1. Introduction

Extreme precipitation is a major natural hazard in the United Kingdom. To assess likely future impacts of extreme precipitation on local scales it is important to understand changes in the intensity of extreme precipitation on decadal and multidecadal time scales. Ultimately, this also requires to (1) understand the natural variability of local precipitation extremes and the relationship to its large scale driving processes, and (2) how regional climate models reproduce variability and relationships respectively.

First, we investigate the relationship between synoptic scale airflow and local extreme daily precipitation, based on a set of 689 rain gauges across the UK. The relationships show pronounced spatial patterns related to the interaction between airflow, orography, and the surrounding seas. Second, we evaluate the representation of precipitation extremes and its relationship with large scale atmospheric flow in a set of 18 25km-resolution regional climate models (RCMs) used in the ENSEMBLES project. Common metrics to evaluate RCM simulated precipitation such as mean precipitation or numbers of wet days do not assess the representation of physical mechanisms causing precipitation events, i.e. the representation of potential drivers and the relationships between these drivers and precipitation. Yet this shortcoming might be crucial when different mechanisms affect precipitation, and when these mechanisms respond differently to climate change. Here, we apply the inferred relationships as metrics to evaluate the representation of physical relationships by comparing the spatial patterns of the observed relationships with the spatial patterns of the simulated relationships.

2. Data and Statistical Model

**Observational:**
1. **UKMO:** 5km gridded daily data from Perry et al., 2009, 1958-2005; averaged to 25km.
2. **EOBS:** 25km gridded daily data from Haylock et al., 2008, used are 1961-2000.

**RCM data:**
14 RCMs from the ENSEMBLES project, 25 km resolution, driven with ERA40 reanalysis, 1981-2000; available from ensembles.erslim.dk

**Airflow:**
daily strength $s$, direction $d$ and vorticity $v$ calculated from sea level pressure in the area $45^\circ$S-$65^\circ$N, 20W-10E

**Generalised extreme value distribution**
We model the monthly maxima of daily precipitation in each month, occurring at day $i$ using the GEV (e.g. Coles, 2001).

**Vector generalised linear model (VGLM)**
We model the influence of the airflow covariates on the GEV parameters using a VGLM (Yee and Stephenson, 2007).

3. Example Grid Box (West Scotland, 57°N, 5°W)

4. Spatial Relationships

5. Model Evaluation Relative to UKMO

6. Summary

1. Airflow exhibits a strong influence on UK daily precipitation extremes, with a spatial pattern related to the interplay between the prevailing westerlies, the surrounding seas and orography.
2. The selected ENSEMBLES 25 km resolution RCMs simulate the relationship between synoptic airflow and extreme precipitation reasonably well. However, the dependence on cyclonic vorticity and direction is considerably biased. These biases might affect regional projections of future precipitation extremes in the corresponding areas of the United Kingdom.

References:
3. Yee and Stephenson, 2007
8. Haylock et al., 2008
9. Maraun, D; Meier, M; Weisheimer, A; Doblas-Reyes, FJ. Relationships between UK precipitation and large-scale circulation patterns. Clim. Dyn., 2010
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