Does regional hydroclimate change scale linearly with global warming?

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Introduction

This Supporting Information file contains 13 figures that are referenced in the main text. Details on the figures are either given in their captions or in the main text, e.g., when they are analogues to figures the main text.
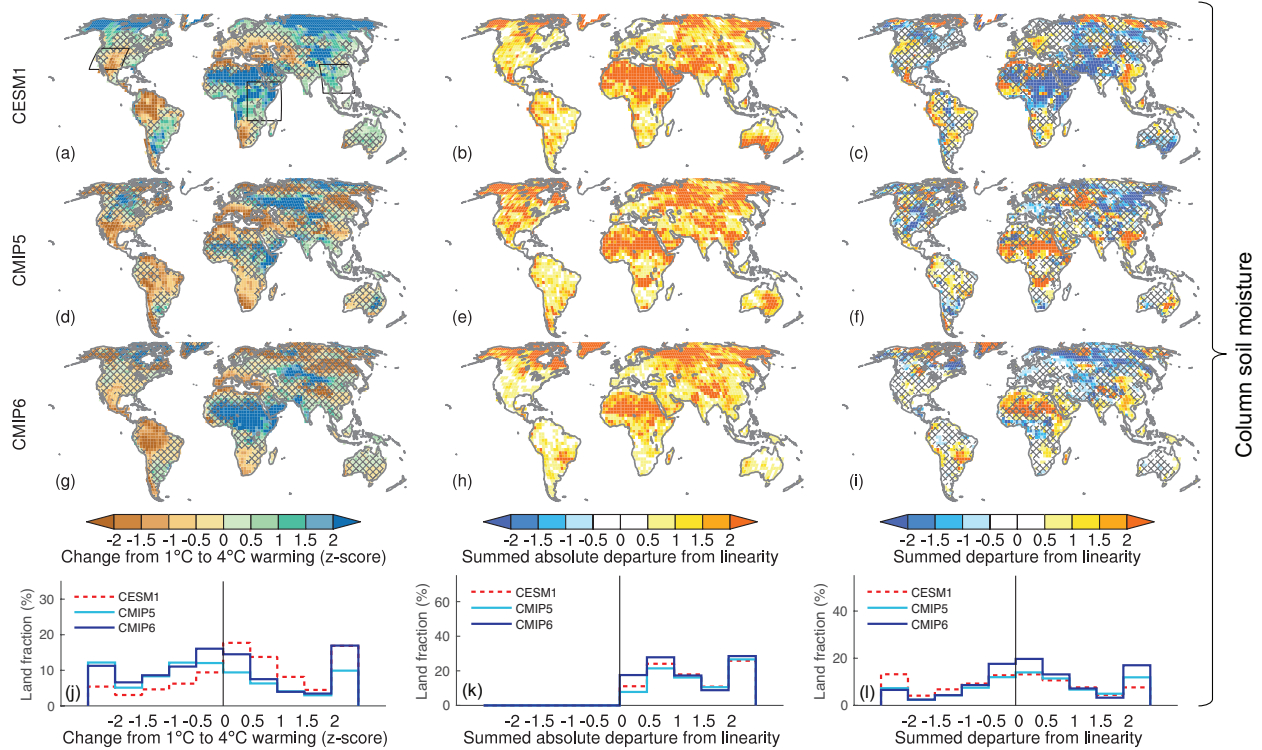
Figure S1: (a) Change in normalized annual mean soil moisture for the 20-year period with ~4°C global warming relative to 1920-1949 in CESM1; hatching indicates differences that are not significant according to a two-sided t test (95% confidence level). (b) Summed absolute departure from linearity as a function of global warming of 1°C, 2°C, 3°C and 4°C. (c) Summed departure from linearity as a function of global warming of 1°C, 2°C, 3°C and 4°C; hatching indicates where the signal-to-noise ratio is smaller than one. Blue colors tend to indicate a convex trajectory with global warming, red colors a concave trajectory. (d-f, g-i) Same as (a-c) but for CMIP5 and 6; hatching indicates <67% models agree on the sign. (j-l) Histograms give the land fraction occupied by a certain color bar category.
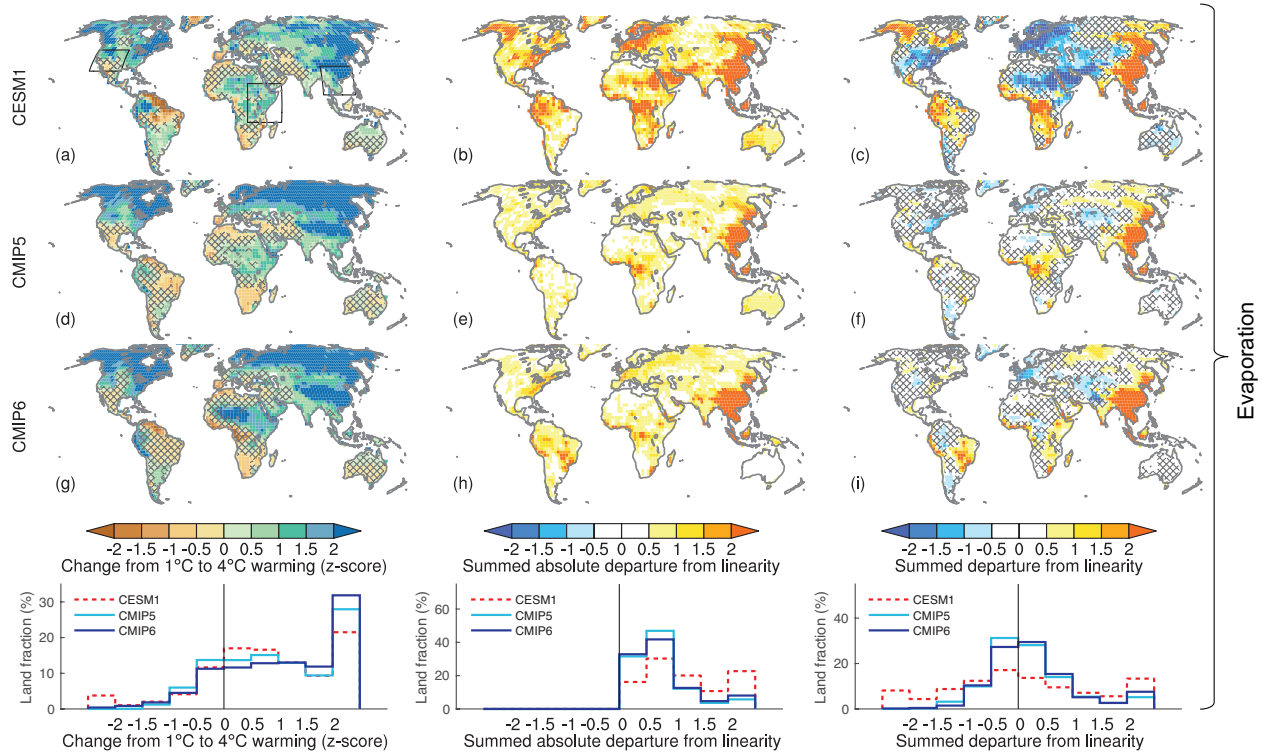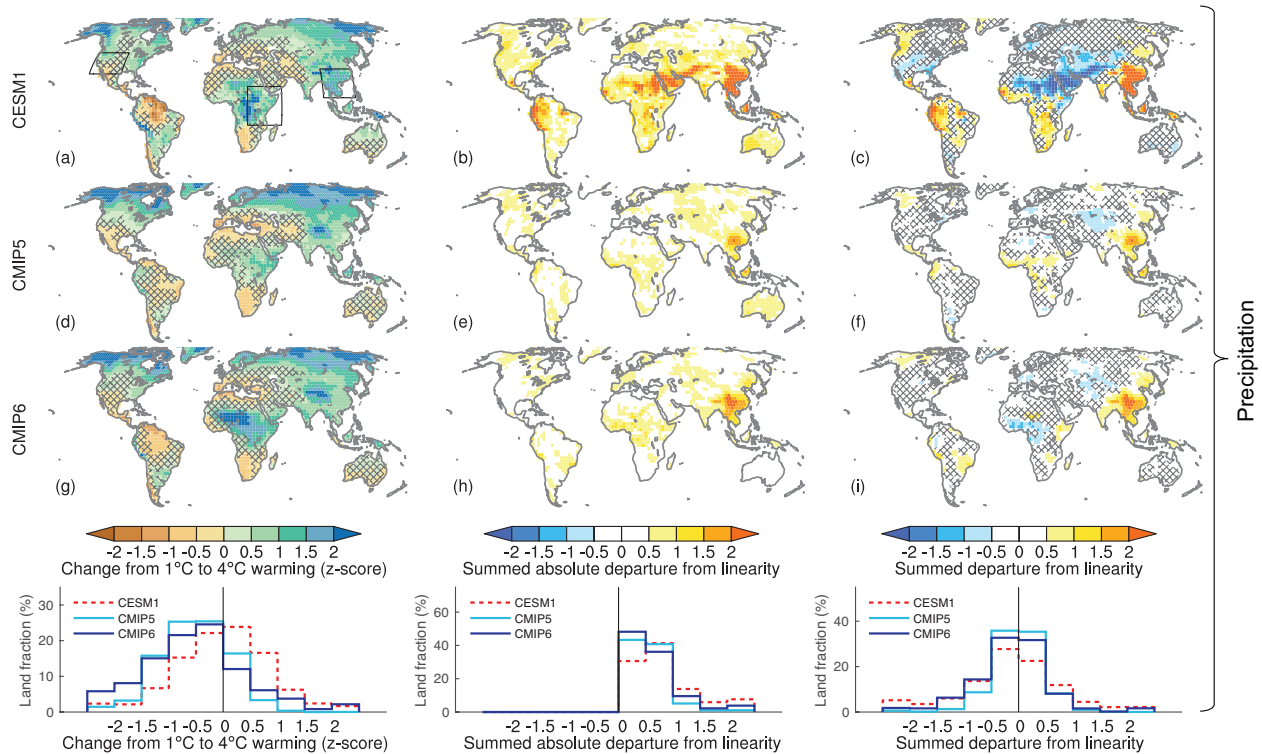
Figure S2: Same as Fig. S1, but for evaporation.

Figure S3: Same as Fig. S1, but for precipitation.
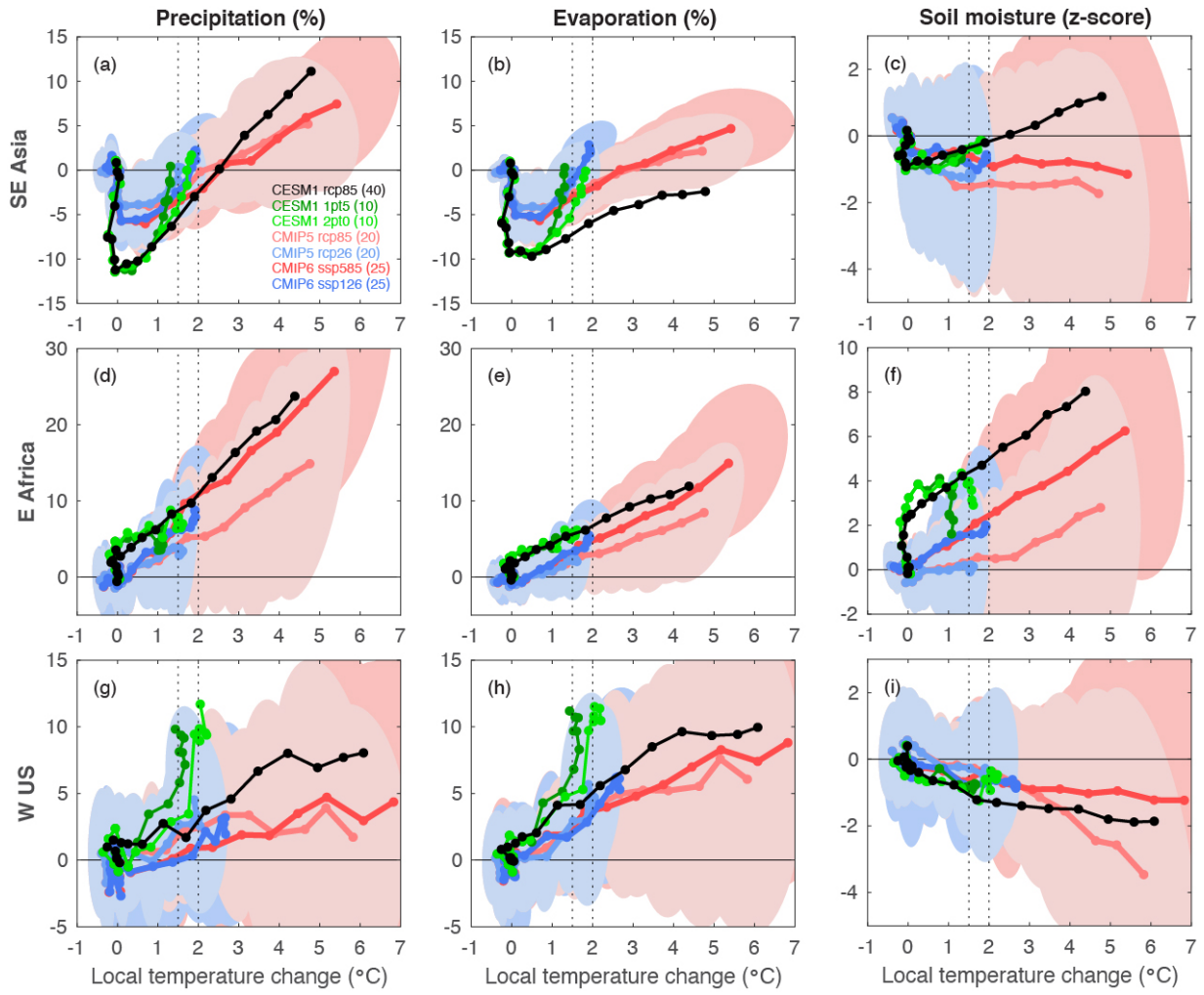
Figure S4: Same as Fig. 2 but showing local instead of global temperature change on the x-axis.
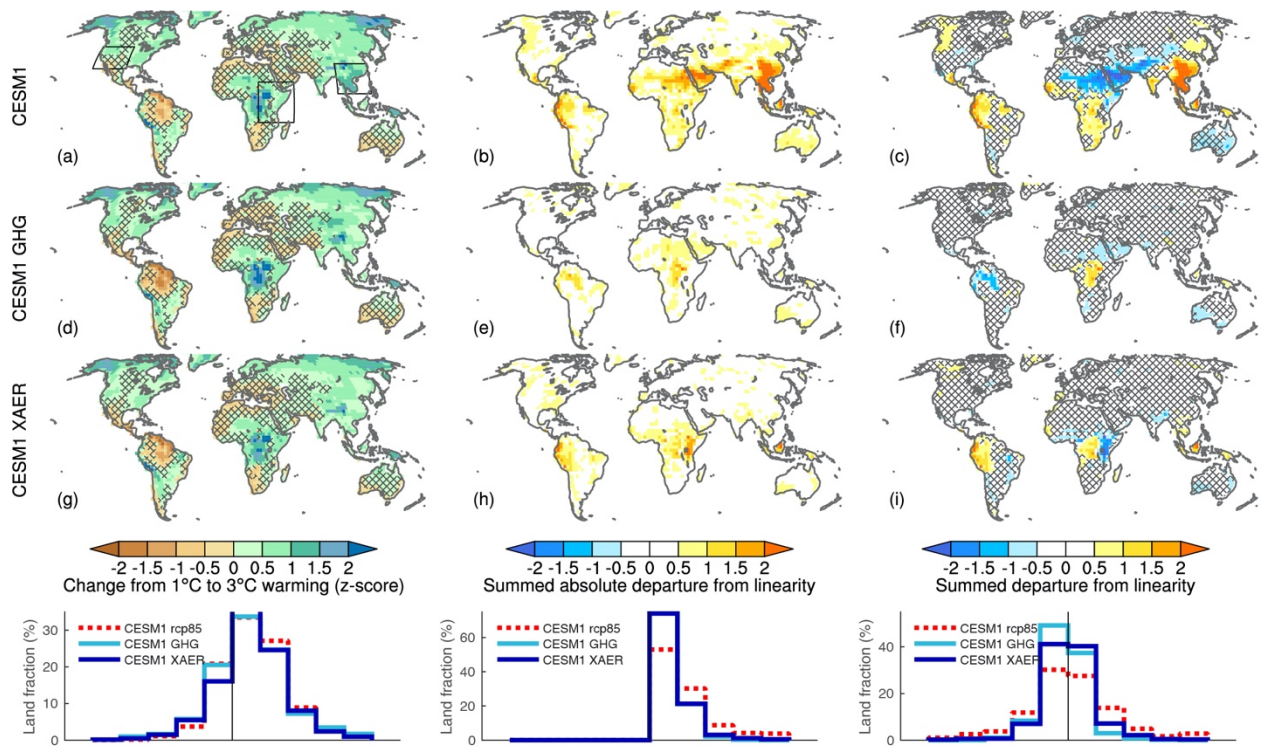
Figure S5: Same as Fig. S3 for precipitation, but for the CESM1 simulations under 'rcp85', 'GHG' and 'XAER' forcing. The changes and departures from linearity are assessed over changes from 1°C to 3°C, due to not all simulations warming by 4°C.
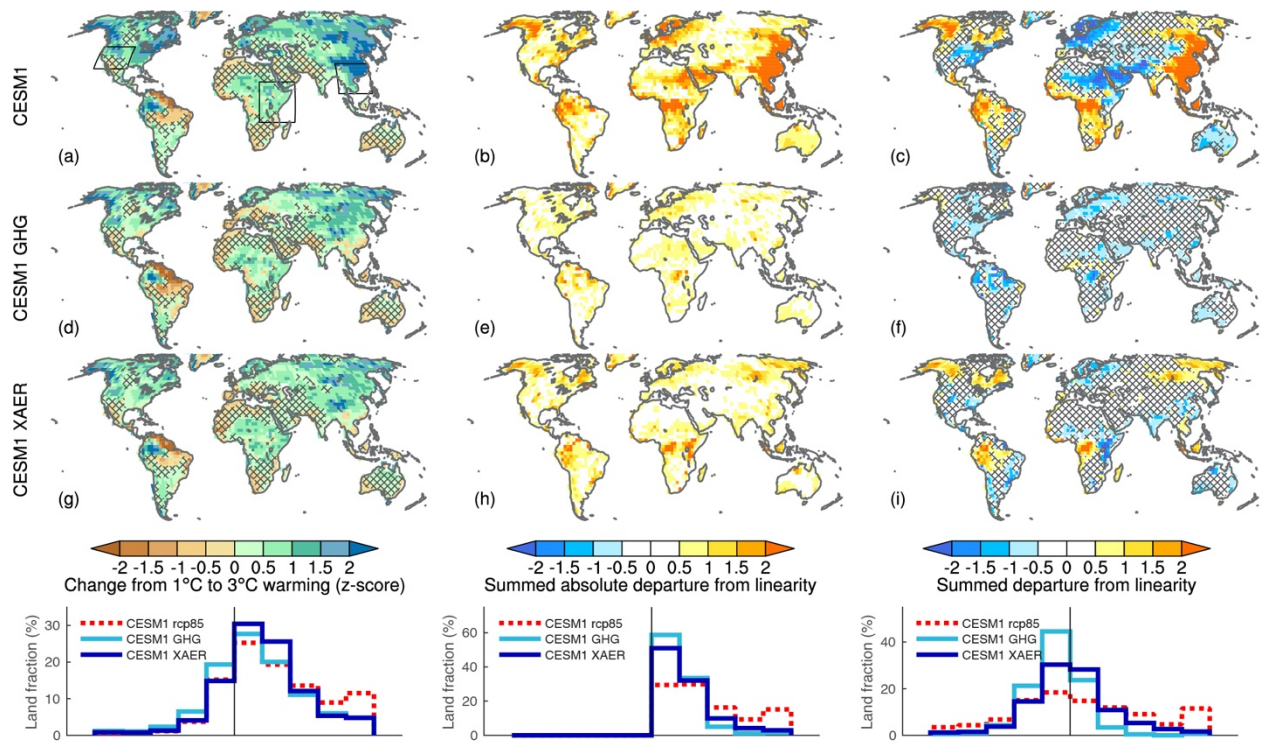
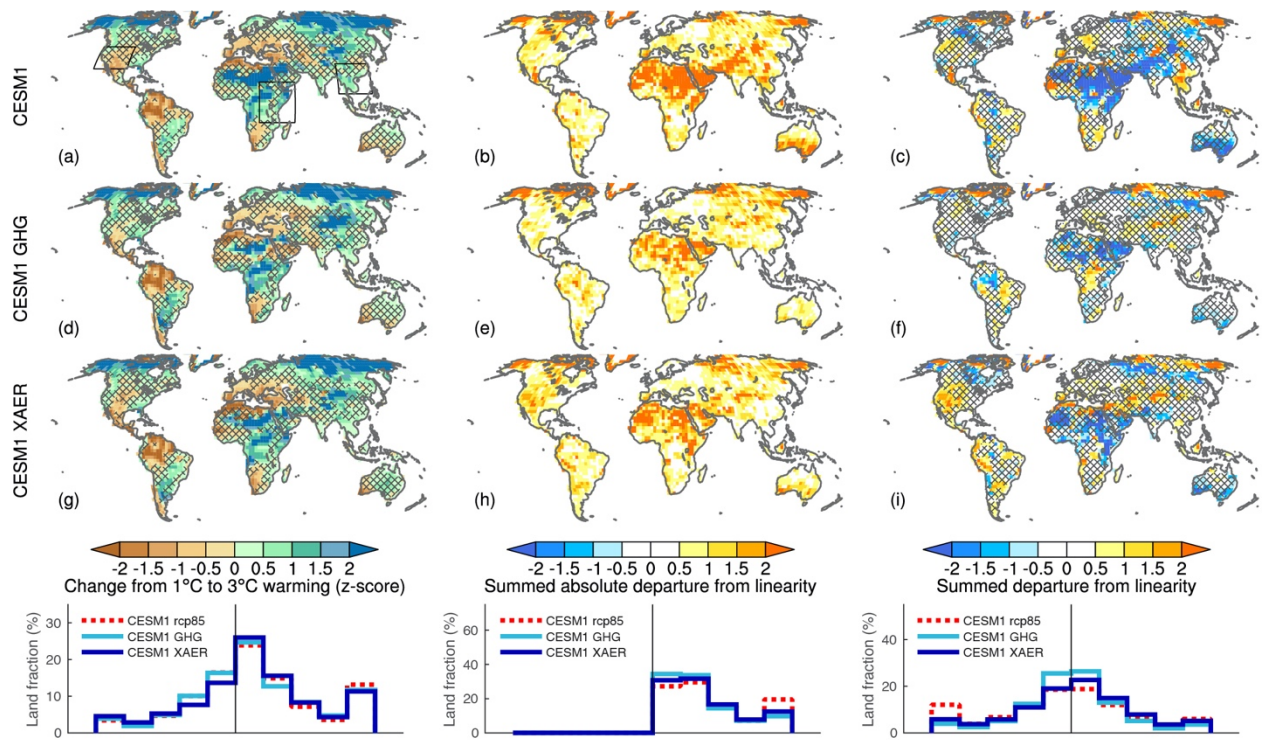**Figure S6:** Same as Fig. S5, but for evaporation.

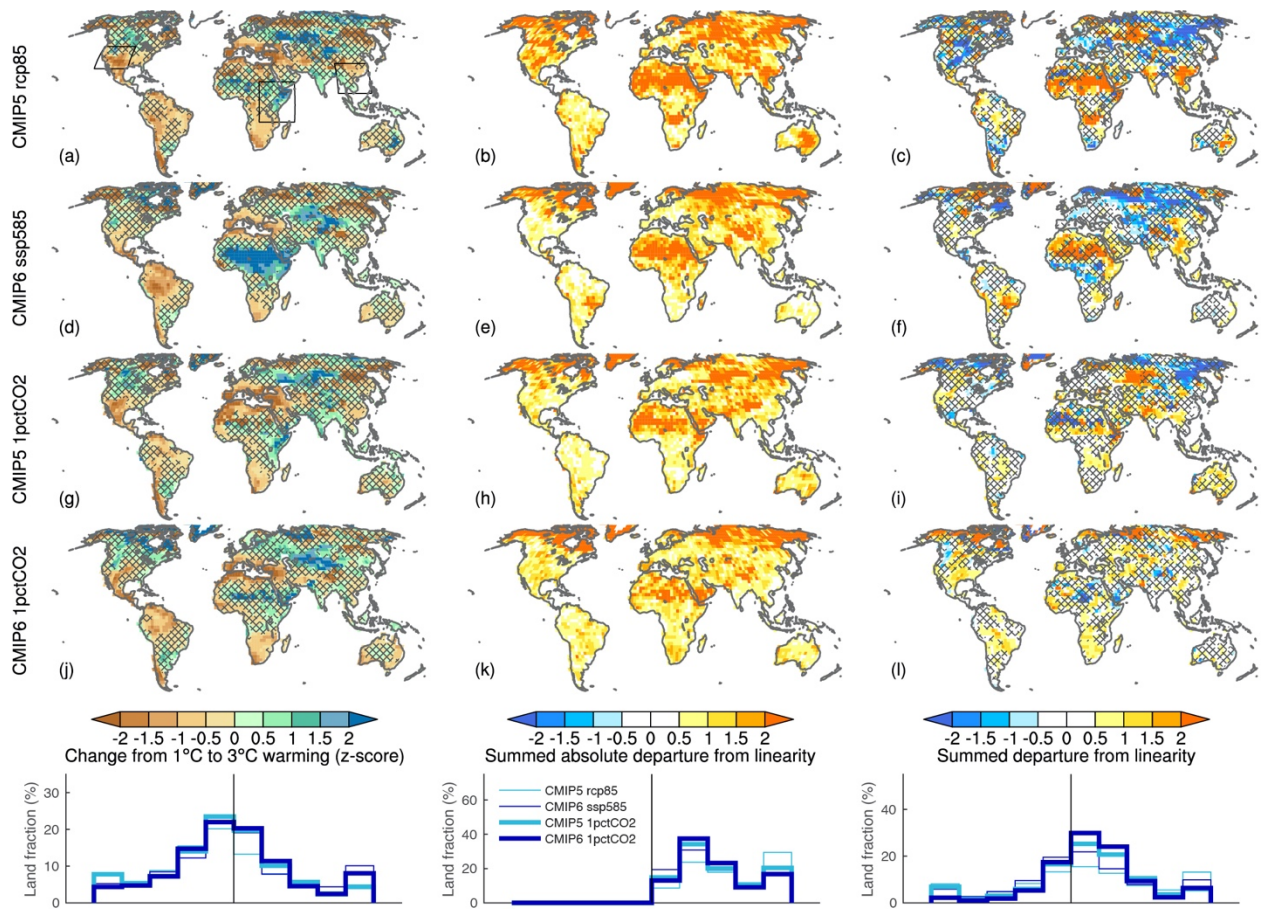**Figure S7:** Same as Fig. S5 but for column soil moisture.

Figure S8: Same as Fig. S1 for column soil moisture, but for 'rcp85', 'ssp585' and '1pctCO2' simulations from CMIP5 and 6. The changes and departures from linearity are assessed over changes from 1°C to 3°C, due to not all models warming by 4°C under '1pctCO2'.
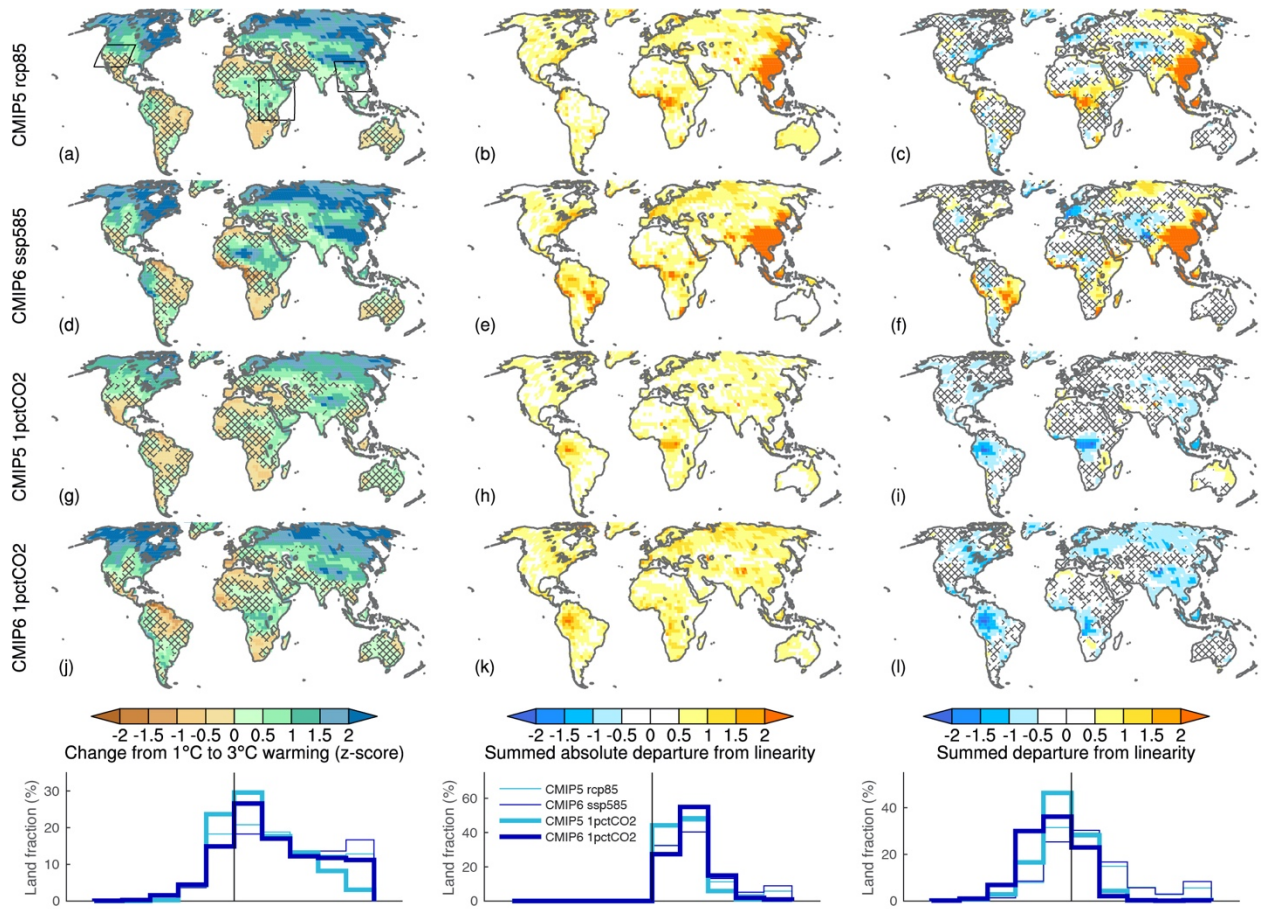
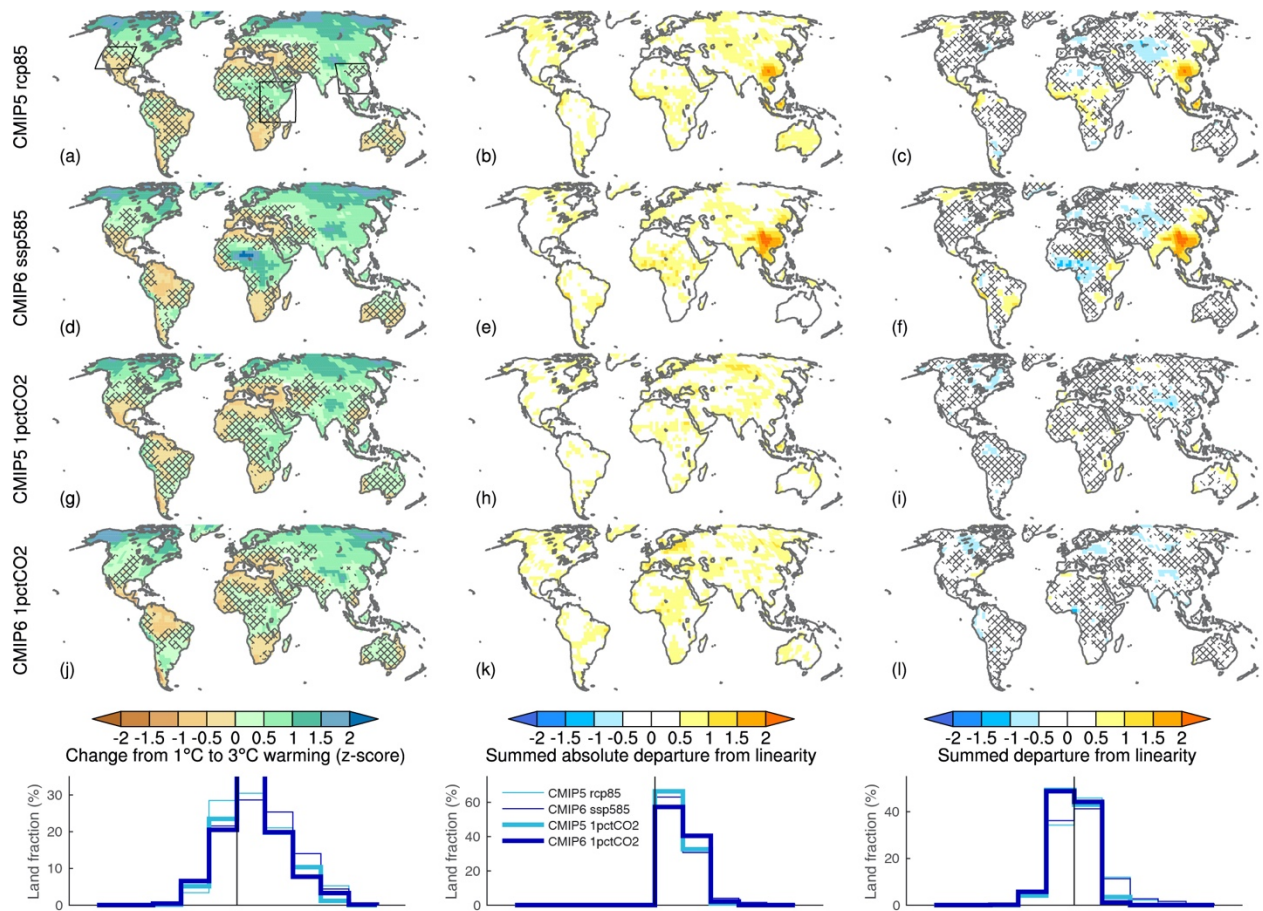**Figure S9:** Same as Fig. S8, but for evaporation.

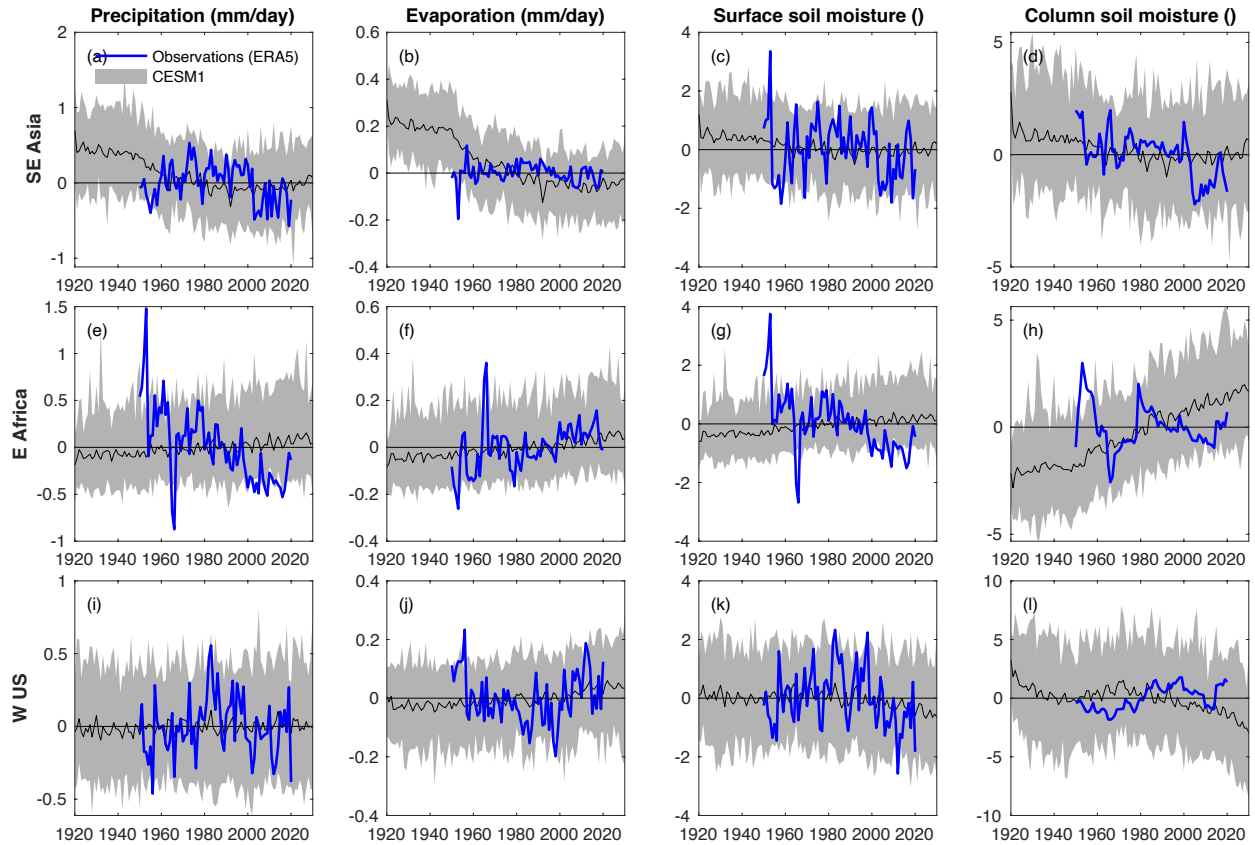**Figure S10:** Same as Fig. S8, but for precipitation.

Figure S11: (a-d) Comparison of annual mean hydroclimate variables from ERA5 (1950-2020) and the full range and ensemble mean of CESM1 ALL for Southeast Asia. Precipitation and evaporation are expressed relative to their 1950-2020 mean, soil moisture is expressed normalized over the same period. Surface (column) soil moisture refers to the top 7cm (289cm) in ERA5 and the top 10cm (340cm) in CESM1. (e-h) and (i-l), same as (a-d) but for Eastern Africa and Western US.
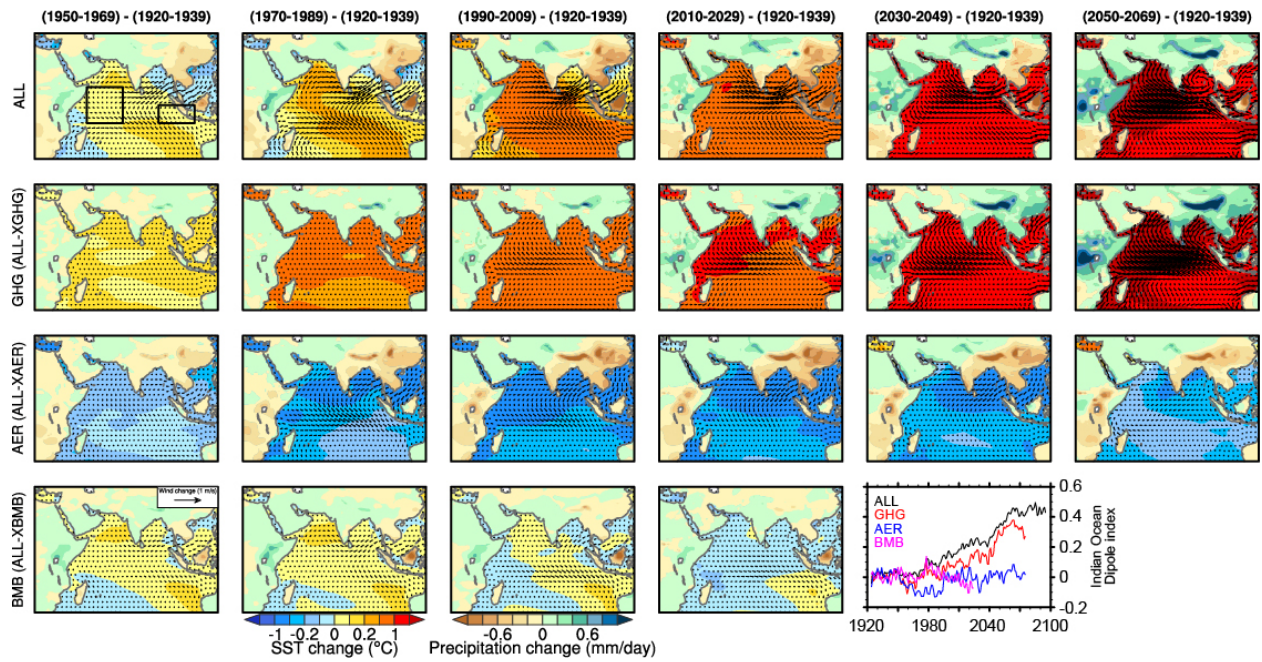
Figure S12: Sequential 20-year mean changes for precipitation (over land), sea surface temperatures (ocean), and near surface winds (ocean) from different CESM1 ensemble combinations (ALL, GHG, AER, BMB). The bottom right panel shows the Indian Ocean Dipole index, calculated as the western box minus the eastern box indicated in the first panel.
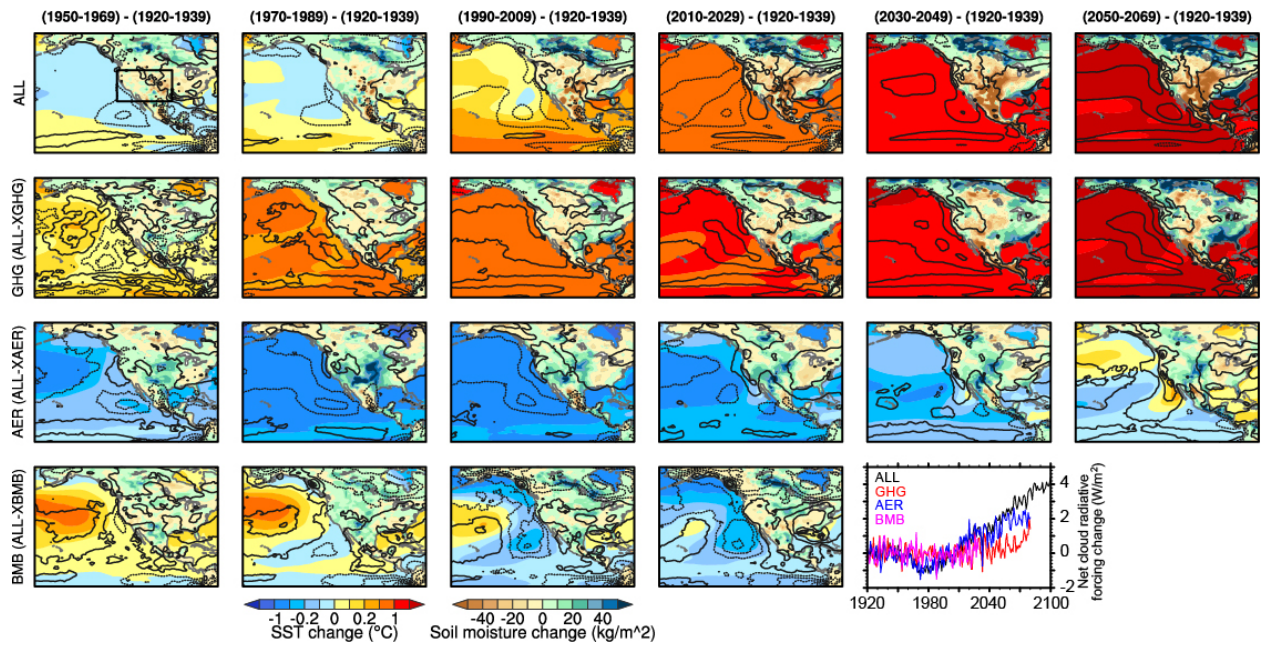
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Figure S13: Sequential 20-year mean changes for soil moisture (over land), sea surface temperatures (ocean), and net cloud radiative forcing from different CESM1 ensemble combinations (ALL, GHG, AER, BMB). The bottom right panel shows the net cloud radiative forcing change over the Western US (box in first panel).