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Long tails in regional surface temperature probability distributions with implications for extremes under global warming

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## Introduction

Table A1 provides a list of 29 total stations for which temperature distributions were analyzed, including 21 not explicitly shown in the paper, summarizing occurrences of longer- or shorter-than Gaussian tails (denoted by subscript L or S, respectively) for the low (L) or high (H) side of the distribution for each of daily minimum, average or maximum temperature ( $T_{\min}$ ,  $T_{\text{ave}}$ ,  $T_{\max}$ ), for each season (JJA and DJF). Candidates for departure from Gaussian had to meet the following criterion: For long tails, at least 90% of the points beyond  $2\sigma$  (with  $\sigma$  the standard deviation of the core) exceeded the 95<sup>th</sup> percentile error bar generated for each bin from the AR(1) process described in the main text. For short tails, at least 90% of the points beyond  $1.5\sigma$  fell below the corresponding 5<sup>th</sup> percentile error bar. The distributions meeting these criteria were then examined, further applying a subjective criterion of eliminating candidates that did not appear as clear-cut as those shown on the main text. Specifically, 1 long and 6 short tail candidates were dropped for which the tail points were modestly above the 95% or below the 5% error bounds but for which it could be conceivable that an alteration of the procedure, for instance a asymmetric fit of the core, could put these within the error bars. This was done to provide a conservative count of non-Gaussian tails that includes only convincing cases. The subjectively excluded cases were all from stations having other non-Gaussian tails, so these do not affect the summary counts below except for the count of short tails.

Out of the 3 variables, 2 seasons and 29 stations, i.e. 174 entries in Table A1, 81 of the entries qualify as having non-Gaussian tails on at least one side by this criterion, i.e. 47% (49% in JJA, 44% in DJF). Out of the 29 stations, the number having at least one long tail among the three temperature variables is 18 in JJA and 15 in DJF. The number of stations having at least one short tail is 11 in JJA and 13 in DJF. Of the 29 stations, 22, i.e. 76%, had at least one variable qualifying as non-Gaussian in each of JJA and DJF. Only 2 stations qualified as close to Gaussian for all variables in both seasons.

Figure A1 shows the information from Table A1 but in graphical format, focusing (for graphical clarity) on the continental United States where 17 of the 29 stations occur. In addition to providing a visual sense of the prevalence of non-Gaussian tails, this format helps to illustrate the strong dependence of the tail characteristics on region discussed in the main text, underlining the need to better understand the physical mechanisms that produce the departures from Gaussianity, including the asymmetry and the sources of regional dependence. It is conjectured that a fairly high spatial resolution will be required to address this, suggesting that a suitable procedure may involve validating high resolution reanalysis and/or regional models against station data for these properties, and then investigating spatial dependence in the reanalysis or model data set with full spatial coverage.

Table A1. Occurrences of non-Gaussian tails at additional stations. For each of the three variables ( $T_{\min}$ ,  $T_{\text{ave}}$ ,  $T_{\max}$ ),  $L_L$  and  $H_L$  represent low-side and high-side longer-than-Gaussian tails, respectively, and  $L_S$  and  $H_S$  represent low-side and high-side shorter-than-Gaussian tails, respectively; 0 represents no tail meeting the criteria.

Station	JJA			DJF		
	$T_{\min}$	$T_{\text{ave}}$	$T_{\max}$	$T_{\min}$	$T_{\text{ave}}$	$T_{\max}$
Baltimore-Washington Intl. AP, Baltimore, MD	$H_S$	0	0	0	0	0
Beijing Capital Intl. AP, China	0	0	$L_L$	0	0	0
Capetown Intl. AP, South Africa	0	0	$H_L$	$L_L$	$H_L$	0
Changi AP, Singapore	$L_S, H_S$	$L_L$	$L_L$	0	$H_S$	$L_L$
Chitose Air Base, Sapporo, Japan	0	0	0	0	0	0
Ciampino AP, Rome, Italy	0	0	0	$L_S$	$H_S$	$H_L$
Dallas-Fort Worth Intl. AP, TX	$L_L$	$H_S$	$L_L$	0	0	$H_S$
Dubai Intl. AP, United Arab Emirates	0	0	0	0	0	$H_L$
Ellington AFB, Houston, TX	$L_L$	$L_L, H_S$	$L_L$	$L_S$	0	$H_S$
Fiumicino AP, Rome, Italy	0	0	$H_L$	$L_S$	0	0
Johannesburg Intl. AP, South Africa	0	$L_L$	$L_L$	$L_L$	0	$L_L$
La Guardia AP, New York City, NY	0	0	0	0	0	0
Lakeland Linder Reg. AP, FL	$L_L, H_L$	0	$L_L$	$H_S$	$H_S$	$H_S$
Long Beach AP, CA	0	$L_S, H_L$	$H_L$	0	$H_L$	$L_S, H_L$
Los Angeles Intl. AP (LAX), Los Angeles, CA	0	$H_L$	$H_L$	0	$H_L$	$L_S, H_L$
March AFB, Riverside, CA	0	0	0	0	0	$L_S$
Modesto City-County AP, CA	0	0	0	$L_S$	0	0
Ocean pier, Santa Monica, CA	0	$H_L$	$H_L$	0	$H_L$	$L_S, H_L$
O'Hare Intl. AP, Chicago, IL	0	0	0	$H_S$	0	$L_L$
Orly AP, Paris, France	0	$L_S$	$L_S$	0	$H_S$	0
Philip Billard Muni. AP, Topeka, KS	0	0	0	0	0	0
Phoenix Sky Harbor Intl. AP, AZ	0	$L_L, H_S$	$L_L$	0	0	0
Ruzyne AP, Prague, Czech Republic	0	0	$L_S$	$L_L, H_S$	$L_L$	0
San Juan Intl./Martin AP, Puerto Rico	0	$L_L$	$L_L, H_L$	$L_L$	0	$L_L, H_L$
Seattle-Tacoma AP, WA	$H_L$	$L_S, H_L$	$H_S$	0	$L_L$	0
Stockton Met. AP, CA	$L_S, H_L$	$L_S$	0	$L_S$	0	$L_L$
Travis AFB, Fairfield, CA	$H_L$	$L_S, H_L$	$L_S$	0	0	0
Walker Field AP, Grand Junction, CO	0	$L_L$	$L_L$	$L_L$	$L_L$	0
Wiley Post-Will Rogers AP, Barrow, AK	$H_L$	$H_L$	$L_S$	0	0	$H_L$

Figure A1. Occurrences of non-Gaussian tails at stations in the continental US. Information from Table A1 is displayed in graphical form for the 17 stations examined in the continental US. For each of the three variables ( $T_{\min}$ ,  $T_{\text{ave}}$ ,  $T_{\max}$ ),  $L_L$  and  $H_L$  represent low-side and high-side longer-than-Gaussian tails, respectively, and  $L_S$  and  $H_S$  represent low-side and high-side shorter-than-Gaussian tails, respectively. A dot marking a station with no accompanying letter indicates a case with no tail meeting the criteria.

