Hydrol. Earth Syst. Sci. Discuss., 12, C4808–C4811, 2015
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Hydrology and Earth System Sciences
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Discussions

Interactive comment on "A parsimonious analytical model for simulating multispecies plume migration" *by* J.-S. Chen et al.

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Received and published: 11 November 2015

Please note. Authors' responses follow immediately below the reviewers' comments. This is a nice piece of work advancing the multispecies plume (2D) migration from an analytical standpoint. The literature review is almost complete and through, the mathematical model is based on a technique developed by the same author (Dr. Chen) in 2012, but with substantially new materials and a physically based boundary condition (third-type or Rubin type) and extension to 2D. The solutions have been compared with carefully designed and proved numerical solutions. The examples used in the paper are relevant to actual applications and the details of all the derivation and programming are nicely documented. The figures are also well presented. The paper is well written

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and easy to follow. The following revisions are necessary to improve the quality of the paper.

1. I think the title has to be changed. First of all, the word “parsimonious” should be deleted (as it is not parsimonious to me at all). Also, the author may want to add “two-dimensional” in the title as the problem investigated is 2D in nature.

Response: Thanks for the constructive comment. This study present a novel analytical model with a parsimonious mathematical expression for describing multispecies plume migration. The concentration of arbitrary species can be directly evaluated from the unique mathematical expression. The parsimonious mathematical structures of the analytical are easy to code into a computer program for implementing the solution computations for arbitrary target species. This is quite different from previous analytical models in literature that generally used a distinct mathematical expression for distinct species of a decay chain. Thus, we think the word “parsimonious” can reflect the mathematical expression of our compact solution. The title is thus changed to as suggested “A parsimonious analytical model for simulating two-dimensional multispecies plume migration”.

2. I also think the use of “verified” or “verification” is inappropriate. A numerical solution cannot be used to verify an analytical solution per se, as it itself may involve the potential (and sometimes hidden) numerical errors. I think a better word is “compared” or “comparison” instead.

Response: Thanks for the constructive comment. We fully agree that the analytical models are used to verify the numerical model. Thus, we have replaced “verified” or “verification” with “compared” or comparison.

3. Despite the fact that the authors have done a careful review of the previous studies. Some important references are still missing. For instance, the paper of “Mieles, J., and Zhan, H., Analytical solutions of one-dimensional multispecies reactive transport in a permeable reactive barrier-aquifer system, Journal of Contaminant Hydrology, 134-

HESSD

12, C4808–C4811, 2015

135, 54-68, 2012. doi: 10.1016/j.jconhyd.2012.04.002" is closely related to this study and is a reference that should be included. The study of Mieles and Zhan (2002) dealt with the multispecies transport in a permeable reactive barrier (PRB)-aquifer system, with similar use of the third-type or mixed type boundary condition and other boundary conditions and the technique of Laplace transform.

Response: Thanks for the valuable comment. Indeed, these are very important references. We have included these references in the revised manuscript.

4. In equations (13)-(15), there are a number of parameters introduced without explanation. Although the authors explained them in the Appendix, I still think it is necessary to explain a few key parameters in the main text. For instance, the and terms, et al. Otherwise, it is difficult to follow the mathematics.

Response: Thanks for the helpful suggestion. We have these parameters explained in the main text for better readership.

5. In section 3.3, the author mentioned three verifications at the first sentence, but then only discussed two cases in the first and second paragraphs. The third case is only mentioned from the third paragraph. It should be revised. I suggest moving the first sentence of the third paragraph "The third verification example is : : :." to the first paragraph of section 3.3.

Response: Thanks for the constructive comment. The first sentence of the third paragraph of section 3.3 is move to the first paragraph of section 3.3.

6. For the FORTRAN program, what type of FORTRAN program? (FORTRAN 95?). Also, since the summations terms involved (M and N) are so large for some cases, how long is it going to take for the program to generate the result? (CPU time? PC or Workstation?) This type of information should be mentioned for the application of the method.

Response: The computer code is written in FORTRAN 90 language with double pre-

HESSD

12, C4808–C4811, 2015

cision. The computation is not time-consuming. The computational time for evaluation of the solutions at 50 different observations only takes 3.782s, 11.325s, 23.95s and 67.23s computer clock time on an Intel Core i7-2600 3.40 MHz PC for species 1, 2, 3, and 4 in the comparison of example 1. We have added the discussions on the computational time in the revised manuscript.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 8675, 2015.