EGUsphere, referee comment RC1
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Comment on egusphere-2022-1262

Paolo Benettin (Referee)

Referee comment on "mesas.py v1.0: a flexible Python package for modeling solute transport and transit times using StorAge Selection functions" by Ciaran J. Harman and Esther Xu Fei, EGUsphere, https://doi.org/10.5194/egusphere-2022-1262-RC1, 2023

The paper by Harman and Xu Fei is a great contribution to the field of hydrology and solute transport. The software they describe in the manuscript is well packaged, fully-documented and it is flexible to several possible user needs. The code is shown to provide accurate numerical solutions against meaningful benchmarks. The paper clearly illustrates the model capabilities and provides the readers with novel benchmark analytical and discretized solutions. I only have minor suggestions for improvement; therefore, I am glad to recommend the paper for publication on GMD after minor revisions.

Minor points

- Unfortunately, I was not able to install the latest version on any windows machine. I tried many times to conda-install mesas on a fresh, base Anaconda environment, but I got environment inconsistency problems. Conda automatically iterated over previous mesas version and the first version that it was able to install was version 0.2021.0909. It would be great if this issue could be checked before the paper is accepted.
- The authors stress in the abstract that the mesas implementation "*provides a 15x reduction in mass balance errors compared to a previous implementation of SAS*" (i.e. the tran-SAS implementation). While this is true, it also seems to be an unbalanced selection of the results, since for other metrics and parameters the difference is not always as large. Figure 3e shows that the difference between the two implementation is the largest for k=1, but there are also values of k for which the two implementations have identical performances. There is no doubt that mesas is generally more accurate than the Euler-Forward-based implementation of tran-SAS, but I think it would be fair to: 1) compare the computational times in addition to the numerical accuracy; 2) if possible, make a comparison with the higher-order implementation of tran-SAS.

Detailed comments

29: “sophisticated”, I am not sure how to interpret this word in this context

46: here it is mentioned that “*solute/tracer storage and outflow rates as part of the solution, not through a subsequent convolution integral*”, but I find this sentence possibly inaccurate. Solute storage rates do not need a convolution integral while for solute outflow rates it seems to me that equation (13) is in fact a convolution-like equation.

114: In some circumstances, small quantities of chloride can be taken up by plants, so I would not assume the concentration in the evapoconcentration “must” necessarily be 0. See Xu, G., H. Magen, J. Tarchitzky, and U. Kafkafi (1999), Advances in chloride nutrition of plants,Adv. Agron.,68, 97–150, doi:10.1016/S0065-2113(08)60844-5

150—156 (Eq 15—17): I don’t get the notation using the delta symbol δ instead of the traditional *d*. Why can one not jump from Eq. (15) to Eq. (17) simply by diving by dT?

182: “*The accuracy of the results obtained this way may be poor*”. Can you expand on why? A user would want to understand this.

183: I’d suggest to remove “*Uniform*” from the section’s title because one may be induced to think that there is a uniform CDF available in the code

Table 4 is very useful

368-378: In figure 1r the error seems to be nonstationary and fast-growing. Perhaps a longer simulation test is needed in this case to quantify the correct error magnitude.

398 (Figure 2): I find it a bit confusing to present in the same figure a benchmark comparison and a demonstration of the model solution for different parameters. I recommend to separate these subplots into different figures.

Technical corrections & Typos

40: implementation

103: for clarity, consider spelling out C_Q instead of starting the sentence with “it”

141: whose with

171: Sm

Table 2 and 3: these different tables have the same caption: is this on purporse? If yes, perhaps it will be good to rename them to 2a and 2b upon article production

Figure 3: There are no subplot indices a), b) etc… in the figure.

Figure 3 caption: “an high-accuracy”