Response to reviewer 2

We would like to thank the anonymous reviewer for his/her valuable comments and important insights into the manuscript. The reviewer raised three broad concerns:

There is heavy referencing especially at the introduction, which sometimes appears to be inadequate (see comments in attached manuscript). Also, some literature on uncertainty in hydrograph separation is missing.
P2L8-13, L15-17, L35-36: please remove some of the references. A good statement doesn't need more than 3 references for support...

We will try and optimize the number of references in the introduction section. Also, we will add references relevant to hydrograph separation in the revised manuscript.

Some work is necessary at section 2 (Model description and implementation) to add more clarify and structure to this section. It is hard to understand what the authors are doing here.
P4L10 (Section 2): Some serious work is necessary to add more clarify and structure to this section. It is hard to understand what the authors are doing here...

We will move some of the discussion in the introduction section about linear mixing problems (P2L19-31) to this section to provide a context behind the theoretical underpinnings of HydroMix. We will also modify text within the model description section to simplify the explanation in the revised manuscript.

Do you really need so many case studies? They make the paper long and heavy. If you don't need them to make your point, please reduce to 1 or two of them.
P7L13-15: Do you really need 5 case studies? They make the paper long and heavy. If you don't need them to make your point, please reduce to 1 or two of them...

The first case study evaluates whether HydroMix converges to the correct results in standard statistical tests. As also suggested by reviewer 1, we will modify the first case study into a benchmarking test to prove the validity of the new mixing approach. The second case study evaluates HydroMix using a conceptual hydrologic model and highlights a key deficiency in commonly used mixing approaches. The third case study shows how to account for the deficiency identified earlier. The fourth case study uses HydroMix in a real case study, with the fifth one showing the flexibility offered by this HydroMix to infer additional model parameters. We feel that it is important to demonstrate both the reliability and flexibility of HydroMix. We will make this clearer in the revised manuscript.

Responses to the specific comments are mentioned below:

P2L23-L31, P3L4-12: too methodological for an introduction

We will replace Eq. 1 with an in-line description and move the equation to the methods section in the revised manuscript. For P3L4-12, we will try and condense the discussion with the key insights from the studies, instead of providing a detailed explanation in the introduction.

P3L37-38: Some improvement is necessary to provide a proper state-of-the-art with more information on what was exactly done in the many references provided above. Also, here seems to be some missing literature on methods that quantify uncertainty of mixing models. There should be many of them as first studies have been published in the 90s already:
Genereux, D., 1998. Quantifying uncertainty in tracer-based hydrograph separations. Water Resour. Res. 34, 915–919. doi:10.1029/98wr00010

We agree with the reviewer that we have not done an exhaustive review of tracer-based hydrograph separation studies because hydrograph separation is only one of the common applications of mixing models used in hydrology. HydroMix is meant for applications beyond the classic hydrograph separation. However, we do understand that it might be useful to include studies spanning various hydrograph separation techniques and we will include a short overview of the same in the revised manuscript.

P4L30: The time lag only accounts for advection right? what about dispersion or retardation?

The time lag is meant to simulate advection, we assume that the source components are conservative in nature and do not account for dispersion as that lies beyond the scope of this paper. We will clarify this in the revised manuscript.

P4L42: these studies use the storage selection functions approach, which is somewhat different from the approach introduced here. How do they link to this list?

The time scale for subsurface flow strongly depends on the catchment moisture conditions. The studies cited (Benettin et al., 2017; Harman, 2015) show that the fraction of young water in streamflow depend on catchment moisture conditions, often referred to as the "inverse storage effect", i.e. there is more event water in the stream when catchment soil moisture is high. That is what we want to say. We will try and clarify this in the revised manuscript.

P6L29-40: This is a small state-o-the-art which rather belongs to the introduction. Please keep the methods section as clear as possible.

This section discusses the different approaches for inferring model parameters, which is why we mention this in the "*Parameter inference in a Bayesian framework*" section.

Reference:

Benettin, P., Bailey, S. W., Rinaldo, A., Likens, G. E., McGuire, K. J., & Botter, G. (2017). Young runoff fractions control streamwater age and solute concentration dynamics. *Hydrological Processes*, *31*(16), 2982–2986. https://doi.org/10.1002/hyp.11243

Harman, C. J. (2015). Time-variable transit time distributions and transport: Theory and application to storage-dependent transport of chloride in a watershed. *Water Resources Research*, *51*(1), 1–30. https://doi.org/10.1002/2014WR015707