P1.22 NEW SCANNING STRATEGIES FOR THE WSR-88D

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1. INTRODUCTION

The Weather Surveillance Radar - 1988 Doppler (WSR-88D) has used the same scanning strategies, or volume coverage patterns (VCPs), since being deployed in the early 1990s. Forecasters have requested VCPs that do more than the current set. Since 1998 new VCPs have been designed and evaluated as part of a joint effort between the Radar Operations Center (ROC) and the National Severe Storms Laboratory (NSSL). Recent evaluations are expected to result in a recommendation to implement one new VCP for field operations as part of a near-term Open Radar Product Generator (ORPG) software build with more VCPs to follow. This paper provides details of the VCP likely to be implemented soonest, a summary of recent evaluations, and potential impacts on WSR-88D operations.

2. CANDIDATE VCPS

Three experimental VCPs (Beta, Gamma, and Delta) were developed for shallow convection, deep convection, and rapid evolution. VCP Beta is to be used with shallow convection or distant storms or stratiform precipitation. VCP Beta completes 12 unique elevation cuts from 0.5° to 8.1° in five minutes. For deep convection, VCP Gamma is faster and density of data points is greater at lower elevation angles than VCP 11 (Fig. 1). For rapid severe weather threats, VCP Delta completes six unique elevation angles from 0.5° to 6.5° in 2.3 minutes. Spratt et al. (2001) suggested a VCP with an additional low-level elevation cut to improve detections of small, short-lived tornadoes such as those found with tropical storms. With VCP Delta, rapidly evolving events that exhibit signs of danger on radar displays can be monitored more frequently, possibly increasing warning lead times.

These new VCPs possess dense vertical sampling as a result of elevation angles specified to maintain constant height uncertainty (Brown et al. 2000). Recent field test results affirmed that VCP Gamma is a good first choice to supplement current WSR-88D scanning strategies. The remainder of this paper will mainly focus on VCP Gamma.

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3. VCP GAMMA

VCP Gamma will provide forecasters with faster volumes and denser vertical sampling at low levels while imposing minimal adverse impact on the WSR-88D user community. VCP Gamma, shown in Fig. 1, provides 14 unique elevation angles from 0.5° through 19.5° in 4.1 minutes. VCP Gamma would be best used during severe thunderstorms. Forecasters can sample deep convection at a faster rotation rate than VCP 11. VCP Gamma offers better estimates of rainfall and snowfall since the series of elevation angles are closer to the earth's surface than elevation angles of current VCPs and discrete samples are more frequent.

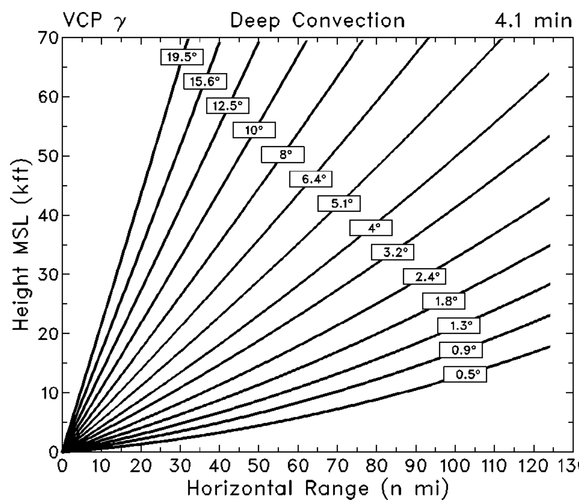

Figure 1 - VCP Gamma provides 14 unique elevation angles in 4.1 minutes.

4. DENSE VERTICAL SAMPLING

Denser vertical sampling will cause more storm cells to be identified while providing greater temporal continuity of cells from volume to volume. This enhancement was observed time after time during a new VCP field test (discussed later in this paper). Continuity of cells over time made trend products more useful. Denser vertical sampling at low elevations will also increase the spatial coverage and detection capabilities of radars impacted by terrain blockage, particularly in the western third of the United States (Maddox et al. 2002). Denser vertical sampling at lower elevations will supply kinematic algorithms with more vertically stacked data points within

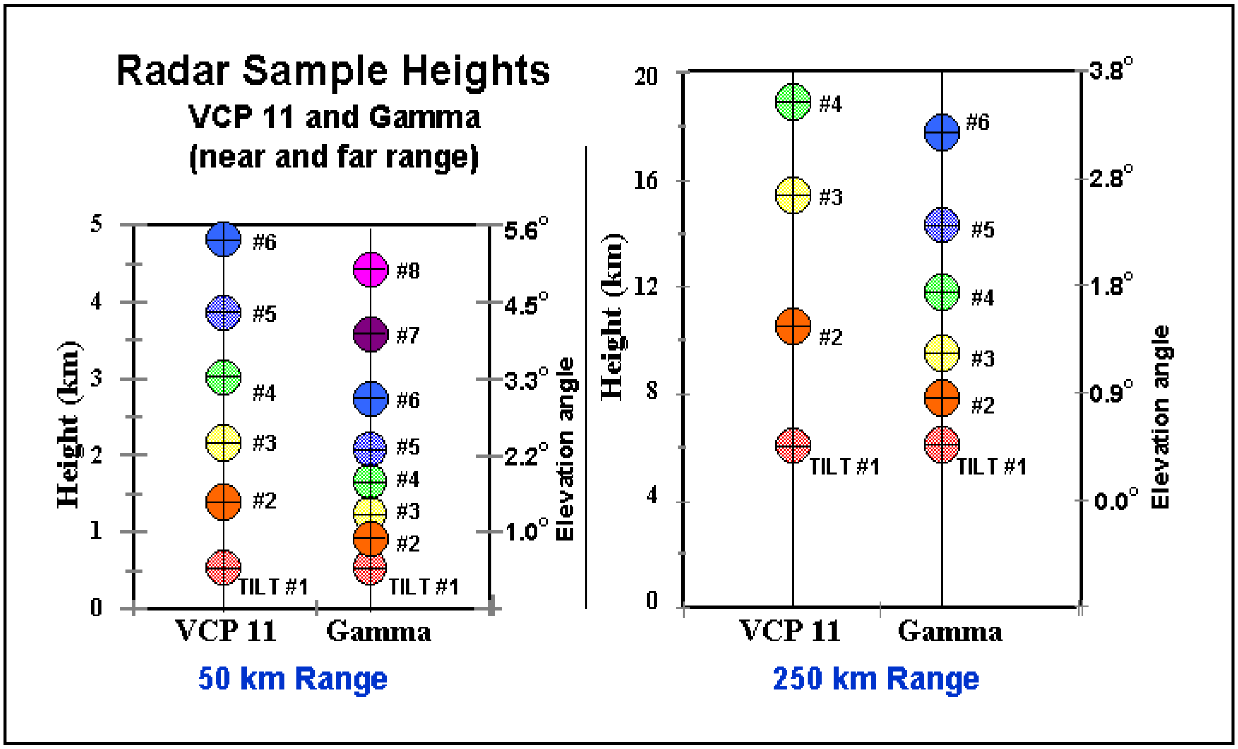

Figure 2 - Comparisons of the vertical resolution beam center between VCP 11 and VCP Gamma at ranges of 50 and 250 kilometers. VCP Gamma collects denser data at low-levels as compared to VCP 11.

a unit of space. Target features, as recognized by some of the meteorological algorithms, will be more likely detected if the vertical gaps between data points are reduced, as depicted in Fig. 2. At a range of 250 km from the radar there are six vertically stacked data points below 20 km (65,000 feet) from new VCPs. VCP 11 has only four data points at the same vertical extent and range.

5. RECENT FINDINGS

Over 8900 volumes of Level II data from new VCPs were collected from April through June, 2002, as part of a field test. The WSR-88D at Keesler AFB, Biloxi, MS (KBIX), was configured with software that allowed test observers to use six experimental VCPs and the four current VCPs (11, 21, 31, and 32) in real-time meteorological situations. Based upon the characteristics of new VCPs used for specific meteorological situations (Steadham et al. 2002), instructions for selecting new VCPs were provided to field test observers located at the control center in Norman, OK. Forecasters from surrounding NWS offices, Jackson, MS (KJAN), Mobile, AL (KMOB), and Slidell, LA (KLIX), operated their respective WSR-88Ds with current VCPs in a normal mode. Level II data from the four radars were collected for post-test analysis. Storms equidistant from KBIX and one or more of surrounding WSR-88Ds will be analyzed to compare algorithm outputs.

During the field test, observers frequently found more storm cells identified after switching from VCP 11 or 21 to any of the new precipitation mode VCPs. The lifetime of storm cells was observed to be longer with new VCPs. That is, once a storm was labeled by the system, observers noted the storm would maintain its identity more consistently than one identified with current VCPs. As a result, cell trend products had long durations of trended values. More past positions of storm tracks were available with new VCPs making storm motion more reliable.

While replaying data from fast VCPs it was noted that the morphology of storms in a time lapse mode exhibited greater detail than from current VCPs. Of the problems encountered, we found after switching to a fast VCP that the Routine Products Set (RPS) list would need to be manually trimmed of product requests since narrowband loadshedding would begin on the 14.4K bps line.

Bandwidth measurements of compressed Level II data were taken during the test for each experimental VCP to quantify communication line rate sufficiency. NSSL scientists have made preliminary comparisons of algorithm outputs by replaying archived current and new VCP radar data from the field test.

A preliminary study of a few individual storms shows longer lead times for detecting maximum reflectivity and mesocyclone strength. VCP comparisons will include cell and mesocyclone tracking variation. Vertically Integrated Liquid (VIL) simulations were performed for new and current VCPs with several storm profiles (Wood et al. 2002). Actual cell-based VIL comparisons will be used to verify the theoretical results.

6. IMPACTS TO WSR-88D OPERATIONS

Operational forecasters and radar researchers have envisioned and suggested improvements in the way the WSR-88D scans the atmosphere. Tradeoffs in data quality and/or total volume coverage become a design issue. New VCPs were designed to optimize known tradeoffs while satisfying operational needs.

With new VCPs, Doppler radars will become capable of faster volumes and increased lower-altitude sampling, thus increasing target resolution. Increased temporal and spatial resolutions will facilitate better warnings and forecasts. Forecasters will see improved hydrological radar estimates (Seo et al. 2000), more refined storm structures, and, potentially, more consistent algorithm performances. Products will exhibit less artificial variation in radar derived quantities due to beam geometry. For example, elevation angles for new VCPs were chosen to make target height uncertainty constant with range (Brown et al. 2000), a particularly effective sampling strategy for viewing mid- and far-range storms.

New VCPs will affect other parts of the system and some parts must be changed. The Precipitation Processing Subsystem (PPS) algorithm was hard coded to process nothing more rapid than 5 minute volumes. An improved precipitation algorithm will accompany deployment of the first new VCP to compensate. More computer processing will be required since there will be more storm cells identified at greater range. Processing more storms is not a constraint to the system since the recent deployment of the ORPG. The field test bandwidth measurements indicated that current communication lines were sufficient for VCP Gamma. From an administrative perspective, baseline software, testing, and configuration management will be more complex due to more varieties of Level II data.

New VCPs were designed for specific meteorological applications. Judicious use of a particular VCP at a particular time will minimize the increased wear and tear on the radar caused by faster antenna rotation. Forecasters will need to consider several factors when they select from a larger number of VCPs.

7. SUMMARY

New VCPs, when compared to current VCPs, will provide greater temporal and vertical resolution, particularly at low altitudes. Increased resolution in time and space should result in improved algorithm performance capabilities leading to improved warnings and forecasts. Faster VCPs will provide forecasters a greater opportunity to see first signs of potentially severe weather from quickly evolving phenomena. More accurate radar-based precipitation estimates are anticipated. Radar data processing systems will need to be ready for WSR-88D data changes resulting from new VCPs. New scanning strategies promise to become effective operational tools for forecasters with the proper training and application. The proposed date for new VCP fielding is Fall 2003.

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