Quantifying Precipitation Gauge Network Uncertainty in the Canadian Rockies

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ABSTRACT

Sparse gauging networks cause uncertainties in areal precipitation estimates, and the degree of uncertainty is especially high in mountain regions. Since snowfall is the primary input to cold regions hydrological models and is challenging to measure well, quantifying its uncertainty is crucial for hydrological estimation. The purpose of this research is to create a 30-year gauge-based rainfall and snowfall database to estimate the spatial-temporal-elevational precipitation uncertainty in the snowmelt-dominated Canadian Rockies – the headwaters of rivers that flow to three oceans. Data from 206 precipitation (rainfall+snowfall) gauges from several Canadian and US networks were utilized to create a 30-year database in the 125,601 km^2 mountain region ranging from NW Montana (MT) and S Alberta to NE British Columbia (BC). Available observed meteorological data were used for snowfall undercatch correction, and 9-km ERA-5 Land reanalysis data were utilized for infilling where observations were unavailable. The daily precipitation database was used for gauge network uncertainty estimation (standard deviation per grid-cell) using kriging aided by elevation at 2-km spatial resolution. The results show that uncertainty decreased in 87% of the region from 602 to 553 mm between 1991 and 2020. In the remaining 13%, which was near to decommissioned gauges or due to other factors, uncertainty increased from 531 to 543 mm. In 2020, uncertainty remained greatest in the remote northern part of the region (BC), and was least in the southern part of the region (MT). Uncertainty increases with elevation in most of the region, and it is greatest above 2,500 m. These findings suggest that although the uncertainty has decreased, it is still substantial in the most remote areas and highest elevations of the Canadian Rockies.

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