# Supplementary information – 'Different response of surface temperature and air temperature to deforestation in climate models'

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## Overview

Table S1: Inter-model comparison of the local effects, spatially averaged values.

Figure S1: $\Delta T_{2m}/\Delta T_{surf}$ to illustrate where the annual mean 2m-air temperature and the surface temperature respond differently in the MPI-ESM.

Figure S2: $T_{surf}$-$T_{atm}$ as a measure of near-surface atmospheric instability, separately for nighttime and daytime conditions.

Figure S3: Illustration temperature at different heights over grasslands and forests.

Figures S4-S6: Maps corresponding to the inter-model comparison of the local effects.

| Model | | CanESM2 | CCSM4 | CESM1-CAM5 | GFDL-CM3 | HadGEM2-ES | IPSL-CM5A-LR | MPI-ESM-LR | NorESM1-M |
|---|---|---|---|---|---|---|---|---|---|
| # ens | | 5 | 6 | 3 | 5 | 4 | 6 | 3 | 3 |
| DJF | $\Delta T_{2m}$ | -0.50 | -0.28 | -0.25 | -0.14 | -0.59 | -0.22 | -0.33 | -0.32 |
| | $\Delta T_{surf}$ | 0.72 | -0.45 | -0.44 | -0.13 | -0.71 | -0.31 | -0.40 | -0.46 |
| | $\Delta T_{2m}/\Delta T_{surf}$ | -0.69 | 0.62 | 0.56 | 1.11 | 0.82 | 0.71 | 0.83 | 0.70 |
| JJA | $\Delta T_{2m}$ | 0.33 | 0.22 | 0.23 | 0.26 | -0.27 | 0.09 | 0.06 | 0.12 |
| | $\Delta T_{surf}$ | 0.60 | 0.40 | 0.35 | 0.74 | -0.13 | 0.19 | 0.18 | 0.23 |
| | $\Delta T_{2m}/\Delta T_{surf}$ | 0.55 | 0.56 | 0.66 | 0.35 | 2.15 | 0.45 | 0.36 | 0.54 |

Table S1: Numerical values for the inter-model comparison of the local effects in Fig. 3. In every model, the difference between 30-year means of the 'historical' simulations of CMIP5 are analyzed. The number of available ensemble members for the 'historical' simulations (# ens) differs across the models. In every model, we cut the 'pi-Control' simulations into 6 time slices of 30 years. For instance, in the MPI-ESM we then analyze $3 \times 6 = 18$ combinations of 'historical' and 'piControl'. Analogous to Fig. 3, the values shown here denote the local deforestation response averaged over mid-latitude areas (40-60° N) that experienced intense deforestation ($\geq 15\%$), and the maps from which these averages are obtained are shown in Figs. S5 and S6. Shown are winter (DJF) and summer months (JJA) separately for near-surface air temperature ($\Delta T_{2m}$), surface temperature ($\Delta T_{surf}$), and the ratio between the two ($\Delta T_{2m}/\Delta T_{surf}$).

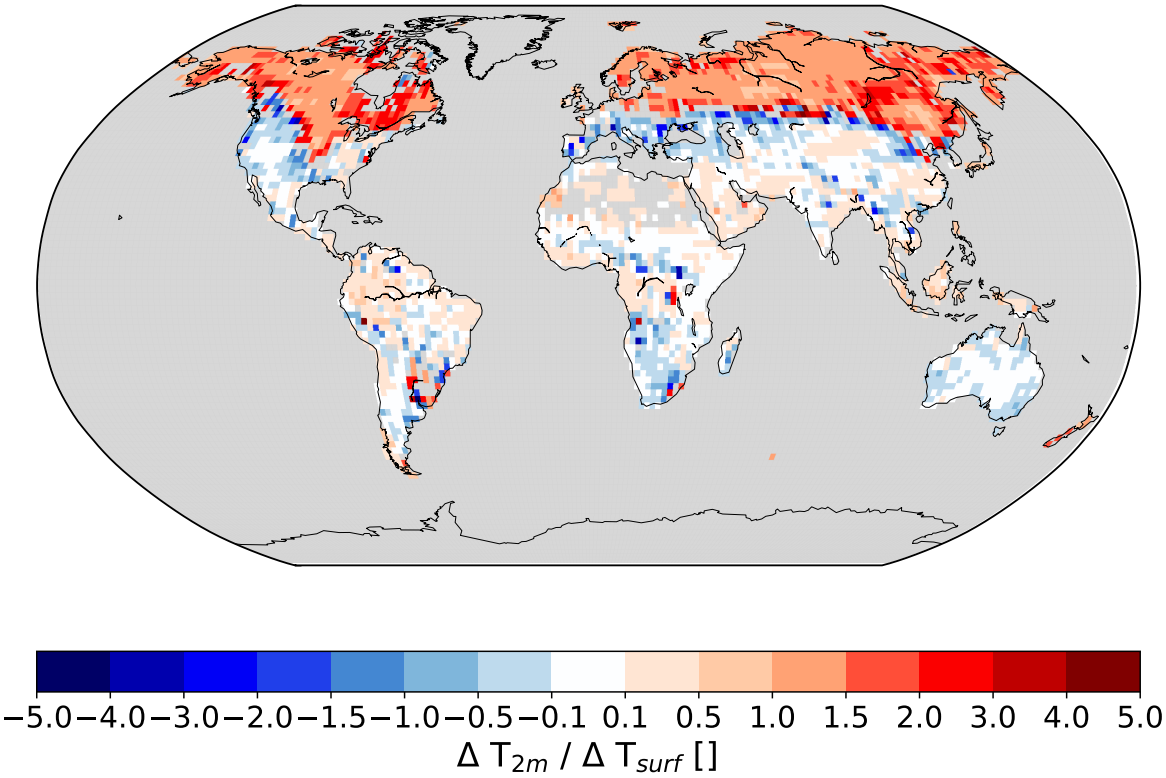


Figure S1: Local effects of deforestation in the MPI-ESM, annual mean 2m-air temperature divided by surface temperature. Values below zero indicate areas where the responses of the two variables differ in sign. Values above one indicate areas where 2m-air temperature responds stronger than surface temperature.

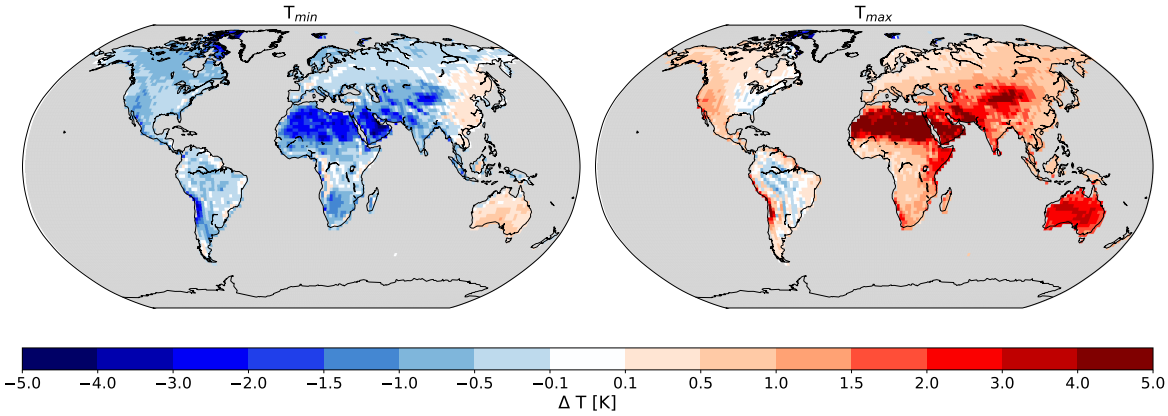


Figure S2: $T_{surf}$-$T_{atm}$ as a measure of near-surface atmospheric instability, separately for nighttime and daytime conditions, time mean for the 'forest world' simulation. During nighttime, the surface is cooler than the lowest atmospheric layer in most regions. During daytime, the surface is warmer than the lowest atmospheric layer in most regions. In the maps, some regions exhibit a different sign than the rest of the world, possibly because the comparison here is not perfectly consistent: $T_{min}$ and $T_{max}$ at the surface may be reached earlier than in the lowest atmospheric layer. However, in the main text only differences between the forests and grasslands are considered, and a possibly different timing of $T_{min}$ and $T_{max}$ matters less for this difference.

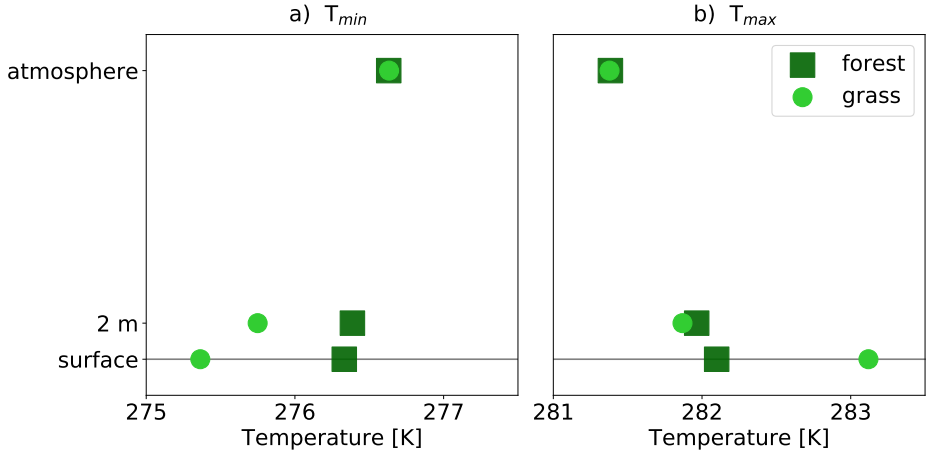


Figure S3: Values for different temperature variables in the MPI-ESM, separately for a) mean daily minimum temperature, and b) mean daily maximum temperature. The 'forest' values are taken from the forest world simulation and the 'grass' values are the 'forest' values plus the local effects of deforestation on the respective variable. Values are averaged over mid-latitude areas (40-60° N) that experienced intense deforestation ($\geq$ 15%) since 1860.

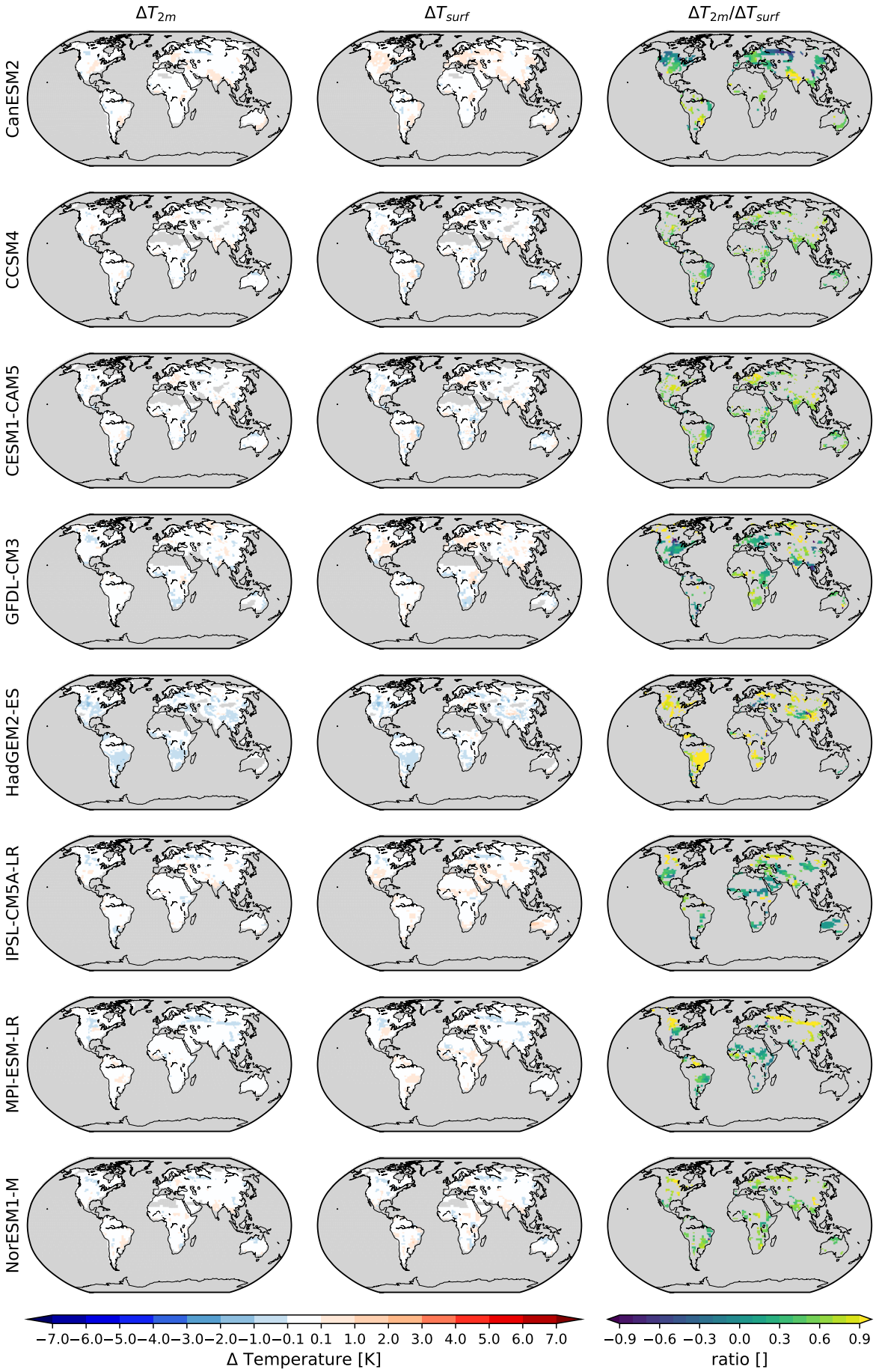


Figure S4: Maps for the **annual** means from which the averages in Fig. 3 and Table S1 were obtained. Local deforestation response of near-surface air temperature (left), surface temperature (middle) and the ratio between the two (right).

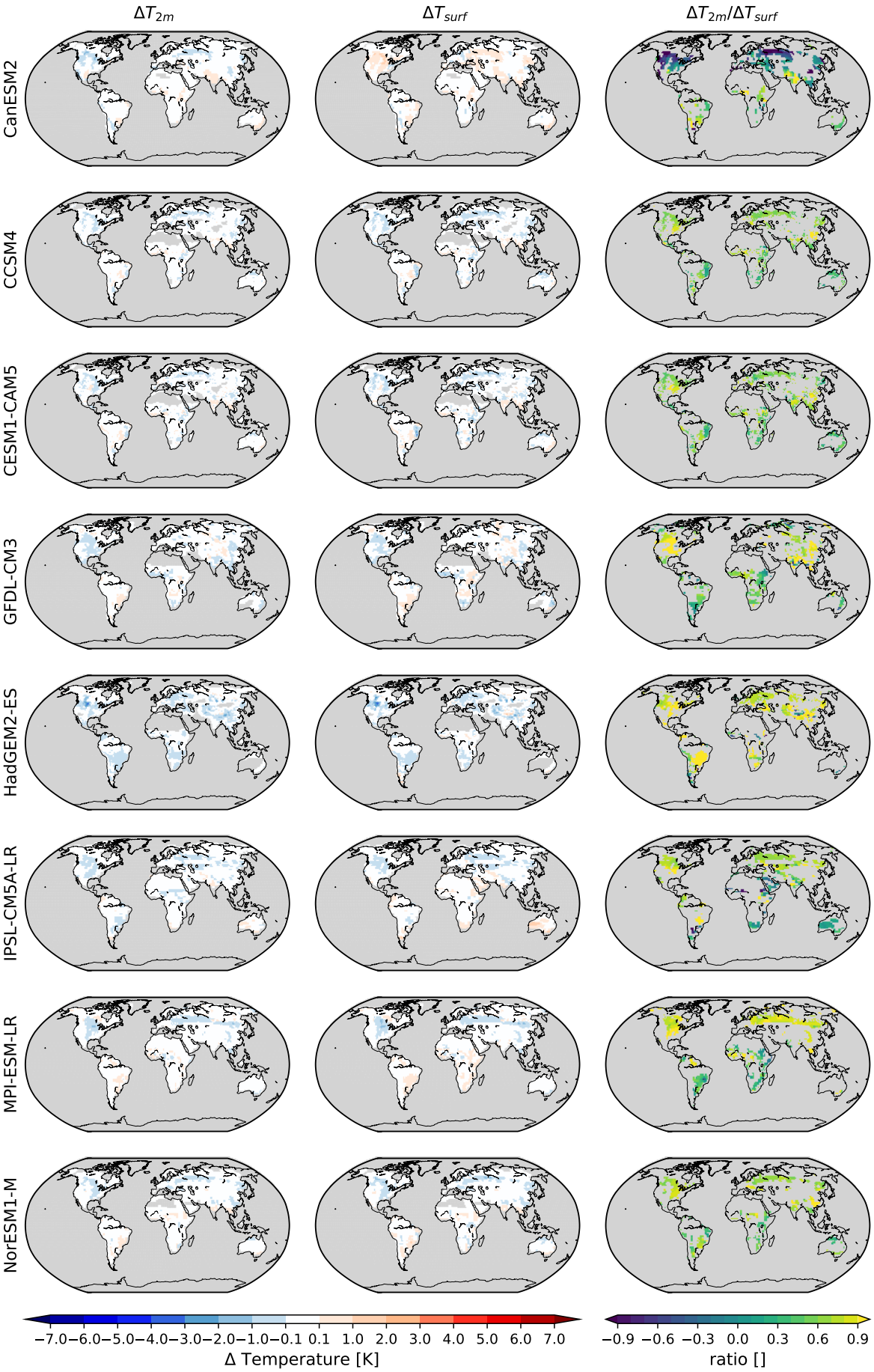


Figure S5: Maps for the **northern-hemispheric winter (DJF)** means from which the averages in Fig. 3 and Table S1 were obtained. Local deforestation response of near-surface air temperature (left), surface temperature (middle) and the ratio between the two (right).

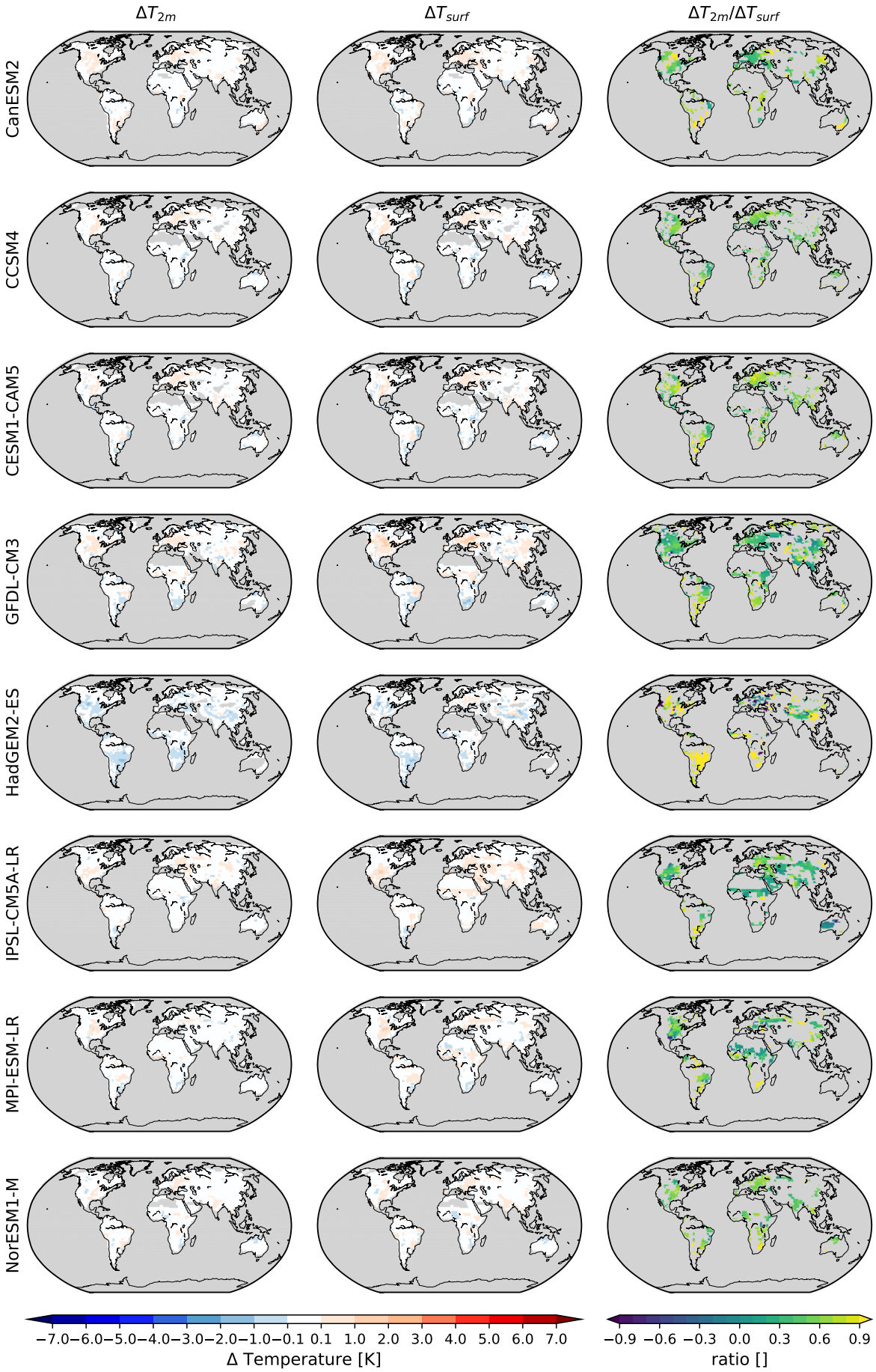


Figure S6: Maps for the **northern-hemispheric summer (JJA)** means from which the averages in Fig. 3 and Table S1 were obtained. Local deforestation response of near-surface air temperature (left), surface temperature (middle) and the ratio between the two (right).