

Attribution of 2019 Extreme Spring–Early Summer Hot Drought over Yunnan in Southwestern China

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Monthly simulations driven by all (ALL) and natural only (NAT) forcings since 1961 are extracted from the CMIP5 archive (Taylor et al. 2012) in this study. The corresponding simulations under representative concentration pathway 4.5 scenario (RCP4.5) are also adopted here to extend the time series of the ALL simulations through 2019, similar to Sun et al. (2016). All simulations are bilinearly regridded into 0.5° resolution in order to be consistent with the observational data before attribution analysis. Due to the data availability, only one pair of realizations (r1i1p1) is used to assure an equal weight for different CMIP5 models. We further evaluate their performance in capturing the observed distribution of March–June mean temperature and precipitation variations via a Kolmogorov–Smirnov test at the 5% significance level (Figs. ES1a,b). Moreover, the relationship between the March–June mean temperature and precipitation in Yunnan is also assessed, and results show that the CMIP5 models capture the inverse correlation between temperature and precipitation that is evident in the observations (Fig. ES1c). As a result, 12 simulations are selected (see Table ES1) and then used to represent temperature and precipitation response to the ALL and NAT forcings over Yunnan province in southwestern China. Note that all anomalies are calculated relative to the overlap period 1961–2005 of the observation and CMIP5 models.

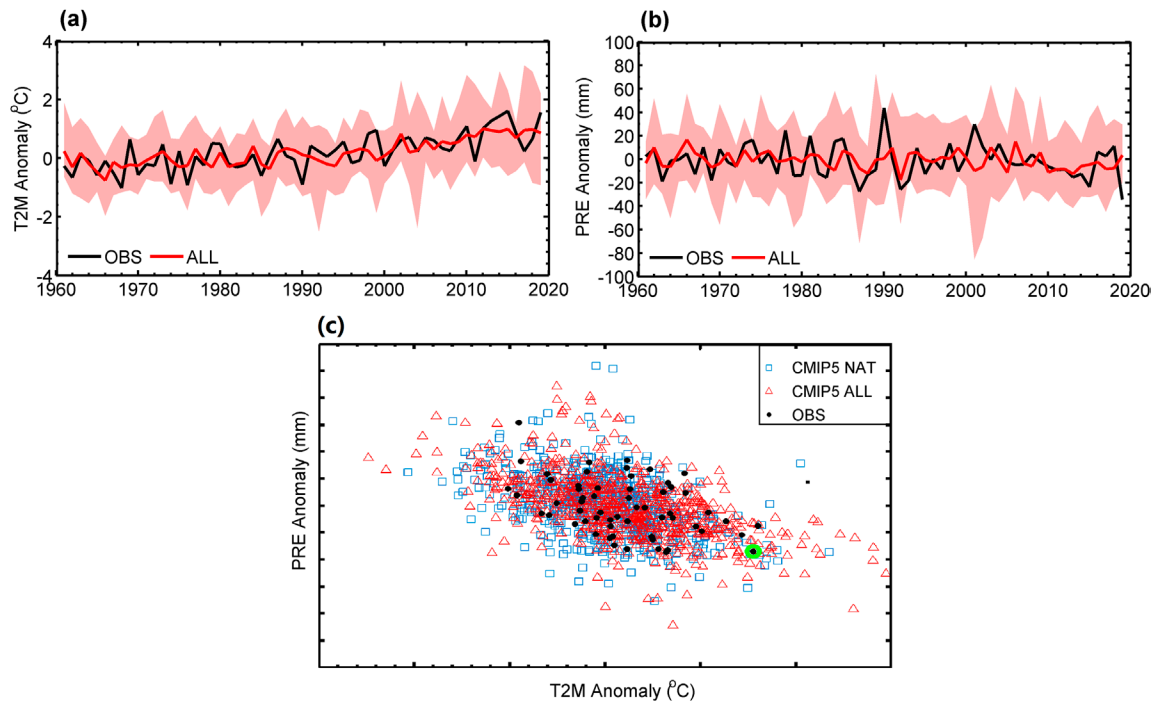


Fig. ES1. Time series of March–June (a) temperature anomalies and (b) precipitation anomalies over Yunnan province in southwest China during the period of 1961–2020 from observations and the CMIP5 ALL/RCP45 simulations. The black curve denotes the observed temperature and precipitation and the shading displays the ranges of in ALL-forcing simulations with their ensemble mean in red curve. Model simulations are listed in Table ES1. (c) Scatters of March–June temperature anomalies against the precipitation anomaly. The black dots, red triangles, and blue squares denote the observation and the CMIP5 ALL- and NAT-forcing simulations respectively.

Table ES1. List of CMIP5 models used in this study.

Model	ALL/RCP45 (period)	NAT (period)
ACCESS1.3	r1i1p1 (1961–2019)	r1i1p1 (1961–2019)
CNRM-CM5	r1i1p1 (1961–2019)	r1i1p1 (1961–2012)
CSIRO-Mk3.6.0	r1i1p1 (1961–2019)	r1i1p1 (1961–2012)
GFDL CM3	r1i1p1 (1961–2019)	r1i1p1 (1961–2005)
GFDL-ESM2M	r1i1p1 (1961–2019)	r1i1p1 (1961–2005)
GISS-E2-H	r1i1p1 (1961–2019)	r1i1p1 (1961–2012)
HadGEM2-ES	r1i1p1 (1961–2019)	r1i1p1 (1961–2019)
IPSL-CM5A-LR	r1i1p1 (1961–2019)	r1i1p1 (1961–2012)
IPSL-CM5A-MR	r1i1p1 (1961–2019)	r1i1p1 (1961–2012)
MIROC-ESM	r1i1p1 (1961–2019)	r1i1p1 (1961–2005)
MIROC-ESM-CHEM	r1i1p1 (1961–2019)	r1i1p1 (1961–2005)
MRI-CGCM3	r1i1p1 (1961–2019)	r1i1p1 (1961–2005)

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