



## **East Asian summer monsoon substantially affects the inter-annual variation of carbon dioxide exchange in semi-arid grassland ecosystem in Loess Plateau**

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The net ecosystem CO<sub>2</sub> exchange (NEE) of a semi-arid grassland on the boundary area of the East Asian summer monsoon (EASM) was measured continuously by eddy covariance technology in the Loess Plateau from 2007 to 2012. The results show that the maximum daily NEE was  $-2.1 \text{ g C m}^{-2} \text{ day}^{-1}$ . The grassland ecosystem was a weak carbon source with a mean of  $17.1 \pm 12.1 \text{ g C m}^{-2} \text{ year}^{-1}$  during the measure period. The annual NEE ranged from 52.3 to  $-27.6 \text{ g C m}^{-2} \text{ year}^{-1}$ , and the interannual variability in NEE was significantly related to the annual precipitation amount. The mean annual gross primary productivity (GPP) and ecosystem respiration (Reco) were 263.8 and 280.9  $\text{g C m}^{-2} \text{ year}^{-1}$ , respectively. NEE was greatly constrained by GPP. Drought stress suppressed GPP more than Reco. Furthermore, soil moisture reduction could result in sensitivity weaker of Reco dependence to soil temperature (Ts), and GPP estimated by Reco-Ts exponential growth function might be overestimated under severe soil drought when high Ts ( $> 22 \text{ }^\circ\text{C}$ ). Additionally, warm spring has been found to be able to enhance the grassland's carbon uptake, and the grassland was expected to be enhanced  $^{-1}2 \text{ g C m}^{-2} \text{ season}^{-1}$  of carbon uptake per  $1 \text{ }^\circ\text{C}$  of air temperature increase in spring. Warmer spring has been found to be able to enhance the grassland's carbon uptake, and compensate for the reductions induced by the summer drought. Finally, we found that annual carbon balance had strong linear relationship with the EASM ( $R^2=91\%$ ), and the EASM played an essential role in the CO<sub>2</sub> exchange of grassland at the boundary region of monsoon thought dominating climatic variables, such as the annual precipitation amount and seasonal drought. Our results contribute to understanding of the specific driving mechanism for inter-annual variability of carbon fluxes in the Loess Plateau, and enhancing the terrestrial ecosystem model's performance in carbon fluxes estimate under the drought stress environment.