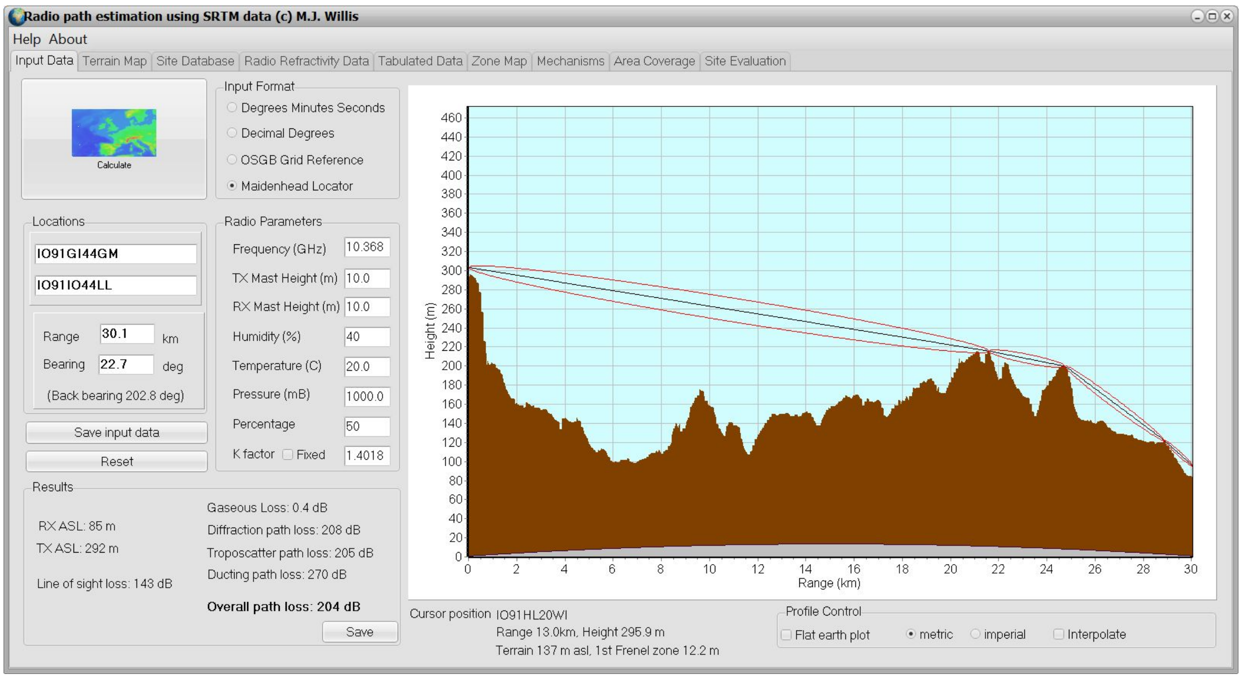
Introduction

Microwave Path Profile Generator

This software is beta and I can accept no responsibility for anything it might do. To get it to work, put it in a directory along with the SRTM .HGT or ASTER .HGT files for the region you are interested in.



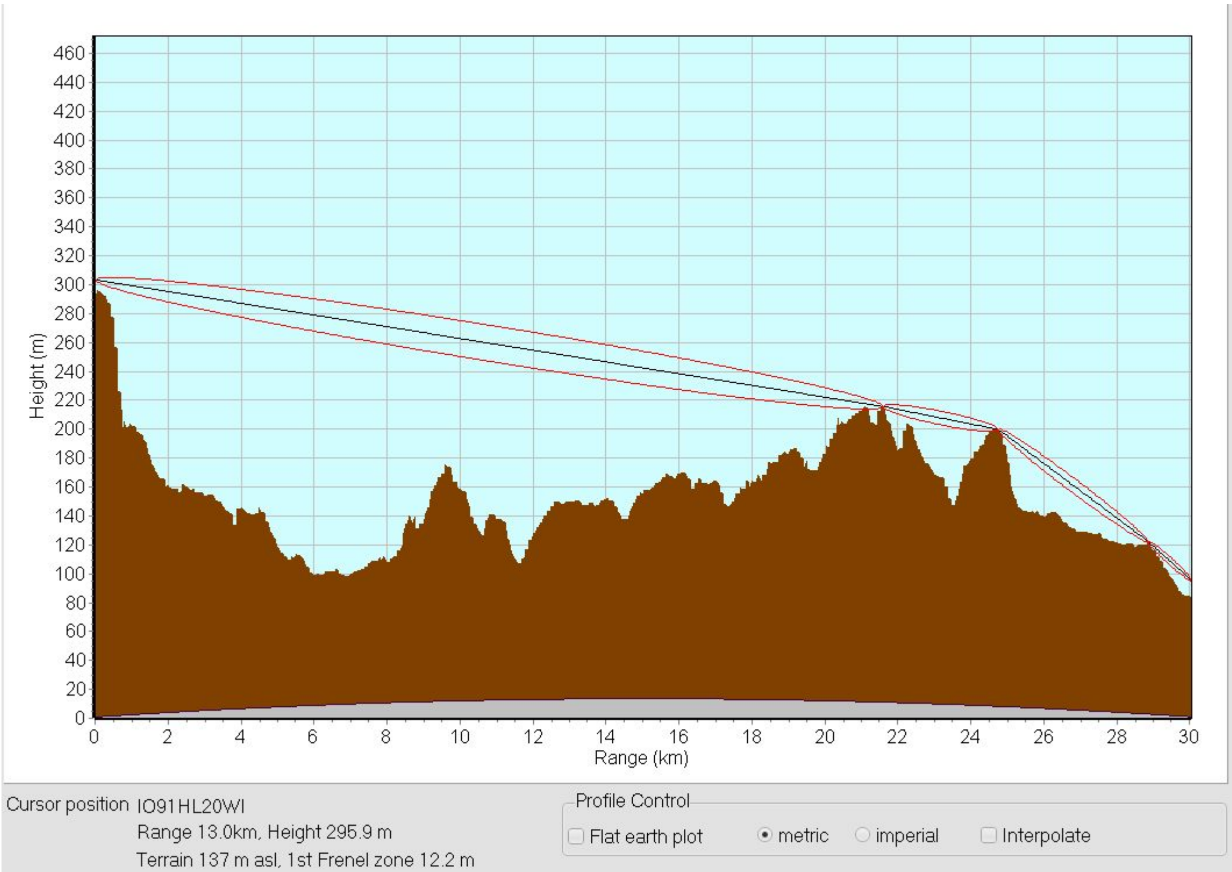
This package grew out of a requirement needed to quickly generate path profiles, which it can write out for use in other prediction programmes. It now includes a propagation model based on the initial version of ITU-R recommendation P.1812, with some modifications. This model used the 3 edge Deygout diffraction model and several other elements of the ITU-R P.452 recommendation. Nwever models, including Delta Bullington, have not been included here as I am not sure they actually improved predictions all that much. Strictly it is valid between 30MHz and 3 GHz, but all Ionospheric effects are ignored. The path lengths are valid from 1km to around 1000km, though odd, non-physical things can happen for short paths at very low time percentages. Use common sense, if it violates the laws of thermodynamics, its wrong. To make this useful for higher microwaves I have added in gas losses using the line by line model from ITU-R P.676 (one of ther modifications). This increases the maximum frequency limit to 24GHz and above, with increasing schepticism. Most of the models should be good to at least 30GHz. The gas losses are good to 300GHz. The troposcatter model is not so good at any frequency and can't be relied upon at the higher frequencies, but the loss is ususally huge anyway. Also rainscatter is not included.

One important thing that is missing from the model is the effects of clutter - that is buildings, vegetation etc. The reason it is not thre is because there are no free clutter databases available. Clutter is most important near the terminals and if you know there is no clutter you can ignore it. If you know there is clutter, expect the path loss to be higher than indicated. Also missing are aeroplanes which can provide reflections bypassing the lossy terrestrial paths.

Code was written by Mike Willis based on software by Jonathan Naylor and Chuck Gantz and ideas by Andrew Talbot, Ken Craig, and Ian White. Several others including Chris Townes and Ian Lamb contributed to the testing There are undoubtedly many bugs in this beta version. Feedback on bugs may help me find and fix them.

Profile

The profile displayed is that taken from SRTM or ASTER data. It is more or less accurate, but note that 1 or 3 arc seconds is still a fairly course grid. Depending on the path length, the programme will attempt to use no more than 2000 points. Points are initially spaced at 50m intervals with the spacing increased as required.



The profile shows the earth bulge corrected for the effective earth radius based on the value in the K-Factor box. Usually a 4/3 effective earth radius is used. In order to see the terrain for longer paths, there is an option to flatten out the earth bulge - this is only a visual aid and has no effect on the profiles.

There is a checkbox to select the units for display, metric or imperial. Internally, everything is in metres.

Therefore

Selecting the metric option gives height in metres and distance in kilometres.
Selecting the imperial option gives height in feet and distance in miles.

You can zoom in and out of the profile and save it to the clipboard.
Hovering over the profile with the cursor will give a reasout of the locator of the point on the path under the cursor
Double clicking will copy to the clipboard.
As well as the profile, the first Fresnel zone is shown along with a streched string representation of the path. If there is blockage in the first Fresnel zone, there may be some additional diffraction loss.

Data Entry Panels

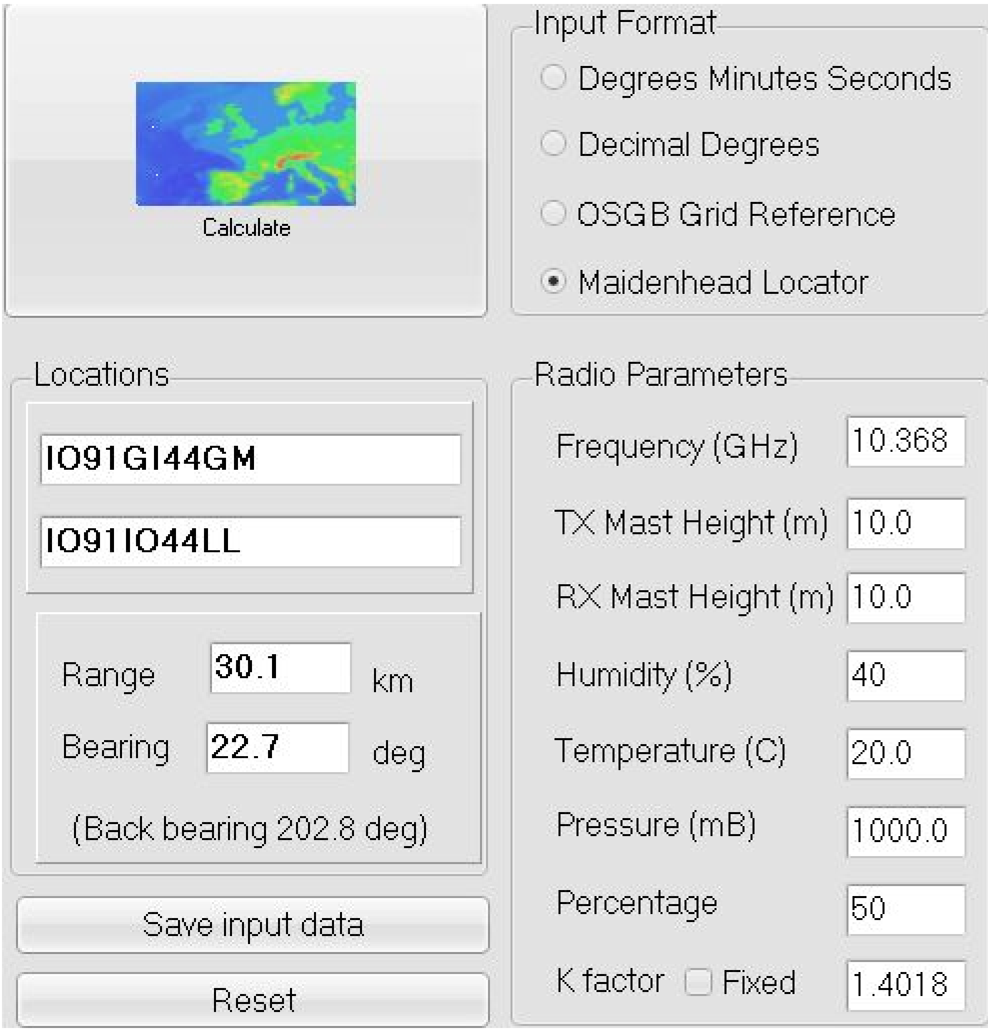
The main screen of the programme is used for data entry.

Start (Transmit) and End (Receive) locators may ented along with frequency (validity 30MHz-30GHz), the key station parameters and the key met parameters. You can either enter two locators or a start point plus a distance and bearing.To select the latter, click on the entry panel

In the location data panel, select the format and enter the path data in each field. The format can be one of:

Maidenhead - Enter the Maidenhead locator e.g. IO91IN - you can have up to 10 characters
UK NGR - Enter the UK OSGB NGR, e.g. SU100200
Decimal Degrees - Enter the Latitude and Longitude in decimal format e.g. 51.525 N 1.55 W
Deg, Min, Sec- Enter the Latitude and Longitude in DMS format, e.g. 51 36 32 N 1 13 32 W

With distance in km and bearings in degrees. Site names are planned for a future enhancement.



The radio parameters are entered in the adjacent panel. The format is fairly obvious.

It is possible to save the entered data as an ini file called profile.ini. This file, located in the program directory is loaded on startup. If the program is crashing on start up, the ini file is probably corrupt. Delete it , the program will enter some default values and you can then save a new ini file.

Maidenhead Locators

The maidenhead locator was invented to provide a worldwide simple to use locator based on latitude and longitude.

The format is recursive with alternating pairs of numbers and letters. The first character representing Latitude and the second Longitude. Resolution increases with the number of pairs of digits. More than 5 pairs is unusual and therefore not supported by this program.

UK OSGB NGR

The UK NGR is based on a projection of an ellipsoid to allow a curved surface to be represented on a flat map. It is only valid for the UK - attempts to convert non-UK locations to NGR will produce an "INVALD" locator.

The ellipsoid used in the OSGB36 datum which was invented in 1830 by the Astronomer Royal, Sir George Airy. The calculations in this programme are fairly detailed and should give results accurate to a few metres. Beware of Ellipsoids. GPS data is often based on WGS84. Using the incorrect ellipsoid can result in errors of several 100m.

The UK national grid reference should be entered as a two letter plus 4 digit, 6 digit or 8 digit locator.

E.g. SU59, SU500900, SU50009000

The more digits the higher the accuracy - 8 is generally more than enough resolution unless you are into surveying. These locators are commonly printed as a grid on UK Ordinance Survey maps.

The grid covering the UK is 700km by 1300km. The letters indicate the large square, the first letter represents a 500x500km square and can be S,T, N, O, H or J. Placed over the UK as below, with North being at the top.

H J
N O
S T

The second letter represents a 100kmx100km square within the 500km squares. It can be any letter except I. The format is:

A B C D E
F G H J K
L M N O P

Q R S T U
V W X Y Z

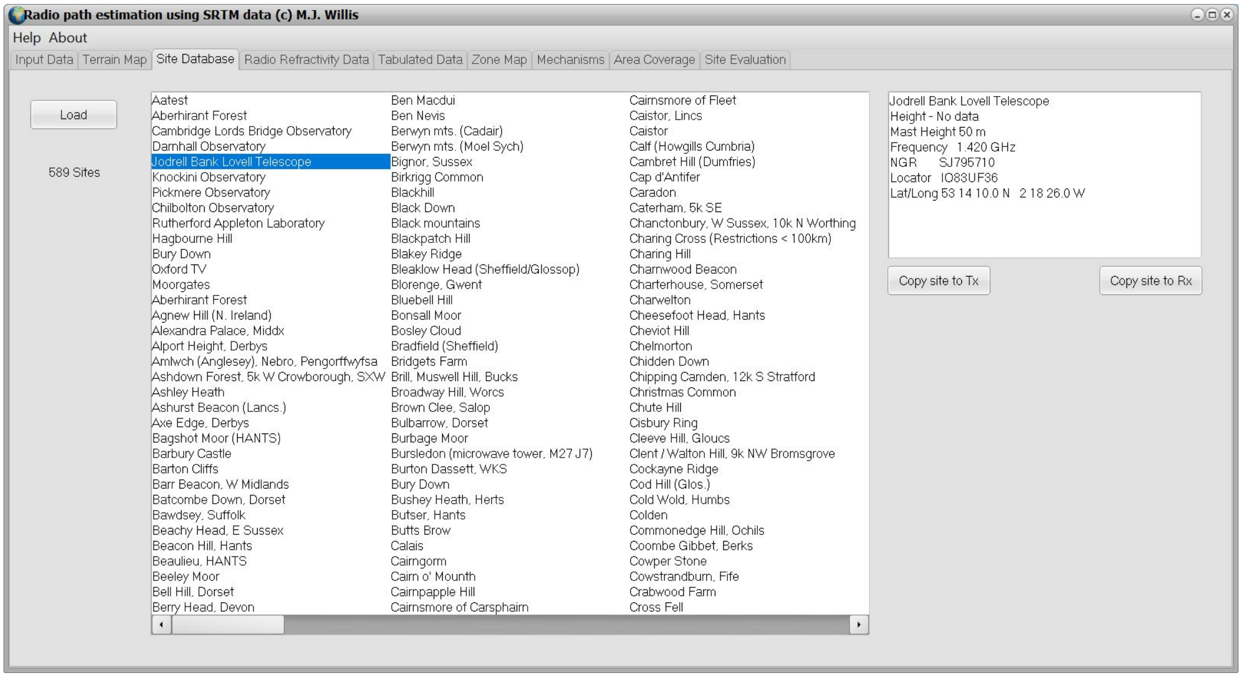
The numbers are then the range East and North of the bottom left corner of the square. With 2 digits, the first is East and the next is North. Naturally, the digit is in units of 10km. With 2 digits, the first 2 are East and the next 2 North in units of 1km and so on for increasing numbers of digits.

Not all grid squares contain land and as there is a false zero, the easiest way to picture it is as an image.

It is also possible to avoid all these complicated letters and numbers and simply quote two numbers, the distance East and distance North of the reference point, which is at the bottom left of the map. The distance is usually expressed in metres.

Site Database

This tab allows a site database file to be loaded. Once the database is loaded, sites can be selected and transfered to the TX and RX boxes in the input data screen.



A sample is provided, the file is plain ascii. It is possible to edit it in notepad. The format is clear from the examples and the program makes an attempt to distinguish between NGR and Maidenhead locators.

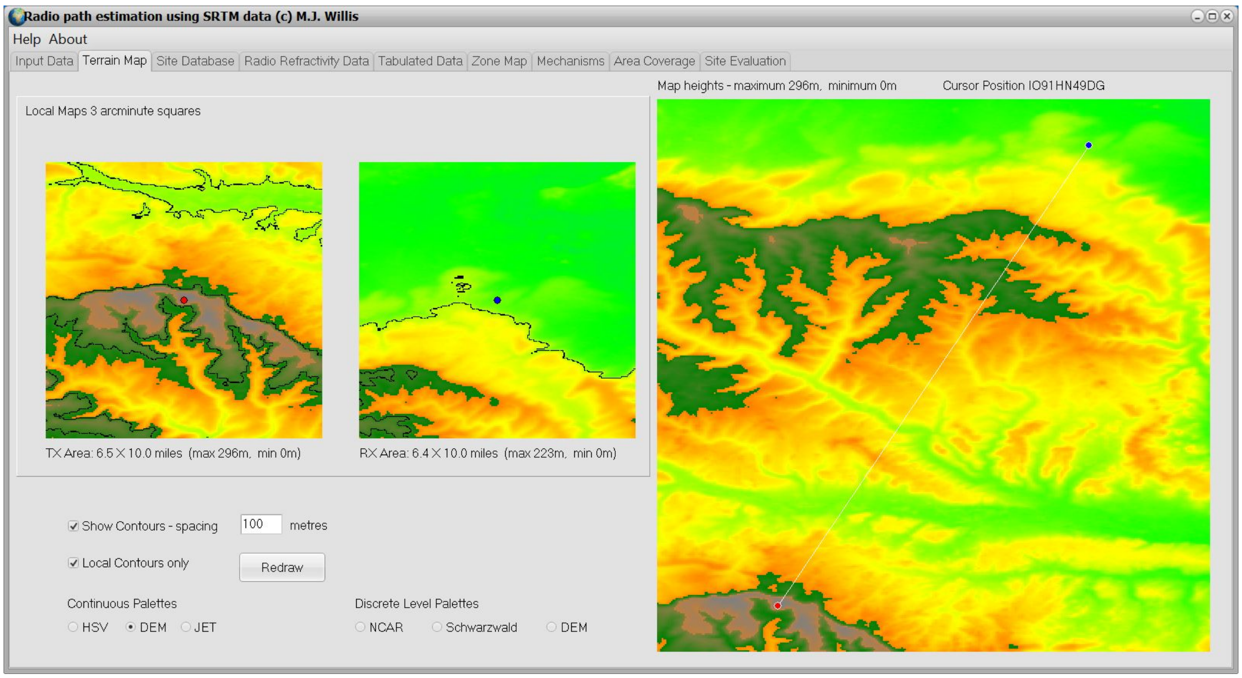
Here is a sample showing OSGB and Maidenhead inputs - the last item, e.g. "ph12" is not used as most sited don't have it.

GB3ALD - Alderney, 1k NE St Anne, 10100 MHz~XD864799
GB3AMU - ~IO81JN
GB3ANG - ~IO86MN~ph9
GB3AND - ~IO91GF
GB3CEM - Wolverhampton,10368.88MHz~IO82WO~ph9
GB3CLE - Clee Hill, 1296.91~IO82RL~ph9

GB3SCS - Bell Hill, Dorset 2320.905MHz~ST800082~ph12

Terrain Map

This screen shows the terrain along the selected path and also the terrain close to the transmitter and receiver. For very long paths, it can take a while to load.



Note the terrain map is only generated once a path has been calculated. This is to prevent slow program startups.

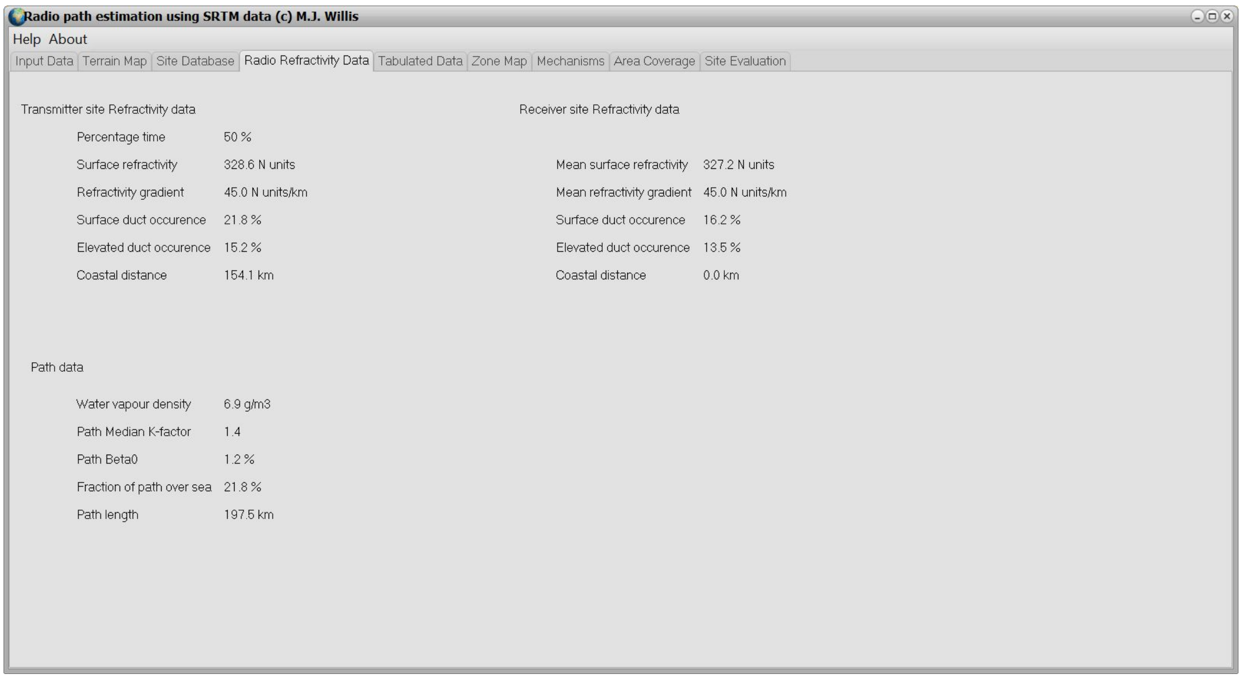
Colour coding is used to represent height, the scale is automatic based on the maximum and minimum in the area. Several different colour maps are available.

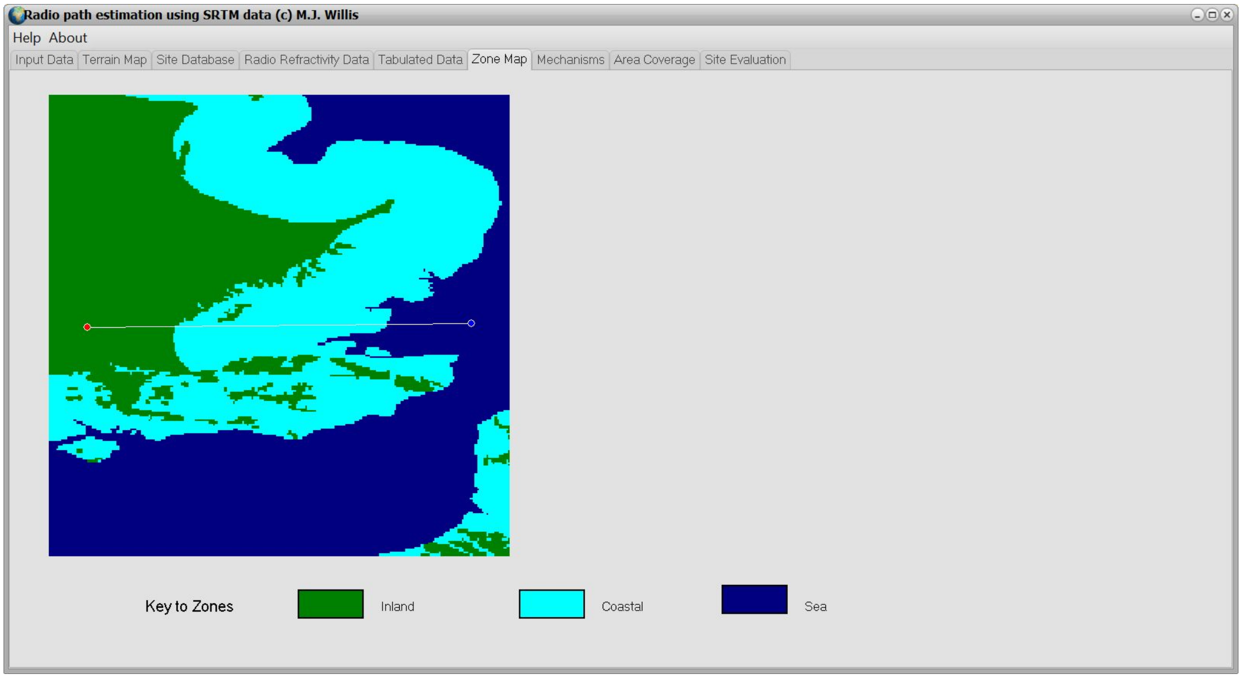
Hovering over the large map with the mouse will show the locator (in the selected format) of the point under the cursor. This can be useful in identifying local high spots.

Radio Refractivity Data

These are the values read from the ITU maps and calculated in the software. They are provided to be used as inputs to other propagation models.

Coastal distances are measured along the path. If the coastal distance is -1 it implies the path is entirely inland.




Radio path estimation using SRTM data (c) M.J. Willis
Help About
Input Data
Terrain Map
Site Database
Radio Refractivity Data
Tabulated Data
Zone Map
Mechanisms
Area Coverage
Site Evaluation
Key to Zones
Inland
Coastal
Sea

Tabulated Data

This panel provides access to the path profile data.

Double clicking on the data will allow a filename to be specified to save the data in.

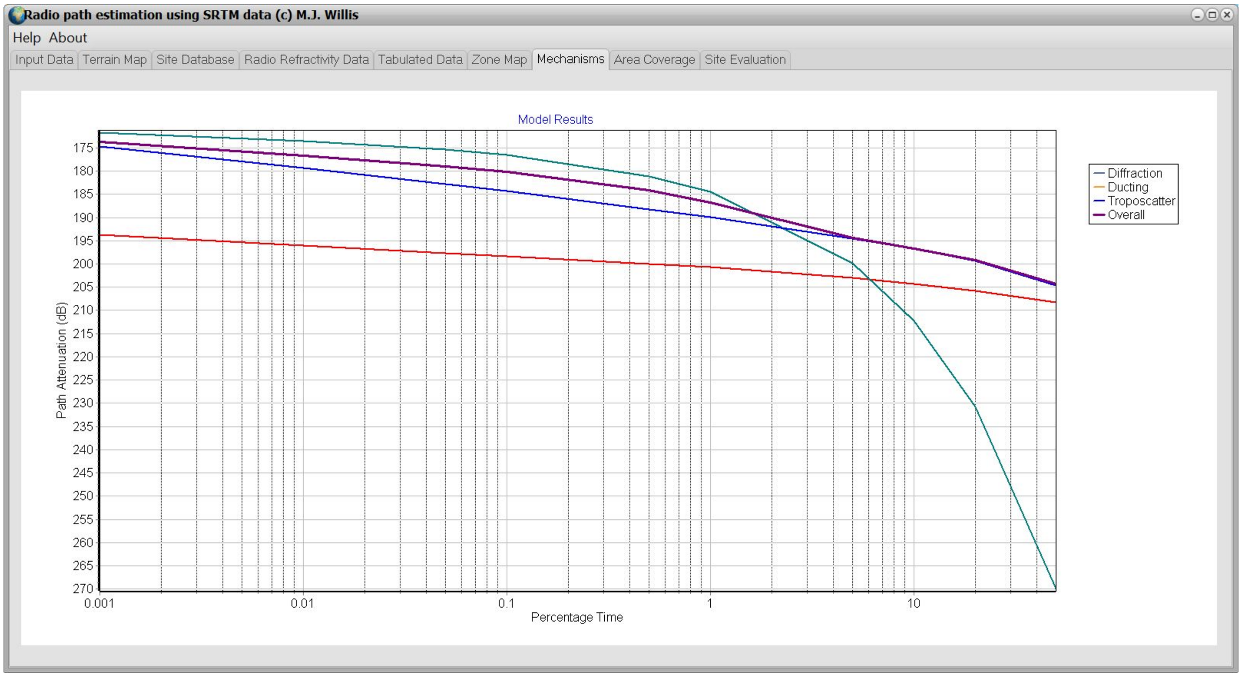
The output file format has been designed to be compatible with the ARRL HF Terrain Assessment program HFTA . One thing you must be aware of is the limitations of the database with about 90m steps and some artefacts in hilly terrain due to the method of collection. If you have a better idea of your local terrain, say from an OS map, use that.

The file is plain text and the format looks like this:

meters
0, 65
50, 54
100, 57
150, 57
....

Mechanisms

This graph shows the contribution at various time percentages for each propagation mode. The format is as a cumulative distribution for enhancements.



To make sense of it, look at a time percentage, say 1%. Then read the level. The Y axis then shows what the minimum path loss you can expect for that time percentage.

What this means is, for less than that time percentage, e.g. under 1% of the time, the path loss will be lower that the figure read. This is of great interest in interference studies but the other end of the distribution, i.e. what is the maximum path loss that will not be exceeded for a given time percentage is of more interest to link planners.

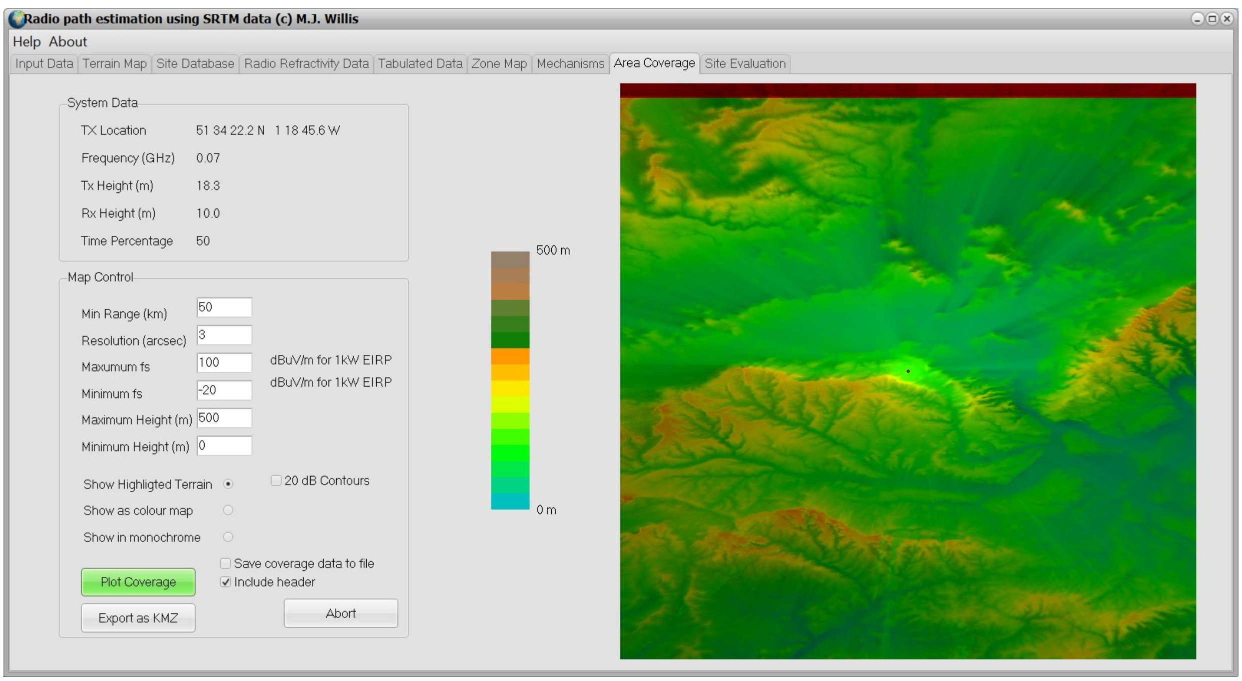
Radio amateurs are usually more interested in the enhancement side of the distribution, which is what this program predicts. The level of most interest when evaluating a site is the 50% level. This is the most likely at any given time, e.g. in a contest. But, if you are planning a location where you intend to stay, or to put a beacon, the lower time percentage figures then become important.

Area Coverage

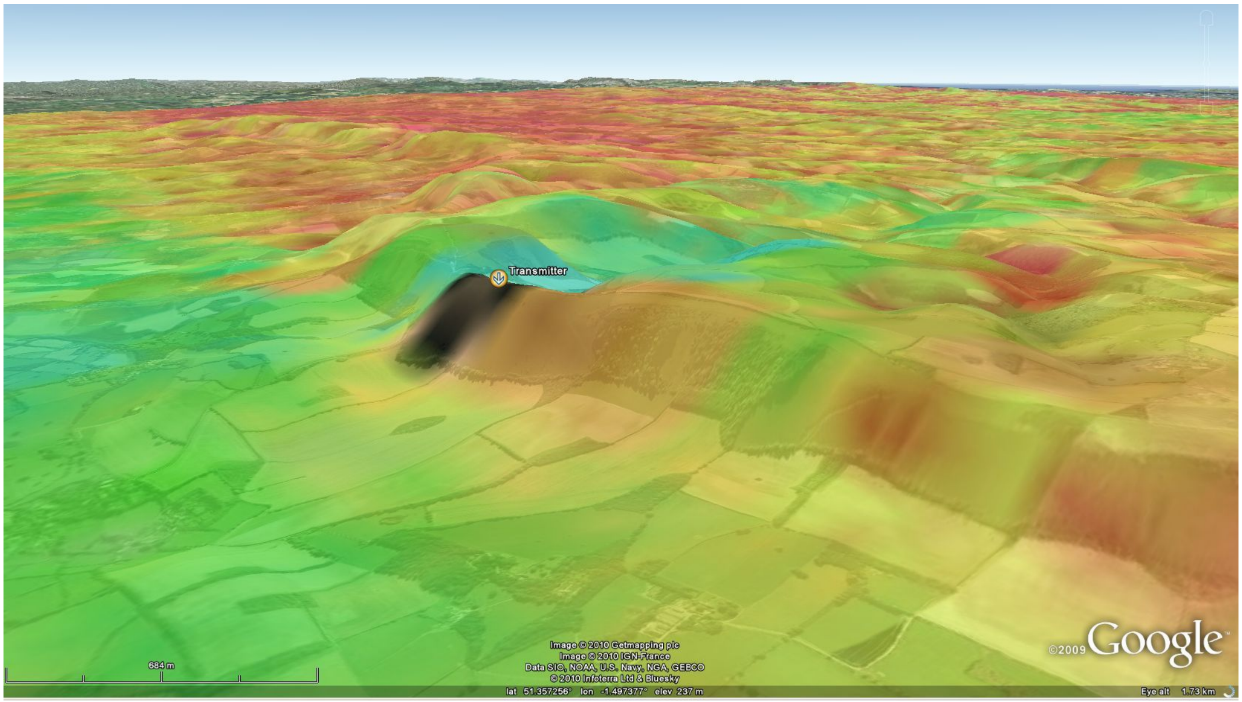
This can take a while - several minutes for example but is worth it. The aim is not just to make nice pictures, the figures show what area coverage you would get from a given site. In this case only the TX location data is used and the RX data is ignored. The time percentage is used, so you can do a 1% enhancement area coverage plot if you like.

The plot can be in terms of a colour or black and white indication of path loss, or my favourate which is to highlight the terrain - hough this gives no real quantatative information on the actual path loss it looks good.

Here is an example plot of the predicted coverage of a GB3RAL beacon. The site is good to the North but has the Ridgeway to the South.



The data can be exported as a KML file for further processing in Google Earth.


Transmitter
684 m
Image © 2010 Getmapping plc
Image © 2010 IGN-France
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2010 Infoterra Ltd & Bluesky
lat 51.357256° lon -1.497377° elev 237 m
©2009 Google
Eye alt 1.73 km

ASTER Data

In 2009 the ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) terrain data was released to the public by JAXA/NASA. This data has a resolution of 1 arc second (approx 30m pixels) for much of the world. ASTER data can be downloaded from USGS https://asterweb.jpl.nasa.gov/data.asp . You must register to get the data but beware, because of the increased resolution the tiles are 25Mb each.

When you unzip the utility you will notice several data files - these need to be in the same directory as the program. On a first run, it will probably ask you where the terrain data files are. Just select any one of the SRTM or ASTER files and it will be OK. If you then save the input data it should find it on subsequent runs.

SRTM Data

The Shuttle Radar Topography mission (SRTM) mapped the world using a radar from orbit. The database generated by the mission has been used to generate accurate terrain height data between latitudes 60S and 60N. The data that is publicly available is provided on a 3 arc second grid in latitude and longitude. To make file sizes reasonable, this public data is split up into tiles of 1 degree latitude and longitude with the filename based on the location of bottom left corner.

The point 50.1N 15.1E would therefore be found in the STRM tile n50e015.

<u>Finding the Data</u>

The SRTM 3 arcsecond data is a fair compromise between resolution and size. The software can make use of the complete SRTM database but as each tile is 2 Mbytes of data, it is often best to only download the tiles for areas you are interested in. Any files not available will simply be treated by the program as representing sea.

This program requires the .HGT format files to generate a path profile. These .HGT files are the most widely available and recently corrected versions of these files produced by enthusiasts have been made available. These enhusiasts have also developed SRTM format files for regions not covered by the original database, e.g. Iceland.

STRM data is also available in .BIL format, which this program does not support. Data is available for download and also can be bought on DVDs. Useful link (may be out of date but OK early 2006)

http://srtm.usgs.gov/

If you are in the UK, you probably want to download all the files between 50N and 60N and -10W to 2E. Each tile is just under 3Mbytes and you need 130 of them to cover the UK. This compresses down to under 200Mbytes but is still a lot of downloading, so it best to start off with only one or two local tiles.

If they are zipped, DO NOT USE WINZIP to decompress them without first checking you have disabled the "smart" CR/LF substitution. Each file should be exactly 2,884,802 bytes.