

# **Meteorological Setting of Sri Lanka**

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The meteorological setting of Sri Lanka and the neighborhood regions which brings about the rain-producing phenomena operating over Sri Lanka had been the subject of investigation by several scholars (Bamford, 1922; Dassanayake, 1948a; Davies, 1952; Domroes, 1974; Jameson, 1933; Jayamaha, 1955, 1956, 1959, 1972a, 1972b, 1973a, 1973b; Kandasamy, 1948; Sirinanda, 1971; Thambyapillay, 1953; 1954a&b, 1959, 1960b). Much of the material for this research article has been drawn from these sources.

## **1. Planetary and Regional Factors**

Sri Lanka's location in the equatorial latitudes towards the northern rim of the Indian ocean and immediately south of the Asian continental mass, in general and the Indian sub-continent, in particular, plays a crucial role in its meteorological setting.

The country exhibits typical characteristics of tropical weather owing to its latitudinal position ( $5^{\circ} 55'$  -  $9^{\circ} 51'$ ). On the other hand, it is also a part of the South Asian monsoon climatic realm. The monsoonal conditions can be seen in the seasonality of rainfall, while the tropical conditions can be seen in the temperature pattern, the lowlands being between  $26^{\circ}$  and  $28^{\circ}$  C, whereas in the highlands the values can be between  $13^{\circ}$  and  $20^{\circ}$  C. Overall temperature pattern is characterized by a moderate diurnal range ( $8^{\circ}$ C).

The seasonal reversal of wind direction and special characteristics imparted by the seasonal or short-term changes in the temperature and pressure fields of the Indian land mass and the Himalayan massif affect Sri Lanka's climate. Also, due to the relatively small extent of the land mass and its insularity (no part of the island

is farther than 110 km from the coast) maritime influence is felt over much of the island.

Latitudinally, Sri Lanka is well within the Inter Tropical Convergence Zone (ITCZ), which on an average extends  $10^{\circ}$  north and  $5^{\circ}$  south, and subject to north-south movement following the apparent seasonal migration of the sun. Atmospheric activity and weather systems associated with the ITCZ are most typical during vernal equinoctical period in March–April and the autumnal equinoctical in October–November period. When the ITCZ swings north or south during the solstice phases of the sun, Sri Lanka comes within the influence either of the two easterly wind systems.

Rainfall of Sri Lanka is clearly associated with the meteorology of the ITCZ. Also, the ITCZ plays an important role in the climate variability of the South Asian monsoons as a whole. Its weather patterns are dominated by the thermally controlled instability (convective) systems with more or less predictable diurnal cycle. Precipitation from the ITCZ clouds system is almost entirely convective, being a result of either small convective cells or large better organized features with the potential to grow into large tropical storms.

The ITCZ is flanked in either hemisphere by the tropical easterlies, which are strong and steady winds blowing in the lower troposphere from the sub tropical high pressure belts towards the equatorial trough. These air streams from two boundaries or zones of convergence, one with the northern hemisphere easterlies (Northern Convergence Zone (NCZ)) and the other with the southern easterlies (Southern Convergence zone (SCZ)). The NCZ and SCZ generally move northwards or southwards according to the seasons. On the account of these movements, the NCZ lies over the island, or at its near vicinity, during March–April on its northward journey, and during October –November on its return journey, whereas the SCZ lies towards the south somewhat far of the island. Each of these two periods (March–April and October–November) forms a stage of transition from one monsoon season to the other and hence are commonly known as 'inter-monsoon' seasons. March–April period (vernal equinoctical), is known as the first inter-monsoon season and

October to November period (autumnal equinoctical), the second-inter monsoon season.

During the two inter-monsoon periods, the weather over the island is controlled by two important factors, namely the NCZ and the thermal effect. When the NCZ is lying across the island, the weather situation is associated with heavy clouds and precipitation, and occasionally accompanied by thunder. When the NCZ is positioned some distance away to the north or south of the island, the resulting precipitation would be in the form of light rain. Whenever the NCZ is inactive during a transition period the weather over the island is controlled by thermal influences (convective activity), which is at maximum during the two inter-monsoon seasons. The inter-monsoon seasons are also characterized by a very gentle pressure gradient across the island, thereby leading to light prevailing winds of variable directions over the island. The atmosphere tends to be markedly unstable and the differential heating of the land mass set up intense convective currents in the inland areas. This convective action leads to the build up of large cumulus and cumulonimbus clouds in the inland areas. Thunderstorm activity may commence in the interior around mid-day and gradually spread towards the coastal areas during the late after noon or evening. When the lapse rate is steeper, the process starts earlier and, if the lapse rate is only moderately steep, the convective action and the resulting cloud development and precipitation are restricted mostly to the hill country. During these two inter-monsoon periods rainfall is well spread over the island due to the predominance of depressional systems and convective action and does not appear to be influenced that much by topography.

From May to September the NCZ is positioned to the north of the island and as a consequence, the influence of the southern westerly wind system is evident. However, at the lower atmosphere levels, land-ocean contrasts and orographic barriers modified the seasonal reversal of wind directions associated with the northward migration of the NCZ. These seasonal winds also combine with the easterly winds from the Arabian anti-cyclone systems. This equatorial air moves over the warm equatorial belt of the Indian ocean and consequently becomes warmer and moist within the lower layers of the air mass as well as the upper layers. When this air stream reaches the island it is warm and moist and is an

unstable condition. Generally by the month of May, Sri Lanka begins to get under the influence of the summer monsoon, also called southwest monsoon. However, well-developed monsoon activity is not experienced over the island until the late half of May because the air streams are not at a sufficient depth as required for typical monsoon activity.

The weather during June is similar to that of May, but sometimes troughs of low pressure create a strong westerly or southwesterly airflow across the island. Normally the southwest monsoon in July and August heavy spells of rains are caused by mid-tropospheric disturbance. These disturbances travel from west to east and are preceded by thunderstorm cloud development and isolated patches of rain in the southwest quarter of the country and the southern and western slopes of the central highlands. The southwest monsoon does not come as continuous air stream. Sometimes, a 'surge' in the southwest monsoon is found to be associated with the movement of trough line, depending on the nature of the surface and upper atmospheric conditions in the Indian region. In some years, the fluctuations in the southwest monsoon may occur, in terms of its intensity and spatial extent when the NCZ is associated with disturbances or low pressure systems. When a sudden intensification and deepening of the air streams of the monsoon normally associated with heavy rain occurs, the phenomenon is called the 'burst' of the monsoon. There are also occasions when abruptly intensification of southwest monsoonal activity or depth of the air currents or long 'lulls' in between advances may cause sub-normal rainfall or relatively dry conditions. When such episodes occur, the monsoons are considered to have 'failed' or to have experienced 'breaks'.

During the period from December to February, because the NCZ is positioned around 50 N, Sri Lanka comes under the direct influence of the weather associated with the interplay of the NCZ and the northern easterlies. This is the northeast monsoon season. During this season the surface pressure and circulation patterns experience a complete reversal from that of the northern summer, assuming an opposite gradient. The northern easterlies, or north-easterlies, on reaching the Sri Lanka region as northeast monsoons, gives heavy rainfall predominantly to the north and northeastern parts of the country and the eastern slopes of the central highlands. But no parts of the country can be considered to be free of the rains

during this season. When compared with the total space-averaged rainfall amount yielded by the southwest monsoon, that due to the northeast monsoon is normally relatively less. This can be attributed to the nature and structure of the northeast monsoon air streams, which can be relatively less moist, stable air-flows of less vertical extent. But the northeast monsoon rains are more widespread over the country than the southwest monsoon rains, of the condition of lesser effectiveness of the northern and northeastern slopes of the central highlands as an orographic barrier compared with the southwest 'slopes' on the southwest monsoon. Often, the northeast monsoons are accompanied by tropical disturbance mostly of the depressional type, which have little or no regard for the physiography of the country.

During the northeast monsoon season, the weather in the country is, at times, associated with low pressure systems or depressions in the South Asian region are commonly known as cyclones or tropical storms. On average, only two or perhaps three tropical storms may occur every year close to the island affecting Sri Lanka's weather.

## **2. Local Physiography**

As a result of the above meteorological setting, Sri Lanka's rainfall incidence forms, and seasons are determined by three types of circulations: monsoonal systems thermally induced local instability or convective systems and depressional or cyclonic systems. However, the local geography, mainly the south-central highland region and, to a much smaller extent, the insularity of the country, which have modified the efficiency of the above systems as rain producers and have significantly affected the spatial distribution pattern of rainfall.

The surrounding sea with warm water may enhance or interrupt the diurnal rhythm of the convective cells through the land and sea breeze. Rainfall distribution duration the inter-monsoonal seasons in the coastal area is particularly indicative of this influence to different degrees.

This is attempt to focus on the role of the central highlands in relations to the surrounding mid country and low country areas as principal control of the spatial distribution and the variation of the seasonality of rainfall in Sri Lanka. They represent a complex of topographical features such as ridges, peaks, plateaus, basins, valleys and escarpments. These features have strong direct effect on rainfall through the modification of the spatial pattern of air flow and weather systems and indirect effect through other climatic elements such as air temperature, relative humidity and water balance components. The control is particularly felt during both monsoon seasons in relation to the orographic effect which is clearly evident in the highly concentrated rainfall distribution pattern during the southwest monsoon season. The windward southwestern slopes receive heavy rain while on the eastern slopes (leeward side) the southwest monsoon air currents are turned into dry, katabatic, fohn-like winds (locally known as 'kachchan'), which brings very little or no rain and indeed, turns out to have a decreasing effect. Figure no. 1 depicts the wind directions during the southwest monsoon season and the northeast monsoon season.

As interesting feature, arising out of the orographic effect of the central highlands due to the reversal of direction of the two air streams is the change of the windward and leeward sides according to the rhythm of the monsoon change. However the windward-leeward difference is much less evident during the northeast monsoon due to the difference in the nature of the slopes and the structure of the two monsoon air streams.

### **3. Air Masses**

It is possible to classify the types of air which influence the weather over Sri Lanka and the neighboring regions under five main categories. They can be identified as Indian continental air, Siberian air, the north Pacific trade winds, the South Pacific trade winds and equatorial air.

Indian sub-continental air is the air from the tropics which is initially cold, dry and great vertical stability. It reaches Indian through the western gap in the mountain range to the north and northwest of the Indian sub-continent. The air stream reaches the country from northwesterly or northeasterly directions. It is very dry

due to its track over the dry Indian land mass. On the other hand, when Indian continental air comes from a northeasterly direction it would have travelled over a short sea track while coming down over a portion of the Bay of Bengal and it absorbs a certain amount of water vapor. This air stream would be in a state of conditional instability by the time it reaches Sri Lanka. This type of air generally prevails over the island from December to February.

Siberian air is subsided air of the sub-tropical anti-cyclone belt of the northern hemisphere. During its southward journey the air masses over China and breaks through the gaps in the mountain of east Central Asia. This air stream also starts off as a cold and dry mass but become warmer as it moves southwards. It begins to collect moisture after it bursts into the Bay of Bengal. This air probably never moves as far south as Sri Lanka but it exerts an indirect influence on the weather over the island because it affects the weather in the Bay of Bengal.

North Pacific air mass also can be identified as a dry and cold stream at its source. During the southward passage across the north Pacific ocean its temperature and vapor content gradually increase but a certain amount of this moisture is deposited while the air stream cross the land mass of Southeast Asia. This type of air mass reaches the country on very rare occasions during the northeast monsoon season.

The South Pacific trades become warmer and collect a great deal of moisture while moving up towards the equator. During the period between May to September or perhaps from April to October, the air stream of the south Pacific trades moves right up into the equatorial zone but is rarely crosses the equator in a pure state. This air stream never reaches to the country but it has an influence on the weather immediately south of Sri Lanka.

The equatorial air or equatorial westerlies remain within the equatorial region and has a general direction of movement from west to east. While this air moves over the warm equatorial belt of the Indian Ocean and consequently, becomes rapidly warmer and more moist within the lower layers of the air mass. This leads to the convection and results in an increase in the moisture content in the upper layers as

well. When the air stream reaches Sri Lanka it is warm and moist and is an unstable condition. This type of air prevail over the island from May to September

#### **4. Seasonal Distribution of Rainfall**

Based on the relative dominance of the causative factors, the rainfall year in Sri Lanka (March to February) can be divided in to four seasons.

- (1) First Inter-monsoon season (March to mid May)
- (2) Southwest monsoon season (Mid May to September)
- (3) Second Inter-monsoon season (October and November)
- (4) Northeast monsoon season (December to February)

The distribution pattern of rainfall in Sri Lanka within an average year which reflects this seasonality can be quantified following Domroes (1974): first inter-monsoon season, 21%; southwest monsoon season, 38%; second inter-monsoon season, 16%; and northeast monsoon season, 25%. The two monsoons, therefore account for a little less than two-thirds of the total annual rainfall.

#### **5. Characteristics of the Four Rainfall Seasons**

##### **5.1 Inter-monsoon Seasons**

The distinctive pattern during the two inter-monsoon periods is the afternoon or evening rains and thunderstorms. This is the result of convective process taking place in the atmosphere. Conditions are similar during the two inter-monsoon periods. But in the first inter-monsoon season the rainfall is less, mainly because of less depressional activity. The island receives widespread heavy rainfall during the second inter-monsoon season mainly due to the passage of low pressure systems. During this period, depressions or cyclones across the island or their formation near the island can be seen.



## **5.2 Southwest Monsoon Season**

During the southwest monsoon season, the rainfall is mostly over the southern parts of the country. At the beginning of the season rains occurs in the southern western low country. As winds strengthen it spreads gradually to the interior, with considerable heavy rainfall in western and southwestern slopes of the central highlands and exceeds 2,400 mm of rainfall at some stations. These stations receive average monthly totals of 1,000 mm or more during this season.

## **5.3 Northeast Monsoon Season**

The northeast monsoon is comparatively dry stable and lesser vertical extent. During this season rainfall is mainly confined to the northeastern parts of the island with the heavier falls being concentrated along the eastern slopes of the central highlands. The weather in the island is, at times, associated with low pressure systems or depressions which in the South Asian region are commonly known as cyclones or tropical storms.

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