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Marked increases in catchment evapotranspiration in an Alpine region and their possible drivers

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Increased evapotranspiration rates are expected as a consequence of climate change. However, due to the difficulty of measuring evapotranspiration, observed variations in evapotranspiration and their causes are not well characterized. Here we investigate changes in water balance derived catchment evapotranspiration over the past 40 years, using a high quality data set of more than 150 catchments in Austria. We attribute the observed changes to changes in atmospheric conditions, vegetation, and available water as possible drivers. We found significant increases in evapotranspiration in 60% of the catchments ($p \leq 0.05$). On average over all catchments, the increase is 29 mm y^{-1} or 5.0 % per decade. The changes in evapotranspiration are accompanied by increases in global radiation, air temperature, and changes in other climatic variables. Scattered pan evaporation data shows, on average, increases by 6.0 % per decade. Averaged over all catchments, reference evapotranspiration, estimated by the Penman-Monteith equation, increased by 17 mm y^{-1} or 2.6 % per decade. This increase was largely driven by increases in net radiation and further contributions from increases in air temperature. Vegetation activity strongly increased over 1982–2014, as analyzed by a satellite-based vegetation index (NDVI). It was estimated that this contributed to an increase in potential evapotranspiration by 6-12 mm y^{-1} or 0.9-1.8 % per decade, depending on the method used. Changes in evapotranspiration are positively correlated with changes in annual precipitation and a regression shows an increase in evapotranspiration of 0.24 ± 0.05 mm y^{-1} per 1 mm y^{-1} increase in precipitation. Our analyses indicate that 26–51% of the observed increase in catchment evapotranspiration can be directly attributed to changes in atmospheric conditions (increased global radiation and air temperature), 24–46% to increased vegetation activity, and 18–35% to increased water availability due to increases in precipitation.