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Hot moments and hotspots of reactive oxygen species production in the salt marsh rhizosphere under combined diel and tidal cycles

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Salt marshes play a disproportionally important role in the burial of organic carbon (OC) in relation to their areas. A key factor for OC preservation is flooding-induced anoxia in salt marsh soils. However, episodic soil aeration (oxygen resupply) occurs due to tidal flooding and drainage cycles as well variations in radial oxygen loss from plant roots during diel cycles. While soil aeration is known to stimulate OC decomposition, the interactive effect of tidal and diel cycles on the formation of hot moments and hotspots for the oxidative decomposition of OC remains elusive. Here, we aimed to determine the combined effect of tidal and diel oscillations on the potential for oxidative OC decomposition in the salt marsh rhizosphere, particularly via reactive oxygen species (ROS). ROS are key oxidants for the non-selective decomposition of polymeric OC, which can be produced from oxygen reacting with one-electron donors such as Fe(II). We hypothesize that, in sulfate-rich salt marsh soils, the formation of ROS depends not only on the oxygen supply but also on the buildup of dissolved Fe(II) controlled by the balance between Fe(III) reduction and sulfide-induced immobilization during reduced periods. In this rhizobox experiment using marsh soil with or without *Spartina alterniflora*, we subjected rhizoboxes to diel light cycles and two contrasting tidal regimes which represented marsh environments of high and low degrees of tidal flushing. During the experimental period of six weeks, the 50-minute lag between a tidal and a solar day accumulated and created various tide-light combinations for investigation. We followed oxygen, pH, ROS (as H_2O_2), Fe^{2+}, sulfide, and DOC using a combination of time-resolved pore water sampling and microsensor measurements. The dynamics of ROS, oxygen, Fe^{2+}, and sulfide were compared to test our hypothesis on ROS formation. The hot moments and hotspots of ROS production will be informed, respectively, by the temporal trends of ROS and their contrasts between two marsh environments with or without plants. These results will improve our understanding of ROS production in salt marshes, providing insights to the spatiotemporal heterogeneity of OC decomposition in this vast Blue Carbon reservoir.