Chapter 7

SUMMARY AND CONCLUSIONS
The Indian subcontinent, with its unique physiographic features exhibits wide variations in surface meteorological parameters both in space and time. Studies on the variations of meteorological parameters have drawn the attention of many scientists. The present thesis is concerned with a detailed analysis of the spatial and temporal variations of rainfall, surface temperature and sea-level pressure.

The study on the rainfall distribution over Indian subcontinent reveals that the predominant feature of the distribution of rainfall is the orographic effect. It is seen that apart from the frequency, intensity and tracks of the migratory synoptic disturbances, the topographic configuration plays an important role on the influence of rainfall pattern over the Country. The Western Ghat region and the north eastern part of the country experiences large amplitudes in annual cycle, whereas and very low amplitudes are noticed in the northwestern part of the country. The amplitude of the annual cycle is found to be directly connected with the annual mean precipitation pattern, with large amplitudes in regions of high rainfall and vice versa. The western peninsular region, where the annual rainfall pattern is bimodal also experiences large amplitudes in semi-annual oscillation. The first three harmonics of the seasonal cycle account for most of the variance in annual rainfall distribution.
The phase of annual oscillation shows a maximum during the months of July and August in the entire country, except in the northeastern part when the annual rainfall maximum is noticed during the month of June. Regions coming under the sway of summer monsoon experiences a secondary maximum in rainfall during the month of January, and regions of winter rainfall experiences the phase maximum during the months of October and November.

The spatial distribution of the thermal regions over the Indian subcontinent is caused due to the topographical and atmospheric variations, which in turn influence local and regional thermal regimes. The highest peak in mean sea-level temperature is noted in central peninsular region and low temperatures are noticed in northeastern part of the country. A low amplitude annual cycle in temperature is noted in the central part of the Western peninsula and island stations in Arabian sea and Bay of Bengal. The highest annual oscillation in temperature is seen in the northwest part of the country, with scorching summers and freezing winters. The amplitudes of the semi-annual oscillation is much smaller in magnitude compared to that of the annual oscillation. The shorter period oscillations in temperature are significant in the Western Ghat region. The phase of annual oscillation in temperature is noted during April to June months, whereas the semi-annual oscillation attains its peak during middle of September to middle of November.
The amplitude of annual oscillation in sea-level pressure indicates very high values in the northwest part of the country and low values along the west-coast, south of Mangalore and the island stations. The highest amplitude of semi-annual oscillation of the order of 1-1.5mb is seen along Gujarat coast which is influenced by the monsoon trough. Over most of the country the highest pressure is noted during January, when the country is at the periphery of the Siberian high and a secondary maximum is observed during November. However, south of 15°N the secondary maximum is seen only in February due to the cyclonic circulation in Bay of Bengal.

The spectrum of the meteorological parameters over Indian subcontinent is of particular interest because of the large interannual variability displayed by these parameters. The overall spectrum suggests that most of the variability is contained in bands of known physical origin and hence predictable. Apart from the annual cycle and its sub-harmonics the major periodicities detected are the 11-year oscillation, 5-year oscillation, quasi-biennial oscillation (QBO), quasi-triennial oscillation (QTO) and Chandler-Wobble (CW) Oscillation. The period of QTO for meteorological parameters over the Indian sub-continent is 33-40 months, while the QBO exhibits a periodicity of 28-29 months in rainfall and 24-months in temperature and sea-level pressure over India. The QBO, QTO and CW are well pronounced in coastal stations for rainfall and in
interior stations for temperature. Rainfall over India does not show any significant trend during the last century, however the temperature is generally increasing and the mean sea level pressure is decreasing in most part of the country.

Principal component analysis produces a decomposition of the data field into spatial eigen vectors and temporal principal components. The rainfall and temperature data for a period of 85 years (1901-1985) show that PCA is a valuable and in gaining insight into the spatial and temporal behaviour of meteorological parameters. The similarity between western and central part of the country as far as annual rainfall distribution is concerned is brought out by the study. Rotation of principal components reveal the influence of EL-Nino oscillation on rainfall pattern. Monthly transitions of rainfall shows that September rainfall is an indicator for the rainfall during the first month of the northeast monsoon. While interannual variability in monthly rainfall is not clearly captured by the study, the second principal component of annual temperature indicates definite patterns. However, further detailed analysis is required to quantity the spatial and temporal patterns.

Among the various techniques adopted to predict the meteorological parameters, the method of harmonic analysis is not found suitable to predict the seasonal variation. The 'summation' tone of the 11-year oscillation and the Chandler-
Wobble oscillation with the 12 months annual term at 11.13 months and 6.6 months and a 'difference' tone of these oscillations with the semi-annual term at 13.12 months are well documented in all the stations for rainfall series. The western region of India are well pronounced by the "combination of tones" as far as rainfall is concerned. A 4.2-months oscillation, which is "combination tone" of the 5 year cycle and 4 months oscillation influences the thermal pattern of Indian subcontinent. Even though, the principal component analysis is an efficient technique to predict the rainfall at a particular station, it is unable to capture all the modes of variability that influences the rainfall pattern.

The outcome of the present thesis work is expected to provide a better understanding on the physical processes responsible for the climate variability and its predictability over the Indian subcontinent. The study is useful to delineate and emphasis the various boundaries and areas of transition to bring out the regional and temporal characteristics of the distribution of meteorological parameters over the country. The results obtained from the present study can be incorporated for climate modelling and long-term prediction of the meteorological parameters over Indian subcontinent.