Geophysical Research Abstracts
Vol. 15, EGU2013-10551-2, 2013
EGU General Assembly 2013

Hourly and multi-hourly extreme precipitation climatology for the UK and long-term changes in extremes

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It is likely that changes to the intensity and frequency of climatic and hydrologic extremes as a result of climate change will have large impacts on UK communities. The CONVEX (CONVective EXtremes) project is combining observational evidence and understanding from new modelling capabilities to explore key uncertainties (e.g. rainfall mechanisms, model parameterisations and model resolution) in the simulation of extreme rainfall processes by climate models. However, a better understanding of climate model deficiencies first requires an improved understanding of observed precipitation extremes.

UK (multi-) daily precipitation records have been comprehensively analysed over recent years however sub-daily precipitation is less well understood. There is a need therefore from practitioners engaged in building adaptive capacity to the risk of increased extreme rainfall and flooding for a comprehensive analysis of such historical precipitation data. This work therefore analyses newly combined hourly rainfall gauge data from a number of different sources to establish an up-to-date, spatially extensive, sub-daily precipitation climatology for the UK. Precipitation observations are analysed and presented for a range of accumulations from 1h to 24h.

This work presents analyses showing the spatial variability of annual and seasonal UK sub-daily precipitation, including means and variability but with a focus on both the frequency and intensity of extremes. Extreme events are defined using a range of methods including fixed thresholds, Extreme Rainfall Alert (ERA) thresholds issued by the UK Flood Forecasting Centre, annual maxima and extreme value theory using a peaks-over-threshold approach. As one of the key aims of CONVEX is to assess the performance of new 1.5 km resolution, convection-permitting, regional climate model simulations against coarser resolution models with convective parameterisation, particular attention is paid to short-duration summer extremes. In addition, seasonal spatial patterns in (multi-) hourly precipitation distributions are examined, along with variations in the relationships between different precipitation accumulation periods.

Although the number and therefore spatial extent of long-term hourly precipitation gauges is relatively limited, some UK hourly gauge records exist for over 40 years and where such records exist longer term changes and variability in extremes are identified.

Subsequent work in the CONVEX project will build upon this climatology to identify the drivers of extreme events to better understand the key processes responsible. This in turn will provide a better means of identifying the strengths and weaknesses in the ability of climate models to simulate extreme precipitation events and, importantly, the processes which generate them.