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Long term CO_2 enrichment in a temperate grassland increases soil respiration during late autumn and winter

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Soil respiration of terrestrial ecosystems, a major component in the global carbon cycle may comprise a potential positive feedback to elevated atmospheric CO_2 concentrations. However, analyses reflecting seasonal variability of soil CO_2 fluxes under long term CO_2 enrichment including winter soil respiration are rare. At the Giessen free-air CO_2 enrichment in a temperate grassland (Gi-FACE), adding +20% to the ambient CO_2 concentration since 1998, we analyzed the seasonal dynamics of soil respiration including dormant seasons. We defined five seasons, with respect to management practices and phenological cycles. For a period of three years (2008-2010), we performed weekly measurements of soil respiration with an LI-8100 soil CO_2 efflux survey chamber from four vegetation-free subplots per FACE or control plot and tested for a CO_2 effect within the defined seasons. The results revealed a pronounced and repeated increase of soil respiration during winter dormancy. However, during spring and summer season, characterized by strong above- and below-ground plant growth, no significant change in soil respiration was observed at the Gi-FACE under elevated CO_2. This suggests (i) that measuring soil respiration only during the vegetative growth period in CO_2 enrichment experiments may underestimate the true soil-respiratory CO_2 loss (i.e. overestimate the C sequestered), (ii) that additional C assimilated by plants during the growing period, getting transferred below-ground until autumn, will quickly be lost again via enhanced heterotrophic respiration during the off-season, driving the increased winter soil respiration under elevated CO_2.