A study on the microphysics of tropical extreme precipitating systems using X-band dual-polarization radar

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by

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ABSTRACT

Precipitation is one of the major components of the water cycle, and energy budget and is responsible for most of the fresh water on the planet. The agrarian countries, like India, depend heavily on precipitation. Doppler Weather Radars (DWRs) provide areal precipitation (within the radar range) with high spatial and temporal resolutions and are ideal for understanding the spatiotemporal variability of precipitation. However, single polarization DWRs do not provide deep insights into the microphysical processes occurring in different types of precipitating systems, which remains an open question even today.

This is more so for monsoonal precipitation, which exhibits large spatiotemporal variability over India governed by various synoptic and topographical forcings. The emergence of dual-polarization radars in recent years became a boon for understanding precipitation microphysics, either through height time variations of retrieved raindrop size distribution (DSD) or directly from the variation of polarimetric parameters, like differential reflectivity (Z_{DR}) and differential propagation phase (Φ_{DP}) and copolar correlation coefficient (ρ_{HV}). It is now known that the DSD exhibits large seasonal variability in southeast peninsular India; appropriate relations for different DSD models need to be empirically derived to convert polarimetric radar parameters into geophysical parameters. It forms the first objective of the thesis, i.e., deriving appropriate relations between the radar and DSD parameters in different seasons and their validation using X-band Dual-polarization Radar for Observing Precipitation (DROP-X) and disdrometer measurements at Gadanki.

A very severe cyclone – NIVAR, passed close to the radar location, allowing one to study the life cycle of convective cells. This work mainly focuses on unraveling the microphysical processes at different stages of convective cells originating in a cyclonic environment. In another study, the rain DSD and its moments in the inner core, inner rain band, and outer rain bands of tropical cyclones that occurred in the last 16 years are compared and contrasted to understand the dominant microphysical processes in those regions. An extreme rainfall event occurred over the study region producing about 115 mm rainfall in 2 hours. A detailed analysis has been made with multiple data sets to characterize the event, in terms of rain rate and microphysical parameters, and also to understand the dynamical and microphysical processes that caused such a downpour. Improved understanding of microphysical processes in different types of extreme precipitating systems allows us to improve the parameterization schemes and also assimilation of radar data can improve numerical weather forecasts.