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Episodic drought and flooding impacts on disruption of mineral-organic associations in the rhizosphere

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Mineral-organic associations are crucial for soil organic matter dynamics, acting as significant carbon sinks and nutrient reservoirs for plants and microbes. However, climate change could impact their fate in soils by altering precipitation patterns, leading to more intense rainfall events and droughts. These changes will affect plant rhizodeposition and soil redox dynamics, potentially altering the stability of Fe-containing minerals, especially the less crystalline ones. In this study, we investigate the impact of changes in precipitation patterns on the disruption of mineral-organic associations. The fate of labeled mineral-organic associations (^{13}C-labeled microbial necromass adsorbed to ^{57}Fe-labeled minerals, either more or less crystalline: goethite or ferrihydrite) was tracked in soil planted with wheat (*Triticum aestivum* L.) during a 12-week pot experiment. The experiment simulated (1) optimal precipitation conditions and (2) intermittent droughts and (3) floodings, as expected in central Europe due to climate change. The destabilization of mineral-associated organic matter was quantified through ^{13}C-CO_2 fluxes analyses throughout the experiment, and the degree of disruption of mineral-organic associations and mineral transformation at the end of the experiment was determined using sequential extractions and ^{57}Fe Mössbauer spectroscopy. Our results show 20% greater destabilization of C previously protected with ferrihydrite compared to goethite. Destabilization of C associated with ferrihydrite was most pronounced under intermittent floodings, followed by optimal precipitation conditions, and then intermittent droughts. These findings suggest that changes in precipitation patterns are likely to alter the intensity of disruption of mineral-organic associations, particularly those containing poorly crystalline Fe minerals.