Geophysical Research Letters

Supporting Information for

Changes in the frequency of observed temperature extremes largely driven by a distribution shift

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Introduction

This supporting information includes additional figures and videos that were not suited to being in the main text. The methods used to generate these figures can be found in the main text. Information about the used ECMWF ERA5 reanalysis data can be found at Hersbach et al. (2023).

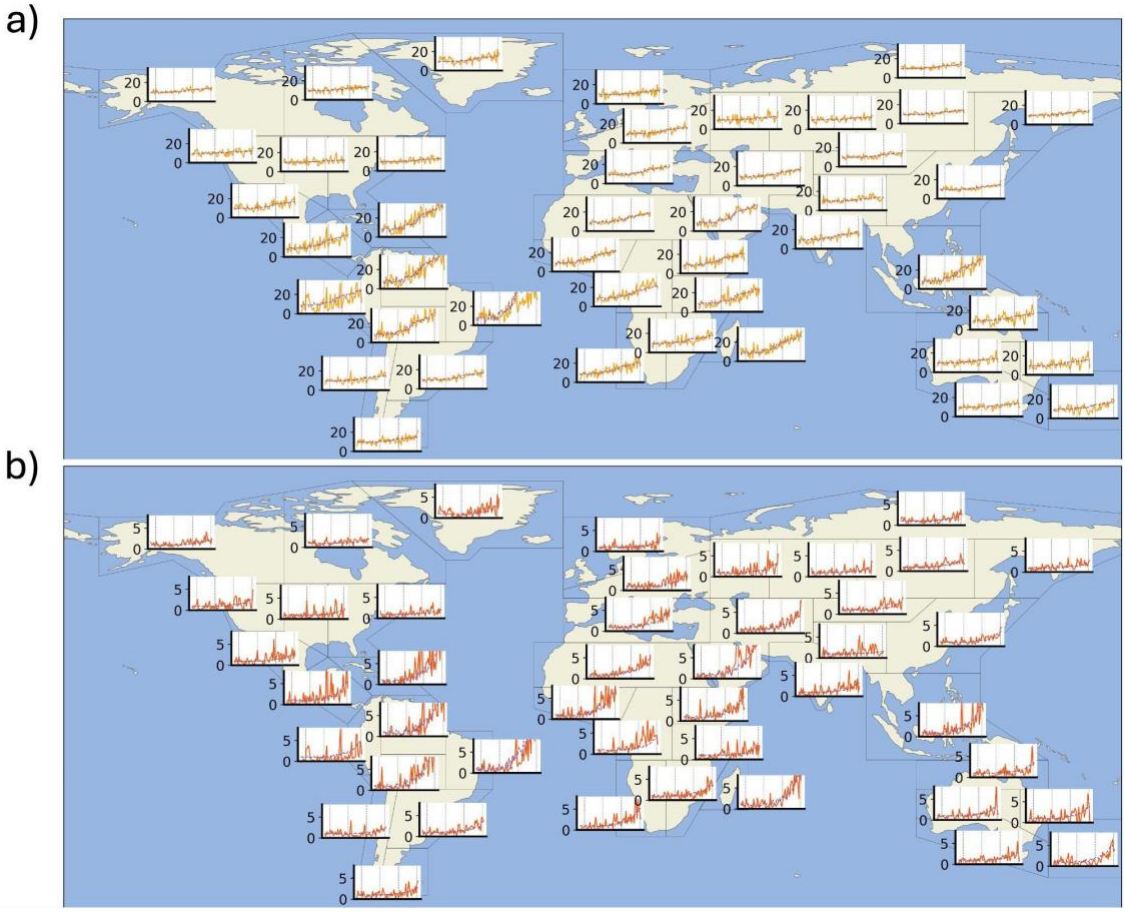

Figure S1. Observed extreme warm days and associated most slowly changing components from 1955 to 2021. The percent of days each year from 1955 to 2021 above the historical (a) 90th and (b) 99th percentiles for each of the IPCC AR6 land regions (solid lines). The most slowly varying component of this change (Methods) is plotted with a purple dashed line. The historical period is defined as 1961-1990. Every 20 years starting in 1960 is marked with a vertical grey line.

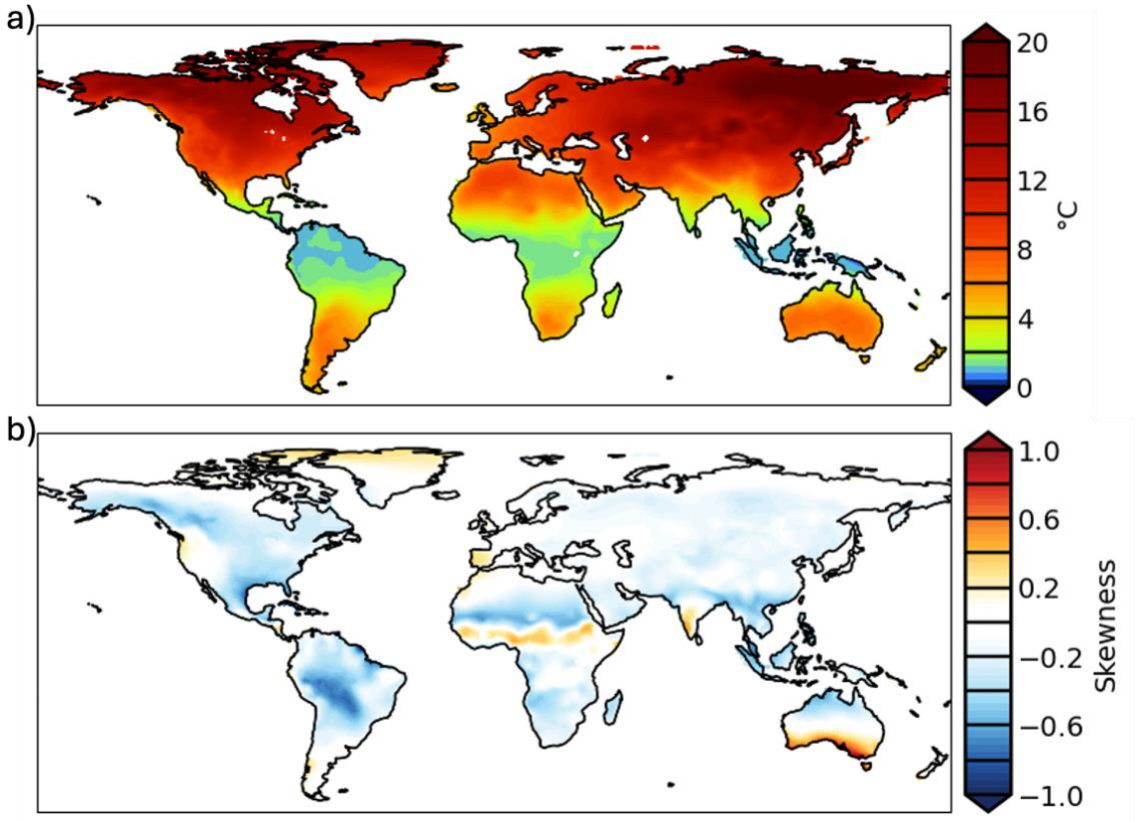

Figure S2. The (a) standard deviation and (b) skewness for the daily maximum temperature distribution for the period 1961-1990 in the *Berkeley Earth Surface Temperatures* dataset.

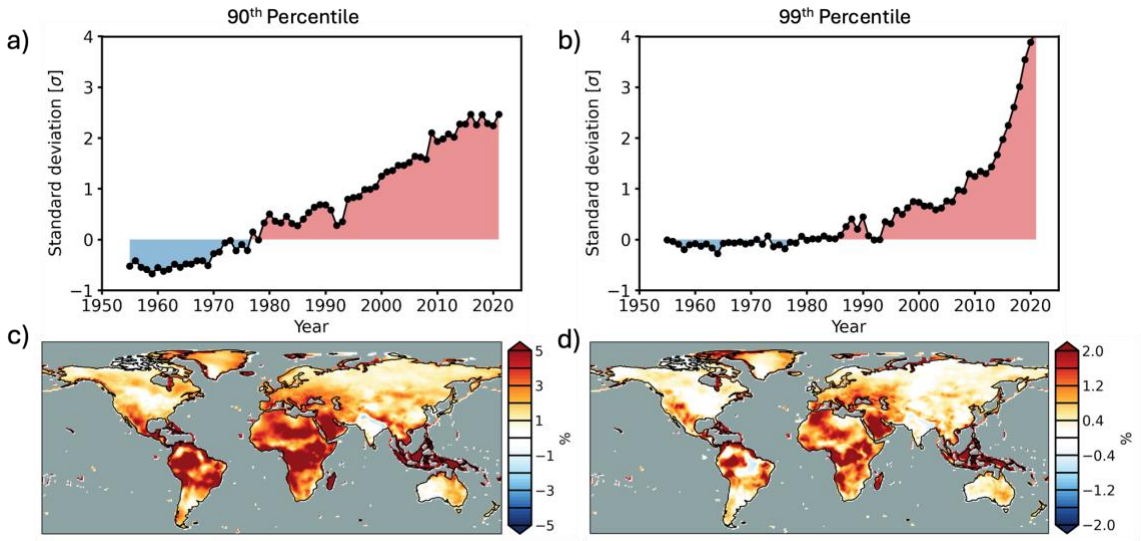

Figure S3. The slowest low-frequency components and corresponding low-frequency patterns in surface temperature extremes for *ERA5*. The first (a) low-frequency component (LFC) and (c) corresponding low-frequency pattern (LFP) of the percent of days in a year where the daytime maximum temperature exceeds the historical (1961-1990) 90th percentile threshold. (b-d) Same as (a-c) but for the 99th percentile. Note different color bar limits. Ocean data points are masked in grey.

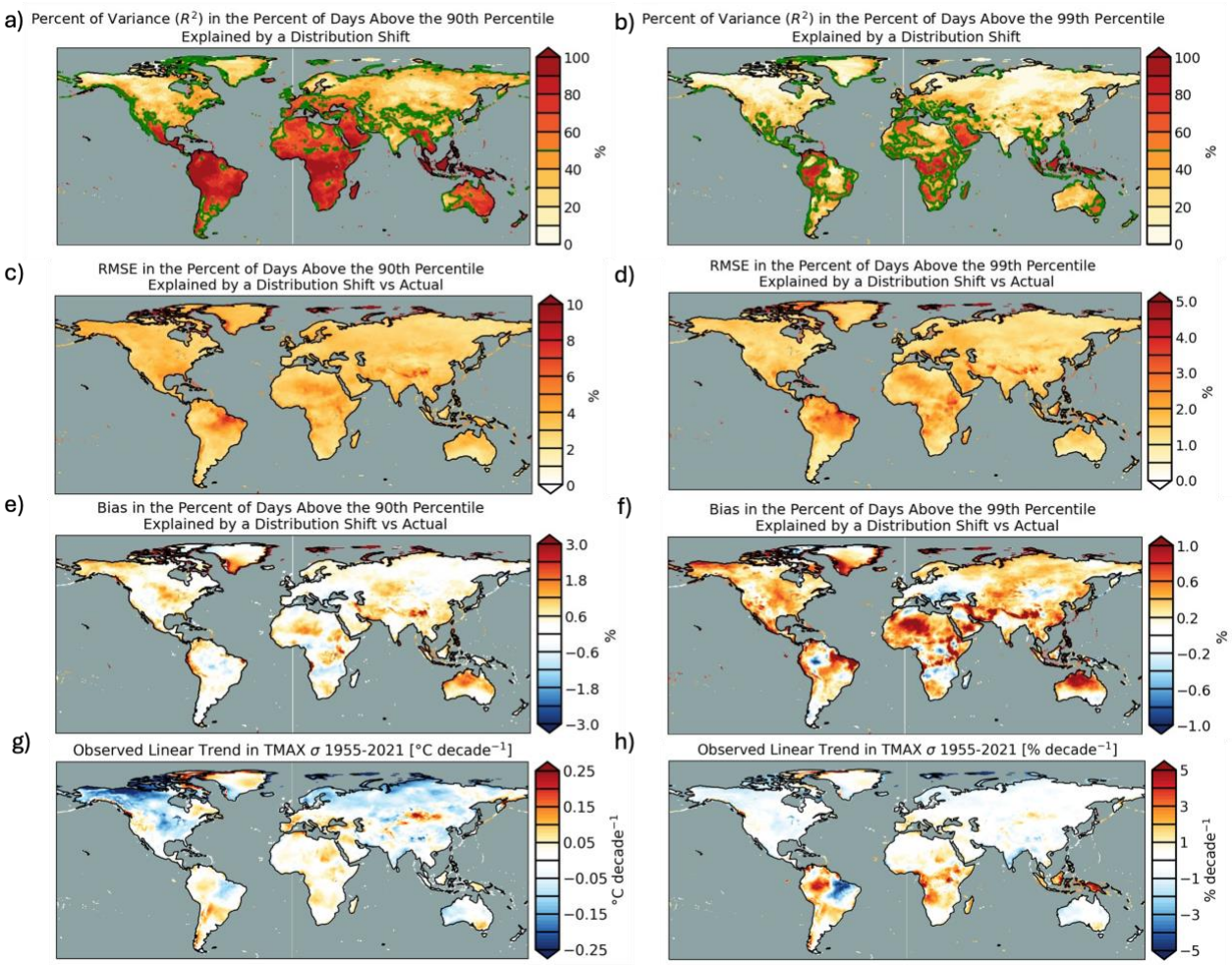

Figure S4. The square of the Pearson correlation coefficient between the expected number of days above the historical (a) 90th and (b) 99th percentiles based on a shift of the historical temperature distribution compared to the observed number of days for 1955 to 2021 in *ERA5*. The isoline of R^2 = 50% is marked in green. (c-d) Same as (a-b), but for the root mean squared error. (e-f) Same as (a-b) but for the bias of only having a distribution shift. (g) Linear least squares regression slope of the standard deviation of the annual temperature distribution from 1955 to 2021. (h) Same as (g) but normalized relative to the historical (1961--1990) standard deviation. Ocean data points are masked in grey.

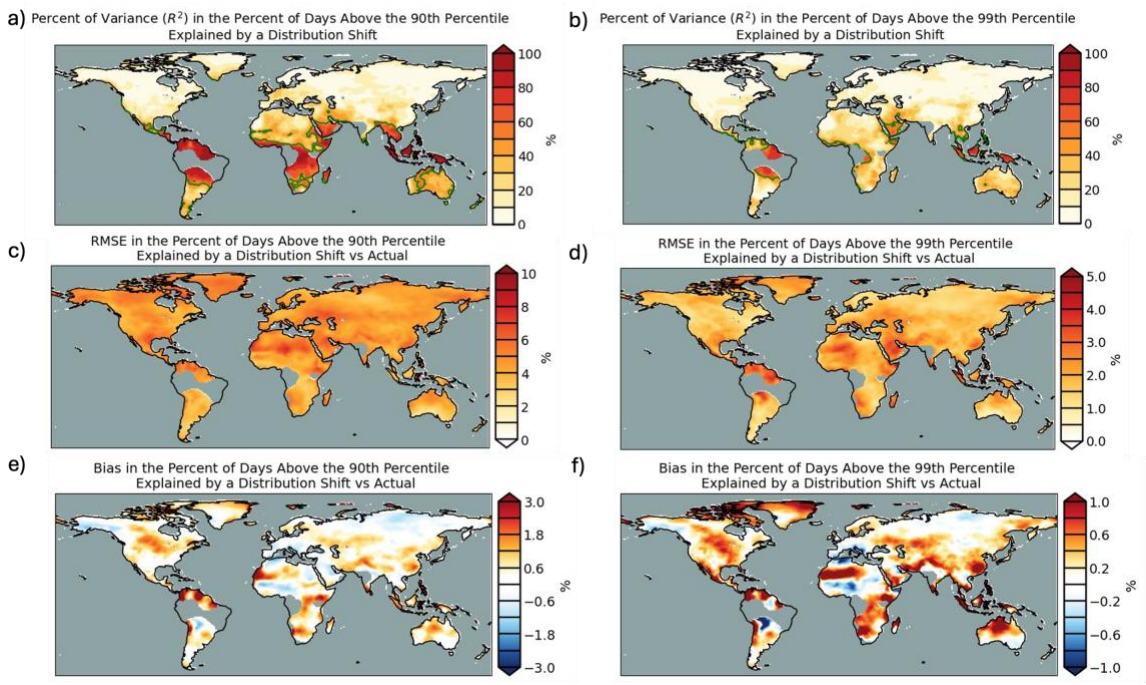

Figure S5. Similar to Figure 4, but for shifting the distribution by the *annual median* warming relative to the historical baseline (1961-1990). The square of the Pearson correlation coefficient between the expected number of days above the historical (a) 90th and (b) 99th percentiles based on a shift of the historical temperature distribution compared to the observed number of days for 1955 to 2021 in the *Berkeley Earth Surface Temperatures* dataset. The isoline of R^2 = 50% is marked in green. (c-d) Same as (a-b), but for the root mean squared error. (e-f) Same as (a-b) but for the bias of only having a distribution shift.

Video S1. Change in the percent of days above the historical 90th percentile relative to the 1961-1990 baseline for each year from 1950 to 2021 in the Berkeley Earth Surface Temperatures dataset.

Video S2. Change in the percent of days above the historical 99th percentile relative to the 1961-1990 baseline for each year from 1950 to 2021 in the Berkeley Earth Surface Temperatures dataset.