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COMMENT
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This article is a comment on Tu and Yang (2022), https://doi.org/10.1029/2021WR031486; Yang et al. (2022), https://doi.org/10.1029/2022WR033674

Key Points:

- The wet-surface temperature estimates of Szilagyi and Jozsa (2008) are more realistic than the ones by Yang and Roderick (2019)
- The latter estimates are often lower than the corresponding wet-bulb temperatures, which is thermodynamically problematic
- The same does not happen with the former estimates

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Comment on "On the Estimation of Potential Evaporation Under Wet and Dry Conditions" by Z. Tu and Y. Yang

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Abstract It is argued here that the wet-surface temperature (T_{ws}) estimation method employed by Tu and Yang for their potential evaporation estimates yields physically unreachable low values not only during dry, but frequently under wet environmental conditions as well. For these reasons it is claimed that the wet-surface temperature estimation method of Szilagyi and Jozsa (2008, https://doi.org/10.1016/j.jhydrol.2008.03.008) may produce more realistic T_{ws} values than the one by Yang and Roderick (2019, https://doi.org/10.1002/qj.3481) as employed by Tu and Yang (2022, https://doi.org/10.1029/2021WR031486).

Tu and Yang (2022) employ the wet-surface temperature estimation method of Yang and Roderick (2019) in their potential evaporation estimation approach and frequently end up with wet-surface (T_{ws}) temperatures 10–12 K lower (seen e.g., in their Figure 9) than the actual air temperature (T_a). In their example of Figure 9, their estimates of T_{ws} under dry conditions drop below even the actual wet-bulb temperature, T_{wb} (compare Figure 9 with Figure 1 here). Note that between days 40 and 91 the T_{ws} values of Yang and Roderick (2019) stay predominantly below 285 K, while it never happens with T_{wb} in Figure 1. T_{wb} represents the lowest possible temperature the air can be cooled by evaporation under an isenthalpic (i.e., adiabatic and isobaric) process (Figure 2) and zero net radiation (R_n) at the evaporating surface (i.e., at the wet-bulb of the thermometer). The hypothetical wet land surface however cannot be cooler than T_{wb} (Monteith, 1981; Szilagyi, 2021) since at the land surface R_n on a daily basis is almost always positive under typical conditions (and it is definitely so in each single day in Figure 1), raising its temperature above that of the wet-bulb of the thermometer (Monteith, 1981) where R_n is zero, achieved by double metal tubing of the for example, aspirated psychrometer (e.g., Stull, 2000).

Also, during wet environmental conditions (starting with Day 211 in Figure 9 with rains almost every day and relative humidity values often exceeding 85% in Figure 1) T_{ws} cannot be expected (as seen in Figure 9) to be (significantly) lower than the actual air temperature measured over the wet land and therefore yielding downward sensible heat (H) fluxes. It would contradict the common observation that even over extensive wet surfaces the equilibrium air (potential) temperature profile near the surface is decreasing with elevation facilitating an upward H.

Tu and Yang (2022) dismisses the T_{ws} estimation method of Szilagyi and Jozsa (2008) that assumes unchanging net radiation (R_n) during drying/wetting of the environment, by arguing that net radiation would increase with decreasing surface temperatures (due to declining thermal radiation of the surface, R_{lo}) as the surface becomes wetter. However, they did not take into consideration that a weakening incoming shortwave radiation can counteract the effect of dropping R_{lo} on R_n as cloudiness and humidity typically increase with a regional wetting of the land surface, thus making it possible to leave R_n practically intact (Brutsaert, 1982).

In summary, the wet-surface temperature estimation method of Yang and Roderick (2019) as employed by Tu and Yang (2022) appears to significantly underestimate the wet surface temperature leading to physical/thermodynamical contradictions. At the same time the Szilagyi and Jozsa (2008) estimated T_{ws} values always stay above T_{wb} and predominantly above T_a (depending on e.g., the degree of saturation of the air) under wet conditions, as demonstrated in Figure 1 and therefore claimed to be a more realistic wet-surface estimation method than that of Yang and Roderick (2019) as was employed by Tu and Yang (2022).

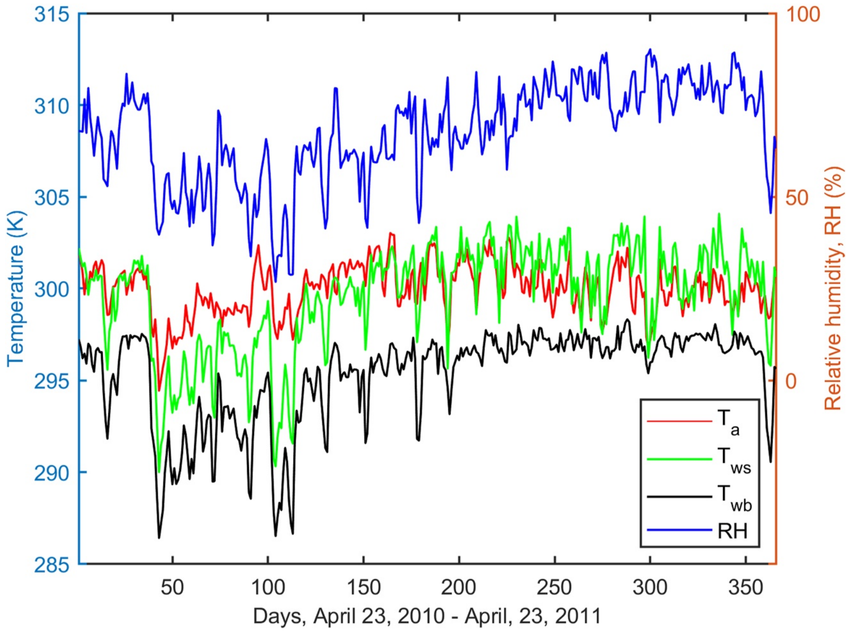

Figure 1. The measured air temperature (T_a), wet-surface temperature (T_{ws}) estimated by the method of Szilagyi and Jozsa (2008), the corresponding wet-bulb temperature (T_{wb}) and relative humidity (RH) for the same station and period displayed in Figure 9 of Tu and Yang (2022). T_{wb} can be obtained (Monteith, 1981; Szilagyi, 2014) iteratively from Figure 2 as (e^*_{wb}–e_a) = γ (T_a–T_{wb}), where e^*_{wb} is the saturation vapor pressure at T_{wb} and e_a is the actual one and γ is the psychrometric constant. For a validation of the T_{wb} estimates see Figure 3.

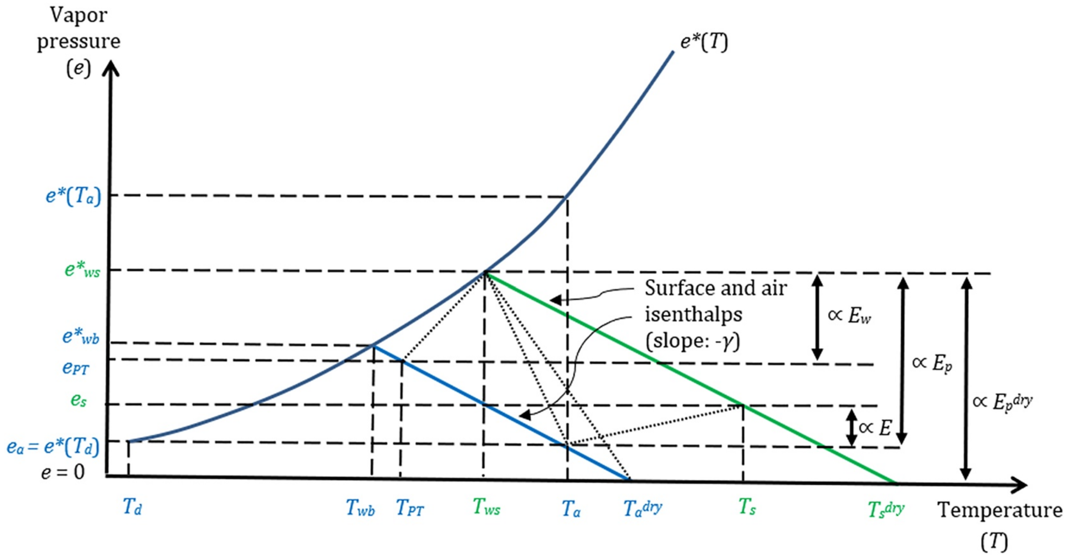

Figure 2. Saturation vapor pressure (e^*) curve, air (blue) and surface (green) isenthalps (Crago & Qualls, 2021; Szilagyi, 2021) during a full drying-out of the environment from a completely wet to a completely dry state. The air and surface (T, e) value pairs move along the same respective isenthalps during wetting/drying cycles as long as R_n does not change. While R_n is positive at the land surface the surface isenthalp is located above the air one (Monteith, 1981), thus resulting in wet surface temperatures (T_{ws}) always larger than T_{wb}. The vertical and horizontal projections of the dotted lines are proportional ($\propto$) to the different latent ($E \le E_w \le E_p \le E_p^{dry}$) and corresponding sensible heat fluxes. See Szilagyi (2021) for additional definition of the different variables.

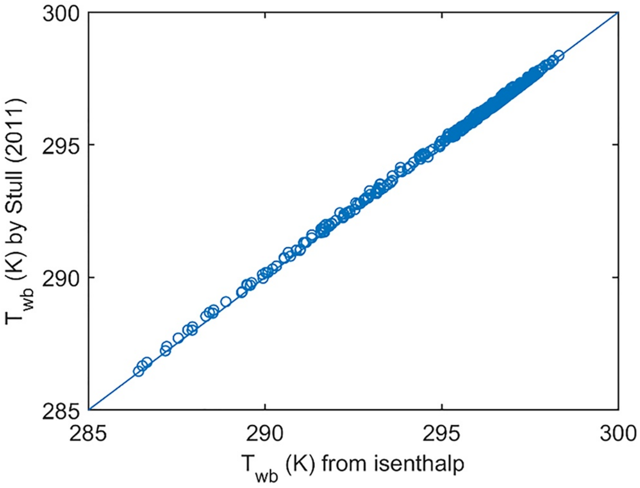

Figure 3. Validation of the isenthalp-derived T_{wb} values in Figure 1 against an empirical formula by Stull (2011).

Data Availability Statement

Data were not used, nor created for this research.

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