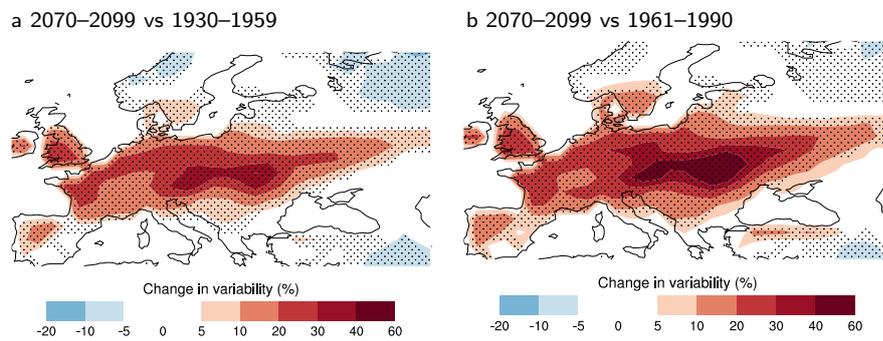
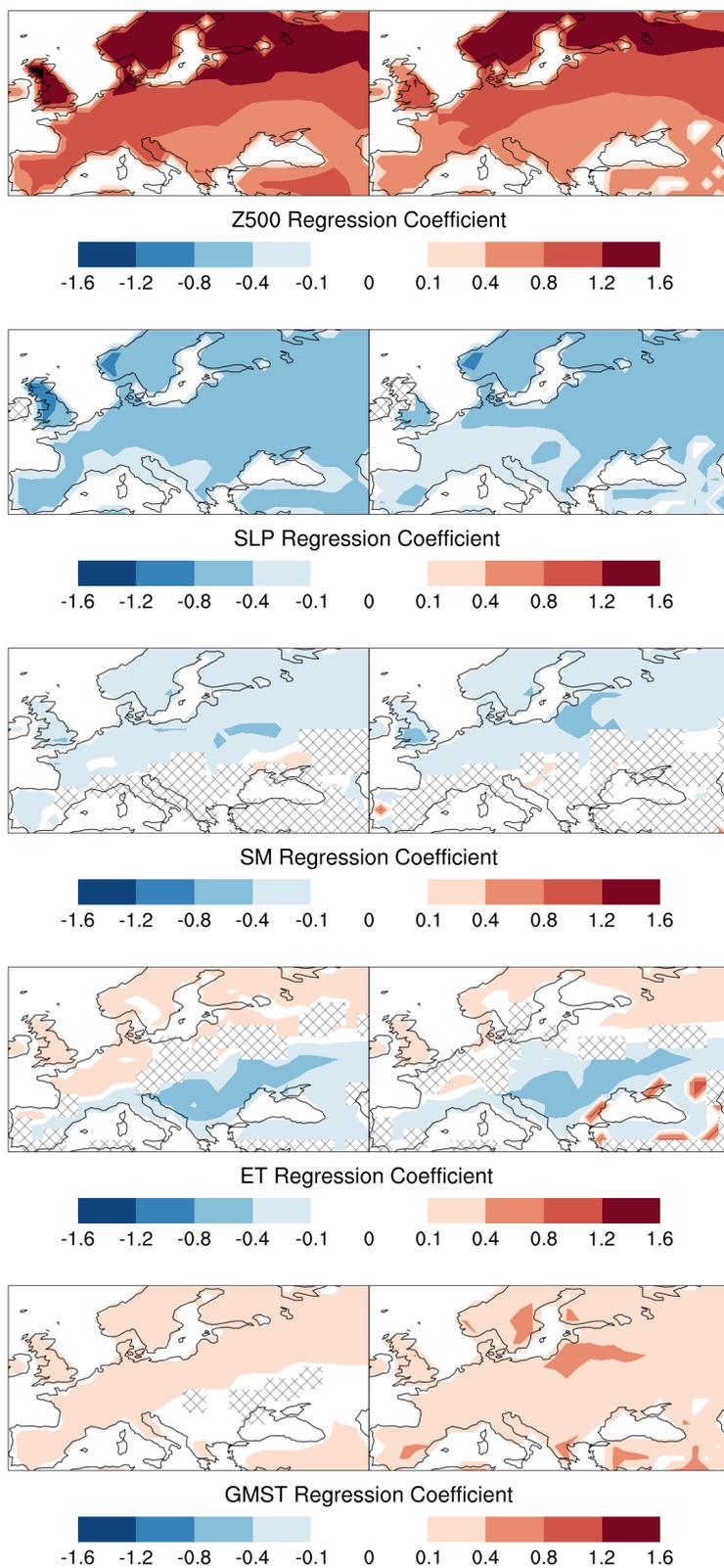
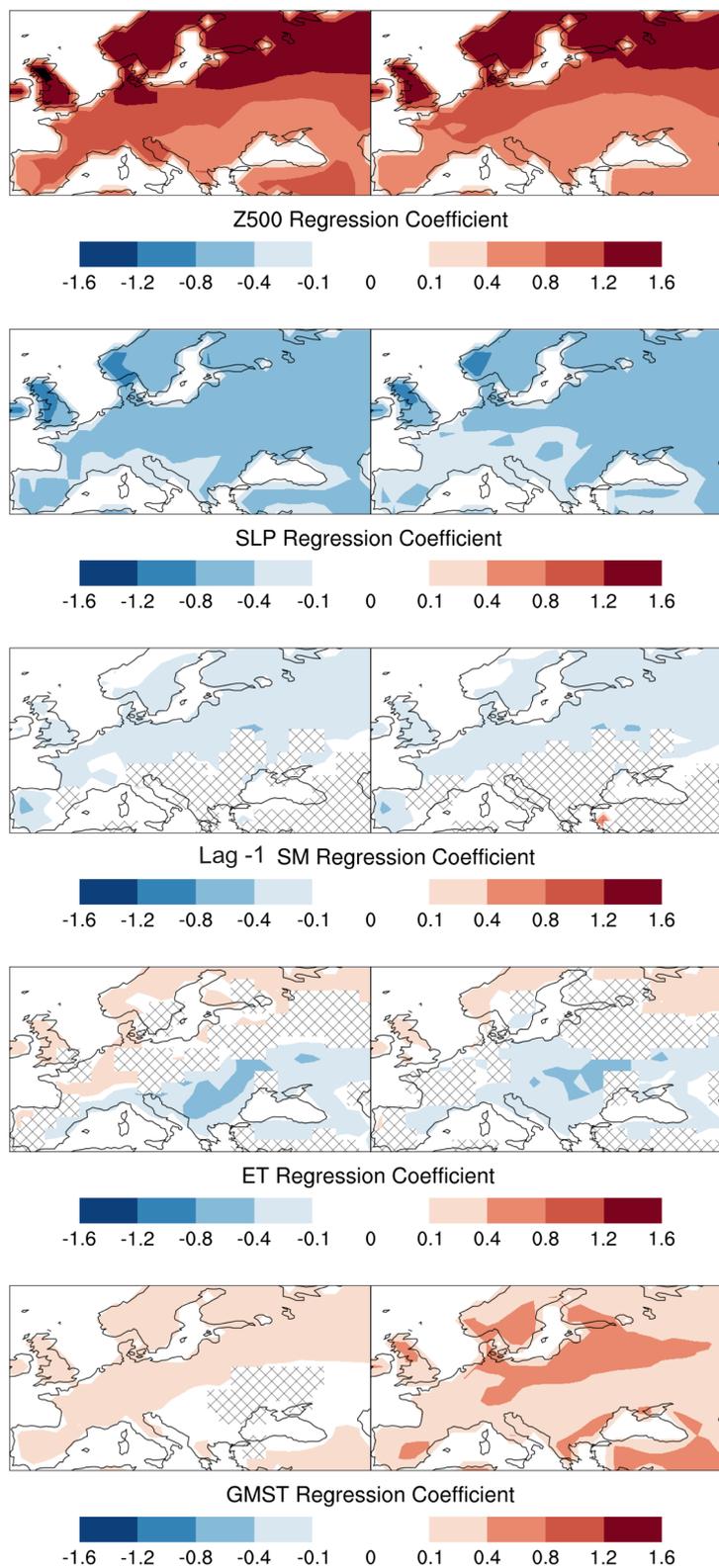


816 **Supplementary Information**

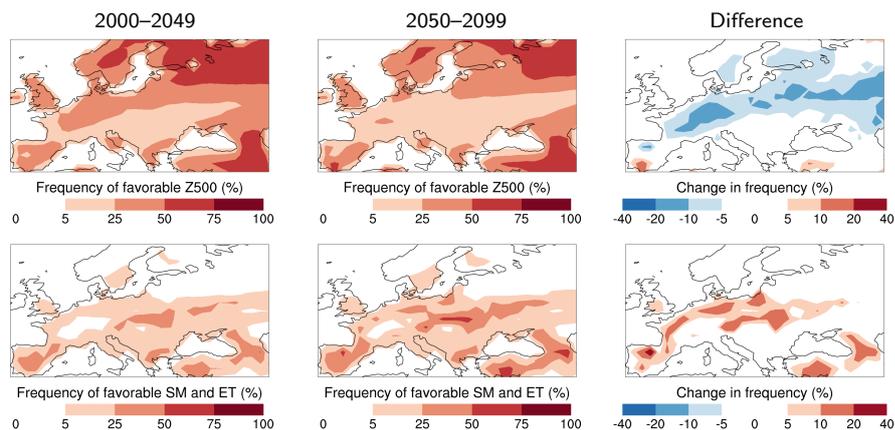
**Fig. S1 Change in European summer temperature variability relative to different reference periods. (a)** Relative change in variability based on change in EuST probability density distribution width (2.5th–97.5<sup>th</sup> percentiles) for late 21st century (2070–2099) compared to mid 20th century (1930–1959) for each grid cell. **(b)** Relative change in variability based on change in EuST probability density distribution width (2.5th–97.5<sup>th</sup> percentiles) late 21st century (2070–2099) compared to the 20th century climatological period (1961–1990) for each grid cell. Stippling shows significance for late 21st century PDF widths larger (or smaller) than all the possible 30-year PDFs in the 20th century. Simulations are historical runs for the period 1850–2005 and RCP4.5 runs for the period 2006–2099 from the MPI-GE. All anomalies are calculated with respect to the climatological period of 1961–1990.



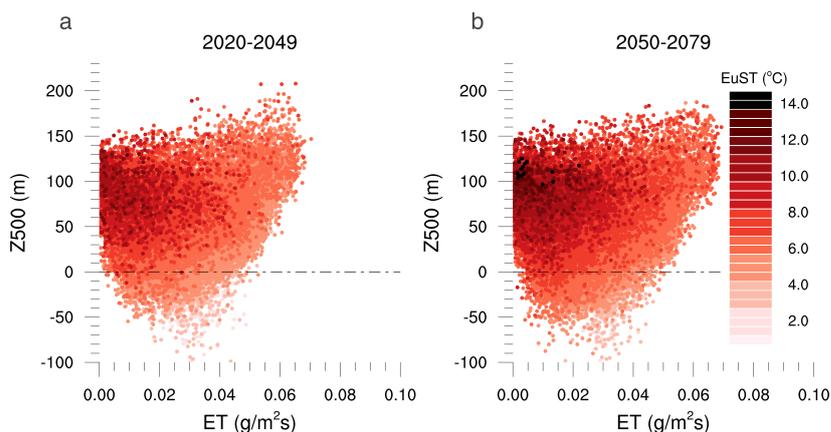
**Fig. S2 Regression coefficients from multiple regression with higher multicorrelation threshold.** Point-to-point standardized regression coefficients between  $2\sigma$  extreme EuST and different drivers from multiple regression analysis for the 20th century (left column) compared to for the 21st century (right column) for a more conservative multicorrelation threshold of 0.9, corresponding to a VIF of 5. Hatching represents regions where the variable is excluded from the regression model either because its contribution is not significant or because it exhibits too high multicollinearity with the remaining predictors in the model.



**Fig. S3 Regression coefficients from multiple regression with lagged SM** Point-to-point standardized regression coefficients between  $2\sigma$  extreme EuST and different drivers from multiple regression analysis for the 20th century (left column) compared to for the 21st century (right column), but considering soil moisture in the previous month (Lag -1 SM). Hatching represents regions where the variable is excluded from the regression model either because its contribution is not significant or because it exhibits too high multicollinearity with the remaining predictors in the model.



**Fig. S4 Extreme temperatures under extreme atmospheric or moisture conditions during the 21st Century.** Percentage of extreme  $2\sigma$  EuST events that exhibit simultaneous favorable  $2\sigma$  extreme Z500 positive anomalies (top row) and simultaneous favorable  $2\sigma$  extreme negative ET and SM anomalies (bottom row) during the first half of the 21st century (2000–2499; left column), and second half of the 21st century (2050–2099; middle column) and difference in this frequency in the second period minus in the first period (right column). Z500, SM and ET extremes are defined as anomalies that deviate by more than two standard deviations from the average preindustrial conditions in each driver, defined for the period 1850–1899.



**Fig. S5 Atmospheric and moisture conditions during extreme temperature events during the 21st Century.** Z500 against ET absolute values during EuST extreme events for the early 21st century, period 2020–2049 (a), and for the mid-late 21st century, period 2050–2079 (b) for each grid cell with an increase in extreme EuST events during the 21st century of 50% or larger in the [35–68°N, 10°W–50°E] domain. Each point represents one extreme event at grid cell level, defined for EuST anomalies larger than the  $2\sigma$  threshold for the given grid cell. The color gradient represents the EuST anomaly for each event. Z500 and ET represent absolute values, with the thermal expansion effect removed from Z500.