Hydrology and
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Discussions

Interactive comment on "Forchheimer flow to a well considering time-dependent critical radius" *by* Q. Wang et al.

Q. Wang et al.

zhan@geos.tamu.edu

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Response to Reviewer #1: General Comments: 1. The manuscript deals with the modeling of well flow in the subsurface. It suggests a modification of the dual domain (Darcian and non-Darcian) approach developed in the past by adopting a time dependent critical radius, which delimits the two regions. The manuscript is well written and organized, and the topic is of potential interest for the HESS reader. Reply: Thanks!

2. The innovation brought by this contribution can be considered as incremental; the method is interesting but it mainly brings some fine-tuning to the otherwise known two-region approach. Thus, I believe that the contribution is more suited to a technical note rather than a full paper. This is also somewhat suggested by the nature of the discus-

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Interactive Discussion

Discussion Paper

sion, the figures and the conclusions; most of the items reproduced in the conclusions seem rather a technical check of the model rather than a novel finding. Reply: We have changed the manuscript as Technical Note.

Specific Comments: 1. It is still unclear to me why a single non-Darcian region should not work well within the entire domain. When the velocity is low, the inertial term is small and the model approximates the Darcian one. This issue is briefly touched in the Introduction, but it is not adequately discussed in my view. This point raises a question mark about the usefulness of the two-region approach, as well as the present contribution. Reply: We have added more explanation (see P8 Lines 1-3 and Lines 15-20; P9 Lines 1-3). In addition, the results show that the difference between the single non-Darcian region model and the two-region model is obvious even at late stage (see P8 Lines 1-3), as show in Fig. 4b.

2. The advantages of the method are not fully clear. What are the benefits in introducing a time variable critical radius? Is the method more accurate? This is not immediate as the conceptual model adopted (two distinct regions with two flow behaviors) is anyway an approximation. Reply: We have given some detailed explanations (see P8 Lines 15-20; P9 Lines 1-3).

3. The interested reader may want to know when the non-Darcian models are needed: can you please provide some values regarding head gradient or flux, as compared to the hydraulic parameters? Reply: The condition that non-Darcian happens depends on the critical Reynolds number, which is not only related to the head gradient, but is also related to the porous media properties (see P10 Lines 1-6). For instance, one can see from Eq. (1) that in addition to the Darcy velocity and viscosity of water, the characteristic grain diameter is also needed to calculate the critical Reynolds number.

4. Page 14100, line 20: Why Pec is set equal to 10? Reply: ReC has been changed to 100 to make sure non-Darcian flow happens (see P10 Lines 8-10).

5. Equation 2. The solution is given before having discussed the various approxi-

mations involved (fully penetrating well, homogeneous and isotropic formation, etc.) Reply: We have given the conditions for Eq. (2) (see P10 Lines 17-18).

6. Choice for beta in the examples: the value seems rather large to me; please provide a range of realistic values for it. Clearly, a large beta overestimates the effect of non-linearity in the flow solution. Reply: We have explained this point (see P13 Lines 3-10, P14 Lines 13-15).

7. Is the convergence of the method always warranted? Reply: The answer is yes (see P18 Lines 4-7; P19 Lines 9-10).

8. Figure 4. The sudden change of slope and regime in the drawdown regime (two region models) look rather unrealistic, and it indeed reflects the two-region conceptual model that is adopted here. Same for Fig. 7. Can the Authors provide a sound physical justification of such behavior, beyond the model adopted? Reply: We have given the explanations on this observation (see P20 Lines 11-14).

9. Line 14110, line 24: the choice for beta is important; please better explain your choice, beyond the Wen et al. citation Reply: We have presented the explanations for this point (see P13 Lines 3-10; P14 Lines 13-15).

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 14095, 2013.