Supplementary Information for “Global projections of flash drought show increased risk in a warming climate”

Jordan I. Christian, Elinor R. Martin, Jeffrey B. Basara, Jason C. Furtado, Jason A. Otkin, Lauren E.L. Lowman, Eric D. Hunt, Vimal Mishra, Xiangming Xiao

Corresponding author: Jordan Christian

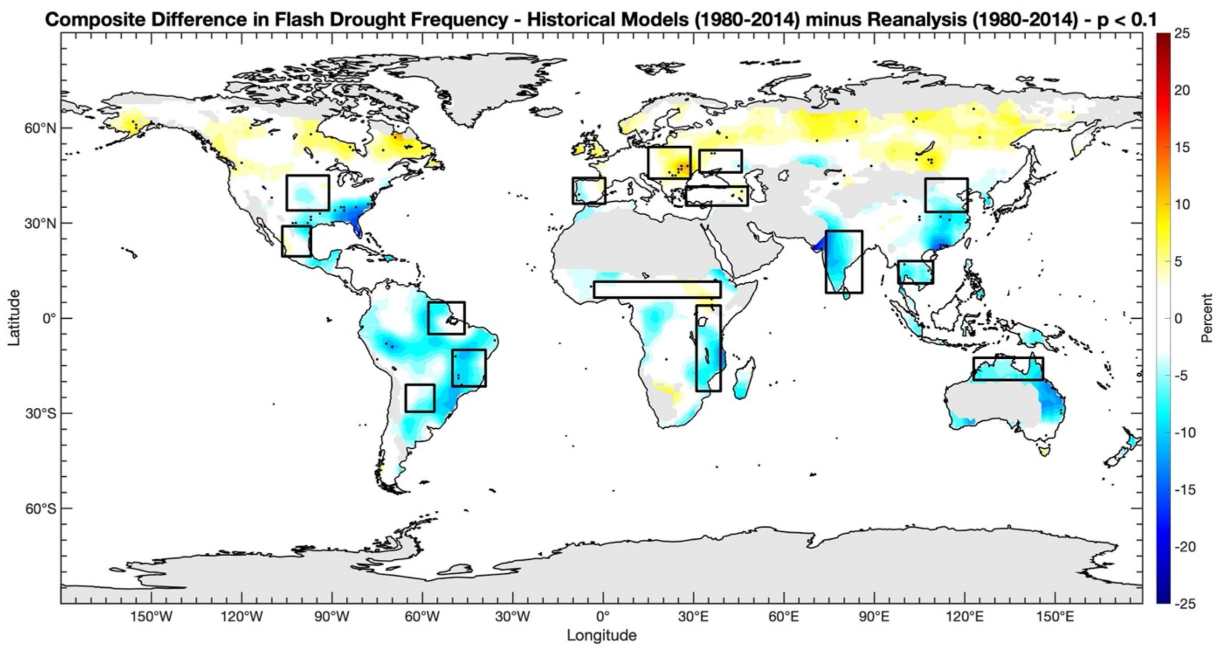
Address: School of Meteorology, University of Oklahoma, Norman, OK

Phone number: 405-325-6561

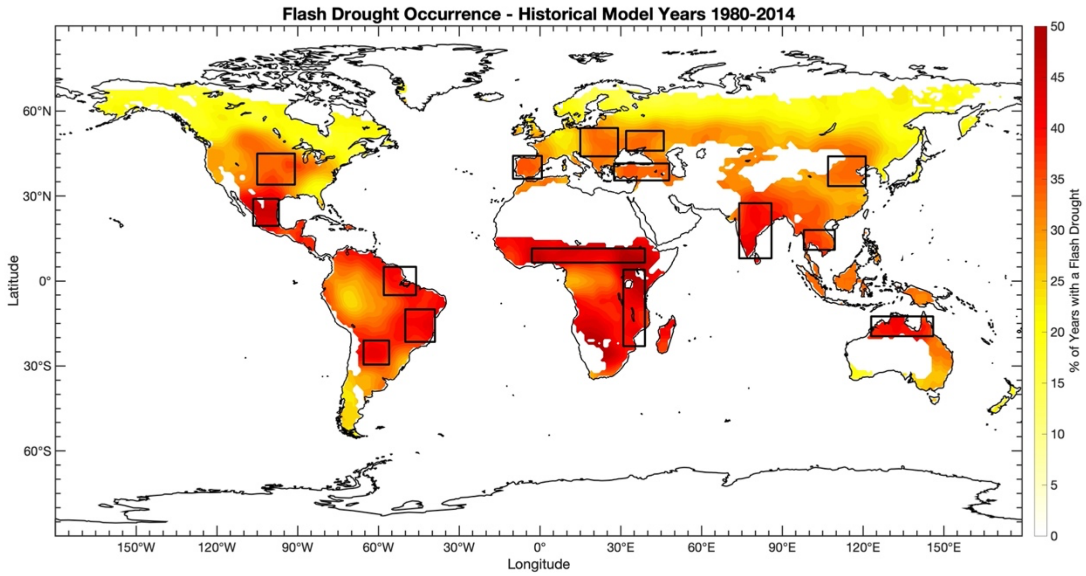
Email address: jchristian@ou.edu

Supplementary Table 1 CMIP6 models and variables used.

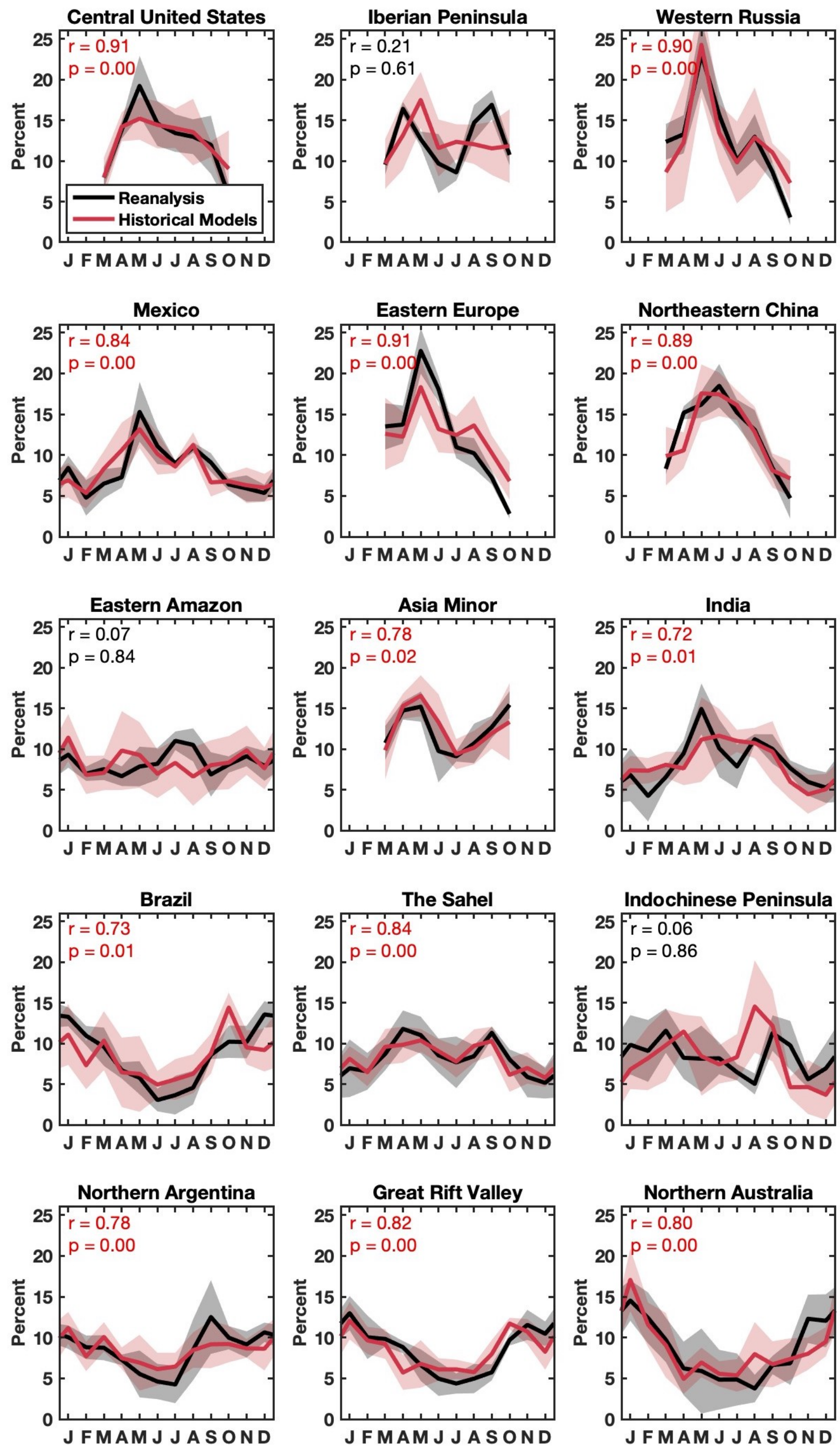
Model	Resolution	Variables	Institution
IPSL-CM6A-LR	2.5° x 1.3°	Latent heat flux (hfls), sensible heat flux (hfss), 2-meter relative humidity (hurs), 5-cm soil moisture (mrsos), precipitation (pr), surface pressure (ps), 10-meter surface wind (sfcWind), 2-meter air temperature (tas)	Institut Pierre Simon Laplace
MPI-ESM1.2-LR	0.9° x 0.9°		Max Planck Institute for Meteorology
MPI-ESM1.2-HR	1.9° x 1.9°		German Climate Computing Center
MRI-ESM2.0	1.2° x 1.2°		Meteorological Research Institute
NorESM2-LM	2.5° x 1.9°		Norwegian Climate Centre
NorESM2-MM	1.3° x 0.9°		Norwegian Climate Centre



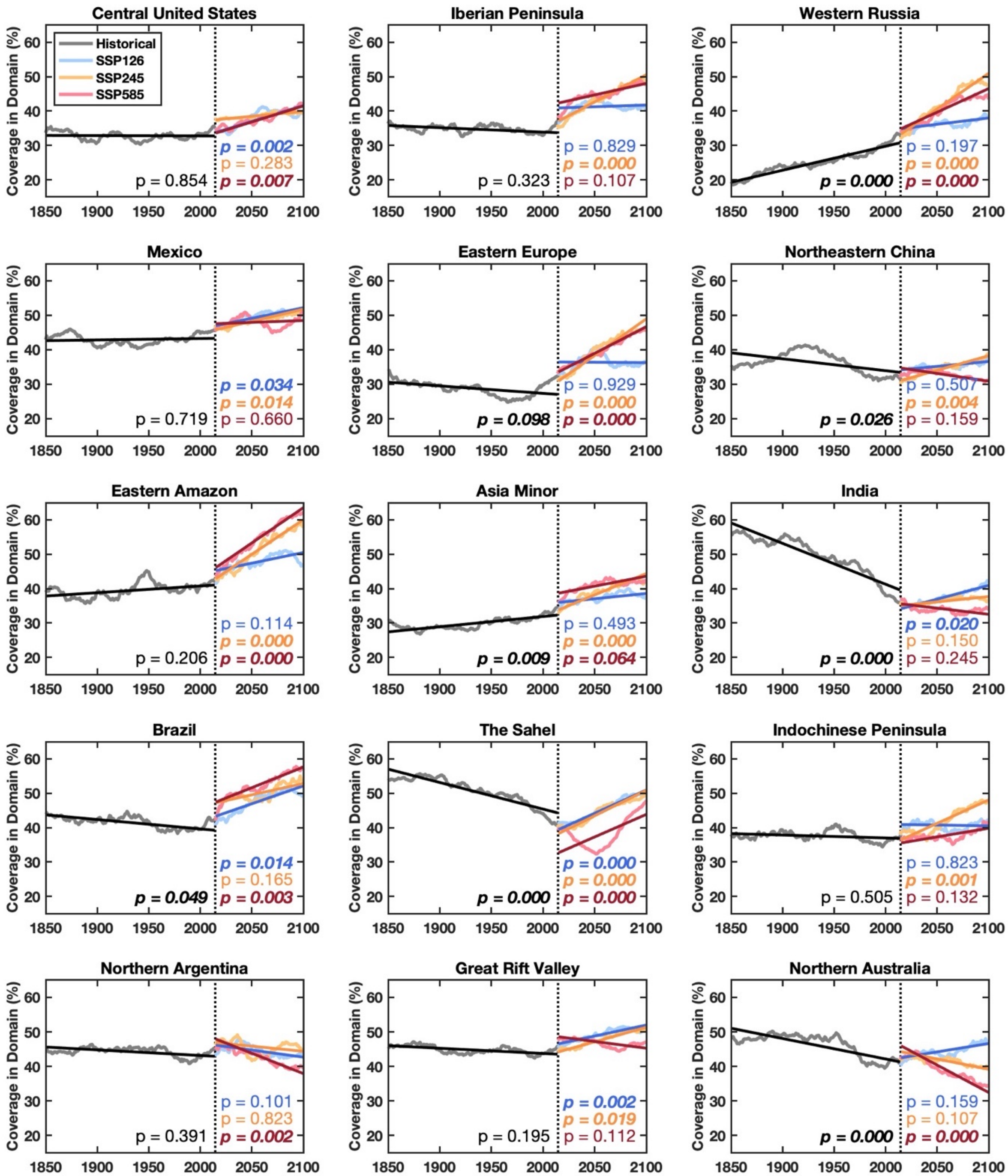
Supplementary Figure 1 The change in flash drought frequency (multi-model mean) between historical models (1980-2014) and reanalysis data (1980-2014). Unanimous agreement between the models is stippled in black.



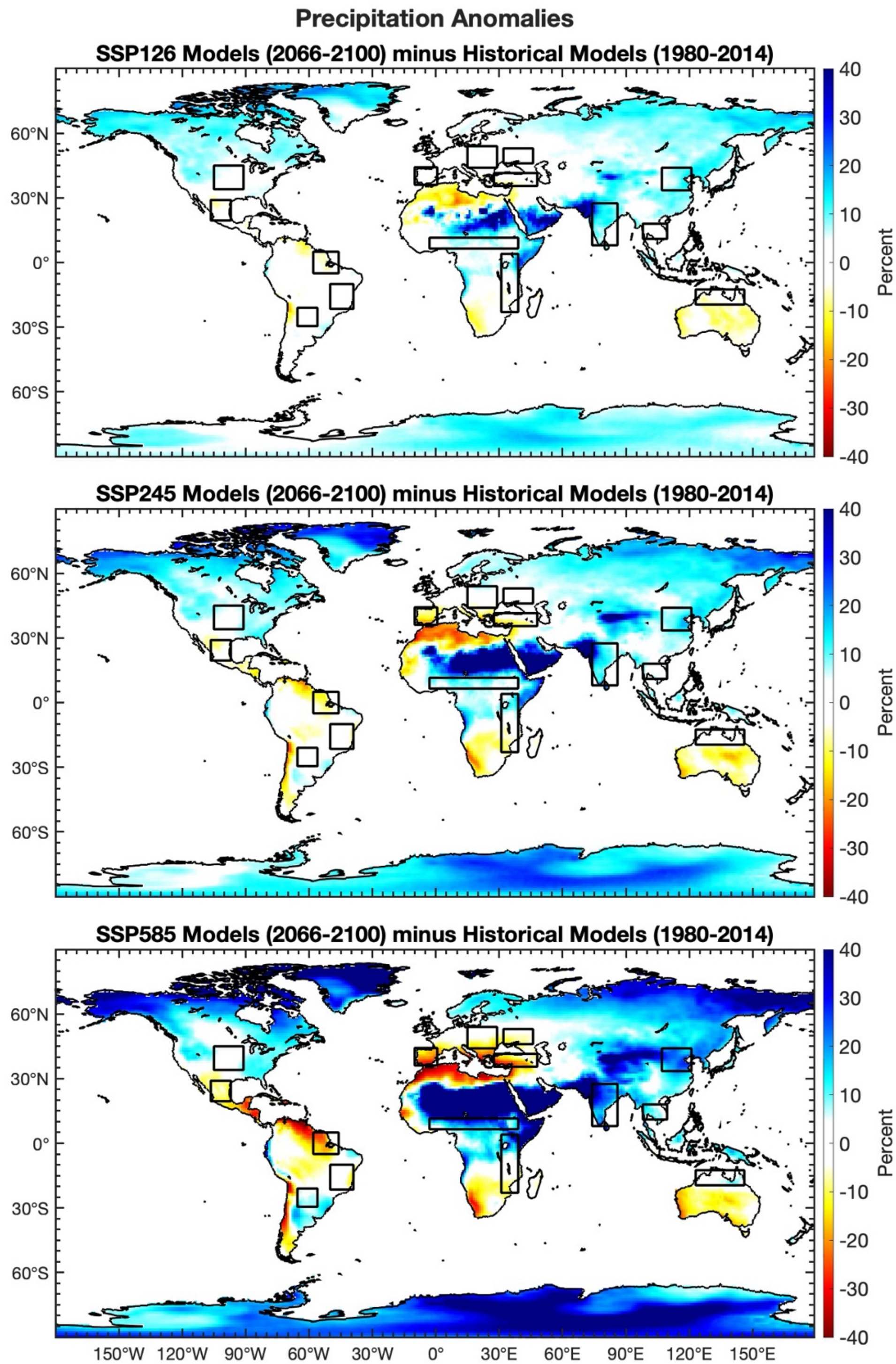
Supplementary Figure 2 Flash drought frequency (multi-model mean) from the historical models (1980-2014).



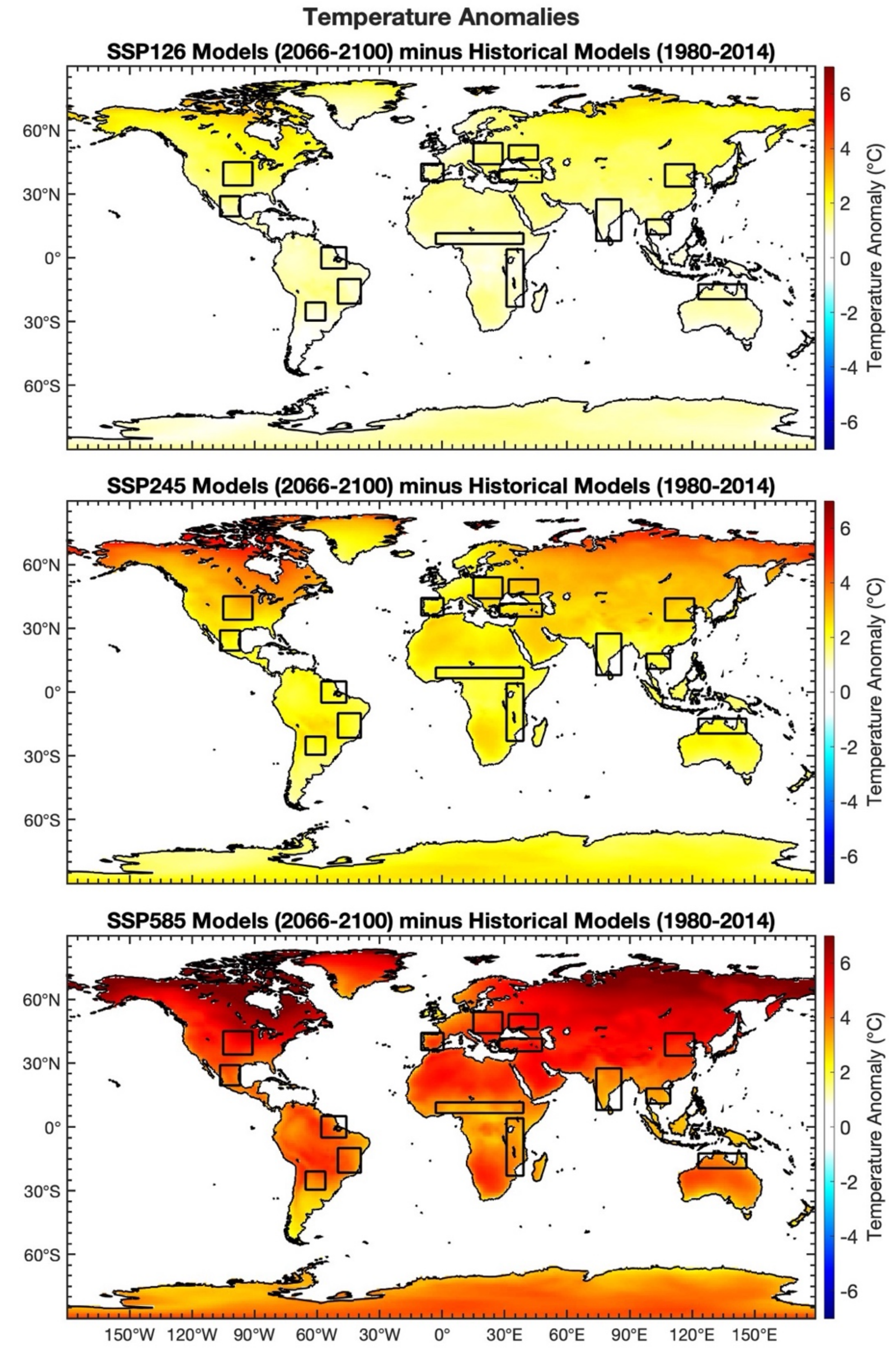
Supplementary Figure 3 Monthly flash drought occurrence (1980-2014) in each study domain for the historical models (multi-model mean) and reanalysis data (multi-reanalysis mean). The shaded regions indicate the variability (± 1 standard deviation) among the six historical models (red) and four reanalysis datasets (black).



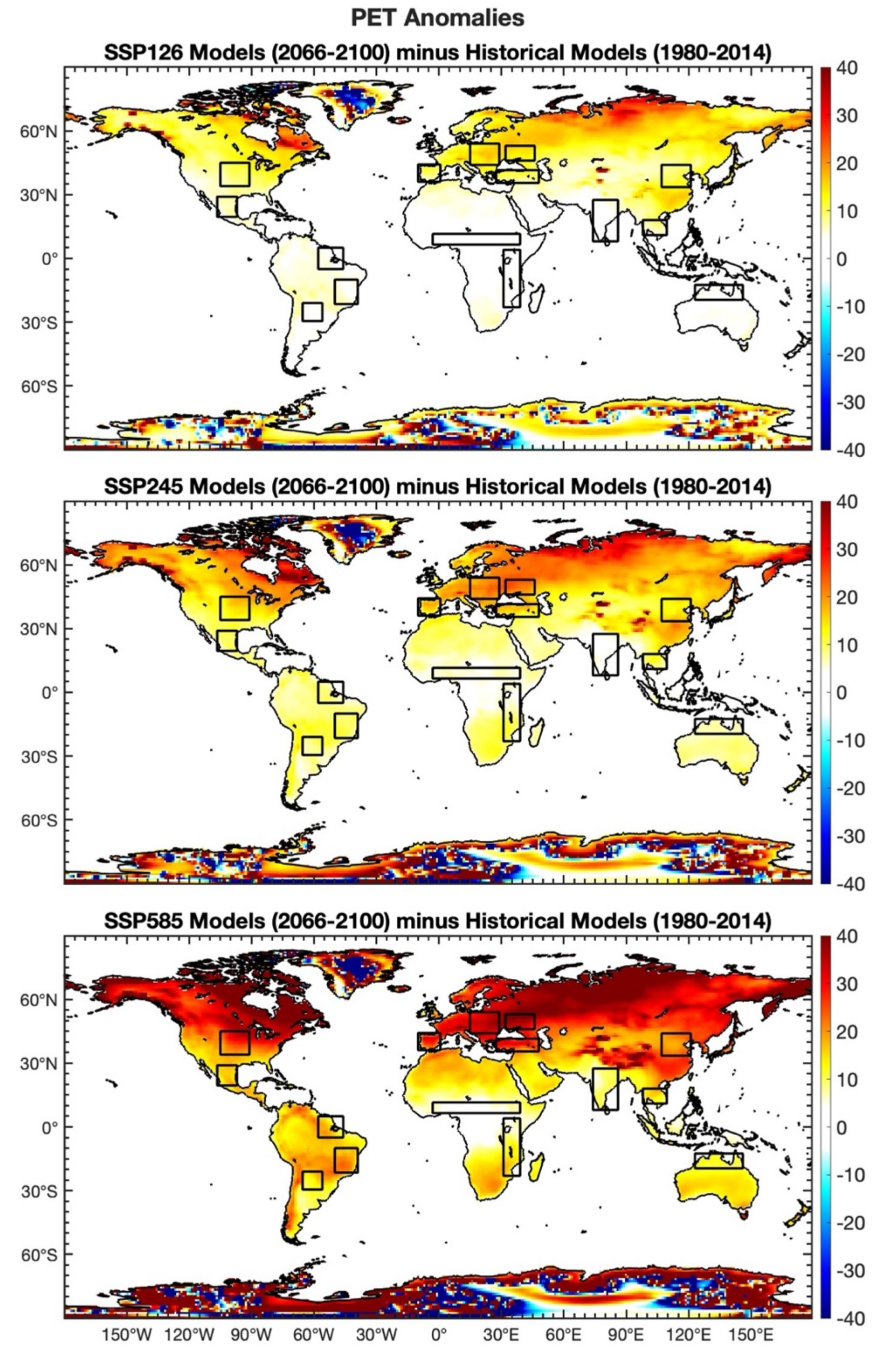
Supplementary Figure 4 Yearly flash drought coverage in each study domain (multi-model mean) for historical (black), SSP126 (blue), SSP245 (orange), and SSP585 (red) models. The 30-year centered moving average is applied to each time series. Trend lines are shown for each experiment. P-values that are bold and italicized indicate statistical significance ($p < 0.1$).



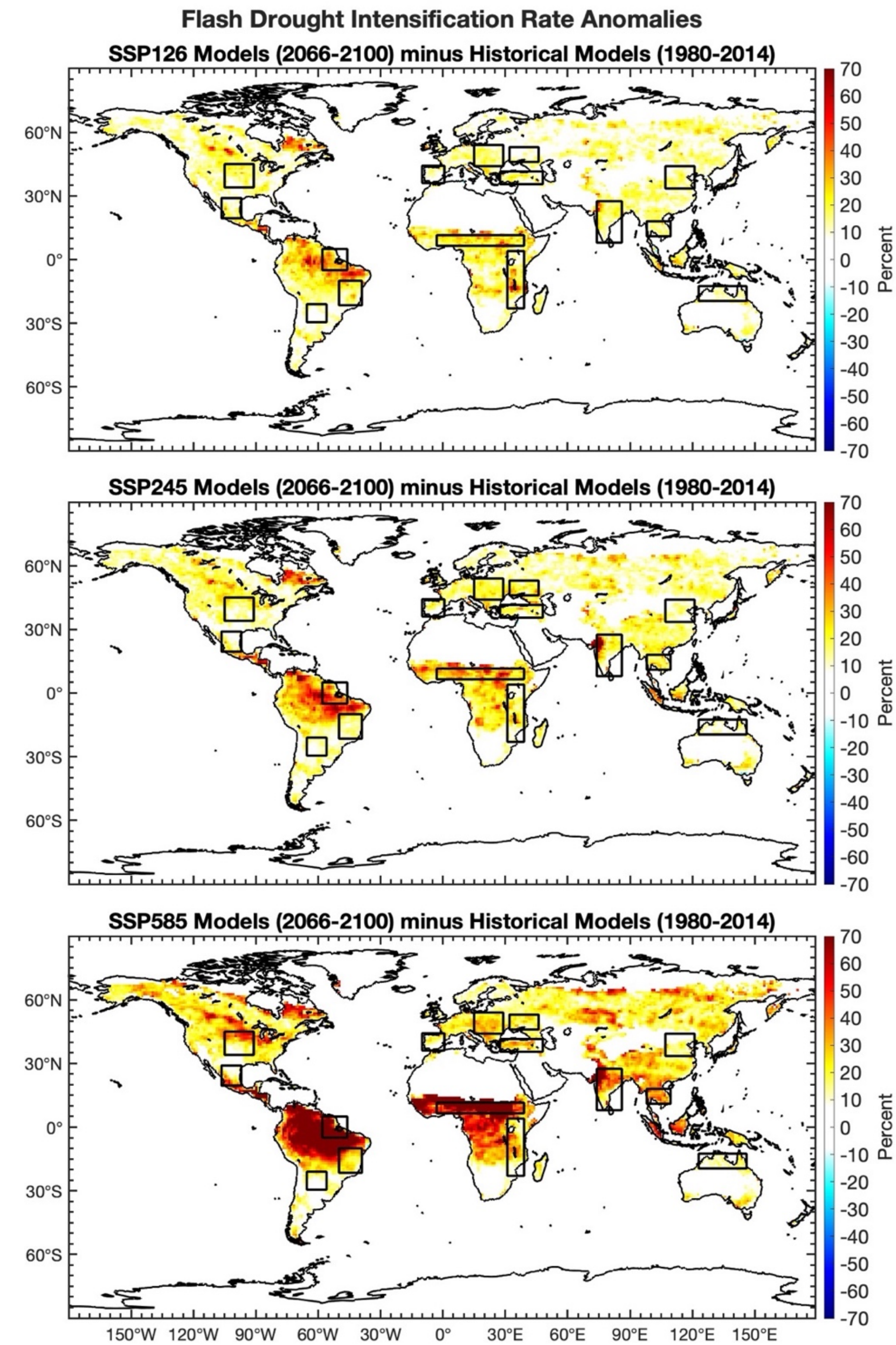
Supplementary Figure 5 The change in average annual precipitation (multi-model mean) between future scenarios (2066-2100) and historical models (1980-2014), including SSP126 (a), SSP245 (b), and SSP585 (c).



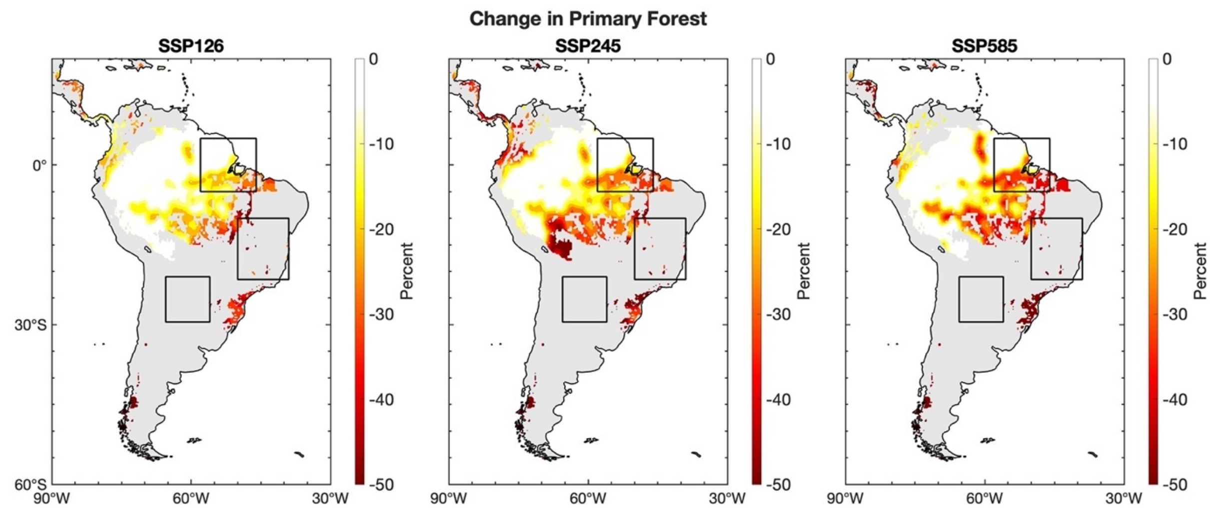
Supplementary Figure 6 The change in average temperature (multi-model mean) between future scenarios (2066-2100) and historical models (1980-2014), including SSP126 (a), SSP245 (b), and SSP585 (c).



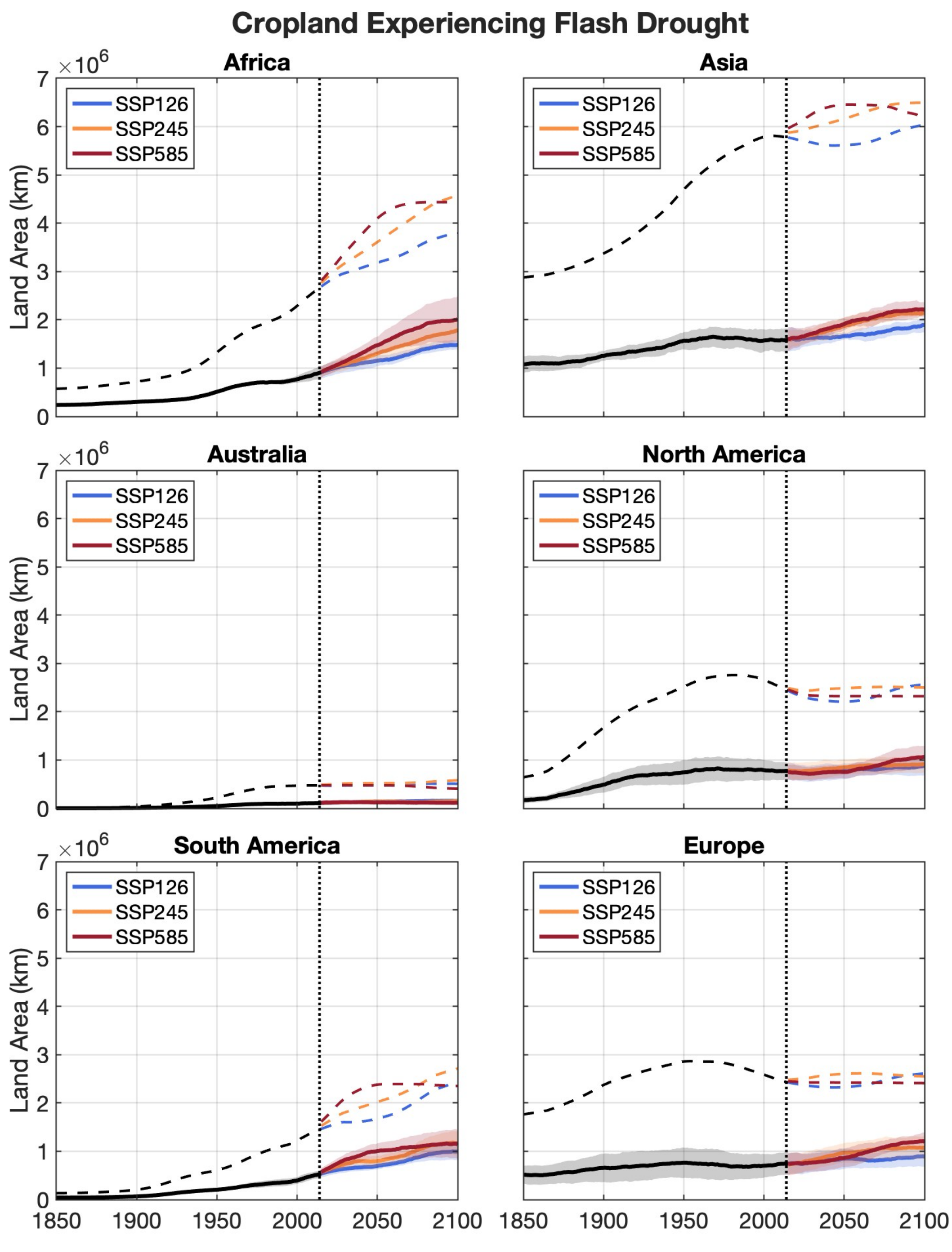
Supplementary Figure 7 The change in average PET (mean of the models) between future scenarios (2066-2100) and historical models (1980-2014), including SSP126 (a), SSP245 (b), and SSP585 (c).



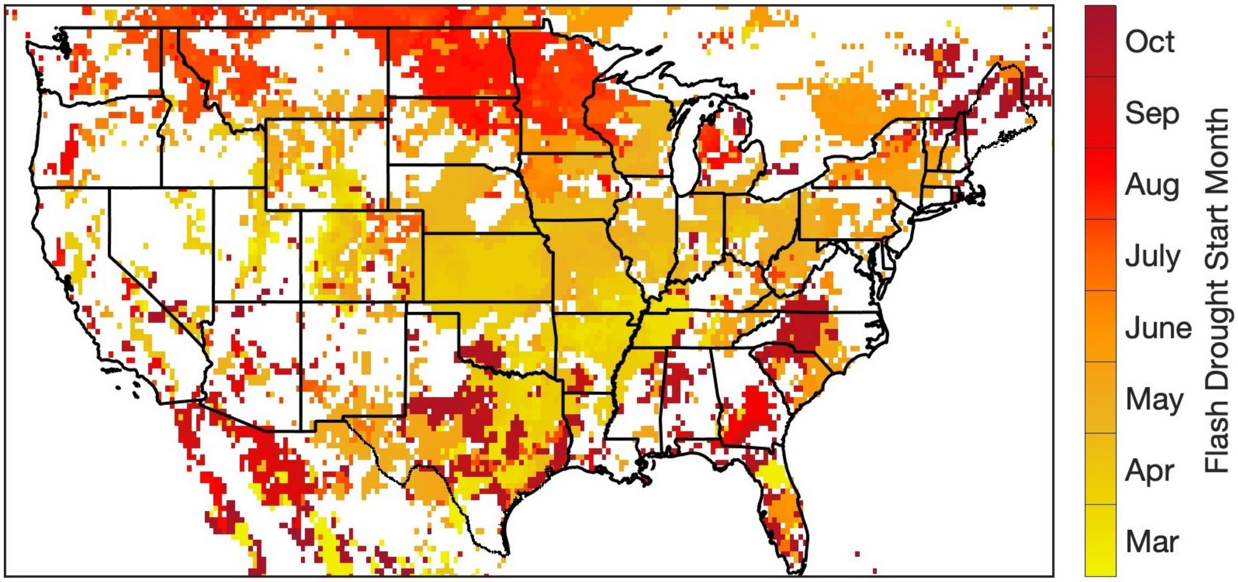
Supplementary Figure 8 The change in average flash drought intensification rate (multi-model mean) between future scenarios (2066-2100) and historical models (1980-2014), including SSP126 (a), SSP245 (b), and SSP585 (c).



Supplementary Figure 9 The change in primary forest (mean of the models) between future scenarios (2100) and historical models (2014), including SSP126 (a), SSP245 (b), and SSP585 (c).



Supplementary Figure 10 The multi-model mean of the yearly land area (km) of cropland experiencing flash drought over continents for the historical (solid black), SSP126 (solid blue), SSP245 (solid orange), and SSP585 (solid red) scenarios. Yearly land area (km) of cropland is shown with dashed lines. The 30-year centered moving average is applied to each time series. The shaded regions indicate the variability (± 1 standard deviation) among the 30-year centered moving averages between all six models for the corresponding historical and future scenarios.



Supplementary Figure 11 The timing of flash drought via ERA5 data during 2012 across the United States.