The physics of clouds and precipitation for Mumbai Monsoon

Kaustav Chakravarty[1*] and G.Pandithurai[1]

Indian Institute of Tropical Meteorology, Pune, India

*Email : kaustav@tropmet.res.in

Abstract

In the recent decades, many urban areas all around the world, including the coastal megacity of Mumbai, has witnessed the increasing threat of heavy rainfall and flooding. With the increase of population, as the cities continues to expand, the impact of urbanization creates unique problems related to land use, transportation, agriculture, housing, pollution etc. which in turn have measurable impact on weather and climate processes over these regions. The city of Mumbai, considered as the financial capital of India and situated on the western coast of peninsular India experiences heavy rainfall spells during the pre-monsoon and monsoon periods from the cloud systems originating from the eastern and western part of the region respectively. The present study tried to highlight the morphology of the vertical structure of clouds and microphysical features of precipitation during the inter-seasonal and intra-seasonal phases of monsoon over Mumbai for a continuous period of 4 years (2018-2021). The study will also portray the cause and the impact of the severe rainfall events of Mumbai which creates severe flooding at the city quite frequent during the monsoon times. The analysis has been done by using a Joss-Waldvogel Disdrometer data set up at IMD campus in Santacruz along with the radar reflectivity data from S-band Doppler Weather Radar placed at Colaba in southern Mumbai. The preliminary results show that the Mumbai receives rainfall primarily from easterly winds during the pre-monsoon time which then shifts to the south-westerly direction during the monsoon period. Looking into the diurnal variation of rainfall, three distinct rainfall peaks was noted for the pre-monsoon period. The corresponding vertical profile of radar reflectivity shows that these rainfall peaks are complimented with clouds of reflectivity more than 40 dBz and the presence of severe lightning flashes. But in case of monsoon month, no such distinct diurnal variations are visible over these regions. The dominance of urban convective environment in the pre-monsoon period and the impact of moisture supply from the marine sources over the city during the monsoon months are considered to be one of the contributing factors for the contrasting diurnal pattern of rainfall for these inter-seasonal phases of monsoon. Correspondingly, the giant cloud condensation nuclei (GCCN) from the bursting of sea salt aerosol in the Arabian Sea also plays a significant role in the enhancement of warm rain processes in the coastal urban region during the monsoon months. In addition to that while looking into the microphysical characteristic of rainfall, it has been found that the raindrops of diameter 2.5 mm and above dominate the pre-monsoon months with respect to the monsoon period. The convective urban environment characterized by higher localized CAPE aids vigorous thermals leading to smaller drops shifting aloft and thereby allowing bigger drops to precipitate locally during the pre-monsoon season. These findings and the observations that helped to develop the analysis, are expected to aid heavy rainfall analysis over the urban coastal regions in the future, particularly for the Indian monsoon regimes.