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Discussions

Interactive comment on "Comment on "Technical Note: On the Matt–Shuttleworth approach to estimate crop water requirements" by Lhomme et al. (2014)" *by* W. J. Shuttleworth

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The comment by Shuttleworth (2014) shows that some aspects of Lhomme et al. (2014) technical note have been misunderstood, mainly those concerning the conditions when the equivalence between E0 and EPT applies. He writes (P5371L13): "Shuttleworth (2006) does not assume that reference crop evapotranspiration rate, E0, is equal to the Priestley-Taylor estimate of evapotranspiration rate, EPT, every day as Lhomme et al. (2014) wrongly assume." In fact, Lhomme et al. (2014) have never assumed that E0 = EPT on each day; they clearly identify specific conditions in which crop resistance is inferred from Kc with the assumption E0 = EPT, as in Shuttleworth

(2006), since they write (P4222L18): "It is worthwhile noting that Eq. (10) is only valid under the standard climatic conditions used to derive the value of the crop coefficient. Consequently, the crop surface resistance rs,c should be first determined under the "fictitious" standard climatic conditions corresponding to the determination of crop coefficients and then introduced into Eq. (3) with the actual climatic conditions. The problem, however, is to define these "fictitious" or "preferred" weather conditions in order to estimate the most correct value of crop resistance through Eq. (10)." Lhomme et al. (2014) clearly make the difference between: (1) the climatic conditions under which the crop coefficient is determined and the crop resistance should be derived through Eq. (10); (2) the current climatic conditions under which the crop resistance (previously calculated) is used within the Penman-Monteith equation on each day. The equality E0 = EPT is clearly restricted to the conditions when the crop coefficient is obtained and when the crop resistance is determined through Eq. (10); it is not assumed to be true on each day. This point being specified, it is difficult to understand the statement by Shuttleworth (2014) in his introduction (P5369L9): "rsc . . . is never the complex function of weather variables and Kc given as Eq. (10) of Lhomme et al. (2014)".

In fact, the crux of the matter is that the environmental conditions, in which crop coefficients were determined, are very poorly defined. This issue is clearly pointed out by Shuttleworth (2014) in his comment (P5370L9): "Presumably there must be environmental conditions when there is a definable pairing between the effective values of Kc and rsc, specifically the prevailing meteorological conditions when the field experiment to determine Kc was carried out. If these meteorological conditions were known, then the same data used to specify the particular value of Kc relevant in these conditions could alternatively be used to specify the equivalent value of rsc used in the Matt–Shuttleworth approach. But unfortunately, the meteorological conditions when tabulated values of Kc were defined are not available, hence an assumption is required". The problem is right here: the exact conditions in which the crop coefficients were derived are not known. In FAO-56, it is only specified that they were "sub-humid conditions" with a mean wind speed of 2 m s-1. Consequently, using different types of explanations, Shuttleworth (2006, 2014) assumes that these “sub-humid” conditions justify the equivalence between E0 and EPT (the so called M-S assumption), which is used first to calculate the preferred value of the climatological resistance rclim and then to derive the effective value of crop resistance with this preferred value r_climˆpref . The main argument of Shuttleworth (2014) behind this assumption is the history of reference crop evapotranspiration, which has been calculated in several different ways. He writes (P5371L24): “If either KcE0 and KcEPT can be used to calculate crop evapotranspiration optimally in sub-humid conditions, then E0 = EPT can presumably be used to specify the value of rclim”.

In their technical note, Lhomme et al. (2014) recalculated the crop resistance in sub-humid conditions (as defined in their Table 1) and also in other conditions, with and without the M-S assumption. They varied some weather conditions (temperature, solar radiation, etc) because “the meteorological conditions, when tabulated values of Kc were defined, are not available” and also because these conditions should certainly change depending on the crop. A given crop grows in a given environment characterized by specific weather conditions. It is what Lhomme et al. (2014) stated in their conclusion (P4227L20): “Indeed, the weather conditions corresponding to a tropical crop (such as cassava, banana or millet) are certainly different from those corresponding to a temperate one (such as winter wheat or potato)”. Figure 1 in Lhomme et al. (2014) shows that under sub-humid conditions E0 is lower than EPT (i.e., α lower than αPT =1.26) and Figures 2 and 4 show that under the same sub-humid conditions, the value of crop resistance inferred from Kc can differ significantly depending on whether or not the assumption E0 = EPT (or its equivalent form rclim = r_climˆpref) is used. Under no circumstances Lhomme et al. (2014) “wrongly” assumed that E0 is equal to EPT on each day, as supposed by Shuttleworth (2014).

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