

ABSTRACT

Present study deals with study of atmospheric boundary layer characteristics and thermodynamical structure of the atmosphere during pre-monsoon thunderstorm season (March, April and May) over two tropical locations, namely Kharagpur (22°3'N, 87°2'E), and Ranchi (23°25'N, 85°26'E). Over these locations, occurrence of thunderstorms is quite frequent during these months. For this purpose, micro-meteorological tower data (slow as well as fast response) and upper air radiosonde observations during pre-monsoon months of years 2007, 2009 and 2010 at Kharagpur, and 2008, 2009 and 2010 at Ranchi have been used. These data sets are obtained from the field experiments under the Severe Thunderstorm – Observations and Regional Modeling (STORM) programme sponsored by Department of Science & Technology, Govt. of India. In this study an attempt has been made to understand the variations in the atmospheric boundary layer exchanges and the thermodynamical structure during the days of occurrence of thunderstorm to fair weather days during the pre-monsoon season. The surface energy fluxes contribution and their variation during different epochs of thunderstorm has been studied at both the sites. It is found that, the contribution of the surface energy exchanges such as fluxes of sensible, latent heat and soil heat fluxes during the various epochs of thunderstorm activity, show different pattern. The atmospheric turbulence characteristics of both mechanical and thermal components show distinct variations at both the sites. Site specific relationships for turbulent kinetic energy dissipation rate, mechanical and thermal characteristics of turbulence have been proposed for both the sites during the study period. Identification of organized motions (coherent structures) in the atmospheric surface layer and their contribution to fluxes of momentum and heat has been quantified using wavelet technique. The dynamical and thermodynamical structure of atmospheric boundary layer and their variations are examined based on profiles of wind components, equivalent and saturated equivalent potential temperature, convective and stability indices as well as Skew-T thermodynamic diagram analysis on the days of occurrence of thunderstorm event (TD) and fair weather days (NTD). The study reveals the existence of precursor signals for the thunderstorm occurrences over both the sites. The surface sensible heat flux and surface latent heat flux value reaches same level before the occurrence of thunderstorm on the TD cases. It has been found that high values of turbulent kinetic energy (TKE) are associated with higher magnitude of buoyancy generation and shear production on thunderstorm days. The dissipation rates of TKE are higher for non thunderstorm days. The study reveals that the contribution of coherent structures in momentum flux is higher in TD than NTD, whereas for heat flux their contribution is higher for NTD to that of TD. Metrics for days of thunderstorm and non thunderstorm days over Kolkata have been established and the study has identified few thermodynamical parameters that are able to differentiate the thunderstorm days to that of non thunderstorm day over Kharagpur.

Keywords: Thunderstorm, Atmospheric Boundary Layer, Sensible heat flux, Coherent structures