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Hydroclimatic role of the Alps as sinks and sources of moisture

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The Alps have been recognised as hotspot areas for European climate change impacts. The ongoing and future changes in air temperature and precipitation impact the hydrological cycle not only for what concerns snowmelt and rainwater magnitude and timing but also for evapotranspiration fluxes. Evapotranspiration (ET) plays a major role in the water balance of alpine catchments as it pumps back to the atmosphere 60-80% of the precipitation and regulates precipitation recycling. Its importance is not limited to the alpine region but goes far beyond the Alps influencing the atmospheric moisture transport and impacting the water availability in downwind areas.

The recycling and downstream effects of changes in ET are not only hydrological but extend to economic and socio-political dimensions, particularly when countries rely on precipitation originating in foreign countries. Understanding these dynamics is crucial to addressing challenges in water resource management, land use, agriculture sustainability, and energy production.

While hydrological effects due to the decreases in snow and glacier cover over the Alps have been widely studied both at catchment and regional scales, studies on the downwind effects of the variations in ET at regional and continental scales are still few. This study addresses this knowledge gap by assessing both the geographical region of origin of the water that precipitates on the Alps and the areas where the evapotranspiration water from the Alps precipitates (constituting the so-called green water for these are., In doing this, we pay particular attention to precipitation recycling processes and the green water corresponding to agricultural lands, highlighting water vapor-mediated links between alpine and agricultural areas.

To effectively evaluate the destination of evapo-transpired water we employed the water vapor tracking model UTrack over the 2008-2017 mean year. Due to the spatial variability and the critical role of local factors in shaping ET within the alpine environment, we coupled UTrack with the high-resolution ERA5-Land dataset. This approach provides insights into the relationship between alpine water cycles and downstream hydrological dependencies.