# Implementation of mycorrhizal mechanisms in a soil carbon model improves predictions of long-term plant liter decomposition processes

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Weilin Huang[1], Peter van Bodegom[1], Toni Viskari[2], Jari Liski[2], and Nadejda Soudzilovskaia[1]
[1]Leiden University, [2]Finnish Meteorological Institute
Contact: w.huang@cml.leidenuniv.nl
Universitiet Leiden
Finnish Meteorological Institute

## 1. Motivation

Mycorrhizae are hypothesized to play especially important roles in soil carbon sequestration. Ecosystems dominated by plants featuring ectomycorrhizae (EM) and arbuscular mycorrhizae (AM) promote distinct soil carbon dynamics[1,2].

The comparison of AM and EM impacts on litter decomposition is an important question to address, however, current soil carbon models treat mycorrhizal impacts on the processes of soil carbon transformation as a black box.

Soil carbon model Yasso15[3,4] provides an ideal framework for a mechanistic integration of mycorrhizal impacts into the modelling of plant litter decomposition processes.

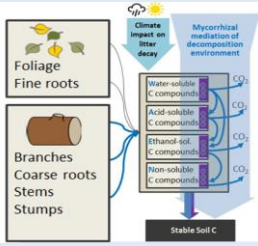



*Fig.1 Litter decomposition controlled by climate and mycorrhiza environment*

## 2. Conceptualization of mycorrhizal impact

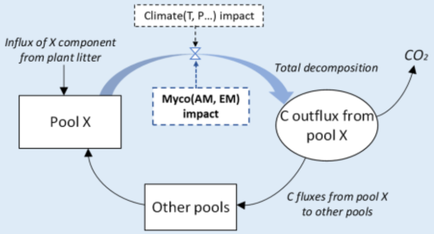



*Fig.2 Carbon fluxes from and to each X pool of carbon, with X being W, A, E or N, as represented by the modified Yasso model. Blue arrow and blue box show conceptualization of added impact of mycorrhizal environment on litter decomposition process. While in the original version of the Yasso plant litter decomposition process was represented as a function of climate and litter quality, in our model decomposition is a function of proportions of ectomycorrhizal and arbuscular mycorrhizal plants in vegetation, climate and plant litter quality.*

We accounted for mycorrhizal impacts in the original Yasso litter decomposition model by modifying the decomposition rate terms α, which in the original Yasso model were controlled solely by climate dynamics.

➢ **Key message:**
**Our model separates impacts of climate and mycorrhizas of decomposition.**

## 3. Model performance

Comparing four conceptualizations of mycorrhizal impact on decomposition of litter featuring different recalcitrance levels; our comparison exhaustively covered all possible representations of mycorrhizal impacts of labile and recalcitrant C fractions of litter.

*Table.1 RMSE of each model*

| | Yasso15 | Myco-a1 | Myco-a2 | Myco-a3 | Myco-a4 |
|---|---|---|---|---|---|
| CIDET | 10.74 | 10.87 | **10.48** | 10.86 | 10.74 |
| LIDET | 20.81 | 21.09 | **19.83** | 19.72 | 19.88 |
| ED12 | 7.36 | 6.50 | **6.49** | 6.89 | 6.85 |

➢ **Key message:**
**The optimal model Myco-a2 implements mycorrhizal impact on labile litter pools as being distinct from that of recalcitrant litter pools.**

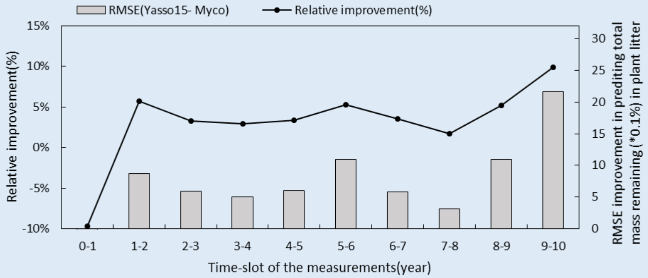



*Fig.3 Improvement of Myco-Yasso model accuracy compared to Yasso along time. Histogram bars represent relative RMSE differences per time slot between Yasso15 and Myco-Yasso. The line with dots shows the absolute value of RMSE differences (Yasso15- Myco).*

We observe a reduction trend of RMSE in long tern(1-10yrs predictions), compared to the original model (Fig.3).

➢ **Key message:**
**Mycorrhizal impact is an essential mechanism to be included especially for longer terms litter decomposition. It's capacity to predict and capture more reliable time dynamic pattern will enhance it's utility in analyses of longer tern C decomposition and cycling.**

We test the sensitivity of the litter decomposition to parameters and input (Fig.4), and model variability in litter decomposition estimations.

➢ **Key message:**
**Yasso-Myco has lower sensitivities to 'decomposition rate' and temperature parameters compare to Yasso15**

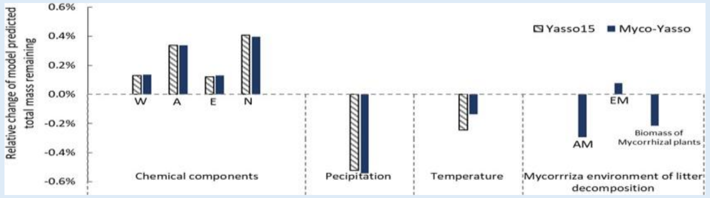
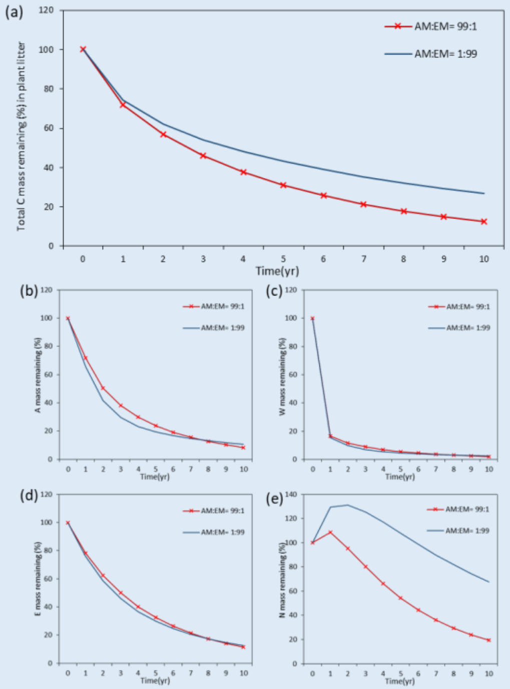



*Fig4. Model sensitivity to input. Relative change of predicted litter remaining after 10 years decomposition (%)*

## 4. Mycorrhizal impact on labile and recalcitrant litter decomposition




➢ **Key message:**
**Consistent with the predominant view, time dynamic of carbon loss from litter depends on whether the litter is subjected to AM or EM decomposition environment. AM lost more C then EM dominant environment.**

➢ **Key message:**
**In the long term, EM decomposition environment leads to accumulation of recalcitrant C components, while AM decomposition environment leads to a loss of recalcitrant C components (AM a bit stronger)**

*Fig.5 Dynamics of plant litter decomposition in AM dominant vs EM dominant environments. (a) decomposition of total carbon mass from plant litter; (b), (c) and (d) show the dynamics of C remaining of labile carbon components (W – water-soluble C fraction, E – ethanol-soluble C fraction, A – acid hydrolysable C fraction); (e) dynamics of carbon remaining of recalcitrant C compnoent (N-non-hydrolysable fraction).*

## References

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