P1.23   NEXRAD TO SHAPEFILE CONVERSION AND GIS BEAM PROPAGATION
ANALYSIS IN 3D

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1. INTRODUCTION

The NWS Office of Science and Technology/ Systems Engineering Center has adapted the NEX2SHP.exe NEXRAD to Shapefile conversion utility (Shipley, 2000) to support NWS NEXRAD siting analyses using ArcView version 3.2 GIS with the Spatial Analyst and 3D Analyst extensions. The resulting ArcView GIS project and Avenue scripts compute and visualize beam propagation and occultation over terrain databases, and support the correlation of NEXRAD coverage with geographic Census datasets. This paper outlines the procedures that enable such analyses on a desktop computer. A brief history of the NEX2SHP.exe utility and plans for future development are also presented. The NEX2SHP.exe public domain utility is currently used to convert NEXRAD Level 3 Product #19 reflectivity into Shapefiles (TM ESRI) for use with desktop GIS and ArcIMS applications.

2. NEX2SHP.EXE

The NEX2SHP utility is a freeware executable for Windows developed to directly convert the NEXRAD Level 3 Product #19 (n19, radar reflectivity) to Shapefiles. The n19 files are extremely efficient in packing the reflectivity information, which consist of approximately 360 each radials with reflectivity information provided at 1 km resolution along each radial out to a range of 230 km. The ESRI Shapefile, on the other hand, is extremely inefficient in packing the reflectivity information. Each Shapefile is actually defined by three files with the same filename, but with extensions *.dbf (the relational part), *.shp (the spatial part), and *.shx (an index which ties each relational record to a geographic shape). A typical shapefile PPI depiction is shown in Fig. 1 for Tropical Cyclone Georges using Mobile, AL NEXRAD on September 27, 1998, at 2053Z. The packed n19 file is 28 kbyte, whereas the resulting point Shapefile for the same information is a total of 2.8 Mbyte (a factor of 100 expansion). Therefore, it is recommended that the NEXRAD information be stored and distributed in its packed form, then unpacked when needed.

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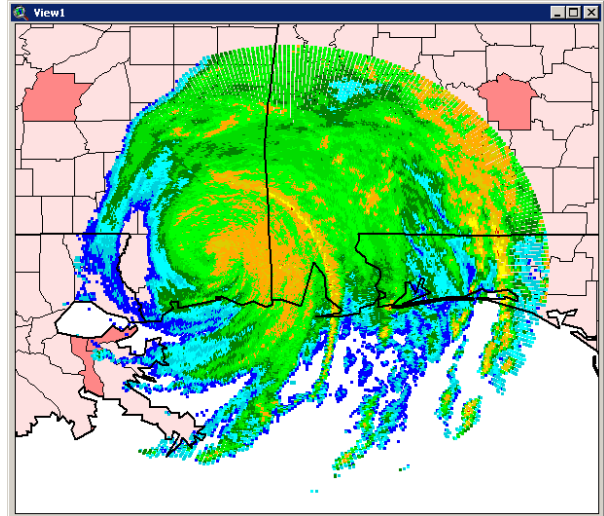
Figure 1 – Tropical Cyclone Georges radar reflectivity at 0.5 degree beam elevation for Mobile, AL on September 27, 1998, at 2053Z, visualized as a point Shapefile with ArcView GIS version 3.2.

Fig. 1 reflectivity is visualized as points at the centroids of each 1 km range by 1 degree azimuthal cell. Each point includes the reflectivity of the cell with values from 1 to 15 (zeros are deleted to conserve space), plus an estimate for the beam height MSL using the standard NWS height-range calibration (Saffle, 2002). Capability is also provided in NEX2SHP to produce polygons with the same centroids, but care is taken to ensure that adjacent polygons share the same vertices. A polygon Shapefile for radar cells as trapezoids is approximately five times larger than the corresponding point Shapefile.

3. RADAR BEAM PROPAGATION

The NEX2SHP utility was adapted to analyze the propagation path and resulting coverage for existing and planned radars. Radars to be supported include NEXRAD and the FAA TDWR. Step by step procedures are provided to allow a single user to analyze radar coverage using a desktop GIS, resulting in presentation quality graphics in 2- and 3- dimensions, as follows:

1) Startup ArcView GIS,
2) Establish the map databases and radar position/characteristics,
3) Create the theoretical radar coverage,

4) Merge the radar and terrain databases to calculate beam height above terrain, assuming no obstructions,

5) Calculate beam obstruction (accumulation in percent) along each radial,

6) Extract range ring depicting theoretical performance limit, and

7) Convert products (from 2-6 above) to 3-D.

A result of these procedures is given in Fig. 2, showing two overlapping radars over the Pacific Coast of Washington State and Oregon. The ArcView 3D extension supports pan and zoom, plus drag and drop capability to tour and "fly through" the 3D Scene. Users have the ability to identify terrain and/or towers that may obstruct future radar installations, and the GIS allows the insertion of higher resolution surface information in such areas of interest.

3.1 *Required Components*

Workstation with ArcView GIS (version 3.2 or later)
- Spatial Analyst Extension for ArcView
- 3D Analyst Extension for ArcView
NEX2SHP.exe VB application
Terrain and obstruction databases
- Digital Elevation Model (DEM), 1 km or better
- FAA Obstructions to Flight database
- Other map databases as desired (optional)

Radar configuration
- Latitude [decimal degrees]
- Longitude [decimal degrees]
- Radar elevation [MSL]
- Beam elevation angle [decimal degrees]
ArcView Project with Avenue scripts:
- WxAgrid.ave   extracts terrain height from grid to radar shapefile
- WxAPower.ave   calculates beam power reduction along radials
- WxASelec.ave   selects performance limit point in each radial
- WxAPt2Py.ave   converts performance limit selection to a "range ring"
- WxAPy2Pl.ave   converts range ring polygon to polyline shapefile

4. References and Acknowledgments

Saffle, R.E. (2002) Standard NEXRAD conversion for height vs. range by elevation angle, personal communication.

Shipley (2000) http://geog.gmu.edu/projects/wxproject/, freeware courtesy of George Mason University.
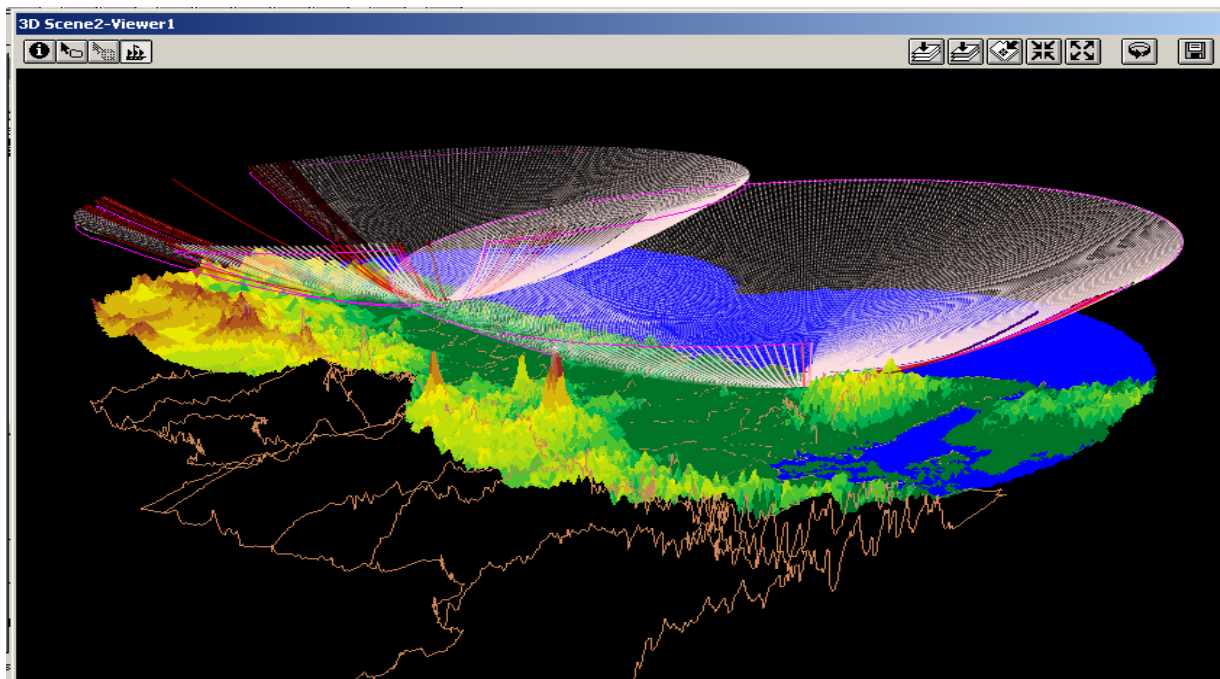
Figure 2 – Theoretical beam coverage patterns for NEXRAD radars located in Washington State and Oregon. Beam blockage is depicted for terrain obstacles, where beam height is located within one beam width of surface elevation. Graduated color (red) is used to show percentage beam blockage for cases of grazing incidence.