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On the application of novel 2D techniques to model streamflow generation in response to rainfall

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SUMMARY

An accurate modeling of the rainfall-infiltration-runoff partitioning is one of the key points in hydraulic/hydrologic simulation, specially in long duration events, where the cumulative errors may be relevant. In particular, the infiltration/exfiltration processes become very important in the water balance computation as they serve as connection between both surface and groundwater flows. Hence, in the last decades a lot of effort has been made to accurately predict this phenomenon. Several models to calculate soil infiltration rates have been proposed in the literature over the past 100 years (Horton, Phillip, Green-Ampt, etc.) but a new hypothesis based on the use of fractional derivatives is challenging the traditional infiltration laws.

In this work, a novel application of the fractional derivatives to the Green-Ampt infiltration method [1, 2, 3] is combined with a 2D overland flow model based on the shallow water equations in order to predict the surface water losses due to this phenomenon. This allows to improve previous published results in the literature for several rainfall events on catchments where the infiltration process occurs. The surface flow model is connected to a 2D depth-averaged groundwater flow and tested in several challenging situations with dry-wet fronts and phreatic level disconnection from the surface.

Keywords: hydrological modeling, numerical methods, fractional derivatives

AMS Classification: 76M12, 76S05, 35Q35

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