HESS 4141

General Comments

This technical note presents algebraic reformulation of the key transfer function from corrected neutron counts to soil moisture content for Cosmic Ray Neutron Sensing (CRNS). With some further definitions and normalisation, there is the concept of detected neutrons and 'missing' neutrons. Whether or not this approach is ultimately useful is debatable; there is no real fundamental advantage - currently corrected neutron count rates can be directly compared, albeit with dependency (usually) on the detector sensitivity (which could anyway be overcome by normalisation). Therefore, the claim that the new formulation allows "to fully compare CRNS neutron count rates independent of…" whilst technically correct, does not offer a significant step forwards, in my opinion.

Other points raised are often not adequately supported by references or fully justified (see examples below). Some of this manuscript becomes more of a perspective piece than a technical note.

Specific Comments

1. In Fig.1 dashed lines are fitted for N_max and N_bg. What is the fitting method used? What is the uncertainty on the fit? As this is one of the few relatively novel parts of this work, there should be a clearer description of the method, so that it is reproducible, and more discussion of how well this can be achieved in practice (uncertainty).
2. The reformulation and new parameters introduced may be useful, but the claim to be able to apply CRNS without field calibration, applies equally well to the Desilets formulation e.g. by adjusting N_0 such that the soil moisture output during wet (field capacity) periods matches the expected field capacity for the soil type - without knowing how N_max and N_bg are fitted exactly, it appears to be similar guesswork.
3. The introduction of the concept of a two-fold Poisson process (line 224) lacks any literature reference or proper justification. There is confusion over the Poisson statistics of *detecting neutrons* versus the abundance or flux of neutrons in the environment. I do not believe that this is an accurate description of the statistics of neutron generation by cosmic rays, and variations in neutron flux are not 'statistical noise' but the true variation in the neutron environment. Variation in the ground level neutron flux should not be conflated with Poisson detection statistics; after correction of ground level counts for changes in incoming neutron flux, this effect should be mostly removed - and if not, there's additional uncertainty to consider (the uncertainty of the incoming neutron flux correction).
4. The additional variability discussed due to soil moisture patches of contrasting wetness, is not properly justified, and a Monte Carlo neutron scattering model should be used to show this properly, and likely shows this does not cause as much variation as argued here. Again this is postulation without proper testing. 'Statistical deviation' is not well defined, and soil moisture variation is true variation in the quantity of interest, granted that its effect on the measured neutron count (hourly) could add additional variation due to the random probing (but this has not been shown in a meaningful or realistic way).
5. At the end of Section 2.4, there is no quantification provided for this 'statistical deviation', just an expectation of it being larger than sqrt(Nc).
6. Section 2.5 - good to note this, but it is rather trivial, and to be expected from the non-linear relationship between Nc and soil moisture.
7. Section 3.2 suggests using point profile sensors to unweight the CRNS signal - but its application or testing is not presented.
8. Section 3.3 gives other thoughts on possible improvements on various aspects of corrections, but these are not new.

Technical Comments

L.47 Title of Section 2, suggest: 'Turning Attention to…' (more natural English)

L.136 - analogy with effective saturation is not helpful (and could cause confusion).

L.142-3 missing verb?

L.410 missing 'be'

L.422 change 'crossly' to 'grossly'