

The SOPHIE initiative – The first interlaboratory comparison of the wet end of the soil water retention curve

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Introduction

Soil water retention curves (SWRCs) are key inputs to feed Richards's equation-based hydrological models and play a role in a wide range of societal issues. However, the methods and procedures for the determination of SWRCs are not harmonized across soil physics laboratories. The impact of using these non-harmonized procedures/methods on SWRC measurements remains unclear. The lack of interlaboratory comparisons of SWRC measurements can be attributed to the fact that these properties are structure-dependent and that soil samples must be kept in an undisturbed structure during and between measurements.



This work aims to gain insight into the real variability introduced by SWRC measurements in laboratory with an interlaboratory comparison using an artificial constructed reference sample that can be transferred safely between laboratories.



Reference samples were constructed with 180g of glass beads (0.250 mm < x < 0.500 mm), 20 g of pure air dry Portland cement and 35 g of water.

Our approach

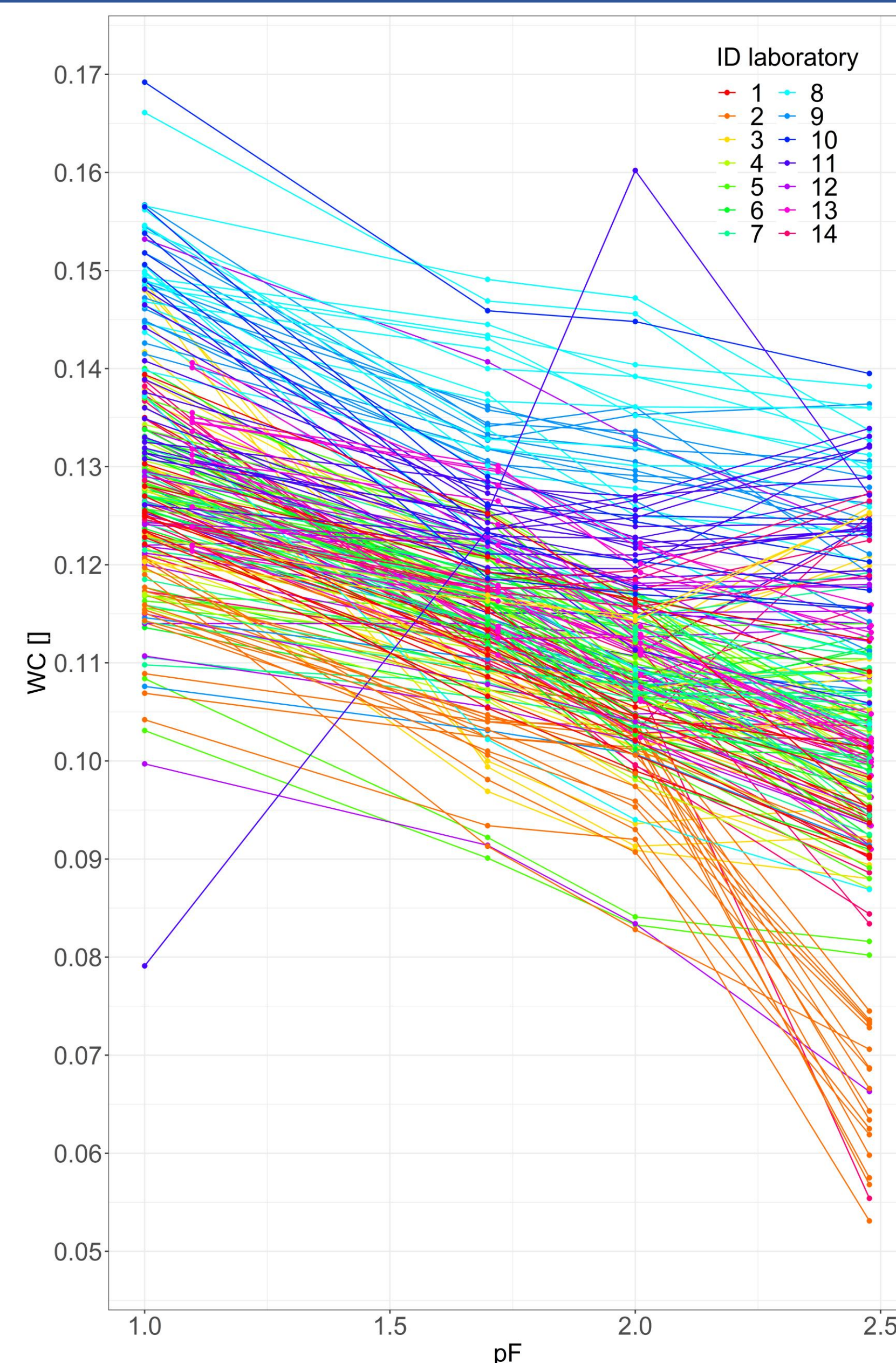
The interlaboratory comparison consisted of three successive rounds where the water content of each sample was measured at 10, 50, 100 and 300 hPa. The ring test involved 84 reference samples distributed among 14 laboratories. The samples were divided into three exchange modalities between the laboratories.

- Stay** : Samples analyzed by the same laboratory all along the three rounds.
- Move**: Samples analyzed by a different laboratory in each of the three rounds.
- Back** : Samples analyzed by a different laboratory for the second round and analyzed back by the original laboratory for the third round.

This scheme is designed to estimate **intra/extra laboratory variability** as well as the effect of **transport** of samples between laboratories on the SWRC measurements.

What is wrong with these samples?

Some retention curves show an increase in water content between two increasing suction steps. This is a **physical nonsense**. This could partially be explained by a **lack of hydraulic contact** between the porous medium and the samples, preventing the release of water from the samples. We also suspect that chemical reactions may have occurred in the samples, such as the **carbonation** of cement ($\text{Ca(OH)}_2 + \text{CO}_2 \rightarrow \text{CaCO}_3 + \text{H}_2\text{O}$), leading to an **increase in the mass and porosity changes of the samples**. The bulk densities of samples are also highly variable and ranged from 1.575 g/cm³ to 1.835 g/cm³.



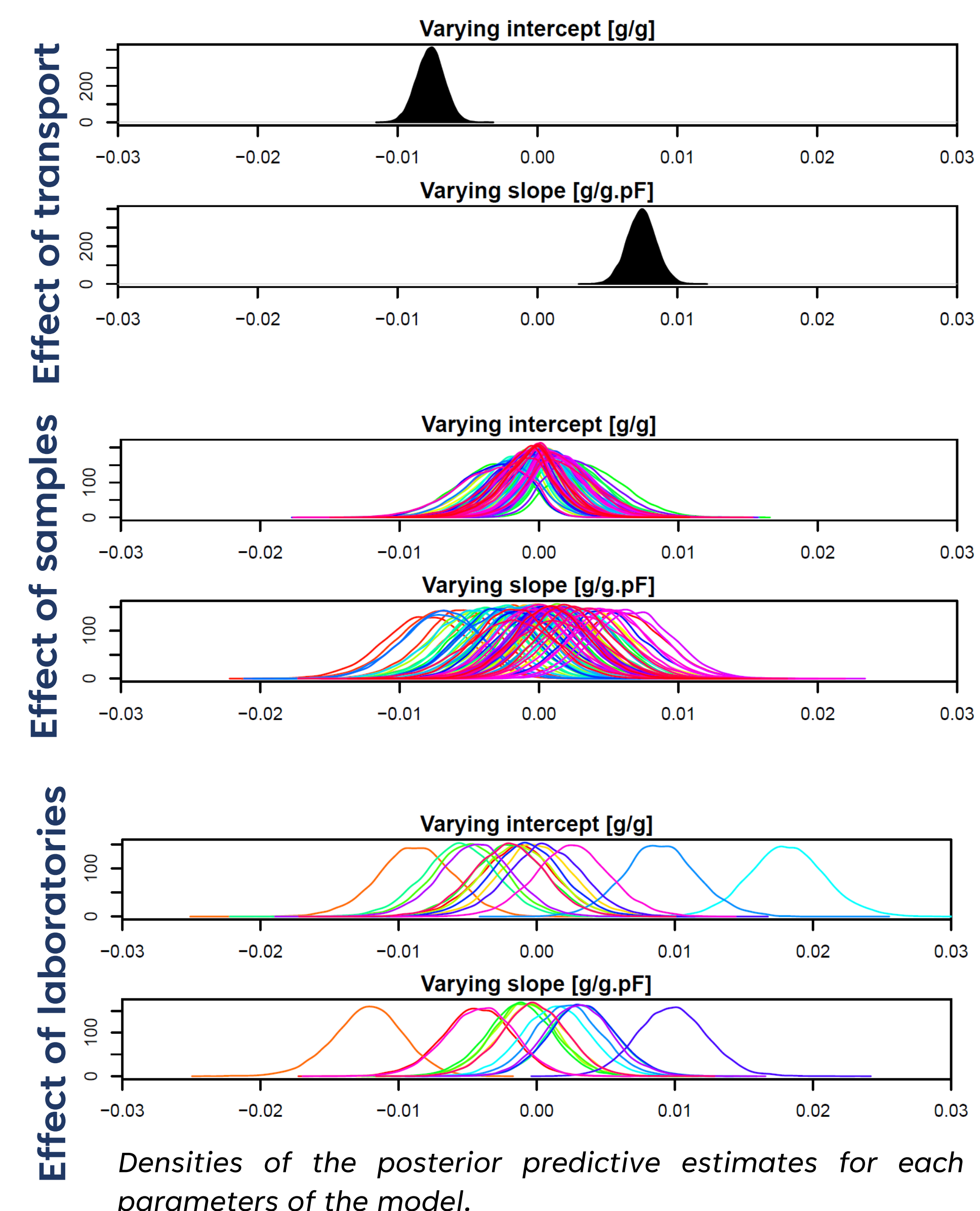
Retention curves obtained from each laboratory during the ring test. Water contents are expressed in g/g.

Adding a transport effect to the model may reveal that the **transfer of samples between laboratories influences the SWRCs**.

Nevertheless, the model shows that differences between **laboratories** are larger than the differences between **samples**, making a higher contribution to the overall variance.

The SWRCs from the interlaboratory comparison are modeled by **varying intercept, varying slope mixed effect model** that adjust the general intercept and slope depending on the **sample and the laboratory**.

Linear Mixed Effect Model



Densities of the posterior predictive estimates for each parameters of the model.

Take-Home Message

- There is evidence that SWRC measurements might differ depending on the laboratory.
- However, to gain insight into the real variability introduced by SWRC measurements in laboratory, **we need and seek (more suitable) porous reference samples with specific requirements** :
 1. Water release must be a **measurable** amount between 0 and 3000 hPa, preferably a linear amount as a function of log(h).
 2. Water release must be **reproducible** for a same sample and, ideally, **consistent** between samples.
 3. The reference sample needs to be **robust**, with a **flat surface** and a **continuous porosity** ranging from ≈ 5 to 2000 μm diameter.

Any idea ? Contact us !

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Our website :

