Spatial and temporal patterns of tropical forest microclimate in Mount Kenya

Jinlin Jia, Alice C. Hughes, Erone Ghizoni Santos, Petri K.E. Pellikka, and Eduardo Eiji Maeda

1School of Biological Sciences, Faculty of Science, The University of Hong Kong, Hong Kong, Hong Kong SAR
2Department of Geosciences and Geography, University of Helsinki, Helsinki, Finland
3State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing, Wuhan University, Wuhan, China
4Finnish Meteorological Institute, Helsinki, Finland

Tropical-montane forests are global biodiversity hotspots, and also play important roles in regional hydrological systems. Yet, climate and especially microclimate in these areas, and how they vary spatially and temporally have been largely neglected. Due to the buffering effect of vegetation, microclimate (i.e. environmental conditions experienced by organisms inside the forest) can be substantially different from the conditions outside the forests. Additionally, sparse meteorological stations and satellite data cannot provide accurate climate estimates over tropical mountains, especially on microclimate under the canopy. Consequently, further research is needed to clarify the spatial and temporal patterns of environmental conditions in these regions.

In this study, we set 16 microclimate sensors on the southern and southeastern slopes of Mount Kenya, with an elevation range of 720 m (from 1730 m a.s.l. to 2450 m a.s.l.) across the Lower Montane Wet Forest. The sensors measured understory air temperature and soil moisture every 15-minutes across a 2-year period.

We found that average soil moisture in the study area varied with monthly precipitation, synchronously increasing with the start of the rainy seasons, but decreasing with a approximate one month lag towards the dry seasons. Soil moisture did not have a linear relationship with altitude, presenting a local minimum at about 2050 m a.s.l.. The understory air temperature changed linearly with altitude, whereas the lapse rate varied across seasons. The seasonal variation of diurnal lapse rate was about three times larger than that during the night. For the intra-daily temperature, minimums occurred simultaneously (at 4:30 am) independently of altitude. Conversely, at higher altitudes, the maximum temperature occurred earlier. The lowest average daily temperature and smallest daily temperature range occurred between June and August, whilst the opposite phenomena occurred from January to March. Furthermore, Jan-Feb-Mar also presented the smallest lapse rate and low soil moisture, representing the main period of vegetation growth. Our results will contribute for clarifying the conditions sustaining the disproportionally high biodiversity and biomass observed in tropical mountain forests. Further research will investigate the drivers and biophysical feedbacks of microclimate, as well as their sensitivity to climate change.