Supplementary material - Importance of surface roughness for the local biogeophysical effects of deforestation

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This supplement provides additional information for the paper 'Importance of surface roughness for the local biogeophysical effects of deforestation'. The figures are numbered according to the order of their reference in the main text.

- Fig. S1 shows the difference in surface albedo in the MPI-ESM between forests and grasslands.
- Fig. S2 shows the areas that are where surface properties in the MPI-ESM are changed.
- Figs. S3-S6 show the maps that correspond to the zonal averages shown in Fig. 2 in the main text.
- Fig. S7 shows the pairwise comparison of the zonally averaged local effects of deforestation on surface temperature in the MPI-ESM versus observation-based data-sets.
- Fig. S8 shows the nonlocal effects for the particular areal extent and spatial distribution of deforestation of the simulations described in the main text.
- Fig. S9 shows the total (local plus nonlocal) effects for the particular areal extent and spatial distribution of deforestation of the simulations described in the main text.
- Fig. S10 shows the areas north of 45° N where the snow cover fraction in March exceeds 0.5. These areas are used for the averages in Fig. 4 in the main text.

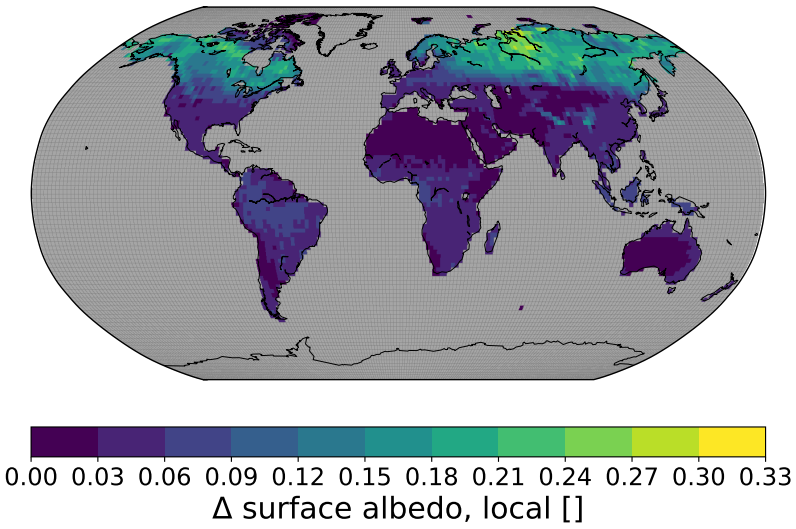

Figure S1: Difference in surface albedo in the MPI-ESM between forests and grasslands (grasslands having a higher surface albedo).

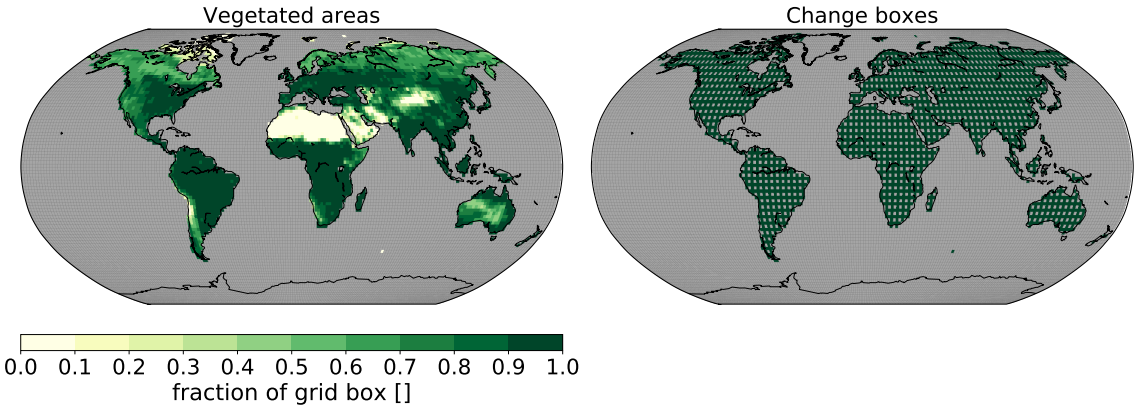

Figure S2: Left: fraction of vegetated areas that is used for prescribing forests in the 'forest world' simulation. Right: The dark grid boxes (3 of 4 grid boxes) are the 'change boxes' where surface properties are changed from forest to grass values.

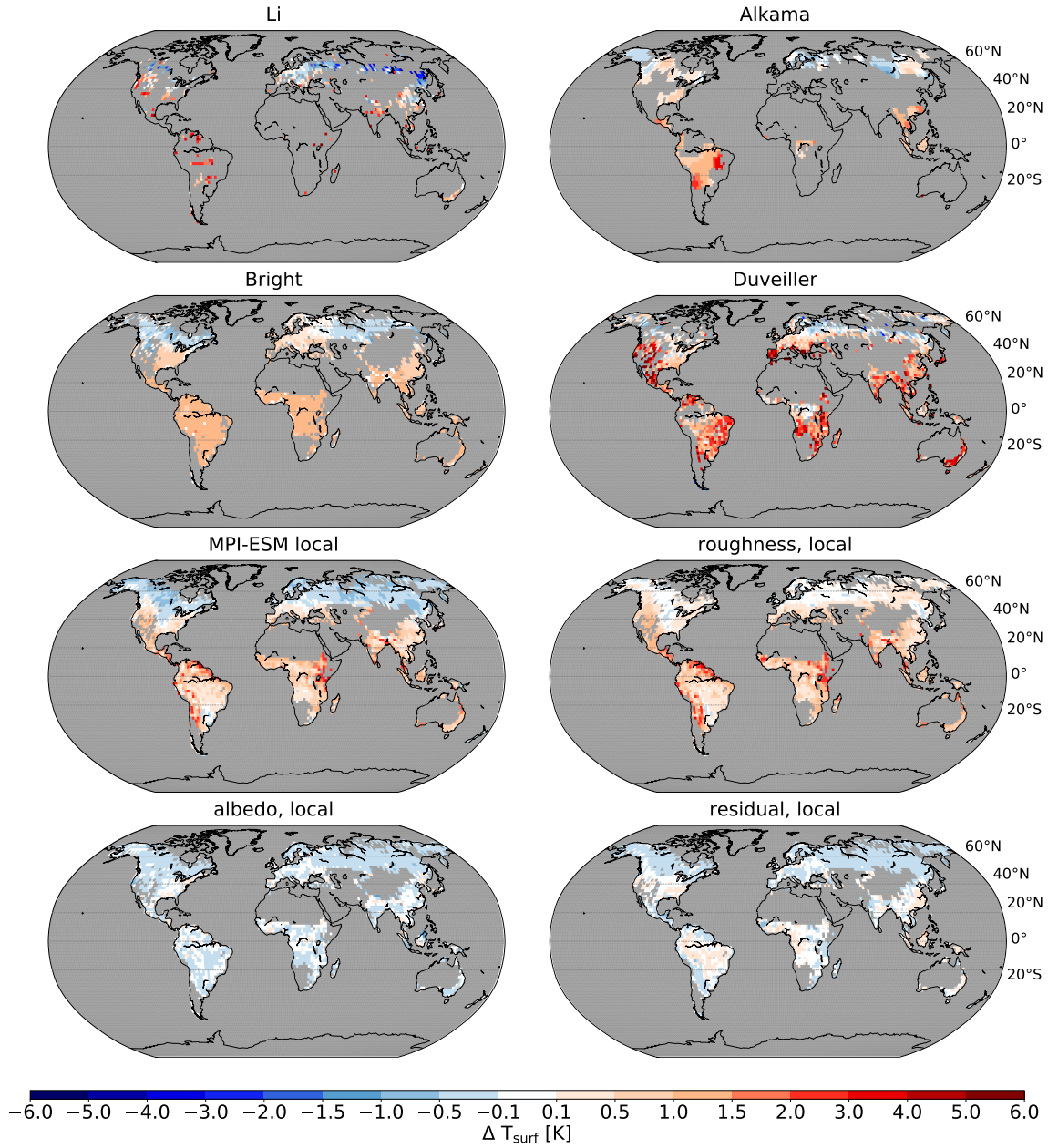

Figure S3: Maps that correspond to the zonal means in Fig. 2a) in the main text. Annual mean local effects of deforestation on surface temperature for various observation-based data-sets and the MPI-ESM. The 'residual' (lowest plot, right) refers to changes in the MPI-ESM that are neither explained by isolated changes in surface roughness nor surface albedo.

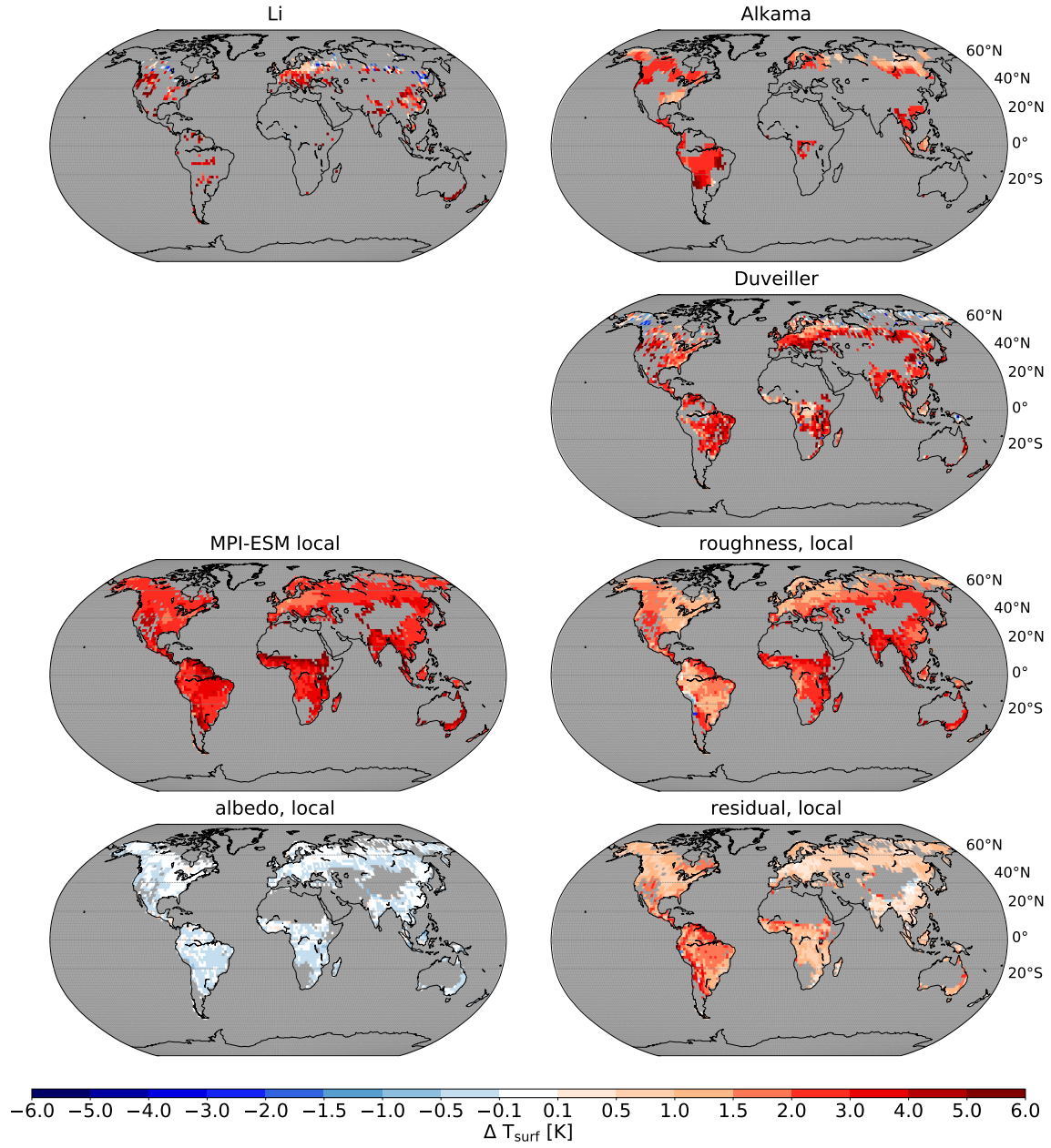

Figure S4: Maps that correspond to the zonal means in Fig. 2b) in the main text. Changes in the diurnal temperature range due to the local effects of deforestation on surface temperature for various observation-based data-sets and the MPI-ESM. No values are available for the data-set by Bright et al. [2017]. The 'residual' (lowest plot, right) refers to changes in the MPI-ESM that are neither explained by isolated changes in surface roughness nor surface albedo.

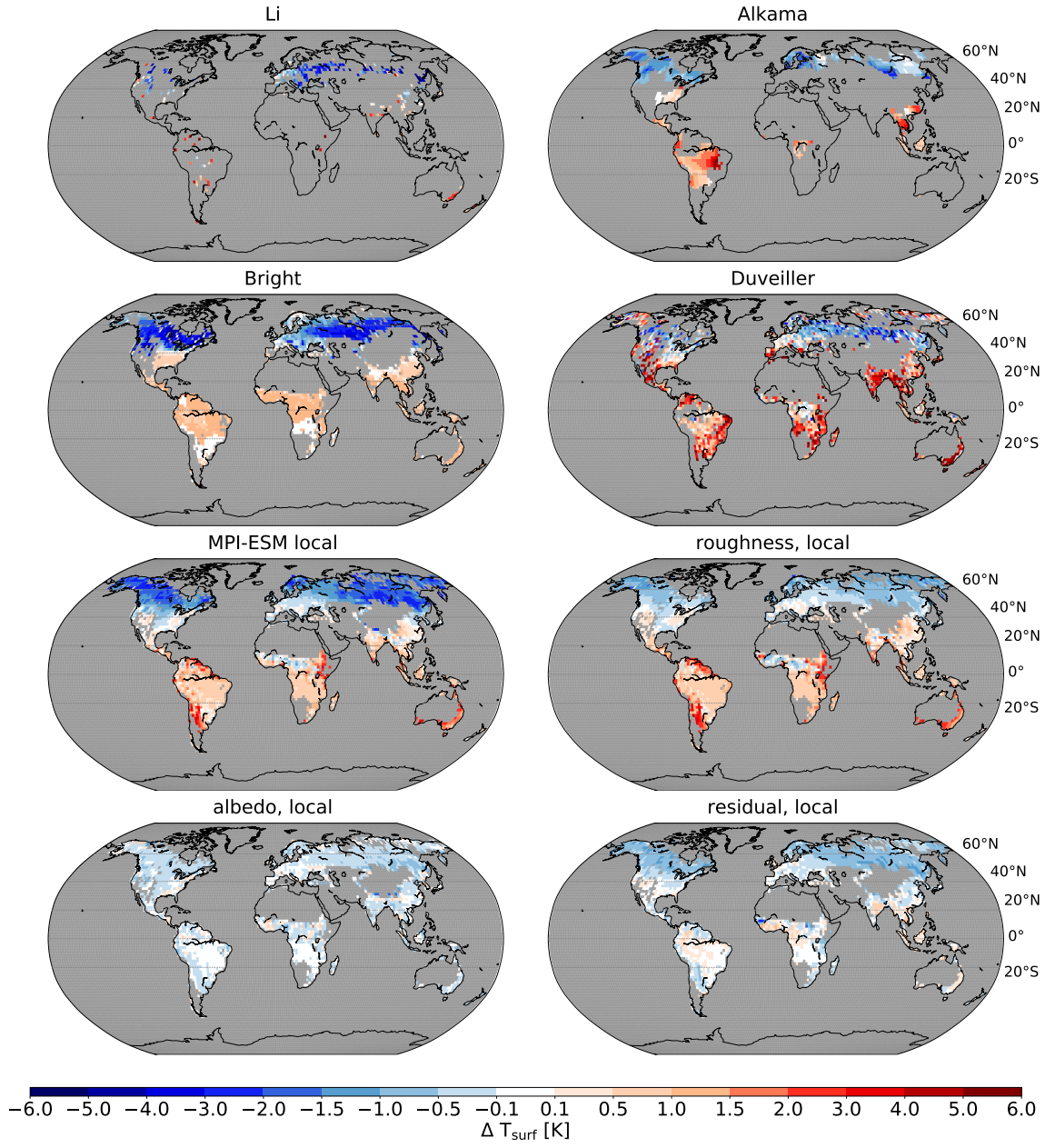

Figure S5: Maps that correspond to the zonal means in Fig. 2c) in the main text. Boreal winter means (DJF, December, January and February) of the local effects of deforestation on surface temperature for various observation-based data-sets and the MPI-ESM.

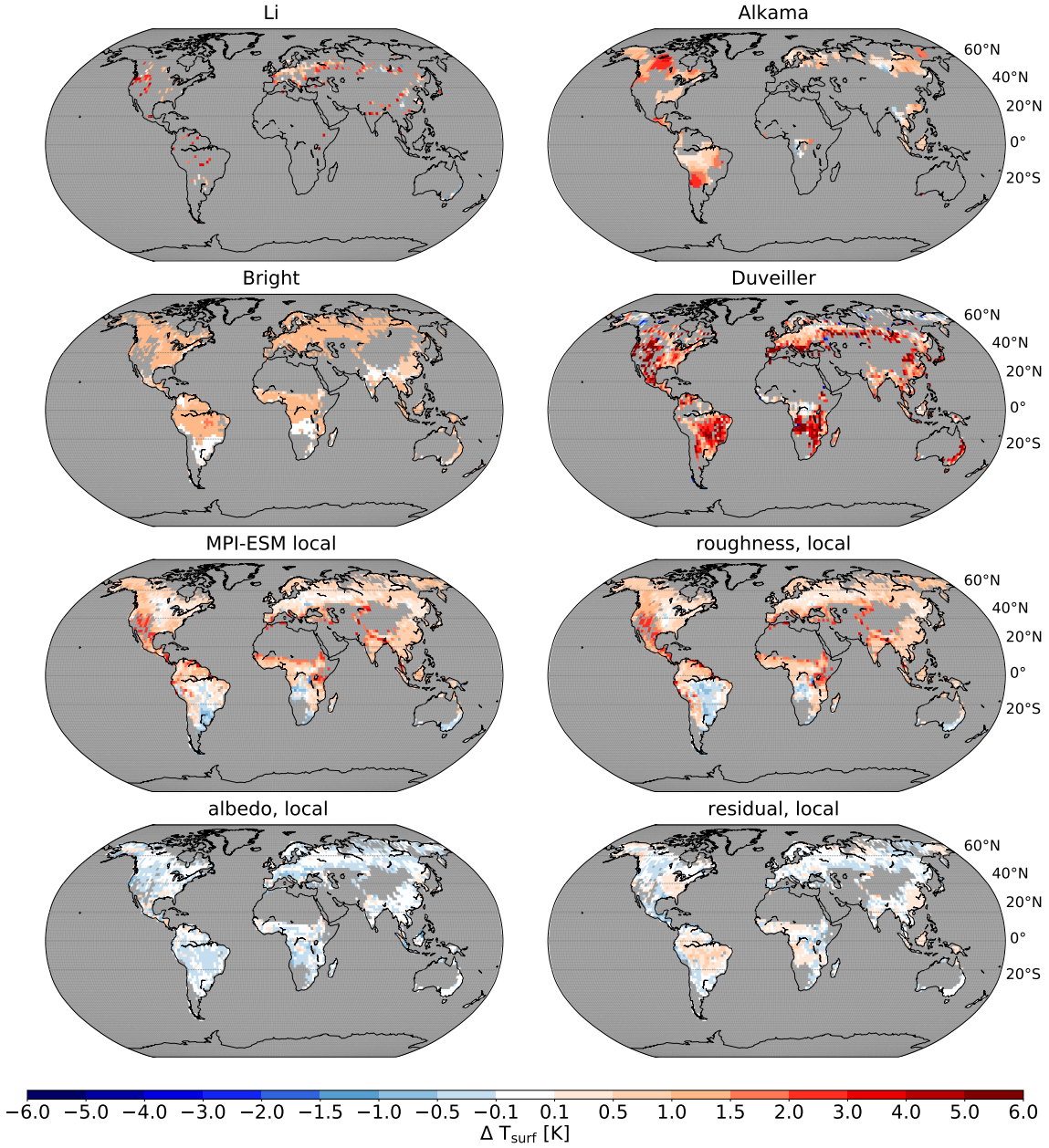

Figure S6: Maps that correspond to the zonal means in Fig. 2d) in the main text. Boreal summer means (JJA, June, July and August) of the local effects of deforestation on surface temperature for various observation-based data-sets and the MPI-ESM. The 'residual' (lowest plot, right) refers to changes in the MPI-ESM that are neither explained by isolated changes in surface roughness nor surface albedo.

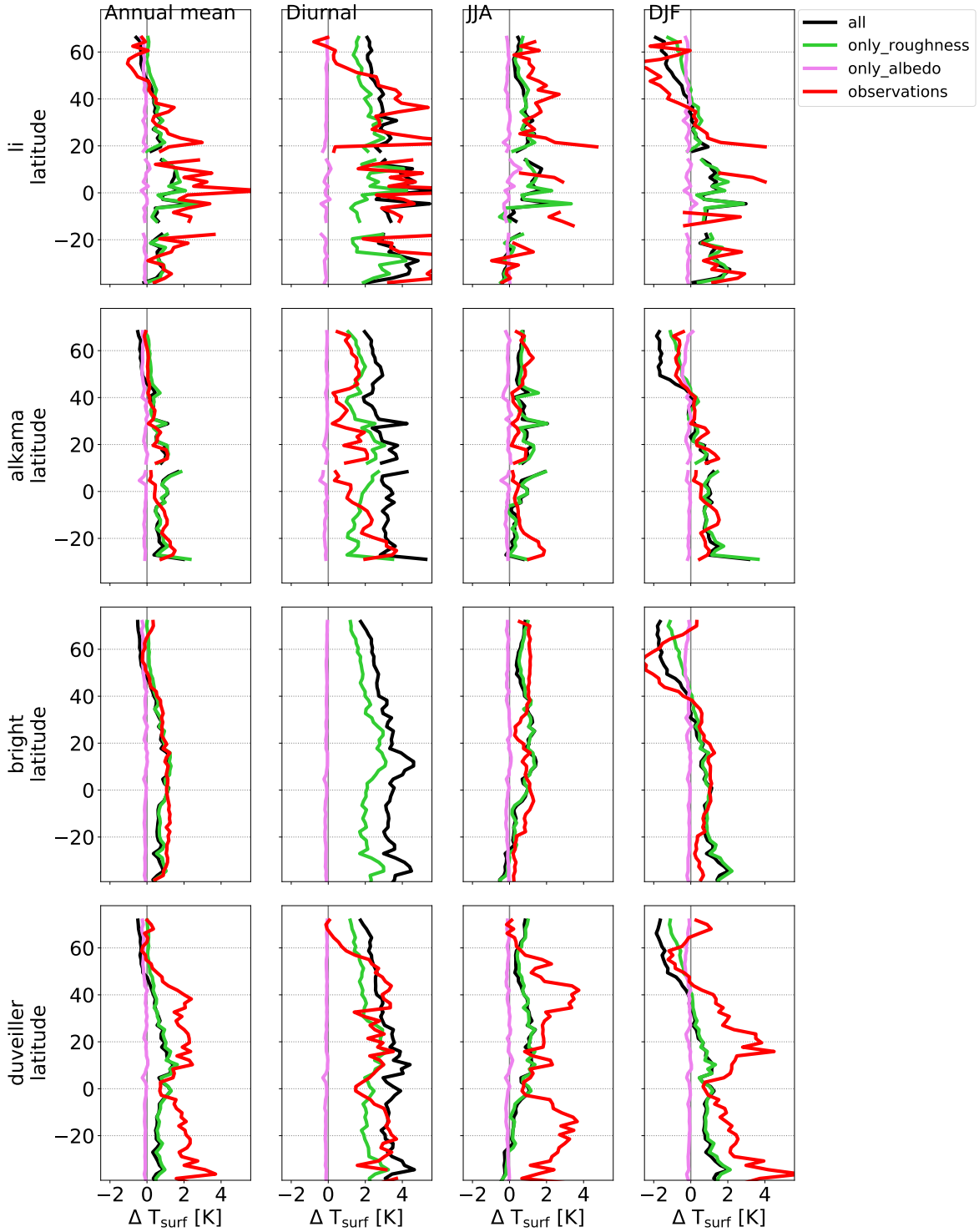

Figure S7: Comparison of the MPI-ESM to observation-based data-sets. Deforestation-induced local effects on surface temperature for the annual mean temperature the amplitude of the diurnal cycle changes in December to February temperature changes in June to August temperature. Locally induced changes in surface temperature for (black) changing all surface properties from forest to grass values in the MPI-ESM, and contributions of changing only surface roughness or only surface albedo from tree to grass values. Observation-based data-sets from Fluxnet [Bright et al., 2017] and remote sensing from satellites [Li et al., 2015, Alkama and Cescatti, 2016, Duveiller et al., 2018]. The data-set by Bright et al. [2017] does not contain diurnal values. The values for the MPI-ESM are zonally averaged where data are available in the respective observation-based data-set. The respective maps are shown in Figs. S2-S5.

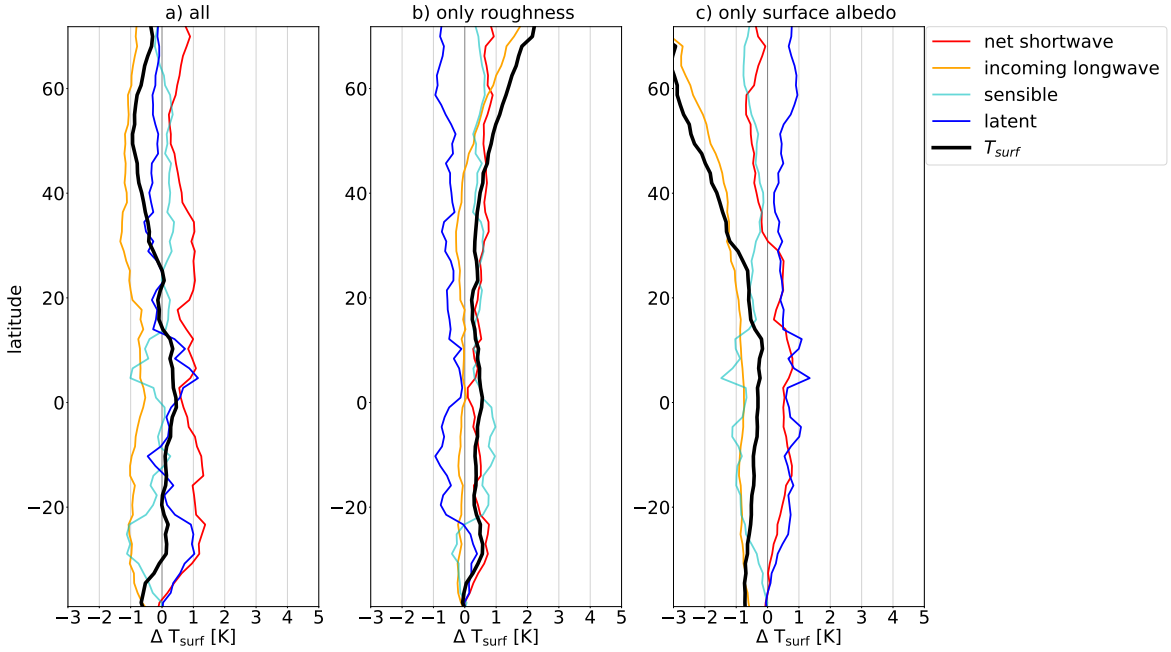

Figure S8: Energy balance decomposition of the nonlocal effects of surface temperature in the MPI-ESM. The lines denote deforestation-induced changes in (a) all surface properties, (b) only surface roughness, and (c) only surface albedo. Shown are the nonlocal effects on surface temperature, net shortwave radiation, incoming longwave radiation, sensible heat, and latent heat. To be consistently comparable to the local effects shown in Fig. 3 in the main text, values are zonally averaged over areas where at least one of the observation-based data-sets is available. The values of the energy balance components were converted from W/m^2 into Kelvin as described e.g. in the study by [Luyssaert et al., 2014].

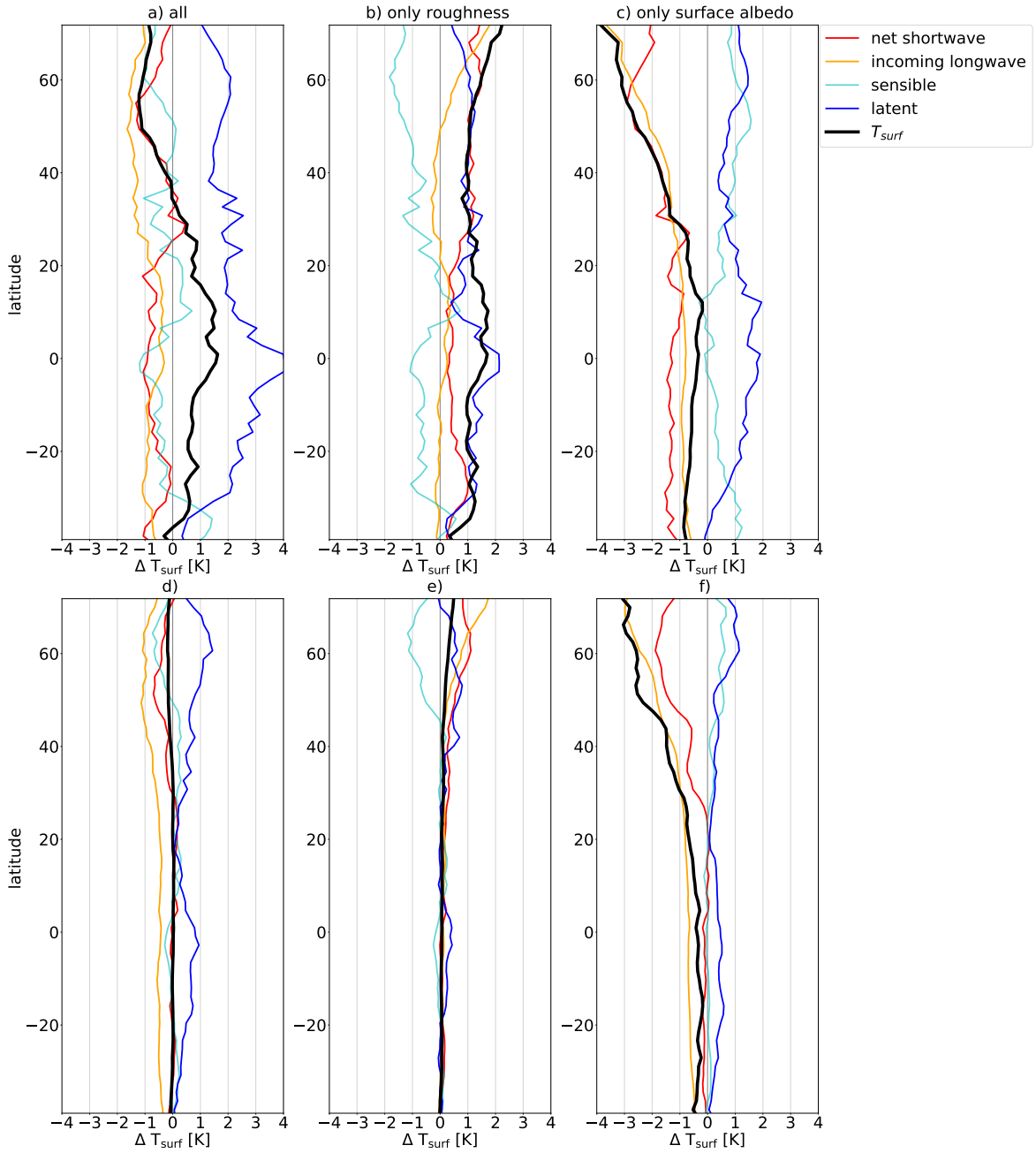

Figure S9: Energy balance decomposition of the total (local plus nonlocal) effects of surface temperature in the MPI-ESM. The lines denote deforestation-induced changes in (a, d) all surface properties, (b, e) only surface roughness, and (c, f) only surface albedo. Shown are the biogeophysical effects of deforestation on surface temperature, net shortwave radiation, incoming longwave radiation, sensible heat, and latent heat. To be consistently comparable to the local effects shown in Fig. 3 in the main text, values in (a-c) are zonally averaged over areas where at least one of the observation-based data-sets is available. To be comparable with previous studies on the total effects [Davin and de Noblet-Ducoudré, 2010, Li et al., 2016], values in (d-f) are averaged over all longitudes including oceans. Note that in (d-f) the energy balance components do not add up to the change in surface temperature because of missing terms for heat storage and redistribution in the oceans. The values of the energy balance components were converted from W/m^2 into Kelvin as described e.g. in the study by [Luyssaert et al., 2014].

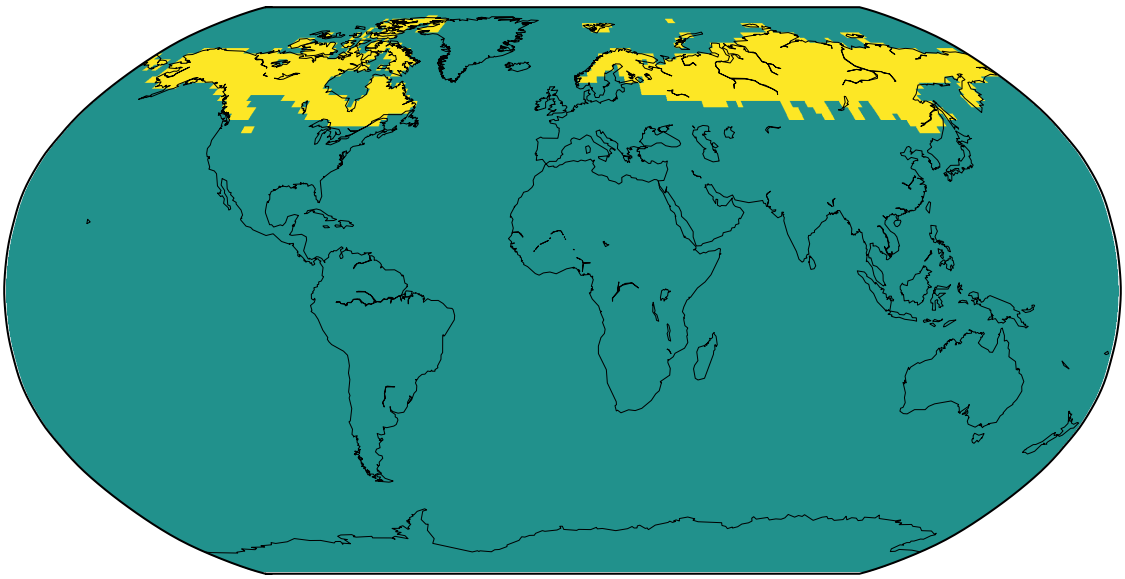

Figure S10: Yellow indicates areas north of 45° N where the snow cover fraction in the MPI-ESM exceeds 0.5. These areas are used for averaging the values in Figure 4 in the main text.

References

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