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Investigating the complementarity of thermal and physical soil organic carbon fractions in mainland France

Amicie DELAHAIE

Laboratoire de Géologie, École Normale Supérieure, CNRS, PSL University, IPSL, Paris, France

Assessing soil organic carbon biogeochemical stability is critical for estimating future changes in soil carbon stocks. Several methods for the assessment of soil organic carbon (SOC) biogeochemical stability have been proposed but very few can be implemented on large sample sets. Indeed, to date, only simple physical fractionation protocols (e.g. Lavallee et al., 2020) and Rock-Eval® thermal analysis techniques (Delahaie et al., 2022, SOIL discussion) have been implemented on data sets larger than a few hundred samples. Simple fractionation techniques allow separating a particulate organic carbon fraction (POC; considered labile) and an organic fraction associated with minerals (MAOC; considered more stable). Regarding thermal analyses, Rock-Eval® results associated to the $PARTY_{SOC}$ machine-learning model (Cécillon et al., 2021) provide a measure of the active (mean residence time of ca. 30 years) and centennially stable SOC fractions.

In this study, we present the results of physical fractionations performed on ca. 1000 samples and thermal analyses performed on ca. 2000 samples from French mainland topsoils (RMQS program). We compare the amount and the drivers of each fraction. Our results show that most of the MAOC fraction is not stable at a centennial timescale. However, we show using a Random Forest model that the MAOC content and the centennially stable SOC content are similarly influenced by a common set of drivers (figure): clay, pH and climatic conditions (mean annual temperature and mean annual precipitation). Finally, we discuss the complementarity of these two types of relatively high-throughput fractionation protocols.

References

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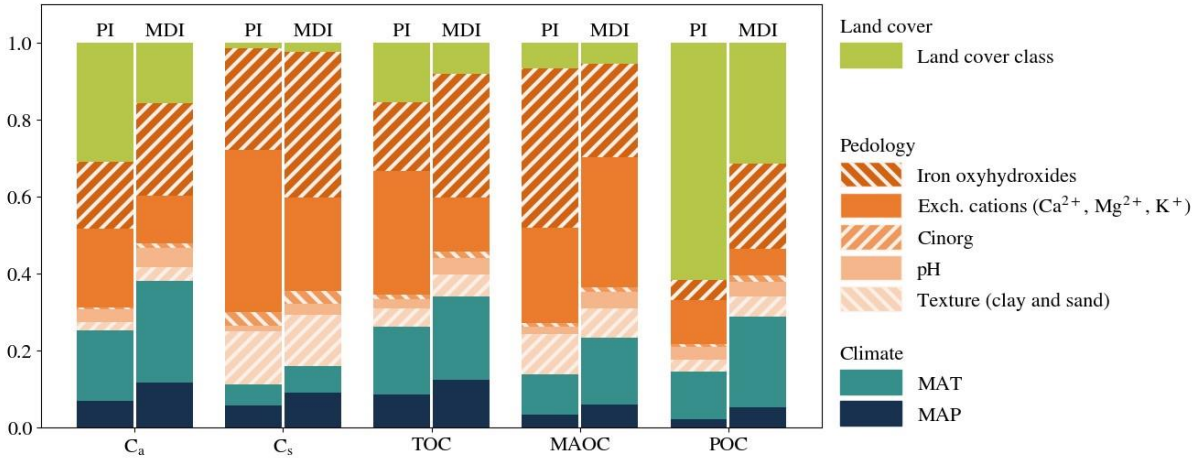

Figure: Drivers of the different fractions, determined by Random Forest modeling.