Review of the manuscript entitled:
COSMOS: The COsmic-ray Soil Moisture
Observing System
Submitted by M. Zreda et al.
Hydrol. Earth Syst. Sci. Discuss., 9, 4505–4551, 2012

General comments

This manuscript is a useful contribution. It is a complete collection of the basics and technical details needed to sensibly use this method. However, it reports little new information. Hence, it is an educational summary of the innovation process of the past few years after making this method operational, as stated on p.4508 l.15-19 ("comprehensive description of information distributed in precursor articles"). Some chapters are a long manual-like documentation. In each chapter the authors try to be complete , which leads to repetition.

The example given in Fig. 12 is the most simple case for demonstrating the positive features of the method because the site has almost no vegetation, little soil organic matter, and low lattice water. This eliminates many possible complications. It would be worthwhile to show another example, e.g. from a humid site to demonstrate the shortcomings, which are mentioned here and there in the manuscript.

This method yields mass of water in g cm^{-2}, but at best soft information about the vertical distribution of this "mass" below surface. It closes a methodological gap. I fully agree with your conclusions on p.1, l .21-22, but you should not downplay the significance of knowing the spatial distribution of local soil moisture at smaller scales. The variance of soil moisture, the soil moisture pattern is what the plants encounter – not th mean –, what is heavily influencing the spatial routing of water on and into the soil, information which is needed to get a better handle on evapotranspiration and heterogeneous in- and exfiltration processes. The latter may funnel the water out of reach for this and other soil moisture detection methods. Sure, this is not the topic of this manuscript, but the reader could be carried away with the wrong impression if the deficiencies of local soil moisture information are weighed against the benefits of area-averaged soil moisture information. This is the big misunderstanding between climate-focused scientists and soil hydrologists.

I agree only in part with your assessment of SMOS data. This technique is also being used to obtain ground based areal soil moisture on a similar scale as the COSMOS probes, at the very surface though. These measures are temporally as continuous as the COSMOS probes and could be used to complement the COSMOS data, discriminating the role of the temporally highly dynamic surface soil moisture and soil water storage in the upper rooting zone. However, the vegetation is largely transparent at the L-Band, but still contains some information about the vegetation structures with characteristic scales of >0.2 m .

Hence, I suggest a clear message recommending that this method must be combined with other soil moisture observation methods.

Editorial comments

p.4506, l.2: Kodama who first described this method is being cited later in the manuscript. However, he used the sensor installed below surface. The authors of this paper and his partners definitely contributed more in the past few years than Kodama to make this areal soil moisture observation method operational than Kodama. Nevertheless, the way the author's self-citation appears in the first sentence of the abstract creates the wrong impression of intellectual property.

p.4506, l.6: The term "neutronavka" does not sound familiar to me. Is it really a must to know it being an average reader of HESS? If not, delete it because it does not convey an important message. In earlier papers this instrument has been introduced under a

different name. To place this “ad” in the abstract is a too obvious marketing spot. Redefining introduced terms adds to confusion.

p.4511. l.27: Is the variation in water vapor pressure not more important than the barometric pressure ? Is this statement in conflict with that on p.4515, l.25 and p.4517, l.11/12?

p.4513, l.20-27 and p. 4514 l.26 : How about soil organic matter (C and H). This constituent is probably as important as the mineral soil matrix? This remark relates to almost all parts of the manuscript where the role of the H in the mineral lattice is addressed.

p. 4514, l.2 … travelling …penetrating

p. 4518, l5: I really wonder why ? … The COSMOS network is getting large and larger and this information is more than needed.

p.4518, l.10-15 and l.19-23: The neutron probe literature shows that the calibration of organic surface horizons differ from that of the subsoil, even when the sphere of importance (the 86% of H contributing to the signal) does not extend beyond the soil surface. The main difference is probably not due to the lattice water nor due to the mineral composition but to the presence of H in the soil organic matter.

p. 4521, l.21: 108 samples in an area of roughly 30 ha is a very good data support for estimating the mean of the usually normally distributed θ. The rather large literature on spatial variability of soil water contents shows that the coefficient of variation (standard deviation/mean) of (local) soil water content is in the order of 0.10-0.15 for high water contents but increases above 0.30 in drier soils. Your error estimate (standard error) is apparently somewhere in the middle range of the values. I add a graph at the end of the review. There is much more of spatial variability information than this in the literature of the eighties.

p.4522, l.22: Do you mean the COSMOS probe at the San Pedro site or is this instrument a special version of a (preliminary) design? Stick to one expression for one thing and define it when it is first mentioned.

p.4522, l.22: Looking at Fig.7 I do not understand this explanation since this figure is used for a different message.

p.4522, l.23: same comment as above (p. 4521 l.21)

p.4524, l.5-10: Lattice water is time invariant. So is the concentration of H contained in the below-surface organic matter, at least in the medium term. To account only for the former is inconsistent, especially regarding many soils of temperate and even more so of boreal and alpine regions.

p.4531/32. “ Concluding remarks” (entire paragraph): This is not really a scientifically based conclusion, but rather like a commercial advertisement.

p.4537: You should not cite web pages with a short life expectancy ! *Shuttleworth, W. J.: The Langbein Lecture at the Fall 2011 AGU Meeting, San Francisco, available at: http://hydroinnova.com/video shuttle 2011 long.html (last access: 1 March 2012), 2011.*
On this web page you get the answer **Page Not Found**
The page you are looking for might have been removed, had its name changed, or is temporarily unavailable. Please try the following: If you typed the page address in the Address bar, make sure that it is spelled correctly. Click the Back button in your browser to try another link. Use a search engine like Google to look for information on the Internet.

Figures and Table

Table 1: It would be worthwhile to list also elements abundant in soils that are literally “transparent” for neutrons such as Al (as mentioned on p.4512, l.15)

Fig. 1: With the following remark, I am swimming upstream, I know, but the term soil moisture is the envelope of all the water components somewhere in the soil profile. Soil water content would be more precise. E.g. in Fig. 1, the “soil water content” is being plotted

and the axis should be labeled with values < 1.0 as indicated by the dimension [m^3/m^3]. This remark applies also to Fig. 8).

Fig 3: The spatial resolution of this figure is too small. Even zooming-in does not make it easier to distinguish the various symbols and lines

Fig 6: Use small symbols for all elements (as for H). This disentangles the piling up of element symbols B,C, and Mg, (?), or Na (?) onto each other, which makes them non-legible.

Fig.8: Caption: The "differences" are ABS[θ^{meas} (t) - θ^{neutr} (t)]? It would be interesting to plot the θ^{neutr} (t), which results without compensating incoming neutron intensity, atmospheric pressure and atmospheric water vapor.

Terminology

The SI (système international) recommended abbreviations for seconds are "s" , for years it is "y" (or "a"), for meters it is "m" … the dimensions used here are "SI-tolerated", but not all of them are recommended. In HESS, let us converge to the SI agreement.

Coefficient of variation of the soil water content (example)

Each of the data points shown below refers to a large sample of gravimetric water content.

Schulin, R., H. Flühler, H. M. Selim, B. Sevruk, and P. J. Wierenga, 1993: Soil moisture, WMO-Report No. 749. Snow cover measurements and appeal assessment of precipitation and soil. World Meteorological Organization.