Reply on RC2
Alban de Lavenne et al.

Author comment on "Quantifying pluriannual 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-AC3, 2021

Thank you for taking the time to review our paper and for all your remarks. As we wrote to the previous reviewer, we will answer the main remarks here and address the detailed comments when preparing the revised version.

Vocabulary

- “multi-year” is effectively more common in the literature, we just found "pluriannual memory" in comparison to “annual memory” easier to read. But we want to describe the same temporal aspect. “Multi-year” will be preferred in the next version.

- In Figure 5, we have divided the catchments with significant memory into two subgroups of equal size (short memory and long memory). In doing so, we have sought to refine the analysis of catchments with multi-year memory. However, the vocabulary in the introduction to the document can be confusing. In the next version, we will better distinguish between seasonal memory, short multi-year memory and long multi-year memory.

Water use and regulation
We have tried to avoid dealing with human influences in order to focus (as much as possible) on the natural behaviour of the catchments. In order to qualify these influences, we refer to the two hydrological databases we used for this study (in France and Sweden) where some indicators are provided. The degree of regulation is the percentage of the volume of the mean annual flow that can be stored in reservoirs located upstream of the gauged catchment outlet. We agree that this type of indicator does not fully qualify all possible human influences on hydrology and we share this view on the importance of this topic. However, this issue is beyond the scope of this paper where we specifically try to exclude influenced catchments. We will make this clearer in the next version.

Influence of elevation and catchment area

As mentioned in the introduction, some papers explain catchment memory by catchment area. We have not been able to demonstrate this on a multi-year time scale, so we agree with the reviewer that small catchments may also have a long-term memory (we mention this point with the study by Tomasella et al. (2008)). The opposite relation between France and Sweden regarding the effect of catchment area underlines that even if a correlation could be found, catchment area is not a first-order determining factor of catchment memory. We simply use it in our graphs because it is a descriptor that is often used in the literature to understand catchment memory.

We were not able to demonstrate an effect of elevation on multi-year memory. The effect of snow accumulation is not even visible in Sweden where northern catchments (where snow accumulation is important) do not show longer memory than the south. If snow obviously impacts seasonal memory, it does appear as a driver of multi-year catchment memory. However, our analysis looks at each catchment descriptor one at a time enabling only first order relation. We will discuss further the effect of elevation that was missing in our literature review.

Time steps

The elasticity analysis is performed at annual time steps using hydrological years. Thus, "1 year" refers to all months between October 1st and September 30. We believe that this is a relevant time step to study multi-year memory. We do not use a moving average strategy. We have deliberately chosen not to use a finer time step, as we generally follow the idea of the common annual water balance analysis where
precipitation volume, precipitation and evaporation are assumed to be comparable. Seasonal storage dynamics are therefore not addressed by this study. It is discussed as a limitation/perspective of this work, as we believe that the proposed methodology could not deal with both memories at the same time.

**Link between memory and dry climate**

- The analysis shows that in dry conditions, catchment memory is longer. We do not think that it means that water storage is larger in dry conditions. We rather mean that in dry catchments, the hydrological behaviour is more impacted by past meteorological conditions, just because in humid catchments the wet conditions erase the impact of past conditions by “resetting” the storage states. We will make that point clearer in the next version.