

## ***Interactive comment on “Development and evaluation of a variably saturated flow model in the global E3SM Land Model (ELM) Version 1.0” by Gautam Bisht et al.***

### **Anonymous Referee #2**

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Strength 1. The simulations derived from ELMv1-VSFM is compared with the different dataset and other simulations so that the performance of the model is expressed well. 2. They developed a method for subsurface drainage parameterization and its performance in estimating WTD in global scale is analyzed.

Weakness 1. Given that ELMv1-VSFM is  $\sim 30\%$  more expensive than the default ELMv1 model, the advantage of using a unified physics formulation is not clearly indicated in the paper. 1.1 The reason why they intended to unify the treatment of soil hydrologic processes should be stated. (c.f. Distinct representation for different flow domains, unsaturated zone, and aquifer, is more useful to represent dynamic interac-

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tions between the flow domains) 2. They use variably saturated Richards' equation to estimate WTD using the relationship of soil moisture-pressure head. Assuming proper soil type for each soil layer is critical for accurately estimating pressure distribution in the soil column, but their assumption (or investigation) about soil type in the soil column is not indicated. 3. Lateral movements in phreatic zone (aquifer) is not considered. The variably saturated Richards' equation is the form that can apply to 3-dimensional analysis, but this study uses the equation only for vertical flow in the soil column. 4. Why is a zero-flux boundary condition applied to the last hydrologically active soil layer when the water table is within the soil column? 4.1 Constant pressure head condition could be used as a bottom boundary condition to represent the water table located within the soil column. 5. The simulations derived from the newly developed model VSFM are evaluated by comparing with the simulations from PFLOTRAN. As a supplementary basis for model prediction performance, the authors use ILAMB score. For the details of ILAMB metrics and scores are not indicated on the paper, it is difficult to determine the performance of the model prediction skill with ILAMB score (How the ILAMB provides a comprehensive evaluation of predictions of carbon cycle states and fluxes, hydrology, surface energy should be stated). 6. The area of each grid-cell of ELMv1-VSFM is  $1.90$  (latitude)  $\times$   $2.50$  (longitude) and time-step is 30 min. Some indexes could be used to show that the variably saturated Richards' equation is converged well in that spatio-temporal scale (e.g., Peclet number). Plus, if the authors indicate what method (e.g., upwind difference scheme) they use to determine interfacial properties (e.g., hydraulic conductivity), their work will be better understood by readers.

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