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Extremely Warm Days in the United Kingdom in Winter 2018/19

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CMIP5 models and evaluation.

The models used in the analysis are ACCESS 1.3, BCC-CSM1, CanESM2, CCSM4, CESM1-CAM5, CNRM-CM5, CSIRO-Mk3.6, GFDL CM3, GFDL-ESM2M, HadGEM2-ES, IPSL-CM5A-LR, IPSL-CM5A-MR, MIROC-ESM, MIROC-ESM-CHEM, MRI-CGCM3, and NorESM1-M.

Simulated long-term trends of the warmest day in winter are consistent with the expected range from CET observations (Fig. S1a), but the modeled variability is smaller than the observed (Fig. S1b). To reconcile the discrepancy, each simulation is inflated, after removing the forced response, to have the same standard deviation as the observations and the forced response is then added back. After the correction, power spectra (Fig. S1c) and quantile–quantile (Q-Q) plots (Fig. S1d) show that the modeled variability and distribution are in good agreement with the observations.

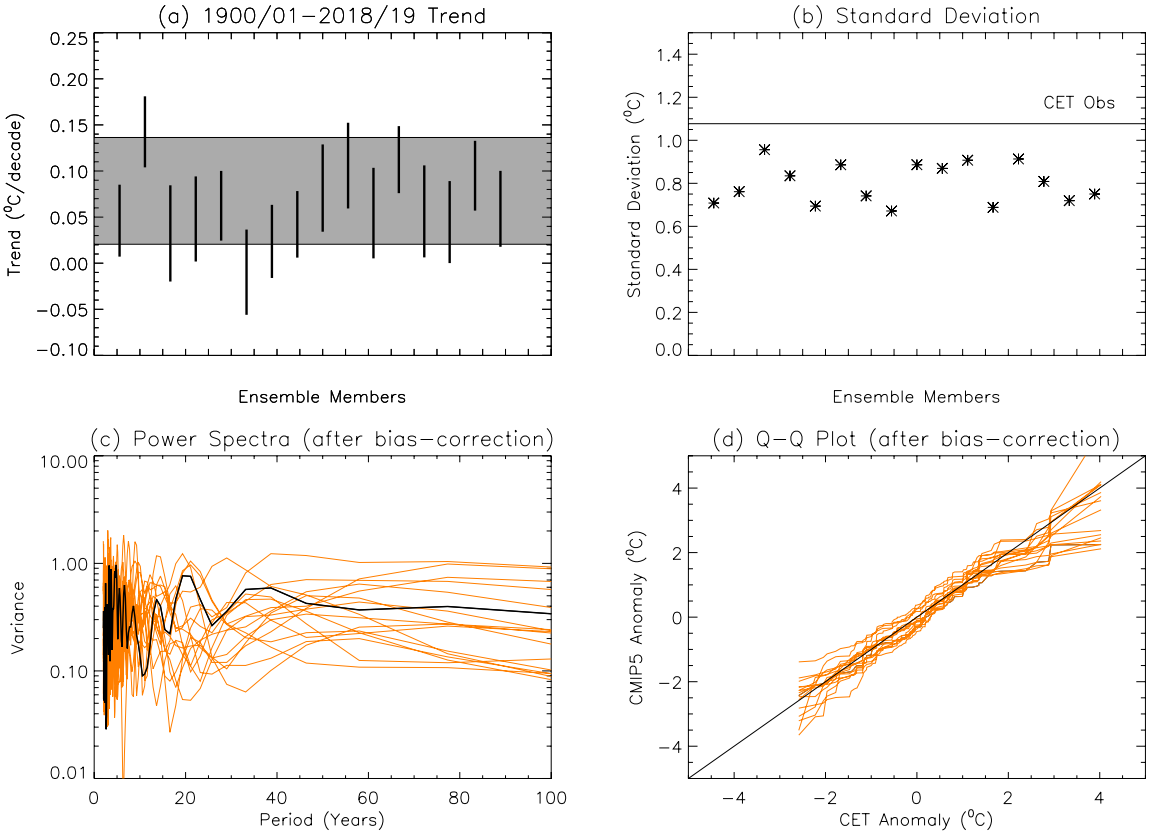

Fig. S1. Model evaluation. (a) The ±2 standard deviation range of the 190%1–2018/19 trend in the warmest day in winter in central England calculated with least squares fits using observations (gray area) and CMIP5 ALL experiment data (vertical bars). (b) Standard deviation over the observational period estimated with the Central England temperature dataset (CET; horizontal line) and the ALL simulations after removing an estimate of the forced response (mean of ALL simulations). (c) Power spectra from the observations (black line) and the CMIP5 simulations (orange lines). (c) Qunatile–quantile (Q-Q) plots for each of the ALL simulations.

HadGEM3-A simulations.

The Hadley Centre attribution system (Christidis et al. 2013; Ciavarella et al. 2018) generates two 525-member ensembles of simulations for the ALL and NAT climate on a monthly basis in a quasi-operational framework. Observed sea surface temperatures (SSTs) and sea ice from the HadISST dataset are prescribed in the ALL simulations, while the anthropogenic change (estimated from CMIP5 models) is subtracted from the HadISST data prescribed in the NAT simulations (Christidis et al. 2013). Daily Tmax data from the simulations for December 2018–February 2019 are used in this study. Fifteen simulations of the historical climate over

the period 1960–20 are also available and used to evaluate the model. As with the CMIP5 models, the HadGEM3-A variance is found to be small and is corrected to be consistent with the observations.

It is not possible to estimate return times with HadGEM3-A for the 2018/19 event, mainly because conditioning on the observed oceanic state leads to a narrower distribution as discussed in the paper. HadGEM3-A also yields a smaller anthropogenic warming over 1960–2012 than the CMIP5 ensemble (by +0.25°C), but even with this additional warming, the likelihood of the event would still be too small to be estimated. As Kendon et al. (2020) suggest, the role of the atmospheric circulation is key for the event, hence conditioning the results on the circulation (e.g., by selecting only winters with a similar circulation pattern) would be expected to shift the modeled distribution more toward the observed anomaly.