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Dynamically Downscaling Precipitation from Extra-Tropical Cyclones

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Recent flooding events experienced by the UK and Western Europe have highlighted the potential disruption caused by precipitation associated with extra-tropical cyclones. The question as to the effect of a warming climate on these events also needs to be addressed to determine whether such events will become more frequent or more intense in the future. The changes in precipitation can be addressed through the use of Global Climate Models (GCMs), however the resolution of GCMs are often too coarse to drive hydrological models, required to investigate any flooding that may be associated with the precipitation.

The changes to the precipitation associated with extra-tropical cyclones are investigated by tracking cyclones in two resolutions of the ECHAM5 GCM, T213 and T319 for 20th and 21st century climate simulations. It is shown that the intensity of extreme precipitation associated with extra-tropical cyclones is predicted to increase in a warmer climate at both resolutions. It was also found that the increase in resolution shows an increase in the number of extreme events for several fields, including precipitation; however it is also seen that the magnitude of the response is not uniform across the seasons. The tails of the distributions are investigated using Extreme Value Theory (EVT) using a Generalised Pareto Distribution (GPD) with a Peaks over Threshold (POT) method, calculating return periods for given return levels.

From the cyclones identified in the T213 resolution of the GCM a small number of cyclones were selected that pass over the UK, travelling from the South-West to the North-East. These are cyclones that are more likely to have large amounts of moisture associated with them and therefore potentially being associated with large precipitation intensities. Four cyclones from each climate were then selected to drive a Limited Area Model (LAM), to gain a more realistic representation of the precipitation associated with each extra-tropical cyclone. The suitability of the LAM for downscaling was evaluated by running the LAM for the events of June and July 2007 (UK floods) and comparing the output to observations. The results from this comparison provide confidence that the model is able of reproducing realistic intensities for extreme precipitation events.

Whilst this method does not allow for a robust comparison between the climates it does for allow for an analysis of the method, and whether dynamically downscaling individual events is suitable. It was found that by nesting the LAM within the GCM, large increases in the precipitation intensities were seen, as well as gaining a greater temporal resolution. Analysis of more events will allow a more robust comparison between climates.