Supplementary material

Manuscript title: Challenges in Soil Carbon Modelling and Measurement: A decade of Experimental Data vs. RothC Simulations in an Organic Olive Grove

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Table S1. Main characteristic of the compost used in incubation experiment on a dry weight basis, and RothC model input data and parameters used for the inversion procedure.

EOM	Co-S1	Co-S2	Co-S3
Feedstock	Olive Mill Waste Sheep Manure Olive Tree Pruning	Olive Mill Waste Sheep Manure Olive Tree Pruning	Olive Mill Waste Sheep Manure Olive Tree Pruning
TOC (%)	36.6	36.6	36.6
C/N	16.4	16.4	16.4
pH	8.75	8.75	8.75
WSC$_{org}$ (%)	2.86	2.86	2.86
Soil location	Jaén	Jumilla	Santomera
C Added ($\mu g \cdot g^{-1}$)	6222	6222	6222
BD (Mg $\cdot m^{-3}$)	1.54	1.54	1.53
Clay (%)	13.7	6.5	14.4
Temp (°C)	25	25	25
DPM·RPM^{-1}	0.25	0.25	0.25
Depth (cm)	20	20	20
Time (days)	63	63	51

Co-S: Compost-Soil; EOM: Exogenous Organic Matter; TOC: Total Organic Carbon; WSC$_{org}$: Water-Soluble organic Carbon; C Added: C added to soil by EOM at the beginning of incubation; BD: Bulk Density; DPM·RPM^{-1}: ratio between Decomposable Plant Material and Resistant Plant Material required by RothC model; C released: TOC released as CO2 at the final of incubation.

Table S2. Summary of Soil Organic Carbon (SOC) concentrations for solid samples measured in the field experiment through the total experiment duration. These results represent the Mean Standard Deviation (mean Std.Dev), and mean Coefficient of Variation (CV) for all replicates.

Treatment	Mean Std.Dev (g·100g^{-1})	Mean SE (g·100g^{-1})	Mean CV (%)	SOC increase (g·100g^{-1})	SOC rate increase (g·100g^{-1}·yr^{-1})	Final SOC (g·100g^{-1})
Control	0.27	0.11	16.85	0.49	0.04	1.80
Compost	0.34	0.14	15.51	1.25	0.11	2.56
Mixture	0.37	0.16	15.54	1.54	0.14	2.84
Biochar	0.46	0.20	15.63	1.71	0.16	3.01

Supplementary Information Text

a) Fitting the simulated curve of cumulative CO_2 flux to the measurement from incubations requires an optimization method that searches for the simulation minimizing the discrepancies with observed data. To achieve this, the Differential Evolution Adaptive Metropolis (DREAM) R package (Vrugt et al., 2009a) was used for solving the optimization task in RothC (Scharnagl et al., 2010). This method uses Monte Carlo Markov Chain (MCMC) combined with evolutionary algorithms, improving the accuracy of the solutions and effectively handling high-dimensional problems with multiple solutions (Vrugt et al., 2009b) . For the Exogenous Organic Matter (EOM) optimization task, the aim is to estimate a reliable size for each pool and its decomposition rate.

EOM were incubated in Mediterranean soils, specifically from the south of Spain, and the samples were collected at 20 cm depth. The soils employed in incubations were three, so, the materials were named by the number of compost and the type of soil. Table S1 shows the different materials for the soil analysed.

RothC requires the following parameters for performing the simulation: EOM added (Mg C · ha^{-1}), soil clay content (%), temperature (°C), DPM/RPM ratio, depth (cm), and experiment time (days). Table S1 displays the main parameters in the incubation experiment.

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Vrugt, J. A., ter Braak, C. J. F., Diks, C. G. H., Robinson, B. A., Hyman, J. M., and Higdon, D.: Accelerating Markov Chain Monte Carlo Simulation by Differential Evolution with Self-Adaptive Randomized Subspace Sampling, International Journal of Nonlinear Sciences and Numerical Simulation, 10, https://doi.org/10.1515/IJNSNS.2009.10.3.273, 2009a.

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