Interactive comment on "A consistent implementation of the dual node approach for coupling surface-subsurface flow and its comparison to the common node approach" *by* Rob de Rooij

Anonymous Referee #2

Received and published: 16 May 2017

R. deRooij (RdR) presents the dual node approach for coupling surface and groundwater flow including a comparison to the common node approach and other dual node approximations based on synthetic numerical experiments and also numerical measures (i.e. number of non-linear iterations).

I have two major points of concern with the manuscript. While I like and appreciate the effort by RdR to clarify general misperceptions and confusion of different common and dual nodes approaches, the manuscript reads more like a reckoning with numerical, hydrologic scientific software than a research paper. It is important to keep in mind

that we are dealing with a highly non-linear problem ultimately cast in discrete mathematics that a computer can understand. As such there will always be ambiguities and errors. For example, I was always wondering, how these models handle the following situation. Imagine the following thought experiment of model with a cell-centered grid, where the top layer is just under tension saturation. Adding an incremental amount of water will switch the pressure value at the cell center from some negative value to $\sim dz/2$. A dual node right at the land surface interface would switch from some negative value to ~ 0. In both cases surface runoff is initiated. Thus, there is something like a discontinuity in pressure due to the discrete mathematics, which will lead to errors under both excess infiltration and saturation conditions for both the dual and common node approach, which can only be resolved with very high spatial discretization. This can be nicely seen, in my opinion in the results of the numerical experiments presented here and have been shown before in publications related to the simulation of coupled groundwater-surface water flow and the development of integrated hydrologic scientific software. Looking at the results presented here, these types of problems are still not resolved by the proposed dual node approach, and probably never will be because of the limitations of discrete mathematics.

Therefore, because of numerical aspects, it is also not appropriate to compare directly the non-linear iterations for both coupling schemes. The common and dual node implementation are different discrete approaches that of course will exhibit different non-linear convergence, and, second, it is not clear from the presentation how the common node approach has been implemented by RdR.

My second concern is related to the RdR's dual node approach, which is not novel. As the author acknowledges himself that "Nonetheless, their [An, H., and S. Yu (2014)] approach is actually a properly implemented dual node approach practically similar to the one proposed in this paper." Thus, it appears that main contribution of the manuscript is the discussion of the difference between the common and dual node approach and clarification of some of the applied concepts in different scientific hydrologic software.

While I feel this is a valuable contribution to the scientific literature, the manuscript requires major revisions and a more objective discussion. After all, for example, figure 2 suggests that for coarse spatial resolution both the common and dual node approach are quite far off the reference simulation. But in the past ten years or so, model implementations improved and a spatial discretization of 0.5m at the land surface is rarely used in todays models that I read about.

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