Dear reviewer,
please check our responses to your comments (marked in blue). The final changes will be made to the manuscript at the stage of submitting revision later. Thank you!

RC2:

Overall, this is a nice contribution seeking to explore the impact of the slope of a hillslope transect on nitrate transport and export with the aid of numerical simulations. The analysis is developed using a coupled numerical model for water and solute transport, which also simulates water ages. The topic is of interest to the readership of HESS and I think the Ms could make a good addition to the literature. The text is in general well written and properly organized. However, there are a few limitations that I would like to emphasize in what follows.

I think this is not the first study to explore the impact of the slope of water ages using numerical tools (e.g. Zarlenga and Fiori, 2020), nor the first study to model the export of nitrogen in the context of water ages (van der Velde et al., 2012; Benettin et al., 2020) so I would better put this work in the context of the state of the art. Jasechko et al., 2016 should not be the only conerstone for this study, as it seems to be at times.

Response #1:

Thanks for pointing out that! We will correct the statements in the introduction and add the previous studies in the state of the art. This update will be made in the revised version of this manuscript.

The lack of empirical data to constrain the underlying model parameters is a little bit worrisome. I understand it is difficult to have a full comprehensive analysis of the uncertainty owing to significant computational times, but the authors should put more effort in demonstrating that their simulations are a r**easonable representation of the real world**. I would add more simulations under different scenarios in terms of model parameters, trying to identify how the results obtained in the paper could change if some settings of the numerical simulations are modified (e.g. profile likelihood, sensitivity analysis). A lot of parameters are simply assumed a priori.

Response #2:

Thanks for the suggestions. We will try to link our simulated nitrate concentration with the measurements, to show that they are comparable. We will add sensitivity analysis for the parameters (e.g., profile length). These parts will be updated during the revision.

The way evapotranspiration is treated in the transport model is not described in detail. This is a key process in this context (e.g. changes in the uptake depth of the roots might have a strong impact on the results in some cases) and more emphasis should be given

to describe how the numerical code models the green water.

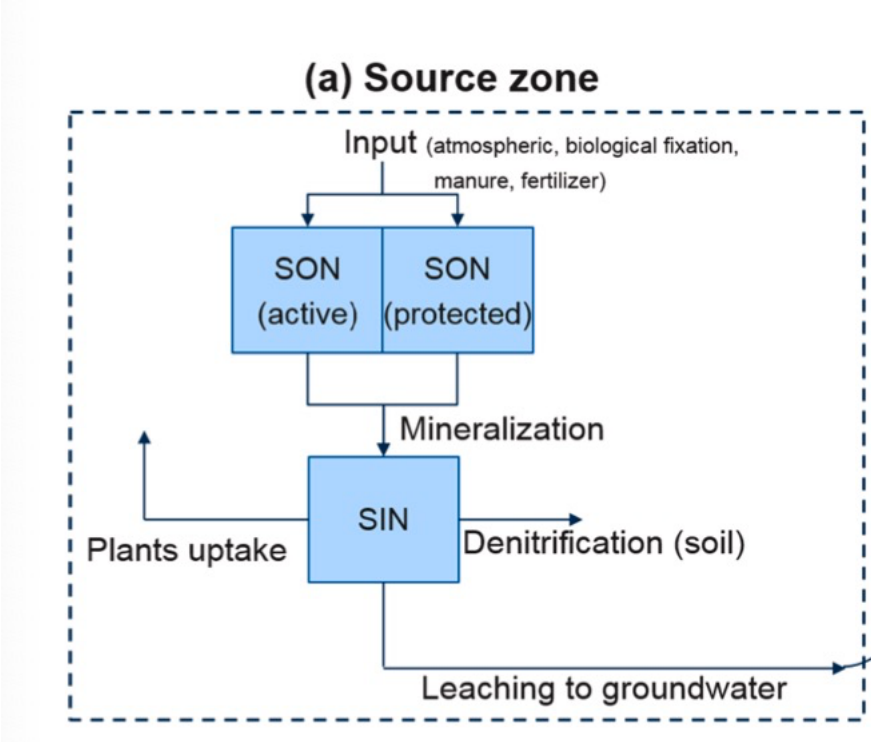
Response #3:

Thanks for the suggestions! We will clarify the computation of ET in the HydroGeoSphere model and add contents to describe the simulation of water flow. These updates will be made during the revision.

Nitrate is here described as a decaying solute, but I'm not fully convinced by the explanation given by the authors to justify their approach. In particular, I'm not sure that **biogeochemical processes** other than degradation that take place during the transport processes along the hillslope can be completely ignored (i.e. treated as an off-line mechanism that impacy only the initial condition C_J) especially if the solute export is the final goal of the study. More emphasis should be given to the export in the paper as compared to the "transport" issue.

Response #4:

Thanks for pointing out that! We used an approach of N source concentration curve, which force the N concentration in the rainfall to change along the curve at the moment of entering the soil. Using this approach the biogeochemical processes happened in the nitrogen source zone was ignored. This approach did cause mass imbalance of the system. To overcome this limitation, we will use a different approach, which has been used in the study of *Yang et al.,* 2021, to simulate the nitrogen fluxes in the soil, including the input, mineralization, degradation in soil, crop-uptake and leaching into groundwater (see the figure below). This approach will increase model complexity by introducing new parameters, however, ensure a mass balance. This work will be updated to the manuscript in our revised version.



Reference:

Yang, J., Heidbüchel, I., Musolff, A., Xie, Y., Lu, C.*, Fleckenstein, J.H. (2021). *Using nitrate as a tracer to constrain age selection preferences in catchments with strong seasonality*, Journal of Hydrology, 603, 126889.

Generalizability issues should be disccused more deeply. How these results might apply to other settings beyond the specific case study presented in the MS and the role of the 3D complexity of a catchment, which is not modeled here? Why do the authors believe their findings are general?

Response #5:

We agree with that! We will be very careful when descript our conclusion found in the specific case in a general way. We will also clarify that our study was based on the hillslope-scale and discussion the influences of the scale differences. This work will be updated to the manuscript in our revised version.

Minor points

96: a fairer chain of references here – especially if you talk about TTD of ET - should be Botter et al., 2010; 2011; Van der Velde et al., 2012; Rinaldo et al., 2015, Harman et al., 2015, 2019.
123-124: this seems to be somewhat speculative at this stage. Move to the discussion

and elaborate plz.
150: maybe “Climate” instead of “Climates”?
165: plz explain in the caption the motivation for the 6 shaded regions represented in panel b of the Figure
195-205: plz provide more details about the boundary conditions at the bottom of the domain.
260: not sure this is correct. Plz double check. Why a Deltat is needed from the physical viewpoint? This should be something in the continuous-time domain. Morevoer, the T should appear also on the r.h.s. of the equation (I see there is some text on this in the following lines but I would polish the expression a little bit to make it consistent with the existing literature).
Figure 4: mean should be intermediate here
Line 430: what about continuous instead of monotonous?

Response #6:
Thanks for the minor comments. They will be carefully responded and corrected correspondingly in our revised version at the stage of submitting the revised manuscript.