identified, for example, removing uncertainty over the direction of change for summer rainfall.
- There is significant interest in the persistence of dry conditions for the study of drought which requires quantitative information, including time series of rainfall, and multi-variable inputs.
- Ideally time series data were identified as most useful, but in case of derived metrics it would be useful to have additional information about any changes in clustering of events in time.
- Rather than a reliance solely on return levels there is a requirement for information on thresholds, sensitivities and tipping points which are relevant to users, for example, thresholds for “flashy” catchments.
- Information on the reliability of (or our confidence in) various aspects of model outputs (i.e. different variables, variability, persistence) may be as useful as improved model precision for some applications.
- There is an interest in baseline vulnerability as well as future projections and the former should not be neglected.

A second discussion session centred on **how the utility of climate projections can be maximised for policy makers and flood risk assessment** around three themes:

User-identified difficulties and limitations in current climate products

A series of *practical issues* were identified that were largely related to the volume of data provided making data use challenging. Some users highlighted a high resource requirement to identify, understand, obtain, and use much climate data which is compounded by different products using different formats and structures. Understanding the relevance and limitations of individual products and their effective use is therefore difficult. *Fundamental deficiencies* in current climate products that were identified included the low resolution of model output and poor representation of extremes (particularly the reliability of model simulations of events with long return periods); issues that are central to CONVEX. The lack of clear information on how to investigate combinations of risks was also highlighted, for example, examining water quality after a dry spell. This was associated with issues related to the *interaction between the scientific and end-user communities* centred on the lack of understanding of the problems the end user community is seeking to address. In communicating their work it was noted that researchers need to provide a narrative which links that work to an understanding of these problems. However, it was suggested that this is not straightforward as different sectors require different outputs/messages.

Overcoming these issues to increase the utility of outputs from CONVEX

Several approaches to tackle some of these issues were raised in the discussion.

- An analysis of extremes could use regional data pooling to overcome the constraints on the temporal availability of observed and modelled data.
- General concerns regarding the robustness of projections could be addressed through the provision of quality standards or ratings to communicate quality of individual climate products.
- Results and messages need to be tailored to end user needs with different requirements to balance detail and simplicity. In some instances large volumes of data have limited use whereas narratives are useful although these need to go beyond climate descriptions as these are of limited use to many.
- Many of these issues can be resolved through two-way dialogues about end user requirements but this process should be a continuous one.

How CONVEX and the wider research community can better communicate with end users?

One of the key points raised was that the output or associated messages provided by CONVEX should be set in the context of existing tools and knowledge that users are familiar with, highlighting the differences between new and existing knowledge and practice. This applies to new analysis of historical observations and model output. For example, it was suggested that the former should be communicated in the context of information provided in the Flood Estimation Handbook whilst the latter should be related to products such as UKCP09 or ENSEMBLES. It was also argued that users frequently want simplified, resonating messages e.g. for businesses at senior/director level, local authorities and politicians. Simple summaries of methods used, data provenance etc., should be provided with project outputs which should engage users, e.g. interactive, layered maps. It was also suggested that terminology must be appropriate for the audience, for example, for many “annual expected probability” is more readily interpretable than return period.

2. Scientific understanding of extreme rainfall

The second day of the workshop focussed on the science questions that CONVEX and other projects are seeking to address. The day saw a series of presentations from the CONVEX team outlining progress on the observational and climate modelling work within the project. Stephen Blenkinsop outlined work on the analysis of observational data, currently centred on the study of hourly rainfall gauge data and how this will be used in association with other variables to gain a better understanding of the processes responsible for the generation of heavy rainfall events. Steven Chan and Lizzie Kendon presented results from the climate modelling component of CONVEX. Steven compared the representation of precipitation in 50 km, 12 km and 1.5 km models and has identified an improvement in orographic precipitation at higher resolution in the north-west of the main study domain (southern Britain). Over the south-east of the domain there is no improvement in mean precipitation with increased resolution although more realistic, higher frequencies of heavy precipitation are produced. Lizzie summarised initial results from the ERA-interim driven 20-year run of the 1.5 km model which show that at this resolution the model appears to give a better representation of rainfall occurrence and a more realistic spatial and temporal structure of heavy rainfall, although such events tend to be too intense. This work has now been published by the Journal of Climate and is summarised in more detail in the current CONVEX newsletter. Nigel Roberts concluded the CONVEX presentations by presenting results from several studies examining flood-producing storms in convection-permitting Numerical Weather Prediction models. Such models can represent such storms whereas previous models were unable to do so; however, modelled storms are rarely in the right place.

Presentations were also given from other projects in the Changing Water Cycle (CWC) and Storm Risk Mitigation (SRM) Programmes, demonstrating the range of complementary research currently being undertaken.

- Richard Allen (Horyuji PAGODA) presented global-scale analyses of precipitation trends and the role of climate model resolution on the transport of moisture. Changes in modelled and satellite-based tropical precipitation and future projections from CMIP5 models indicate a robust drying of dry tropical land.
- David Lavers (HYDEF) described atmospheric rivers, regions of moisture transfer from the subtropics to the mid-latitudes and their association with winter floods in the UK, particularly in fast-responding basins in the western UK.
- Chris Taylor (SWELTER-21) summarised work aimed at understanding how feedbacks within the water cycle affect hydrological stores and fluxes and whether soil moisture feedbacks will increase the frequency of summer droughts across Europe. The soil water influence on convection was examined on regional and global scales which included the application of CMIP5 models.
- Cameron Rye (HYDRA) presented results from climateprediction.net. A new experiment, “weatherathome.net” is using a regional climate model (HadRM3P) to assess simulated precipitation using a perturbed physics ensemble. This was demonstrated with reference to the predictability of precipitation for the Congo basin in Africa.
- Adrian Champion (DEMON) described dynamical downscaling over a range of resolutions on numerical weather prediction (NWP) timescales. This is an ECMWF

operational analysis using the Unified Model at 12km, 4km and 1.5km resolution with lead times out to 48 hours, as beyond this rainfall becomes unrealistic. One of the aims will be to generate high temporal and spatial resolution datasets for use in hydrological models.

In addition, Jessica Loriaux from the Delft University of Technology in the Netherlands described her PhD work examining the influence of temperature on the increase of (sub-) hourly rainfall extremes and the potential for hourly convective extremes to be associated with "super" scaling with temperature (up to 2x the Clausius–Clapeyron relationship). We were also delighted to welcome our keynote speaker, Prof. Erik Kjellström from the Swedish Meteorological and Hydrological Institute (SMHI). Prof. Kjellström provided a review of regional climate model (RCM) simulations of European precipitation extremes demonstrated through results from the ENSEMBLES project. Of particular relevance was the current work investigating the benefits of high-resolution RCMs, running the RCA3 (hydrostatic model) at resolutions of 50km to 6km and the development of the non-hydrostatic RCM HARMONIE, run at 2km resolution for a 5 year period.

The main discussion of the day focussed on potential research links in this field of study. Two common topics that emerged strongly included interest in the large-scale drivers of localised extreme events and the links between soil moisture and convection.

In particular, the nature of potential collaborative opportunities with other CWC and SRM projects were identified, for example:

- DIAMET - centred on the role of latent heating in the structure of extra-tropical cyclones and associated feedbacks;
- DEMON - a potential focus on numerical weather prediction of storms;
- DYMECS - use of the Chilbolton radar to examine the structure of storms;
- SWELTER-21 - potential further exploration of links between convection and soil moisture;
- HYDEF - links with hydrological modelling and analysis of large-scale drivers of precipitation;
- TEMPEST - examining extratropical cyclones including the quantification of key processes that determine the range of model projections and their response to climate change in high resolution global model experiments

Wider international collaborations such as the ECLISE project and the CORDEX network were also noted, and in particular the opportunity to foster links between CONVEX and SMHI emerged with regards to high resolution RCM simulations. Links with hydrological modelling work would also provide a potential application for high resolution data with the suggestion of the Thames as a potential test catchment. It was noted that the discussions taking place on the previous day regarding end user engagement should not be disregarded as the science must increasingly start by asking "What are the questions that need answering?" with a subsequent need to "market" results directly to users.

3. Using the workshop contributions to inform our research

In response to comments and suggestions made at the workshop we have identified many areas which could be pursued by researchers in CONVEX. Provided below are some of the areas that we considered offered the potential for CONVEX to improve its ability to meet the needs of users. It should be stressed that there are many other ideas which will continue to be appraised as the project's progresses and we would continue to welcome any further thoughts or comments.

- The issue of drought and persistence was raised several times during the course of the meeting. We therefore plan to investigate (time-permitting within CONVEX) the clustering of rainfall in time in the 1.5km and 12km RCMs, with a view to characterising whether there is a different representation of drought in the model at very high resolution. The persistence and clustering of heavy events as well as extreme rainfall intensity will also be explored.
- The project provides the opportunity to examine whether there is any evidence of urban influence on the initiation and evolution of convection over London. In this region we have good confidence in the radar data, so this can be used to validate behaviour in the 1.5km RCM. We also have several different observed rainfall datasets over this area, comprising both radar and rainfall gauge data. This provides the opportunity to compare these to gain a reliable picture of current rainfall characteristics over London.
- Further investigation of the relationships between soil moisture and convective initiation in the 1.5km RCM may be undertaken in collaboration with other CWC projects, particularly SWELTER-21.
- The Flood Estimation Handbook (FEH) was identified as a major tool widely used by practitioners in the water sector and some analysis of observed historical data used in CONVEX will be undertaken in the context of information presented in the FEH.
- It was pointed out that there will be considerable interest in high resolution simulations/data outside the main southern UK study area and that the project should not be limited in terms of dissemination to this domain. In the first instance, links established with SMHI will be developed to utilise synergies between work on development of high resolution RCM simulations.
- We are very aware of the importance of continuing communication with the academic and user communities and will maintain regular communication via newsletter, internet and social media and would continue to welcome comments and feedback.
- We have identified a need to broaden the reach of CONVEX following suggestions that we establish links and engage with representatives from a wide range of institutions, including planning authorities, trade organisations, regulatory authorities and other water companies). This engagement will need to be considered outside the framework of formal events like this workshop.
- The importance of developing narratives which summarise our work is recognised and this will be incorporated into our results as we translate academic outputs to

formats which are relevant to different sectors. This will need to be developed alongside the relationships identified above.