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# A theoretical approach to assess soil moisture–climate coupling across CMIP5 and GLACE-CMIP5 experiments

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**Table S1.** Overview of the 20 CMIP5 models and the four GLACE-CMIP5 models that are used for the analyses. Additionally, the respective modeling centers/groups that contributed the simulations are indicated.

| N° | Model name | Modeling center (or group) |
|---|---|---|
| | **CMIP5** | |
| 1 | BCC-CSM1.1 | Beijing Climate Center, China Meteorological Administration |
| 2 | BNU-ESM | College of Global Change and Earth System Science, Beijing Normal University |
| 3 | CanESM2 | Canadian Centre for Climate Modelling and Analysis |
| 4 | CMCC-CM | Centro Euro-Mediterraneo per I Cambiamenti Climatici |
| 5 | CMCC-CMS | Centro Euro-Mediterraneo per I Cambiamenti Climatici |
| 6 | CNRM-CM5 | Centre National de Recherches Météorologiques / Centre Européen de Recherche et Formation Avancée en Calcul Scientifique |
| 7 | CSIRO-Mk3.6.0 | Commonwealth Scientific and Industrial Research Organization in collaboration with Queensland Climate Change Centre of Excellence |
| 8 | FGOALS-g2 | LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences and CESS,Tsinghua University |
| 9 | GFDL-CM3 | NOAA Geophysical Fluid Dynamics Laboratory |
| 10 | GFDL-ESM2G | NOAA Geophysical Fluid Dynamics Laboratory |
| 11 | GFDL-ESM2M | NOAA Geophysical Fluid Dynamics Laboratory |
| 12 | INM-CM4 | Institute for Numerical Mathematics |
| 13 | MIROC-ESM | Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute (The University of Tokyo), and National Institute for Environmental Studies |
| 14 | MIROC-ESM-CHEM | Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute (The University of Tokyo), and National Institute for Environmental Studies |
| 15 | MIROC5 | Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology |
| 16 | MPI-ESM-MR | Max-Planck-Institut für Meteorologie (Max Planck Institute for Meteorology) |
| 17 | MPI-ESM-LR | Max-Planck-Institut für Meteorologie (Max Planck Institute for Meteorology) |
| 18 | MRI-CGCM3 | Meteorological Research Institute |
| 19 | MRI-ESM1 | Meteorological Research Institute |
| 20 | NorESM1-M | Norwegian Climate Centre |
| | **GLACE-CMIP5**[a] | |
| 1 | ACCESS | Commonwealth Scientific and Industrial Research Organization (CSIRO) and Bureau of Meteorology (BOM), Australia |
| 2 | EC-EARTH | EC-EARTH consortium |
| 3 | GFDL | NOAA Geophysical Fluid Dynamics Laboratory |
| 4 | MPI-ESM-LR | Max-Planck-Institut für Meteorologie (Max Planck Institute for Meteorology) |

[a]Only for ACCESS, EC-EARTH, GFDL, and MPI-ESM-LR all necessary data for conducting the analyses were available. For IPSL daily soil moisture and daily net radiation is missing for all 3 experiments (CTL, Clim20C, ClimCTL), for CESM daily soil moisture is missing for all 3 experiments and daily latent and sensible heat fluxes are missing for CTL).

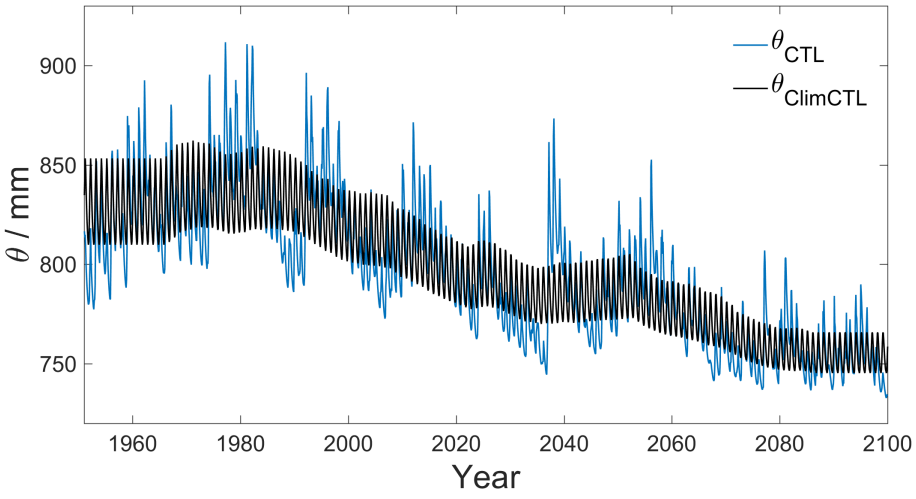


**Figure S1.** Example of soil moisture evolution in the GLACE-CMIP5 control run ($\theta_{\mathrm{CTL}}$) and the run with transient soil moisture climatology ($\theta_{\mathrm{ClimCTL}}$) in EC-EARTH at a grid point close to Jerusalem.

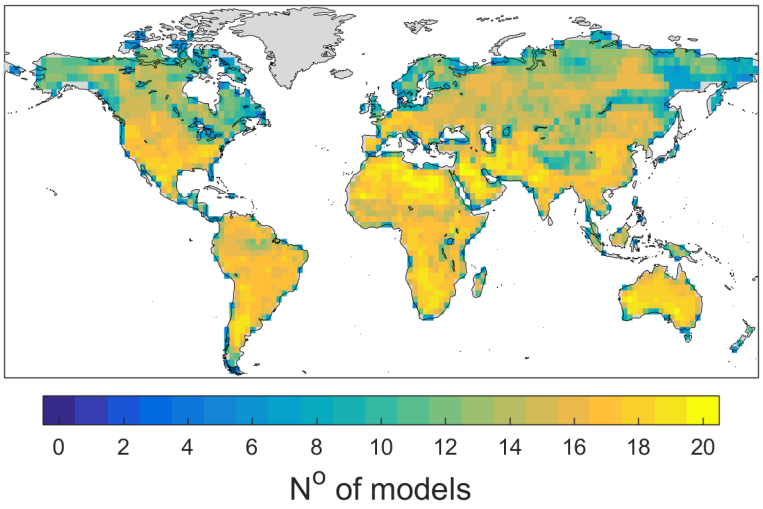


**Figure S2.** Number of CMIP5 models that are considered at each grid cell. For each model, grid cells at which the monthly mean of the reconstructed daily soil moisture values does not agree with the monthly mean soil moisture from the CMIP5 standard output are not considered in the analysis according to the following criteria: Soil moisture data are masked at grid cells where the correlation between both monthly soil moisture estimates is lower than 0.99 and where the root mean squared error is smaller than 10 % of the standard deviation of the monthly CMIP5 soil moisture values (see Section 3.1.2 for more details).

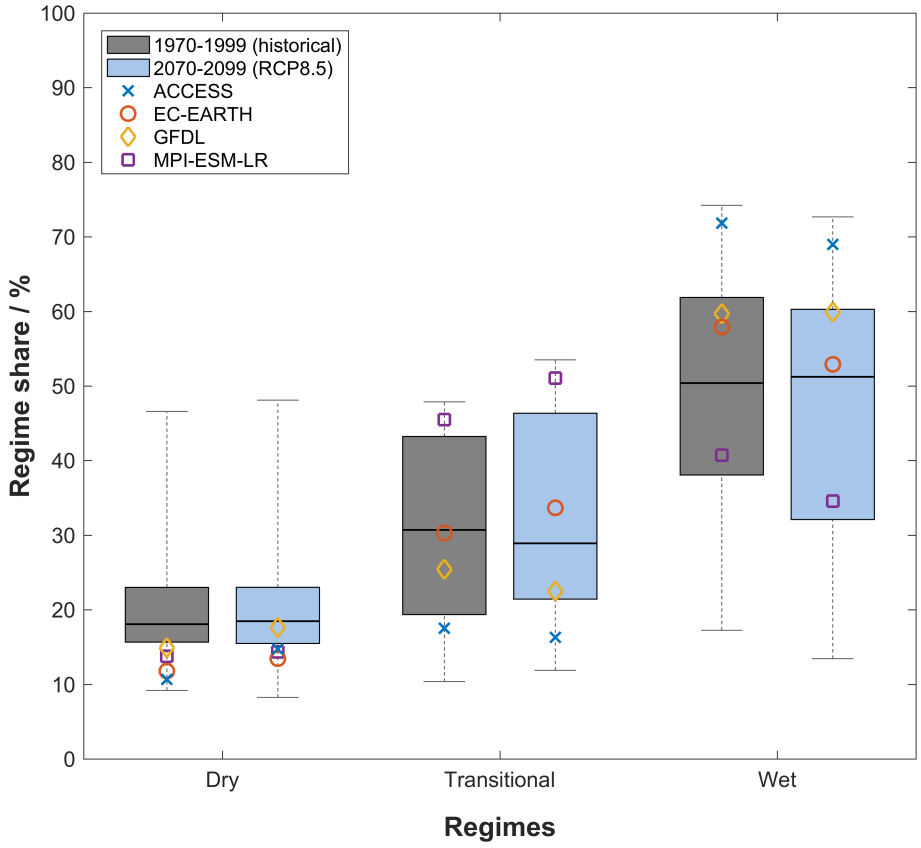


**Figure S3.** Global shares of the different soil moisture regimes in CMIP5 (box and whisker plots) and GLACE-CMIP5 (colored markers) for the time periods 1970–1999 (using historical simulations) and 2070–2099 (using RCP8.5 simulations).

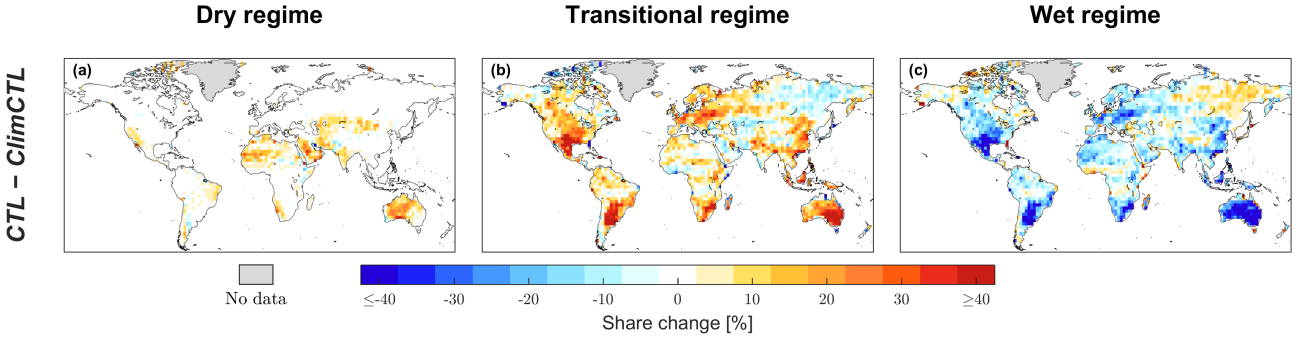


**Figure S4.** Difference in soil moisture regime occurrence in GLACE-CMIP5 between the control run (CTL) and the run with prescribed transient soil moisture climatology (ClimCTL) for the time period 2070–2099.

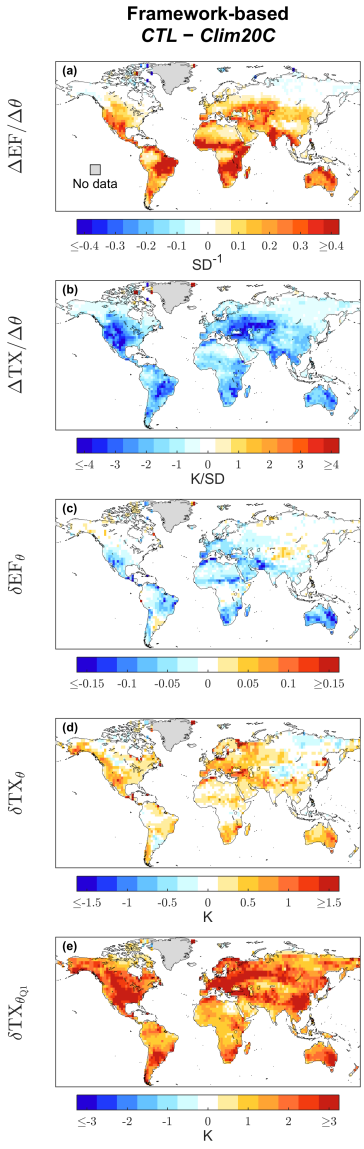


**Figure S5.** As in Figure 3 (central column) but using surface soil moisture instead of total column soil moisture. Only ACCESS, EC-EARTH, and GFDL are included here because MPI-ESM-LR does not provide surface soil moisture data. Note the different colorbar limits in (a) and (b) compared to Figure 3.

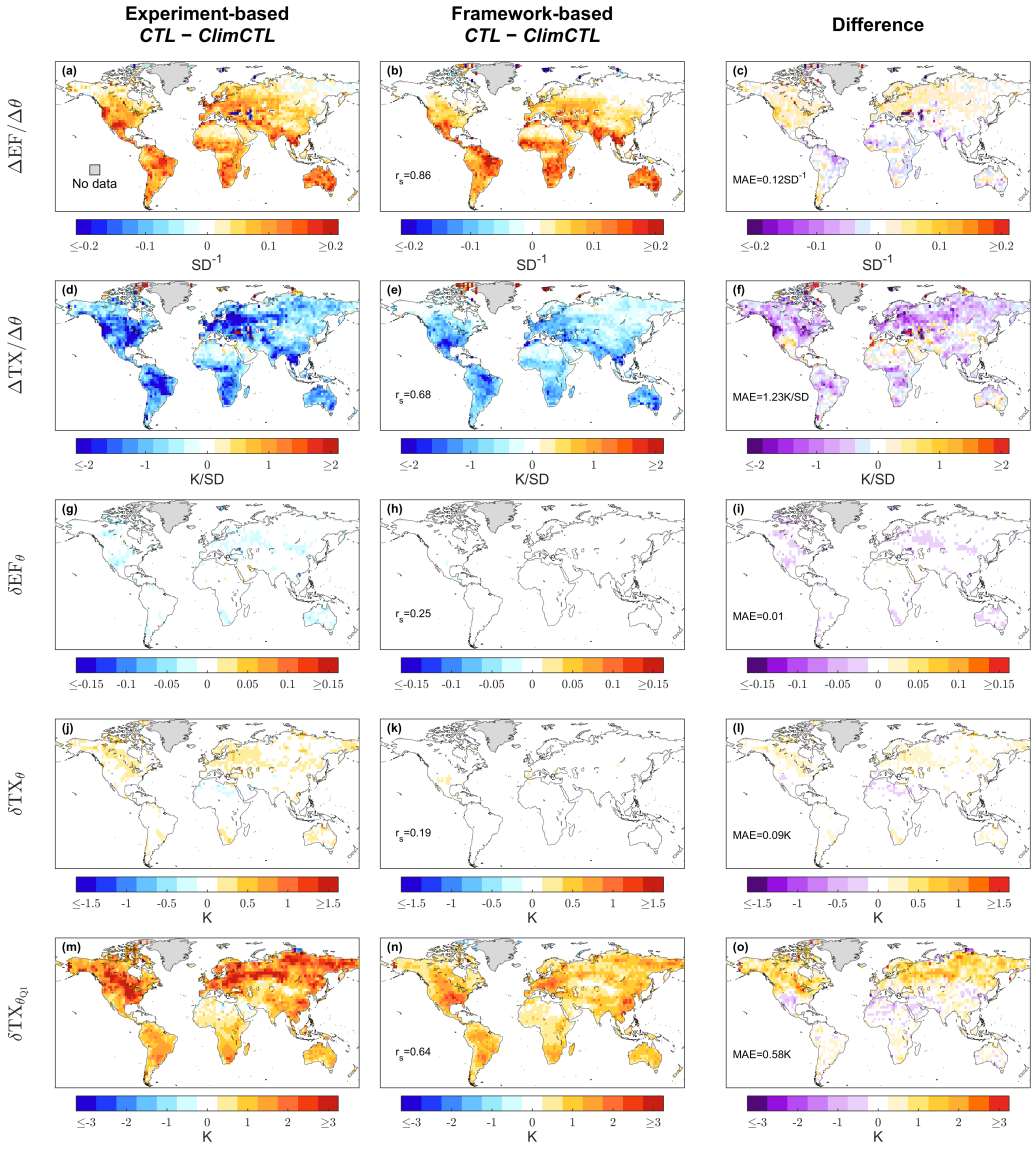


**Figure S6.** As in Figure 3 but for CTL and ClimCTL.

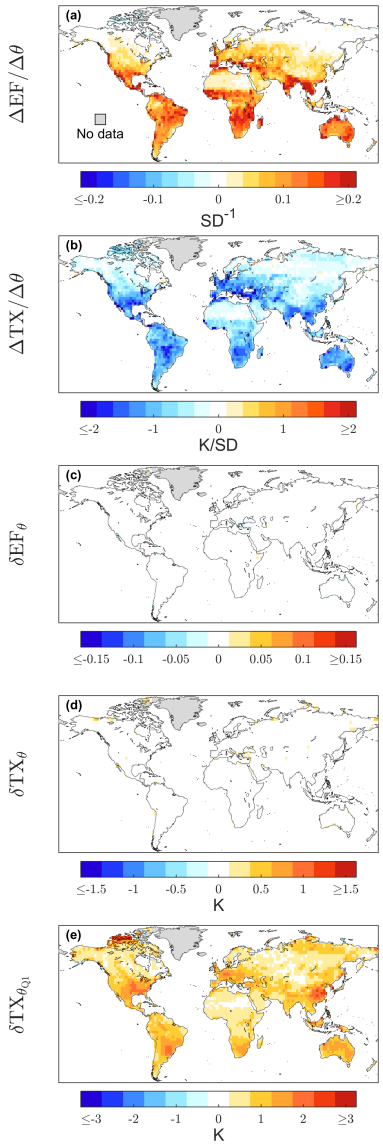


**Figure S7.** As in Figure 4 but for CTL and ClimCTL.

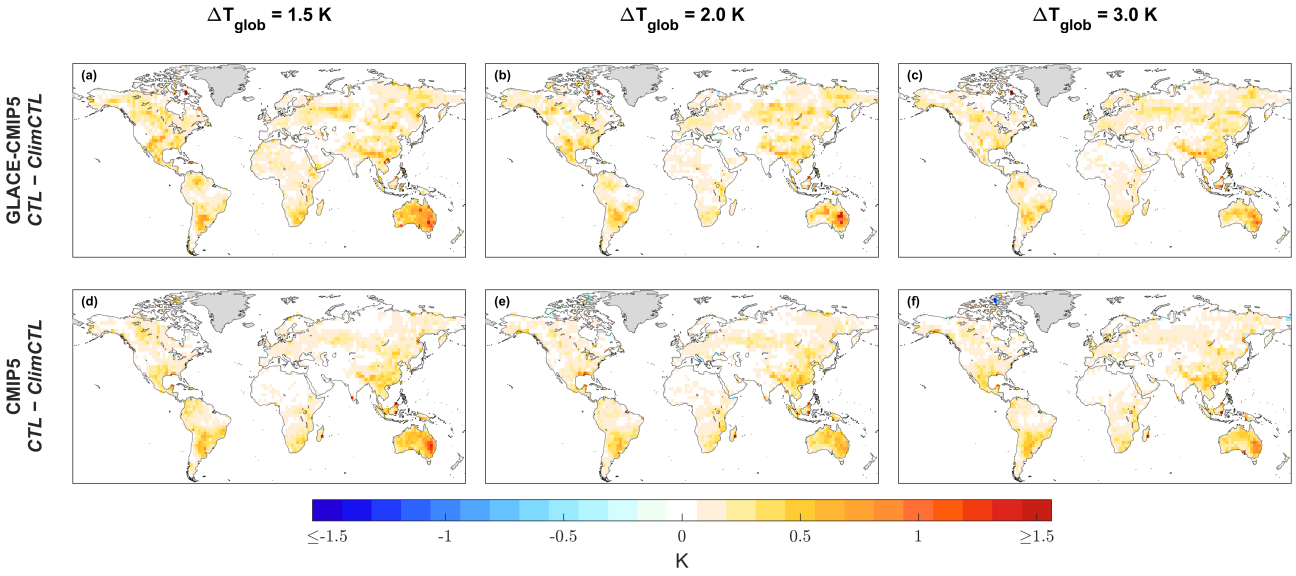


**Figure S8.** As in Figure 5 but for CTL and ClimCTL.

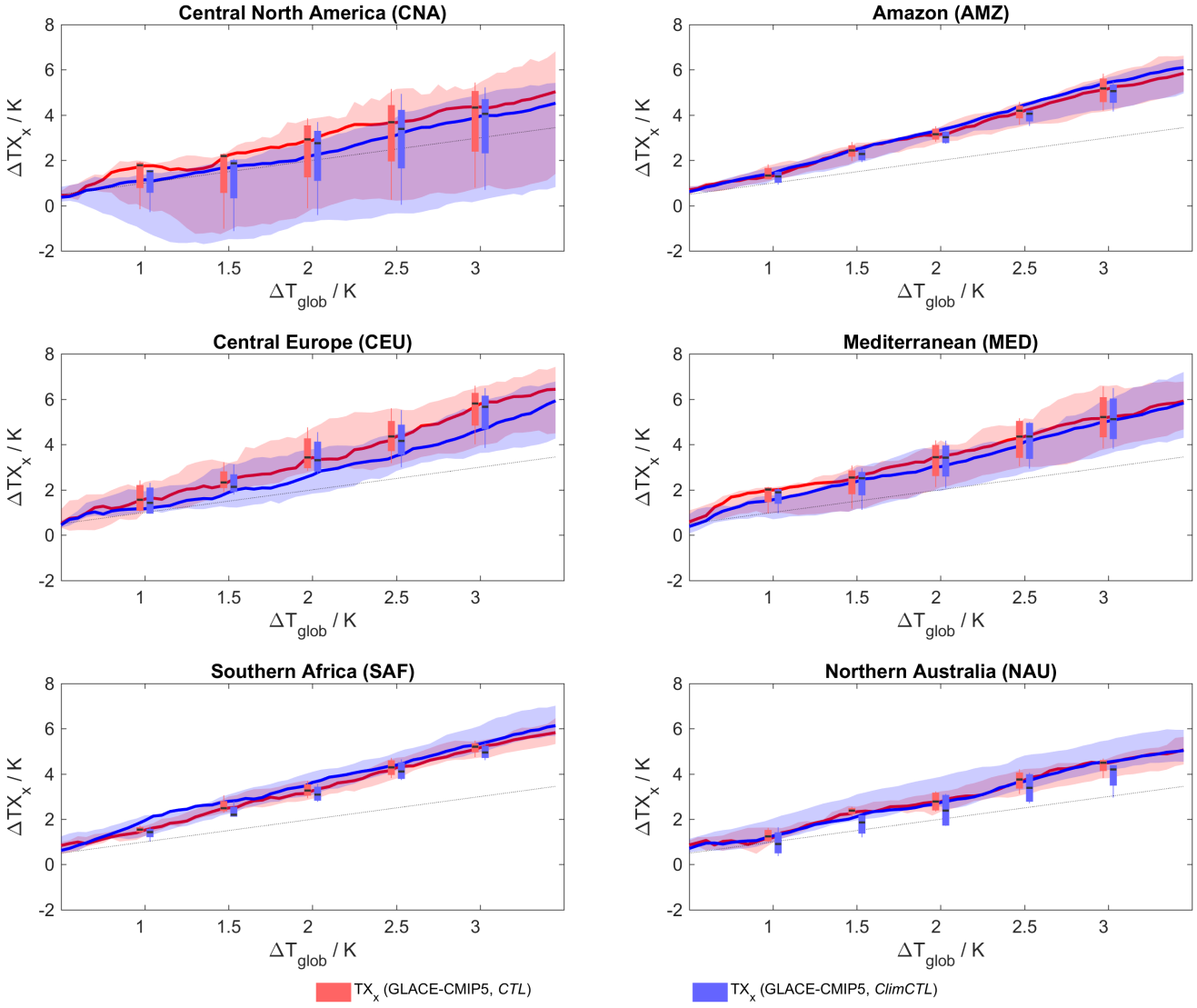


**Figure S9.** As in Figure 6 but for CTL and ClimCTL.

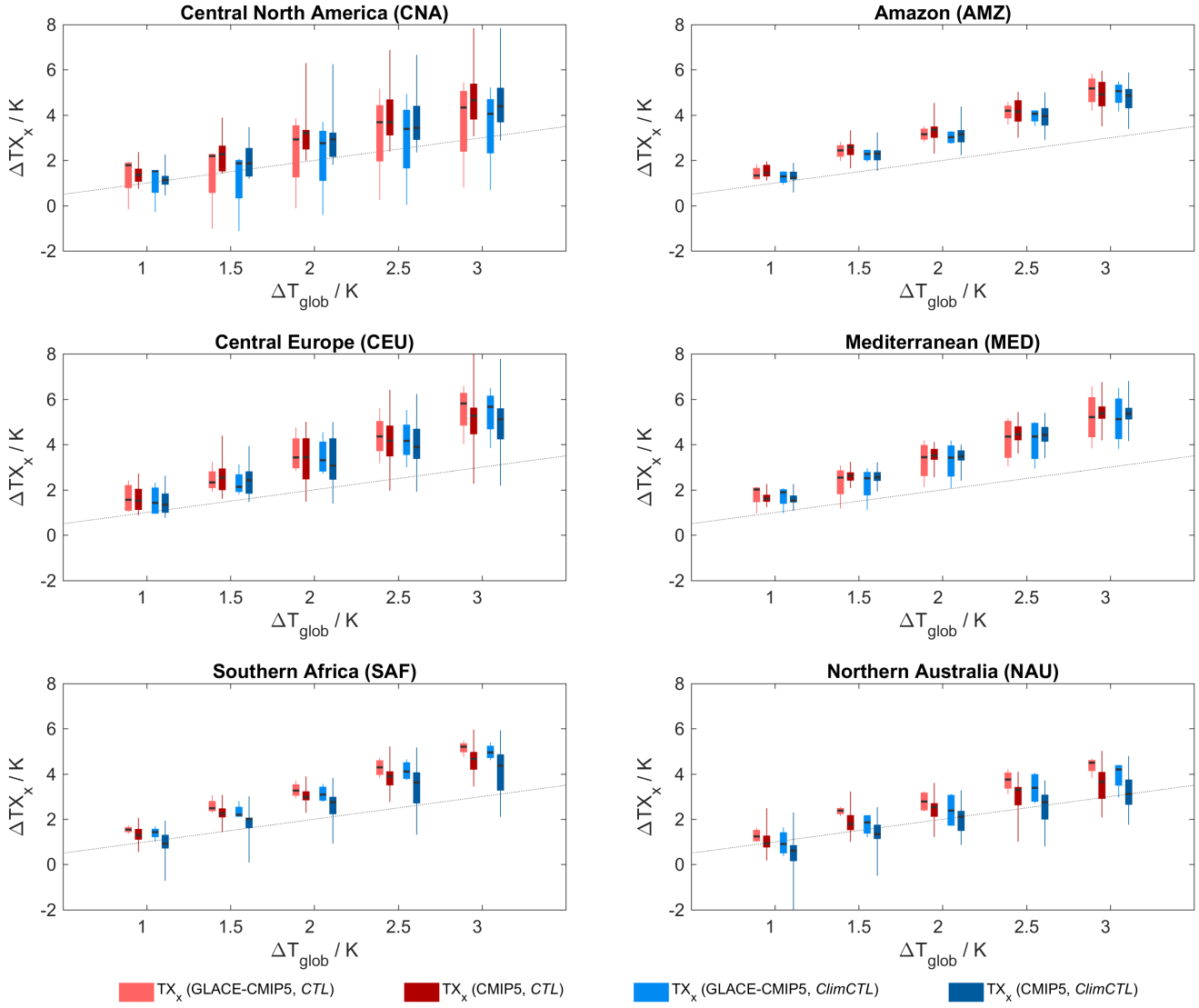


**Figure S10.** As in Figure 7 but for CTL and ClimCTL.