

**Supplementary Information for ‘Embracing the complexity of extreme weather events when quantifying their likelihood of recurrence in a warming world’**

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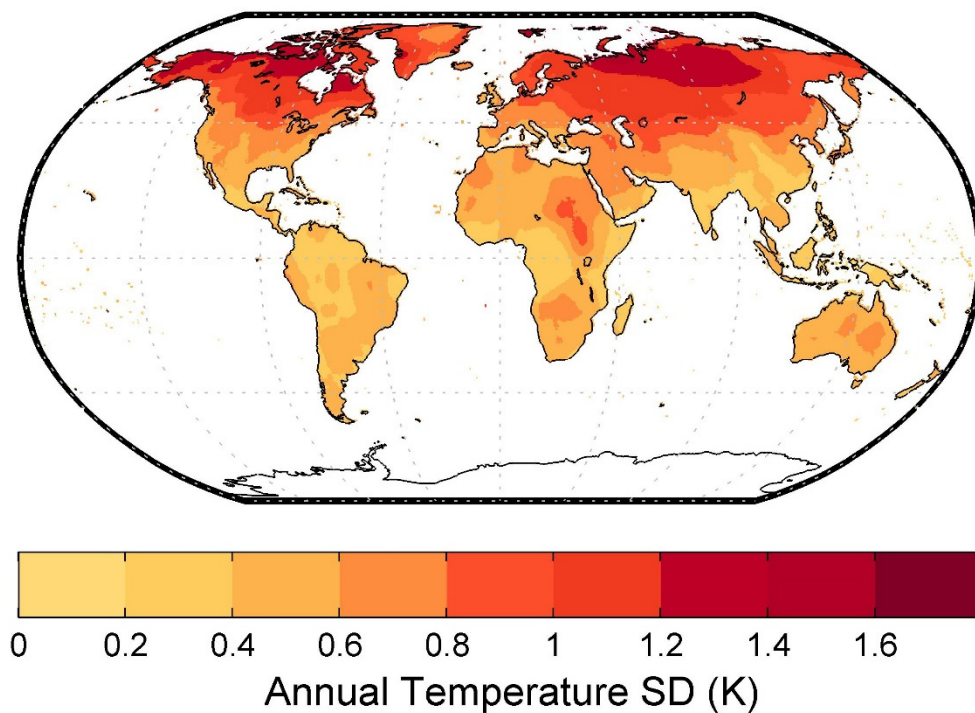
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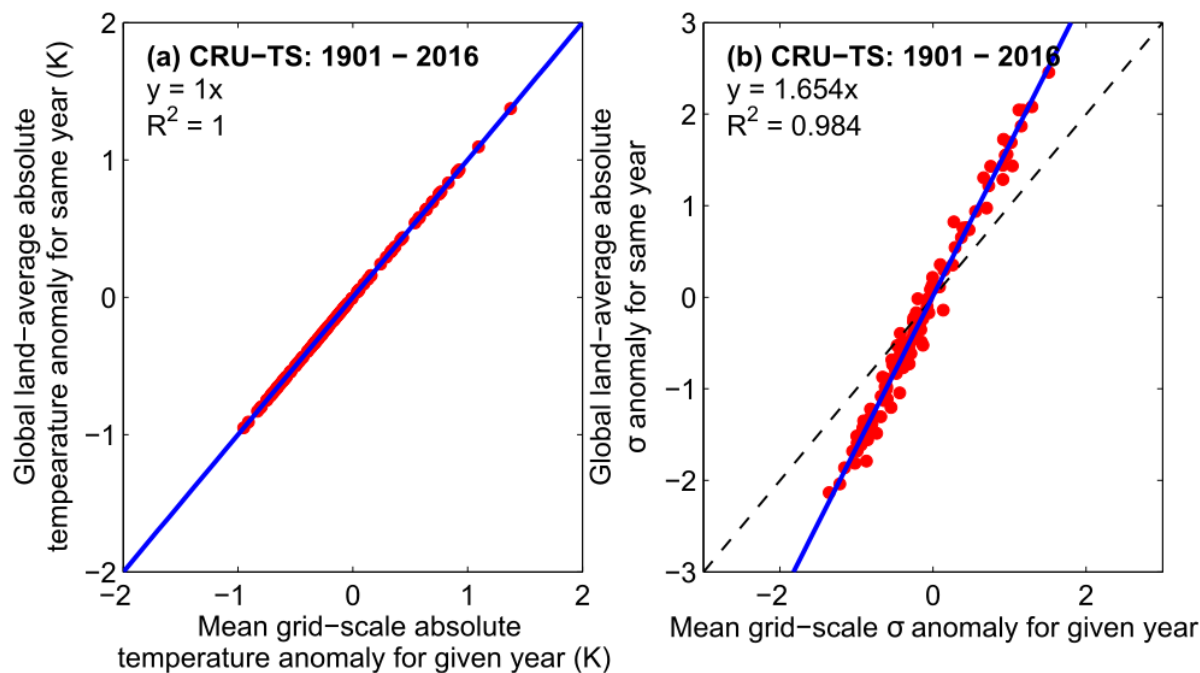
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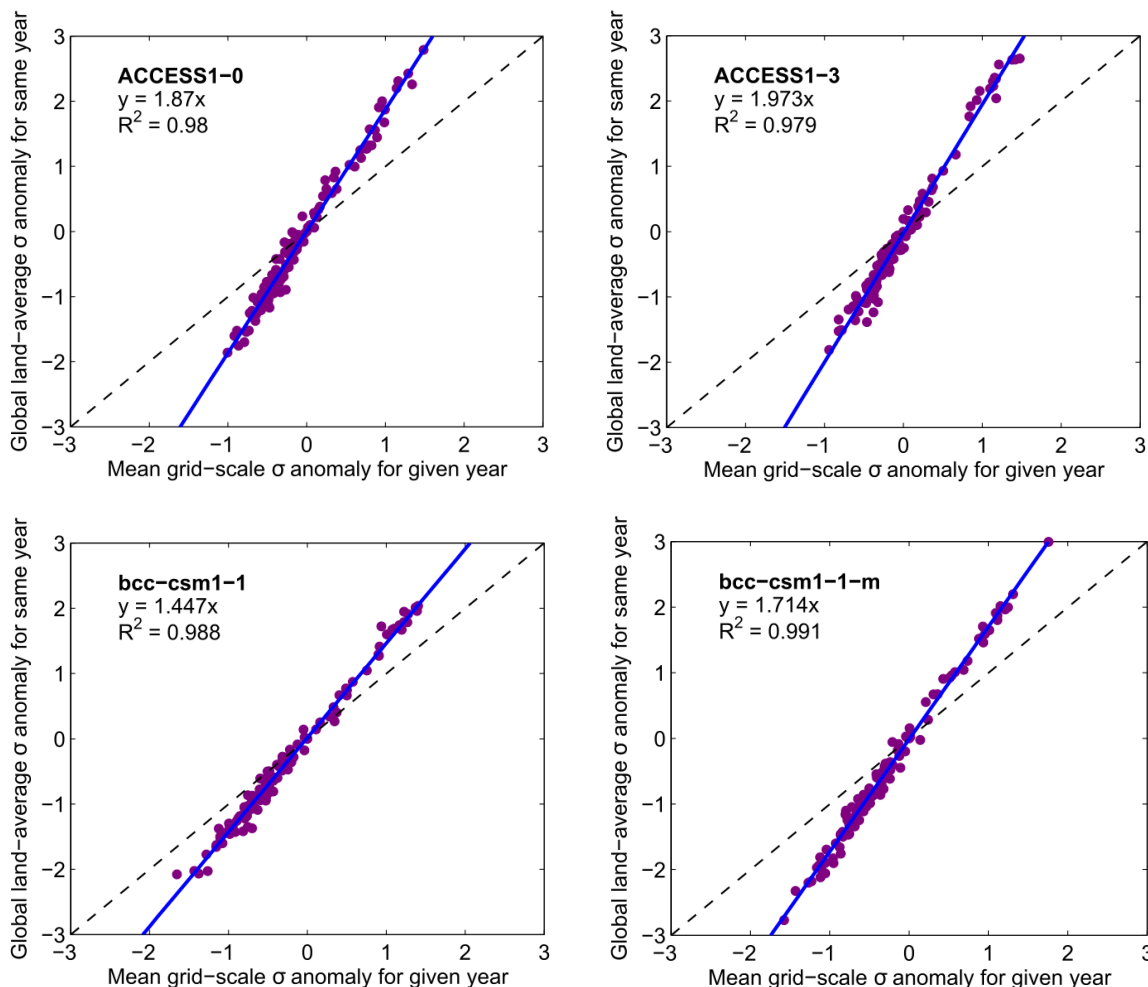
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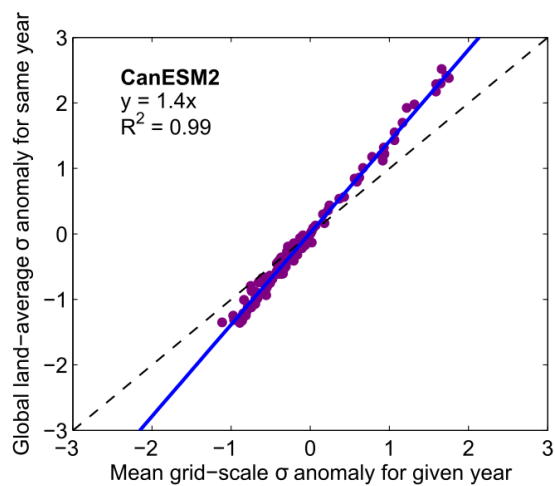
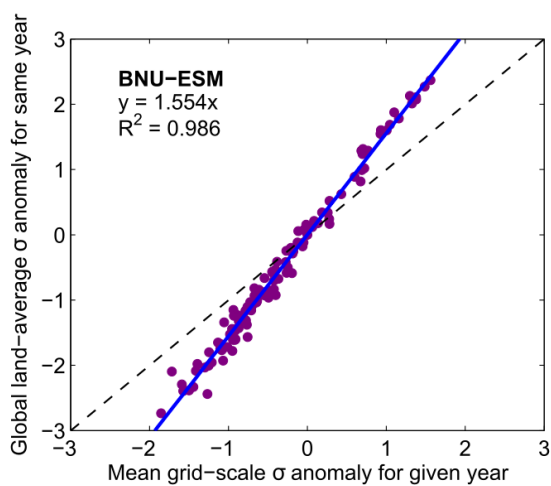
**Figure S1:** Map of observed “Noise” in annual temperatures, defined as the standard deviation of annual mean temperatures over the period 1951-2010 at each local grid cell.



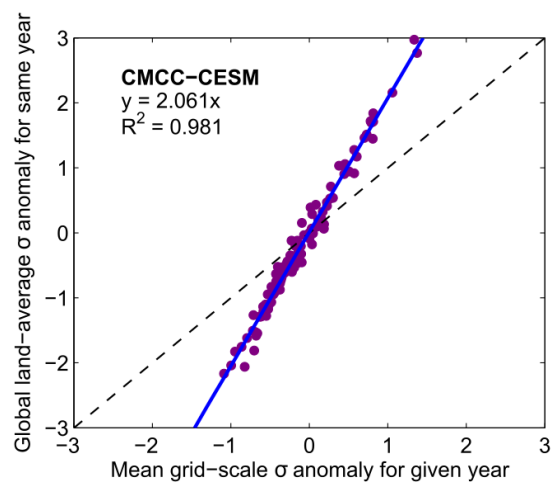
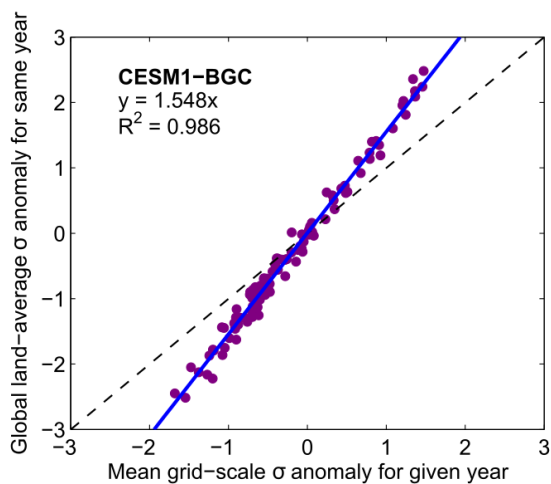
**Figure S2:** Linear regression analyses, comparing the ‘global-mean’ annual temperature anomaly (y-axis, thick teal lines from Figure 2) against the corresponding local anomaly for the ‘average grid cell’ (x-axis, thick brown lines from Figure 2), for each of the 116 years in the CRU-TS observational record (red filled circles). Results are presented in units of K, and in normalised units of local  $\sigma$ , in panels (a) and (b) respectively.



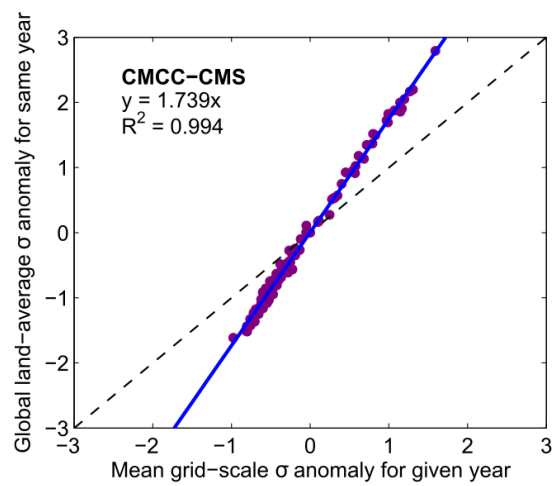
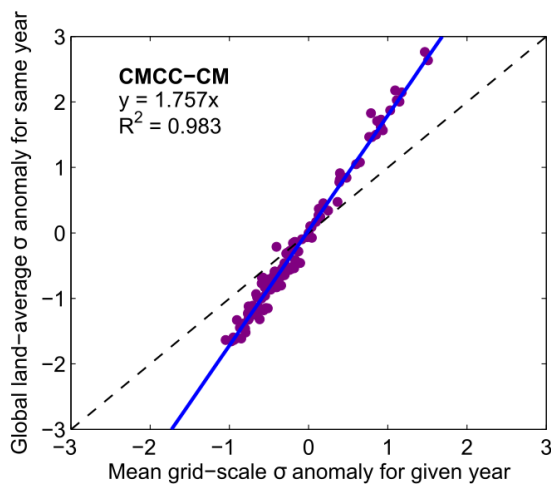
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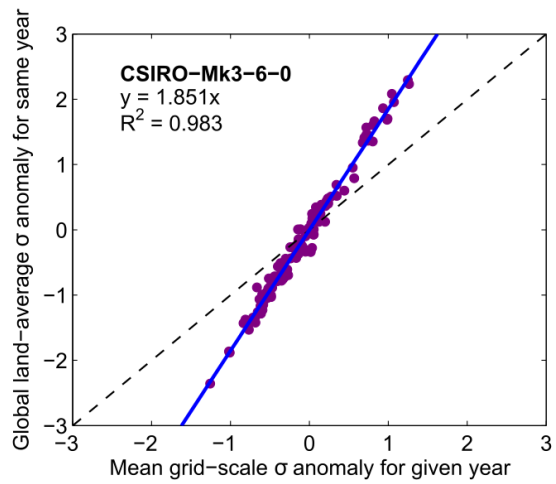
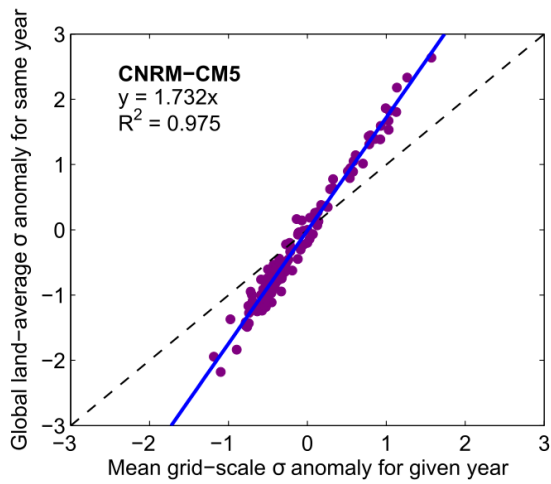
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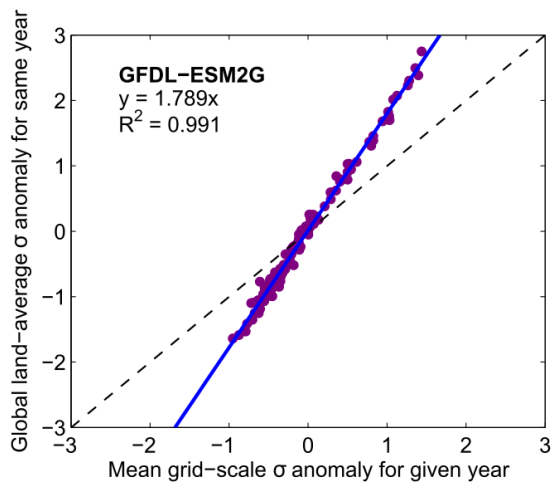
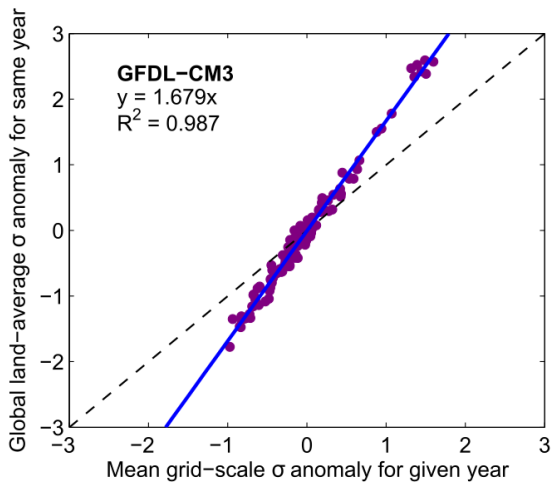
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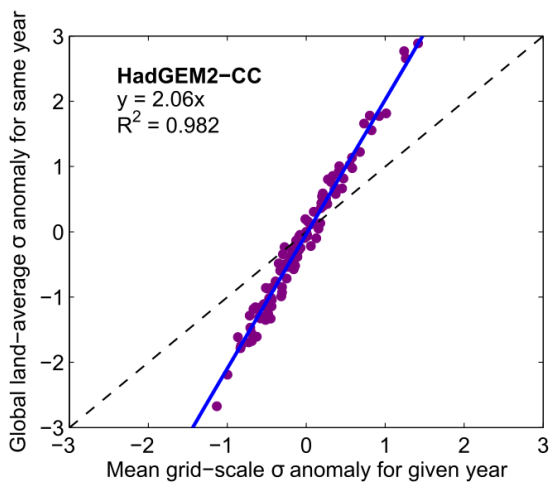
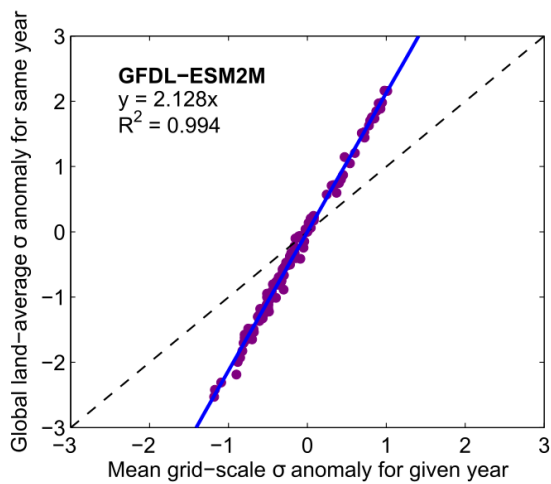
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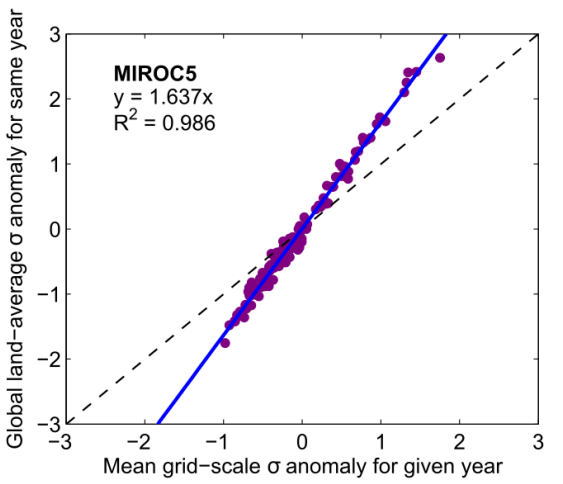
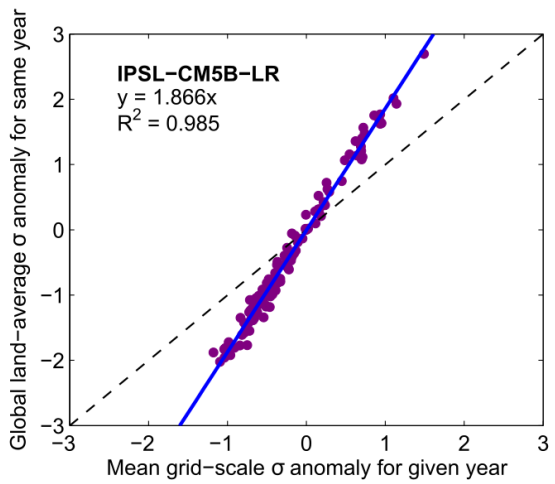
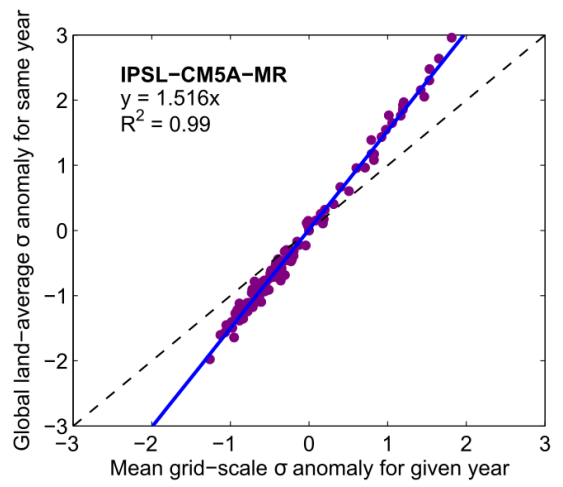
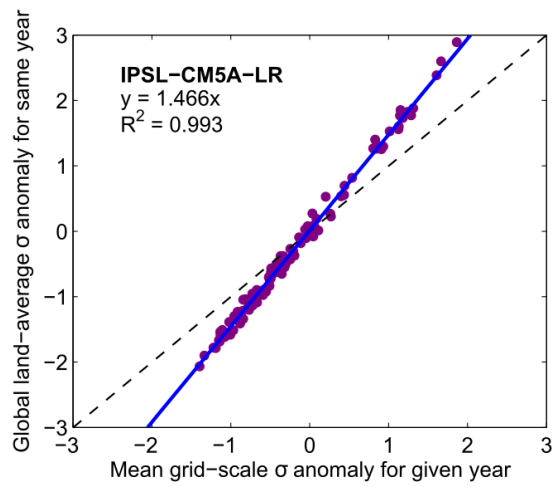
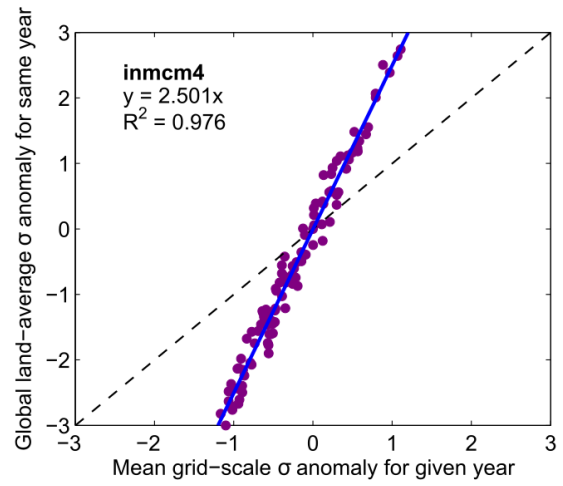
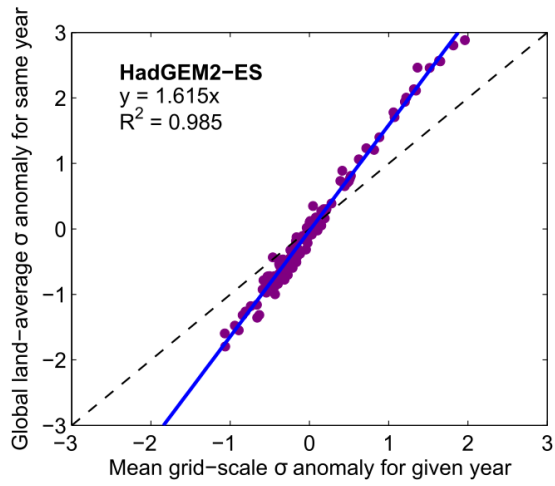


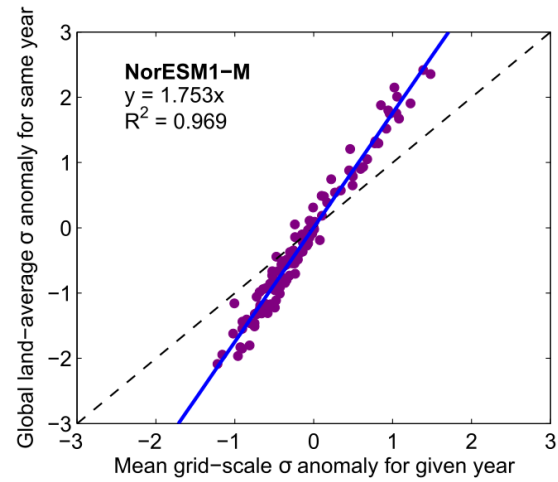
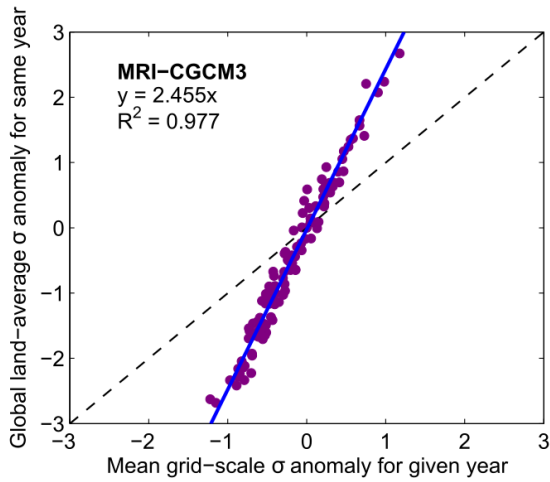
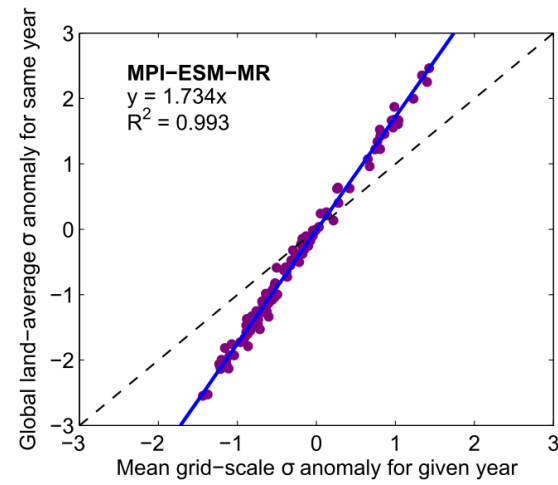
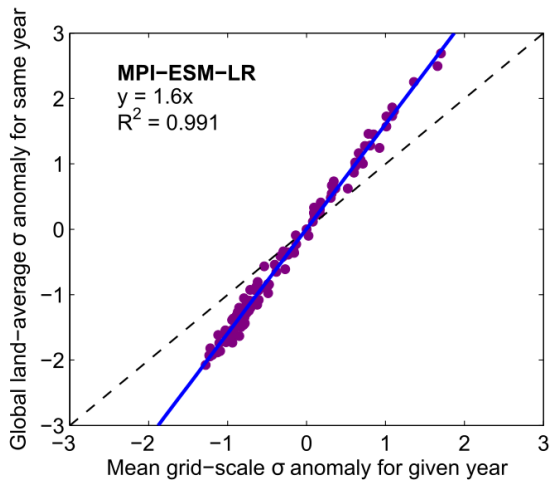
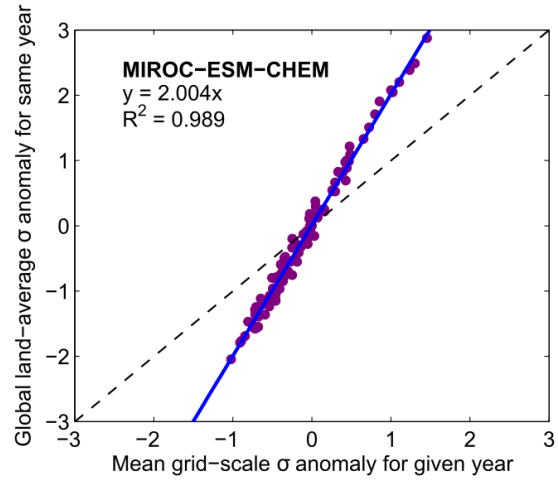
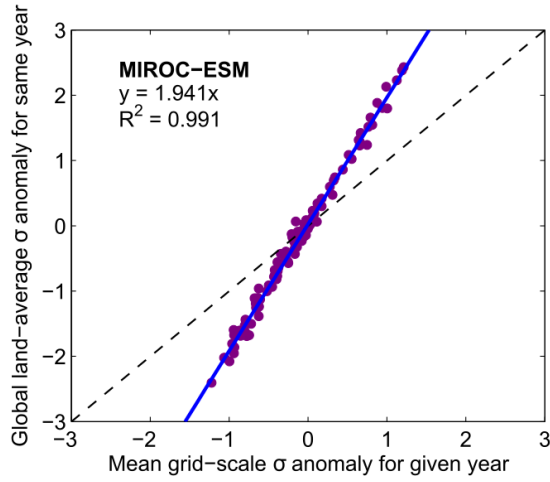
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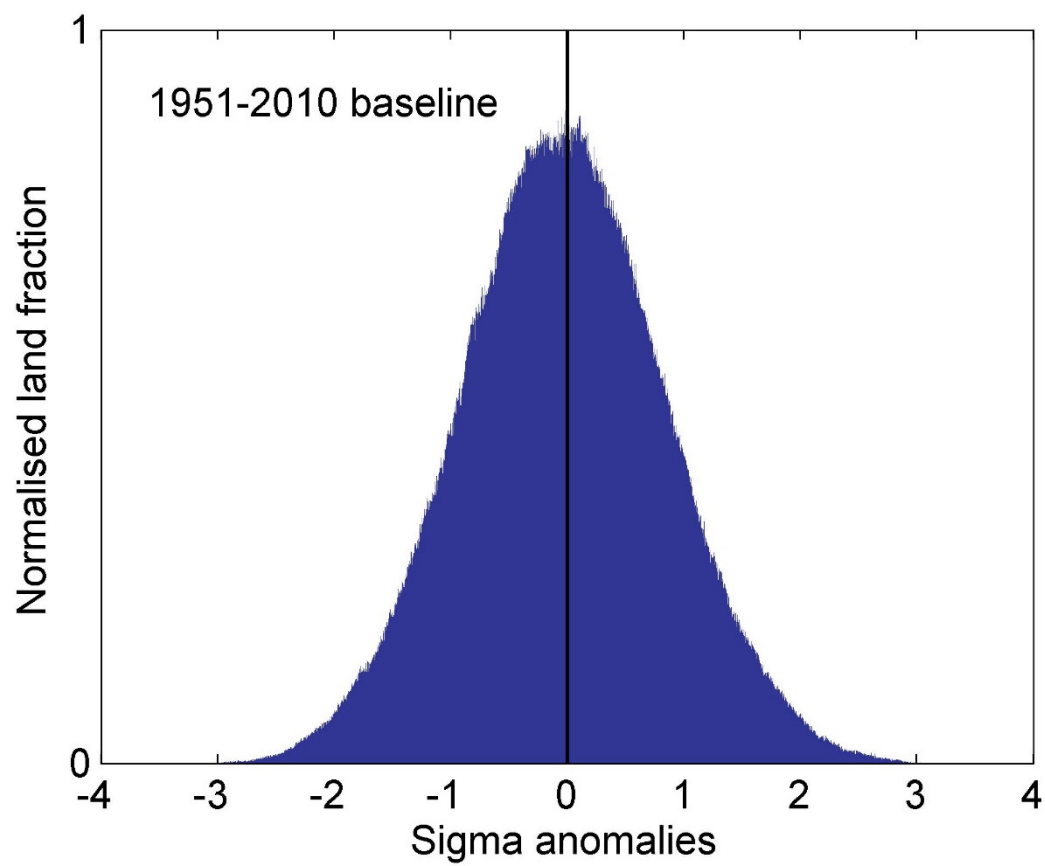
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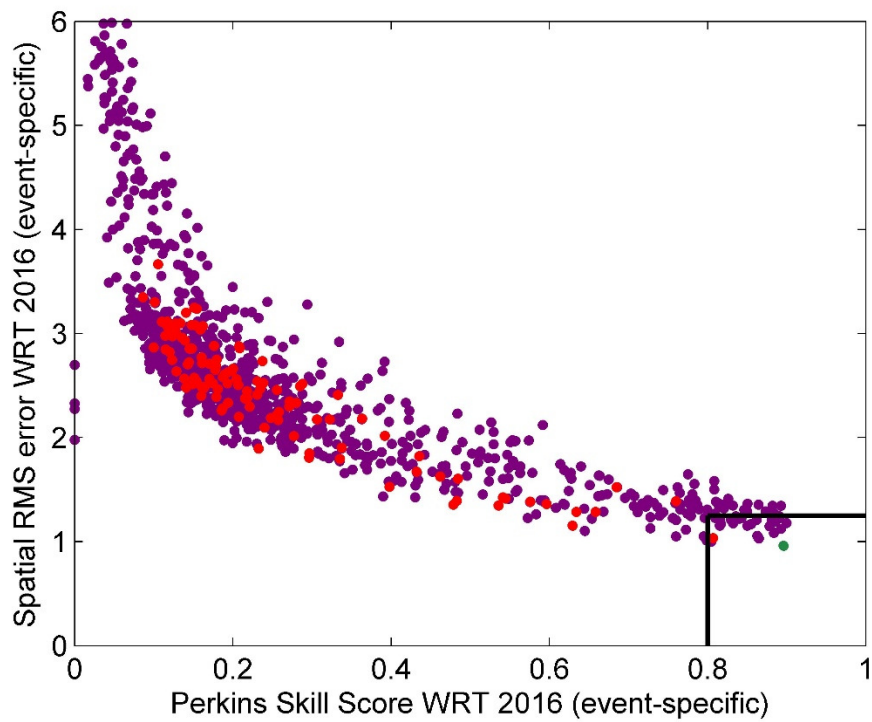




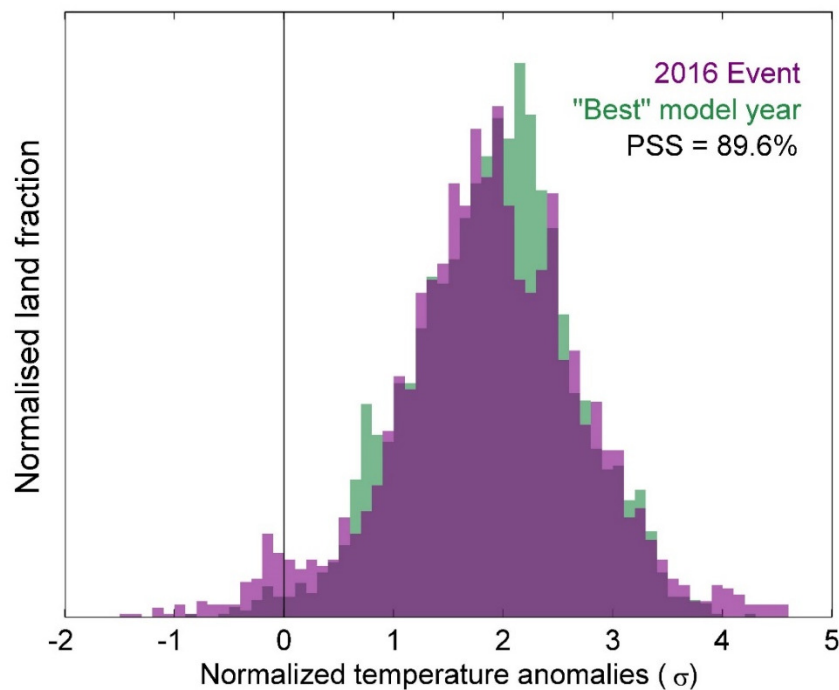
**Figure S3:** Same as Figure 3b of the main manuscript, but showing equivalent results for each of the 28 CMIP5 models considered in this study. Model years from 1901-2016 are used to calculate the gradients, compatible with the observations.



**Figure S4:** Aggregate frequency distribution of all normalised annual temperature anomalies for all land grid points, and for all sixty years in the baseline period of 1951-2010, using the CRU-TS data set. The distribution of local sigma anomalies is well-represented by a Gaussian distribution, thus supporting the assumptions made to calculate the return periods in Figure 5 of the main manuscript.

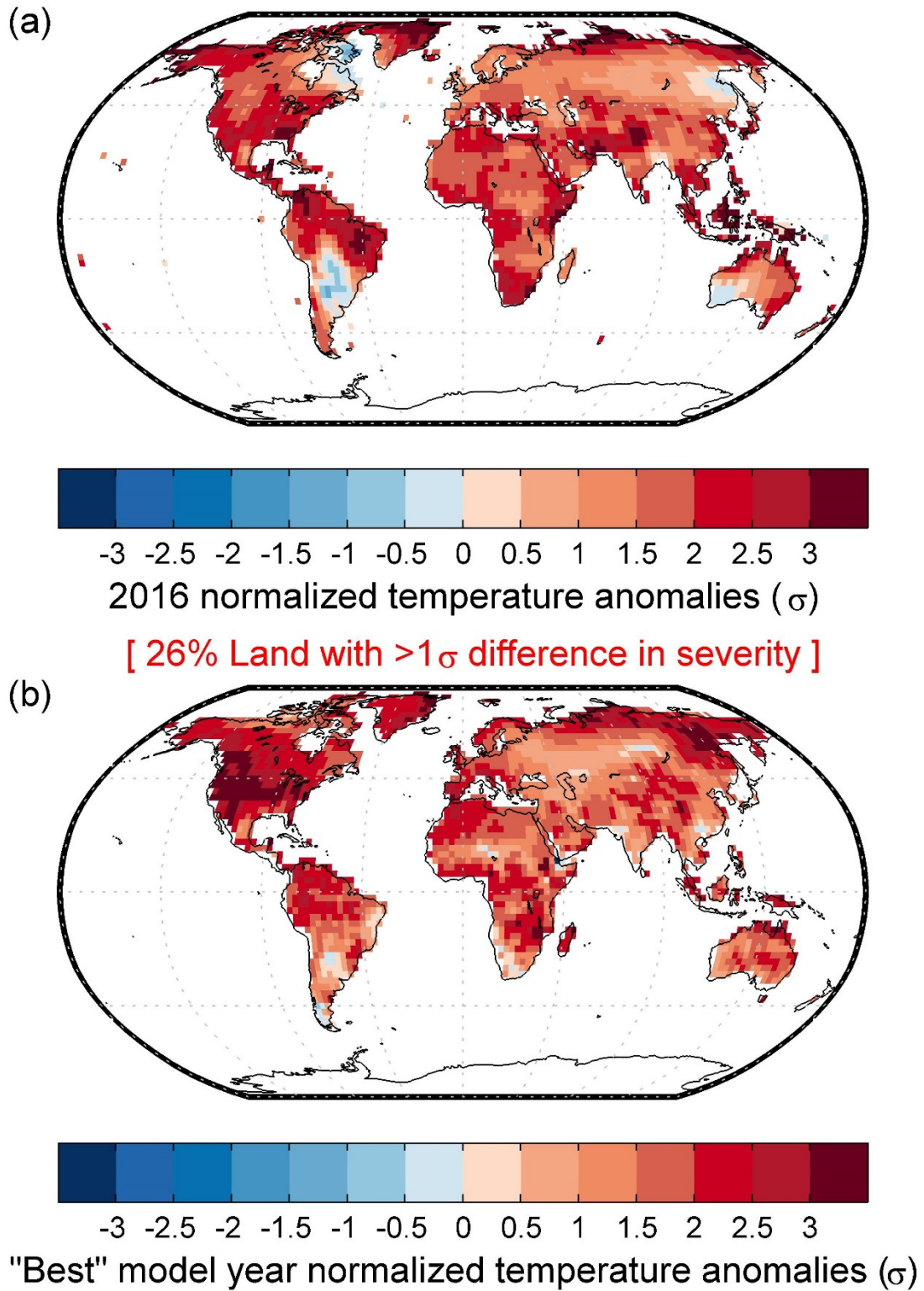


**Figure S5:** Scatter plot comparing the PSS and RMS error of each individual model (purple filled circles) and observed year (red filled circles) presented in Figure 6 of the main manuscript, with respect to the observed hot year of 2016. The black lines capture the region used to identify the Time of Maximum Similarity in Figure 6 of the main manuscript. The green filled circle corresponds to the 'Best-fitting' analogue year across all models and observations, which is subsequently used in Figures S5 and S6.



**Figure S6:** Aggregate PDFs of the sigma anomalies found across all grid cells in 2016 (purple), and for the 'best-fitting' model year (green). Note that the purple PDF is identical to that shown in Figure 2c of the main manuscript, but using a coarser  $2.5^\circ \times 2.5^\circ$  resolution. The areal overlap of the two PDFs (i.e. the PSS) is 89.6%.





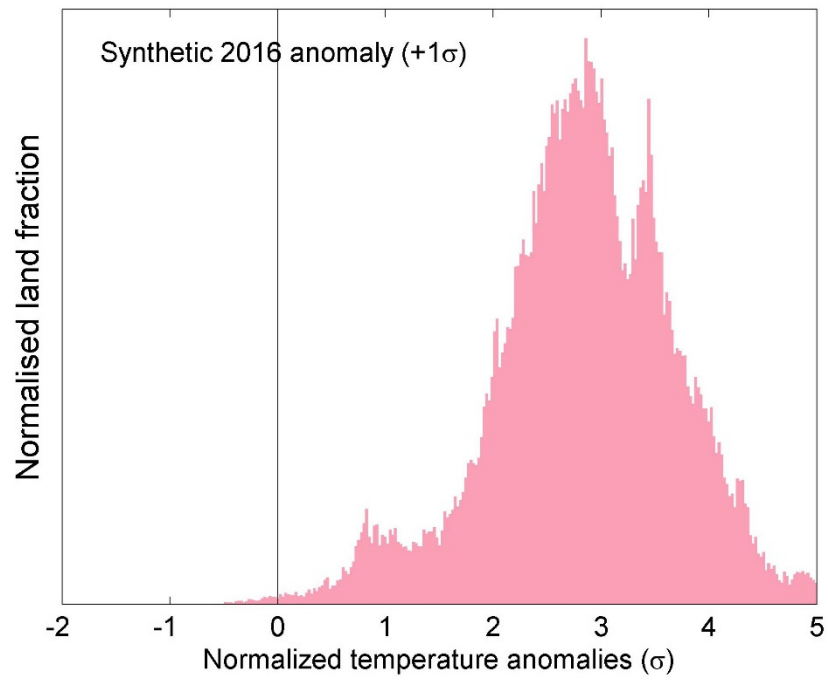
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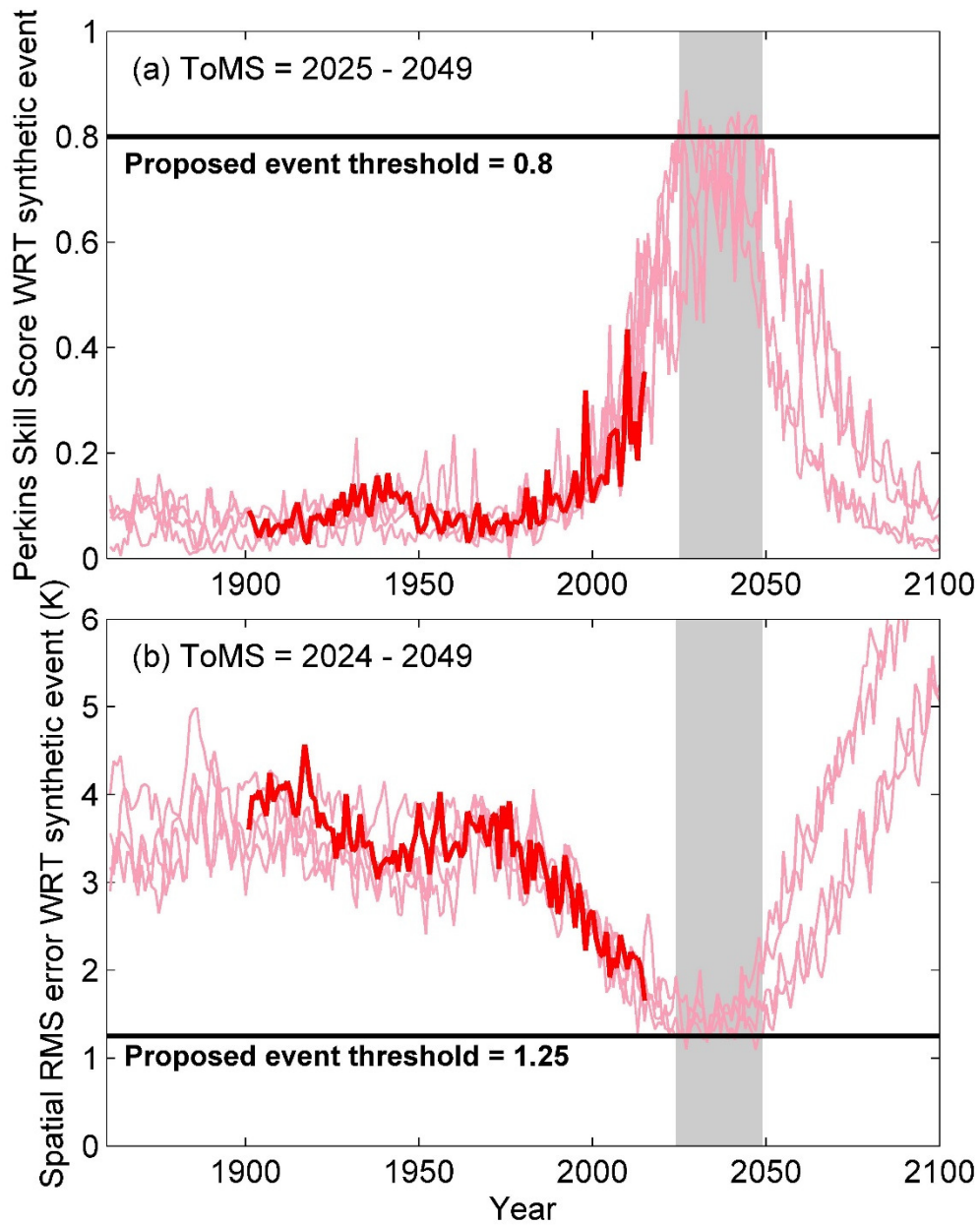
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**Figure S7:** Panel (a) shows the 2016 sigma anomaly map (identical to Figure 1b of the main manuscript). Panel (b) shows the corresponding anomaly map for the 'best-fitting' model year (defined as having the lowest RMS error score). Inset calculation denotes the fraction of land for which the difference between the anomalies presented in (a) and (b) exceed  $1\sigma$ .



**Figure S8:** Same as Figure 2c of the main manuscript, but instead showing the distribution for a ‘synthetic’ event, which has a full  $+1\sigma$  transposition of the distribution of anomalies found for the 2016 event (i.e. Figure 2c).



**Figure S9:** Same as Figure 6 of the main manuscript, but instead showing results for the synthetic event (2016 anomalies shifted by a further  $+1\sigma$ ) presented in Figure S7.