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Actual evapotranspiration at the Andean grasslands: comparison of daily and hourly measurements and estimates

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The páramo ecosystem provides most of the water for the tropical Andean highlands in South America. Thus, the proper closure of the water balance in this environment is of outmost importance. Although actual evapotranspiration (ETa) is a key component of the water balance, it has not been properly assessed at the páramo. ETa has been recently measured through the eddy-covariance (EC) method. However, this technology is still expensive, complex, and rarely available at similar sites. This study aims at finding alternative methods by comparing EC daily and hourly measurements with lysimeters (Lys) measurements and ETa estimates from the water balance (WB), the energy balance (EB), the Penman-Monteith calibrated equation (PMCal), and two hydrological models: Probability Distribution Model (PDM) and Hydrologiska Byråns Vattenbalansavdelning model (HBV-light). The study site was the Zhurucay Ecohydrological Observatory, located in the high Andes of Ecuador (3500 – 3900 m a.s.l.). Zhurucay is representative of the páramo ecosystem: mean temperature is 7 °C, mean annual precipitation (P) is 1200 mm, vegetation corresponds mainly to tussock grasses, and soils are classified as Andosols. At the end of one year, ETa / P ratio was 0.57 and daily ETa was 1.7 mm on average. The best daily and hourly estimates, according to percentage bias (pbias), root mean square error (RMSE), Pearson's correlation coefficient (r), coefficient of correlation (R2), and volumetric efficiency (ve) were obtained with the HBV-light model, followed by the PDM and the PMCal. Percentage bias was 2 – 20 %, RMSE was 0.5 – 0.6 mm, r was 0.7 – 0.8, R2 was 0.5 – 0.8, and ve was 0.8. On the other hand, the lysimeters were only useful at monthly timescales, the WB was only useful at annual scale and the EB estimates presented poor performance at all temporal scales. This study includes discussion on the suitability and application of methods based on their costs, temporal resolution, and accuracy. Ongoing research focuses on ETa events (dry and wet periods, high radiation, etc.) that allows the understanding of the process and allows the partitioning of this important variable (transpiration and interception). So far, we have found that net radiation (Rn) and relative humidity (RH) are the most important drivers of ETa at the region. In fact, Rn and RH can be used as predictors of ETa through multiple linear correlation (R2 = 0.9). Transpiration rates were quantified during dry periods (1.3 mm/day on average). Interception in relation to total precipitation (IL/P) was quantified during wet periods. IL/P rates can be as high as 90 – 100 % during small events (P < 2 mm). IL/P decreases from 100 to 10 % for larger events (2 < P < 8.5 mm). The implications of these findings include, among others, the proper closure of the water balance, improvement on hydrological processes modelling, and better understanding of the atmosphere-vegetation-soil interaction at a very important tropical environment.