ABSTRACT

India gets most of its rainfall from the southwest monsoon. During the southwest monsoon a belt of low pressure region forms over the North Indian plains. It is called the "monsoon trough". It runs parallel to the southern edge of the Himalayas. In order to understand the boundary layer processes occurring in the monsoon trough, an experiment known as the MONsoon Trough Boundary Layer EXperiment (MONTBLEX) was conducted recently. During this experiment, data were collected using various instruments such as the micrometeorological tower, radiosonde and Doppler SODAR.

The present study aims to understand the structure of the atmospheric boundary layer (ABL) under the influence of monsoon depressions using the data from that experiment. A few stations from the eastern end of the monsoon trough were chosen and the progression of changes in the structure of the ABL over these stations during the passage of a depression has been studied. Thermodynamic parameters like the potential temperature, equivalent potential temperature, specific humidity, and the saturation pressure difference were computed. Surface fluxes were also computed and they are seen to precede the maturity stage of the depressions by 30 to 45 hours. The locus of the Lifting Condensation Levels (LCLs) and the conserved variable diagram were drawn. A few days with very less rainfall or no rainfall, and a few other days with heavy rainfall were chosen and the contrast in their structures is noted.

When the monsoon depression was in the vicinity, the potential temperature increased at the lower part of the ABL, and the subcloud layer was well mixed. During nights the ABL was more convectively unstable with a very low equivalent potential temperature near the ABL top. The wind speed was higher, and the conserved variable diagrams showed a well mixed structure. During disturbed conditions it was found that the mixed layer and the

LCLs were low, the moist static energy higher in the mixed layer, and the region above the mixed layer was well saturated.

Using the Acoustic Doppler SODAR data the structure parameter for the velocity, and the rate of dissipation of Turbulent Kinetic Energy (TKE) were studied during the passage of a depression. The structure parameter velocity was found to be lower, and the dissipation of TKE much higher when the depression was in the vicinity. Occurrence of downdraft, wind shear echoes, echoes showing mixed layer recovery, nocturnal inversion, and thermal plumes were identified with the help of echograms. Vertical and horizontal components of the wind velocity were plotted. They showed the entraining downdraft from the free atmosphere and the suppression of the mixed layer when the monsoon depression was near the observing station.

Using the above results, the following picture of the disturbed ABL emerges: As a depression approaches the observing station, the surface fluxes increase in their magnitude. This warms the entire mixed layer. These fluxes tend to wash out the temperature discontinuity at the top of the ABL. Moreover, during disturbed conditions, the air from the free atmosphere entrains due to various cloud top processes and starts reducing the strength of inversion, from above the ABL. Once the discontinuity is removed, the moist and warm parcels below the ABL are transported above the ABL and the cool and relatively dry air from the free atmosphere entrains. Thus the ABL gets well mixed. The absence of inversion helps free transport across the ABL. This situation favours a rapid growth of convective ensembles.

This thesis is devoted to a detailed study of these processes occurring in the ABL during the passage of three typical monsoon depressions.

KEYWORDS

Atmospheric Boundary Layer, depressions, Entrainment Surface fluxes, Turbulent Kinetic Energy, SODAR, Echograms, Cospectrum, Monsoon trough, Cloud top processes.