EGU22-8138
https://doi.org/10.5194/egusphere-egu22-8138
EGU General Assembly 2022


# Lysimeter experiments reveal effects of elevated atmospheric carbon dioxide on soil-water fluxes and biomass production of alpine grassland under drought

**Steffen Birk**[1], Matevž Vremec[1], Veronika Forstner[1], Markus Herndl[2], and Andreas Schaumberger[2]
[1]University of Graz, Institute of Earth Sciences, NAWI Graz Geocenter, Graz, Austria (steffen.birk@uni-graz.at)
[2]Agricultural Research and Education Centre Raumberg-Gumpenstein, Austria

Elevated atmospheric carbon dioxide ($eCO_2$) has led to global warming and thus increased evaporative demand of the atmosphere. Yet, the vegetation response to $eCO_2$ may counter the effect of warming by improving plant water-use efficiency (WUE). Here we use a lysimeter-based experimental approach to investigate the effect of $eCO_2$ on the evapotranspiration (ET), soil-water availability, and aboveground biomass (AGB) production of managed alpine grassland under drought. For this purpose, we use data from six weighable high-precision lysimeters at the ClimGrass experimental site operated by the Agricultural Research and Education Centre Raumberg-Gumpenstein (Austria). While one of these lysimeters is operated under ambient conditions, mini-T-FACE systems are used for controlled manipulation of the other lysimeters. Two lysimeters are operated under constant warming of +3 K relative to the ambient surface temperature, two under constant $eCO_2$ of +300 ppm relative to the ambient atmospheric concentration, and one with a combination of elevated temperature and $eCO_2$.

Considering the observations from 2018 to 2020, $eCO_2$ is found to lower ET relative to ambient conditions. Yet, biomass production does not appear to benefit from the water savings resulting from the reduced ET, because plant growth at this humid alpine site generally is energy-limited rather than water-limited (Forstner et al., Hydrol. Earth Syst. Sci., 2021). During summer 2019, however, a distinct dry spell was observed in which actual ET was well below potential ET. This suggests a depletion of the soil-water availability, potentially limiting plant growth in this time period. Under these drought conditions, ET was temporarily higher at the lysimeters with $eCO_2$ compared to those with ambient carbon dioxide concentrations. This corresponded to higher soil water contents and matric potentials resulting from the water savings in the pre-drought period at the lysimeters treated with carbon dioxide. As opposed to other time periods, under the drought in summer 2019 AGB and WUE were found to be higher at the lysimeters with $eCO_2$ than at those with ambient carbon dioxide concentrations. This effect appears to be most evident at the heated plots. It can be concluded that the water savings resulting from $eCO_2$ enabled prolonged water consumption into the drought period, thus mitigating the water limitation and benefiting plant growth. In summary, our results suggest that elevated atmospheric carbon dioxide can help mitigate water stress in alpine grassland during drought.