Rain Drop Size Distributions in Relation to Atmospheric Instability at a Tropical Location

Pallabi Saha* (1), Gargi Rakshit(1), and Animesh Maitra(1)
(1) Institute of Radio Physics and Electronics, University of Calcutta,
92, Acharya Prafulla Chandra Road, Kolkata-700009, India

Rain microphysics is determined in a major way by rain Drop Size Distribution (DSD), and hence reliable estimation of rain DSD parameters is essential in characterizing rain events. The role of atmospheric instability, indicated by Convective Available Potential Energy (CAPE), in determining DSD parameters has been investigated over a tropical location Kolkata (22.57° N, 88.37° E), India which experiences a combinational rainfall pattern [1]. The data of the rain DSD used in the study are collected from a ground based disdrometer operated at the Institute of Radio Physics and Electronics, University of Calcutta during the pre-monsoon (March-May) and monsoon periods (June-September) of 2016-2017 [1]. CAPE values are obtained from ERA-5 data. DSDs are modelled in terms of a three-parameter gamma function ($N(D) = N_o D^{\mu} e^{-\Lambda D}$) [2]. The mass weighted mean drop diameter (D_m), obtained as ratio of M_4/M_3, where M_3 and M_4 are 3rd and 4th moment of $N(D)$), has increased with CAPE for all the rain events considered together. However, the rain events are classified into two categories namely convective and stratiform, based on the collocated observations from Micro Rain Radar (MRR) [1]. The presence (absence) of bright band structure in the rain rate profiles during an event indicates the rain as stratiform (convective) type. The variations of D_m, Λ, and μ with CAPE are more prominent for convective rains compared to stratiform rains as shown in Figure 1. An increase of CAPE causes an enhanced presence of larger drops and larger width of DSD spectrum as evident from increased D_m and decreased μ and Λ values. Higher CAPE values imply increased updraft favouring coalescence over break-up process. The changes in DSD parameters with CAPE is appreciable for convective rains when vertical wind plays an important role [1]. Whereas in the case of stratiform rain events towards which the advection of air mass from Bay of Bengal has a major contribution, the effect of vertical air draft is not as significant. The study reveals the impact of local convective activities on rain DSD parameters under varying raining conditions at a tropical location.

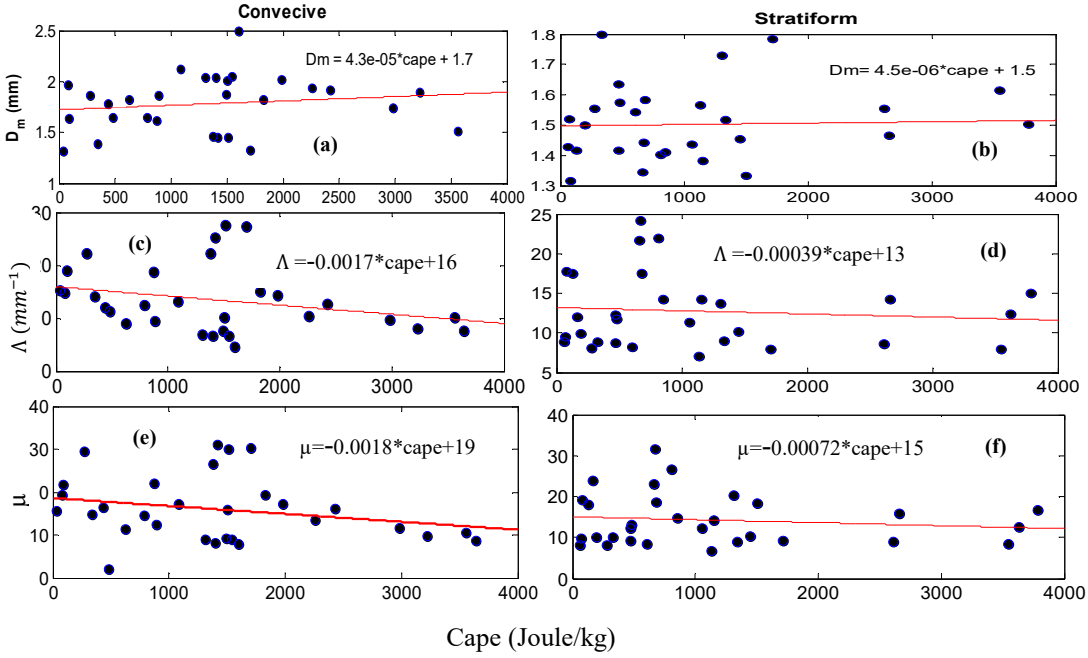

Figure 1. Variation of D_m (a, b), Λ (c, d) and μ (e, f) with CAPE for both convective and stratiform rain.

References

[1] A. Maitra, G. Rakshit, S. Jana and R. Chakraborty, "Effect of Boundary Layer Dynamics on the Profiles of Rain Drop Size Distribution During Convective Rain," *IEEE Geoscience and Remote Sensing Letters*, **16**, 7, pp. 1007-1011, July 2019.

[2] J. Vivekanandan, G. Zhang, and E. Brandes, "Polarimetric radar estimators based on a constrained gamma drop size distribution model," *Journal of Applied Meteorology*, **43**, 2, pp. 217-230, February 2004.