5.4 FORECAST USES OF TERMINAL DOPPLER WEATHER RADAR (TDWR) DATA

Steven M. Zubrick*
NOAA/National Weather Service Forecast Office, Sterling, Virginia

1. INTRODUCTION

Since January 1999, forecasters at the National Weather Service (NWS) Weather Forecast Office (WFO) in Sterling, Virginia, have had real-time access (via a Web browser) to a limited set of radar data from the Federal Aviation Administration (FAA) Terminal Doppler Weather Radar (TDWR) near Baltimore-Washington International (BWI) airport. The FAA operates a network of TDWRs located near many major airports. There are 42 operational TDWRs (see Vasiloff 2001 for a map of locations).

TDWRs were designed primarily to detect wind shear and microbursts near airports. In order to detect small features like gust fronts, TDWRs operate at a lower elevation scanning angle ranging of 0.1° to 0.3° compared to the fixed 0.5° lowest elevation scan used in Weather Surveillance Radar-1988 Doppler (WSR-88D) radars. TDWRs also have a narrower azimuthal beamwidth of 0.5°. This nearly doubles the resolving power compared to the 0.9° beamwidth used in the WSR-88D even though both radars have the same size antenna (8.2 m diameter). Although signal attenuation for the C-Band TDWR (5 cm) is slightly greater than for the S-band (10 cm) WSR-88D radar in precipitation, TDWR velocity data are largely unaffected.

Recent work has shown the advantages of using a narrower 0.5° beamwidth (compared to 0.9°) when sampling a thunderstorm mesocyclone (Wood et al., 2001). Also, access to near-surface elevation scan angles (like those from the TDWR) allows enhanced detection and monitoring of important severe weather features (like tornadoes). To this end, NWS Headquarters (HQ) is working closely with the FAA to incorporate TDWR radar data (and other FAA radars) into NWS field offices (Saffle et al. 2000).

The purpose of this paper is to share some forecaster experiences in using BWI-TDWR data to supplement WSR-88D data in support of NWS Sterling WFO forecast and warning operations.

2. TDWR DATA ACCESS AT WFO-STERLING

The BWI-TDWR is located 8 km south of BWI airport and 74 km east of the KLWX WSR-88D radar in Sterling. Until TDWR data are directly available in NWS offices, forecasters at Sterling access BWI-TDWR data via a password-protected Internet web page. A high-speed data line is used to transfer radar data from the BWI-TDWR to a web server at NWSHQ in Silver Spring, Maryland. Software on this server, developed by the Massachusetts Institute of Technology - Lincoln Laboratory, ingests and processes the data, and creates web images (in GIF format) in real-time. Sample BWI-TDWR images available through the web site can be found at: http://www.nws.noaa.gov/er/lwx/_TDWR

Using the Web browser, forecasters can routinely view a full 360° rotation elevation scan at 0.3° for both base reflectivity and velocity out through 89 km. Other 360° scans are available at 1.0°, 3.4° and 6.1° whenever the TDWR operates in the "monitor" scanning mode. Radar data are available every 5 min in this mode. When hazardous weather is detected (e.g., precipitation, microbursts, etc.), the TDWR switches to a "hazardous weather mode" (HWM) that scans a sector over the airport. When scanning in HWM, the lowest elevation scan at 0.3° is still available every 5 min for the full 360° volume, but the aforementioned upper scans are sectorized in a 45° -wide scan centered on BWI airport.

The Web browser software allows creation of a 4-panel display of different elevation scans of either reflectivity or velocity data. Other attributes of the browser include the ability to zoom on any loop or radar image (including the 4-panel display), animation of reflectivity or velocity data, auto-update of displayed images and loops every 1 min, and interactive java scripts that interrogate the 0.3° base reflectivity and velocity data to display bin values, azimuth and range, and beam centerline height by moving a cursor over the Web-GIF image.

3. USES OF TDWR DATA AT WFO-STERLING

Data from the BWI-TDWR complement many operational programs within the WFO. The data have cross-cutting value; for example, use of TDWR data to monitor shallow and weak boundaries for convective initiation applies to all program areas.

a. Marine applications

The BWI-TDWR, being located in northern Anne Arundel County, Maryland, is about 15-50 km from the western shoreline of the Chesapeake Bay. The beam centerline height at these distances ranges from 45-120 m above ground level (AGL) over the

**Corresponding author address:* Steven Zubrick, NWS Sterling, 44087 Weather Service Rd., Sterling, VA 20166; e-mail: steven.zubrick@noaa.gov

Bay. Due to this close proximity to the Bay, BWI-TDWR data help forecasters monitor wind fields over the Bay, where few real-time data buoys are located.

On fair weather days during the warm season, often there is an area of increased surface winds over the Bay that's observed to follow the main channel up the Bay. This "channeling" of southerly winds can cause small craft advisory conditions (i.e., 20 knots sustained) to occur. In many instances, a late afternoon and early evening wind speed maximum is also present over the main channel of the Bay. The clear-air boundary layer sensed by the BWI-TDWR often shows both this enhanced wind speed maxima and channeling over the western Bay. Forecasters can monitor the TDWR and other data and issue appropriate advisories or statements, as well as update the coastal forecast as needed.

TDWR data are used to monitor gust fronts that move over marine areas. TDWR velocity data associated with the gust front provides the forecaster with near-surface ground truth in data–sparse locations. Many shallow gust front features located near the marine areas are not sensed by the KLWX WSR-88D radar but do contain winds of 20 to 40 kts.

b. Aviation applications

BWI-TDWR data are used in a variety of ways to support the aviation program at WFO-Sterling. For example, areas of drizzle can be monitored using TDWR data. The TDWR, operating at 5 cm, is more sensitive than the 10 cm WSR-88D to the smaller droplet size distribution associated with drizzle. Hence, the TDWR depiction of drizzle areas that may impact an airport and the associated low ceilings and visibilities are monitored and incorporated into terminal aviation forecasts (TAFs).

TDWR data are also used to monitor winds near the surface and below 1 km. Over the mid-Atlantic, a nocturnal low-level (below 1 km) jet has been observed to develop after sunset and last through 0700-1000 UTC the next day. When this jet occurs, winds at the surface will be gusty. In addition, low-level wind shear criteria can be met due this feature, if winds decouple at the surface. The TDWR is a good means to monitor this phenomena.

c. Public weather

Owing to its location near the Chesapeake Bay, during the warm season, a thermally-driven "bay" breeze, or front, will often move inland from the western shores of the bay. When a large thermal contrast between the water and land exists, temperatures can drop 15 to 20 degrees behind the this bay front. The TDWR data are used to monitor the position of the bay front, since the KLWX-88D radar beam typically overshoots this boundary. Also, the bay front often serves as a focus for convective initiation so its position is important to monitor.

Clear-air horizontal convective roll (HCR) vorticies appear in both the WSR-88D and TDWR radar data. However, TDWR frequently shows the HCRs much longer after they have faded from the WSR-88D. Forecasters have found the location of HCRs often serves later as a focus for convection.

c. Severe weather

Vasiloff (2001) provides an excellent review of TDWR use for tornado detection. The advantages of lower elevation scanning angle and higher azimuthal sampling benefit forecasters during severe weather operations. In the three years that WFO Sterling forecasters have had access to BWI-TDWR data, four tornadoes (F0-F1) and many small microbursts and bow echoes were detected that otherwise were not sampled well by the KLWX WSR-88D radar.

TDWR data are obviously used to monitor supercell storms moving within its range. Forecasters use TDWR data to confirm tornadic and mesocyclone signatures depicted in 88D radar data. In addition, the BWI-TDWR data provide a means to monitor weak boundaries and their interactions.

4. SUMMARY

This paper illustrated use of the TDWR data to supplement WSR-88D radar data in support of NWS forecast and warning operations. The TDWR's narrow beamwidth, lower-level elevation scans, and its favorable location in Southern Maryland, allows a complementary second radar view for detection and monitoring of weather features in the WFO area.

5. ACKNOWLEDGMENTS

My thanks go to Bob Saffle and his staff for their support in maintaining the TDWR BWI data stream.

6. REFERENCES

Saffle, R. E., M. Istok, S. Sherma, S. M. Holt, and L.D. Johnson, 2000: Progress in the use of weather data from the Federal Aviation Administration (FAA) radars in combination with the WSR-88D. Preprints, *Ninth Conf. on Aviation, Range and Aerospace Meteorology*, Orlando, FL, Amer. Meteor. Soc., J11-J14.

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

Wood, V. T., R. A. Brown, and D. Sirmans, 2001: Technique for improving detection of WSR-88D mesocyclone signatures by increasing angular sampling. *Wea. Forecasting*, **16**, 177-184.