

Chapter-6

Variability of NE Monsoon Rainfall

NE monsoon exhibits variability in all time scales, from diurnal, synoptic to intra-seasonal, inter-annual and decadal time scales. In this chapter, the NE Monsoon variability in all time scales is discussed.

6.1. Diurnal Cycle of NE Monsoon Rainfall

The diurnal cycle is one of the most important modes of precipitation variability over the Indian monsoon region (Rajeevan et al. 2012, Bhate et al. 2019, Raj and Amudha 2022). It is a manifestation of the atmosphere-ocean-land-cryosphere response to incoming solar radiation. A detailed analysis and discussions on diurnal variation during the southwest monsoon season are given in Sahany et al. (2010).

This section discusses the results from a detailed analysis of 3-hourly rainfall derived from TRMM satellite data. Harmonic analysis was made to understand the phase and amplitude of diurnal variations. More details of the analysis of diurnal variation are available in Bhate et al. (2019) and Rajeevan et al. (2012).

Fig. 6.1 shows the 3 hourly variation of climatological rainfall over the Indian region during the northeast monsoon season as estimated using TRMM satellite data for the period 1998-2019. It shows distinct types of variations over the Oceans and land. Over the east coast of India, maximum rainfall is observed in the early morning hours, but over the interior parts, rainfall peaks in the late evening and early night.

The spatial map of the phase (hours with maximum rainfall) revealed by the Harmonic Analysis explained is shown in Fig. 6.2. The phase diagram clearly shows the distinct difference in the rainfall peak over the oceans and land. Over the oceans and off the east coast of India, rainfall during the NE monsoon season peaks in the morning. On the other hand, rainfall peaks over the interior parts and the west coast, during the late evening/early night (between 1830 and 2130 IST). Thus, the northeast Monsoon over south peninsular India exhibits significant diurnal variations with large spatial variations.

Along the east coast of India, an early morning peak is observed and over the inland regions and the west coast, an afternoon/evening peaking is observed.

Fig. 6.3 shows hourly average rainfall during the NE monsoon season (Oct-Dec) showing the diurnal variation of observed rainfall over different stations over the south Peninsula. These plots are made using hourly station rainfall data, taken from the IMD archives. These plots clearly suggest that the stations over the east coast experience maximum rainfall during the morning hours. Over the interior parts and the west coast, maximum rainfall occurs during the evening and early night hours. Different physical mechanisms could be responsible for the observed rainfall diurnal variations over land and oceans. The observed rainfall peak in the late afternoon over the land could be due to intense surface solar heating and resultant convective instability. Over the east coast, the presence of a strong sea-land breeze is also noted to be responsible for diurnal variations (Bhate et al., 2019, Ramesh Reddy et al., 2021).

It is important to make a detailed analysis using Numerical Weather Prediction (NWP) model results, whether the NWP models are capable of predicting these observed diurnal variations. An analysis of diurnal variations for the southwest monsoon revealed that NWP model (WRF model) has constraints in predicting diurnal variations accurately (Bhat et al., 2019). The model was found successful in simulating the pattern of diurnal variation of rainfall, but underestimates its amplitude compared to the observed one especially over the western Himalayas, northeast India, central India, and the north Bay of Bengal (BoB). It is important to carry out an extensive analysis to examine how the NWP models are capable of predicting the diurnal variations of NE monsoon rainfall accurately.

6.2. Intra-seasonal variation of NE monsoon rainfall

Several studies have shown that during the southwest monsoon season (June to September) a substantial component of the variability of convection and rainfall over the Indian region arises from the fluctuations on the intra-seasonal scale between active