

Supplement of Hydrol. Earth Syst. Sci., 24, 2921–2930, 2020
<https://doi.org/10.5194/hess-24-2921-2020-supplement>
© Author(s) 2020. This work is distributed under
the Creative Commons Attribution 4.0 License.



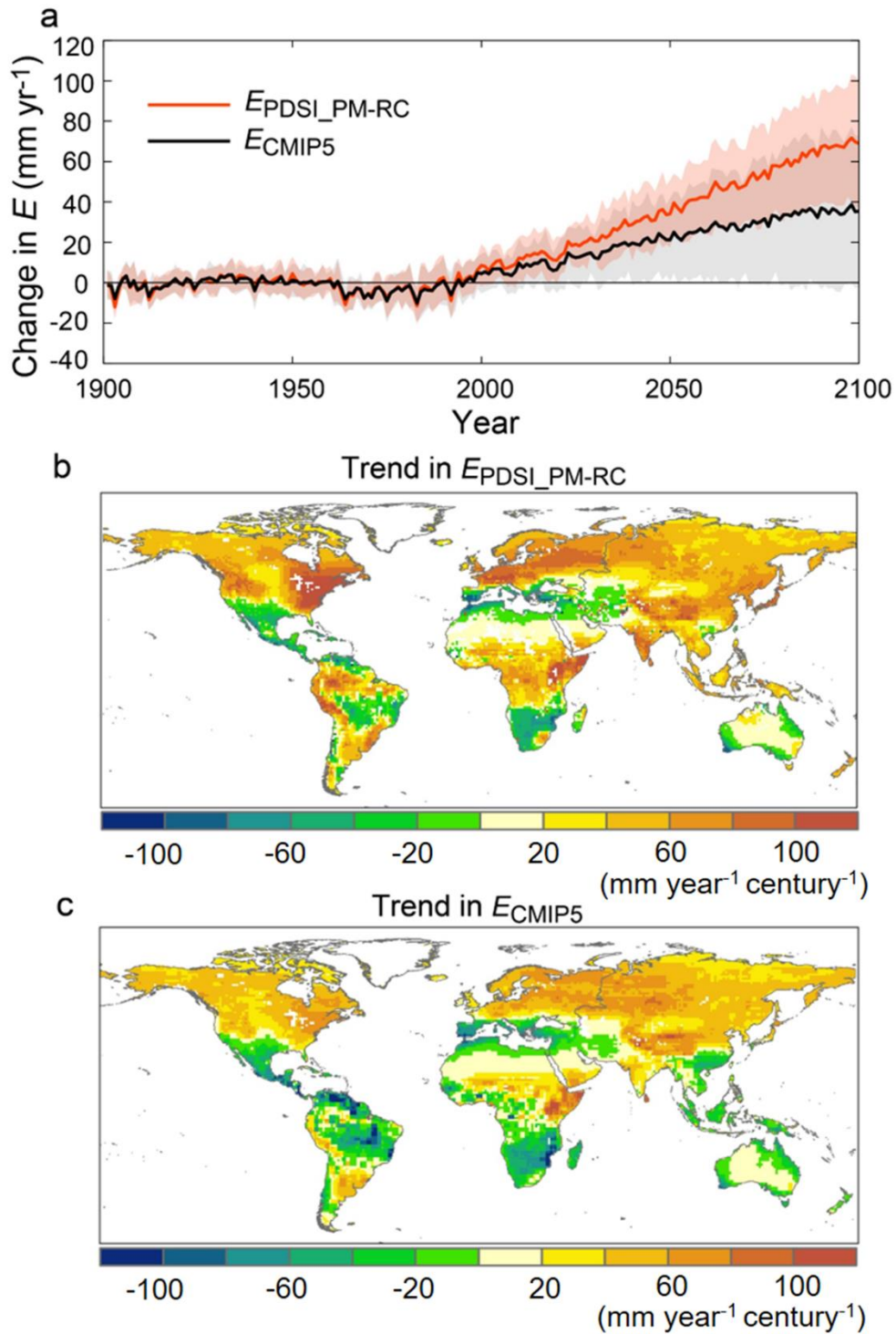
Supplement of

Comparing Palmer Drought Severity Index drought assessments using the traditional offline approach with direct climate model outputs

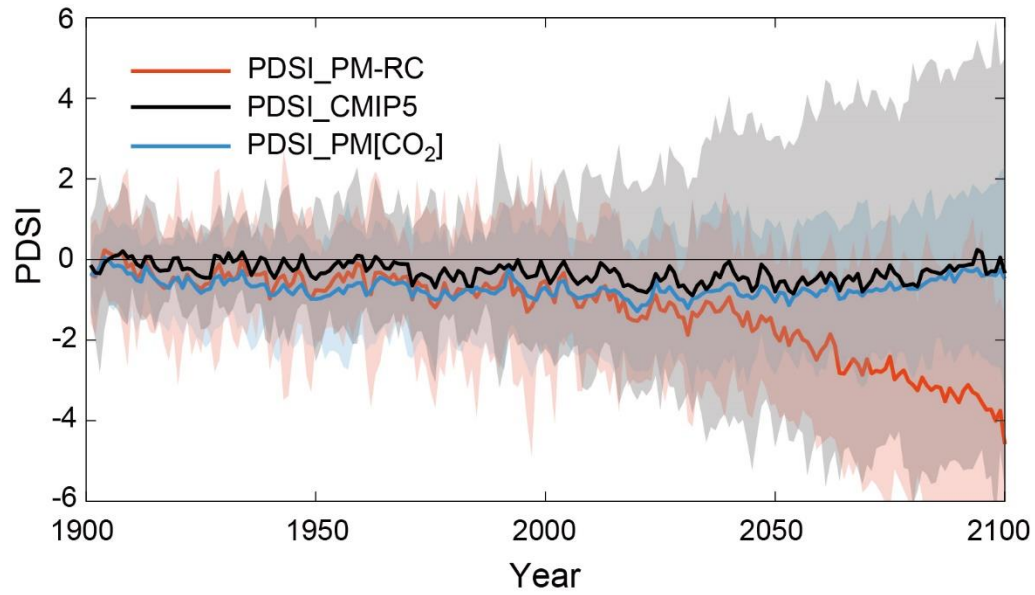
Yuting Yang et al.

Correspondence to: Yuting Yang (yuting_yang@tsinghua.edu.cn)

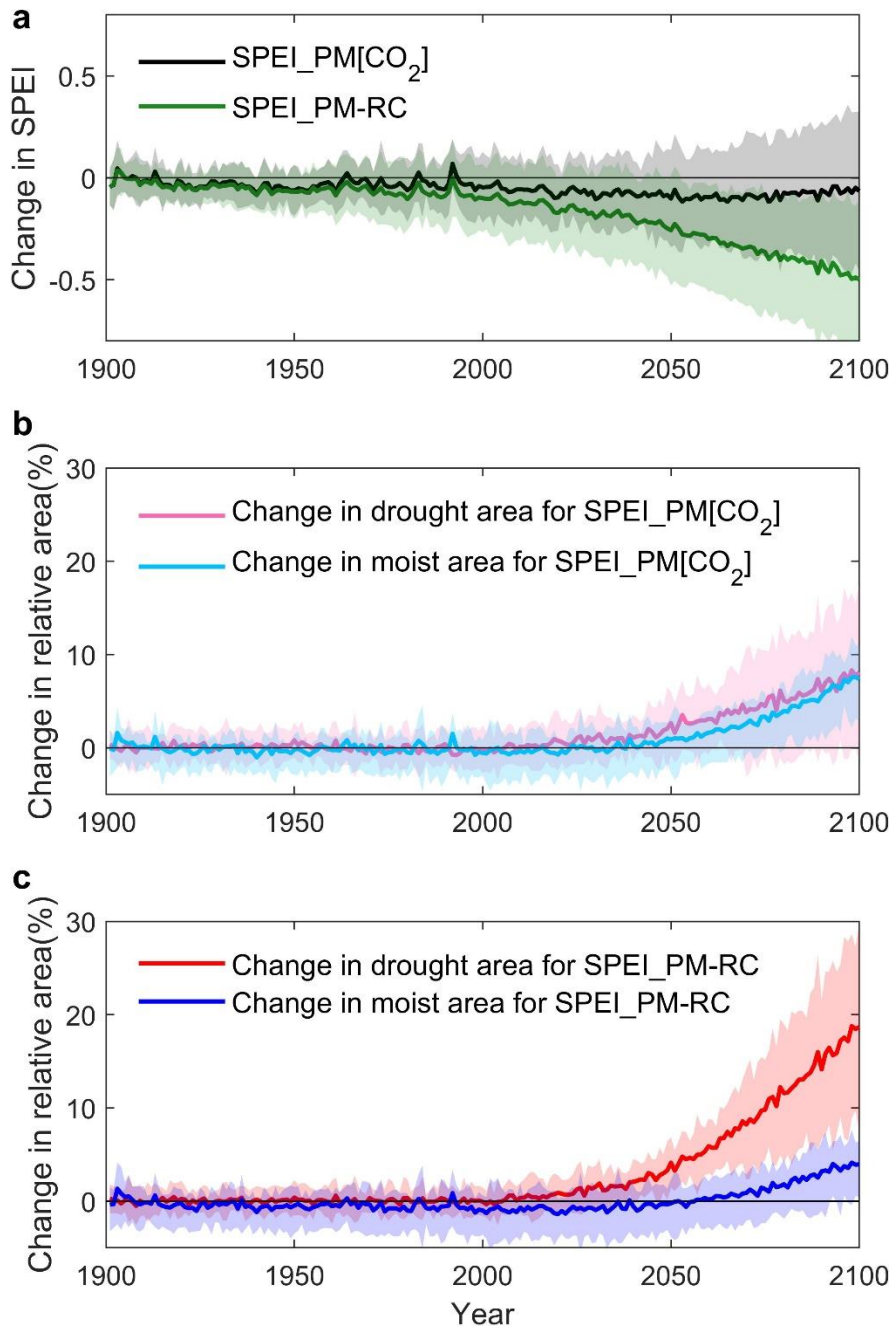
The copyright of individual parts of the supplement might differ from the CC BY 4.0 License.



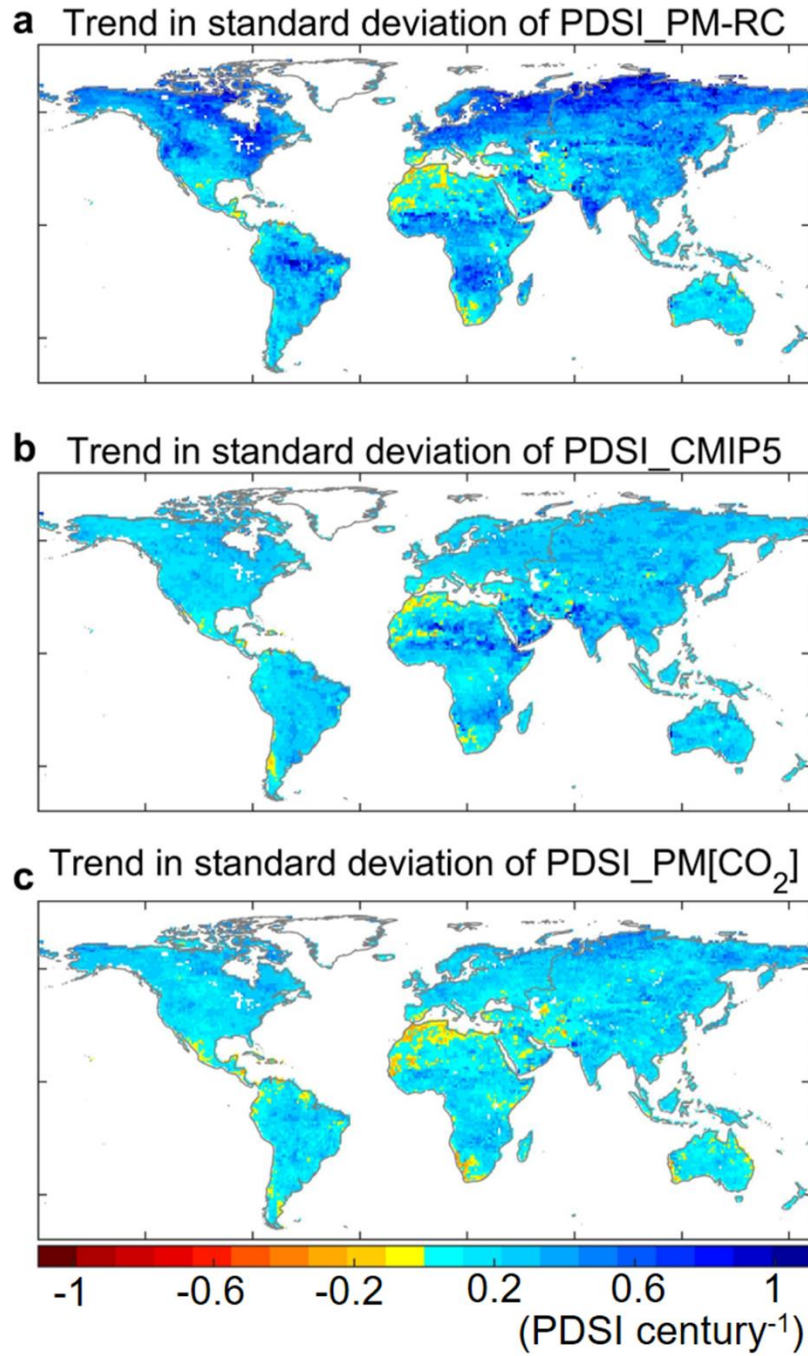
Supplementary Figure S1. Evapotranspiration estimated using the standard PDSI model forced with reference crop E_P ($E_{\text{PDSI_PM-RC}}$) compared with the direct output from the CMIP5 models (E_{CMIP5}). **a**, Changes in annual mean $E_{\text{PDSI_PM-RC}}$ and E_{CMIP5} relative to the 1901-1960 baseline. The solid curves represent the ensemble mean of 16 CMIP5 models and the shaded areas are the range of individual models. **b**, Spatial distribution of trend in annual $E_{\text{PDSI_PM-RC}}$ over 1901-2100. **c**, Spatial distribution of trend in annual E_{CMIP5} over 1901-2100.



Supplementary Figure S2 Time series of the PDSI during 1901-2100 at the global scale. PDSI_PM-RC (red), PDSI_CMIP5 (black) and PDSI_PM[CO₂] (blue). The solid curve represents the ensemble mean of the 16 CMIP5 models and the shading represents the range of individual models. The time series are averaged over global land areas excluding Greenland and Antarctica. Here the PDSI is calculated using the global averaged forcing variables.



Supplementary Figure S3. Changes in global mean Standardised Precipitation-Evapotranspiration Index (SPEI) and area in drought/moist relative to the 1901-1960 baseline. **a**, SPEI with E_p calculated from the reference crop Penman-Monteith E_p (SPEI_PM-RC; green line) and SPEI with E_p calculated from the modified Penman-Monteith model with CO₂ adjustment (SPEI_PM[CO₂]; black line). **b**, Changes in drought (SPEI < -1.5) and moist (SPEI > 1.5) areas relative to the 1901-1960 baseline detected by SPEI_PM[CO₂]. **c**, Changes in drought (SPEI < -1.5) and moist (SPEI > 1.5) areas relative to the 1901-1960 baseline detected by SPEI_PM-RC. The solid curves represent the ensemble mean of 16 CMIP5 models and the shaded areas are the range of individual models. The time series are averaged over global land areas excluding Greenland and Antarctica.



Supplementary Figure S4. Trends in standard deviation of (a) PDSI_PM-RC, (b) PDSI_CMIP5 and (c) PDSI_PM[CO₂] during 1901-2100. The standard deviation was calculated using the 120 monthly PDSI values within each decade.

Table S1. The 16 CMIP5 models used in this study. These models are selected as they output all variables, including runoff, required for our analysis.

Model name	Nation	Modeling Center	Reference
bcc-csm1-1	China	Beijing Climate Center, China Meteorological Administration	Wu et al. [2012]
bcc-csm1-1-m	China	Beijing Climate Center, China Meteorological Administration	Wu et al. [2012]
BNU-ESM	China	Beijing Normal University	Wei et al. [2012]
CNRM-CM5	France	Centre National de Recherches Météorologiques	Voldoire et al., [2013]
GFDL-ESM2G	USA	NOAA Geophysical Fluid Dynamics Laboratory	Dunne et al. [2012]
GFDL-ESM2M	USA	NOAA Geophysical Fluid Dynamics Laboratory	Dunne et al. [2012]
GISS-E2-H	USA	NASA Goddard Institute for Space Studies	Schmidt et al. [2014]
GISS-E2-R	USA	NASA Goddard Institute for Space Studies	Schmidt et al. [2014]
IPSL-CM5A-LR	France	Institute Pierre-Simon Laplace	Hourdin et al. [2013]
IPSL-CM5A-MR	France	Institute Pierre-Simon Laplace	Hourdin et al. [2013]
IPSL-CM5B-LR	France	Institute Pierre-Simon Laplace	Hourdin et al. [2013]
MIROC5	Japan	National Institute for Environmental Studies, The University of Tokyo	Watanabe et al. [2011]
MIROC-ESM	Japan	National Institute for Environmental Studies, The University of Tokyo	Watanabe et al. [2011]
MIROC-ESM-CHEM	Japan	National Institute for Environmental Studies, The University of Tokyo	Watanabe et al. [2011]
NorESM1-M	Norway	Norwegian Climate Centre	Bentsen et al. [2013]
NorESM1-ME	Norway	Norwegian Climate Centre	Bentsen et al. [2013]

References in Supplementary Table S1

Bentsen, M. et al: The Norwegian Earth System Model, NorESM1-M – Part 1: Description and basic evaluation of the physical climate, *Geosci. Model Dev.*, 6, 687-720, 2013.

Dunne, J. P. et al: GFDL's ESM2 Global Coupled Climate–Carbon Earth System Models. Part I: Physical Formulation and Baseline Simulation Characteristics, *J. Clim.*, 25, 6646-6665, 2012.

Hourdin, F., et al: Impact of the LMDZ atmospheric grid configuration on the climate and sensitivity of the IPSL-CM5A coupled model, *Clim. Dyn.*, 40, 2167-2192, 2013.

Schmidt, G. A., et al: Configuration and assessment of the GISS ModelE2 contributions to the CMIP5 archive, *J. Adv. Model. Earth Sy.*, 6, 141-184, 2014.

Voldoire, A., et al: The CNRM-CM5.1 global climate model: description and basic evaluation, *Clim. Dyn.*, 40, 2091-2121, 2014.

Watanabe, S., et al: MIROC-ESM 2010: model description and basic results of CMIP5-20c3m experiments, *Geosci. Model Dev.*, 4, 845-872, 2011.

Wei, T., et al: Developed and developing world responsibilities for historical climate change and CO₂ mitigation. *Proc. Natl. Acad. Sci. U.S.A.*, 109, 12911-12915, 2012.

Wu, T.: A mass-flux cumulus parameterization scheme for large-scale models: description and test with observations, *Clim. Dyn.*, 38, 725-744, 2012.