Responses to comments of anonymous reviewer #2 for manuscript 10.5194/egusphere-2025-372

This manuscript outlines the inclusion of dual-permeability, two-site kinetic deposition formula for microbial transport in HydroGeoSphere (HGS). I believe this topic is relevant and of interest to the readers of EGUsphere. The manuscript is generally well-written, with the inclusions of expected sections outlining the model development, validation and illustrative application, all written in a clear manner.

We would like to thank the reviewer for the time and effort invested in reviewing our manuscript. We would like to point out that the manuscript is a technical note and not a research paper - a mistake that happened during the submission process.

As presented, my primary concern relates to the novelty and contributions of this work. How does this differentiate from other subsurface reactive transport models available – why should someone choose to use HGS over these models? I understand that the primary feature of including these equations in HGS is the inclusion with an integrated hydrologic model as opposed to solely a subsurface model, but no part of this manuscript uses or highlights the benefit of an integrated approach over subsurface-only. The authors outline the equations that govern surface flow and transport, but the verification and illustrative application do not seem to utilize the surface domain at all. Perhaps it is simulated, but the results are not presented or discussed. I think this is critical to the contributions of this work – what does this newly developed feature provide that was otherwise lacking? Perhaps a comparison between groundwater-only simulations and the integrated approaches can help demonstrate the benefit of including these equations with HGS as opposed to solely a subsurface approach.

Given this concern is critical to the contributions and novelty of this research, I feel the authors need to make significant revisions before this manuscript can be considered for publication.

We agree that the novelty lies in the combination of dual-permeability, two-site kinetic deposition based microbial transport with an integrated surface-subsurface model that is capable of explicitly simulating reactive solute transport, for example of noble gas radioisotopes. The capability of the integrated model is demonstrated explicitly in the 3-D illustrative model, where both increased microbial and Helium concentrations in the surface water (here the river) are transported into and through the subsurface during a peak flow event. Indeed this could also be oversimplified into a pure groundwater model, as many users of single domain models would argue most situations that concern groundwater systems would allow. Our illustrative example nevertheless demonstrates the capability of the new implementation. While it isn't the purpose or aim of our manuscript to highlight the importance of using integrated surface-subsurface hydrological models in general - this has been demonstrated and reviewed extensively already elsewhere, e.g. by Paniconi and Putti (10.1002/2015WR017780) or Simmons et al. (10.1016/j.jhydrol.2019.124309) - we agree that an additional illustrative case can highlight the potential of the new implementation even better. In the revised manuscript, we will thus include an additional illustrative model based on an implementation of the Borden benchmark model by Gutierrez-Jurado et al. (10.1029/2019WR025041), which shows rainfall-runoff generation and also generates return flow from the subsurface to the surface. The model will thus illustrate not only microbial transport from the surface into the subsurface, but at the same time the inverse, which should

satisfy the desire of seeing a yet more complex situation that benefits from the application a fully integrated simulator.