Evaluating 21st century projections of anticyclonic weather frequency and persistence over the British Isles

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Hydro-meteorological hazards such as heatwaves, droughts and flooding are often linked to persistent weather patterns[1]. In this study we investigated the ability of a CMIP5 multi-model ensemble (MME) of 10 GCMs at reproducing seasonal frequencies and lag-1 persistence[2] of anticyclonic (A) weather patterns[3, 4] over the British Isles (BI). Historical runs, along with 21st century projections of A-type occurrence and persistence under RCP8.5, provide a basis for evaluating climate models and inferred impacts on society.

A-type frequency is projected to increase significantly ($p<0.01$) under RCP8.5 (2006-2100) during summer (June-August). A-type persistence shows large variability within the MME and is on average underestimated in winter (December-November), but within other seasons there is better agreement when compared with reanalyses (i.e. ERA-20CR and NCEP-NCAR, during the historical period 1971-2000). Changes in A-type persistence between the MME historical and 2020s, 2050s and 2080s within RCP8.5 are not statistically significant according to the Mann-Whitney-Wilcoxon two-tailed test. However, when testing the statistical significance of each GCM within the MME using boot-strapping (n=1,000 simulations), all RCP8.5 model projections fall outside the 95% confidence intervals of historical persistence. Our results show that A-type persistence increases during summer. Greater A-type frequency and persistence during summer implies increased likelihood of blocking episodes that could translate into higher risk of droughts, heatwaves and episodes of severe air pollution.

Assessing changes in the frequency and persistence of the A-type is useful for diagnosing GCMs realism and also provides a basis for investigating future variations and narratives for hydro-meteorological hazards. CMIP5 models lack the ability in reproducing A-type activity at mid-latitudes, an issue that hopefully will be addressed by the next generation of high-resolution models that will be used in CMIP6. Our pragmatic approach is readily applicable to weather types linked to flooding (e.g. cyclonic and westerly), as well to other mid-latitude regions with objective weather classification schemes in Europe and North America.

References

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