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Threshold of soil water content for ecosystem carbon fluxes and their response to climate warming in an alpine meadow

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1. Soil water content (SWC) has been recognized to largely regulate ecosystem carbon (C) fluxes and their responses to climate change. However, it remains unclear whether there exists a SWC threshold for ecosystem C fluxes and their responses to climate warming.
2. Based on a field warming experiment in an alpine meadow on the Qinghai-Tibet Plateau (QTP), we examined how SWC regulates ecosystem C fluxes in response to experimental warming.
3. We first detected a SWC threshold of 27.3 $\pm$ 5.2% for all the C flux variables except root respiration. This threshold did not change over years in 2014 or 2015 across all the warming or clipping treatments. C fluxes increased with SWC below the threshold but significantly decreased with SWC above it. Warming effects on C fluxes varied with seasons and years due to the changes in SWC. Experimental warming stimulated C fluxes when SWC was above the threshold but depressed C fluxes when SWC was below the threshold. C fluxes were always positively correlated with soil temperature when SWC was above its threshold. When SWC was below its threshold, net ecosystem exchange (NEE) and gross ecosystem production (GEP) decreased but root respiration, soil respiration, and ecosystem respiration increased with soil temperature.
4. This study provided field evidence on the traditionally speculated concept of SWC threshold and revealed how SWC threshold regulates responses of different ecosystem C fluxes to climate warming. The findings offer mechanistic explanations for ecosystem C fluxes in response to climate warming under varying SWC status and changing precipitation regimes.