

Implementation and validation of a new mulch module

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Daisy mulch module

Inspired by PASTIS mulch module (Garnier et al. 2003)

- Daisy mulch description
 - Major structural and hydraulic parameters
 - Implementation in Daisy
- Daisy mulch validation
 - soil column measurements from Aslam et al. (2018)

Daisy mulch description

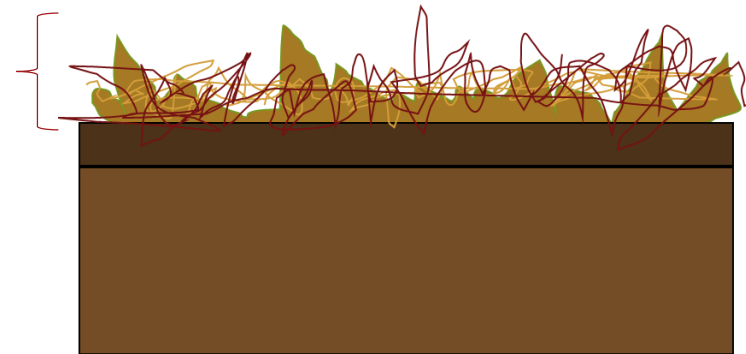
Structural parameters

One mulch layer:

- Dry mass (DM, g cm⁻²)
- Bulk density (BD, g cm⁻³)
- Specific mulch area index (MAI, cm² g⁻¹)

$$\text{Cover (-)} = 1 - e^{-\alpha \text{ SMAI DM}}$$

$$\text{Height (cm)} = \frac{\text{DM}}{\text{BD}}$$



Daisy mulch description

Hydraulic parameters

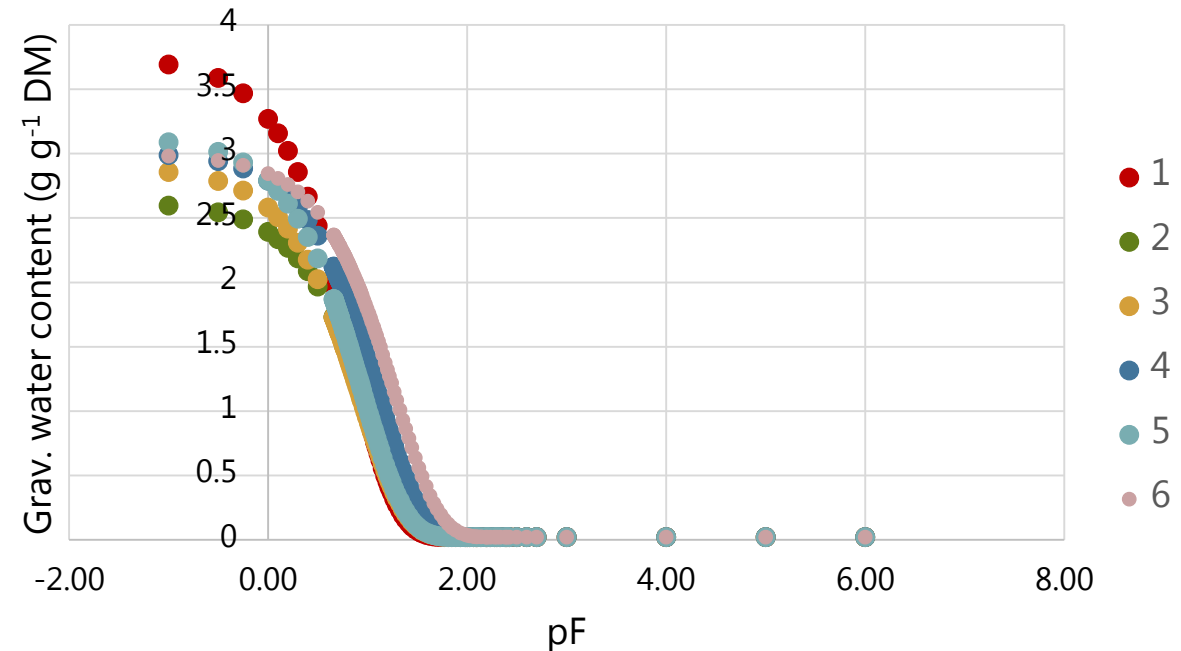
- Mulch max. and res. water contents (g g^{-1}) for water interception and retention
- Mulch propensity to water recharge

$$\Delta WC(\text{mm}) = \Delta \text{rainfall} * e^{-\alpha \frac{WC_{max} - WC_{res}}{WC_{max} - WC}}, \text{ if } WC < WC_{max}$$

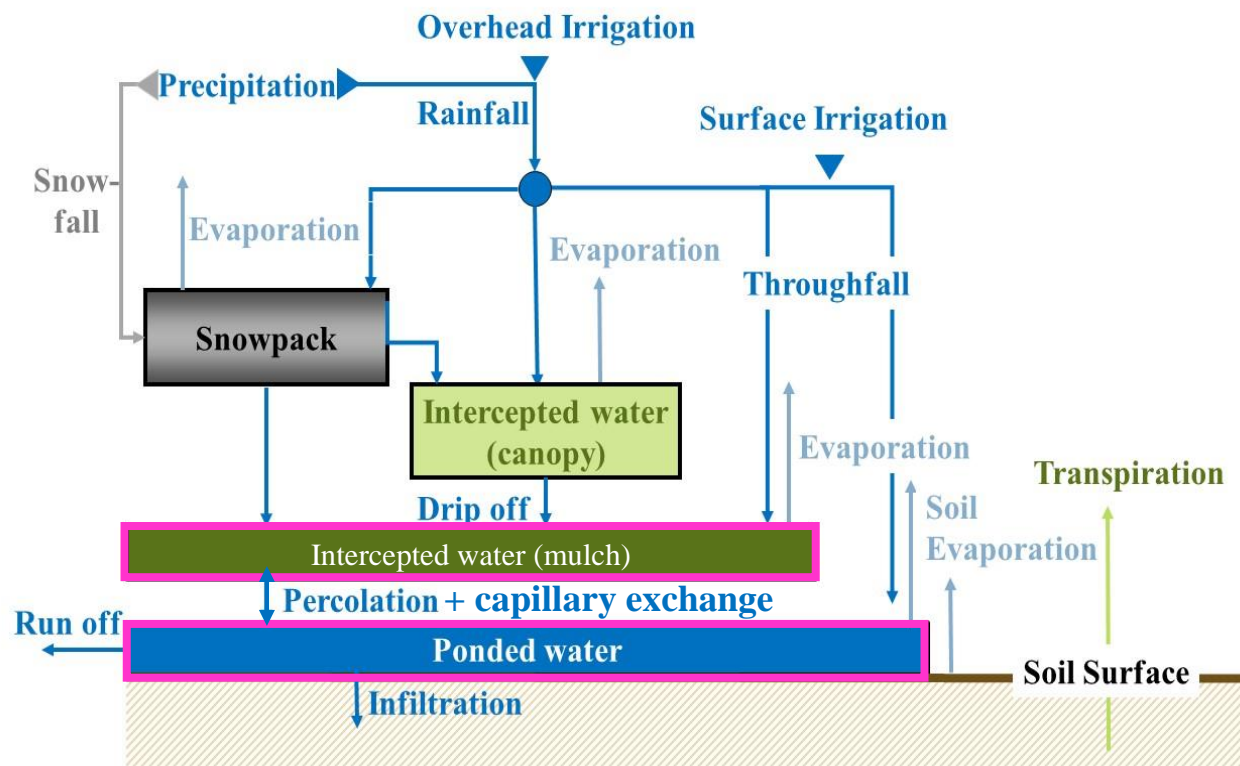
(Findeling et al., 2007)

- Exponential retention curve, k (cm^{-1})

$$\theta(h) = \theta_R + (\theta_S - \theta_R) * e^{kh}$$



Daisy mulch implementation – Water flow



Modified from Hansen et al. (2012a)

- Mulch:
 - receives water not intercepted by canopy according to water capacity (max. water content)
 - delivers water to surface according to surface detention capacity

Daisy mulch description - OM

- Mulch = AOM pools: crop/cover crop residues, falling leaves

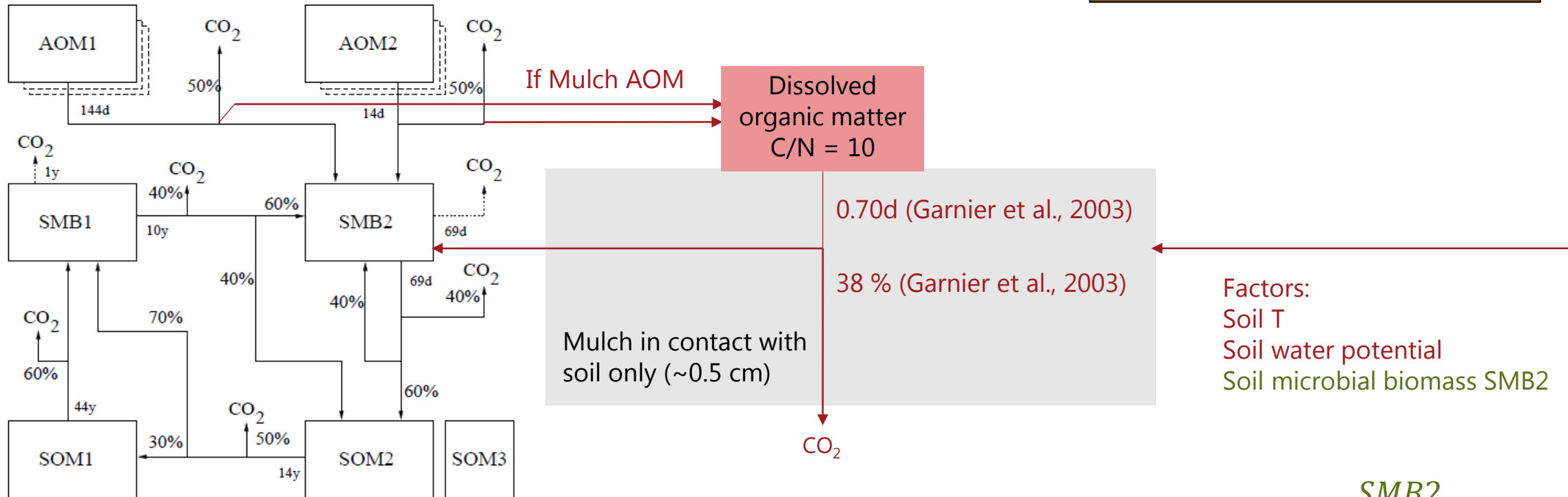
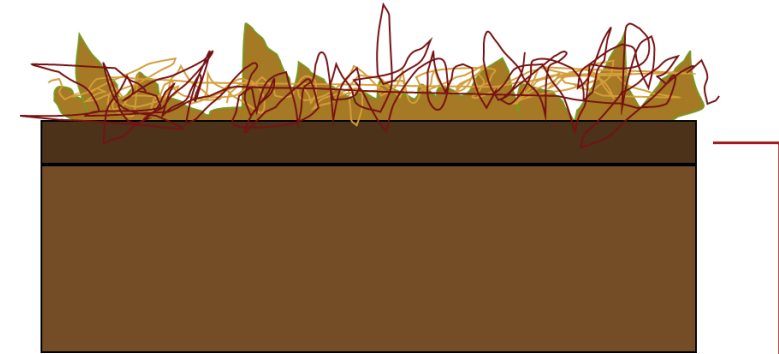
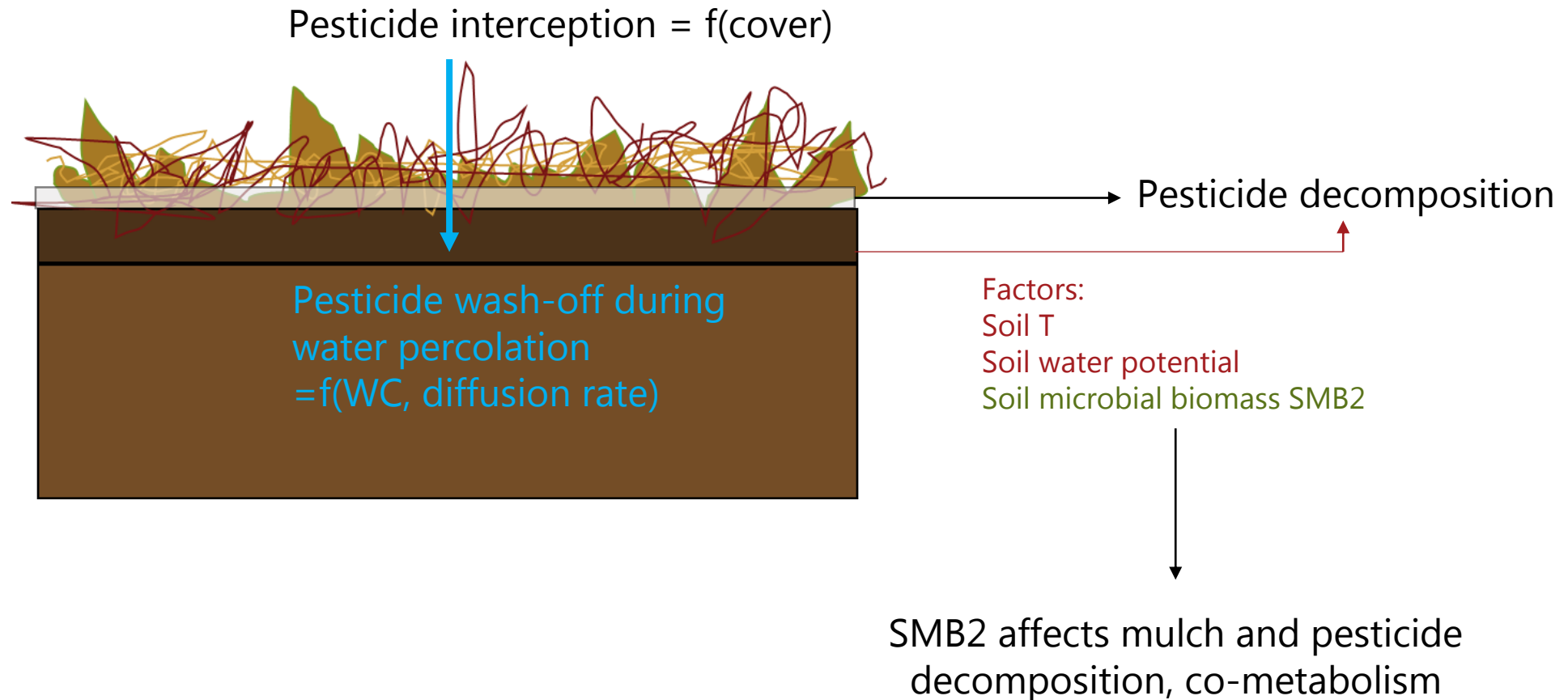


Fig. 1. Current standard organic matter model in Daisy.

(Abrahamsen, Gjettermann, & Hansen, 2010, manuscript)

K_M Michaëlis-Menten constant ($g\ cm^{-3}$)

Daisy mulch description - Pesticide



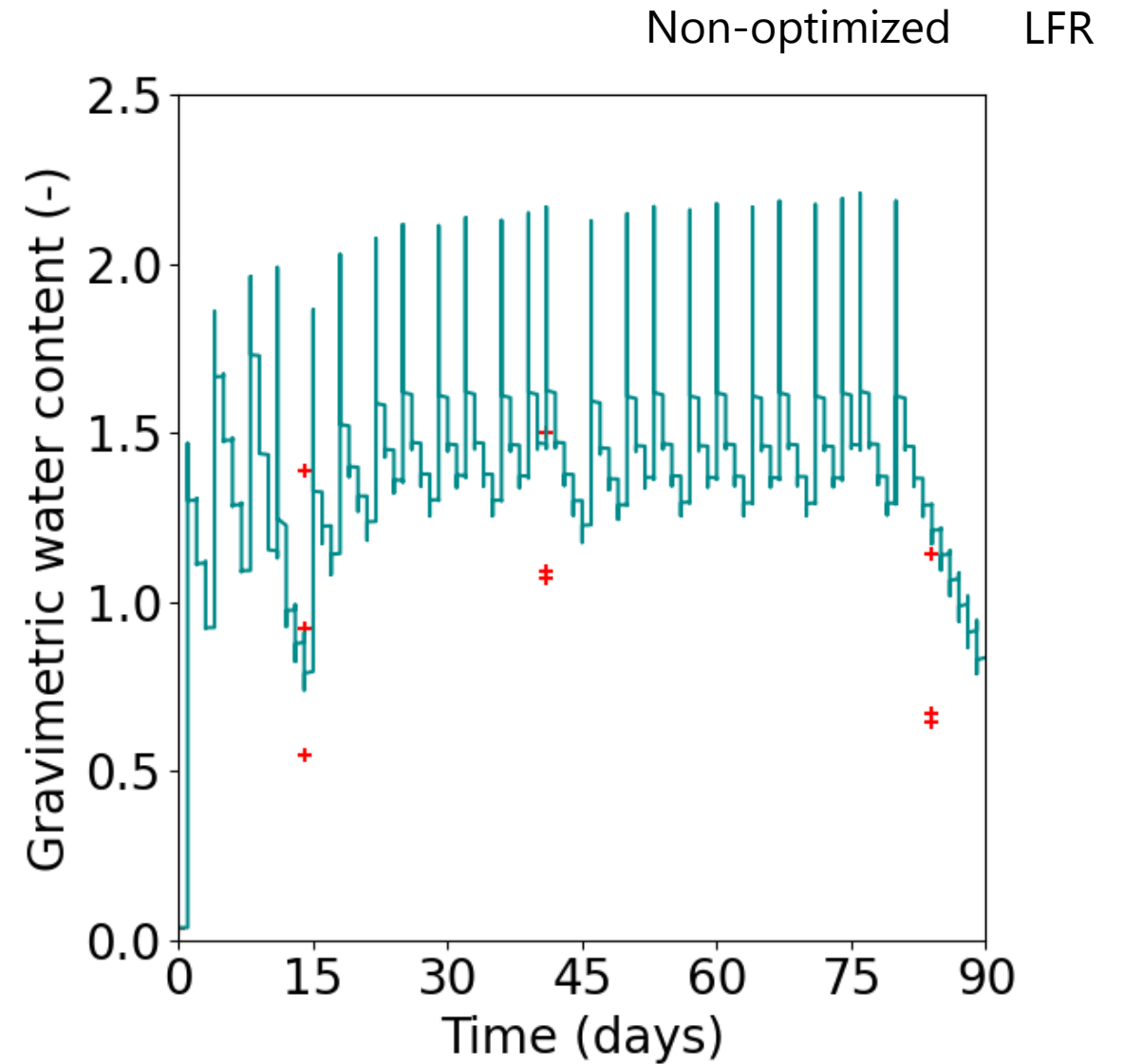
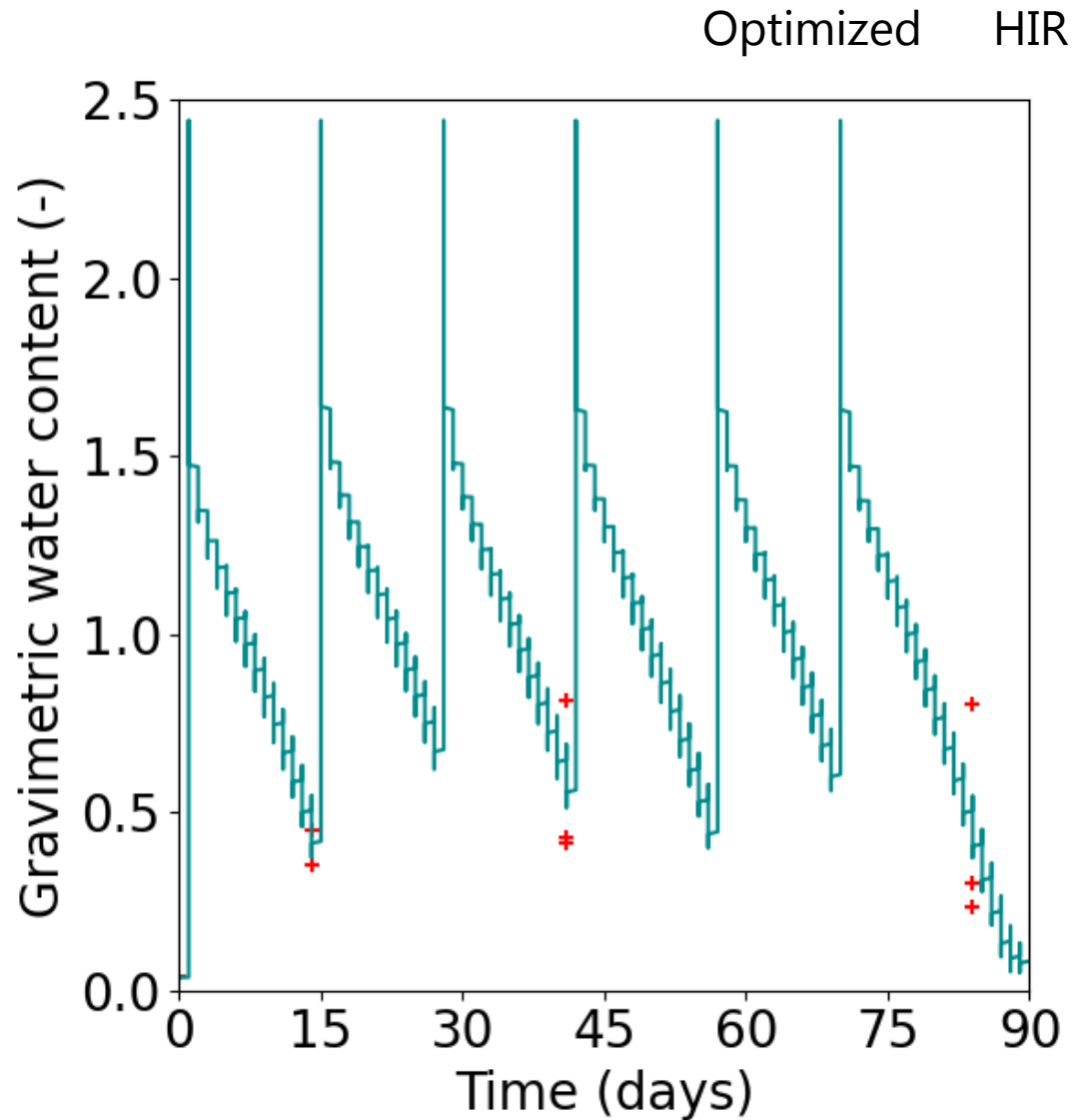
Daisy mulch validation

Soil column experiment from Aslam et al. (2018):

- 25-cm column with 2 soil horizons (0-5, 5-25 cm)
- mulch: 758 g m⁻² of crop residues (maize and dolichos)
- s-metolachlor and glyphosate application (1.04 and 1.29 kg ha⁻¹)
- Two artificial rainfall regimes: high and infrequent (HIR), low and frequent (LFR)

Observations to fit	Optimized parameters
Pesticide residues in mulch	Pesticide parameters (DT50, Kd) from EFSA assessment reports
Pesticide residues in first soil layer	Pesticide diffusion coefficients
Mulch water content (grav.)	Mulch water retention and exchange to soil

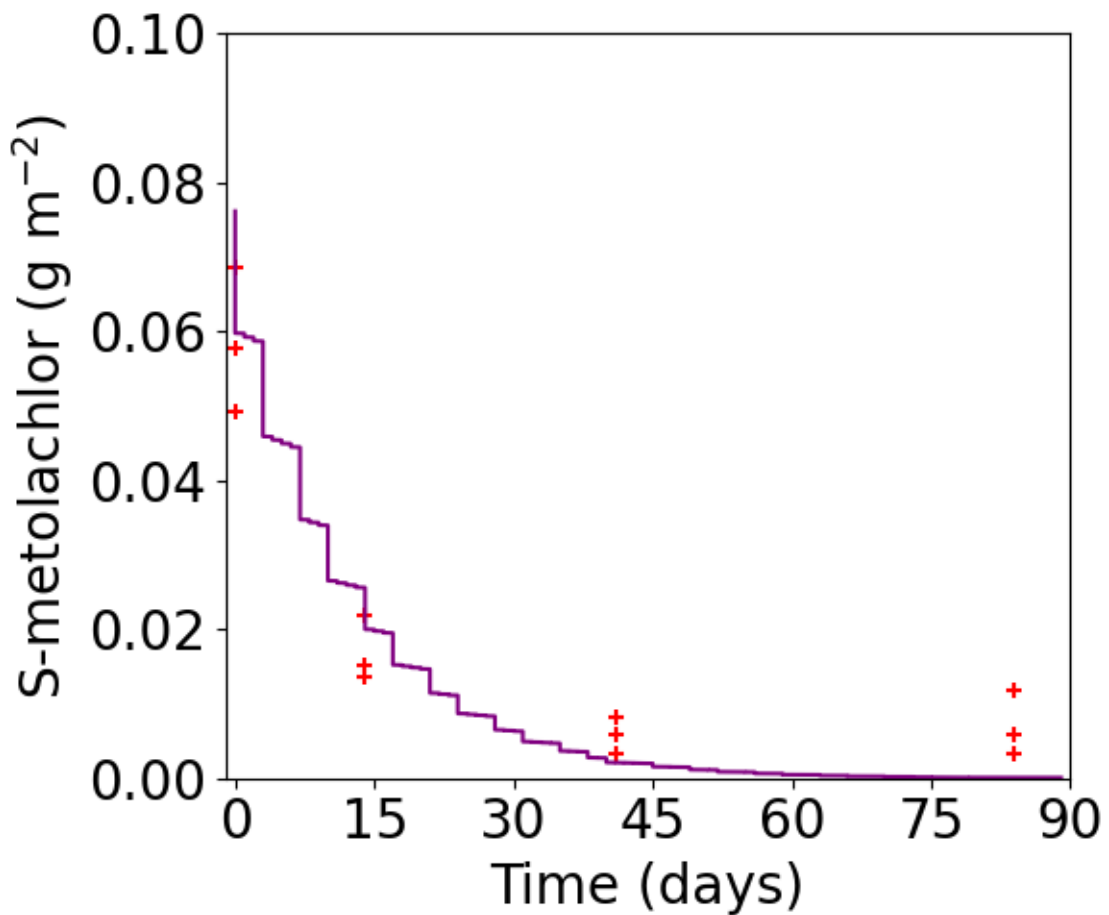
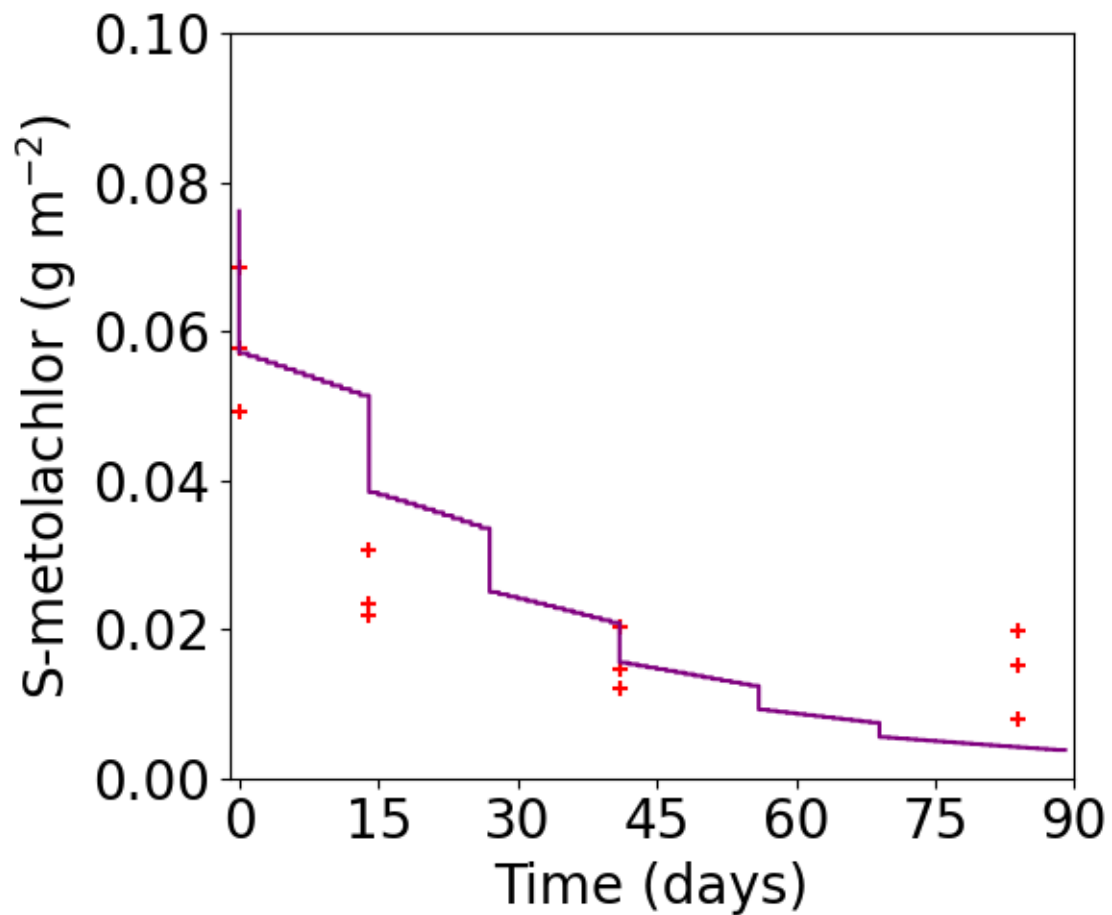
Daisy mulch validation – mulch water content (g/g)



Daisy mulch validation - mulch pesticide content (g/m²)

Optimized HIR

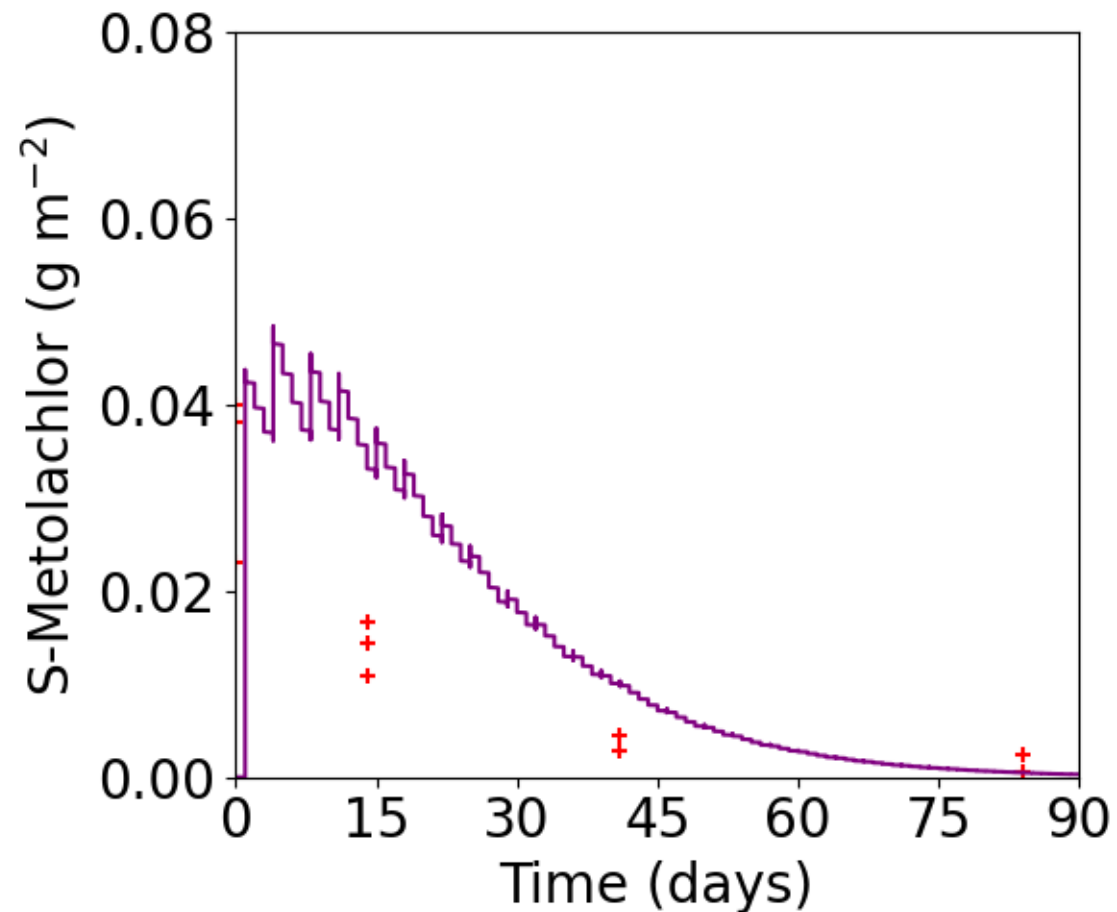
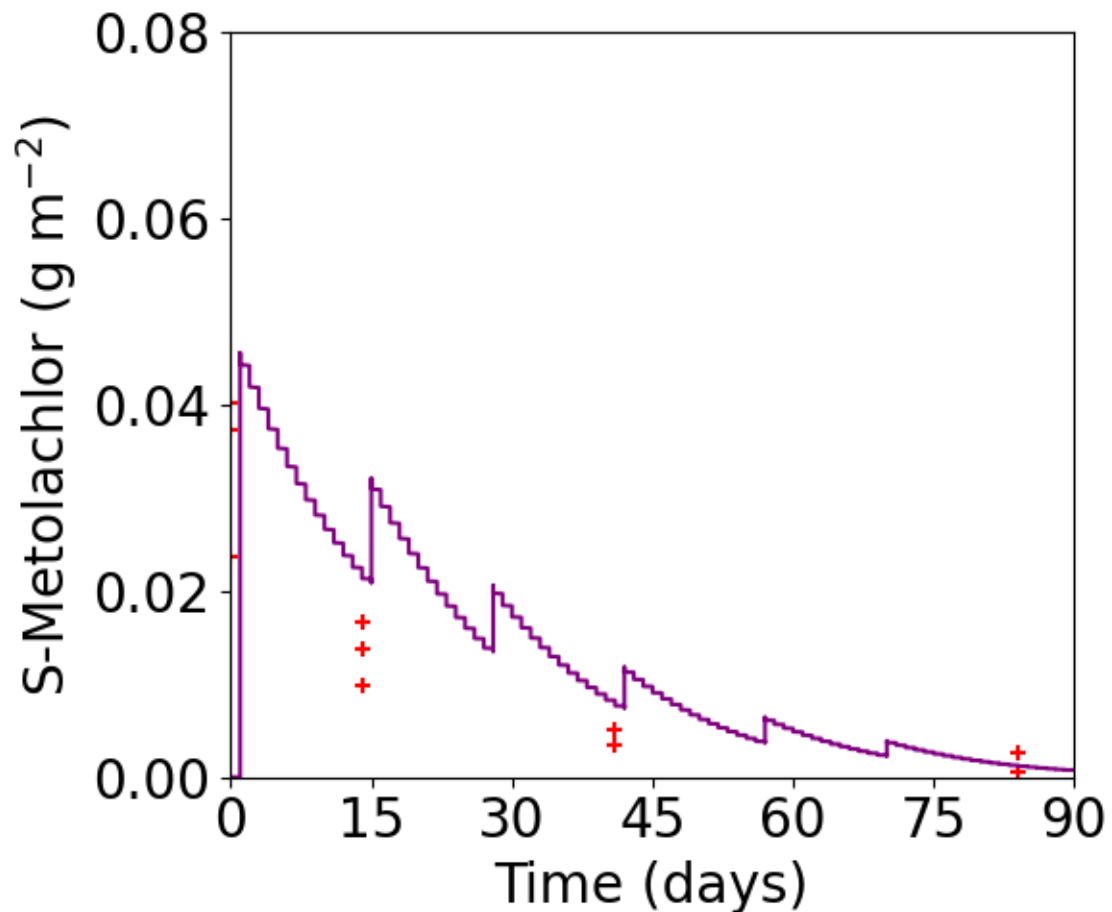
Non-optimized LFR



Daisy mulch validation - soil pesticide content (g/m²)

Optimized HIR

Non-optimized LFR



Conclusions and perspectives

- Good fit to available data
- More generalizable mulch module: non-specific parameters

- Better data needed to improve the description

- Mulch parameters to be adjusted for long-term simulations
 - SMB factor: SMB pool behaviour over long period?
 - Dissolved organic matter: SOM pool?



References

Garnier, P., Néel, C., Aita, C., Recous, S., Lafolie, F., & Mary, B. (2003). Modelling carbon and nitrogen dynamics in a bare soil with and without straw incorporation. *European Journal of Soil Science*, 54(3), 555–568.

<https://doi.org/10.1046/j.1365-2389.2003.00499.x>

Aslam, S., Iqbal, A., Lafolie, F., Recous, S., Benoit, P., & Garnier, P. (2018). Mulch of plant residues at the soil surface impact the leaching and persistence of pesticides: A modelling study from soil columns. *Journal of Contaminant Hydrology*, 214, 54–64. <https://doi.org/10.1016/j.jconhyd.2018.05.008>

Extra

Daisy mulch description vs PASTIS

Daisy	PASTIS
Sorption of pesticide in soil	Sorption kinetics in both mulch and soil
1 layer	2 layers
Factors of mulch and pesticide decomposition: - T, h, and SMB pool from soil surface layer	Factors of mulch and pesticide decomposition: - T, h from mulch layer in contact - SMB pool from soil surface layer
Daisy	PASTIS
Pesticide parameters (DT50, Kd) from EFSA assessment reports	Measured adsorption/desorption rates in the studied mulch and soil
Same DT50 in mulch and soil	Measured specific DT50 for mulch and soil
Mulch water retention curve estimated from measurements	Not documented