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Controls of water use efficiency across different land use types and climate conditions along a mountain range

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At ecosystem scale, water use efficiency (WUE) represents the ratio between the carbon dioxide assimilated through photosynthesis and the water vapor released through transpiration and direct evaporation. Although global maps of WUE have been recently released, the role of single environmental drivers on different vegetation types is hardly disentangled at a regional scale. For instance, it is not clear if and to which extent, changes in air temperature or soil water availability affect WUE and if such effects are the same across different vegetation types. We analyzed four vegetation types along several growing seasons in South Tyrol (northern Italy), differing in terms of air temperature and precipitation. By using the eddy covariance technique, we assessed GPP and ET as well as WUE of a mountain forest, an irrigated apple orchard in the bottom of a valley, a meadow and a pasture, spanning 1500 m elevation gradient. The WUE in the two tree ecosystems was similar in spite of the contrasting climate. Daily GPP generally increased at increasing ET values, but when ET approached the highest levels, GPP leveled off. Daily WUE recorded in summer decreased with a logarithmic trend at increasing VPD and irradiances and to a less extent at increasing air temperatures. ET in the forest was similar to that in the orchard in spite of significantly lower VPD values, a fact indicating a different conductance to water vapor between the land use types. In the perspective of global change, our findings suggest contrasting effects of current and future variation in atmospheric chemistry and temperature. While the increase in atmospheric CO_2 concentration is expected to increase the WUE across the different ecosystems, increasing temperature and radiation will likely have an opposite effect.