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Using Fuzzy Sets to quantify uncertainty of precipitation estimates caused by sparse gauging networks in a remote, mountainous watershed.

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Watershed modeling requires reliable climate input data which provide a reasonable representation of the spatial variability. In many cases limited access, complex terrain and remoteness of these watersheds make it difficult to acquire good data and we often have to rely on one or two precipitation gauges for watersheds of considerable size (> 10 km2). In this paper we characterize the variability of precipitation in a small (8 km2), remote, mountainous head watershed in British Columbia and quantify the uncertainty of precipitation estimates caused by sparse precipitation gauging stations in contrast to a relatively dense experimental measurement network using a new, robust and low maintenance mass replacement precipitation gauge design.

We found that spatial precipitation variability is particularly of concern during the summer months. When one gauge within the watershed is recording precipitation, integration times of more than 8 days are necessary for all gauges recording. This time is reduced to 4 days for large scale intense winter precipitation events.

A multiple linear regression with fuzzy upper and lower limits was applied to estimate the average basin precipitation. Using this method, the difference in average basin precipitation between the dense experimental gauging network and typically available sparse gauging set-ups was quantified. Depending on the integration time, the mean absolute error was found to be 1.3 mm d-1 for hourly observation time steps for the most suitable sparse set-up. These results are accompanied by the fact that the average basin precipitation of the sparse networks is outside the fuzzy limits in at least 30 % of the days during the observation period.

These findings indicate that even on such small scales, common sparse networks are likely to frequently miss entire precipitation events, especially originating from small summer storm cells. Furthermore, sparse gauging networks, consisting of one or two gauges, tend to seriously misrepresent the actual average basin precipitation throughout the year.