Moisture conditions are limiting evapotranspiration changes of alpine mountains of Qilian Mountains

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Abstract

Changes in evapotranspiration and its response to control variables are crucial for understanding water balance and climate change in high-altitude areas. Environmental changes will inevitably disturb regional water cycles and water balance, especially in the high-altitude alpine regions of the Qilian Mountains. To better understand the variation of evapotranspiration at different altitudes in the high-altitude region of the Qilian Mountains and the applicability of the model and its response to environmental factors, we measured the variation of actual evapotranspiration at three altitude gradients using meteorological stations and automatic observation of continuous data with a weighing-type micro-lysimeter at three altitude gradients of 3797 m, 4250 m, and 4303 m in the Shaliu River basin of the Qilian Mountains during the growing season from June 2020 to October 2022 in our research. Using ten models to calculate the variation of reference evapotranspiration, and fitting them to the actual evapotranspiration, we selected the most suitable model. The results showed that the cumulative total evapotranspiration during the growing season in our study period was 1974.556 mm, 2203.066 mm, and 2201.393 mm, respectively, with intra-annual fluctuations consistent across the three elevation gradients. The value of evapotranspiration in August showed the highest at the monthly scale of 4.809 mm·day $^{-1}$ and a bimodal variation at the daily scale with peaks at 10:00 and 15:00. The model of Dalton simulations showed the best results with the lowest analysis of residuals (RA), root mean square error (RMSE), and percentage error (PE), which had values of 3.291 mm·day $^{-1}$, 3.994 mm·day $^{-1}$, and 0.692%, and the values of R^2 between simulated and measured values of 0.622, 0.609, and 0.420. Water balance results showed that a portion of evapotranspiration in the study area originated from deep soil moisture. Partial Least Squares Regression (PLSR) analysis and enhanced regression tree model results indicated that precipitation was the most important variable, with Variable Importance in Projection (VIP) scores of 2.079 and a relative contribution to evapotranspiration of 52.6%. Overall, moisture conditions and precipitation were important factors limiting evapotranspiration variation in our research area. Our findings have implications for future climate change conditions. This conclusion is important for future water budget details in alpine mountains under climate change.

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