Supporting Information for "Projected Antarctic extreme heat events in a warming world"

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Introduction The supporting information contains a more detailed description the heatwave calculations made in this study (Text S1), a table for ensemble members and horizontal resolution of the CMIP6 models used in this study (Table S1), and additional figures (S1 to S8). These figures show results for each CMIP6 model, while the figures in the main text show results for the CMIP6 multi-model mean.

Text S1.

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We used the following steps to determine whether a day experiences a heatwave:

1. Any models with leap years have all February 29th days removed.

2. T_{max} from 1949–2099 is detrended by fitting a third order polynomial least squares fit and subtracting this trend from the entire time period.

3. Heatwave thresholds are determined for each day of the year by calculating the 90th percentile of T_{max} within a 15-day rolling window. Using a rolling window captures the time dependence of surface temperature. The 15-day rolling window is centered on the day being evaluated, for all years over the period from 1950–1979 of the detrended T_{max} values. For example, the threshold for January 8th is evaluated as the 90th percentile T_{max} of all days from January 1st to January 15th from 1950–1979 (a total of 450 days).

4. A separate threshold is determined for each ensemble member, each calendar day (i.e., if a model uses a 365 day calendar, 365 thresholds are determined), and for each grid box over Antarctica.

5. A day experiences a heatwave if the detrended T_{max} is greater than or equal to that day's threshold T_{max} and is one of at least three consecutive days experiencing T_{max} values above their own respective heatwave threshold T_{max} values.

Table S1. CMIP6 models and ensemble members

Model name	Ensemble members	Atmospheric resolution
ACCESS-CM2	r1i1p1f1, r2i1p1f1, r3i1p1f1	250 km
ACCESS-ESM1-5	r1i1p1f1, r2i1p1f1, r4i1p1f1, r5i1p1f1, r10i1p1f1	250 km
AWI-CM-1-1-MR	r1i1p1f1	100 km
CAMS-CSM1-0	r2i1p1f1	100 km
CanESM5	r10i1p1f1, r10i1p2f1, r11i1p1f1, r11i1p2f1, r12i1p1f1	100 km
CMCC-ESM2	r1i1p1f1	100 km
CNRM-CM6-1	r1i1p1f2	250 km
CNRM-CM6-1-HR	r1i1p1f2	100 km
CNRM-ESM2-1	r1i1p1f2	250 km
EC-Earth3	r1i1p1f1, r4i1p1f1, r11i1p1f1, r13i1p1f1, r15i1p1f1	100 km
EC-Earth3-Veg	r1i1p1f1, r4i1p1f1, r6i1p1f11	100 km
FGOALS-g3	r1i1p1f1, r3i1p1f1, r4i1p1f1	250 km
GFDL-CM4	r1i1p1f1	100 km
GFDL-ESM4	r1i1p1f1	100 km
GISS-E2-1-G[a]	r1i1p1f2	250 km
HadGEM3-GC31-MM	r1i1p1f3, r2i1p1f3, r3i1p1f3, r4i1p1f3	100 km
INM-CM4-8	r1i1p1f1	100 km
INM-CM5-0	r1i1p1f1	100 km
IPSL-CM6A-LR	r1i1p1f1, r2i1p1f1, r3i1p1f1, r4i1p1f1, r14i1p1f1	250 km
KACE-1-0-G	r1i1p1f1, r2i1p1f1	250 km
MIROC-ES2L	r1i1p1f2	500 km
MIROC6	r10i1p1f1, r11i1p1f1, r12i1p1f1, r13i1p1f1, r14i1p1f1	250 km
MPI-ESM1-2-HR	r1i1p1f1, r2i1p1f1	100 km
MPI-ESM1-2-LR	r1i1p1f1, r2i1p1f1, r3i1p1f1, r4i1p1f1, r10i1p1f1	250 km
MRI-ESM2-0	r1i1p1f1, r2i1p1f1, r4i1p1f1, r5i1p1f1	100 km
NESM3	r1i1p1f1	250 km
NorESM2-LM	r1i1p1f1	250 km
TaiESM1	r1i1p1f1	100 km
UKESM1-0-LL	r1i1p1f2, r2i1p1f2, r3i1p1f2, r4i1p1f2, r8i1p1f2	250 km

[a] Model only included in heatwave calculation and not in melt day analysis due to data availability.

References

Wilks, D. S. (2016). "The stippling shows statistically significant grid points": How research results are routinely overstated and overinterpreted, and what to do about it. *Bulletin of the American Meteorological Society*, *97*(12), 2263–2273. doi: 10.1175/BAMS-D-15-00267.1

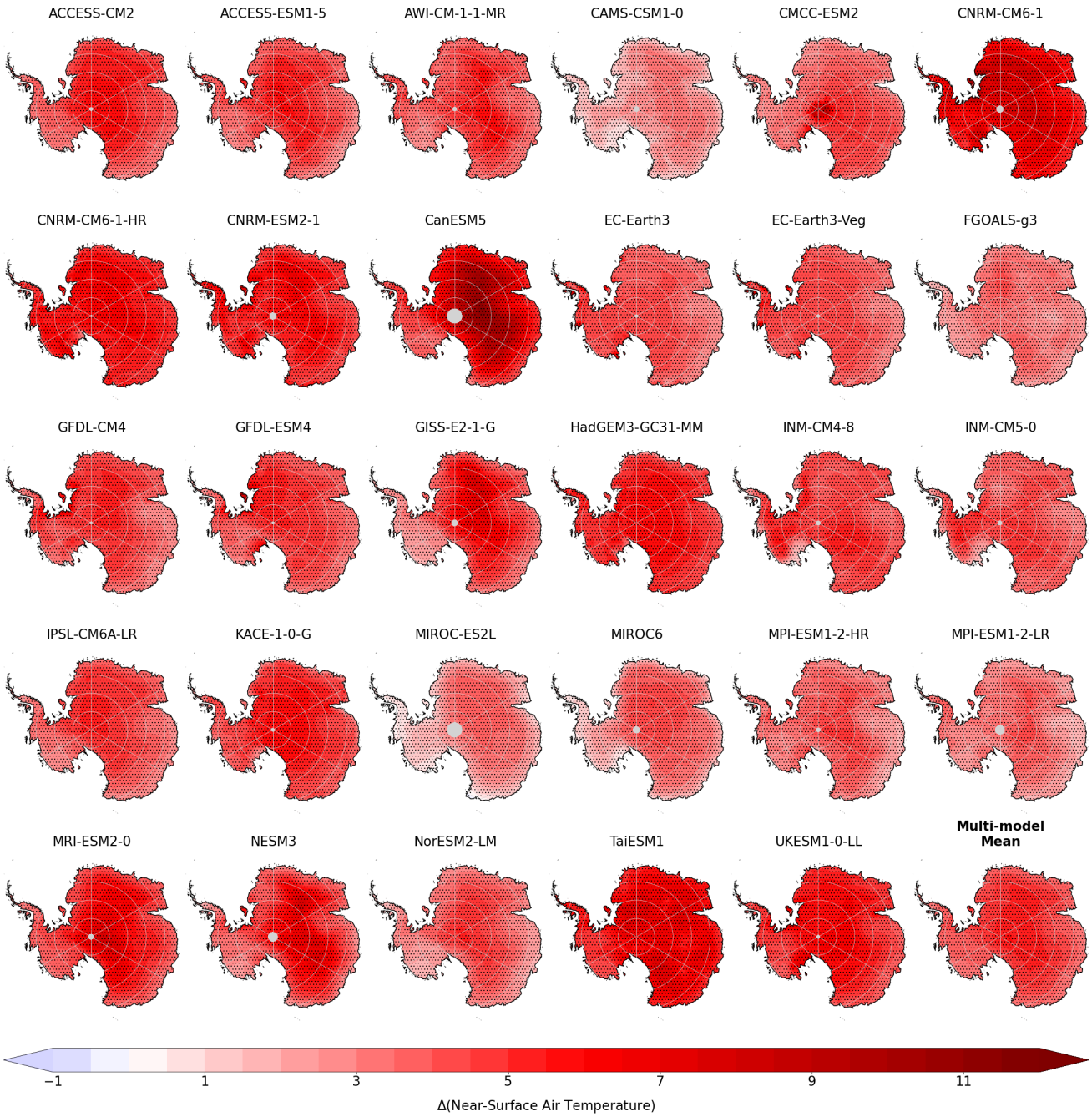

Figure S1. Change in CMIP6 models' ensemble member mean summer near-surface air temperature, 2070-2099 minus 1951-1980. The last panel is the CMIP6 multi-model mean. Stippling on each model's panel indicates where changes are statistically significant. Significance is determined using a Welch's t-test at every grid cell. Significance determinations are further limited for false discoveries using the recommendations made by Wilks (2016). We use an α_{FDR} of 0.10 to approximate a global significance level of 0.05. Stippling on the multi-model mean panel indicates where ≥80% of the CMIP6 models agree on the sign of the change.

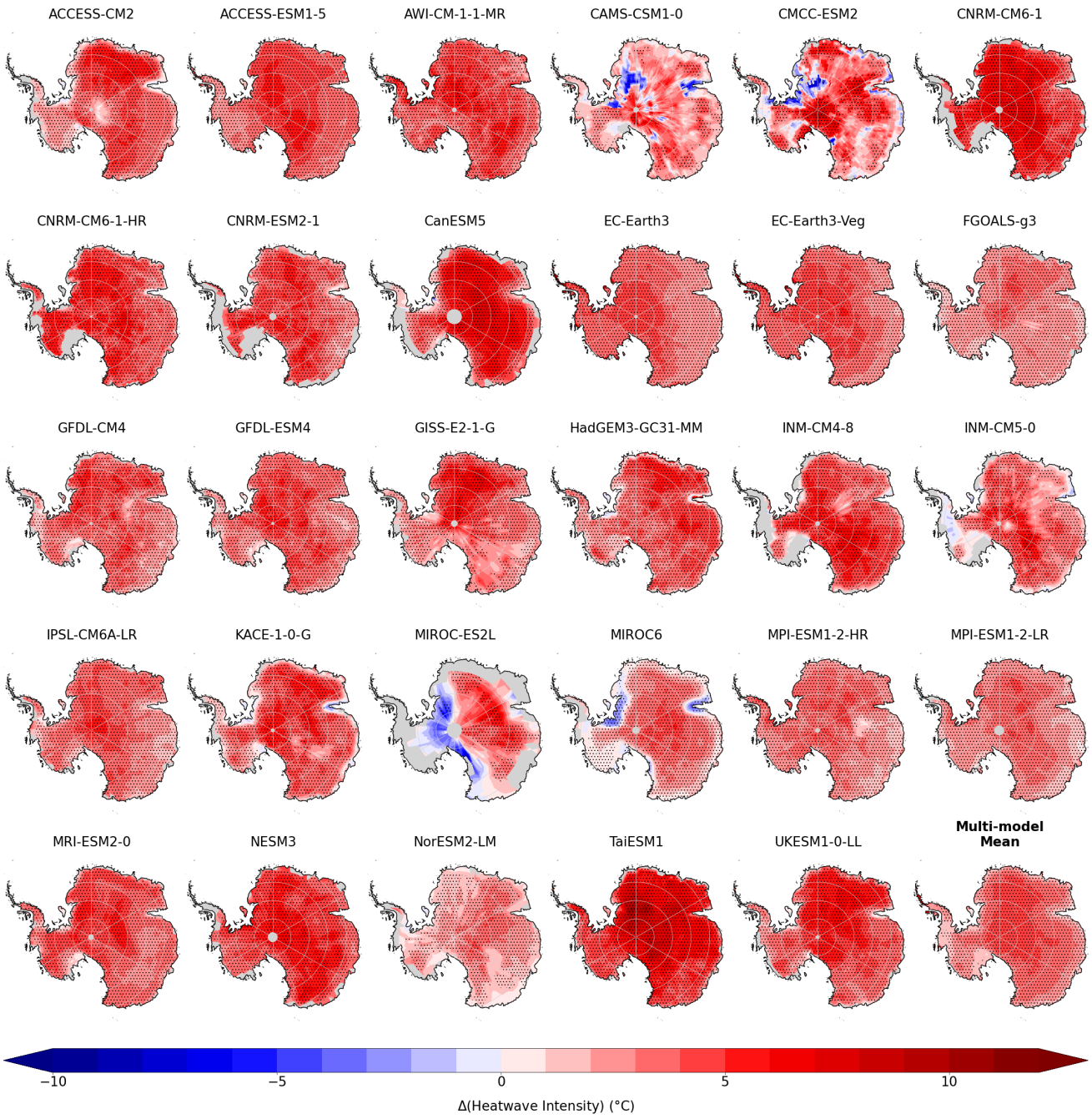

Figure S2. Change in CMIP6 models' ensemble member mean summer heatwave intensity, 2070-2099 minus 1951-1980. Intensity is the average heatwave temperature. The last panel is the CMIP6 multi-model mean. Stippling is as in Figure S1.

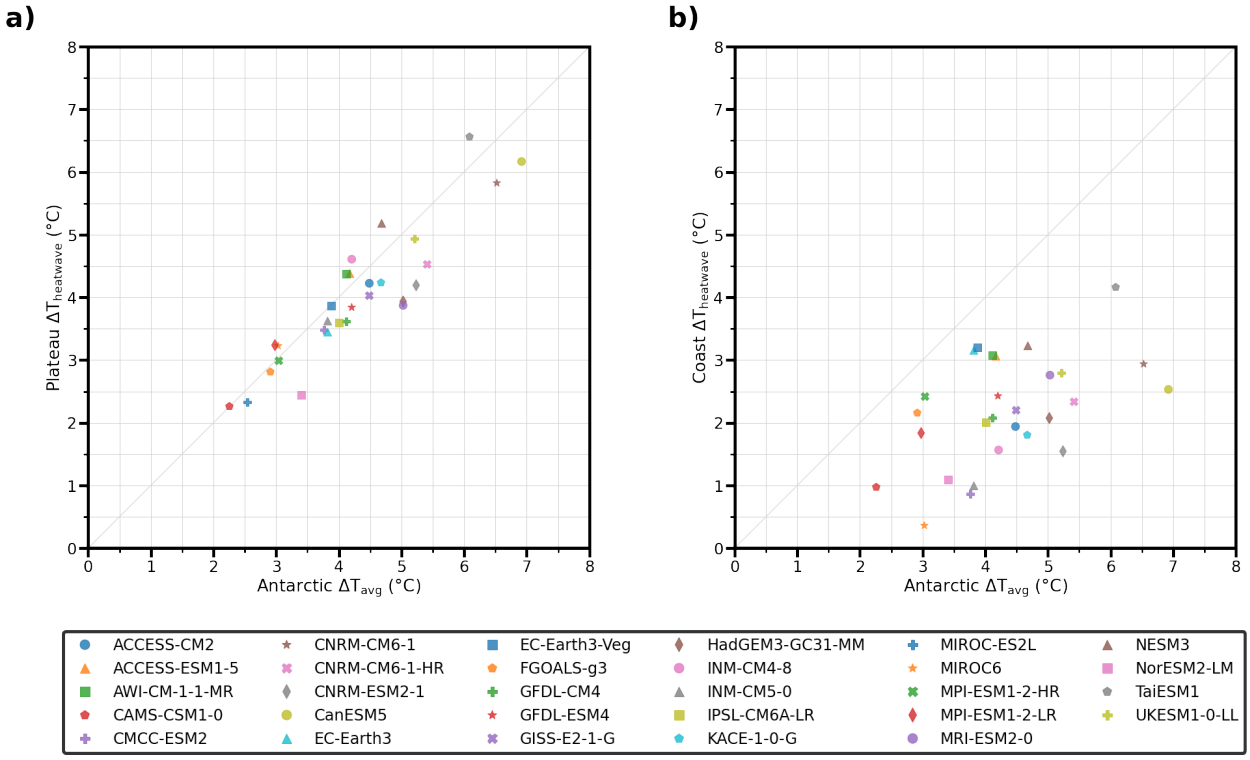

Figure S3. a) Scatterplot of change in CMIP6 models' summer heatwave intensity vs change in average daily near-surface air temperature over the East Antarctic Plateau (EAP), 2070-2099 minus 1951-1980. b) As in (a) except for over the non-EAP regions of Antarctica.

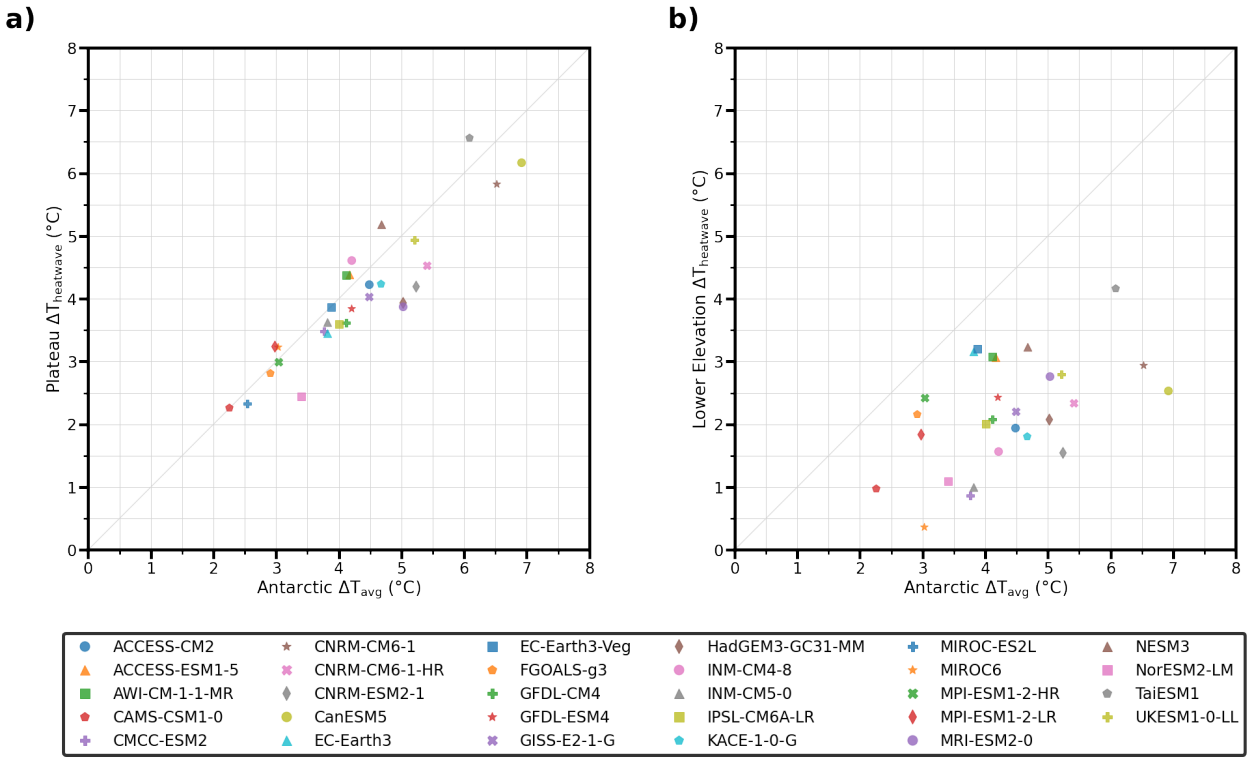

Figure S4. Change in CMIP6 models' ensemble member mean summer heatwave frequency, 2070-2099 minus 1951-1980. Frequency is the number of days that fall under heatwave conditions. The last panel is the CMIP6 multi-model mean. Stippling is as in Figure S1.

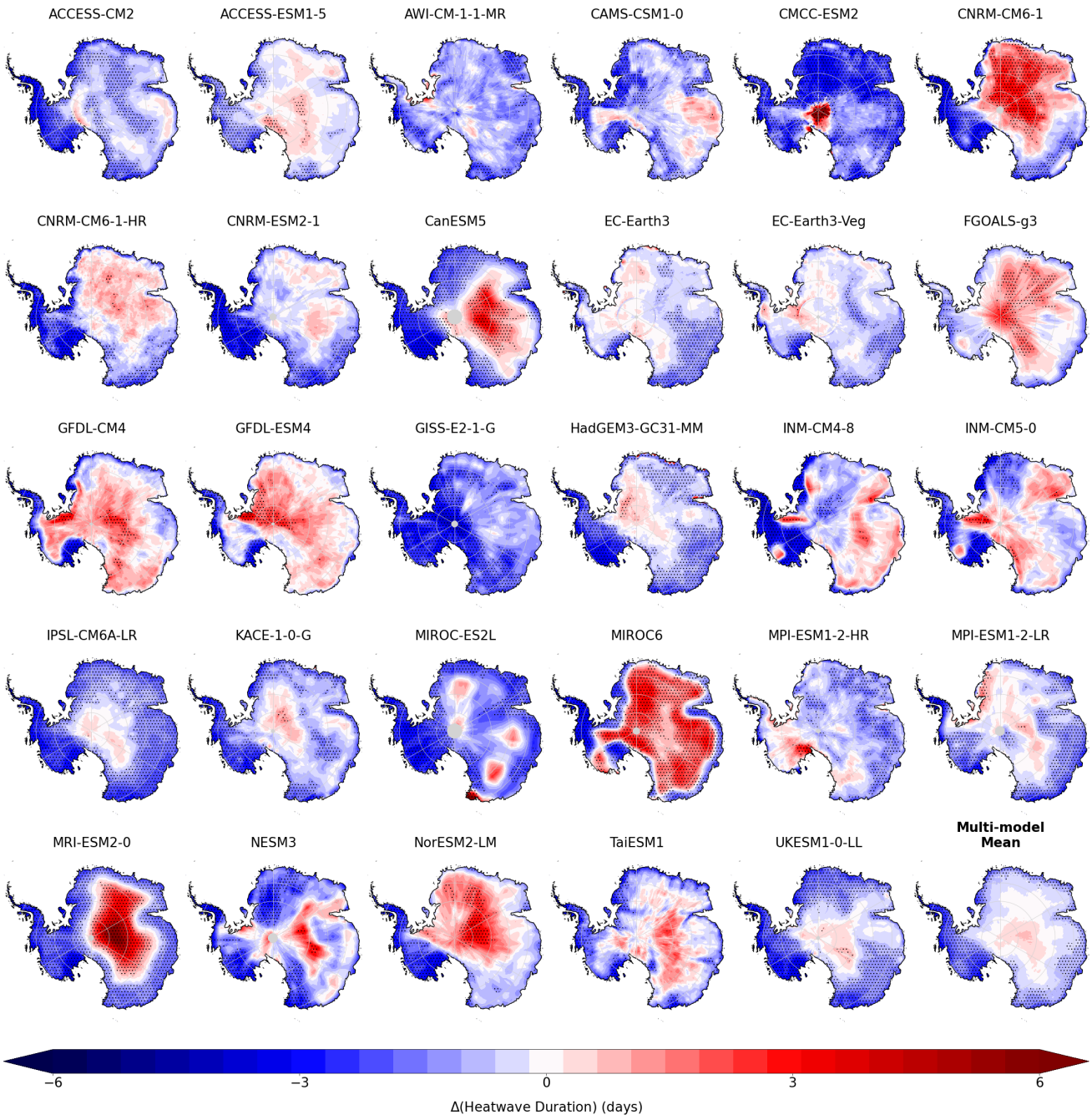

Figure S5. Change in CMIP6 models' ensemble member mean summer heatwave duration, 2070-2099 minus 1951-1980. A heatwave must last at least three days. The last panel is the CMIP6 multi-model mean. Stippling is as in Figure S1.

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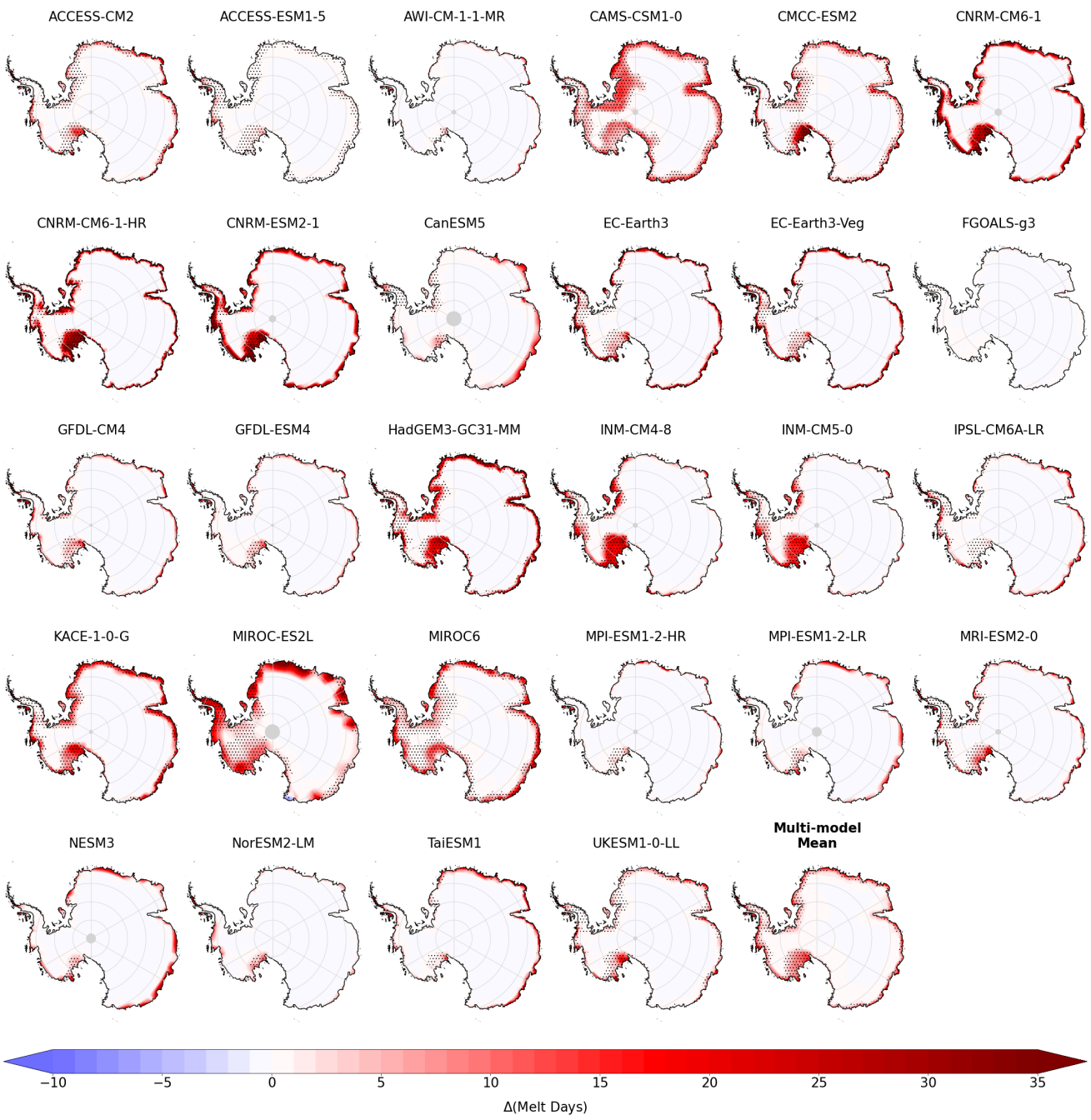

Figure S6. Change in CMIP6 models' ensemble member mean summer melt day frequency, 2070-2099 minus 1951-1980. The last panel is the CMIP6 multi-model mean. Stippling is as in Figure S1.

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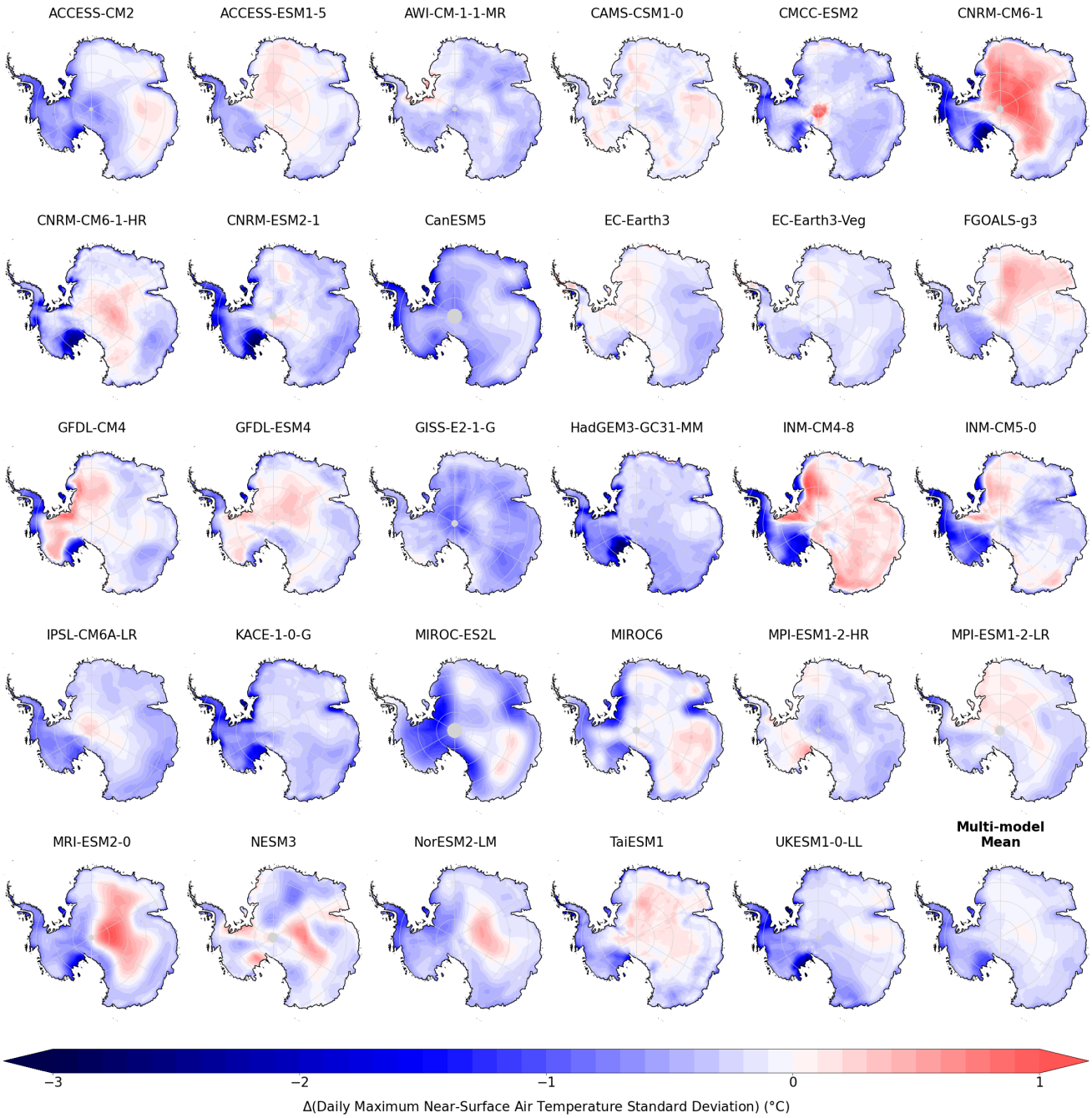

Figure S7. Change in CMIP6 models' ensemble member mean standard deviation of summer near-surface air temperature, 2070-2099 minus 1951-1980. The last panel is the CMIP6 multi-model mean.

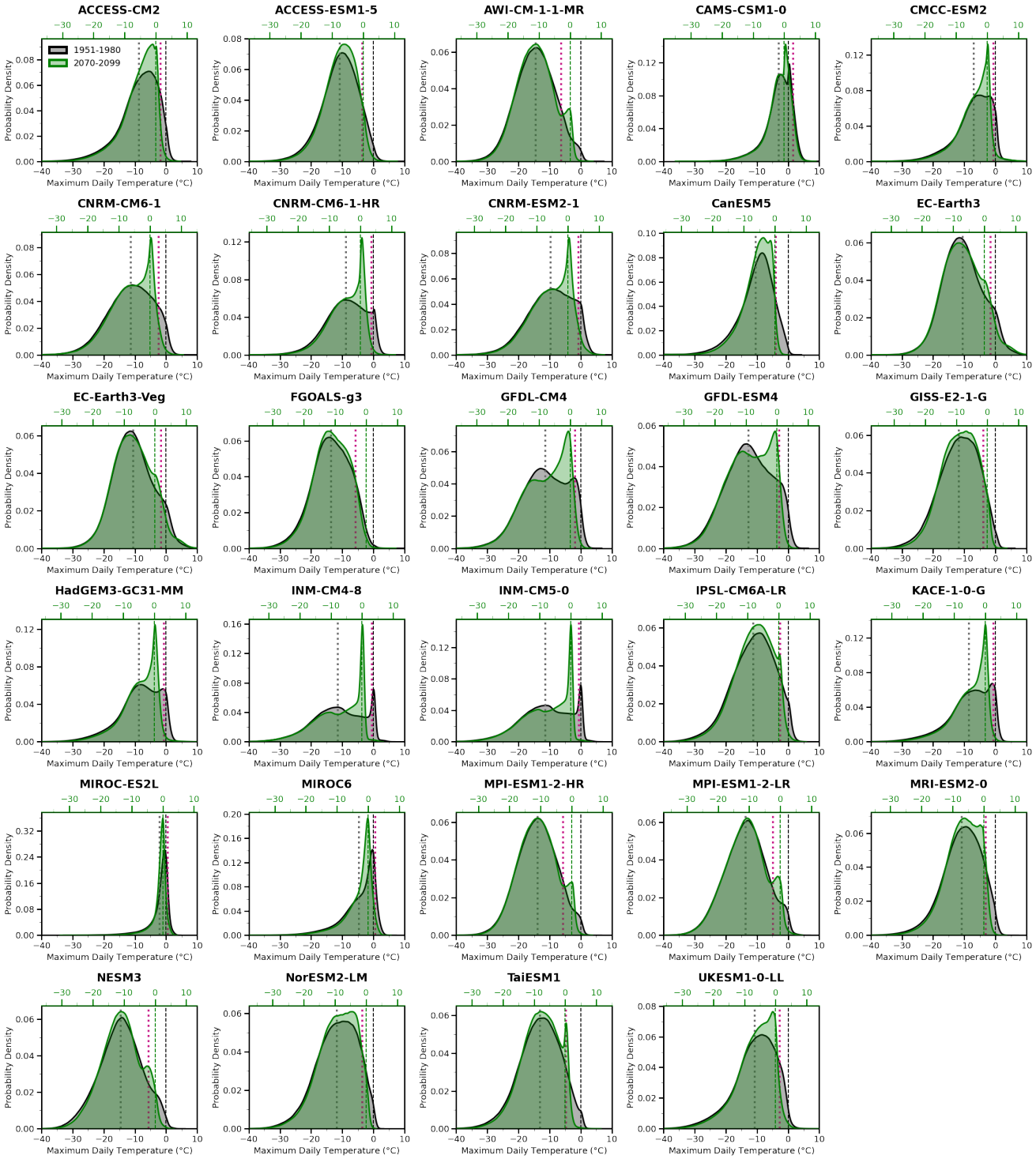

Figure S8. Probability distribution functions of non-EAP near-surface temperatures in CMIP6-participating ESMs, 1951-1980 (black) and 2070-2099 (green). The probability distribution functions are overlapped so the mean of each time period falls on the gray dotted line. The magenta dotted line is the 90th percentile of T_{max} during 1961-1980, or the threshold for calculating whether a day falls under heatwave conditions. The black (green) dashed line is the 0C threshold during 1951-1980 (2070-2099).