

# Evaluation of a linked stand growth and decomposition model with stand level measurements

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## Background

We compare results of an empirical growth model, MOTTI, linked to a soil carbon model, Yasso, with measurements made at three Scots pine stands. Yasso is used in Finnish greenhouse gas (GHG) reporting. Our aim is evaluate the Motti-Yasso model to estimate stock changes of biomass, dead wood, litter and soil organic matter.

One of the stands is located at Hyttiälä in southern Finland, the SMEAR II measuring station, and provides measurements of biomass, litter production, and NPP (photosynthesis and respiration) of trees and ground vegetation, soil respiration and NEE (net ecosystem exchange, with Eddy covariance technique). The measurements pertain to a 1.4

ha footprint area in a 40-year old Scots pine-dominated forest. The other two stands are UN-ECE Integrated Monitoring 0.16 ha plots (HJ1 and HJ4) in the Hietajärvi catchment in eastern Finland and provide measurements of litterfall and C stocks in the humus layer and soil. The stand at HJ1 is 100-years-old and that at HJ4 230-year-old.

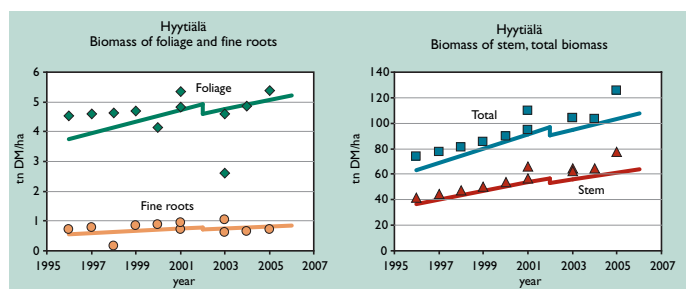


Figure 1. For the Hyttiälä stand, we initialized MOTTI with tree inventory measurements made in 2001. MOTTI was ran both forward and backward from this initial state. A thinning made in the part of area in 2002 shows as a dip in the simulated curves. Biomasses predicted by MOTTI compared reasonably well with measured values (markers).

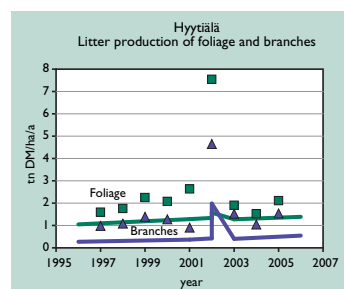


Figure 2. MOTTI underestimates of both foliage and branch litter production at Hyttiälä. The sharp decrease in simulated litter production in 2002 is related to a thinning made in the part of area and to an dry summer.

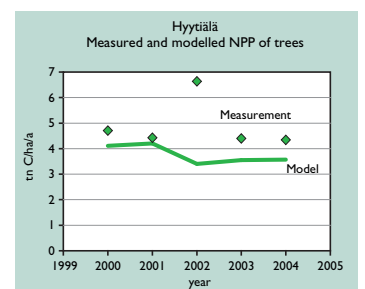


Figure 3. MOTTI estimates of NPP (change in biomass plus litter production) in comparison to measured values are lower due to lower litter production estimates. MOTTI is not able to generate annual variation exhibited by the measured values since its growth functions do not depend on weather conditions.

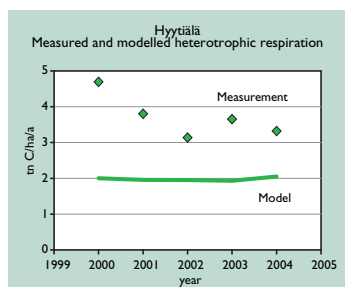


Figure 4. Heterotrophic respiration (decomposition of dead organic matter) predicted by Motti-Yasso is clearly lower than the measured values. This is also related, at least partly, to the underestimation of litter production by MOTTI.

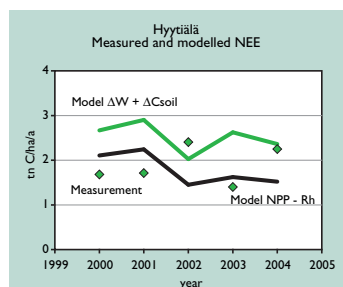


Figure 5. NEE predicted by Motti-Yasso both as NPP less heterotrophic respiration and change in biomass and dead organic matter reasonably match measurements. Model errors in NPP and litter production (Figs. 2 and 3) probably cancel each other out.

MOTTI predicted larger foliage litter production for HJ1 and HJ4 than measured, but branch litter production by MOTTI is small so that modelled and measured total (foliage plus branch) litterfall values match quite closely.

Litterfall production in Hietajärvi plots HJ1 and HJ2, tn DM/ha

	Plot HJ1		Plot HJ4	
	Foliage	Total	Foliage	Total
MOTTI	1.64	1.74	1.22	1.28
Measured	0.78	1.58	0.64	1.26

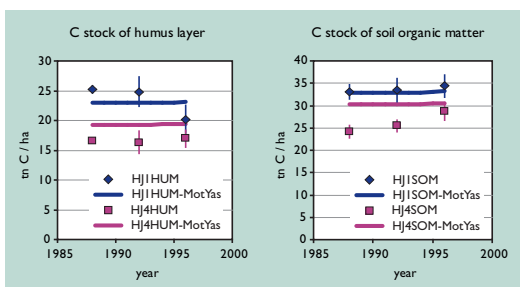


Figure 6. MOTTI was initialized for the Hietajärvi plots (HJ1, HJ4) using tree measurements made in 1988. Simulated litter production for 1998 was used to calculate the steady-state carbon stocks in soil. Levels of modelled soil C stocks compare favourably with measured (humus + 0-80 cm layer) values (vertical lines show  $\pm 1$  sd). The simulated stocks vary little during the short time period covered by the study while measured soil C stocks indicate considerable variability. The variability reflects both natural variability and sampling error.

## Conclusions

The linked Motti-Yasso model was able to reproduce most features of the Hyttiälä and Hietajärvi data sets. We are therefore encouraged to develop the Motti-Yasso model as a tool for carbon dynamics, and Yasso as a component in national GHG reporting. However, litter production estimates did not match measurements as well as expected. MOTTI underestimated crown litter production in the young stand at Hyttiälä while overestimating it in the old stands at Hietajärvi.

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