

The authors propose a methodology to infer patterns of the subsurface critical zone at the catchment scale from seismic refraction data for hydrological modelling. The overall study appears to be a very good physically based distributed hydrological model applied to a mountainous catchment. As such, the study is highly relevant and fits within the scope of HESS.

Thanks a lot for your appreciation of our work.

The manuscript is well structured and well written. Nevertheless, I have some concerns regarding the thickness definition. In the NIHM model, transmissivity (\bar{T}) is obtained by integrating the hydraulic conductivity between z_b and z_w in the saturated zone and between z_w and z_s in the unsaturated zone - where z_w is the hydraulic head with respect to the bottom z_b . The water content ($\bar{\vartheta}$) is determined by integrating ϑ in the unsaturated zone, while the storativity (\bar{S}) is determined by integrating S between z_b and z_w . Thus, by definition, \bar{T} , $\bar{\vartheta}$ and \bar{S} also depend on the state variable, i.e. the hydraulic head.

Yes, we agree. z_w is the water table elevation with respect to a reference which could be different from z_b

On the other hand, on page 16 (lines 425-430), the authors state: "The equations defining the groundwater flows show that key hydraulic variables such as the transmissivity \bar{T} and the water content $\bar{\vartheta}$ correspond to the integration over the porous media thickness of the hydraulic parameters $K(h)$ and $\theta(h)$, respectively as stated in (6). Thus, to solve the inverse problem seeking the hydrological model parameters, misestimating the thickness of the hydrological model underground compartments would inherently lead to a wrong assessment of the hydraulic parameters."

In my opinion, the term "thickness" is misleading here. It is not clear whether the author is referring to saprolite or soil thickness, or saturated or unsaturated thickness. In fact, if the former, it is only necessary to rewrite the text, but if they mean the saturated or unsaturated thickness, the dependence of hydraulic head and MRS on both hydraulic parameters and saturated thickness is not new. Please clarify this aspect in the manuscript before proceeding.

Thanks for your comment. The sentence needs to be clarified and we will reformulate it by:
"Thus, to solve the inverse problem seeking the hydrological model parameters, misestimating the soil and saprolite thicknesses of the hydrological model would inherently lead to a wrong assessment of the hydraulic parameters"