

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

### **Anonymous Referee #2**

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Review of

The COsmic-ray Soil Moisture Interaction Code (COSMIC) for use in data assimilation  
by Shuttleworth et al.

General comments:

A new simplified model able to simulate the response of the cosmic-ray neutron intensity to soil moisture profiles is presented (COSMIC). The main added value of the COSMIC is the high computing time efficiency. A comparison with a more complex model is performed and the 6 parameters (3 of them are site-specific) of COSMIC are determined for a number of sites. Then, the COSMIC model is used as an observation operator coupled with a land surface model in a land data assimilation system. This

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is a very interesting paper presenting a pragmatic way to use a new and promising measurement technique for water resource evaluation. This is fully consistent with the scope of HESS. However, the data assimilation part is not sufficiently well described to be convincing. It should be either removed or filled out. Moreover, the modelling assumptions made in section 2 should be better explained/justified.

Recommendation: major revisions.

Particular comments:

- P. 1100, L. 8: do you mean (1) and (2) ?
- P. 1100, L. 25 and P. 1102, L. 2: any reason to think that the reduction with depth is exponential in the real world ?
- P. 1101, L. 2, L. 10, and P. 1102, L. 8: “units of gm per unit area” ? Unclear. Do you mean “g cm<sup>-2</sup>” as in Table 1 ? Using units of “kg m<sup>-2</sup>” could be more convenient.
- P. 1104, L. 2 (and elsewhere in the text): please replace “gm cm<sup>-2</sup>” by “g cm<sup>-2</sup>”, or (even better) “162 gm cm<sup>-2</sup>” by “1620 kg m<sup>-2</sup>”.
- P. 1104: why does the nature of the data used to optimize the parameters varies from one occasion (L. 9, COSMOS observations) to another (L. 20, MCNPX model) ?
- P. 1105, Table 1: the bulk density and lattice water content may vary considerably from one soil horizon to another. At which depth were these quantities determined/measured ?
- P. 1109: What do you mean by “assimilation” ? How is soil moisture modelled in NOAH ? Optimization of parameters of the land surface model (e.g. soil depth) ? Sequential correction of state variables ? In this case, did you match the observations with the model before assimilation ? Are other variables simulated by the model improved such as evapotranspiration or drainage ? How could COSMIC be implemented in a completely new site ? Does one need to measure the bulk density ? At which

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depth ?

- P. 1122: units of L3 in Fig. 6 ?

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