Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., author comment AC3
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Reply on RC1

Klaus Eckhardt

Author comment on "Technical note: How physically based is hydrograph separation by recursive digital filtering?" by Klaus Eckhardt, Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-186-AC3, 2022

Reply to comment 1:

A precise distinction must be made as to which delay is being referred to. In the publication of Furey and Gupta (2001), d stands for the number of time steps between precipitation and groundwater recharge and not for the number of time steps between precipitation and the exfiltration of baseflow. Baseflow in the current time step is calculated from the groundwater recharge in the previous time step, among other things. Hence we have: time steps between precipitation and baseflow = d time steps between precipitation and groundwater recharge + 1 time step between groundwater recharge and baseflow. The statement that baseflow occurs in the same time step as precipitation thus means d + 1 = 0 or k - d - 1 = k - (d + 1) = k.

I suggest to replace the lines 94 to 100 in my text as follows:

In deriving their filter equation, Furey and Gupta (2001) assume that the baseflow in the current time step is a function of baseflow and groundwater recharge one time step in the past (their Eq. (10)). Further, they assume that the groundwater recharge is delayed by d time steps compared to precipitation (their Eq. (11)). In their model of the emergence of baseflow, the number of time steps between precipitation and baseflow is d + 1: d time steps between precipitation and groundwater recharge + 1 time step between groundwater recharge and baseflow. Hence, the index j – d – 1 in Eq. (4) or k – d – 1 in Eq. (5).
If instead it is assumed that baseflow occurs in the same time step as groundwater recharge and groundwater recharge is not delayed to precipitation, in other words, if it is assumed that the delay between precipitation and baseflow is smaller than one time step, then d + 1 = 0 and thus k - d - 1 = k - (d + 1) = k. Equation (5) is then

Reply to the comment 2:

It is true that this point should be critically questioned. However, I cannot and do not want to go into it in depth in this technical note, which only deals with the comparison of two algorithms. Just two notes on this: (1) I have since corrected my text to the effect that I no longer equate baseflow with exfiltrating groundwater alone, see my reply 2 to CC1. (2) When I write that the generation of baseflow still occurs in the same time step as precipitation, this is a statement entirely within the framework of Furey and Gupta's (2001) modelling of how baseflow occurs. I am merely pointing out a difference to the

algorithm of Furey and Gupta (2001). To what extent this algorithm itself accurately reflects reality is another question.

In my reply to CC2, I have already made a suggestion on how to replace lines 121 to 124. I modify this suggestion as follows:

Furey and Gupta (2001) introduced the parameter d in Eq. (5) as the number of time steps between precipitation and groundwater recharge. A sensitivity analysis they conducted showed that the filter performance was "relatively insensitive to changes in d" so that d = 0 seemed to be an acceptable choice. Furthermore, when using Eq. (1), it is assumed that not only the groundwater recharge but also the generation of baseflow still occurs in the same time step as precipitation. When assessing this prerequisite, two aspects should be considered:
(1) The streamflow component calculated with Eq. (1) is usually likely to consist not only of groundwater, but also of transient water sources, including interflow (Cartwright et al., 2014; Yang et al., 2021).
(2) In this publication, the algorithm of Eckhardt (2005) is compared to the model ideas of Furey and Gupta (2001) on the formation of baseflow, not to the reality. If the baseflow calculated with Eq. (1) occurs in Furey and Gupta's model world at the same time step as precipitation, this does not necessarily mean that it also corresponds to a runoff component in the real world that occurs without a relevant time lag to precipitation.