P0488

A simple approach to isolate slow and fast cycling organic carbon fractions in central European soils - importance of dispersion methods

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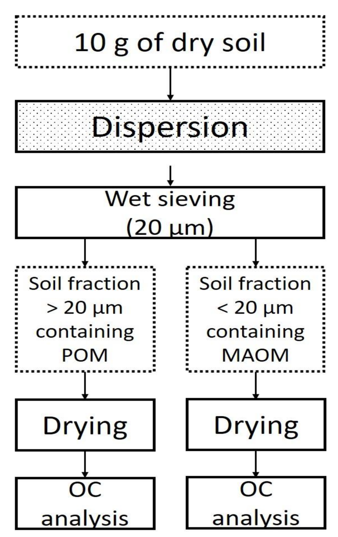
Introduction & Objectives

Which dispersion method separates fractions with different turnovers in a simple particle size fractionation procedure?

Soil organic matter (SOM) provides many beneficial functions such as improving nutrient and water storing capabilities and biological activity in soils. Moreover it sequesters organic carbon and helps to reduce the magnitude of climate change. As SOM turnovers are linked to particle sizes, we are developing a simplified fractionation method that isolates fractions containing mineral-associated organic matter (MAOM) and particulate organic matter (POM) using a 20 µm particle size threshold. Our fractionation scheme is aimed to: i.) separate fractions with distinct turnover times; ii.) to be easy and cheap to process; iii.) allow acquisition of large data sets regarding the state of OM on a regional scale.

Summarized goals:

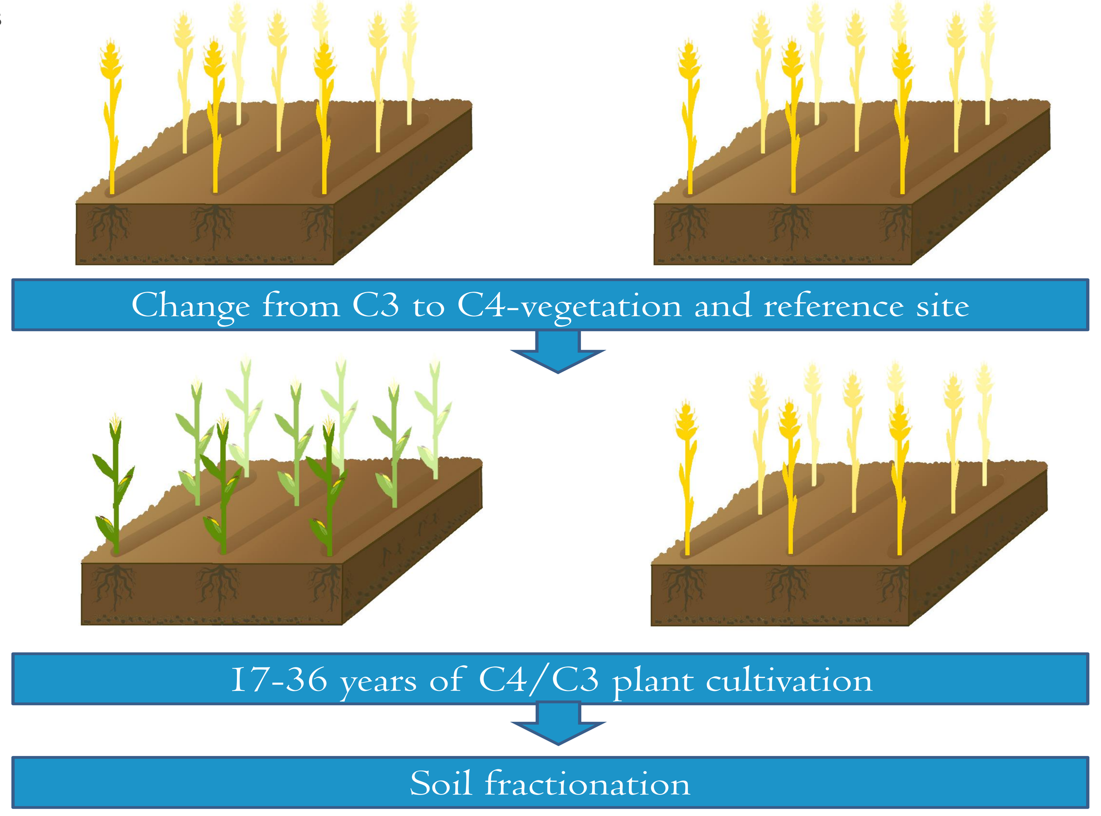
- Develop a simplified fractionation scheme with focus on the dispersion method.
- Use δ13C natural abundance measurements to link fractions to turnover times.
- Isolate and quantify labile and stable SOM pools.
- Challenge / verify SOC saturation models and predict soil potentials to sequester OC in ongoing experiments



Experimental sites & design

How to distinguish/vlidate old and young fractions?

- We use agricultural soils from 5 experimental sites with a change from C3 to C4 vegetation and adjacent control sites to link fractions to their turnover times utilising δ13C – natural abundance measurements.
- Soils have a gradient in texture classes representing sandy, silty and clayey soils



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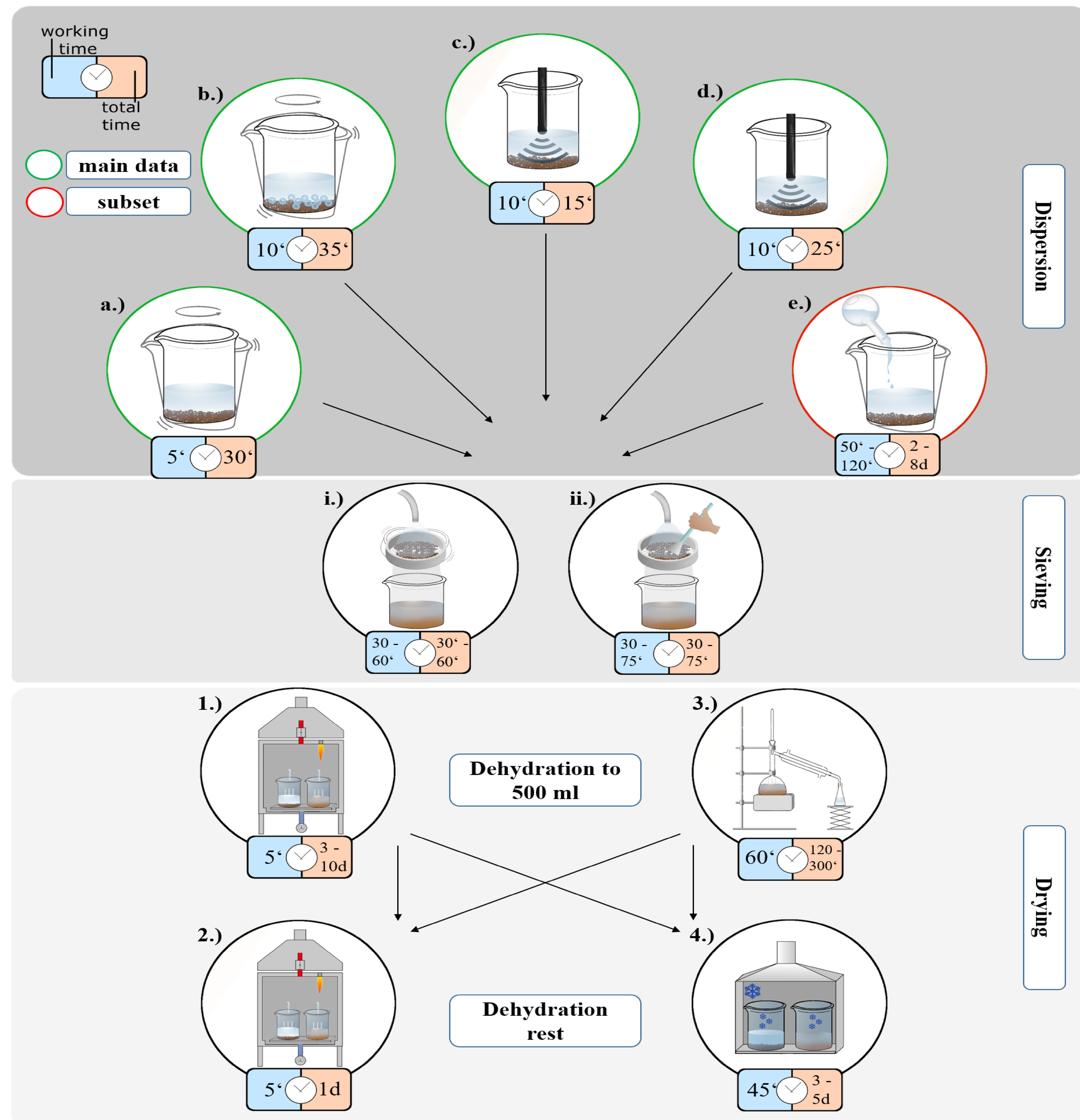
Particle-size fractionation procedure

What did we compare?



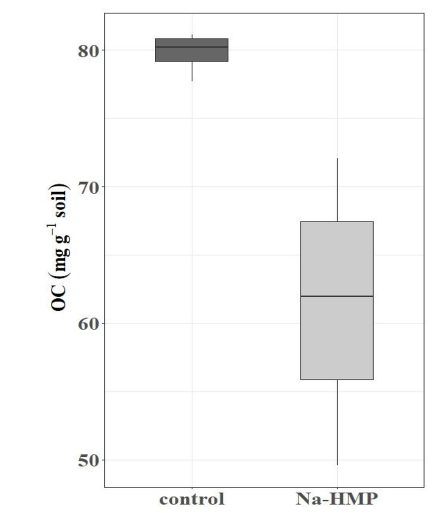
Aggregate dispersion determines the composition of the separated size fractions.
We tested following dispersions methods:
a.) Soils shaken in 100 ml deionized water on flatbed horizontal shaker for 25 minutes at 250 rpm (H2O)
b.) Soils shaken in 100 ml deionized water on a flatbed horizontal shaker for 25 minutes at 250 rpm with 10 glass beads with a diameter of 4 mm (Glassbeads)
c.) Ultrasonication in 150 ml deionized water with low energy input of 100 J ml-1 (US100)
d.) Ultrasonication in 150 ml deionized water with high energy input of 450 J ml-1 (US450)
e.) Dispersion (40 ml 0.5 % Sodium-hexametaphosphate (NaPO3)6) with flatbed horizontal shaker. (HMP)

Moreover, we measured time periods needed for different dispersion steps classified into working time and total time comprising working time and waiting time (in minutes / days).
We assessed time requirements for further fraction steps:
Sieving: i.) Automated wet sieving (20 µm) on a horizontal shaking machine.
ii.) Manual wet sieving (20 µm) using a rubber spatula.

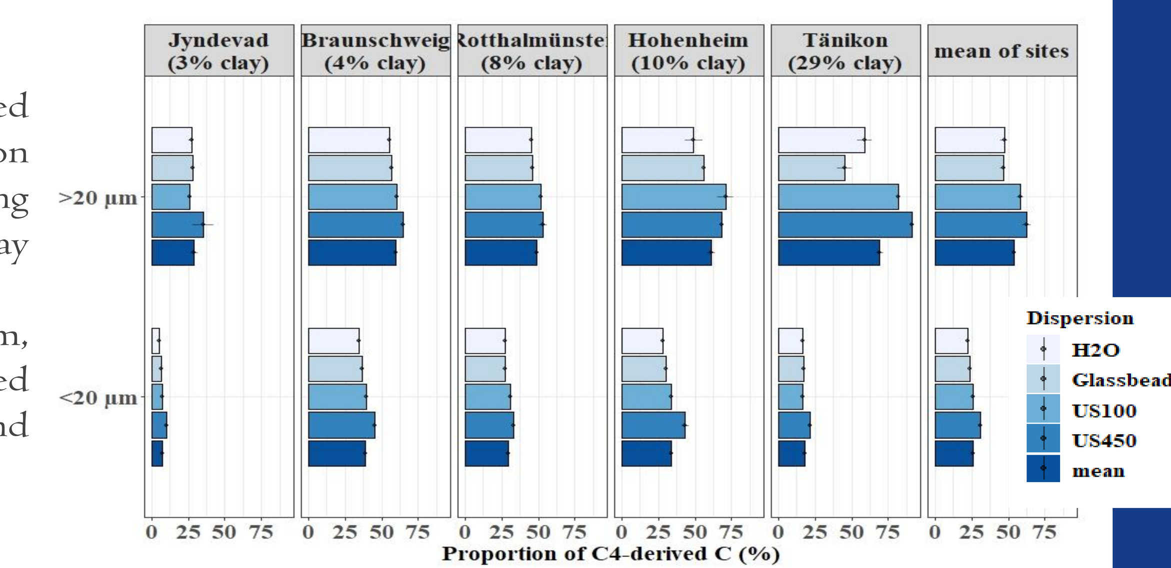
Drying: 1.) Evaporate H2O in drying cabinet to 500 ml
2.) Final drying in drying cabinet.
3.) Evaporate H2O with rotary evaporator to 500 ml
4.) Final drying with freeze dryer.

Results

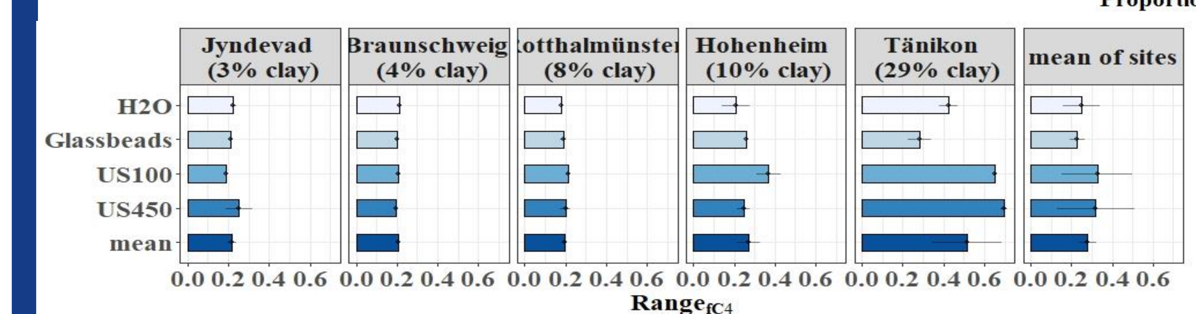
Which dispersion was performing best? Evaluation of fractions turnovers, method reproducibility and recovery.



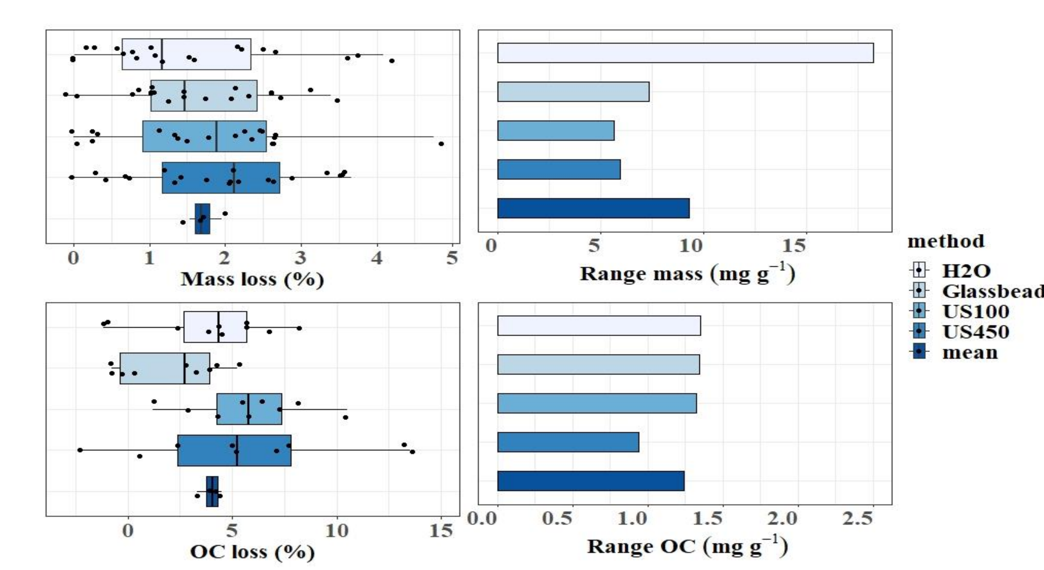
- Na-HMP dispersion (Method e.) had limited performance exceeding time restrictions and having significant OC loss due to rinsing of Na-HMP in selected soils.
- The method was therefore discontinued.
- Further research is needed to quantify OC losses caused by rinsing with Na-HMP in different soils.
- The results demonstrate the necessity to quantify OC recovery rates in SOM fractionation procedures.



- The proportion of C4-derived OC increased in the fraction >20 µm with increasing dispersion intensities and clay content of the soils.
- Within the fraction < 20 µm, the C4-derived OC increased slightly due to destruction and translocation of POM.



- We used the difference in the C4-derived OC (> 20µm - < 20µm) as a quality indicator to of the methods to isolation of fractions with distinct turnovers.
 Higher $Range_{fC4}$ = better performance.
- Clay particles tend to form stable aggregates that require stronger dispersion.
- Ultrasonication performed best in isolating fractions with distinct turnover for being highly reliable especially in clayey soils.



- Mass and OC loss were small indicating good recovery for all tested dispersion methods.
- Reproducibilites were high in general. The mass reproducibility of the H2O method was lower compared to the other methods indicating that this method is less reliable.

Conclusion

- We propose particle size fractionation combined with ultrasonic dispersion as a fast/highly reliable method to quantify slow and fast cycling SOC pools for a wide range of soil types and textures.
- The method can be used as an indicator to track changes in fast and slow cycling OC pools induced by management practices and climate change