Uncovering the diverging factors that control microbial carbon sequestration and respiration in soils exposed to moisture fluctuations

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• A new model (EcoSMMARTS) to study SOC dynamics during drying-rewetting (D/RW)
  • Strong decoupling between microbial growth and respiration
  • Unlike previous models, SMMARTS captures growth-respiration decoupling
  • Allows identification of mechanisms governing SOC dynamics during D/RW
Decoupling between microbial growth and CO$_2$ emissions

Growth starts increasing linearly after RW and reaches its peak only after several hours.

Respiration peaks rapidly upon RW and then decrease exponentially.

[e.g., Blazewicz et al. (2014), de Nijs et al. (2018), Göransson et al. (2013), Meisner et al. (2013), Tiemann and Billings (2011), Zheng et al. (2019)]
New process-based soil microbial model: EcoSMMARTS

[mod. from Brangari et al., 2020]
Dynamics under D/RW

Reproducing the experiment in Miller et al. (2005)

Comparison with models by Lawrence et al. (2009) [LMs]

All models capture respiration peaks

Only EcoSMMARTS reproduces delayed growth

SMMARTS results in a very low CUE after RW

[mod. from Brangarí et al., 2020]
Dynamics when moisture is kept constant after RW

Only EcoSMMARTS reproduces delayed growth

Only EcoSMMARTS captures respiration peaks

SMMARTS predicts stronger dynamics in CUE

[mod. from Brangari et al., 2020]
Conclusions

- EcoSMMARTS captures respiration peaks in soils exposed to cycles of D/RW and to constant moisture after RW
- EcoSMMARTS is the first model to reproduce strong decoupling growth-respiration
- Based on calibration, the strongest candidate mechanisms to explain dynamics:
  - C accumulation during dry periods,
  - drought-legacy effects on the synthesis of new biomass,
  - osmoregulation.

Brangarí et al. (2020): A soil microbial model to analyze decoupled microbial growth and respiration during soil drying and rewetting. SBB [under review]!!!
References