Radio Mobile Coverage Application

Introduction to an Online VHF/UHF/+GHz Tool

CCARES Meeting, May 20, 2025

Ron – K8RJH

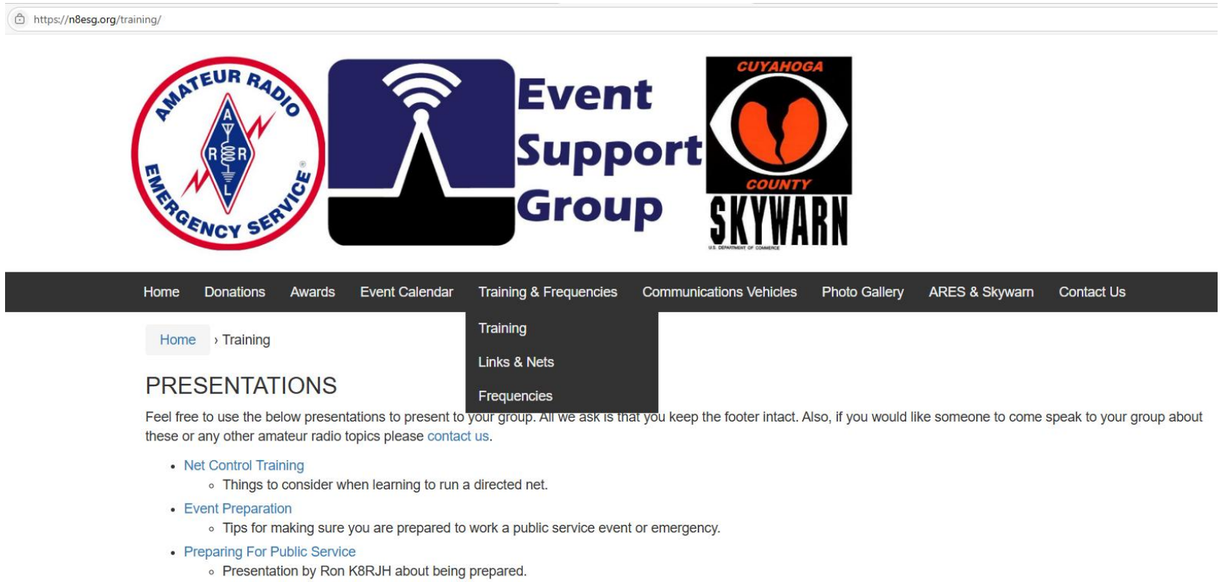
Radio Mobile Coverage Application

Exploring Coverage Prediction & Network Planning

Radio Mobile Coverage Application

Presentation may be downloaded at:

https://n8esg.org/training/



Event Support Group

Are you interested in knowing your VHF station coverage range?

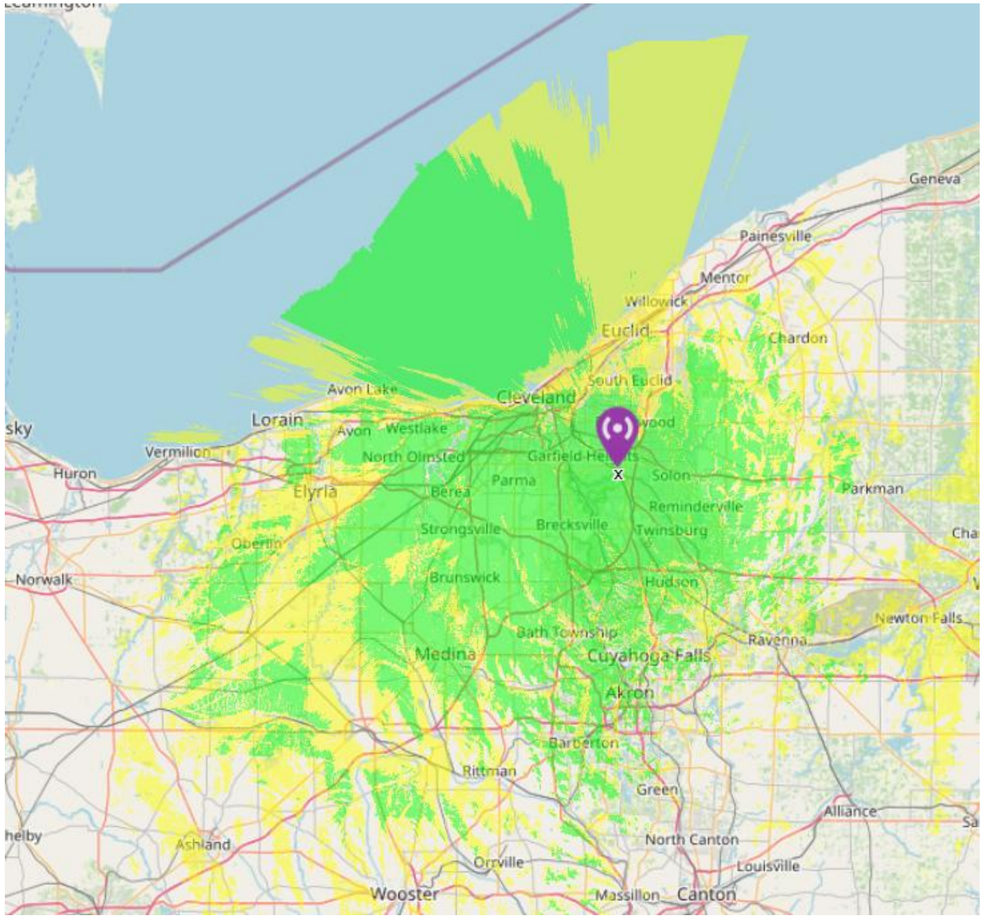
New Coverage

From: K8RJH 146 MHz

Centre Site	K8RJH	
Antenna Height (m above ground)	10	32.81 ft
Antenna Type	Omni	
Antenna Azimuth (°)	0	
Antenna Tilt (°)	0	
Antenna Gain (dBi)	6	
Mobile Antenna Height (m)	2	6.56 ft
Mobile Antenna Gain (dBi)	2	
Description	K8RJH 146 MHz*	
Frequency (MHz)	146	
Tx power (Watts)	20	43.01 dBm
Tx line loss (dB)	3	
Rx line loss (dB)	0.5	
Rx threshold (µV)	0.5	-113.02 dBm
Required reliability (%)	70	
Strong Signal Margin (dB)	10	
Strong Signal Color		
Weak Signal Color		
Opacity (%)	50	
Maximum range (km)	100	62.1371 mi
Rendering	Very High resolution	
Use land cover	☑	
Use two rays	☑	

Define as default values | Restore original values

Submit



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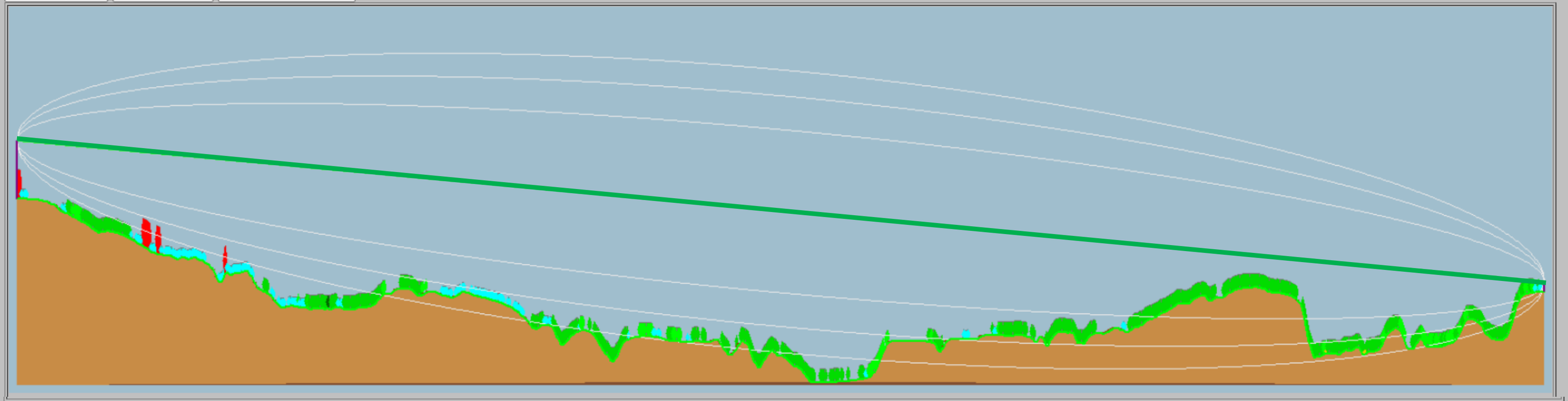
Or the path profile from your station to a repeater site?

Add to my links | Modify this link | Return to main menu



K8ZFR - Blossom Hill (1)			(2) K8RJH		
Latitude	41.305111	°	Latitude	41.391302	°
Longitude	-81.661531	°	Longitude	-81.539300	°
Ground elevation	379.0	m	Ground elevation	283.1	m
Antenna height	60.0	m	Antenna height	10.0	m
Azimuth	46.75 TN | 55.34 MG	°	Azimuth	226.83 TN | 235.51 MG	°
Tilt	-0.66	°	Tilt	0.53	°

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Or the path profile from your station to a repeater site?

New Link

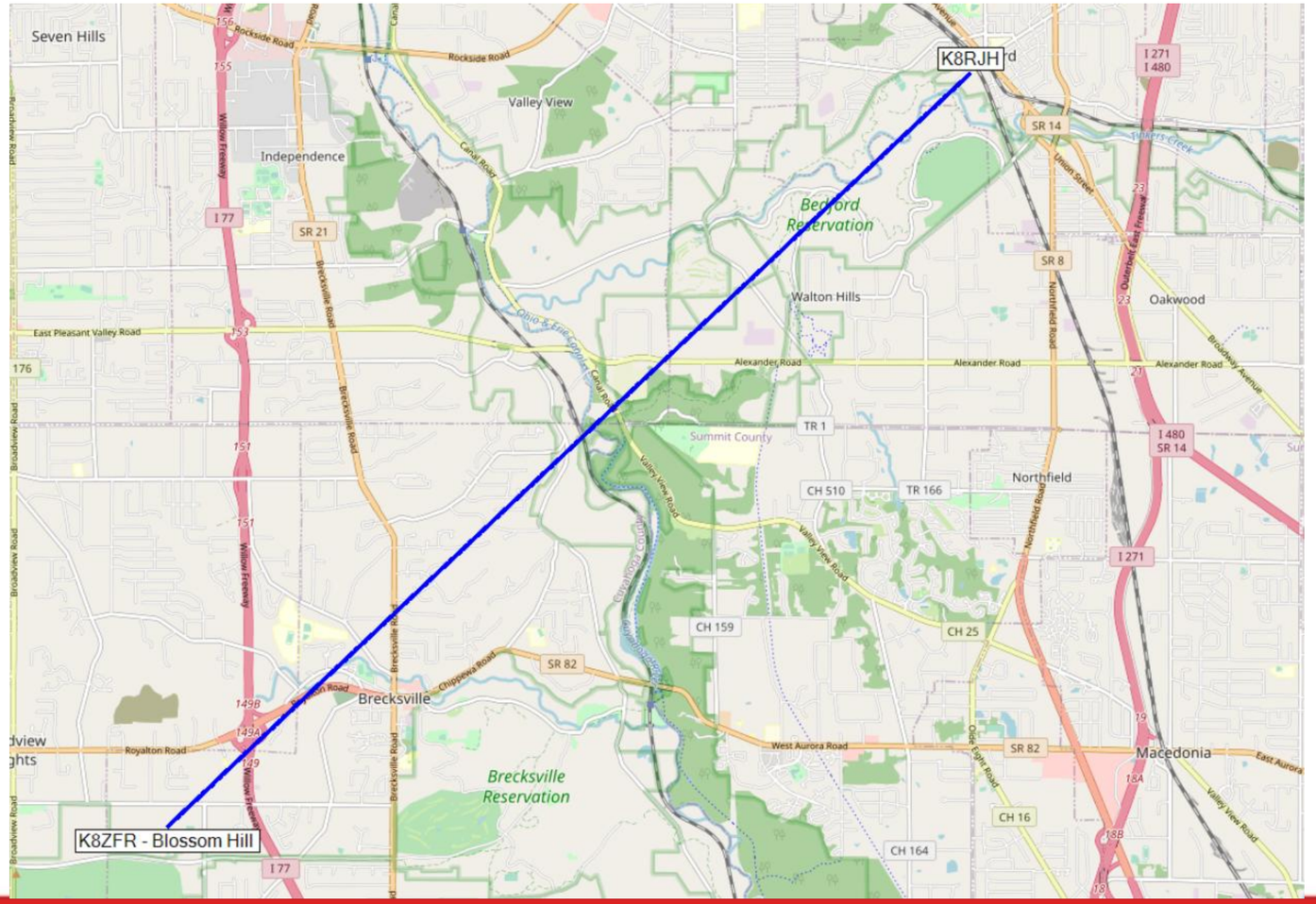
-

From	K8ZFR - Blossom Hill	
Antenna height (m above ground)	60	196.85 ft
To	K8RJH	
Antenna height (m above ground)	10	32.81 ft
Description	Radio link study 2	
Frequency (MHz)	146	
Tx power (Watts)	20	43.01 dBm
Tx line loss (dB)	3	
Tx antenna gain (dBi)	6	
Rx antenna gain (dBi)	2	
Rx line loss (dB)	0.5	
Rx threshold (µV)	0.5	-113.02 dBm
Required reliability (%)	70	
Use land cover	☑	
Use two rays	☑	

Define as default values | Restore original values

Submit

Cancel



Radio Mobile Coverage Application

What is Radio Mobile?

- **An on-line software tool used for radio propagation modeling**
- **Designed for network planning and coverage analysis**
- **Utilizes digital elevation models (DEMs) for accurate simulations**

What is a digital elevation model (DEMs) ?

A Digital Elevation Model (DEM) is a representation of Earth's surface that captures elevation data in a digital format.

It provides a detailed, three-dimensional view of terrain by storing elevation values at regularly spaced points.

DSM Model of Downtown Cleveland, Ohio

What is a digital elevation model (DEMs) ?

There are two primary types of DEMs:

- **Digital Terrain Model (DTM)** – Represents the bare-earth surface, excluding buildings, vegetation, and other structures.
- **Digital Surface Model (DSM)** – Captures elevations of all features, including trees, buildings, and other objects on the landscape.

DEMs are typically created using remote sensing techniques like LiDAR, satellite imagery, or photogrammetry. They are an essential tool for geographic information systems (GIS) and can help visualize terrain for various scientific and practical purposes.

DSM Model of Downtown Cleveland, Ohio

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What is the Radio Mobile link and coverage application?

There are many programs that can be used to simulate radio links and base station coverage, some of which cost thousands of dollars.

By using an on-line link simulator, you can save considerable time during link planning and analysis.
For example, if a link is proven to be impossible in simulation, there is little need to perform a site survey, and other options have to be considered (such as the use of repeater sites).

Radio Mobile is a free program developed for radio amateurs by Roger Coudé that is based on the well known Longley-Rice Irregular Terrain Model and predicts radio propagation, making use of several sets of freely available Digital Elevation Maps.

What are the options to on-line Radio Mobile link and coverage application?

- **VHF Propagation Path Profiler**: A web-based application that graphically renders and computes various VHF/UHF propagation metrics, including terrain effects and atmospheric refractivity.

- **TAP Software**: A comprehensive RF design and analysis tool that includes multiple propagation models such as Longley-Rice, Okumura, and Bullington. It supports path analysis, area coverage studies, and interference analysis. Prices range from **$5,270.76** for basic coverage studies to **$11,205.74** for advanced area coverage studies

- **CloudRF**: Offers online RF planning tools with pricing based on subscription tiers.

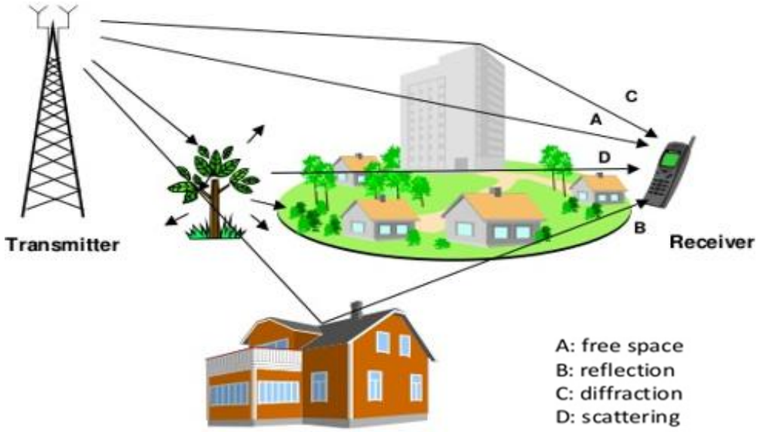
(Check with your mobile radio vendor for private brand options)

What is the Longley-Rice Model?

Key Features; (**Used by Radio Mobile**)

Frequency Range: Designed for frequencies between 20 MHz and 100 GHz.
Terrain Consideration: Unlike simpler models, Longley-Rice accounts for irregular terrain, making it useful for real-world applications.
Prediction Modes:

- Point-to-Point Mode: Estimates signal loss between two fixed locations.
- Area Mode: Provides broader coverage predictions over a geographic region.



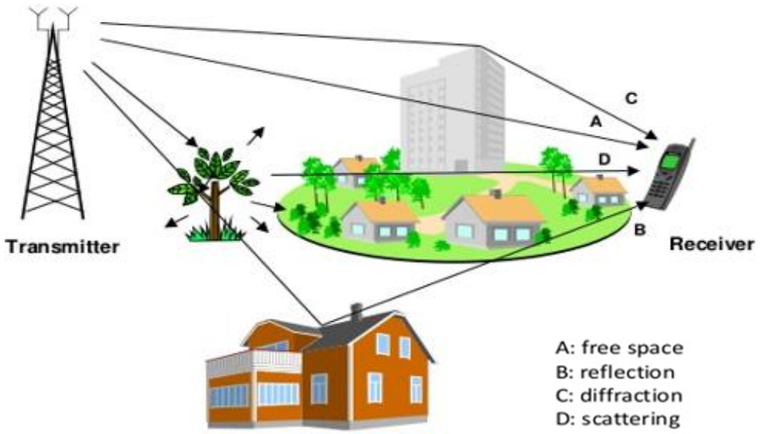
Multi path propagation effect

What is the Longley-Rice Model?

Key Features; (**Used by Radio Mobile**)

Propagation Mechanisms:

Line-of-Sight: Direct transmission when no obstacles exist.
Diffraction: Signal bending around obstacles like hills or buildings.
Scatter: Signal dispersion due to atmospheric irregularities.
Statistical Variability: The model incorporates situation, time, and location variability to refine predictions.



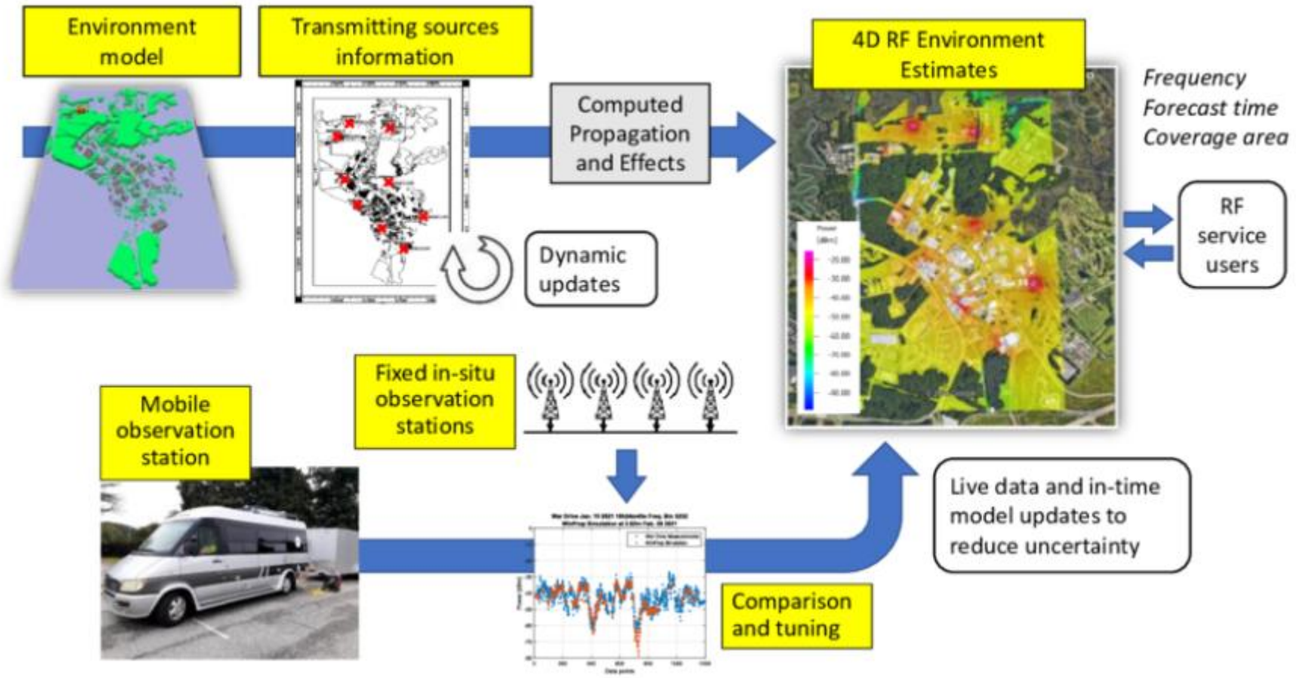
Multi path propagation effect

Are there other Evaluation Models?

Durkins's Model: Designed for detailed evaluation of irregular terrain and losses caused by obstacles in a radio path.

Okumura Model: Optimized for 150 MHz to 1920 MHz. Does not contain complex computations or elaborate theory. Good initial results for urban and suburban areas. Widely used worldwide. Limitations for path lengths and base station antenna heights.

Hata Model: Well Suited for Large Cell and Trunking mobile systems. Good algorithms for sector antennas, low power handheld and intercarrier RF interference.



Radio Mobile Coverage Application

Why Amateur Radio Operators Use It

- Helps predict signal coverage over different terrains
- Assists in repeater site selection and frequency planning
- Evaluates interference and propagation paths

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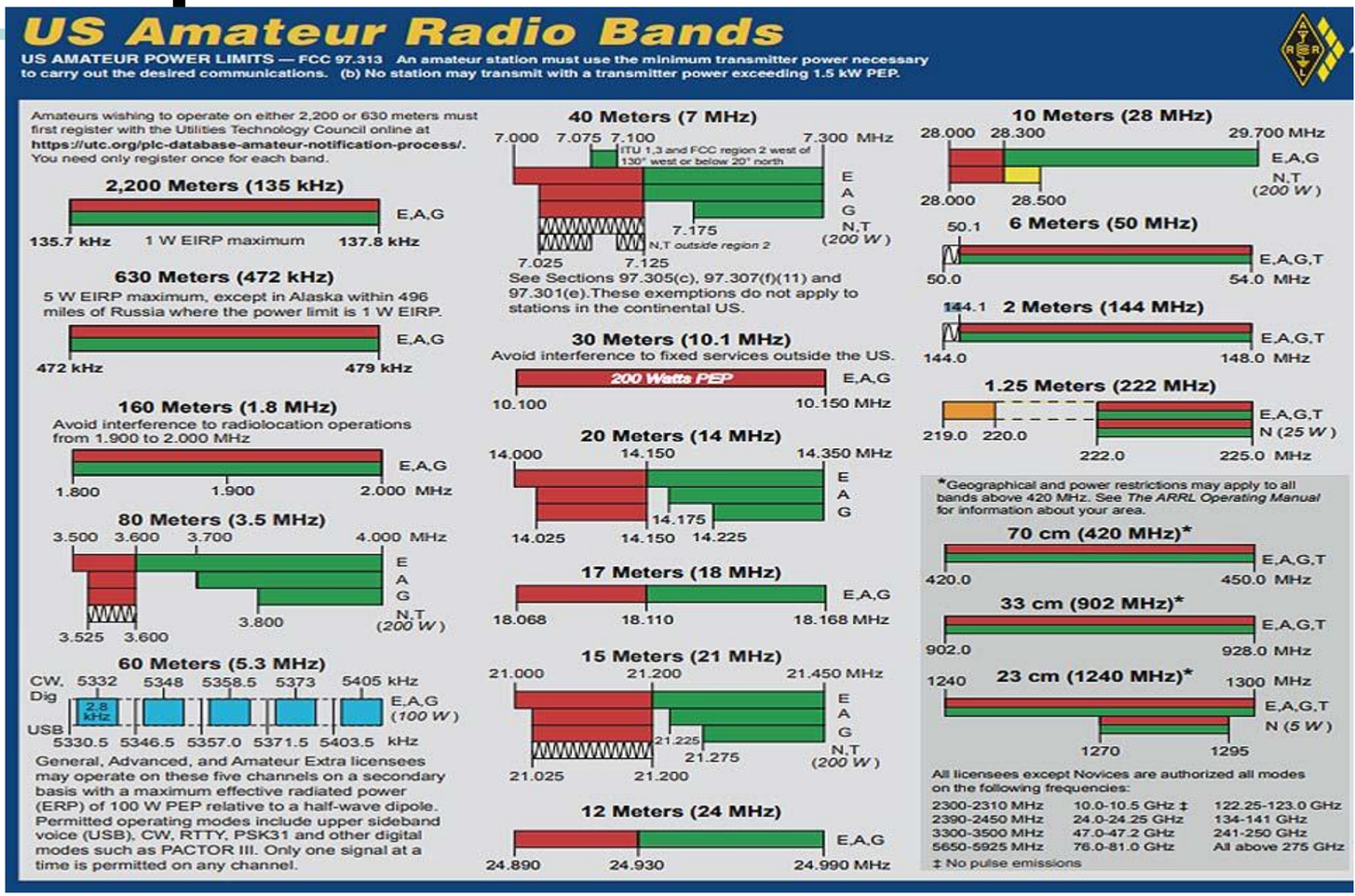
Radio Mobile Specifications

Radio Mobile Permitted Frequencies (MHz)

From	To
10	30
50	54
70	70.5
144	148
222	225
420	450
462.5625	462.7125
467.5625	467.7125
863	870
902	928
1240	1300
2300	2310
3300	3500
5650	5725
5825	5925
10000	10500
24000	250000



Radio Mobile Coverage Application

How Radio Mobile Works

- Inputs: Transmitter location, frequency, antenna height, power
- Computes propagation paths using terrain elevation data
- Outputs maps showing signal strength and coverage

Radio Mobile Variables

Mobile Radio Online is a Hertzian wave propagation prediction tool dedicated to the amateur radio community. A mathematical model and digitized information from the terrain are used to simulate the transmission of waves between two fixed sites (Radio link) or between a fixed site and a mobile (Radio coverage).

The numerical data includes three databases: land elevation, land cover and population density. These three databases are located on the server and total more than 200 Gigabytes.

Transmitter Power
Transmitter Line Loss
Transmitter Antenna Gain
Transmitter Antenna Type (for coverage only)
Transmitter antenna azimuth (for coverage only)
Transmitter Antenna Elevation Angle (for coverage only)
Transmitter Antenna Height
Issuer latitude
Longitude of the transmitter
Transmitter Ground Altitude
Ground elevation elevations between transmitter and receiver (up to 2000 samples)

Receiver latitude (for radio link only)
Receiver longitude (for radio link only)
Receiver Ground Altitude (for radio link only)
Receiver Antenna Gain
Receiver Antenna Height
Receiver line loss
Reception threshold
Reliability Required (Percentage of time that the signal is above the threshold for a reliable link).
Color corresponding to above-threshold reception (for coverage only)
Margin for strong signal (for coverage only)
Color to match a strong signal (for coverage only)
Transparency of cover on the plan (for cover only)

Initial Station Entry can use GUI and default settings for quick reports.

Radio Mobile Coverage Application

Key Features

- **Supports digital terrain mapping**
- **Uses propagation models such as ITU-R P.452, Longley-Rice, etc.**
- **Provides detailed link budget analysis**
- **Generates coverage maps for visualization**

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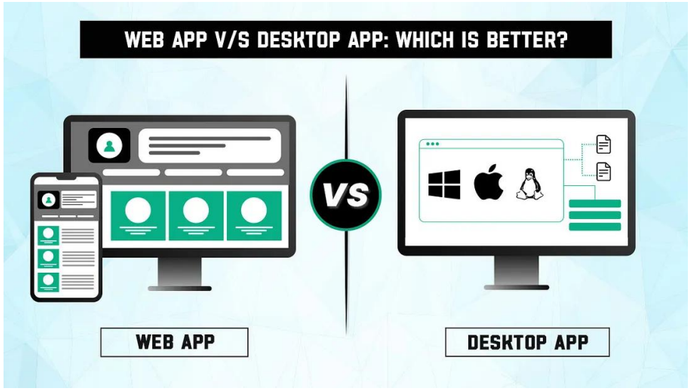
Radio Mobile Key Features

Differences between the free standalone and the online version.

The free Radio Mobile is a standalone application run on a computer with Windows. It is a powerful tool and can be difficult to master.

A large amount of data must be downloaded from the Internet in order to build the elevation and canopy databases required by the model. The program can be very slow when calculating coverage in high resolution depending on the power of the computer.

The online version also has its limitations: it depends on an Internet connection and is limited to amateur radio bands.

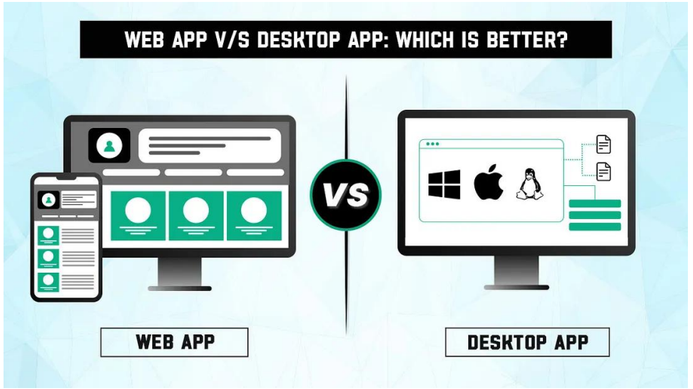


Radio Mobile Key Features (cont.)

Differences between the free standalone and the online version.

However, the online version also has its good sides:

- **It runs in the web browser and on all platforms, such as Windows, Linux, Mac, Ipad, and mobile devices**
- **Input parameters have been simplified to a minimum**
- **Positioning has been simplified and improved with the OpenLayers application interface**
- **There's no longer a need to download large amounts of data and find the source for your location**
- **The best data available for the whole world is available automatically and transparently**
- **Only a very small amount of data is exchanged between the server and your browser**
- **The online version is capable of distributing tasks over multiple threads (Currently limited to two threads per user)**
- **The coverage calculation is faster than that of the free coverage, with pixel-perfect images.**
- **The outings are nice to see and can be downloaded to your computer**
- **Your calculations are saved on the server, so you can access it from anywhere**

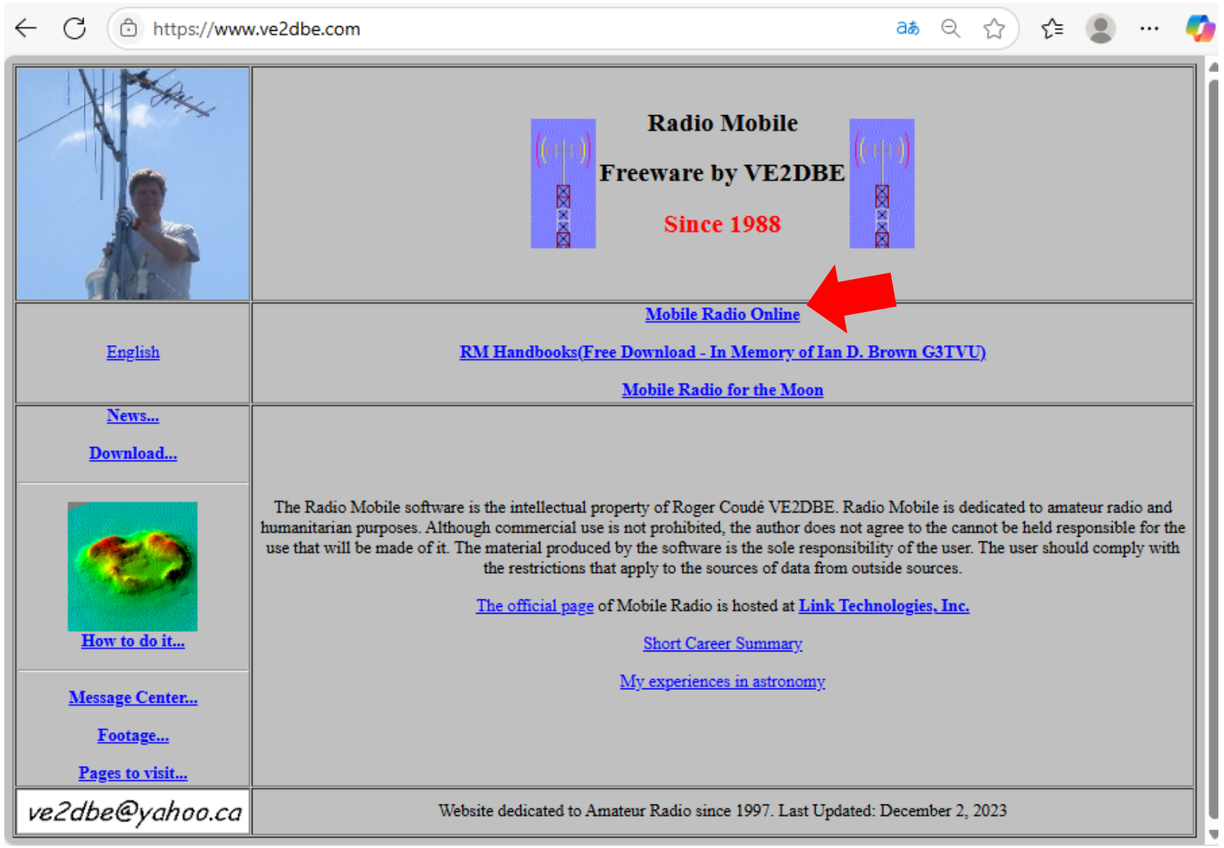


Radio Mobile Coverage Application

Setting Up Radio Mobile

1. Install Radio Mobile from [official site]
2. Load terrain data from online sources (NASA SRTM, etc.)
3. Configure transmitter and receiver parameters
4. Run coverage simulations

Creating a Radio Mobile On-Line Account



Navigate to www.ve2dbe.com

Select “English” if prompted

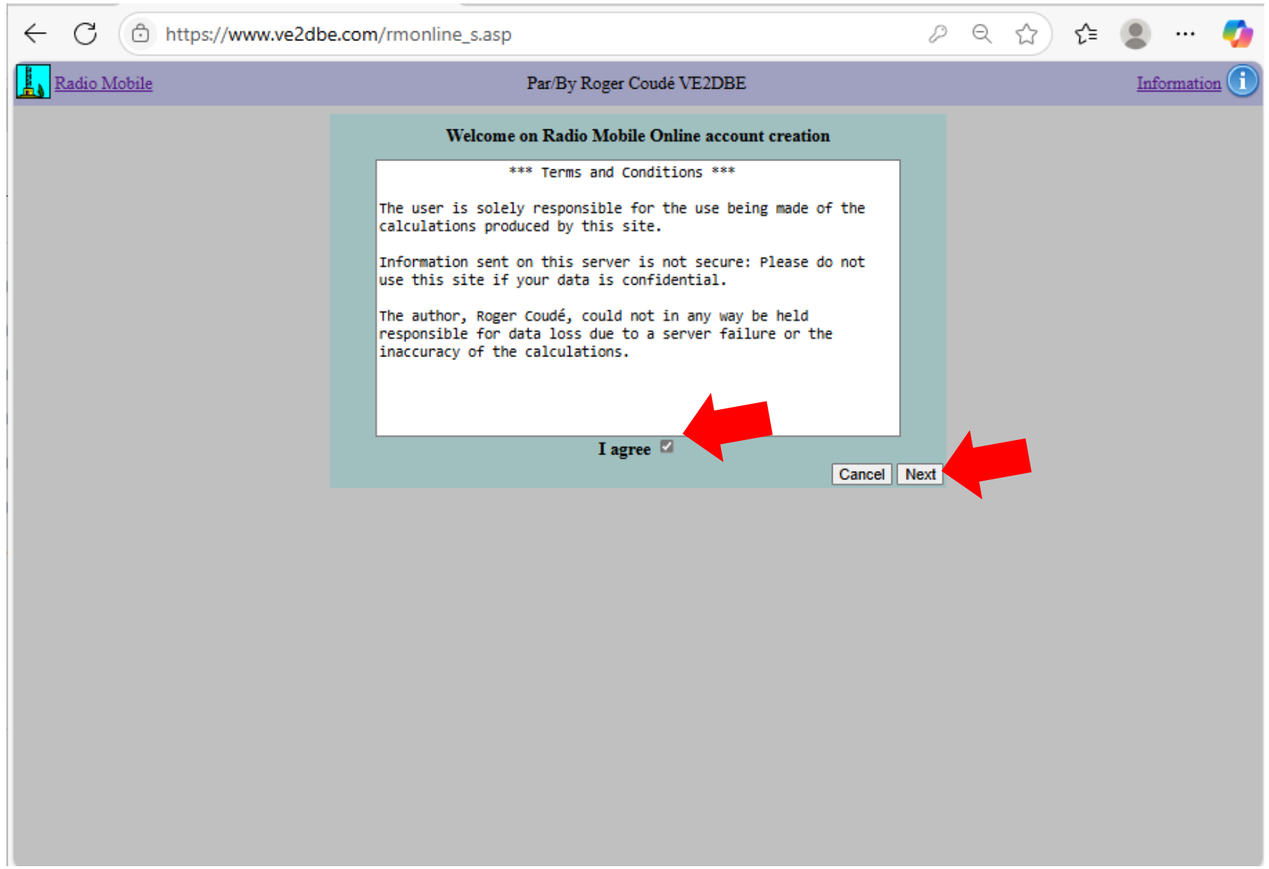
Click on “Mobile Radio Online”

Creating a Radio Mobile On-Line Account

Then Choose

“Create a New Account”

Creating a Radio Mobile On-Line Account

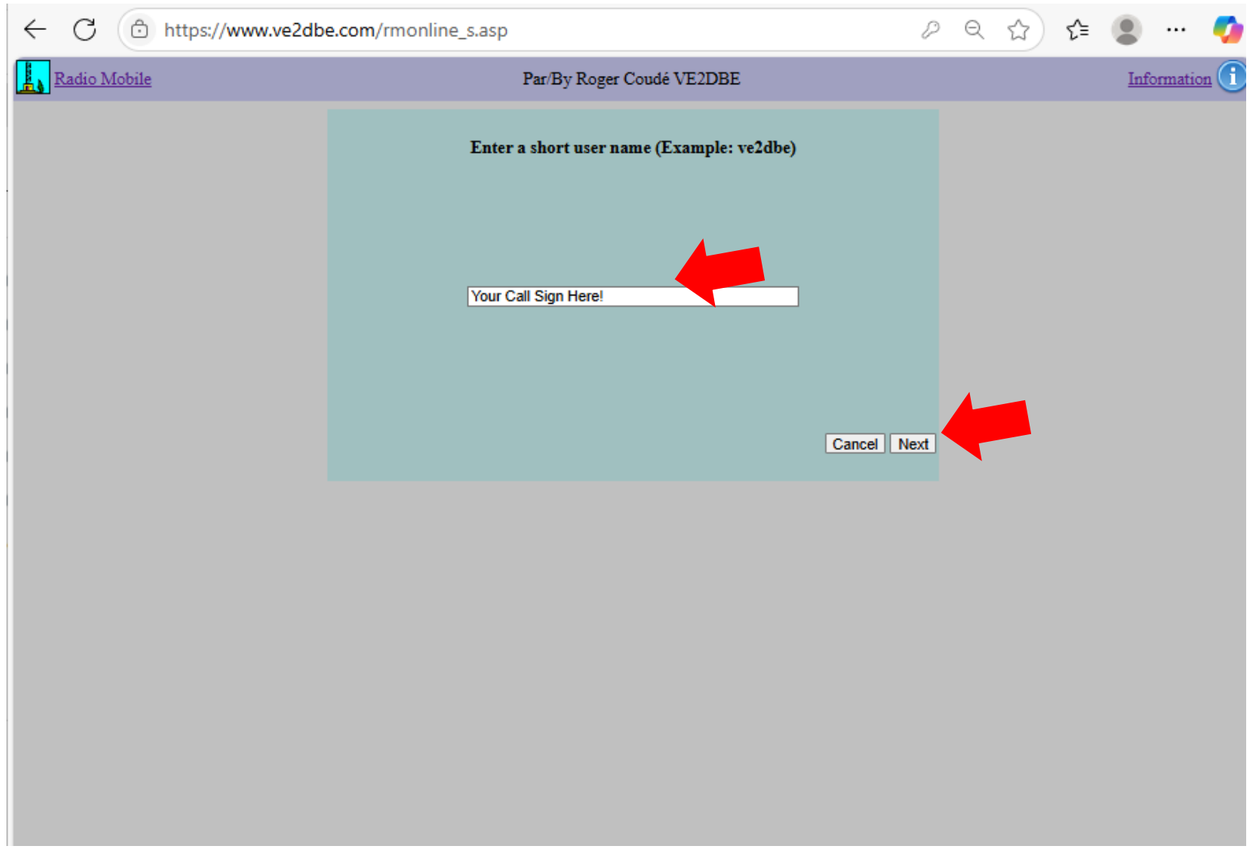


After reading the Terms and Conditions,

Check the “I Agree” box,

Then the “Next Button”

Creating a Radio Mobile On-Line Account



The next several screens will ask for a User Name (Suggest your Call Sign), Password, Email, etc…

An Email will be sent to you when the account is active.

Creating a Radio Mobile On-Line Account

Create your free personal account. A personal account is required to use the online version of Radio Mobile. A link on the homepage allows you to create it on your own.

Since the username is the basis for creating the directory structure associated with the account, it is important to have a username that respects the server's syntax rules: The username must not include special characters such as spaces, commas, periods, etc.

Your amateur call sign is probably the ideal username.

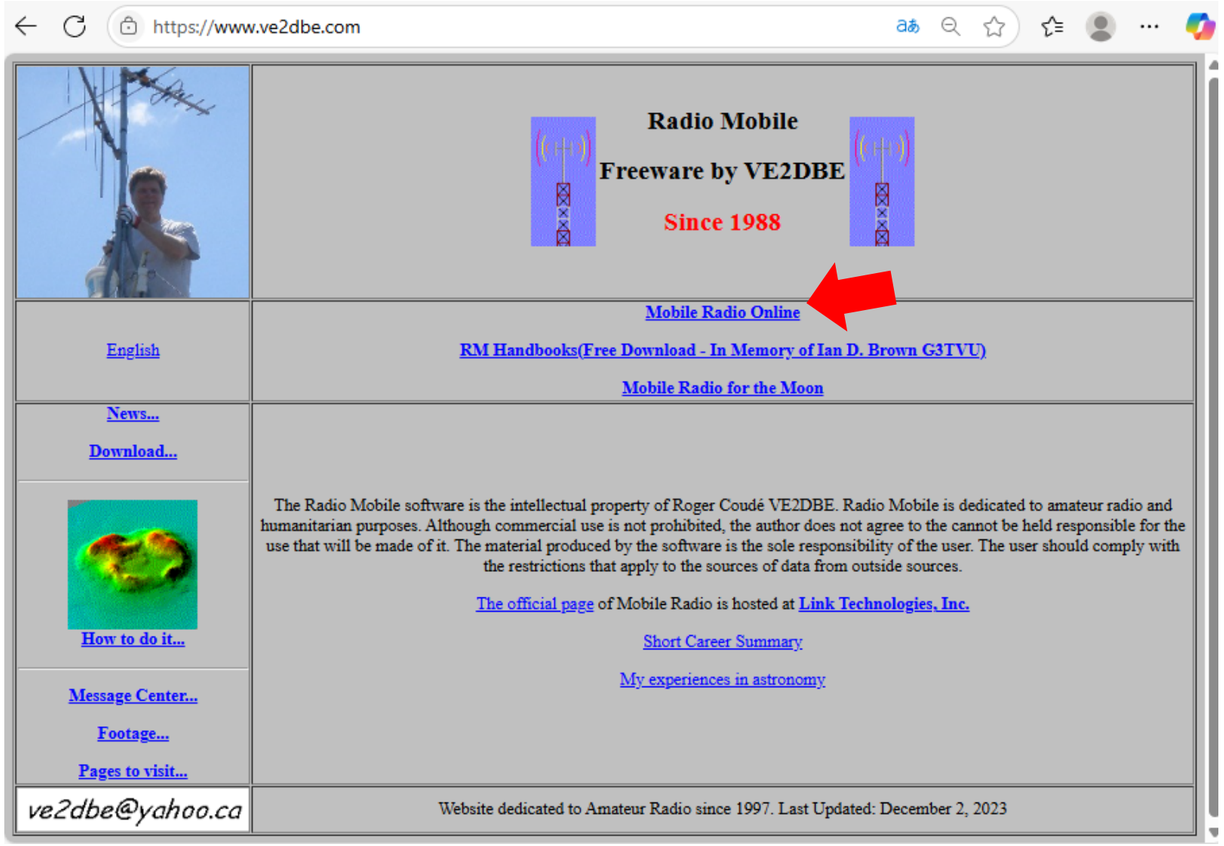
Note: If no site has been created within ten days of account creation, it will be deleted.

Radio Mobile Coverage Application

Example Applications (Coverage and Links)

- **Emergency communications and disaster response planning**
- **Optimizing repeater placements for amateur radio networks**
- **Predicting coverage for portable and mobile stations**

Logging into the Radio Mobile On-Line Account



Navigate to www.ve2dbe.com

Select “English” if prompted

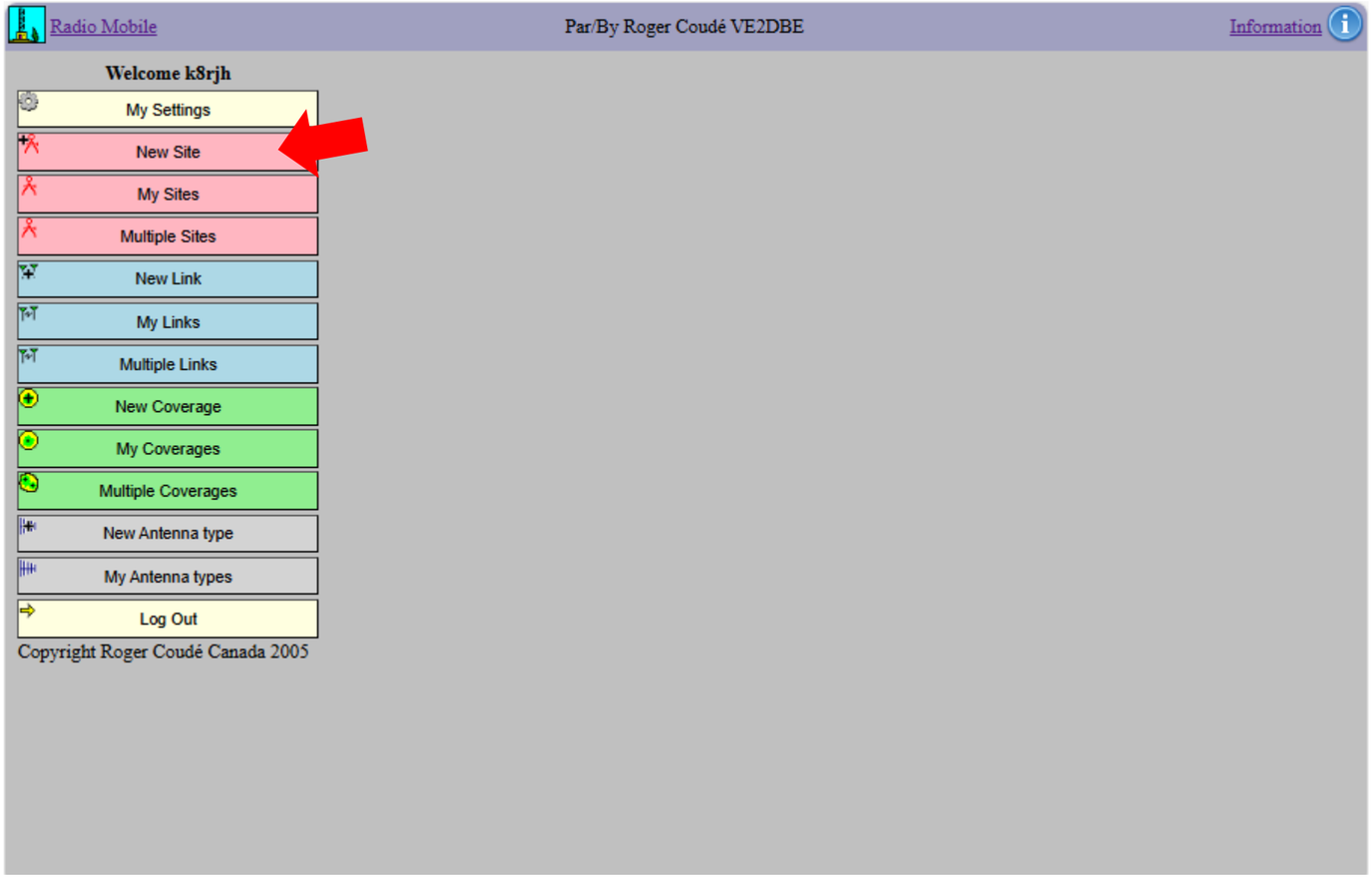
Click on “Mobile Radio Online”

Logging into the Radio Mobile On-Line Account

Enter your account credentials, then the security question.

Click the “Submit” button to enter the program.

Radio Mobile - Station Coverage

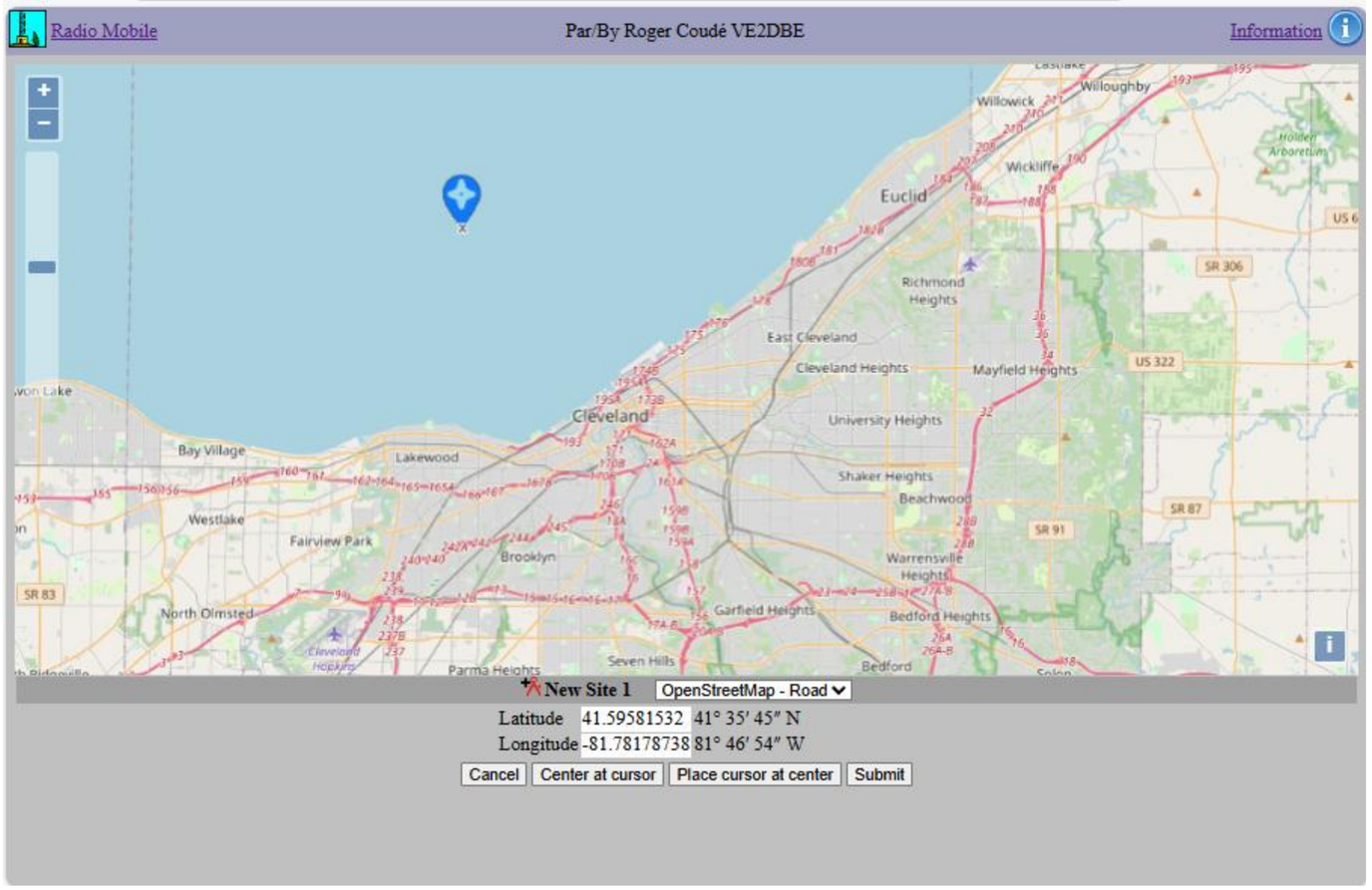


Welcome Screen.

Start by selecting

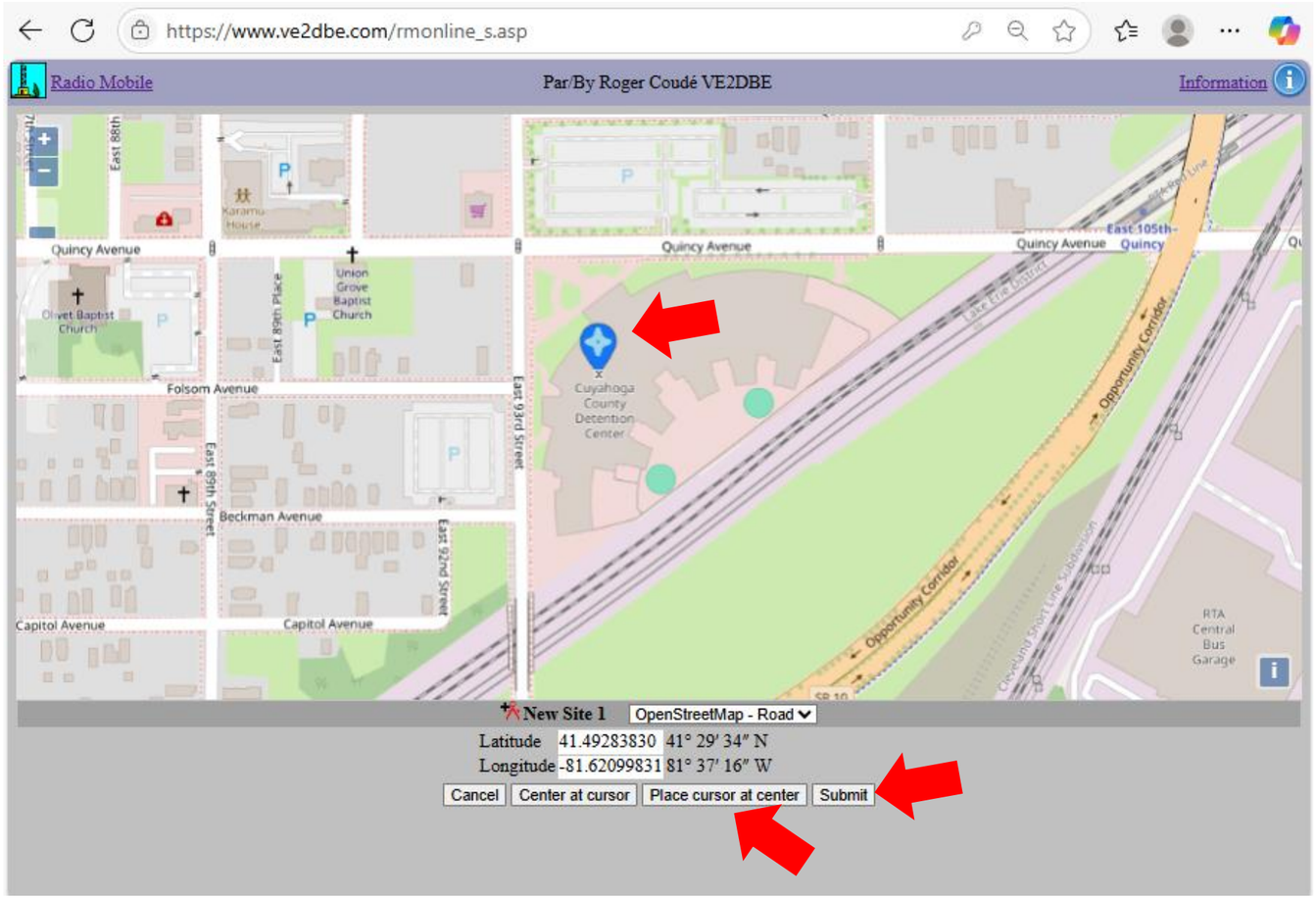
“New Site”

Radio Mobile - Station Coverage



Screen will open to a window were one may scroll and zoom to select a station location.

Radio Mobile - Station Coverage

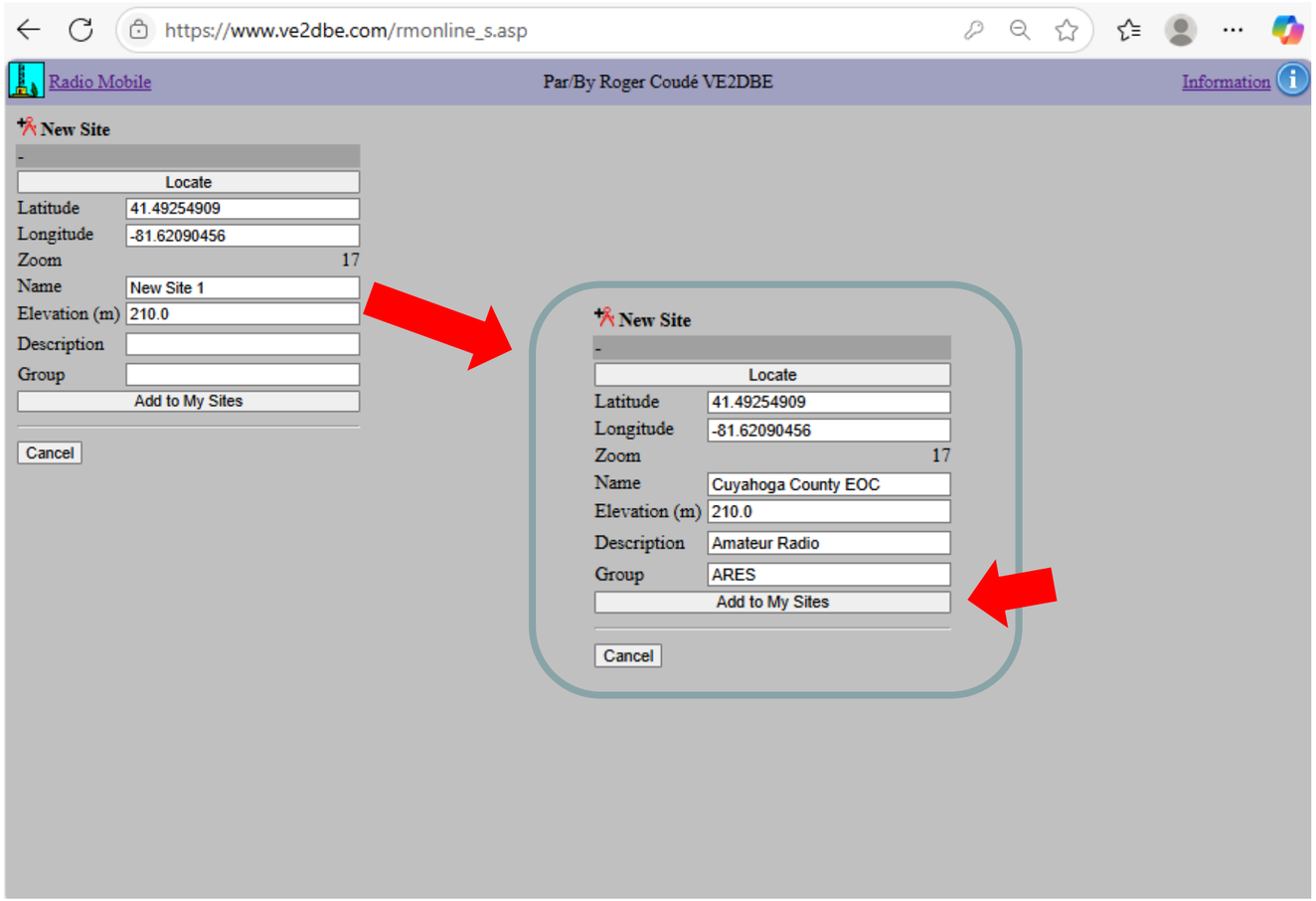


Bring the map cursor into view by clicking “Place cursor at center”.

Use mouse to drag the cursor at the exact location of interest.

Then click “Submit”.

Logging into the Radio Mobile On-Line Account

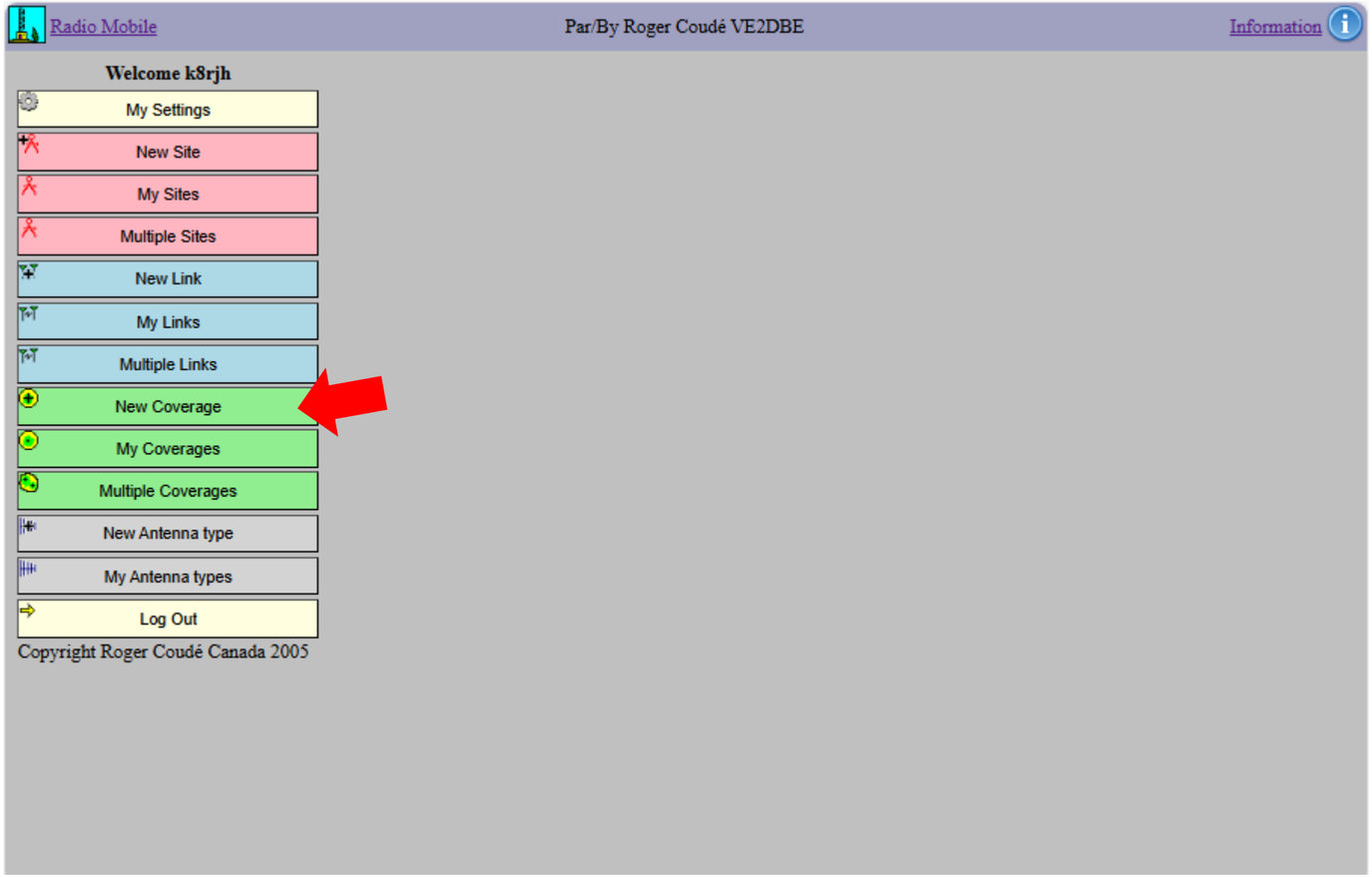


Complete the open form as desired.

Then click “Add to My Sites”.

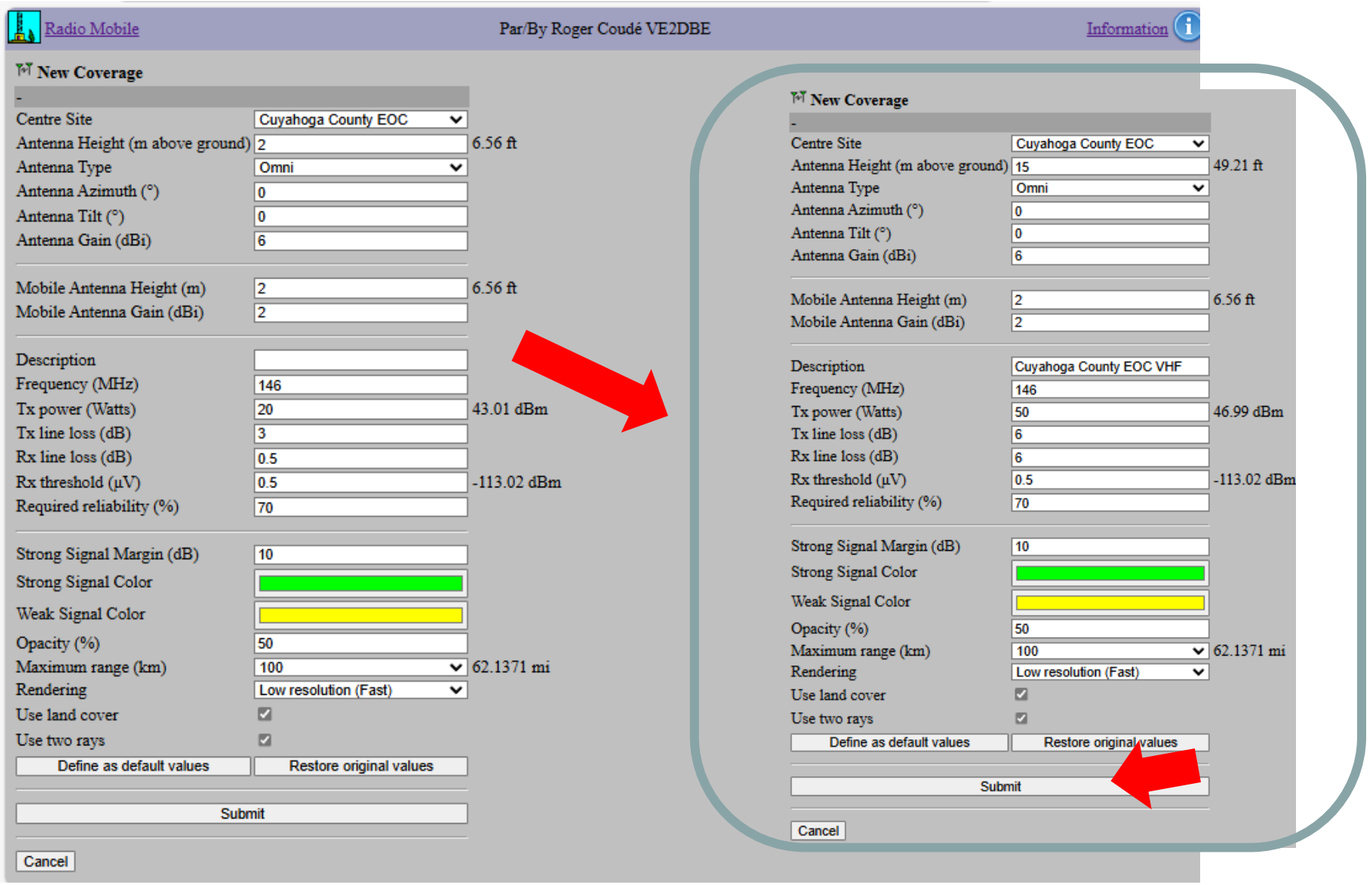
This will be stored on the server for future reference.

Radio Mobile - Station Coverage



One will be returned to the main menu. Select "New Coverage" to make station adjustments.

Radio Mobile - Station Coverage



Make station adjustments and notes as required.

Click on “Submit” to save and calculate Station Coverage.

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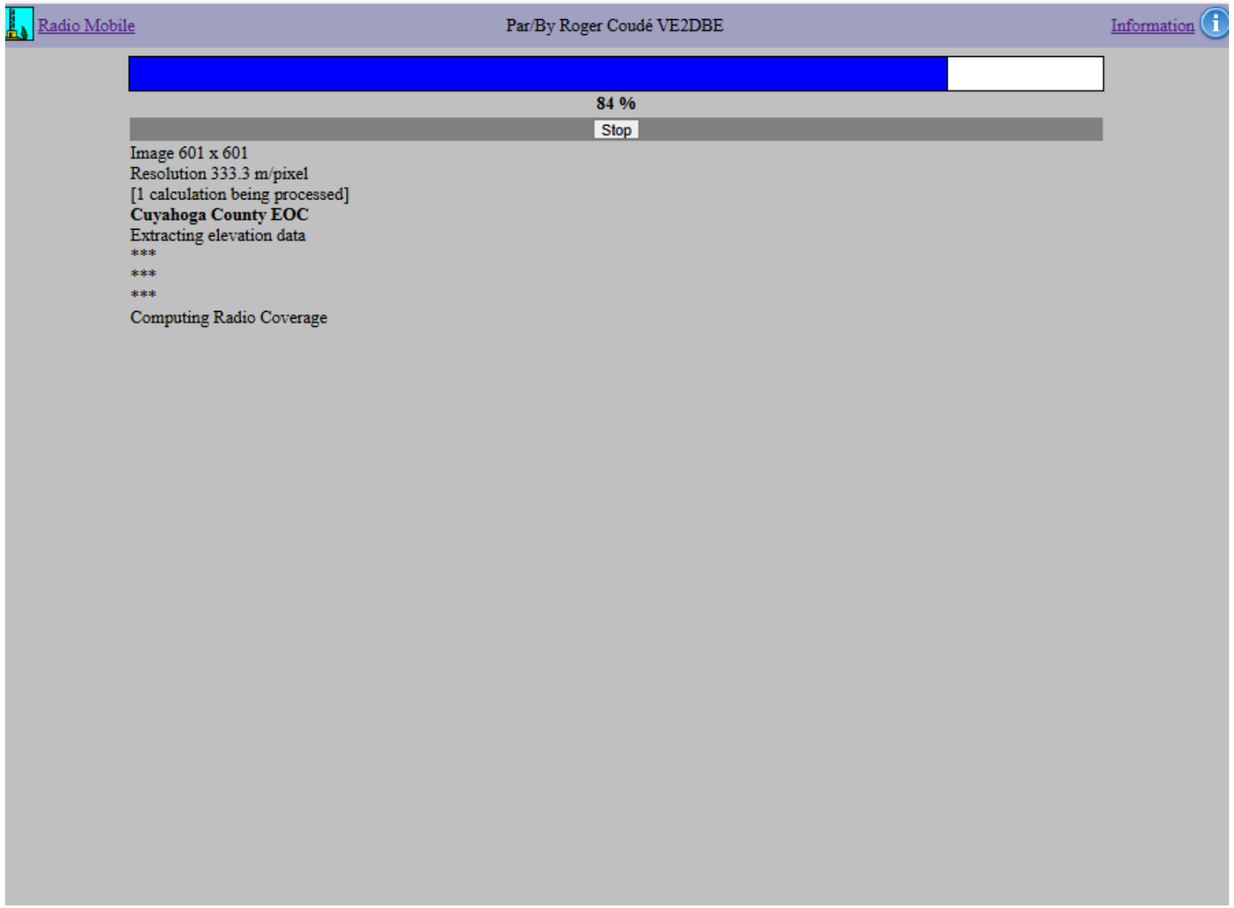
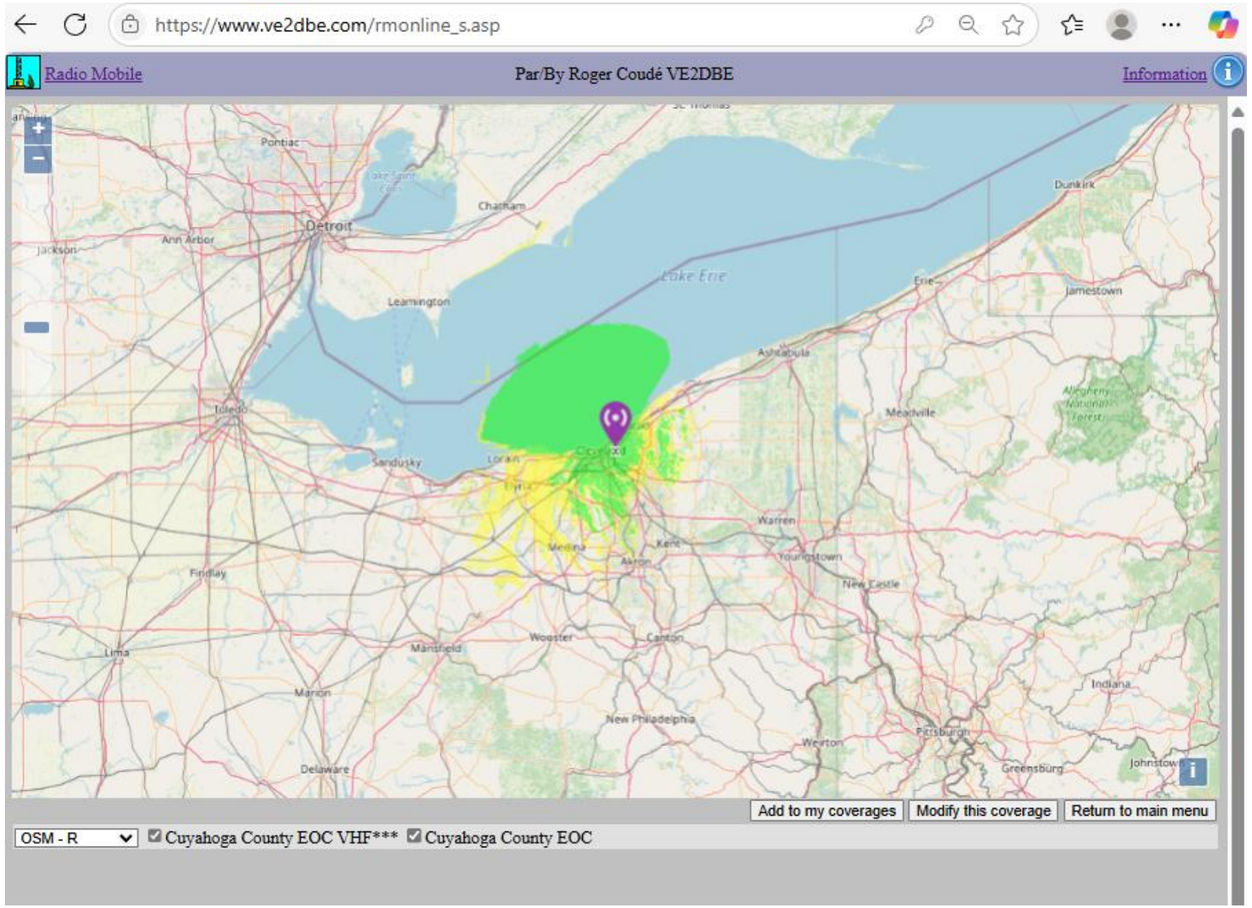
Radio Mobile - Station Coverage



Station Coverage takes just a few moments. Speed is determined by computer and internet connectivity.

Radio Mobile - Station Coverage



Station Coverage results for 70% reliability using 2 “Ray” calculations. Coverage will shrink according to the higher reliability required.

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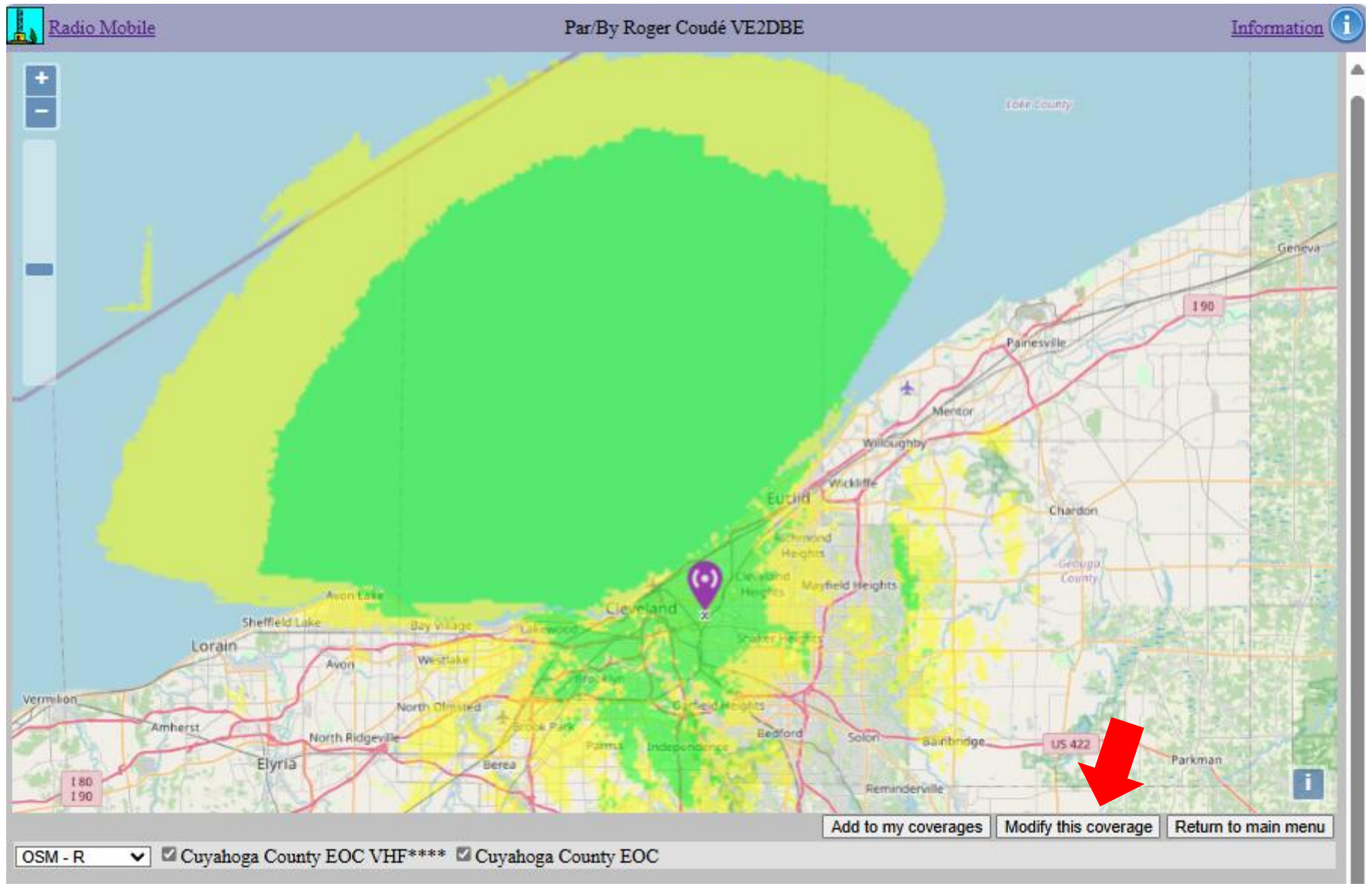
Radio Mobile - Station Coverage

	Availability	Maintainability	Reliability
Describes	How often the service can be accessed	How easily incidents can be responded to	The user's perception of the service working as expected
Determined by	Monitoring metrics	The codebase and incident response procedures	Tools reflecting user impact, such as SLOs
Improved via	Reducing downtime-causing incidents	Eliminating technical debt, improving response procedures	A wide variety of SRE practices and cultural lessons

Radio Mobile - Station Coverage



Station Coverage results for 90% reliability using 2 “Ray” calculations. Coverage will shrink according to the higher reliability required.

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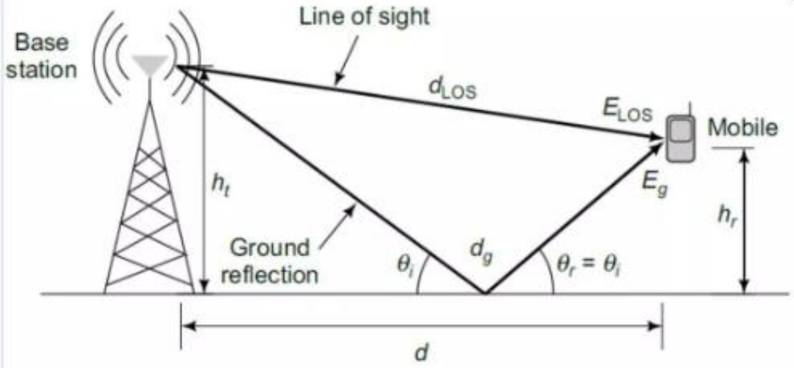
Radio Mobile - Station Coverage

GROUND-REFLECTION (TWO RAY) MODEL



- ✓ As Free space model is inaccurate when used alone
- ✓ Two ray model considers both the direct path and a ground reflected propagated path between transmitter and receiver.

Certain Assumptions
1. ht & hr >> λ
2. ht & hr << d
3. Earth may be assumed to be flat

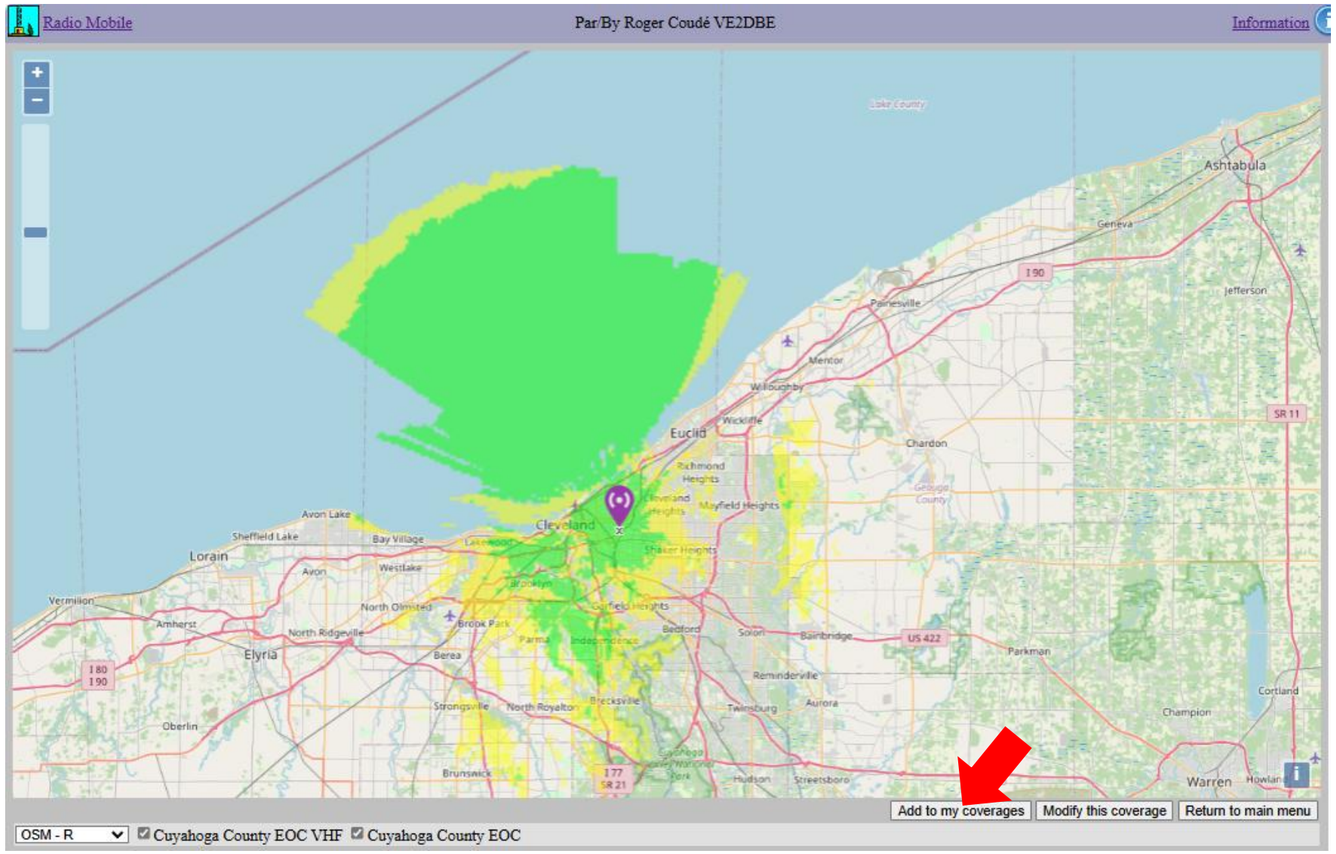
- ✓ A two-ray model, which consists of two overlapping waves at the receiver, one direct path and one reflected wave from the ground so it is called as Two ray model.
- ✓ The total received E-field is the result of the direct line of sight component ELOS and the ground reflected component Eg.

The free space propagating E-field for d>d0 is given by

$$E(d,t) = \frac{E_0 d_0}{d} \cos(\omega_c (t - \frac{d}{c})) \quad (d > d_0)$$

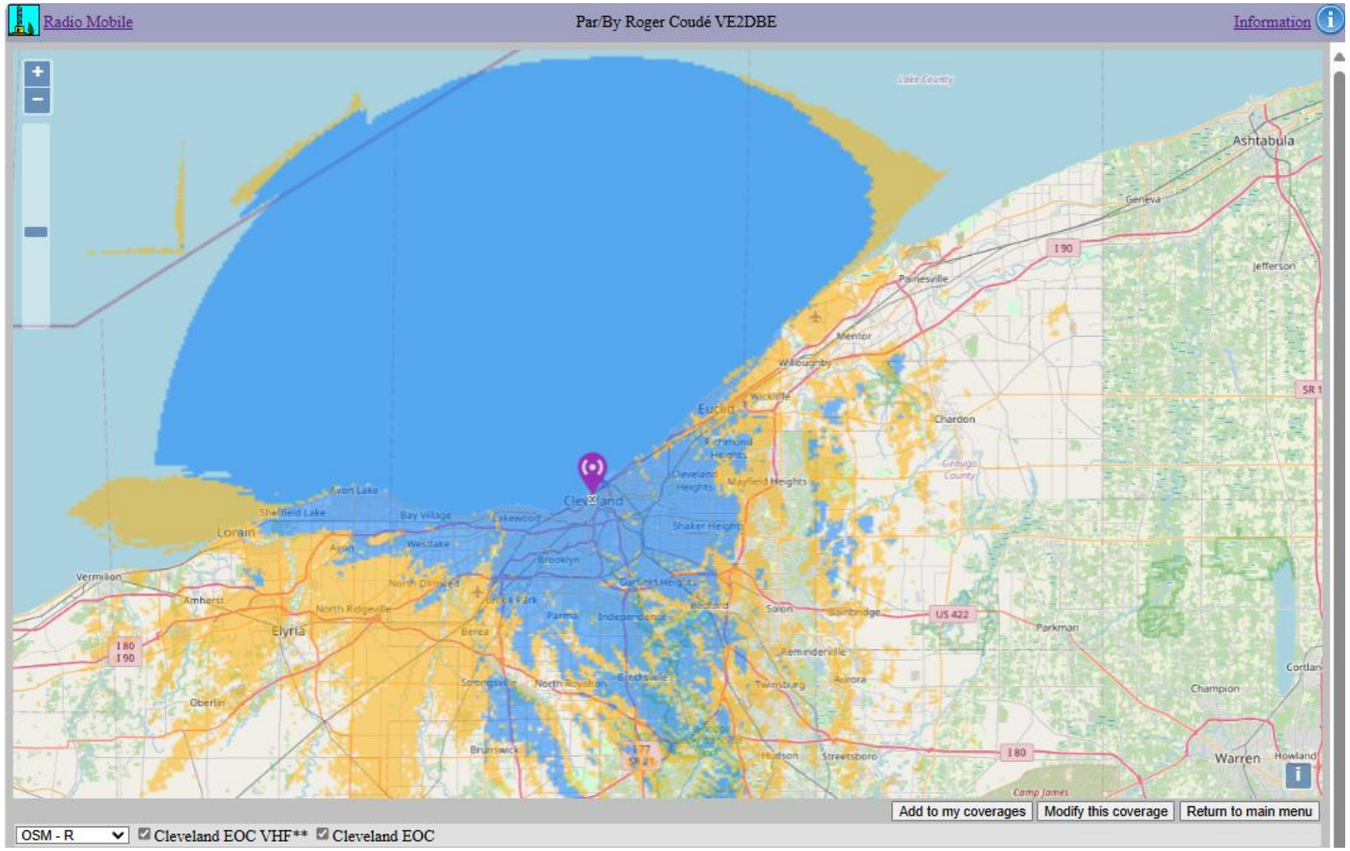
- ✓ where E0 is the transmitted signal amplitude at a reference distance d0, and d is the propagation distance for the LOS component

Radio Mobile - Station Coverage



Station Coverage results for 90% reliability using 2 “Ray” calculations. Coverage will shrink according to the higher reliability required. Clink on “Add to My Coverages”.

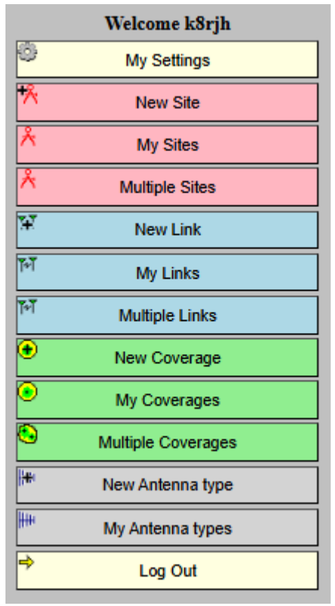
Radio Mobile - Station Coverage



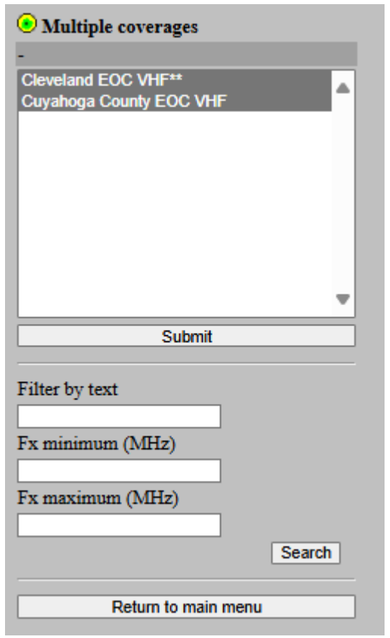
Station Coverage for <u>Cleveland EOC</u> predicted for 90% reliability using 2 “Ray” calculations.

(Be sure to change the color pallet for signal ranges).

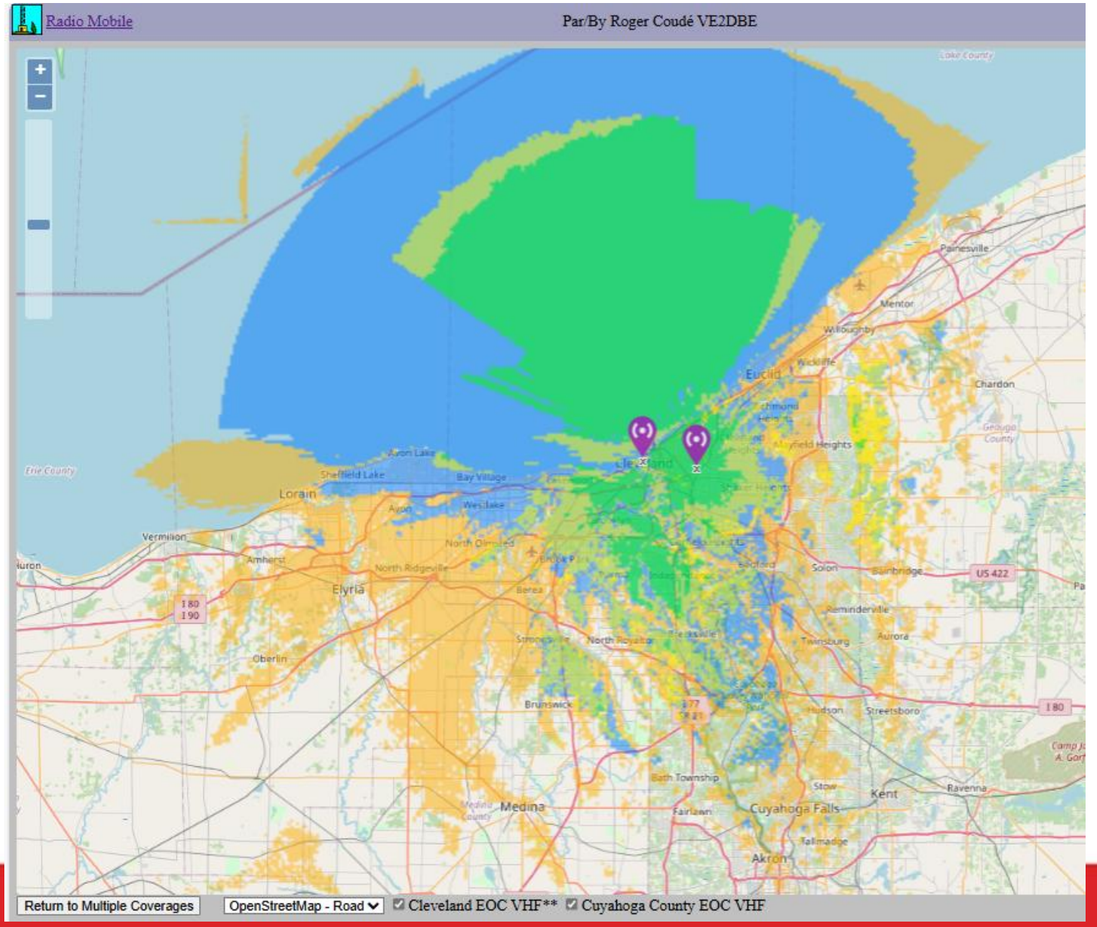
Radio Mobile – Compare Station Coverages



Select “Multiple Coverages”

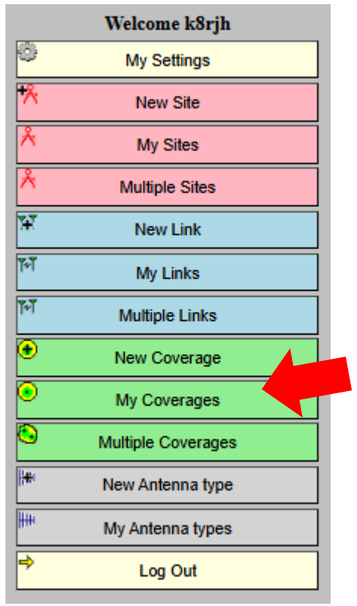


Shift and Select the Stations to be compared, Click on Submit to view the results.

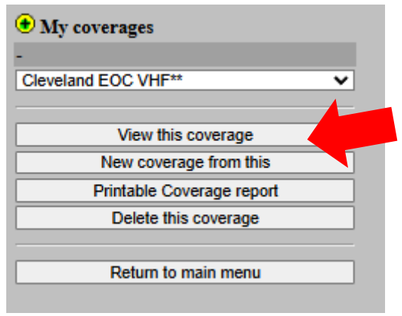


“Multiple Coverages” view

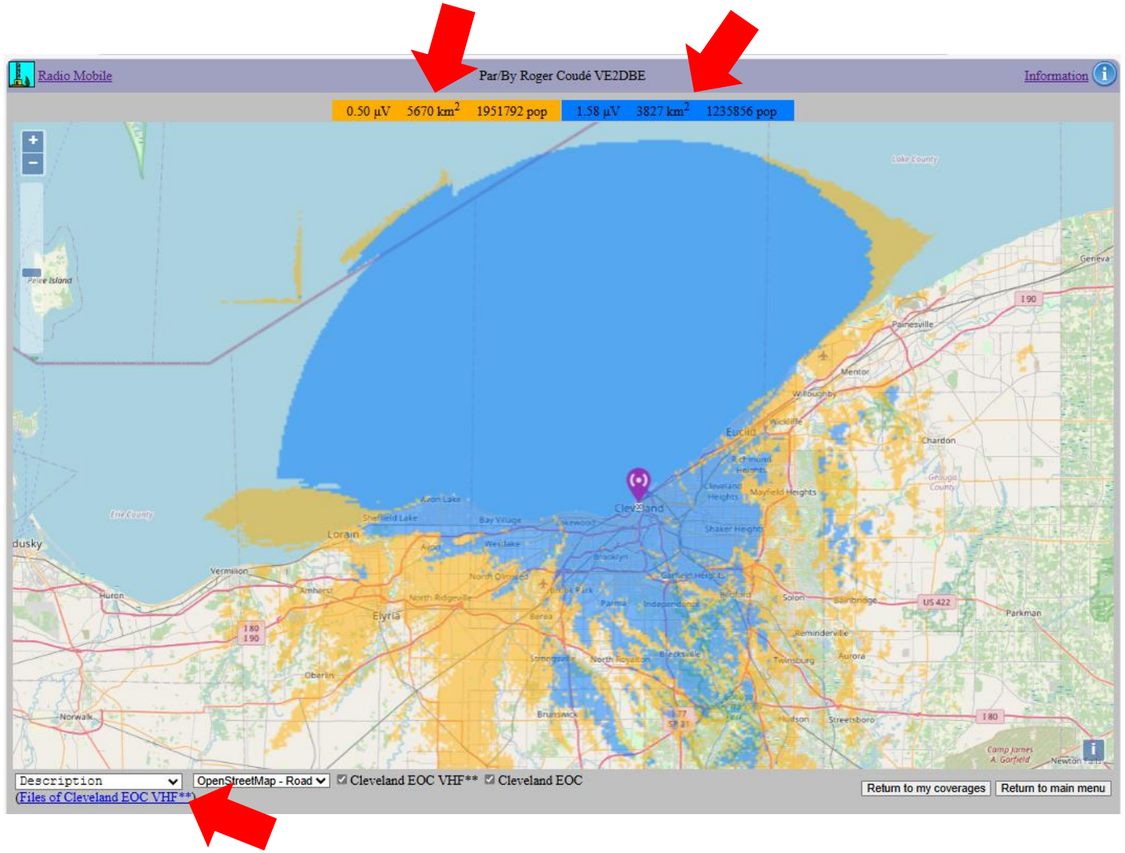
Radio Mobile – Station Coverage Data



Select “My Coverages”



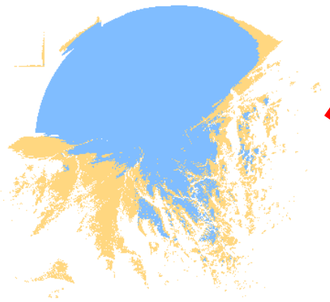
Click on “View this Coverage”.



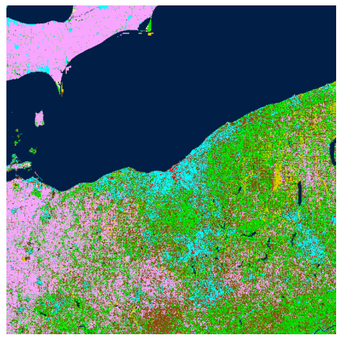
“Coverage” view now contains additional information and a link to “Files…” in lower left of window.

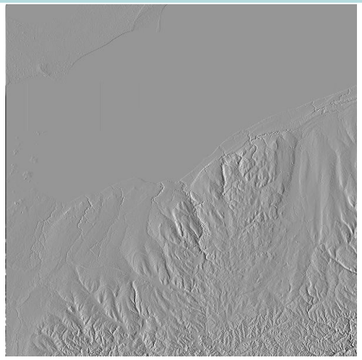
Select “Files…” to download data.

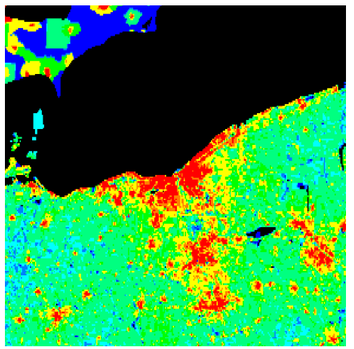
Radio Mobile – Station Coverage Data



Name	Type	Compressed size
RM77CA2341A370_0	PNG File	10 KB
RM77CA2341A370_0.dat	DAT File	1 KB
RM77CA2341A370_0.kml	KML File	1 KB
RM77CA2341A370_0_	Opera Web Document	148 KB
RM77CA2341A370_0_CLU	PNG File	
RM77CA2341A370_0_CLU.dat	DAT File	1 KB
RM77CA2341A370_0_ELV	JPG File	53 KB
RM77CA2341A370_0_ELV.dat	DAT File	1 KB
RM77CA2341A370_0_POP	PNG File	
RM77CA2341A370_0_POP.dat	DAT File	1 KB





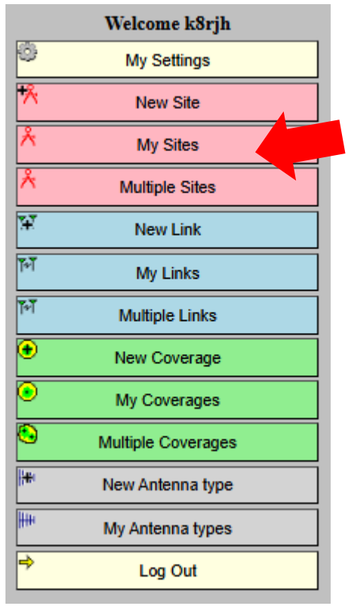


Geo Referenced files in exported .ZIP File…

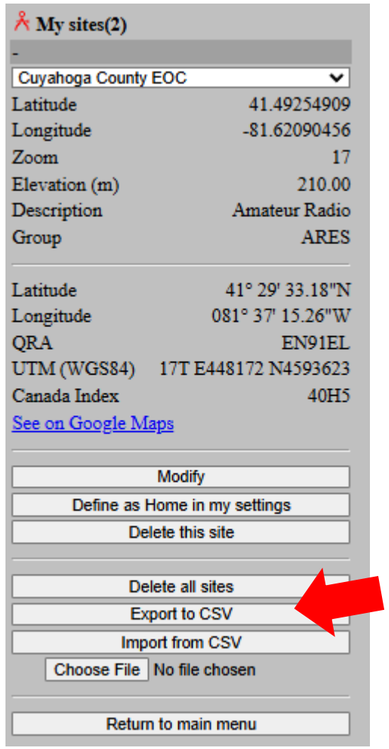
Radio Coverage Map (PNG Transparent)
Terrain Relief Plan (_ELV.JPG)
Land cover plan (_CLU.PNG)
Population Density Plan (_POP.PNG)

Note: The file coverage image can be viewed with GoogleEarth by changing the file extension .zip to .kmz

Radio Mobile – Exporting / Importing Station Data



Select “My Sites”

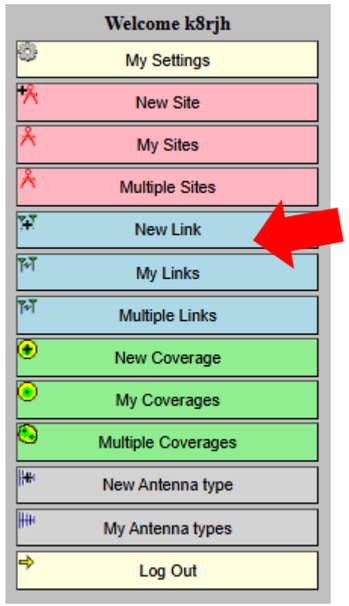


Click on “Export or Import from CSV”.

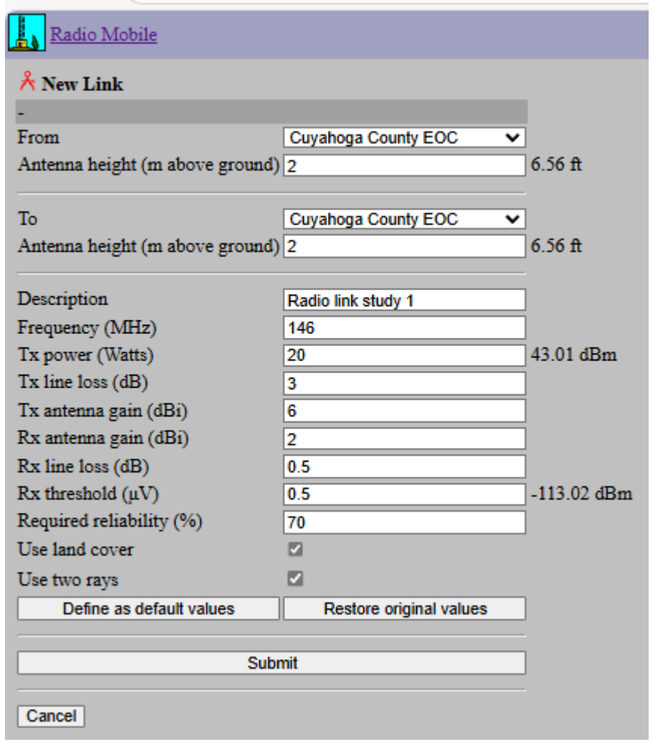
	A
1	Cuyahoga County EOC;41.49254909;-81.62090456;17;210.00;Amateur Radio;ARES;EN91EL;17T E448172 N4593623;'40H5'
2	Cleveland EOC;41.50060211;-81.69599186;18;198.00;Amateur Radio;ARES;EN91DM;17T E441911 N4594565;'40H12'

Once Station Data is collected and Saved, It can be modified or exchanged in a CSV files and shared.

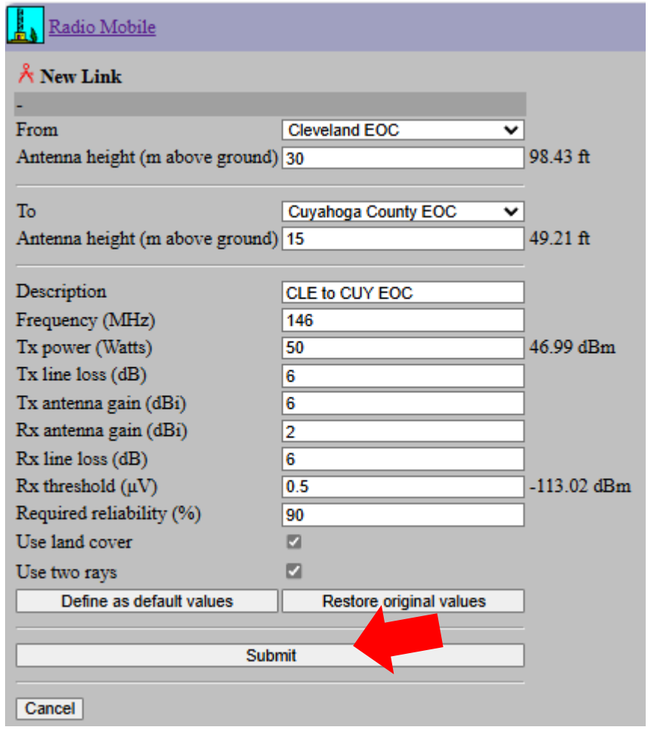
Radio Mobile – Station Link Study



Select “New Link”



Modify the Link Property Page (Default Shown).

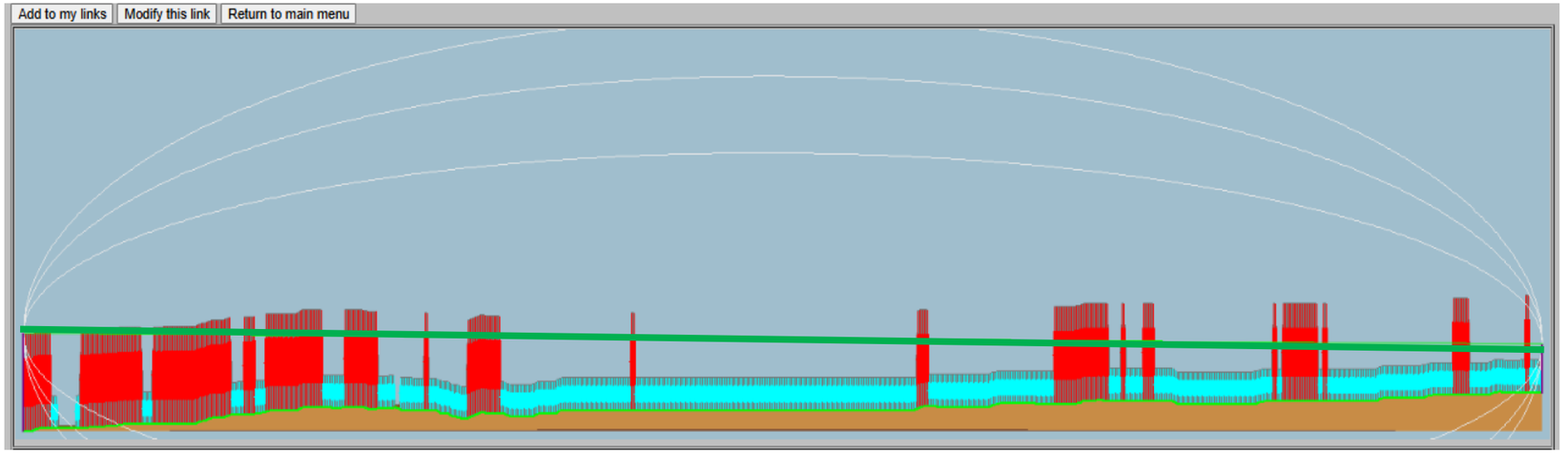


After Updates, Select “Submit” to calculate RF Link.

“Coverage” view now contains additional information and a link to “Files…” in lower left of window.

Select “Files…” to download data.

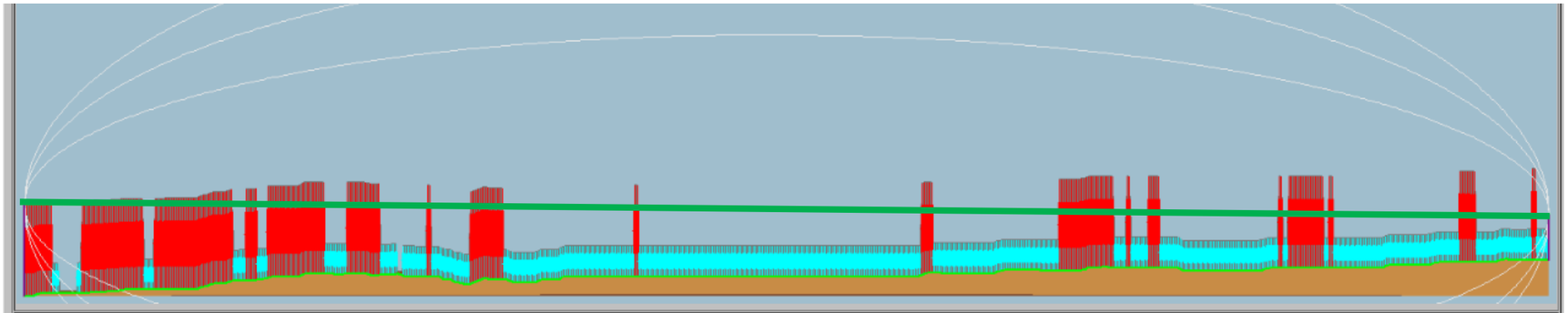
Radio Mobile – Station Link Study



Be sure to ”Add to my Links” to save results for future reference.

RF Mobile Link displays LOS (Line of Site), any Diffraction, Elevations, and Obstructions (Natural and Man-Made).

Radio Mobile – Station Link Study



CLE to CUY EOC

Cleveland EOC (1)		(2) Cuyahoga County EOC	
Latitude	41.500602 °	Latitude	41.492549 °
Longitude	-81.695992 °	Longitude	-81.620905 °
Ground elevation	198.0 m	Ground elevation	210.0 m
Antenna height	30.0 m	Antenna height	15.0 m
Azimuth	98.12 TN | 106.73 MG °	Azimuth	278.17 TN | 286.82 MG °
Tilt	-0.06 °	Tilt	0.00 °

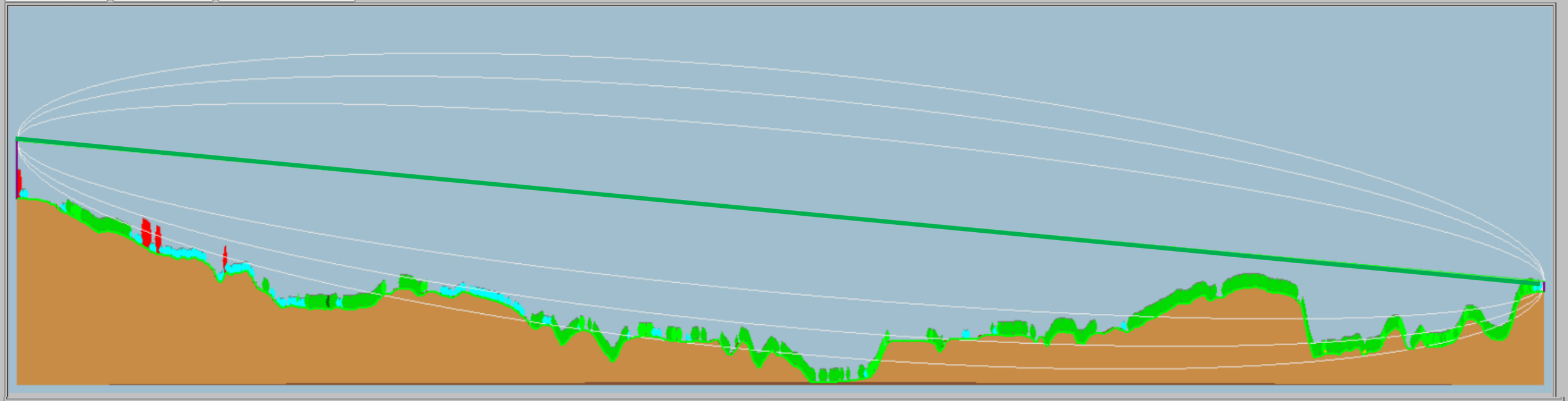
Radio system		Propagation	
TX power	46.99 dBm	Free space loss	91.70 dB
TX line loss	6.00 dB	Obstruction loss	5.44 dB
TX antenna gain	6.00 dBi	Forest loss	0.00 dB
RX antenna gain	2.00 dBi	Urban loss	22.03 dB
RX line loss	6.00 dB	Statistical loss	11.24 dB
RX sensitivity	-113.02 dBm	Total path loss	130.40 dB

Performance	
Distance	**6.317 km**
Precision	10.0 m
Frequency	146.000 MHz
Equivalent Isotropically Radiated Power	50.000 W
System gain	156.01 dB
Required reliability	90.000 %
Received Signal	-87.41 dBm
Received Signal	9.54 µV
Fade Margin	**25.61 dB**

RF Mobile Link Calculates the Predicted RF performance.

Good Link from Station QTH to Repeater Site

Add to my links | Modify this link | Return to main menu



K8ZFR - Blossom Hill (1)			(2) K8RJH		
Latitude	41.305111	°	Latitude	41.391302	°
Longitude	-81.661531	°	Longitude	-81.539300	°
Ground elevation	379.0	m	Ground elevation	283.1	m
Antenna height	60.0	m	Antenna height	10.0	m
Azimuth	46.75 TN | 55.34 MG	°	Azimuth	226.83 TN | 235.51 MG	°
Tilt	-0.66	°	Tilt	0.53	°

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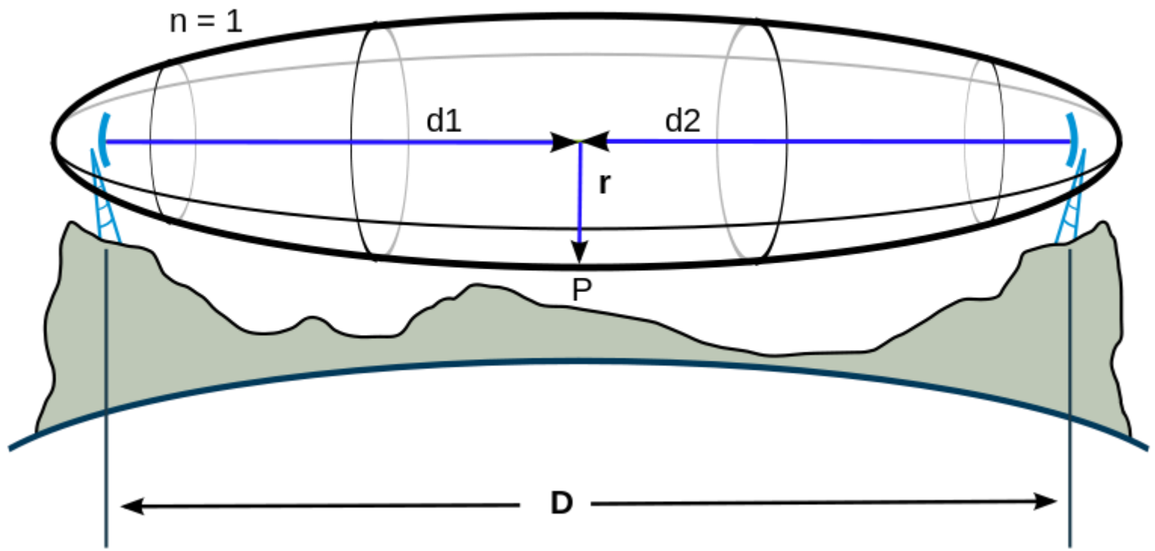
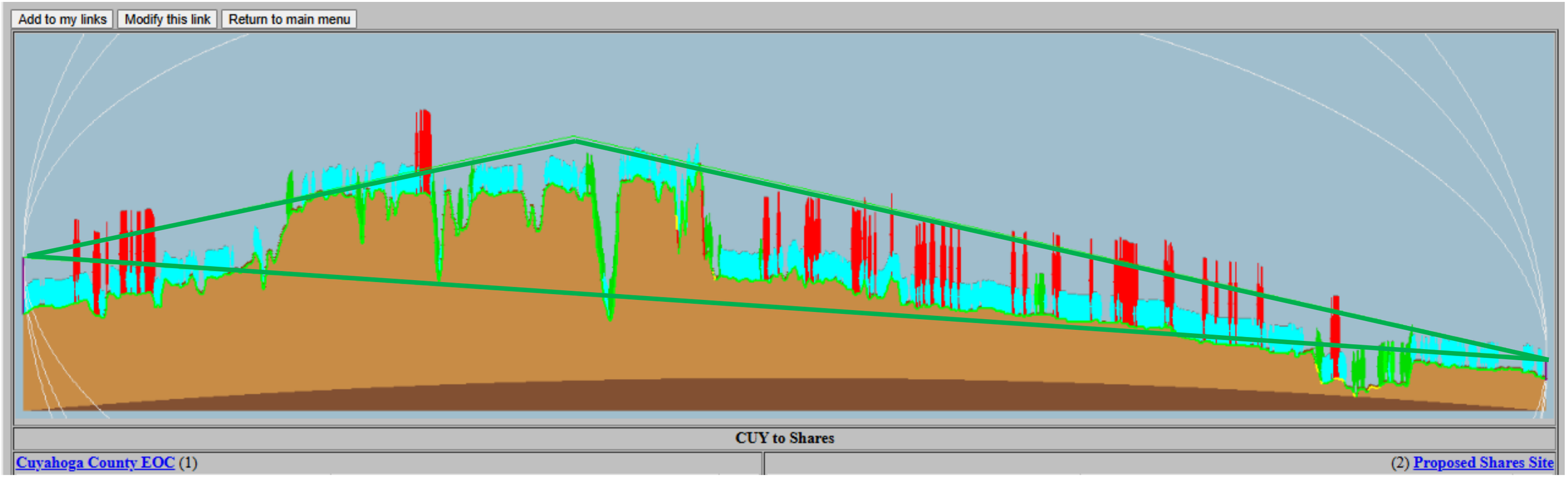
Notes on Fresnel Zones

The Fresnel zone is a 3D elliptical region around the line of sight between a transmitter and receiver in wireless communication. It's named after French physicist Augustin-Jean Fresnel. The size of the Fresnel zone depends on the distance between the transmitter and receiver and the frequency of the radio waves. Maintaining a clear path within the Fresnel zone is crucial for optimal signal reception.

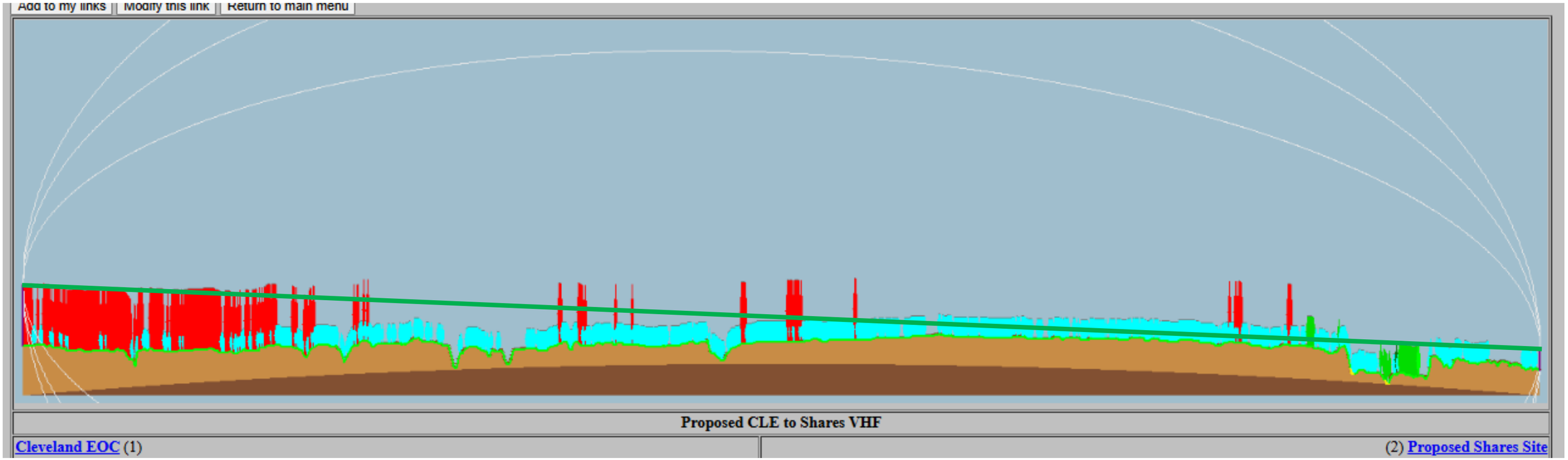


If the blockage is greater than 55%, the obstruction behaves as “scatter”

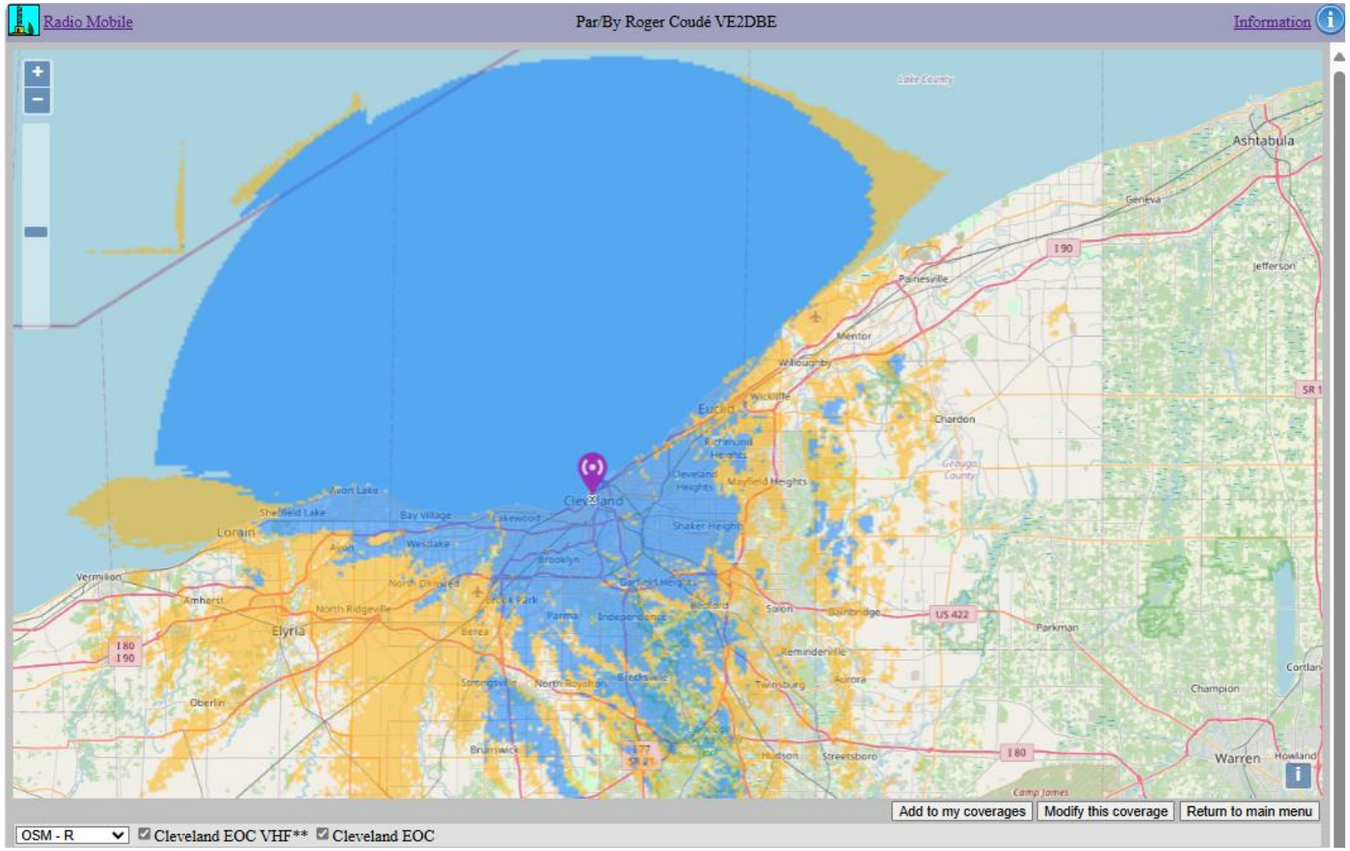
Evaluation of CUY EOC to new SHARES VHF site



Evaluation of CLE EOC to new SHARES VHF site



Radio Mobile - Station Coverage



Station Coverage for <u>Cleveland EOC</u> predicted for 90% reliability using 2 “Ray” calculations.

(Be sure to change the color pallet for signal ranges).

Radio Mobile Coverage Application

Limitations & Challenges

- Accuracy depends on terrain data resolution
- Requires understanding of propagation models
- Not a replacement for field testing,

… but a valuable tool for planning

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Radio Mobile RF Link Application

Conclusion

Radio Mobile is an invaluable tool for amateur radio operators

- **Enables smarter planning & efficient use of radio resources**
- **Helps optimize coverage for emergency response and**

  … everyday operations

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Additional Presentation Resource Topics

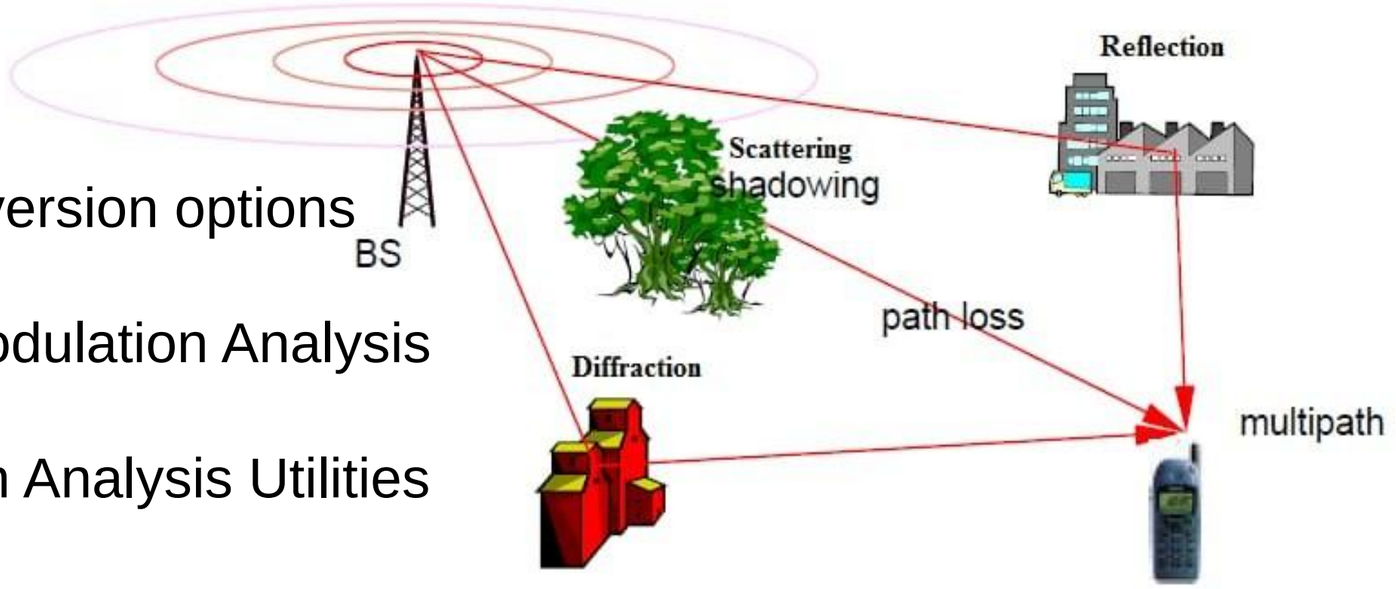
Links for Radio Mobile FAQ

Customization and Downloadable version options

On-Line RF Calculators and Intermodulation Analysis

Interactive Wireless Network Design Analysis Utilities Tools

Link to free book… Wireless Networking in the Developing World



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Additional Presentation Resource Topics

Link to free book… Wireless Networking in the Developing World

https://wndw.net/

Additional Presentation Resource Topics

Customization and Downloadable simulation software and version options (Complete)

http://radiomobile.pe1mew.nl/

Additional Presentation Resource Topics

On-Line RF Calculators and Intermodulation Analysis

Interactive Wireless Network Design Analysis Utilities Tools

http://radiomobile.pe1mew.nl/?RF_Aids___On-Line_calculators

This website offers a collection of on-line RF tools.
The tools are collected from all over the web.

RF Calculator

Conversion from and to various RF units

Intermodulation

Calculate intermodulation for 2 and 3 frequency's up to the 9th order.

Other on-line calculators

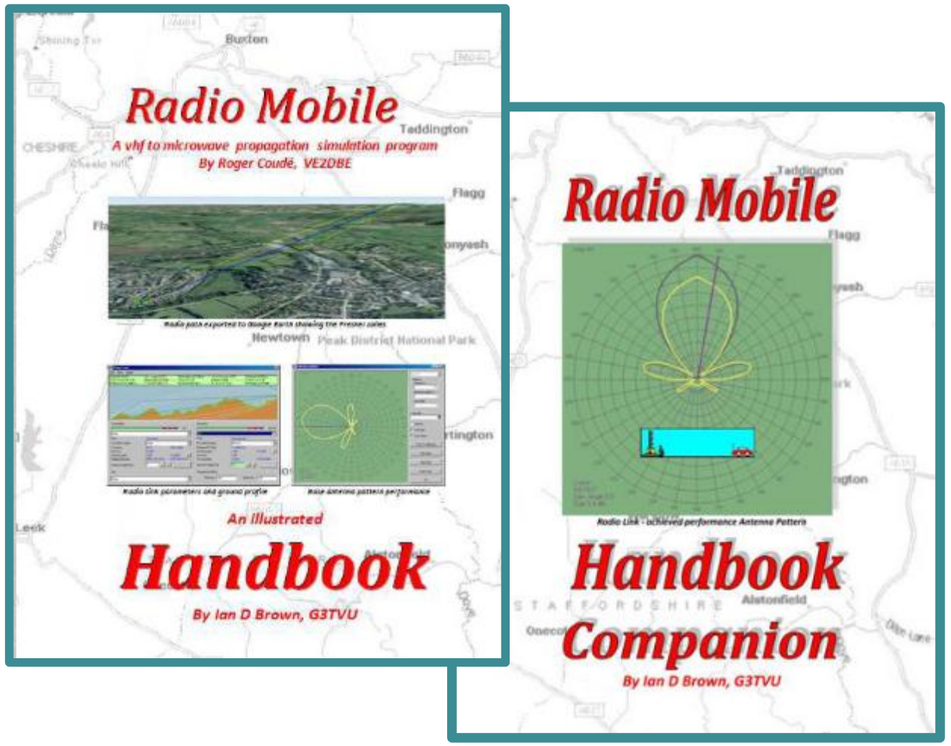
There are more calculators on the world wide web than the ones on this website.
More calculators and the source scripts can be found at:

- http://www.qsl.net/n9zia/wireless/page09.html

Additional Presentation Resource Topics

Links for Radio Mobile Handbook (352 pages) and Companion (184 Pages)…. Available for paid download

http://www.g3tvu.co.uk/Radio_Mobile_Handbook.htm



Radio Mobile Coverage Application

Exploring Coverage Prediction & Network Planning

Radio Mobile Coverage Application

Introduction to an Online VHF/UHF/+GHz Tool

CCARES Meeting, May 20, 2025

Ron – K8RJH