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Abstract

Comprehensive monitoring of the atmosphere has become increasingly important in recent years for study of the earth's environment. Observations of wind velocity profiles are the key for studying meteorological phenomena and weather forecasting. Radar wind profilers, the most suitable remote sensing instruments for wind profiling, measure Doppler due to the radio refractive index irregularities 'advecting' with the wind. Propagation of radar signals through the atmosphere is strongly dependent on local meteorological conditions, especially in the atmospheric boundary layer. Due to their small aperture, UHF profilers operating around 900-1300 MHz are most suitable for measuring the winds in the atmospheric boundary layer and lower troposphere regions. They have large number of applications in both research and operational meteorology.

The historical evolution of radar wind profiler, from the theoretical and experimental studies pursued in the fields of ionospheric radio probing, radar meteorology, and terrestrial radio propagation, is presented. Basic theory and technique of radar wind profilers including the parameter extraction are described.

A new L-band radar is designed, developed and scientifically validated at NARL for lower atmospheric wind profiling. A 'simplified' active array configuration, which has sensitivity similar to a fully active phased array and simple in complexity like a passive phased array, is introduced and realized for the new radar. A fully solid-state active array, that is fed with a novel two-dimensional modified Butler matrix, is built for the new radar, which also has modern features like direct IF sampling and digital signal processing, pulse-compression etc. Test results of all the subsystems are presented.

The new radar wind profiler is found to yield very good quality data, with high-temporal and spatial resolution, in both clear air conditions and precipitation. The winds measured by this profiler are validated by comparing them with the data obtained with the collocated GPS Sonde. Sample observations made by the new radar wind profiler are presented. The observational results obtained with the new radar confirm that the adopted 'simplified' active array radar configuration results in compact, low cost, calibration-free and high-performance radar wind profiler. The author hopes that the present work will contribute to advancement of the understanding and prediction of atmospheric processes.