Earth System
Dynamics
Discussions

# *Interactive comment on* "Fractional governing equations of transient groundwater flow in unconfined aquifers with multi-fractional dimensions in fractional time" *by* M. Levent Kavvas et al.

**Anonymous Referee #1**

General comments:

This paper deals with the theoretical study of deriving the governing equation of unconfined aquifer flow using Caputo fractional derivative approach. The derivation process is very clearly presented for the reader to understand. Including further discussion of the following is expected to further enhance the value of the fundamental research work.

Specific comments:

1) The paper needs to contain the minimum information of the numerical scheme needed to draw Figure 3. This will provide important information to persuade the paper's reproducibility. 2) The authors simulated a state after a very long time to draw Figure 3 (b). For integer cases, one can derive a simple steady-state analytical solution, as shown in Eq. 24. However, This reviewer is curious about what the fractional case might look like. It is necessary to include the authors' views on this curiosity. 3) Further discussion is needed about the time required to converge to a steady state. The time required will naturally be affected by the fractional order. 4) In addition to the head results, the authors need to explain the behavior of the discharge. In the case of integer cases, the discharge at steady-state can be derived analytically simply, but what happens in the case of fractional cases, and the effects of fractional order on steady-state discharge need to be discussed further.

Technical corrections:

Too many terms are given in eq. (15). Matching the order and number of terms in eqs. (14) and (15) will help readers better understand. Line 255: storage coefficient S = 0.2 popped out abruptly without any explanation, and the effective porosity Sy is missing a description of what value is given in the numerical analysis.

Interactive comment on Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2019-37, 2019.