Supplemental Material

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Anthropogenic contribution to the Unprecedented 2022 Mid-Summer Extreme High Temperature in Southern China

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Methods:

The dynamic adjustment methodology is based on the partial least squares (PLS) regression. The tasmax and sea level pressure (SLP) are processed by next steps: (1) The tasmax needs high-pass filter firstly, then tasmax and the corresponding SLP are standardized. (2) Grid-point tasmax are correlated with the SLP field, resulting in a one-point cross-correlation map. (3) The monthly SLP field is projected onto the correlation pattern to derive the first PLS predictor (Z1). (4) Z1 is regressed out of both the grid-point tasmax and its SLP predictor field, employing conventional last squares fitting to obtain residual tasmax and SLP field. (5) Repeated steps (2) to (4) on the residual tasmax and SLP field to obtain successive PLS predictors. Each of these predictors is mutually orthogonal. Three predictors were remained through cross-validation.

The optimal fingerprint analysis has mentioned in previous research (Sun et al., 2014, 2016). For each interpolated model dataset, we calculated its anomalies relative to 1991-2020 and then computed the multimodel ensemble mean under ALL and NAT forcings, respectively. The preindustrial control (CTL) simulations were divided into 44-year-long blocks and then processed similarly. Then, the optimal fingerprinting method is employed for regional mean Tasmx for 1979-2022 to detect and attribute (Hegerl et al. 1997; Allen and Stott 2003; Ribes et al., 2013). This involved regressing the observations onto one or more model-simulated responses to ALL (NAT) forcings. The scaling factors were used to adjust the model-simulated responses to best match the observations, producing the ALL and NAT reconstructions.

REFERENCES


Fig. S1. (a) Return period of TX90p anomaly. Red circle represents 2022. (b) As in (a), but for TXx. (c) 200 hPa standard geopotential height anomalies during mid-summer 2022. (d) As in (c), but for 500 hPa. (e) Global sea surface temperature anomalies during mid-summer 2022. All anomalies are relative to 1991-2020. Blue dotted lines represent 10% confidence intervals.
Fig. 2. (a) The 5-year summer mean non-overlapping Tasmax anomalies (°C) from the observations (black) and model simulations under ALL (red) and NAT (blue) forcings for southern China from 1979-2022. The last data is 4-year mean (2019-2022). k and blue shadings show the 10%–90% ranges of the individual model simulations from ALL and NAT experiments, respectively. (b) Scale factor of two-signal detection over southern China. (c) GEV-fit of Tasmax anomalies under ALL and NAT over southern China. (d) Models used by CMIP6 used in this study.