Will This Rover Site Make The Path?

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Introduction:

Roving has been getting more and more popular in VHF contesting in recent years. Right after getting some equipment together, the very next question is "Where do I setup"? Now there are lots of strategies for choosing the general areas from which to operate to maximize one's score, but this paper will concentrate on the mechanics of picking the very best site in an area to make a specific path. I will admit right at the start, there is no new science in this paper. Rather, by combining one of a number of inexpensive mapping programs that have become available in recent years with an old troposcatter link calculation program, we can take a lot of the guessing out of selecting a rover site.

The process for calculating how loud the signals will be along a link between 2 stations was very well described by Bob Atkins -- KA1GT in his article in Communications Quarterly.[1] Although quite some time has passed since Bob's article was published, I have seen very little discussion in the amateur literature about path prediction. I guess we all like to JUST TRY IT and see if it works!…. Figuring it out first? Some will say that just takes all the fun out of it! Well, I'm sorry. I don't agree. I think we can save ourselves a lot of time and effort if we take a stab at doing some calculations first. At least, we can improve our chances by selecting the best site in that new grid, even if we don't want to believe the numbers. Further, even if we don't want to go through all that trouble with each site and each path, then at least going through the process a few times will acquaint us with what really matters in site selection.

The Basics:

The first step in predicting how loud signals will be along a path is recognizing what kind of propagation will dominate along that path. The most common modes along VHF, UHF and microwave paths are point-to-point line-of-sight propagation, knife-edge diffraction, and troposcatter propagation. Obviously anyone familiar with VHF and higher-frequency propagation knows there are LOTS of other modes, like meteor scatter, tropospheric ducting, aurora, moon-bounce etc., etc. The first 3 will be discussed in this paper because they are always present for reliable results. If conditions happen to be good during some contest, that's great, the signals will be louder than predicted and we can make the contacts that much more easily.

To determine the type of propagation likely between 2 points, we need to visualize the path between them. It is most helpful if we can draw a graph showing the height of the land along the path between the sites. This graph is known as the elevation profile of the path. For paths longer than a few miles, earth curvature must be taken into account. Figure 1 is an example of an elevation profile of the path between Mt. Greylock and Mt. Wachusett in Massachusetts. A straight line can be drawn from one site to the other so there must be a line of sight path between the two locations. For a path like this, the formulas for direct point to point propagation apply. The path loss is simply related to the square of the distance. This is true at VHF, UHF and the lower microwave frequencies. Losses due to water vapor and oxygen become important at frequencies above about 15 GHz and become a dominant issue in the 24 & 47 GHz ham bands.

Figure 2 shows the path between Mt. Greylock and Whiteface Mt. in the Adirondack Mountains. On this graph, no straight line can be drawn directly between the two locations. The most direct path between the two ends passes over a high point in the middle that can be seen from both ends. In this case, the propagation loss along the path is the sum of the free space path loss from each end to the midpoint plus the loss caused by the knife edge diffraction at the peak in the middle. This kind of path has a much more loss than a line of sight path, depending on just how sharp the angle is at the common point in the middle.

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[1] Bob Atkins - KA1GT, "Radio Propagation By Tropospheric Scattering", *Communications Quarterly*, Winter 1991, pages 119-127 [ARRL can provide reprint for $3.00 (members); call 860-594-0278]

FIGURE 1 – Line-of-Sight Path From Mt Greylock to Mt Wachusett, MA

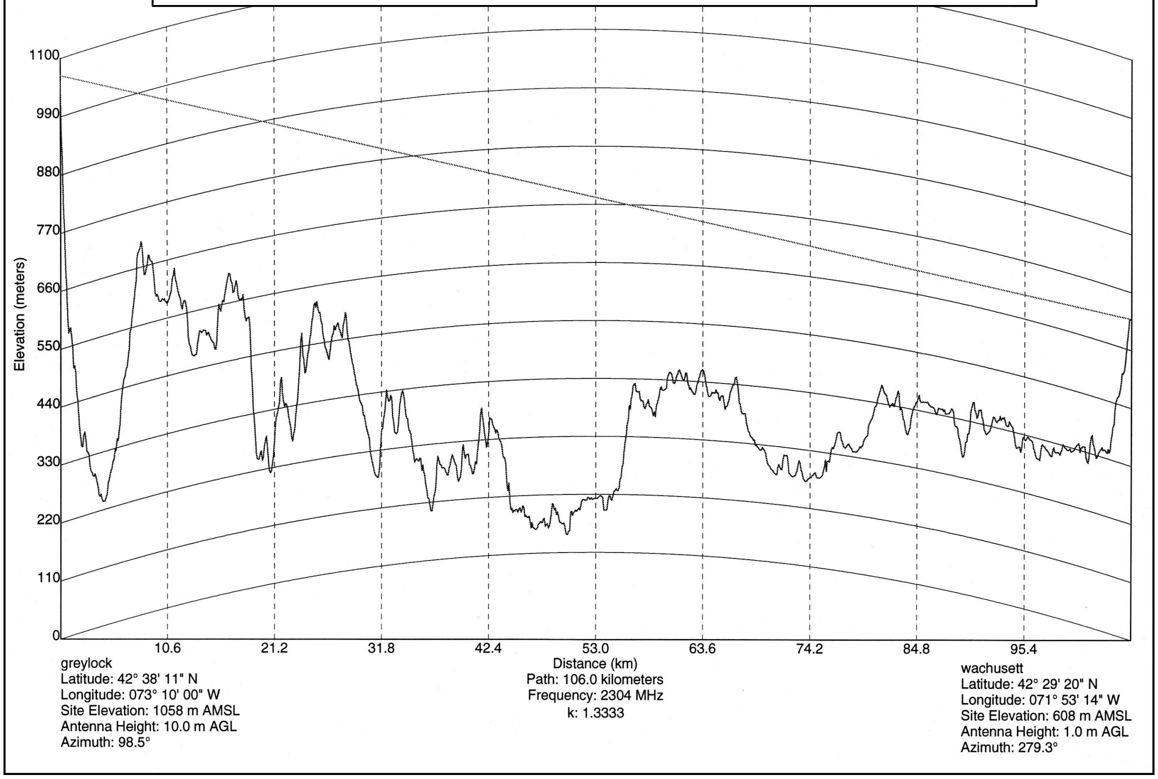
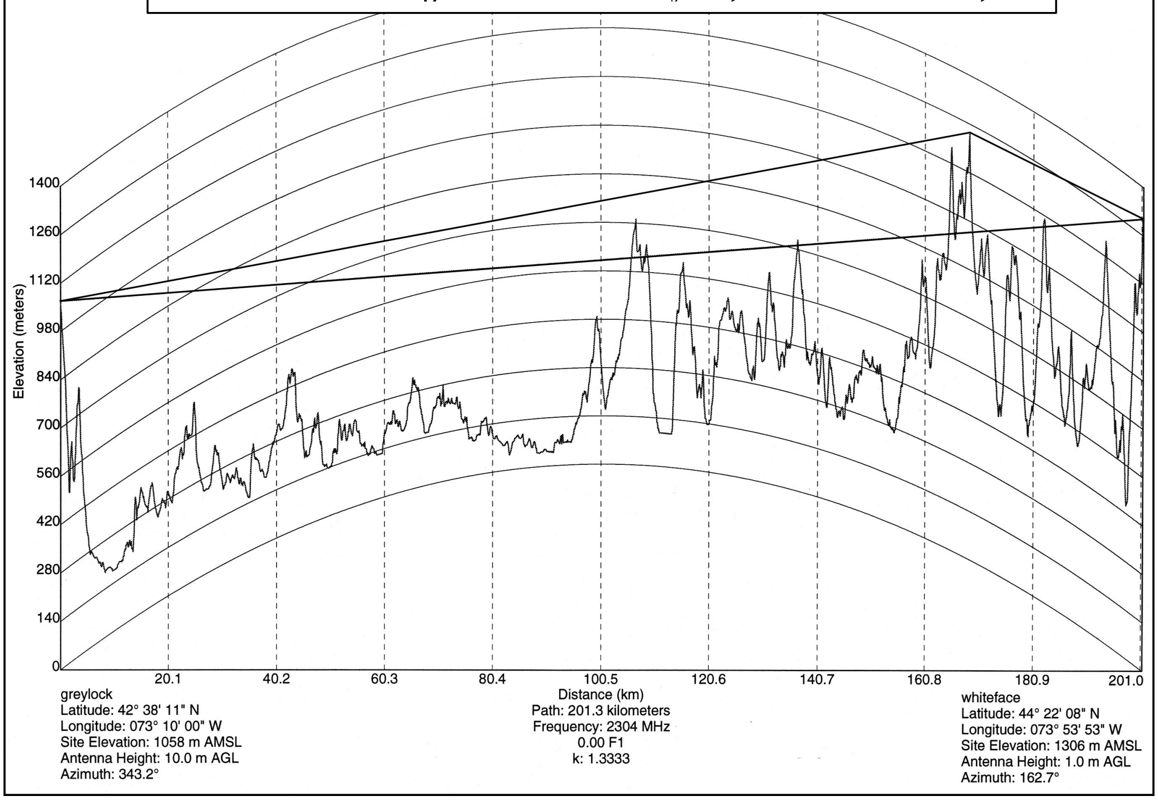


FIGURE 2 – Knife-Edge Path From Mt Greylock, MA to Whiteface Mt, NY



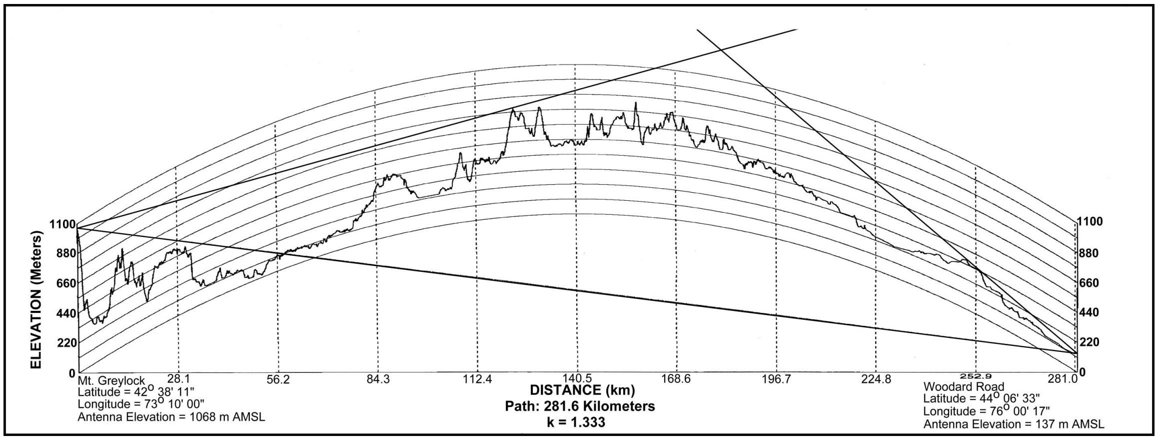


Figure 3 -- Troposcatter Path From Mt Greylock, MA to Woodard Rd, Near Watertown, NY

Finally, Figure 3 shows the path between Mt Greylock, MA and Woodard Rd near Watertown, NY. When this profile is drawn on graph paper showing earth curvature, there is no line of sight between the ends and the ends cannot even "see" a common point somewhere in the middle. Signals from each end of this path are blocked by different obstructions near each end of the path. A signal from one end just travels out into the lower atmosphere (or troposphere). Here the signal encounters variations in water vapor that cause a very small part of the signal to change direction toward the other end of the path. This process is called troposcatter. In fact, most ham QSOs on VHF and higher frequencies are made with this mode. It is rare that we have a true line of sight between stations except when we operate from high mountains. The good news is that troposcatter never goes away. It's always there. It's a mode we can count on. The bad news is that troposcatter paths have a lot of loss, but modern, well equipped ham stations can, and routinely do, communicate over long distances using troposcatter propagation.

Once the elevation profile between two locations is known, the dominant type of propagation can be determined. Then given the details of the profile, the loss along the path can be calculated. First, consider a simple path where there is a direct line-of-sight between the two ends. Figure 1 above shows a line of sight path from Mt Greylock to Mt Wachusett. For a LOS path we only need to know the distance and the frequency to calculate the path loss. The loss between the two end points is given by the formula:

$$L_{FS} = 92.45 + 20 \log f + 20 \log d$$

Where: L_{FS} is the free space path loss in dB
f is the frequency in Gigahertz
d is the distance in kilometers

For a path that is obstructed by one or more hills between the two endpoints, the calculations become much more difficult, and are best done by computer. KA1GT's article in Communications Quarterly covers troposcatter path loss calculations very thoroughly and is a "Must Read" for anyone interested in this topic. In his paper, KA1GT also includes a BASIC program for calculating path loss over an obstructed path.

If the antenna gain, the transmitter power and the receiver sensitivity is known for the equipment at each end of the path, then the signal to noise ratio can be calculated at each end. This way, we can know ahead of time if a particular path is a good bet or not. At the very least, we can compare several possible locations to see which one is best for a particular grid square.

How To Do It:

Simply put, to determine the path loss, first determine the elevation profile, and then calculate the path loss according to some model depending on the propagation expected. Simple isn't it! Well it is fairly simple if we have either line of sight propagation or troposcatter propagation. We even have a computer program that KA1GT wrote nearly a decade ago… so what's the big deal?

If anything, Bob, KA1GT was a little ahead of his time when he published his article on troposcatter path calculations. Certainly the BASIC programs that Bob wrote, ran easily on computers of the day. They took almost no time to run the program even then. The problem was (and is) getting the input data needed for the program can be a real PAIN. I can remember plotting a path with maps laid out all over a large conference room table, nearly going blind trying to read tiny contour lines on the large scale maps. If I had used more detailed maps, I would have needed more than a dozen so just plotting the path would have been a challenge, although reading the elevations would have been much easier. In a nutshell, the method worked, but it took <u>*forever*</u>! For over a decade now, a number of commercial programs have been able to create elevation profiles for doing radio coverage calculations, but these have generally been very expensive or proprietary to the companies where they were written.

Recently, things have begun to change. First, several years ago, the USGS made its entire 3-second Digital Elevation Model (DEM) database available for download on the World Wide Web. (Even it has some problems – more on that later.) Second, a number of consumer mapping programs are now available that can create elevation profiles. Even though the output from these programs is still not exactly what is needed for propagation analysis, it is fairly easy to convert the data into a usable form. Third, Matt Reilly, KB1VC has a Radio Line-of-Sight Plot Server which will create elevation profiles as an overnight service to Hams if you just send him the endpoints of the path. This approach is particularly valuable since he calculates the elevations along a true great circle path, something the average consumer mapping programs may not always do. The Web address of the Plot Server is http://www.tiac.net/users/reilly/los_form.html

The Elevation Profile:

There are basically 3 ways for a Ham to create an elevation profile between 2 sites.

1. **Plotting The Profile by Hand –** This is the hard way, but it is sensible for short paths or for paths where the critical obstructions are obvious. (You don't need to plot a lot of points!)
2. **Use A Consumer Mapping Program –** This method is available to anyone who invests a modest sum in a mapping program meant for consumer use. It is the method I use, so I will explain it in some detail.
3. **Use A Internet Plotting Request** – This is a service currently provided by Matt Reilly, KB1VC, but numerical values for elevation and distances are not provided except in graphical form. Matt calculates along true great circle paths so the results should be very accurate.

Terminology: It will be helpful to define some terms before we get into the details of creating an elevation profile. A typical troposcatter path profile is shown in Figure 4. In order to calculate the troposcatter loss along the path, we need to know the length of the path and the scattering angle. The scattering angle in turn is determined by the height and locations of the obstructions at each end of the path, and of course, by the heights of the two antennas and the overall length of the path. The problem boils down to determining 3 distances and 4 heights. As the figure shows, we need to determine the angle to the hill that gets in the way at each end. Sometimes it isn't as easy as it appears in the figure to determine which hill gets in the way, so accurately knowing distances and heights along the path is really necessary. The highest hill that gets in the way at each end is known as the *critical obstruction*. For each end of the path then, we need to know the elevation (plus the height of the antenna above ground) ($H_1$and H_2). We also need to know the distance to the critical obstruction at each end (D_1 and D_2) and the elevations of those critical obstructions (O_1 and O_2). Finally we need to know the overall length of the path L. The KA1GT troposcatter program takes these 7 numbers as input to describe the geometry of the path and then calculates the scattering angle and path loss. Other troposcatter programs will require the same input information in one form or another.

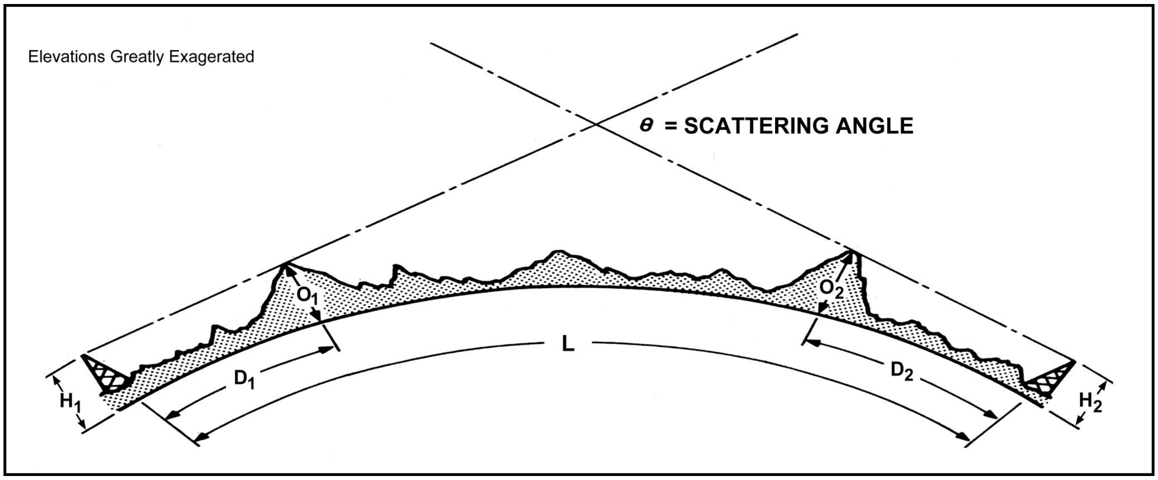


FIGURE 4 – Troposcatter Path Terminology

Plotting By Hand:

1. Get Topographic Maps That Cover the Length of the Path
2. Draw Line on the Map(s) That Represents The Path
3. Take Elevation and Distance Data From the Contours on the Map Along the Path
4. Plot Elevation and Distance On Curved Graph Paper to Determine Critical Obstructions

Plotting an elevation profile by hand makes sense for short paths especially if the entire path fits on a single topographic map. Paper topographic maps are commonly available from sporting goods stores for the areas they serve. Some of the better book stores also carry the USGS topographic maps. A paper map still has the very best detail and resolution of any map available. I strongly suggest any rover get paper topo maps of the sites they wish to use. Topo maps come in a variety of scales. The most common has a scale of 1:24,000 or 1:25,000. They show tremendous detail right down to individual buildings in rural areas. Another useful type of map is the 1:250,000 scale topographic map. Each of these maps represents a complete 2 x 1 degree grid square… one map per grid… very convenient! Some stores even have raised relief versions of these maps that are wonderful for finding high spots in a particular grid square. It can be quite difficult to read elevations from 1:250,000 scale maps, especially if there is little elevation change or if the elevations change very rapidly.

Once maps are on hand covering the entire length of the path, the maps can be taped together and a line drawn to represent the path. The path drawn will not be a great circle path, but it will be very, very close so the errors won't matter. Next the elevations long the path must be read from the map under the line that represents the path. Only the highest elevations need to be noted along with the distance from each end of the path. One of these elevations will be the critical elevation for each end of the path. These elevations should then be plotted, preferably on graph paper with a curved coordinate system to represent the curvature of the earth. An example of curved coordinate graph paper is included as a figure at the end of this paper. (KA1GT also included a BASIC program listing in his article that will plot curved coordinate paper on an HP pen plotter.) Finally the elevations and distances shown in Figure 4 should be determined by just looking at the graph and using a straight edge to determine the critical obstructions.

Topographic maps are also available in electronic form. The USGS sells CDROMs of most of the US. Many states have archive web sites where scans of all the topographic maps for the state are stored and available for free. These files are called Digital Raster Graphic (DRG) files and can be viewed with software that comes with most scanners. In the Northeast, Massachusetts, Connecticut, New York and

Pennsylvania have complete archives of all the Topo maps for their states available on line. A fairly complete list of internet sites that provide DRG files free for downloading can be found at the web site: http://www.mgef.org/wa2aau/index.htm If your state does not provide this service, contact your state representatives and ask them WHY NOT!! Another URL where many (but not all) DRGs can be found free for downloading is http://www.gisdatadepot.com/

4/3 Earth Radius ??? What ARE You Talking About?

The effective permittivity of the atmosphere varies with elevation. This means radio waves DO bend slightly toward earth as they travel along a path. To represent this fact, radio paths are generally plotted on graph paper where the earth radius is larger than it really is by a factor of 1.3333 (or 4/3 times the normal earth radius).

Using Consumer Mapping Programs to Generate Profiles:

1. Choose a Mapping Program That Can Generate Elevation Profiles
2. Select the End Points of the Path in the Mapping Program
3. Command the Program to Generate the Elevation Profile
4. Examine the Profile – DOUBLE CHECK The Elevations Against the Contours On the Path
5. Enter High Elevations Into Elevation Profile Worksheet to Determine Critical Obstructions

Several consumer mapping programs are now available that will generate an elevation profile of a path created on a map. This feature is intended to show hikers how much they are climbing or descending along a particular route. The profiles of hiking trips are typically short, perhaps a few 10s of miles at the very most. Even so, by using a few tricks, hams can use these programs to plot elevation profiles even hundreds of miles long, and it's certainly a lot easier than plotting the paths by hand with paper maps. In fact, without computer mapping to help with generating profiles, this whole process usually takes too long to be practical.

In this paper, I will specifically describe how I have used the Delorme Topo USA program to do troposcatter path prediction. Other consumer mapping programs can almost certainly be used in a similar fashion, but I have only tried Topo USA so I will concentrate on its features. Topo USA version 2.0 can be purchased from Delorme at: http://www.delorme.com/ for $50 for the Northeast regional edition or for $100 for the complete national edition. In my case, the regional edition works just fine since my site is located near the middle of the Northeast region. Topo USA runs pretty well directly off the CDROM, if you have a modern computer with a fast CDROM. I have found it works better for me if I copy the entire contents of the CD to a separate partition on my hard drive and install and run it from there. That means setting aside 600+ megs just for the mapping program, but that works for me, because I use it quite a lot and I want all the speed I can get panning across the map.

To create a profile, you must first find the endpoints and any intermediate points along the path. Use the "FIND" button near the bottom left of the screen. Pick a common geographic name near your endpoint. Names may be stored in unexpected ways. For example, Mt Greylock, MA is stored WITHOUT the period after Mt and if you type the period, the program will not find it! You can also find locations using their latitude and longitude. Once one endpoint is near the center of the screen, click the navigate button, select the "WAYPOINT" or "SHAPEPOINT" button and the click on the endpoint of the path on the map. Next move the cursor to the bottom of the screen and select "FIND" again. Find the second endpoint of the path as you found the first endpoint. Then select "NAVIGATE" again, and select the "WAYPOINT" or "SHAPEPOINT" tool again. When you drag the cursor onto the map on the screen, your path will appear attached to the cursor. Click on the second endpoint of the radio path. Now drag the cursor back down into the command area of the screen and select the "DONE" button. Wait a few seconds while the machine thinks about what you've done. Finally select the "PROFILE" button at the lower left of the screen in the Navigate mode. Typically in a minute or less a profile of the path will appear at the bottom of the screen. Now the fun begins! Figure 5 shows a typical screen display of a path profile.

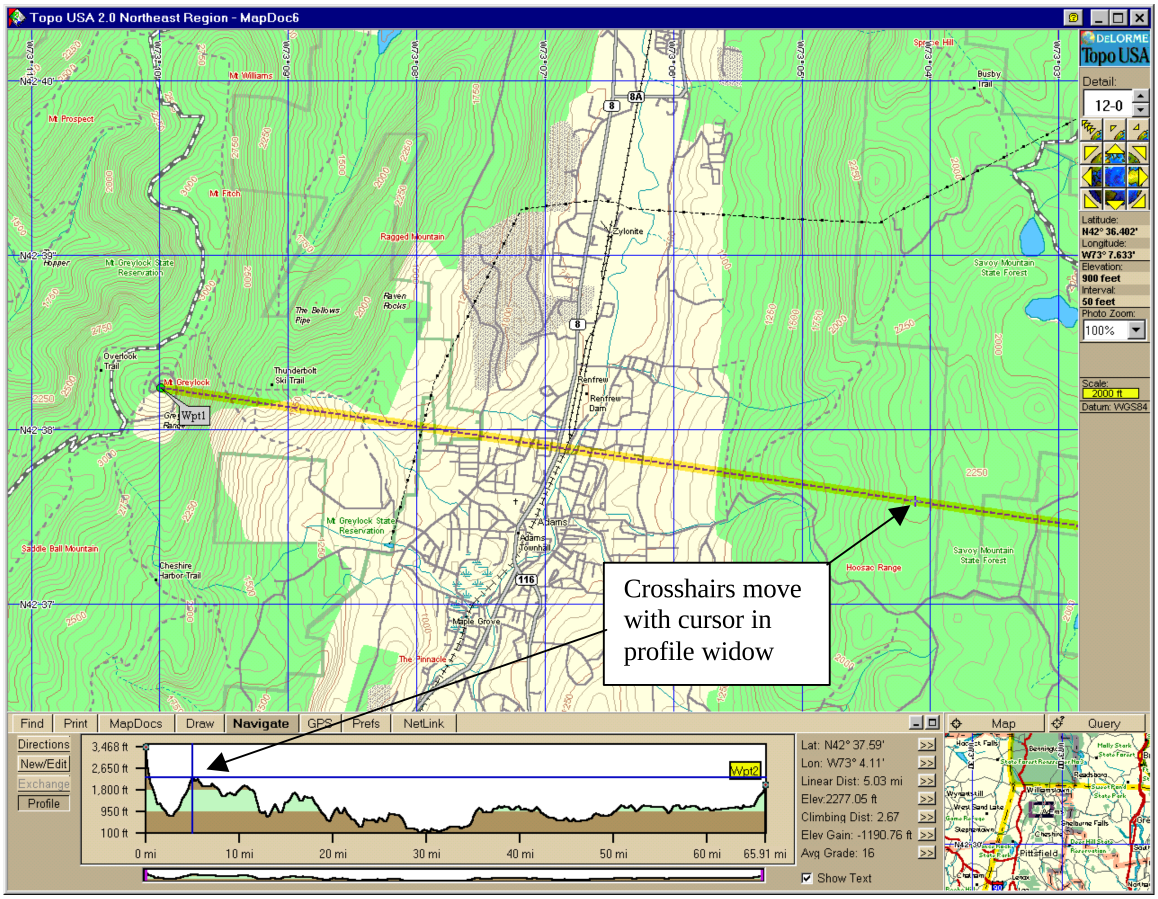


Figure 5 -- Topo USA Navigation Window

Unfortunately the profile generated by Topo USA can only be displayed and printed as a rectangular graph. This is OK for short paths, but not very useful on longer paths typical on troposcatter. Even more unfortunate, Topo USA does not provide a tabulated list of distances and elevations that could then be inserted into another program, so we need to intervene manually here. As the cursor is run along the length of the profile, the elevation and distance is shown to the right of the profile. Write down the local high points at various distances especially near each end of the path. The first few times, take lots of points until you get some experience. Now we discover the first serious shortcoming of using Topo USA. The elevations shown on the profile may not be quite right…. In fact, sometime they are quite far off! But there is a way around this too!

As best I can tell, the elevations can be wrong for at least 2 or 3 reasons. First, if we profile a very long path (hundreds of miles), the distance between data points along the profile is too large and we can easily miss a high point. Second, even on short paths, the elevation database used to generate profiles has errors *especially near the tops of mountains.* This is particularly aggravating to radio engineers, but this probably isn't Delorme's fault. I have downloaded and examined the 3-second elevation database directly from USGS and found serious elevation errors near the summit of Mt Greylock and the summit of Mt Kearsarge, as well as numerous other peaks around the Northeast. By serious, I mean errors of 30 feet or more compared to the elevations shown on the 1:24,000 USGS paper maps. If Delorme is using the 3-second USGS DEM database, then they will have a built-in error. Third, elevations can be wrong because I don't think Topo USA plots paths along a true great circle but even this can be overcome.

So what to do? By an unlikely stroke of luck, the first 2 problems described above can be overcome using another feature within Topo USA itself! When the cursor is drawn along the profile in the Navigate mode, the Topo USA program displays a small set of crosshairs at the corresponding point on the map display along the path. The elevation can be read directly off the contour lines on the map display. For whatever reason, the contour information is much more accurate than the elevation information in the profile window. So to get the best available elevation information, find the high spots from the profile, but then take the actual elevations directly from the map contour lines displayed on the screen. In my experience, the contour line elevation information is typically correct to within about 10 feet compared to the best paper maps from USGS. This process is a little tedious but not too bad, and still MUCH better than generating profiles with paper maps.

The great circle problem can be overcome by selecting some intermediate points along the path that are in fact on the great circle. A very long and detailed list of navigation formulas can be found at the following web page, including one for determining intermediate points along a great circle path. The web address is:
http://prestwick.simplenet.com/aviation/aviaform.htm#Int or http://www.best.com/~williams/avform.htm
I have found very little difference even on E-W paths 100s of miles long when I add intermediate points. Who knows, maybe TopoUSA does use great circle plotting – I just don't know.

ELEVATION PROFILE WORK SHEET

East Isle Causeway -- FN25

First End Mount Greylock, Adams, MA
Latitude = 42.6364 Longitude: 73.1667

Use Earth Radius of
5279 Miles or
8496 km

2nd End East Isle Causeway, Long Sault, ON, Canada
Latitude = Longitude: FN25

True R	4/3 R
3959	5279

Profile From First End

Distance (miles)	Distance (km)	Elevation (meters)	Elevation (feet)	Take Off Angle (deg)		Location
0	0	1072.9	3520			Mt. Greylock
64.2	103.3	396.2	1300	-0.724		Edge of Shingle Mt.
93.9	151.1	670.6	2200	-0.662	*	Rankin Pond Mt.
99.4	160.0	716.3	2350	-0.667		Vanderwhacker Mt.
105.1	169.1	640.1	2100	-0.717		Spruce Hill
109.0	175.4	731.5	2400	-0.703		No Name
111.2	179.0	800.1	2625	-0.691		W. of Little Santanoni Mt
116.4	187.3	960.1	3150	-0.666		SW Edge of Mt Emmons
	0.0	0.0				
	0.0	0.0				NOTE: Need to "Fill Down"
	0.0	0.0				Take Off Angle column if
	0.0	0.0				more entries are needed.

Profile From Second End

Distance (miles)	Distance (km)	Elevation (meters)	Elevation (feet)	Take Off Angle (degrees)		Location
0.0	0.0	76.2	250			East Isle Causeway
38.1	61.3	716.3	2350	0.391	*	Brushy Top Mountain
45.1	72.6	579.1	1900	0.152		No Name
49.7	80.0	670.6	2200	0.156		Long Pond Mt.
62.5	100.6	594.4	1950	-0.044		No Name
66.0	106.2	685.8	2250	-0.029		No Name
67.9	109.3	922.0	3025	0.075		W. of Seward Mt.
68.8	110.7	960.1	3150	0.084		SW Edge of Mt. Emmons
	0.0	0.0				

* = Critical Obstruction

Form Last Revised 11/3/98 - RLF

Figure 6 -- Elevation Profile Worksheet to Find Critical Obstructions

The Elevation Profile Worksheet:

Since Topo USA elevation profiles do not show earth curvature, we must determine which hills actually obstruct the path on each end before we can run the troposcatter program. One way would be to plot the elevation data on curved graph paper, but this takes a lot of time and it can be hard to read especially on long paths. If you've done this once or twice, you understand what's going on physically so now you can visualize the problem. At each end of the path we want to find the obstruction that appears to have the highest elevation angle looking down the path to the other end. We can create a simple worksheet using a spreadsheet program like Excel to find the critical obstruction. An Elevation Profile Worksheet using Excel is available at the web site: http://www.mgef.org/wa2aau/index.htm Figure 6 shows an example of the worksheet. To use the worksheet, simply enter the distances and elevations for the path being studied. The values calculated within the worksheet will automatically change as new values are entered. When all points have been entered, look for the largest number (or smallest negative number) in the "Take Off Angle" column. These are the "Critical Obstructions". The distances and elevations for the critical obstructions must be entered in the KA1GT troposcatter program. This worksheet can be used to confirm the takeoff angles to various points on a path no matter how the distances and elevations are determined.

Using The KB1VC Line-Of-Sight Plot Server:

Matt Reilly, KB1VC has just published a paper on using his Web-based Radio Line-of-Sight Path Plot server.[2] The graphs that this plot server returns can also be used to determine the critical obstructions along troposcatter path that can then be entered into the KA1GT Troposcatter Path Loss program. Figure 7 shows

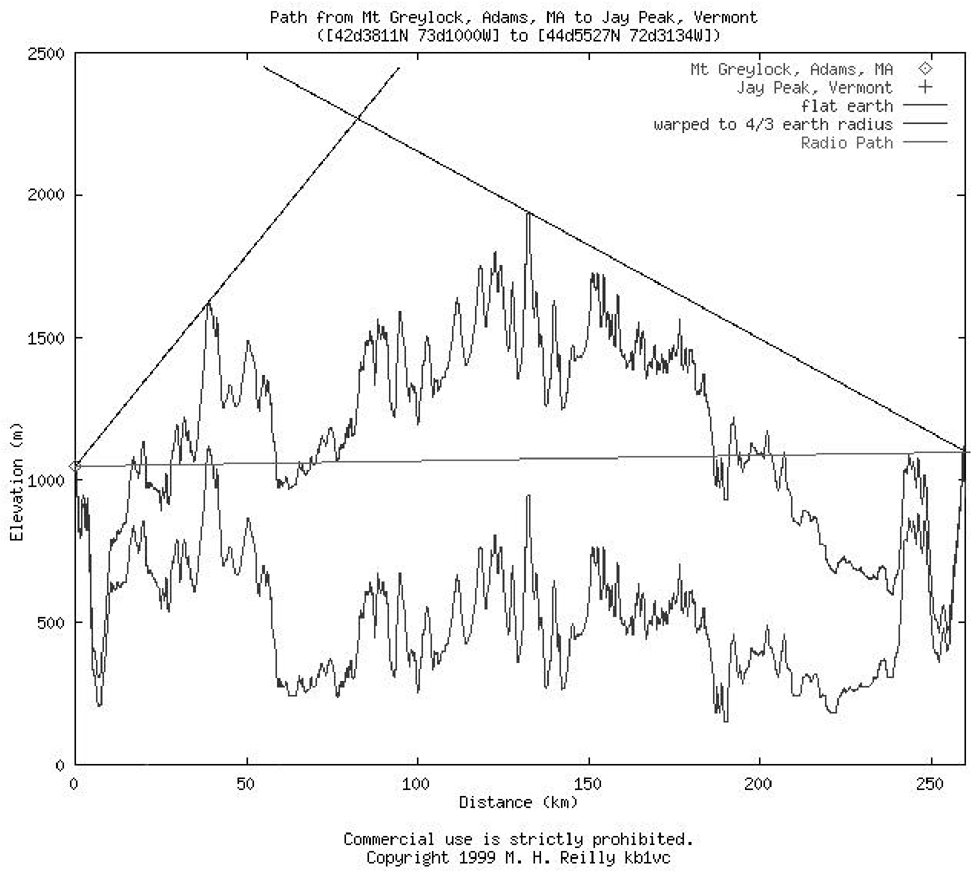


FIGURE 7 – Output From KB1VC Radio Line-of-Sight Path Plot Server

[2] Matt Reilly – KB1VC, "Radio Line-of-Sight Paths from the USGS Digital Elevation Database", *QEX* Sept/Oct 2000, pages 46-50.

a typical path from Mt Greylock, MA to Jay Peak in Northern Vermont. The lower trace in the figure is the elevation profile drawn with no earth curvature (flat earth), and the upper trace is warped to reflect a 4/3 earth radius. To determine the critical obstructions, draw lines as shown in the figure from each end of the path. Then read the true elevations of the critical obstructions from the LOWER trace and enter the elevations and distances into the troposcatter program.

Troposcatter Link Calculation:

Once the critical distances and elevations have been determined either from a graph plotted on 4/3 R curved graph paper or from the elevation profile worksheet, a link calculation can be made for the troposcatter path. In his 1991 paper, KA1GT included a QuickBASIC program that calculates troposcatter loss by Yeh's method. He also offers a more extensive program that calculates troposcatter loss by several different methods and also calculates received signal to noise ratios based on transmitter, receiver and antenna parameters. SCATTER.EXE, the executable version of this program, can be downloaded from: http://www.bobatkins.com/radio/scatter.html Thank you Bob! Although this program is now almost 10 years old, it is still the only one available that I know of. It can still be run under DOS or in a DOS window under Windows 95 or 98. I have used it extensively to evaluate various rover sites with good results. Figure 8 shows a sample screen of the program in operation. Parameters are changed simply by moving the cursor to the appropriate field and entering the desired value. Then the cursor is moved to the bottom of the screen and the RECALCULATE question is answered with a "Y".

Figure 8

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          TROPOSCATTER AND LOS LINK BUDGET CALCULATOR - KA1GT

STATION PARAMETERS              STATION #1  STATION #2   Scat Ang =  2.61
Antenna Height (m asl)               125       240
Obstruction height (m asl)           150       275      TOA #1   =  0.47
Distance to obstruction (km)           3       4.6     obstruction limited
Transmitter power (W)                100        50
Transmitter line loss (dB)           1.2       0.8      TOA #2   =  0.42
Receiver noise figure (dB)           1.65      2.15    obstruction limited
Receiver line loss (dB)              1.2       0.8
Antenna gain (dBi)                  23.4      20.7        atmospheric
Antenna noise temperature            300       300        attenuation
Receiver Bandwidth (Hz)             1000      1000          0.80 dB
Receive system sensitivity (dBW) -194.5      -191.7
Frequency (MHz)                     1296
Distance between stations (km)       256
Surface refractivity (sea level)     310

                                 YEH      ITT     CCIR  COLLINS
Path Loss =                    224.0    221.6    216.8    221.6
S/N ratio at station 1 =         7.3      9.7     14.5      9.7
S/N ratio at station 2 =         9.8     12.2     17.0     12.2
RECALCULATE ? (y/n) ?
```

Most entries in the troposcatter program are self-explanatory. Be careful to use meters for the heights and kilometers for distances. I find I often forget and use feet and miles. A nominal value to use for the refractive index is 310 for most typical situations. For really long haul CW microwave contacts, I specify 1000 Hz for a receiver bandwidth since most people can copy CW down to about 0 dB signal-to-noise ratio in a 1000 Hz bandwidth. This is true even if a SSB filter is used in the receiver since the ear can pick out the tone mixed in with the noise more easily in a wide filter as in a narrow filter. As the filter becomes narrower, the noise sounds more like a howl rather than a hiss and the CW tone is harder to distinguish than in a wide filter. It's nice to know the human has the ability to do BSP (Brain Signal Processing).

The output from the KA1GT troposcatter program can be printed directly by using the Print Screen key command under DOS or in the DOS mode in Windows 95. When running the program in a DOS Window under Windows 95 or 98, an electronic copy of the text on the screen can be saved by first right clicking on the upper border of the window then selecting the "Edit" button followed by the "Mark" button. Next, use the mouse to draw the cursor from the upper left corner to the lower right corner, "Marking" everything in the DOS window. Then select the "Copy" function in the toolbar at the top of the DOS window. This places the text that has been marked on the Windows clipboard. This text can then be pasted into any other Windows application such as a text processor. The formatted text from the troposcatter program is most easily viewed using a constant-width font such as Courier.

Choosing the Best Site:

To choose the best site in a particular grid square to work a particular path, first find a number of candidate locations on topographic maps. Some of the better sites may be obvious, but some may not be accessible, so be sure to choose enough possibilities. Especially look for locations where there is a sharp drop off in elevation, but with no vegetation shown on the map. (Unfortunately most vegetation information on USGS topo maps is woefully out of date, so you will have to make a trip to the location to really know if the site has a clear shot.) Next, create elevation profiles from each of the candidate locations and determine the path length and critical obstructions for each. Finally, run the troposcatter program for each site and see which one has the best signal to noise ratio. You may be surprised to learn a low but clear location will actually work better if it is closer to the edge of the grid than a high mountaintop located deep in the middle of the grid. This is because the path length strongly affects scatter angle and about a 46 mile increase in path length increases the scatter angle by 0.5 degree. To make up for this, the operating location would need to be on a mountain 1000' above the surrounding countryside out to about 50 miles. Such superior sites are quite rare at least in the Northeastern US.

Conclusion:

So now that we have picked the best spot in the grid, let's go out there and have some FUN. Remember these calculations are estimates ONLY and if conditions are above average, you can work MUCH FURTHER than these predictions say. But knowing about what one should expect at a particular location can be very helpful. Among other things, it should help us understand what equipment we should plan to bring when we try to work a certain path. Also remember, just because it looks good on a map doesn't mean much if you can't get there, or if the site is overgrown. In my experience, you just gotta go look at it to really know if the site will work… so we're really back to where we started… calculations can help, but WE'VE JUST GOT TO TRY IT. Happy Hunting!