

Hydrol. Earth Syst. Sci. Discuss., author comment AC2  
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## Reply on CC1

Alban de Lavenne et al.

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Author comment on "Quantifying multi-year hydrological memory with Catchment Forgetting Curves" by Alban de Lavenne et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-331-AC2>, 2021

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Thank you for your positive feedback. I think we fully agree with your description of what we have done in this paper. We also agree that for a more complete understanding of the system, the water volume would need to be tracked somehow. However, tracking a water volume from the moment it enters the system to the moment it gets out is not exactly what we aimed to do here. We had maybe a more modest ambition that we would like to remind just to avoid confusions. We used this name "forgetting curves" in order to avoid calling them "travel time distribution" deliberately for this reason. We preferred to use dimensionless variables (and anomalies), because we rather aim to describe catchment behaviour (in terms of Q/P) and for how long one climatic anomaly could affect this behaviour. We believe there is an interesting distinction to make here that we aimed to emphasise with the distinction of "water age" and "catchment memory" in the introduction. We would expect the age of the water to be much longer than what we have described here.

Apart from this limitation, we agree with you that quantifying the water storage (using a water balance model or antecedent precipitation index) is a key question. It might bring further physical understanding behind these "forgetting curves", or at least a more easily understandable variable than P/E<sub>0</sub> ratios. Despite this conceptual description without any physical processes, we believe it provides an interesting understanding of catchment behaviour with a rather simple approach and a limited data requirement.

Below is our response to the other three points you raised:

- We chose the gamma distribution mainly for this reason (instead of a lag and route approach for instance). Its flexibility during calibration allows having a zero value at year 0 (it happens mostly in France) or to have this shift to the left with a non-zero value at year 0 (it happens mostly in Sweden), as in Figure 3. So, it's not due to the discretisation of the year, but it's rather because we looked at this distribution only between year 0 and year 5 (although it can be defined for any value, even negative.). It is then rescaled to sum up to 1. We will better explain that in the revised version.
- Thank you for pointing this, the objective function was missing in the description of the calibration. As the model estimates the anomalies of Q/P for each year, we simply used the RMSE of these anomalies.
- It is true that the complexity of this algorithm is probably not necessary to calibrate a single parameter. We have kept this strategy mainly for consistency between the calibration of Eq 1 and Eq 2 (where PSO is useful for calibrating the gamma distribution). The calibration of Eq 1 is simply a linear regression between the Q/P anomalies and the P/E\_0 anomalies that we have classically fitted by minimising the RMSE, but other methods could have been used.