P4A.8 TERMINAL DOPPLER WEATHER RADAR OBSERVATIONS OF A MICROBURST

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1. INTRODUCTION

Between 0000 and 0100 UTC on 9 October 2002 (7 and 8 PM CDT 8 October 2002), a microburst (Fujita, 1985) occurred in the western sections of the city of Norman, OK. Wind damage produced by the microburst occurred between 0020 and 0026 UTC 9 October 2002 (720 and 726 PM CDT 8 October 2002). A damage survey was completed by 0300 UTC 9 October (10 PM CDT 8 October), and revealed significant damage to trees and fences, and light damage to some structures within the affected areas, all in a well-defined starburst pattern (Figure 1). This microburst occurred within 10 to 20 km of both the Twin Lakes (KTLX) WSR-88D radar, and the Oklahoma City Terminal Doppler Weather Radar (TDWR). This paper will examine the reasons, mainly owing to a combination of sampling factors that will be discussed in detail in section 3 of this paper, why data from the lowest elevation slice from the TDWR were vastly superior to data from the lowest elevation slice from KTLX in monitoring the evolution and intensity of this microburst. Previous work by Vasiloff, 2001 has documented the value of supplementing WSR-88D data with TDWR data in warning operations, and a further discussion of the operational advantages for supplementing WSR-88D data with data from TDWR will also be presented.

2. RADAR OBSERVATIONS

During the microburst, the maximum inbound radial velocity sampled by the lowest elevation slice (0.3 degrees) from TDWR was 33 ms^{-1} (66 kt), at a range of approximately 6 km south of the radar site at 0022 UTC (722 PM CDT). Radar beam height of the 0.3 degree elevation slice (assuming standard refraction) at this location is approximately 30 m AGL (100 ft AGL). The location of the maximum sampled velocity corresponds very well with observed damage west of Interstate 35 on the west side of Norman. At the same location, data from the lowest elevation slice (0.5 degrees) from KTLX revealed inbound radial velocities of 13.5 ms^{-1} (27.1 kt) at 0019 UTC and 3 m/s (9.7 kt) at 0024 UTC. Radar beam height at the 0.5 degree elevation slice from KTLX (also assuming standard refraction) at this location is approximately 213 m AGL (700 ft AGL). The significant sampling differences between TDWR and KTLX are illustrated in Figures 2 and 3 on the following pages. It should also be noted that TDWR performs sampling at the lowest elevation slice once every minute as compared to once every 5 minutes from KTLX. Thus, there are six lowest elevation slice samples of this microburst from TDWR as opposed to only 2 from KTLX. This is an important sampling advantage of TDWR and will be discussed in more detail in the next section.

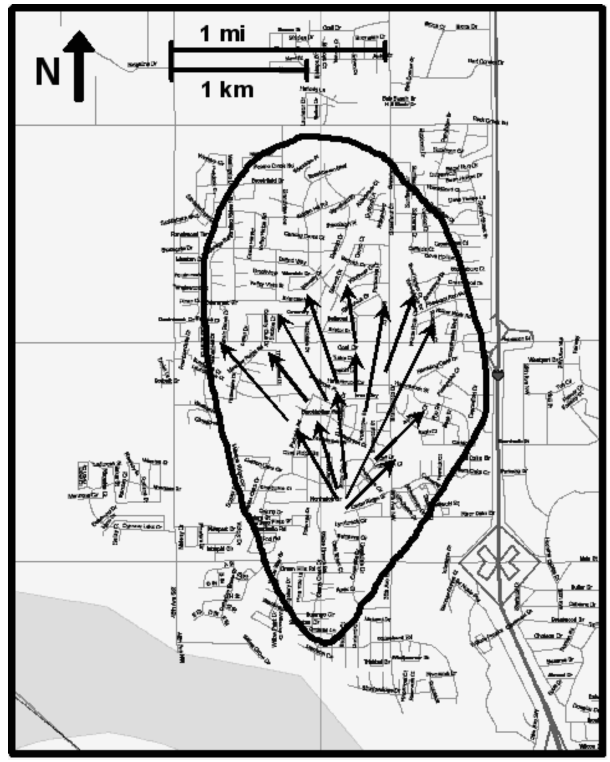

Figure 1. Map of the damage caused by the 8 October 2002 microburst in Norman, OK. Wind damage was observed within the area outlined, with the most intense damage in the area highlighted by the damage tracer arrows. The damage survey indicated winds predominantly from a southerly direction within the microburst. From the damage observed, wind speeds were estimated to have been between 23 and 33 ms^{-1} (55-65 kt or 65-75 mph). For reference to similar features in Figures 2 and 3, Interstate 35 is the black line extending north-south across the right side of this image.

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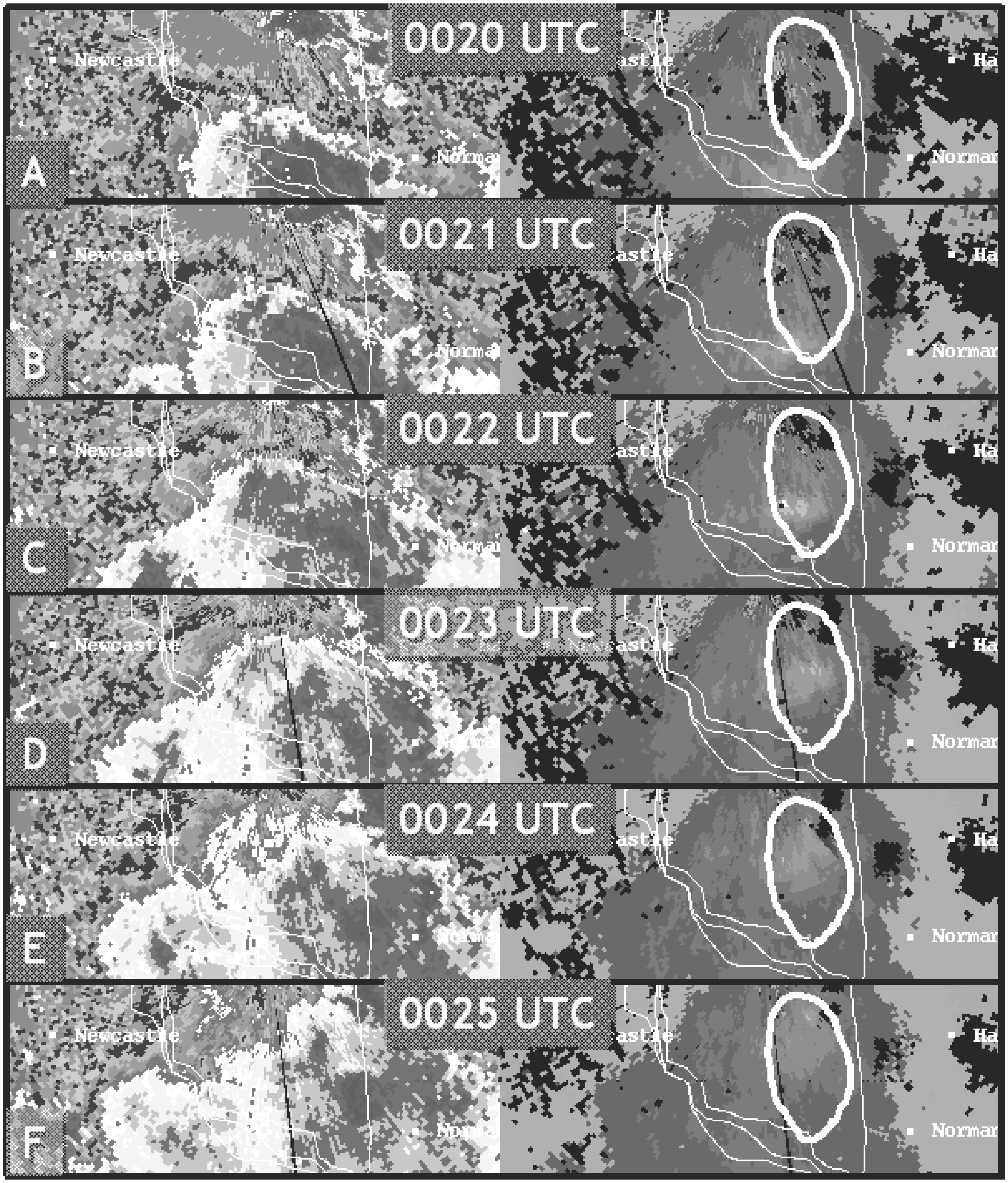

Figure 2. 1-minute Reflectivity (left) and Radial Velocity (right) from the 0.3 degree elevation slice from TDWR at **A)** 0020 UTC, **B)** 0021 UTC, **C)** 0022 UTC, **D)** 0023 UTC, **E)** 0024 UTC, and **F)** 0025 UTC. Microburst damage area is annotated by the thick white line on radial velocity images. Maximum inbound radial velocities in **A)** 23 ms^{-1} (46kt), **B)** 30 ms^{-1} (60kt), **C)** 33 ms^{-1} (66kt), **D)** 28 ms^{-1} (56kt) **E)** 25 ms^{-1} (50kt) and **F)** 32 ms^{-1} (63kt). Beam height AGL at this location was ~ 30m (100 ft). For reference to Figures 1 and 3, the thin white line just to the right of the annotated microburst area is Interstate 35.

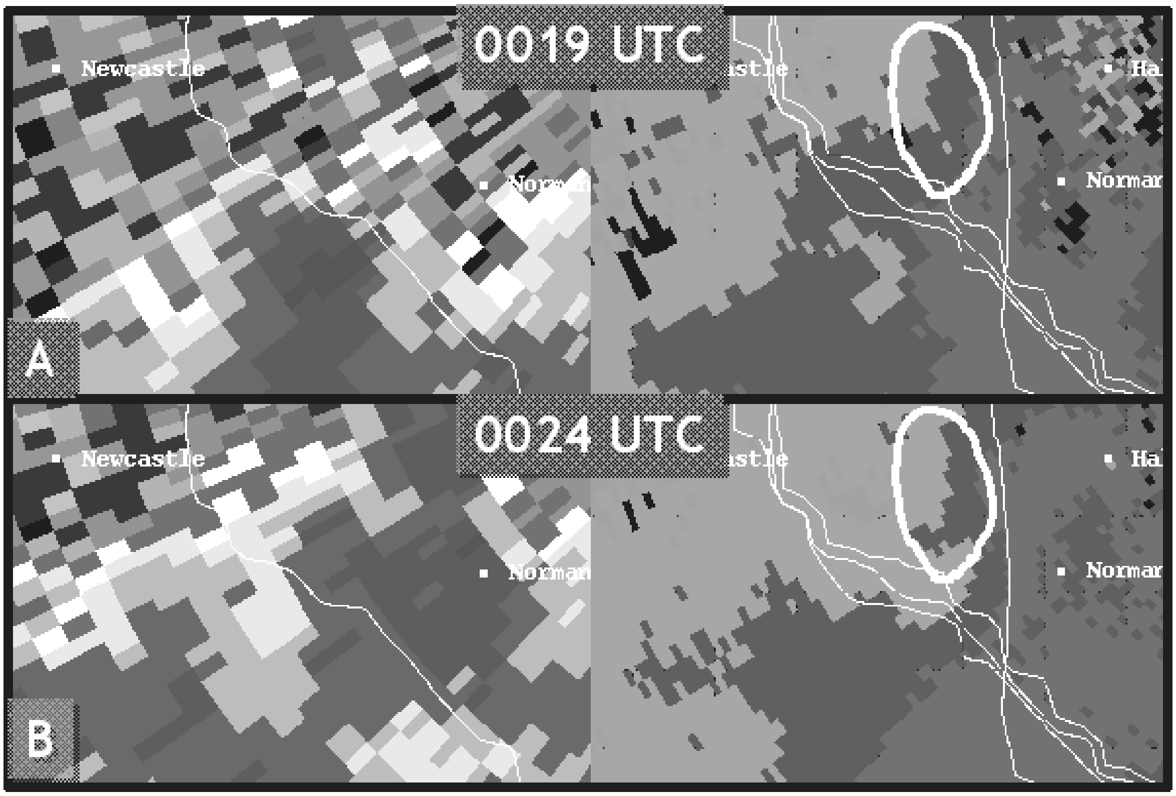

Figure 3. 5-minute Reflectivity (left) and Radial Velocity (right) from the 0.5 degree elevation slice from KTLX at **A)** 0019 UTC, **B)** 0024 UTC. Microburst damage area is annotated by the thick white line on radial velocity images. Maximum inbound radial velocities in **A)** 14 ms^{-1} (27kt), **B)** 5 ms^{-1} (10kt). Beam height AGL at this location was ~ 213m (700 ft). For reference to Figures 1 and 2, the thin white line just to the right of the annotated microburst area is Interstate 35.

3. DISCUSSION OF RADAR OBSERVATIONS

As illustrated in Figures 2 and 3, data from TDWR was vastly superior to data from KTLX in monitoring the strength and evolution of this microburst. Several factors related to sampling contributed to TDWR superiority. The combination of a much closer range and 0.3 degree elevation slice (versus 0.5 degrees from KTLX), resulted in significantly lower beam sampling above ground level from TDWR. The damage survey clearly revealed winds in the microburst were predominantly from a southerly direction (see Figure 1). As a result, wind direction was nearly parallel to radial sampling from TDWR, while wind direction as sampled from KTLX was nearly 70 degrees skewed to the radials, severely limiting detection of the strongest radial velocities. In addition, the already superior velocity range gate resolution from TDWR (1 degree by 125 m as opposed to 1 degree by 250 m from KTLX) was accentuated by the closer range, and resulted in a much smaller sample volume size from TDWR. *Finally, and perhaps most importantly, TDWR performs an elevation slice at 0.3 degrees every minute, while KTLX samples at 0.5 degrees every five minutes. The 1-minute sampling in the near-ground layer for this microburst resulted in* ***TDWR sampling that was 3 times more frequent than from KTLX, vitally important for a rapidly evolving feature.*** The table below summarizes the sampling differences between TDWR and KTLX.

	TDWR	**KTLX**
Range (km)	7	19.5
Beam Height (m/AGL)	30	240
Radial Viewing angle	~ 5^0	~ 70^0
Samples	6	2

4. OPERATIONAL IMPLICATIONS

This is one of numerous cases where forecasters at the Norman, OK NWS WFO have significantly benefited from TDWR data since it was made available in the spring of 2000 (Johnson, et al). This case is representative of several others in which TDWR data were used in warning operations for central Oklahoma as a supplement to data from KTLX. TDWR data are especially useful over the western and southern sections of the Oklahoma City metro area, where the combination of a closer range and a 0.3 degree elevation slice results in sampling much closer to ground level, thus allowing the significantly higher resolution detection of potential severe weather producing features in areas where storms are still approaching the densely populated Oklahoma City metro area. In addition, 1-minute sampling at the lowest slice from TDWR provides much greater temporal continuity of rapidly evolving storm scale features than provided from the WSR-88D. Additional documentation of the use of TDWR data in warning operations at the Norman, OK NWS WFO during the 8 and 9 May 2003 tornado events in Oklahoma City will be forthcoming in future work.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

Fujita, T. T., 1985: The Downburst: Microburst and Macroburst. SMRP res. Pap. 210, University of Chicago, 122 pp.

Johnson, J. T., D. J. Miller, M. D. Eilts, and R. E. Saffle, 2000: The Utility of the TDWR Data in Weather Forecast Offices. *Preprints:* 9th Conference on Aviation, Range and Aerospace Meteorology, Orlando, FL, 2000. Amer. Met. Soc. P J18.

Vasiloff, S. V., 2001: Improving Tornado Warnings with the Federal Aviation Administration's Terminal Doppler Weather Radar. *Bull. Amer. Meteor. Soc.*, **82**, 861-874.