Rhizosphere priming doubles soil carbon loss from northern circumpolar permafrost area

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The formerly frozen soils of the northern circumpolar permafrost region are now teeming with microbial life. While these soils are warming and biotic processes accelerate, the rate of microbial degradation of their vast carbon stocks is still a key uncertainty of current global climate projections. Such microbial degradation is affected by plant-microbe interactions (rhizosphere priming), which may be especially important as Arctic plant productivity increases. Although rhizosphere priming can amplify decomposition by up to 380%, it is currently not incorporated in projections of future carbon losses from circumpolar permafrost soils. Large-scale estimates of priming in natural systems have so far been hampered by the complexity of plant-soil-microbe interactions and a lack of data for spatial scaling. By combining a meta-analysis of the rhizosphere priming effect with high-spatial and depth resolution datasets on key plant and permafrost soil properties, while accounting for the combined uncertainties using Monte Carlo simulations, we estimate that priming-induced microbial respiration will cause an additional loss of 78 (20 – 148) Pg soil organic carbon until 2100. This doubles previously projected carbon losses from permafrost soils. We identify the highest priming risk in lowlands within the boreal forest biome, including large areas across the Hudson Bay, Mackenzie delta and Siberia, and in surface soils where large carbon stocks meet high plant activity. Our findings stress the importance of fine-scale ecological interactions for large-scale greenhouse gas emissions, and suggest a serious further restriction of the estimated 200 - 400 Pg anthropogenic carbon emission budget available to constrain global warming.