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Effects of elevated temperature and CO_2 concentration on the soil water balance in permanent grassland areas

Veronika Slawitsch (1), Steffen Birk (1), Markus Herndl (2), Erich Pötsch (2), and Andreas Schaumberger (2)

(1) Institute of Earth Sciences, University of Graz, Austria (veronika.slawitsch@uni-graz.at), (2) Institute of Plant Production and Cultural Landscape, Agricultural Research and Education Centre Raumberg – Gumpenstein, Irdning-Donnersbachtal, Austria

The predicted climate change involving increasing CO_2-concentrations and increasing temperatures will directly affect both precipitation and evapotranspiration rates and thus soil water fluxes. In addition, climate change is expected to alter the vegetation and potentially also the soil properties, which will indirectly affect soil water fluxes.

The aim of this work is to gain a better understanding of potential direct and indirect effects due to the changes of elevated temperatures and CO_2-concentrations on the soil water balance components in alpine areas (permanent grassland). For this purpose, three high precision weighable grassland lysimeters are available, which are part of a Lysi-T-FACE concept, where the free air on one lysimeter will be enriched with CO_2 (+300 ppm; FACE-Technique) and another one is heated by infrared heaters (+3° C; T-FACE-Technique). The third lysimeter is a reference plot which is neither heated nor fumigated. The Lysi-T-FACE concept was developed on the "Clim Grass Site" at the HBLFA Raumberg-Gumpenstein (Styria, Austria) (Pötsch and Herndl, 2014). The quantification of the soil water balance components is based on both an automatic and a user-defined control (Slawitsch et al., 2016) including the recently developed filter method AWAT (Adaptive Window and Adaptive Threshold Filter) (Peters et al., 2016). The water balance components are compared over a period of three years, where in the first year the lysimeters were neither heated nor fumigated.

The precipitation rates calculated from the lysimeter weights differ only slightly on the three plots, whereas the measured seepage, soil water storage as well the calculated evapotranspiration were different between the individual lysimeters, except for the first year (without treatment) where the differences were small between individual lysimeters. In the following two years the seepage water as well the upper boundary flux showed the lowest rates on the heated plot, the highest rates on the fumigated one, reaching a difference of more than 200 mm. The evapotranspiration exhibits an opposing trend in the two years with treatment. A distinct difference with the highest rates of the heated plot (816 mm/789 mm) and the lowest rates of the fumigated one (647 mm/587mm) was observed. Thus, an increase of the CO_2 concentration is found to cause a lower yearly evapotranspiration as well a higher seepage water, whereas an increase of the air temperature caused a higher yearly evapotranspiration as well as a lower seepage. Further work will also examine the interactive effects of elevated CO_2 and temperature and attempt to identify changes of soil hydrological processes and properties using inverse modelling.

Literature:

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