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

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Introduction

- Earth system models in general perform poorly when predicting soil carbon stocks (Guenet et al. 2013). But precise and accurate predictions are needed to predict biosphere feedback to climate.
- Previously individual soil carbon models have been tested against repeated soil carbon with reasonable results (e.g. Yasso07, ROMUL and Q model) by Rantakari et al. (2012) and Ortiz et al. (2013). But the match with data and models do not tell if all essential processes are included by these models.
- These simpler soil models include litter quantity and – quality and weather impacts. But often lack more complicated soil processes.

The objective of this work was to test spatial trends of steady-state carbon stocks of Yasso07 and ROMUL models against measured soil carbon data.

Here we tested:

- If the litter quantity, -quality and weather data are enough to estimate spatial trends with soil carbon stocks in Finland
- If variation in soil texture affects carbon stocks through vegetation and decomposition. We hypothesize that increased fraction of coarser soil textures, like sand reduces carbon stocks.

Material and methods

- We used national forest inventory 9 (NFI9) stem volume- and species dominance maps based on kriging to estimate the level of biomass and litter input across Finland.
- Also litter from understorey vegetation was modelled based on empirical observations and 1995 field survey, where 3000 permanent sample plots were measured and also the coverage of the understorey vegetation was mapped.
- The litter resulting from harvesting residues and natural mortality was also included into the analysis.
- All litter input was generalized into 10x10 km grid on mineral forest soils.
- We run Yasso07 (Tuomi et al. 2011) model with Scandinavian and global parameter sets, while ROMUL (Chertov et al. 2001) model was run with and without soil water holding capacity data.

Results

- Yasso07 and ROMUL were able to produce similar pattern in the soil carbon when plotted against Northern latitude (Fig. 2). Yasso07 with Scandinavian parameters had a best match against meanvalues of the measured data, when compared to other model estimates. ROMUL model with soil water holding capacity produced an increasing trend of soil carbon stock towards South coast of Finland as indicated with Biosoil data.
- Models were also evaluated against data by comparing their estimates against means of data in 43 latitude bands (Fig. 3). The best agreement with measured data and model estimates were foundwith Yasso07 and Scandinavian parameters, when RMSE was used as criterion. We also found that ROMUL with soil water holding capacity had a best correlation with data, noting though that this version produced systematically lower carbon stocks than were measured (Fig. 3).

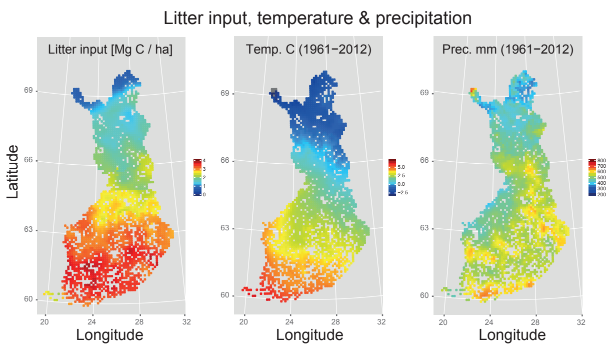

Figure 1. Spatial estimates for annual litter input [Mg C per ha], mean temperature (1961–2012) [Celsius degrees] and mean annual precipitation (1961–2012) [mm].

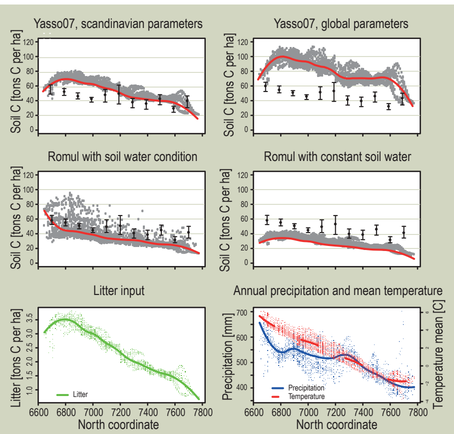

Figure 2. Soil carbon estimates for Finland by Yasso07 and ROMUL soil models and by Biosoil data according to Latitude (means and 1.96 times standard errors of means with black whiskers) on top and middle rows. Estimated litter input, mean annual temperatures and annual precipitation on the lowest row.

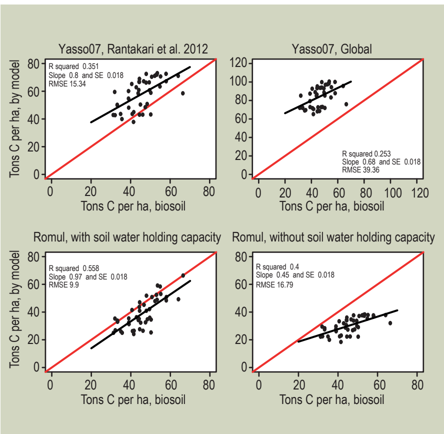

Figure 3. Mean soil carbon estimates for Finland by Yasso07 and ROMUL soil models plotted against Biosoil data, by latitude bands. Data has been divided into 52 equal latitude bands and those with three or more soil carbon measurements were included (n=43). Graph include also R2 of a linear model, its slope and slopes standard error and root mean square error (RMSE) of model mean vs. measured means.

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