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Testing steady states carbon stocks of Yasso07 and ROMUL models against soil inventory data in Finland

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Soil carbon pool is a significant storage of carbon. Unfortunately, the significance of different drivers of this pool is still unknown. In order to predict future feedbacks of soils to climate change at global level, Earth system model (ESMs) are needed. These ESMs have been tested against soil carbon inventories in order to judge whether models can be used for future prediction. Unfortunately results have been poor, and e.g. Guenet et al. 2013 presents a test where soil carbon stocks by ORCHIDEE models are plotted at plot level against measurements without any correlation. Similarly, Todd-Brown et al. (2013) concludes that most ESMs are not able reproduce measured soil carbon stocks at grid level.

Here we estimated litter input from trees and understorey vegetation to soil, based national forest inventory 9 data. Both, biomass estimates for trees and for understorey vegetation were smoothed with ordinary kriging methods and thereafter litter input was modeled by dominant tree species. Also regional litter input from natural mortality and harvesting residues were added to the input.

Thereafter we applied Yasso07 (Tuomi et al. 2011) and ROMUL (Chertov et al. 2001) soil models to estimate steady-state carbon stocks for mineral soils of Finland on a 10*10 km2 grid. We run Yasso07 model with annual time step and using parameters based on Scandinavian data (Rantakari et al. 2012) and also with parameters based on global data set (Tuomi et al. 2011). ROMUL model was applied with and without soil water holding capacity information. Results were compared against Biosoil measurements of soil carbon stocks (n=521).

We found out that the best match between model estimates and measurements by latitudinal bands (n=43) were by ROMUL model with soil water holding capacity, with RMSE of 9.9 Mg C. Second best match was with Yasso07 with Scandinavian parameters, with RMSE of 15.3 Mg C.

Results of this study highlight two things, it is essential to run dynamic soil models with time steps that are short enough to take into account non-linear effects of soil moisture and temperature to decomposition. In addition, adding soil water holding capacity into ROMUL model improved the fit between measured and modelled data by 6.7 (Mg C) units of RMSE. We propose that soil model development community should focus more into impacts of soil moisture to decomposition. This is needed especially due to fact that future precipitation pattern is predicted to be more variable, with higher likelihood of dry periods and extreme rain events.