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Subalpine grassland carbon dioxide fluxes indicate substantial carbon losses under increased nitrogen deposition, but not at elevated ozone concentration

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Ozone (O_3) and nitrogen (N) deposition affect plant carbon (C) dynamics and may thus change ecosystem C-sink/-source properties. We studied effects of increased background O_3 concentrations (up to ambient x 2) and increased N deposition (up to +50 kg ha^{-1} a^{-1}) on mature, subalpine grassland during the third treatment year. During ten days and 13 nights, covering the vegetation period of 2006, we measured ecosystem-level CO_2 exchange using a steady state cuvette. Light dependency of gross primary production (GPP) and temperature dependency of ecosystem respiration rates (R_{eco}) were established. Soil temperature, soil water content, and solar radiation were monitored. Using R_{eco} and GPP values, we calculated seasonal net ecosystem production (NEP), based on hourly averages of global radiation and soil temperature. Differences in NEP were compared to differences in soil organic C after five years of treatment.

Under high O_3 and with unchanged aboveground biomass, both mean R_{eco} and GPP decreased throughout the season. Thus, NEP indicated an unaltered growing season CO_2-C balance. Under high N treatment, with a +31% increase in aboveground productivity, mean R_{eco}, but not GPP increased. Consequently, seasonal NEP yielded a 53.9 g C m^{-2} ($\pm$ 22.05) C loss compared to control. Independent of treatment, we observed a negative NEP of 146.4 g C m^{-2} ($\pm$15.3). This C loss was likely due to a transient management effect, equivalent to a shift from pasture to hay meadow and a drought effect, specific to the 2006 summer climate. We argue that this resulted from strongly intensified soil microbial respiration, following mitigation of nutrient limitation. There was no interaction between O_3 and N treatments.

Thus, during the 2006 growing season, the subalpine grassland lost $>$2% of total topsoil organic C as respired CO_2, with increased N deposition responsible for one-third of that loss.