4.1.1 AN EVALUATION OF ERRORS OBSERVED IN THE MEASUREMENT OF LOW WIND VELOCITIES

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INTRODUCTION

Measurements of low wind velocities ($|V_H| \simeq 0$ to 6 m/s) with a VHF wind profiler can be difficult if ground clutter, or other biases in the system dominate in altering the position of the perceived peak in the calculated power spectrum. A variety of methods for "ground clutter" suppression are used in profiler systems today (CORNISH, 1983). Typically, dc offsets are removed before the spectra are calculated. Several other techniques for editing are used for clutter suppression after the spectra are calculated. One of these methods called "zero suppression" takes the spectral value of a selectable number of points (N) on each side of 0 velocity (one point on either side, in this study) and sets them equal to the mean value of the points exterior to the specified N points on either side of 0. Our analysis done with the PSU VHF(1) radar, shows that this zero-suppression method can systematically bias horizontal winds (V_H) below 6 m/s. With the zero suppression, an artificial increase in absolute wind velocities occurs when the spectral peaks fall within the ± N points of the FFT (personal communication, Strauch, 1985). We have also established that the method artificially decreases the absolute wind velocities inferred from spectral peaks that are outside but near the suppressed region. In the remainder of this short report we show comparisons of wind profiles observed with and without zero suppression. The range of the biased velocities extends to about ± 6 m/s. Biases have been deduced to be as much as 2 m/s, but more commonly they are on the order of 1.0 m/s.

OBSERVATIONAL METHOD

In this study, comparative observations were made using only the high resolution ($\Delta z = 270$ m) mode. Nine separate first moment calculations were averaged together (STRAUCH et al., 1985) for each range gate (24 gates). In the standard observational sequence, 12 such velocity profiles are averaged together to create the reported hourly profile. To obtain the data for this study, the radar was shut off momentarily to manually switch the zero suppression from "ON" to "OFF". A 90-sec observation was then immediately taken after each such change in order to fairly compare the velocity profiles with and without zero suppression.

The first measurements were performed on August 12, 1985, when a single 90-sec observation with this suppression was immediately followed by an observation without it. This was made before we were strongly suspicious that such biases were of sufficient magnitude to be of substantial importance. By taking the first-moment calculations and plotting them as a function of height, one can readily show the bias introduced by the suppression (Figure 1). The corresponding power spectra (each of which is an average of 9 spectra) are shown in Figures 2a,b. The horizontal axis is scaled in FFT points, and the vertical axis represents the relative reflected power at each individual range gate. The topmost spectrum corresponds to the 8.60 km MSL range gate; the lowermost to 1.94 km MSL. The two hack marks indicated on each spectrum indicate the FFT points at which the velocity peaks first reached the noise level. In Figure 2a, the velocity peaks picked seem to lie just outside the suppressed area which can be seen as the "flat tops" near 0 velocity. Figure 2b shows the corresponding spectra evaluated without zero suppression. They were taken approximately two minutes later. The "notch" evident at 0 velocity is a consequence of the dc removal.

Since typical magnitudes of velocity variations between two 90-sec observations can be as large as the bias seen in Figure 1, a single comparative observation as recorded on August 12 would not be statistically significant. Thus, following our initial observation of the possible bias, we waited for the appropriate weather conditions for a second "low velocity" day; it occurred on September 15, 1985. Data were recorded during two observation periods on September 15: labeled Period 1 (04:17 to 04:47 Z) and Period 2 (12:23 Z to 12:45 Z). In Period 1, six comparisons with and without zero suppression were taken. The average wind profiles for the component in each beam are plotted in Figures 3a,b. The histogram of absolute values for velocity differences (Figures 4a,b) show the average bias to be ∿ 1 m/s. During Period 2, although the velocities had changed appreciably, the bias still remained between 0.79 to 0.91 m/s on the average as seen in Figures 5 and 6.

A bias of f1 m/s in an absolute sense is small, but in relative terms this bias can easily be as much as 50 percent of the observed velocity. Furthermore, it could produce a substantial fraction of the rms error associated with the radar when its measurements are compared with conventional wind soundings. The error could be of particular significance when the radar is being used for estimating derived parameters such as temperature advections which are dependent upon the calculated vertical wind shear. On the other hand, referring back to Figures 2a,b, it can be seen that the present zero suppression can be helpful in the uppermost gates in which the signal-to-noise ratio is normally lower. Perhaps a gate-number-dependent zero-suppression technique should be applied which would take into account the number of each gate as well as the characteristics of each site's ground-clutter pattern and typical variations in S/N ratio, etc.

REFERENCES

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Strauch, R. G., D. A. Merritt, and K. P. Moran (1985), Radar wind profilers in the Colorado network, NOAA Tech. Memo. ERL WPL-120, March 1985.

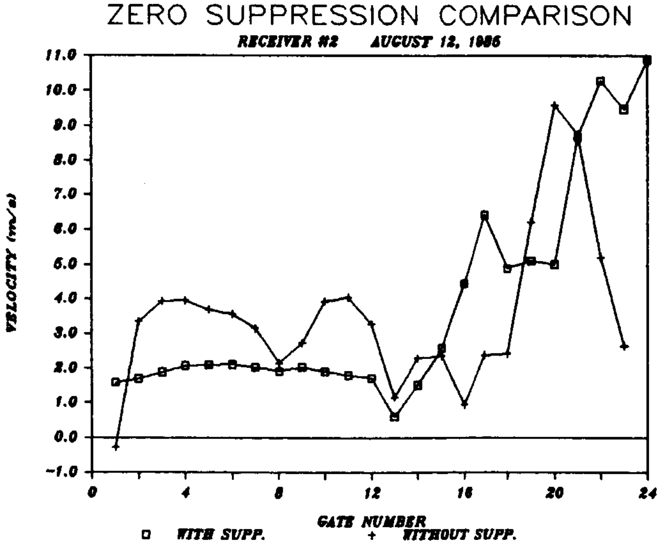

Figure 1.

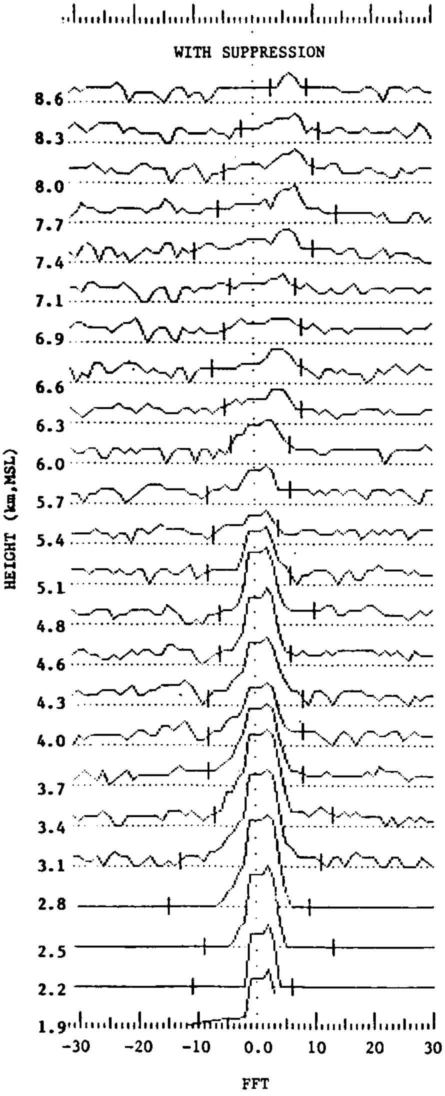

Figure 2a.

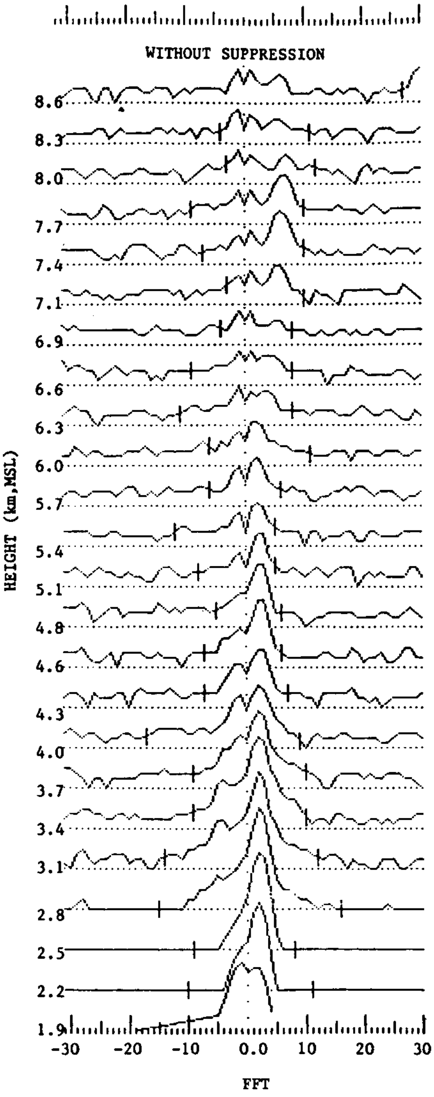

Figure 2b.

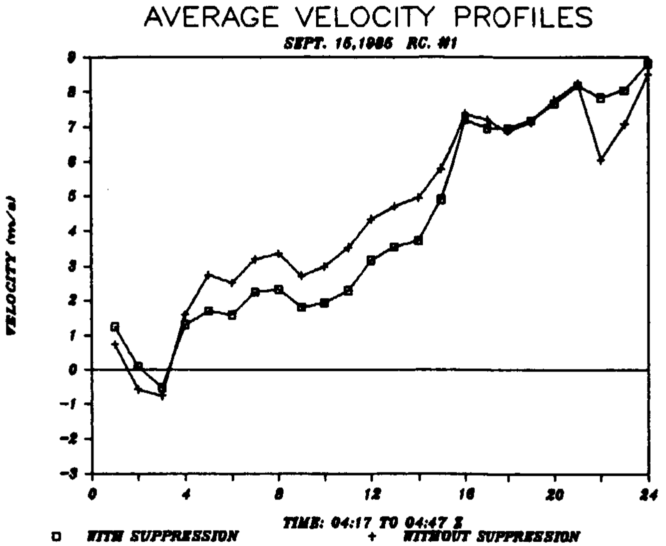

Figure 3a.

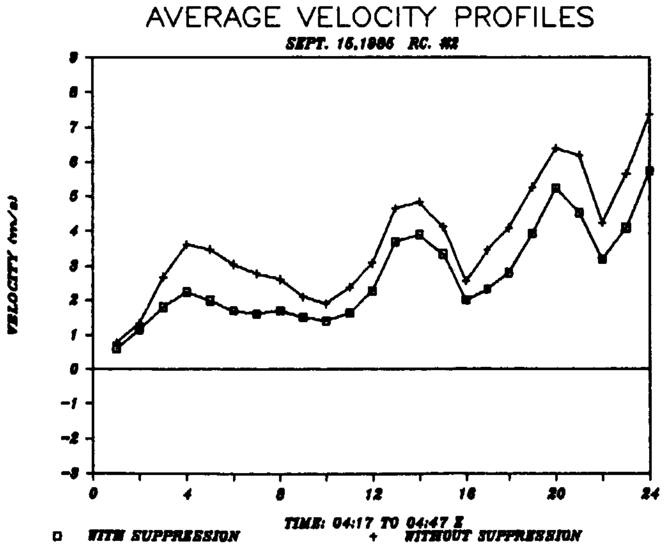

Figure 3b.

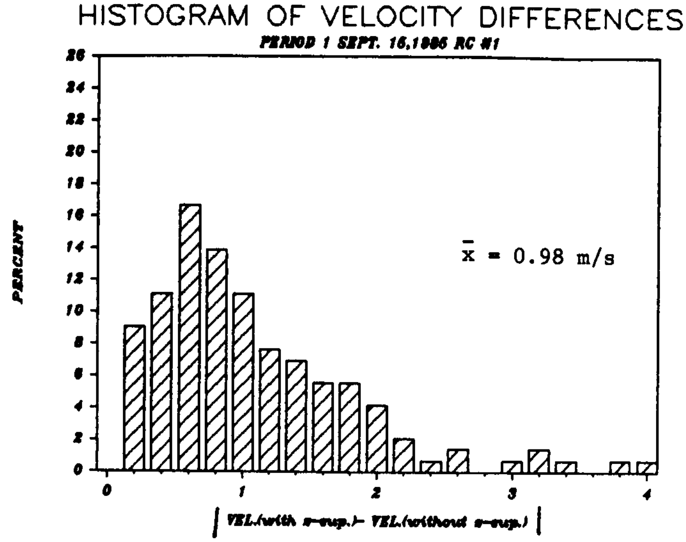

Figure 4a.

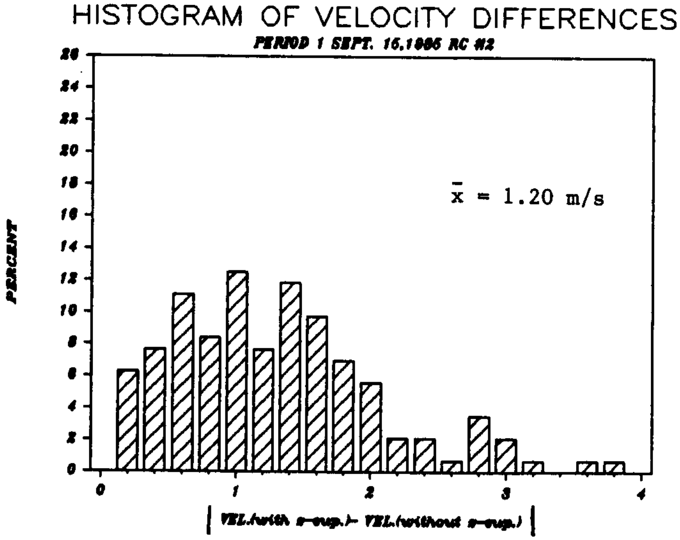

Figure 4b.

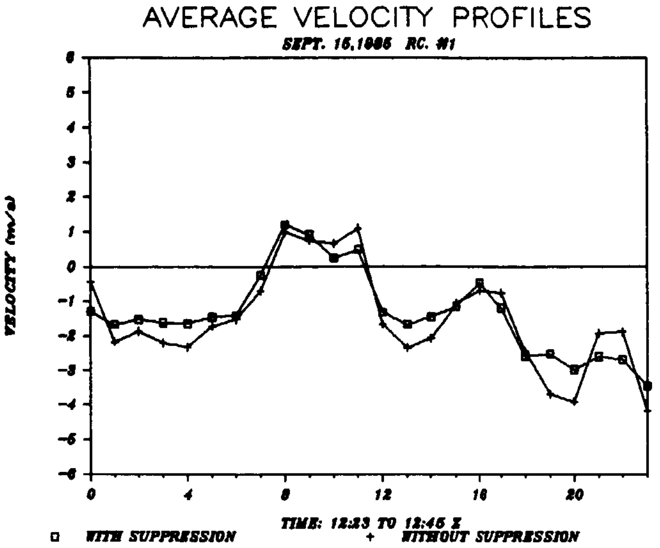

Figure 5a.

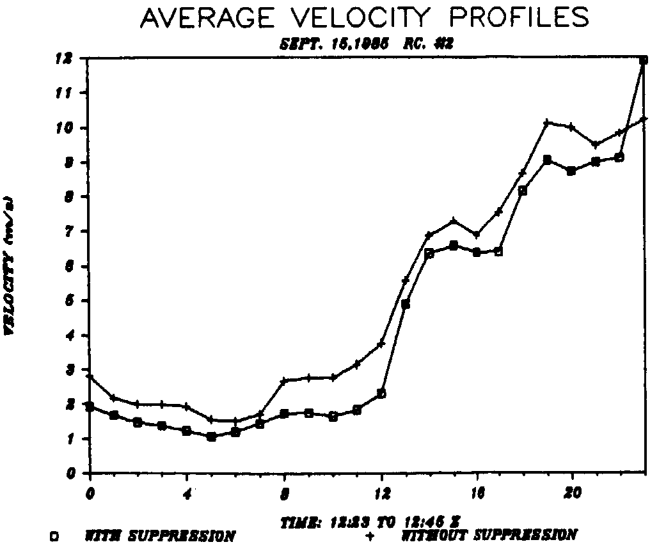

Figure 5b.

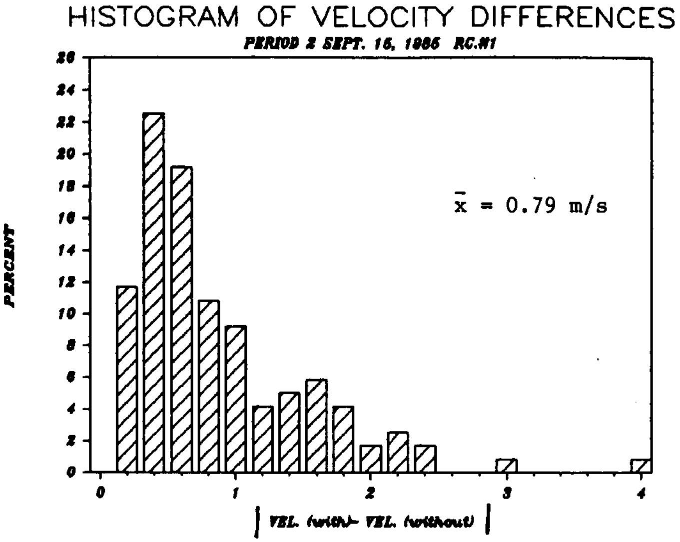

Figure 6a.

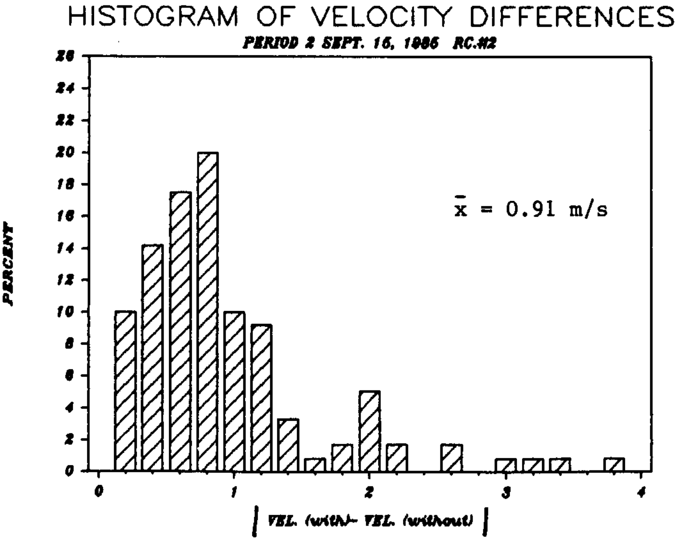

Figure 6b.