

# Supplementary Material: Local Drivers in Accelerating North American Heat Stress

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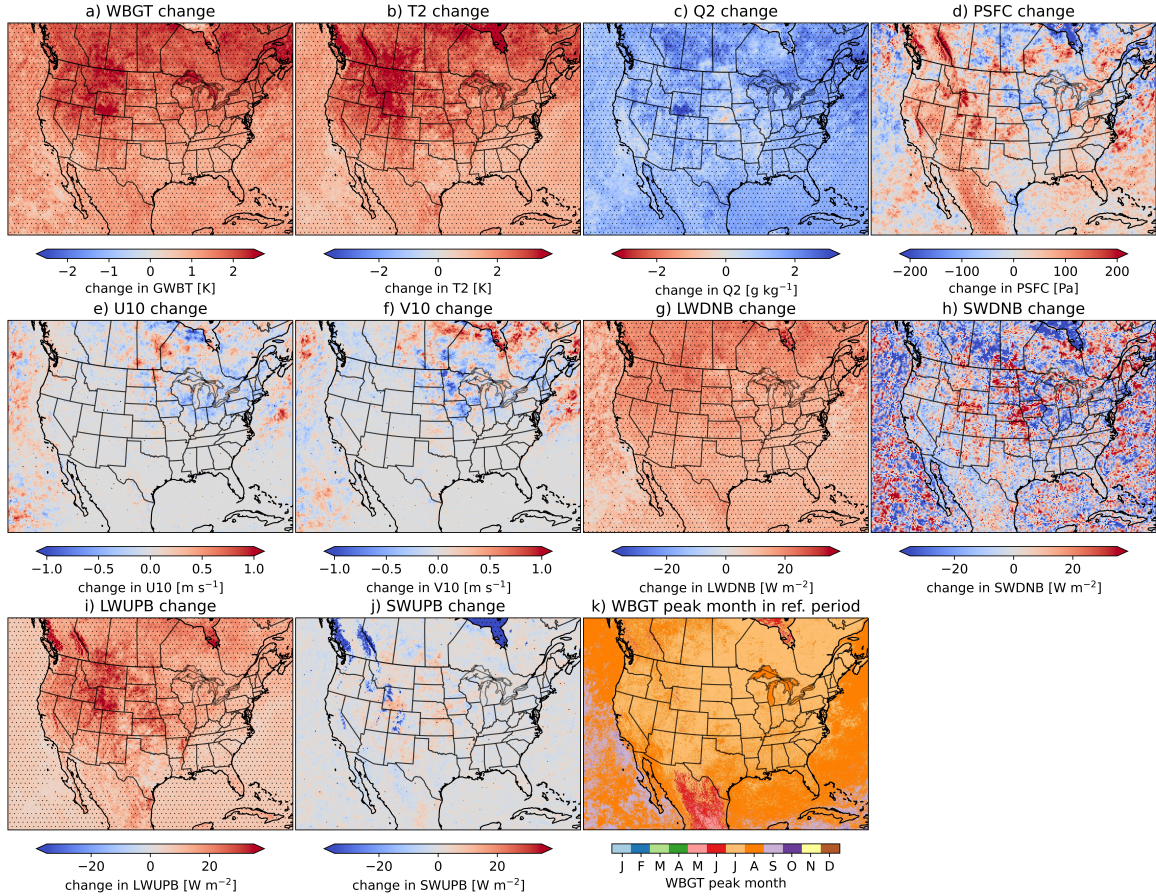
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**Fig. S 1: Changes in atmospheric conditions during the occurrence of annual maxima WBGT hours at 2°C global warming.** Average annual maximum hourly WBGT change (a). Changes in 2 m temperature (b, T2), 2 m specific humidity (c, Q2), sea level pressure (d, PSFC), 10 m zonal (e, U10) and meridional wind (f, V10), downward longwave (g, LWDNB) and shortwave radiation (h, SWDNB) at the surface, upward longwave (i, LWUPB) and shortwave (j, SWUPB) radiation at the surface during the occurrence of annual maximum hourly WBGTs. The median month of WBGT hourly maxima occurrence under the baseline climate (0.25 °C warming; k).



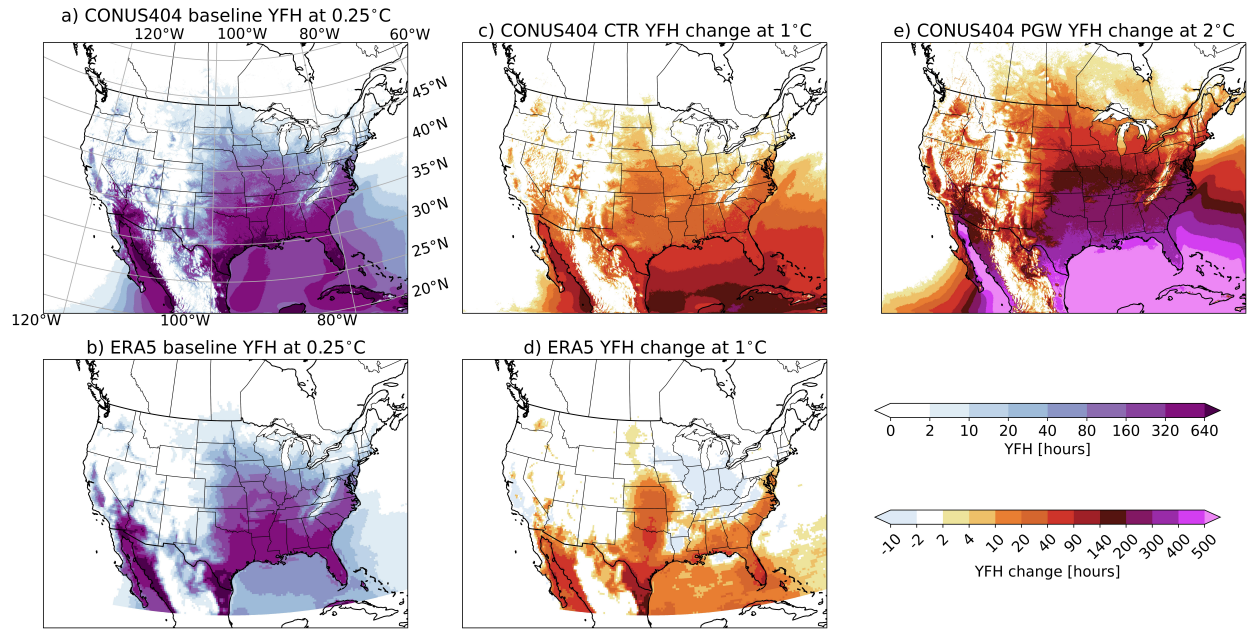
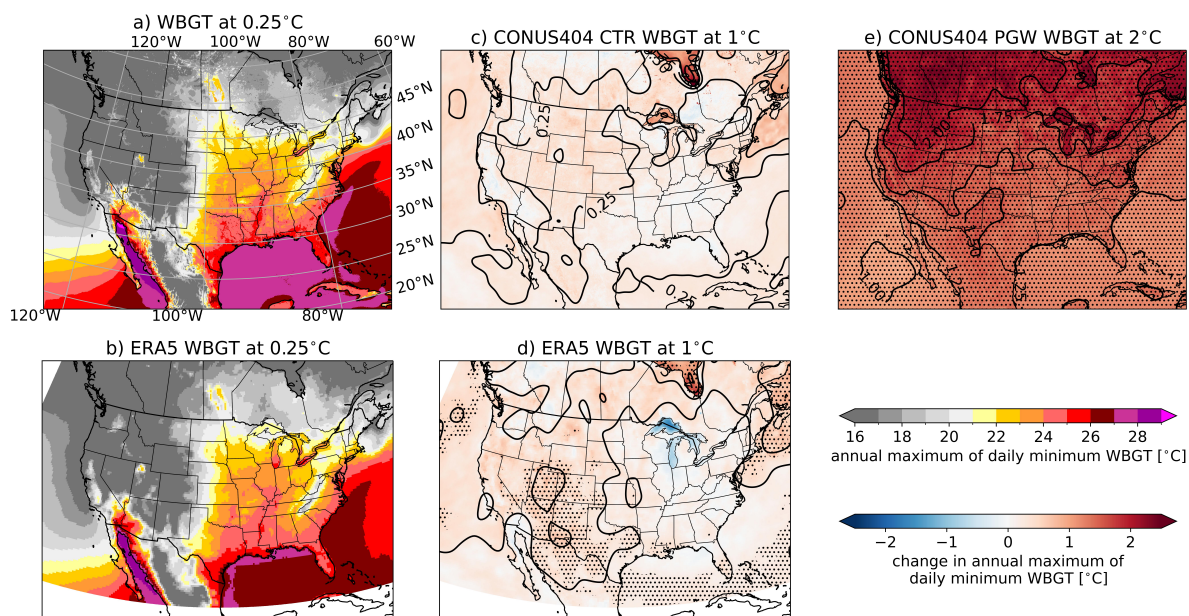


Fig. S 2: **Increases in annual average Yellow flag hours (YFHs) are the largest in coastal regions around the Gulf of Mexico, Gulf of California, the southern U.S. Atlantic Coast, and Caribbean islands with northern regions regularly becoming exposed to YFHs at 2 °C global warming.** Baseline annual average YFH frequency in CONUS404 (a) and ERA5 (b) at 0.25 °C. Changes in annual average YFH frequency at 1 °C (c, CONUS404; d, ERA5), and 2 °C (e, CONUS404) global average warming.



**Fig. S 3: Average annual maximum nighttime minimum WBGTs are increasing fastest in northern land regions under continuous global warming.** Average annual maximum nighttime minimum WBGTs during the baseline period (a, b). Changes in average annual maximum nighttime minimum WBGTs at 1 °C (c,d), and 2 °C global warming (e). CONUS404 results are shown in the top row and ERA5 results in the bottom row. Dashing in (c–e) show areas with significant changes according to a two-sided Mann-Whitney U Test ( $p=0.05$ ).

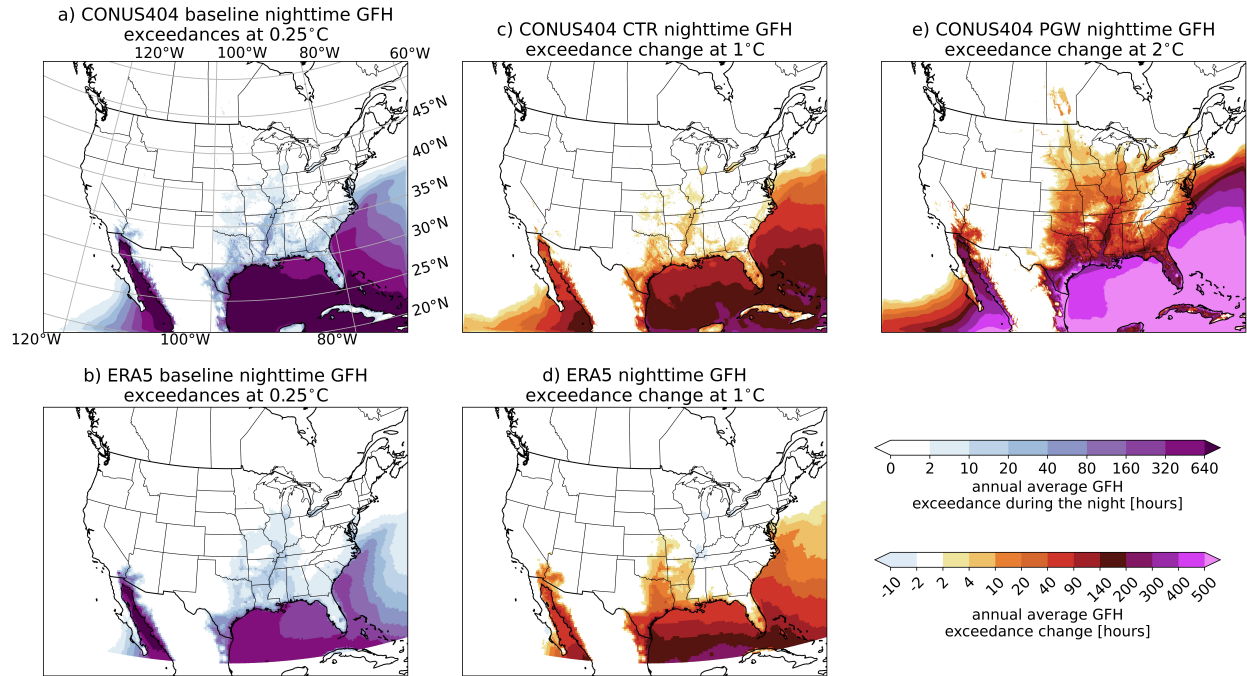
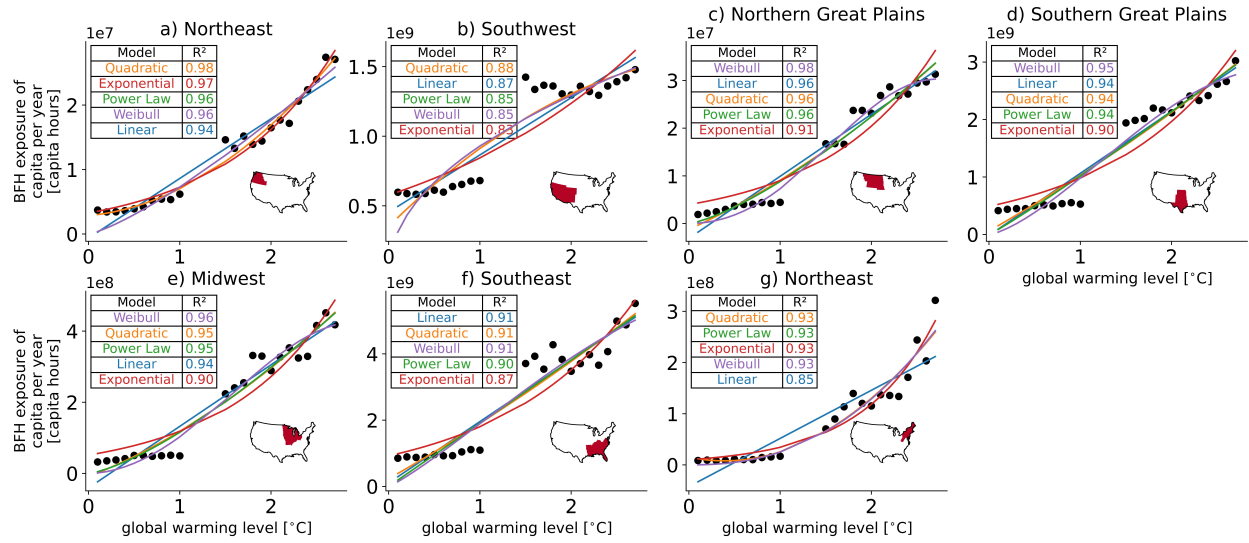
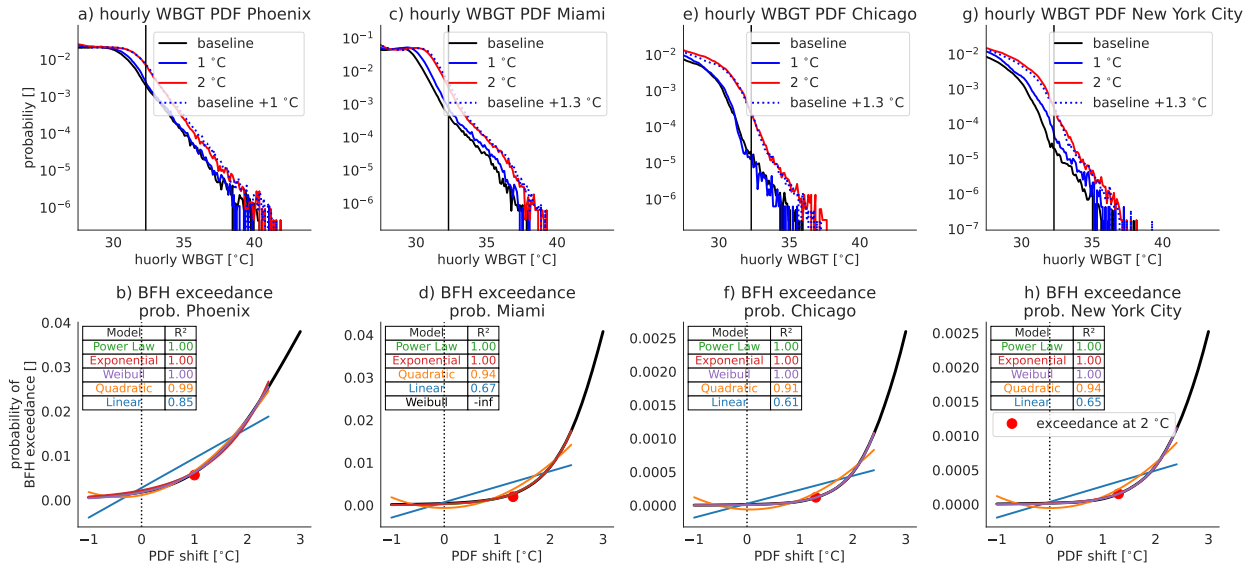


Fig. S 4: **Green Flag Hours (GFH; WBGT  $\geq 26^{\circ}\text{C}$ ) get exceeded very frequently during nighttime hours (20:00–6:00 solar local time) under continuous global warming.** Exceedance frequencies of GFH during the night in the baseline period (a,b;  $0.25^{\circ}\text{C}$  global warming) and corresponding changes at  $1^{\circ}\text{C}$  (c,d), and  $2^{\circ}\text{C}$  global warming (e). Results from CONUS404 are shown in the top row and results for ERA5 are shown in the bottom row.

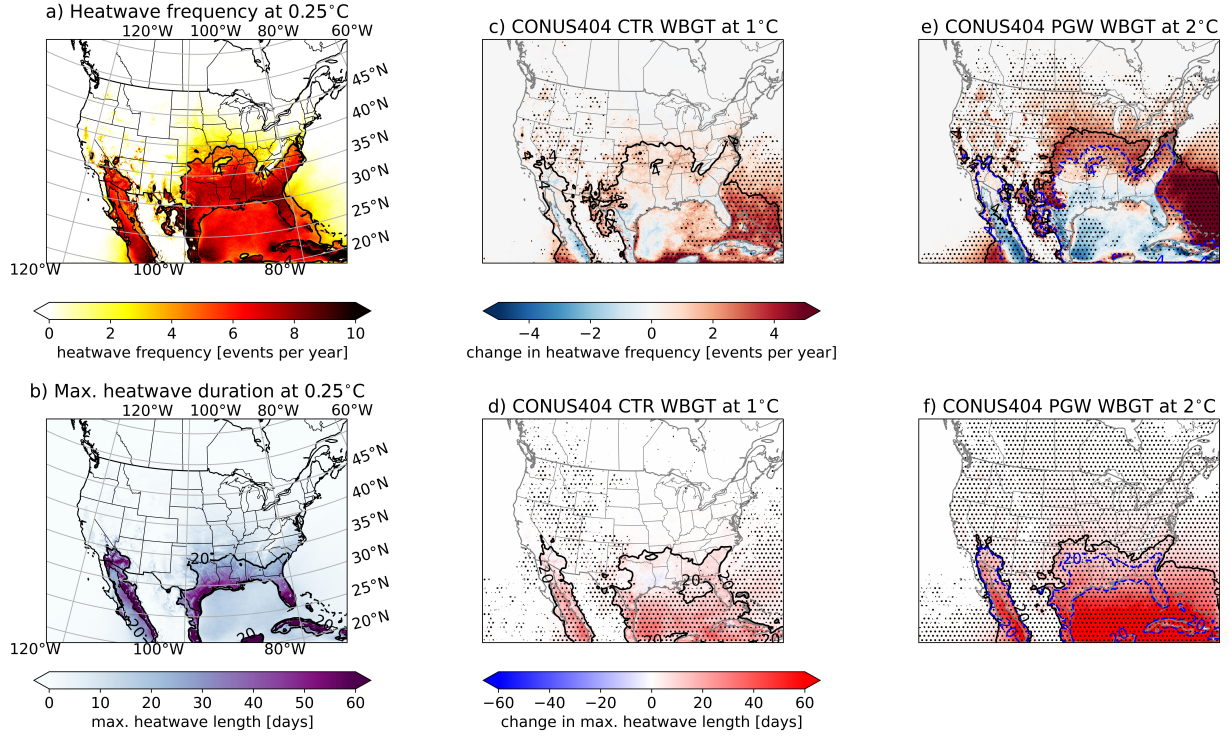


**Fig. S 5: A quadratic function offers the best fit for representing the empirical data of population exposure to BFHs in most regions of North America.** The black dots show the shows the median population exposure for different global warming levels. Different colored lines show the best fit of various functions to the empirical data (colors correspond to font colors in the legend). The coefficient of determination ( $R^2$ ) is shown for each functional fit (higher is better).

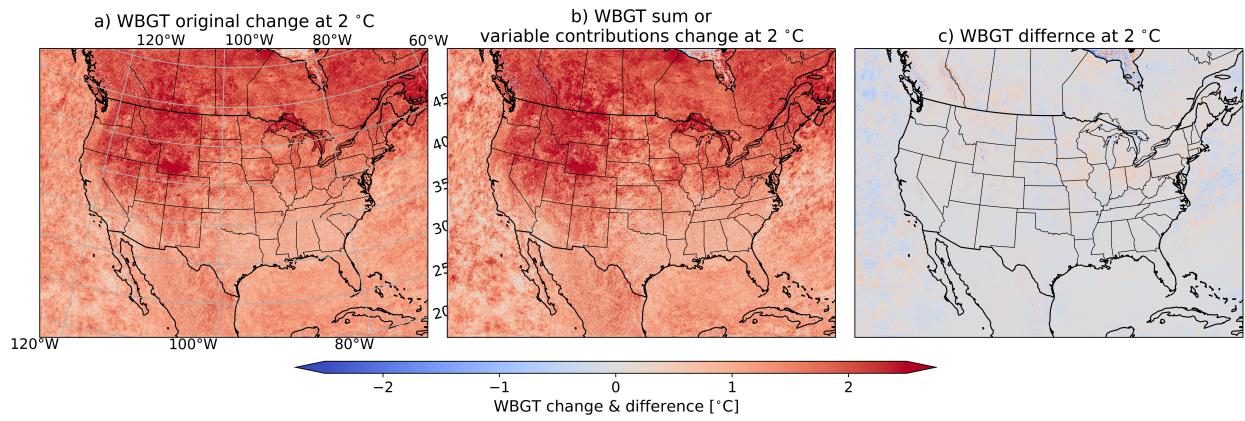




**Fig. S 6: The change in the hourly WBGT probability density function (PDF) with global warming can be very well approximated by rightwards shifting the baseline PDF. The black flack hour (BFH) exceedance probability, thereby, increases approximately exponentially between -1 °C – 2 °C local warming.** Hourly WBGT PDFs for Phoenix (a), Miami (c), Chicago (e), and New York City (g) under the baseline (black), 1 °C (blue), and 2 °C (red) global warming. The blue-dotted PFD is the baseline PDF shifted by 1 °C local warming in Phoenix and 1.3 °C in the other cities. The lower row shows BFH exceedance probabilities (black line) when shifting the baseline PDF to colder or warmer conditions. Different colored lines show the best fit of various functions to this data (colors correspond to font colors in the legend) between -1 °C – 2 °C. The coefficient of determination ( $R^2$ ) is shown for each functional fit in the inset table (higher is better). The red dot shows the empirical BFH exceedance probability at 2 °C global warming derived from the CONUS404 PGW data.



**Fig. S 7: Heatwave frequencies are increasing in the north but decreasing in the Gulf of Mexico and California. The latter is caused by merging of individual heatwaves into mega heatwaves that can last for several months under 2 °C global warming.** Annual heatwave frequencies in the baseline period (a; 0.25 °C global warming) and heatwave frequency changes under 1 °C (b), and 2 °C (c) global warming. Similarly, the average annual maximum heatwave duration and its changes are shown for the same warming levels in panels b, d, and f. Stippling in panels c–f shows significant changes according to a two-sided Mann-Whitney U test ( $p=0.05$ ). The seven-day heatwave frequency contour is shown as a black line in the top panels. The 20-day average annual maximum heatwave length is shown as a black contour line in the lower panels. The baseline contour line is shown in the 2 °C global warming panels as a dashed blue contour line.



**Fig. S 8: The linearized model to decompose annual maximum WBGT changes is very closely replicating the original annual maximum WBGT change at 2 °C global warming.** Original annual maximum hourly WBGT change at 2 °C global warming (a) and the sum of the compositional contribution from single variables (b; Equation 1 and Fig. 5 in the main manuscript). The residual error from the total compositional contribution is mostly smaller than 0.1 °C (c).