Friedrich-Alexander-Universität
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Explicit spatial modeling at the pore scale unravels the interplay of soil organic carbon storage and structure dynamics

Simon Zech, Steffen Schweizer, Franziska Bucka, Nadja Ray, Ingrid Kögel-Knabner, Alexander Prechtel

Research question and (pore scale) modeling

- **How and to what extent does the addition of fresh POM shape the structural re-arrangement of soil aggregates and affect the decomposition of older POM into CO_2 for different textures?**
- **How does the extent and type of surface coverage develop at different textures and possibly enhance aggregate structure formation and the turnover of POM?**
- **How do the factors soil texture, POM input and POM decomposition rate impact soil aggregate formation and what is their relative importance?**

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Drawbacks of macroscopic models:

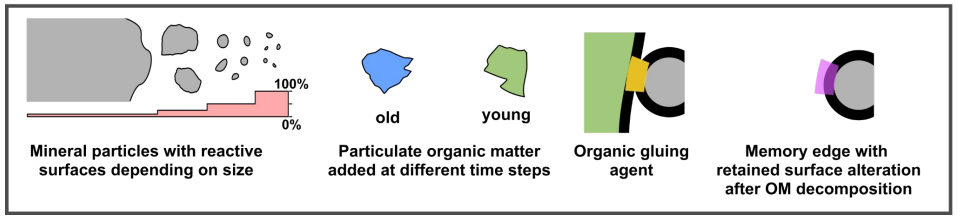
- Many approaches have been limited to a macroscopic view using lumped parameters due to the lack of high resolution microscale information, the high heterogeneity and complexity of the processes, but also the lack of computational power (Bailey et al., 2018; Baveye et al., 2018; Pot et al., 2021).
- Pot et al. (2021) elaborated the deficiencies of macroscopic models to describe the interaction of SOM turnover, microbial dynamics and soil structure.

Benefits from (pore scale) modeling:

- Study processes in detail
- Simulate scenarios / variations not observable in experiment
- Investigate „What if…?“ under the given configuration

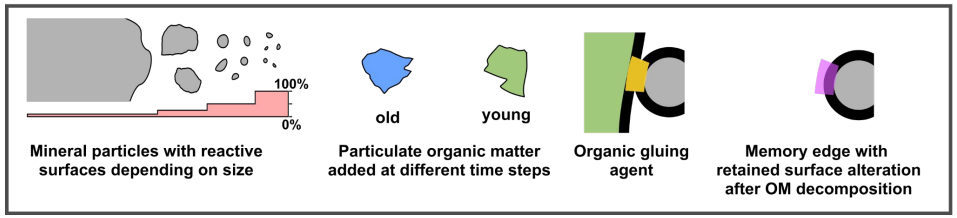
Model and Processes

Model components

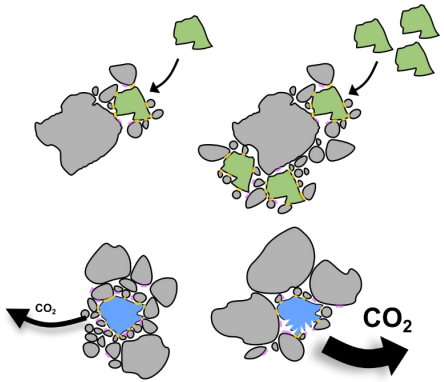


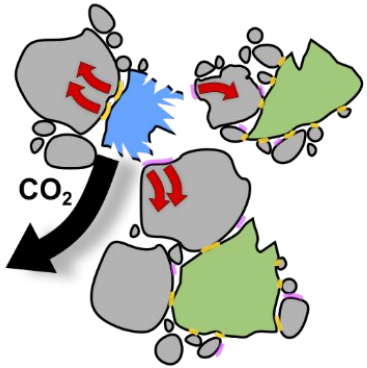
Model and Processes

Model components



Structure dynamics and OM turnover

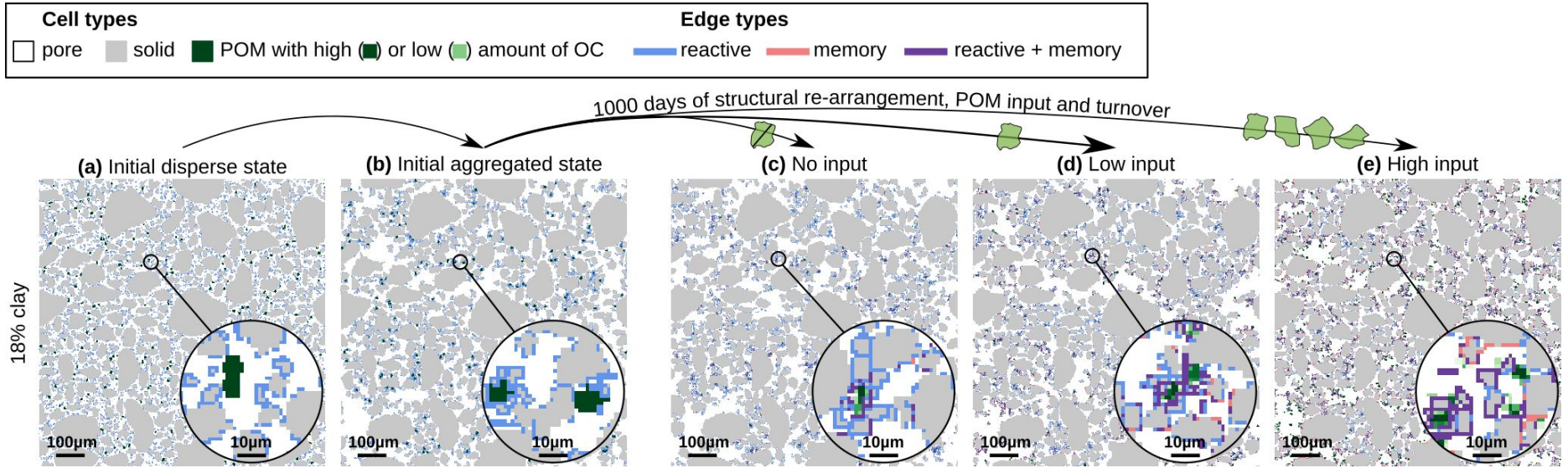




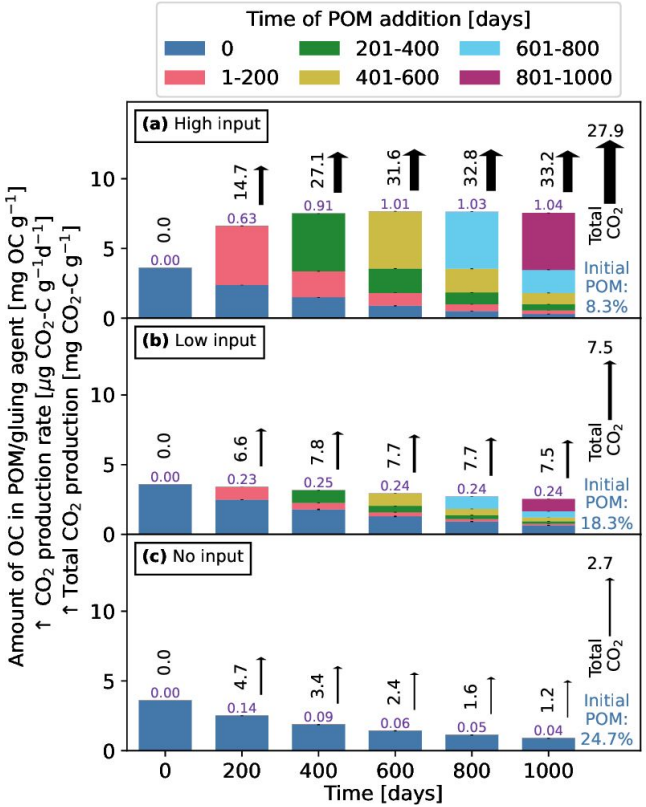
Drivers:

- texture
- surface sites with different reactivity
- POM input
- decomposition rates
- degree of occlusion

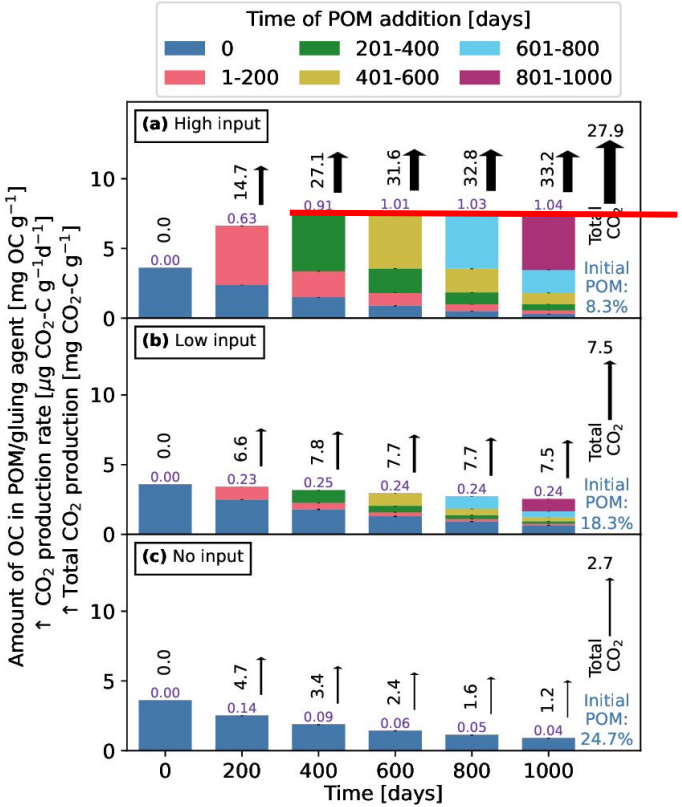
Scenarios


Cell types
pore
solid
POM with high ( ) or low ( ) amount of OC
Edge types
reactive
memory
reactive + memory
1000 days of structural re-arrangement, POM input and turnover
(a) Initial disperse state
(b) Initial aggregated state
(c) No input
(d) Low input
(e) High input
18% clay
100µm
10µm

Results

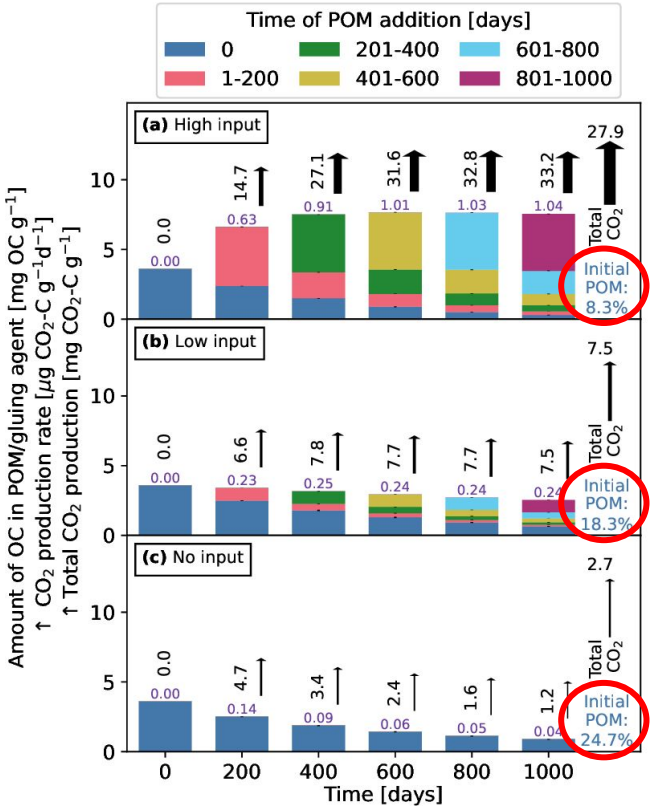

Time of POM addition [days]
0
1-200
201-400
401-600
601-800
801-1000
(a) High input
(b) Low input
(c) No input
Amount of OC in POM/gluing agent [mg OC g⁻¹]
↑ CO2 production rate [μg CO2-C g⁻¹d⁻¹]
↑ Total CO2 production [mg CO2-C g⁻¹]
Total CO2
Initial POM: 8.3%
Initial POM: 18.3%
Initial POM: 24.7%
Time [days]

Results



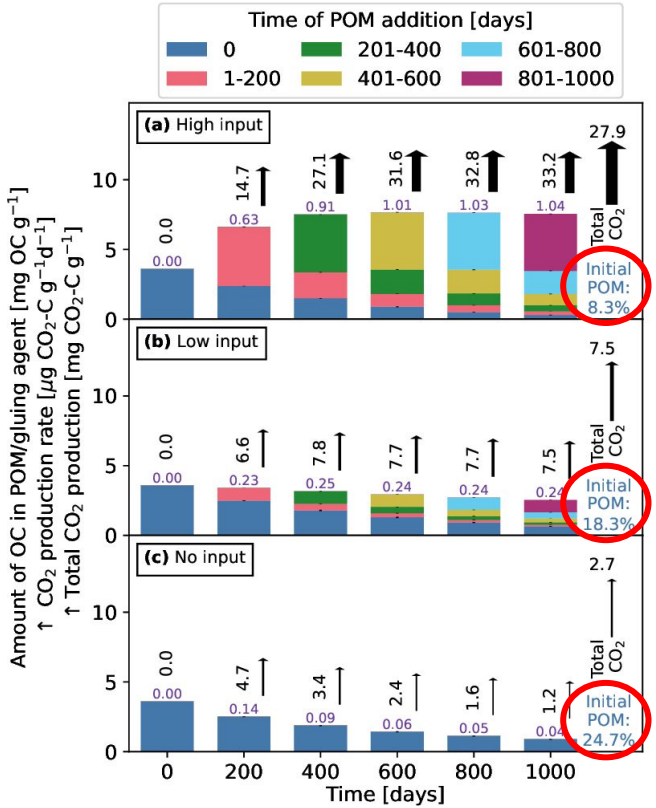
- **Stationary states through simultaneous and balanced OM input and OM degradation**

Results



- **Stationary states through simultaneous and balanced OM input and OM degradation**
- **Primed decomposition of initial POM through structural re-arrangement**

Results



- **Stationary states through simultaneous balanced OM input and OM degradation**
- **Primed decomposition of initial POM through structural re-arrangement**

- **In depth investigations also of further drivers such as texture and decomposition rates are found in**

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2022 accepted in Global Change Biology

Thanks a lot for your attention!

Within the DFG funded Priority Program PP 2089 „Rhizosphere Spatiotemporal Organisation – a Key to Rhizosphere Functions" we offer a three year

PhD Position "Reactive Transport and Structure Formation in Porous Media"

in the section „Modelling and Numerics" at the Department of Mathematics, Friedrich-Alexander Universität Erlangen-Nürnberg/Germany.

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