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Eroding vs. Depositional Sites: Varying Sensitivity of CO_2 Emissions to Temperature

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Erosion induced lateral transport of soil particles not only geographically redistributes soil organic carbon (SOC) across landscapes, but also relocate them to different microclimate conditions, potentially experiencing distinctive biochemical processes. To fully understand the impacts of soil erosion to atmospheric CO_2, it requires to identify individual contributions from different geographic positions. Apart from differentiated CO_2 emission potentials on eroding and depositional sites, previous reports have also recognized that the extents of SOC mineralization during transport can shift erosion induced effects from net sink to net source. However, most of the research or modeling has been carried out under current climate conditions. With more variable temperature patterns in the future, it is essential to understand the varying sensitivity of CO_2 emissions to temperature changes on eroding and depositional sites.
To systematically investigate the potential effects of temperature changes to erosion-induced CO_2 emissions, four erosion plots were set up on the Chinese Loess Plateau. Each of the four plots had an eroding slope (1 m * 5 m, inclined at 20 [U+F0B0]) filled with dark loess soil, and a depositional site (water tank by 1 m * 1 m) at the lower end. Soil temperature, soil moisture and CO_2 emissions from surface at upper, middle and lower positions on each plot were continuously monitored from July 2014 to September 2015 under natural precipitation. Our results show that:
1) The depositional sites had up to 31% greater CO_2 emission rates than the eroding slopes (1.38 vs. 1.05 μmol m-2 s-1 on average). This was probably because the mineralization of the enriched SOC at the depositional sites (6% greater than the original soil of 6.83 g kg-1) was enhanced by the more favorable soil moisture contents (0.25 m3 m-3 vs. 0.21 m3 m-3 at the eroding slopes).
2) The CO_2 emissions from the depositional sites were much more sensitive to seasonal temperature changes throughout the year than the eroding slopes, with a temperature sensitivity (Q10) of 8.14 at the depositional sites while a Q10 merely 2.34 at the eroding slopes. This is probably because the soil and water loss via runoff potentially resulted in slightly depleted SOC as well posed drought stress on the eroding slopes, limiting the timeliness of CO_2 emissions responses to temperature changes; meanwhile, the greater soil moisture and enriched SOC at the depositional sites provided more readily available environmental conditions for microbial activities to timely respond to temperature changes.
The pronounced greater CO_2 emissions yet less sensitivity to seasonal temperature changes from the depositional sites, and vice-versa on the eroding slopes, demonstrate a great uncertainty when estimating erosion-induced CO_2 emissions to the atmosphere. The potential sensitivity of soil CO_2 emissions to temperature changes must be taken into account, especially when looking into future climate changes. Identifying different microbial communities and their specific functions might provide a clue for further research in the future.