Response to Referee 1

The authors numerically investigate coupled flow and deformation processes in an academic test case, a partially saturated hill slope. The flow is modeled with the Richards equation, preferential flow is accounted with a dual permeability model and the results are also compared with a single permeability model. The deformation is modeled with a linear elasticity model using Mohr-Coulomb as failure criterion. Flow and deformation are weakly coupled. The authors conclude that preferential flow has a positive effect on the slope stability for low intensity rainfall while it is vice versa for high intensity rainfall. The linkage of preferential flow with a dual permeability model to the slope stability analysis is new and the results are interesting. The paper is well written.

Answer 1: We thank the reviewer for his positive comments. The quantification of the influence of preferential flow on hillslope hydrology and landslide-triggering is exactly the objective of this study.

A few points require some further investigations and analysis: - Eq. 6: give the unit of Tau_w (m2/s)

Answer 2: We think the reviewer means the Γ_w in equation 6. The Γ_w is the water exchange rate formulated as a source/sink term in the Darcy-Richards equation (see equations (1) and (2)). The dimension of Γ_w was indicated as T^{-1} (see page 13060 line 17~18) and represents the changing rate of soil moisture (volumetric water content) in time.

Eq. 7: you use an arithmetic average for the interface hydraulic conductivity; why haven't you chosen a harmonic average which generally better approximates the fluxes between very heterogeneous media?

Answer 3: We agree that the harmonic average is a good approximation to calculate the water fluxes across an interface between two zones of different permeability. However, the interface between macropore and matrix is a conceptual one. Gerke and van Genuchten (1993, Water Resources Research, vol. 29, pp. 1225–1238) investigated the different formulations of water transfer across the interface, in which the geometrically well-defined rectangular types of macropores or fractures are contained, they stated that "*of the various methods, we judged the arithmetic averaging method, combined with the use of a scaling coefficient, to be the most practical way of evaluating K_a in the proposed dual-porosity models, and arithmetic averaging considers the pressure heads of both pore systems*". Since their paper, it is common to use the arithmetic average for water between domains in dual-permeability models, is adopted by, e.g., HYDRUS-1D, MACRO, etc., and is used by different research groups (the references listed in Table 2 in Section 5.2, Laine-Kaulio (2014 in Water Resour. Res., doi:10.1002/2014WR015381, 50, 8159—8178), and Ray (1997 in J. Hydrol., 193, 270–292). We added the Gerke and van Genuchten reference to the references cited before Eq. 7.

Below eq. 10: Boundary
conditions may be specified for pressure head : : : -
Answer 4: Done

P. 13063: Why have you chosen the pore water pressure of the preferential flow do-main for the effective stress? Why haven't you chosen an averaged pressure of the matrix and preferential flow domain?
Answer 5: The pressure transmission in a heterogeneous subsurface flow system is complex. In section 5.3, the discussion was focused on our understanding about the time delay of the pressure transmission and water diffusion from a preferential flow path to a matrix domain. In some cases, such as the clay with a low hydraulic conductivity of the soil matrix and a low density of fissures, the time delay between water entering the fissure network and pressure increasing in the matrix is relatively large. Our study concerns a system with a very high density of macropores, and consequently the numerical simulations show only a small time delay for the pressure propagation from the preferential flow domain to the matrix domain. We cite two other studies that concluded that slope stability is highly correlated with the pressure in the preferential flow domain.

P. 13065: Can you explain why you have chosen alfa_w = 0.2 /m2. I can imagine that this exchange coefficient has a very important influence on the results. Therefore, I suggest to carry out a sensitivity analysis and to increase and decrease this parameter (or the product alfa_w k_sa) by one or two orders of magnitude. Please then check whether your conclusions are still valid.
Answer 6: The sensitive of the simulated pressure and slope stability to the chosen model parameters is an important issue. The focus of this paper is on using numerical experiments to investigate how preferential flow influences the slope stability. A sensitivity study using ranges of parameters and stresses that may be expected in real-world slopes is far beyond the scope of this paper. We acknowledge that the water exchange parameter is crucial for the simulated non-equilibrium phenomenon. Specifically, the sensitivity analysis of Ray et al (1997 published in Journal of Hydrology, 193, 270–292), shows that a very large water exchange coefficient results in almost instantaneous equilibrium between the two domains and the dual-permeability model behaves like a single-permeability model, which means that the preferential flow has no influence on the hydrological and soil mechanics results.

However, experimental studies of natural soils often show a non-equilibrium phenomenon between the two domains as we mentioned in our Introduction. In Section 5.2 we summarize values used in other studies (Table 2) and emphasize that the water exchange is governed by the product of alpha_w and K_sa, which is similar for all published studies. Our value falls in the same range.

P. 13072, last sentence: The numerical experimental results are compared with field studies and other published numerical results. You should mention that this is done in the following. I was searching for that in sec.
Answer 7: Good point. Done.

4. - P. 13074: check headline 5.3 for typo; 3rd line in 5.3 van der Spek ->Van der Spek
Answer 8: Done

Conclusions and Abstract: Your conclusions are of course valid for the parameters you have chosen and which are typical (Tab. 2). You just have investigated the effect of different cohesion. The question is whether your conclusions are still valid when other sensitive parameters such as the exchange coefficient alfa_w have other values. A parameter study to sensitive parameters would help here.
Answer 9: Two different cohesion values are chosen to show that the results of slope stability may be influenced by the parameter setting. The choice of parameters indeed influences the results (see also answer 06). The valule of coefficient alfa_w cannot be chosen independent of K_sa (see also Answer 6 and Section 5.2 in the manuscript). A full sensitivity analysis is, unfortunately, beyond the scope of this paper.

Fig. 7: skip free line between Dual-permeability model and preferential flow domain –
Answer 10: Done.

Fig. 8: the unit of Tau_w is m2/h not 1/m; Water distribution rate: Positive values : : : (add double point)
Answer 11: Please refer to Answer 02.