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Discussions

Interactive comment on "A comparison of the modern Lie scaling method to classical scaling techniques" *by* J. Polsinelli and M. L. Kavvas

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This paper is very timely as we observe that the Lie scaling and scale invariance investigation method gets more attention from the researchers in the hydrological sciences. There was a need for such comparison and connection of this new method to classical scaling and similitude theorems. The paper clearly explains the similarities and differences, strengths and weakness of each method with various examples. I believe that there are still more room in the literature for such studies to investigate the Lie group methods and the comparison of Lie method to other scaling theorems in theoretical aspects, numerical simulations as well as physical experimentation.

Some comments are listed below:

The Buckingham Pi theorem is referred to Sedov (1993) and Bluman and Anco (2002). It should be cited directly to the original paper as follows:

Buckingham, E.: Notes on the method of dimensions LXXIX, The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, 42, 696–719, 1921.

The Lie group method is also used to investigate the scale invariance of kinematic wave overland flow problem in:

Haltas, I. and Kavvas, M. L. (2011b), Scale invariance and self-similarity in kinematic wave overland flow in space and time. Hydrol. Process., 25: 3659–3665. doi: 10.1002/hyp.8092

this paper should also be cited and in the Abstract section. The sentence: "This new method has been applied by engineers to several problems in hydrology and hydraulics including but not limited to groundwater dynamics, sediment transport, and open channel hydraulics." can be revised as:

"This new method has been applied by engineers to several problems in hydrology and hydraulics including but not limited to overland flow, groundwater dynamics, sediment transport, and open channel hydraulics."

In a recent paper by Haltas and Ulusoy (2015) the scaling behavior and scale invariance conditions of the hydrodynamic processes were investigated by applying the one-parameter Lie scaling transformation directly to the conservation laws in the Reynolds transport theorem framework. This study revealed the physical sense of Lie scaling transformation on hydrodynamic processes by scaling the three dimensional infinitesimal control volume and the spatial and temporal infinitesimals. And for the first time in the literature, the scaling transformation is applied to the four dimensional (three spatial and one temporal dimension) conservation equations. Therefore, this study should be also cited in the paper as:

Haltas, I. and Ulusoy S. (2015). "Scaling and scale invariance of conservation laws in

Reynolds transport theorem framework.” Chaos, 25, 075406. doi: 10.1063/1.4917246

In Section 1 Introduction: "The first technique is based on dimensional analysis, and the scaling is usually referred to as dimensional scaling. The scaling relationships are determined based on the units." should be revised as "... based on the dimensions."

Similarly in Section 3: "Dimensional scaling is based on the idea that non dimensional groups can be formed based on the units of the quantities involved in a physical phenomenon.” should be revised as "...based on the dimensions of..."

Similarly in Section 4: "Gathering the units for these quantities is enough to apply the Buckingham Π theorem and make judgements on modeling and scaling of such systems." should be revised as "Gathering the dimensions for ..."

In Section 2.2: "The Lie scaling transforms the entire system of equations: boundary, initial, and interior equations." and in several sentences in the paper the initial and boundary conditions are refereed as initial and boundary equations. Although mathematically the initial and boundary conditions are expresses with (in a rather simpler form of) equations, customarily they are referred as initial and boundary conditions. Also the interior equations are customarily referred as governing equations. Usually by system of equations it is referred to the system of equations governing the processes. Therefore it may be revised as : "The Lie scaling transforms the initial and boundary conditions and the system of governing equations." Similar revisions are advised in the relevant expressions.

In Section 1 Introduction: "A third scaling method is a special case of a theoretical technique developed by mathematicians for symmetry analysis of differential equations." should be revised as "A third scaling method is a special case of a theoretical technique for symmetry analysis of differential equations."

In Section 2.2: "Preserving both kinematic and dynamic non dimensional groups was a choice that has substantially affected this analysis." This statement should be clarified

further. How did the authors come up with this conclusion ?

In Section 2.1 Ln 9: The scaling transformation is defined some what different than the scaling transformation used in the rest of the paper. How this transformation is evolved and how these two different definitions are related should be explained. Or a consistent form of transformation should be used through out the paper.

In Section 2.2: "Also, the scaling of the 3-D system is similar to the scaling of the Dupuit approximation." statement sounds a little vague. It should be either detailed and justified or removed from the paper.

In pg. 207: "It may be desirable for investigators to take either Frr or Rer as design parameters in creating physical models or in upscaling the point scale equations,... ". In physical modeling and similitude analyses Froude Number or Reynold Number of model and prototype is always equal. Therefore in the literature it is not used as Froude Number Ratio (Frr) but rather just Froude Number (Fr) similarly in the case of Reynolds Number. So this statement should be revised.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 10197, 2015.