Cross-sectoral ISIMIP and PROCLIAS Workshop
05-08 June 2023

Calibration and validation of the model Biome-BGCMuSo for simulation of SOC change in oak forests in Europe – results from STSM in Zvolen

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SOC MODELLING – BiomeBGCMuSo

Biogeochemical model with Multilayer Soil module (Hidy *et al*. 2016)

Inputs:

- daily meteorology - FORESEE DB
- yearly CO_2 and Ndep
- plant ecophysiological parameters
- soil characteristics
- site characteristics
- management

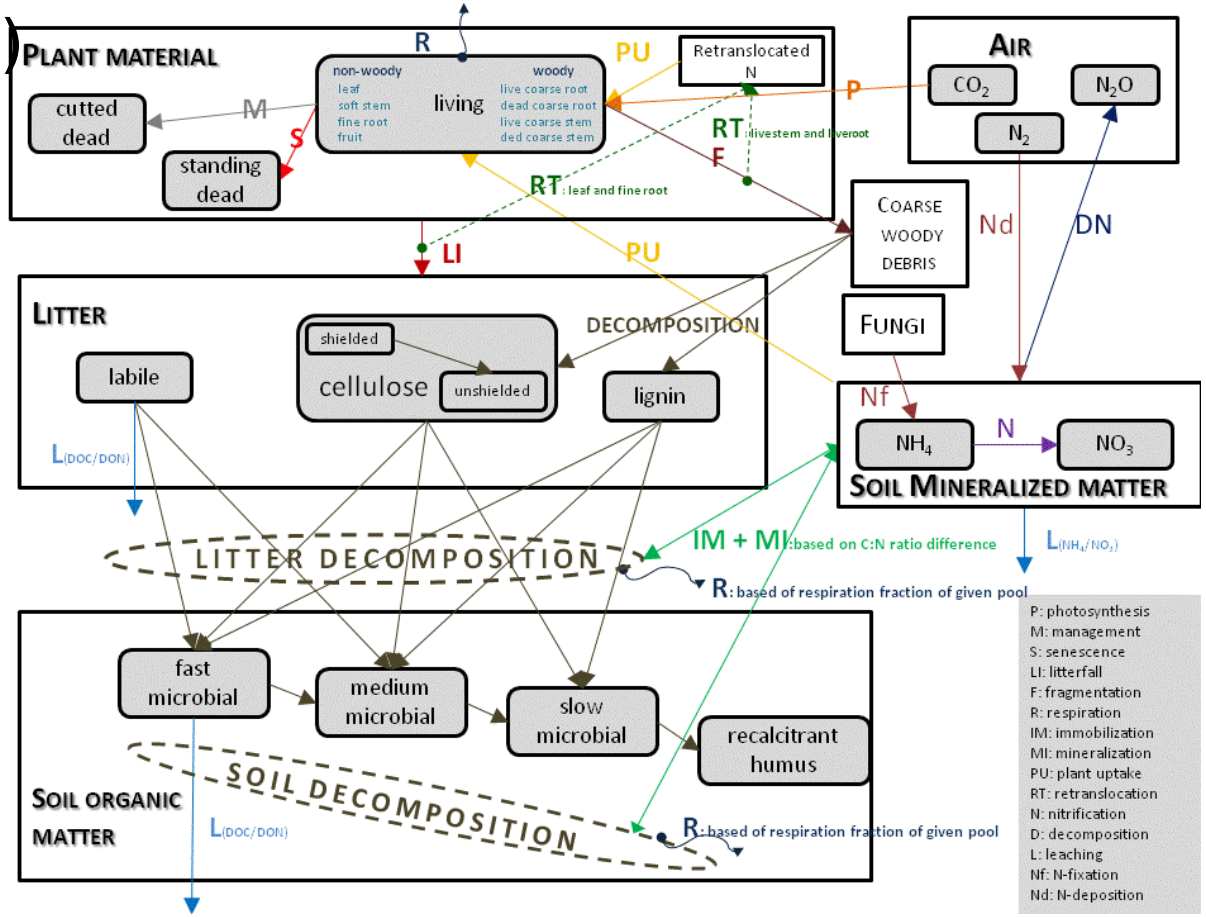
Outputs:

- daily
- annual

Calibrated with eddy-covariance data:

forest (oak) – CRO – for previous model versions

RBBGCMuso package



CALIBRATI

Calibration dataset

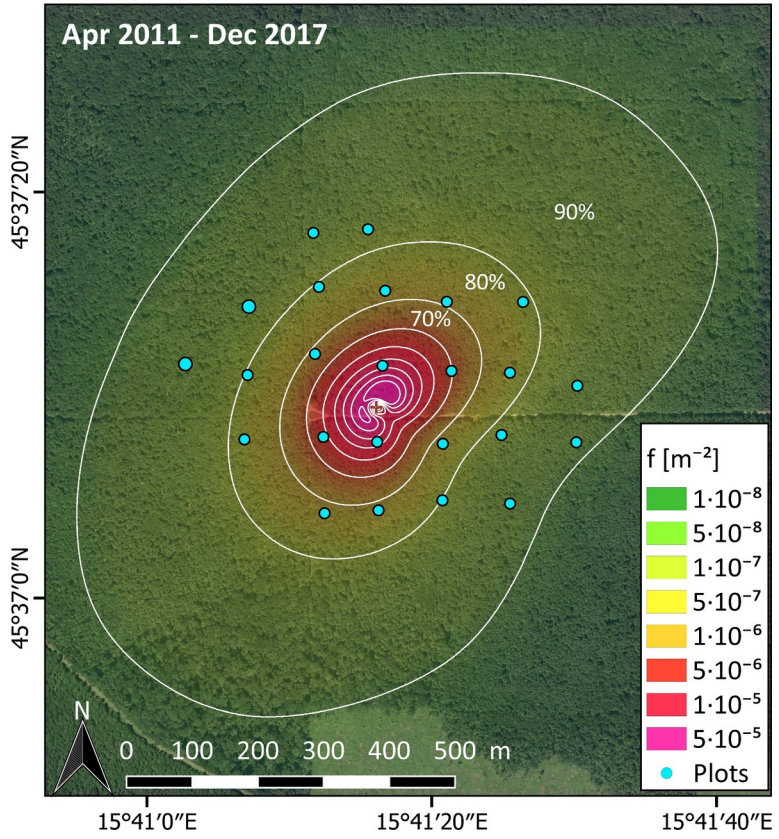
EDDY-COVARIANCE SITE (Anić *et al.* 2018)

High-frequency C fluxes (10-year data)

- Net Ecosystem Exchange (**NEE**)
- Gross Primary Productivity (**GPP**)
- Ecosystem Respiration (**RECO**)

Long-term C stocks

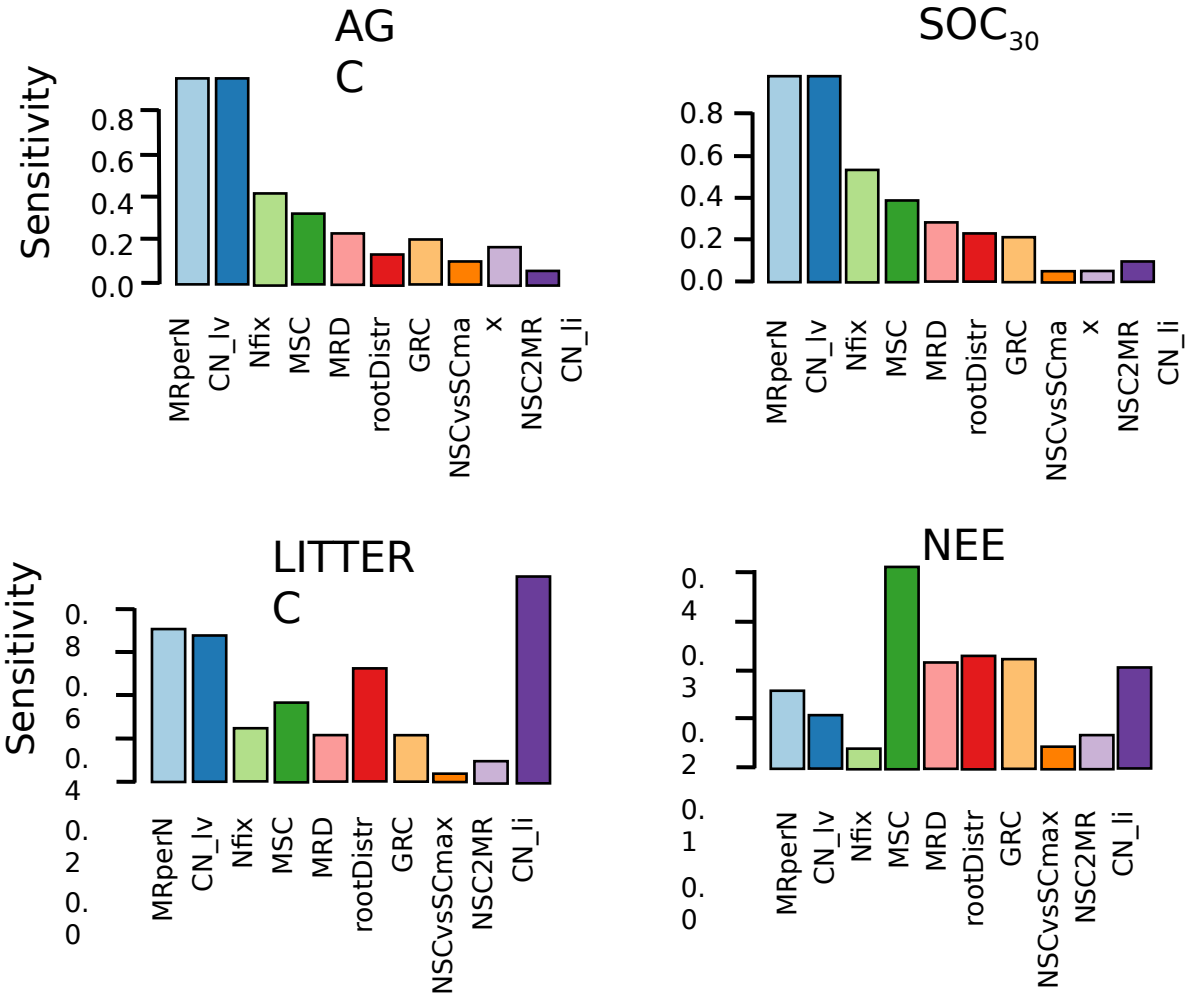
- Aboveground Live Wood (**AGC**)
- Litter (**LITTERC**)
- Mineral Soil Carbon in the top 30 cm (**SOC_{30}**)



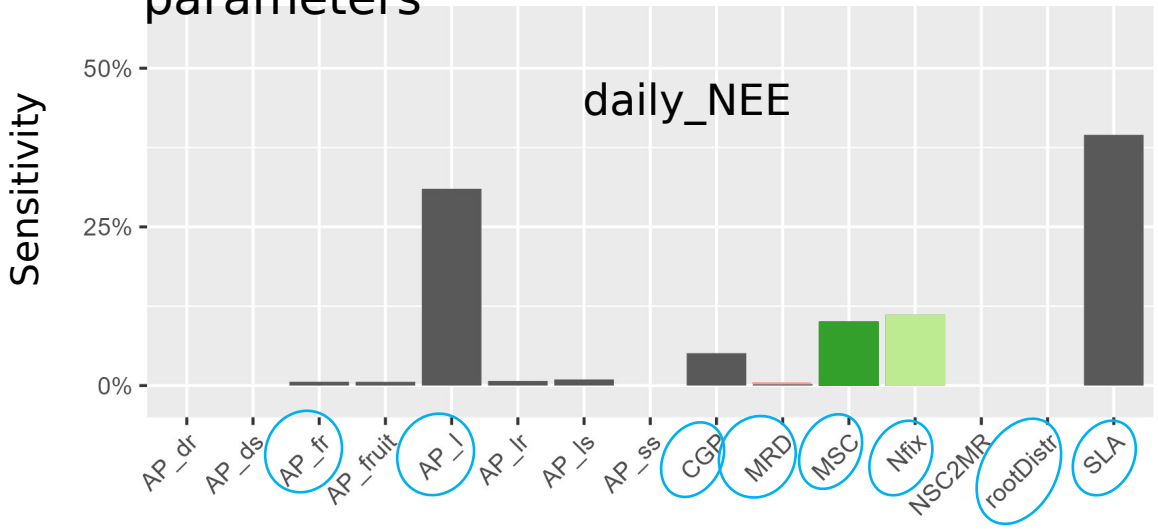
Eddy-covariance (EC) tower in Jastrebarsko lowland pedunculate oak forest and permanent measurement plots in the footprint of the EC tower

SENSITIVITY

① Sensitivity of selected output variables to changes in a **single** eco-physiological parameter



② Sensitivity of daily NEE to changes in a selected **group** of eco-physiological parameters



Which influential parameters to select?

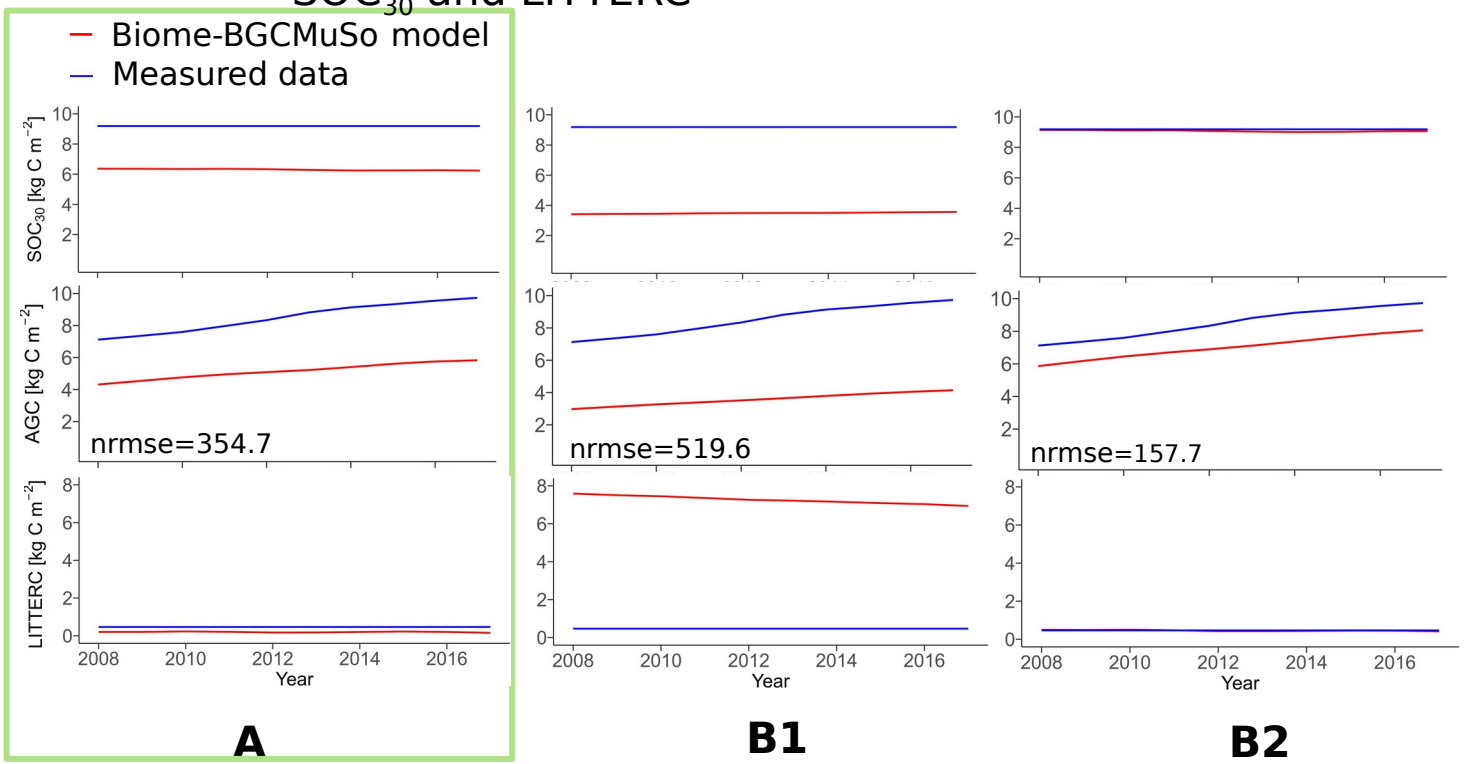
CALIBRATI

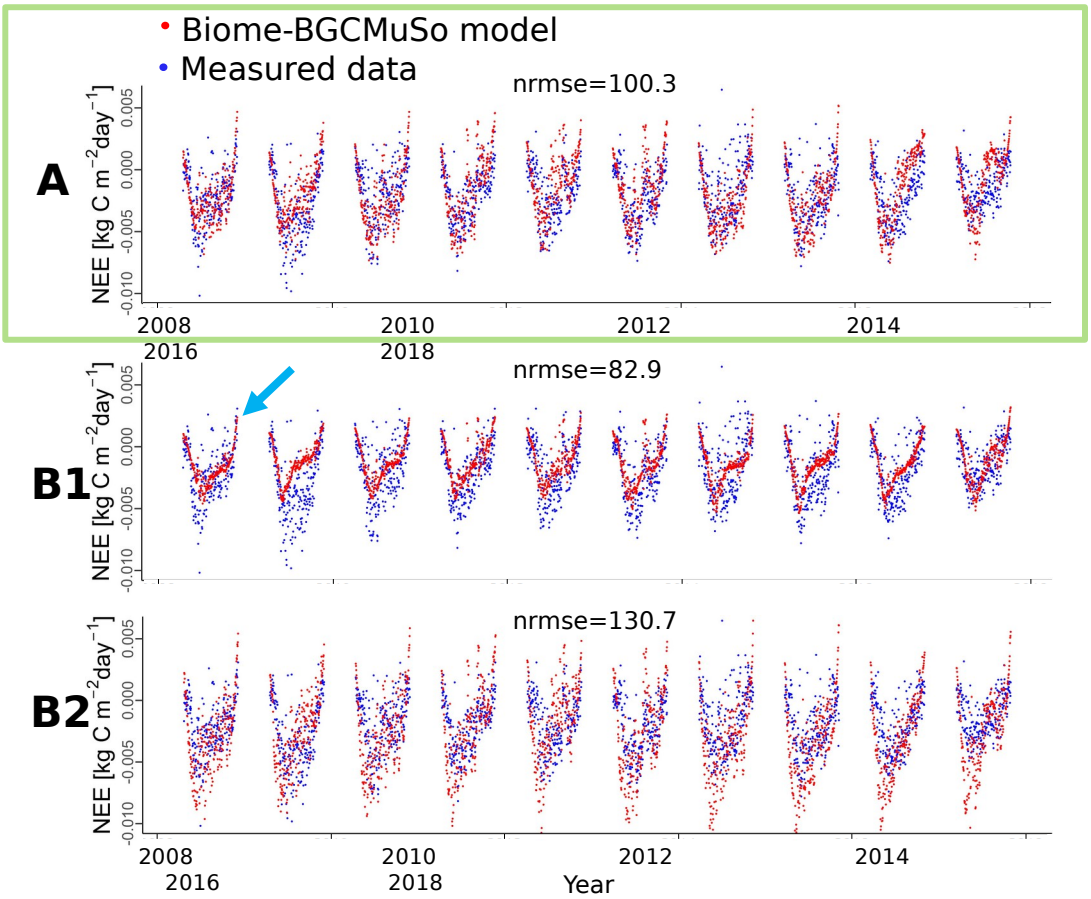
- generalized likelihood uncertainty estimation (GLUE) optimization method with likelihood (LH) function defined as

A) before the calibration (green square)

B1) after the calibration of daily NEE only

B2) after the multi-variable calibration of daily NEE, and annual AGC, SOC_{30} and LITTERC





How to constrain selected influential parameters?

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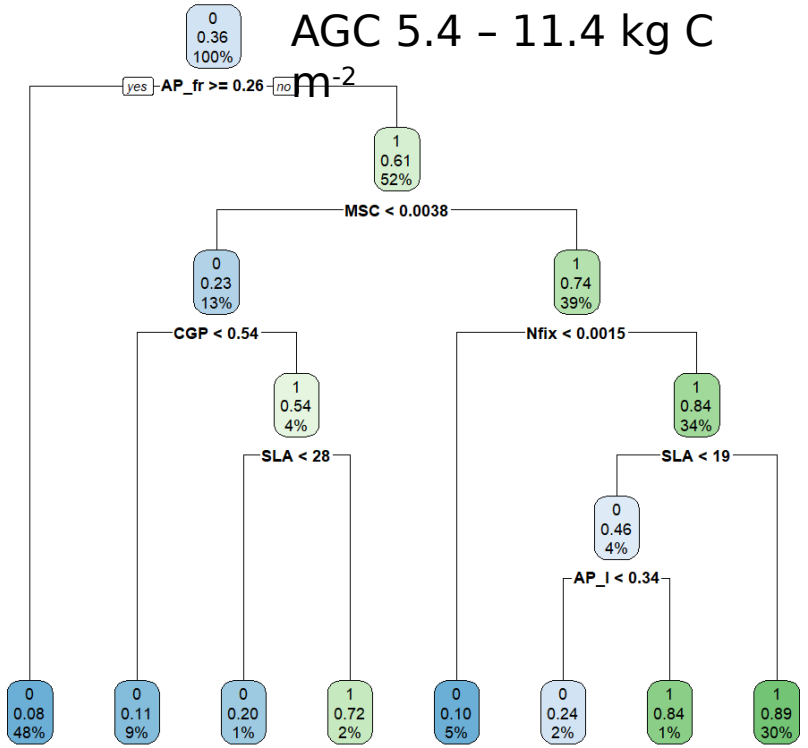
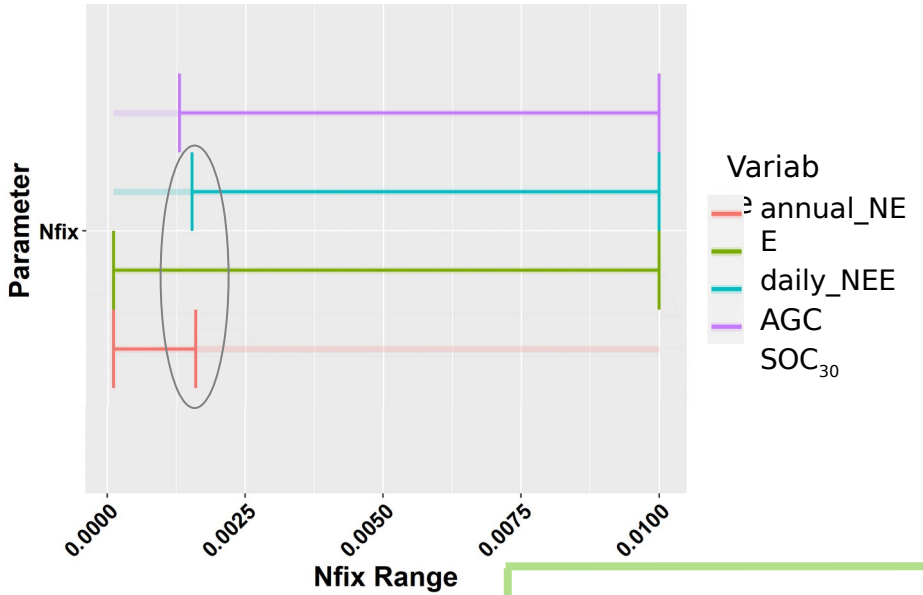
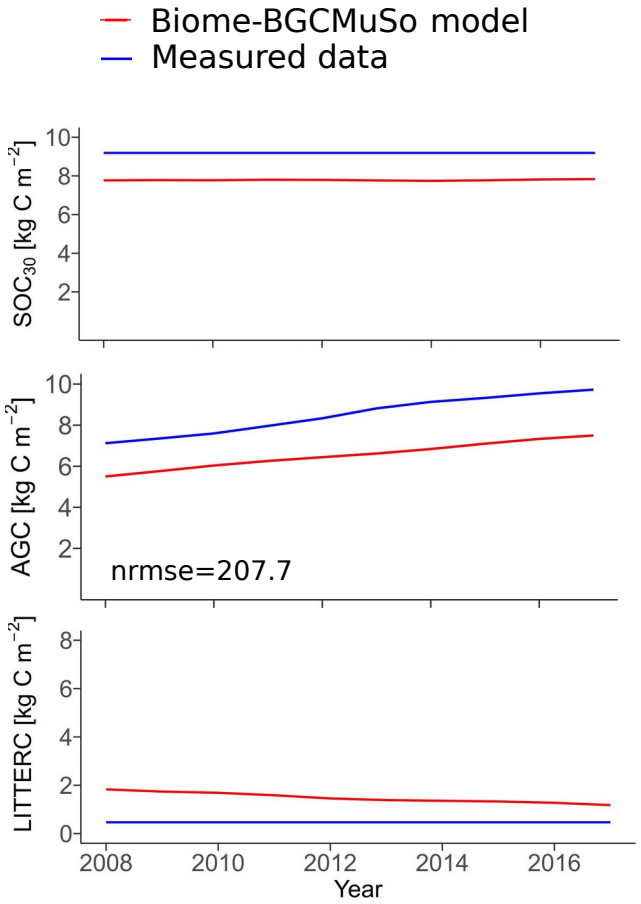
- modified Conditional interval reduction (CIR) method (Hollos *et al*. 2022)

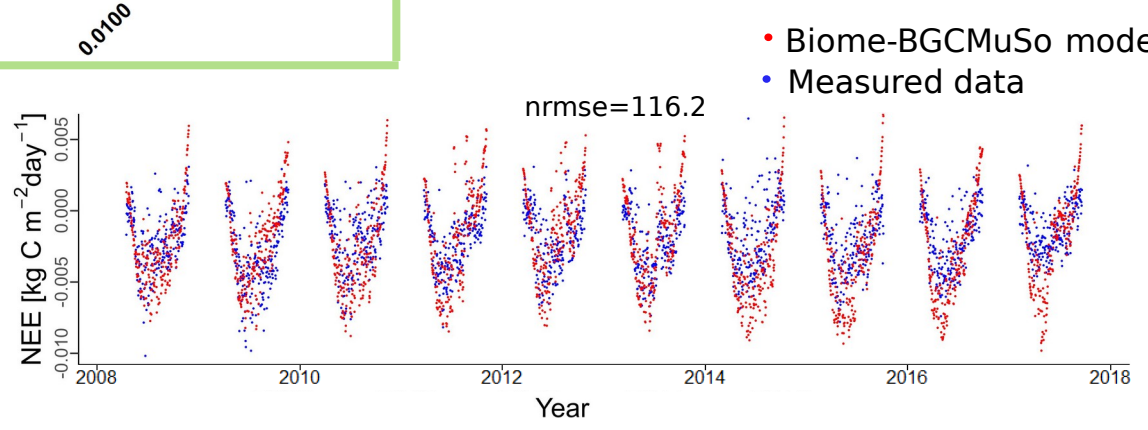
Parameter	Before calibration	Optimized
MSC	0.0024	0.0070
MRD	1.0000	1.6094
RootD	3.6700	3.6422
Nfix	0.0036	0.0037
SLA	34.5000	37.9501
CGP	0.5000	0.5383
AP_l	0.2580	0.2024
AP_fr	0.2450	0.3006



AGC 5.4 – 11.4 kg C m^{-2}







CALIBRATI

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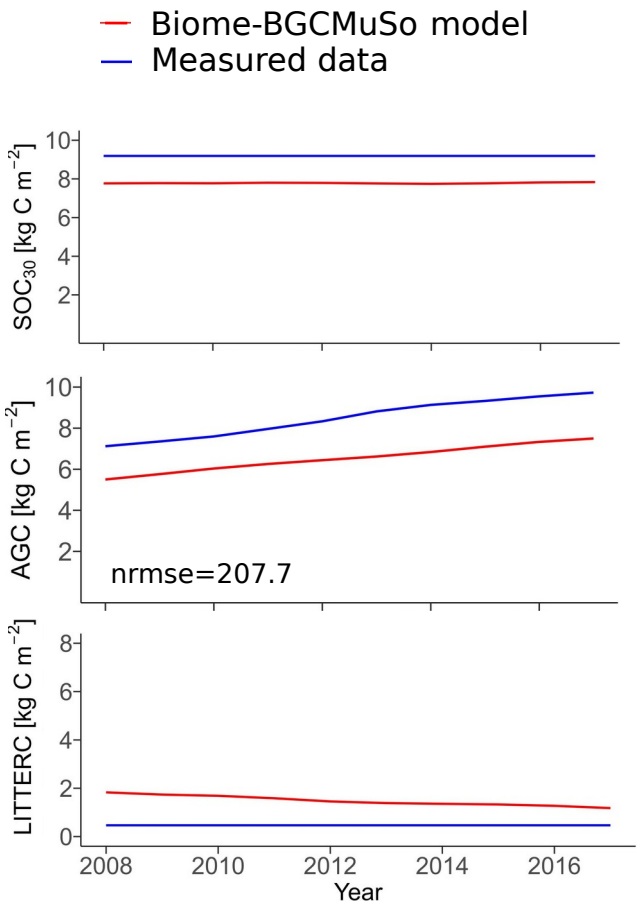
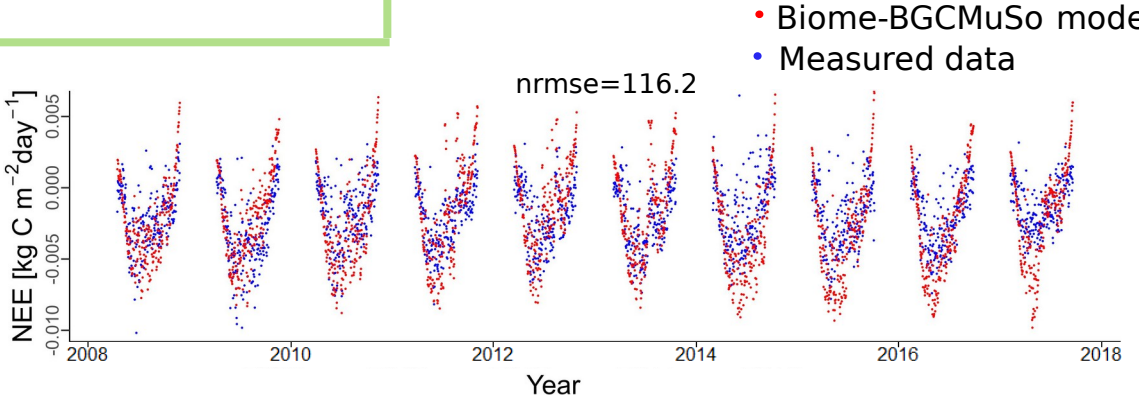


During a calibration process, it is important to take into account datasets with a different temporal resolution!

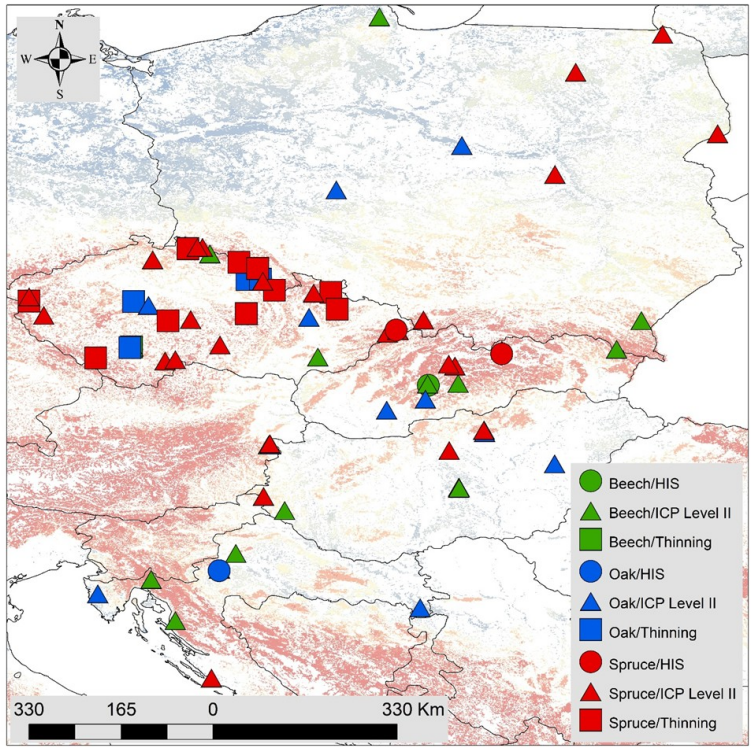


VALIDATIO

Validation dataset

CHRONOSEQUENCE EXPERIMENT (Ostrogović Sever *et al*. 2019)

Long-term C stocks - AGC, **LITTERC** and **SOC_{30}**



@Martin Mokroš

A PLOTS, CZU

Long-term C stocks - AGC, **LITTERC**, **SOC** and Coarse Woody Debris Carbon (**CWDC**)

5

13

53

68

108

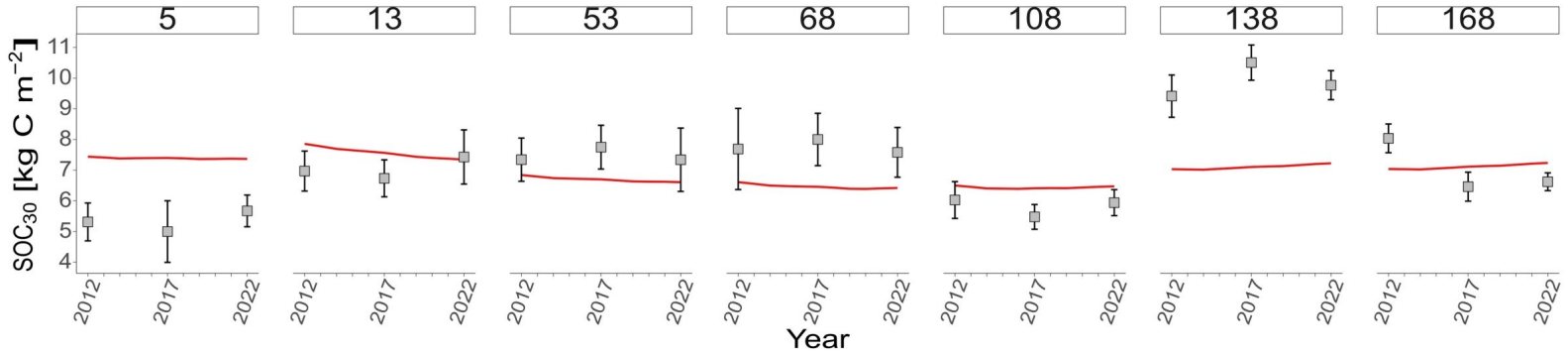
138

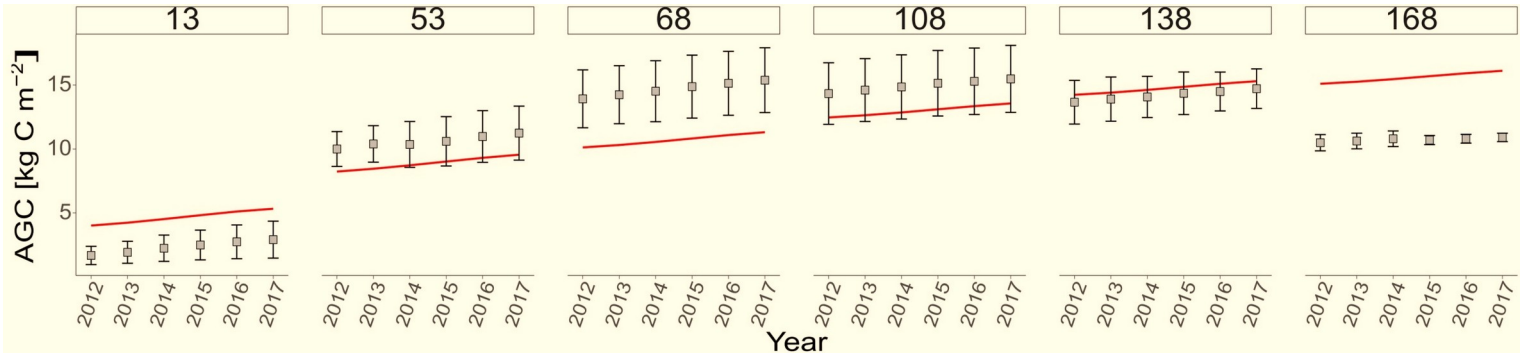
168

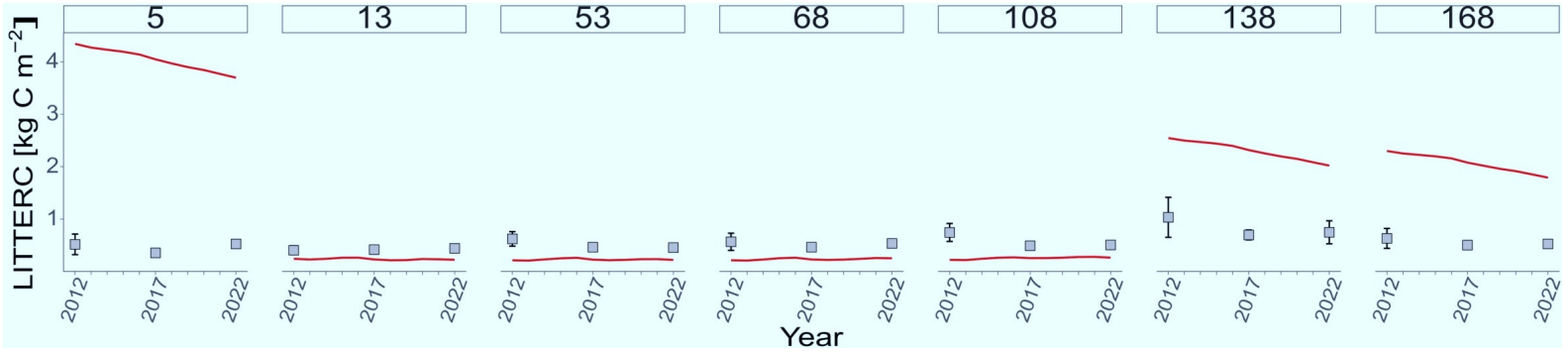
Seven stands aged from 5 to 168 years in Jastrebarsko oak forest (in 2012)

VALIDATIO

① CHRONOSEQUENCE EXPERIMENT







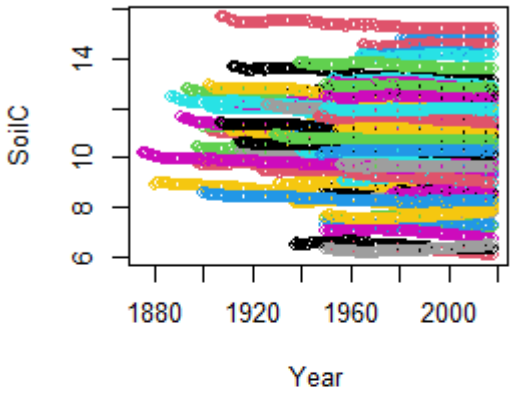
Biome-BGCMuSo model
Measured data (mean±1.96SE)

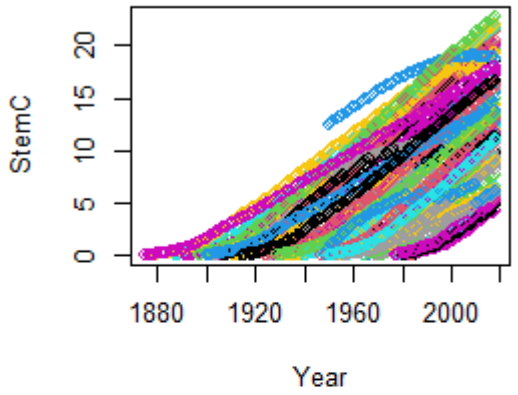
VALIDATIO

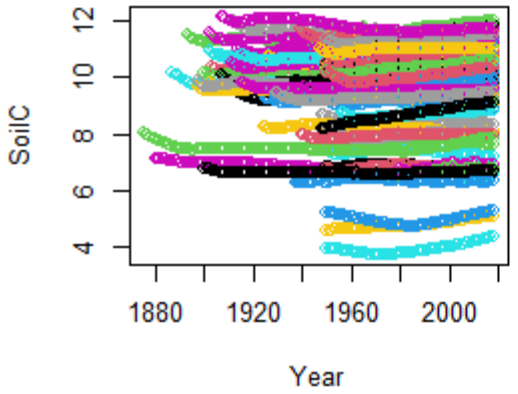
② EVA PLOTS, CZU

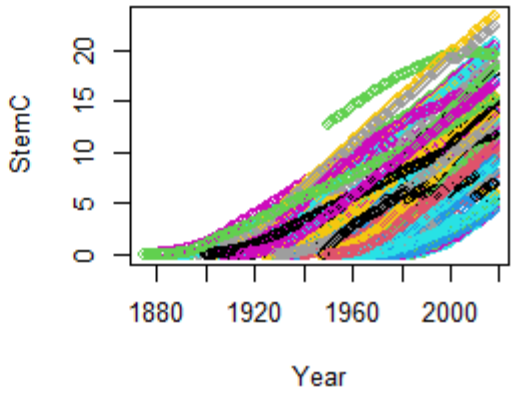
BEFORE CALIBRATION

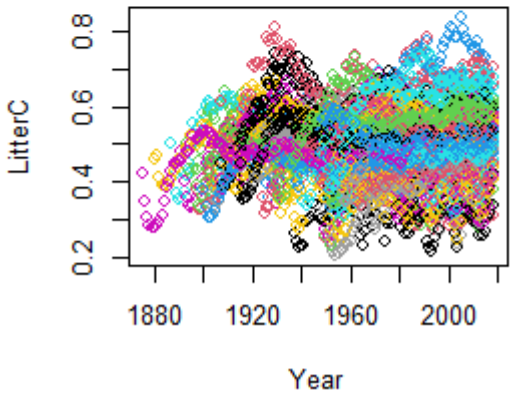
APOSTERIORI CALIBRATED

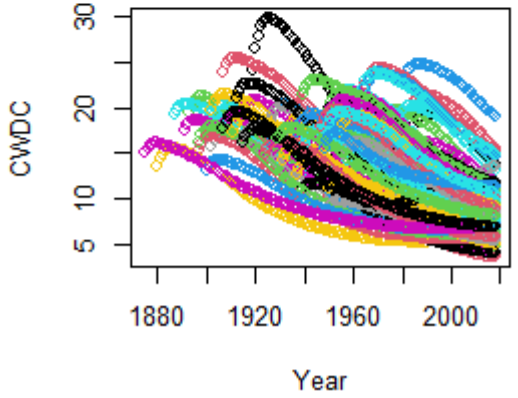


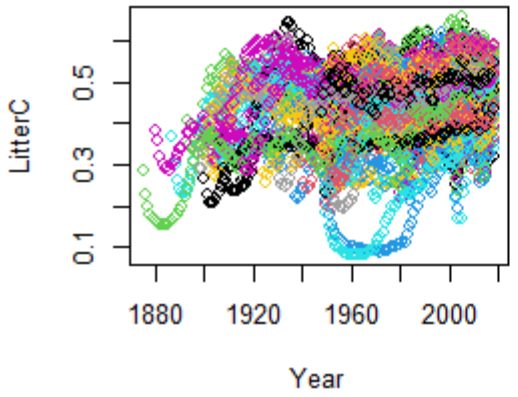


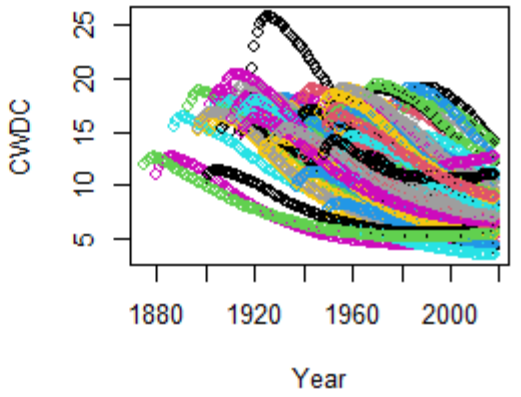












"What I love about science is that as you learn, you don't really get answers. You just get better questions."

John Green

Anić, M., Ostrogović Sever, M. Z., Alberti, (...) Marjanović, H., 2018. Eddy Covariance vs. Biometric Based Estimates of Net Primary Productivity of Pedunculate Oak (Quercus robur L.) Forest in Croatia during Ten Years. Forests 9:764.
Hidy, D., Barcza, Z., Hollós, R., Dobor, L., Ács, T., Zacháry, D., Filep, T., Pásztor, L., Incze, D., Dencső, M., Tóth, E., Merganičová, K., Thornton, P., Running, S., and Fodor, N., 2022. Soil-related developments of the Biome-BGCMuSo v6.2 terrestrial ecosystem model. Geosci. Model Dev. 15:2157–218.
Hollós, R., Fodor, N. Merganičová, K., Hidy, D., Árendás, T., Grünwald, T., Barcza, Z., 2022. Conditional interval reduction method: A possible new direction for the optimization of process based models. Environ. Modell. Softw. 158:105556.
Ostrogović Sever, M. Z., Alberti, G., Delle Vedove, G., Marjanović, H., 2019. Temporal Evolution of Carbon Stocks, Fluxes and Carbon Balance in Pedunculate oak Chronosequence under Close To Nature Forest Management. Forests 10:814.

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