Dear Reviewer 3,

thank you very much for your positive review. We will briefly comment on your concerns in the spirit of the interactive discussion. (RC=reviewer comment, AR=author response)

# Specific comments

> RC3.1: "The authors assume throughout the paper that the soil moisture (and the variability thereof) within a given field is known, which is not usually the case. I understand that in this instance these heterogeneities are artificially created for the purpose of testing the authors’ newly developed methods, but it would be good for the authors to mention whether or not these applications are feasible without intensive soil moisture surveys."

It is true that soil moisture needs to be known before the application of the concept, but this is the nature of all forward models, like COSMIC, MCNP, or URANOS. The great benefit from these models is that they can be used to better understand neutron data, to infer hidden hydrological processes or irrigation events, and to assess the systematic uncertainty of the data. Here, intensive soil sampling is not needed, but one could play with the soil moisture variable in the model to gain a better understanding of potential influencing factors and their impact on the signal. This is already indicated in the conclusion (L413), but we will better communicate this in the revision. Please refer also to the reply to Reviewer 1 (RC1.3.)

> RC3.2: "Except for the last case study, the authors conduct their analyses under constant soil moisture conditions, but in reality soil moisture varies in time, which means the neutron contribution of each unique area will also change with time. This significantly complicates the cases of detected and delineated the effects of heterogeneous soil moisture patterns (section 3.1) and complex land use features (section 3.2). The authors might consider addressing this issue of temporal variability of soil moisture and whether or not the analysis carried out in the first two case studies is practical in reality."

The generalized analytical method is aimed at being practical in reality, while the presented examples were only used to validate the analytical model with Monta Carlo...
physics codes. Since the validation with these specific complex scenarios was successful, we can conclude that the analytical model can be applied to any other user-defined soil moisture condition very easily. The presented framework allows users to quickly assess the neutron signal for their specific and arbitrarily varying soil moisture pattern. The attached online-notebook even provides a user-friendly interface to do exactly that. For example, the user can run the same model for low and high soil moisture conditions to gain insights on the impact of spatial contributions for dry and wet days, respectively. Hence, we hope that the presented method is as practical as possible to emulate reality.