Reply to general comments of anonymous Referee #1:

The authors describe interesting sprinkling experiment, which were performed to study rain-on-snow events. They measured both outflow volumes and isotopic signals, which was possible due to the use of Deuterium enriched sprinkling water. They found that in cold/dry snow (unfortunately only one replicate) the outflow from the snow was faster both in terms of outflow reaction and rainwater travel times. While this finding could be expected with regard to the latter (i.e. rainwater travel times), the former (i.e. slower response of the outflow in wet/warm snow) seems counterintuitive. One explanation might be the development of preferential flow pathways, but without internal measurements/observations, this remains a bit speculative.

My major concern with this study is the not fully satisfactory explanation of the processes leading to the counterintuitive findings. Here I would find some more discussion/reasoning helpful, including a detailed discussion of potential errors, which could (not) explain this (especially since there was only one sprinkling experiment on cold/dry snow).

We would like to thank the referee for his/her helpful comments. We agree that finding a faster runoff response to the onset of sprinkling for cold snow may appear counterintuitive. While some discussion is already available we will expand the section in this regard specifically. We will also extend the discussion on differences between Ex2-4 (warm/wet snow) to address possible uncertainties. Note that we have further evidenced preferential flow paths in Ex. 1 by way of colour tracer, which we will document more clearly (Würzer et al., 2016b)*. Also the quick recession of runoff after the end of sprinkling hints at the presence of preferential flow during exp. 1.*

Reply to specific comments of anonymous Referee #1:

Beyond this, my comments as listed below are rather minor:

Reading the manuscript, at some point I was confused by the four experiments and four rain pulses … Probably it was me missing something, but this could perhaps also be described clearer. The author present much of their observations in form of tables. The manuscript would become much more attractive if these results could be presented (also?) in form of figures. While there obviously is a difference in scale, it would be useful to link the isotope studies in the present study to isotope studies at the catchment scale (e.g., Rodhe,1981, Spring Flood Meltwater or Groundwater?)

We apologize if we failed to describe all four experiments as well as the respective four sprinkling periods in a clear way, obviously there is a need for improvement. We will try to better clarify our approach while revising the manuscript. Each of the four experiments consisted of four sprinkling periods lasting 30 minutes, separated by a 30 minutes break (See Fig. 4 in the manuscript). This approach was chosen to be able to investigate the temporal progression of response times to signals in the sprinkling input as the snowpack conditions changed over the course of the experiment. Additionally, note that rainfall intensity changes on sub hourly timescales can also be observed in nature.

We will expand out discussion on the possible implications of the study results on the catchment scale. We argue that some of the described mechanisms in the point scale have implications on the catchment scale, however processes such as overland flow or lateral flow in snow further add to the

complexity of runoff generation if concerned with the catchment scale. The presented hydrograph separation technique is transferable to larger scale, if the natural rain has constant isotopic signature (McDonnell et al., 1990). But linking to respective catchment studies is certainly beneficial for the discussion which we will implement as suggested.

P2L33: while melting snow and rain can have (and often have) a different isotopic composition, this difference is not a 'fact'.

We agree and will therefore rewrite the sentence to read: "Due to the often different isotopic signature of rain and snow, hydrograph separation can be applied to differentiate rainwater from the melt water in the total runoff from the snowpack."

P3L3: What is meant by discrepancy here? Isn't this just the consequence of the GMWL?

The sentence is redundant and will be deleted in the revised manuscript.

P4L34: is there any evidence for these temperatures being representative?

Assuming that rain temperatures are approximately equal to air temperatures, these temperatures are comparably warm but within range of observations. Unpublished data of rain temperatures during over 1000 natural ROS events evaluated in the context of (Würzer et al., 2016a)*, shown in Fig. 1 demonstrate that. Note that the direct effect of rain temperature on snowmelt is very small in comparison with other energy fluxes.*

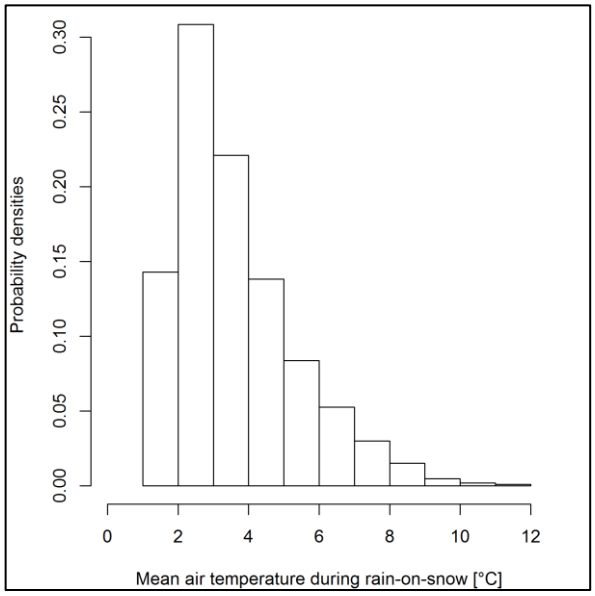

Fig. 1 – Representative mean air temperature during rain-on-snow events in Switzerland.

Eq1: please avoid using x as multiplication sign

We will use symbol "×" instead.

P5L15: delta values are no concentrations

We agree that the delta values are deficits to the V-SMOW standard deuterium concentration and will rewrite the sentence accordingly.

Eq 4: where does this Eq and the tan in it come from?

Equation 4 is a newly introduced formulation and represents an assumption on how the reference isotopic signature could change due to the piston flow effect (Fig.2). The tan function governs the shape of the gradual change of the deuterium reference value. It demonstrates that the reference value change is not a step function, but more likely S curve shape or reverse S curve shape, depending on initial snowmelt and snowpack signature.

P7L1: the sentence 'Unlike our expectations' sounds like discussion

This sentence will be reformulated in the revised manuscript.

P7L3: the location of 'only' seems strange, reformulate to clarify what is referred to by 'only'.

The sentence will be reformulated accordingly in the revised manuscript.

While I am not a native speaker myself, I feel that there is some room for improvement with regard to the English. Among other things, the (not) use of 'the' seems not always correct and some sentences are a bit unclear to read (e.g. P2L19). The authors are also not fully consistent with the use of the tenses, and the tense used for reporting own work sometimes jumps between past and present.

The English style and grammar will be carefully checked by a native speaker.

References

McDonnell, J. J., Bonell, M., Stewart, M. K. and Pearce, A. J.: Deuterium variations in storm rainfall: implications for stream hydrograph separation, Water Resour. Res., 26, 455–458, 1990.

Würzer, S., Jonas, T., Wever, N. and Lehning, M.: Influence of Initial Snowpack Properties on Runoff Formation during Rain-on-Snow Events, J. Hydrometeorol., 1801–1815, doi:10.1175/JHM-D-15-0181.1, 2016a.

Würzer, S., Wever, N., Juras, R., Lehning, M. and Jonas, T.: Modeling liquid water transport in snow under rain-on-snow conditions considering preferential flow, Hydrol. Earth Syst. Sci. Discuss., 18(August), 16488, doi:10.5194/hess-2016-351, 2016b.