Geophysical Research Abstracts
Vol. 15, EGU2013-2378, 2013
EGU General Assembly 2013

Using high-speed photography to study undercatch in tipping-bucket rain gauges

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To better understand the undercatch process associated with tipping-bucket rain gauges, we employed a high-speed camera normally used in determining the structure of lightning. The photo rate was set at 500 frames per second to observe the tipping of the bucket in a commonly used tipping-bucket rain gauge with its case removed. The photos showed detail never seen before as the bucket tipped from one side to the other. The Hydrologic Services Model TB 320 Calibration Device (Australia) was used to provide two fixed rain rates of 19.9 mm/h and 175.2 mm/h.
The high time resolution images show there are usually multiple bounces of the bucket before it finally achieves its rest position on a nylon acorn post. With the higher rain rate, the force of the rain falling into the bucket apparently causes some sloshing when the bucket is nearly full. The sloshing results in a noticeable variable motion of the bucket assembly away from its rest position just prior to the beginning of a tip.
We examined the data from four tips each at the low and high rain rates. The results show that the time from the perceived beginning of a tip to the time the bucket assembly is horizontal – the period during which undercatch occurs – is an average of 0.45 s for the eight cases. The average time from the perceived beginning of a tip to the first strike at the opposite post is 0.53 s. The linear speed of the tip of the lip of the bucket at first strike averages 0.5 m/s. When separated into high and low rain rates, parallel calculations show that their differences are unremarkable.
The undercatch was 0.97% for the lower rain rate given above and 8.79% for the higher rain rate. Traditional laboratory measurements of percent undercatch using the Hydrologic Services Device mentioned earlier are in relatively close agreement with the photographically determined percent undercatch. We plan to discuss the procedure used to estimate the undercatch and present a slow-motion video of the tipping of a bucket.