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Hydrology and Earth System Sciences
Discussions

Interactive comment on "The pulse of a montane ecosystem: coupled daily cycles in solar flux, snowmelt, transpiration, groundwater, and streamflow at Sagehen and Independence Creeks, Sierra Nevada, USA" *by* James W. Kirchner et al.

Anonymous Referee #2

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The manuscript presents a comprehensive study of the hydrological cycle in two montane catchments in the Sierra Nevada, USA. The analysis uses a large dataset to explain how groundwater and streamflow daily fluctuations are dynamically related to transpiration and snowmelt daily cycles forced by solar radiation. A simple and elegant model is used to explain these relationships.

As I understand, the main result of the study is to have identified that in small catchments the links between the daily fluctuations of streamflow (Q) and both transpiration (T) and snowmelt are mediated by the groundwater storage in the riparian zone.

Therefore, the lags appearing between the daily cycles of streamflow and their forcing variables are not due to travel times, but are associated with the dynamics of the whole system with groundwater acting as a buffer that dampens and delays the response of streamflow. This shows that methods to estimate T (or evapotranspiration, ET) using series of Q are not feasible unless characteristics of the riparian aquifer are also known.

Although the manuscript addresses a topic certainly interesting for the readers of HESS, I found it extremely difficult to read. The manuscript is very verbose and I often found myself lost in long explanations about concepts that were not really of interest or strictly relevant.

Therefore, my suggestions and detailed comments listed below are mainly directed to shorten and hopefully improve the readability of the manuscript.

- Title: already the title seems long. Could it be shortened into something like "The pulse of a montane ecosystem: relating daily cycles of hydrological variables".

- Abstract: this is also very long. I would try to shorten it to make the key messages of the study clear to readers.

- Line 31: "...transiently achieves mass balance." This is not clear to me. The mass balance should be always satisfied.

- L34: I would not use here "time constant", because that related to the simple model presented in Eq. 5, which assume τ to be constant to obtain an exact solution of the equation. However, as I understood reading the manuscript, the riparian aquifer might have a response time that is not constant.

- L90-91: is integro-differential the correct term here?

- L108: I believe that the WTF method as defined by White (1932) did not account for Q because the observations were done in a desertic environment where Q was not relevant.

- L129: Gribovszki

- Section 2.1: I would erase the pronunciation of the catchments and historical information that is not necessary to understand the analyses presented later on in the manuscript. I don't think information about potential evapotranspiration is provided for the catchments, and rainfall and temperature are not given for the Independence basin. It would be good if the description of the two catchments followed the same structure to facilitate the reading. L191-195 can be erased.

- Section 2.2: a lot of details can be removed (e.g., precise location of gages). A lot of this information is already in Fig. 1 (latitudes and longitudes could be reported in the figure or tables instead of the text). I would move the description of the sapflow measurements (L232-239) at the end of this section. At the moment, the description starts with weirs and bores, switches to sapflow, and then goes back to bores. L241-245 can be erased.

- L256: "To account for the combined..."

- L345-346: I do not think it is correct to say that solar radiation drives streamflow and groundwater fluctuations. There is an indirect relationship, as also stated at L557-558.

- L385-389: it is not really clear what an integro-differential system is in this context.

- L390-415: this part is rather long and it seems that is repeated more precisely after Eq. 5. I would just introduce Eq. 4, say that Q is assumed to be a linear function of S (i.e., $Q = f(S) = S/\tau$) and then write Eq. 5. I would avoid mentioning that the solution is well known (erase L434) and provide the solutions in Eq. 6. I think it should be better to say that it is assumed that the period considered is without P; I do not think it is reasonable to assume P with a daily cycle as M, G, and E. Should there be a mention of the initial conditions for these solutions? I understand that the point is to look at cycles and the initial transient is not important; however, in Fig. 7, I found it strange that the initial values of Q were different.

- L460-479: I would erase this part. In most cases the inversion of the Fourier transform will be done numerically; therefore, one can just solve Eq. 5 numerically to start with. The point about the lags is clear from Eqs. 6 and their discussion.

- L501-504: the references to the lines in Fig. 8 do not seem correct.

- L572-573: I would erase this phrase.

- Subsection 3.5: I am not sure this is so important to deserve a full subsection.

- Subsection 3.7: I do not think this subsection is really necessary. I found that it was not adding much to what already presented and supported by the data. I would recommend to cut this part out.

- L724-725: the mismatch between the peaks in radiation and sapflow is not surprising. Vapor pressure deficit (VPD) is usually the variable that mostly drives transpiration, and I believe that VPD would likely explain the timing of the transpiration peak during the year (that's because there appears not to be water limitation).

- L773: I would use "changes in storage" instead of "mass balance".

- L779-781: erase?

- Figures: the captions of most figures are very long. Because the figures are explained in detail in the text, I would try to reduce the length of the captions, where a brief description of what the figures show should be enough.

- Figure 2: this figure is repeated in a different format in Figs. 11, 12, and 14. I would have these data in a single figure without repetitions.

- Figure 10: if Subsection 3.5 is reduced or removed, perhaps this figure can be removed as well.

-Figure 11: because sapflow and groundwater are related in this figure, I wonder whether it would be better to report the depth to the water table from the surface to

show that the water table is within reach of the root system. In the caption, it is said that signals were detrended but it is not explained how.

- I would consider removing Figs. 13 and 14 along with Subsection 3.7.

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