Comments on "A scaling approach, predicting the continuous form of soil moisture characteristics curve, from soil particle size distribution and bulk density data"

Assuming a sigmoidal function to represent soil moisture curve and particle-size distribution as well as the idea of relating their shape factors (e.g., N and n) to each other are not new topics in the soil science and hydrology literature. In this study, the authors, Meskini-Vishkaee et al., combined the Mohammadi and Vanclooster (2011) method with the van Genuchten water retention function to predict the continuous form of soil moisture curve from particle-size distribution data. Since this approach underestimates moisture content at high tensions, Meskini-Vishkaee et al. proposed a scaling method to improve soil moisture curve prediction. However, the scaling approach also underestimates moisture content considerably at dry end. Their scaling approach has systematic error: overestimating at low-tension heads (water contents greater than near 0.35) and underestimating at high tensions (water content less than about 0.35).

Major comments:

1- In the beginning of the Abstract and the end of the Introduction, Meskini-Vishkaee et al. emphasize that some models e.g., MV (Mohammadi and Vanclooster, 2011) underestimate water content at high tensions (dry end of SMC). Recently, Bittelli and Flury (2009; Soil Sci. Soc. Am. J. 73: 1453-1460) and Solone et al. (2012; J. Hydrol. 470-471: 65-74) reported errors in SMC measurements with pressure plates, and found large discrepancies between pressure plate and dew point meter measurements at matric potentials less than -100 kPa. They reported that pressure plates would overestimate soil water contents at high tensions. Therefore, any statement or conclusion like Meskini-Vishkaee et al. explanation "some models underestimate SMC at high tensions" based on typical measurements of SMC using pressure plates would be questionable. To clearly answer such a question whether a model underestimates SMC at high tensions, one should compare predictions with experiments measured accurately under equilibrium conditions at dry end.

2- P3L10-12: The authors claim that the MV (Mohammadi and Vanclooster, 2011) approach does not include any empirical parameter and is independent of database. However, Meskini-Vishkaee et al. do not compare their model neither with empirical pedotransfer functions nor with semi-physical approaches e.g., Arya and Paris (1981) and Arya et al. (1999) to clearly demonstrate the impact of their approaches. Since in Mohammadi and Vanclooster (2011) the Arya et al. (1999) approach with texture-constant alpha method was compared to the MV model, to improve the present work the authors could compare their developed theory with the Arya et al. (1999) approach in which alpha is estimated using the Logistic growth curve (method 1 in Arya et al., 1999) or Linear fit (method 2 in Arya et al., 1999), or a pedotransfer function developed using an independent database e.g., Vereecken et al. (1989). Otherwise, one may prefer applying other methods e.g., reliable point pedotransfer functions, or widely used and validated Arya-Paris model for practical purpose of prediction of SMC from particle-size distribution.

3- Although the scaling parameter λ was proposed to improve the soil moisture curve prediction, Fig. 3 shows that the scaling approach still underestimates soil moisture curve considerably at the dry end of SMC. So what's the advantage of proposing such an approach?! How would the obtained results for both the MV-VG and scaling models proposed in this study help the soil science society?

4- The idea of sigmoidal shape similarity between soil moisture curve and particle-size distribution has been already proposed in the literature (see e.g., Braud et al. 2004, Eur. J. Soil Sci. 56:361-374; Haverkamp et al. 2005, Soil Sci. Soc. Am. J. 69:1881-1890; Leij et al. 2005, Soil Sci. Soc. Am. J. 69:1891-1901; Lassabatere et al. 2006, Soil Sci. Soc. Am. J. 70:521-532; Minasny and McBratney 2007, Soil Sci. Soc. Am. J. 71:1105-1110).

For SMC with $\theta_r = 0$, one has (van Genuchten, 1980)

$$\frac{\theta_i}{\phi} = \left[1 + \left(\frac{h_i}{h_a}\right)^n\right]^{-m}, \quad m = 1 - \frac{2}{n} \tag{1}$$

Likewise, for particle-size distribution

$$M(< R_i) = P_i = \left[1 + \left(\frac{R_0}{R_i}\right)^N\right]^{-M}, \quad M = 1 - \frac{2}{N} \tag{2}$$

Equation (2) here has the same form of Eq. (9) proposed by Meskini-Vishkaee et al., if one sets $R_0 = 0.543 \times 10^{-4} \alpha \zeta$. Although M and N in Eq. (2) are different from m and n in Eq. (1) (references above), Meskini-Vishkaee et al. assume that these parameters (e.g., n and N) are equal (Eq. 9 in their paper) or linearly related (Eqs. 12 and 13). Direct fitting of Eqs. (1) and (2) to 660 measured soil moisture curves and particle-size distributions from the GRIZZLY database indicates that generally the value of N is greater than the value of n (note that m=1-2/n and M=1-2/N). The obtained results plotted in Fig. 1 below demonstrate that h (tension head) and R (particle radius) may not simply scale as Eq. (3) proposed by Mohammadi and Vanclooster (2011). In addition, Eq. (3) is only valid for close-packed cubic arrangement with void ratio e less than 0.9099 as Mohammadi and Vanclooster (2011) state. Mohammadi and Vanclooster (2011) further postulate that their Eq. (11), or Eq. (3) in the Meskini-Vishkaee et al. study, would be valid for all soils. However, assumptions considered are rather questionable. For example, $e <$

0.9099 means porosity ϕ < 0.476 which might be true for coarse-texture soils, but not at all for fine-texture soils. This is confirmed by the results of Meskini-Vishkaee et al. reported on page 14315 lines 15-20. Meskini-Vishkaee et al. state, "For the fine and medium textured soils, the values of RI are larger than for the coarse textured soil."

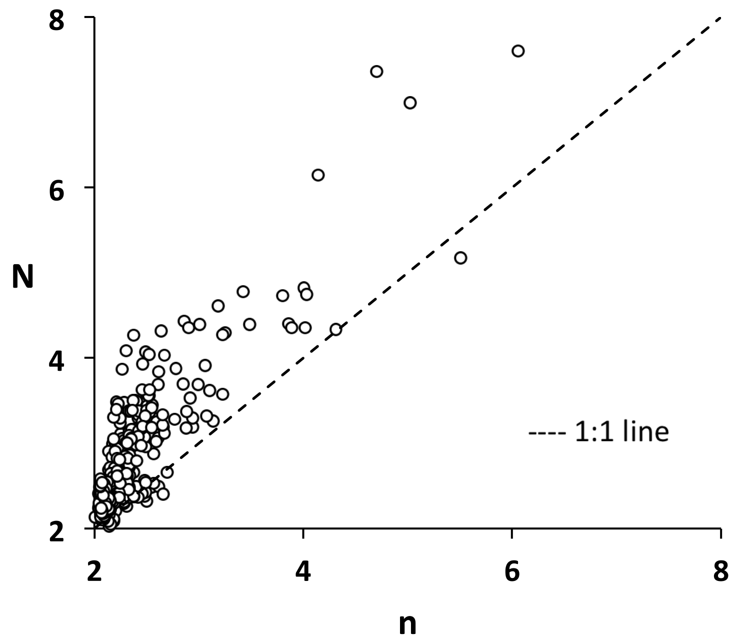

Fig. 1. Calculated *N* and *n* values for 660 soil samples from the GRIZZLY database. This figure indicates that the theoretical relationship *N* = *n* assumed by Meskini-Vishkaee et al. is not supported experimentally (compare their Eqs. (1) and (9)).

5- Although assuming residual moisture content equal to zero may lead to soil moisture curve underestimation at high tensions, Fig. 1 demonstrates that underestimation of SMC at dry end may also be due to *n* value overestimation if one assumes *n* = *N*, as Meskini-Vishkaee et al. consider in their Eq. (9). Below, in Fig. 2 it is demonstrated that if *n* = 1.5 is replaced by a greater value e.g., *n* = 2.5, one would expect underestimations at the dry end of SMC.

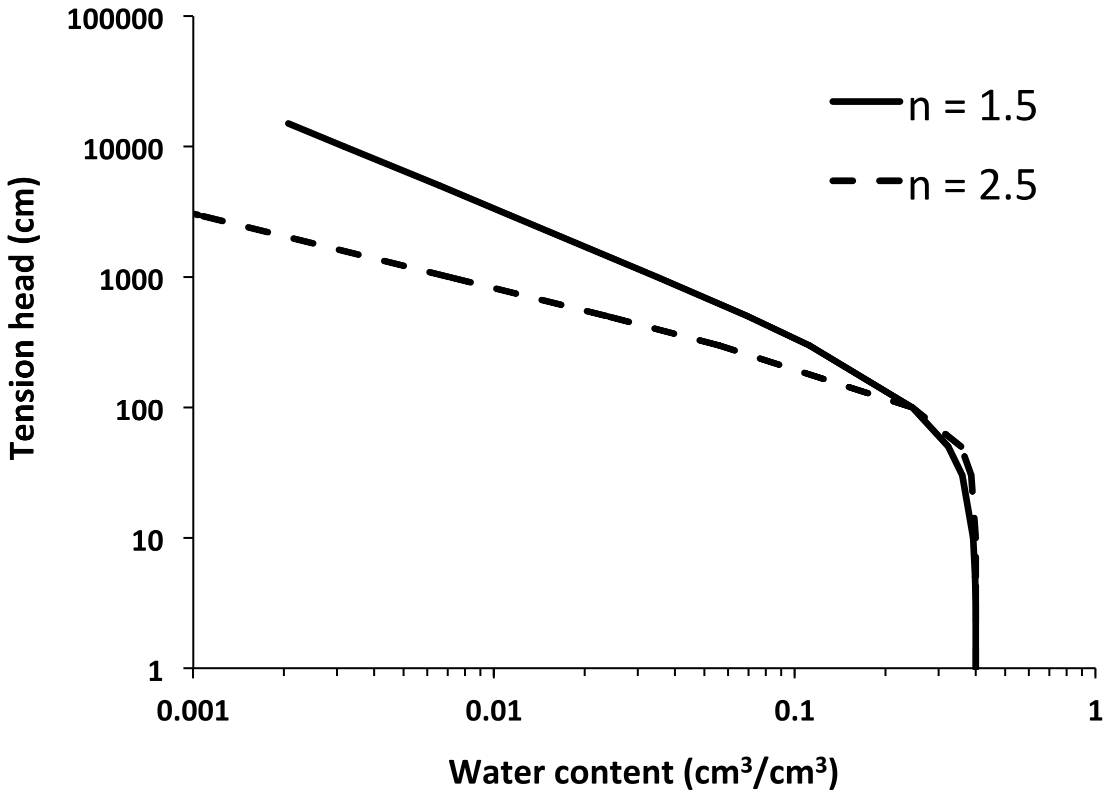

Fig. 2. Soil moisture characteristic curves for a soil sample with ϕ = 0.4, θ_r = 0, α = 0.01 (1/cm), n = 1.5 and 2.5, and m = 0.7. This figure indicates that replacing n by N results in overestimation of n value in the van Genuchten model and consequently underestimation of SMC at the dry end.

6- Lassabatere et al. (2006) (Eqs. (12) and (13) in their original article) as well as Minasny and McBratney (2007) (Eq. (10) in their original article) proposed scaling parameters to relate N to n. Meskini-Vishkaee et al. (2013) might be interested to compare these approaches with their scaling method.

Minor comments:

P14307L20: What does fractal dimension of a tortuous fractal pore mean?!! Alpha would be equivalent to the fractal dimension of tortuous path in the Tyler and Wheatcraft (1989) model, not the fractal dimension of a tortuous fractal pore.

P14309L26: Change "improves" to "improve".

P14310L20: The residual water content should also be listed as fitting parameters in Eq. (1) among others.

P14311L5: Eq. (5) is not correct! The authors should change ρ_s to ρ_b in the denominator. The current form is porosity definition.

References: Change

Havayashi, Y., Kosugi, K., and Mizuyama, T.: Soil water retention curves characterization of a natural forested hillslope using a scaling technique based on a lognormal pore-size distribution, Soil Sci. Soc. Am. J., 73, 55–64, 2007.

to

Hayashi, Y., Kosugi, K., and Mizuyama, T.: Soil water retention curves characterization of a natural forested hillslope using a scaling technique based on a lognormal pore-size distribution, Soil Sci. Soc. Am. J., 73, 55–64, 2009.