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Leaf and ecosystem response of mountain grassland gas exchange to drought

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Climate change is expected to impact the Alpine region by increasing the frequency and intensity of exceptional heat and drought events resulting in a negative impact on water resources with uncertain effects on mountain ecosystem vulnerability. We evaluated the response of CO2 and water vapour exchange of a mountain grassland ecosystem to natural fluctuations of soil water content during 2001-2009. The physiological performance of different mountain forb and graminoid plant species under progressive soil water shortage was explored in a laboratory drying experiment in order to identify the degree of sensitivity to and the ability to recover from extremely dry soil conditions. Our analysis showed that during the observed 9 year time span the natural occurrence of moderate and severe dry periods, as identified by the Standardised Precipitation Index, did not lead to substantial reductions in net ecosystem CO2 exchange and evapotranspiration. Consistently, all the surveyed key grassland plant species were insensitive to progressive soil drying until a very low soil water threshold was reached in laboratory conditions, but never in the field. Re-watering after a short term drought event allowed a fast and complete recovery of all the investigated plant species indicating an excellent resilience of their photosynthetic machinery and the ability to rapidly revert the diffusive limitations arising under very limiting soil water availability. It is concluded that the present day frequency and intensity of dry periods does not substantially affect the functioning of the investigated grassland ecosystem. The observed "water spending" strategy employed by the surveyed mountain grassland species is expected to provide a "cooling" feedback on climate warming under present-day conditions, but it might have negative consequences on the low-land water supply if combined with the high evaporative demand occurring during future dry and hot periods.