**Hydrology and
Earth System
Sciences
Discussions**

Interactive comment on "The COsmic-ray Soil Moisture Interaction Code (COSMIC) for use in data assimilation" *by* J. Shuttleworth et al.

Anonymous Referee #1

Received and published: 5 March 2013

Review:

Title: The COsmic-ray Soil Moisture Interaction Code (COSMIC) for use in data assimilation.

Authors: Shuttleworth, Rosolem, Zreda, and Franz

The paper introduces a simple, physically-based and computationally efficient model (COSMIC) to predict above-ground fast neutron flux as a function of the soil moisture profile. The simple model is verified against the existing Monte Carlo N-Particle eXtended (MCNPX) model that includes process-level descriptions of neutron transfer and is therefore computationally demanding and, unlike the newly developed COSMIC model, not suitable for use in a soil moisture data assimilation system. The authors

demonstrate that estimates of above-ground neutron fluxes from COSMIC match very well with those obtained from MCNPX, although they are not necessarily a perfect match against in situ measurements of neutron fluxes when model inputs are based on in situ soil moisture measurements. Nevertheless, the authors further demonstrate for a single site that COSMIC can be used as an efficient observation operator in a soil moisture assimilation system.

The manuscript is well written and of high relevance to HESS readers. The COSMIC model evaluation part of the paper can be published more or less as is. The data assimilation example, however, requires more substantial edits so that readers get a better sense of what exactly was done. Since these edits are meant mostly for clarification and should not change the results of the paper I recommend publication of the paper after MINOR revisions following the comments outlined below.

Major comment:

The description of the data assimilation example in section 5 needs to provide much more detail. What assimilation method was used? Which model variables were updated (control vector)? What were the model and observation error inputs? What is the skill of the soil moisture estimates in each layer (as opposed to the vertically averaged time series shown in Fig 9, with metrics in Table 2)?

Minor comments:

p1098, line 19: typo: replace "soilis" with "soil is"

p1100, line 8: are "(a) and (b)" the same as "1." and "2." in lines 16 and 18 of page 1099?

p1101, line 2 (and many other places): Use SI unit "g" instead of "gm" throughout the paper.

p1104, line 5 and Figure 4: Why is the wettest profile chosen to be uniform at 0.4 m^3/m^3? Shouldn't this depend on the porosity at a given site?

p1106, line 23: change "alpha and L_3" to "L_3 and alpha" (that is, use the order in which the two are used in lines 22 and 24.

p1108, line 23: typo: replace "thefast" with "the fast"

Fig 6 (a) and (b), x-axis labels in graphic: replace "rho_dry" with "rho_s" for consistency with symbol for bulk density used elsewhere

Fig 8 caption: There are lines in the graphic that are not discussed in the caption. The caption needs to be expanded to include those additional lines and shading.

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