Measuring RothC pools by DRIFT-spectroscopy

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Introduction

Soil organic carbon models are used to predict changes in carbon stocks resulting from changes in land-use, management or climatic conditions. They often consist of conceptual carbon pools with different decomposition rates. The aim was to fractionate soil samples to obtain differentially stabilized SOC fractions, and to compare these fractions with pools of the RothC model (*Coleman & Jenkinson, 1999*) for corresponding sites. Furthermore, we tested a method to measure SOC in fractions from bulk soil samples by infrared spectroscopy and multivariate statistics.

Methods and Results

We fractionated 111 soil samples from agricultural sites (croplands, temperate and alpine grasslands) across Switzerland to obtain two labile, two intermediate-stabilized and one resistant SOC fraction. The amount of SOC in the fractions was first combined and then split, as shown in Figure 1, to correspond to RothC carbon pools.

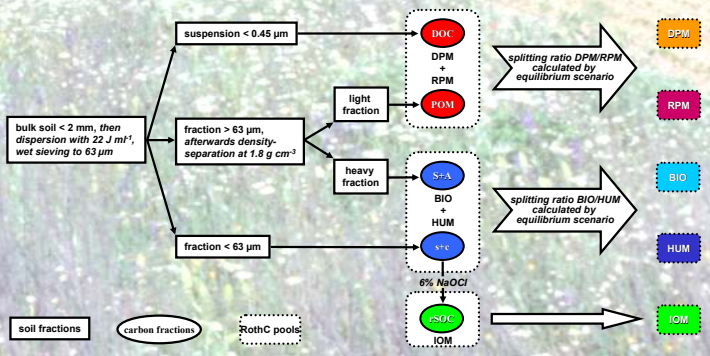

Figure 1) Fractionation procedure and separation of fractions to RothC pools. (s+c = silt and clay, rSOC = resistant soil organic carbon, DOC = dissolved organic carbon, S+A = sand and aggregates, POM = particulate organic matter, DPM = decomposable plant material, RPM = resistant plant material, HUM = humified organic matter, BIO = microbial biomass, IOM = inert organic matter)

SOC fractions combined and split in this manner were then compared to RothC pools obtained after equilibrium simulations for all modelled test sites. Pearson's correlation coefficients (r) varied between 0.85 for decomposable plant material, 0.76 for resistant plant material, 0.99 for humified organic matter and biomass, and 0.71 for inert organic matter (Figure 2).

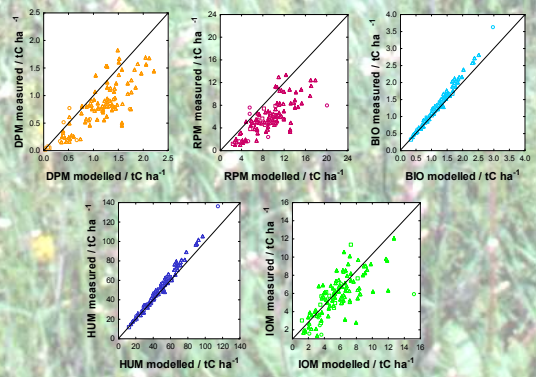

Figure 2) Modelled pools compared with measured fractions. (□=croplands, Δ=temperate grasslands, o=alpine grasslands)

We recorded diffuse reflectance infrared (DRIFT) spectra of all bulk soil samples. These spectra contain information about organic and mineral compounds, as shown in Figure 3.

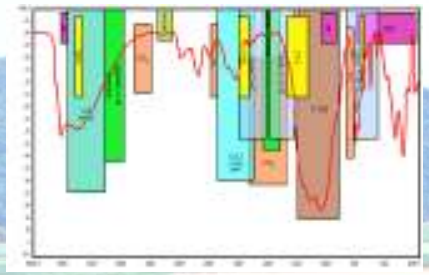

Figure 3) DRIFT spectrum (red line) of a sample of temperate grassland soil in relation to functional groups present in the sample.

Prediction models to quantify the amount of carbon in the combined carbon fractions were calculated by means of multivariate partial least squares (PLS) statistics. We used 100 DRIFT spectra for calibration and validated the prediction models with spectra of 11 soil samples not used for the calibration. Comparisons between SOC fractions predicted by DRIFT-PLS and those measured in the laboratory are shown in Figure 4.

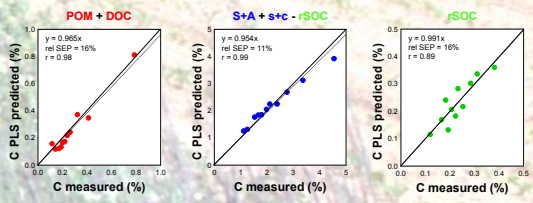

Figure 4) Measured C values compared with those predicted by DRIFT-PLS. Solid lines are 1:1 lines, and dotted lines represent the best fit regressions without intercept (y = ax). rel SEP = relative standard error of prediction (%)

Discussion

The correlations between modelled pools and measured fractions can even be improved by changing the density solution to 2.2 – 2.4 g cm^{-3}. Furthermore, the splitting ratios for DPM and RPM can be estimated from the mean annual temperature (MAT), and can be taken as constant between BIO and HUM. The alpine grasslands showed less accurate comparisons between pools and fractions than the other sites. Using PLS predicted carbon values and MAT-dependent splitting ratios yields in the same accuracy than fractionating the soil samples.

Conclusions

1. **The proposed fractionation procedure can be used to separate soil samples into fractions corresponding to RothC pools (*Zimmermann et al., 2006*).**
2. **Carbon contents of these fractions can be predicted accurately by DRIFT-PLS in a very fast way.**

References:

Coleman & Jenkinson (1999). RothC-26.3. A model for the turnover of carbon in soils. Model description and Windows users guide. IACR – Rothamsted, Harpenden UK.

Zimmermann M, Leifeld J, Schmidt MWI, Smith P, & Fuhrer J (2006). Measured soil organic matter fractions can be related to pools in the RothC model. European Journal of Soil Science, submitted.

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