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Hydrological Processes

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Insight into the stable isotopic composition of glacial lakes in a tropical alpine ecosystem: Chirripó, Costa Rica (Article)

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Abstract

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Tropical high-elevation lakes are considered sentinels of global climate change. This work characterizes the hydrological conditions of tropical alpine glacial lakes located in the highlands of Chirripó, Costa Rica, using a unique data set of water stable isotopes ($\delta^2\text{H}$ and $\delta^{18}\text{O}$) in precipitation, stream water, and lake water between September 2015 and July 2017. A combined dataset of bathymetric, hydrometric, and isotope data collected between July 2016 and July 2017 on Lake Ditkevi was used to calculate the annual water balance of the lake. Evaporation to inflow ratios from three lake systems was estimated using a linear resistance model, the experimentally estimated local evaporation line of Chirripó, and the first glacial lake water evaporation lines in the region. The temporal isotopic variations ($\delta^{18}\text{O}$, d-excess, and lc-excess) confirm variations in the dry and wet season evaporative conditions for the glacial lakes and consistently average annual low evaporation to inflow (E/I) ratios in the range of $2.0 \pm 0.8\%$ and $18.1 \pm 12.2\%$. Lake Ditkevi's water balance indicates annual steady-state conditions, with an estimated evaporation loss of 650 mm/year ($10.0 \pm 5.0\%$ of inflow), a high-water contribution to the catchment (90% of inflow), a residence time of 0.53 ± 0.27 years, and a catchment scale (0.289 km^2) water yield or depth equivalent run-off of 278 mm/yr. These results provide novel information about water balance and evaporation losses in tropical alpine glacial lakes, which can serve as baseline information for future isotope-based hydro-climate research in high-elevation regions in the tropics and elsewhere. © 2018 John Wiley & Sons, Ltd.

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
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