Observation of tropical pre-monsoon thunderstorm by UHF Wind Profiler

R. D. Ruchith[1], Sachin Deshpande[1], P. Ernest Raj[1] and R. R. Joshi[1]

[1]*Indian Institute of Tropical Meteorology, Pashan, Pune-411008, India*

I. INTRODUCTION

Thunderstorms are part of Mesoscale convective systems and are interesting as well as important meteorological phenomenon in many aspects. Although they are short lived they can be intense with strong updraft and downdrafts and local heavy rain. Because of their large vertical extension they are hazardous to aviation also. Wind profilers are the only instrument that can provide virtually continuous observations of vertical motion though a column within convection. Many studies proved that wind profilers are efficient tools to diagnose thunderstorms (May and Rajopadhyaya 1999;Larsen and Rottger 1987). In India some of the works on Thunderstorms are carried out using VHF profiler located at Gadanki (e. g. Rao et al 2001, Kishore Kumar 2005, Abhilash et. al. 2010). Recently Sachin Deshpande and Raj (2009) analyzed a pre-monsoon thunderstorm event using UHF profiler situated at Pune.

II. PRESENTATION OF RESEARCH

The ability of wind profiler to directly measure vertical air motions and hydrometeor fall velocity through precipitating and non precipitating systems has been explored through an analysis of the pre-monsoon (March-May) thunderstorm which occurred in the late afternoon on 3 June 2008 over Pune, India. Using the high resolution UHF radar data the extent of enhancement in vertical velocities (updrafts and downdrafts) and variations in the echo power, spectral width, horizontal wind, vertical shear of horizontal wind and refractive index structure parameter C_n^2 during thunderstorm event have been explored.

III. RESULTS AND DISCUSSIONS

The hourly averaged vertical profile of vertical pointing beam Signal-to-Noise Ratio (SNR in dB) at 1700 hrs from Pune wind profiler is shown plotted in Figure 1. Peak values are observed up to the height of 4 km with a sharp fall above this height. This enhancement of reflectivity is associated with the radar bright band that occurs mainly due to the phase change of hydrometeors near the 0˚C isotherm level. But this bright band is not seen clearly as seen in normal stratiform clouds may be because of its mixed convective and stratiform nature.

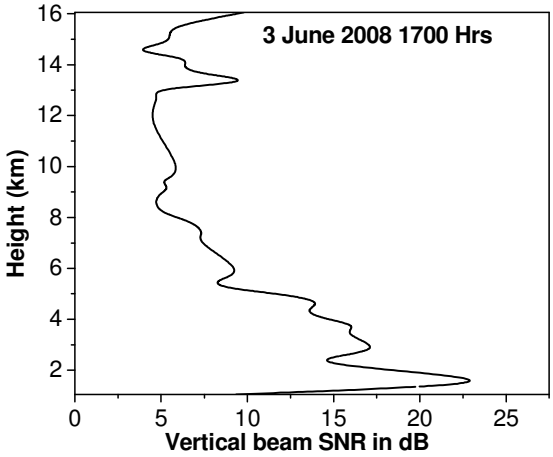

FIG. 1: Vertical profile of hourly averaged vertical Beam SNR (in dB at 1700 Hrs on 3 June 2008) as derived from Pune wind profiler

The time-height variation of 6 minute instantaneous values of vertical velocities, horizontal wind speed, vertical SNR in dB, vertical shear of horizontal wind, spectral width and refractive index structure parameter observed in the height range from 1.05 km to 4.35 km on June 3 2008 during the period 1640 to 1744 hrs from Pune wind profiler are presented in Figure 2 a, b, c, d, e and f respectively.

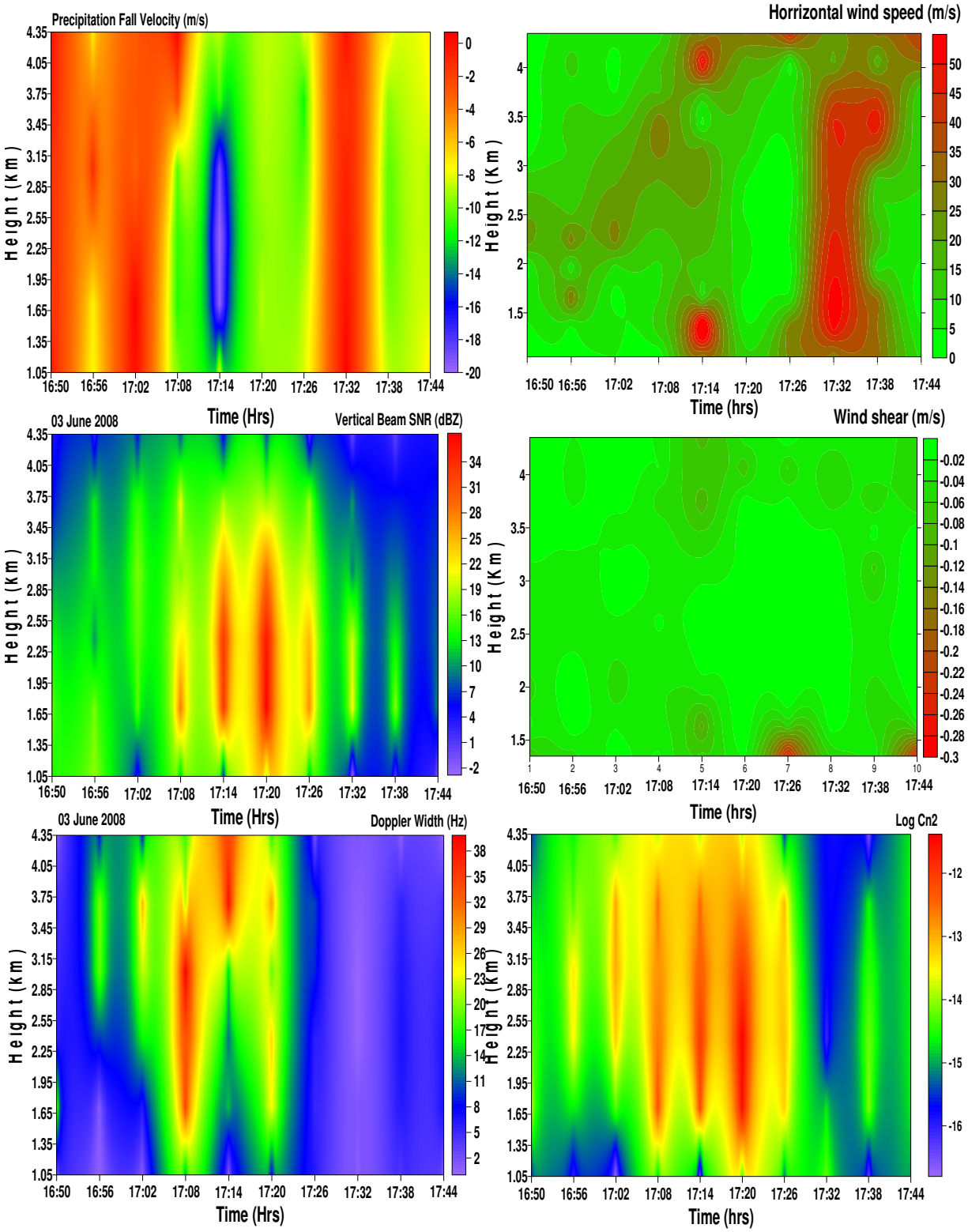

FIG. 2: Time height variations of wind profiler derived a: vertical motions, b: horizontal wind speed, c: vertical beam SNR, d: vertical shear of horizontal wind, e: spectral width and f: refractive index structure parameter (Figures in sequence from Top left to Bottom right – Figure 2a to Figure 2f).

The vertical velocities shows abrupt updraft and downdrafts during the course of a thunderstorm with values ranged between 0 to 18 m/s. The maximum downdraft is seen at 1714 hr. This intense downdraft could be due to the precipitation (hydrometeor falling velocity). Horizontal wind also shows interesting pattern. When the downdraft was maximum, the maximum wind speed occurred in two regions. One in the 1.05 km - 1.95 km range and the second in 3.5 km - 4.5 km range. Analysis of horizontal wind shear indicates the presence of strong wind shear at the time of maximum downdraft occurrence. This shear exists at all the height (1.05-4.35 km) levels. The low values of spectral width were noticed confined in the height range 3.15 km – 4.35 km. But it is seen that the maximum values of spectral width starts appearing at all the vertical levels just before the maximum downdraft occurs and further spectral width shows decreasing trend in its magnitude with the decrease in downdraft strength. Analysis of C_n^2 gives the idea about the turbulence structure during a thunderstorm event. Maximum C_n^2 values are seen in all lower tropospheric levels when the intense downdraft occurred. During this time C_n^2 values reaches even up to 10^{-12} $m^{-2/3}$

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