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Interactive comment on "Hydrological functioning of West-African inland valleys explored with a critical zone model" *by* Basile Hector et al.

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Thank you for all the comments and questions regarding to our submission to HESS: Hydrological functioning of West-African inland valleys explored with a critical zone model".

Both two reviewers (#1 & #2) had relevant interrogations about the impact of topography on the generalization of the results presented in this study.

Although we specified that the V-shaped (virtual) catchment slopes correspond to the actual slopes of the reference inland valley of Nalohou (L. 14: "(mean N-S and E-W slopes correspond to those imposed on the virtual V-shaped catchment)"), it is clear that more details should be provided.

Nalohou catchment has been surveyed with double-difference GPS campaigns to provide accurate topography at 5m resolution. Local mean N-S & E-W slopes come from such dataset.

At the Upper Oueme catchment scale (14 000 km2), comprising many more inland valleys (Giertz et al., 2012), a quick slope analysis from 3" (about 90m) Hydrosheds DEM provided an average slope of 2.6 %. On nearby Togo in similar geomorpholigical context (Région centrale, 13000 km2), Runge (1991), noted that 80% of surface have slopes comprised in the range 1.7 – 5.2 %. They further identified inland valley to develop preferentially in the range 3.0 – 4.4 % along the steepest axis. The transverse axis (X in our case) ranges from 1.7 to 3.5% and the longitudinal axis (Y) from 3.5 to 5.2%. These numbers are very close to our virtual catchment (X: 2% Y: 4%).

Despite this relevance with respect to other (including larger scales) inland valleys, we wanted to check the impact of slopes on simulation results (budgets, and agreement to observations, as suggested by reviewers. We have not had the time to conduct the virtual experiments so far but could do so if needed.

As for the other comments of reviewer #1: - No-flow boundary conditions where applied over the catchment sides (as stated L. 22), but we did not precise that a no-flow boundary condition is also applied to the bottom of the catchment. We could add this precision. This choice is backed-up by the limited regional gradient as explained by 1) the low fracture connectivity within the bedrock (El Fahem et al., 2008) and 2) the low transverse hydraulic gradient at the larger scale (gradient of 0.01 m/m over about 3km) showing very little variations between the dry and the wet season, and suggesting limited larger-scale transverse flow which would affect the boundary conditions. These numbers are based on Hama Garba's Msc thesis (Hama Garba, 2016), available upon request.

- concerning the potential impact of discontinuous layers, this would indeed be an interesting study in itself. There is an extensive literature on the topic, including with the same model (Atchley & Maxwell, 2011, Meyerhoff & Maxwell, 2011, Meyerhoff et al., 2014, Gilbert et al., 2016, among others), which we would could easily add to the paper with addititional comments.

Many thanks again with the reviewing work,

The authors.

References:

Atchley, A. L. and Maxwell, R. M.: Influences of subsurface heterogeneity and vegetation cover on soil moisture, surface temperature and evapotranspiration at hillslope scales, Hydrogeol J, 19(2), 289–305, doi:10.1007/s10040-010-0690-1, 2011.

El-Fahem, T.: Hydrogeological conceptualisation of a tropical river catchment in a crystalline basement area and transfer into a numerical groundwater flow model. Case study for the upper Ouémé catchment in Benin, Thèse de doctorat, Université de Bonn. [online] Available from: http://hss.ulb.uni-bonn.de/2008/1509/1509-1.pdf (Accessed 3 February 2014), 2008.

Giertz, S., Steup, G. and Schönbrodt, S.: Use and constraints on the use of inland valley ecosystems in central Benin: results from an inland valley survey, Erdkunde, 66(3), 239–253, 2012.

Gilbert, J. M., Jefferson, J. L., Constantine, P. G. and Maxwell, R. M.: Global spatial sensitivity of runoff to subsurface permeability using the active subspace method, Advances in Water Resources, 92, 30–42, doi:10.1016/j.advwatres.2016.03.020, 2016.

Hama Garba, O. K.: Etude Hydrogéologique et Géophysique du bassin versant de l'Ara au Benin, Memoire de Master, Université d'Abomey-Calavi, Université d'Abomey-Calavi., 2016.

Meyerhoff, S. B. and Maxwell, R. M.: Quantifying the effects of subsurface heterogeneity on hillslope runoff using a stochastic approach, Hydrogeol J, 19(8), 1515–1530,

doi:10.1007/s10040-011-0753-y, 2011.

Meyerhoff, S. B., Maxwell, R. M., Graham, W. D. and Williams, J. L.: Improved hydrograph prediction through subsurface characterization: conditional stochastic hillslope simulations, Hydrogeol J, 22(6), 1329–1343, doi:10.1007/s10040-014-1112-6, 2014.

Runge , J. (1991): Geomorphological depressions (Bas-fonds) and present-day erosion processes on the planation surface of Central-Togo/Westafrica. In: Erdkunde 45, 52-65. DOI: 10.3112/erdkunde.1991.01.05

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