



EGUsphere, referee comment RC2
<https://doi.org/10.5194/egusphere-2022-119-RC2>, 2022
© Author(s) 2022. This work is distributed under
the Creative Commons Attribution 4.0 License.

Comment on egusphere-2022-119

Anonymous Referee #2

Referee comment on "Probabilistic soil moisture dynamics of water- and energy-limited ecosystems" by Estefanía Muñoz et al., EGU sphere,
<https://doi.org/10.5194/egusphere-2022-119-RC2>, 2022

The manuscript 2022-119 presents an extension of a minimalist probabilistic soil moisture model by Rodriguez-Iturbe, Laio, Porporato and co-workers (hereafter, Laio's model). The point of departure is that Laio's model considers only water limited ecosystems and, as such, needs extension for enhanced generality. The extension is achieved by altering one of the original model parameters, that representing the evapotranspiration rate under well-watered conditions, $ET_{\{max\}}$, (apparently-see below) in two ways: via implementing the Penman-Monteith equation, to determine the reference crop transpiration; and based on an empirical radiation-transpiration relationship, derived from sub-hourly data.

I have some substantial concerns regarding the motivation of this work and the approach(es) followed.

1) As recognized in some lines of the manuscript (L173) but not elsewhere (e.g., L122), Laio's model does take into account the energy constraint, precisely via $ET_{\{max\}}$. With respect to other sensitivity analyses on $ET_{\{max\}}$, here a standard process-based model or an empirical relationship are used to explain variations in such parameter. But, in the end, in its current form, the manuscript appears a sensitivity analysis. Beyond the somewhat misleading framing of this work, all in all changes to the soil moisture balance due to different radiation levels are modest – something that was already concluded in Daly and Porporato (2006, Water Resources Research). Furthermore, neither Laio's model nor the proposed extension take into account the effect of extremely high soil moisture values.

2) More importantly, Laio's model is a stochastic soil moisture model, taking into account the randomness in precipitation timing and amount. Radiation fluctuates too, as also

apparent from the data used for the empirical relationship. This work appears not to consider this aspect in any way, despite considering daily data (from the sub-hourly upscaling). I find this incorrect. Moreover, a solution to this problem is available in Daly and Porporato (2006, Water Resources Research). If, instead, the point is to consider the average seasonal radiation, then this should be made clear when applying Penman-Monteith and would mean dropping the empirical radiation-transpiration relationship.

3) The relative role of Penman Monteith and the empirical radiation-transpiration relationship remains unclear. From my reading, it seems that one of them would suffice in reaching the goal of linking ET_{\max} to radiation (but see point 2 regarding a potential crucial difference).

I also found the manuscript difficult to follow. Aside from the role of Penman Monteith vs the empirical relation (see point 3 above), the structure of the text (and subdivision in sections and subsections) is not intuitive and there are many details reported that appear of low relevance to the questions at hand, or so well established not to require anything beyond a reference (e.g., Table 1 and 2; Appendix A and B). I also note that a large number of references are reported in support of rather general points (e.g., L120), where one or two well-chosen references would suffice and serve the reader better.

Finally, there are some misleading or incorrect statements. Examples are:

- L88: the definition of s

- L90: the fact that transpiration depends only on maximum stomatal conductance, where (as also apparent from Penman Monteith formula) transpiring biomass and leaf-atmosphere coupling play a role too

- L173 (see point 1 above)

- L239: the pdf of s is obtained under **stochastic** steady state, not steady state. This is an important difference

There are also few typos, e.g., lines 92, 137, 730 (and elsewhere).