considerable increase in rainfall activity from September to October and November. In December, rainfall activity is confined only to the coastal districts. The seasonal rainfall during the NE monsoon season is around 44 cm contributing to 48% of its annual rainfall. Over South-interior Karnataka (SIK) seasonal rainfall is around 20 cm, which is about 19% of the annual total. Over SIK, October contributes maximum rainfall during the season, while December hardly contributes to the seasonal total.

Over Kerala, the NE monsoon season contributes about 49 cm, which is about 17% of the annual total. During the NE monsoon season, Kerala receives maximum rainfall, even slightly more than Tamil Nadu. October contributes maximum rainfall over Kerala, which reduces in November and December.

3.2. **Mean Spatial Distribution of Rainfall**

Fig. 3.1 a, b and c show the monthly rainfall climatology during the months of October, November and December. The mean values are calculated using the IMD gridded data (0.25 X 0.25 degree) from 1972-2021. During October, maximum rainfall exceeding 200 mm is observed over the coastal Andhra Pradesh, coastal Tamil Nadu and Kerala. Over central parts of Kerala, monthly rainfall exceeds 300 mm. However, rainfall reduces sharply towards the interior parts of south peninsula, where monthly rainfall is less than 150 mm. During November, monthly rainfall sharply increases over the northern parts of coastal Tamil Nadu and southern parts of coastal Andhra Pradesh, where monthly rainfall is more than 300 mm. Over Tamil Nadu, monthly rainfall sharply reduces towards the interior parts. Southern parts of Kerala experiences monthly rainfall exceeding 200 mm. Over the rest of Tamil Nadu and Kerala, rainfall is between 100 and 150 mm. Over the South interior Karnataka and Rayalaseema, monthly rainfall is less than 100 mm. During December, rainfall sharply reduces everywhere in the south peninsula. Maximum rainfall exceeding 200 mm is observed over coastal Tamil Nadu and reduces sharply towards interior parts. Over the rest of the south peninsula, monthly rainfall is less than 75 mm.

The spatial distribution of mean seasonal rainfall (October to December) is shown in Fig. 3.1 d. The spatial distribution suggests a rainfall maximum along the east coast of north Tamil Nadu and south coastal Andhra Pradesh with seasonal average exceeding 800 mm. Seasonal rainfall reduces sharply towards interior parts of South Peninsula. Another rainfall maximum is observed over Kerala. Over south peninsula, isohyets (lines of equal rainfall) run parallel to the east coast with maximum over the east coast and reducing towards the interior parts. During the NE monsoon season, the Kariakal-Vedarnyam belt receives the highest rainfall in the range 900-1000 mm with Vedarnyam receiving 103 cm. The decrease of rainfall south of Vedarnyam is probably due to sheltered nature of the coast (due to Sri Lanka land mass on the east). Tuticorin registers only 40-45 cm of normal rainfall.

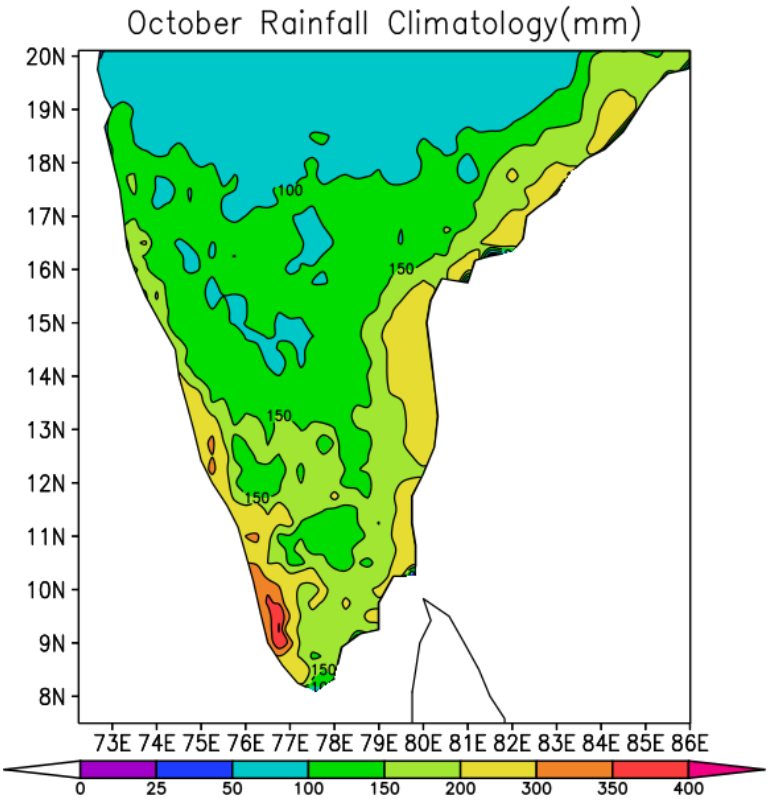

Fig. 3.1 a. IMD Observed Rainfall Climatology in mm during October (1972-2021). Source: IMD gridded data.

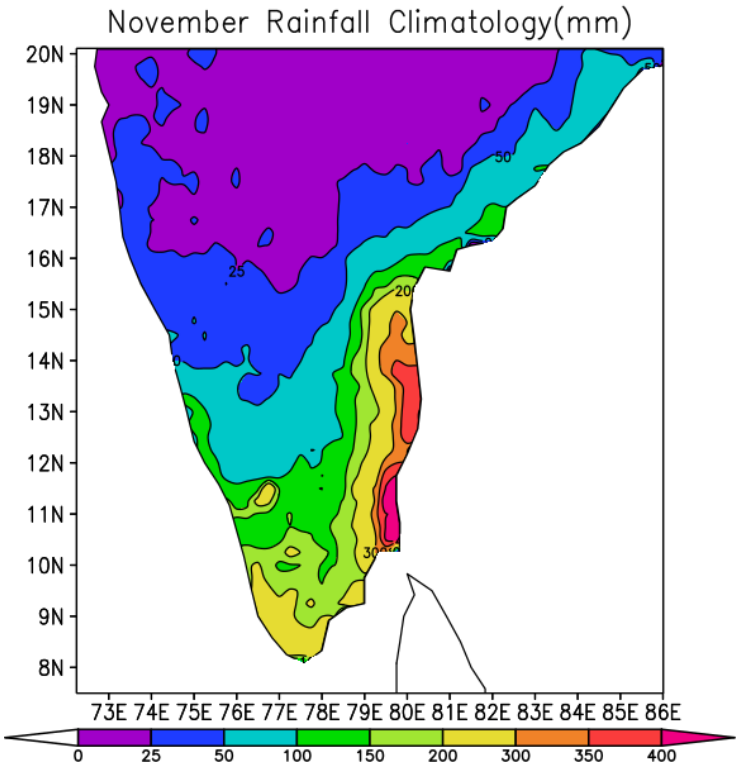

Fig. 3.1 b. Same as 3.1 a, but for November.

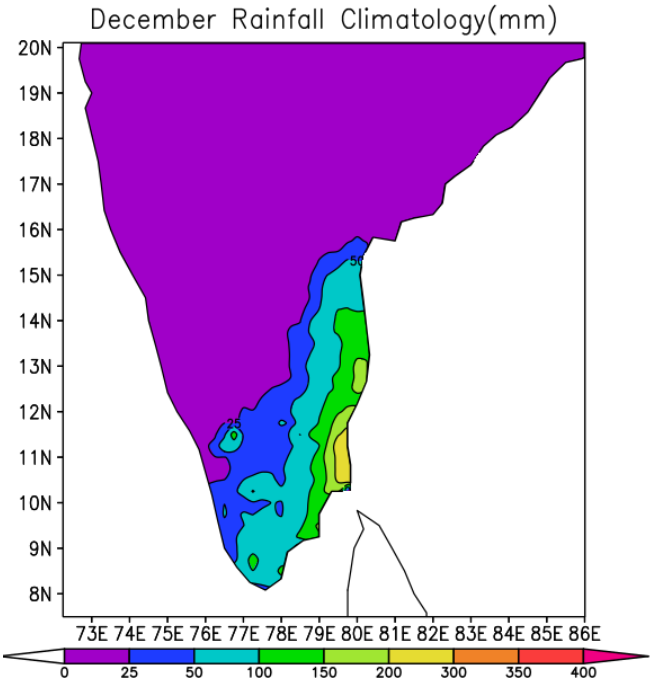

Fig. 3.1 c. Same as Fig 3.1 a, but for December.

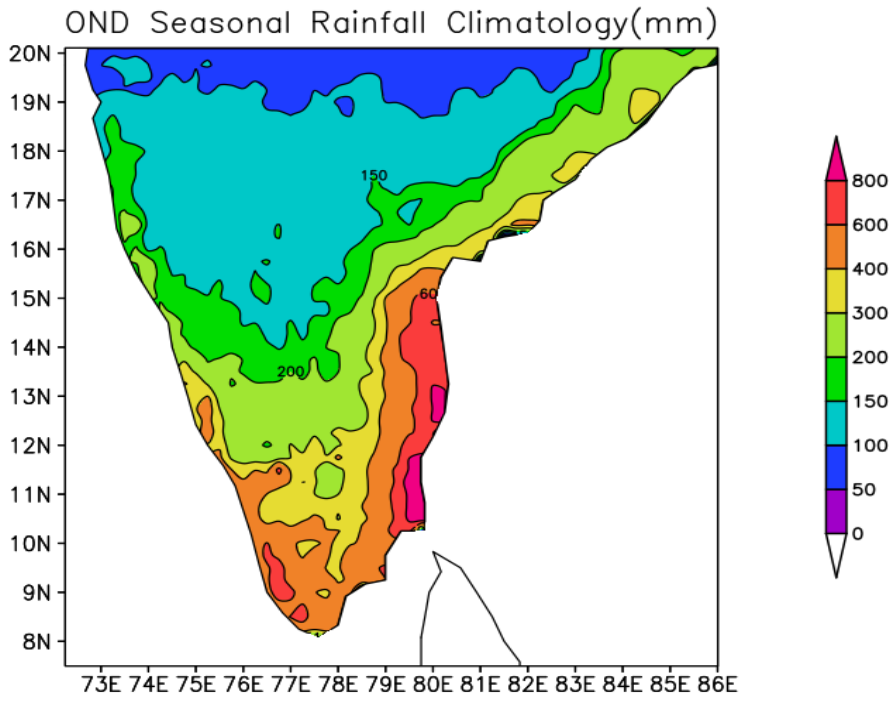

Fig. 3.1 d. Seasonal Rainfall Climatology (in mm) during the northeast monsoon season (October- December), 1972-2021. Source: IMD gridded rainfall data.

Fig. 3.2 shows the time variation of mean rainfall averaged over the south peninsula from 01 Sept to 31 Dec. The mean rainfall is calculated using the data of 1979-2021. The plot shows that October and December months contribute maximum rainfall over the region. From the first week of December, rainfall activity over the region is sharply reduced. This is due to the fact that by first week of December, the ITCZ shifts towards much south and rainfall activity is mostly confined south of 10^0N.

The Coefficient of Variation (CV) of seasonal (October to December) monsoon rainfall over the southern peninsula is given in Fig. 3.3. The CV of NE monsoon seasonal rainfall is generally higher compared to southwest monsoon season. CV varies from 30 to 50% over the south peninsula with the east coast experiencing smaller CVs compared to interior.

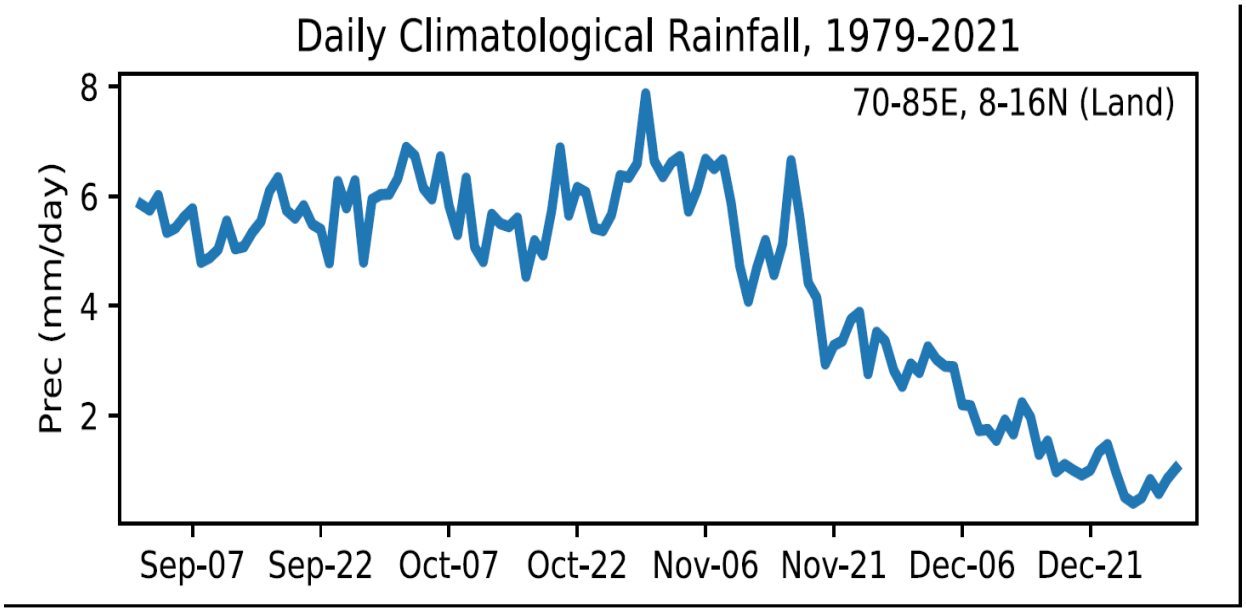

Fig. 3.2. Daily climatological rainfall (in mm/day) over NE India from 1 Sep to 31 Dec averaged over the period 1979-2021. The averaging was done over the area 70-85^0 E, 8-16^0 N.

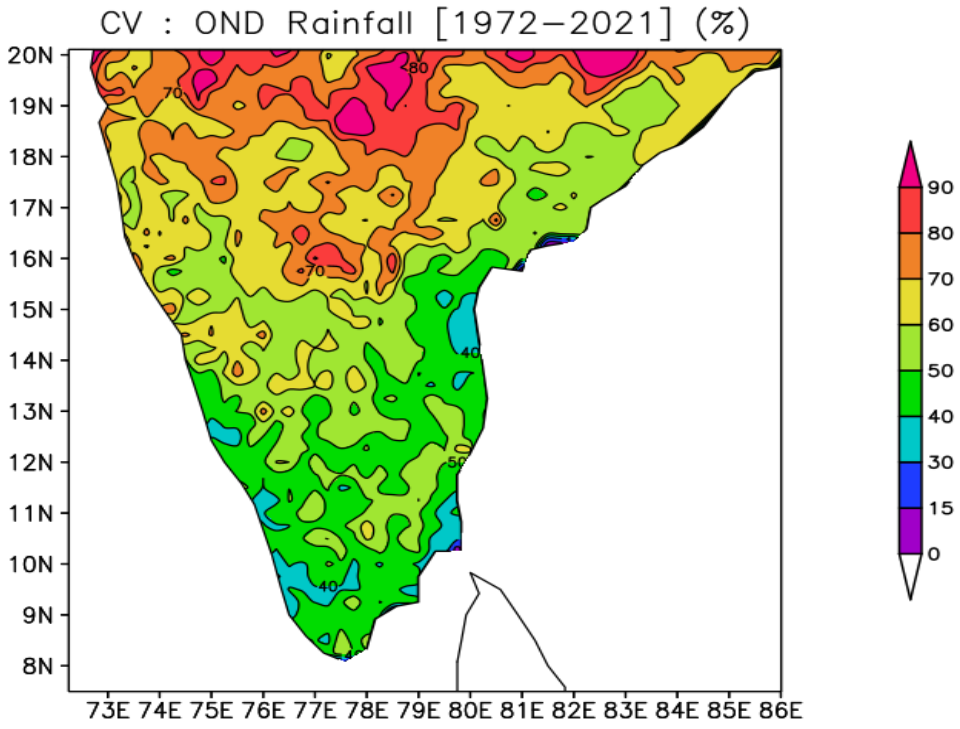

Fig. 3.3. Coefficient of variation of seasonal Rainfall (in %) during the northeast monsoon season (October- December), 1972-2021. Source: IMD gridded rainfall data.

During the NE monsoon season, a rainy day is assumed to be a day with rainfall of 2.5 mm or more. Fig. 3.4 shows the spatial distribution of the mean number of rainy days during the NE monsoon season. Over the north Tamil Nadu coast and parts of Kerala and south Karnataka, mean rainy days are more than 30 during the season. Over the remaining parts of Tamil Nadu, coastal Andhra Pradesh and remaining parts of Kerala, number of rainy days varies between 20 and 30 days. Statistical trend analysis suggests (Fig. 3.5), the mean number of rainy days over the interior parts of south Peninsula is increasing. It is important to note that this pertains to long term climatology. In a particular year, there could be an increase or decrease in the number of rainy days over a particular station.

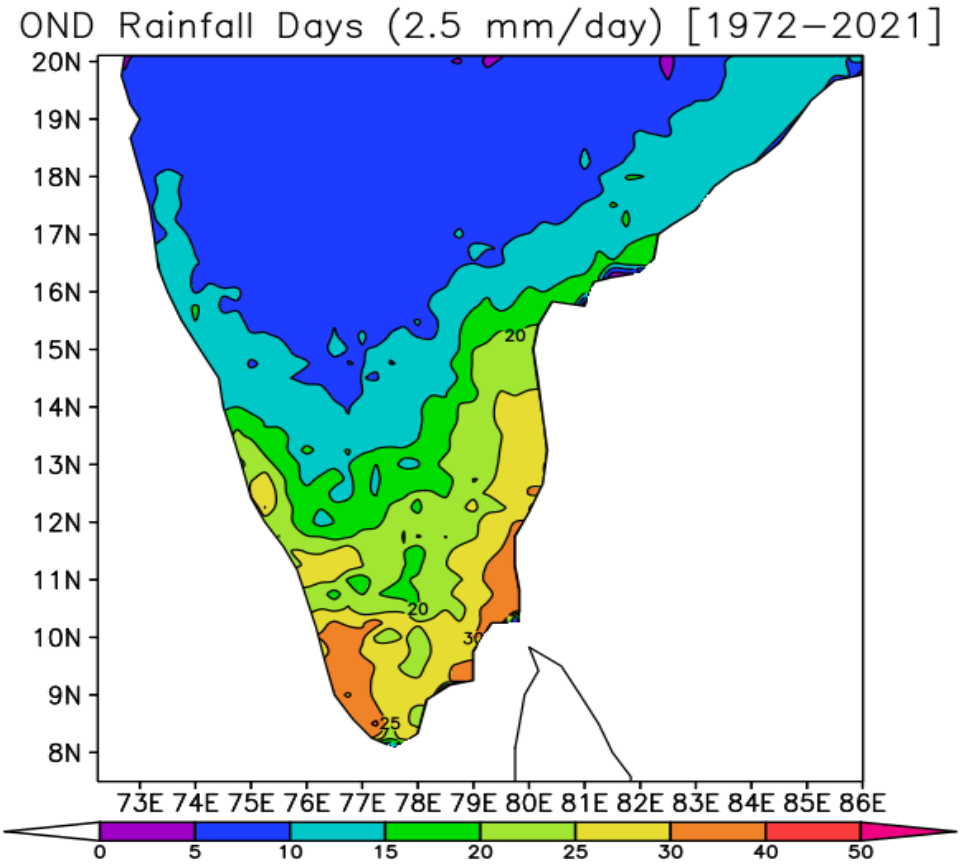

Fig. 3.4. Number of rainy days (> 2.5mm) during October to December (1972-2021). Source: IMD gridded Data

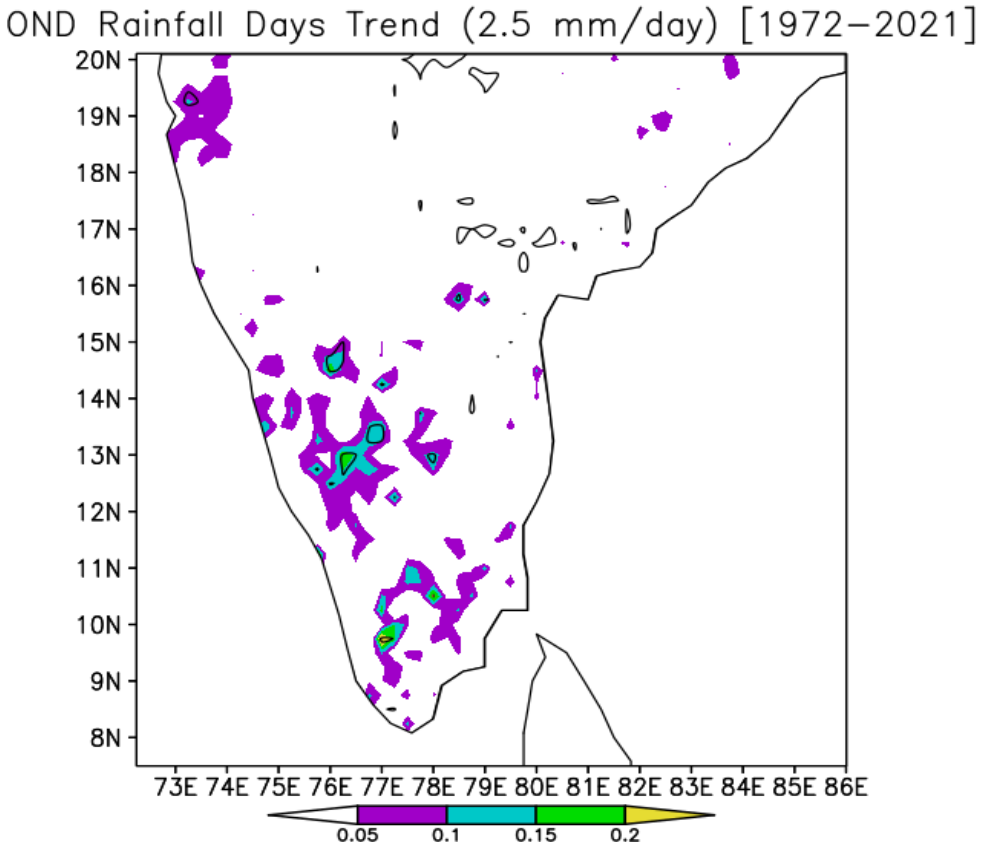

Fig. 3.5. Trend in rainfall days during October to December (1972-2021).

3.3. **Heavy Rainfall events during the NE monsoon season**

It is important to know the spatial pattern of climatology of heavy rainfall over the region. This will provide information on the climatological probability of heavy rainfall occurrence over the region during the season. The spatial pattern of heavy rainfall events was prepared using the IMD 0.25 × 0.25 degree daily rainfall data (Pai et al. (1972-2020). It may be noted that the IMD's definition of heavy, very heavy and extreme heavy rainfall is based on rainfall station data. Since the analysis given below is based on the IMD's gridded data and somewhat smoothed data, IMD's definition cannot be strictly used for defining heavy, very heavy and extreme rainfall. However, even with the gridded data, we could get a reliable understanding of the spatial distribution of such heavy rainfall events.