
The challenges of measuring cloud liquid water content and cloud water interception in tropical montane cloud forests

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Abstract

Tropical montane cloud forests (TMCFs) are important ecosystems that serve as havens for diverse biota and act as a water source for mountain watersheds. The contribution of wind-blown cloud droplets intercepted by TMCF vegetation to the hydrological input of these ecosystems and watersheds is difficult to measure, but important to know given the threats of climate warming, land cover change, and species invasion. Despite recognition of the importance of TMCF hydrology, field measurements of cloud water interception (CWI) and related variables are relatively sparse, in part, because of the difficulty in making reliable observations. The canopy water balance approach can be used to estimate CWI based on measurements of above-canopy precipitation, below-canopy net precipitation (throughfall plus stemflow), and estimates of wet canopy evaporation. To enable estimation of the spatial patterns of CWI, it is useful to measure not only CWI at representative sites, but also wind speed and cloud liquid water content (LWC). The product of those two variables yields cloud water flux (CWF) which, combined with parameters describing the vegetation, can be used to simulate spatially and temporally varying CWI. LWC sensors are generally quite expensive. Therefore, we tested the use of the relatively inexpensive Juvik-type passive fog gauge and an anemometer to estimate CWF and LWC. We found that fog-gauge-derived estimates were well correlated with highly accurate LWC measurements from a phase Doppler interferometer (PDI), although the inferred fog gauge catch efficiency was much lower than expected at approximately 13%. Based on these results, we estimated LWC and CWF based on fog gauge and wind speed measurements at five sites in Hawai'i. Results show varying means and diurnal patterns depending on location relative to topography, elevation, and wind direction. In follow-on analysis, these results will be used to estimate the spatial patterns of CWI across TMCFs of the Hawaiian Islands.

Keywords: tropical montane cloud forests, cloud water interception, fog drip, cloud liquid water content, fog gauges

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