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Evaluating the response of the diurnal range of surface and air temperature to evaporative conditions across vegetation types in ERA5 and FLUXNET data

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The diurnal variations of surface and air temperature are related but their different responses to evaporative conditions can inform us about land-atmosphere interactions, extreme events, and their response to global change. Here, we evaluate the sensitivity of the diurnal ranges of surface (DT_sR) and air (DT_aR) temperature to evaporative fraction, across short vegetation, savanna, and forests at 106 Fluxnet observational sites and in the ERA5 global reanalysis. We show that the sensitivity of DT_sR to evaporative fraction depends on vegetation type, whereas for DT_aR it does not. Using FLUXNET data we found that on days with low evaporative fraction, DT_sR is enhanced by up to 20 °C (30 °C in ERA5) in short vegetation, whereas only by 8 °C (10 °C in ERA5) in forests. Particularly, in short vegetation, ERA5 shows stronger responses, which is attributable to a negative bias on days with the high evaporative fraction. ERA5 also tends to have lower shortwave and longwave radiation input when compared to FLUXNET data. Contrary to DT_sR, DT_aR responds rather similarly to evaporative fraction irrespective of vegetation type (8 °C in FLUXNET, 10 °C in ERA5). To explain this, we show that the DT_aR response to the evaporative fraction is compensated for differences in atmospheric boundary layer height by up to 2000 m, which is similar across vegetation types. We demonstrate this with a simple boundary layer heat storage calculation, indicating that DT_aR is primarily shaped by changes in boundary layer heat storage whereas DT_sR mainly responds to solar radiation, evaporation, and vegetation. Our study reveals some systematic biases in ERA5 that need to be considered when using its temperature products for understanding land-atmosphere interactions or extreme events. To conclude, this study demonstrates the importance of vegetation and the dynamics of the atmospheric boundary layer in regulating diurnal variations in surface and air temperature under different evaporative conditions.