Hydrology and Earth System Sciences Discussions

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Reply on RC1

Yong Chang et al.

Author comment on "Using LSTM to monitor stormflow discharge indirectly with electrical conductivity observations" by Yong Chang et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-77-AC1, 2022

Thank you very much for the valuable comments.

MAJOR

- Title/Premise: The authors present the application of a statistical approach (LSTM) to calculate discharge during rainfall events from EC observations. The title (Using LSTM to monitor continuous discharge indirectly with electrical conductivity observations) might perhaps mislead the reader, as certain time periods (low flow, initial runoff) are clearly excluded from the analysis. A more fitting title would be: Using LSTM to monitor STORMFLOW DISCHARGE indirectly with EC observations.

Response: Thank you. This is an excellent suggestion. We will change the paper title accordingly.

- The performance of a model using EC only is compared to models using both EC and P and only P. It might be interesting to compare the selected model to a more simple approach, to really highlight the added value of a more complex model.

Response: In the manuscript, we have compared the LSTM model to a simple linear regression model (see lines 189-191 and figure 3b). The regression model shows much worse performance than M_{EC}.

- 20: In your abstract in line 20 you write that in your spring EC always has a negative correlation with spring discharge. However, in line 126-130 you mention that there is occasionally a positive correlation (EC peak at the initial runoff).

Response: Thanks. We will revise line 20. The spring EC always has a negative correlation with spring discharge in most times.

- 23-25: "LSTM results indicate that the spring discharge can be predicted well with EC, particularly in storms when the dilution dominates the EC dynamic; however, the prediction may have relatively large uncertainties in the small or middle recharge events." It seems the findings of your study do not support this conclusion at all. As I understood, spring discharge could ONLY be predicted well for large storm events; there are large uncertainties when it comes to intermediate and small events and it was not possible at all to use EC for the estimation of baseflow/low flow. So, one might conclude that overall spring discharge can actually not be predicted well.

Response: We will further revise the sentences. Actually, most spring discharges including the baseflow under large storms can be well predicted by EC. This can be seen in Fig.4 that M_{EC} has a large NSE value in storm events. In the manuscript, we define the discharge in the storm event as the period from the end of the last recharge events to the beginning of the next recharge events. It is also possible to predict the discharge under intermediate events but with a large uncertainty compared to the predictions under storm events. It is true that it was not possible to use EC for the estimation of low flow since a low correlation between EC and discharge in the small recharge events. Although this drawback, our approach is still promising because the discharge dynamic under storms or intermediate recharge events is the key information for flood management or understanding the behavior of hydrological systems combined with other hydrochemical indices.

- 130: It is unclear why a there is a need to correct the maximum EC values in 2017 to match them with 2018 and 2019. Please elaborate why the maximum EC should be the same in all years.

Response: The hydrochemistry of the studies spring is mainly controlled by the dissolution of carbonate rocks. The maximum EC of the spring water corresponds to the calcium carbonate equilibria. Meanwhile, the spring locates in the phreatic zone and its most hydrochemical indices, such as temperature, pH and EC,basically do not show obvious seasonal variation according to the previous monitoring. Therefore, the maximum EC of this spring is always relatively stable in different years. Given two different data loggers were used to monitor EC in 2017 and the other two years, it is reasonable to assert that the discrepancy in maximum EC between 2017 and the other two years is mainly caused by the instrumental drift.

We will add these clarifications in the revised version.

- 130: You corrected for drift of the sensor by subtracting 23μS/cm. Please elaborate why you choose this specific value. Also: A simple subtraction of measured EC does not adequately account for gradual drift.

Response: The selection of 23 μS/cm is based on the assumption that the maximum EC value in the 2017 is same to that in the other two years. Actually, although the maximum EC of spring water is relatively stable without an obvious seasonal variation at the study site, the maximum EC value may still have a slight variation. In the revised manuscript, we will add another plot to show the variation of the simulation result of M_{EC} with the different EC adjustment values in test period 1 to further illustrate the uncertainty caused by this drift adjustment.

- 424: You elaborate that the EC dynamics of the investigated spring are relatively simple without temporal EC peaks at the beginning of storms. However, in line 126-130 you describe that you found indeed initial EC peaks at the beginning of storm events in your 2018 and 2019 data and you state that you excluded these observations from your analysis.

Response: I will further revise the sentence.

- 426: To my knowledge, the cited paper of Hess and White (1993) does not give any reference to “piston flow”, it doesn’t mention the words ‘piston flow’

Response: Thanks. There is a mistake here. The cited reference is a paper published also by Hess and White (1988) in which they found the phenomenon that the spring EC may rise firstly before beginning to drop during the storm. The ‘piston effect’ was named by Goldscheider and Drew (2007) in the book <Methods in Karst Hydrogeology>. We will add this reference in the revised version.

MINOR

83 –geographical coordinates of the spring might be useful

Response: We will add the geographical coordinate.

83-91 citation might be useful

Response: We will add the relevant references.

Figure 1a: labels in map are too small to read

Response: We will increase the label size accordingly.

120 -121: “the spring`s EC dynamic is MAINLY controlled by the rock dissolution and the dilution from the low-EC event water during storms.” – what other minor influencing factors are there?

Response: The spring EC may also slightly influenced by the concentration variation of some other irons during storms, such as K^+, Na^+, Cl^-, and SO_4^{2-}.

133: wrong unit: 23us/cm -> 23μs/cm

Response: Thanks, we will revise the unit.

170: “LSTM belongs to a special kind of recurrent neural network” – I suggest different wording

Response: Revise to ‘LSTM is a special recurrent neural network’.

253: “The performances of MP and MECP deteriorate obviously probably due to …” – obviously or probably, which one is it?

Response: Revise the sentence to ‘The performances of MP and MECP show an obvious deterioration which is probably due to…’.

Figure 3e: red line in legend is missing

Response: Thanks, we will update the legend.

285: wording: middle -> intermediate

Response: Thank you. We will change ‘middle’ to ‘intermediate’ in the revised version.

Reference:

Hess, J. W., & White, W. B. (1988). Storm response of the karstic carbonate aquifer of southcentral Kentucky. Journal of Hydrology, 99(3), 235–252. https://doi.org/10.1016/0022-1694(88)90051-0

Goldscheider, N., & Drew, D. (2007). Methods in karst hydrogeology: IAH: International contributions to hydrogeology (Vol. 26). CRC Press.