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Imprints of evapotranspiration in the diurnal hysteresis of air temperature and incoming solar radiation

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Due to lack of observations of evapotranspiration it has become important to find its imprints in easily observable meteorological parameters, for example air temperature. The diurnal course of air temperature displays a distinctive phase difference to the absorbed incoming solar radiation dependent on the evaporative conditions. For better understanding we plot hourly air temperature against absorbed incoming solar radiation, which results in formation of characteristic hysteresis on sunny days. A bulk model of the atmospheric boundary layer is used to reproduce this hysteresis. In the model, the planetary boundary layer evolves with time from morning to evening for an unstable atmosphere using the energy budget equation. The area enclosed by the hysteresis can be explained as the diurnal variations in sensible heat buffered by the atmosphere. We used identical background conditions and varied the evaporative fraction and the greenhouse effect to evaluate how the size and shape of this hysteresis varies. Since evaporation lowers daytime temperatures, it reduces the increase in temperature during the day, which alters the shape of the hysteresis. Hence, we find that over dry land, the lower atmosphere stores relatively more sensible heat, resulting in a comparatively narrow hysteresis with a large diurnal temperature range. Over moist land, however, more of the heat is stored in latent form and the greenhouse effect alters evening temperatures, resulting in a broader hysteresis. We illustrate the application of this approach with observations taken at sites with contrasting evaporative conditions. We conclude that the size and shape of the hysteresis provides useful information to better understand evapotranspiration from observations of solar radiation and air temperatures.