Reply to Referee #2 interactive comment

We would like to thank Referee #2 for the constructive comments.

This is a well written paper with a clear contribution to ecohydrological modeling and I have very few comments. The first relates to the jargon in the title. Please try to simplify the title for the paper to be appealing to a wider audience. Secondly, the aims and objectives of the paper must be clearly formulated and also indicate what is new or novel about this study and who benefits from it? Lastly, what is the take-home message from this study given that no conclusions are given?
Thank you for the comments. We agree that our original title could be improved. Accordingly, the title of revised manuscript has been changed to "Model Representation of the Coupling between Evapotranspiration and Soil Water Content at Different Depths." We feel that this is more accessible to a broader audience.

In addition, we've revised the abstract and introduction to better emphasize the aim and objectives of the paper and provide a concise summary of major conclusion and the target readers with most potential interest are also highlighted in the abstract.

SPECIFIC COMMENTS
- Keywords: - "surface evapotranspiration" is listed as a keyword/phrase. Delete the word "surface"
Thank you for these comments. The keyword of "surface evapotranspiration" has been revised as suggested.

- Line 27 – indicate that some if the incoming energy is absorbed by the surface… given that you are mentioning biochemical cycles in line 30
To avoid this issue, we've removed all mentions of biochemical cycles in the manuscript.

- There are inconsistencies throughout the paper regarding the evaporation terms. A typical example is in lines 11 to 12 in the abstract where the authors refer to the sensible heat flux and evapotranspiration (ET) in the same sentence. Rather also use the energy equivalent of ET (i.e. the latent heat flux) and be consistent throughout the paper.
Thank you for this comment – we agree this was an issue in the original manuscript. In the revised version, the energy equivalent of ET (i.e., the latent heat flux) has been used consistently when also referencing sensible heat flux.

- Line 59: What is meant by ET entropy? This is not a standard micrometeorology or ecohydrological phrase. Please define such terms.
Thank you for the comments. The original expression of "corresponding ET entropy" refers to the entropy of a corresponding ET time series. This is clarified in the revised

manuscript.

- Throughout the paper rather use the phrase “soil water content” which is more specific than “soil moisture”
We’ve replaced the expressions of “soil moisture” with “soil water content” throughout the manuscript.

- Lines 63-64 not necessary
These two unnecessary sentences have been removed as suggested.

- Line 75 sounds rather cyclic, rephrase!
The sentence has been rephrased to “As described above, θ/ET coupling assessments made using AmeriFlux observations were compared with those using state-of-the-art LSMs including…”

- How did you account for the accuracy of the different types of soil water content sensors or their depth of installation across the AmeriFlux sites? How does this affect your results?
As the most of the AmeriFlux sites involved in the analysis are using frequency domain reflectometer probe for soil water content measurements, the impact of different sensors on our conclusion is limited.

Secondly, to minimize the effect of different measurement depths on our analysis, we designed three different cases to estimate vertically integrated soil water content (θ_V). Case I was based on the application of an exponential filter (Wagner et al., 1999; Albergel et al., 2008) to extrapolate θ_S to a consistent 40 cm bottom layer depth. Therefore, only θ_S was used to derive θ_V and the bottom-layer (or second layer) AmeriFlux θ measurement was neglected in this case. Nevertheless, since the quality of θ_V estimates is important in our analysis, we also calculated two addition cases where 0–40 cm θ_V was estimated using: 1) the bottom-layer soil water content measurement acquired at each AmeriFlux site (hereinafter, Case II) and 2) linear interpolation of θ_S and the bottom-layer AmeriFlux soil water content measurement (hereinafter, Case III).

The sensitivity of key results show that compared to the baseline Case I of exponential filter extrapolated 40-cm bottom layer θ_V, LSMs and GLEAM agree with AmeriFlux observations in that the overall fPET information contained in θ_S is slightly higher than that of θ_V. However, the sensitivity analysis showed this difference between NMI(θ_S, fPET) and NMI(θ_V, fPET) diminishes when using different methods for calculating θ_V using AmeriFlux observations. These experiments and their findings are clearly stated in the revised manuscript.

- The vegetation acts as the link between the atmosphere and soil water content in deep soil profiles. Please give more details on how the vegetation types affected your analysis/results.

Thank you for the comments. As mentioned in the response to the previous comment, in order to minimize the effect of different root depths from different vegetation types on NMI(θ_S, fPET) and NMI(θ_V, fPET), we used an exponential filter to extrapolate θ to a unified 40 cm bottom layer depth and find that the overall fPET information contained in θ_S is slightly higher than that of θ_V. However, the difference between NMI(θ_S, fPET) and NMI(θ_V, fPET) diminishes when using different methods for calculating θ_V using AmeriFlux observations.

The revised manuscript will contain significant new discussion regarding the role of vegetation on key results. In particular, Fig. 4 has been newly expanded to better isolate the impact of vegetation type and the role of vegetation types is now directly addressed via new text appearing in Section 3.3 of the revised manuscript.

Furthermore, we showed the result of NMI(θ_S, fPET)/NMI(θ_V, fPET) ratio as a function of vegetation type in Fig. A1. The conclusion that the overall fPET information contained in θ_S is slightly higher than that of θ_V does not vary with vegetation types, although NMI(θ_S, fPET) is much higher than NMI(θ_V, fPET) in open shrubland and woody savannas.

- Line 107: What is the bottom layer soil moisture measurement? Define this, else rephrase.
As soil water content measurements are generally available at two discrete depths at the AmeriFlux sites, the bottom layer measurements refer to the measurements at the deeper depth or the second observation layer from surface. This has been clarified in the revised manuscript.

- 2) options for θ factor for stomatal resistance (the β factor). Not clear what this represents. What is a theta factor? What does it do? - and reference soil moisture (m3 m-3), How is this defined? Confusion over symbols.
The θ factor stands for soil water content, and different expressions of θ lead to different representations of relationship between θ and stress factor β. We've revised the original expression to "…and schemes controlling the effect of θ on the vegetation stress factor β". As clarified in the revised manuscript, reference soil moisture is set as field capacity in the NOAH official users' guide for parameterization.

- Sometimes you mention stomatal resistance, and at other times stomatal conductance; line 142. Choose one and stick to it otherwise this easily gets very confusing.
As suggested, we've revised the only occurrences of the term "stomatal conductance" in Section 2.2 into "stomatal resistance" to avoid any confusion.

- line142 – stomatal conductance is not the sole driver of ET. It's more complex than that.
To avoid such confusion, we've revised expression as "The minimum of A_C, A_S and light-limited photosynthesis rates determine stomatal resistance r_s, and, consequently

affect the ET over vegetated areas".

- Please elaborate - Eqn 6: what does the symbol H mean here? Thought you said H was the sensible heat flux earlier?
In the original Eq. 6, H represents Shannon-type entropy of the variable ζ. Indeed, it could be easily confused with sensible heat flux symbol mentioned in Section 1. Therefore, we've replaced the symbol H in Eq. 6 with SE.

- Fig 4 these are poor model performances.
Indeed, the consistency of NMI(θ, fPET) between models and observations varies across different vegetation types, and varies across different models. However, it should be noted that the absolute value of NMI(θ, fPET) is not a direct index to measure model performance. Furthermore, our analysis conclusion will not be affected as we are using the relative ratio of NMI(θ_S, fPET)/NMI(θ_V, fPET).