Geophysical Research Abstracts
Vol. 21, EGU2019-2832, 2019
EGU General Assembly 2019

Rhizosphere priming doubles soil carbon loss from northern circumpolar permafrost area

Frida Keuper (1,2), Birgit Wild (3,4,5), Matti Kummu (6), Christian Beer (3,4), Gesche Blume-Werry (2,7), Sébastien Fontaine (8), Konstantin Gavazov (2,9), Norman Gentsch (10), Georg Guggenberger (10,11), Gustaf Hugelius (4,12), Mika Jalava (6), Charles Koven (13), Eveline J. Krab (2,14), Peter Kuhry (4,12), Sylvain Monteux (2), Andreas Richter (15), Tanvir Shahzad (16), James T. Weedon (17), and Ellen Dorrepaal (2)

(1) French National Institute for Agricultural Research (INRA), UR1158 AgroImpact, Barenton-Bugny, France (frida.keuper@inra.fr), (2) Climate Impacts Research Centre, Department of Ecology and Environmental Science, Umeå University, Abisko, Sweden, (3) Department of Environmental Science and Analytical Chemistry, Stockholm University, Stockholm, Sweden, (4) Bolin Centre for Climate Research, Stockholm University, Stockholm, Sweden, (5) Department of Earth Sciences, University of Gothenburg, Gothenburg, Sweden, (6) Water and Development Research Group, Aalto University, Espoo, Finland, (7) Institute of Botany & Landscape Ecology, Experimental Plant Ecology, Greifswald University, Greifswald, Germany, (8) French National Institute for Agricultural research INRA, VetAgro Sup, UMR Ecosystème Prairial, Clermont Ferrand, France, (9) Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Lausanne, Switzerland, (10) Institute of Soil Science, Leibniz Universität Hannover, Hannover, Germany, (11) VN Sukachev Institute of Forest, SB-RAS, Krasnoyarsk, Russian Federation, (12) Department of Physical Geography, Stockholm University, Stockholm, Sweden, (13) Climate and Ecosystem Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA, USA, (14) Department of Soil and Environment, Swedish University of Agricultural Sciences, Uppsala, Sweden, (15) Department of Microbiology and Ecosystem Science, University of Vienna, Vienna, Austria, (16) Department of Environmental Sciences & Engineering, Government University College Faisalabad, Faisalabad, Pakistan, (17) Systems Ecology, Department of Ecological Sciences, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands

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.