Comment on hess-2021-234

Thomas McMahon (Referee)

Referee comment on "Rediscovering Robert E. Horton's lake evaporation formulae: new directions for evaporation physics" by Solomon Vimal and Vijay P. Singh, Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-234-RC1, 2021

I am privileged to review this excellent article. The authors have provided an eclectic assessment of Robert E Horton's lake evaporation formula. All of us until now have considered Horton's evaporation equation as another in a long list of empirical equations available to estimate lake evaporation. Solomon Vimal and Vijay Singh have provided us with a forensic analysis of Horton's research, much of which is buried as unpublished material.

The authors have discussed thoroughly each aspect of the vapour removal from a water surface - diffusion, wind action and convection – in relation to each component of Horton's lake evaporation formula. In doing so they have provided at least to this reviewer a unique explanation of the various evaporative processes that occur at or near the lake surface.

The paper addresses a key question in hydrology, and it is most appropriate that it be published in HESS. Not only is it novel, but it addresses an important hydrologic issue, the calculation of lake evaporation. The title of the paper reflects clearly the content and sufficient details are provided in the Abstract for a curious reader to be excited to read it.

Although long in length, the paper is clearly and concisely written. I do have a number of edits, mainly minor, which I list below. Because Horton worked in the US system of measurement, the discussion around numerical values is mainly in those units. I strongly recommend the authors include the metric equivalent values wherever possible especially with respect to key parameters and equations, for example, Equation 3b.

L72: "etc" is unhelpful. Please insert other contributions or delete.

L84: It would be helpful for future researchers to include in the supplementary material not only year and title of Horton's work but also where the material can be accessed.

L102: I think the word "kettle" will be unfamiliar to many. May I suggest this be briefly explained or another term used.

L102: Please indicate the location of Hemlock lake system.

L113: Comment in parenthesis is incorrect. The citation to Horton was from Rohwer (1931) as noted in Table 1 of McMahon et al. (2016).

L305: The term evaporative capacity is used several times in Section 3.1 and in Section 3.3. I am confused by its use. (i) Is this a term used by Horton? If so, then that should be made clear in the presentation. (ii) While I appreciate it is defined clearly in Equation1(a), it is, in fact, the pan evaporation. Why introduce a new term? (iii) In L315, the term Evaporation capacity is used. Is there a subtle difference between "evaporation capacity" and "evaporative capacity"? Is one a function of V_w and the other a function of V_a? (iv) The definition in L320 appears similar to potential evaporation.

L314, "… in Sec 3": But this line is in Section 3.1. It seems to be referring to itself.

L314, "We provide revised values in Sec. 3 (Table 3)": This paragraph refers only to constant C. There is only one value of C in Table 3.

L315: "w.r.t": Suggest this be spelt out, and elsewhere in the manuscript.

L323, 324: To me, this sentence is particularly important and may not be appreciated by practitioners wishing to apply Horton's equation. To aid future applications, it would be very helpful if the authors were to add another section to the manuscript listing succinctly the steps in applying Horton's procedure to an evaporation pan and to small and large lakes.

Ls432,433: Clumsy sentence, needs rephrasing.

L438: Unclear what is meant by "… motivate the position …".

Ls503,505: In Equation (4a), why introduce another variable E_{cw} when it equals E_p, and thus $F = E_L/E_p$. By not introducing E_{cw}, the explanation would be less tortuous.

L514: "These relationships…". It's unclear which equations "These" refer to. Please clarify.

L593: Because Equation (8a) is the key equation in the paper, may I suggest the word 'lake' be inserted between "general" and "equation".

L594: Again, as Equation (8a) is the key equation, I recommend strongly that the suffixes be included. I had to go back through the text to ensue I understood which values of V and v were being referred to.

L646: This sentence needs redrafting. What does "… various shapes…" mean?

L660, Tables 1 and 2: Although Horton's equation exhibits the smallest bias in all cases, nevertheless, the bias for say one day is $\sim +16\%$, which is large. Could the authors put this value in some context with the level of bias expected from procedures other than the empirical one discussed in the paper. I don't know how widely empirical procedures are currently used in practice compared with other non-empirical procedures.

L683: Capitalize "h" in "How".

L693: "1,68,300" !!!

L699, Table3: (i) "H" should be "**â□□**" rather than "H" as the latter is used as Height in Equation 3. (ii) What is the time-step relevant to the H, K and C values. This comment applies to the other formulae, but it is less important to know that.

L734: I'm unclear why P and Q are included in Figure 2. The paper is about Horton's contribution to E.

I suggest P and Q be deleted from the figure.