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Impact of grazing on carbon balance of a Belgian grassland

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This work analyzes the impact of grazing on the carbon balance of a grassland grazed by the Belgian Blue breed of cattle. The research was run at the Dorinne terrestrial observatory (DTO). The experimental site is a permanent grassland of ca. 4.2 ha located in the Belgian Condroz (50° 18' 44" N; 4° 58' 07" E; 248 m asl.). Other studies are conducted at the DTO including measurements of methane (CH_4) and nitrous oxide fluxes (Dumortier et al., Geophysical Research Abstracts, Vol. 15, EGU2013-2083-1, 2013; Beekkerk van Ruth et al., Geophysical Research Abstracts, Vol. 15, EGU2013-3211, 2013, respectively).

Grassland carbon budget (Net Biome Productivity, NBP) was calculated from Net Ecosystem Exchange (NEE) measured by eddy covariance by taking imports and exports of organic C and losses of carbon as CH_4 into account. After 2 years of measurements (May 2010 - May 2012), the grassland behaved on average as a CO_2 source (NEE = 73 $\pm$31 g C m^{-2} y^{-1}). After inclusion of all the C inputs and outputs the site was closed to equilibrium (NBP = 23 $\pm$34 g C m^{-2} y^{-1}).

To analyze the impact of grazing on CO_2 fluxes, we studied the temporal evolution of gross maximal photosynthetic capacity GPP_{max} and dark respiration R_d (deduced from the response of daytime fluxes to radiation over 5-day windows). We calculated GPP_{max} and R_d variation between the end and the beginning of grazing or non-grazing periods (ΔGPP_{max} and ΔR_d, respectively). We observed a significant decrease of GPP_{max} during grazing periods and measured a ΔGPP_{max} dependence on the average stocking rate. This allows us to quantify the assimilation reduction due to grass consumption by cattle. On the contrary, no R_d decrease was observed during grazing periods. Moreover, we found that cumulated monthly NEE increased significantly with the average stocking rate.

In addition, a confinement experiment was carried out in order to analyze livestock contribution to Total Ecosystem Respiration. Each experiment extended over two days: the first day, cattle was confined in the footprint of the eddy covariance set-up (1.76 ha, 27 LU ha^{-1}) and the second day, it was removed from it. We compared filtered half-hourly data made at 24h intervals, in the presence or absence of cattle, considering that environmental conditions were equivalent (air temperature, wind speed, radiation and wind direction). Results showed that CO_2 fluxes were significantly higher when cattle were on the plot. Livestock contribution estimation to CO_2 fluxes was on average 6.6 μmol m^{-2} s^{-1}.

Key words: grassland, carbon budget, carbon dioxide exchange, impact of grazing.