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Supplement of

Global characterisation of the vertical temperature anomaly structure of heat extremes over land in ERA5

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S1 Mean calendar day of the year during TXx events

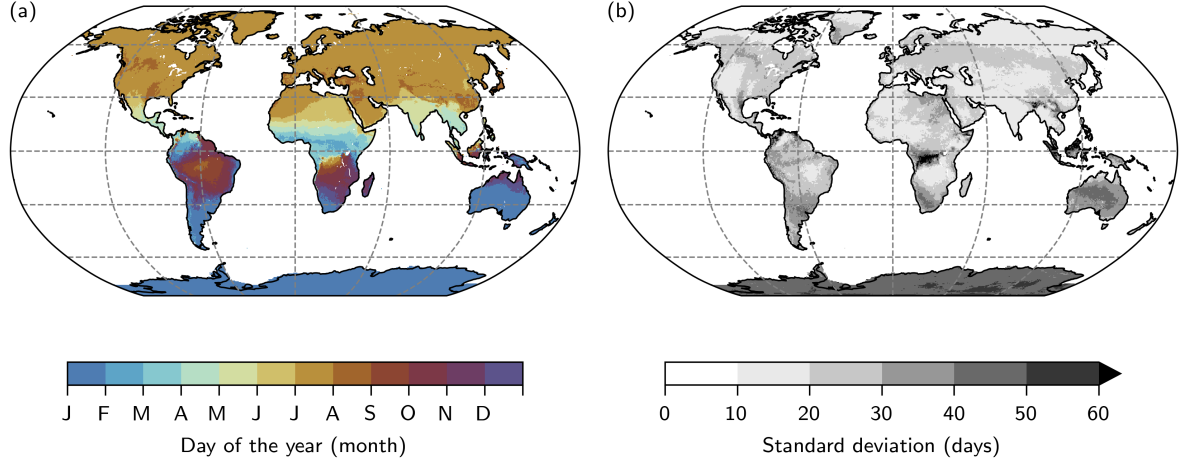


Figure S1. Global distribution of (a) the month of the mean calendar day of the year during TXx events from 1951 to 2023 at each grid point, and (b) the corresponding standard deviation. The mean calendar day of the year for the 73 TXx events at each grid point is computed using a circular mean over 365 days.

S2 Silhouette scores for different methodological choices of the k -means clustering

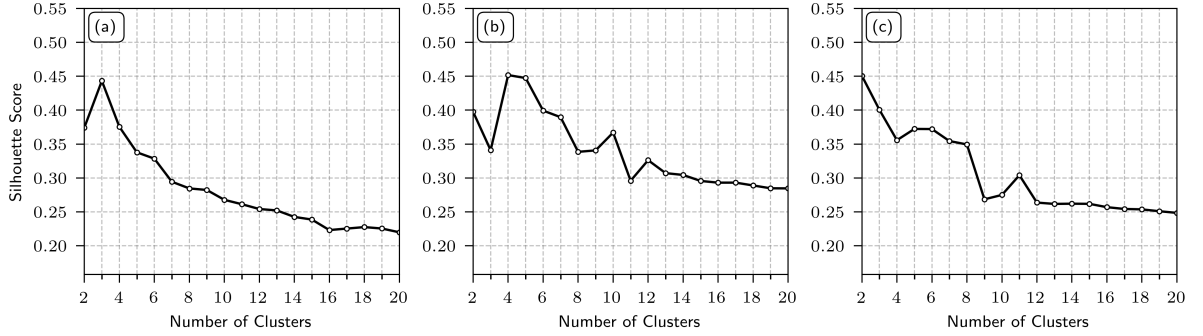


Figure S2. Silhouette scores for finding an optimal number of clusters of the median *scaled* T' profiles over land grid points with the k -means clustering approach, using (a) the eight retaining principal components of all hybrid sigma-pressure levels (40–137) without area-weighting, (b) the five retaining principal components of only the lowermost model levels (90–137) with area-weighting, and (c) the six retaining principal components of the vertically adjusted profiles, which are linearly scaled between the surface pressure and pressure of the dynamical tropopause, without area-weighting.

S3 k -means clustering for different methodological choices

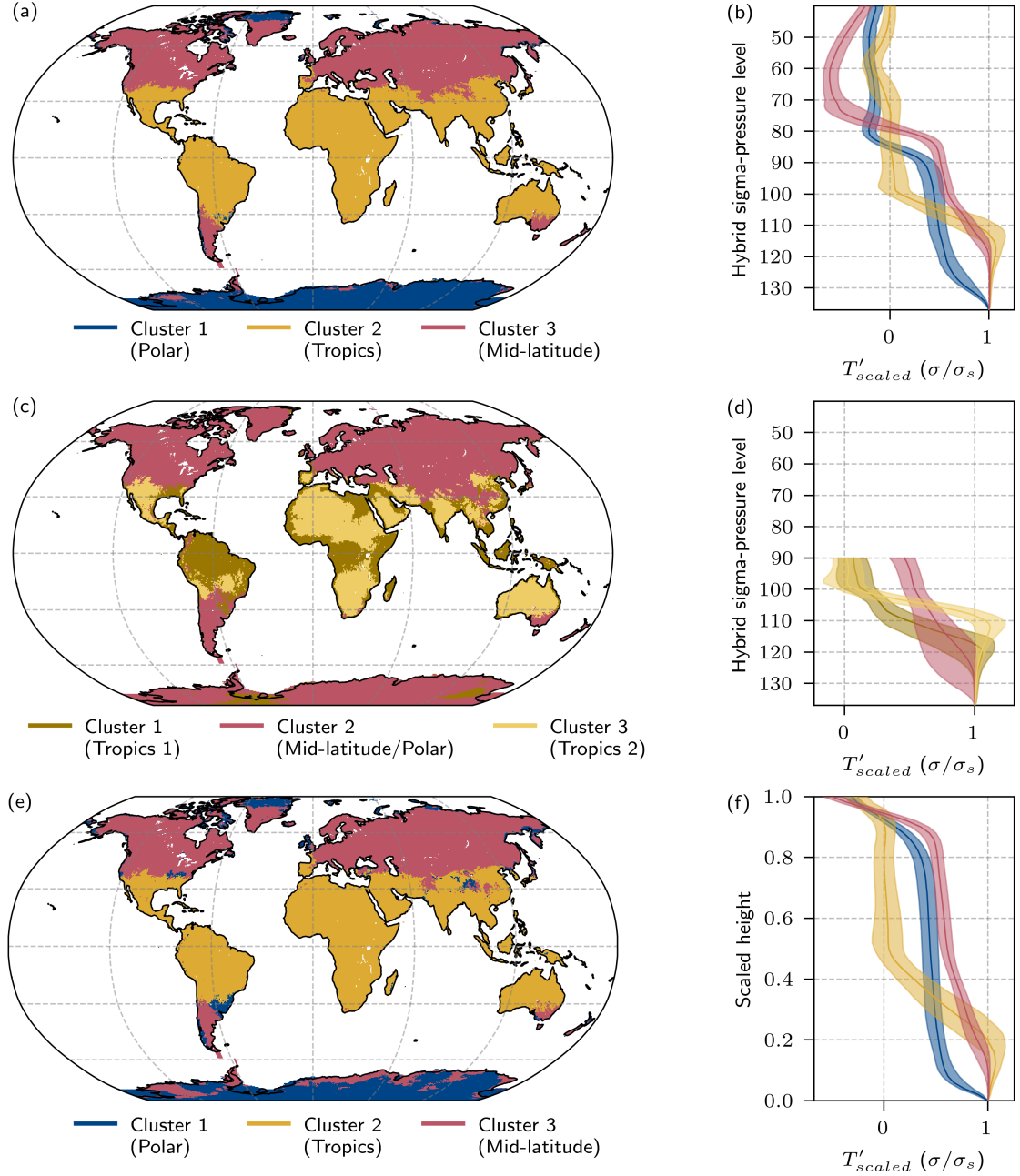


Figure S3. k -means clustering with three clusters over land using (a, b) without area-weighting the eight retaining principal components of full vertical profiles on the hybrid sigma-pressure levels 40 to 137 (Cluster 1: $N = 29\,202$, Cluster 2: $N = 27\,321$, Cluster 3: $N = 31\,626$), (c, d) with area-weighting the five retaining principal components of restricted to the hybrid sigma-pressure levels 90 to 137 (Cluster 1: $N = 15\,920$, Cluster 2: $N = 58\,932$, Cluster 3: $N = 13\,297$), and (e, f) without area-weighting the six retaining principal components of the vertically linear pressure scaled profiles, where zero denotes the surface pressure and one the dynamical tropopause height (Cluster 1: $N = 14\,212$, Cluster 2: $N = 55\,730$, Cluster 3: $N = 17\,487$). The colours (left) show the distribution of the clusters. The vertical profiles (right) denote the median (line) and interquartile range (shading) of the median vertical T'_{scaled} profile of all the grid points within each cluster.

S4 Variance of individual TXx events

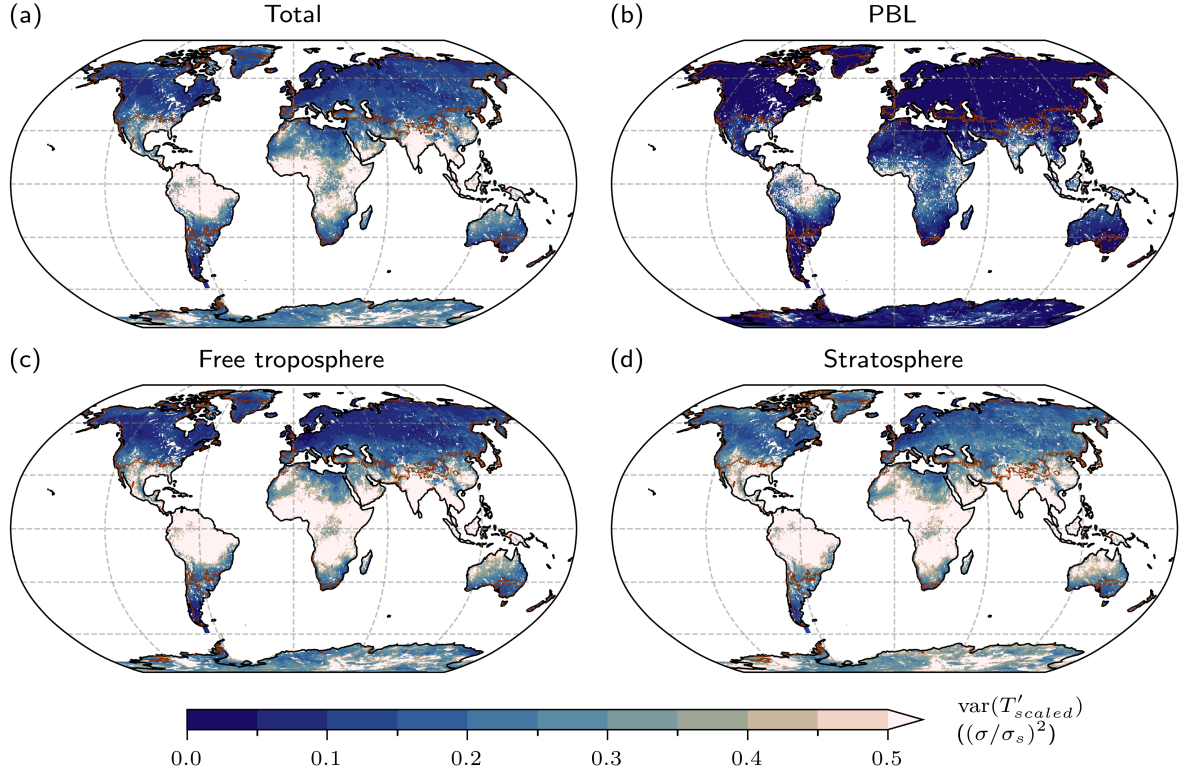


Figure S4. Variance of the TXx events T'_{scaled} profile to their median T'_{scaled} for all TXx events ($\text{var}(T'_{scaled})$), vertically averaged over (a) all hybrid sigma–pressure levels, (b) the PBL, (c) free troposphere, and (d) stratosphere. The brown lines denote the boundaries between the three clusters.

S5 Inter-cluster variability

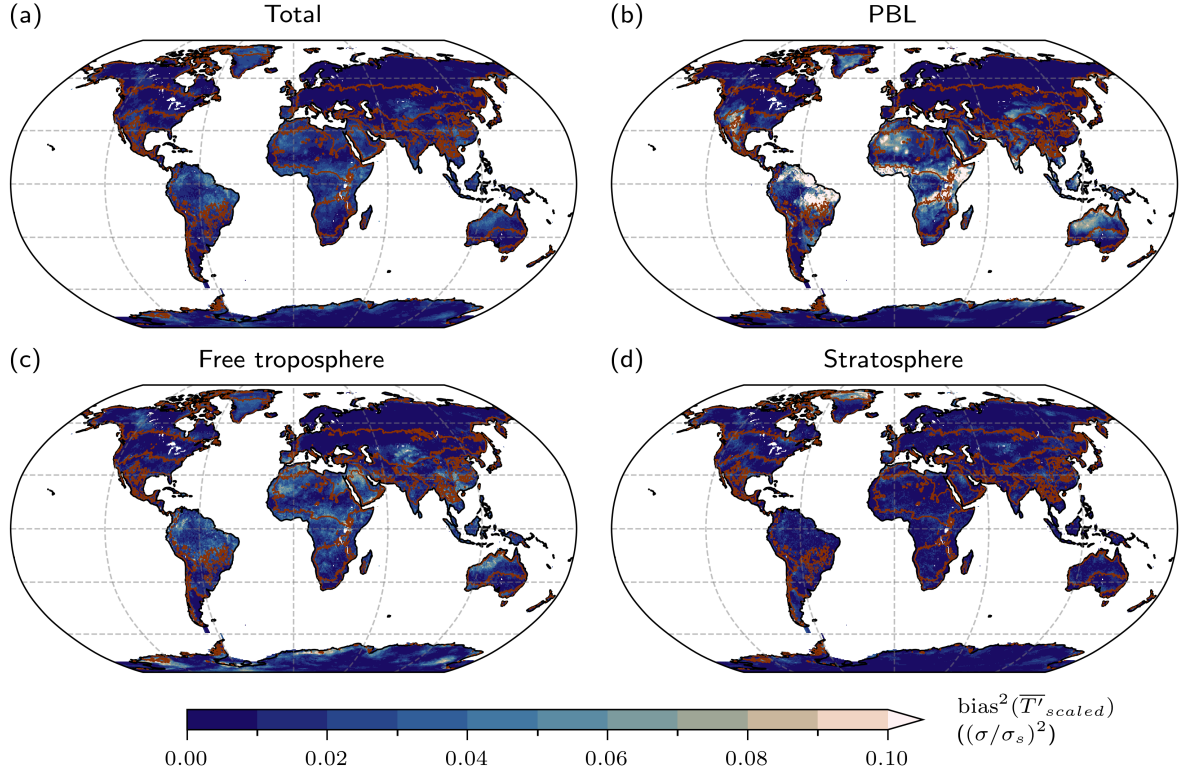


Figure S5. Distribution of squared bias of the grid point's median *scaled* temperature anomaly ($\overline{T'}_{scaled}$) and the corresponding cluster median profile ($\overline{T'}_{cluster}$) of the six clusters ($\text{bias}^2(\overline{T'}_{scaled})$), vertically averaged over (a) all hybrid sigma–pressure levels, (b) the PBL, (c) free troposphere, and (d) stratosphere. The brown lines denote the boundaries between the six clusters. The coldest 10 TXx events are excluded at each grid point.