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Effects of livestock grazing on grassland carbon storage and release override impacts associated with global climate change

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Abstract: Predicting future carbon (C) dynamics in grassland ecosystems requires knowledge of how grazing and global climate change (e.g., warming, elevated CO_2, increased precipitation, drought and N fertilization) interact to influence C storage and release. Here, we synthesized data from 223 grassland studies to quantify the individual and interactive effects of herbivores and climate change on ecosystem C pools and soil respiration (Rs). Our results showed that grazing overrode global climate change factors in regulating grassland C storage and release (i.e. Rs). Specifically, grazing significantly decreased aboveground plant C pool (APCP), belowground plant C pool (BPCP), soil C pool (SCP), and Rs by 19.1%, 6.4%, 3.1%, and 4.6%, respectively, while overall effects of all global climate change factors increased APCP, BPCP and Rs by 6.5%, 15.3%, and 3.4% but had no significant effect on SCP. However, the combined effects of grazing with global climate change factors also significantly decreased APCP, SCP and Rs by 4.0%, 4.7% and 2.7%, respectively, but had no effect on BPCP. Most of the interactions between grazing and global climate change factors on APCP, BPCP, SCP and Rs were additive instead of synergistic or antagonistic. Our findings highlight the dominant effects of grazing on C storage and Rs when compared with the suite of global climate change factors. Therefore, incorporating the dominant effect of herbivore grazing into Earth System Models is necessary to accurately predict climate-grassland feedbacks in the Anthropocene.