EGU2020-16648
https://doi.org/10.5194/egusphere-egu2020-16648
EGU General Assembly 2020

Is microbial resilience to drying-rewetting driven by selection for quick colonizers?

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Climate change is exposing terrestrial ecosystems to more extreme drought and rainfall events, resulting in an increased frequency and intensity of drying-rewetting (D/RW) events in soils. Rewetting a dry soil induces enormous dynamics in both microbial growth and biogeochemistry, including a large pulse of CO_2 release to the atmosphere. Upon D/RW, two different microbial growth responses have been identified; a more resilient response where bacteria start growing immediately with a quick recovery after rewetting and a less resilient response where there is a lag-period of up to 30 hours of near-zero growth before bacteria start to grow. The resilience of microbial growth following D/RW has important implications for the ecosystem C budget, since an extended lag-period of no growth during a time of high CO_2 release will result in net soil C loss. In natural systems, it has been found that a legacy of drought led to a more resilient bacterial growth response upon rewetting, with a reduced lag-period before the onset of growth. Exposing soils to repeated cycles of D/RW in the laboratory has also been shown to shift bacterial growth responses to a more resilient type. We hypothesised that this shift in response is explained by selection for a microbial community which is quick at colonizing the labile C resources made available upon D/RW.

In order to test our hypothesis, we pre-treated soils by exposing them to either (i) three cycles of D/RW, (ii) three pulses of glucose addition or (iii) three pulses of litter addition. The substrate additions were used to simulate the labile C release in soils during D/RW, thereby enabling us to investigate if the colonization of new substrate is the causal mechanism explaining the observed shift in bacterial resilience in soils with a history of D/RW. The pre-treated soils – along with an unamended control soil – were then exposed to the same D/RW event, with bacterial growth, fungal growth and respiration responses measured at high temporal resolution over 4 days. As previously reported, exposing the soil to a series of D/RW events resulted in a more resilient bacterial growth response, with the lag-period reduced from ca. 30 hours to an immediate initiation of growth. Pre-treating the soils with glucose reduced the lag-period before the onset of bacterial growth by ca. 50% whereas pre-treatment with litter induced only a marginally (< 10%) more resilient bacterial growth response to D/RW. Interestingly, pre-treatment of the soils with glucose and litter both induced a more resilient fungal growth response, with the responses resembling the shift in fungal resilience induced by exposing the soils to repeated cycles of D/RW. Overall, our results show that selection for quick colonizers partly explains the shift to more resilient microbial growth in soils exposed to repeated D/RW events, but further investigation is

required to identify additional factors contributing to the shift in resilience.