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Patterns and controls of soil respiration along the hydrological gradients in the alpine wetland of the Tibetan Plateau

Lingfei Yu (1,2) and Jin-Sheng He (2)

(1) Institute of Botany, CAS, Beijing, China (yulf@ibcas.ac.cn), (2) College of Urban and Environmental Sciences, Peking University, Beijing, China (yulf@ibcas.ac.cn)

The Tibetan Plateau is experiencing rapid climate warming, and the wetlands are predicted to have lowered water tables due to the permafrost degradation. These changes may affect the carbon cycle processes such as soil respiration (Rs), the major CO_2 source to the atmosphere from terrestrial ecosystems. However, the magnitude, patterns and controls of Rs remain poorly understood in the alpine wetland with distinct soil hydrology conditions. Here, we conducted a field study on Rs from 2012 to 2014 in three types of alpine ecosystems on the Tibetan Plateau, fen, wet meadow and meadow, with soil water decrease. From 2012 to 2014, the annual Rs were 128.9-193.3 g C m-2yr-1, 281.5-342.9 g C m-2yr-1, and 663.4-709.1 g C m-2yr-1 for fen, wet meadow and meadow, respectively. Abrupt increase of CO_2 emission was caused by spring thawing of the frozen soil in the fen and wet meadow, but not in the meadow. The Rs during the thawing season contributed 20.4-37.6%, 13.2-17.4%, and 3.7-4.6% to the total annual Rs, respectively, in the three ecosystems, and their contribution significantly increased with soil moisture. We found that Rs during the soil-thawed season were primarily driven by air temperature in the fen and wet meadow, and by soil temperature at 5 cm depth in the meadow, whereas the temperature generally had limited impact on Rs in the soil-frozen season. Furthermore, the sensitivity of Rs to air or soil temperature (Q10) varied significantly among the three ecosystems, decreasing with soil moisture. This is the first attempt to measure hourly Rs along the hydrological gradients in the alpine wetland of the Tibetan Plateau, and our study emphasized the important role of soil water conditions in regulating the biophysical effect of spring thawing on soil CO_2 efflux and its response to climate change.