Warming alters soil carbon dynamics at depth in a Qinghai-Tibetan alpine grassland

X. J. FENG [1*, 2], J. JIA[1, 2], N. HAGHIPOUR[4], L. WACKER[5], M. Simpson[6], H. Yang[7], T. I. EGLINTON[4] AND J-S. HE[3*]

[1] Institute of Botany, Chinese Academy of Sciences, Beijing, China (*correspondence: xfeng@ibcas.ac.cn)
[2] University of Chinese Academy of Sciences, Beijing, China
[3] Department of Ecology, Peking University, Beijing, China
[4] Institute of Geological, ETH-Zürich, Switzerland
[5] Institute for Particle Physics and Astrophysics, ETH-Zürich, Switzerland
[6] Department of Physical and Environmental Sciences, University of Toronto, Toronto, Ontario, M1C 1A4, Canada
[7] State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences, Wuhan 430074, China.

Subsoil (<30 cm) stores half of soil organic carbon (SOC) stocks globally but remains poorly constrained in terms of its response to warming. On a "hot spot" of global warming, alpine grasslands on the Qinghai-Tibetan Plateau (QTP) have witnessed varied changes in SOC storage at different depths. However, the underlying mechanisms remain to be elucidated. Here we utilized a long-term soil warming experiment in the QTP alpine grassland and employed source-specific biomarkers and ^{14}C analysis to compare warming-induced changes to the source, composition and degradation of SOC in the top- versus subsoils. In contrast to the unaltered SOC characteristics in the topsoil, four years of simulated warming significantly changed SOC composition and carbon allocation in the subsoil. New carbon accumulated in the subsoil under warming, driven by elevated root distribution. New carbon accrual was accompanied by increased concentrations of certain plant and microbial components. However, lignin phenols decreased in the subsoil despite warming-enhanced root inputs. The high vulnerability of lignin to warming-stimulated degradation may be linked to the shortening of freezing period and/or microbial co-metabolism fueled by labile carbon input in the warmed subsoil. These results underscore the high sensitivity of deep soil carbon cycling to warming in the alpine grassland, which varies from topsoil carbon dynamics.