Greenhouse gas fluxes over managed grasslands in Central Europe

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The biosphere-atmosphere exchange of the three greenhouse gases (GHG) carbon dioxide (CO₂), nitrous oxide (N₂O) and methane (CH₄) over managed grasslands in Central Europe is strongly affected by site-specific management strategies. While most in-situ GHG measurements focus on the quantification of CO₂ exchange, long-term N₂O and CH₄ flux measurements at ecosystem scale remain scarce, which in turn makes the profound evaluation of environmental impacts at site level challenging.

In this synthesis we collected ecosystem CO₂, N₂O and CH₄ fluxes from 14 managed grassland sites, quantified by eddy covariance or chamber techniques. On average, the investigated grasslands were a CO₂ sink (-1783 to -91 g CO₂ m⁻² yr⁻¹), but a N₂O source (18 to 638 g CO₂-eq. m⁻² yr⁻¹), and either a CH₄ sink or source (-9 to 488 g CO₂-eq. m⁻² yr⁻¹). The net GHG balance (NGB) was calculated for nine sites where measurements of all three GHGs were available and were found between -2761 and -58 g CO₂-eq. m⁻² yr⁻¹, whereby emissions of N₂O and CH₄ offset concurrent CO₂ uptake by on average 21 ± 6% across sites. NGB was positive for one site during a restoration year with ploughing. Soil variables were generally poor predictors for observed N₂O and CH₄ fluxes, but their predictive power varied considerably within years. However, after site-specific data normalization it was possible to identify environmental conditions that indicated enhanced GHG source and/or sink activity (‘sweet spots’), with high explanatory values for normalized overall fluxes across sites. The application of animal slurry to grasslands resulted in elevated N₂O and CH₄ emissions. Overall, the N₂O-N emission factor across sites was found at 1.8 ± 0.5%, but it varied considerably at site level among the years (between 0.1 and 8.6%). Generally, grassland management led to increased N₂O and CH₄ emissions, but the CO₂ sink strength was the most dominant component of the annual GHG budget.