

Hydrol. Earth Syst. Sci. Discuss., referee comment RC2
<https://doi.org/10.5194/hess-2021-375-RC2>, 2022
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Comment on hess-2021-375

Anonymous Referee #2

Referee comment on "Effect of topographic slope on the export of nitrate in humid catchments: a 3D model study" by Jie Yang et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-375-RC2>, 2022

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.

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 could put more effort in demonstrating that their simulations are a reasonable 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.

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.

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 impacts 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.

Generalizability issues should be discussed 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?

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 Δt is needed from the physical viewpoint? This should be something in the continuous-time domain. Moreover, 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?