

## Response to Reviewer 3

This manuscript describes an updated analysis of a combined Budyko-Bouchet complementary relation using data from across the US.

There has been a growing (and sometimes confusing) literature on the CR in recent years. Many of these difficulties have been described in a recent mini-review (see section 2 in Aminzadeh et al 2016 WRR).

The manuscript under consideration skips over the above-noted difficulties and in essence returns more closely to the original CR formulations by Brutsaert and co-workers. In that context, the manuscript adds some ideas and much useful data the literature.

The manuscript is, in general, very clearly written, and with the extensive data, is a helpful addition to the literature.

**Recommend: Accept subject to revision**

Thank you for your comments and suggestions.

Comments:

1. Lines 45-57. I agree with the first condition for potential, i.e. no limit on the water supply. However, the second definition, i.e., saturated surface vapour pressure, is used by some scientists but the relevance is not clear. For example, in this manuscript, potential is actually defined by Priestley-Taylor and this does explicitly refer to saturated surface air. The comments here fall into the “difficulties” categories noted above. There is a vast range of definitions of potential E over the years ..... So what to do? Maybe drop the text about saturated vapour pressure at the surface and acknowledge some of the difficulties.

Thank you. We agree that there are different definitions of potential evaporation and we add discussion about the definition “difficulties” and add Aminzadeh et al (2016) as a reference: “We acknowledge that there are different definitions of potential evaporation in the literature (Aminzadeh et al., 2016). Our study will follow the definition of potential evaporation in Brutsaert and Parlange (1998) and Brutsaert (2015).” We also revised the description of the saturated surface vapor pressure to make it more clear: “secondly, the vapor pressure at the water surface and adjacent near-surface area is saturated (Van Bavel, 1966; Brutsaert, 2015).”

2. Lines 45-57. I have advocated dropping the text about saturated vapour pressure in this paragraph. At any rate, it is also useful to note that for evaporation from a pure water surface (e.g. pan), the vapour pressure right at the evaporating surface is assumed to be saturated. I assume what you mean here is the vapour pressure of **adjacent near-surface air**. Please be specific.

Thank you. Yes, the “surface vapor pressure” include the vapor pressure at the water surface and at areas near the water surface. We added this description: “secondly, the vapor pressure at the water surface and adjacent near-surface area is saturated (Van Bavel, 1966; Brutsaert, 2015).”

3. Line 56. TYPO. .... by **an** evaporation pan

Thanks. The sentence is revised.

4. Line 79. See comment 2.

Thanks. This part is deleted since it is repetitive.

5. Line 130-135. You set  $a = 1$ . Why? I note that you say it does not make much difference to your results but it is nice to use a reasonable parameter value if you have one available. That would be 0.7 (instead of 1). The Class A pan (as used here) is elevated above the ground and the water surface evaporation is effected by heat exchange across the side walls. The meaning of the pan co-efficient relates to this additional heat. The traditional value for the pan co-efficient is around 0.7 (see Stanhill 1976 that you cite). Theoretical considerations suggest the value should be 0.65 to 0.9 with a mean close to 0.7 (see Fig. 10 in Lim et al 2013, AgForMet). So why not use 0.7?

Thanks. Yes, the pan coefficient is usually set at 0.7. Kahler and Brutsaert (2006) suggests a different value of 1.0 for mixed natural vegetation. They argued that 1.0 is not an unreasonable value for pan coefficient for mixed natural vegetation. Furthermore, by setting the coefficient value to unity, the error caused by pan coefficient estimation inaccuracies can be avoid. We agree with their opinion and therefore set the pan coefficient value to 1.0.

6. Line 173. TYPO. for each year **at** each weather

Thanks. The sentence is revised.

7. Lines 188-196. I assume you set  $G$  to zero when calculation  $E_p$ ? Please state how you did this calculation.

Thanks. The heat flux into the ground  $G$  is not set at zero. The calculation is done in Zhang et al. (2010). In their paper, they explained the calculation procedure:

$$G = R_n * [\Gamma_c + (1 - f_c) * (\Gamma_s - \Gamma_c)]$$

where  $R_n$  is the net radiation;  $\Gamma_c$  and  $\Gamma_s$  are ratios of  $G$  to  $R_n$  for full vegetation canopy and bare soil, respectively; and  $f_c$  is the fractional canopy coverage.

We collect  $E_p$  data from their dataset based on Zhang et al. (2010). We didn't do any calculation related to the remote-sensing data. The description about the remote-sensing dataset is revised to be more clear: "The potential evaporation  $E_p$  data are collected from a remote-sensing dataset (Zhang et al., 2010), which is generated using the Priestley-Taylor equation with remotely sensed net radiation".