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Reply on CC1

Magdalena Szczykulska et al.

Author comment on "Technical note: A revised incoming neutron intensity correction factor for soil moisture monitoring using cosmic-ray neutron sensors" by Magdalena Szczykulska et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-564-AC1>, 2021

We thank the reviewer for appreciation of our work and for the comments. Below are our responses to the general and specific comments.

1. *"The authors argue that the spurious trend becomes more obvious at site with high soil moisture values due the non-linear calibration function. But the COSMOS-UK site Sourhope (<https://cosmos.ceh.ac.uk/sites/SOURH>) only ~160 km away from Glensaugh also features high soil moisture values up to ~70 Vol.% due to high soil porosity (soil density is 0.65 g/cm³), but there is no spurious trend like Glensaugh."*

We did not state a reason why the trend seems to be more obvious at wetter sites. We simply reported our observation that within the COSMOS-UK network, wetter sites show more obvious trend. COSMOS-UK website already utilises the improved intensity correction and hence VWCs from Sourhope shown there will have any trend removed or reduced.

2. *"Therefore, I think there is a need to test this method at several sites to exclude the possibility that the spurious trend is actually due to a local hydrological change at the Glensaugh site triggered by the extreme drought in 2018. Such decreasing trends after this drought can be observed also at other sites in Europe."*

So far, the authors used only one COSMOS-UK site (Glensaugh) for developing their method and another site (Bunny Park) to test it. The COSMOS-UK network as well as the recent COSMOS-Europe data paper (Bogena et al., 2021) provide a perfect basis for a better testing of the method."

The method has been applied to all sites in the COSMOS-UK network. This is stated and discussed further in section 3 of the technical note. As mentioned in the response above, the COSMOS-UK website already utilises the revised background intensity correction. We very much hope that the methodology described in the technical note is explored by other 'cosmos' networks and agree that the COSMOS-Europe data set will provide an interesting opportunity for further analyses. We note that some of the sites in Figure A.3 of Bogena et al. 2021 (<https://doi.org/10.5194/essd-2021-325>) may display a similar trend to those seen within the COSMOS-UK network (e.g. Harrild, Rollesbroich and Ruraue).

3. *"Although it uses standardised differences using the median, the correction factor derived from the relationship is still influenced by soil moisture dynamics (i.e. it would only perfectly work for a permanently wet site or a lake). I suggest excluding dry periods from the analysis to avoid dry bias."*

We agree that the wet periods contribute points with more stable soil moisture. In the attempt to avoid the dry bias, we applied a lower quartile regression which puts more weight towards counts corresponding to the wetter periods while still utilising all the available data. We feel this is more appropriate than attempting to identify wet and dry periods given the temperate maritime climate of the UK. This is discussed in section 2.1. In practice, the reviewer's suggested approach and the lower quartile regression yield similar results for the COSMOS-UK network sites.

4. *"The correction factor depends on the measurement period. It is unclear, how many years are needed for achieving a reliable correction factor."*

We discuss this aspect in section 3. Since the regression is performed between COSMOS-UK and Jungfraujoch (JUNG) neutron monitor counts, it is not so much the record length but the range of available JUNG counts which very much depends on the solar cycle. For instance, in the period between 2018 and 2021, there was not much variation in the JUNG counts. As a result, sites with data for this period only would not have a reliable estimate of G.