Preface

The Wind Profiler is basically an atmospheric remote sensing instrument. An atmospheric remote sensing instrument gives information about a volume of the atmosphere at a distance without being physically located in the volume. The Wind Profiling Radar System is an extremely versatile and high performance instrument for studies of the lower and middle atmosphere. Wind profilers data are widely used in the meteorological community for research and for the initialization of forecast models. However, any systematic velocity errors, such as those caused by any interference, make these data potentially less valuable or even damaging for analysis and prediction. Therefore computation of wind velocity is significant in the atmospheric radar data processing. It is possible with the sophisticated signal processing techniques to improve the accuracy of the wind velocities measured by the wind profilers.

Continued integration of wind profiling technology into operations and research requires continued improvement in the reliability and accuracy in the derived meteorological products. In particular, extracting measurements of meteorological quantities in the presence of interfering signals and quantifying the error in the measurements introduced by nonhomogeneous and other limiting meteorological conditions must be addressed. Certainly, improvements in profiler hardware offer some advantages and must be pursued; however, these improvements will be incremental. Significant improvements are possible through signal processing advances discussed in this thesis.

This thesis examines how to obtain best wind profile from radar/sodar data by minimizing the systematic errors due to various reasons and also how signal processing techniques helpful in obtaining reliable winds. Though wind profiling radars have been used to measure winds, there are some issues that create errors in radar measured wind velocities. Issues like radar volume, aspect sensitivity, gravity wave effects and scatter intermittency will produce biases in wind measurements.
This thesis has six different parts that may be treated differently. Chapter 1 introduces the basic concepts of wind profiler technology and role of signal processing in wind profilers. Chapter 2 describes the instruments (Radar and Sodar) used for this study and various steps involved in the analysis of data for obtaining meteorological parameters. Next two chapters present a detailed study on two issues that can create errors in wind measurement. One is the study on the optimum angle for wind measurement and also the effect of aspect sensitivity on wind measurement with complete statistical analysis on the data. Second is the reliability of winds in different beam configurations in Doppler Swining Mode. Last two chapters focused on signal processing techniques such as decoding of multi frequency signals for a sodar system and bispectral analysis of atmospheric signals. These two chapters highlights the importance of signal processing to improve the signal detectability under various noisy backgrounds and thereby minimizing the errors.