WxAzygy® Tools

by WxAnalyst

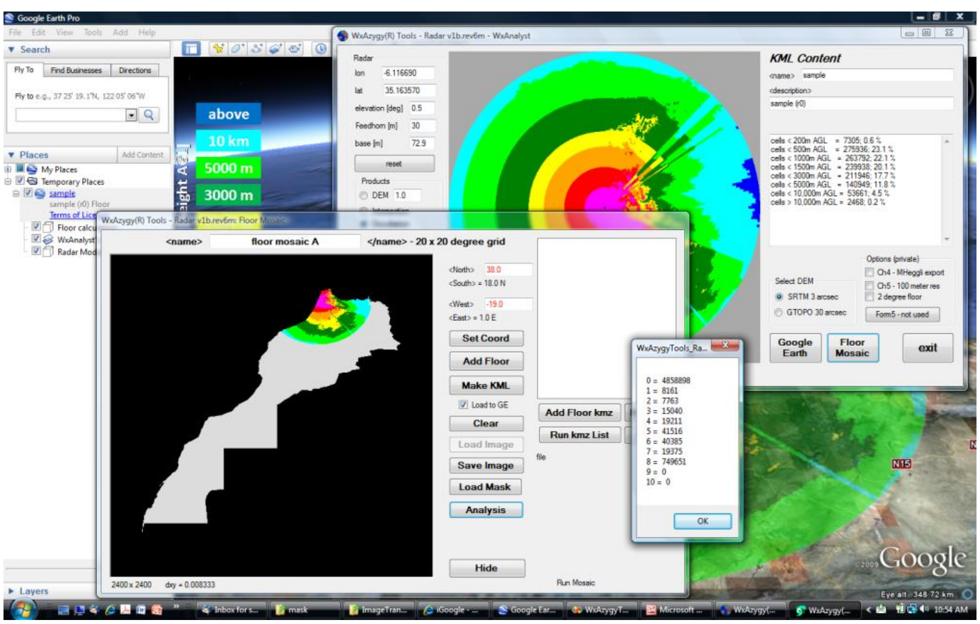
http://wxanalyst.com

- Radar Beam Occultation
- Self-contained global DEM
- Portable – works without internet

The WxAzygy® Tools portable capability using external USB hard drive (new in 2011).

WxAzygy® Tools

WxAnalyst has been working on a commercial capability to calculate weather radar occultation patterns (Shipley et al., 2009) within a Virtual Globe environment such as Google Earth. The interactive nature of Google Earth is used to identify locations for radar equipment, place that equipment at a user defined location and then immediately acquire a depiction of occultation by terrain. WxAnalyst has used this capability internationally with Innovative Hydrology to design a weather radar networks, and with Baron Weather Services to define the optimal weather radar placement. A sample screen shot of these tools for a radar siting activity in Morocco in shown below. The achievements in this area have resulted in a set of utilities dubbed the WxAzygy® Tools. Customer needs for portable capability and operations without internet have resulted in a transportable version of WxAzygy® Tools, which is deployed on an external USB drive. A version of the WxAzygy® Tools for NASA World Wind is in development.



Occultation calculation for weather radar siting in Morocco. WxAzygy® Tools is a WxAnalyst commercial product.

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How to Use and Interpret COLLADA™ Radar Products
WxAnalyst White Paper

This paper describes a set of 3-Dimensional (3D) products for visualization and analysis of radar propagation and spatial coverage using Virtual Globes such as Google™ Earth. The 3D structures are created by the WxAzygy® Tools, a capability developed by WxAnalyst, which takes advantage of the Khronos Group's COLLADA™ Open Standard to achieve high visual quality and spatial accuracy. COLLADA™ (Arnaud & Barnes, 2006) brings the speed associated with game software and commercial animation to this geospatial application.

Radar beams operating in the S-, C- and X-Bands (nominally wavelengths 3 to 10 cm, or frequencies 10 to 3 GigaHertz) are impacted by atmospheric refraction, scattering and absorption. They are also blocked by obstacles which may intersect the radar beam such as the surface terrain, vegetation, and manmade objects such as towers and buildings. The WxAzygy® Tools for Radar currently use a standard atmosphere to model beam propagation through the atmosphere, and follow the methods outlined in Shipley et al. (2006).

Occultation

A concept for radar beam propagation through the standard atmosphere is shown in Figure 1. The lowest elevation radar beam is shown in color and oriented with its CENTROID at one half degree (0.5^o) above the local horizon. The vertical beam spread is set to one degree (full width). Beam energy is not necessarily spread uniformly over the vertical beam, and is typically stronger near the beam CENTROID in most radar systems. Therefore, for engineering purposes we estimate beam blocking or OCCULTATION by finding the geometric fraction of the vertical beam that is intercepted by opaque objects. Radar engineers can use the geometric fraction with detailed knowledge of the radar beam pattern to calculate the actual fraction of beam power that is lost to occultation.

A color key for the occultation product is provided in Figure 2. A sample occultation pattern for the NOAA National Weather Service (NWS) NEXRAD KATX located in Seattle, WA is shown in Figure 3. Color is used to visually indicate degree of blocking. Blues and greens indicate that less than 50% of the beam is blocked by terrain. The NWS uses 50% occultation to indicate that a radar is receiving acceptable signal levels. Yellows and reds indicate that more than half of the radar beam is blocked, and the color grey is used for total occultation (100%).

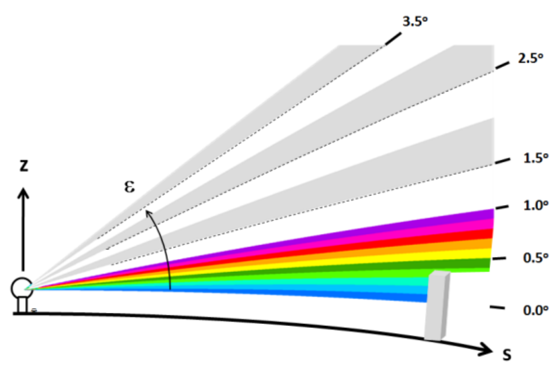


Figure 1 – Concept for radar beam propagation and occultation. The 0.5^o elevation beam is shown in color, spread over a one degree vertical beam width. The color codes in Figure 2 indicate what geometric fraction of the beam is intercepted by objects. Also shown in this figure are higher beam elevations at 1.5, 2.5 and 3.5 degrees. A manmade object is shown blocking about 30% of the lowest beam.

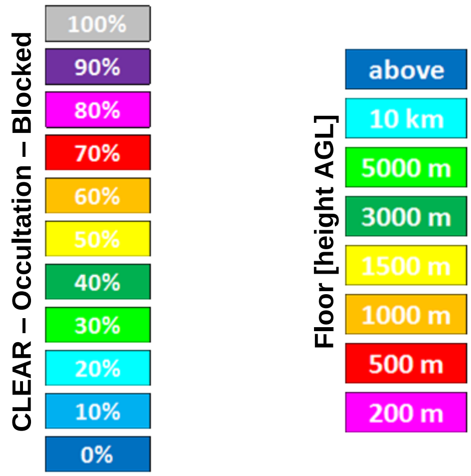


Figure 2 – Color keys for OCCULTATION and FLOOR. For occultation, the 50% blocked condition is located at the boundary of the dark green and yellow bands. Greens and blues indicate that the beam CENTROID has cleared known obstacles. Yellows and reds indicate that the beam CENTROID is intercepted by obstacles. The Floor value indicates that radar beam CENTROID is no higher that the indicated color. For example, a yellow Floor would indicate that beam centroids are in the range from 1000m to 1500m AGL (Above Ground Level).

Note that Google™ Earth terrain intersects the radar beam centroid surface in all the right places.

Beam Centroid Floor

An example of the radar Floor is shown in Figure 4, corresponding to the occultation pattern displayed in Figure 3. The beam centroid Floor provides the lowest beam elevation ngle that can sample the atmosphere over each location {latitude, longitude}, starting with a lower limit of one half degree at the radar, and increased continuously as needed for the beam centroid (half power point) to clear obstacles in the radar beam path. This product must be combined with occultation scans at several beam elevation angles to determine which elevation will provide useful signals at locations subject to occultation. The Floor provides a quantitative measure of the performance of any radar in detection of precipitation as a function of height above the ground. Particular Floor levels are set to mirror precip climatology, as shown in Table 1.

Table 1 – Height range associations with mid Latitude precipitation events in the United States.

Height range	Pressure	Precip Type
≤ 10 km	< 500 hPa	Deep convection
≤ 5000 m	> 500 hPa	Mid Troposphere, Ns
≤ 3000 m	> 700 hPa	Lower Troposphere
≤ 1500 m	> 850 hPa	Boundary Layer

A Floor color of magenta is a special case where the beam centroid is within 200m AGL of the surface. This color was selected to be highly visible, and indicates those regions or locations where wind power generators may intercept the beam and become sources of radio interference.

Using WxAzygy® Products in Google™ Earth

For best results in Google™ Earth, make sure that Terrain Exaggeration is set to ONE and Terrain Quality is High (Tools/Options/3D View). The views provided in Figures 3 – 7 can be achieved following Figure 8 and using the sample KMZ located at:

http://wxanalyst.com/radar/sample.kmz

➊ **Occultation** – Click radio button to show layer; double click layer zooms to View shown in Figure 3. Use Navigation Compass to do a quick tour of the horizon. Note that terrain intersects this layer at the first yellow boundary encountered with range from the radar, indicating intersection with the centroid.

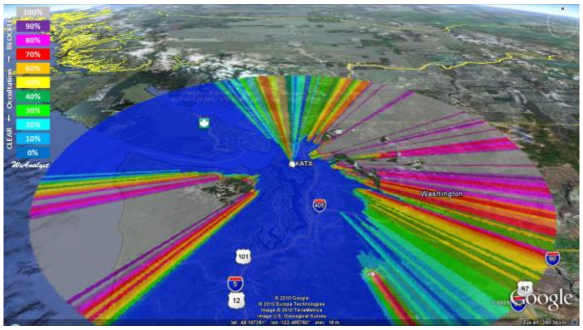
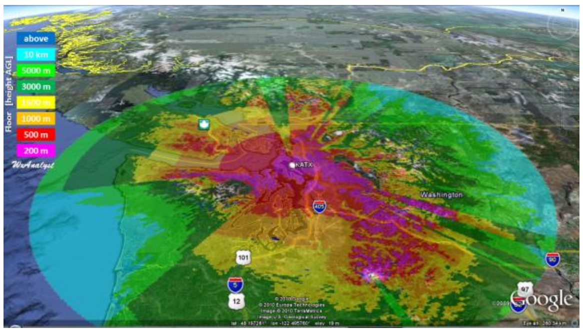


Figure 3 – Occultation pattern for NWS NEXRAD KATX, draped on the 0.5 degree CENTROID surface in 3D and displayed in Google™ Earth. Occultation patterns for the entire US NEXRAD system at http://wxanalyst.com.



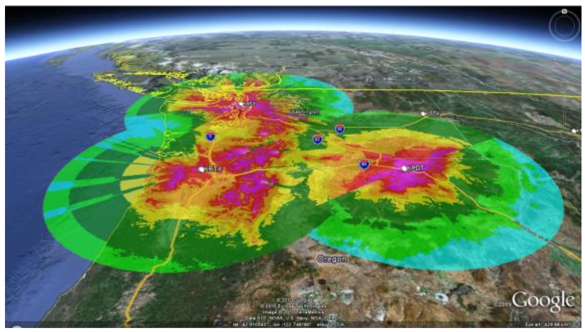
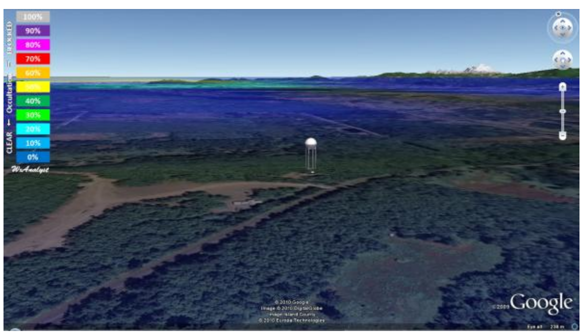


Figure 4 (left) – Radar beam Floor for NWS NEXRAD KATX. The Floor indicates the altitude of the radar beam centroid Above local Ground Level (AGL).

Figure 5 (right) – Mosaic of Floors for adjacent radars, indicating coverage for regions located within the radar network.



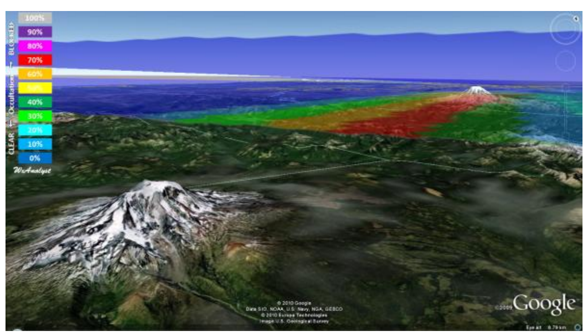


Figure 6 (left) – Scanning the horizon from the radar tower point of view.

Figure 7 (right) – Occultation Stack for the KATX NEXRAD at Seattle, WA, viewing intersection of the 0.5^o centroid surface with Mt Rainier (to the right). The $1.5\ ^o$ surface is shown clearing Mt Rainier (top).

❷ **0.5° Centroid Floor** – Click checkbox to show layer; double click layer zooms to View shown in Figure 4. This product is draped on the 0.5° centroid surface, so it has the same geometry as Figure 3. Note: Click checkbox by ***WxAnalyst's Floor Key*** to view the color key screen overlay.

❸ **Floor Mosaic** – Click checkbox to show the integrated Floor Mosaic as a ground overlay; double click layer zooms to View shown in Figure 5.

❹ **Virtual Reality** – Click checkbox to view a model of the radar; double click layer zooms to a View of the horizon similar to Figure 6. Use Navigation Compass to scan the horizon.

❺ **Occultation Stack** – Click radio button to show the stack. Click the next level of radio buttons to select each elevation one at a time. This folder structure provides a "one click" animation of the intersection of the centroid surfaces by elevation angle with terrain. Use Navigation controls to Pan, Zoom and Tilt your point of view (POV) to the perspective shown in Figure 7.

References

Shipley, S.T., A. Peterlin and S. Cantrell (2009) Radar visualization and occultation in 4-dimensions using Google Earth, 25th IIPS, AMS, Phoenix, AZ.
http://ams.confex.com/ams/89annual/techprogram/paper_150724.htm

Shipley, S.T., I. A. Graffman, R. E. Saffle, and J. Facundo (2006) GIS Tools for Radar Siting and Analysis, 22nd IIPS, AMS, Atlanta, GA.
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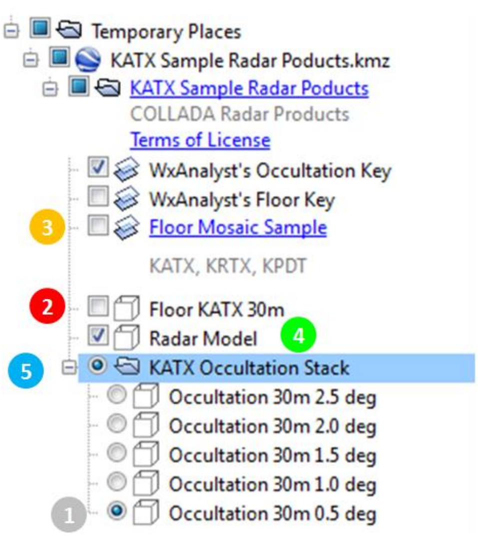

Figure 8 – Google™ Earth Sidebar content for the sample KMZ described in this paper. The sample KMZ is available online at: http://wxanalyst.com/radar/sample.kmz