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Identification and Estimation of Rainfall Intensity using Microwave Radiometric Measurements

Tuhina Halder*(1), Arpita Adhikari (2), and Animesh Maitra(2)
(1) Department of Electronics and Communication Engineering, Budge Budge Institute of Technology, Kolkata 700137, West Bengal, India, e-mail: tuhinahalder12@gmail.com
(2) Institute of Radio Physics and Electronics, University of Calcutta, 92, Acharya Prafulla Chandra Road, Kolkata 700 009, India; e-mail: arpita.adhikari@gmail.com; animesh.maitra@gmail.com

Rainfall information is important in various fields such as agriculture, water resource management, and weather forecast. A proper and efficient forecast of precipitation occurrences and rainfall amounts is important in this connection. Information on the different phases of atmospheric water is necessary to characterize the impending precipitation. A multi-frequency microwave radiometer is capable of continuous monitoring of the brightness temperature of atmospheric emissions which is capable of sensing water vapour, liquid water and their evolution towards forming rain structures with different microphysical properties.

The precipitations at the present location are identifiable into different types, namely, convective, stratiform and mixed type. These types of rain are also recognizable on the basis of radar and disdrometer (DSD) observations. The multi-frequency radiometer measurements can also be utilized to identify rain events where the emission from liquid rain drop dominates and the events for which the emission from water vapour dominates. The difference between brightness temperatures at 31.4 GHz and 22.24 GHz ($T_{b31.4}$ - $T_{b22.24}$) can be an indicator of these two distinct conditions, and, therefore, identify convective and stratiform rain [1]. This identification of rain types has been compared to the identification by Micro Rain Radar (MRR) and disdrometer observations.

A logarithmic regression analysis has been utilized for estimating rain fall intensity during stratiform and convective events. The following relationship between brightness temperature and instantaneous rainfall intensity is used for the estimation [2-3]:

$$R = a + b\ln(300 - T_{b\,22.24}) + c\ln(300 - T_{b\,31.4}) \quad (1)$$

where a, b, and c are the curve fitting coefficients.

The results show that pure stratiform and convective events are identified better from the MRR reflectivity profiles. However, the stratiform events, identified by radiometric measurements, are not purely stratiform but are rather mixed ones. The results also show that for estimating rainfall intensity using logarithmic regression, the correlation coefficient between the actual rainfall intensity and estimated rainfall intensity, is 0.71. The logarithmic regression technique can estimate rainfall intensity up to 20 mm/h irrespective of stratiform and convective rain. Since the brightness temperatures from the radiometer get saturated at higher rain rates, the adopted technique cannot estimate very high rain rate values. This study shows that the multi-frequency radiometric measurements can be utilized to characterize rain events and to estimate rain intensity up to 20 mm/h at the present tropical location.

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