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Hydro-meteorological functioning of the Eastern Andean Tropical Montane Cloud Forests: Insight from a paired catchment study in the Orinoco river basin highlands

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Tropical forests regulate large scale precipitation patterns and catchment-scale streamflow, while tropical mountains influence runoff by orographic effects and snowmelt. Along tropical elevation gradients, these climate/ecosystem/hydrological interactions are specific and heterogeneous. These interactions are poorly understood and represented in hydro-meteorological monitoring networks and regional or global earth system models. A typical case are the South American Tropical Montane Cloud Forests (TMCF), whose water balance is strongly driven by fog persistence. This also depends on local and up wind temperature and moisture, and changes in this balance alter the impacts of changes in land use and climate on hydrology. These TMCFs were until 2010 only investigated up to 350km from the coast. Continental TMCFs are largely ignored. This gap is covered by our study area, which is part of the Orinoco river basin highlands and located on the northern Eastern Andes at an altitudinal range of 1550 to 2300m a.s.l. The upwind part of our study area is dominated by lowland savannahs that are flooded seasonally. Because meteorological stations are absent in our study area, we first describe the spatial and seasonal meteorological variability and analyse the corresponding catchment hydrology. Our hydro-meteorological data set is collected at three gauged neighbouring catchments with contrasting TMCF/grassland cover from June 2013 to May 2014 and includes hourly solar radiation, temperature, relative humidity, wind speed, precipitation, soil moisture and runoff measurements. We compare our results with recent TCMF studies in the eastern Andean highlands in the Amazon basin.

The studied elevational range always shows wetter conditions at higher elevations. This indicates a positive relation between elevation and fog or rainfall persistence. Lower elevations are more seasonally variable. Soil moisture data indicate that TMCFs do not use persistently more water than grasslands. Runoff data from our three catchments reflect the interaction between ecosystems and elevation. The less-forested catchment at lower elevations has a more seasonally variable runoff and present the lowest base flows during the dry season. In this season, soil water storage and the wetter conditions at higher elevations are crucial to sustain their base flow. The hydro-meteorological patterns of our study area are similar to those at the eastern Andean TMCF sites, but differences in the elevation of fog and rainfall persistence suggest that specific upwind ecosystem conditions and distance to the coast are important to explain and understand regional seasonal differences.