Reviewer's comments for Guyumus et al. 2025: "HydroBlocks-MSSUBv0.1: A Multiscale Approach for Simulating Lateral Subsurface Flow Dynamics in Land Surface Models"

General Summary:
In this study, the authors present a novel approach to compute lateral subsurface flow across multi-scale (local, intermediate, and regional) using HydroBlocks coupled in NoahMP LSM. The simulations are setup in a 1deg x 1deg box in western Colorado for a 50-year long-term simulation to test the model efficiency in capturing spatial heterogeneity and temporal variability of the multiscale approach, compared to a high-resolution tiling (1.4 million tiles) for benchmarking. The results show consistent spatial distribution and high temporal variability of the multiscale approach with the high-resolution benchmark in capturing latent heat, sensible heat, soil moisture and runoff.

This novel approach tackles a challenging research problem to accurately represent subgrid heterogeneity and lateral subsurface flow, while also advance in computational efficiency, providing potential revenue towards large-scale/continental simulation. I recognize the substantial amount of work dedicated to this manuscript and accomplishment, but I do have a few comments to make, please see my comments below:

1. Although this study addresses the lateral subsurface flow for groundwater, the computation of local, intermediate and regional flow in Step4 and Step5 seems to add up to soil moisture for that particular layer and column. In particular in Step5, it seems the HydroBlock is only updating soil moisture content to NoahMP - does HydroBlock also update water table depth to NoahMP? That said, there isn't an explicit definition of water table depth (WTD) for each column, separating unsaturated and saturated soil moisture, from this scheme. This is important because the Richard equation would apply to the unsaturated zone while Darcy equation to the saturated zone.
2. In Step2, L223 "the number of RISFUs is determined by the parameter k chosen equal to 20". How is this k parameter determined for this domain? Does it depend on elevation variation? In this case, the domain elevation (Figure1b) exhibits large variation - what about running a simulation over the Great Plains region or along the Mississippi river, where elevation variation could be small and most resolving subgrid microtopography such as potholes, and the water table depth could be very shallow (close to surface)?
3. The performance of HydroBlock multiscale approach - how much does it depend on the resolution of the NoahMP column model? I could have missed it, what's the resolution of the NoahMP column model, is it the same as the meteorological forcing at 1/32 deg (roughly 3km). How is the model performance different from the original NoahMP column model at its own resolution? That said, is it possible to compare the simulation results (multiscale approach, benchmark high-resolution tiling, and original NoahMP grid), it would be curious to see if the multiscale approach improves the spatial distribution compared to the original NoahMP grid?
4. Last but not least, this study focuses on the impacts of resolving subgrid heterogeneity of soil moisture. The authors could also discuss the effect of better resolving this heterogeneity to influence land-atmosphere interactions in regions where groundwater is

shallow, topography heterogeneity is critical (river valley), see Barlage et al. (2021) “The Importance of Scale-Dependent Groundwater Processes in Land-Atmosphere Interactions Over the Central United States” (https://doi.org/10.1029/2020GL092171) and Zhang et al. (2025) “US Corn Belt enhances regional precipitation recycling” (https://doi.org/10.1073/pnas.2402656121) that connecting subsurface groundwater heterogeneity to soil moisture and atmospheric water cycle, precipitation recycling, etc., especially in convection-permitting atmospheric models.

Specific comments:
L134: This should be 2.2
Figure14c: It seems the multiscale and baseline are identical for LH, SH and R, while their difference is large for soil moisture. Are these because the range of the variable, the range for SMC is smaller while LH and SH range are large? Also want to make sure that HydroBlock is updating SMC to NoahMP and then LH/SH/R are computed from NoahMP (with updated SMC)?
L365: 3Results, it would be good for the authors to provide a table to summarize the three simulations conducted in this study - 3.1 homogeneous baseline run, 3.2 heterogeneous conditions run, and a high-resolution tiling benchmark run. I was a bit confused between the baseline and benchmark run. Also it would be good to present NoahMP results without HydroBlock (maybe in supplementary materials).
L530: Please add a clear definition of the root-zone soil moisture, is it 0-1m deep?