The kinematic structure of a supercell thunderstorm seen by airborne Doppler radar

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Introduction

The airborne radar system on the NOAA WP-3D aircraft was designed primarily for studies of tropical cyclones and other mesoscale processes (Jorgensen et al. 1983) and has demonstrated its value to ascertain the internal flow fields of these large-scale systems. An important contribution on the convective scale was by Marks and Houze (1987). They utilized the P-3 airborne Doppler radar (ADR) to describe the inner core features of Hurricane Alicia. They examined the eyewall structure, showing the convective-scale updrafts and downdrafts and their relationship to reflectivity, and their location in the eyewall.

Since the mid-1980s, two NOAA P-3s have been used in the midlatitudes for projects such as AIMCS, OK PRE-STORM, GALE, SWAMP, COPS, and STORM-FEST. Ray et al. (1985) reported on the first use of the ADR as a platform for sensing midlatitude convection. The original radar antenna, mounted in the tail of the P-3, made helical scans normal to the aircraft flight track. To derive quasi-dual Doppler winds, flight tracks were designed in sawtooth or "L" patterns. A major modification in 1989 employed a fore-aft scanning technique (FAST) (Jorgensen and DuGranrut 1991) in which the tail antenna alternately scanned forward approximately 25 degrees to flight path, then aft 25 degrees. This technique allows the quasi-dual Doppler observations to be made in hal fthe time of the old technique of "L" patterns. There is, however, some degradation of scanning resolution and wind accuracy with the new FAST technique, because the beams do not intersect at right angles.

This study examines an isolated thunderstorm complex that developed ahead of a dryline near Tulsa, Oklahoma, on 16 May 1991. There were several reports of tornadoes (F0 and F1) during the lifetime of the thunderstorm complex; however, none occurred during the P-3 sampling period. The analyses show the capabilities and limitations of the NOAA WP-3D ADR when examining rapidly evolving convective-scale features. The thunderstorm complex is also examined using the WSR-88D radar located at Twin Lakes, Oklahoma, approximately 100 km from the storms. Comparisons are made between the airborne and ground-based radars. We also address the likely benefits of using the Electra Doppler Radar (ELDORA), recently developed by the National Center for Atmospheric Research (NCAR), in a convective-scale situation.