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CO_2 Exchange of a Grassland and a Wetland in the Swiss Pre-Alps during the 2003 Heat Wave

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The effect of the summer 2003 heat wave on two differently managed mountain agro-ecosystems, a grassland and a wetland, at the Swiss CARBOMONT site Seebodenalp is investigated. Direct comparisons of eddy covariance CO_2 and water vapor flux measurements from 1 June to 30 September 2003 revealed substantial carbon losses at both sites: the grassland was a net carbon source of 204 ± 20 g C m^{-2}, whereas the unmanaged wetland lost 62 ± 6 g C m^{-2}. In June the maximum net uptake of CO_2 was larger in the wetland than in the grassland, in agreement with the larger biomass measured in the wetland (162 ± 33 g DW m^{-2}) than in the grassland (104 ± 21 g DW m^{-2}). This difference in biomass is mainly due to sufficient soil water availability in the wetland during this early phase of the heat wave. A grass cut turned the grassland into a carbon source during the peak growing season, and led to the expected decrease in transpiration but also to a simultaneous increase in soil evaporation. The two changes roughly balanced each other. As a result of the emerging water stress the evaporation of soil water became the dominant component of the water vapor fluxes at Seebodenalp that were mainly energy driven. The photosynthetic activity of the wetland vegetation decreased steadily from spring to mid-summer due to increasing water stress and early senescence. In the grassland, cattle grazing in the nighttime footprint stimulated dark respiration. In July, soil water levels were low and reduced both dark and daytime respiration. Daytime respiration rates in the wetland were surprisingly low in the beginning of September, the ending of the heat wave, due to low soil water contents. The fact that the water stress not only lowered assimilation rates but also respiration rates emerged one month earlier in the grassland than in the wetland due to the different hydrological regimes.