



EGUsphere, referee comment RC1
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Comment on egusphere-2022-1496

Anonymous Referee #1

Referee comment on "Reproducibility of the wet part of the soil water retention curve: a European interlaboratory comparison" by Benjamin Guillaume et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-1496-RC1>, 2023

This manuscript describes a well-performed interlaboratory comparison of measured water content in samples at low tensions, 10, 50, 100, and 300 hPa with standardized times of saturation, equilibration times, and oven drying time. Samples were composed of a mixture of glass beads and Portland cement with a supposedly stable structure, allowing repeated measurements on the same sample. Water retention was determined in 14 laboratories across Europe and samples moved among these laboratories in a predefined way, allowing the detection of inter- and intra-laboratorial variability or reliability of the determinations.

The experimental effort and the collected data are very interesting and show how imperfect the determination of the soil water retention property is. The statistics are presumably well-performed.

In the end, however, the authors leave the reader with some questions. The main one: Which method/lab is the best one, and if we have so many differences between and within laboratories, how should we deal with that? What is the "correct" (or: reference) value we all should try to reproduce? To discuss this, I suggest an additional item at the end of the Discussion section, see my comments below (where I refer to the Conclusion section).

In my opinion, some issues need to be addressed by the authors:

- The material (glass beads) are of sandy texture. There is no silt or clay at all in the samples. Such a pure sand sample will have a very steep retention and hydraulic conductivity curve. The steep K curve may lead to an easily occurring loss of hydraulic contact between the sample and porous medium or within the sample when submitted to suction or pressure. I would say, this kind of sample is among the most difficult to analyse. Wouldn't the results be less pronounced in real soil samples containing clay, silt, and sand? In other words: didn't you submit yourself to a very hard to analyse sample? This should be commented on.

- When reading line 297, I get confused about the method. From line 81, I assumed samples would be resaturated in between each tension (although that is not fully clear). But from this sentence in line 297, I conclude that unsaturated samples (equilibrated at the previous tension) were submitted to the next tension without rewetting? This needs a disambiguation. If this has been the applied protocol (i.e., not resaturating between tensions, but only wetting the suction plate before reallocating the samples), some hysteretic phenomena may also have been induced.
- pF is defined in soil physics using units of energy/weight, a head unit, i.e., in cm (and not in energy/volume=pressure unit like Pa or hPa). pF is the value of $\log_{10}(-h/\text{cm})$, where $h < 0$ is the pressure head. See e.g. Koorevaar et al. p. 81 (P. Koorevaar, G. Menelik and C. Dirksen. 1983. *Developments in Soil Science*, 13. Elsevier.), or Lal & Shukla p.314 (R. Lal, M.K. Shukla. 2019. *Principles of Soil Physics*), or other textbooks on the subject. It is therefore odd to refer to a correction of cm to hPa (Table 1) or to refer to pF as the \log_{10} of tension in hPa. The opposite would be correct. In line 93 you should write $\log_{10}(h/\text{cm}) = \text{pF}$, and in Table 1 you should refer to a correction of hPa to cm. As tension tables and sandboxes apply hanging water columns or a height above a water level, it is most likely that the laboratories effectively "measured" a vertical distance in cm, which could be converted to pF without any correction.

Similarly, in lines 238-239 it is important to verify that those transforming their cm readings directly to pF are correct and that transforming hPa to pF (without correction) implies an error (and not the opposite, as suggested). This error is exactly quantifiable on the pF-scale, where it is equal to a constant value, exactly $\log_{10}(\text{hPa}/\text{cm}) = \log_{10}(0.981) = 0.00833$. In other words, when converting hPa to pF without correction, the assumed pF values will be 0.00833 units lower than the (correct) pF using cm units. This error does not depend on the pF itself and will therefore be relatively larger near saturation (when pF is low). It is not equal to 2% (as could be interpreted from line 238). Furthermore, it will only affect the intercept, not the slope. I suggest you mention this all in your text.

- Results are presented and statistically analysed and compared, but in the Discussion section no convincing explanation is given for many of the observations. Maybe this is in the nature of the subject, and no conclusive explanations can be found for some of the findings, but there are many speculative affirmations, and some of them could be more elaborated, e.g.:

** I202-206 – if possible, give the explanation Schelle te al. found for this difference. Why only on sandy soils?

** I209-210 This is a very interesting observation. Elaborate on it more. In a pressure device, the pressure is applied via the air, while the sample bottom is at atmospheric pressure. In a suction device, the suction is applied by a hanging water column via a continuum of water-filled pores. So, the propagation of the applied tension is in the opposite domain (via air in one case, and liquid water in the other). That might impose differences, especially under very dry or very wet conditions.

**I211-214 Here it would be interesting to mention that, according to the Clausius-Clapeyron equation (assuming a temperature of 20 °C and relative humidity of 50% in the lab), an oven temperature of 100 °C corresponds to $\text{pF} = 6.91$; and 60 °C corresponds to $\text{pF} = 6.65$. So, your assumed "zero" water content corresponds to these two values of pF (might refer to <https://doi.org/10.2136/sssaj1991.03615995005500040004x> or <https://doi.org/10.1002/saj2.20014> in this context)

**I218-219 It is hard to conclude this, as other factors varied between the laboratories as

well.

**|236-238 The "pF" issue – see my previous comment.

**|240-243 This difference can be perfectly quantified and corrected, so why not do that? For higher values of tension, this factor would become negligible, but at low suctions it could be very relevant. In my analysis, it would affect the intercept, not the slope.

**|247 Lab temperature and humidity have a minor effect. I made a rough calculation and found that at RH=50%, the sensitivity of oven pF to temperature is of the order of -0.007/K. At 20 °C, the sensitivity to RH is -0.0002/%. In terms of water content, this is most probably negligible or even undetectable in a soil sample on a 0.01 g resolution balance.

**|275 Air humidity would not be likely to affect carbonation, as the relative humidity in the sample air will always be around 99-100%

**|304-308 This seems very implausible to me. Why would this only occur at the highest tensions? And: how much weight gain could this represent? If you want to keep this paragraph, you should perform a calculation based on the mass of cement and the carbonation reaction involved in CO₂ fixation.

The CONCLUSION section needs to be rewritten. The first part (|310-320) is a summary of the manuscript, where lines 315-320 contain some conclusions. Lines 321-330 are, in fact, a discussion about how to reduce the observed variability between measurements, and how to standardize. This would better fit in a new item at the end of the Discussion section, and could answer those questions I started with: which method is the best one, and how do we find the true value of water retention? This "best" method should not only allow better reproducibility among laboratories but (more importantly) it should be as close as possible to the true value.

Some other (minor) comments:

|18 – why not include transpiration? or "evapotranspiration"?

|35 for completeness, here you should also add the field method using simultaneous measurements by tensiometers and water content sensors. See e.g. in <https://doi.org/10.3390%2Fs21020447>

|56 add "measurement" - of measurement of soil hydrophysical properties

|84 "ratio of fresh over dry masses" seems an incorrect description. Should be "ratio of water masses (the difference between wet and dry masses) over dry masses" or "ratio of wet over dry masses minus 1".

|90 A comment about why two missing curves?

|92: This should be the opposite: "A linear function was fitted to the measured wet part of SWRCs"

Equations 2, 3 and 4 – the "varying slope" -bracket should not include the (pF-1) term, but only the multiplying (slope coefficient) part.

l124 (Figure 2) In the slope (beta-1) frequency distribution graph, you use the unit (g g-1 pF-1). pF is, in fact, a dimensionless quantity, and you might omit it. On the other hand, if you choose to include it, then your unit of density (y-axis) should be "pF"? Similar in Fig4, 5, ...

l132 (Figure 3) It doesn't seem correct to call these "SWRCs". The figure shows the four observed retention values connected by straight lines. This is better described by "observed water retention values at four pF values" or similar. And: Why not show the fitted lines instead of connecting lines?

Fig5: improve this caption. The "standard deviation of the two "STAY" samples" seems incomplete. Improve to e.g. "the standard deviation of the intercept and slope parameters of the two "STAY" samples"

l150 0.1573 (comma to dot)

l150 replace "by the lab 1 and lab 14" by "by the lab 1 (highest bulk density) and lab 14 (lowest bulk density)"

l203 These acronyms are defined only in the Table 1 caption. I think it would be interesting to define them in the main text as well. The best place for that would be around line 31.

l226 whole curve => (replace by) entire domain of pressure heads

l228 is useful => are useful

l237 "However, 1 cm of water column is not equal to 1 hPa but 0.98 hPa" => (replace by) "Units hPa and cm are commonly considered equivalent, but in fact 1 cm of vertical water column corresponds to 0.98 hPa"

l278 seems => seem

l281 I would remove "without a doubt" – that is a very strong affirmation.

l304 delete "possible" and "probably" from this line.

l311 remove "for the first time"

Table A2 (caption) add: "in order of decrease"