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Extreme Precipitation from Extra-Tropical Storms: A Limited Area Model Climate Change Analysis

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Extreme precipitation events from extra-tropical storms have caused widespread disruption in recent years to the UK and Western Europe. There are many difficulties in forecasting extreme precipitation events, from the duration to the intensity and location of such events. 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.

Firstly two past extreme precipitation events that caused disruption and damage to large parts of the UK in the summer of 2007 are studied. A Limited Area Model (LAM) is used to investigate the ability of Numerical Weather Prediction models to forecast the intensity and location of extreme precipitation events. For this work the UK Met Office UM vn6.1 is used in a limited area mode. The importance of resolution is discussed by comparing the results from 12km and 4km resolution runs of the LAM. The effect of the lead-time and spin-up time in the forecast models is also discussed. It is shown that for a 48 hour forecast, a lead-time of 12 hours produces intensities that correlate closest to raingauge observations. The 6 hour spin-up time for precipitation is also shown.

As a next step the changes to extra-tropical storms in a warmer climate are discussed, by tracking storms in the high-resolution ECHAM 5 T319 Global Climate Model (GCM). Using a tracking algorithm, extra-tropical storms were tracked in a 20th century and a 21st century climate. It is shown that the intensity of extreme precipitation from extra-tropical storms is predicted to increase in a warmer climate. The higher resolution T319 run was also compared to the T213 run to investigate the effect of an increase in resolution on the frequency distributions. It was 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 to study the extreme precipitation events. Return level plots, showing that for a 3.5 mm/hr event the return level reduces from 5 years to 0.5 years for DJF, are presented for all seasons.

The two strands of this work are brought together by identifying events, in both the 20th and 21st century simulations within the T213 ECHAM5 model, that cause extreme precipitation and have similar conditions as the case studies, identified by the tracking algorithm. These events are downscaled to use as boundary conditions for the LAMs. Preliminary results from this downscaling are presented.