Review of

IPA (V1): A framework for agent-based modelling of soil water movement

by Benjamin Mewes, Andreas H. Schumann
submitted to Geosci. Model Dev. Discuss.

Summary and recommendation to the Editor

This manuscript proposed a framework for agent-based modelling (ABM) of soil water movement. The proposed ABM was applied to simulate the changes of the soil moisture in soil columns with homogeneous and heterogeneous soils. The simulation results were used to compare with the cmf framework in a single soil column. The results show that the agent-based model performs well and that its results are comparable to the classical physical-based approach (cmf).

The traditional numerical modeling for soil movement involves computational-consuming processes. The proposed agent-based modelling framework gives an innovative and interesting simulation approach for soil water movement. Nevertheless, this manuscript does not provide sufficient information for readers, especially without agent-based modelling background, to understand the framework and follow it. In addition, the explanation of the rule set for layer agents should be enhanced as I mentioned in the following detailed comments. Overall, **I would recommend to the Editor acceptance of the manuscript after a revision**. Detailed comments/questions are listed below.

Comments and questions

1. Lines 9-10, since the newly developed agent-based model of soil movement is fully based on the known physical assumptions for percolation and water redistribution within the soil matrix, how can this model produce an unexpected outcome where the known modelling approaches fail, such as preferential flow?

2. In Section 2, a conceptual schematic of the definition of dynamic, static, global, and software agents and their interactions should help to understand the IPA framework.

3. In Figure 1, do the layers have a thickness?

4. For dynamic agents, with the same amount of water, the volume of the agent should be inversely proportional to density. Nevertheless, in equation 1, the radius, r, is proportional to density.

5. Page 3, line 30, how to apply equation 2 to IPA? How to calculate the saturation of layers and the surrounding porosity?

6. Page 4, line 11, how to define or calculate the angle, ϕ?

7. Is the Eq 3 based on Darcy's law? How?

8. Is the ks related to hydraulic conductivity?

9. In equation 4, the matrix potential can be in the same sign with the gravitational potential during the downward infiltration when the soil is dry in front of a downward wetting front.

10. How does the matrix potential link to the soil moisture?

11. Page 4, line 22, $\Phi H < 0$.

12. Page 4 line 22, line 27, page 5 line 23 and page 6 line 4, what are the differences between k, kf, Ks, ks?

13. Page 5, line 12, what is the "observing layer"?

14. Page 5, line 24, it should be "Eq 5".

15. Does Eq 5 represent the upper boundary condition?

16. What is S in Eq. 5

17. Page 6, line 11:,2.4 Scheduling should be 2.3 ....

18. Page 6, line 31: in Table 1, please define Qr, Qs, , , l, k0, and ks and how they used in setting up the agents. Are Qr and Qs residual water content and saturated water content? The unit of Qr, Qs might not be correct.

19. The unit of Soil Moisture in Figures 2 to 6, and 8 should be amended.

20. What are the computational times of the IPA and cmf for running the infiltration in the 1-m soil column?

21. Page 7, line 20-30, what are the differences between the layers 1 to 3 and subdivided into 10 layers with a depth of 10cm each (page6 line 23)? What is the thickness of each layer (Layers 1 to 3)?

22. Page 8, line 14, what is the pathfinding algorithm?

23. Page 9, line 8, how did the energy of the agents be calculated?

24. Figure 2, is the unit of the ticks still hours?