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Carbon dioxide and energy exchanges in two intensively managed grasslands in the maritime climate region

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Compared to global grasslands, grasslands in the maritime climate region may exhibit a distinct net ecosystem exchange (NEE) of carbon dioxide (CO_2) due to the absence of severe winter snow cover, summer soil water deficits or heat stress. In addition, intensive grassland management is common in this region, thus providing another important control on NEE. Here, we investigate the CO_2 and energy exchanges in two maritime grasslands (Dripsey and Wexford) located in southern Ireland, using eddy-covariance data collected since 2003. Both sites generally showed consistent and large annual uptake of CO_2 within the range of about 250 to 450 g C m^{-2} y^{-1}. Reduced CO_2 uptake or small net CO_2 loss however was observed at the Wexford grassland during years in which periodic planting of winter kale and grass reseeding occurred during spring/early summer. Following grass harvesting events, CO_2 uptake (i.e. NEE), ecosystem photosynthesis (GEP) and respiration (RE) were reduced during 3-4 weeks. In contrast, grazing events primarily resulted in a decrease of GEP and consequently CO_2 uptake, without apparent effect on RE. Both grazing and harvesting events led to a temporary increase in the Bowen ratio, primarily through enhanced sensible heat flux. Effects from the first harvest cut on CO_2 and energy exchange were more pronounced compared to a second cut within a year. Similarly, early grazing events altered CO_2 exchange more than late summer grazing events. Latter ones however resulted in a greater and longer lasting change (i.e. increase) of the Bowen ratio compared to early grazing events. On an annual scale, silage management resulted in lower annual CO_2uptake and Bowen ratio compared to years in which the grassland was predominantly used for grazing. Our study suggests that i) a prolonged growing season and the lack of climatic constraints may allow enhanced annual CO_2 uptake in maritime grasslands compared to global grasslands, and ii) that the choice of management regime (i.e. grazing versus silage, forage crop planting and grass re-seeding) may considerably alter the annual CO_2 exchange and energy partitioning. Furthermore, additional C fluxes that determine the net biome production have a large potential for modifying the net grassland C balance of these grasslands. The consideration of contrasting effects from grassland management practices on carbon and energy exchange processes is essential to evaluate implications from current and future management regimes on regional carbon, water and energy budgets.