PRELIMINARY OBSERVATIONS OF CONVECTIVE BOUNDARY LAYER OVER GADANKI (13.5^0N, 79.2^0E) USING UHF WIND PROFILER

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1. Introduction

The development of wind profilers has revolutionized the boundary layer studies with excellent height and temporal resolutions [*Balsley and Gage,* 1982]. Particularly, the clear air radar wind profiling technology field programs are increasingly taking advantage of continuous wind observations available from these systems. Convective Boundary Layer (CBL) height is one of the important parameters, which can be used to characterize the boundary layer. CBL height also serves as basic scaling parameter for fluxes and variances. Therefore, CBL height measurements are a part of the experiments designed to elucidate basic boundary layer structure and its behavior. One of the exciting potentials of the wind profiler is, its ability to infer the CBL height. The CBL height measurements using the wind profilers are pioneered by *white et al.* [1991]. The wind profiler observations of range-corrected signal to noise ratio can be used to infer the CBL height. The height profiles of the range corrected signal to noise ratio show a well-defined sharp peak at the CBL top. The vertical profiles of turbulence refractivity structure parameter (C_n^2) are also used for the determination of CBL height from the wind profilers. It has been proved that the C_n^2 peaks at the inversion top of a CBL [*Wyngaard and LeMone 1980; Fairall, 1991*].

Even though, considerable amount of work has been reported on CBL, so far there is no work relating the evolution of CBL and convection triggering. In this regard, the present study aims to closely monitor the evolution of CBL prior to convection triggering using UHF wind profiler observations during pre-monsoon and monsoon periods. In particular, this study was carried out to understand the pre-convective environments in the boundary layer during the pre-monsoon and monsoon periods to find out whether there is any precursor before the convection triggering.

2. Experimental set up

A convection campaign was carried out during May-August, 1999 employing VHF and UHF radars at National MST radar facility, Gadanki, India to explore the tropical Mesoscale Convective Systems. UHF wind profiler, installed at Gadanki for boundary layer studies [*Krishna Reddy et al.,* 2001], was operated to study the pre-convective environments during the campaign period. UHF wind profiler was operated continuously round the clock to monitor the boundary layer dynamics. For the present study, three dimensional wind fields and CBL heights are estimated from the UHF wind profiler observations. During the campaign, from 19 July 1999 to 14 August 1999, radiosonde observations were carried out along with the wind profiler observations. During this period, everyday, a radiosonde was released from the radar site at 1630 LT (LT=UTC+0530). A ground-based collocated optical rain gauge was also used for the precipitation measurements during the campaign.

3. Results and discussion

In the present study, the CBL height is estimated from the wind profiler observations to monitor the evolution of CBL. For the present study, height profile of C_n^2 has been used to retrieve the CBL height. Figure 1 shows the height–time sections of radar reflectivity (in terms of Signal to Noise Ratio (SNR)) on two typical days. Figure 1 shows the potential of the wind profiler to identify the CBL top. A well distinguishable elevated layer of enhanced reflectivity corresponding to the CBL top can be seen from this figure. However, for the present study, height profiles of C_n^2 are calculated for every 10 minutes and height at which C_n^2 peaks is noted. Median of these heights over one hour period has been taken as CBL height for that hour. Figure 2 shows the height profile of virtual potential temperature derived from the radiosonde observations and corresponding C_n^2 profile from the wind profiler observations. These profiles are obtained from the observations made at 1630 LT on 27th July 1999 during the campaign period. A sharp gradient in the virtual potential temperature at 2.7 km corresponding to CBL top can be seen from this profile. The height profiles of C_n^2 shows a well-defined peak at 2.55 km, which corresponds to the CBL top. Thus, these two independent measurements of CBL top are in reasonable agreement. However, the turbulent fluctuations in the CBL height of the order of ± 200 m is expected as reported by *Davis et al.* [1997] based on lidar observations of CBL. The comparison between the measurements of CBL height made by the wind profiler and from the radiosonde data during the campaign period is shown in figure 3. The good agreement demonstrates that the CBL height can be found accurately from the wind profiler C_n^2 measurements.

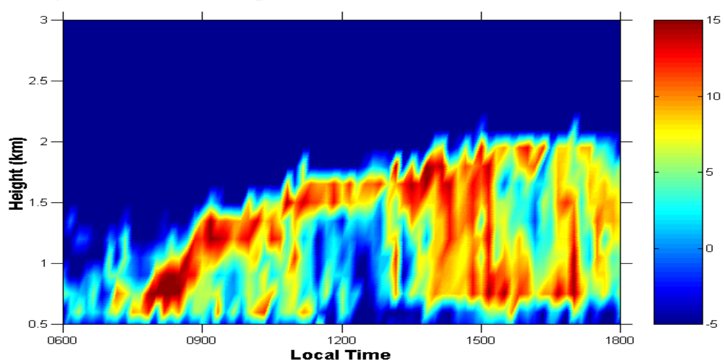


Figure 1: Height-Time section of signal to noise ratio (dB) as observed on 18 March 1999

The present observations are categorized as non-precipitating, pre-monsoon convective and monsoon convective days. Here convective day implies that the precipitation has taken place during that day, which is subjective. Figure 4 (a) shows the evolution of CBL on four non-precipitating days. This plot readily reveals that on all these days a shallow CBL is forming at morning 0800 hrs and afterwards, the CBL grows steadily and reaching its peak at 1200-1300 hrs and coming down thereafter. The interesting feature observed on these days is that the CBL is coming down to the lower heights drastically after 1200-1300 hrs. This happens when buoyancy flux at the surface decreases rapidly which in turn results in poor surface forcing and the shallow CBL. Similar results were reported by *Grimsdell and Angevine* [2002]. Figure 4(b) shows the evolution of CBL on four pre-monsoon convective days. On these days, in the morning hours, the CBL shows more or less similar features like the non-precipitating days.

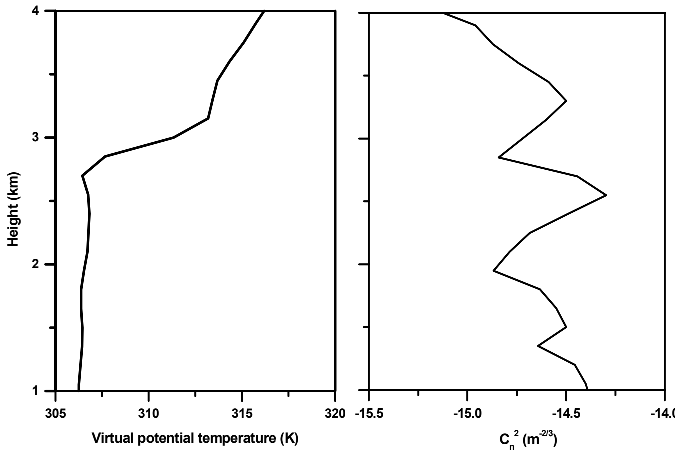


Figure2: Height profiles of Virtual potential temperature and C_n^2 as observed on 27 July1999.

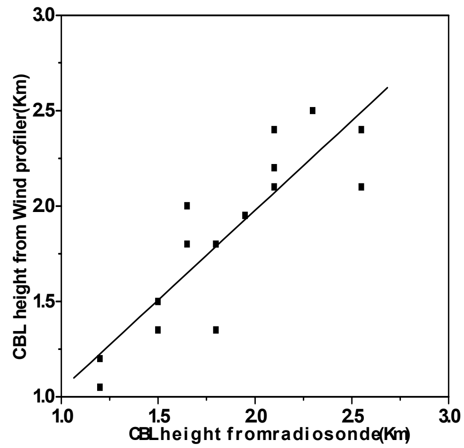
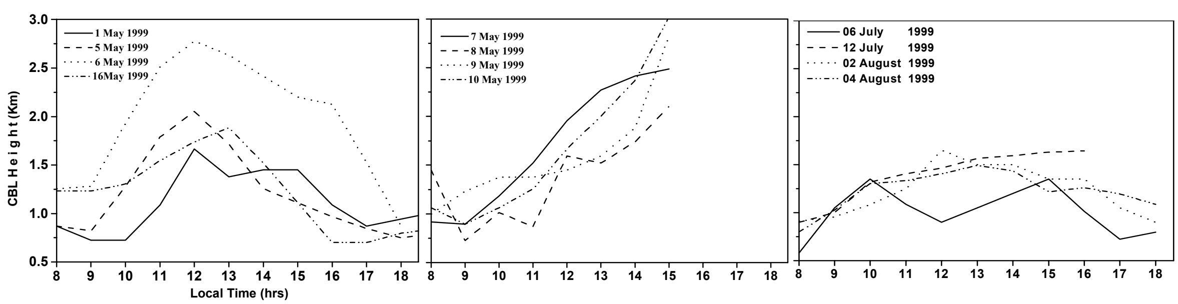


Figure 3: Scatter plot of CBL heights derived from the radiosonde and the wind profiler observations.

The striking feature in the present case is that the CBL is continuously growing after 1200 hrs also. The CBL heights are also very high with an increasing trend up to 1500 hrs, after which precipitation was observed over the wind profiler site. The deepening of the CBL is observed in the late afternoon in the present case, whereas it is observed exactly at the midday on the non-convective days. Figure 4 (c) shows the evolution of CBL on four convective days during the monsoon period. On these days, a different picture has been observed. A shallow CBL confined to ~1.5 km is observed on all the days. It is well known that during the monsoon, boundary layer will be rich in moisture. So, most of the radiation from the surface will be utilized for the evaporation process, which results in a shallow CBL. Enhanced soil moisture probably contributes to increase the latent heat fluxes and thus decreasing the surface sensible flux locally and suppress the CBL growth, as compared to the deeper CBL that develops with reduced soil moisture level on pre-monsoon days. One more cause for the shallow CBLs during the monsoon days may be due to the increased upper level clouds that can reduce the incoming solar radiation. Similar features have been observed on most of the days in each category during the campaign period.



(a) (b) (c)

Figure 4: Evolution of CBL on four (a) non-precipitating days, (b) pre-monsoon convective days and (c) monsoon convective days

4. Summary

An attempt has been made to study the evolution of the CBL in non-precipitating, pre-monsoon and monsoon convective days. A well-distinguishable feature is observed in the pre-convective environments, which can be used as precursor for the convection triggering. In the non-precipitating environments, the CBL has peaked in the mid-day and suddenly descended to lower altitudes and showed decreasing trend thereafter. In the pre-monsoon convective environments, the CBL has continued to grow after mid-day also and shallow CBL has been observed during the monsoon convective days. The intriguing result from these studies is the distinguishable CBL evolution observed in the pre-convective environments of pre-monsoon and monsoon periods. These observations are preliminary in nature and a detailed study using various boundary layer observational facilities like automatic weather station, kytoons and radiation measurements are planed in near future.

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