A BEGINNERS GUIDE TO HFTA

HIGH FREQUENCY TERRAIN ASSESSMENT

How to Load and Use

HFTA
Version 1.04

and mapping utility

MicroDEM
Version 2013.3.6.1

by

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1. General Overview

This document will provide the beginner with detailed step x step instructions for the installation and use of HFTA and its essential companion, MicroDEM. Screen shots for the installation and operation of HFTA and MicroDEM are illustrated each step of the way.

1.1 What does HFTA do?

HFTA is a software tool that generates the vertical radiation pattern of horizontally polarized antennas taking in to account the profile of the surrounding terrain. The irregularity of local terrain has a profound effect on vertical radiation patterns. Note that HFTA does not compute radiation patterns for vertically polarized antenna radiation.

For those of us who live in hilly to mountainous terrain, we will experience signal enhancements with negative horizons, to weakened signal due to the shadows and blockages of hills and mountainous horizons. Question is, how is antenna performance affected by your terrain?

HFTA can tell you. It will characterize antenna performance at your QTH by generating terrain profiles every 5 degrees around the compass (0 to 355).

The HFTA audience is usually the DX / contesting crowd interested in enhancing antenna performance. To be more specific, HFTA is not about NVIS (high angle radiation) but low angle radiation at less than about 35 degrees using yagi antennas on towers.

HFTA can be used as a design tool to report on your specific terrain. One can run characterizations of installed antenna systems or facilitate the design of new installations and locations when choosing a site.

To do these calculations, HFTA has to have access to topographical maps complete with elevations. This is where a second software tool, MicroDEM, is needed to support HFTA.

1.2 What does MicroDEM do?

MicroDEM is the mapping tool that HFTA requires to generate terrain profiles. The land profile along any given bearing directly and significantly affects vertical radiation characteristics.

Fortunately, digitized topographical maps (Latitude, Longitude, and Elevation) for Canada and the US are available on-line and are free. These maps are referred to as Digital Elevation Models, or **DEM**s. Each DEM represents a mapped area bounded by a specific latitude and longitude.

One searches the on-line map databases to find the map or maps that provide coverage for the QTH of interest. This is easy to do.

MicroDEM is the tool that imports and manipulates the DEM or DEMs needed for the profile analysis. It will be set up to generate a terrain (land) profile every 5 degrees around the compass resulting in 71 individual profile files designated as a .PRO (profile) file.

HFTA will import the PRO files and will plot the terrain profile and the vertical radiation pattern for a selection of antennas ranging from a dipole to a 2 element yagi up to an 8 element yagi, from 2 to 300 MHz.

The MicroDEM mapping tool was created by Professor Peter Guth, PhD, MIT, Geology, of the US Naval Academy and it is an extraordinary piece of work. He continues to support this free software for our and others use. Terrain is of course critical to our propagation interests in many ways. MicroDEM offers features in addition to supporting HFTA, Appendix VII.

1.3 What Sort of Computer will be Required?

HFTA and MicroDEM have been installed on two machines. One runs on an older XP PC and the other runs on a modern Lap Top with Win 7. The older desktop PC is an Intel Pentium Dual 2200 with 2 GB RAM, running XP, Service Pack 3. The newer laptop runs Win 7 on an HP 2.4 GHz Pavilion g7 with 6 GB RAM. This is a 64 bit machine but it will run the 32 bit HFTA and MicroDEM under the Program Files (x86) folder.

There are slight operational & appearance differences between the O/S's, but both work well.

This document is written around the XP O/S and all the screen shots are XP. Win 7 windows have the same content but obviously employ the Win 7 presentation style.

Appendix 1 has notes regarding the Win 7 installation where it differs slightly from XP.

2   Process Overview

This section provides a high level overview of what will be done, and in what order to get HFTA and MicroDEM up and running.

2.1 HFTA Install and Tutorial (Section 3)

- Install HFTA from the CD that accompanies the ARRL Antenna Handbook.
- Download the HFTA manual from the ARRL website.
- Learn to use HFTA using demonstration files thereby developing basic proficiency to plot the terrain and antenna patterns.

2.2 MicroDEM Installation (Section 4)

- Installation of latest version of MicroDEM from an on-line source.

2.3 Downloading of Maps (Section 5)

- Search the Canadian and US Geo databases for the maps that contain your QTH.
- Save the maps as DEM's. CDN maps will be unzipped and saved in a DEMs folder. US maps likewise saved but do not need to be unzipped.

2.4 Opening and Merging Maps (Section 6)

- The saved maps will be opened in MicroDEM.
- Decide if one map is OK or adjacent maps need to be opened to provide QTH coverage
- Name and Save your QTH DEM maps.
- Reopen the DEM maps and merge them as needed.

2.5 Latitude, Longitude and Elevation (Section 7)

- Ascertain your location exactly by using Latitude, Longitude and Elevation

2.6 Generating PRO Files (Section 8)

- What is a FAN and how to set up the FAN process
- Generating the terrain profile (PRO) files
- Moving the PRO files from Fans to Terrain folders

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When all the above is completed HFTA will be ready to plot profiles and antenna patterns.
You might want to look at Appendix V to get an idea of the file structure for HFTA and MicroDEM.

Appendix VI is a condensed, short form procedure for those rather proficient in the installation and management of software.

The web page references contain hyperlinks. If this document does not have functional links, simply copy & paste the link in to the URL field of your web browser.

3   HFTA Install and Tutorial

3.1 Installing HFTA

HFTA is only available from the ARRL and is bundled with the ARRL Antenna Handbook on the "Complete CD for the ARRL Antenna Book". The CD for this tutorial was provided with the 21st edition of the ARRL Antenna Handbook although it has been available with the 20th edition published since 2003.

HFTA is currently version 1.04 and the documentation provided on the CD is dated 8 Jan 2007. This documentation is out-dated. The latest version is 22 February 2013, and is available to download from the ARRL website.
<div align="center">http://www.arrl.org/</div>

Search under HFTA and click on the **HFTA-ARRL** link to bring up the current pdf file. Save and Print for reference purposes.

To load HFTA, insert the CD and check the HFTA folder; the sub folders will appear and may all be checked by default. If not, manually check them ALL.
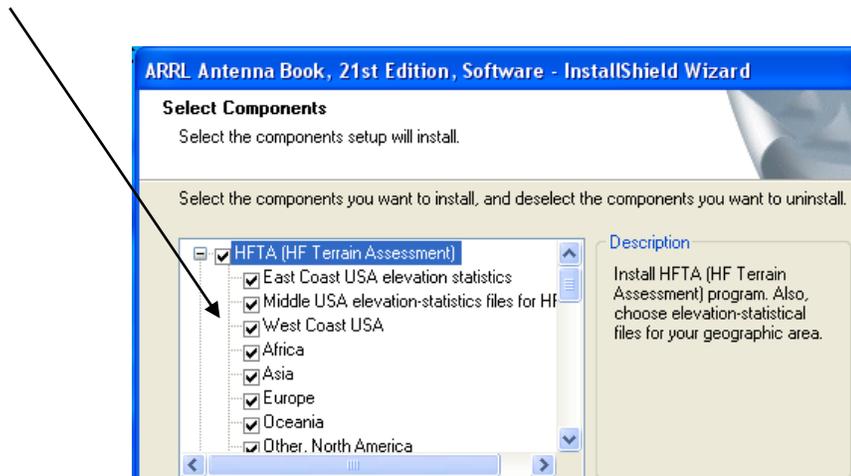

<div align="center">Figure 1</div>

DO NOT download MicroDEM from the ARRL CD. A newer version will be downloaded later.

HFTA s/w installs under C:\ Program Files > ARRL > AntBK21 (21st edition this case) > Book & Terrain as per Figure 2.

Figure 2

The HFTA icon should appear on Desktop. If it is not there, right click on the HFTA.exe icon in the Terrain folder to create a second shortcut and then drag it to the desktop.

- The Terrain folder contains the HFTA application, PRO and PRN files.
- **.PRO** (Profile) files loaded from the CD are sample terrain files. MicroDEM will later generate the PRO files specific to your QTH.
- **.PRN** files are the Elevation Angle Statistical data files that profile the lowest angles of arrival of DX signals from various parts of the world. This data can be overlaid on the radiation plot to see how the antenna will perform for low angle signal arrival from various parts of the world to your (general) QTH.

3.2 Opening HFTA

In this tutorial, "click" means a single left click of the mouse.

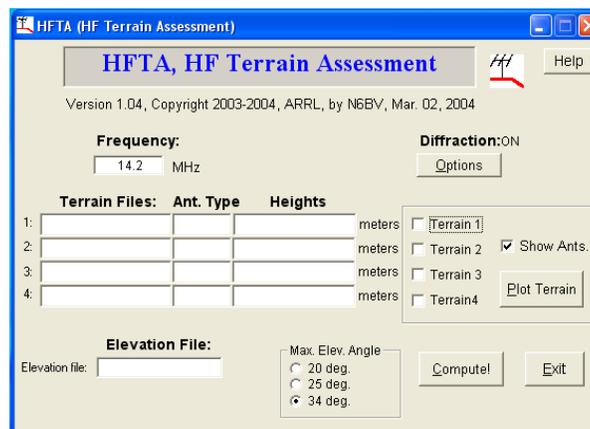Opening HFTA for the first time, the Main window, Figure 3, appears.

Figure 3

Hovering the mouse over the various fields, it will bring up a brief explanatory note.

Hover the mouse over **Terrain Files**: field, line 1 in Figure 4. An instruction set "Select Terrain. Click on Cancel for blank file selection" will appear. Click on this field line and the Terrain folder opens. Many PRO files appear.   Click on the N6BV-45.PRO file and it will then be entered on line #1. (Note that N6BV is Dean Straw, author of HFTA and these are his included demo files).

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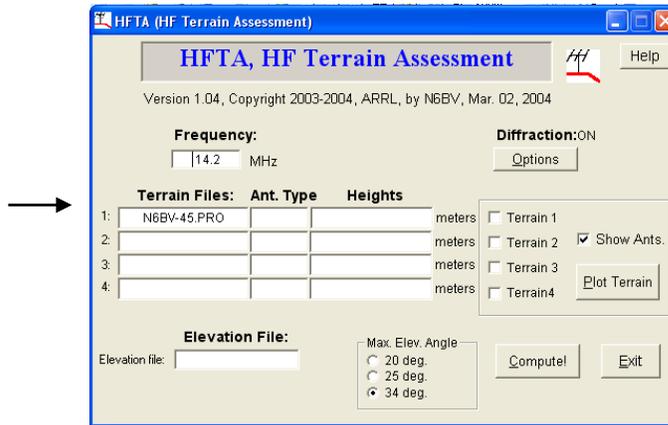# HIGH FREQUENCY TERRAIN ASSESSMENT

Figure 4

This is how all Terrain Files will be entered. The PRO file has the distance vs. elevation information that has been created in MicroDEM by N6BV for an azimuth of 45 degrees. This is just one of the many 5 degree PRO files that will be generated by MicroDEM for his QTH.

Select another terrain file. Hover over the line 4 field and click. The Terrain folder will open again. Click on the FLAT.PRO file and Open. This will populate field #4.

Two PRO files are now loaded, a terrain file for N6BV and a FLAT file as per Figure 5. The FLAT file provided by HFTA plots the land profile and antenna pattern over flat terrain for comparison purposes to your terrain.

Note that only PRO files are loaded in the **Terrain Files** field.
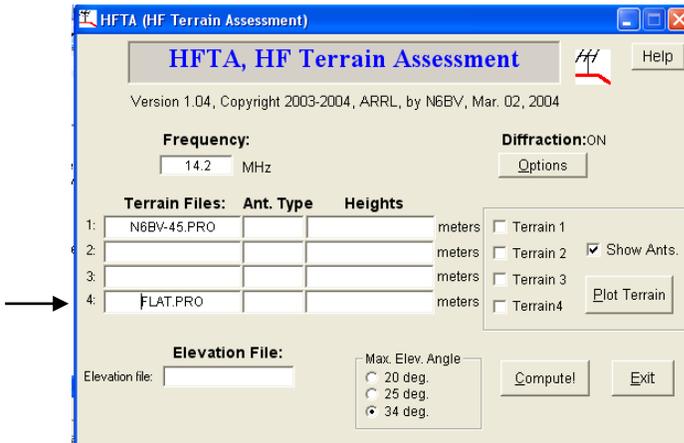
Figure 5

Hover over **Ant Type** field, Figure 6, and select a 3 element yagi for instance from a number of possibilities. Do the same for **Heights** and choose 60 feet (must be > 1 foot).

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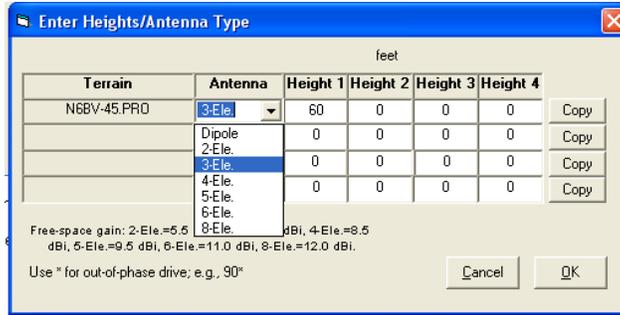# HIGH FREQUENCY TERRAIN ASSESSMENT

Figure 6

Other settings for the HFTA window as follows,

Elevation File: field is left blank for now.

Frequency field; enter a frequency of interest, i.e. 14.2 MHz (range 160 to 10 m)

Diffraction is normally ON

34 deg is normally checked. Recall that low angle radiation is primarily of interest as they are most important for DX. Angles higher than 34 angles are not plotted. (Lower angles selectable).

Show Ants Button. Click this Button to show the height of the antenna over ground in the profile plot.

Terrain 1, 2, 3, 4 boxes: In order to plot terrain, the box beside the PRO file must be checked**.** Note that HFTA can display up to 4 at-a-time plots of terrain for comparison purposes.

To CLEAR any of the main window fields, click the field, and when the file folder window listing appears, click **CANCEL.** To clear the field, click YES; to keep the data**,** click NO**.**

The HFTA control panel should now look per Figure 7.

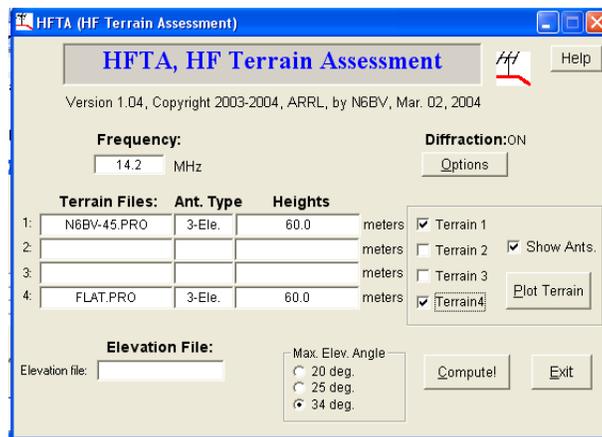

Figure 7

3.3 Plot Terrain

Click the **Plot Terrain** button and make sure the Terrain box is checked. Figure 8 reveals the terrain profile.
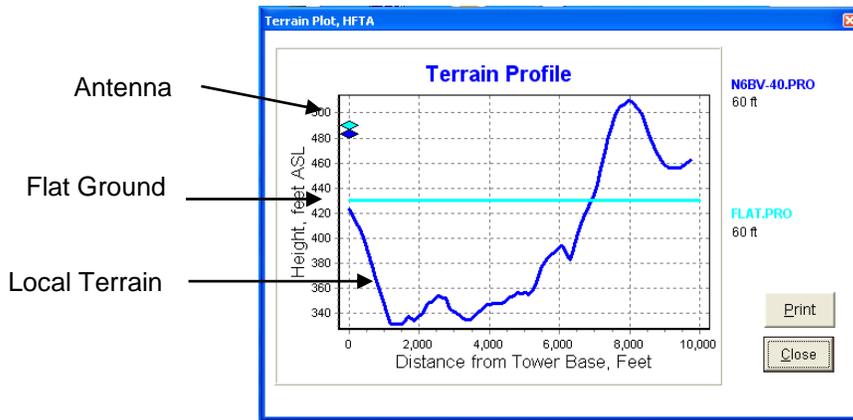
Figure 8

The light blue plot is the FLAT file terrain plot and the dark blue is the QTH terrain plot. The antennas are shown figuratively at 60 feet above terrain on the left.

3.4 Compute Pattern

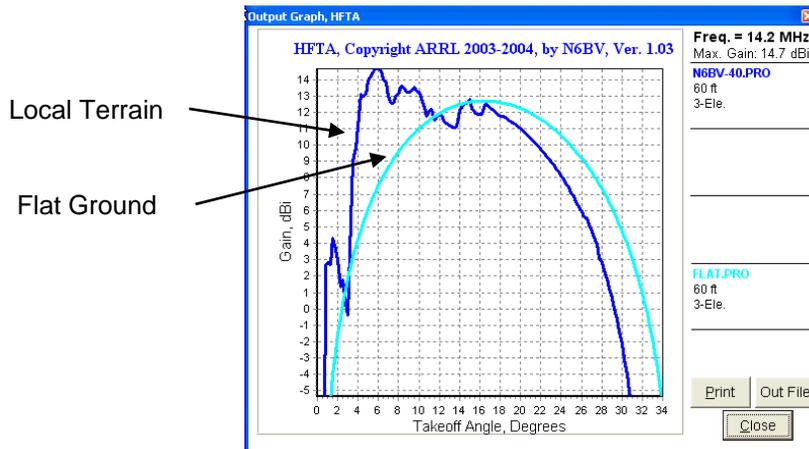Click the **Compute** button and HFTA will compute your vertical radiation profile per Figure 9.
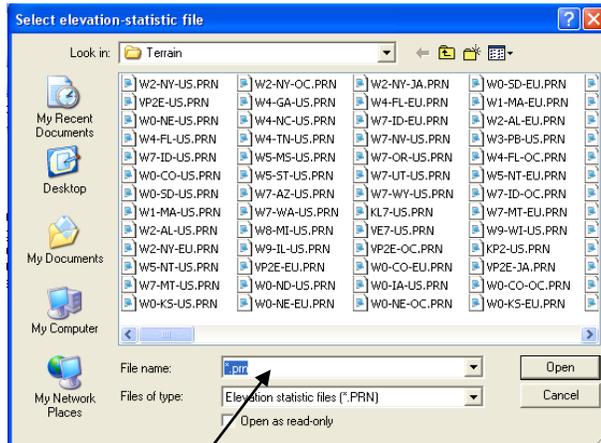

Figure 9

Note the light blue FLAT file plot shows the pattern over flat ground compared with the local terrain. In this case there is significant improvement at very low angles (~ 6 degrees) which is what most operators strive for when working DX. In this case, the low angle is achieved as the site has a significant down sloping terrain profile in front of the antenna.

3.5 Elevation Statistics Files, also known as Signal Arrival Angle

A useful overlay is a bar graph that can be imposed on the above plot that displays the statistical average angle of arrival of signals within a call sign / geographical area. The graph assumes a US or Canadian location with a choice of signals arriving from Europe (EU), Far East (JA), South America (SA), South Asia (AS), Southern Africa (AF), and South Pacific (OC). These files are located in the Terrain folder and are designated as .PRN files.

Click in the **Elevation File** field to load the statistics files, Figure 10, containing a list of PRN files.

Enter call area prefix ….   Figure 10

As an example, take N6BV's QTH. We need to locate the PRN file that has the data for his <u>call area W6</u>. Type W6 in the **File name** field as his call district and a drop down menu appears, Figure 11.
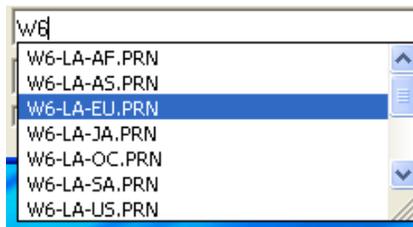

Figure 11

The W6 files appear, centered on LA with the various DX location sources listed as .PRN files. Click the direction of interest. The PRN file will appear in the **Elevation File** field, Figure 12.
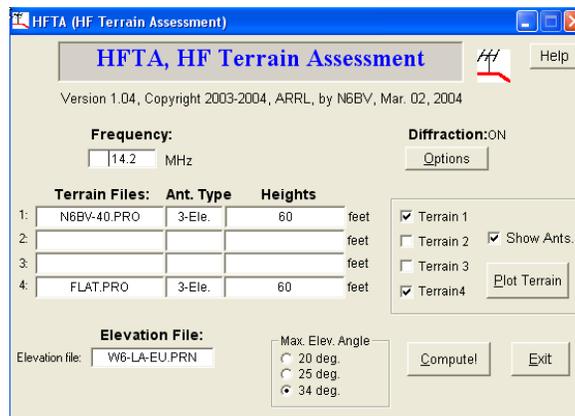

Figure 12

3.6 Display Statistical Files

Click **Compute** again and the Bar Graph is imposed on the antenna pattern, Figure 13.
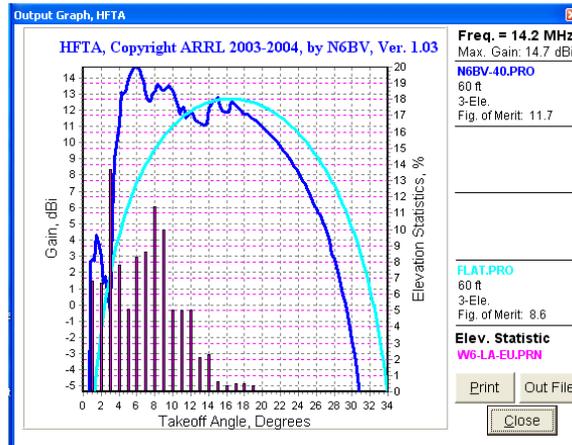

Figure 13

Ideally, the antenna pattern would have the same envelope as the bar graph envelope in order to capture the low angle DX signals. If the antenna pattern does NOT match well with the bar graph due to pattern nulls, blockages or higher angle patterns attributable to the QTH terrain or antenna height, then DX signal strengths will be less. Maybe you didn't want to know about this.

On the right hand side of the plot, the files being plotted are listed, being assigned unique colors.

This completes the basic operation on HFTA. You are now able to run basic HFTA.

4   MicroDEM Installation

DO NOT download the older version MicroDEM from the ARRL CD.

The current version is available on the MICRODEM Home Page website. In this instance, version 2013.3.6.1

http://www.usna.edu/Users/oceano/pguth/website/microdem/microdem.htm

Click the "Download" Link. Then click the complete MICRODEM install (75MB) link. Save.

To install, click on microdem_setup.exe

MicroDEM will install TWO directories, C:\mapdata and C:\microdem, both with subdirectories.

DO NOT CHANGE from root directory or rename. They will self install per Figure14.

       C:\mapdata   the DEMs are saved here as well as the generated PRO files
       C:\microdem   contains the application

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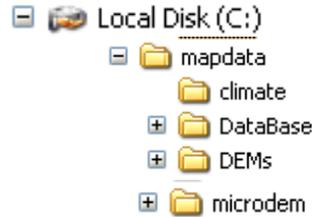# HIGH FREQUENCY TERRAIN ASSESSMENT

Figure 14

Open MicroDEM by clicking the shortcut icon which should have been placed on the desk top upon installation. If it is not there, right click on the microdem .exe icon in the C:\microdem folder and create a second shortcut. Drag it to the desktop.

The MicroDEM Option's settings on the main menu bar must be set up exactly per the settings in Appendix II. Do this NOW, before doing anything else with MicroDEM. These setting are CRITICAL to the success of operating MicroDEM and HFTA.

If in the process of working with MicroDEM it crashes you might be able to restore using the field in the bottom left of the Options screens, Figure 15.
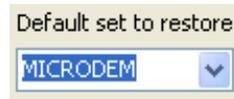

Figure 15

5 Down Loading Maps

Recall that a DEM is a digitized topographical map which includes elevation information. HFTA requires these maps in order to plot terrain and vertical radiation pattern.

The vertical contour interval used is 30 meters. The 10 meter intervals are not used.

The US and Canada are divided in to Regional maps. The US is organized by State, County, and then subdivided in to local area Data Sets. Canada is somewhat different in that a grid system is utilized for Regions which then contain smaller map Data Sets. Both systems yield compatible DEM maps for use in MicroDEM.

You have to know your geographic location so that you can select the correct map or maps. Both systems allow one to easily search to get you in the "ball park" for the map to down load.

The two recommended sites for locating and down loading the DEM maps are,

Canada   http://www.geobase.ca/
USA   http://data.geocomm.com/dem/demdownload.html

For directions in downloading the CDN maps, go to Appendix III.

For directions in downloading the US maps, go to Appendix IV.

For both countries, registration is required before downloads can take place. The maps are free.

By way of example, the authors QTH looks to be located in the 092G07 DEM Data Set. The 092 represents a major map Region and G07 represents a smaller Data Set map within that Region.

Download your "best guess" map(s) before proceeding to Section 6.

Save the DEM maps to C:\mapdata\DEMS.

Note: The author set up a subdirectory under DEMs labeled Zip Files for the downloaded Canadian Zip files. The Zip files are then extracted (unzipped) to the DEM's folder, Figure 16. This is not needed for the US files.

Figure 16

6 OPENING and MERGING MAPS

6.1 Opening a Map in MicroDEM

As this instruction document is written by VA7JW located near Vancouver, British Columbia, Canada, the instructions will be in the use of the Canadian DEM system. The US process is very much the same and if anything a bit easier as the DEM files is ready to use.

There are two differences between the US and Canada DEMs.

The **Canadian** DEM Data Set comes as an East (E) and West (W) file. Under the Data Set designated 092G07 there are actually TWO file sets, which when downloaded and saved, will appear per Figure 17.
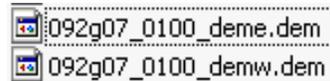

Figure 17

The East and West files are differentiated as deme (E) and demw (W).

If you were to open only the deme file, you will only see the eastern half of the 092G07 map. To see the whole Data Set, you would have to open both deme and demw files at the same time. You can open one or both as individual maps within the MicroDEM window. They are not MERGED maps at this time – that process is explained in Section 6.2 following.

The **US** DEM Data Set comes as a .GZ file which is ready to use in MicroDEM, whereas the CDN Zip file must be unzipped prior to use in MicroDEM. The US files are not split as in the Canadian system.

Open MicroDEM. Click the X to close the MICRODEM advisory window, Figure 18.

Figure 18

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MicroDEM likes to occupy the whole screen when opened. This is OK but recommend reducing on-screen size somewhat using the window reducing icon in the upper right of the window. Reduce the width to about 60% and height to about 90%, then re-center on-screen. This allows for viewing of other material on the screen.

To load recently downloaded DEM map(s), click File > Open > Open DEM.

For US DEM's, retrieve the ready for use file from C:\mapdata\DEMs.

For Canadian DEM's, retrieve both the E and W <u>unzipped</u> .dem maps from C:\mapdata\DEMs.

Hold down the CTRL key and click on both of those files. They will be highlighted per Figure 19.
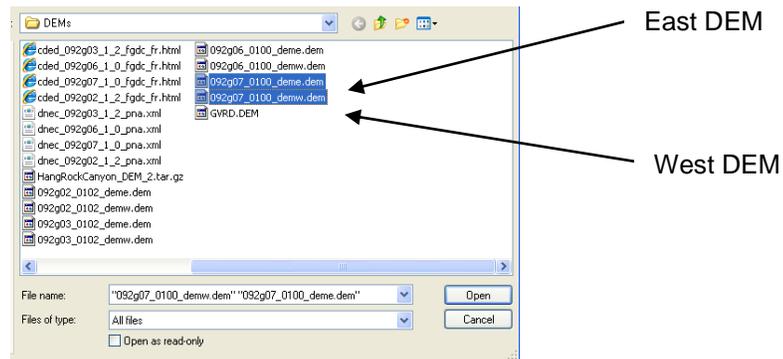
Figure 19

Click Open and the 2 maps, Figure 20A and Figure 20B ought to be displayed, both the DEMW.DEM (west) and the DEME.DEM (east) maps.

Note that one map will open exactly on top of the other map giving the appearance of only one map, so grab and hold the "top" map with the mouse and move aside to expose both such that DEMW is on the left and DEME on the right.

Ensure that the overall MicroDEM window is sized to display the entire map, height as well as width.

If this color elevation scale bar on the top left is annoying, make it go away.

1. right click anywhere on map
2. select "Legends/marginalia"
3. click on "Elevations" button
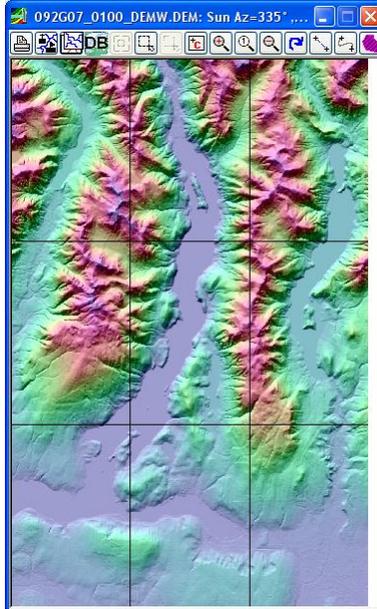4. clear "Include on maps" radio button
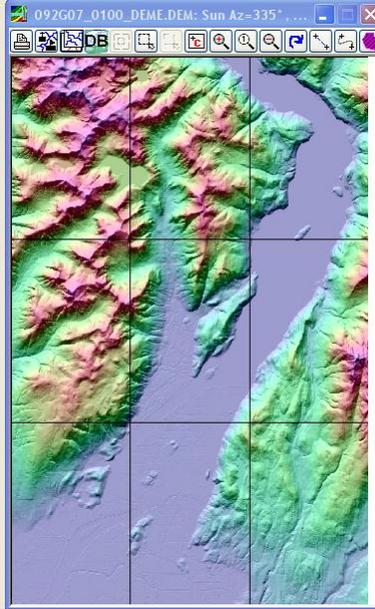
Figure 20 A   Figure 20 B

Notice at the bottom right of the MicroDEM window there is a display of Latitude, Longitude and Elevation in meters. This reads the mouse cursor position. Mouse over the map and see that this LAT and LONG and elevation changes with position. It ought to be reporting in Degrees, Minutes and decimal Seconds as set up in the Units Tab under Options (Appendix II).

It may be that only one of the two maps in 092g07 Data Set is sufficient for HFTA analysis at your QTH, especially if the QTH is in the middle of the map. If it is off to a side or corner, you may well need adjacent maps to ensure a full analysis.

Save both maps for now. Click File > Save DEM > EntireDEM, MD DEM.

Since the Name of map 092G07 in the GeoBase is Port Coquitlam, (US Databases also have names for the maps), the two will be saved as two separate maps, PoCo-West and PoCo-East.

The new DEM window opens. Figure 21, as the location in which the map file is to be saved.
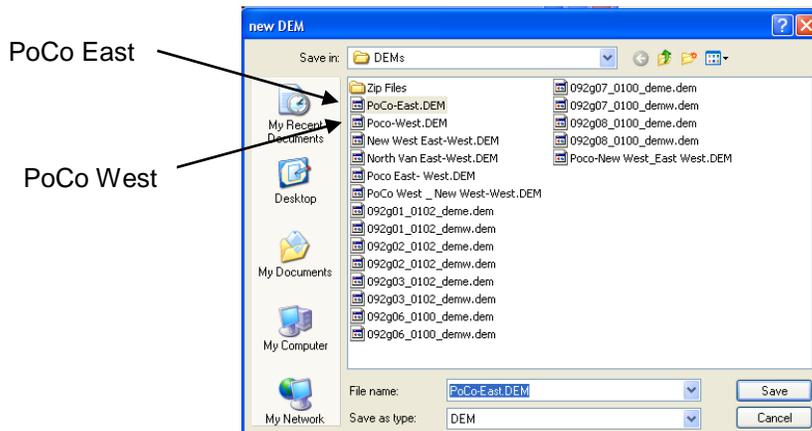
Figure 21

Click Save and ensure it is saved to C:\mapdata\DEMs, and NOT in C:\microdem.

Close MicroDEM.

Test. To retrieve the map, open Microdem; File > Open > Open DEM.

Hold down the CTRL key and click on both files and then click Open. If only one map shows, the second map may be underneath. Drag and separate the maps.

If the 2 maps appear, everything is good.   Close MicroDEM.

6.2 Merging Maps

As mentioned, one map may not provide complete coverage of your QTH. Based on a visual inspection of your QTH map, it may be necessary to merge other adjacent maps to ensure that HFTA has access to sufficient range to do a complete analysis.

As a guide, HFTA examines terrain out to 4.4 km./ 14,400 ft The km legend at the bottom right will provide guidance in this respect. If later, you want to plot the horizon in MicroDEM, you might want to go out to 50 km / 31 miles, plus or minus.

In this example, the East and West maps of 092G07 will be merged to make a complete map of 092G07, i.e. East and West will be merged.

Open MicroDEM.   File > Open > Open and Merge DEMs.

The DEM folder will open and select (highlight) the two maps to merge using the CTRL key, i.e. PoCo-West and PoCo East. Then click Open.

MicroDEM will automatically merge the two maps. A progress bar appears on screen.

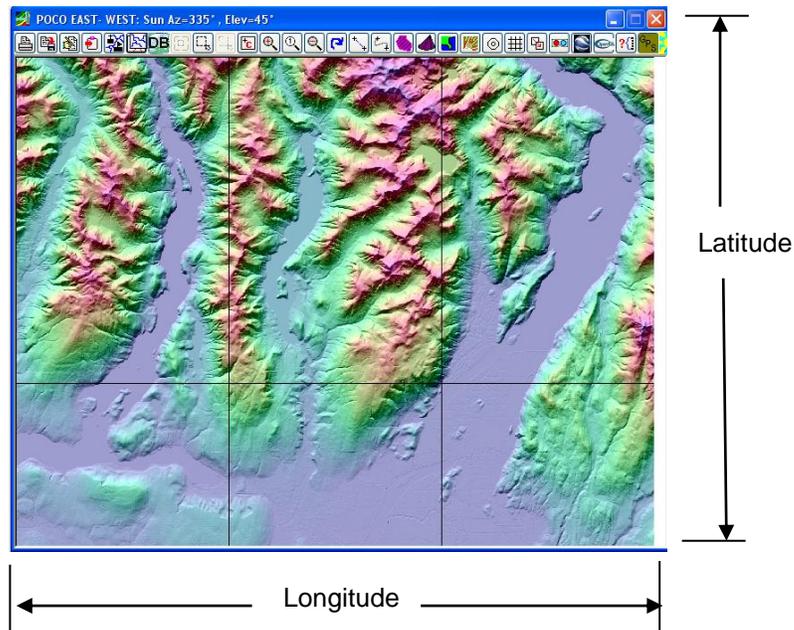The new map will appear as a continuous and seamless map of the two areas.

Figure 22

You can check that the two maps have merged properly. Figure 22, by checking the Latitude and Longitude boundaries.

Save this new map as a new DEM in the DEMs folder, i.e. PoCo East-West.dem.

Note – If you inadvertently merge maps that have already been merged, or can't be merged, a white MERGE screen will still appear, and while looking to be merging the maps as indicated with the progress bar, the screen will remain blank when the process completes, thus indicating an error.

Close MicroDEM. You are now able to create merged maps.

7 Latitude, Longitude and Elevation

You have to know where you and your antenna are located geographically. This will be determined through the use of Latitude, Longitude and Elevation determination.

Latitude measures distances North and South of the equator whereas Longitude measures distances around the Earth.   At the equator, 1 degree of Longitude is equal 1 degree of Latitude. However as one moves North or South of the equator, the distances between lines of Longitude get closer together (distances become less) and at the poles, the distance becomes zero.   Table 1 gives approximate distances of Latitude. Longitude will be decreasing as one moves North or South. Distance between Latitudes always remains constant.

1 degree	111 km	69.2 miles
1 minute	1.86 km	1.15 miles
1 second	30.9 m	101 feet
1/10 second	3.09 m	10.1 feet

Table 1

For more information, visit http://calgary.rasc.ca/latlong.htm

ACCURACY of location is really important in MicroDEM. Significant differences in the plots are noted if locations are casually entered.

HFTA centers the assessment on the Lat and Long of the QTH. Radial lines are going to be generated every 5 degrees out from your location plotting terrain elevations for a few thousand meters. Small changes in the QTH location can cause significantly different profiles to be measured thus affecting the vertical radiation plot. Locations to less than a second are needed for accuracy and repeatability.

If you do not know your EXACT tower / antenna base location, now is the time to use Google Earth to determine Lat, Long and Altitude. It will be far more accurate than trying to determine it on a paper topographical map.

In Google Earth, enter your address and zoom in on your QTH. Place the curser on the exact location of the tower or antenna base and read off Latitude, Longitude and Elevation in lower right corner, Figure 23.

49°16'59.73" N 122°52'28.55" W elev 426 ft

Figure 23

Write these numbers down and keep them handy as they are often used in MicroDEM.

Refer also Appendix VIII

8   FAN's and PRO Files

8.1 What are FAN's?

The word "FAN" as used within MicroDEM describes radial lines which MicroDEM will create, radiating out from the specified location (your QTH) every 5 degrees around the full azimuth of the QTH. These are the PRO files and contain the elevation vs. distance data.

Open MicroDEM, File > Open DEM to bring up your map.

Mouse over the map to see that the Lat and Long is reporting at the bottom. Move the mouse cursor to find your approximate QTH location. This helps visualize your terrain as well as knowing "where you are" on the map.

Note that you can see more detail by clicking on the magnifier icon on the map menu bar to Zoom In on your QTH. Select a Zoom-In factor as 2 or 3 times typically to view detail and ensure that the terrain looks like your terrain. When finished zoom back out to a magnification of 1.

8.2 Generating PRO files

The mouse does not have to be exactly on your QTH. Close is good enough as you will enter your EXACT location using a location window as per Figure 24..

Click the FAN icon at the top of the map menu bar. The Weapons Location window, Figure 24 should appear.
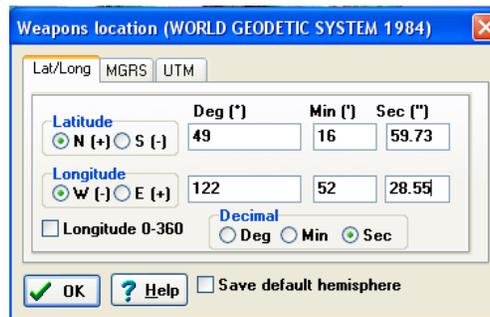
Figure 24

If the icon is not presented in the map menu bar top of the map, click Calculate > Intervisibility > ViewShed on the MicroDEM menu bar.

Some clarification of terminology used in MicroDEM.

Intervisibility is the ability to see a distant visible object over a relatively long distance

Line of Sight (LOS) is the unobstructed view of a distant object.

ViewShed is an area of land or water that is visible from your QTH.

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When the Weapons Location window appears as per Figure 24, enter your exact Lat and Long down to the fraction of a second, then click OK. (this S/W was/is a military work).

The ViewShed window, Figure 25, will appear with your Lat and Long imbedded embedded at the top of the window as **Observer.** Check that this is so.
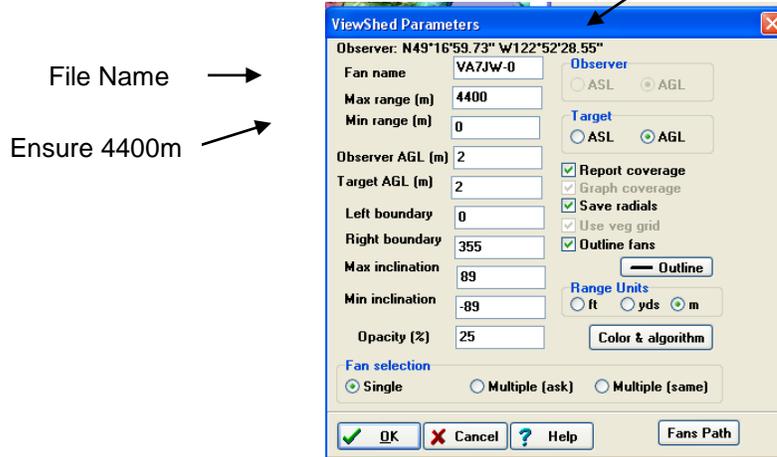
File Name →

Ensure 4400m →

Figure 25

Provide a **Fan name** in the "Fan name field" (other than VA7JW-0). As you will likely be generating a number of FAN / PRO files, suggest you name and organize each batch of PRO files separately since each PRO file contains 71 profile files. Suggest a PRO folder be created, for instance, Appendix V, to keep track of the files by date and/or "job". A time and date stamp within the PRO file name might be useful, as shown in blue,

VA7JW-1330-9nov12-20.00PRO

Enter data as shown. Check Report Coverage, Save Radials, Outline Fans.

When the OK button is clicked, the PRO files will be automatically saved in the C:\mapdata\MD-PROJ /FAN folder under this file name.

If you happen to click **Fans Path** it indicates that the FAN files will be saved in C:\mapdata\temp, Figure 26, which they are NOT. In spite of this the PRO files do get saved in the FANS folder. This path can be changed to C:\mapdata\MD-PROJ\FANS without incurring problems but it reverts back to the temp folder next time used, so just leave it alone.

Figure 26

MicroDEM will create quantity 71 .PRO files at 5 degree intervals around 360 degrees and will automatically save them in C:\mapdata\MD-PROJ\FANS\filename.

The map, Figure 27, should show the 2200 m and 4400 m range circle encompassing the profile out to 4400 m.

4400 m range circle

Your QTH

2200 m range circle
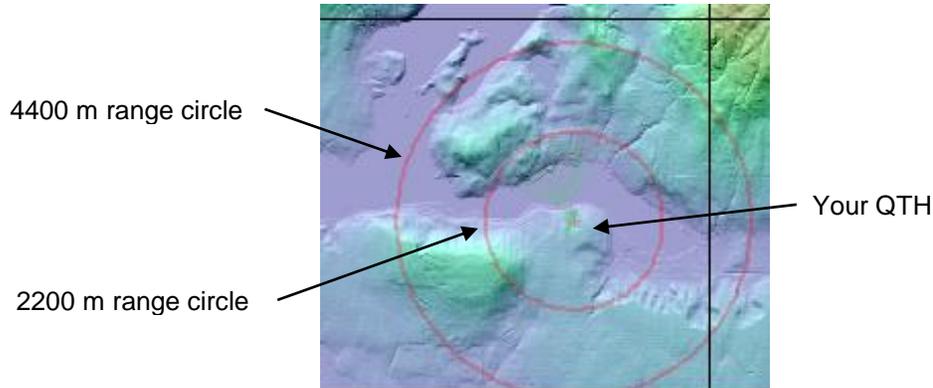
Figure 27

Inspect the folder C:\mapdata\MD-PROJ\FANS and confirm that "VA7JW-0.." files are there.
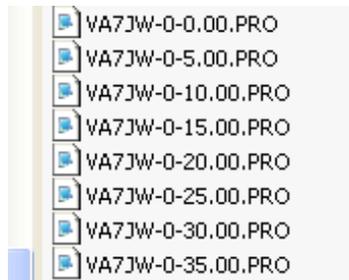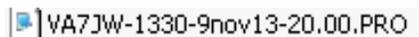

or as VA7JW would save them,

Figure 28

Each file is 5 degrees increased from the previous file, hence the -0.00 file starts as true North at 0 degrees, the next file at -5.00 being 5 degrees east of true North and so on to the last file at 355 degrees.

If you see the files listed as such, you have generated the PRO files needed to run HFTA and are ready to set up your own QTH maps, create PRO files and run HFTA. .

Have a look at Appendix VII for other MicroDEM features of use in characterizing your site.

8.3 Moving PRO Files from FANS Folder to a Terrain Folder (Optional)

HFTA looks for PRO files in the Terrain folder but they were generated and saved to the C:\mapdata\MD-PROJ\FANS folder.

To run the PRO files in HFTA, you have to navigate HFTA to C:\mapdata\MD-PROJ\FANS where the generated PRO files are stored, select the profile file to be examined, and enter in the HFTA **Terrain Field.**

The author prefers to move the PRO files immediately after they are generated to a folder per Figure 29 named by call sign (VA7JW) or some other designator so that various studies can be segregated and accessed more easily within HFTA.

A portion of VA7JW's file structure is shown in Figure 29 where dated subfolders store various studies on 9 Nov 2012 from my QTH.
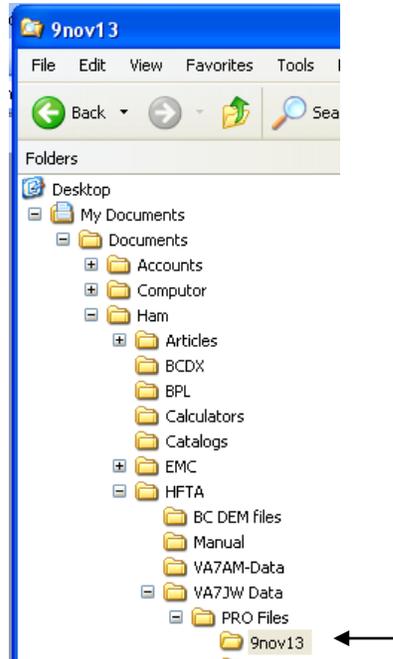
Figure 29

In Win 7, Program Files would be Program Files (X86) as this is a 32 bit application.

The generated PRO files are manually copied out of the FANS folder into the VA7JW DATA location with dates/ time the runs were performed.

To load the PRN files, click in the **Elevation File**: field and enter the required PRN file as before.

That's it! You now have the basics for running HFTA and MicroDEM

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APPENDIX I
Windows 7 Installation Notes

HFTA and MicroDEM were first installed on a Windows XP machine. All operations and screenshots in this document are described and taken using XP.

The Win 7 installation is slightly different regarding some of the operations and the screenshots. There is no fundamental difference between the two as operations and appearances are closely related. Differences are related below.   Refer to the XP process at the same time if uncertain.

Installing HFTA

Insert CD

Win 7 displays the contents of the CD. Click on the Setup Icon (Application file)

The Install wizard will be activated

Check Custom

Select Install ARRL Antenna Book.

Not necessary to install these old Adobe PDF files as not related to HFTA.

Check ALL HFTA boxes; these are the PRN files.

Uncheck all other applications, PDF's etc. Not necessary for HFTA.

UNCHECK MicroDEM. DO NOT INSTALL this file. It is obsolete.

VB6Runtime at bottom of list is permanently checked.

Install Adobe 7.0?   NO if have later versions already installed (currently ver 10).

Install

Icon on desktop? YES

The installation will run and when finished, close windows.

Check that the HFTA icon is on the desktop.

Check that ARRL file is installed under Program Files (x86) / AntBk21/ Terrain.

Check that the Terrain folder contains the .PRN files.   Close

---

Functionality Test:

Click the HFTA icon; HFTA window should appear.

Click the **Terrain Files**: & bring up the .PRO file list. Select N6BV-45.PRO.

Enter or change **Antenna** field to 3-Ele and **Heights** to 60 ft.

Click **Plot Terrain**. Terrain graph should appear. Close graph.

Click **Compute**   Vertical radiation graph should appear.

Hover over Elevation File: Select the W6—LA-EU.PRN file. Click Compute. Bar graph should appear in vertical radiation plot.

If these have all worked, HFTA is set to go.

Close all windows.

Installing MicroDEM

The program requires a 32 bit version of Windows such as XP and will run on 64 bit Windows 7 but in the in Program Files (X86) directory.

Follow instructions per installation windows.

Programs MUST self install to C:\microdem\ and C:\mapdata. DO NOT CHANGE.

Install & Finish.

MicroDEM advises BDE (Borland Database Engine) not installed. Install BDE now?   Yes.

BDE Utility installation window appears. Check Install DBE 5.2. Follow Installation windows and install location per recommendation. Finish.

MicroDEM advises SAT_BAND_NAMES_V4 not installed. Confirm Install?   Yes.

MicroDEM advises MD_TABLE_DEF_v2.DBF required. Confirm Install?   Yes.

Check that microdem and mapdata have both installed at the C:\ root

Open MicroDEM using icon on desktop. If not present, create a desktop shortcut.

MicroDEM should now run.   Close the Overview window.

Before any other operation with MicroDEM, open **Options** on the main menu bar and set up ALL tabs per Appendix II following.

Close MicroDEM.

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APPENDIX II
MicroDEM OPTIONS Setup

The **OPTIONS** menu appears on the top menu bar of the MicroDEM window. <u>Do not load any maps before completing the Options set-up</u>. These settings MUST be EXACTLY as shown. Submenu buttons are NOT shown unless the installed default settings have to be altered. Always click OK if a setting is altered.

1 Programs Tab
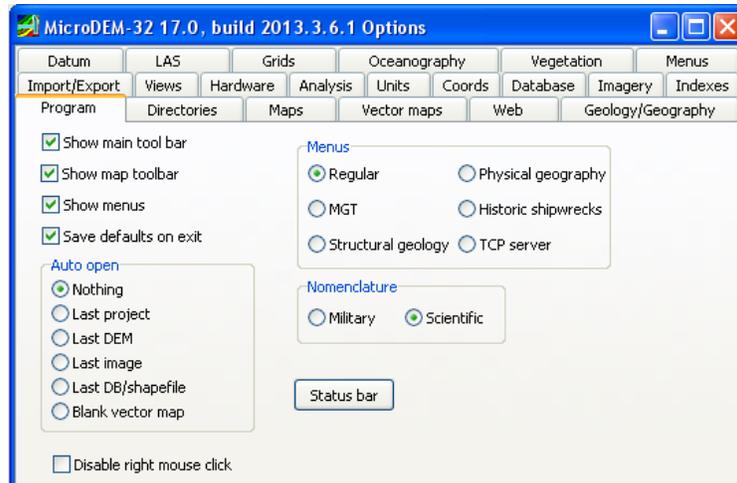
2 Directories Tab
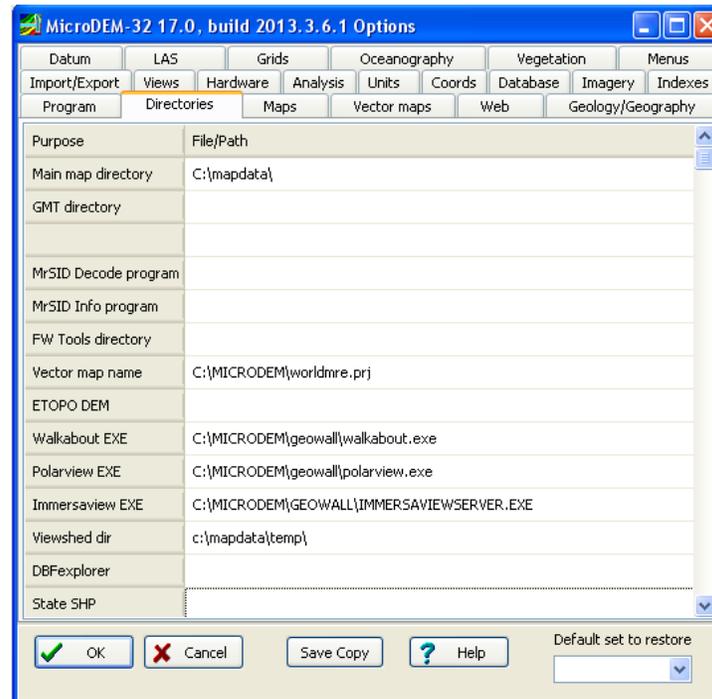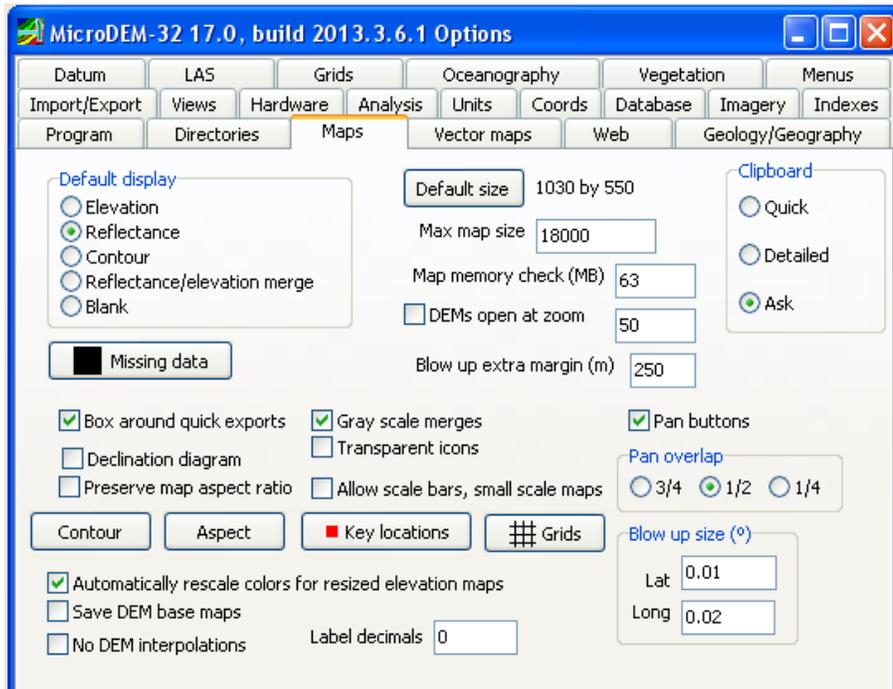
3 Maps Tab

4 Vector Maps Tab
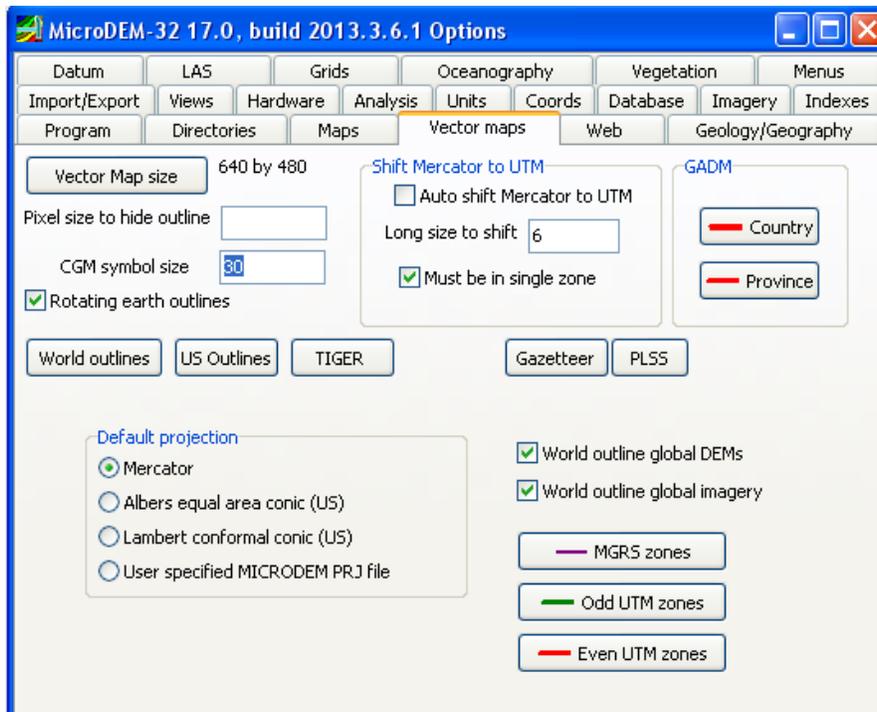
Change PLSS > PLSS file to read C:\mapdata\DEMs
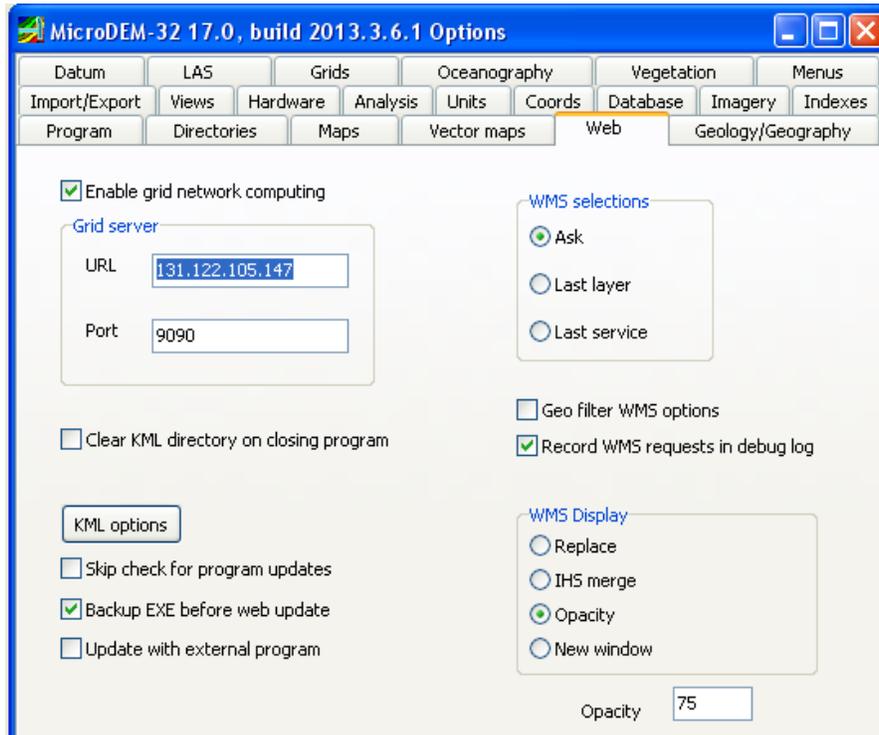
5 Web Tab

6 Geology / Geography Tab
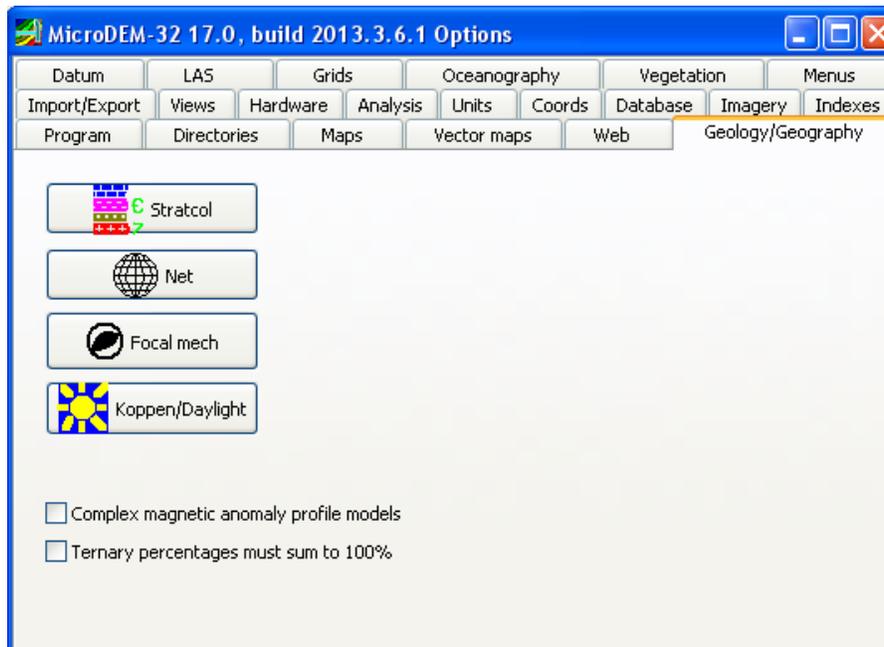
7 Import / Export Tab
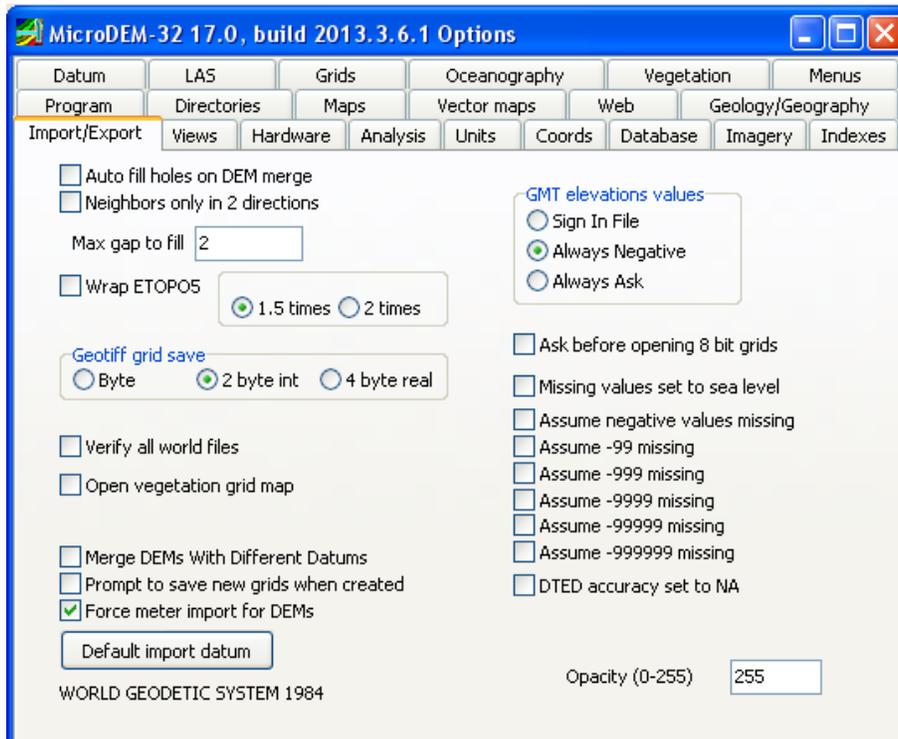
8 Views Tab
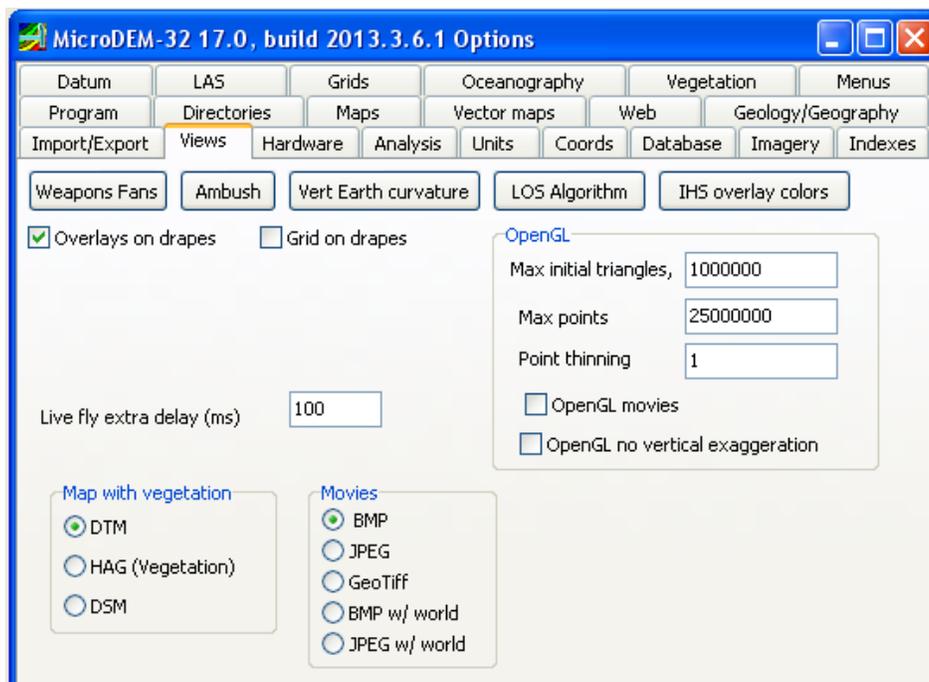
Sub Menu buttons need to be set up.

8.1 **Weapons Fans**
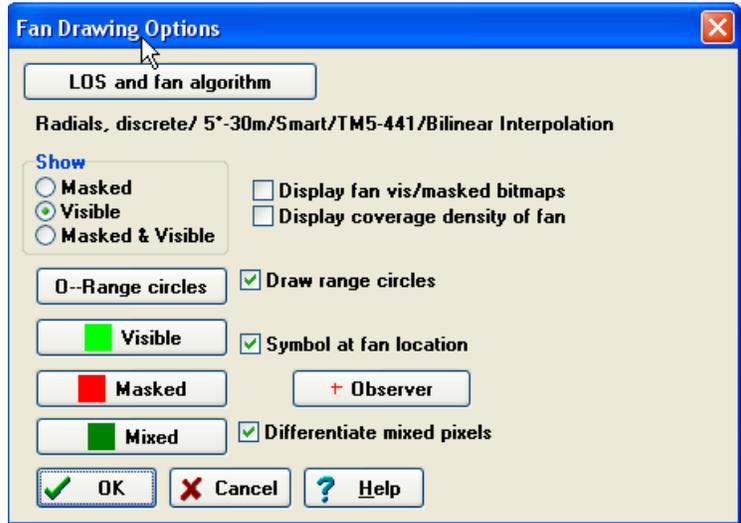
8.1.1 **0--Range circles**

Enter 2200 and 4400 and select Range Units = meter

8.2 **Ambush**

8.3 Vert Earth curvature

Vertical Earth Curvature

Algorithm
- ○ None
- ◉ TM5-441
- ○ Radio   K 1.33
- ○ Yoeli

8.4 LOS and fan algorithm

LOS/Fan Algorithm Options

Vertical Curvature   TM5-441

Fan drawing method
- ◉ Radial lines, discrete
- ○ Point to point
- ○ Radials, full coverage

☐ Radials from zoom map size

Ray Spacing (°): 5

☐ Viewer on grid node
☐ Target on grid node

DEM spacing multiple 0.5
Map spacing multiple 0.5

Point selection method
- ○ Scaled radial spacing
- ◉ Constant radial spacing
- ○ Grid square sides (Yoeli)
- ○ Nearest grid point (Bresenham)

Point Spacing (m): 30

Point interpolation
- ◉ Bilinear Interpolation
- ○ Grid triangle
- ○ 1/R weighting
- ○ 1/R² weighting
- ○ Nearest grid
- ○ SW grid

Horizontal earth curvature
- ○ DEM Grid
- ○ UTM
- ○ Lat/Long
- ○ Geodetic
- ◉ Smart

Switchover distance

25000

Defaults

Closest blocking distance (m) 0

Fan zoom factor 50

☐ Missing data blocks LOS

8.5 IHS overlay colors   No new window appears. This is normal
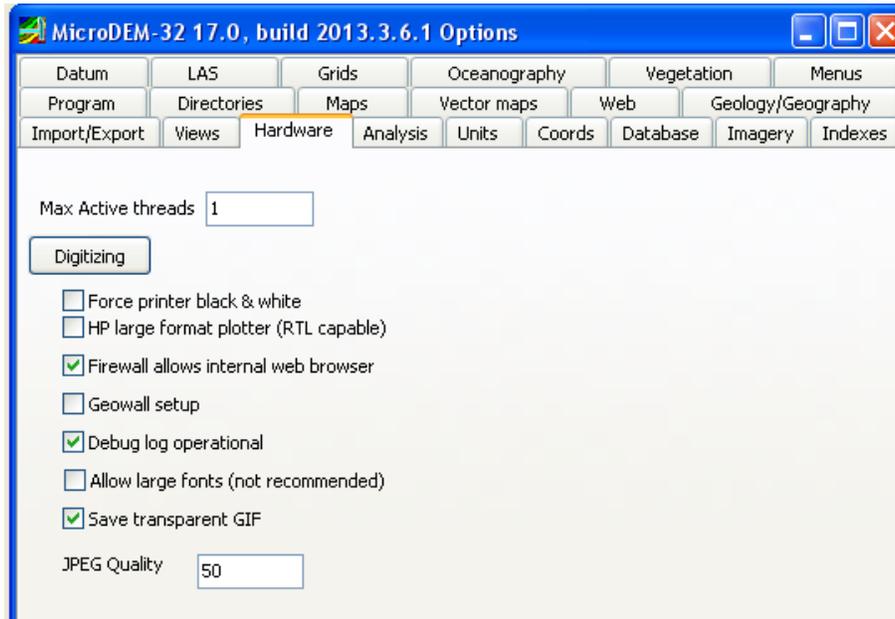
9 Hardware

10 Analysis
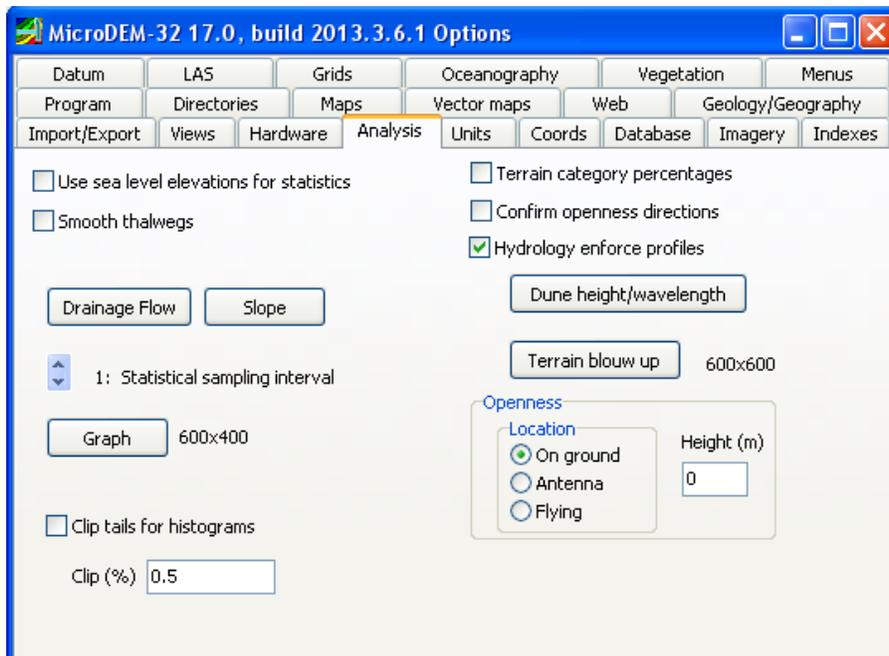
11 Units

Setup for using Degrees / Minutes / Seconds for Lat and Long rather than decimal degrees
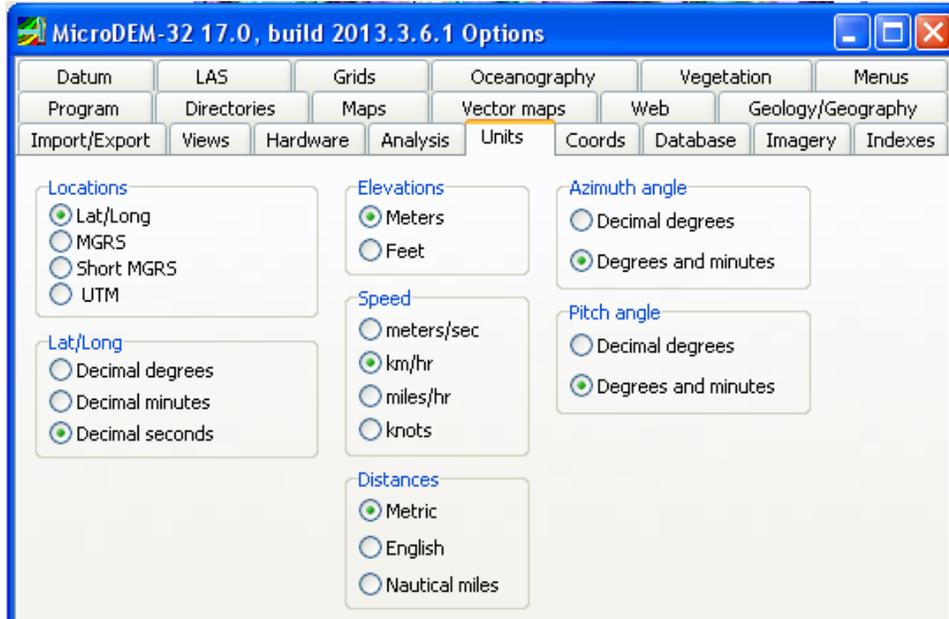
12 Coords
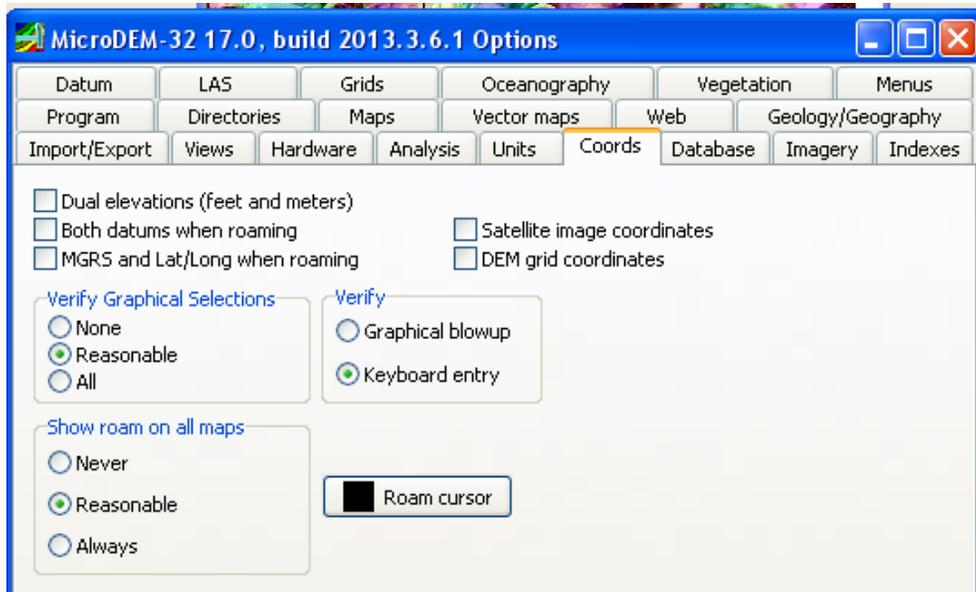
13 Database
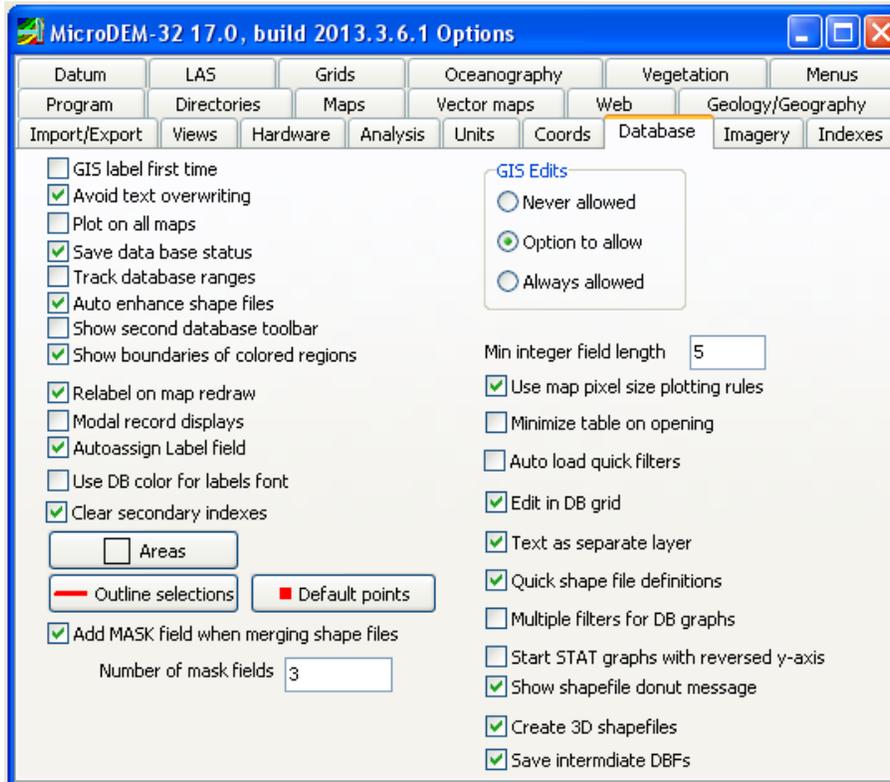
14 Imagery
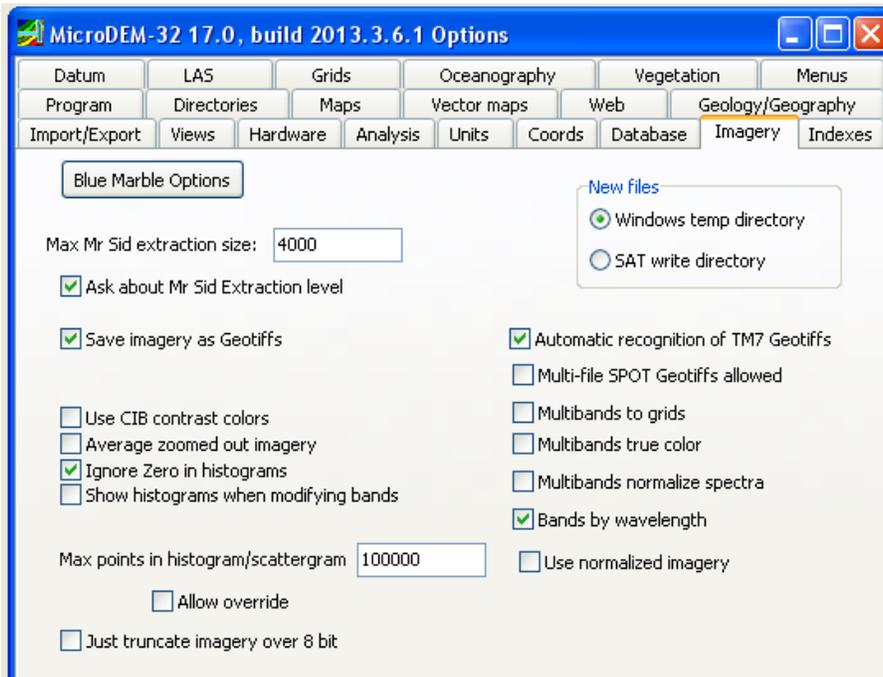
15 Indexes
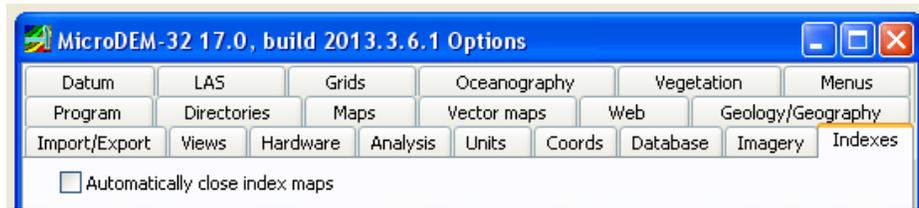
16 Datum
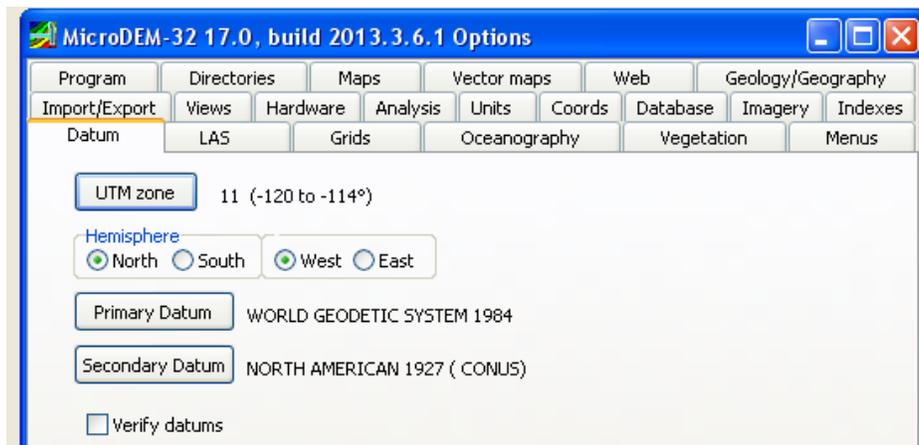
<u>17 LAS</u>
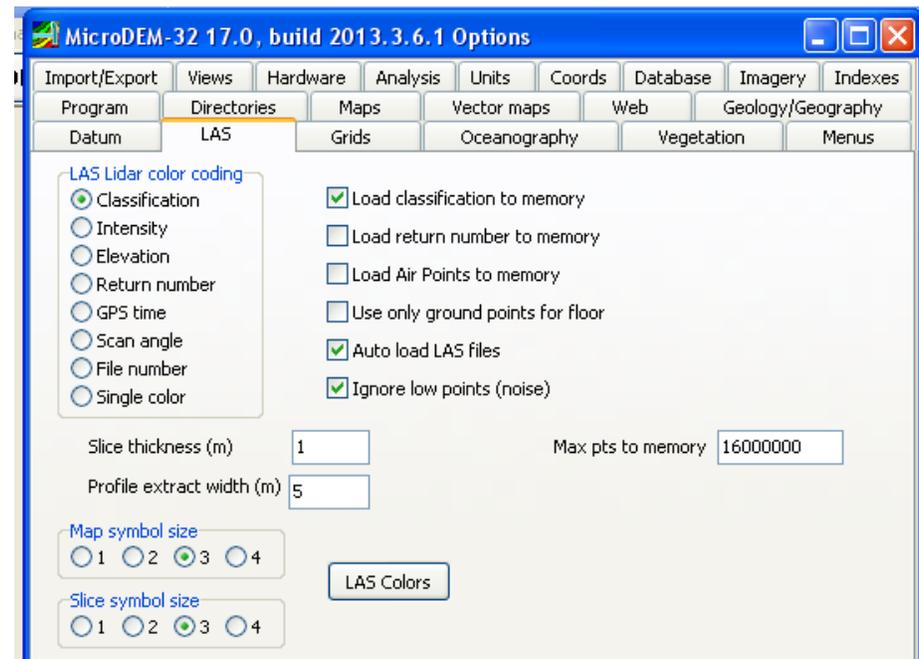
18 Grids
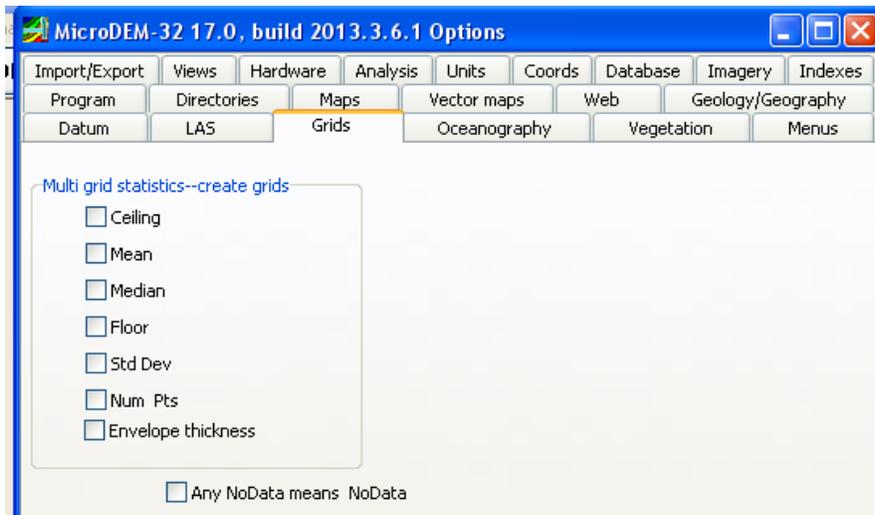
19 Oceanography
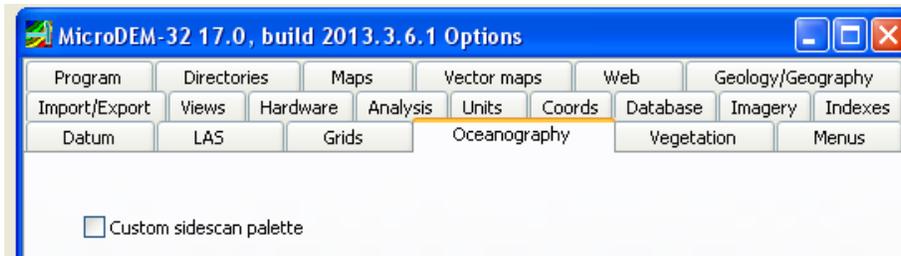
20 Vegetation
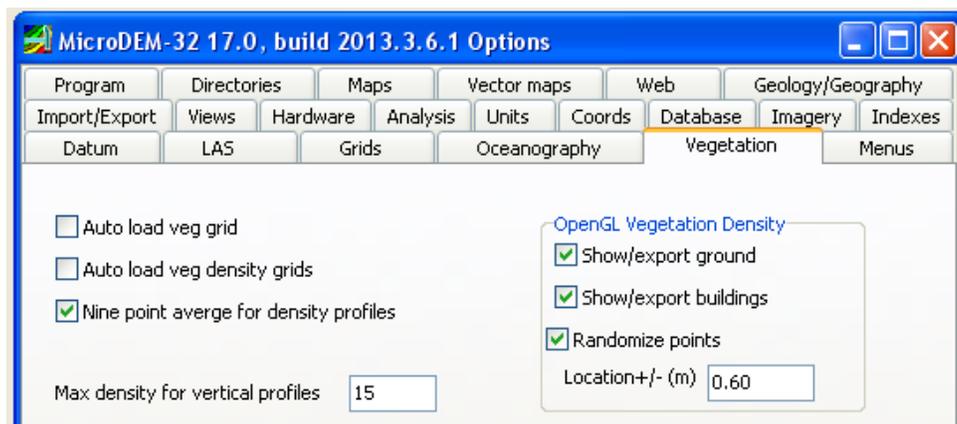
21 Menus
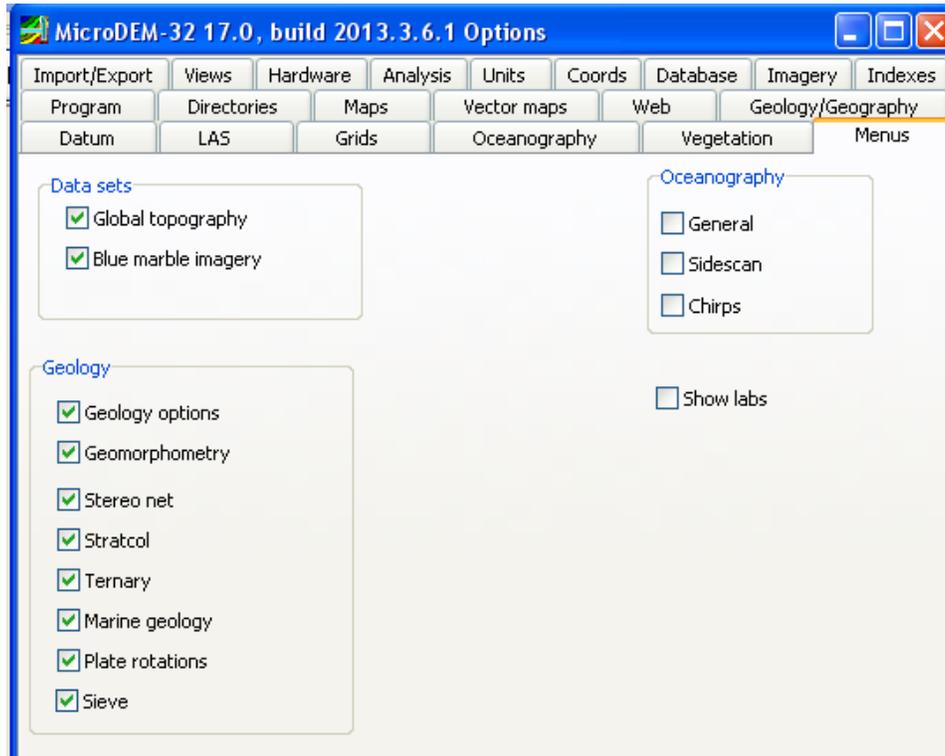
The authors experience has been that anomalies in the behavior of MicroDEM as used for our purposes will result from some setting not being correct. Meticulously go through this tedious exercise and click the OK button for every change made. I went through the set more than once, re-checked everything and clicked OK every time, and it worked.

If during the course of regular use, something does not work, review the setup. The author has experienced infrequent, but unexplained, "uncommanded" changes which prevent the application from working properly. In particular pay attention to the Views and their subsets, 8.1 thru 8.5, Units, and Coords tabs.
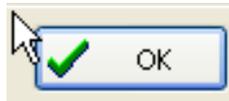
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Appendix III
Canadian DEM Download Process

Go to the GeoBase Home page, http://www.geobase.ca/   Scroll down to User Registration and click the link Register Now. This is a simple process and there is no cost to do so as all maps are free. To start,

- Select **Language** > Mouse over **Data** tab in upper left. Click on **Digital Elevation Data**.
- Canadian Digital Elevation page should show. Click on **Download**.
- Map of Canada showing grid squares appears, Figure III.1.
- The elevation contours are 30 meter.

Figure III.1

Option 1 will aid in searching for the map squares of interest. Choose the 1:50,000 to locate & click the required map, in this case, Region 92, on the first, large scale map, then click 92G on the next more detailed map and then click Data Set 7 on the third most detailed map. This will yield file 092G07 which will be loaded in the **Identifier** field, Figure III.2,.then click **Submit**

Figure III.2

Maps entered in the Identifier filed are presented. In this case only one. Choose http

Figure III.3

You will be asked for your User name and Password

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Figure III.4

When entered and recognized, your profile will be displayed.

If all OK, click **Download File**. The file will be identified per Figure III.5 as

Figure III.5

SAVE this file to the C:\mapdata\DEMs\Zip folder

Go to C:\mapdata\DEMs\Zip Files and locate this 092g07 file. Double left click on the zip file in to list contents. The contents of the zip file will appear as Figure III.6.

Figure III.6

Click **Extract all files** and the extraction Wizard will begin the process.
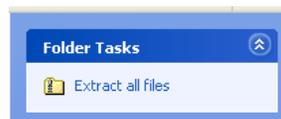
Figure III.7

Extract to C:\mapdata\DEMs. Confirmation of a successful extraction is provided.   Click Finish on the Wizard.

The extracted files now appear as per Figure III.8.

Note list of files is the same as the unzipped listing, but the file size of all the files are much larger.

Figure III.8

These two files are the important ones – they are BOTH required to generate a map.

Note that deme means DEM East & demw means DEM West in this case, Figure III.9.
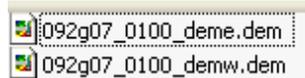
Figure III.9

The file when clicked provides information about this map.
The file provides a HTML page & is of no further interest.

Close this window.

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Appendix IV
USGS DEM Download Process

US Geocomm Home page, http://data.geocomm.com/dem/demdownload.html   Figure IV.1.

Figure IV.1

If already registered, LOGIN or click the GIS Data tab to escape from the Welcome screen and LOGIN.

If you have not registered, do so now by clicking on the LOGIN tab in upper left menu area, Figure IV.2. The process is straight forward and there is no cost to do so as all maps are free.
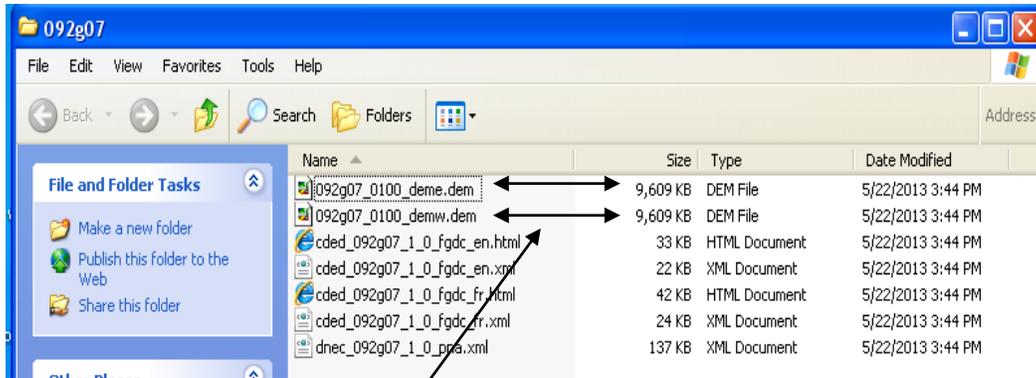

Figure IV.2

When registered, LOGIN. Next screen, click the GIS Data tab to escape from the Welcome screen.

Click USGS DEMS
Scroll down and click DOWN LOAD DEM DATA HERE link
US country map appears. Click on your State, i.e. Washington
County List appears. Click on your County i.e. Whatcom
Click on link Digital Elevation Models. (DEM) – 24K
Click on your DEM by description, i.e. Bellingham North WA

Note – the free downloads require clicking the green icon

The DEM selection is displayed, Figure IV.3.

Figure IV.3

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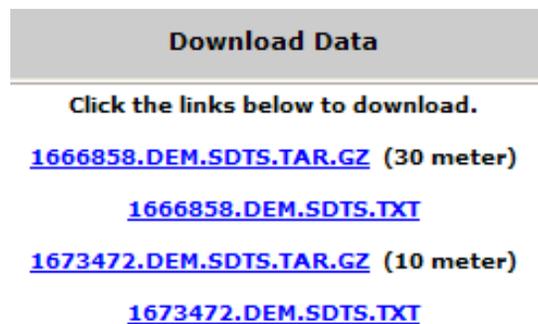
If both 30m and 10m files available, use the 30m contour file as MicroDEM and HFTA are set up for this contour interval.

Only the GZ file needs to be downloaded. It is not a Zipped file.

Click the link and download to your C:\mapdata\DEMs folder.

Save and Close the Geocomm page.

The map is now ready to be opened in MicroDEM.

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Appendix V
DIRECTORY STRUCTURE and FILE STORAGE

A lot of files are downloaded, extracted, maps generated, PRO files produced. It is important that as these files are generated, they be kept in their appropriate directories & folders as installed.

Under no circumstances are the BLUE directories or subdirectories to be moved or re-named.

However, a HFTA directory was created later by the author to store project work and consolidate the generated PRO files and other most often used files such as the FLAT file and PRN files.

Initially HFTA will go to the originally installed locations where it expects to find the generated PRO, PRN and FLAT files. These files remain there but copies are made and are moved in to the HFTA folder. HFTA will remember the last (new) locations used. I find keeping these files together makes data keeping and finding much easier
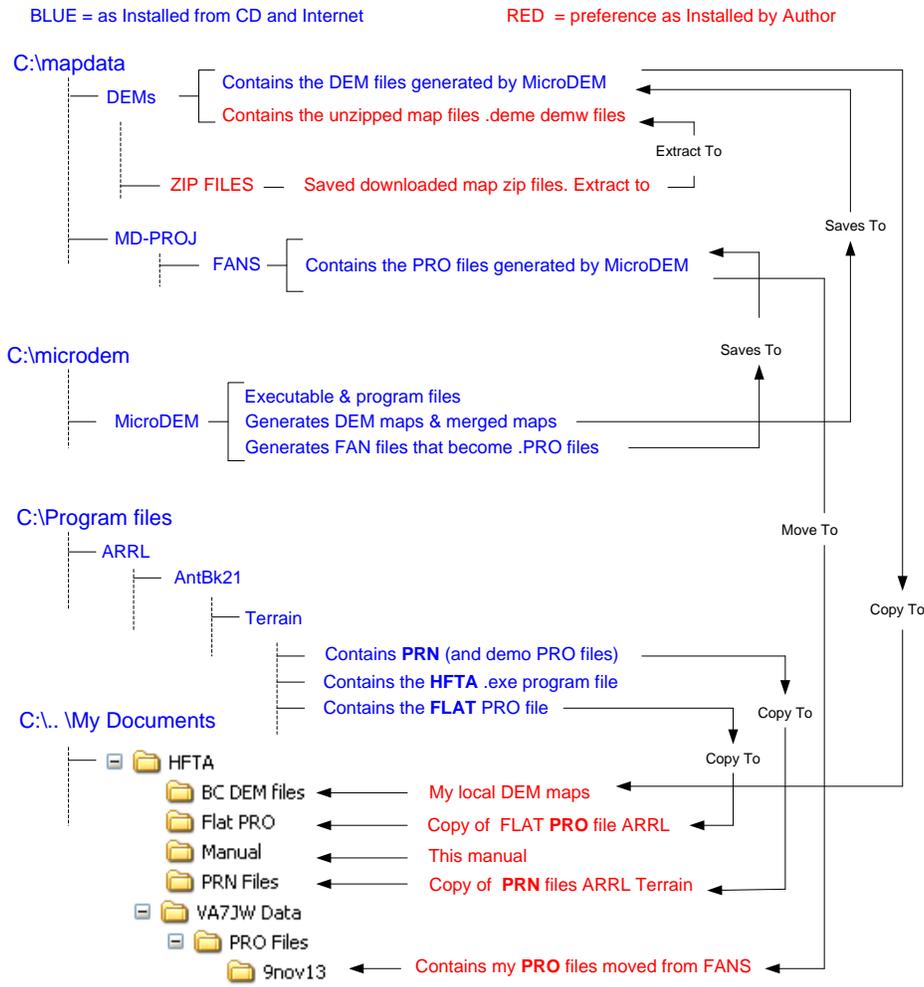
BLUE = as Installed from CD and Internet   RED = preference as Installed by Author

C:\mapdata
— DEMs — Contains the DEM files generated by MicroDEM
          Contains the unzipped map files .deme demw files   Extract To
— ZIP FILES — Saved downloaded map zip files. Extract to
— MD-PROJ
  — FANS — Contains the PRO files generated by MicroDEM   Saves To

C:\microdem
— MicroDEM   Executable & program files   Saves To
             Generates DEM maps & merged maps
             Generates FAN files that become .PRO files

C:\Program files
— ARRL
  — AntBk21
    — Terrain
      Contains **PRN** (and demo PRO files)   Move To
      Contains the **HFTA** .exe program file
      Contains the **FLAT** PRO file   Copy To   Copy To

C:\.. \My Documents   Copy To
— HFTA
    BC DEM files ← My local DEM maps
    Flat PRO ← Copy of FLAT **PRO** file ARRL
    Manual ← This manual
    PRN Files ← Copy of PRN files ARRL Terrain
  — VA7JW Data
    — PRO Files
      — 9nov13 ← Contains my **PRO** files moved from FANS

Figure V.1

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APPENDIX VI
QUICK SETUP GUIDE to USING HFTA & MicroDEM

Read Sections 1and 2 to get an Overview and Understanding of the Software.

1   Install **HFTA** version 10.4 from the ARRL Antenna Book CD. All the HFTA boxes need to be checked. It is automatically installed to C:\ARRL\AntBk21\book\Terrain\ files. Do not alter or relocate this directory.

2   Do NOT install MicroDEM from the CD. Step 10 will load most recent version.

3   Get latest HFTA Manual from ARRL web page; search HFTA, HFTA-ARRL will lead to the PDF file dated 22 Feb 2013 at time of writing. Save and print manual for use.

4   Open HFTA. The Main window opens,

- PRO files are the demo terrain Profile's found in the Terrain folder.
- PRN files are Elevation Angle Statistical data (angle of arrival DX signals) and are also found in the Terrain folder. See HFTA manual for details.
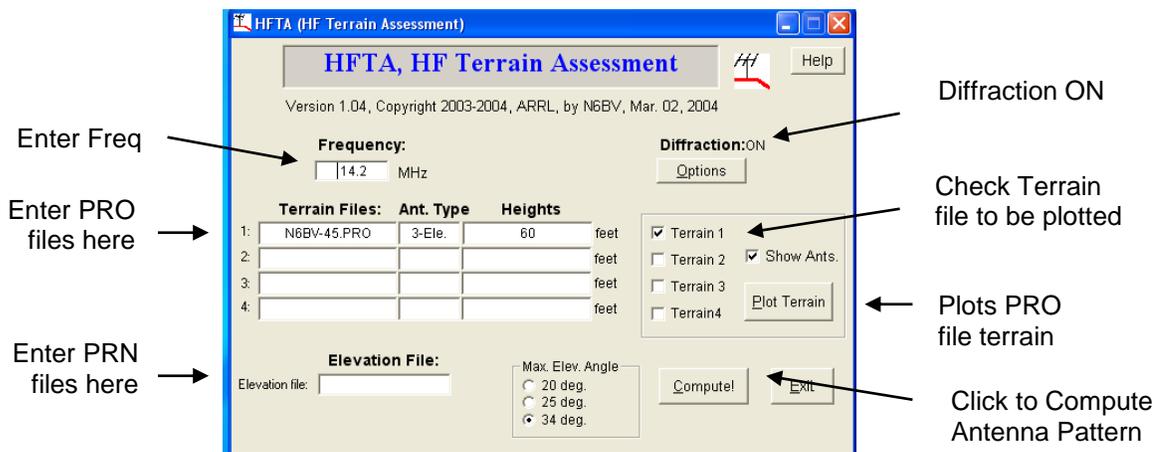

Figure VI.1

5   Load **Terrain Files** by left click in field. Select file from Terrain folder listing, i.e.N6BV-45.PRO.

6   Set **Ant Type** and **Heights** by left click in field. Fill in drop down window. Type in Height OK.
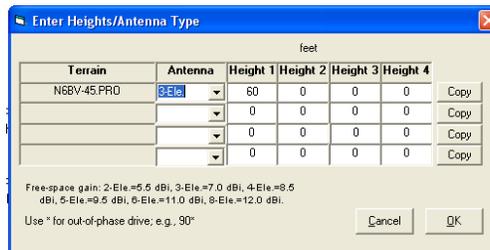

Figure VI.2

7   Check **Terrain 1** box and click Plot Terrain. Plot window Figure VI.3 opens,

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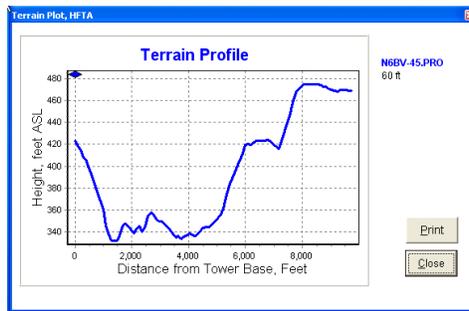# HIGH FREQUENCY TERRAIN ASSESSMENT

Figure VI.3

8   Click **Compute!** and the antenna vertical radiation pattern window Figure VI.4 opens,
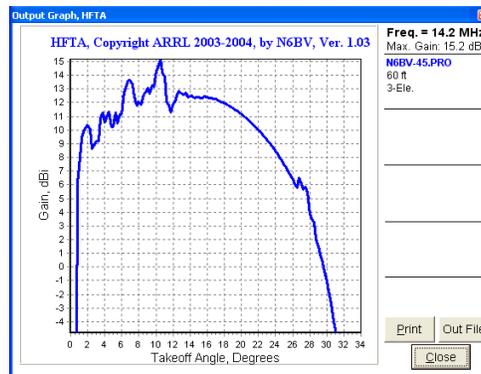

Figure VI.4

9.   If this is all OK, HFTA is working. Close all windows.

MicroDEM. This is a mapping program that generates the profile files from maps, designated as PRO. Maps are downloaded from the web to cover the area of interest   MicroDEM configures the maps for use by HFTA.

10   Install MicroDEM from web.

 http://www.usna.edu/Users/oceano/pguth/website/microdem/microdem.htm

Automatically installs directories, C:\database\ and C:\DEMs and C:\microdem\. Do not alter or relocate these directories.

DEM means Digital Elevation Module. These files provide the distance and elevation data for the map to be generated for use in HFTA. This becomes the PRO file.

11   Download QTH relevant DEM map files. They are found at,

- Canada   http://www.geobase.ca/
- USA   http://data.geocomm.com/dem/demdownload.html

These instructions are based on the Canadian DEM maps and software. The US is much the same except there is no East or West (so far as is known).

12 GeoBase, select Language > Registration and complete the registration; free & easy.

13 Go back to opening GeoBase screen and mouse over Data tab & click Digital Elevation Data. Select a map area of interest, i.e. Port Coquitlam area, map 092G07. Download zip file.

14 Save download to C:\mapdata\DEMs. Suggest create a ZIP folder under DEMs to store zipped files.

15 Extract the 092G07 zip file to C:\mapdata\DEMs. The files of interest are,

   092g07_0100_deme.dem   note the e appendage means EAST
   092g07_0100_demw.dem   note the w appendage means WEST

   Each is a stand alone map, but both are needed to make up the entire 092G07 map.

16 Open MicroDEM using the shortcut placed on the desktop during the installation step.

17 Close the MicroDEM information window in the main window.

18 Click File > Open > Open DEM. DEMS folder opens. Click (use CTRL to select both) each of the two files in the listings, i.e. 092G07… deme and demw. Click Open.

19 Two colored relief maps, E and W of 092G07 will load, Figure VI.5. The two maps are over top of each other. Grab and move the top one over to expose both E and W. Determine which one contains your QTH.
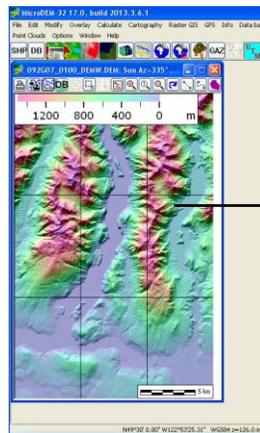
Grab and move off the map underneath

Figure VI.5

These two maps have not been merged. Section 6.2 explains how to do that. For now, save the map that contains your QTH.

20 To save this map, click File > Save DEM > EntireDEM, MD DEM and provide a name for the file, for example PoCo_East or PoCo_West. Save.

21 If this has worked, close MicroDEM
Now that the map is created and saved, the PRO profile files can be generated. This is done using the FAN utility in MicroDEM. FAN refers to radial lines, like spokes of a wheel, which will be the 5 degree azimuth profiles.

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You need to know your **exact** Latitude, Longitude and Elevation of your antenna tower base or antenna. This is critical to HFTA generating an accurate profile.

Location can be determined easily using Google Earth. Enter your address, zoom in on your location and place the mouse cursor at the exact antenna location and read Lat, Long and Elev. at bottom left of screen. Must be down to the last "second"   Make a note of your Lat. Long and Elevation and use it consistently if you want consistent reports.

22 Open MicroDEM. Click File > Open > Open DEM and look for the Poco file you saved. Open and the map will re-appear.

23 Click the Fan Icon on map menu bar or click Calculate > Intervisibility > ViewShed on MicroDEM menu bar.

24 Mouse over your approximate location on map and double click. Location window opens asking to enter Lat and Long, Figure VI.6. Enter exact data and click OK.
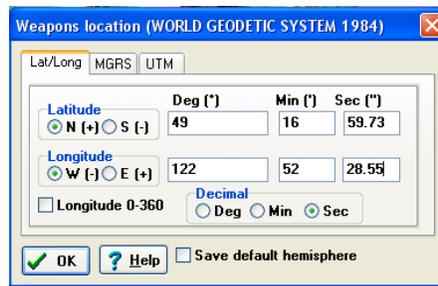

Figure VI.6

25 The ViewShed window, Figure VI.7 opens. This will generate the "FAN" of azimuthal radials at a 5 degree spacings resulting in 71 profile files being generated so that the terrain is determined in all directions.
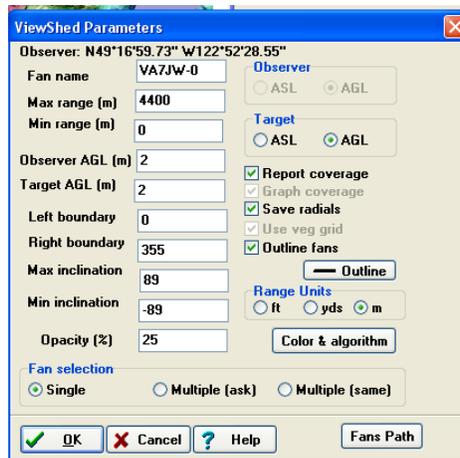

Figure VI.7

26 Ensure all entries are as shown except for the Fan name which you supply. Click OK.

27 MicroDEM will now generate the PRO files and place them in C:\mapadat\MD-PROJ\FANS under the filename you assign, such as VA7JW-0-XXX.PRO. XXX is the AZ angle. i.e. 10 = 10 degrees off true North etc

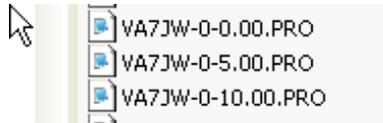28 Check in the above directory that the PRO files are there and appear as Figure VI.8.

Figure VI.8

29 The PRO files are now ready to use. Close MicroDEM.

Test

30 Open HFTA. Click in **Terrain File** field per step 5. Navigate away from the Terrain folder to C:\mapadate\ND-PRO-PROJ\FANS and click on one of your PRO files.

31 Click the **Ant Type** and Heights field and enter your antenna details.

32 Now click **Plot Terrain** and check that the plot works and looks sensible.

33 Now click the **Compute** button and view your vertical radiation pattern. It might displease you but that's not HFTA's fault.

If this is all OK, you are ready to characterize your QTH.

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Appendix VII
Other MicroDEM Features

MicroDEM offers some other features of interest and importance to characterizing your QTH.

This section presumes that maps have already been created for your areas of interest.

A. Distance

This utility will calculate a distance between two selected points. You may need to merge maps depending on distance to be measured.

Open MicroDEM > File > Open > Open DEM, and select your .DEM map file.

From the Main menu, click Calculate > Distance.

Mouse over the STARTING location (First Point) on the map (typically your QTH) and double click the map there.
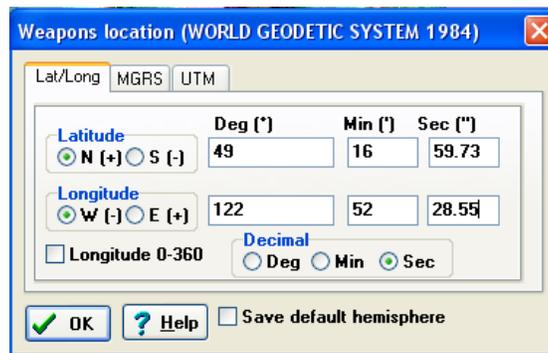

Figure VII.1

The Location window, Figure VII.1 opens and defines the start point. Enter the Lat and Long accurately.

Click OK.

A line appears and can be manipulated from the anchor point / starting location / QTH to a point of interest elsewhere on the map. Again double click to anchor the END (Second Point) per Figure VII.2.
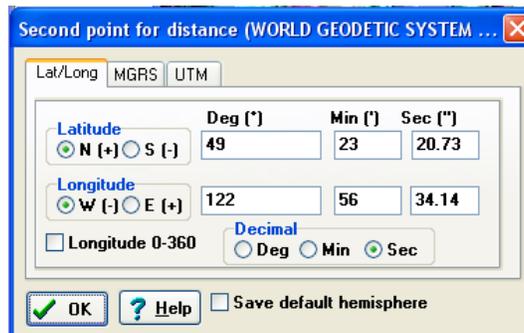

Figure VII.2

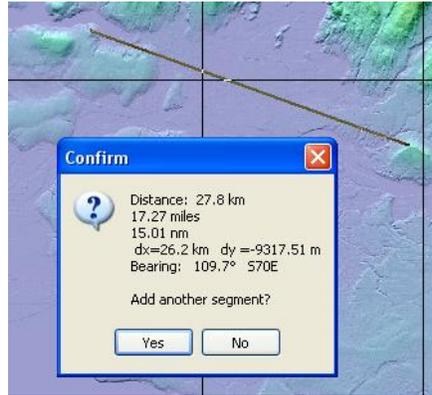A table appears, Figure VII.3 with the required info and more.

Figure VII.3

Close the map.

B. Line Of Sight (LOS) and Profiles

Open MicroDEM > File > Open > Open DEM, and select your .DEM map file.

From the Main menu, click Calculate > Indivisibility > Line of Sight.

Mouse over the starting location on the map and double click. The familiar position window will appear, Figure VII.4. Again, enter exact coordinates of your starting (QTH) site, same as Section A.

Click OK

Line tool is launched; drag loose end to the Line of Sight location and double click to anchor the line at desired position. End position window appears. Accept or refine the location by entering the Lat and Long.
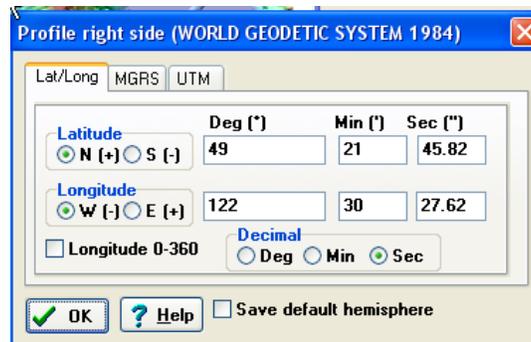

Figure VII.4

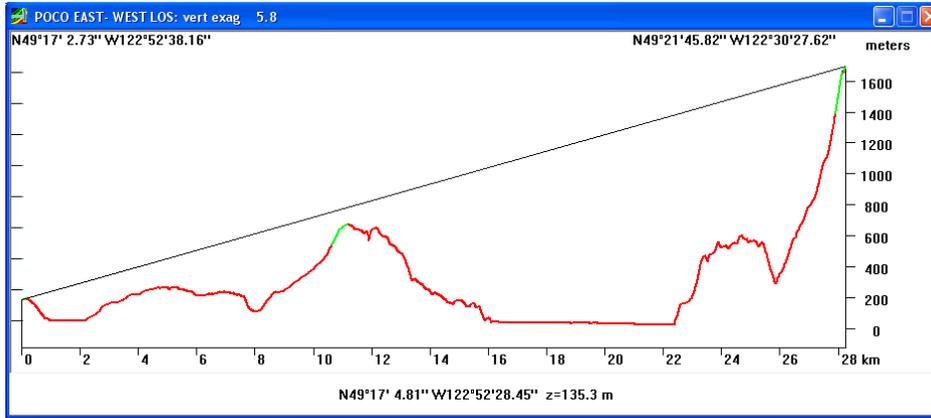Click OK and the LOS / path profile is presented per Figure VII.5.

Figure VII.5

Figure VII.6 shows the segment plotted on the map. Green is actual visible form QTH site. Red is not visible.
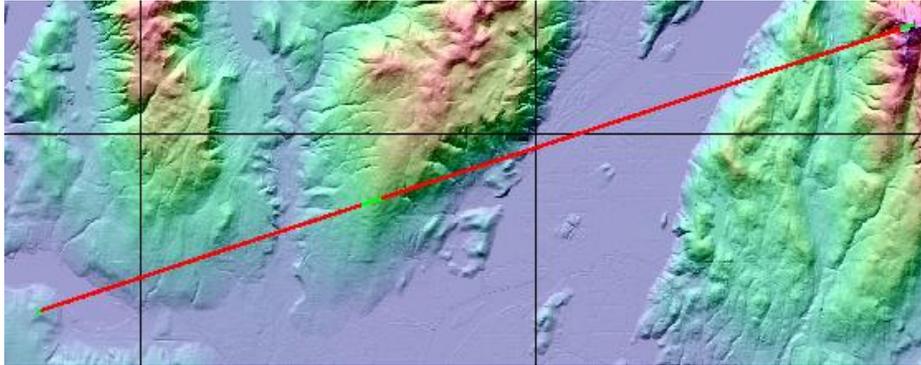

Figure VII.6

Close the map.

C. Horizon Blocking

Horizon blocking will plot the optical / radio horizon in terms of distance, degrees of elevation, around a full 360 degree azimuth, as viewed from your QTH. Note that the blocking horizon is the ultimate limit to your low angle radiation.

Open MicroDEM > File > Open > Open DEM, and select your .DEM map file.

From the Main menu, click Calculate > Indivisibility > Horizon Blocking.

As before, mouse over the starting location on the map and double click. The familiar position window will appear. Again, enter exact coordinates of your starting (QTH) site.

Click OK and the Horizon Options window, Figure VII.7 appears.

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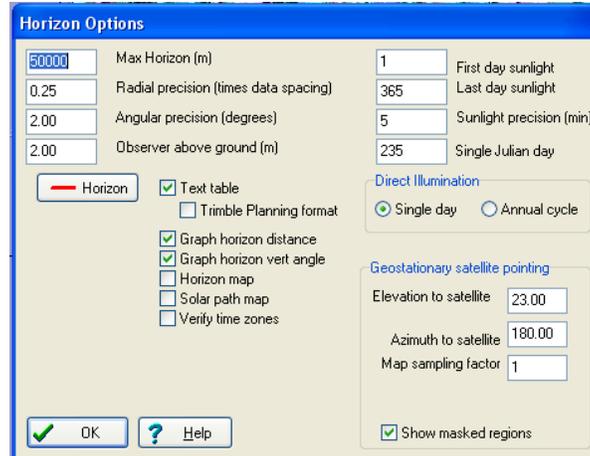# HIGH FREQUENCY TERRAIN ASSESSMENT

Figure VII.7

Most are default settings. The fields in the upper left may be the only fields that need to be adjusted. **Max Horizon** used is 50,000 meters ~ 31miles and **Angular precision** of 2 degrees. Click OK when done with entries and the calculations begin.

Two graphs, Distance to Horizon and Elevation to Horizon as well as a text file table appears.

The Distance and Elevation graphs get placed one on top of the other giving the impression that only one graph has presented. Drag the top graph of to the side to view both.

This is the Elevation angle to the blocking horizon for the QTH, Figure VII.8.
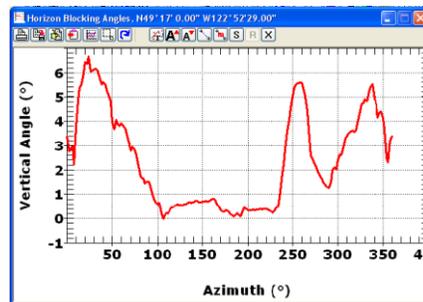

Figure VII.8

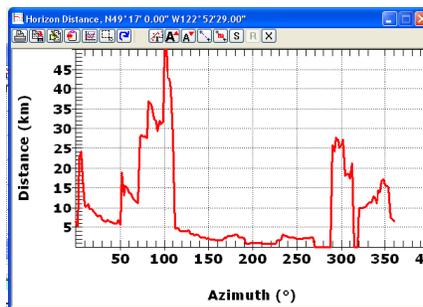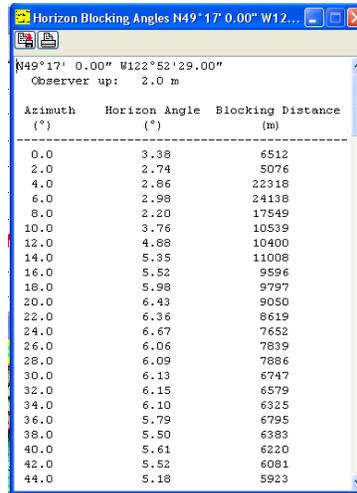This is the Distance to the blocking horizon for the QTH, Figure VII.9.

Figure VII.9

Text file of the first two graphs listing distance and elevation vs. azimuth, partial only shown, per Figure VII.10.


```
Horizon Blocking Angles N49°17' 0.00" W12...

N49°17' 0.00" W122°52'29.00"
   Observer up:   2.0 m

 Azimuth    Horizon Angle   Blocking Distance
  (°)           (°)              (m)
-----------------------------------------------
   0.0          3.38             6512
   2.0          2.74             5076
   4.0          2.86            22318
   6.0          2.98            24138
   8.0          2.20            17549
  10.0          3.76            10539
  12.0          4.88            10400
  14.0          5.35            11008
  16.0          5.52             9596
  18.0          5.98             9797
  20.0          6.43             9050
  22.0          6.36             8619
  24.0          6.67             7652
  26.0          6.06             7839
  28.0          6.09             7886
  30.0          6.13             6747
  32.0          6.15             6579
  34.0          6.10             6325
  36.0          5.79             6795
  38.0          5.50             6383
  40.0          5.61             6220
  42.0          5.52             6081
  44.0          5.18             5923
```

Figure VII.10

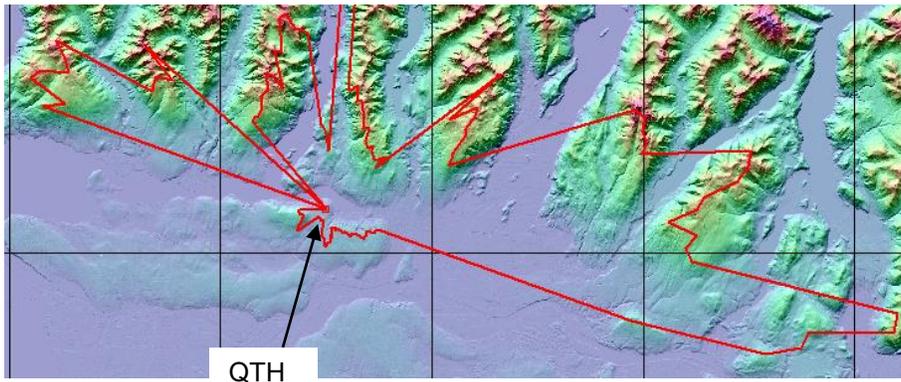Area limits covered on map also displayed per Figure VII.11.

QTH

Figure VII.11

Close the map.

D. Panoramic View

This is pretty "cool".

Open MicroDEM > File > Open > Open DEM, and select appropriate .DEM map file.

From the main Menu, click View > Panorama.

As before, mouse over the starting location on the map and double click. Enter exact coordinates of your starting (QTH) site. The familiar position window will appear, Figure VII.12.

Figure VII.12

Again, enter exact coordinates of your starting (QTH) site, same as Section A. Click OK.

The map presents with a ring centered on the QTH per Figure VII.13.
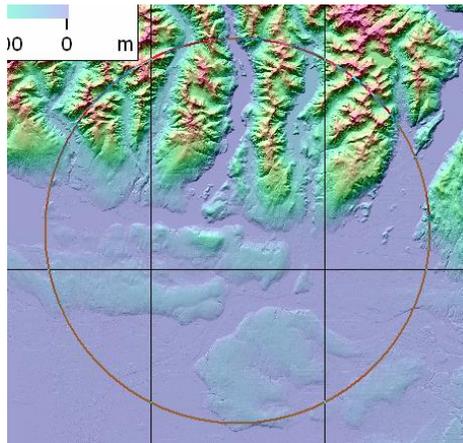

Figure VII.13

The mouse cursor is attached to the radius of view ring. The ring can be closed in or opened out.

The radius of view was set at ~ 10km based on the distance legend on bottom right of map. Double click when ring diameter is set.

A new Perspective window, Figure VII.14 opens with many settings.

I found to reduce foreground clutter, the default height of 250 meters works well to give the panoramic view.

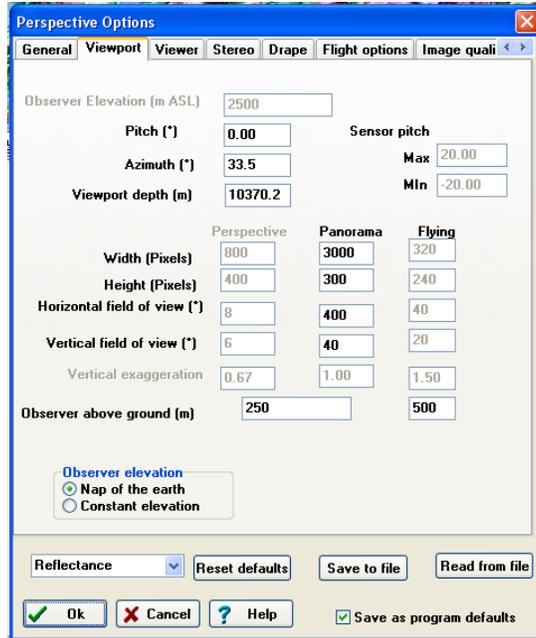Accept the other defaults. It works well as is.

Figure VII.14

Click OK and the Panorama viewing window, Figure VII.15 opens,
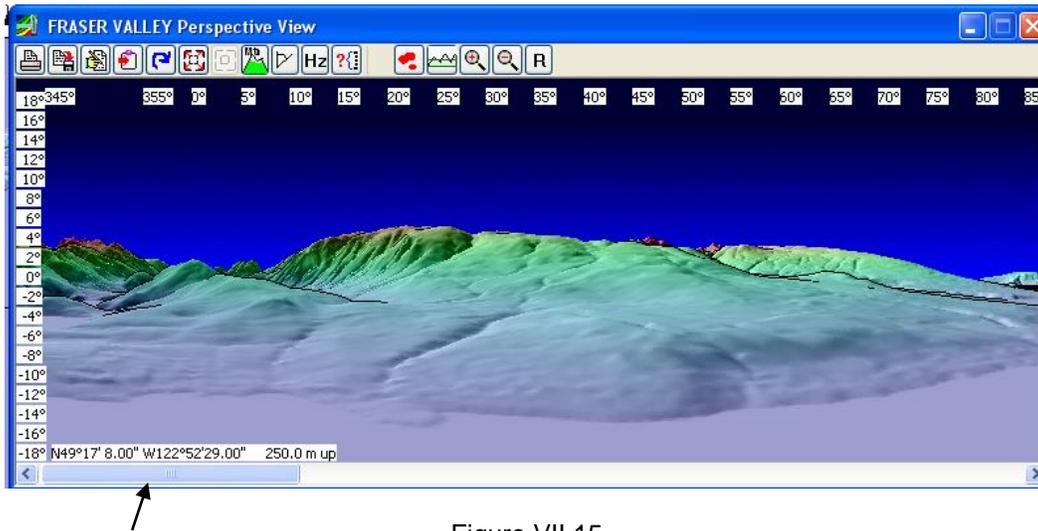

Figure VII.15

Use the scroll bar to take you through the full 360 degree view.

Close the map.

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References & Acknowledgements

REFERENCES

Refer to HFTA MANUAL dated 22 February, 2013, written by Dean Straw, N6BV which can be down loaded from ARRL. This manual will provide more information, and advanced instruction.

WEBINARS

1. Potomac Valley Radio Club,   http://www.pvrc.org/

    Go to Recorded webinars > Sept 24.   "Hints and Kinks for using HFTA".

2. World Wide Radio Operators Foundation, http://wwrof.org/category/webinar-archive/

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HFTA was written by Dean Straw N6BV while employed by ARRL as Senior Technical editor for many publications. The software is owned by ARRL and supported by Dean. Read about Dean's great contributions to the hobby.

http://www.arrl.org/news/arrl-quot-antenna-expert-quot-to-retire

I wish to thank Dean for this unique, terrific software tool. He has been more than patient with me and my questions, and exceedingly prompt and helpful in assisting this author to get HFTA and MicroDEM up and running.

I am hoping this introduction to HFTA will encourage others to try out this terrific resource. The MicroDEM mapping tool by Professor Peter Guth of the Naval Academy is extraordinary. Learning MicroDEM turned out to be a bonus as it opened up many mapping utilities that are of interest, such as measuring paths and distances as well as profiling the limiting horizon.

For enquiries, comments, discussions, errors, contact VA7JW as below.

Disclaimer

The author is NOT an expert user. I wrote this instruction set as I worked my way through the setup and thought it might be helpful to others who also wanted to give this tool a try. MicroDEM is a powerful application with numerous settings and menus, most of which I know nothing about. Leave the defaults as is, and change only the settings as directed.

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