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Evaluation of Measurement Errors of Tipping Bucket Rain Gauges

Guangxu Jiang, Jiufu Liu, Xuegang Li, Hongwei Liu, and Aimin Liao

Nanjing Hydraulic Research Institute, Hydrology and Water Resources Department, China (jiangguangxu123@163.com)

The observation accuracy of rainfall processes affects every aspects of the meteorological and hydrological affairs, which is widely monitored by various types of tipping bucket rain gauges—TBRs—because of the simple structure and reliable performance. The study of the measurement errors of TBRs is quite valuable and necessary for improving the rainfall data quality and evaluating the uncertainty of the research based on the dataset.

In this study, an artificial rainfall and monitor experiment system is designed with peristaltic pump, balances, recorder and controller for the accurate rainfall and the TBRs instrumental values record, based on which the error distribution and instrument stability were analyzed. Eight types of TBRs are chose for the error evaluation experiment, including five single-layer TBRs, three double-layer TBRs. For each TBRs, we observe its performance under 6 rain intensity (0.1-4mm/min) in turn. With regard to each rain intensity, when the simulated total rainfall reaches 10 mm, the experiment stops and records the data, then repeats the same experiment 6 times.

The result shows that the single-layer TBRs have a good linear relationship between the rainfall and the measurement error, and the double-layer TBRs has a significant regulating effect on the continuous heavy rain intensity, which can make the rain flow steadily down to the lower tipping bucket (metering tipping bucket) with a stable rain intensity to avoid the rain intensity variation influence on the measurement error. However, due to its high resolution of 0.1mm, it is greatly affected by the residual water volume of the tipper bucket.

According to the results, the single-layer TBRs can correct the actual rainfall measurement process according to the error ~ rainfall intensity curve. The double-layer TBRs can play an important role in the rainy day record, but the randomness of the residual in the tipping bucket needs to be further estimated. Because the proportion of the light rainfall intensity in most of the rainfall events are quite high according to the statistics, it is necessary to have lower measurement error under the light rainfall in the TBRs chosen and calibration process. It's a good idea to choose a combination of rain gauges(0.1mm&0.5mm) to improve the accuracy of rainfall and rainy day.