



# CloudRF Documentation

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# CONTENTS

<b>1</b>	<b>About CloudRF</b>	<b>3</b>
1.1	Benefits . . . . .	3
1.2	Our Mission . . . . .	4
1.3	Innovation Roadmap . . . . .	4
1.4	Supported Technologies . . . . .	4
1.5	Platforms . . . . .	5
1.6	CloudRF.com (public API) . . . . .	5
1.7	Choosing an Interface . . . . .	20
<b>2</b>	<b>Web Interface Overview</b>	<b>23</b>
2.1	Interface elements . . . . .	24
2.2	Hot Keys / Keyboard Shortcuts . . . . .	24
2.3	UI Mode . . . . .	25
2.4	Transmitter Marker . . . . .	25
2.5	Input Menu . . . . .	26
2.6	Save and Run Buttons . . . . .	55
2.7	Templates . . . . .	55
2.8	Output Console . . . . .	61
2.9	System Version . . . . .	62
2.10	Documentation . . . . .	62
2.11	Account Information . . . . .	62
2.12	Mobile Operation . . . . .	65
2.13	3D Interface Elements - Mobile View . . . . .	67
<b>3</b>	<b>Web Interface Map</b>	<b>69</b>
3.1	Mapping Selection Menu . . . . .	69
3.2	Managing Layers . . . . .	75
3.3	Map Management Menu Elements . . . . .	76
3.4	My Obstacles . . . . .	80
3.5	LiDAR . . . . .	89
3.6	Mobile View . . . . .	90
3.7	Outputs . . . . .	92
<b>4</b>	<b>Web Interface RF Tools</b>	<b>95</b>
4.1	Function Menu . . . . .	95
4.2	Function Menu Overview . . . . .	95
4.3	Expand/Collapse Side Menu . . . . .	95
4.4	Path Profile Tool . . . . .	96
4.5	Best Server Tool . . . . .	101
4.6	My Archive . . . . .	103

4.7	Super Layer . . . . .	106
4.8	Interference Analysis . . . . .	108
4.9	Best Site Analysis . . . . .	110
4.10	Route Analysis . . . . .	115
4.11	Multipoint Analysis . . . . .	116
4.12	MANET planning tool . . . . .	117
4.13	Satellite planning tool . . . . .	121
4.14	Clear Layers . . . . .	124
<b>5</b>	<b>Web Interface Import Data</b>	<b>125</b>
5.1	Reference display . . . . .	126
5.2	Coverage analysis . . . . .	126
5.3	Route analysis . . . . .	126
5.4	MANET network . . . . .	126
5.5	Survey data . . . . .	126
5.6	Calibration . . . . .	126
5.7	Best Site Analysis . . . . .	126
5.8	Automatic processing . . . . .	126
5.9	File Validation . . . . .	127
5.10	Reference Display (Shapes on the map) . . . . .	127
5.11	Coverage Analysis (Measurements, Locations, Routes) . . . . .	130
5.12	Route analysis . . . . .	133
5.13	MANET network . . . . .	136
5.14	Best Site Analysis . . . . .	139
5.15	Automatic processing . . . . .	140
<b>6</b>	<b>ATAK Plugin</b>	<b>143</b>
6.1	Requirements . . . . .	143
6.2	Release and debug builds . . . . .	144
6.3	APK installation . . . . .	144
6.4	Plugin installation . . . . .	145
6.5	Using the plugin . . . . .	147
6.6	KMZ coverage export . . . . .	152
6.7	Radio Templates . . . . .	155
<b>7</b>	<b>Google Earth™ Interface</b>	<b>161</b>
7.1	Requirements . . . . .	162
7.2	Google Earth Settings . . . . .	162
7.3	Authentication . . . . .	163
7.4	Operation . . . . .	164
7.5	Inputs . . . . .	164
7.6	Known issues . . . . .	164
<b>8</b>	<b>TAK Server Interface</b>	<b>165</b>
8.1	Supported versions . . . . .	166
8.2	Design . . . . .	166
8.3	SOOTHSAYER chatbot setup . . . . .	167
8.4	Certificate generation on TAK server . . . . .	167
8.5	Testing communications . . . . .	168
8.6	TAK server administration . . . . .	168
8.7	SOOTHSAYER Commands . . . . .	170
8.8	Functions . . . . .	174
<b>9</b>	<b>API</b>	<b>183</b>
9.1	OpenAPI 3 Schema . . . . .	183

9.2	API Endpoint . . . . .	183
9.3	Authentication . . . . .	184
9.4	API “Hello World!” Getting Started Example . . . . .	184
9.5	Example API Requests . . . . .	185
9.6	Area API with bounded output . . . . .	220
9.7	More Information . . . . .	221
9.8	API scripts . . . . .	221
<b>10</b>	<b>Reference Data</b>	<b>223</b>
10.1	Antenna Patterns . . . . .	223
10.2	Terrain data . . . . .	241
10.3	Buildings and LiDAR . . . . .	241
10.4	Clutter data . . . . .	242
<b>11</b>	<b>Common Tasks</b>	<b>247</b>
11.1	Measure the coverage of a WISP tower . . . . .	247
11.2	Model multiple sites for multiple frequencies . . . . .	248
11.3	Design a network that meets a coverage requirement . . . . .	248
11.4	Model HF NVIS coverage . . . . .	250
11.5	Test a route for coverage against a network . . . . .	251
<b>12</b>	<b>Documentation Changelog</b>	<b>253</b>
12.1	2.8.0 . . . . .	253
12.2	2.7.1 . . . . .	253
12.3	2.7.0 . . . . .	253
12.4	2.6.1 . . . . .	253
12.5	2.6.0 . . . . .	254
12.6	2.5.6 . . . . .	254
12.7	2.5.5 . . . . .	254
12.8	2.5.4 . . . . .	254
12.9	2.5.3 . . . . .	255
12.10	2.5.2 . . . . .	255
12.11	2.5.1 . . . . .	255
12.12	2.5.0 . . . . .	255
12.13	2.4.0 . . . . .	255
12.14	2.3.0 . . . . .	256
12.15	2.2.0 . . . . .	256
12.16	2.1.2 . . . . .	256
12.17	2.1.1 . . . . .	256
12.18	2.1.0 . . . . .	256
12.19	2.0.1 . . . . .	257
12.20	2.0.0 . . . . .	258



This documentation is up-to-date for the following components:

Component	Version
API	3.15
UI	3.13
SLEIPNIR	1.13
GPU Engine	1.10
3D Engine	1.0

If you find parts of this documentation are missing or incorrect contact [support@cloudrf.com](mailto:support@cloudrf.com).



## ABOUT CLOUDRF

**CloudRF** is an accessible service for modelling radio propagation.

The scalable service was built and shaped from user feedback since its inception as a popular Android app “RFSignal” in 2011.

CloudRF was built for radio operators and engineers who either could not justify the extortionate price tags for legacy desktop packages and/or do not have weeks of time required to use complex tools, designed for planning cellular networks, effectively.

At CloudRF, we pride ourselves on **innovation** and have transformed the way people conduct radio coverage modelling, disrupting what was a very expensive, and exclusive, desktop market.

### 1.1 Benefits

#### 1.1.1 Accuracy

Our API supports LiDAR at 1m resolution, soft clutter / land cover and custom obstacles. You can define regional clutter profiles for different trees, seasons and building architectures.

#### 1.1.2 Speed

Our CPU and GPU engines are the fastest, and most economical, on the web and support 1m LiDAR.

We include global soft buildings and clutter in all our plans, but with a clear price which we are proud to publish.

#### 1.1.3 Availability

Our global terrain data, 10m land cover and 2m buildings are ready to go now. Save yourself hours of mission preparation.

This is why we’re used globally for fire-fighting, search and rescue, events, security operations and disaster management.

### 1.1.4 Economy

User-friendly interfaces designed for busy humans with options to support most radio technologies from HF to SATCOM.

Cross-platform interfaces with tips and videos to help you plan your network today, not next week.

## 1.2 Our Mission

Our mission is to make radio planning **simple** and **accessible**.

**Radio modelling** is complicated that usually needs an enormous number of resources and preparation to do it accurately. We want it to be accessible, accurate, and user-friendly.

## 1.3 Innovation Roadmap

Year	Milestones
2011	RFSignal for Android launched. Top 50 in communications category on Play Store.
2012	CloudRF.com website launched with web interface
2013	Keyhole Radio™ interactive layer for Google Earth.
2014	Virtual machines offered.
2015	ITU propagation models added to engine. Channel intersection. Mesh functionality.
2016	LiDAR high resolution data in engine and interfaces. UK 2 meter and US city DSM uploaded.
2017	Drone photogrammetry support via Pix4D. Global 30m DSM
2018	New LiDAR propagation engine SLEIPNIR developed. LiDAR uploaded for New Zealand, Estonia, Sweden, DC and Baltimore GPU prototype engine
2019	30 meter landcover with 584 types for CONUS and EU. KML “do-it-yourself” clutter upload utility. 3D clutter with material densities.
2020	3D building support with configurable attenuation. 3D cross-platform interface. 26k antenna patterns added ATAK integration
2021	ATAK chatbot SOOTHSAYER™ virtual machine with BYO LiDAR 10 meter global clutter More API client examples inc Windows Points API for many-many analysis CSV coverage metrics
2022	GPU area API Satellite planning tool MANET planning tool Hardware API integration GPU Best site analysis API
2023	GPU Multisite / MANET GPU clutter attenuation ATAK plugin
2024	3D API with multipath and phase effects. General purpose model and multi-obstacle diffraction models Output bounded GPU calculations for SATCOM viewsheds

## 1.4 Supported Technologies

- Anything that uses radio from **2-90,000 MHz**.
- The protocol agnostic API can be used to model specific technologies like **LoRa / LTE / 4G / 5G**.

## 1.5 Platforms

The following platforms are supported:

- **Android, Linux, Mac/OSX** and **Windows** are supported.
- Our **ATAK** plugin lets you pick radios from a list and it's server based architecture won't deplete your battery..
- Our unique Google earth plugin lets you run the software directly from within the application.
- Our **3D interface** will adjust to any device from phones to desktop computers.

**Google Chrome** is recommended for best performance.

## 1.6 CloudRF.com (public API)

### 1.6.1 Account Registration

To **Register your Account** on the CloudRF:

- On the **CloudRF website** (<https://cloudrf.com/>):
  - Click on **My Account** tab.
  - The **My Accounts** screen will appear.



- Product ▾
- Documentation ▾
- Enterprise ▾
- Pricing
- My account**

[Home](#) > My account

## My account

### Login

Username or email address \*

  
  
Password \*

Remember me

Log in

[Lost your password?](#)

### Register

Email address \*

A link to set a new password will be sent to your email address.

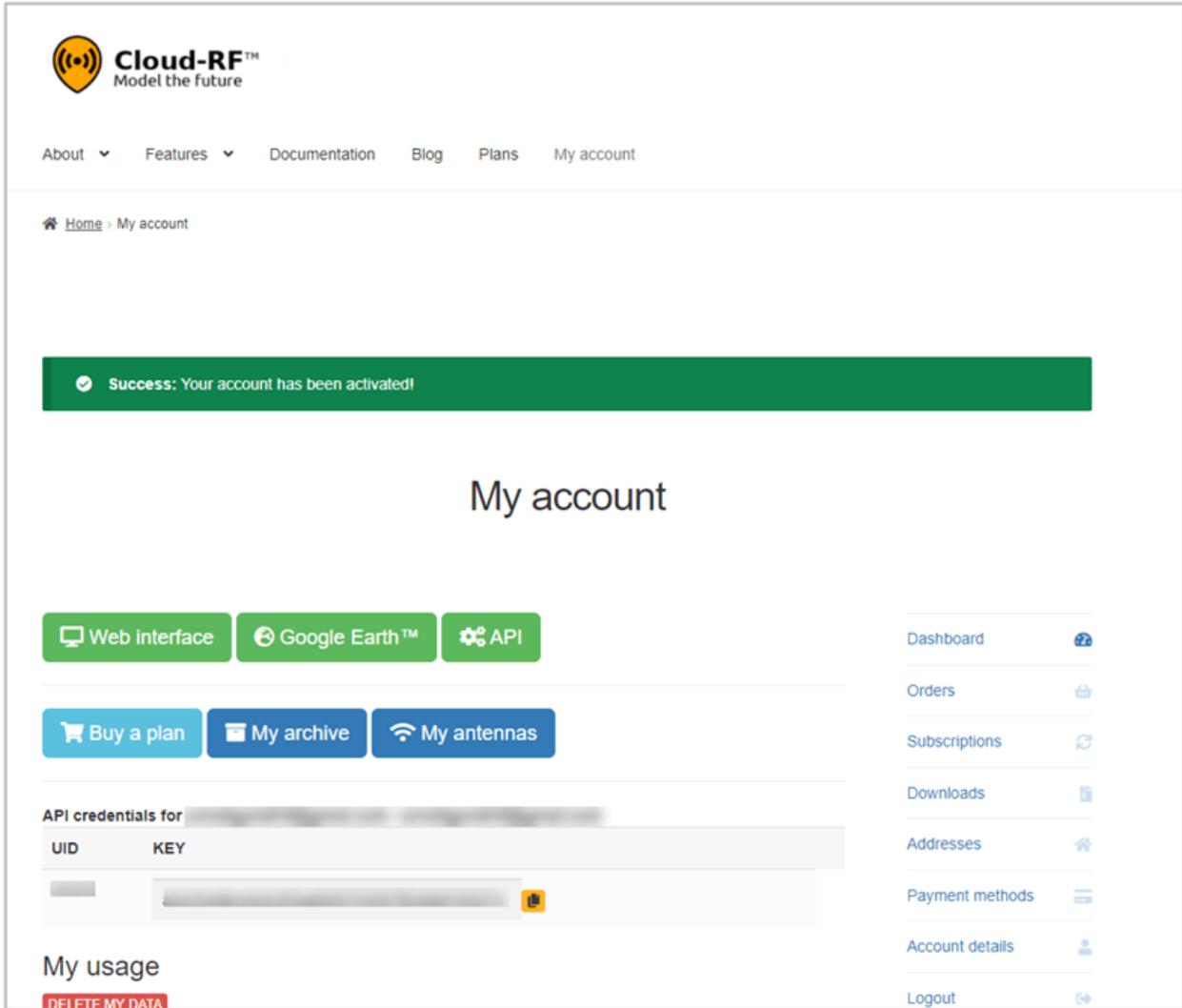
Which band has the shortest wavelength: HF, VHF, UHF or SHF? (Required)

Your personal data will be used to support your experience throughout this website, to manage access to your account, and for other purposes described in our [privacy policy](#).

Register

- Under the **Register** section,
  - In the **Username** field, enter the username as desired.
  - In the **Email Address** field, enter your email address.
  - In the **Quiz** field, enter your answer to the respective question.





- The **CloudRF Tool Home Page** will be displayed.

## 1.6.2 Login

To **Log in into your Account** on the CloudRF:

- On the **CloudRF website** (<https://cloudf.com/>):
  - Click on **My Account** tab.
  - The **My Accounts** screen will appear.



Product ▾ Documentation ▾ Enterprise ▾ Pricing **My account**

[Home](#) > My account

## My account

### Login

Username or email address \*

Password \*

Remember me

Log in

[Lost your password?](#)

### Register

Email address \*

A link to set a new password will be sent to your email address.

Which band has the shortest wavelength: HF, VHF, UHF or SHF? (Required)

Your personal data will be used to support your experience throughout this website, to manage access to your account, and for other purposes described in our [privacy policy](#).

Register

– Under the **Login** section:

- \* In the **Username or email address** field, enter your username or email address.
- \* In the **Password** field, enter your password.
- \* You may select the **Remember me** checkbox to save the credentials on your device.
- \* Click on **Log in** button.

### 1.6.3 Lost Your Password?

If you have lost your password, you can reset it through your **registered email address**.

To do so:

- Click on **Lost your Password?** link.



## My account

### Login

Username or email address \*

Password \*

Remember me

Log in

[Lost your password?](#)

### Register

Email address \*

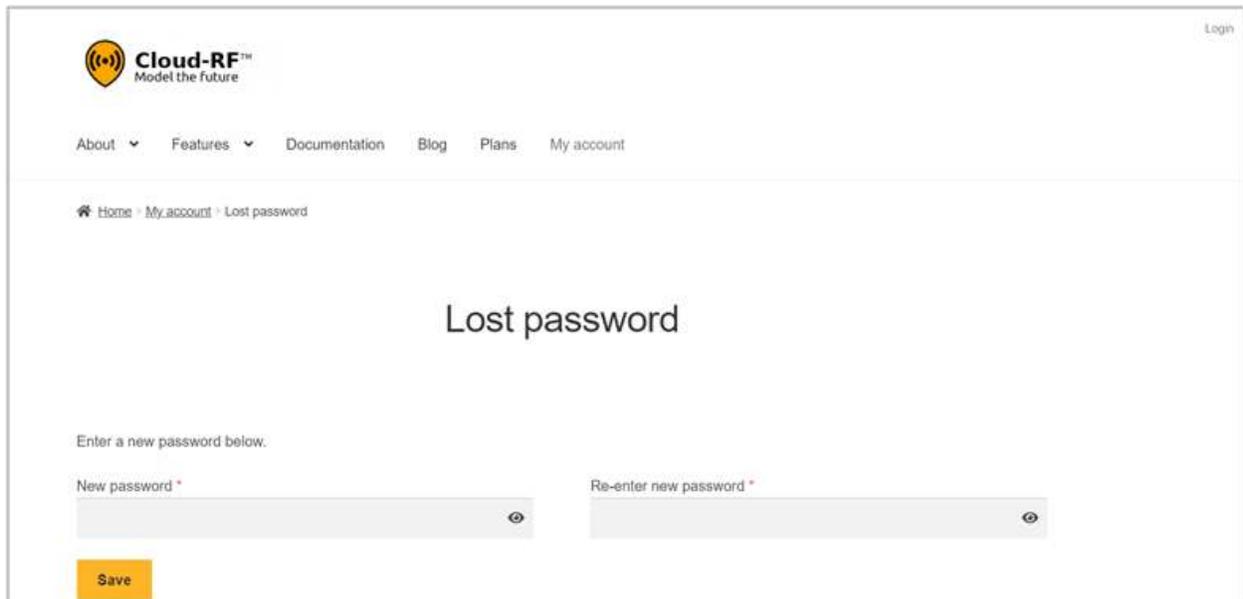
A link to set a new password will be sent to your email address.

Which band has the shortest wavelength: HF, VHF, UHF or SHF? (Required)

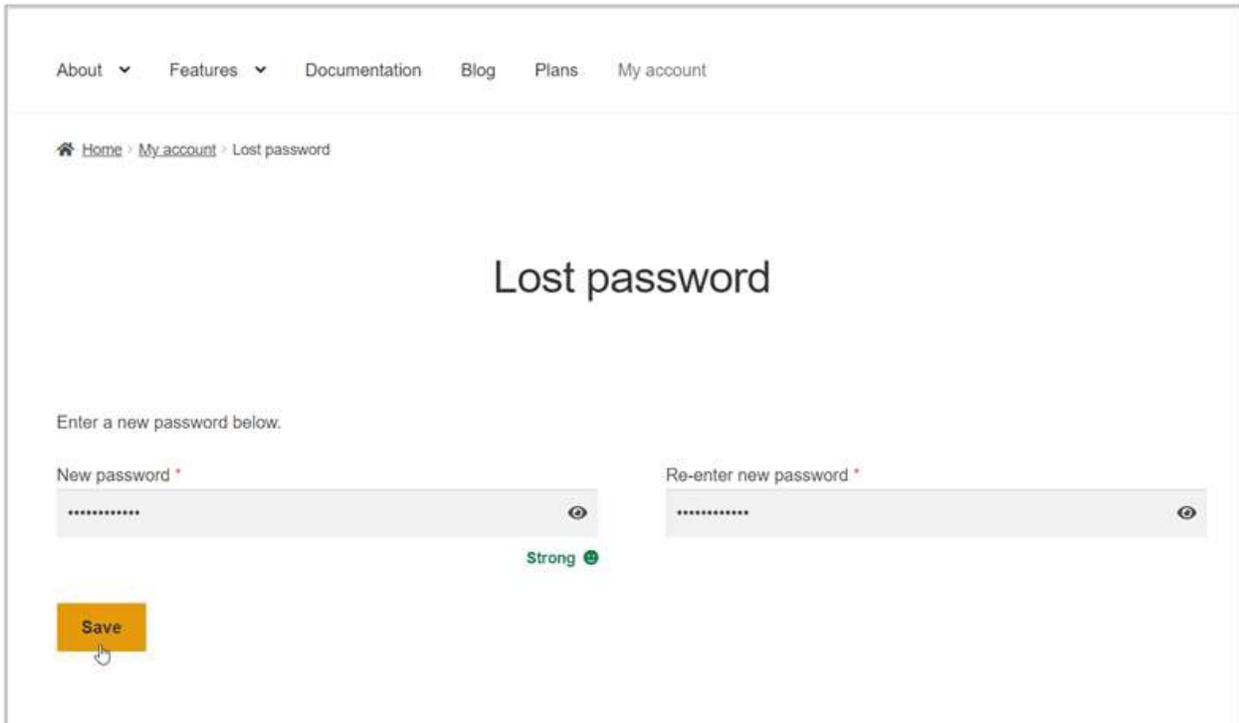
Your personal data will be used to support your experience throughout this website, to manage access to your account, and for other purposes described in our [privacy policy](#).

Register

- The **Lost Password** screen will appear.

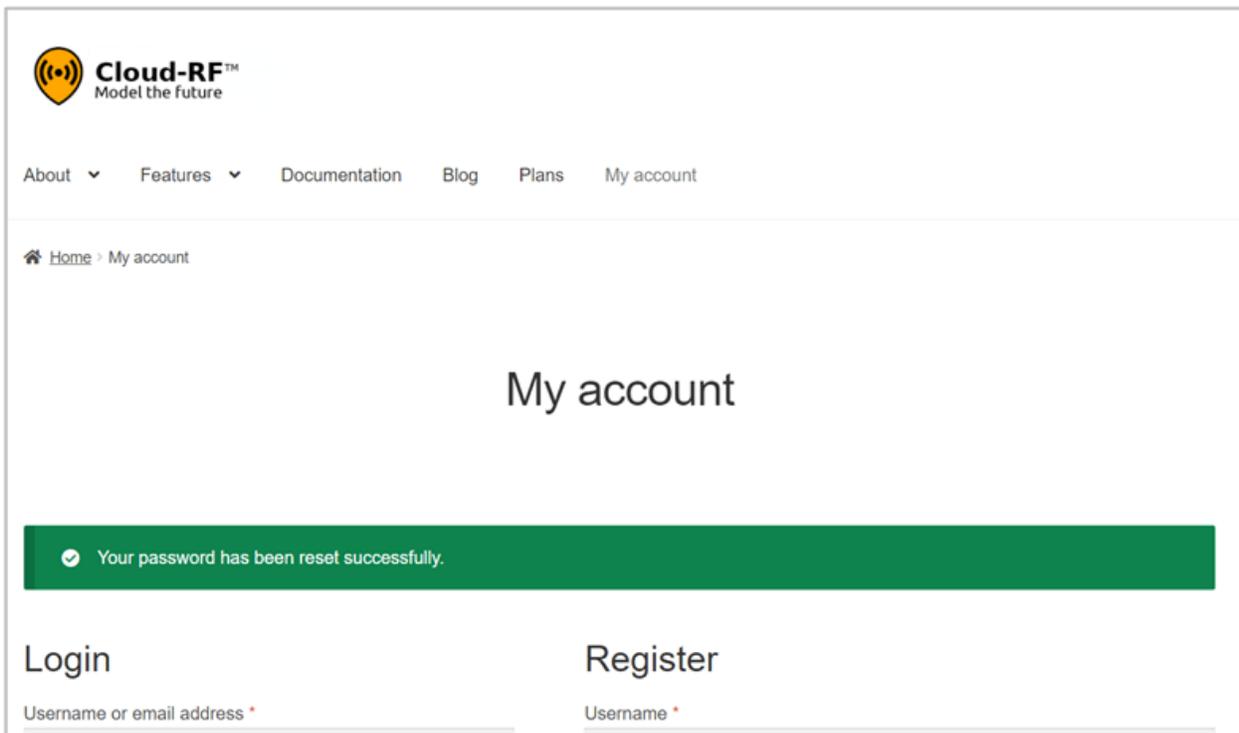


- Enter the **New Password** as desired.
- **Re-enter new password** to confirm.
- Click on **Save** button.



The screenshot shows the 'Lost password' page. At the top, there is a navigation menu with links for 'About', 'Features', 'Documentation', 'Blog', 'Plans', and 'My account'. Below the navigation, a breadcrumb trail reads 'Home > My account > Lost password'. The main heading is 'Lost password'. Below this, the instruction 'Enter a new password below.' is displayed. There are two input fields: 'New password \*' and 'Re-enter new password \*'. Both fields contain masked characters (dots). The 'New password' field has a strength indicator below it that says 'Strong' with a green smiley face icon. To the left of the 'New password' field is an eye icon to toggle visibility. Below the input fields is a yellow 'Save' button with a mouse cursor hovering over it.

- The **Success message** pop-up will appear.



The screenshot shows the 'My account' page. At the top, there is a navigation menu with links for 'About', 'Features', 'Documentation', 'Blog', 'Plans', and 'My account'. Below the navigation, a breadcrumb trail reads 'Home > My account'. The main heading is 'My account'. A green success message banner is displayed, containing a checkmark icon and the text 'Your password has been reset successfully.'. Below the banner, there are two sections: 'Login' and 'Register'. The 'Login' section has a text input field labeled 'Username or email address \*'. The 'Register' section has a text input field labeled 'Username \*'.

## 1.6.4 The Home Page

After you login into your CloudRF account, the **Home Page** will be displayed.



Product | Documentation | Enterprise | Pricing | My account

Home | My account

# My account

[Buy a plan](#) *Test for free on the island of Ibiza.*

## Interfaces

- Web interface
- Google Earth™ layer
- API examples

## Data

- My archive
- My antennas
- My clutter

Email [support@cloudrf.com](mailto:support@cloudrf.com) for assistance

- Dashboard
- Orders
- Subscriptions
- Downloads
- Addresses
- Payment methods
- Account details
- Logout

## Developer's API

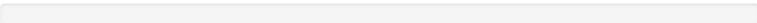
Use this token in your apps to interact with the API.  
[Postman Docs and examples](#)  
[Developer's reference \(Swagger OAS3\)](#)



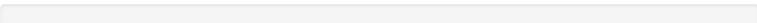
## My usage

[DELETE MY DATA](#)

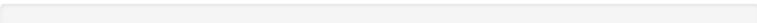
11 API calls from a plan limit of 5000 (0%). On-demand credit balance: 0



17MB storage used from a limit of 5000MB (0%)



0 API calls in the last 24 hours. Taking it easy...



## My plans

[Missing orders?](#)

Time	Product	Expiry
2021-12-01 12:01:10	Silver plan	2022-12-08 12:01:10

## My networks

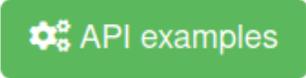
#	Network	Calculations
1	My_network	164
2	mymesh	1

Verification status: **Unverified**

- You can access the **Web Interface**, **Google Earth**, **API**, **My archive**, **My antennas** and **My clutter** by clicking on the respective button on the Home Page.

 Buy a plan *Test for free on the island of Ibiza.*

### Interfaces

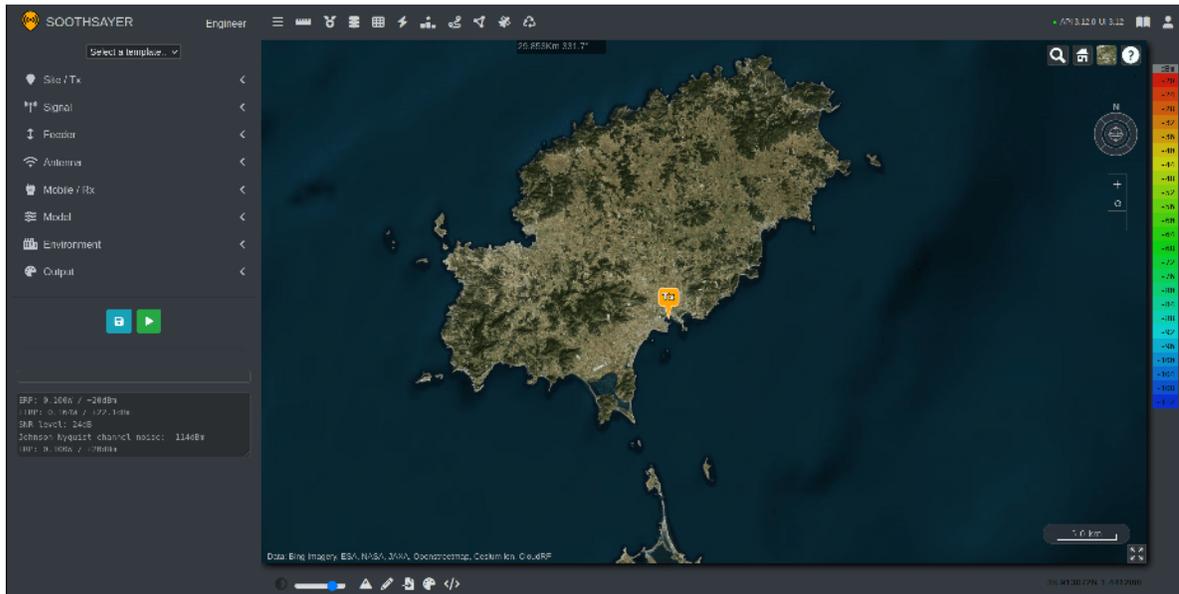
 Web interface  Google Earth™ layer  API examples

### Data

 My archive  My antennas  My clutter

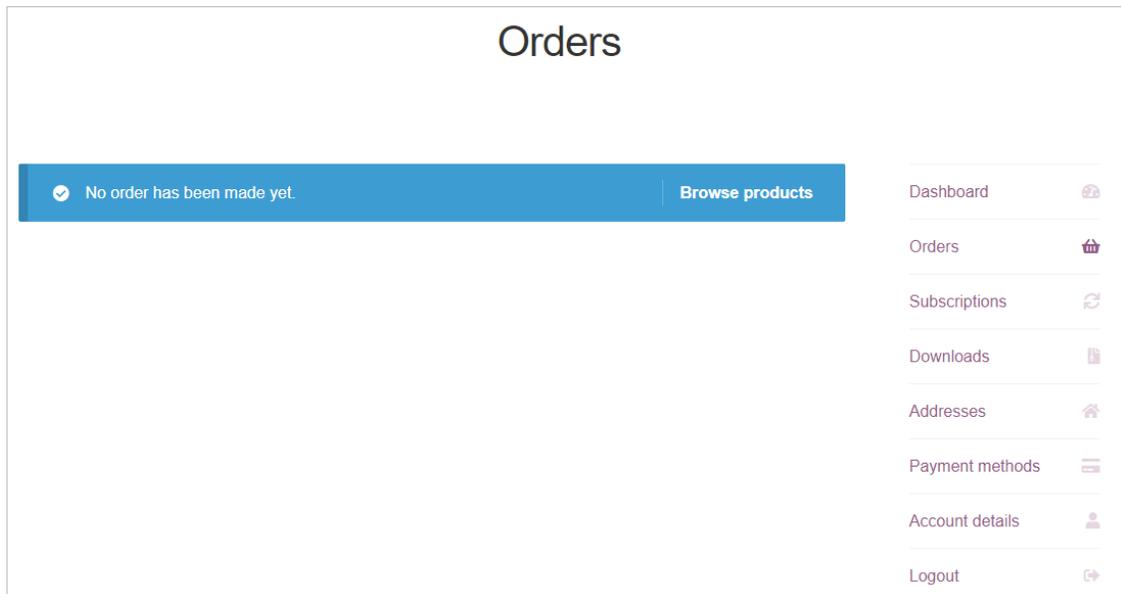
Email [support@cloudf.com](mailto:support@cloudf.com) for assistance

- Click on **Web Interface** button to know how you will access the CloudRF Modeling tool itself right in your web browser.



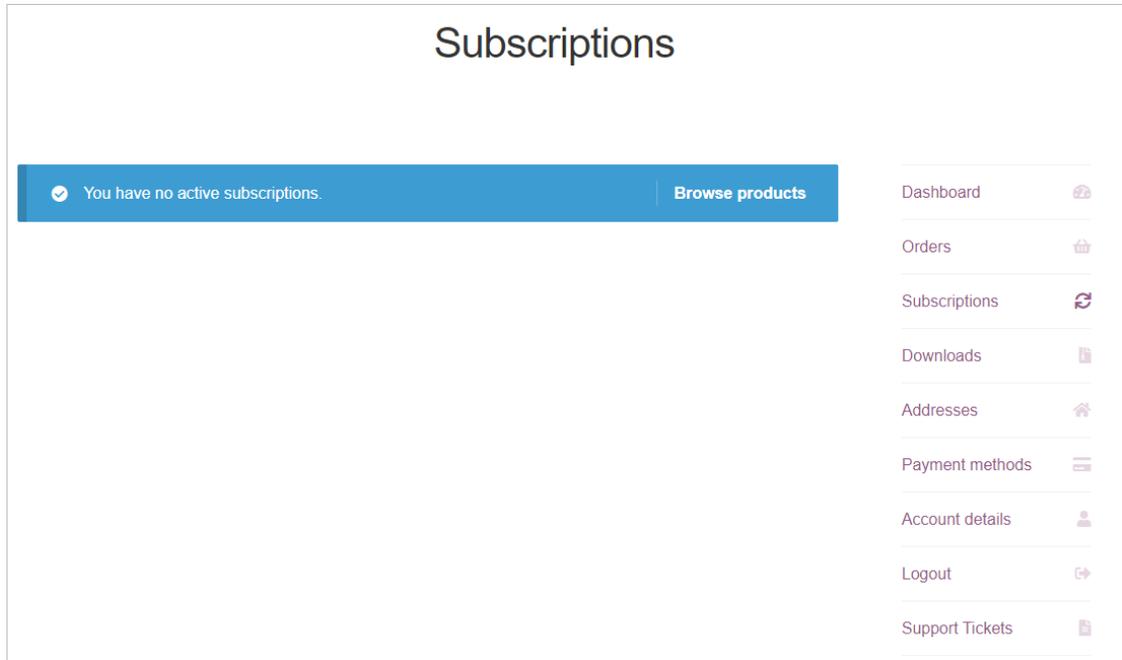
- Click on **Google Earth™** button to access the Google Earth.
  - The Keyhole Radio.kml file for Google Earth will be downloaded.
    - \* **Keyhole Radio** is a unique and powerful radio planning plugin for *Google Earth™*.
    - \* The software is entirely server based, so you only need to open the Keyhole Markup Language (KML) overlay in Google Earth to use it.
    - \* It's ideal for organisations already using Google Earth as it can be deployed rapidly to users as a URL and the KML output is visualised along with 3D terrain and existing data layers, for example network infrastructure.

- \* The system's terrain data, radio templates, antenna patterns and ground clutter are all managed from server side.
- To open the downloaded Google Earth KML, you may either launch the KML File or add a *network link* within Google Earth with the URL: <https://cloudrf.com/ui/kml>
- Click on **API** button to access the API.
  - You can see your API key and your current subscription plan as well.
  - The **CloudRF API** for radio planning lets you model radio coverage for any RF system between *20 and 90,000MHz*.
  - A **CloudRF account** and **active plan** are required to use the API.
- Click on **Buy a Plan** button to purchase a plan.
  - Moreover, it lets you upgrade your account as well to access all the available features.
  - You can add the desired plan(s)/subscription(s) to your cart by clicking on the **Add to Cart / Sign up now** button.
  - You may also scroll down to view the **FAQs** section.
- The **Right Navigation Menu** with the following menu options will be displayed. You can click on the:
  -  **Dashboard** - for accessing the Home Page.
  -  **Orders** - to view all your orders.



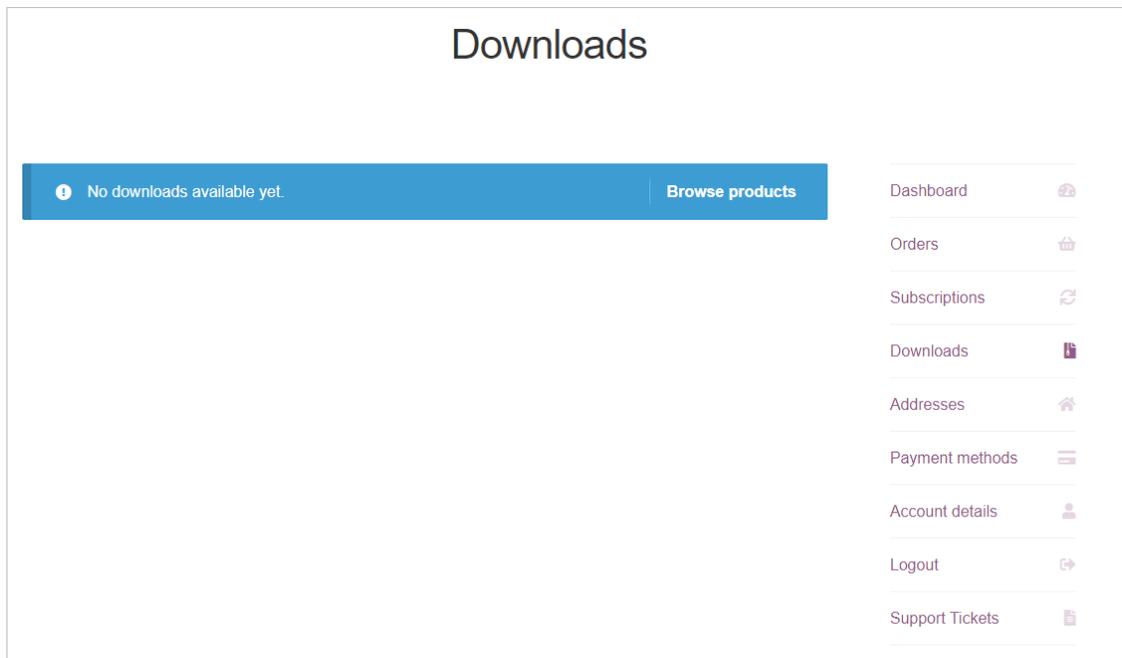
\* If no orders have been made, you may click on *Browse products* button to browse the available products.

-  **Subscriptions** - to view all your subscriptions.



\* If you have no active subscriptions , you may click on *Browse products* button to browse the available subscriptions.

-  **Downloads** - to view all the downloaded files.



\* You may click on *Browse products* button to browse the available products.

-  **Addresses** - to view the shipping and billing addresses added to your account.

## Addresses

The following addresses will be used on the checkout page by default.

**Billing address**

*You have not set up this type of address yet.*

**Shipping address**

*You have not set up this type of address yet.*

Dashboard

---

Orders

---

Subscriptions

---

Downloads

---

**Addresses**

---

Payment methods

---

Account details

---

Logout

---

Support Tickets

- **Payment methods** - to view the payment methods added to buy your orders or subscriptions.

## Payment methods

No saved methods found.

**Add payment method**

Dashboard

---

Orders

---

Subscriptions

---

Downloads

---

Addresses

---

**Payment methods**

---

Account details

---

Logout

---

Support Tickets

\* You may also add a payment method by clicking on the *Add Payment Method* button.

- **Account details** - for accessing your account details and edit them if required.

\* You can change your **password**, **contact preference**, and **time zone settings** from here.

## Account details

First name \*

Last name \*

Display name \*   
This will be how your name will be displayed in the account section and in reviews

Email address \*

**Password change**

Current password (leave blank to leave unchanged)

New password (leave blank to leave unchanged)

Confirm new password

[Save changes](#)

[Dashboard](#)

---

[Orders](#)

---

[Subscriptions](#)

---

[Downloads](#)

---

[Addresses](#)

---

[Payment methods](#)

---

[Account details](#)

---

[Logout](#)

---

[Support Tickets](#)

\* Click on **Save Changes** button after making the required changes.



– **Logout** - if you wish to logout from your account.

\* The *Login/Register* screen will be displayed.

### 1.6.5 Dashboard

- The **API credentials** of your account - *UID* and *KEY* will be displayed.



- To copy the **API Key**, you can click on the *copy* icon.

## Developer's API

Use this token in your apps to interact with the API.

[Postman Docs and examples](#)

[Developer's reference \(Swagger OAS3\)](#)



- Under **My usage** section:
  - The **API Calls details** and the **Storage used** will be displayed.
  - You may click on the **Delete My Data** button to delete the data of your usage.
- Under **My Plans** section:
  - Your **Plan details** (*Time, Product and Expiry*) will be displayed.
  - You can click on **Missing your orders** link as per your requirement.
- Under **My Networks** section:
  - Your **Network details** (*Network and Calculations*) will be displayed.

### 1.6.6 Ordering a Plan

You can order a plan or a subscription by adding the desired product in your cart and then paying for the same.

To order a plan or a subscription:

- Under **My Accounts** tab, you can click on the **Buy a plan** button.

OR

- Click on **Plans** tab.

OR

- Under **My Accounts** tab:
  - Click on **Orders, Subscriptions** or **Downloads**.
  - Click on **Browse Products** button.
- The **Plans** screen will be displayed.
- You can add the desired plans or subscriptions by clicking on the **Add to cart** or **Sign up now** button respectively.
  - You can also upgrade your account from here to access all the available features.

## 1.7 Choosing an Interface

In CloudRF tool, there are **four major Interfaces** available:

- **3D Interface**
- **ATAK plugin**
- **Google Earth layer**
- **CloudRF API**

The following is the description and the steps of loading of each interface:

### 1. 3D Interface

- The **3D interface** is the primary user interface for CloudRF that works on desktops, tablets and mobiles.
- To load the **3D Interface**:
  - Under *My Accounts* tab, click on **Web Interface** button.
  - The 3D Interface will be displayed.

### 2. ATAK plugin

- The **SOOTHSAYER ATAK plugin** works with ATAK for Android. You must already have this installed to use this. To use the plugin:
- Install the .apk file from the Github repository
- Enter the plugin settings and update your API key

### 3. Google Earth layer

- **The Google Earth layer™** is a unique and powerful RF planning interface, accessed by loading a Keyhole Markup Language (KML) overlay in Google Earth™. It's ideal for busy organisations already using Google Earth as existing data can be overlaid with your RF overlays and the software with supporting terrain data is ready to go so long as a client has Google Earth and a network connection.
- A **CloudRF user account** is required to use the service. Registration is free.
- To load the **Keyhole Radio™ interface for Google Earth**,
  - Under *My Accounts* tab, click on **Google Earth** button.
  - The *Keyhole Radio.kml* file for Google Earth will get downloaded.
  - To open it, you may either launch the KML File or add a *network link* within Google Earth with the URL: <https://cloudrf.com/ui/kml>

### 4. CloudRF API

- The **CloudRF API** is a *public programming interface* which allows developers to pull upon the power and data of CloudRF with just a few lines of code (in a language of your choice).
  - Moreover, with this, you can integrate radio planning into your application or website without worrying about the heavy CPU, memory or disk resources required to do RF planning.
  - It's up all year round, 24 hours a day!
- To load the **CloudRF API**:
  - Under *My Accounts* tab, click on **API** button.
  - You can access your API and view your API key & your current subscription plan.

- The **CloudRF API** for radio planning lets you model radio coverage for any RF system between *20 and 90,000MHz*.
- A **CloudRF account** and **active plan** are required to use the API.

### 1.7.1 Performance Tips

Following are the tips and tricks that can help you maximise 3D interface performance.

- Ensure you have a GPU video card and a web browser that supports WebGL. If it does not you will be warned.
- Reduce your screen resolution to no more than 1920 x 1080px.
- Switch off 3D terrain and 3D buildings layers in the interface as these layers use a lot of memory
- Close any other apps like Google Earth which will compete for video memory
- Close unused browsers and tabs. Every open page will cost memory and resources.



## WEB INTERFACE OVERVIEW

The 3D web interface is the primary user interface for CloudRF. This interface is compatible with desktops, laptops, tablets and even mobile phones.

The interface supports Android, Linux, Mac/OSX and Windows and works best with Google Chrome.

MINIMUM HARDWARE: 4GB of memory, dual core CPU

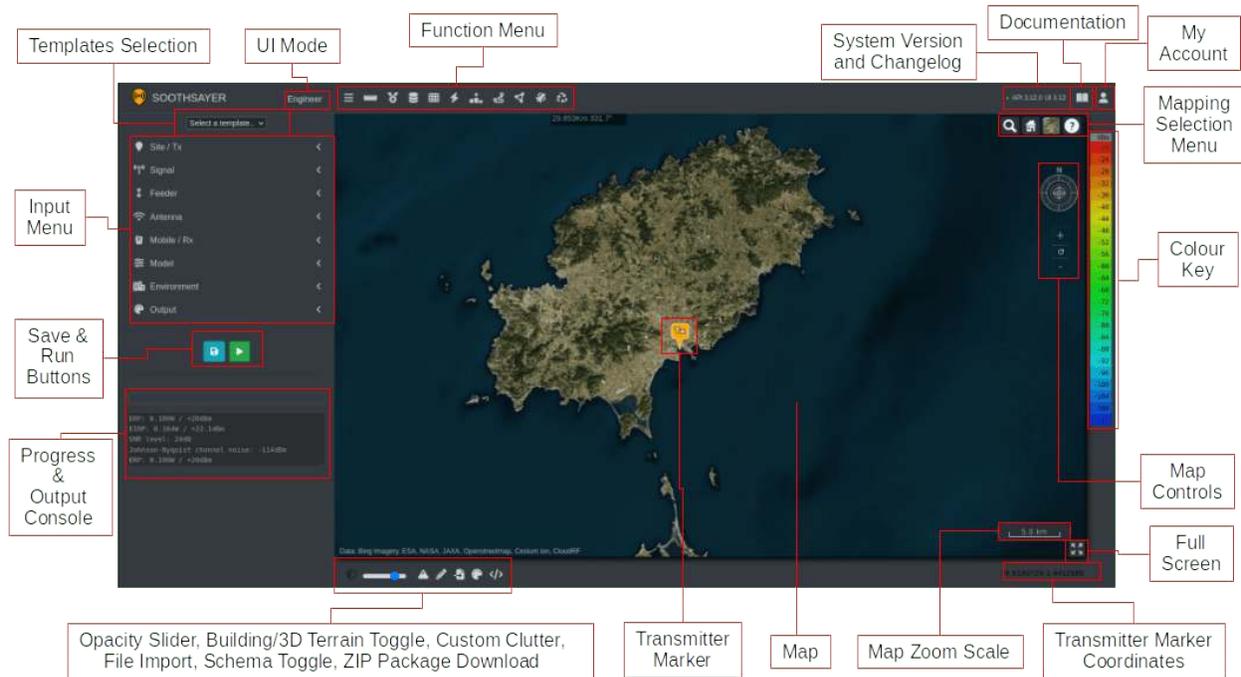
RECOMMENDED HARDWARE: 8GB of memory, quad core CPU, 1GB GPU



To access the CloudRF 3D Interface:

- Click on the **Web Interface** button on the Home Page.

## 2.1 Interface elements



## 2.2 Hot Keys / Keyboard Shortcuts

There are a number of hot keys / keyboard shortcuts which are enabled in the interface which can allow you to manipulate your view/settings without moving your mouse.

You can use the following keyboard shortcuts:

- Home - Reset your view to your current Tx marker.
- Page Up - Zoom out.
- Page Down - Zoom in.
- Left Arrow - Pan view left.
- Up Arrow - Pan view up.
- Right Arrow - Pan view right.
- Down Arrow - Pan view down.
- Control + Left Arrow - Move Tx marker left.
- Control + Up Arrow - Move Tx marker up.
- Control + Right Arrow - Move Tx marker right.
- Control + Down Arrow - Move Tx marker down.
- Control + Space - Run a calculation.

## 2.3 UI Mode

The CloudRF UI supports users of different radio knowledge.

You can quick toggle between the two modes by clicking on the mode name which you are currently using.

### 2.3.1 Engineer Mode

Engineer mode will be indicated by “Engineer” in the UI Mode portion in the top left of the window.

In engineer mode you will have full access to all tools and input fields to fully customise your requests.

This mode is typically used by advanced users, or those who wish to fine-tune calculations.

### 2.3.2 Operator Mode

Operator mode will be indicated by “Operator” in the UI Mode portion in the top left of the window.

Operator mode is designed to provide the minimum required fields to allow a user to execute calculations, whilst avoiding overwhelming with fields which might not be fully understood. Therefore, in operator mode you will notice that many of the tools and input fields are removed. If you wish to use these then you should use a different mode.

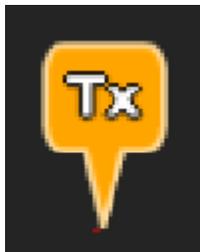
This mode is typically used by beginner or novice users, or those who don’t need to be able to fine-tune settings.

The following settings are used when making use of operator mode.

- The general purpose model is used as the propagation model (See [model section](#) for more details).
- Deygout 94 is used as the diffraction model (See [model section](#) for more details).
- A DTM elevation is used with landcover and 3D buildings (See [environment section](#) for more details).
- Various values are calculated which would otherwise be manually input:
  - Noise floor and receiver sensitivity are inferred from the bandwidth value which is used.
  - The maximum radius is calculated based upon the maximum theoretical radius that could be achieved based upon your settings.
  - The resolution of the output is calculated based upon the maximum megapixel output which can be produced by your subscription plan and combining it with your specified radius. A larger radius will result in a reduced resolution output.

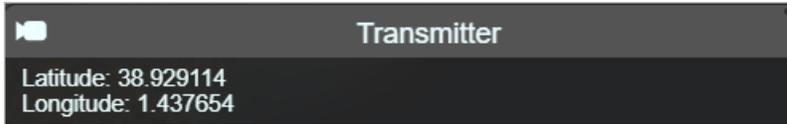
## 2.4 Transmitter Marker

The **Transmitter Marker (Tx)** indicates your *Antenna Location*.

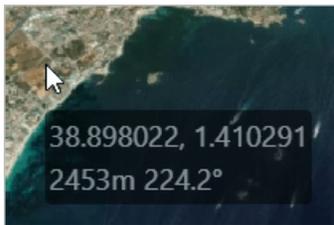


To update your **antenna location settings**:

- On the map, click on the **desired location**.
  - The transmitter marker will move to your clicked location.
  - The location settings under the input menu will be updated respectively.
- Click on the transmitter marker to view the **location parameters** of the Transmitter - *Latitude* and *Longitude*.

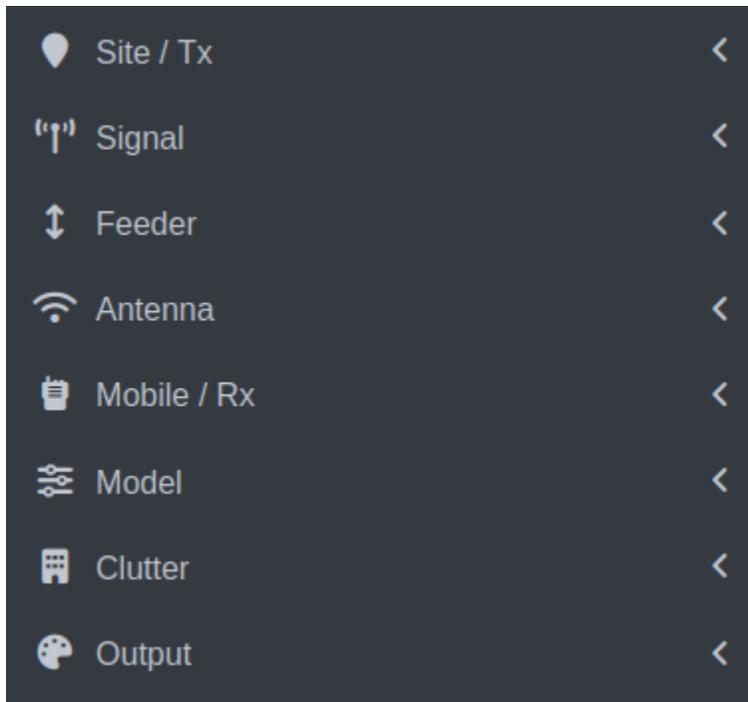


- When you have a layer, the **information box** next to the cursor will display the current co-ordinates, signal strength, distance and angle from the site.



## 2.5 Input Menu

The **Input Menu** is an accordion style menu consisting of various collapsible sections with input fields. It allows you to focus on several settings which are further grouped into the various categories making it user-friendly.

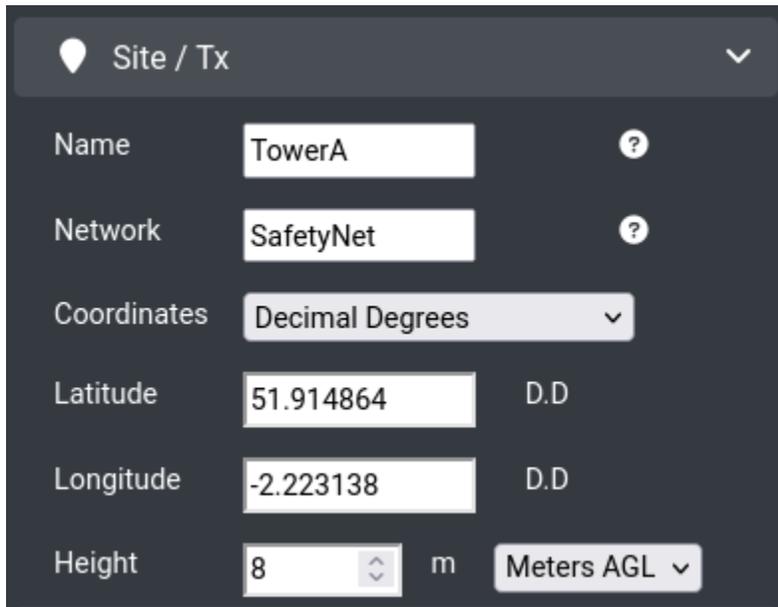


The fields in the various input menu categories have a **Help**  icon beside them. To know the details regarding a field, you can click on the Help icon of the respective field.

## 2.5.1 Site / Tx

The Site / Tx (Transmitter) input menu consists of the settings related to the **physical location of the antenna**. These settings are relative to the ground and the Name & Parent of the site.

The Site/Tx settings will be of greater importance as your network grows and you need to perform analysis such as the best server analysis.



You can set location in the following two ways:

- **Manually** - You can enter the Location fields (Latitude and Longitude) manually in the respective fields.

*OR*

- **Clicking on the Map** - You can click on the map and the location fields will be set accordingly.

All the inputs in the form of Decimal Degrees, Degrees/Minutes/Seconds and NATO MGRS are acceptable. The system will make necessary conversions automatically.

Configure the following **Site/Tx fields**:

### Name

Enter the desired unique name for your site.

### Network

Enter the network name for logical grouping (as per the cities/area) of your site(s). Minimum length 2 characters eg. "N1"

NOTE: Setting the network is really important as it will help you group and analyse data in the future. Do not use the same value eg. TEST for all your work as you will never find it or be able to run analysis functions on it like the 'network' analysis or 'interference' tools.

### Coordinates

Select the desired coordinate format from the drop-down.

- **Latitude and Longitude** - These location fields can be entered manually or set automatically by clicking on the map.

### Height

Enter the height (in meters or feet) as either above mean sea level (AMSL) or above ground level (AGL). If using LiDAR and height AGL this is the height above the roof, otherwise it's relative to the ground. The system's resolution is 1m minimum so a shoulder mounted radio should be set as 2m and a smart meter on (or below) the ground should be 1m.

*The height above mean sea level is relative to the DTM used vs the WGS84 ellipsoid. All sea levels in CloudRF are 0 without tidal adjustments.*

The Distance units applying to all heights and radiuses are set here. The default units of the system are metric (m/km)

Choosing Feet will set the distance calculations to Imperial (ft/Mi)

## 2.5.2



### Signal

The Signal input menu consists of the settings related to the **actual radiation**.



The screenshot shows a dark-themed configuration panel for a signal. At the top, there is a header 'Signal' with a dropdown arrow. Below it are three rows of settings:

- Frequency:** A text input field containing '868' followed by a 'MHz' unit dropdown.
- RF power:** A text input field containing '1', a unit dropdown set to 'W', and a help icon (question mark).
- Bandwidth:** A text input field containing '0.1', a 'MHz' unit dropdown, and a help icon (question mark).

Configure the following **Signal fields**:

### Frequency

Enter the system frequency (MHz) in the range: **2 to 90,000 MHz**. For a wideband system use the center frequency. For a dynamic system which can go low and high, use the higher value since this will produce the more conservative coverage for planning purposes.

### RF Power

Enter the transmitter power (watts or dBm) before feeder loss and antenna gain.

ERP will be auto-calculated and displayed in the output console.

### Bandwidth

Enter the channel bandwidth (MHz). Range is 1KHz (0.001MHz) to 200MHz.

- Bandwidth will affect Channel Noise and Signal-to-Noise ratio.
- Wideband channels will incur increased channel noise and reduced Signal/Noise Ratio.

The system will compensate for wide-band noise by making adjustments to the receiver sensitivity inline with Shannon's theorem.

**WARNING:** Bandwidth is ignored for Received power mode (dBm) which is independent of channel noise as it is just the carrier (eg. cw). It becomes very relevant in SNR and RSRP modes, where it will make a significant difference in coverage.

## 2.5.3 Feeder

The Feeder input menu consists of the settings related to the cabling & connectors between a transmitter and a radio.

If you have a long feeder, it will absorb power and reduce the efficiency of your system. The most efficient systems have no feeder as the antenna screws onto the radio.

The screenshot shows a configuration panel for a feeder. At the top, there is a header 'Feeder' with a double-headed arrow icon on the left and a dropdown arrow on the right. Below this, the 'Coaxial type' is set to 'Belden 8215 (RG-6A)' in a dropdown menu. The 'Coaxial length' is represented by a slider that is currently at the 0m mark. The 'Connectors' field is a dropdown menu set to '0', with a question mark icon to its right. The 'Loss' field is a text input set to '0' followed by 'dB'. Below these fields, the 'ERP' is calculated as '1.000W / +30dBm' and the 'EIRP' is '1.641W / +32.2dBm'. The 'Efficiency' is shown as 'Good (100%)' in a green box, with a question mark icon to its right.

For UHF signals above 300MHz, feeder loss is a significant issue which must be budgeted carefully. A long cable will introduce a lot of loss into a antenna system. They're also more expensive so get the shorter cable and communicate further!

### Coaxial Type

Select the Coaxial standard from the drop-down as per your requirement. The Coaxial Cable used will affect the feeder loss.

This can be safely ignored if the antenna screws directly onto the radio.

### Coaxial length

Set the slider to the desired Coaxial length of the cable. The cable length will significantly affect the feeder loss. Even a few meters of coaxial could reduce your system efficiency by 50%.

This can be safely ignored if the antenna screws directly onto the radio.

### Connectors

Select the number of connectors from the drop-down as per your requirement.

This will affect the feeder loss.

## Loss

Enter the computed feeder loss in decibels. This will typically be in the range: 0 to 15dB.

If the feeder loss is more than 15dB, it indicates that your system is *very* inefficient and a redesign is recommended.

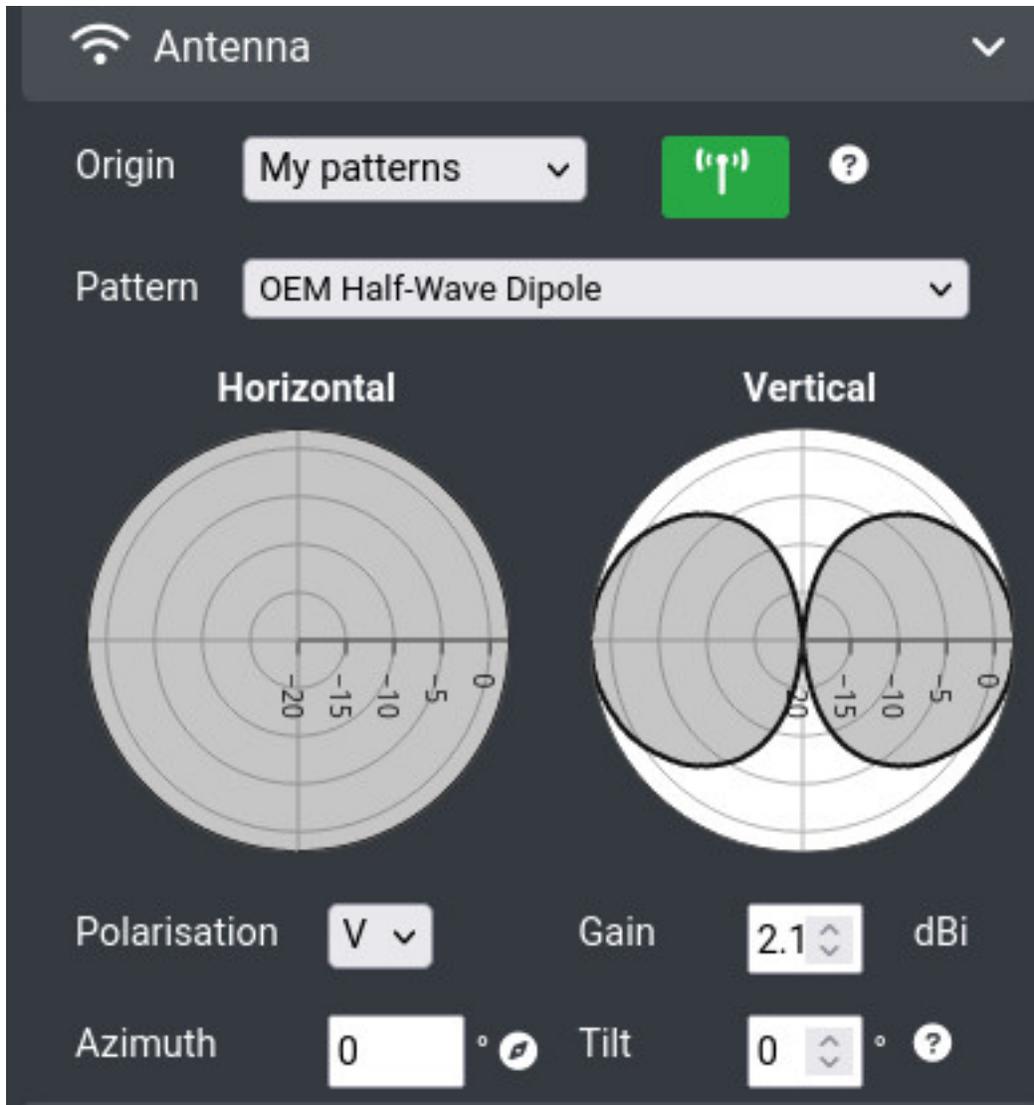
- **ERP** and **EIRP**- The dynamically calculated Effective Radiated Power (ERP) and Effective Isotropic Radiated Power (EIRP) will be displayed in the respective fields.

The ERP and EIRP values will change as you manipulate the powers and gains on the interface and will be visible in the corner console.

- **Efficiency** - This label will display the computed efficiency for your system based upon the RF input power and the computed ERP.

## 2.5.4 Antenna

The Antenna input menu consists of the settings that lets you choose or build an antenna.



Configure the following **Antenna fields**:

- **Origin** - You can select *My Patterns* (system template) or *Custom Pattern* option from the drop-down. A custom pattern lets you build an antenna using beamwidth values in degrees.
  - If you select the **Custom Pattern** option:
    - \* You can configure the fields:
      - *Beamwidth* (horizontal and vertical)
      - *Gain, Front-to-back ratio* (use gain if unsure)
      - *Down-tilt* relative to the horizon
      - *Azimuth* relative to true north. You can use more than one azimuth at a time to simulate the same antenna pointing in different directions. To do this please use a comma-separated list, for example `0, 120, 240` would simulate 3 antennas spaced 120 degrees apart from true North. You can enter up to a maximum of 20 azimuth values. Works with the 'Area' API only.

For further information, refer **Custom Antenna Pattern Generation** topic.

- **Antenna Pattern database** - Explore thousands of patterns in the database and select favourites to appear on your pattern select list.

For further information, refer **Antenna archive - searching and favouriting a pattern** topic.

- **Polarisation** - You can select *Vertical* or *Horizontal* option from the drop-down. Circular polarisation is not yet supported but can be adjusted for using the gains/losses if known.
- **Gain** - Enter the antenna gain relative to an isotropic radiator. A dipole is 2.15 dBi

The peak gain is measured in decibel-isotropic (dBi) and will affect the ERP. For further information, see **Feeder** input menu.

- **Azimuth** - Enter the horizontal direction of the main lobe relative to grid north (in degree).
  - You can use more than one azimuth at a time to simulate the same antenna pointing in different directions. To do this please use a comma-separated list, for example **0,120,240** would simulate 3 antennas spaced 120 degrees apart from true North. You can enter up to a maximum of 20 azimuth values.
  - You can disable this in path profile mode so it always points along the path by clicking on the **Compass**

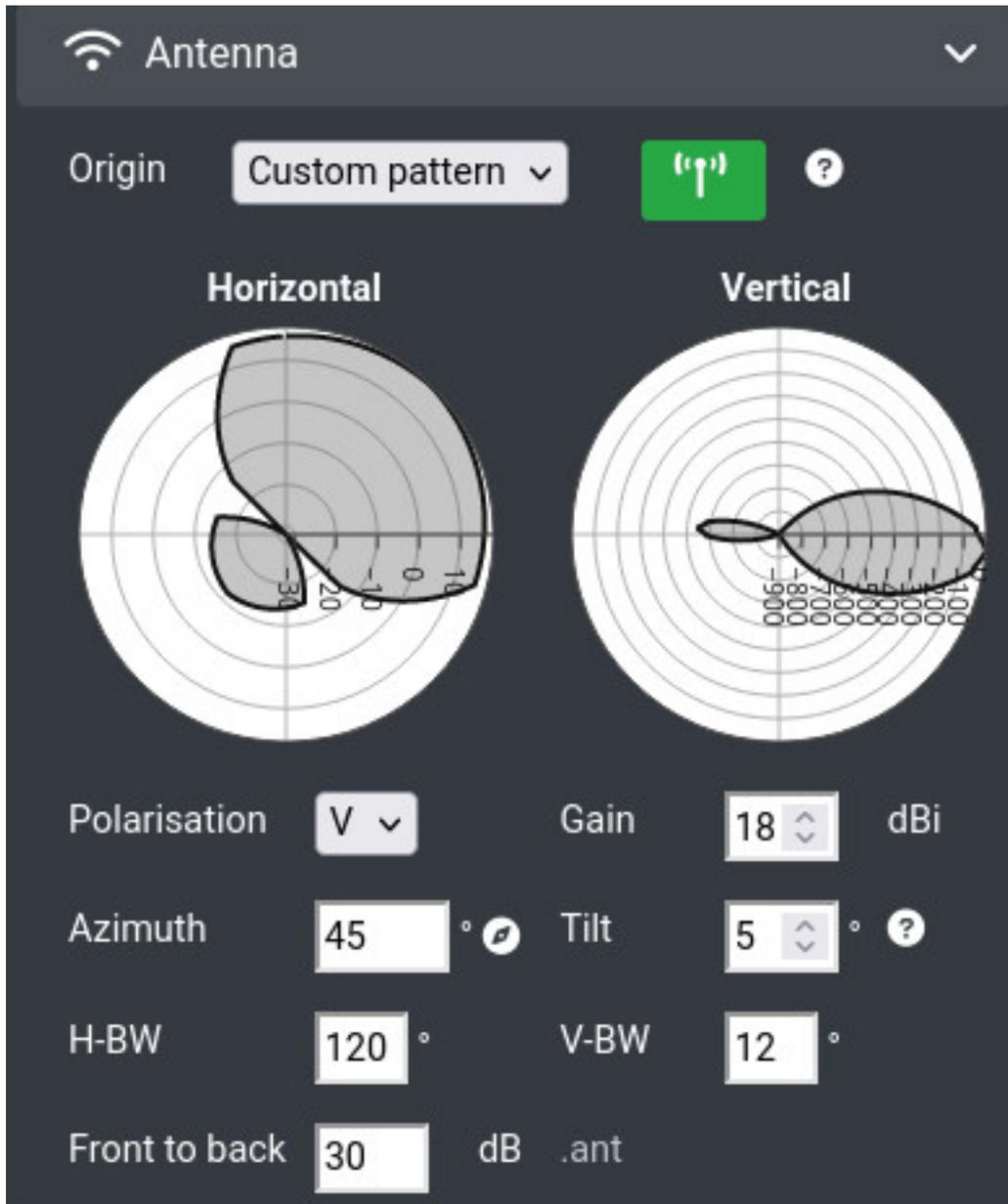


icon.

- To enable it, click on the Compass icon again.
- **Down-Tilt** - Enter the vertical direction of the main lobe relative to the horizon.

A positive value is towards the earth and a negative value is towards the sky.

## Custom Antenna Pattern Creation



You can create custom antenna patterns using the extended options, available when you choose “custom pattern” from the selection.

- **Custom: Horizontal Beamwidth** - Enter the beamwidth in degrees between the half power (-3dB) points on the pattern in the horizontal plane. A cell tower panel might be 120.
- **Custom: Vertical Beamwidth** - Enter the beamwidth in degrees between the half power (-3dB) points on the pattern in the vertical plane. A high gain cell tower panel might be 30.
- **Polar Plots** - The polar plots of the antenna pattern will update as you change the settings so you can see if it looks right.
- **Custom: Front to back ratio** - Enter the Ratio in decibels between the forward and rear gain values of a pattern. Use gain value if unsure.

Ensure you set a positive gain and front-to-back ratio when building a custom pattern.

### Antenna database

You can explore antenna patterns in the central database. This is the source for patterns visible when you use the “pop-up” search form in the web interface. The table has columns on the right which may be hidden from view. To reveal them, use the slider at the bottom of the pop up window.

To find and use pattern files:

- Click on the **green Antenna** icon to launch a pop-up form and then click the “Manage My Antennas” hyperlink to redirect.



- The *Antenna Database* screen will appear in a modal window. You can click a link to open it in a new tab.

ADF Wizard
Add ADF File

**Antenna ID:** 2946  
**Manufacturer:** ALPHA WIRELESS LTD  
**Model:** AW3014\_T0.MSI  
**Gain:** 17.71 dBi  
**Centre Frequency:** 3550 MHz  
**Frequency Range:** 3450 - 3650 MHz

---

NAME AW3014  
 MAKE Alpha Wireless Ltd  
 FREQUENCY 3550.0  
 H\_WIDTH 65  
 V\_WIDTH 7  
 GAIN 17.7dBI  
 TILT ELECTRICAL

**Horizontal dBi**

**Vertical dBi**

Manufacturer	Model	> dBi	< dBi	> MHz	< MHz	Rating	Action
Filter...	Filter...	Lower gain..	Upper gain..	Lower frequen	Upper frequen		
ALGCOM	<a href="#">AS-2500-17-65-DP_2450MHZ.ADF</a>	17		2200	2700	★★★★★(1) +	♥️ ⬇️
ALGCOM	<a href="#">AS-700-14-65-DP_825MHZ.ADF</a>	14		690	960	★★★★★(1) +	♥️ ⬇️
ALPHA WIRELESS LTD	<a href="#">AW3014_T0.MSI</a>	17.71		3450	3650	★★★★★(1) +	♥️ ⬇️
CAMBIUM NETWORKS	<a href="#">C030045A002A_3GHZ_PMP_450I_AP.ADF</a>	17		3300	3900	★★★★★(1) +	♥️ ⬇️
CAMBIUM NETWORKS	<a href="#">CAMBIUMNETWORKS_FPMP_3000_5800_90DEGREEFEE-SECTOR.MSI</a>	16.71		5700	5900	★★★★★(1) +	♥️ ⬇️
RADIO INNOVATION SWEDEN AB	<a href="#">RI_763_MHZ_23.2_DBI_20DEGS_LOBE.MSL.ADF</a>	23.2		663	863	★★★★★(1) +	♥️ ⬇️
RF ELEMENTS S.R.O.	<a href="#">HG3-TP-A60-V2.ADF</a>	17		5180	6000	★★★★★(1) +	♥️ ⬇️
TARANA WIRELESS INC	<a href="#">TARANA_BN_3GHZ.ADF</a>	22.5		3300	3800	★★★★☆(1) +	♥️ ⬇️

- You can either **Search and favourite a pattern** or **upload** antenna patterns to add them to your list. For more information on pattern formats and validation, see the antennas section within the reference data section.

### Selecting patterns for use

- To **Search** an Antenna Pattern:
  - Select the **Manufacturer** from the drop-down.
  - Select the Model by typing characters from the name eg. DIP..
- For **Favouriting** an Antenna Pattern:
  - In the ‘Action’ column on the right of the table, click on the heart  icon of the pattern.
  - The icon will turn red  indicating that the pattern has been short-listed. It will appear in your antennas list after re-loading the user interface.

### Antenna ratings system

Antenna patterns vary in quality. You can provide feedback on good patterns which helps your team find them quicker since they are ranked by score. Click the rating stars and provide a score and a reason.

### Removing patterns

At the time of writing, patterns can only be removed by emailing [support@cloudrf.com](mailto:support@cloudrf.com) with the name and ID number(s). A delete function is scheduled.

### Antenna pattern validators

An ADF validator is [here](#).

A multi-format conversion wizard is [here](#).

- To upload a new antenna pattern,
  - Click ‘Add ADF file’ to open the form and upload your file:

#### TIA/EIA-804-B antenna pattern import tool

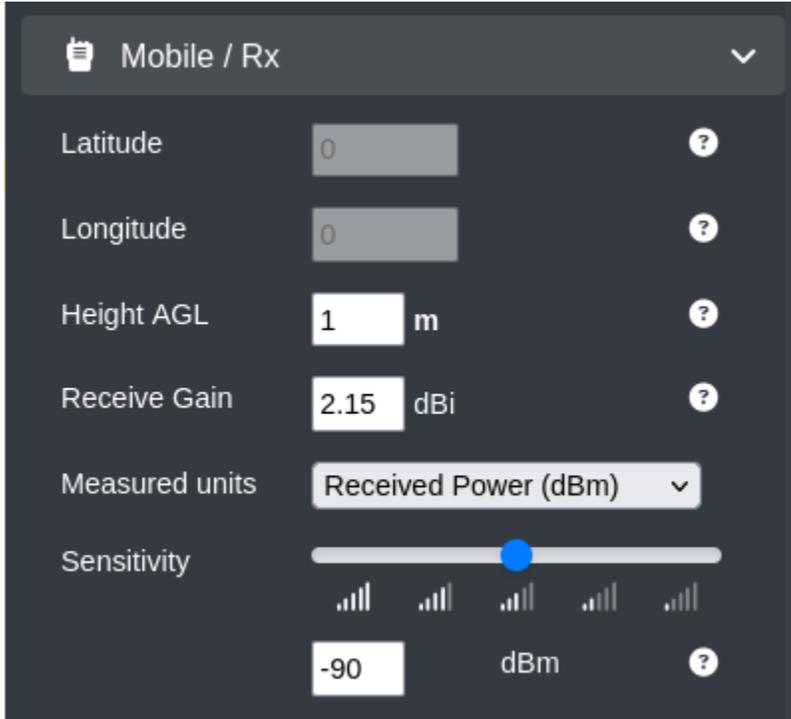
This script will import a standard TIA-EIA Antenna Data File (ADF) into CloudRF. By default ADF files are available to all users. To keep it private to your account check the private box. [Example ADF file](#)

No file chosen  Private?

- Click on **Choose File** button to browse and select the desired file to upload.
  - If you wish to keep the uploaded pattern file private to your account, select the **Private?** checkbox. Be aware that the OEM will still be public.
- Click on the **Upload** button.

## 2.5.5 Mobile / Rx

The Mobile / Rx (Receiver) input menu contains settings for the **remote** end of the link. This could be a mobile outstation, a customer or a vehicle.



Configure the following **Mobile/Rx** fields:

### Latitude and Longitude

These location fields will be disabled by default. To enable the fields, you can click on the **Path Profile tool**  icon on the *Function Menu*.

You can set the receiver location by one of the following ways:

- Click on the **map**. The location values will be set automatically.
- Enter the values **manually** if you know the GPS or map locations.

### Height

The height (surface model) in meters or feet. The Height units (*metres/feet*) and mode (AMSL or AGL) can be set under **Site/Tx** Input Menu in the Height field. For example: If the surface model is LIDAR that includes a 30m building and your mobile station is 4m on the roof then the Height AGL will be 4m.

If LIDAR is not present the height should be 34m AGL, and if height units above sea level (AMSL) are used, with a ground height of 100m, then the height should be 134m.

For a handheld or shoulder mounted radio, you should use a height value of 2m as the system's minimum resolution is 1m. Using 1.5m would be rounded to 2m at the API. Using 1.4m would give a more conservative prediction as it would be rounded down to 1m.

### Receive Gain

Enter the receiver gain in dBi. This is the combined receiver and antenna gain. The receiver gain considers the antenna, receiver noise and (receive) feeder loss. For example: If the receiver has a 3dBi antenna and a 3dBi receiver noise figure, the Receive gain would be 0 dBi.

For a Mobile Phone, you should use a gain value of 0dBi. The actual performance varies by band, so a phone may have 1dBi gain for GSM900 but 0dBi for UMTS2100. Choose the lower value if you are unsure.

### Measured units

Select the output units option from the drop-down as per your requirement. CloudRF has support for a wide range of different measured units. The units must correspond with the selected colour key if performing area coverage plots.

### Path Loss (dB)

Discounts transmitter power. Useful for selecting equipment for a link as this will give you an idea of what transmit power you will need to overcome the path loss.

### Received Power (dBm)

Default units for consumers and operators. This is for modelling the carrier/signal only so **it discounts noise floor and bandwidth** and is used widely in IoT / LPWAN, WiFi and consumer applications. For full-bandwidth modelling see RSRP below.

### Field Strength (dBμV)

Decibel-micro-volt-per-meter. Used for broadcasting and specialist power measurement. Has a relationship with received power so you can convert one to the other.

$$\text{dBuV} = \text{dBm} + 90 + 20\log(\text{ohms})$$

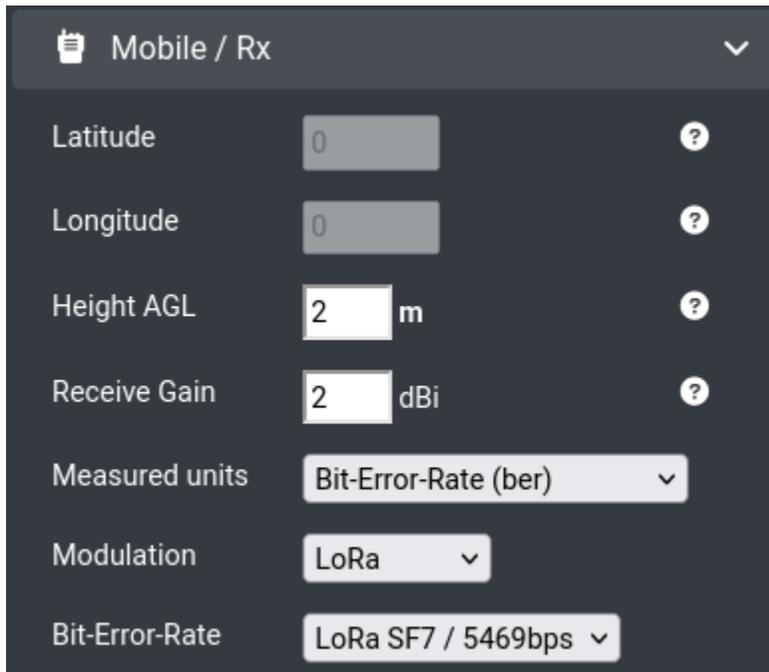
## Signal to Noise Ratio (dB)

SNR considers noise floor and bandwidth. Used for MANET, Radar, cellular, 4G and 5G technologies. If you have noise data for the noise API, you need to be using SNR.

## Bit-Error-Rate (BER)

Uses modulation curves and the noise floor to dynamically compute an SNR value as a threshold. Used for SATCOM and microwave links.

Pick your modulation schema from the list, then select the Bit-Error-Rate. The system will use these inputs, in conjunction with the noise floor to apply the appropriate SNR as dB.



The screenshot shows a dark-themed mobile application interface for the 'Mobile / Rx' section. It contains several input fields and dropdown menus:

- Latitude:** A text input field with the value '0' and a help icon (question mark) to its right.
- Longitude:** A text input field with the value '0' and a help icon (question mark) to its right.
- Height AGL:** A text input field with the value '2' followed by the unit 'm' and a help icon (question mark) to its right.
- Receive Gain:** A text input field with the value '2' followed by the unit 'dBi' and a help icon (question mark) to its right.
- Measured units:** A dropdown menu currently showing 'Bit-Error-Rate (ber)'.
- Modulation:** A dropdown menu currently showing 'LoRa'.
- Bit-Error-Rate:** A dropdown menu currently showing 'LoRa SF7 / 5469bps'.

LoRa spreading factor (SF) can be applied by choosing “LoRa” as the modulation. SF7 gives the best throughput but has a higher SNR requirement. Conversely, SF12 has the best range at the cost of throughput.

### Reference Signal Received Power (dBm)

RSRP considers bandwidth. This is widely used in cellular systems with variable bandwidth like 4G (LTE) and 5G-NR and is **always a lower figure** than the received power (dBm) for the same signal.

### Best Site Analysis (%)

The output for BSA is a percent (%) denoting relative site efficiency. Please note that BSA is only supported with *Best Site Analysis calculations*.

### Sensitivity

Set the sensitivity slider to define the sensitivity of the mobile station in units corresponding to the measured units.

#### **WARNING! SET WITH CARE**

Use -90dBm if unsure.

A mobile phone's sensitivity is between -100dBm and -115dBm. Setting the sensitivity too low (eg. -120dBm) will result in an unrealistic BIG prediction. Be aware also that phones can report signal strength as RSRP **or** received power yet the difference between the two is significant depending on bandwidth. RSRP is the lower value.

IoT protocols like LoRa / LPWAN can theoretically operate down to -140dBm but this is under ideal conditions. To simulate man-made noise, add a margin of at least 10dB so your threshold is at least -130dBm.

### Noise floor (SNR and BER units only)

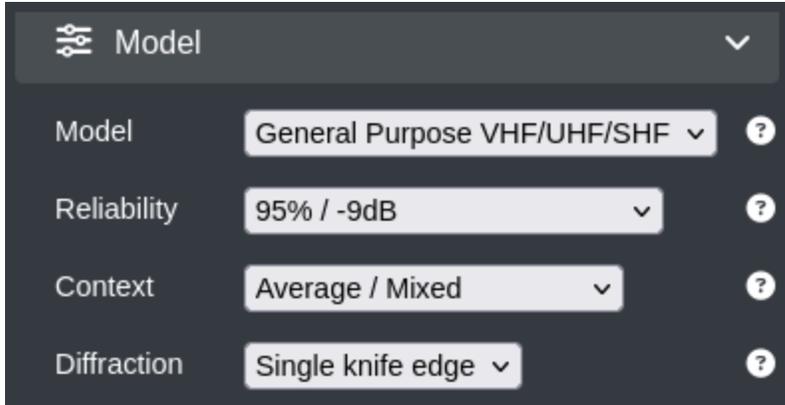
Since v3.9, noise floor has been moved to the environment menu. Enter the local noise floor value in dBm. It is used in conjunction with the required SNR to establish the sensitivity.

The system will help you with a thermal noise value (Johnson-Nyquist) based upon your chosen bandwidth but for best results, you need to measure the noise in your area and enter a measured value.

Since v3.9, you can enter noise in real time through the noise API. If you have live measurement data, you can then ensure that your planning matches the reality, whatever the reality may be. Click the network icon next to noise to enable "database" mode instead of system default, or guessed, values.

## 2.5.6 Model

The Model input menu consists of the settings related to the Propagation Model.



Configure the following **Model fields**:

- **Model** - Select the Propagation model from the drop-down as per your requirement. Some empirical models like Hata and SUI have minimum frequencies and heights. This is enforced as these models will only be accurate if used within their parameters.

Use the ITM model if you are unsure. This is used by the FCC for general purpose applications and is the most advanced model here where VHF/UHF diffraction is present.

Code	Model	Purpose	Frequency Range	Minimum Height	Tx
1	Irregular Terrain Model	General Purpose VHF/UHF	2 - 20,000 MHz	0.1m	
2	Line of Sight (LOS)	Visibility testing	~	~	
3	Okumura-Hata	Cellular	150 - 1500 MHz	3m	
4	ITU-R P.1546	VHF/UHF/Terrestrial	30 - 4,000 MHz	0.1m	
5	SUI Microwave	UHF/SHF	1900 - 11,000 MHz	3m	
6	COST231-Hata	Cellular	150 - 2000 MHz	3m	
7	ITU-R P.525 (Free Space)	<i>Reference model</i>	2 - 90,000 MHz	0.1m	
8	RADAR with RCS	RADAR for surveillance	2 - 90,000 MHz	0.1m	
9	Ericsson 9999	Cellular	150 - 1900 MHz	3m	
10	General Purpose	General Purpose VHF/UHF/SHF	~	~	
11	Egli VHF/UHF	General Purpose	2 - 1500 MHz	0.1m	
12	HF NVIS	Ionospheric communication to 500km	2 - 20 MHz	~	

These models are grouped as the following, which are reflected in the dropdown selection:

- Deterministic Models
  - General Purpose
  - Irregular Terrain Model
- Cellular Models
  - Okumura-Hata
  - COST231-Hata
  - Ericsson 9999
- Empirical Models

- SUI Microwave
- ITU-R P.525 (Free Space)
- Egli VHF/UHF
- Special Purpose
  - HF NVIS
  - RADAR with RCS
  - Line of Sight (LOS)
  - ITU-R P.525 (Free Space)

WARNING: The ITU-R P.525 model is a simple reference model. It will provide a *very* optimistic prediction (eg. +20dB gain) unless you temper it with losses elsewhere.

WARNING: When selecting the “Line of Sight” model knife edge diffraction should be disabled.

## RADAR

When you select the RADAR propagation model you will also be prompted to specify a RADAR Cross Section (RCS) value. This value is used to describe an object’s reflective surface and is measured in square meters (m<sup>2</sup>). In general, the larger the object the higher its RCS value. Some examples are listed below:

- **RCS**
  - Bird: 0.01 m<sup>2</sup>
  - Small drone: < 0.04 m<sup>2</sup>
  - Human: 1.0 m<sup>2</sup>
  - Jet aircraft: 2 - 6 m<sup>2</sup>
  - Cargo aircraft: 100 m<sup>2</sup>
  - Automobile: 100 m<sup>2</sup>
  - Coastal vessel: 300 - 4000 m<sup>2</sup>
  - Container ship: 10,000 - 80,000 m<sup>2</sup>

## HF NVIS

When you select HF NVIS, the context will change to allow you to select the reflective height. For more on this see the context section. The antenna will also be set as a horizontal dipole with a special pattern to consider the local nulls found around a horizontal dipole. You may change the gain and azimuth but not the pattern.

HF NVIS will not work with frequencies greater than 30MHz. Optimal frequencies are 4 to 8MHz, subject to season, location and time of day.

## Reliability

This field enhances a model with a configurable (10dB) fade margin. You can select the reliability percentage as per your requirement.

99% indicates a conservative 'high confidence' prediction (+9.9dB path loss)

90% is the default set value.

50% is an optimistic "sunny day" prediction (+0dB margin on path loss)

## Context

Select the context of the model from the drop-down as per your requirement. Many models have environmental variables which provide different outputs. Typically code 1 is urban/conservative, 2 is average and 3 is rural/optimistic. For the HF NVIS model, context refers to the reflective layer where 1 is D, 2 is E and 3 is F.

For a conservative output, select Conservative/Urban as the option. Else, keep the default Average/Mixed option and use the reliability for tuning.

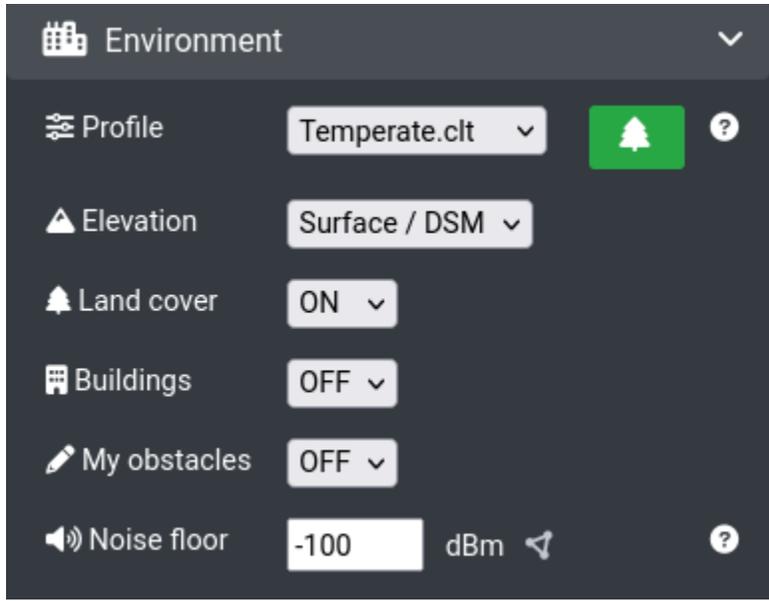
## Diffraction

Diffraction will show coverage beyond an obstacle. The radio shadow size will vary by frequency and the obstacle distance/height with a low frequency having a low angle of diffraction. If Line of sight is critical eg. Microwave links, then switch this off. If you are using a sub-GHz system eg. VHF or UHF-L then this should be on. The recommended model is Bullington.

Model	Description
Single Knife Edge	Basic Huygens formula which considers each obstacle in isolation. Can be optimistic
Bullington	Advanced multi-obstacle model with approximation. Good trade off between accuracy and speed
Deygout	Advanced multi-obstacle model. Can be conservative

### 2.5.7 Environment

The Environment input menu consists of the settings related to the system and custom clutter. For more information see the [clutter reference](#).



### Profile

Select the regional profile from the drop-down as per your requirement. If no profile has been created you will be shown `Minimal.clt`. See the clutter manager section below for how to manage clutter profiles.

### Elevation

Select the digital elevation model.

- `Surface / DSM` will use a rough surface model or LiDAR if it is available. Heights are relative to rooftops.
- `Terrain / DTM` will use a bare earth model so heights are relative to the ground.

### Land cover

Select the Land cover mode from the drop-down as per your requirement.

- `OFF` will just use terrain data.
- `ON` will add system 10m landcover.

### Buildings

Select the Buildings mode from the drop-down as per your requirement.

- `OFF` will just use terrain data.
- `ON` will add a buildings layer to the surface model (Coverage varies by region)

### My obstacles

Choose to enable your custom clutter. Your items, such as a building, will be placed upon the terrain by default and can be used alongside land cover. To use this function, you must have clutter items saved to your account. See the *clutter reference* for more.

- OFF will not add any custom clutter.
- ON will add custom clutter on the chosen elevation model. Use with care.



### Clutter Manager

The clutter profile manager can be opened with the green-tree clutter manager button.

1. Selected clutter profile
2. Save/delete profile as name
3. Building attenuation
4. Delete all obstacles on your account

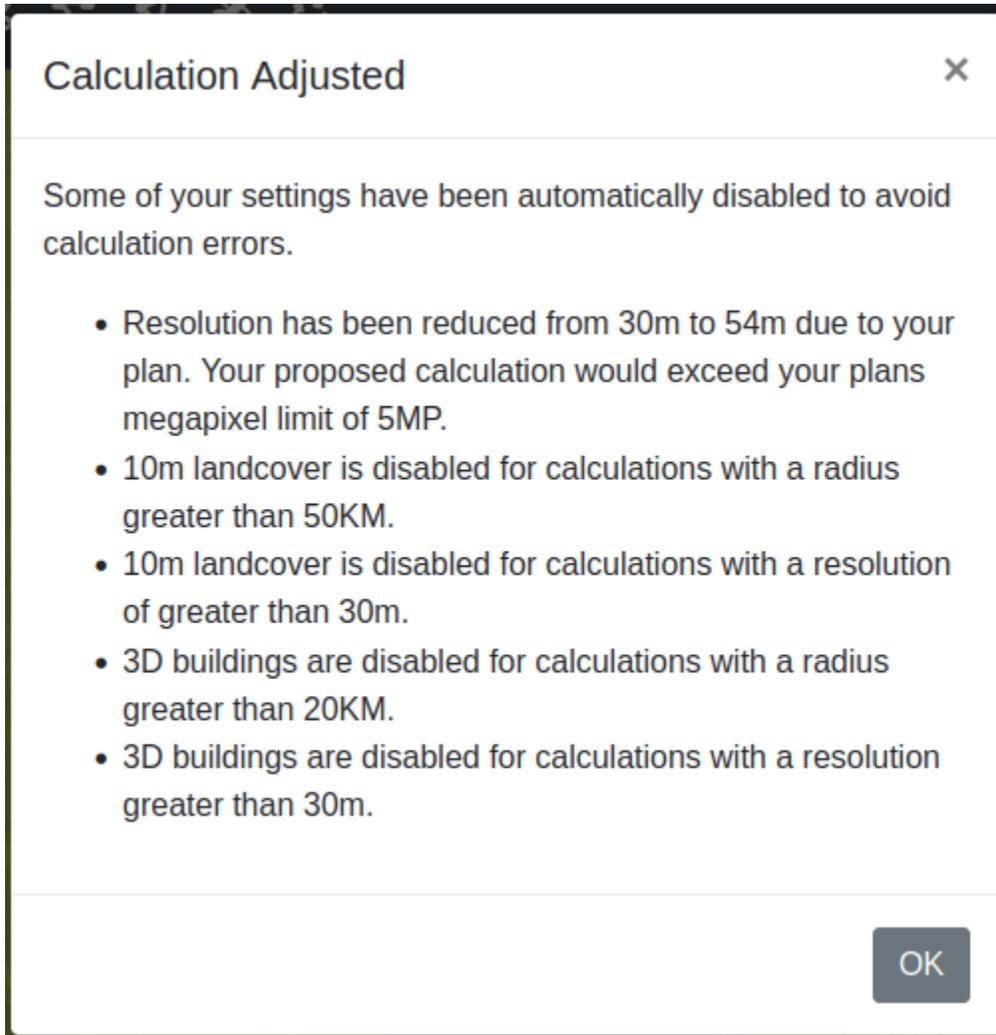
5. Land cover types with customisable height and attenuation values
6. My obstacle (clutter) types with customisable name, colour, height and attenuation values

### Clutter Restrictions

Please note that there are restrictions in place on the public API which will protect it from being run with unnecessary or bogus values. The rules which are enforced on the API are:

- Enabling 10m landcover on calculations with a radius greater than 50km.
- Enabling 10m landcover on calculations with a resolution greater than 30m.
- Enabling 3D buildings on calculations with a radius greater than 20km.
- Enabling 3D buildings on calculations with a resolution of greater than 30m.

In such circumstances you will receive a “Calculation Adjusted” message with your response indicating what has been adjusted or disabled from your request.



## Clutter attenuation

The Clutter Attenuation is a nominal value measured in decibels per metre (dB/m) for an obstacle, not the material itself, based on the principle of a hollow composite house or a forest with uniform gaps between trees.

For example: A 10m house with 2x 7dB brick walls and 2x 3dB partition walls would have an average of 2.0dB/m. This would be very conservative due to the Windows which permit signals, at the right angle ;), so by using a quarter of this we get 0.5dB/m which is a better nominal value for “a house”.

No two houses or forests are the same so **results will vary by town and country**. For best results, calibrate a profile based upon **street level measurements**. Taking measurements from up high will miss clutter and likely provide an optimistic profile.

The following values are used in the minimal template. For codes, see the *clutter reference*.

1	1	0.0
2	5	0.05
3	1	0.0
4	1	0.02
5	1	0.05
6	2	0.05
7	1	0.03
8	1	0
9	1	0
10	0	0
11	6	0.1
12	8	0.2
13	3	0.25
14	4	0.3
15	5	0.4
16	6	0.5
17	7	0.6
18	8	0.7
19	3	1.0

## Building attenuation

Building attenuation is a separate value to the 9 land cover attenuation values as it is a distinct layer. Like other types, it is a nominal attenuation value measured in dB/m and is applies to the whole of a building, not just the walls.

For example, a house with 2x 10dB thick walls, measuring 8m deep, will have a value of  $(2 \times 10) / 8 = 2.5\text{dB/m}$ . In reality, a house has windows which allow signals to pass. Depending on the glass, this could be as low as 2dB so a glass house becomes  $(2 \times 2) / 8 = 0.5\text{dB/m}$ . Taking an average of the two gives 1.5dB/m.

For cellular networks, building attenuation is significant. Most of the signal behind a house is diffracted from the roof, so going away from the house to the end of the garden will boost your signal.

Value	Building type
0.1	Timber
0.2	Light brick
0.3 - 0.5	Brick / Concrete
0.5 - 0.8	Concrete
0.8 - 4.0	Concrete / Metal

### Saving and deleting profiles

Enter the name for your profile eg. POLAND and click the save button. To delete, enter the full name of the profile plus the file extension eg. POLAND.clt then click the delete button.

### Noise floor

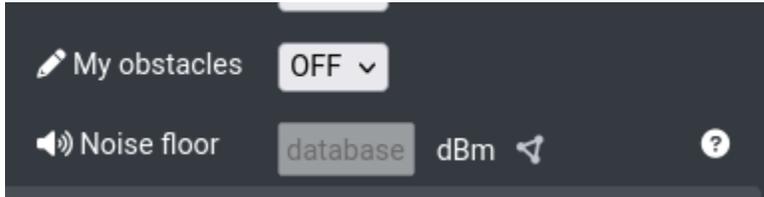
Since v3.9, noise floor has been moved to the environment menu.

Enter the local noise floor value in dBm. It is used in conjunction with the required SNR to establish the sensitivity when using **SNR, RSRP or BER units only**.

NOTE: Noise floor is ignored in received power mode (dBm)

The system will help you with a thermal noise value (Johnson-Nyquist) based upon your chosen bandwidth but for best results, you need to measure the noise in your area and enter a measured value.

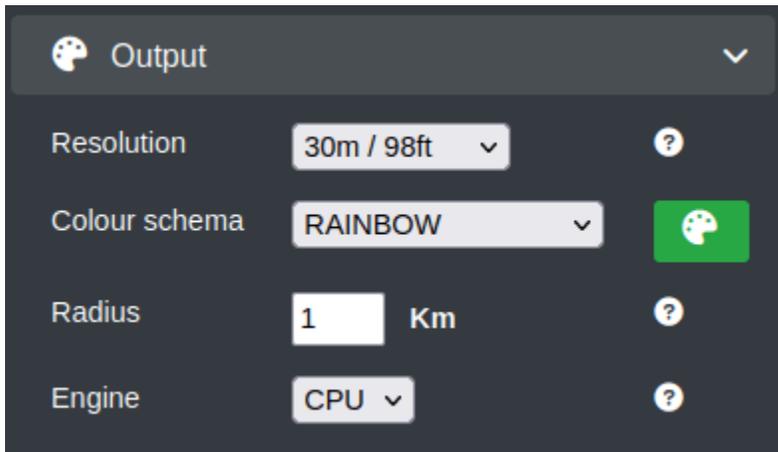
Since v3.9, you can enter noise in real time through the noise API. If you have live measurement data, you can then ensure that your planning matches the reality, whatever the reality may be. Click the network icon next to noise to enable “database” mode instead of system default, or guessed, values.



To push in noise data, send a POST request to the <https://api.cloudrf.com/noise/create> endpoint or paste CSV data into the hosted form at [https://cloud-rf.github.io/CloudRF-API-clients/integrations/noise/noise\\_client.html](https://cloud-rf.github.io/CloudRF-API-clients/integrations/noise/noise_client.html)

## 2.5.8 Output

The Output input menu consists of the settings related to the system output.



Configure the following **Output fields**:

## Resolution

Select the desired resolution from the drop-down as per your requirement. Make sure that the resolution when combined with the radius to compute a mega-pixel value, is within your plan limit.

- 2m is not recommended unless you know that the city or area supports this data via LiDAR.
- TIP: **20m** presents a much better compromise for accuracy in most countries due to proximity to the underlying surface model and the use of 10m landcover.

## Colour Schema

Specify how the produced calculation will be coloured based on a selected colour schema.

- **Please Note** that schemas here listed are based on your selected “Measured Units” value in the “*Mobile / Rx*” menu. If you are looking for a schema which isn’t listed here then it is likely caused by the schema belonging to a different measured unit eg. dB vs dBm
- You have a list of system-default colour schemas to choose from, however if these do not fit your use-case then



you can also create your own colour schema by clicking on the **colour palette** icon.

When you do this you will be presented with the **My Colours** screen. Here you can build a colour schema.

### Create

Name

Top  dBm

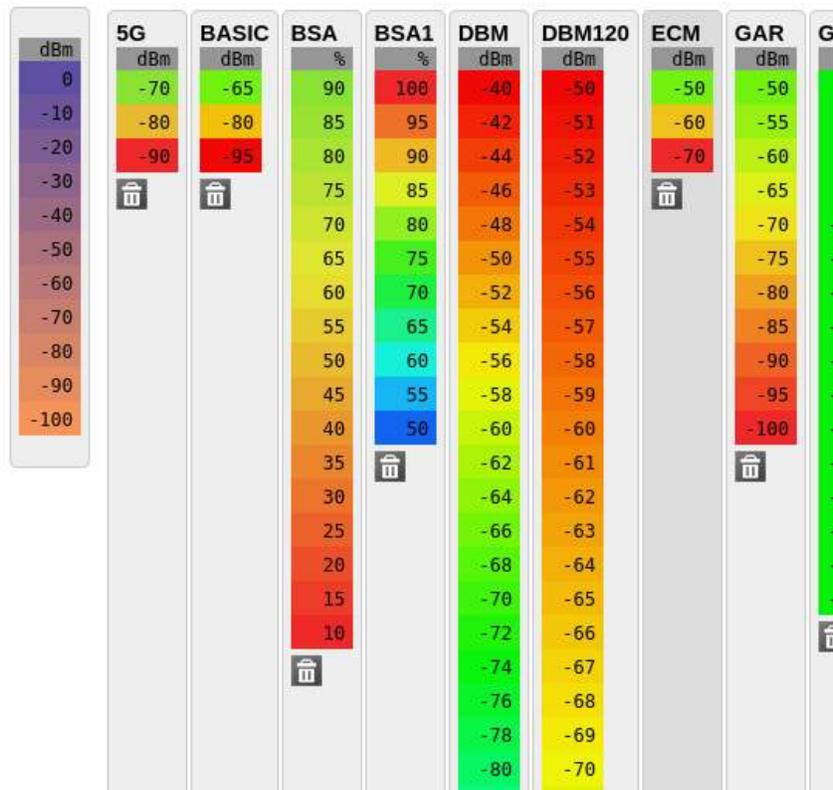
Steps

Step size  dB

Top  Bottom

RGB  HSL

### My Colours



1. Choose your units eg. dBm

2. Give it a name eg. GREEN2RED
3. Choose a sensible top value. -30dBm is a good place to start.
4. Choose a step size and steps with the slider.
5. Choose your colours - this is what you came for
6. Choose a colour schema. HSL is recommended for a dynamic rainbow range.

### Radius

Enter the desired radius in the units as chosen in the *transmitter menu*. This value is used with resolution to compute mega-pixels which are displayed in the corner console. For example: 5km radius calculation at 2m resolution would result in 25MP image. Similarly, 5km at 10m = 1 MP.

**NOTE:** Do not request an excessive radius/resolution eg. > 32MP. For example, a 20km radius calculation at 2m resolution would create a 400(!) megapixel image which would crash any image processing software and web browser - if you generated it. There are restrictions in place on the API to enforce limits.

Target radius	Recommend resolution	Megapixels
1km	1m	4MP
2km	2m	4MP
5km	10m	1MP
10km	10m	4MP
20km	20m	4MP
30km	30m	4MP
500km	180m	32MP

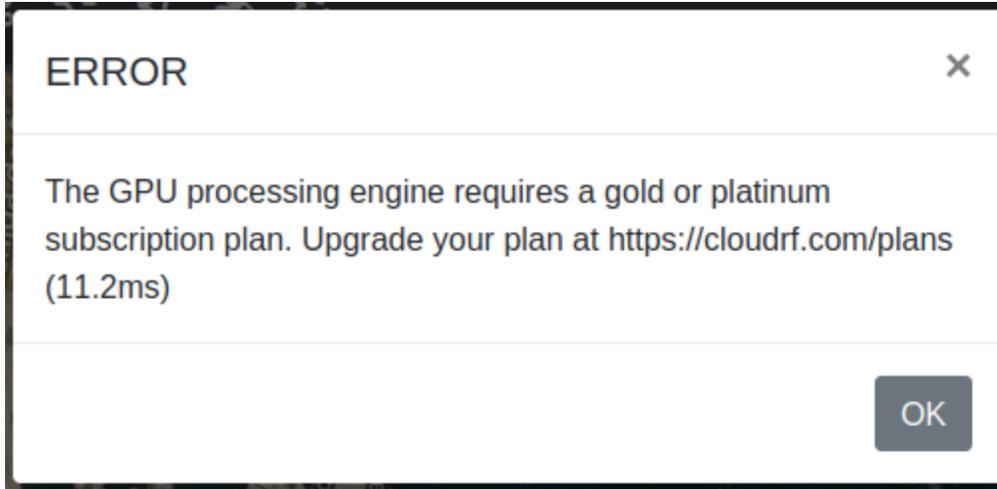
### Engine

Choose your desired processing engine to produce the calculation. You have a choice between **CPU** or **GPU**.

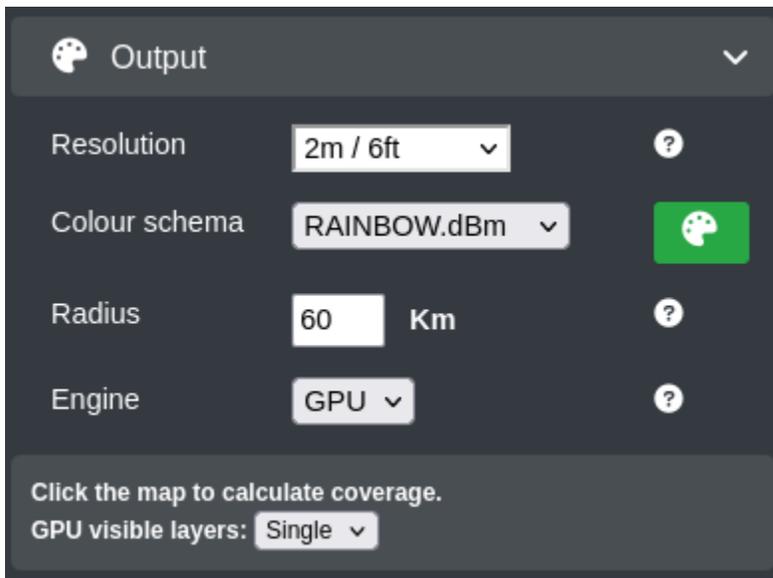
- **CPU** is our most robust and tested processing engine “SLEIPNIR”. It uses a traditional computer CPU in the background to run through your calculation. This has the benefit of being well matured and tested and so your results will be as accurate as the inputs you specified.
- **GPU** is our newest processing engine. It uses a graphics card so is 20 times faster than CPU processing. It can do diffraction, attenuation and the same propagation models as the CPU engine.

### GPU Engine

In order to make use of the GPU processing engine you will need to have either a gold or platinum subscription plan, or an enterprise server. If you do not have either then you will receive a forbidden message for the response.



When you select “GPU” from the “Engine” dropdown a section will show at the bottom:



This indicates that you are in GPU mode and you should note a few things:

- You can now click on the map to run a calculation. The GPU engine is so fast that a progress bar is not required and so the classic green “Calculate” button is hidden.
- You can change the GPU visible layers:
  - **Single** means that only one GPU calculation will be kept on the map at a given time.
  - **Many** means that you can have as many GPU calculation layers on the map as you wish. However, please note that the GPU engine is fast and so it can very quickly use up your browser resources if you are adding many layers. You can manage layers in the same way as you do for CPU calculations in the top right.

## Colour Palettes

You may find that the system-defined colour schemas do not meet all of your requirements and so to resolve this CloudRF has functionality to build your own colour schema with your own colours, units and limits.

To create custom colour pattern:



- Select the colour schema by clicking on the **Manage My Colours** icon. This button can be found in both the “Output” menu and also in the “Account Information” modal.
- The **My Colours** screen will appear in a separate tab on your browser.



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**Note** When you load this manager you may have no colours to the right under the “My Colours” heading. This is normal, as you have not yet created any colours.

You may create a customised colour pattern by using the form on the left.

## Create

- **Name** is the name of your custom colour schema.

- To edit an existing pattern, enter the colour pattern name here. You may edit the fields as per your requirement.
- **Top** is the top-most value of the colour pattern. Use -30 for a received power schema.
  - As part of **Top** you should select the unit under which your colour pattern will be used. Your pattern can only be used with that measured unit. If you require patterns for other units then you should create those separately.
    - \* **dB** - Decibels
    - \* **dBm** - Decibel milliwatts
    - \* **dBuV/m** - Decibel microvolts per meter
    - \* **%** - Percentage coverage for *best site analysis* calculations
    - \* **BER** - Bit-error-rate
      - When selecting BER you will see a second dropdown get created which asks you for your modulation.
    - \* **RSRP (dBm)** - Reference signal received power in decibel milliwatts
- **Steps** is the number of steps/buckets you wish to be displayed in the colour pattern.
- **Step size** is how spaced apart each step/bucket is, for the total number of **Steps**.
- **Top** and **Bottom** are the colours you wish to use for the top and bottom of the colour pattern.
- **RGB** and **HSL** correspond to the colour format to be used between the steps. **RGB** (red, green, blue) are more computer-readable. **HSL** (hue, saturation, lightness) are more human-readable and will provide a better dynamic range.

As you adjust the settings from the form the colour schema will be built on-the-fly to the right of the form. RAINBOW

Once you get the colour schema to a stage which you are happy with then you can click on the **Save** button where your colour schema will be attempted to saved to your profile.

If there are any problems then you will received a validation message towards the top of the screen.

Create

My Colours

Your specified name conflicts with a system schema. Please choose a different name.

Name

Top  dBm

Steps

Step size  dB

Top  Bottom

RGB  HSL

dBm
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150

ALPHA	NARROW	SPECTRUM
dB	dBµv	dBm
60	80	-20
63	65	-24
66	50	-28
69		-32
72		-36
75		-40
78		-44
81		-48
84		-52
87		-56
90		-60
93		-64
96		-68
99		-72
102		
105		
108		
111		
114		
117		
120		

If your colour schema could be created successfully then you will be notified with a success message and your new colour schema will be displayed on the right under the “My Colours” heading.

Create

My Colours

Schema created. Please re-load your interface to use the new schema

Name

Top  dBm

Steps

Step size  dB

Top  Bottom

RGB  HSL

dBm
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150

ALPHA	NARROW	PASTEL	SPECTRUM
dB	dBµv	dBm	dBm
60	80	-20	-20
63	65	-30	-24
66	50	-40	-28
69		-50	-32
72		-60	-36
75		-70	-40
78		-80	-44
81		-90	-48
84		-100	-52
87		-110	-56
90		-120	-60
93		-130	-64
96		-140	-68
99		-150	-72
102			
105			
108			
111			
114			
117			
120			

You can now return to the web interface and your colour schema will be present in the “Colour Schema” dropdown on the “Output” menu, as long as you have the correct “Measured Units” selected from the “Mobile / Rx” menu which matches your new colour schema.

## 2.6 Save and Run Buttons

After configuring the Input Menu, you can **Save** and **Run** the configuration by clicking on the respective button. These buttons are displayed below the Input Menu.

### 2.6.1 Save

**Save** button lets you create a template with all your configured settings that you can reuse later whenever required.

For further information, refer [Templates](#) topic.

### 2.6.2 Run

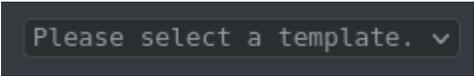
**Run** button will execute a coverage calculation using your configured settings.

- The execution may take several seconds depending on the resolution and the radius. The **Progress Bar** will be displayed in this case.
- In case there are **errors** in the configuration, the respective error dialog box will appear.
  - Make the necessary corrections and re-run the updated configuration.
- After successful execution, the **Site name (Network name)** field will be displayed in the *Output Console*.

For further information, refer the **Output Console** topic.

## 2.7 Templates

Templates allows you to quickly apply settings from a saved/custom or system-defined configuration.



Please select a template. ▾

Templates are useful in a shared account where an Engineer might prepare the template(s) and a sales person might use them to qualify customers.

## 2.7.1 Custom Templates

To manage your custom templates:

- Configure the Input Menu as per your requirement.



- Click on the **Save** button.
- The **Manage Your Templates** dialog box will appear.

A screenshot of the 'Manage Your Templates' dialog box. The dialog has a title bar 'Templates' with a close button 'X'. It is divided into three sections: 'Save', 'Upload', and 'Delete'. The 'Save' section has a text input field for 'Template name' and a green 'Save' button. The 'Upload' section has a 'Browse...' button, the text 'No file selected.', and a green 'Upload' button. The 'Delete' section has a dropdown menu showing 'You have no custom templates.' and a red 'Delete' button with a trash icon. At the bottom right, there is a grey 'OK' button. The text 'Browse and select system templates?' is located at the bottom left of the dialog.

## Saving a Custom Template

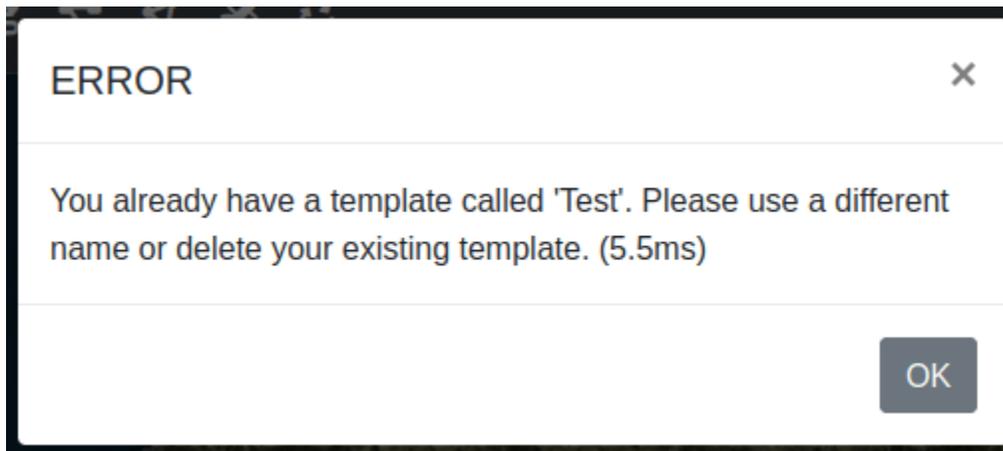
To save a custom template:



- After configuration in the Input Menu, click on the **Save** button.
- In the **Manage Your Templates** dialog box.
  - In the **Template Name** field, enter the desired name of your custom template.  
You can give a user-friendly name, for example: “Radio X”.
  - Click on **Save** button.
- The created Template will be displayed under **My Templates** drop-down. All custom templates will be prefixed with the words “Custom”.

If your settings have any issues when you attempt to create a template then you will be notified via a modal window.

An example of a bad template upload is below.



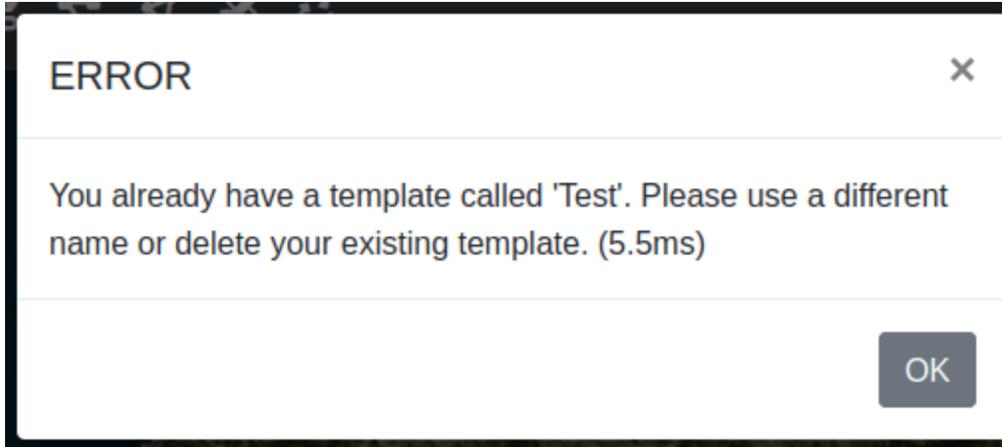
## Uploading a Custom Template

You can upload templates directly into the system. This is useful if you would like to create and share your own templates.

To upload a custom template:

- Click on the “Browse...” button to search through your local filesystem to find the JSON template which you wish to upload.
- Click on the “Upload” button.
- The template will be uploaded and validated. If your template has all of the required fields in the correct formats then your template will be made available to use in your user account. If your uploaded template has any problems then you will be notified via a modal window.

An example of a bad template upload is below.



### Deleting a Custom Template

To delete a custom template:

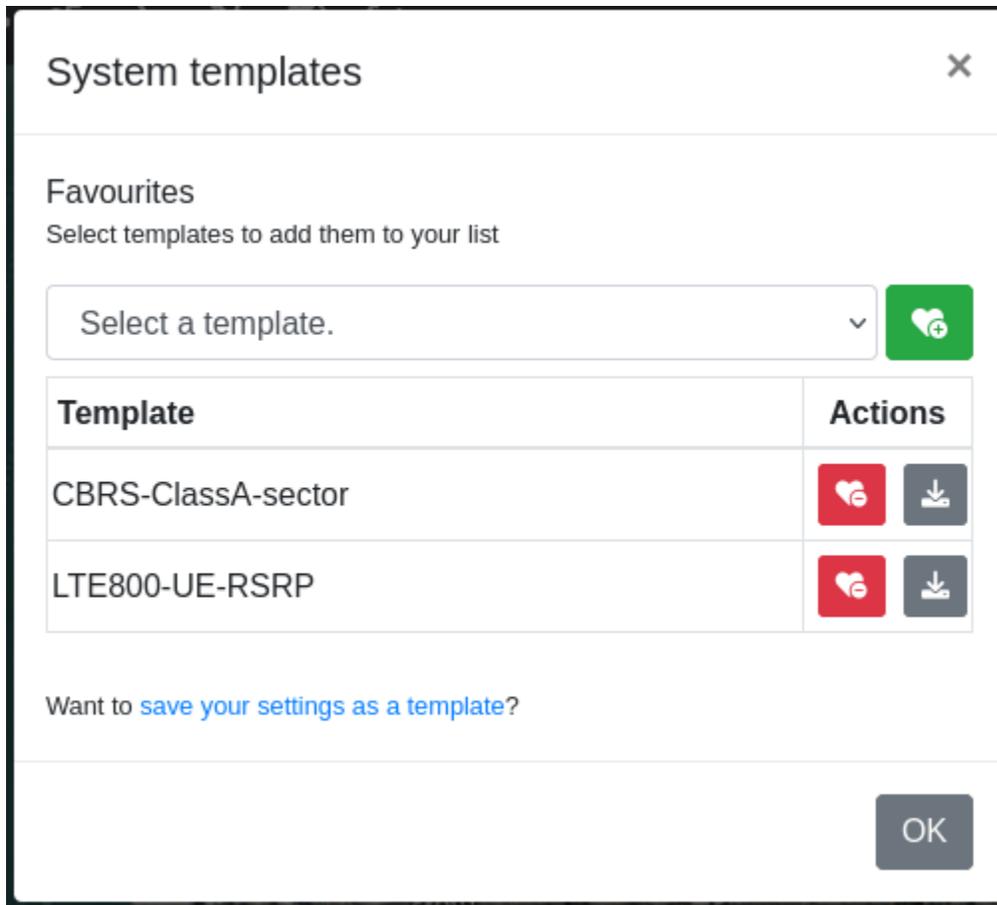
- Click on the **Template save**  button.
- In the **Templates** dialog box.
  - In the **Delete** field, select the Template Name that you wish to delete.
  - Click on **Delete** button.
- The deleted Template will be removed from the **My Templates** drop-down.

## 2.7.2 System Templates

System Templates provide a list of pre-built templates, built from product data sheets.

To manage your system templates there are 2 methods:

1. Click on the “Templates” button  in the manager in the “Account Information” modal.
2. Click on “system templates” in the “*Templates*” modal.



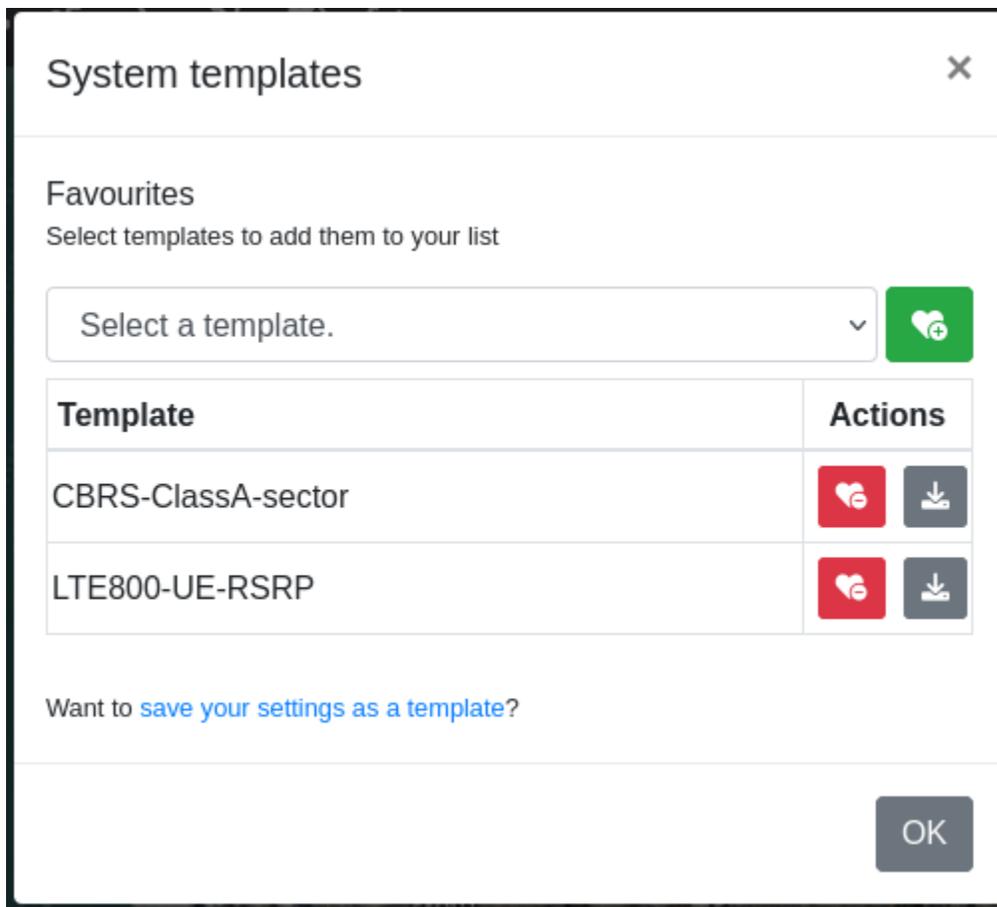
### Favouriting System Templates

To add a system template to the templates dropdown you can find the template you wish to favourite from the select



list, then click the favourite button

The chosen template will then be shown in the list below where you will have the option to either remove it or download the system template as a JSON file.



When you have favourited a system template it will be populated into the **My Templates** dropdown and will be prefixed with the words “System”.

### Unfavouriting System Templates



To unfavourite a system template click on the “Unfavourite” button

This will remove it from the list of templates at the bottom of the system-template manager, but also from the **My Templates** dropdown.

### Downloading System Templates

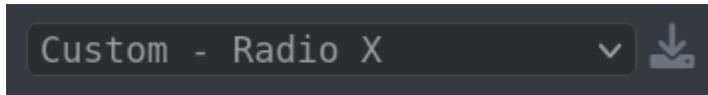


To download the content of a system template click on the “Download” button

This will download directly to your browser the raw content of the template in a JSON file. You may edit this in any text editor. A reference for the values is linked in the header of each file.

### 2.7.3 Download Templates

You can download the raw content of a template directly to your browser by clicking on the download button to the right of the dropdown.



This will download the template as a JSON text file. This will contain all of the settings related to applying that template.

You can download both custom and system templates in this way. You may edit this in any text editor. A reference for the values is linked in the header of each file.

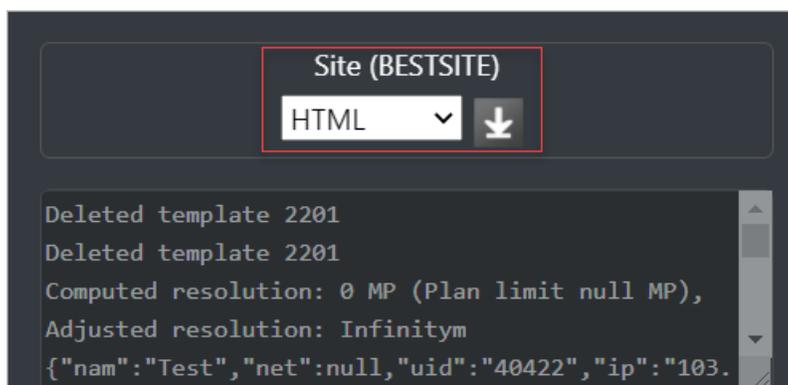
### 2.7.4 Template privacy and copyright

A template file is potentially sensitive as it can describe equipment configurations and performance. User templates are stored in a user's private folder with a random cryptographic hash to prevent file guessing attacks. The copyright for a created template belongs to the customer and (JSON file) sharing is actively encouraged.

## 2.8 Output Console

The output console provides the useful feedback related to the settings, errors, API inputs and API outputs as you use the CloudRF tool.

- The **Effective Radiated Power (ERP)** and the computed **resolution (in mega-pixels)** will be printed in this console as you adjust the settings so that you can keep an eye on the same.
- As an area calculation processes, you will see periodic updates in the console from the SLEIPNIR propagation engine.
- When you submit a calculation for processing, all the API parameters will be displayed here. If you are a developer, you can directly copy paste this to use it in your code.
- To do so:
  - Click on the **Run** button for execution, the *Site name (Network name)* field will be displayed in the *Output Console*.

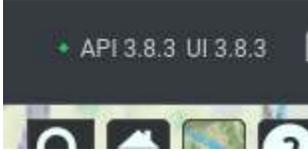


- Select the **file format** in which you wish to download the configuration settings file.

\* Click on **Download**  icon.

## 2.9 System Version

In the top right corner of the interface indicates the current version of the API and UI which you are using. The discrete green / amber / red light to the left denotes connectivity to the backend processing service / API. Green is good, amber is connected but the API has been under a sustained load for more than a minute and red is API unavailable.



You can click on either of the API or the UI which will open up a modal window in the interface which will give you a full changelog of what has changed in the version you are using.

## 2.10 Documentation

To refer to the 3D Interface Documentation:

- Click on the **Documentation**  button located on the top right of the interface.

## 2.11 Account Information

You can view information about your account by clicking on the **Account Information**  icon located on the top right of the interface.

When you click on this a modal window will be opened which will contain various information.

The screenshot displays the 'Account Information' page with the following sections:

- Logout**: A red button with a user icon.
- Operator / Engineer Mode**: A dropdown menu currently set to 'Engineer'.
- Subscription Plan**:
 

Plan	Gold plan (5)
Balance	25000
Expires	2024-11-27 10:50:15
UID	[blurred]
API key	[blurred]
- Managers**: Four green buttons labeled 'Antennas', 'Clutter', 'Colours', and 'Templates'.
- Default Colour Schemas**: A list of measured units with corresponding dropdown menus:
 

Path loss	PATHLOSS
Received power	RAINBOW
Field strength	TV
Signal to noise ratio	SNR
Modulation & bit-error-rate	SNR
RSRP	BLUE
Best Site Analysis	BESTSITE
- Custom Map (WMS / WMTS URL)**: Two input fields for 'Google Satellite' and 'Google Roads', each with a URL and a list of map services (Google Satellite, Google Maps, Cycle OSM, ESRI World Topo).
- API Usage**: A section titled 'API Usage Since 2023-11-21 10:50:15' with a 'Breakdown' pie chart.
 

Category	Count	Percentage
Path	99	44%
Area	52	23%
undefined	41	18%
Points	25	11%
Best Site Analysis	8	4%
Manet	0	0%
Interference	0	0%
- Total API Calls**: 225
- OK**: A grey button at the bottom right.

- **Logout** is used to log you out from the system.
- **Operator / Engineer Mode** is used to toggle between operator and engineer mode. See *UI Mode* for more details.
- **Subscription Plan** contains information about your current subscription details.
- **Managers** are buttons to other tools to allow you to customise your system settings.
- **Default Colour Schemas** allows you to specify which colour schemas are selected by default for each of the available measured units.
- **Custom Map** lets you define either WMS or WMTS URLs which can be used in the UI to set your own custom map service.

- **API Usage** gives a breakdown of your API usage over the period of your subscription.

### 2.11.1 Logout

You can logout from the interface by clicking on the logout button at the top of the “Account Information” modal.



### 2.11.2 Subscription Plan

Details about your current subscription plan are listed in the “Account Information” modal. Such information includes:

- Your plan name.
- Your account balance.
- The expiry date of your current subscription.
- Your UID.
- Your API key, with a quick copy button.

### 2.11.3 Managers

CloudRF by default may not have the required settings or customisations which you require, and so we include a number of different managers to allow you to build elements yourself.

-  **Manage My Antennas** allows you to import your own antenna patterns. Please consult the *antenna management reference* for further details.
-  **Manage Clutter Profiles** allows you to define the height and attenuation of environments. Please consult the *clutter profile management reference* for further details.
-  **Manage My Colours** allows you to build your own colour schemas. Please consult the *colour management reference* for further details.
-  **Manage System Templates** allows you to manage your favourite system templates which can be quickly selected from the **My Templates** dropdown. Please consult the *templates reference* for further details.

## 2.11.4 Default Colour Schemas

With CloudRF we support a number of different *measured units*. As such there are limitations to using some measured units with some colour schemas. The utility in this section allows you to easily select a default colour schema for a number of different measured units:

- Path loss
- Received power
- Field strength
- Signal-to-noise ratio
- Modulation and bit-error-rate
- Reference Signal Received Power (RSRP)
- Best site analysis

The schema which you choose here will be the default when you switch your measure unit in the “*Mobile / Receiver*” *menu*.

## 2.11.5 Custom Map

The **Custom Map** URLs let you define your own map tile servers which can then be used in the interface and selected on the imagery icon. This is useful if the default map layers provided do not meet your own particular needs or requirements.

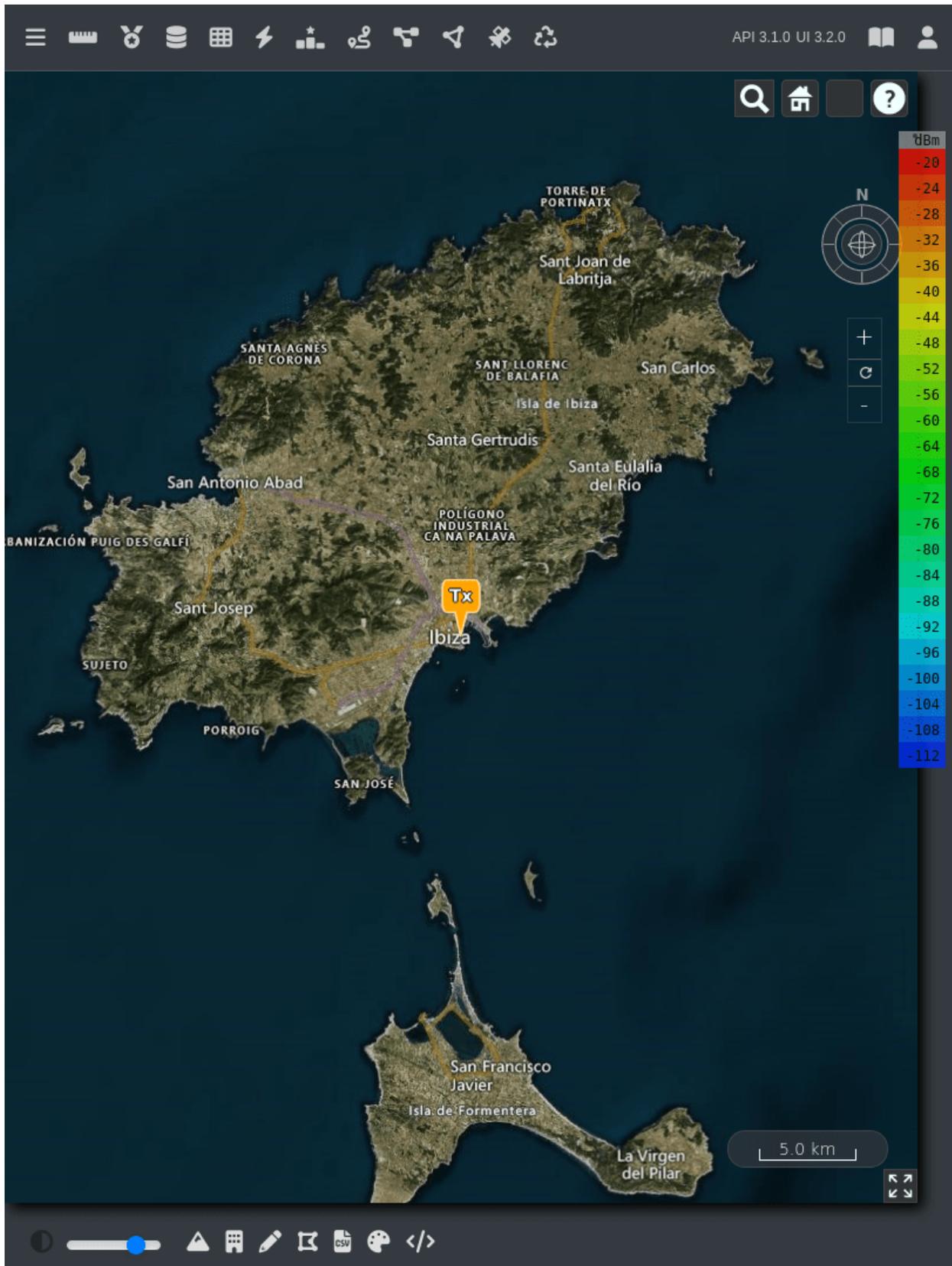
## 2.11.6 API Usage

API usage will give you a breakdown of your usage since your subscription was created. This includes a chart and full breakdown of the number of each individual API requests.

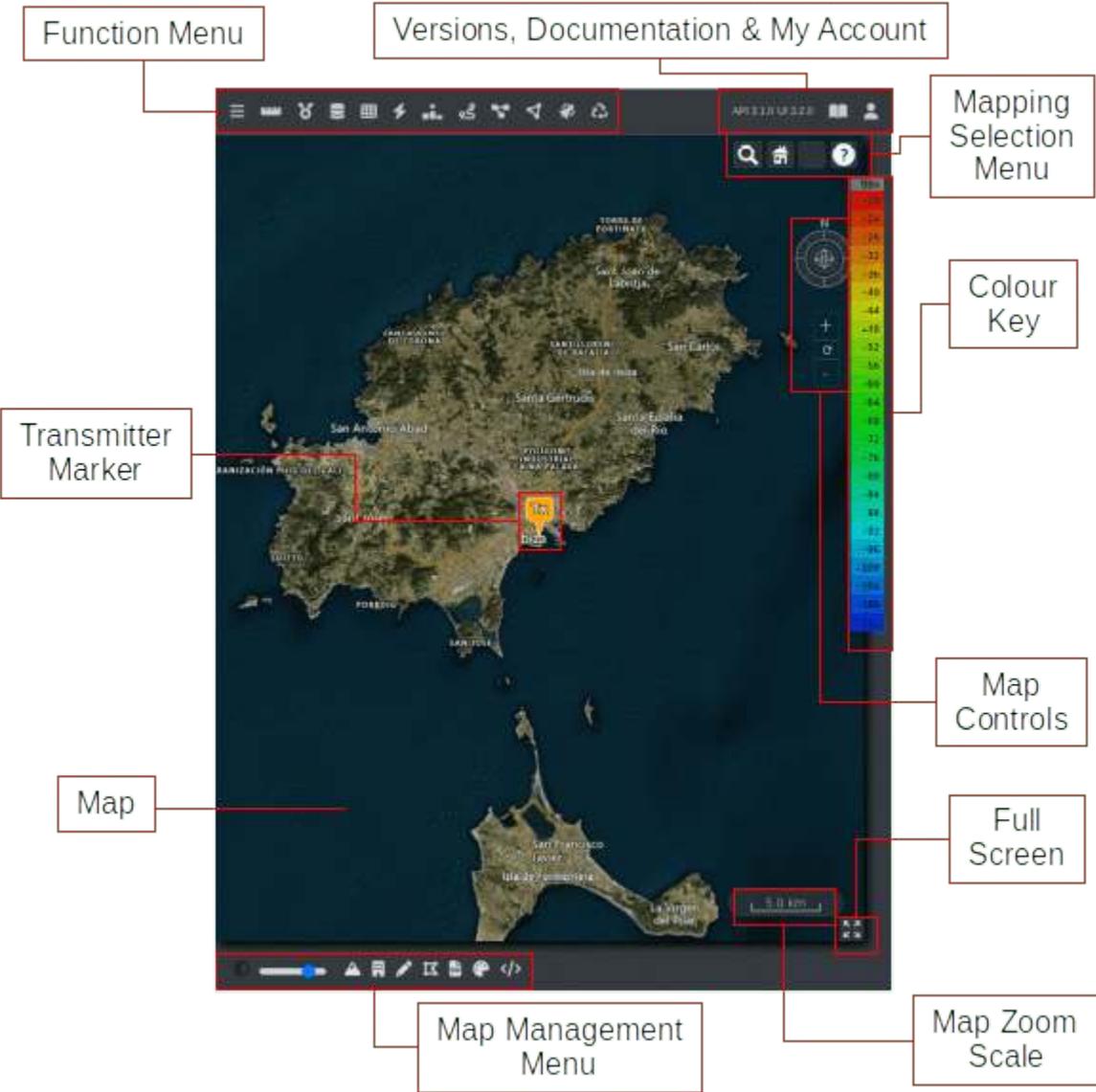
## 2.12 Mobile Operation

The CloudRF 3D Interface can be easily accessed on your mobile phone.

The following UI will be displayed on your mobile phone, with a collapsed menu:



## 2.13 3D Interface Elements - Mobile View



### 2.13.1 Expand/Collapse

The **Expand/Collapse**  button of the Function Menu lets you expand or collapse the Side Menu consisting of Templates, Input Menu and Output Console.



## WEB INTERFACE MAP

### 3.1 Mapping Selection Menu

The **Mapping Selection Menu** is a set of key mapping functions located on the top-right of the interface.

#### 3.1.1 Mapping Selection Menu Elements

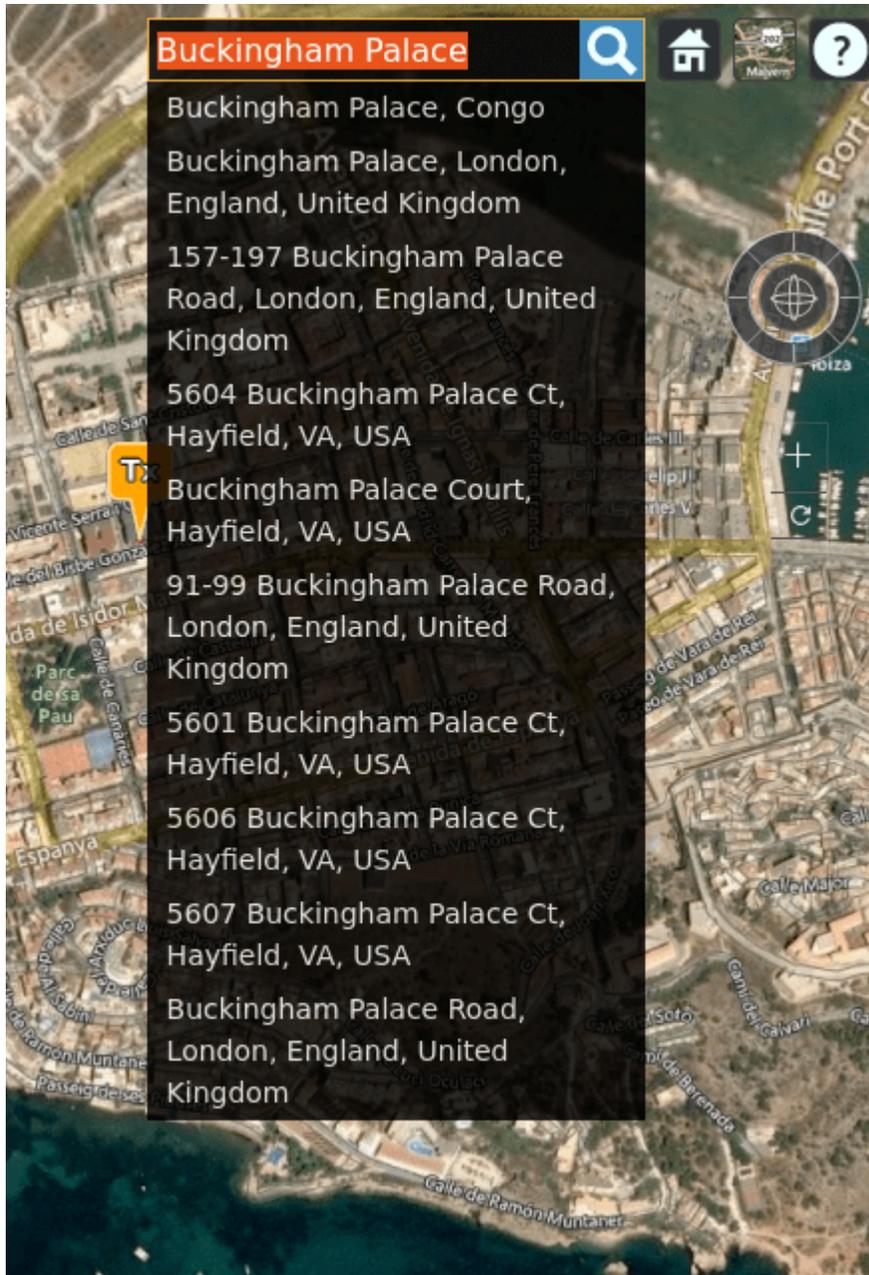


**Address search**

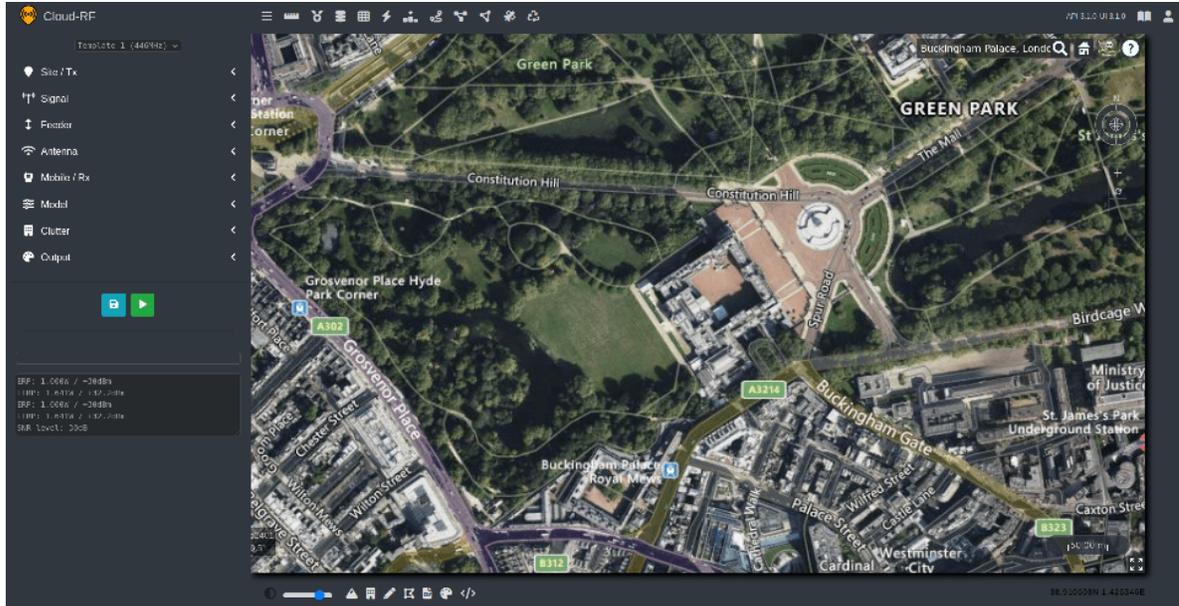
The search tool lets you search an address, landmark, geocode or postcode / ZIP code.



- Click on the **Search**  icon to open the search box.
- Type the desired address or landmark you wish to search on the map. You will be prompted with different suggestions.



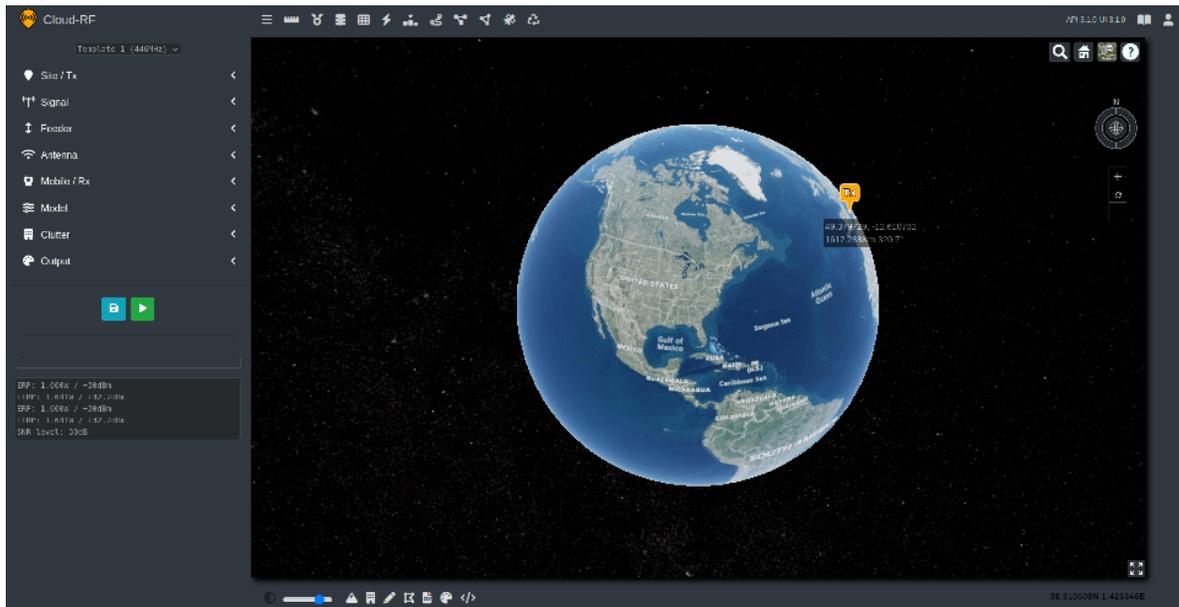
- Select your chosen address/landmark/geocode/postcode and the map will be moved to the location.



View Home

The **View Home** button is used to reset the interface back to an overview of the whole of the Earth.

- Click on the **View Home**  icon.
- The following screen will be displayed.





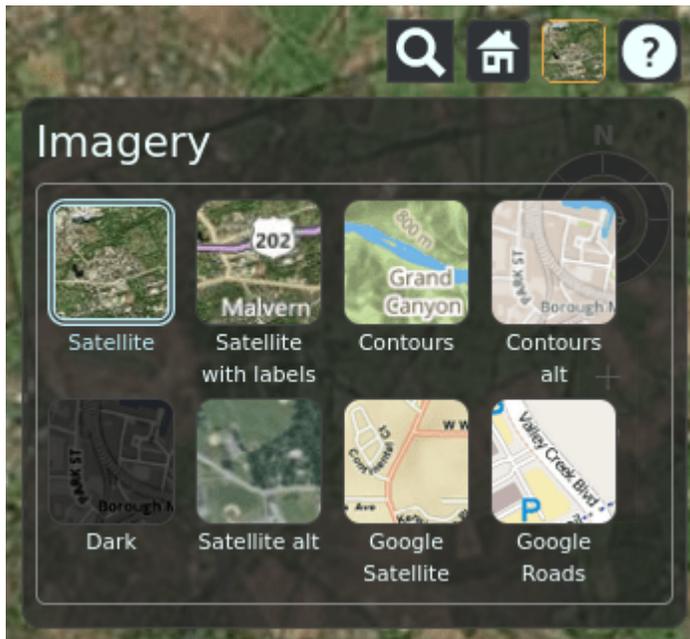
## Choosing Imagery

The **Imagery** tool lets you change the mapping/imagery style.

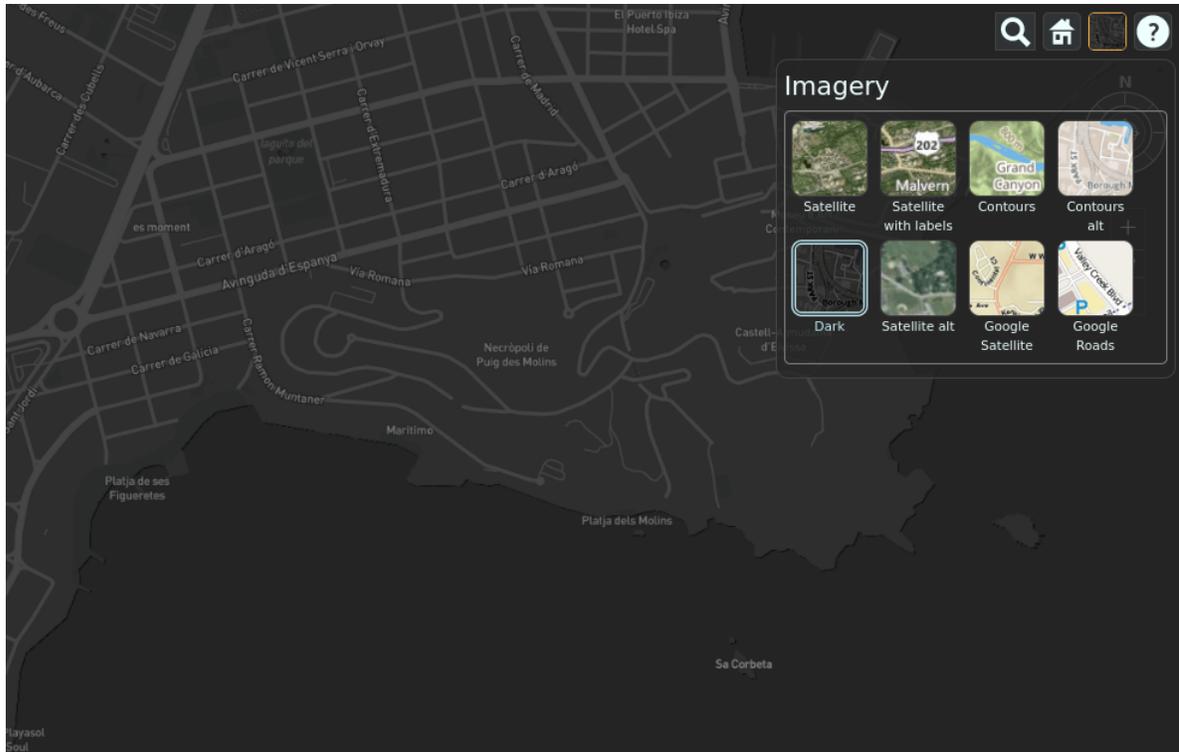
The **Imagery choices** offered include satellite imagery, street mapping and high contrast ‘dark’ layers for use with colourful overlays.

To choose the desired imagery:

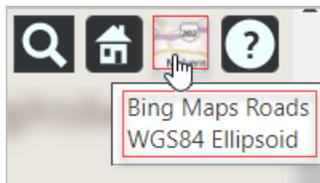
- Click on the **Imagery**  icon.
- The **Imagery** dialog box will appear and the various imagery options will be displayed.



- Choose the desired Imagery.
- The same will be reflected on the map.



- The **Imagery** icon and the **mouse-over text** will be changed depending upon the selected imagery.
  - For Example: On selecting the *Bing Maps Road* imagery, the following icon and mouse-over text will be displayed.



- You can also **enable/disable** the underlying **3D terrain** here.
  - By default, the 3D terrain is disabled to improve performance.
  - You can enable it by clicking the **Toggle 3D Terrain**  icon located at the bottom-left of the interface.
  - The same will be reflected on the map.

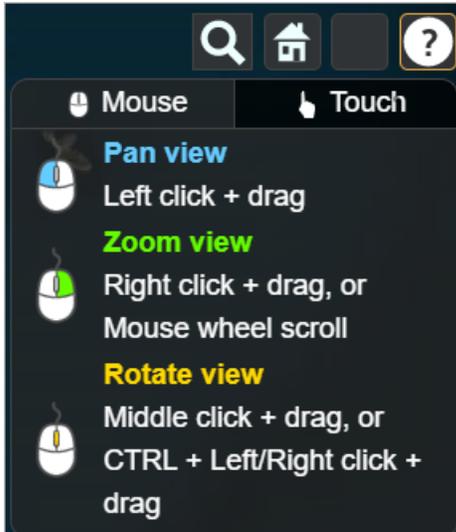


## Navigation Instructions

The Navigation Instructions tool will display the navigation instructions for using the 3D interface on your computer and mobile.



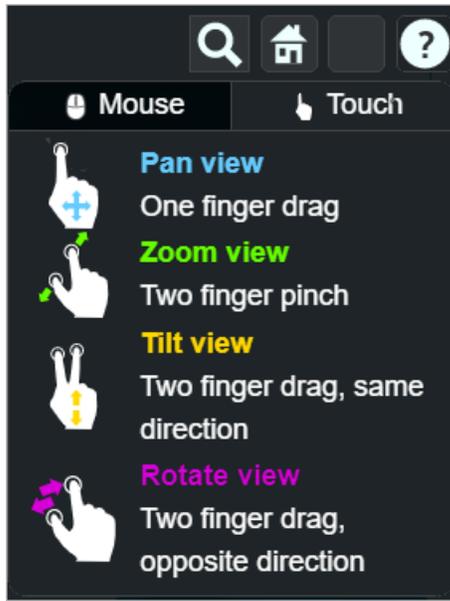
- Click on **Navigation Instructions** icon.
- The *Navigation Instructions* dialog box will appear.



- For navigating the 3D Interface on your *computer*, click on the **Mouse** tab.



- For navigating the 3D Interface on your *mobile*, click on the **Touch** tab.



### 3.1.2 Full Screen View

To **enable** the Fullscreen view:

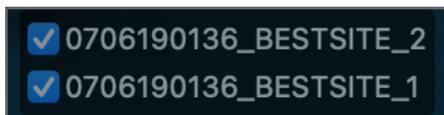
- Click on  icon located at the bottom right of the 3D Interface.

To **exit** the Fullscreen view:

- Click on  icon located at the bottom right of the 3D Interface.

## 3.2 Managing Layers

Any created heatmap **Layer(s)** will be displayed on the map and listed as a filename with a checkbox in the top right corner.



- You may **enable** or **disable** the layers as per your requirement by simply checking and unchecking the checkboxes.

To clear the layers from the map (but not delete them from your archive) use the recycle button on the top menu.

To hide the list of layers if it becomes very long, use the layer list toggle button located next to the search and home icon. Click it once to hide the list and again to show the list.

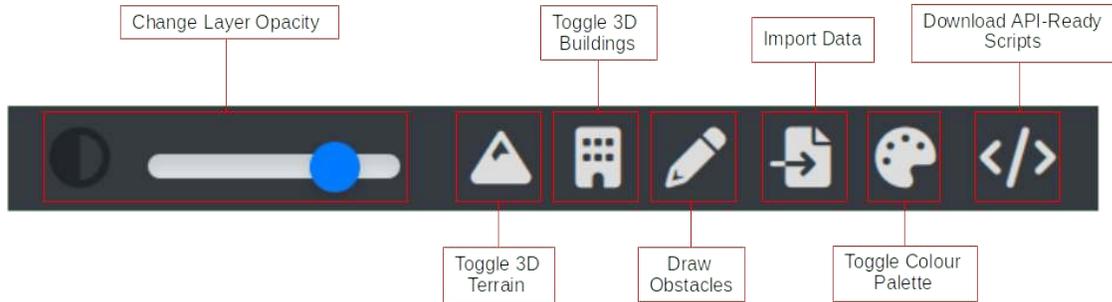


### 3.3 Map Management Menu Elements



The map tools located at the bottom of the interface lets you manage several elements which is detailed in the following section.

The left side of the bottom of the interface contains a number of tools which can be used to improve the interactivity of the interface.



The right side of the bottom of the interface contains the decimal degrees location of the current transmitter location. This is a duplication of the information which is already available in the menu on the left of the interface, and is provided as a quick reference.

#### 3.3.1 Changing Layer Opacity

You can change the opacity of the layer(s) on the map with the help of the opacity slider.



- To increase the opacity, move the slider to the right.
- To reduce the opacity, move the slider to the left.

#### 3.3.2 Toggle 3D Terrain

You can toggle (enable/disable) the **3D Terrain** as per your requirements by clicking on the **Toggle 3D Terrain** icon. For performance, 3D terrain is disabled by default.

-  icon indicates that the 3D Terrain has been disabled.
-  icon indicates that the 3D Terrain has been enabled.

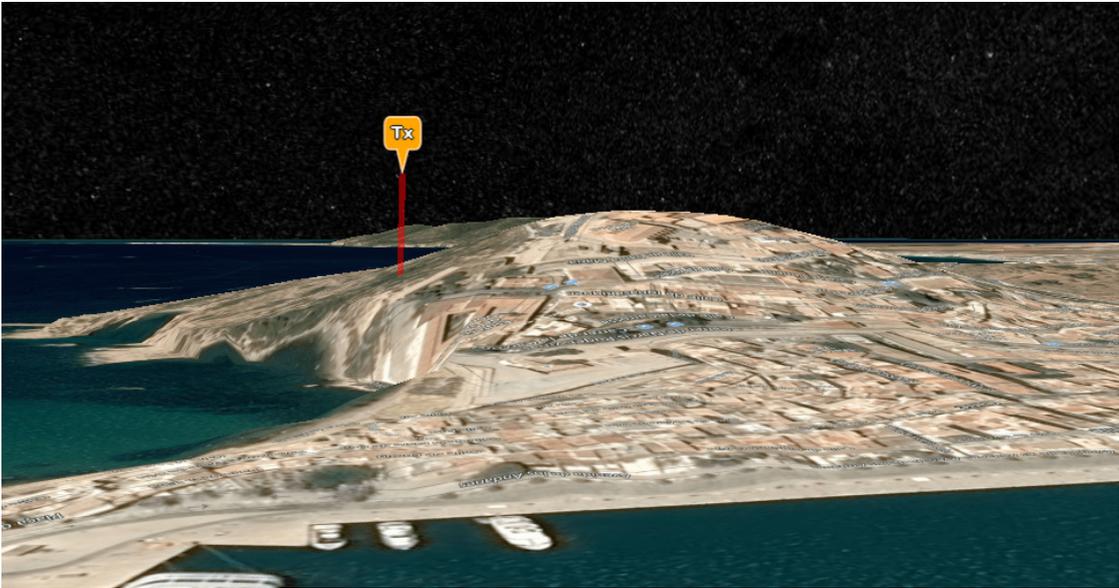
Please note that when you enabled 3D buildings, 3D terrain will automatically be enabled.

- Following are the screenshots for reference showing the changes in the Map when the 3D Terrain is disabled and enabled:

– Map when the 3D Terrain is Disabled 



– Map when the 3D Terrain is Enabled 



### 3.3.3 Toggle 3D Buildings

You can toggle (enable/disable) the **3D Buildings** as per your requirement by clicking on the **Toggle 3D Buildings** icon. For performance, 3D buildings area disabled by default.

-  icon indicates that the 3D Buildings have been disabled.

-  icon indicates that the 3D Buildings have been enabled.

Please note that when you enabled 3D buildings, 3D terrain will automatically be enabled.

Following are the screenshots for reference showing the changes in the map when the 3D Buildings are disabled and enabled:

- **Map when the 3D Buildings are Disabled** 



- **Map when the 3D Buildings are Enabled** 



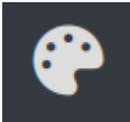
### 3.3.4 Draw Custom Clutter

The “Draw Obstacles” tool is used for drawing your own custom clutter, with support for polygons. Please consult the *clutter reference* for more information.

### 3.3.5 Import Data

For more details on this please consult the *dedicated documentation resource*.

### 3.3.6 Toggle Colour Palette

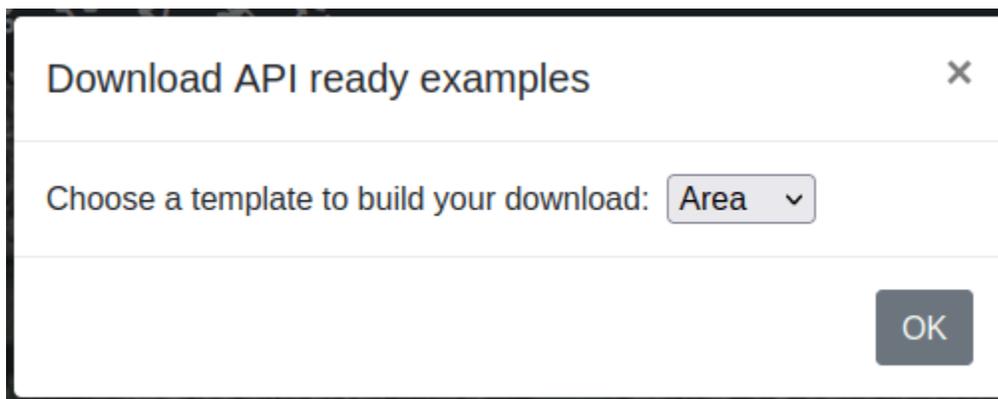
At the bottom of the interface there is a palette icon . When you click on this button this will hide your colour palette on the right side of the screen. This can be useful when you are working on devices with smaller screen sizes as the colour palette may obscure certain interface elements.

### 3.3.7 Download API Ready Scripts

If you wish to build up a number of settings which you can then take away and use in your own scripts which make use

of the Cloud-RF public API, then you can click on the “Download API ready scripts”  icon.

When you click on this icon you will be presented with a modal window:



From the dropdown you can select one of the following endpoints:

- **Area** will download scripts with your current settings suitable for an `area` calculation.
- **Path** will download scripts with your current settings suitable for a `path` calculation.
- **Points** will download scripts with your current settings suitable for a `points` calculation.

Regardless of which you choose, each will download a respective ZIP file with a number of files which have been built with your specific settings. The files included should contain the following:

- `readme.txt` with some basic instructions on how to use the downloaded scripts.
- `sites.csv` with your transmitter and, if present, receiver locations along with their network names.
- `template.json` with a raw request as it would be made to your chosen endpoint.
- A Python script named after the chosen endpoint, such as `area.py` if you selected **Area**.
- `cloudrf.ini` with some configuration values based on your particular values, such as your API key, and the URL for the Cloud-RF public API.
- `cloudrf.py` is the Python base class if you wanted to extend your own requests and is based on the Python script available on [GitHub](#).

## 3.4 My Obstacles

Custom obstacles or **Clutter** can be defined as anything which could impede a signal's path.

For RF planning purposes, the clutter can predominantly be trees and buildings. As the trees and the buildings vary greatly in density, you may wish to, we have included their different types.

The global clutter data for telecommunications planning is very expensive, and often outdated, despite their price. We have developed a much more flexible way of self-generating accurate clutter models.

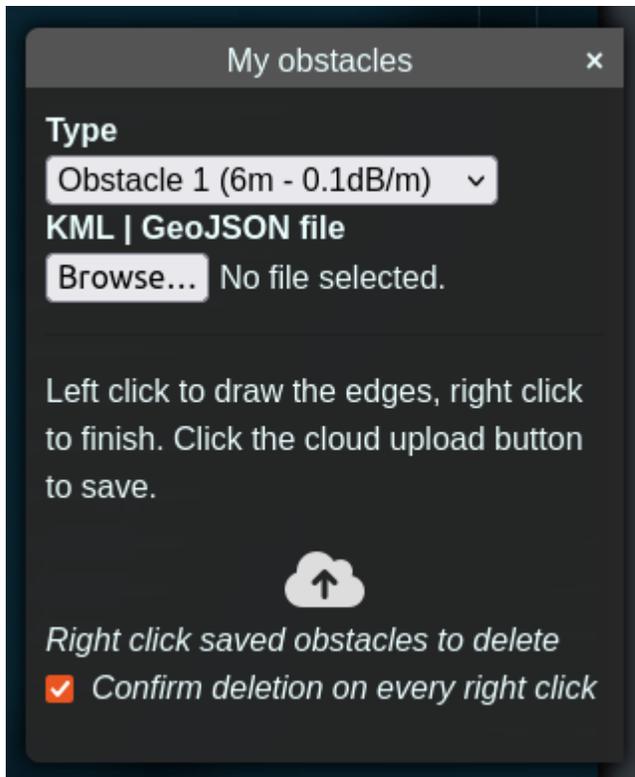
Whether you need to define one big building which is being planned for construction or you need to upload a plan for an entire city - we support both **DIY (Do It Yourself)** and **BYO (Bring Your Own)** clutter.

- **DIY Clutter** - You can draw your own clutter directly in the Cloud-RF interface to meet your requirements, defining the **Type** of the clutter.
- **BYO Clutter** - You can upload your own **KML / GeoJSON file** directly.

### 3.4.1 DIY Clutter

DIY clutter allows you to draw and build your clutter directly in the Cloud-RF interface to meet your requirements.

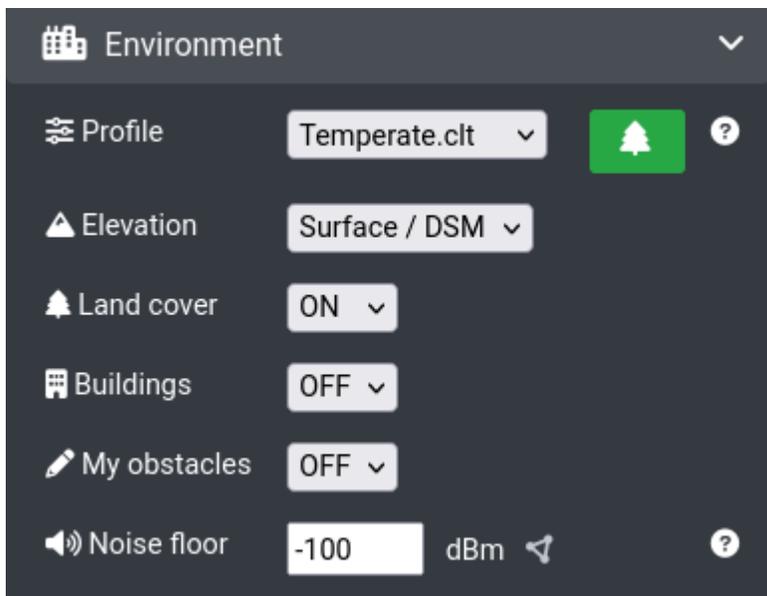
- Click on the **Draw obstacles button**  icon to draw custom clutter located at the bottom-left of the interface.
- The **My obstacles** Dialog box will appear.



For information regarding Drawing Clutter, refer to the *Drawing a Polygon* section.

The dialog box is split into several parts.

- **Type** determines the type of the material under which you clutter will be allocated. This is for DIY clutter. The value set here will be taken based upon your clutter profile which you select in the “Environment” menu from the “Profile” dropdown on the input menu on the left of the interface. This is used to determine the height, attenuation, name and colour of the clutter.



- The “Browse”/“File” button is used to submit **KML** or **GeoJSON** files for BYO clutter.



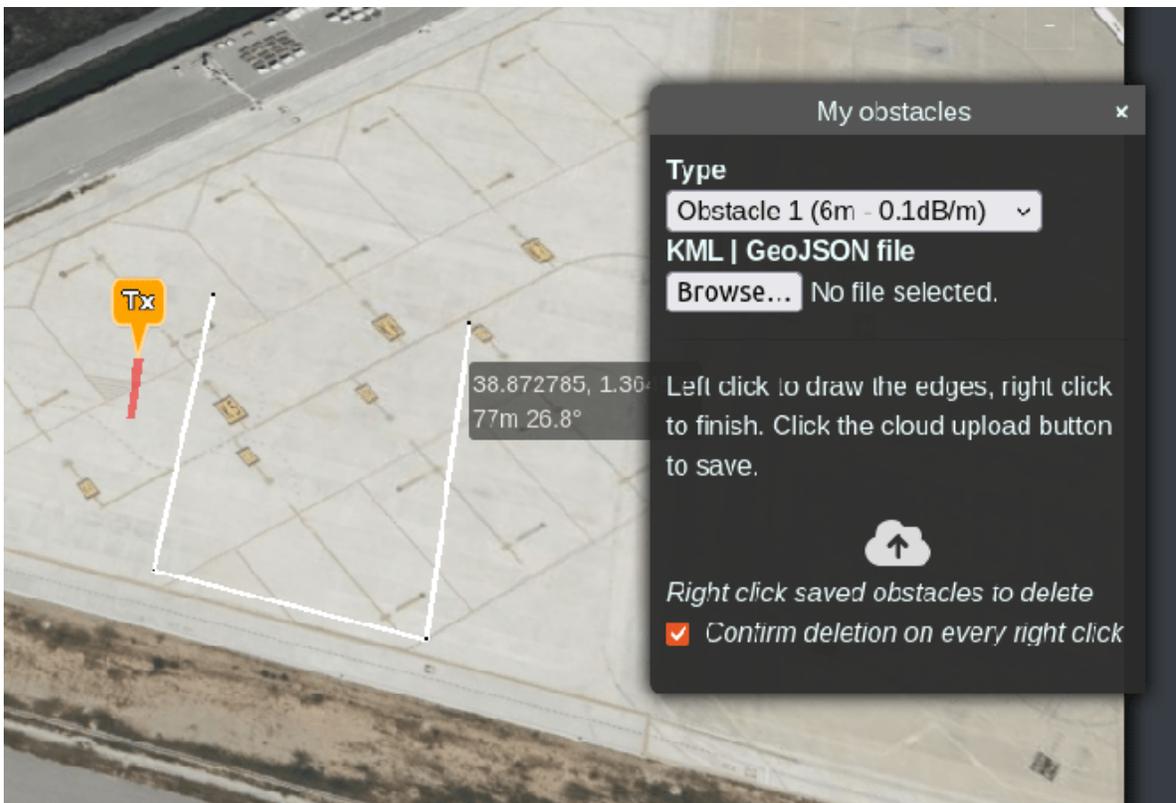
- The upload button is used to send your clutter to the Cloud-RF service to handle your clutter.
- The checkbox at the bottom for “Confirm deletion on every right click” is a safety catch as you may have multiple clutter on your profile - rather than having to confirm deletion of every one you might decide to disable this checkbox at which point right-clicking on a clutter will instantly delete it without any confirmation.

### Drawing Custom Clutter

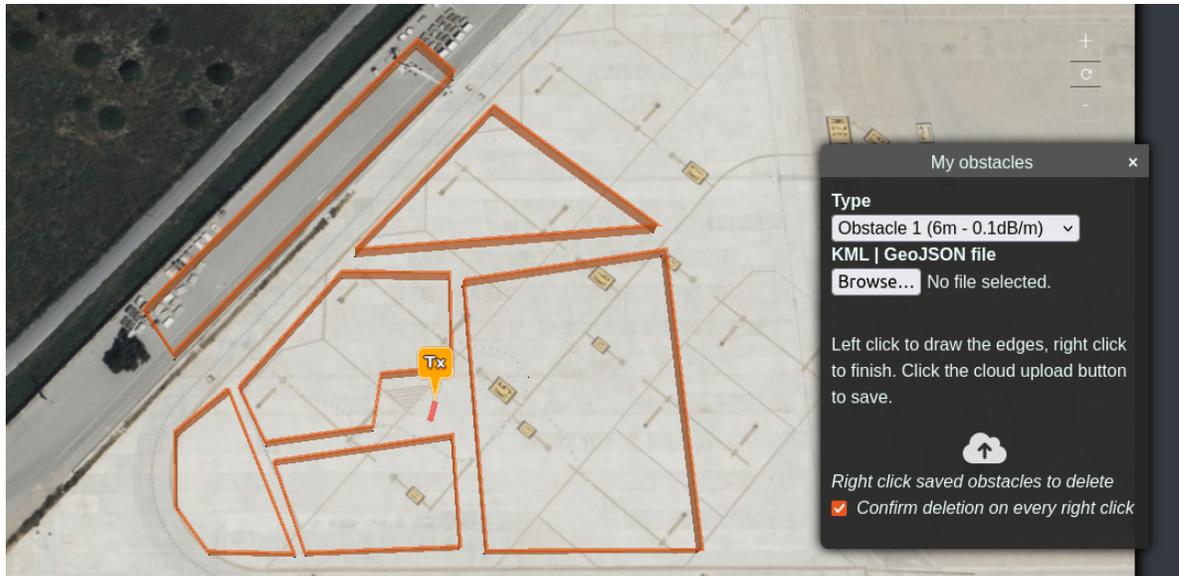
To define a clutter polygon:



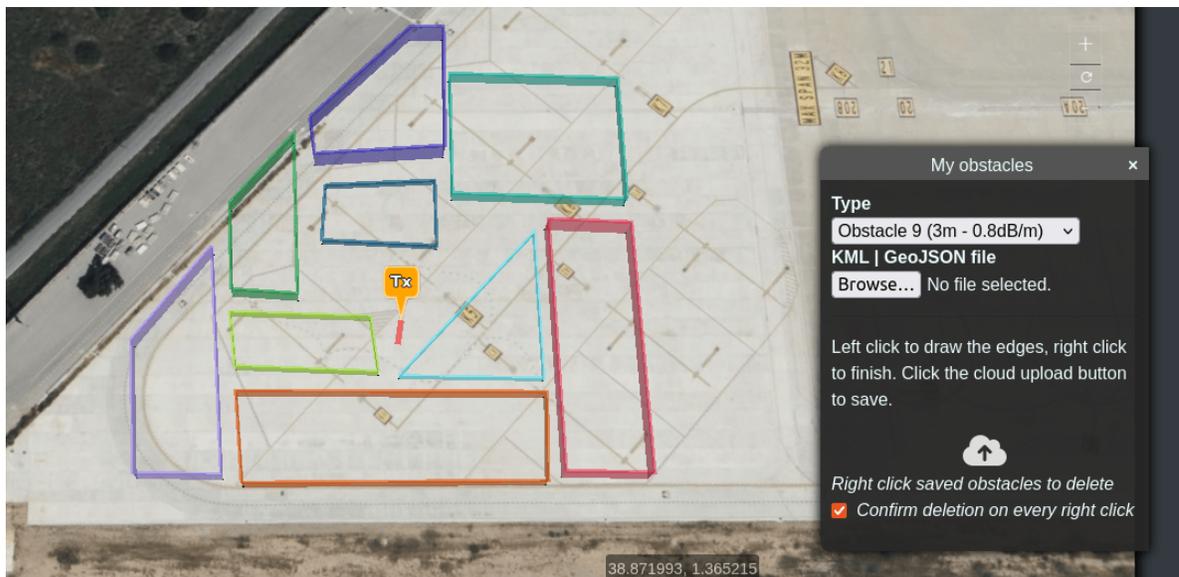
- Click on the **Draw Obstacles** icon located at the bottom-left of the interface.
- **Left-Click** on the map to draw the edges of the polygon as per your requirement.



- **Right-Click** to finish. You can repeat as many times as necessary to draw multiple polygons with the same properties.



- You can change the “Type” to draw as many different types of clutter as you wish with the available types you have to work with. The properties of each type is taken from your clutter profile.

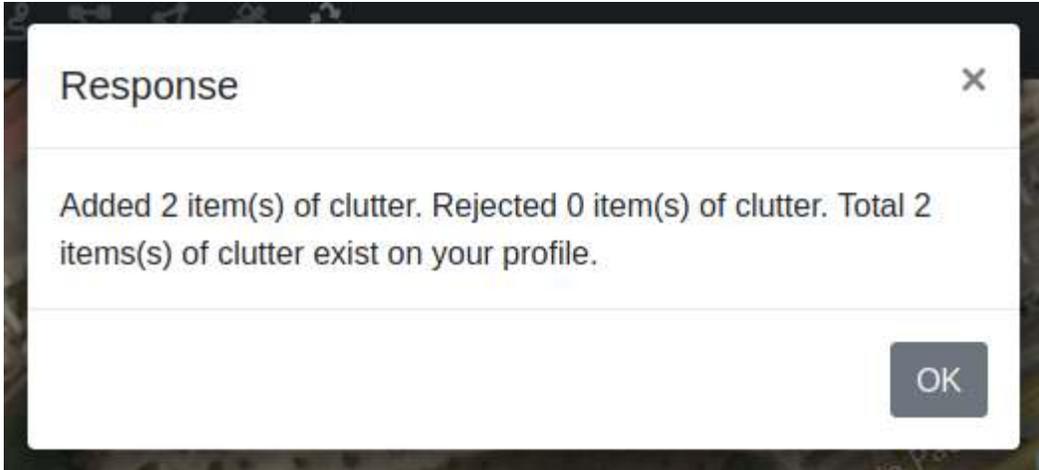


- The **Custom Clutter** Dialog box will also be displayed.

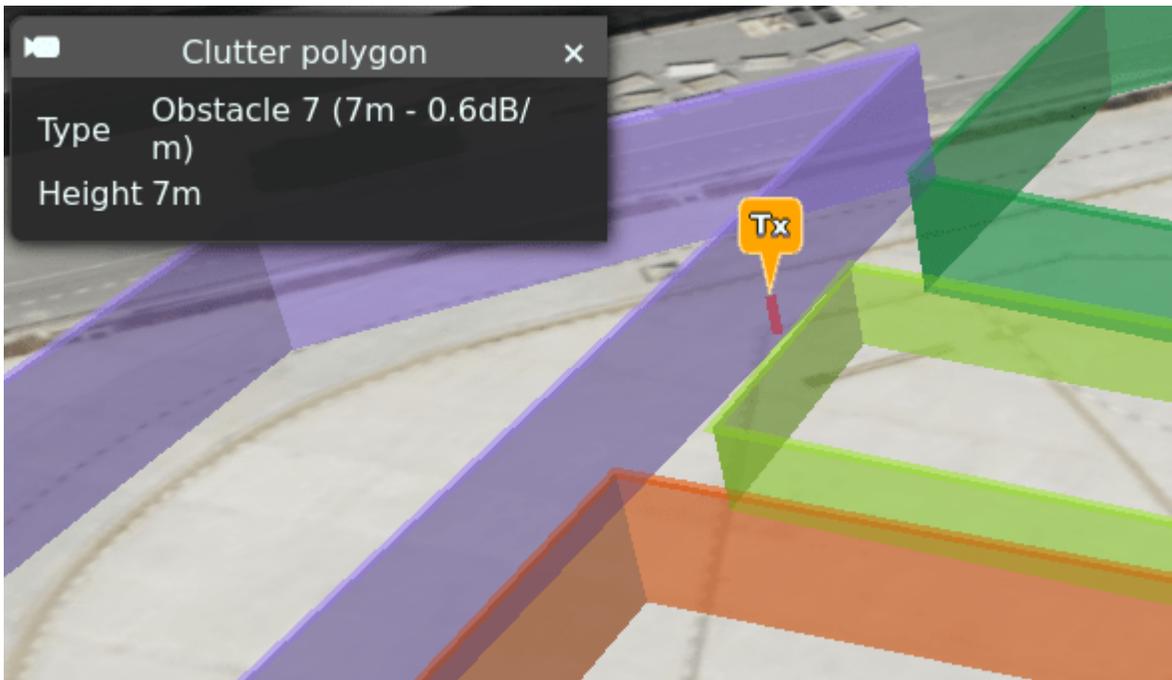
For more information, refer to the **Custom Clutter** section.

- After you have finished drawing your clutter you should then click on the upload button.
- You will be presented with an overview of the clutter which was uploaded to your profile.





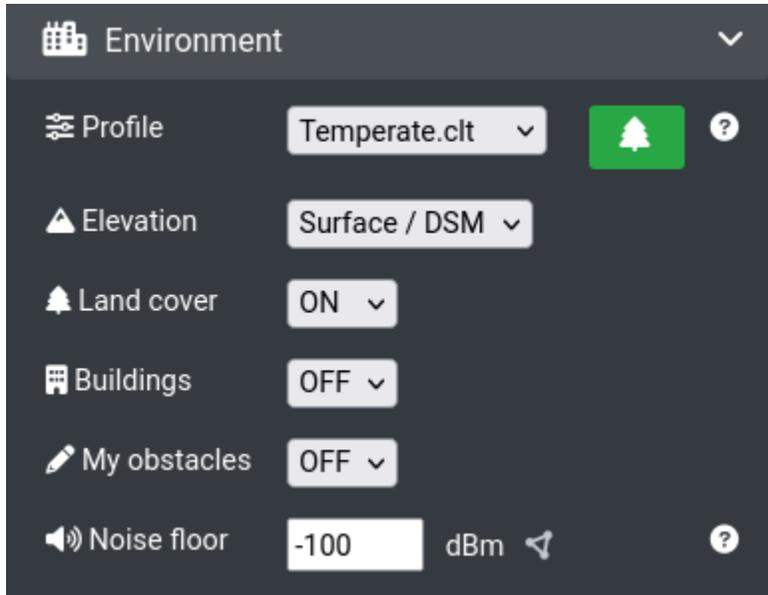
- When you close the clutter menu your drawn clutter will be displayed on the map. You can left-click on it to show its properties.



### Selecting/Changing Clutter Type and Height

Clutter properties are applied based on the **Type** you choose from the clutter dialog box.

The attenuation and height for these types are defined in your clutter profile which is selected from the “Environment” menu.

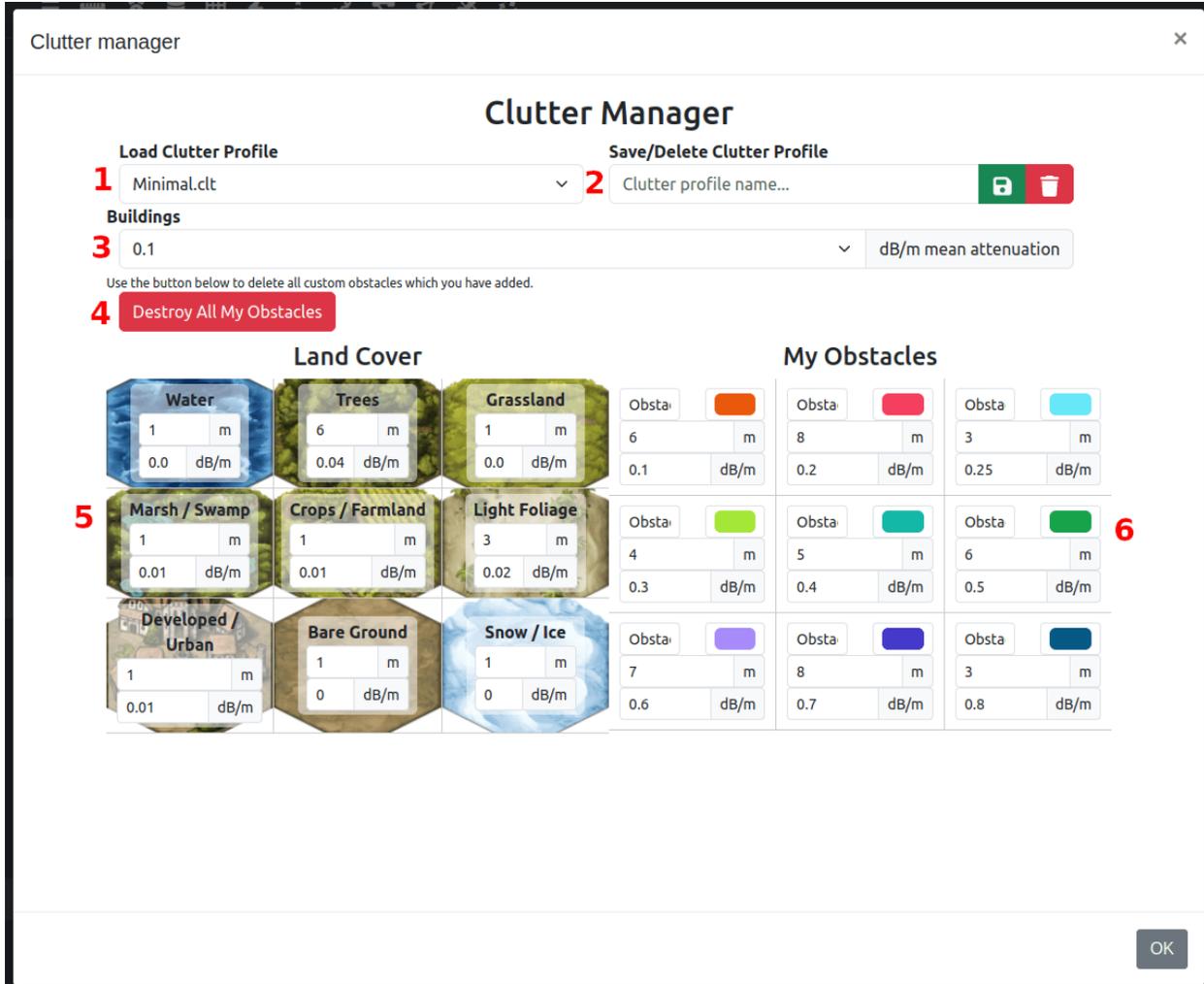


You can choose different clutter profiles to match your environment, or you can create your own clutter profile to define



your height and attenuation by clicking on the “Clutter Manager” button.

From the clutter profile manager you can create and define your own attenuation and heights for listed materials.



1. Selected clutter profile
2. Save/delete profile as name
3. Building attenuation
4. Delete all obstacles on your account
5. Land cover types with customisable height and attenuation values
6. My obstacle (clutter) types with customisable name, colour, height and attenuation values

### Deleting Clutter Profile

If you wish to delete a custom clutter profile then please enter its name into the input box then press on the delete button. Please note that the name must exactly match, including the casing and the extension name. You are also unable to remove system clutter profiles.

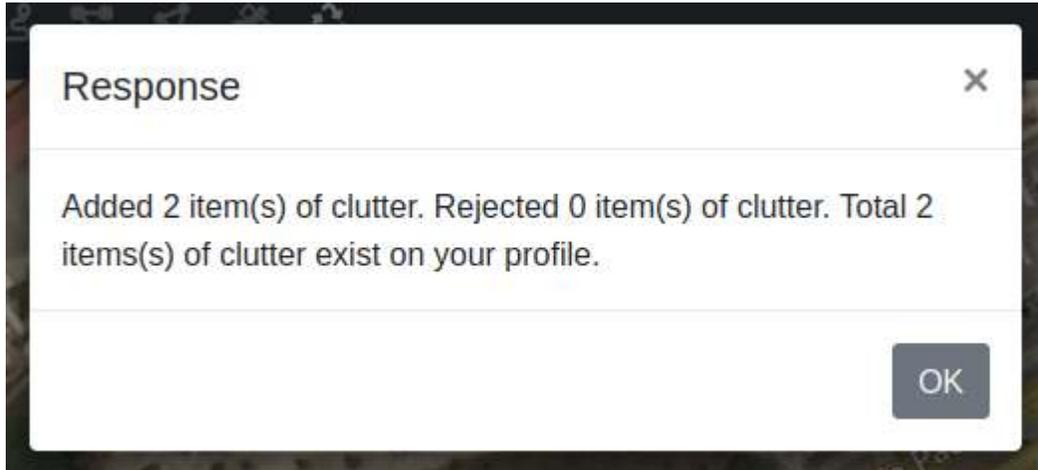
### 3.4.2 BYO Clutter

#### Uploading a KML / GeoJSON file

This is a **BYO** type of clutter.

You can import multiple clutter items as a KML or GeoJSON file.

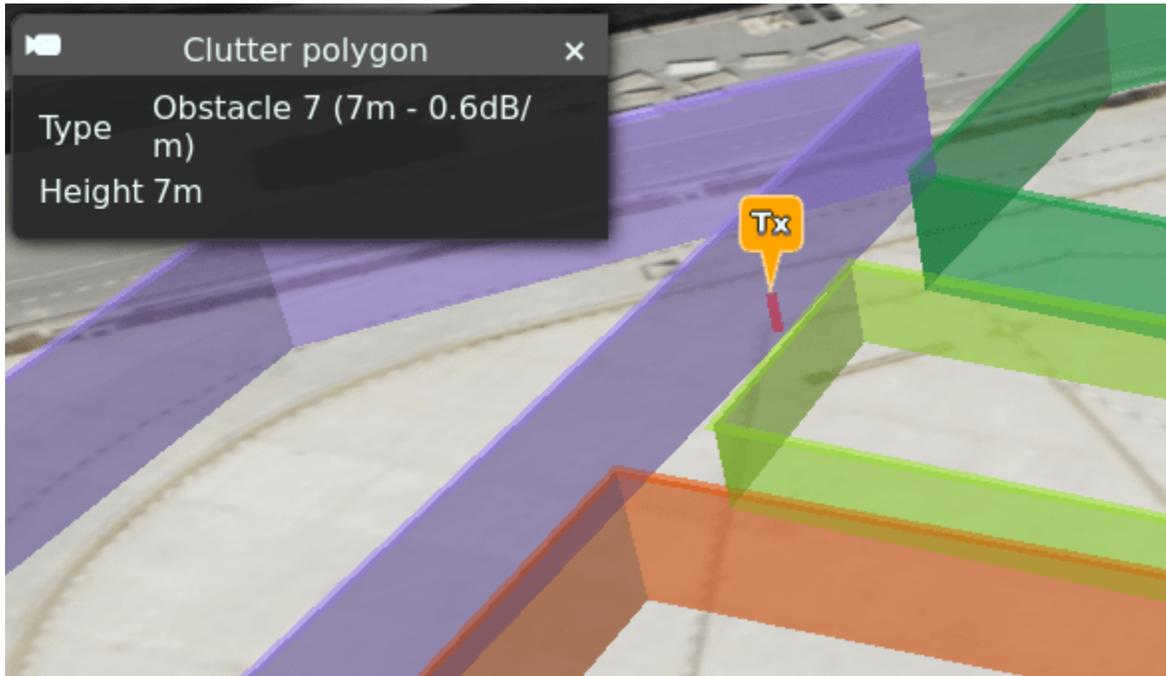
- Open the custom clutter menu by selecting the **Draw obstacles button**  icon located at the bottom-left of the interface.
- Click on **Choose File** button.
  - Select the desired *KML/GeoJSON* file.
- Click on the **Upload**  icon to save the clutter.
- A **Response** box will be displayed stating that the Clutter has been added.



#### 3.4.3 Viewing the Defined Clutter

After drawing, defining and uploading the clutter, you can view the defined clutter on the map.

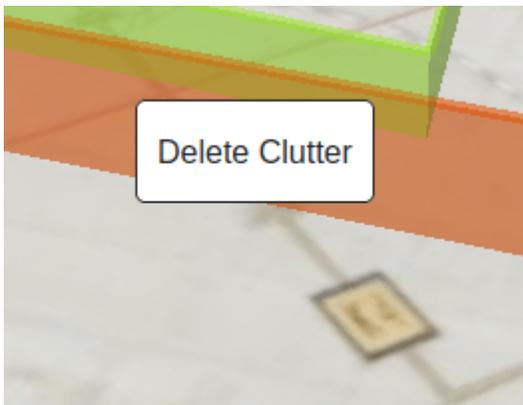
## Polygon Clutter



### 3.4.4 Deleting Clutter

To delete a clutter:

- *Right-Click* on the respective clutter on the map.
- If you had the “Confirm deletion on every right click” checked in the custom clutter dialog box then you will be prompted to confirm deletion of each piece of clutter. Otherwise the clutter will be deleted without any confirmation.



You can also delete all clutter in your profile by opening the clutter manager and pressing the “Delete my obstacles” button.

## 3.5 LiDAR

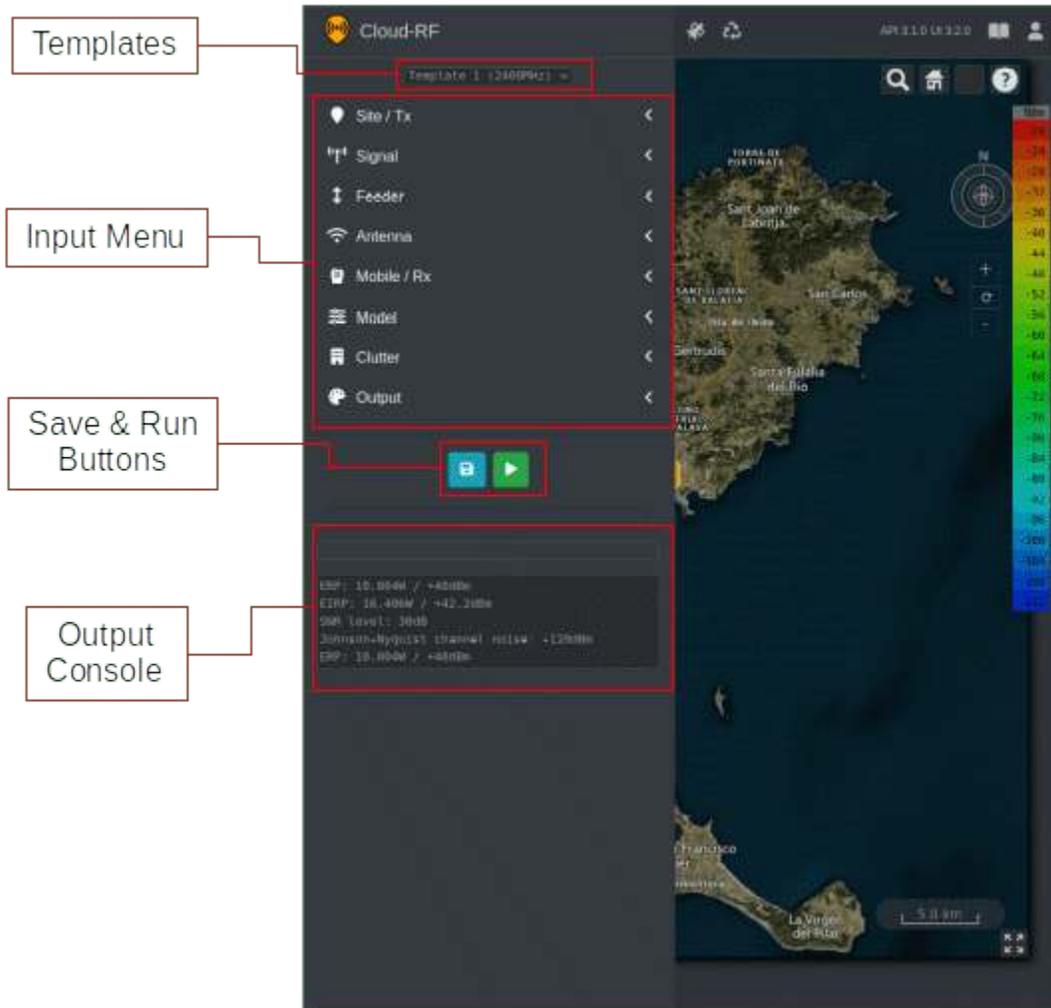
LiDAR data is the highest accuracy data available and is available for many cities at 2m resolution.

Check the [coverage map](#) to see if you are covered.

It's a surface raster, hence, it is not permeable like the custom clutter but is very useful for line of sight analysis as even trees and bushes are represented.



### 3.6 Mobile View



### 3.6.1 Hiding the Side Menu

To hide/collapse the Side Menu, you can tap on map area on the right side.

### 3.6.2 Touch Screen Gestures

You can pan view, zoom, tilt and rotate on your touch screen phone using the following finger gestures:

#### Pan Map

You can pan the map by selecting with a single finger and dragging your finger across the screen.



#### Zoom Map

You can zoom the map by placing two fingers on the map and pinching the fingers together or away from one another to either zoom in or zoom out, respectively.



#### Tilt Map

You can tilt the map by placing two fingers on the map and dragging them both in the same direction up or down the screen.



#### Rotate Map

You can rotate the map by placing two fingers on the map and rotating your hand clockwise or counter-clockwise.



## 3.7 Outputs

### 3.7.1 Embed Code

The new **Embed Code** functionality lets you **Copy** the HTML code and upload it to your website with the desired filename and the html extension.

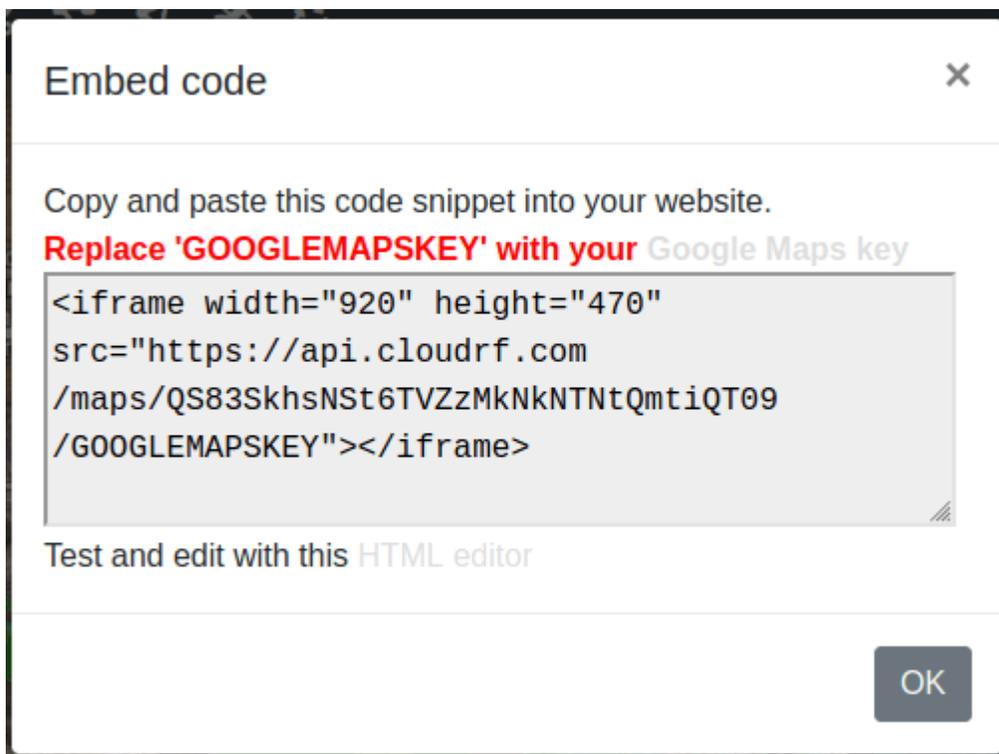
You can reap the following benefits and more using the HTML Embed Code functionality:

- Build your own Coverage Map.
- Create radio heatmap for your website.
- Add Google Maps to your website.
- Add RF Coverage on the Google Maps.

For more information regarding this, refer to the Embed Code Benefits topic.

To access the *Embed Code* functionality:

- Click on **My Archive**  button on the Function Menu.
- The **My Archive** dialog box will appear.
- Click on the **HTML Embed Code**  icon.
- The **Embed Code** dialog box will appear.



- You can copy the HTML code snippet from here and paste it to your website.
  - Replace the `GOOGLEMAPSKEY` in the code with your [Google Maps Key](#).

- You may **Test** and **Edit** the code snippet with the help of [HTML editor](#)

### 3.7.2 Build Your Own Coverage Map

Are you a wireless internet service provider or an organisation that requires an online coverage map to be displayed on their website?

Building your own Coverage Map is just a few clicks away...

The most basic option is to accomplish this is using an arbitrary polygon on a free map like Google Maps. However, if you require **a beautiful and accurate physics-based coverage map, at no extra cost**, *CloudRF's Embed Code* functionality is all you need.

Using the CloudRF's **Embed Code** functionality is the easiest way to add a map to your website or blog that supports the HTML content. You just need to copy-paste an HTML code snippet to your website and replace the `GOOGLEMAPSKEY` in the code with your own Google Maps API key.

For further information regarding *Hosting your own Network Map*, click on this [link](#).

### 3.7.3 Create Radio Heatmap for Website

The **Embed Code** functionality lets you create the radio heatmap for your website.

With the help of GIS mapping and the LIDAR Imaging from the satellites, the CloudRF tool will output a heatmap of the signal strength on the 3D map. Hence, you can create the radio heatmap for your website and also determine how well your signal propagate based on some variables that you configure in the tool.

For further information, refer to this [link](#).

### 3.7.4 Add Google Maps to the Website

All you need is a web browser and you are just three steps away from adding the Google Map plus RF layer to your website:

- **Create a basic HTML web page**
- **Add a [Map](#)**
- **Get your own [API Key](#)**



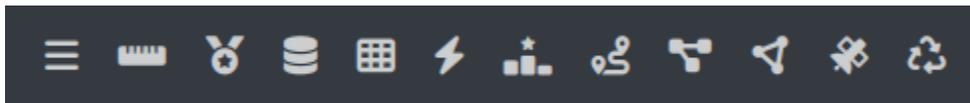
## WEB INTERFACE RF TOOLS

### 4.1 Function Menu

The **Function Menu** is a set of various key functions located on the top of the interface.

Each function has a designated clickable button that allows you to locate them easily on the interface, thus making the tool easy-to-use and user-friendly.

### 4.2 Function Menu Overview



### 4.3 Expand/Collapse Side Menu

The **Expand/Collapse** button lets you expand or collapse the Side Menu consisting of Templates, Input Menu and Output Console.

To **Collapse** the side menu:

- Click on the **Expand/Collapse**  button.
- The *Side Menu* will collapse.

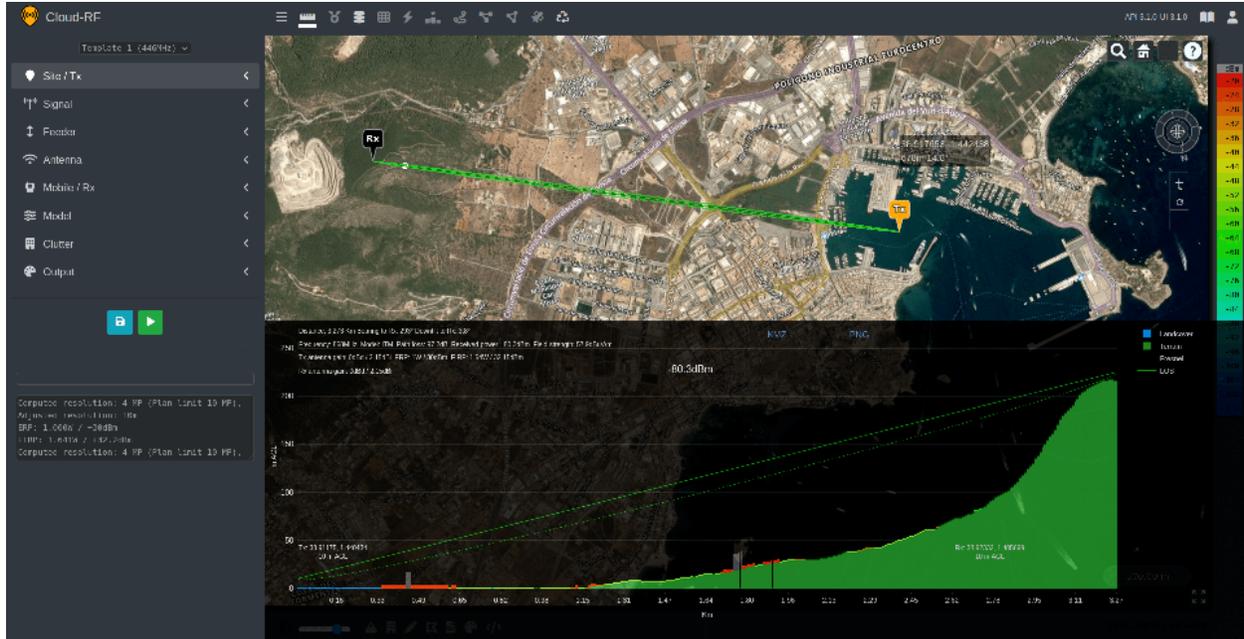
When you mouse-over upon the Side Menu, the expanded view of the menu will appear.

To **Expand** the side menu:

- Click on the **Expand/Collapse**  button.
- The *Side Menu* will expand.

## 4.4 Path Profile Tool

The Path Profile Analysis tool lets you inspect the terrain profile between two positions - **Transmitter** and **Receiver**.



### 4.4.1 Point-to-Point Path Profile Analysis (Tx to Rx)

For Point-to-point path profile analysis (Tx to Rx), you can set the Transmitter and Receiver location either by *Visual Map Placement* or *Precise Location Entry* method.

#### 1. Visual Map Placement

You can click on the Map to site your **Transmitter** and **Receiver** location visually:

- Site your **Transmitter** location on the map.
- Click on the **Path Profile Tool**  button on the Function Menu.
- Click on the map to site your **Receiver** location.

#### 2. Precise Location Entry

To use GPS co-ordinates, you can configure the **Transmitter** and **Receiver** location manually:

- Configure your **Transmitter** location (Latitude and Longitude) in the *Site/Tx* Input Menu.

- Click on the **Path Profile Tool**  button on the Function Menu.
- Configure your **Receiver** location in the *Mobile/Rx* Input Menu.

- Click on **Run**  button.

### Dynamic chart

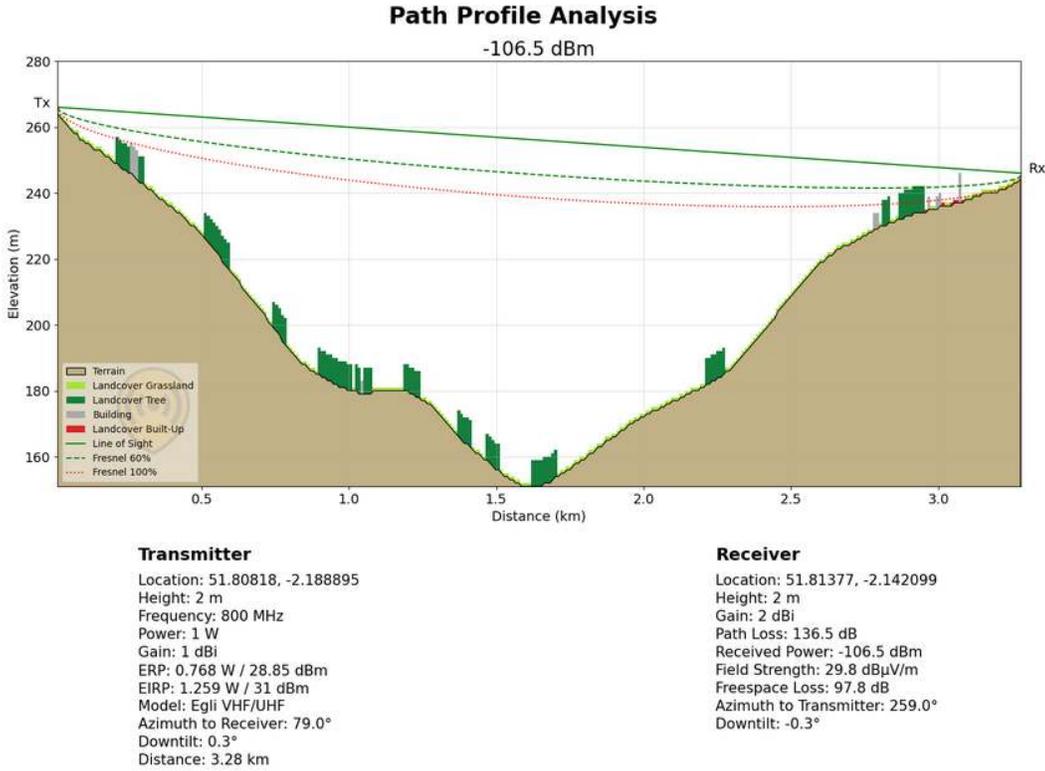
After setting your Transmitter and Receiver locations, the **Dynamic chart** will appear.

- The **Path Profile** in the form of a dynamic chart consisting of the path profile components - *Terrain, Fresnel* and *LOS* will be displayed.

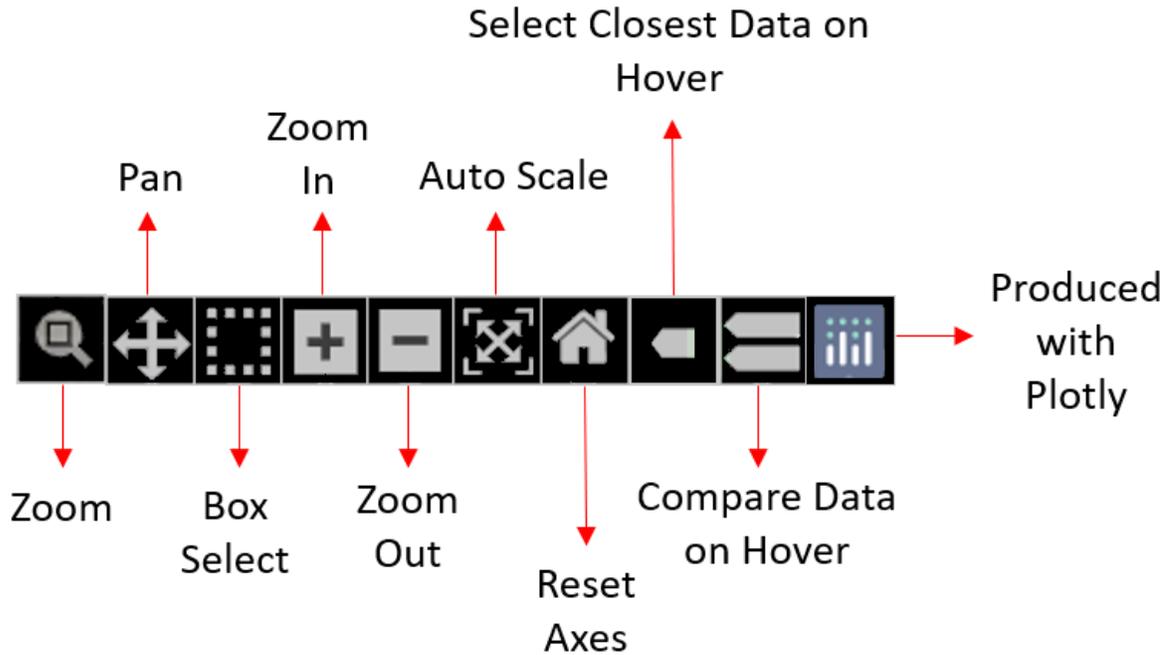


- The Transmitter and Receiver related information (*Distance, Frequency, Model, Path Loss, Received Power, Field Strength, Tx Antenna Gain, ERP, EIRP, Rx Antenna Gain*) will also be displayed along with the interactive chart.
- You can click on the **PNG** link to download the Path Profile as a static PNG image suitable for insertion into a report. Attribution is included as a watermark behind the key.

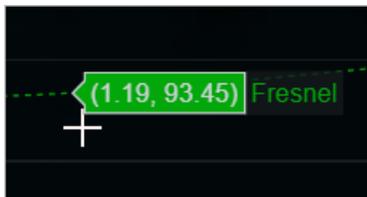
Note the static image will appear with different dimensions but the same result as it comes from the same API but uses a different plotting library.



- Various **Function Icons** will be available as you mouse-over on the dynamic chart.



- **Zoom** - lets you zoom the desired section of the Path Profile Graph.
  - \* Click on the desired section's starting point and without releasing the mouse, select the section.
- **Pan** - lets you pan view the graph interactively.
  - \* On selecting the *Pan function* icon, the pan mode for axes gets turned on in both x and y directions.
  - \* Click on the graph and without releasing your mouse, move in the direction you wish to pan view the Path Profile.
- **Box Select** - lets you select a particular section of the graph that you wish to view.
  - \* The selected box section will be highlighted from the rest of the path profile graph for clear view.
- **Zoom In** - lets you zoom in the Path Profile Graph.
- **Zoom Out** - lets you zoom out the Path Profile Graph.
- **Auto Scale** - lets you auto scale the axes of the graph.
- **Reset Axes** - resets the axes as per the original graph.
- **Show Closest Data on Hover** - shows you the closest data from the point on the graph where you hover.
  - \* The closest path coordinate will be displayed as below:



- **Compare Data on Hover** - shows you the comparison of the data from the point on the graph where you hover.

\* The graph comparison will be displayed as below:



– **Produced with Plotly** - redirects you to the Plotly website.

#### To Change the Resolution

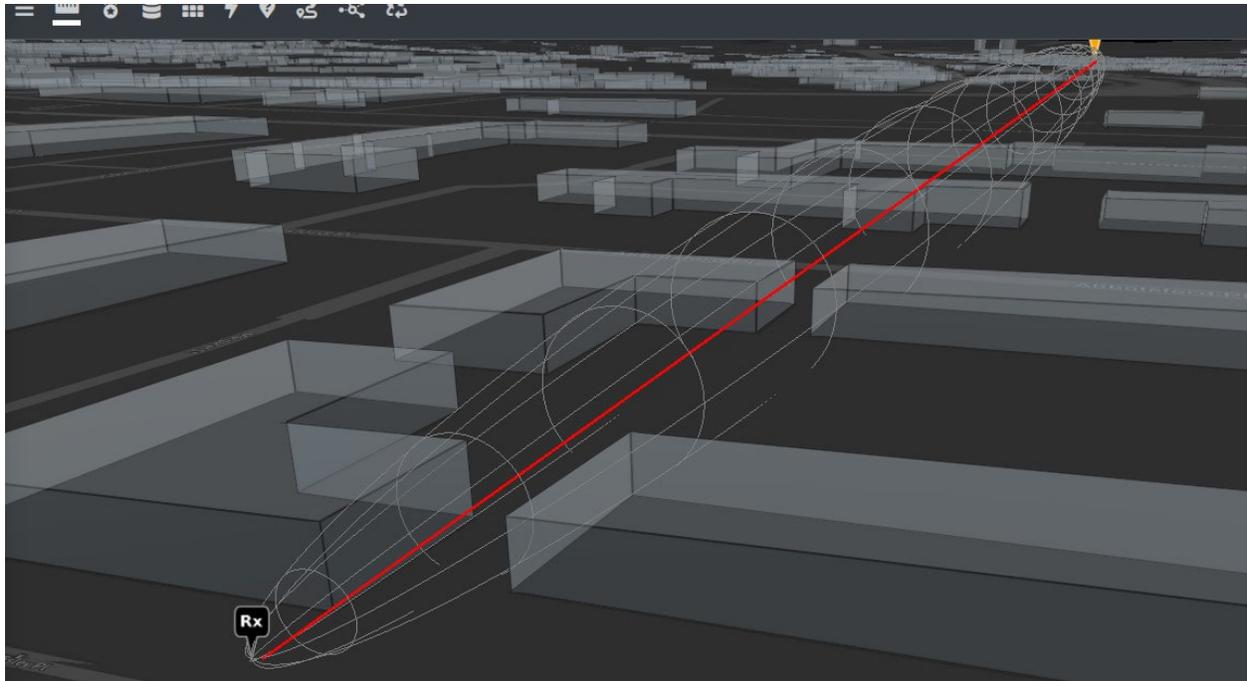
- Click on **Output** Input Menu.
- In the **Resolution** field, select the resolution that you wish to set from the drop-down.

#### To Change the Building / Clutter Attenuation

- Click on **Clutter** Input Menu.
- In the **Clutter Mode** field, select *Soft/NLOS* as the option from the drop-down.
- In the **Min attenuation** field, select the Clutter attenuation that you wish to set from the drop-down.

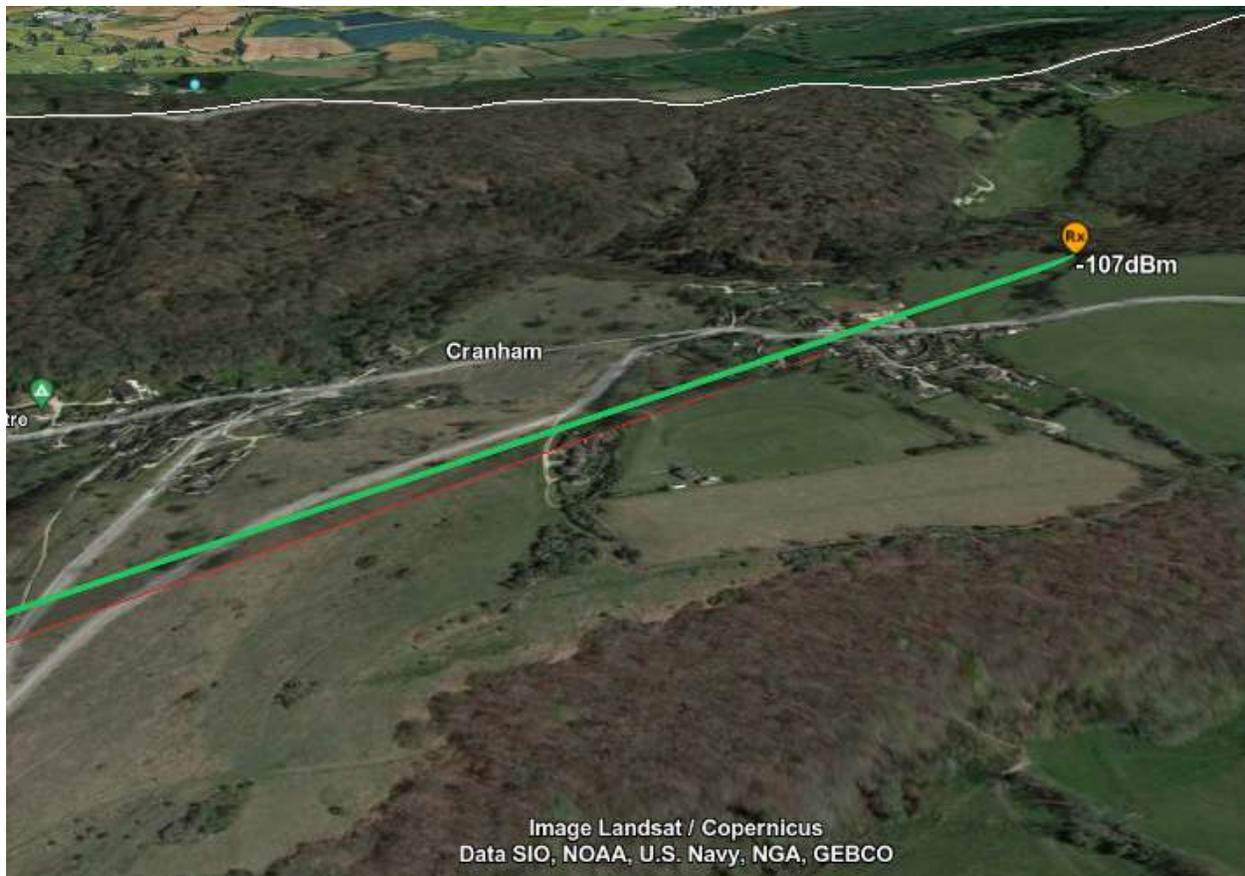
### 4.4.2 Fresnel zone

Around each link will be a 3D ellipsoid showing the estimated fresnel zone. This cone of power has a direct relationship with frequency/wavelength so a VHF signal has a huge fresnel zone and a SHF signal has a small focused one, like a laser. An ideal link would have an unobstructed fresnel zone otherwise you will be losing power. A viable microwave link needs at least 60% of its fresnel zone to be clear of obstructions. If you are modelling over the sea and a link is near the water you should budget for tides also as these can be more than 10m and will disrupt a marginal link.



#### 4.4.3 Path Profile KMZ

The **KMZ** link on the dynamic chart will download a KMZ path for use in Google Earth etc. It contains Tx and Rx placemarks, a 3D fresnel zone and an interactive balloon with a path chart and full metadata from the API if you click anywhere upon the path.



## 4.5 Best Server Tool

The **Best Server Tool** is useful for checking coverage against an established network. A typical use case for this would be a Wireless Internet Service Provider (WISP) who want to check ZIP codes or properties for coverage.



To use the **Best Server Tool**:



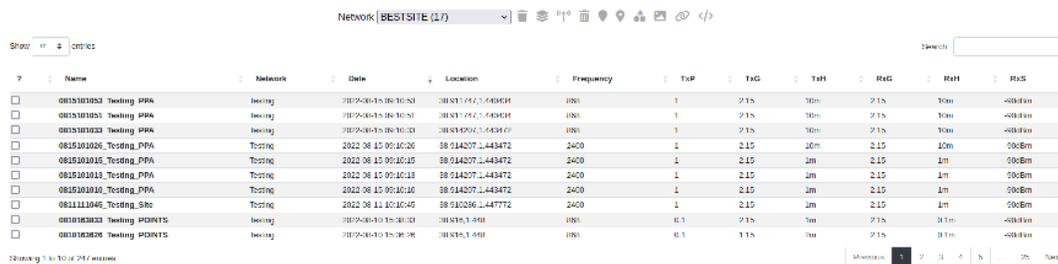
- Click on the **Best Server Tool** button on the Function Menu.
- The *Best Server Tool* dialog box will appear.
- Site your **Transmitter** location on the map.
- **Select a network to test coverage** at the set transmitter location from the drop-down.
- Click on **Check Coverage** button.
- The **Network Coverage** as per your transmitter location will be reflected on the map.

- You can change your transmitter location on the map to check the **best server location and the network coverage**.

## 4.6 My Archive

**My Archive** lets you view the list of your saved networks and their details. It's also where you can download data in open GIS formats like KML, KMZ, SHP, GeoTIFF and HTML.

- Click on **My Archive**  button on the Function Menu.
- The *My Archive* dialog box will appear.



Name	Network	Date	Location	Frequency	TxP	TxG	TxH	RxG	RxH	RxS
001310103_Testing_PPA	Testing	2022-08-15 09:10:21	38.9311442, 44.94341	1001	1	2.15	10m	2.15	10m	<0dBm
001310105_Testing_PPA	Testing	2022-08-15 09:10:21	38.9311442, 44.94341	1001	1	2.15	10m	2.15	10m	<0dBm
001310103_Testing_PPA	Testing	2022-08-15 09:10:20	38.9314952, 44.94342	1001	1	2.15	10m	2.15	10m	<0dBm
081510106_Testing_PPA	Testing	2022-08-15 09:10:20	38.914207, 44.94342	2400	1	2.15	10m	2.15	10m	000Bm
081510105_Testing_PPA	Testing	2022-08-15 09:10:18	38.914207, 44.94342	2400	1	2.15	1m	2.15	1m	000Bm
0815101010_Testing_PPA	Testing	2022-08-15 09:10:18	38.914207, 44.94342	2400	1	2.15	1m	2.15	1m	000Bm
0815101010_Testing_PPA	Testing	2022-08-15 09:10:16	38.914207, 44.94342	2400	1	2.15	1m	2.15	1m	000Bm
081510106_Testing_Site	Testing	2022-08-11 10:10:45	38.910286, 44.9772	2400	1	2.15	1m	2.15	1m	000Bm
0013101033_Testing_PPA	Testing	2022-08-15 09:10:20	38.93151, 44.94342	1001	0.1	2.15	1m	2.15	0.1m	<0dBm
0013101036_Testing_PPA	Testing	2022-08-15 09:10:20	38.93151, 44.94342	1001	0.1	1.15	1m	2.15	0.1m	<0dBm

### 4.6.1 Searching and filtering by network

You can select and filter the Network(s) to reduce the entries in your table. This allows you to quickly recover a project or find MESH or MANET networks which are tagged with these network names.

- Select the desired **Network** from the drop-down.
- The list of networks will be displayed.
- Select a network to filter results to those tagged sites only
- You can then find a specific site(s) with the **Search box** on the right side
- The **filtered entries** will be displayed.



Name	Network	Date	Location	Frequency	TxP	TxG	TxH	RxG	RxH	RxS
0008120005_BESTSITE_PPA	BESTSITE_PPA	2022-08-04 19:50:05	38.93131, 44.94342	548	1	2.15	1m	2.15	1m	<0dBm

## 4.6.2 Sorting

You can sort the Network entries in ascending or descending order as per your requirement.

To do so:

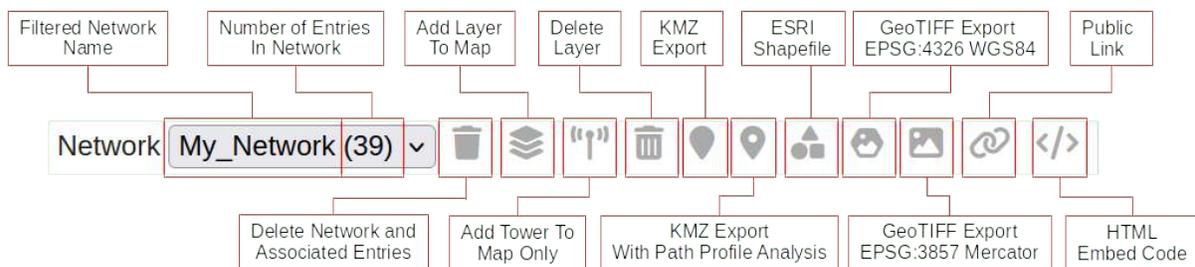
- Click on the **Sort**  icon of the respective column.
- The sorted entries will be displayed in the table.

 indicates Sorting in the **Ascending** Order.

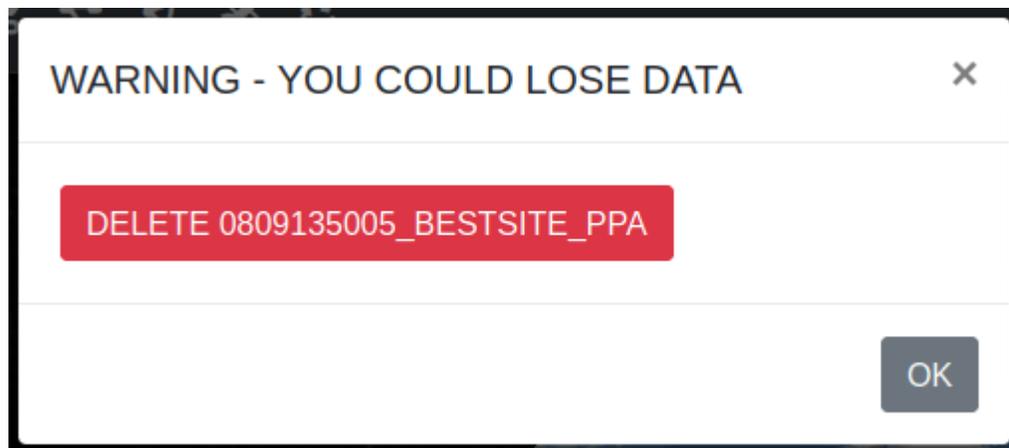
 indicates Sorting in the **Descending** Order.

## 4.6.3 Functions

Various **Function Icons** are also available.

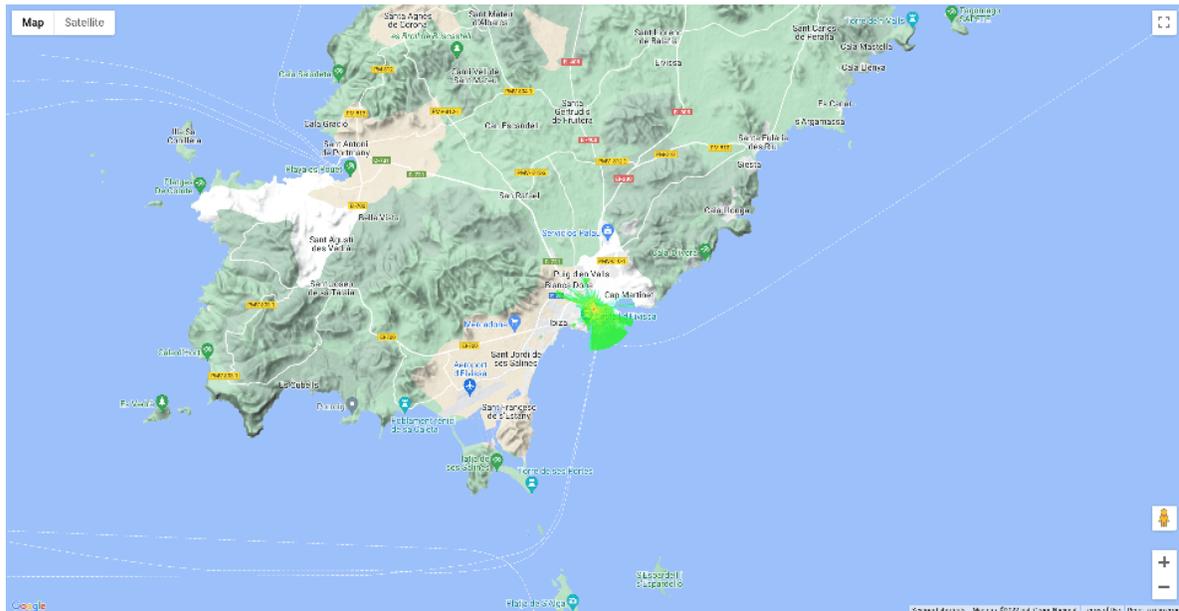


- **Add Coverage Layer(s) to Map** - lets you add the selected network(s) coverage layer(s) to the map.
  - You can manage (select/deselect) the network site locations by clicking on the respective *layer checkbox*.
- **Add Tower(s) only to Map** - lets you add the tower(s) to the map in the selected network(s).
- **Delete Selected** - lets you delete the selected Network(s).
  - When you click on the *Delete Selected* button, the following warning dialog box will appear.



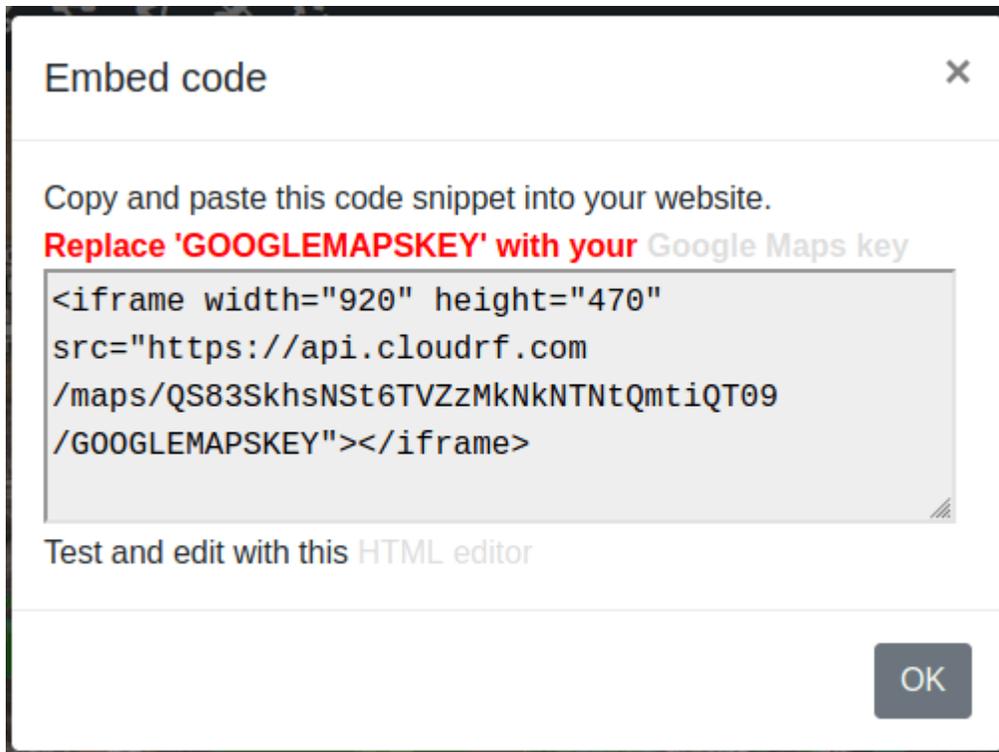
\* Click on **OK** button to confirm.

- **KMZ with Local Content** - lets you download the KMZ file with the local content.
- **KML with Remote Content** - lets you download the KML file with the remote content.
- **KMZ with Path Profile Analysis** - lets you download the KMZ file with a embedded Path Profile Analysis utility (Internet connection required).
- **ESRI Shapefile** - lets you download the Coverage zip file consisting of the *DBH*, *PRJ*, *SHP*, *SHX* files of the selected network(s).
- **GeoTIFF Export** - lets you download the *GeoTIFF* image of the selected network(s). You can choose either 4326 or 3857 projection.
- **Public Link** - lets you view the selected Network(s) in the **Google Map**.



- **HTML Embed Code** - opens a modal window with a code snippet which you can use to embed the layer on your own web page. Please note that here we make use of Google Maps. You should have your own Google Maps API key to properly embed the code.

All the API parameters of the selected network(s) will be displayed here. If you are a developer, you can directly copy paste this to use it in your code.

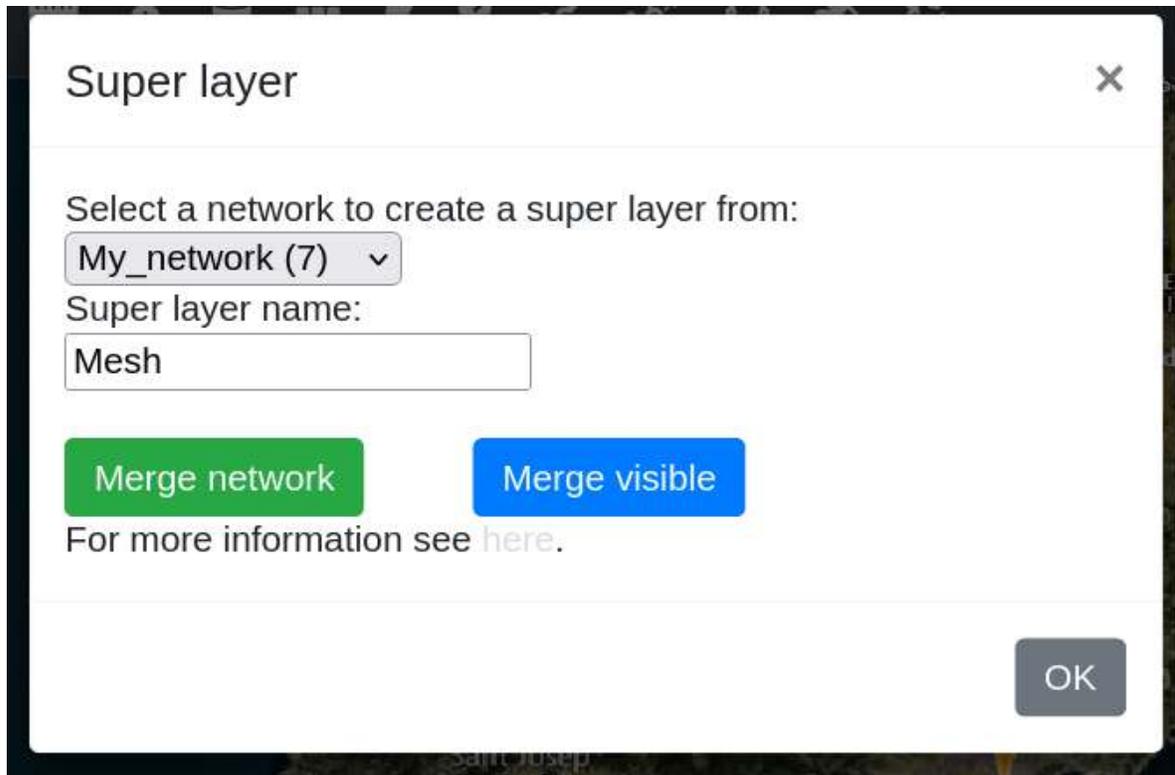


## 4.7 Super Layer

The super layer tool lets you generate a super layer composed of different layers. The layers can be from the same network or different networks by using whatever visible layers are on the map.

Layers must use the same colour schema.

- Click on **Super Layer**  button on the Function Menu.
- The **Super layer** dialog box will appear.



Super layer

Select a network to create a super layer from:

My\_network (7) ▾

Super layer name:

Mesh

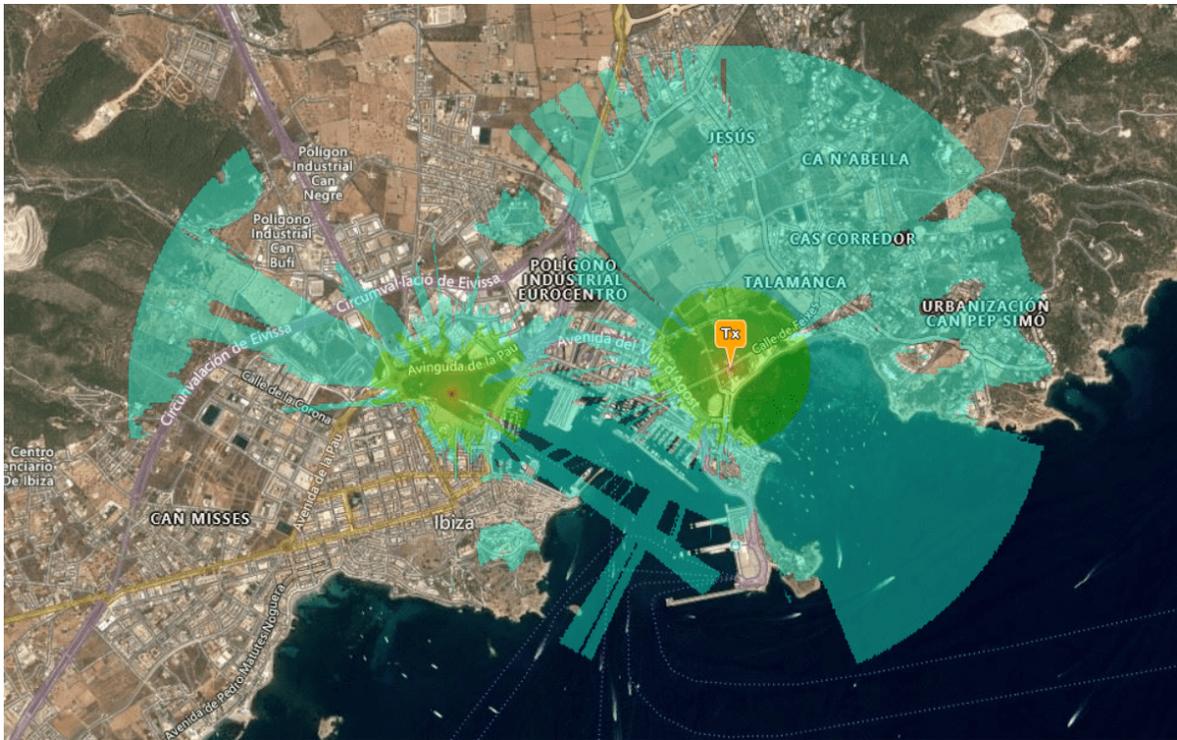
Merge network Merge visible

For more information see [here](#).

OK

#### 4.7.1 Merge network

- In the **Select a network to create a super layer from:** field, you can select a network to create a super layer from the drop-down.
- In the **Super layer name:** field, enter the desired super layer name.
- Click on the **Merge network** button
  - For further information, click [here](#).
- The created **Super Layer** will be highlighted on the map and the corresponding checkbox (enabled) will be displayed.



- You may **enable** or **disable** the *super layer* checkbox as per your requirement.  
The super layer will be displayed on the map when the checkbox is enabled and will not be displayed when the checkbox is disabled.

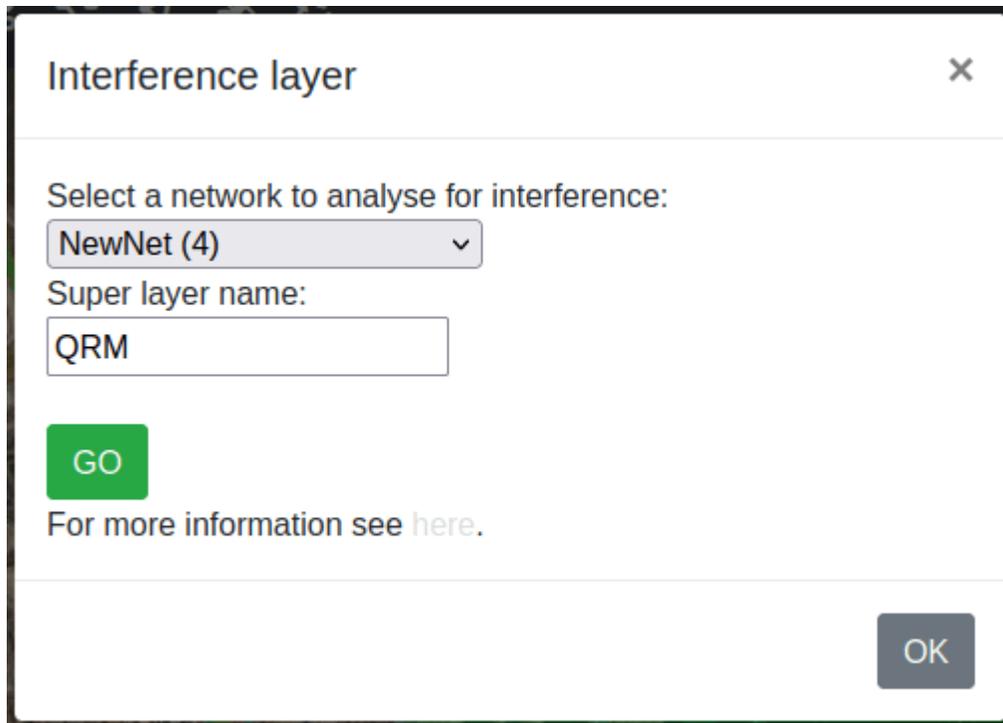
#### 4.7.2 Merge visible

The tool will use the layers which are on the map. These must use the same colour schema. Click on the **Merge visible** button

### 4.8 Interference Analysis

The Interference Analysis tool lets you generate a new interference layer.

- Click on **Interference Analysis**  button on the Function Menu.
- The **Super layer** dialog box will appear.



Interference layer

Select a network to analyse for interference:

NewNet (4) ▾

Super layer name:

QRM

GO

For more information see [here.](#)

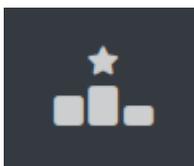
OK

- In the **Select a network to analyse for interference:** field, you can select a network to create an interference layer from the drop-down.
- In the **Super layer name:** field, enter the desired super layer name.
- Click on the **Go**  button.  
For further information, click [here.](#)
- The created **Interference Layer** will be highlighted on the map and the corresponding checkbox (enabled) will be displayed.



- You may **enable** or **disable** the *Interference layer* checkbox as per your requirement.

The super layer will be displayed on the map when the checkbox is enabled and will not be displayed when the checkbox is disabled.

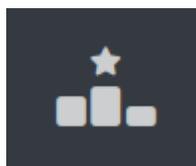


## 4.9 Best Site Analysis

The best site analysis tool is GPU-powered analysis tool to allow you to find the best locations in a large area for a transmitter.

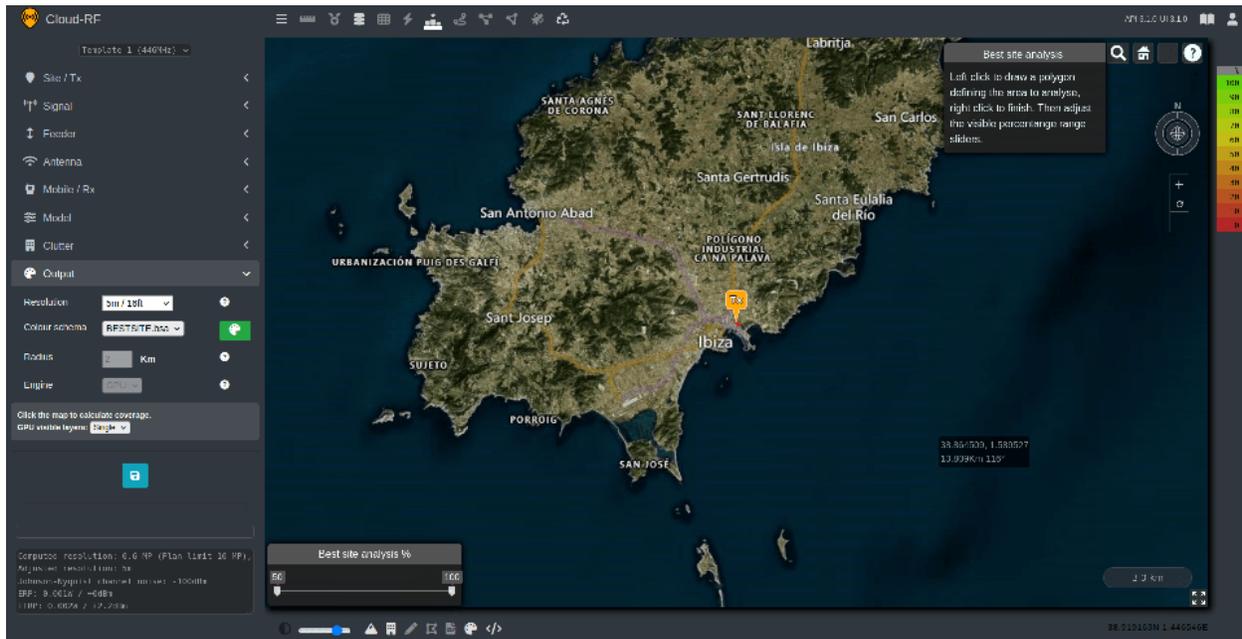
Please note that the response from a best site analysis calculation is **NOT** a response of signal strength. Instead it is normalised result which takes an input bsa colour schema to show the absolute best locations in an area.

Best Site Analysis is used in the following way:

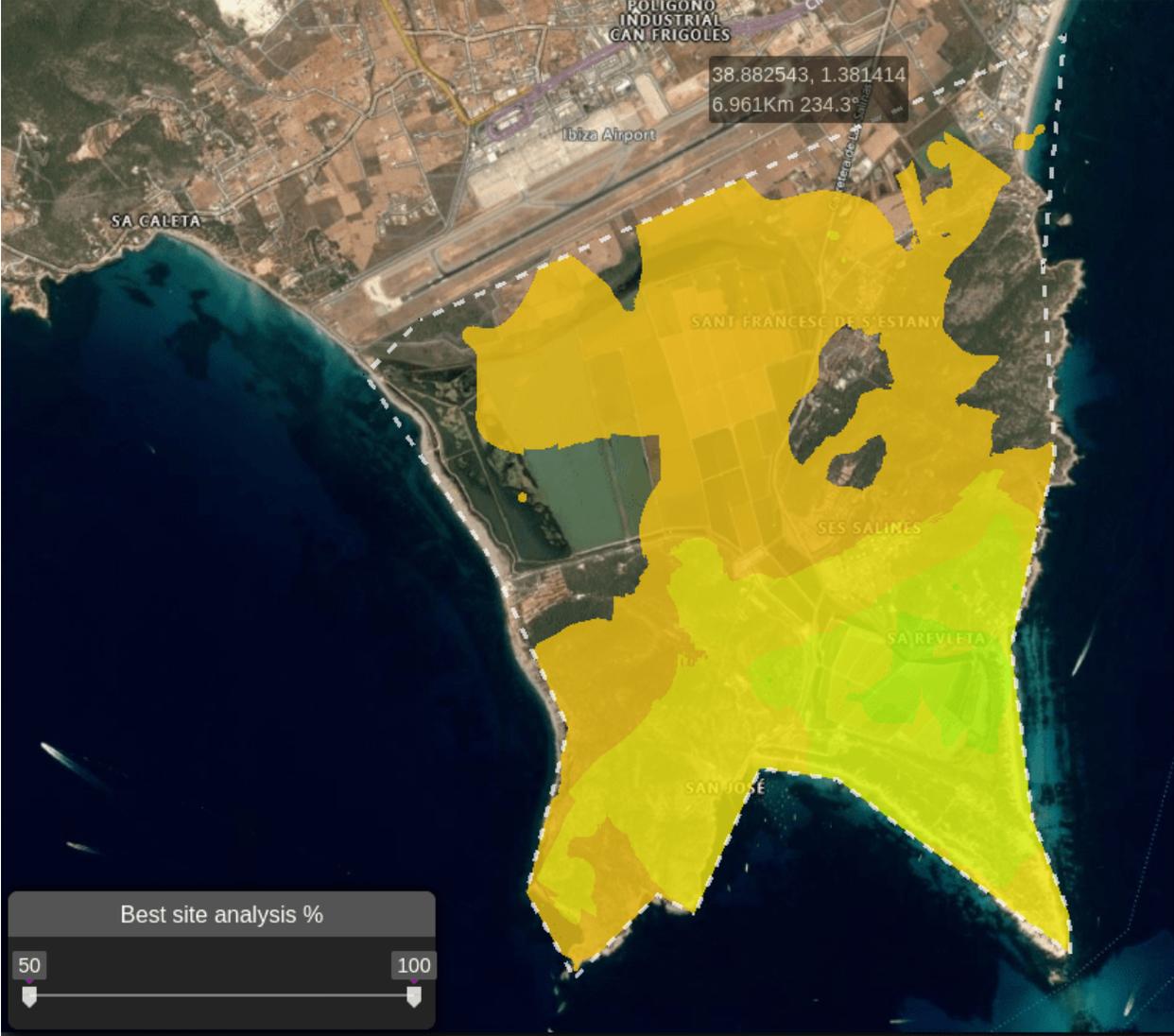


- Click on **Best Site Analysis** button on the Function Menu.

- The interface will be converted to Best Site Analysis mode. With this you may notice a number of things:
  - The small dialog in the top right of the interface indicating you are in Best Site Analysis mode.
  - The percentage slider in the bottom left of the interface.
  - “Radius” in the “Output” menu has been disabled.
  - “Engine” in the “Output” menu has been disabled and set to “GPU”.
  - “Colour schema” in the “Output” menu has been changed to a bsa colour schema.



To use the best site analysis tool you can draw a polygon around an area by making use of left-click on the map to set the points of your polygon. Once you have finished drawing your polygon you can right-click to join up to the first point and set an area. Once you right-click your area will be sent to the Cloud-RF API where it will be handled and return your response.

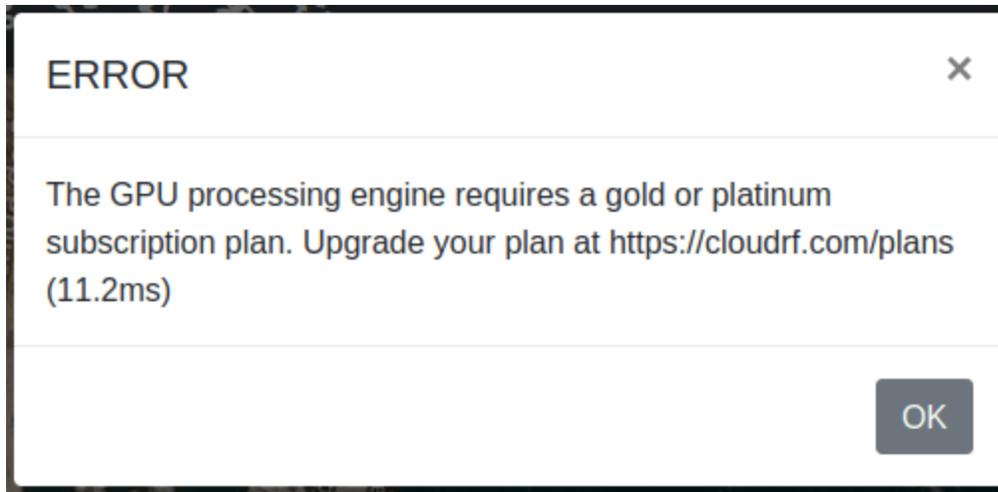


You can then use the slider in the bottom left corner to fine-tune your result and show results between certain percentage thresholds.



This is useful for showing coordinates which meet your threshold, as it allows you to pinpoint the best locations to place your transmitter.

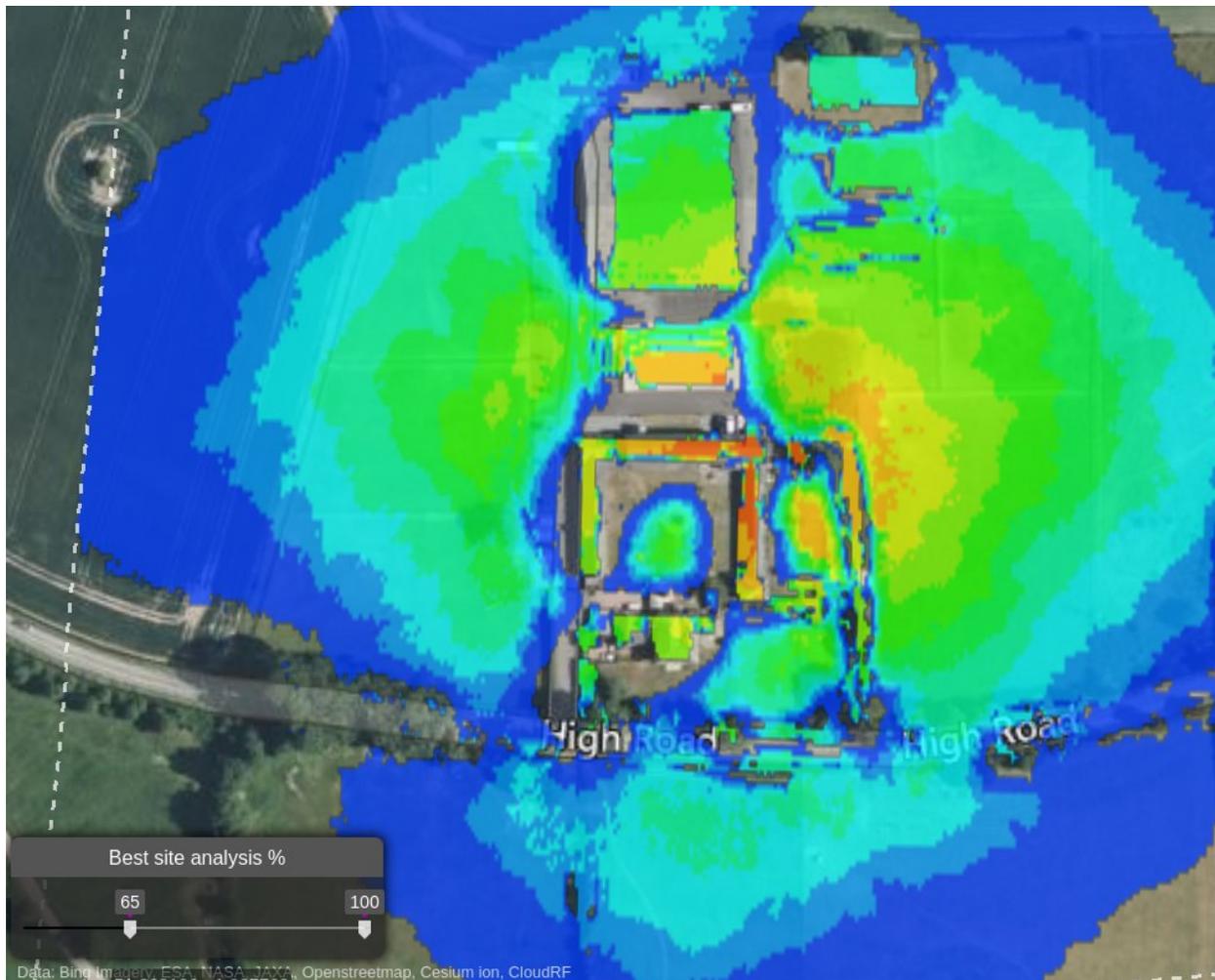
Please note that to make use of the Best Site Analysis tool you will require a Gold or Platinum subscription plan. If you do not have either then you will receive a forbidden message for the response.



#### 4.9.1 Satellite NTN LOS analysis (Starlink, Oneweb, Lync)

The BSA tool is ideal for LOS analysis for LEO ground terminals as it can recommend the best site for maximum visibility of the sky. As Low Earth Orbit (LEO) satellites are almost omni-directional in the sky, and fast, isolating one or two is impractical.

To use BSA for LEO, expand the search perimeter beyond the area of interest and then set the receiver altitude to be higher than local obstructions eg. 30m to achieve a steep angle of incidence. As a rule of thumb, set the receiver height to the search radius to achieve a 1:1 (45 degree) angle.



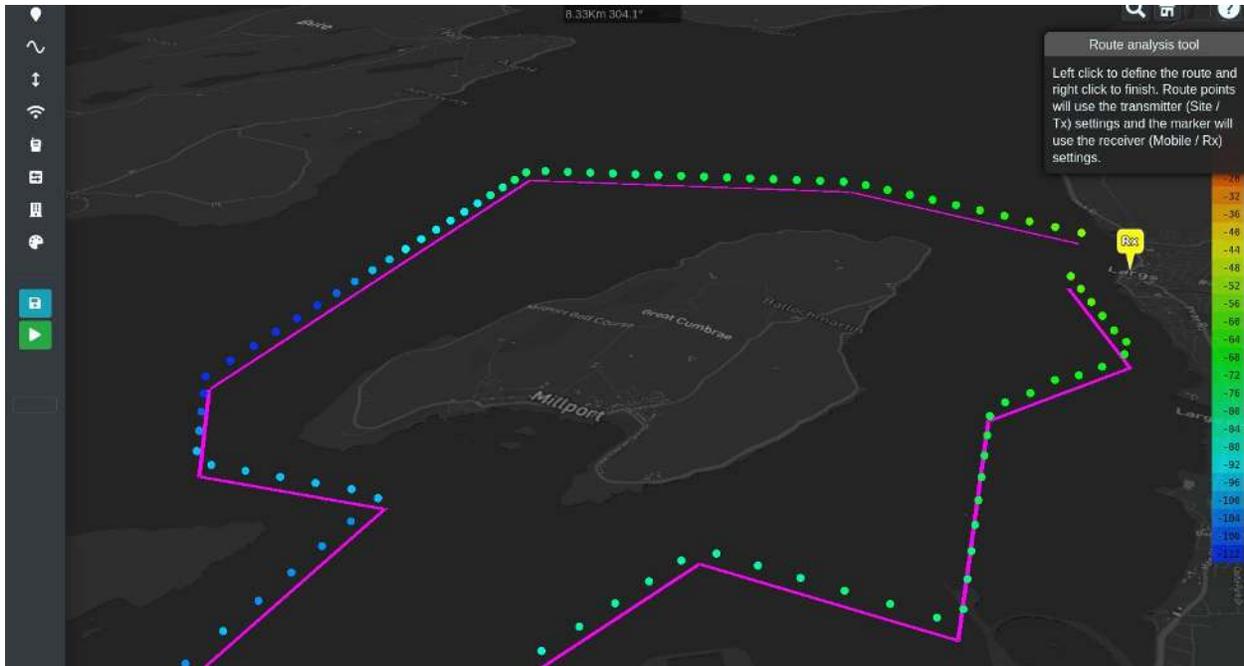
## 4.10 Route Analysis

The route analysis function will let you define a route by clicking upon the map. Points along the route will be tested as transmitters back to your map marker's location which assumes the role of receiver. The transmitter and receiver settings will come from the form.

To add a route:

- Left click route analysis button.
- Left click points on the map to draw a route. A polyline will appear.
- Right click to finish the route. Result will appear after a brief delay.
- The points are colour coded based upon the selected colour key.
- Click the recycle button to remove the layers.

**WARNING - Routes are not saved to your database**



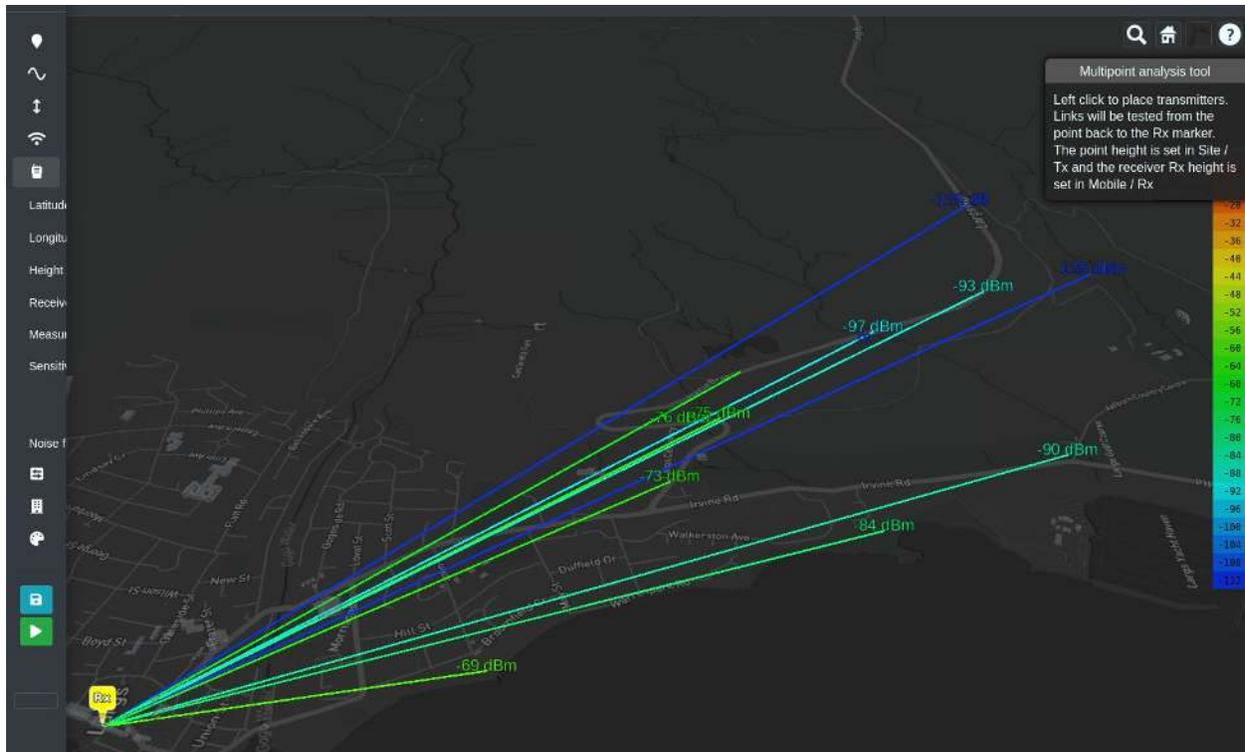
## 4.11 Multipoint Analysis

The multipoint analysis function will let you define many links quickly by clicking upon the map. Points will be tested as transmitters back to your map marker's location which assumes the role of receiver. The transmitter and receiver settings will come from the form.

To add points:

- Left click multipoint analysis button.
- Left click points on the map to draw links.
- The points are colour coded based upon the selected colour key.
- Click the recycle button to remove the layers.

**WARNING - Multipoint links are not saved to your database**

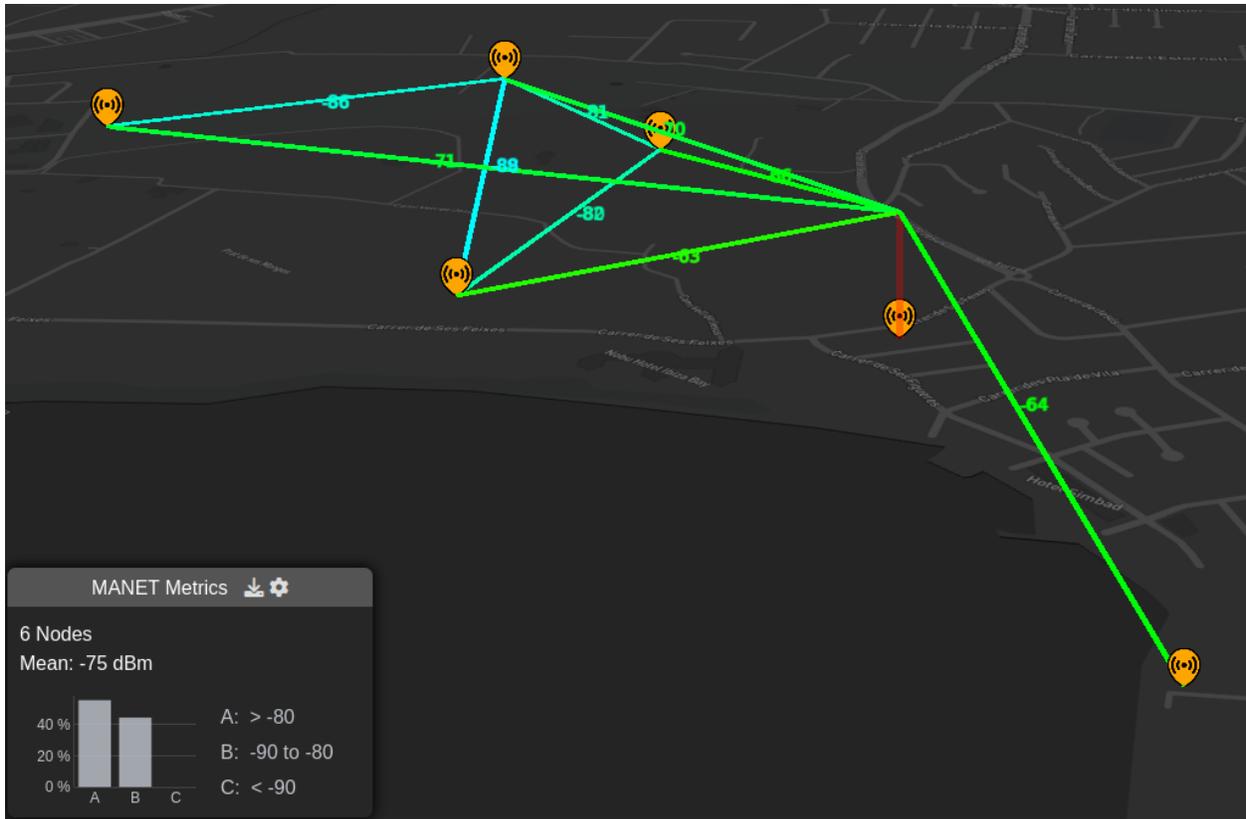


## 4.12 MANET planning tool

The Mobile Autonomous Network (MANET) planning tool lets you rapidly define a MANET network composed of independent nodes. Nodes can have distinct configurations so you can simulate different radios and/or antennas together.

To create a MANET network:

- Define or select a template for your radio
- Left click the MANET button.
- Left click on the map to add a node / radio.
- The nodes will use the settings defined in the input menu. If you need different settings, make the change then add the node.
- Drag a node to move it to a better location
- Right click a node to delete it

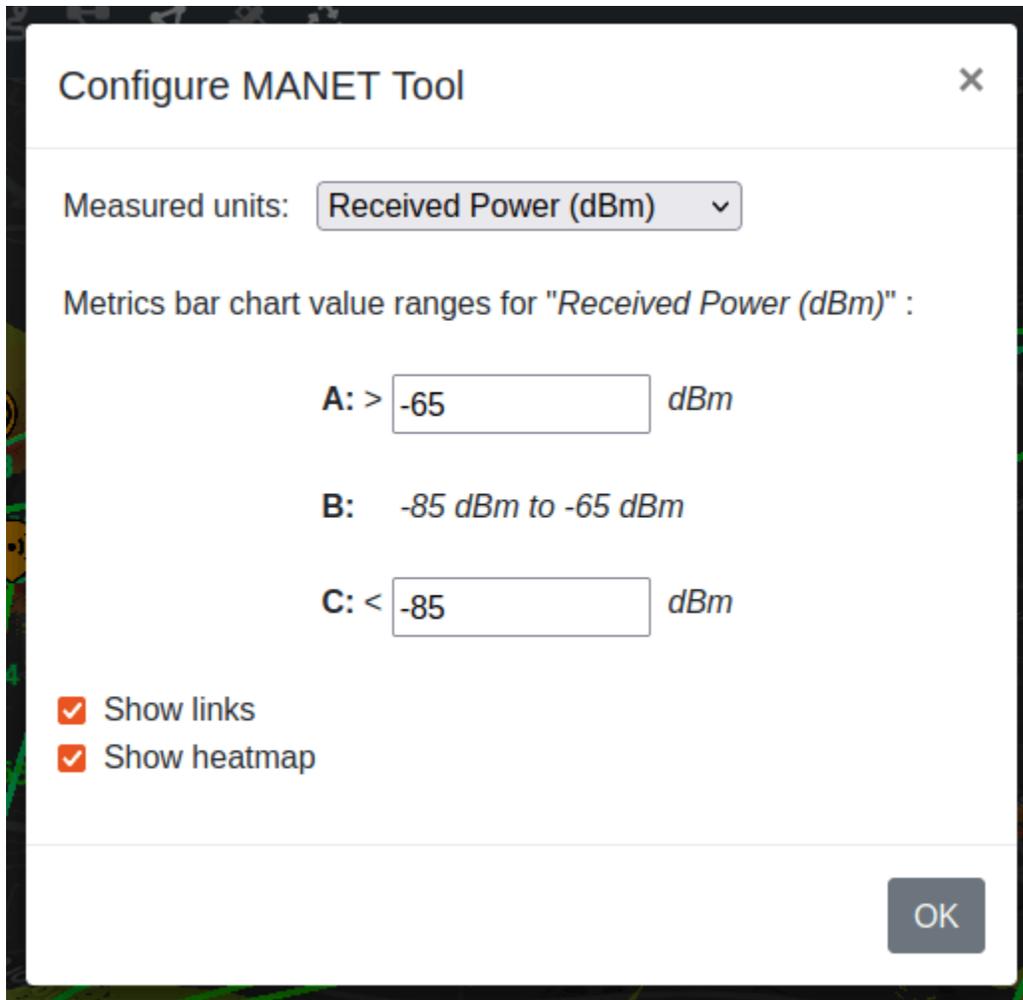


You can configure options for the “MANET Metrics” modal in the bottom left of the screen by clicking on the settings



cog icon which is located to the right of this “MANET Metrics” heading.

When you select the settings then this will open up a modal where you can configure a number of settings:



Configure MANET Tool

Measured units:

Metrics bar chart value ranges for "Received Power (dBm)" :

A: >  dBm

B: -85 dBm to -65 dBm

C: <  dBm

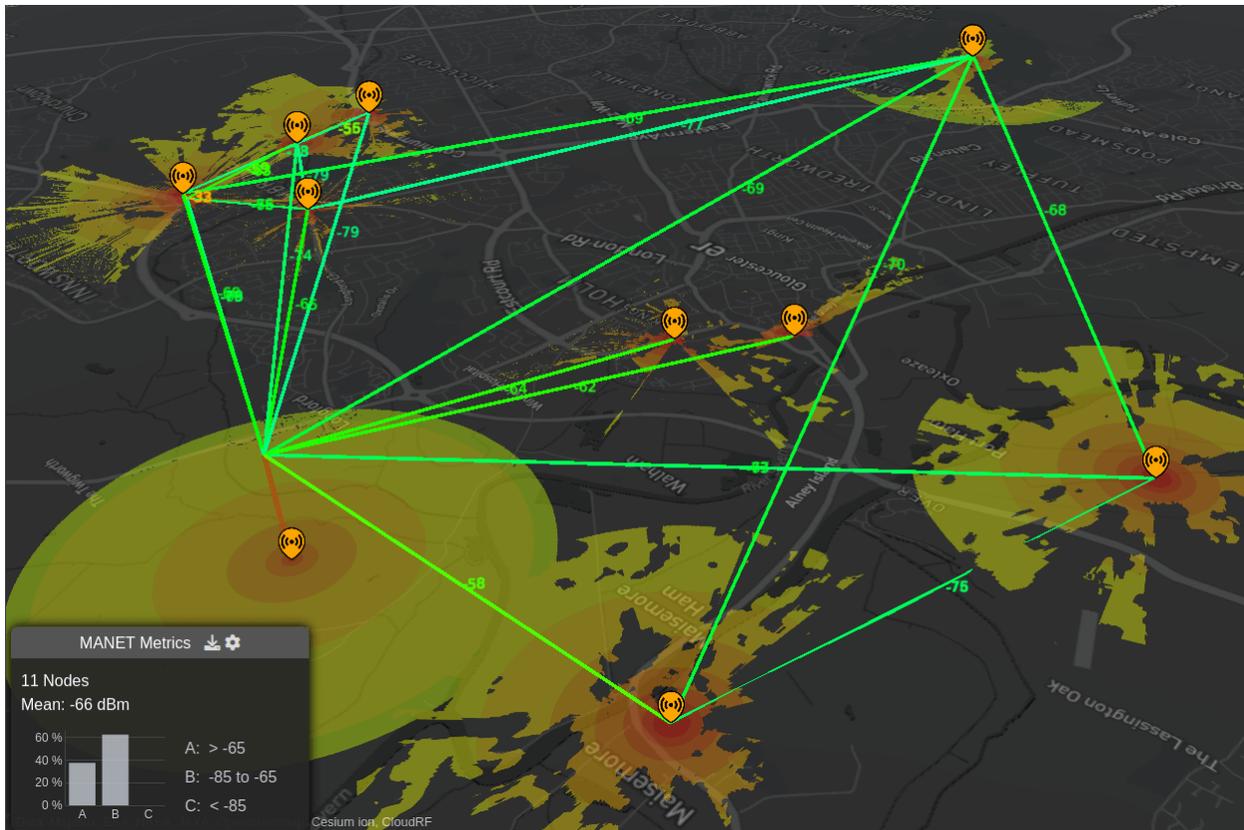
Show links

Show heatmap

OK

- **Measured units** drop down allows you to select the measured unit which is being used to calculate your MANET network links. Default is Received Power but you can set SNR here also.
- The bar chart thresholds allow you to dynamically configure the QoS thresholds for your MANET network so you can model efficiency for different waveforms or requirements eg. video.
- **Show links** allows you to enable coloured links between network nodes. A link will be shown if it exceeds your receive threshold - otherwise it will not be drawn.
- **Show heatmap** shows you a coverage heatmap for all the MANET network nodes, out to the defined threshold. This uses the GPU engine so a premium plan is required.

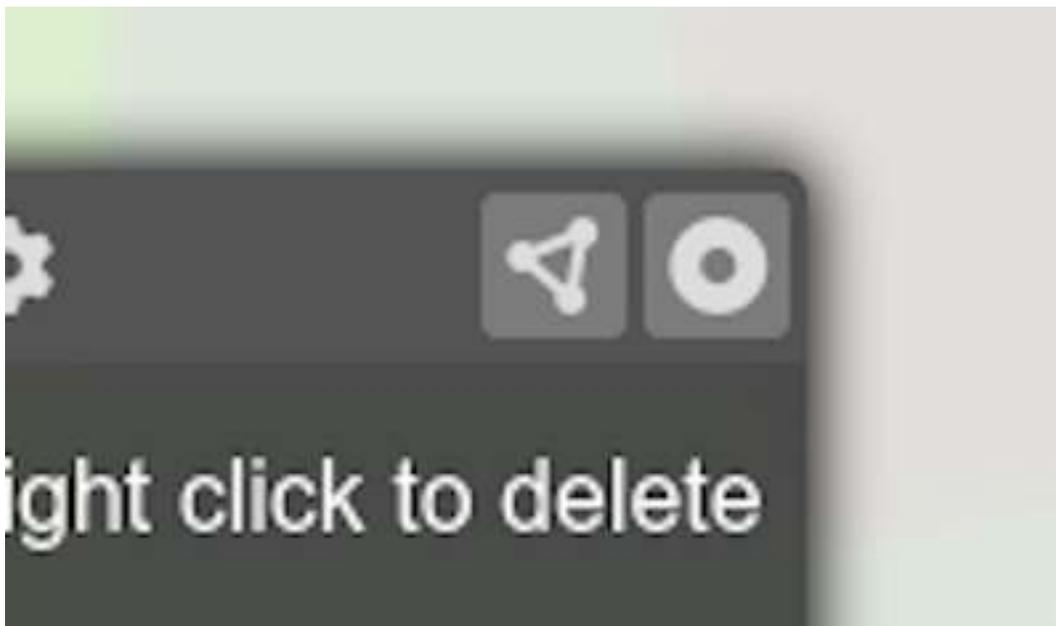
Below shows an example of a MANET network with both links and heatmap enabled.



**NOTE - Heatmaps are GPU accelerated and require a Gold subscription.**

#### 4.12.1 MANET layer controls

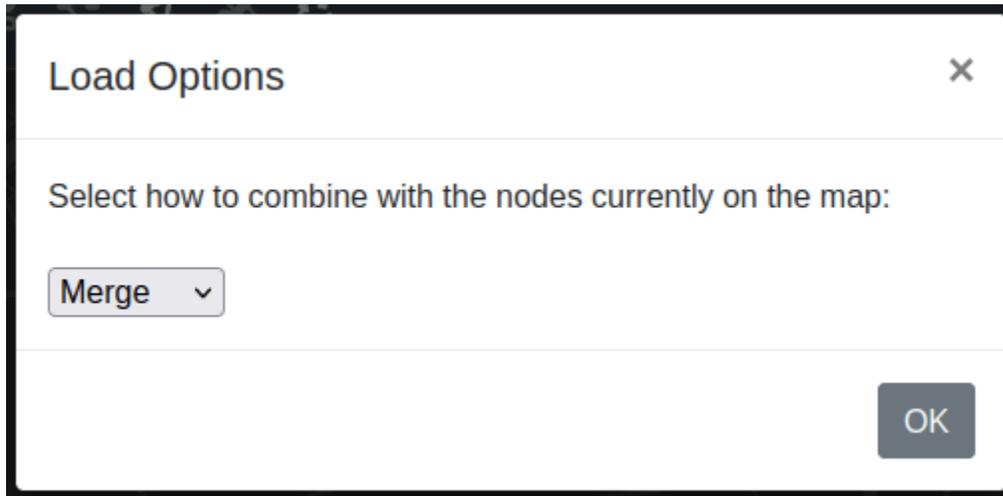
The links and heatmap layers can also be toggled on and off by clicking the relative icons in the top right corner of the MANET dialog.



### 4.12.2 Saving and loading MANET networks

The MANET network is auto-saved after every re-calculation. A re-calculation is performed when a node is added, removed or added. Unlike other API calls, MANET networks are saved to a file instead of the database due to their complexity. This will appear in your archive under the **MANET** network and can be reloaded by selecting it and choosing to add it to the map.

You can choose to reset or merge with existing MANET networks. This allows you to merge two puddles of radios. Please note that you will only be prompted with this window if you have existing MANET nodes already on the map.



### 4.12.3 Downloading a MANET network

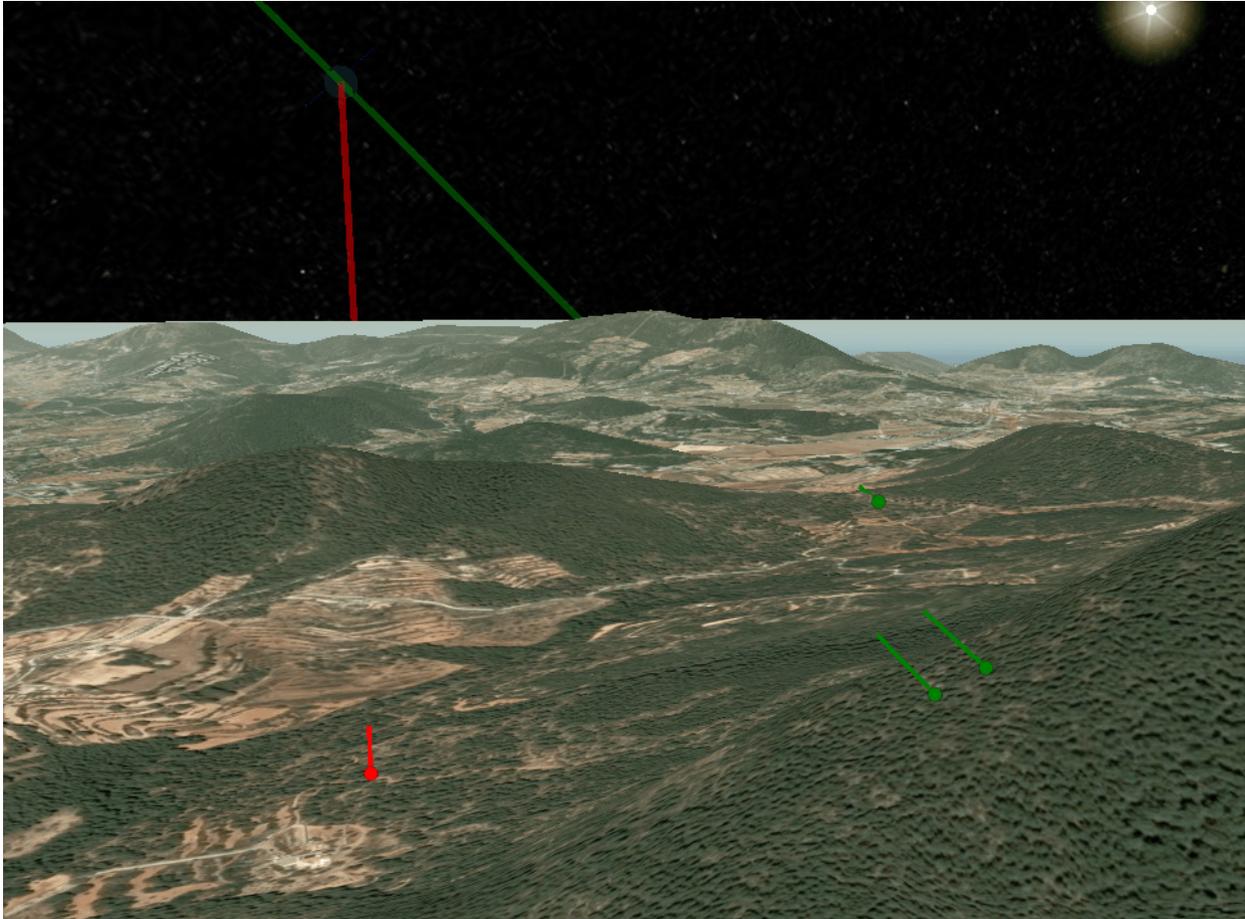
A network can be downloaded as either KMZ, SHP, GeoTIFF, URL or HTML from either the bottom left menu directly after completion, or via the archive using the standard workflow for fetching files.

## 4.13 Satellite planning tool

The Satellite planning tool lets you test for visibility to over 5400 active satellites from a database. Unlike sat-finder apps this considers topography and clutter to determine visibility.

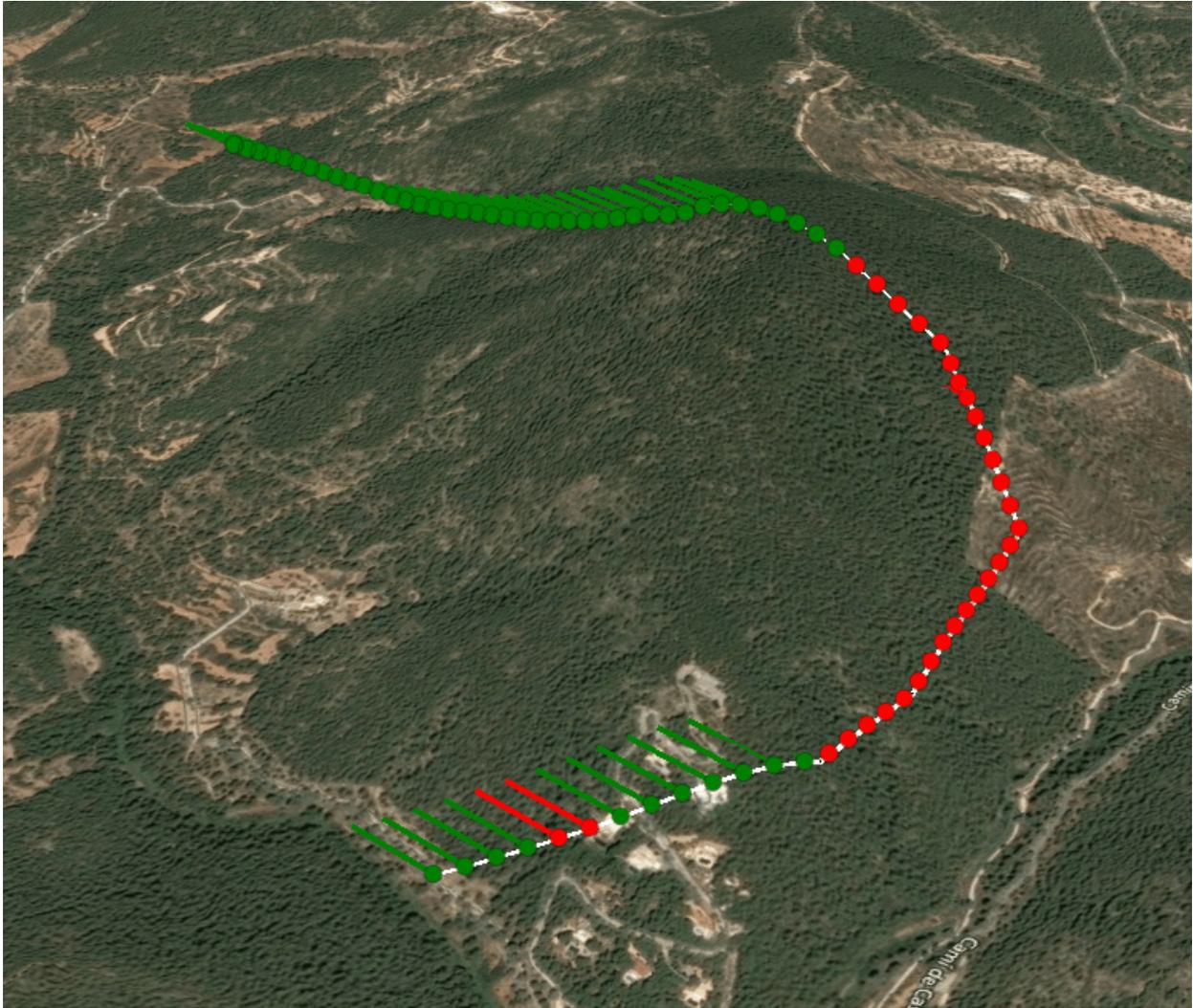
To test a point for satellite visibility:

- Left click SATELLITE button.
- Enter search parameters eg. STARLINK in the search popup
- The results will be listed. Click the satellite of interest
- The satellite will now be added above the earth on an orbit which you control the time of using the time slider at the bottom of the screen.
- Use the multipoint tool to test points by clicking on the earth.



To test a route for satellite visibility:

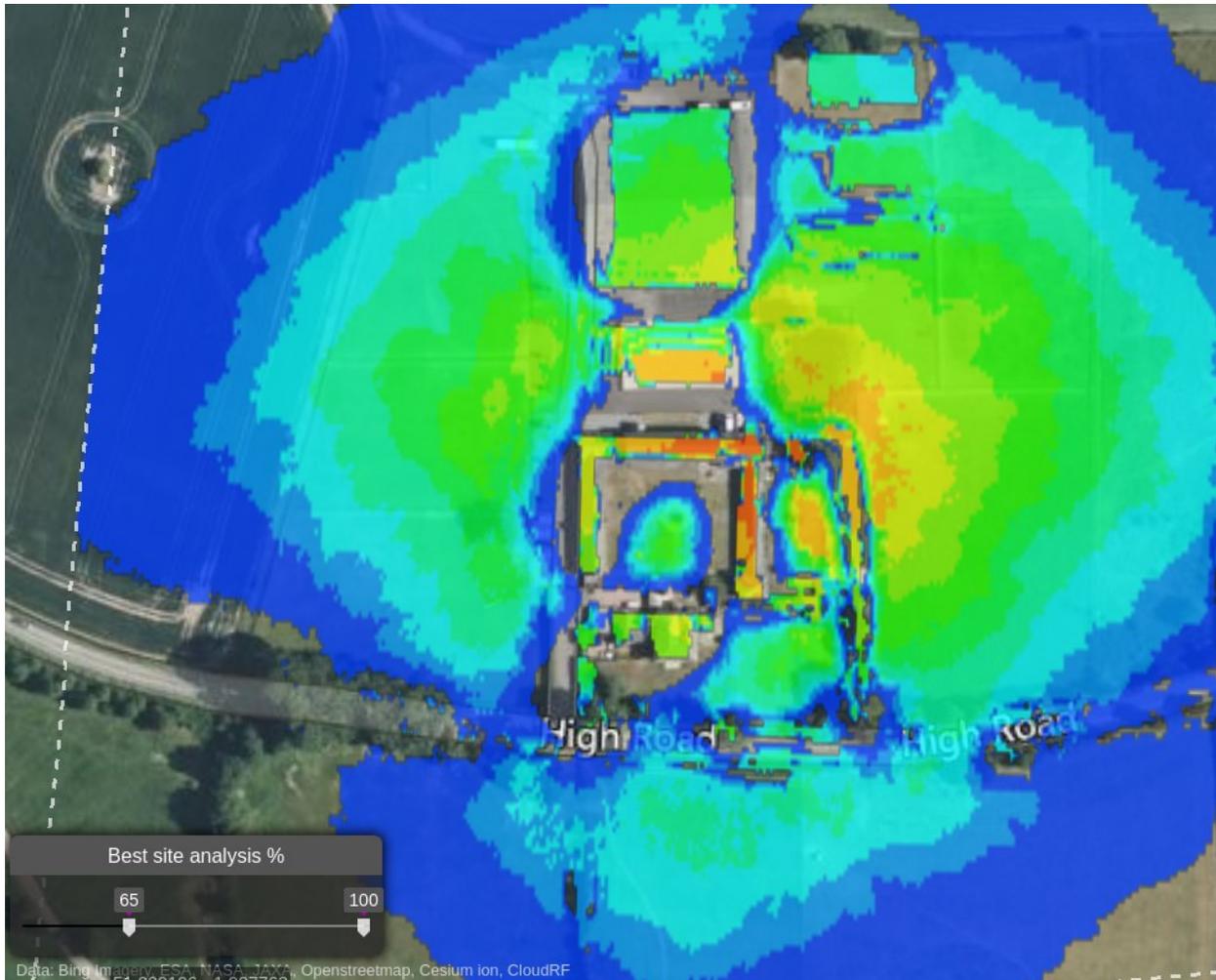
- Left click SATELLITE button.
- Enter search parameters eg. STARLINK in the search popup
- The results will be listed. Click the satellite of interest
- The satellite will now be added above the earth on an orbit which you control the time of using the time slider at the bottom of the screen.
- Use the route tool to test a route by left-clicking a path upon the earth then right clicking to finish.



#### 4.13.1 Satellite NTN LOS analysis (Starlink, Oneweb, Lync)

The Best Site Analysis (BSA) tool is ideal for LOS analysis for LEO ground terminals as it can recommend the best site for maximum visibility of the sky. As Low Earth Orbit (LEO) satellites are almost omni-directional in the sky, and fast, isolating one or two is impractical.

To use BSA for LEO, expand the search perimeter beyond the area of interest and then set the receiver altitude to be higher than local obstructions eg. 30m to achieve a steep angle of incidence. As a rule of thumb, set the receiver height to the search radius to achieve a 1:1 (45 degree) angle.



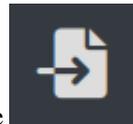
## 4.14 Clear Layers

The recycle icon will clear and reset the map of all layers. The layers can be reloaded from within your archive.

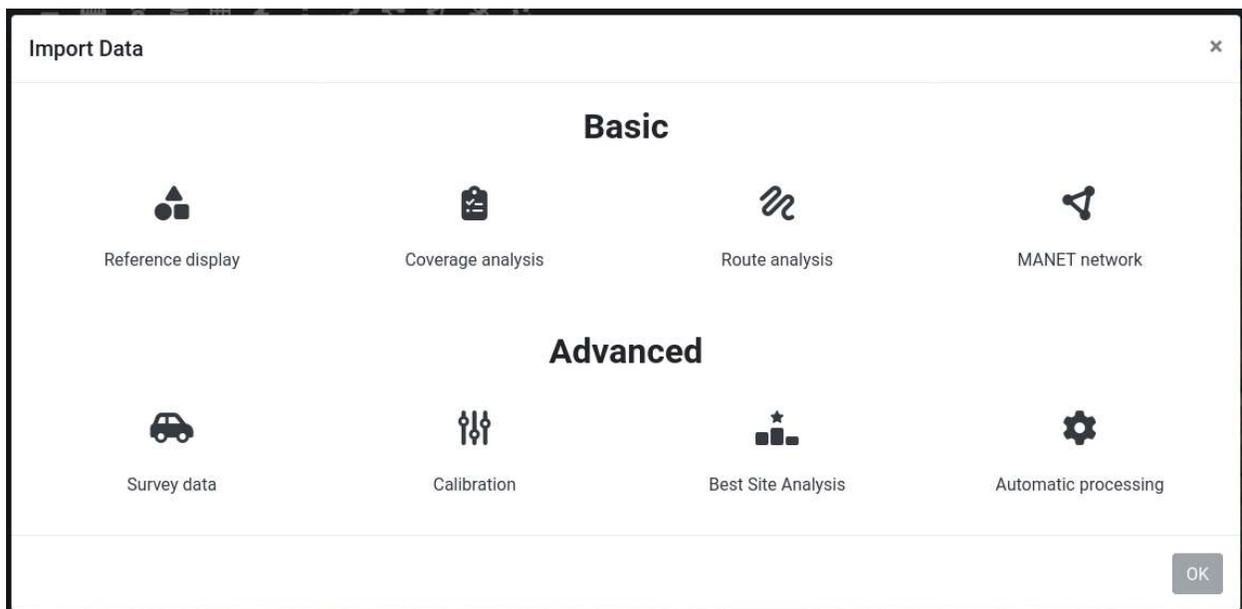
To clear the layers on the map:

- Click on **Clear Layers**  button on the Function Menu.
- All the layers on the map will be **cleared** and **reset**.
- The required layers can be reloaded from the *Archive*.

## WEB INTERFACE IMPORT DATA



You can import structured data in different open formats by clicking on the  which is located at the bottom of the web interface. This will open a dialog modal window from where you can select a function to work with.



This modal window is separated into the following sections:

## 5.1 Reference display

Add markers / boundary lines to the map from a KML

## 5.2 Coverage analysis

Import zip codes / locations to study coverage statistics

## 5.3 Route analysis

Import a route or flight path to analyse coverage

## 5.4 MANET network

Import locations from a file to model a network

## 5.5 Survey data

Import field measurements (Lat, Lon, RSSI)

## 5.6 Calibration

Import field measurements (Lat, Lon, RSSI)

## 5.7 Best Site Analysis

Import an area to study it using a Monte Carlo simulation

## 5.8 Automatic processing

Import a spreadsheet of data for processing via the API

To make use of this tool simply select your chosen “Purpose” and upload your data in one of the specified formats.

At any point if you wish to remove your reference data from the map then you can simply click on the “Clear Layers”

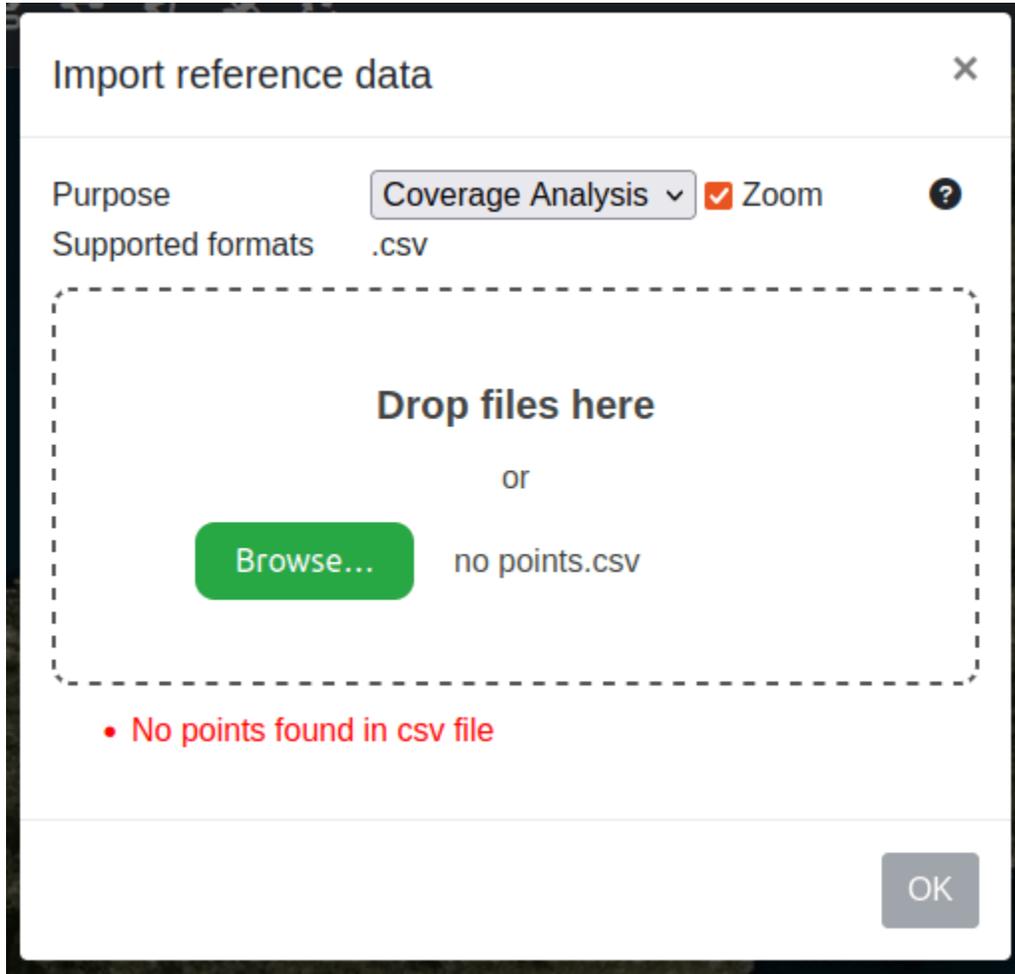


button along the top of the interface.

## 5.9 File Validation

Regardless of the “Purpose” selected, your files will be validated when you upload them. This ensures that your files will work with the interface and be interpreted correctly.

If you have an error in your reference data then this will be displayed in the modal window.



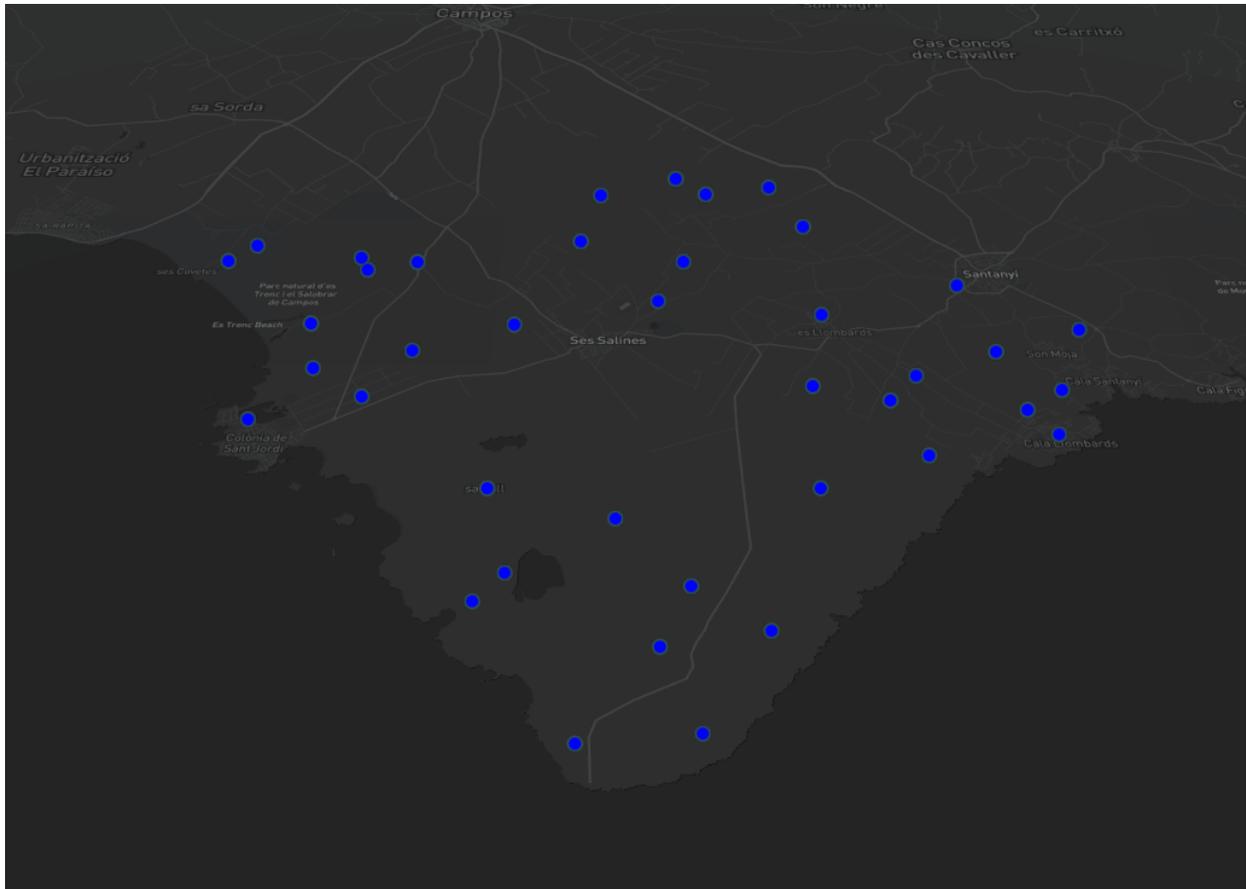
## 5.10 Reference Display (Shapes on the map)

If you select “Reference Display” from the “Purpose” dropdown then this can be used to display imported data on the map such as polygons or pins.

When you select this option from the “Purpose” dropdown this will also show a new colour picker input which can be used to set the colour of your import data when it is drawn on the map.

This functionality can be used to create guides on the map where you can visualise where certain points or boundaries may be. For example, you may upload a CSV of points to indicate important landmarks, or you may upload a GeoJSON file which includes a boundary.

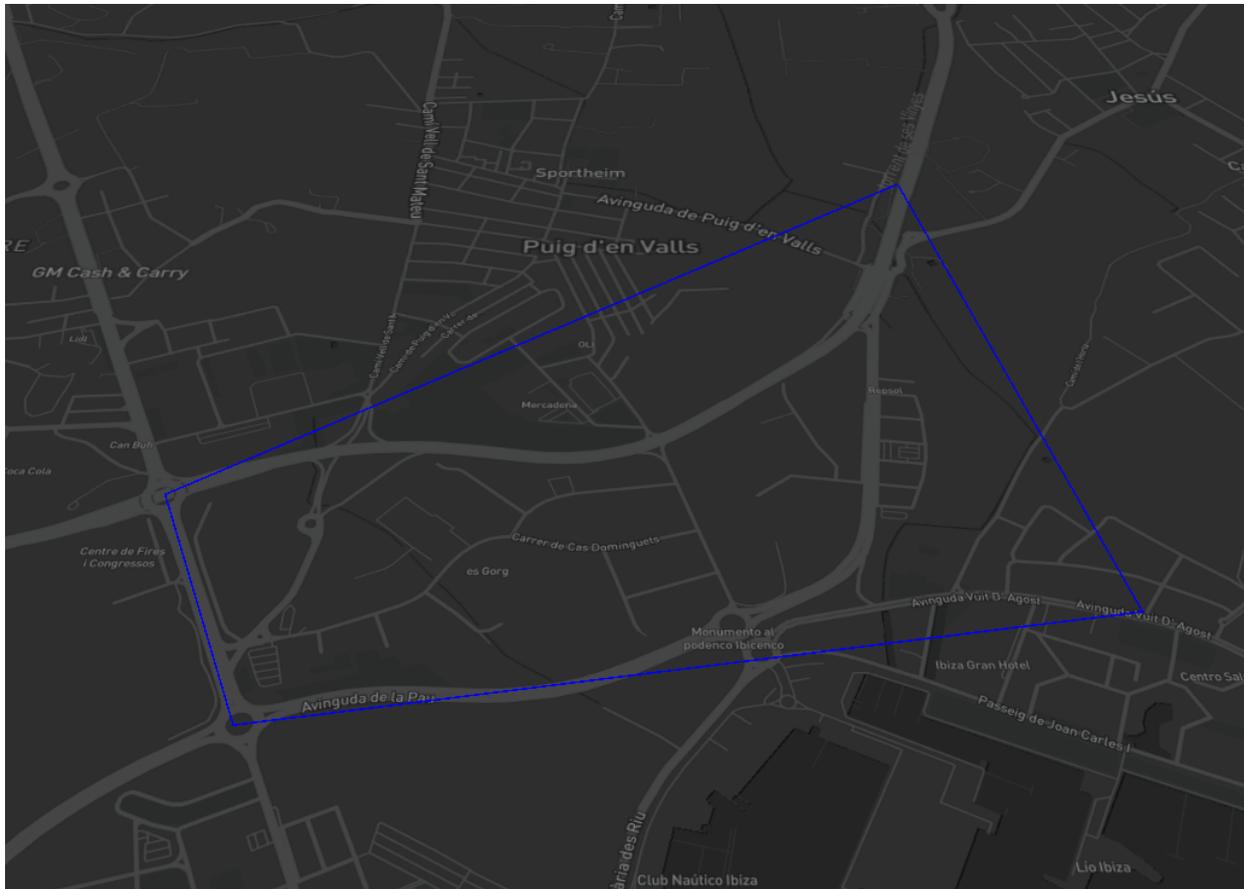
Below shows uploaded points using the “Reference Display” from a CSV:



Below shows a sample CSV which was partially used to produce the above screenshot:

```
longitude,latitude,rssi
3.0505242,39.2707224,-70
3.0807366,39.2866678,-50
3.0560174,39.304735,-92
3.068377,39.2935764,-90
3.0340447,39.3100479,-67
3.0910363,39.3100479,-75
3.0381646,39.295702,-81
3.0632271,39.2842762,-91
```

Below shows a boundary uploaded using the “Reference Display” from a GeoJSON file:



Below shows the GeoJSON which was used to produce the above screenshot:

```
{
  "type": "FeatureCollection",
  "features": [
    {
      "type": "Feature",
      "properties": {},
      "geometry": {
        "coordinates": [
          [
            [
              1.4256018139448656,
              38.92015233473046
            ],
            [
              1.4280509904125438,
              38.91581165124461
            ],
            [
              1.4449950785628118,
              38.91780215762395
            ],
            [
              1.441954782658172,
```

(continues on next page)

```
        38.92844609186906
      ],
      [
        1.4256018139448656,
        38.92015233473046
      ]
    ]
  ],
  "type": "Polygon"
}
}
]
```

## 5.11 Coverage Analysis (Measurements, Locations, Routes)

If you select “Coverage Analysis” from the “Purpose” dropdown then this powerful utility can be used for several purposes:

- Upload field measurements / RF survey data which can be used to calibrate and optimise simulation settings by reporting the error
- Upload location data eg. zip / postal codes which can be used to gather metrics about coverage for areas and points.
- Upload a KML route for coverage analysis. This will report the percentage (%) of the route covered

### 5.11.1 Coverage analysis of locations

You can upload a CSV with data about multiple points, for example customer properties by ZIP or UPRN.

For basic ‘points’ your CSV should follow the following rules:

- The following fields are accepted:
  - `id` is a unique identifier of the point.
  - `latitude` is the latitude coordinate of the point. Should be a decimal value between -180 and 180.
  - `longitude` is the longitude coordinate of the point. Should be a decimal value between -90 and 90.
  - `group` is an optional field which allows you to group certain points together.
- Your CSV must contain a header indicating the ordering of your fields.

An example CSV might look something like the below:

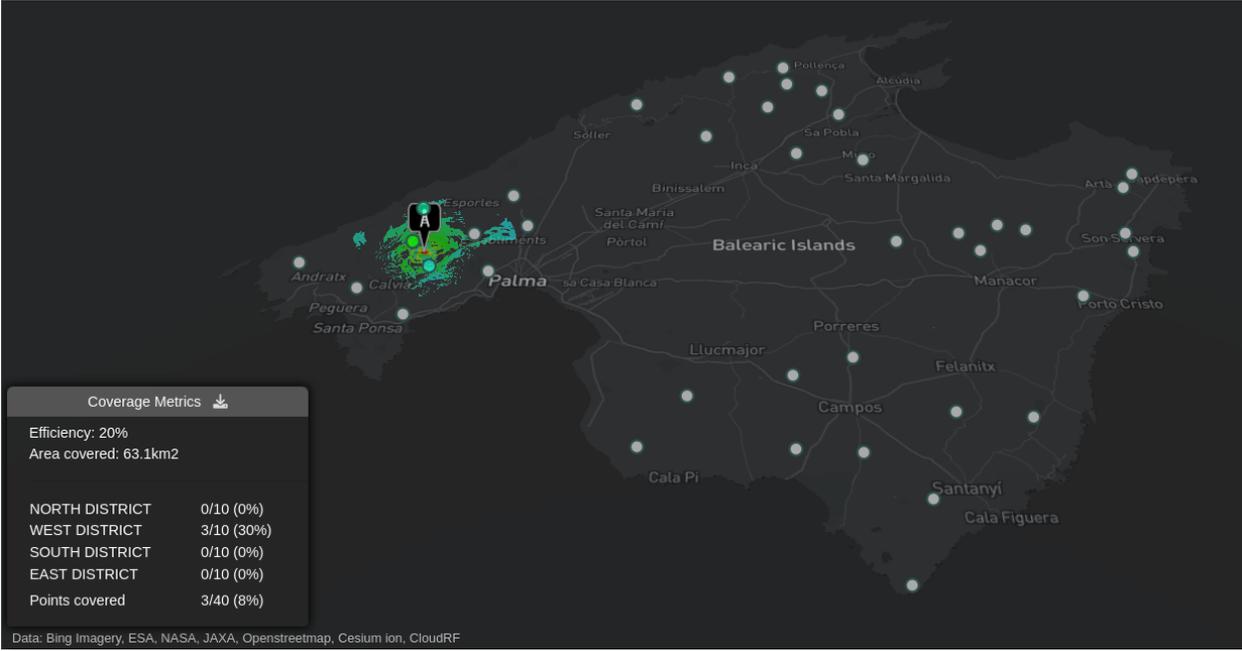
```
id,longitude,latitude,group
Point 1,3.0505242,39.2707224,SOUTH DISTRICT
Point 2,3.0807366,39.2866678,SOUTH DISTRICT
Point 3,3.0520286,39.3742523,NORTH DISTRICT
Point 4,3.0678215,39.3787639,NORTH DISTRICT
```

After successfully uploading your CSV it will be parsed and the interface will automatically draw your points onto the map.

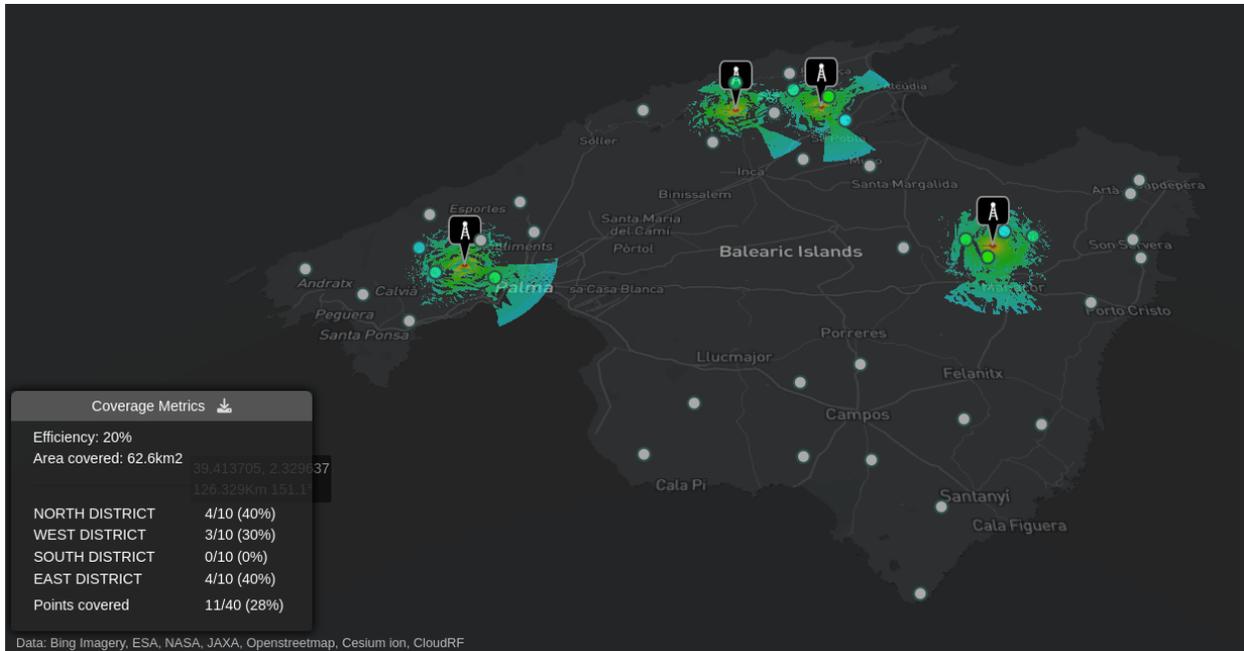


You may notice that a new window will be added to the bottom left of the screen. This is a live-updating metrics report which gives you details about your calculations, giving indications as to whether your points are covered or not.

If you next click on the map and run through a calculation you should see the points being coloured based on the signal strength but also the metrics report should update automatically when new calculations cover points.



As you add new calculations this will update the metrics report showing you how much coverage you have in total. Each group as defined in your CSV will also be calculated based on its coverage.



As you do multiple calculations this will build up your available layers on the map. As you check/uncheck them it will automatically update your metrics report in the bottom left of the interface. This is useful for seeing the effect removing a single layer has on an overall network.



In the “Coverage Metrics” window you can click on the “Download Coverage Metrics Report” icon to obtain a report from your calculations. This is a `txt` file with information:

```

Location Coverage Metrics Report
Thu Apr 06 2023 12:56:54 GMT+0100 (British Summer Time)
Cloud-RF

NORTH DISTRICT: 4/10 (40%)
WEST DISTRICT: 3/10 (30%)
SOUTH DISTRICT: 2/10 (20%)
EAST DISTRICT: 4/10 (40%)

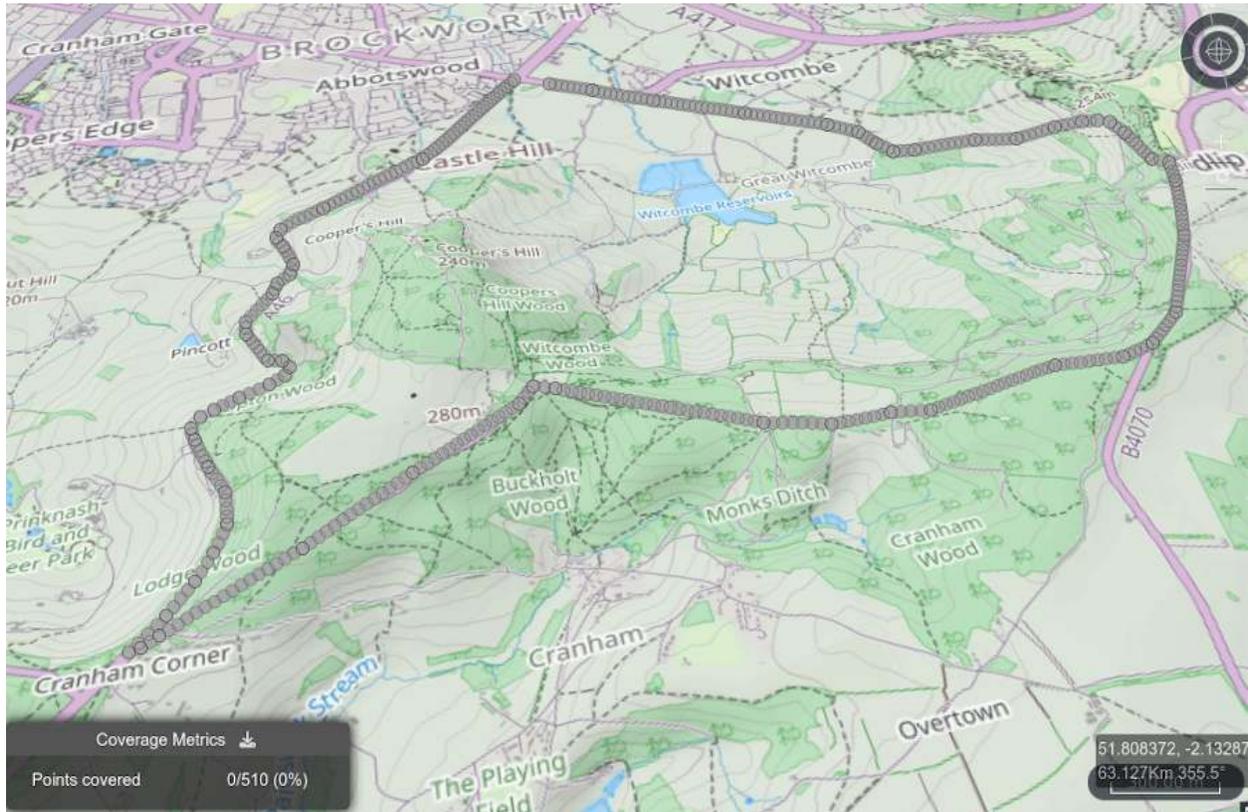
TOTAL COVERAGE: 13/40 (33%)

Layers:
0406125414_My_Site
0406125639_My_Site
0406125642_My_Site
0406125645_My_Site
0406125651_My_Site
    
```

## 5.12 Route analysis

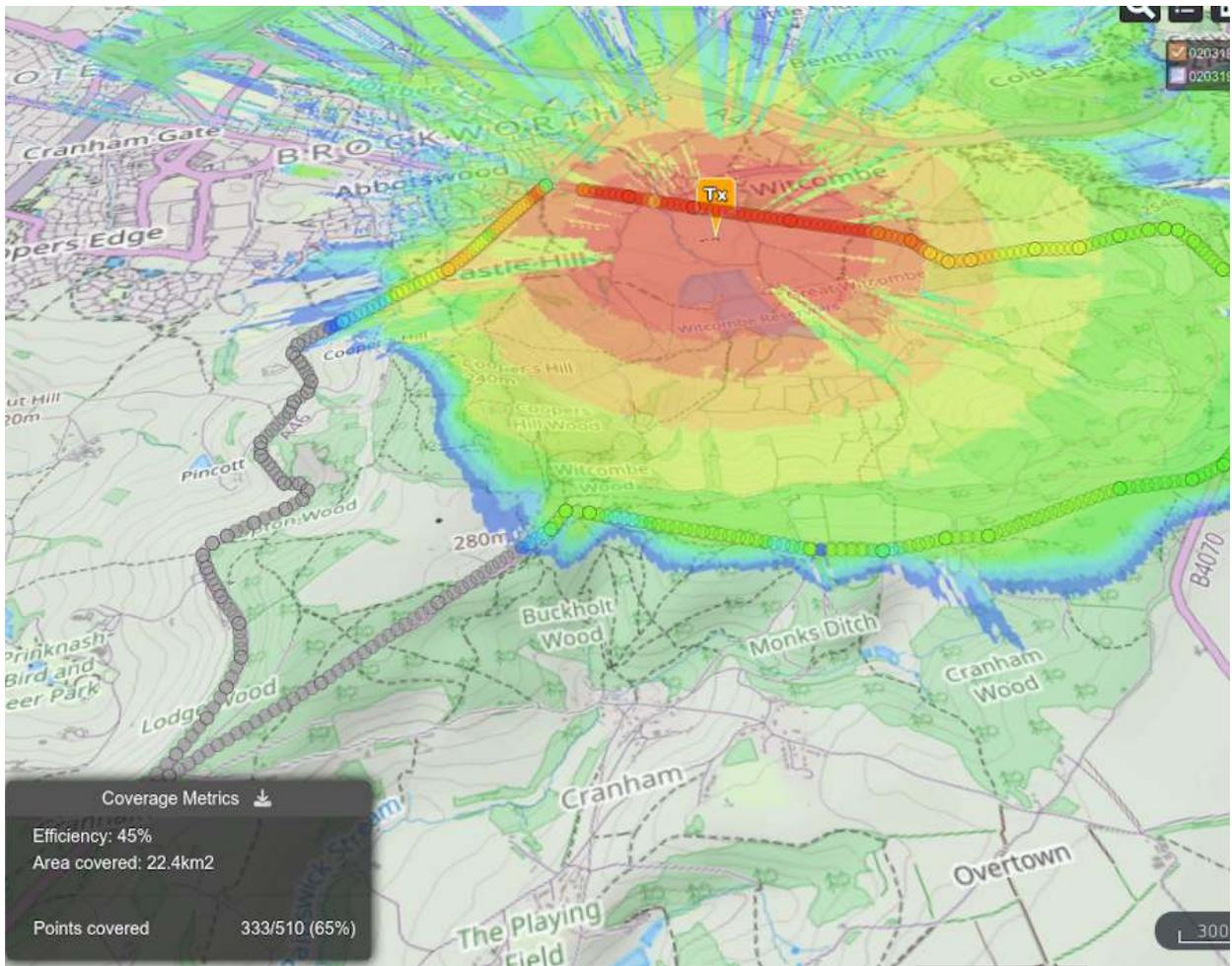
The route import feature lets you load a CSV, KML or KMZ polyline describing a route for analysis. This is a more advanced and powerful alternative to the “route analysis” tool which is only a freehand “quick look” against the start position.

Load in the KML to render it on the map and then create or reload a heatmap layer. This layer can be either an “area” calculation or a multisite heatmap using the MANET tool.

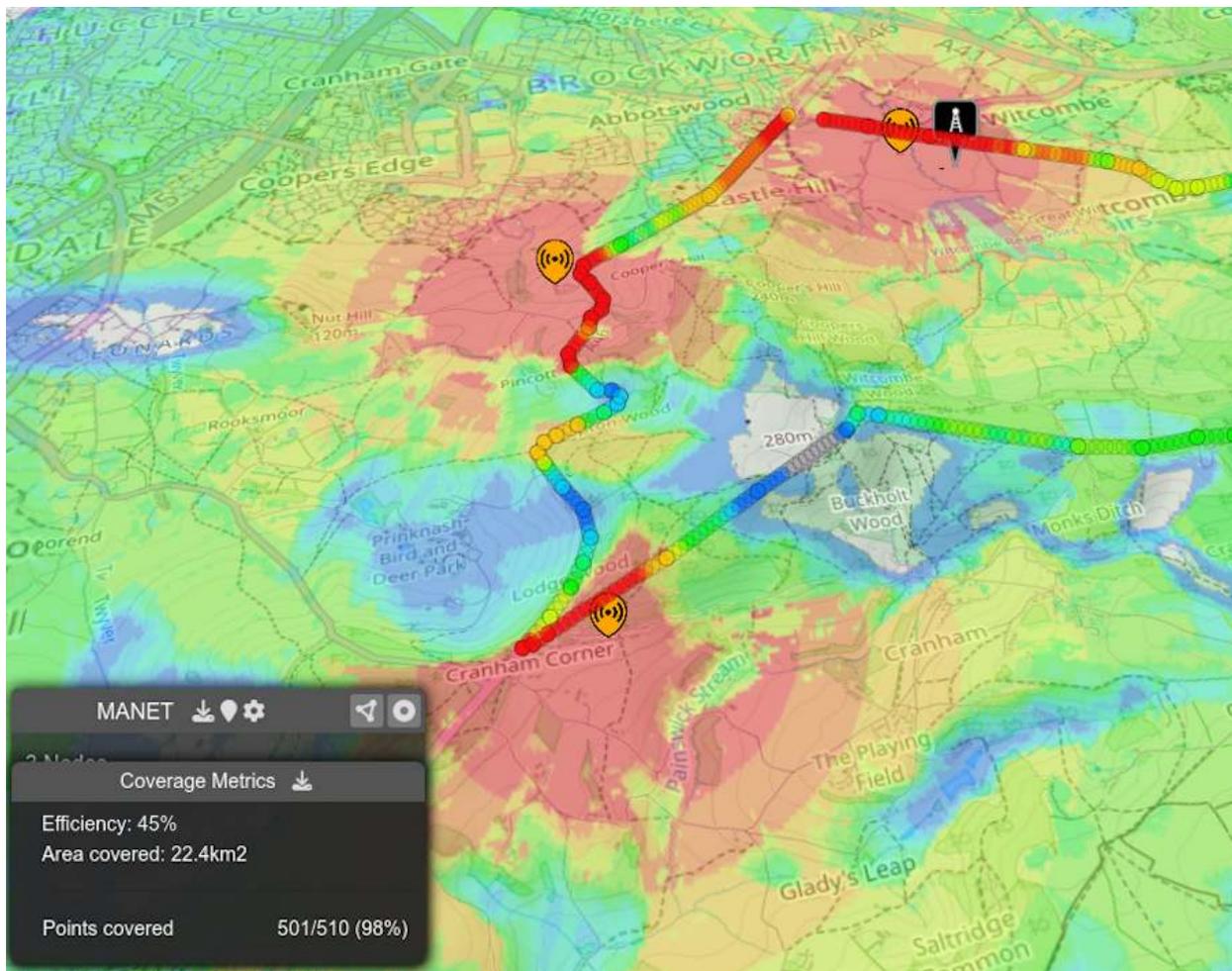


Multiple layers can be added to the map for analysis. When a layer is removed, it is updated.

*Note that clearing the map at this point will also clear the route so use the layer manager instead to hide layers.*



The MANET tool, when used in conjunction with route analysis will update the coverage statistics after every change.



### 5.12.1 Import a flightpath

The data only needs points for each vertex as it uses interpolation to complete the route. Route coverage is presented in the corner as a percentage against use defined radio parameters eg. 75%.

The route import feature supports flightpaths above the ground as CSV or KML. Both OGC line strings and gx extensions are supported. You can fetch a flightpath from ADSB exchange and load it in directly.



Only one flightpath is supported within a KML file and sometimes ADSB files contain several; for example one for taxiing and another post take off.

Altitudes will be placed using the selected altitude units. If you need height AMSL then ensure you select this.

To test coverage to a ground site, click on the map to site the receiver and click the play button to test the path using the points API.

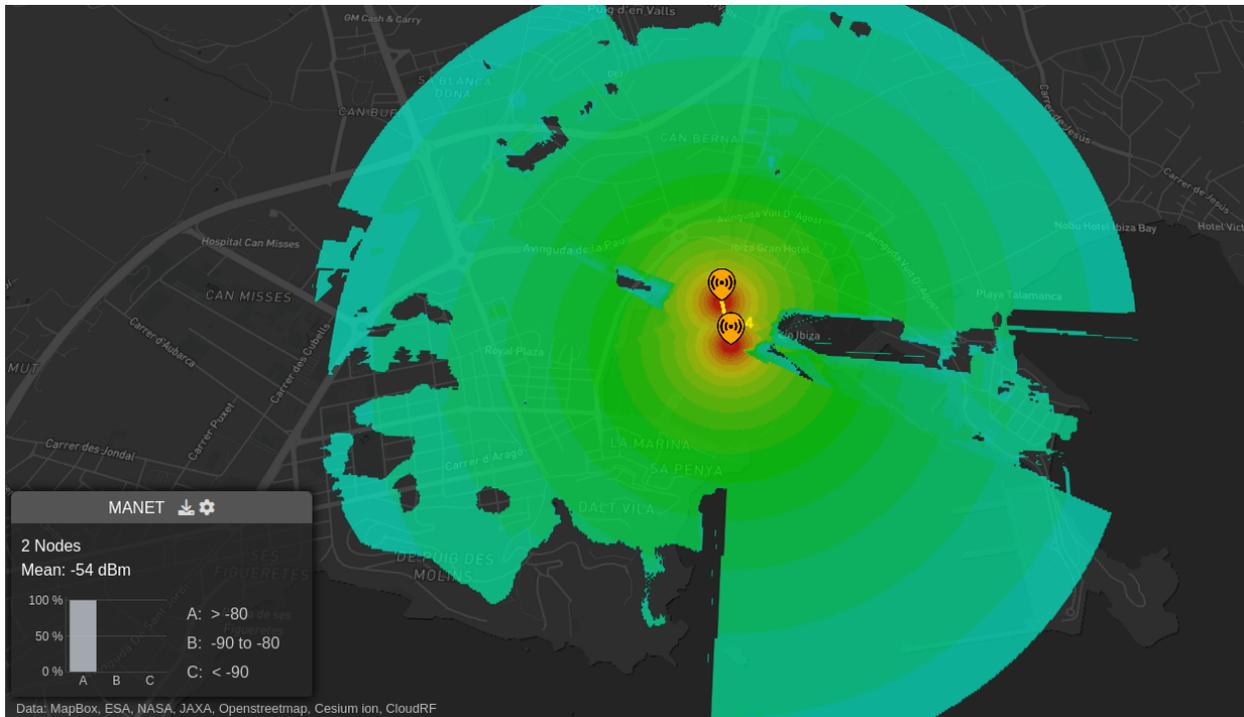
## 5.13 MANET network

If you select “MANET Tool” from the “Purpose” dropdown then this can be used to import points for use with the MANET tool (GPU required). This is useful when you wish to use the MANET tool but don’t want to have to keep redrawing markers at the same locations if you want to test different profiles for example.

Please note that when you upload your file using “MANET Tool”, each point in your uploaded file will be applied with the same values that you currently have set for your settings.

After you submit your uploaded file a MANET calculation will be fired off immediately using your settings and preferences.

Below shows the result of a MANET calculation after being uploaded from a KML file:

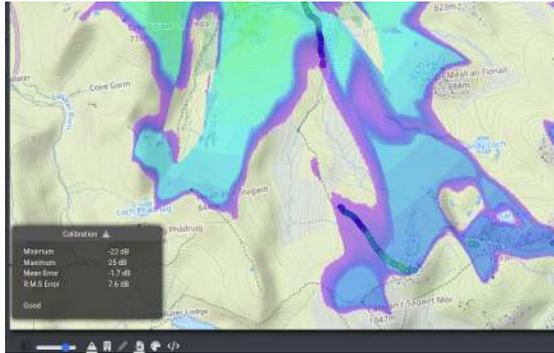


The above screenshot is taken from the following KML:

```
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://www.opengis.net/kml/2.2">
  <Document>
    <Placemark>
      <name>Point 1</name>
      <Point>
        <coordinates>
          1.4397022,38.9146682,0
        </coordinates>
      </Point>
    </Placemark>
    <Placemark>
      <name>Point 2</name>
      <Point>
        <coordinates>
          1.440185,38.9130821,0
        </coordinates>
      </Point>
    </Placemark>
  </Document>
</kml>
```

For more information please consult the section relating to the *MANET planning tool*.

### 5.13.1 Survey data and Calibration



You can upload a CSV with field measurements for easy modelling calibration. This was developed with CSV output from Cellmapper which is recommended for cellular surveys like the LTE800 survey in the image above.

*Survey hardware like Nemo Handy and SDRs are also supported providing power measurements can be represented as dB or dBm.*

For basic power measurements, your CSV should follow the following rules:

- The following fields are accepted:
  - `latitude` is the latitude coordinate of the point. Should be a decimal value between -180 and 180.
  - `longitude` is the longitude coordinate of the point. Should be a decimal value between -90 and 90.
  - `rsi` is the measured signal strength in dBm. For cellular this can be either received power or RSRP providing it matches what you are using in your modelling.
- Your CSV must contain a header indicating the ordering of your fields.

An example CSV might look something like the below:

```
longitude,latitude,rsi
3.0505242,39.2707224,-77
3.0807366,39.2866678,-82
3.0520286,39.3742523,-83
3.0678215,39.3787639,-88
```

Your CSV will be automatically validated when you upload it, if there are any errors then this will be displayed in the dialog window.

After successfully uploading your CSV it will be parsed and the interface will automatically draw your points onto the map and compute the delta between any visible layer upon it.

You may notice that a new window will be added to the bottom left of the screen. This is a live-updating metrics report which gives you details about the *computed error*. A good error value is less than 8dB and an excellent value is less than 5dB. Anything greater than 8dB normally requires adjustments to your modelling parameters.

*Be aware that field measurements contain receiver error. This can vary from 1dB for a high quality receiver to 3dB for a cell phone. This inherent error is separate to modelling error so if you achieve 9dB alignment with cell phone measurements then this represents a modelling error of about 6dB - pretty good.*

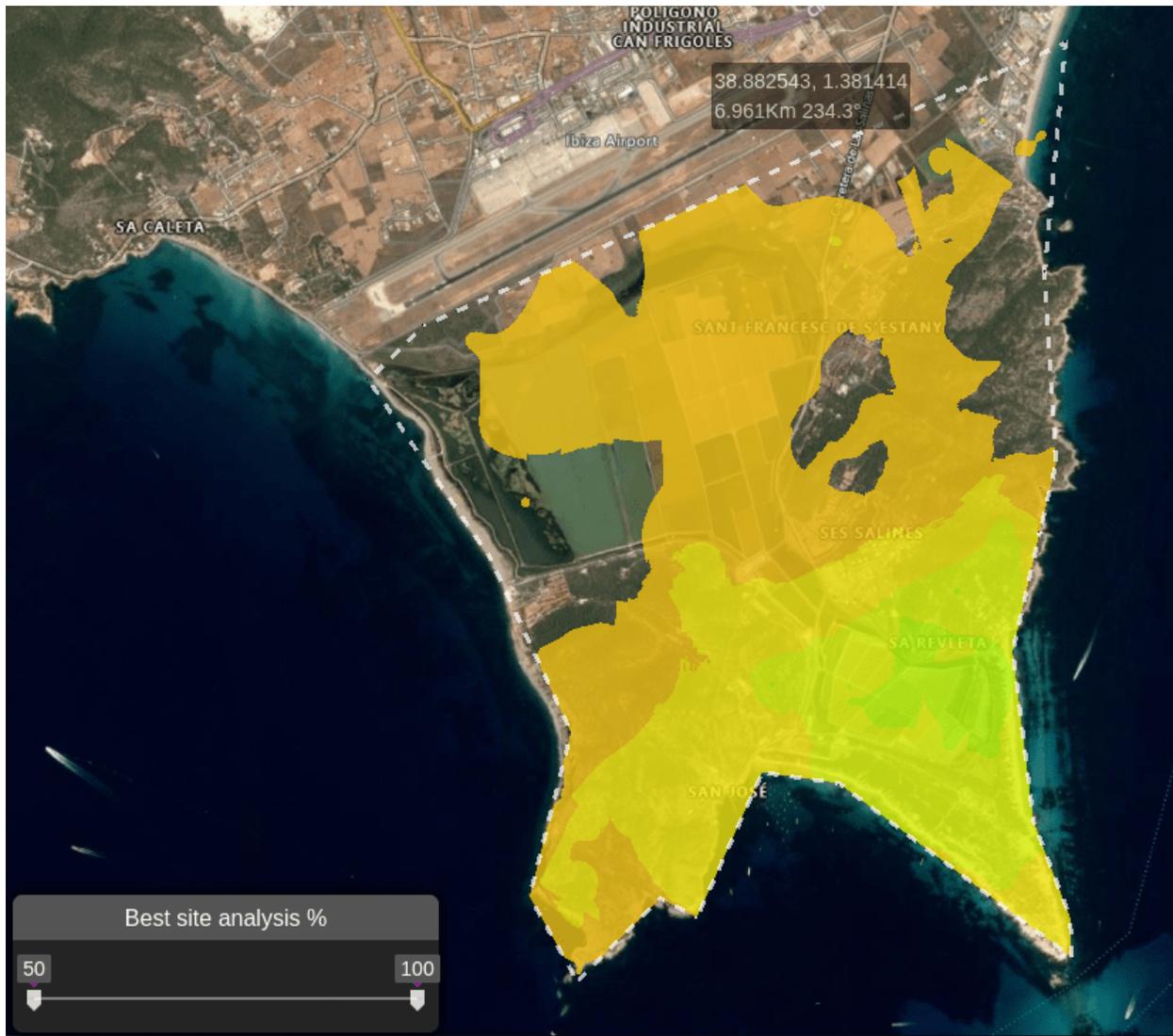
If you next click on the map and run through a calculation you should see the points being coloured based on the signal strength but also the metrics report should update automatically where new calculations cover points.

As you do multiple calculations this will build up your available layers on the map. As you check/uncheck them it will automatically update your metrics report. This is useful for comparing settings.

## 5.14 Best Site Analysis

If you select “Best Site Analysis” from the “Purpose” dropdown then this is used to upload a polygon of a boundary which is used with the best site analysis functionality. This is useful if you are working with very specific boundaries and don’t wish to keep redrawing the area. Instead you can upload your file and have the calculation repeated with the same values every time.

Upon successful upload of your boundary the best site analysis tool will be immediately fired off using your current settings.

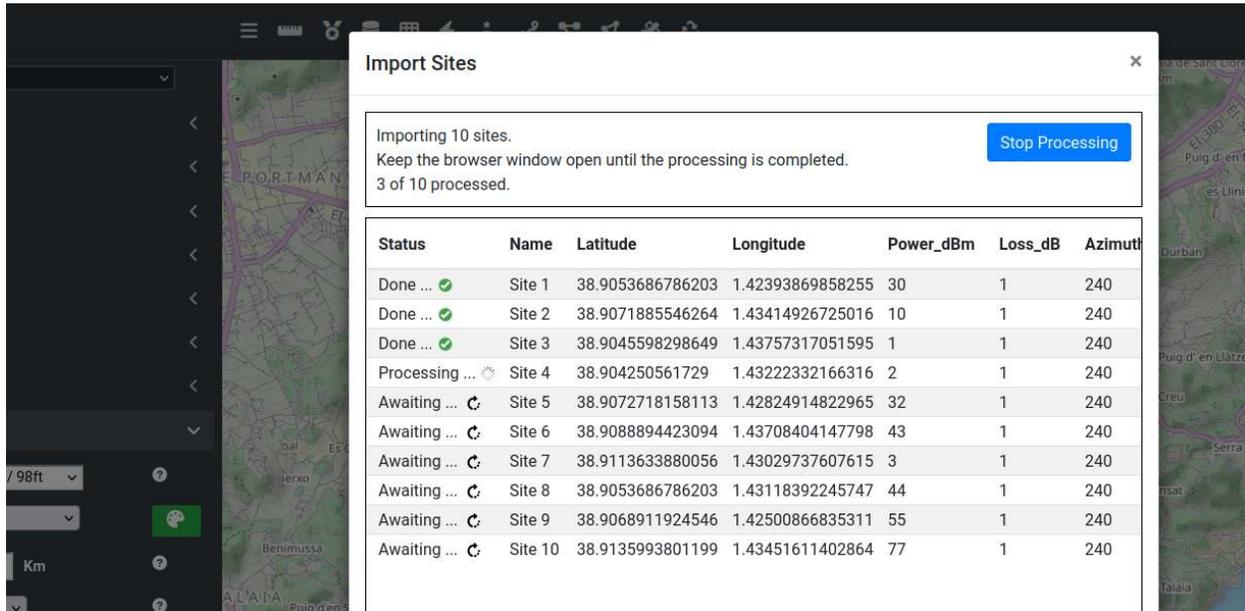


For more information please consult the section relating to the *best site analysis planning tool*.

## 5.15 Automatic processing

If you select “Automatic processing” from the “Purpose” dropdown then this will enable you to upload a simple CSV spreadsheet describing the sites in your network. This uses a subset of what is available in the API and all other settings will be set in your form at the point of upload eg. Radius and Resolution.

**This is a simplified way to use the API via the user interface which has limited options compared to the full examples documented on [GitHub](#)**



Importing 10 sites.  
Keep the browser window open until the processing is completed.  
3 of 10 processed.

Status	Name	Latitude	Longitude	Power_dBm	Loss_dB	Azimuth
Done ...	Site 1	38.9053686786203	1.42393869858255	30	1	240
Done ...	Site 2	38.9071885546264	1.43414926725016	10	1	240
Done ...	Site 3	38.9045598298649	1.43757317051595	1	1	240
Processing ...	Site 4	38.904250561729	1.43222332166316	2	1	240
Awaiting ...	Site 5	38.9072718158113	1.42824914822965	32	1	240
Awaiting ...	Site 6	38.9088894423094	1.43708404147798	43	1	240
Awaiting ...	Site 7	38.9113633880056	1.43029737607615	3	1	240
Awaiting ...	Site 8	38.9053686786203	1.43118392245747	44	1	240
Awaiting ...	Site 9	38.9068911924546	1.42500866835311	55	1	240
Awaiting ...	Site 10	38.9135993801199	1.43451611402864	77	1	240

The CSV format must conform to one of two standards; a short format or a long format.

### 5.15.1 Short format CSV

Your CSV files must have these column headers:

- Name
- Latitude: between -90 and 90 (required)
- Longitude: between -180 and 180 (required)
- Power\_W: (required)
- Loss\_dB
- Azimuth\_deg: between 0 and 359
- Downtilt\_deg: between 0 and 359
- Height\_m: between 0.1 and 60000 (required)
- Gain\_dB

## Example CSV

```
Name,Latitude,Longitude,Power_dBm,Misc Loss (dB),Azimuth_deg,Downtilt_deg,Height_m,Gain_
→dB,Loss_dB
Site 1,38.9053686786203,1.42393869858255,30,0,240,10,6,8,1
Site 2,38.9071885546264,1.43414926725016,10,0,240,10,1,8,1
Site 3,38.9045598298649,1.43757317051595,1,0,240,10,10,8,1
Site 4,38.904250561729,1.43222332166316,2,0,240,10,11,8,1
Site 5,38.9072718158113,1.42824914822965,32,0,240,10,10,8,1
Site 6,38.9088894423094,1.43708404147798,43,0,240,10,9,8,1
Site 7,38.9113633880056,1.43029737607615,3,0,240,10,7,8,1
Site 8,38.9053686786203,1.43118392245747,44,0,240,10,8,8,1
Site 9,38.9068911924546,1.42500866835311,55,0,240,10,9,8,1
Site 10,38.9135993801199,1.43451611402864,77,0,240,10,7,8,1
```

### 5.15.2 Long format CSV

Your CSV files must have these column headers:

- Site
- Latitude: between -90 and 90 (required)
- Longitude: between -180 and 180 (required)
- Height\_m (required)
- Frequency\_MHz: between 2 and 100000(required)
- Bandwidth\_MHz: between 0.1 and 200
- Power\_W (required)
- Receiver\_Height\_m: between 0 and 60000
- Receiver\_Gain\_dBi: between -30 and 60
- Receiver\_Sensitivity\_dBm
- Antenna\_Pattern: Pattern name or “Custom”
- Antenna\_Polarisation: “V” for vertical or “H” for horizontal
- Antenna\_Gain\_dBi
- Antenna\_Loss\_dB
- Antenna\_Azimuth\_deg: between 0 and 359
- Antenna\_Tilt\_deg: between 0 and 359
- Antenna\_Horizontal\_Beamwidth\_deg: between 0 and 360 (required for custom patterns)
- Antenna\_Vertical\_Beamwidth\_deg: between 0 and 360 (required for custom patterns)
- Front\_to\_back: between 0 and 360 (required for custom patterns)
- Noise\_floor\_dBm
- Measured\_units
- Colour\_schema
- Model

- Context
- Diffraction
- Reliability
- Profile

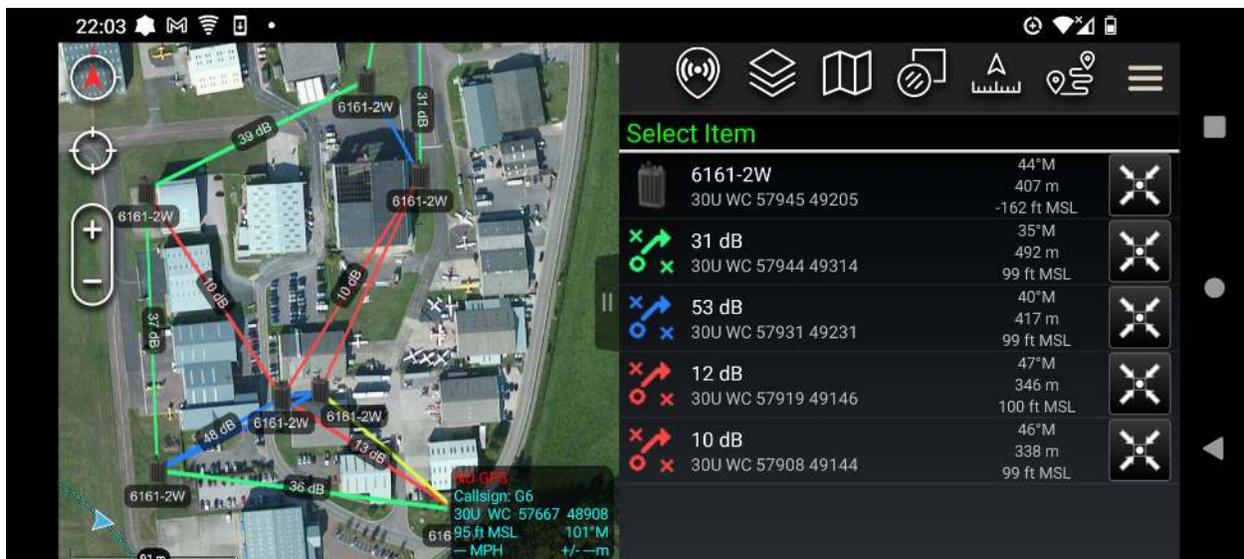
### Example CSV

```
Site,Latitude,Longitude,Height_m,Frequency_MHz,Bandwidth_MHz,Power_W,Antenna_Pattern,  
↪Antenna_Polarisation,Antenna_Loss_dB,Antenna_Azimuth_deg,Antenna_Tilt_deg,Antenna_Gain_  
↪dBi,Noise_floor_dBm,Model  
Site 1,38.9053686786203,1.42393869858255,10,446,1.4,30,OEM Half-Wave Dipole,V,0,240,10,8,  
↪-120,Egli VHF/UHF (< 1.5GHz)  
Site 2,38.9071885546264,1.43414926725016,11,800,10,10,OEM Half-Wave Dipole,V,10,240,10,8,  
↪-90,Egli VHF/UHF (< 1.5GHz)  
Site 3,38.9045598298649,1.43757317051595,20,2400,20,1,OEM Half-Wave Dipole,H,11,240,10,8,  
↪-70,Egli VHF/UHF (< 1.5GHz)  
Site 4,38.904250561729,1.43222332166316,15,2100,22,2,OEM Half-Wave Dipole,V,4,240,10,8,-  
↪180,Egli VHF/UHF (< 1.5GHz)  
Site 5,38.9072718158113,1.42824914822965,7,900,1.9,32,OEM Half-Wave Dipole,H,5,240,10,8,-  
↪90,Egli VHF/UHF (< 1.5GHz)  
Site 6,38.9088894423094,1.43708404147798,30,1700,1.8,43,OEM Half-Wave Dipole,V,6,240,10,  
↪8,-120,Egli VHF/UHF (< 1.5GHz)  
Site 7,38.9113633880056,1.43029737607615,31,1800,18,3,OEM Half-Wave Dipole,H,1,240,10,8,-  
↪140,Egli VHF/UHF (< 1.5GHz)
```

## ATAK PLUGIN

Android Team Awareness Kit (TAK) is a US Government situational awareness application, available for free on Android (ATAK). The civilian version is available for free on the Google Play store.

ATAK-CIV <https://play.google.com/store/apps/details?id=com.atakmap.app.civ>



### 6.1 Requirements

- ATAK (CIV or MIL)
- A CloudRF account or a local SOOTHSAYER server
- A network connection

## 6.2 Release and debug builds

Due to the byzantine plugin signing process and compatibility matrix, there are a bewildering number of ATAK versions. **Our plugin is signed by the TAK Product Center (TPC)** which at the time of writing means it should work on CIV and MIL flavours.

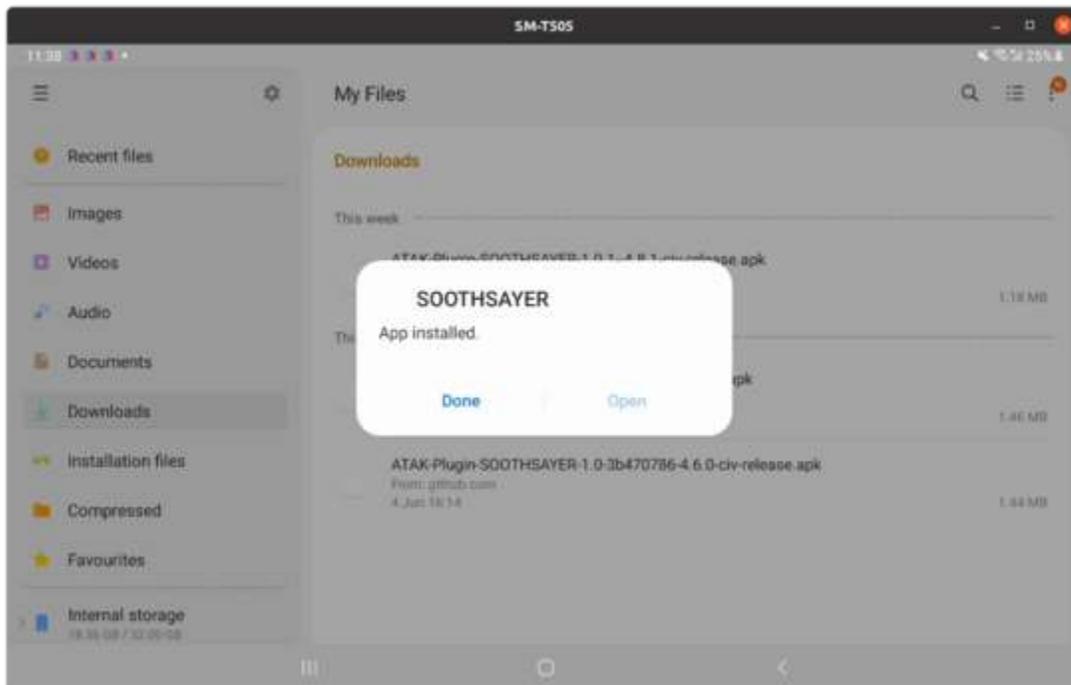
*A debug release is offered to work with the [Github](#) version which allows developers to demo capabilities without the need for plugin signing. A debug plugin build will only work with a debug build of ATAK. You can recognise this by the red letters **DEVELOPER BUILD** across the screen.*

## 6.3 APK installation

Install ATAK-CIV on your phone first and then download the latest APK file from <https://cloudrf.com/atak>

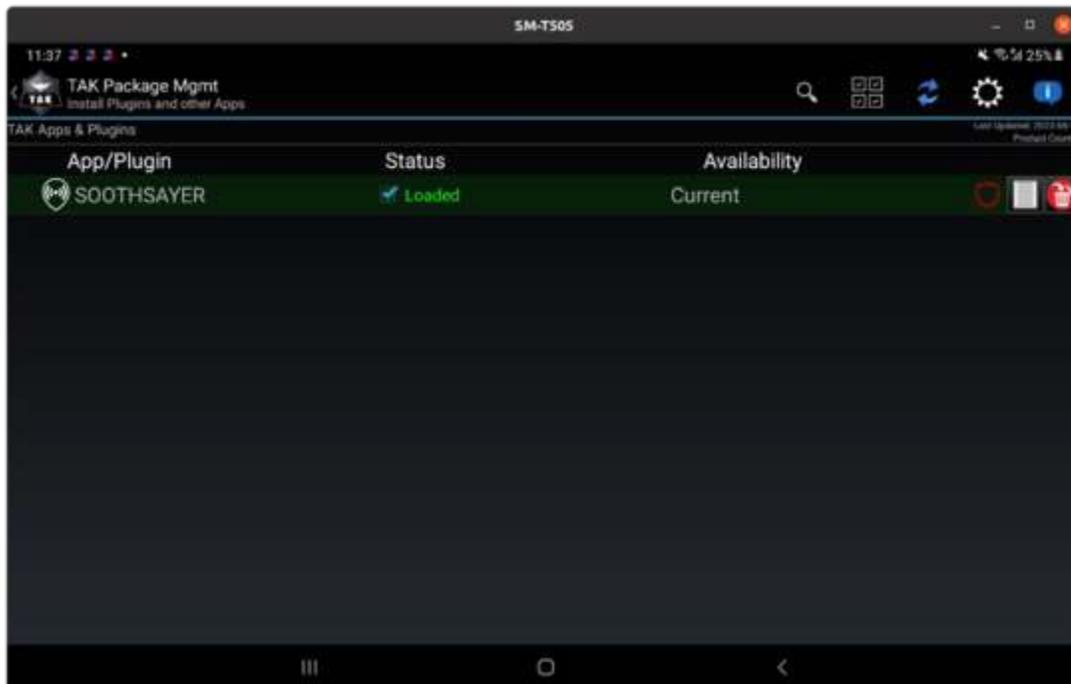
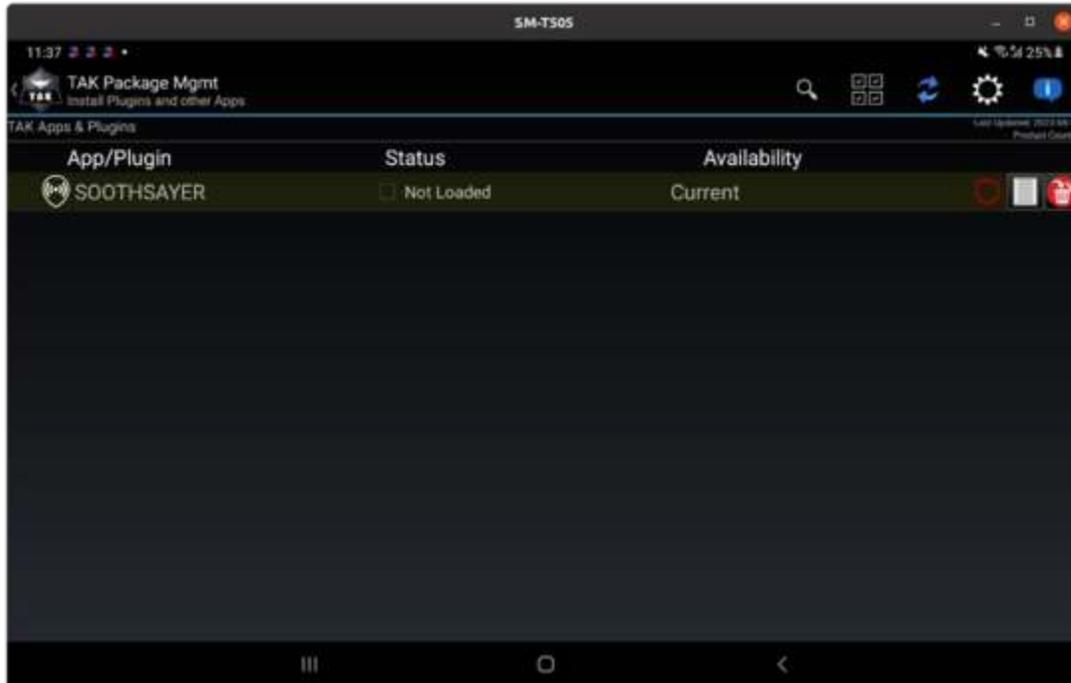
You can download it directly from the device with a browser, send the file to the device via email/IM or copy it over via USB.

Before you attempt installation of the APK, ensure ATAK is running. If it is not running, installation will fail which is expected behaviour



## 6.4 Plugin installation

Within ATAK, open the plugin manager (jigsaw icon) and you should see the SOOTHSAYER plugin listed as available but not loaded. At this point you need to check the central status box to load the plugin. This is also where ATAK will check compatibility.



### 6.4.1 Validating the plugin version

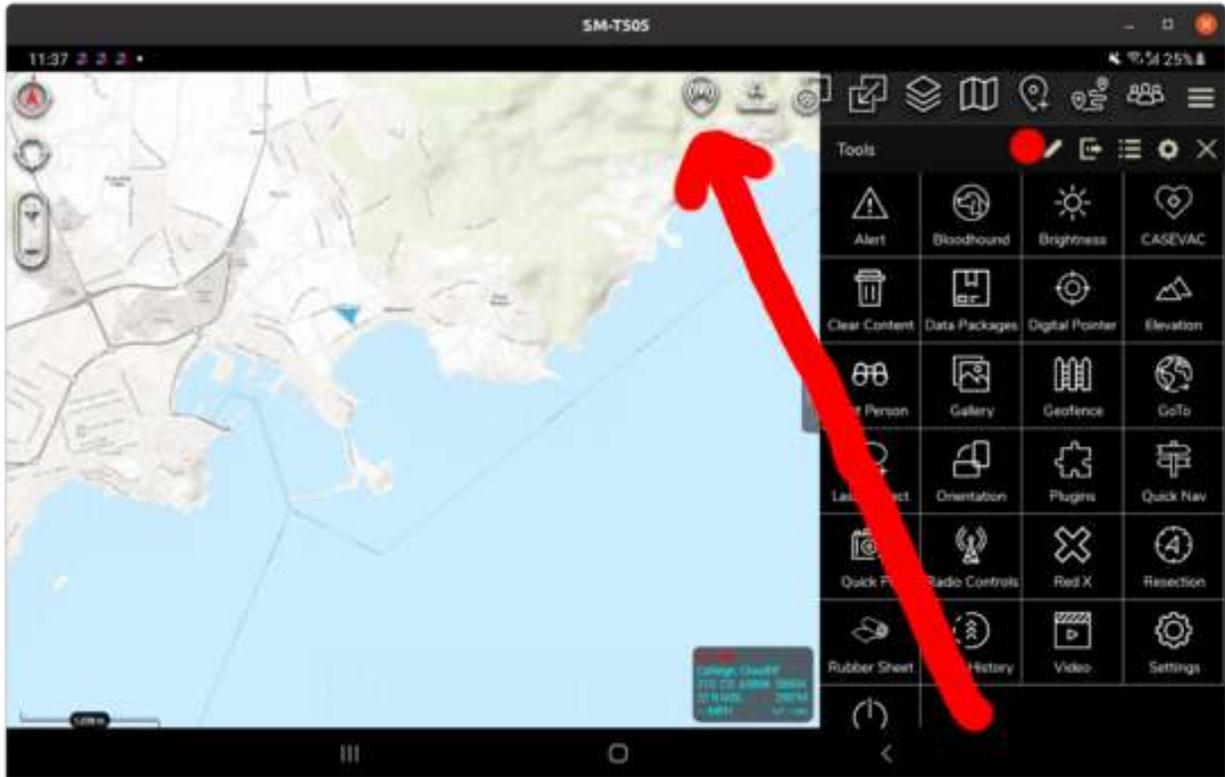
To see details about the plugin version, click the report icon to the right. It should specify the required Android OS (10 in our case) and ATAK version (4.8.1.CIV) as well as the signature validity which for a TPC signed plugin should be



valid:

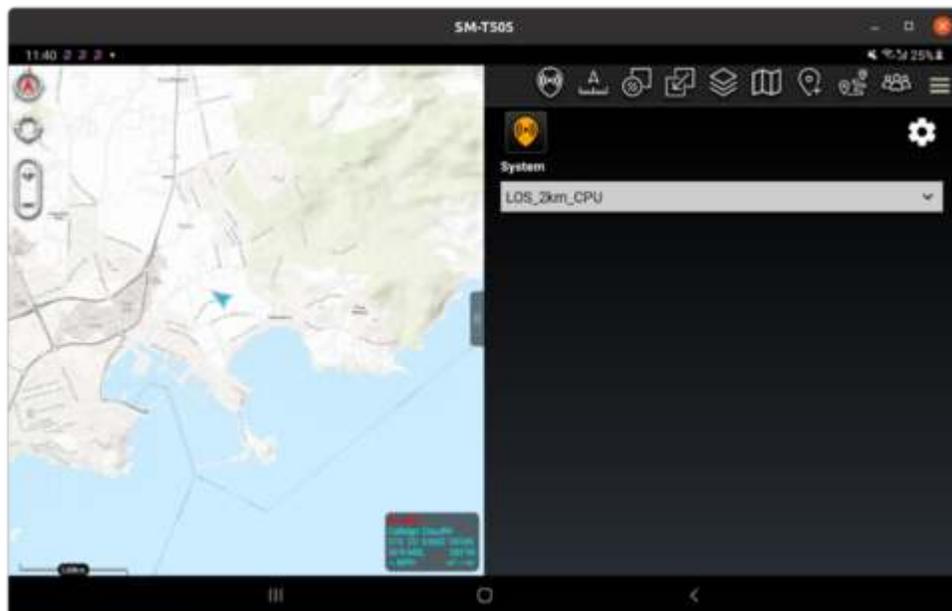
### 6.4.2 Adding a shortcut in ATAK

Once installed the plugin will be available within ATAK. To add it to the quick menu, click the pencil marker adjacent to the “Tools” label above the icons. This opens up the navigation bar to editing so you can drag your new plugin up there.



## 6.5 Using the plugin

Press the icon to open the plugin. You should have a list select and at least two buttons. To add a radio to the map, choose the system from the list, then click the SOOTHSAYER button above it. A marker will be added to the middle



of the map.

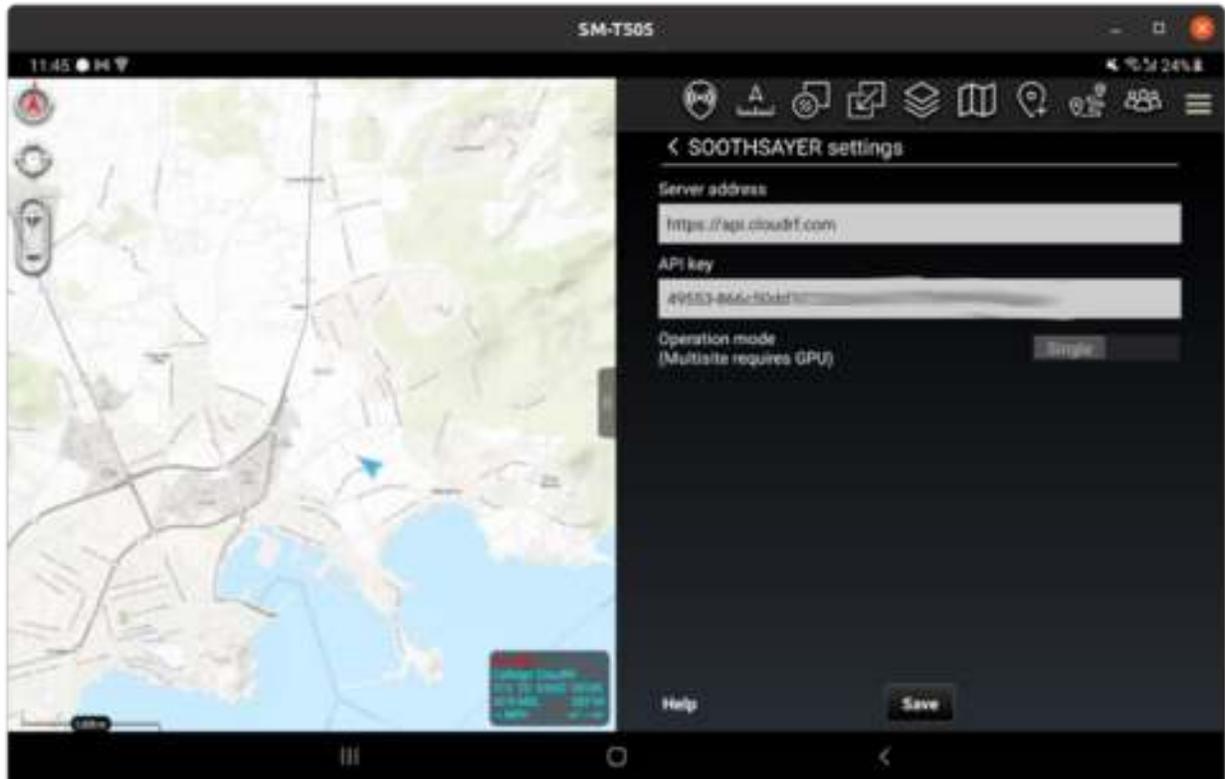
You must **drag this marker to the desired location** using a long press. Once released, the coverage will be calculated. A network connection is required to communicate with the server at this point.



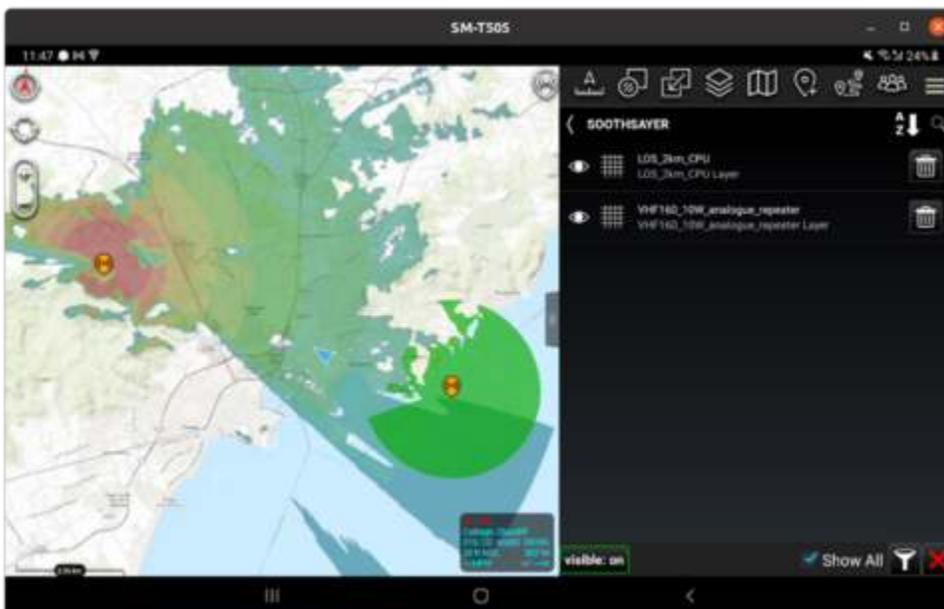
### 6.5.1 Single site mode

The default mode for calculations is to consider each site separately, as a separate layer. This allows different equipment to be placed upon the map, with different colour schemas, and site layers to be managed individually.

The downside to this mode is you may end up with many overlapping layers which you will need to manage through the ATAK layer menu to focus on what you need. These layers are available under the “SOOTHSAYER” category in the layers menu and can be hidden or deleted to suit.



In this image, two different templates are used. One is a LOS coverage with green colours and the other is a VHF repeater with a rainbow heatmap.



## 6.5.2 Multisite mode

The multisite mode is a more powerful network planning capability which models all radios together to show the entire network coverage. Designed for MANET networks, it will model changes to the network as soon as you reposition a node.

Multisite requires a server with a GPU or a CloudRF Gold subscription.



A multisite layer is a single layer which is available in the ATAK layers menu under the “SOOTHSAYER” category. It can be hidden or deleted to suit.



### 6.5.3 Satellite coverage

The Satellite coverage feature lets you test an area for line-of-sight to a satellite. It offers a high resolution study beyond basic sat-finder apps which will recommend a shot through a mountain.

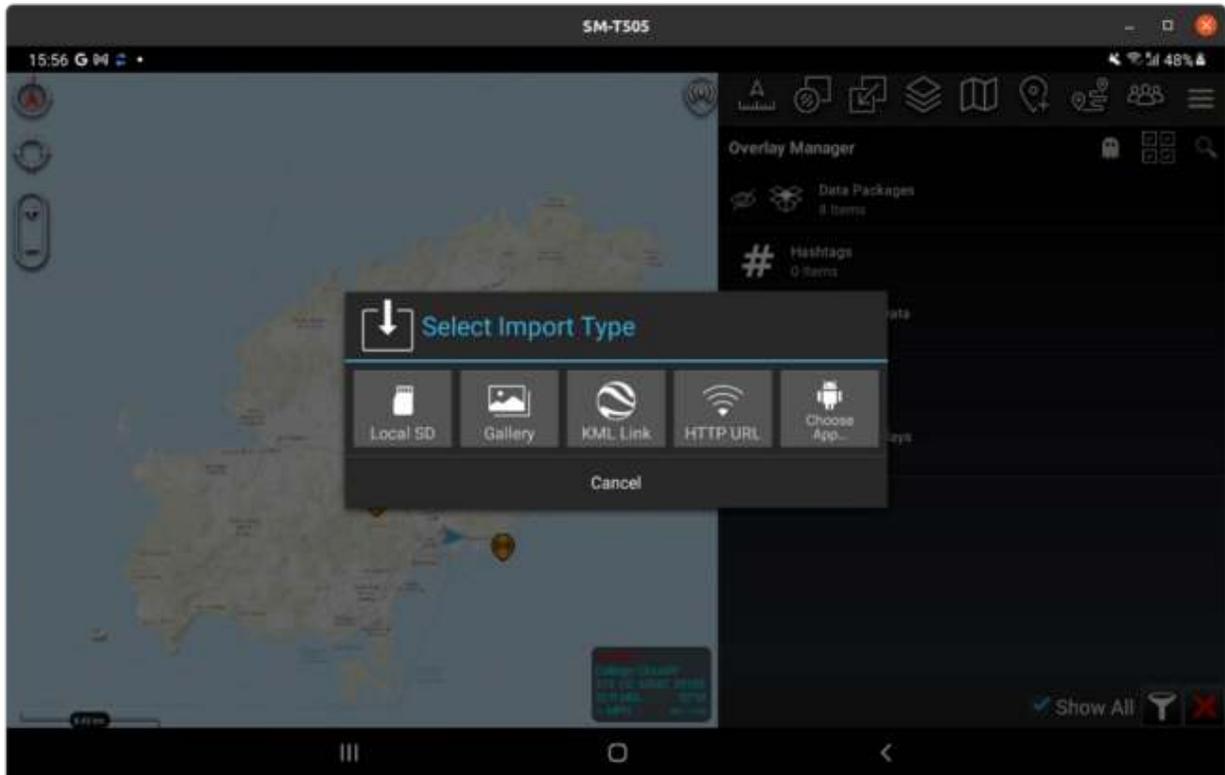
Select your satellite and time of day, resolution and finally drag the marker to test that area. A high resolution will reduce the study area to produce the layer quicker.

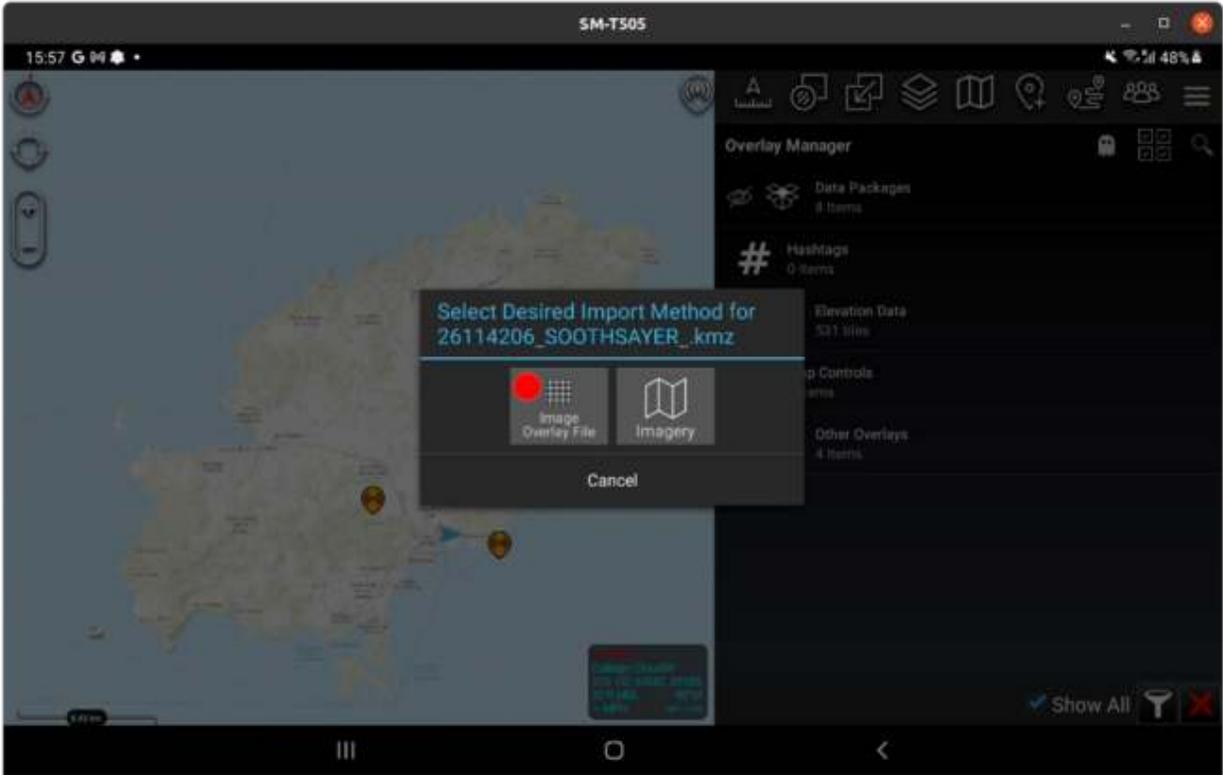
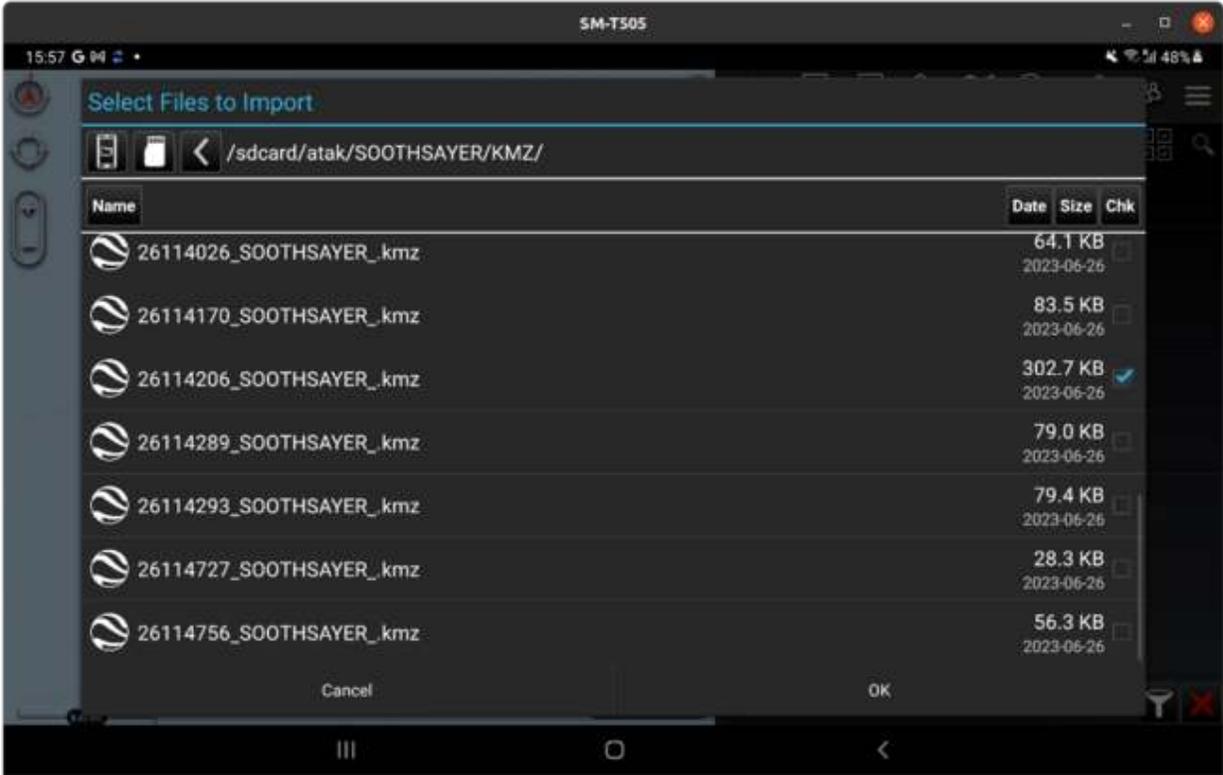
Satellite TLE data is updated periodically on CloudRF from public sources and SOOTHSAYER server customers can manager their TLE source in their server configuration.

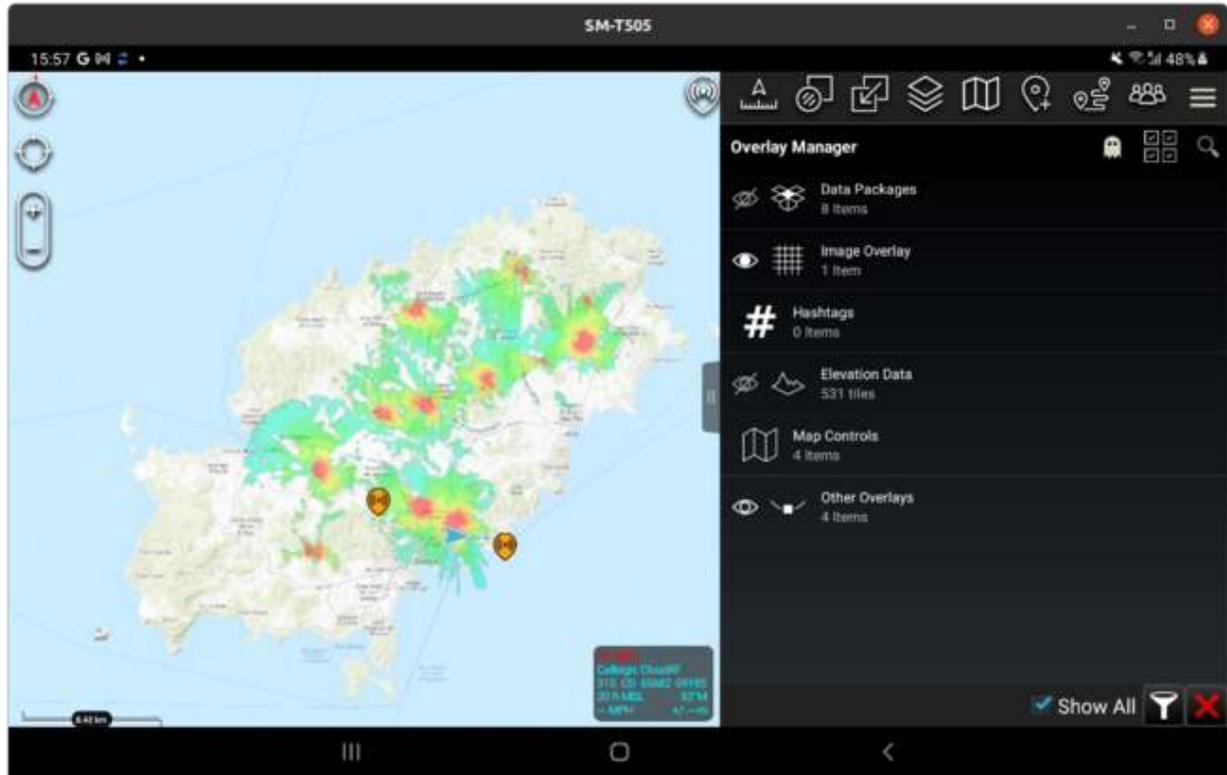


## 6.6 KMZ coverage export

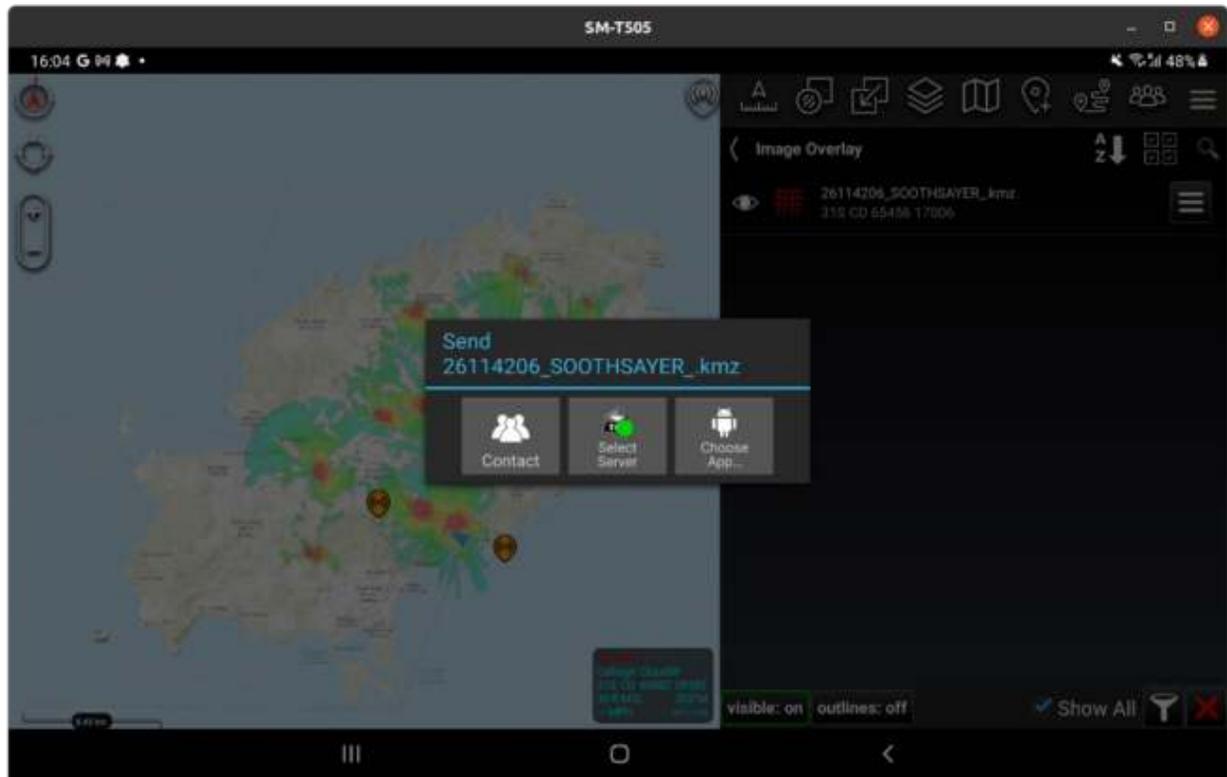
Layers generated with the plugin are saved as KMZ on the SD card in the atak/SOOTHSAYER/KMZ/ folder. You can load them into ATAK as standard KMZ overlays using the “Local import” dialog or export them to another viewer such as WinTAK or TAK-X. When prompted for a choice of the import method, choose “Image Overlay File”.







To send a KMZ to another TAK user, load it onto your map to validate it's the right one, then using ATAK's native send functionality, click the 3 bars to the right of the selected layer to open the send dialog. From here you can choose to send it to a contact, server or third party app eg. Bluetooth or Google Drive.



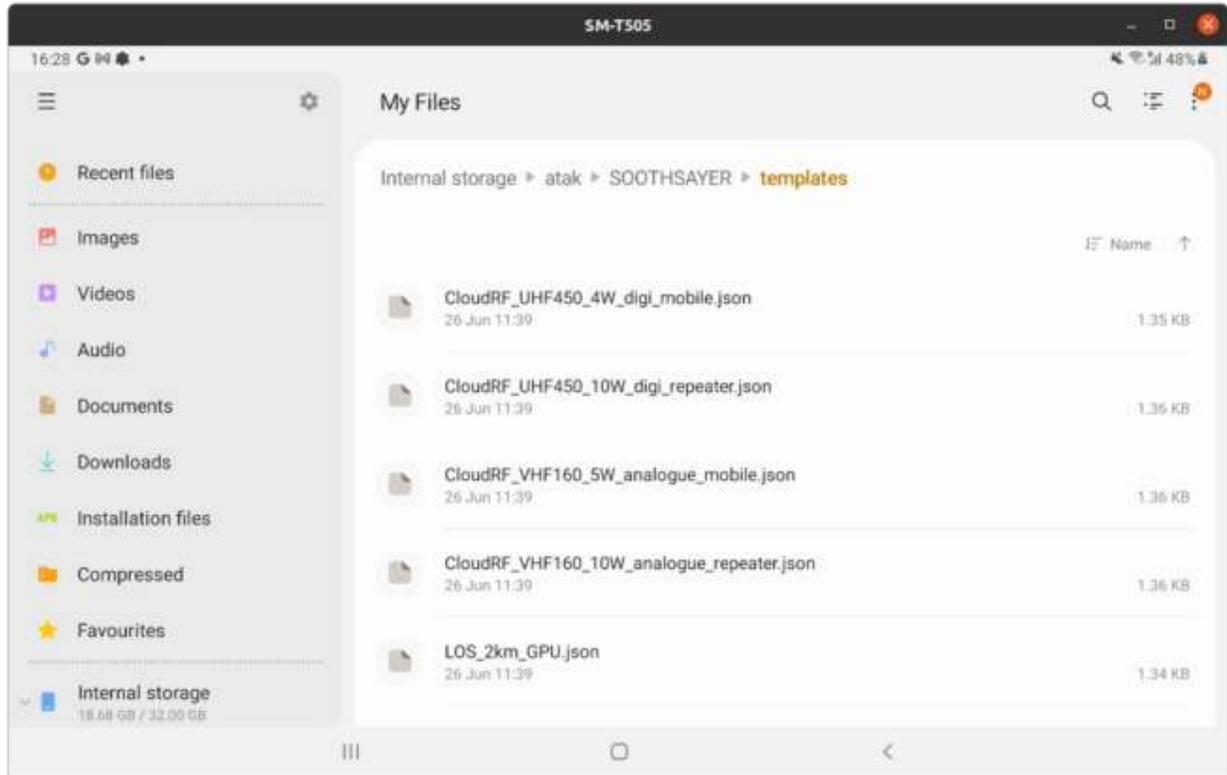
## 6.7 Radio Templates

Templates are synchronised after you login with your account.

To add more radio systems, place your CloudRF/SOOTHSAYER JSON templates in the `atak/SOOTHSAYER/templates` folder. You can download templates from the top left corner in the CloudRF/SOOTHSAYER web interface. Templates in the plugin will refresh when you open it.

A template can be edited within any text editor and must conform to the CloudRF API specification detailed at <https://cloudrf.com/documentation/developer/>

At the time of writing both the old environment variables (`cll,clm,clt`) and the new ones (`elevation,landcover,clutter,profile`) are accepted.



### 6.7.1 Example DMR template

This template is for a 700MHz handheld radio with 2W of RF power, a CPU engine (engine: 2) with the ITM model, 3km radius and 5m resolution.

```
{
  "version": "CloudRF-API-v3.8.2",
  "reference": "https://cloudrf.com/documentation/developer/",
  "template": {
    "name": "Motorola DMR 2W",
    "service": "CloudRF https://api.cloudrf.com",
    "created_at": "2023-04-12T06:35:40+00:00",
    "owner": 1,
    "bom_value": 0
  },
  "site": "Site",
  "network": "MOTO",
  "engine": 2,
  "coordinates": 1,
  "transmitter": {
    "lat": 51.96403,
    "lon": -2.113952,
    "alt": 2,
    "frq": 700,
    "txw": 2,
    "bwi": 0.1,
  }
}
```

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```
    "powerUnit": "W"
  },
  "receiver": {
    "lat": 0,
    "lon": 0,
    "alt": 1,
    "rxg": 2,
    "rxs": -100
  },
  "feeder": {
    "flt": 1,
    "fll": 0,
    "fcc": 0
  },
  "antenna": {
    "mode": "template",
    "txg": 2.15,
    "txl": 0,
    "ant": 39,
    "azi": 0,
    "tlt": 0,
    "hbw": 1,
    "vbw": 1,
    "fbr": 2.15,
    "pol": "v"
  },
  "model": {
    "pm": 1,
    "pe": 2,
    "ked": 1,
    "rel": 95
  },
  "environment": {
    "clm": 0,
    "cll": 0,
    "clt": "Minimal.clt"
  },
  "output": {
    "units": "m",
    "col": "LTE.dBm",
    "out": 2,
    "ber": 1,
    "mod": 0,
    "nf": -124,
    "res": 5,
    "rad": 3
  }
}
```

## 6.7.2 Example GPU 'line of sight' template

This template uses the more powerful GPU engine (engine: 1) to model line of sight out to 3km at 2m resolution (if your area of interest has 2m LiDAR).

```
{
  "version": "CloudRF-API-v3.8.2",
  "reference": "https://cloudrf.com/documentation/developer/",
  "template": {
    "name": "LOS_3km_2m_GPU",
    "service": "SOOTHSAYER https://185.11.204.106",
    "created_at": "2023-05-05T15:43:42+00:00",
    "owner": 8,
    "bom_value": 0
  },
  "site": "Site",
  "network": "TALON",
  "engine": 1,
  "coordinates": 1,
  "transmitter": {
    "lat": 50.806335,
    "lon": -1.112032,
    "alt": 2,
    "frq": 1250,
    "txw": 2,
    "bwi": 0.1,
    "powerUnit": "W"
  },
  "receiver": {
    "lat": 38.913,
    "lon": 1.45,
    "alt": 1,
    "rxg": 2,
    "rxs": -90
  },
  "feeder": {
    "flt": 1,
    "fll": 0,
    "fcc": 0
  },
  "antenna": {
    "mode": "template",
    "txg": 2,
    "txl": 0,
    "ant": 39,
    "azi": 0,
    "tlt": 0,
    "hbw": 1,
    "vbw": 1,
    "fbr": 2,
    "pol": "v"
  },
  "model": {
```

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```

    "pm": 7,
    "pe": 2,
    "ked": 0,
    "rel": 50
  },
  "environment": {
    "clm": 0,
    "cll": 0,
    "clt": "Temperate.clt"
  },
  "output": {
    "units": "m",
    "col": "GREEN.dBm",
    "out": 2,
    "ber": 1,
    "mod": 0,
    "nf": -124,
    "res": 2,
    "rad": 3
  }
}

```

### 6.7.3 Template limits

As a server based system, limits for APIs and accounts are set at the server. For premium users this means a 500km / 310Mi radius and a resolution between 1m / 3ft. The combination of these two will determine the resulting file size. *The API will automatically reduce unreasonable parameters to fit within memory.*

As well as memory, a large layer needs more bandwidth to communicate and is generally not recommended. You should be aiming for smaller layers which can be generated and communicated quickly. You can still do a large radius eg. > 100km, but will need to offset your resolution to keep the total size less than 1 mega pixels (1000 x 1000px).

As a rule of thumb, multiply the radius in km by 2 to get the resolution in metres

The following guide is recommend for practical IMP ATAK templates:

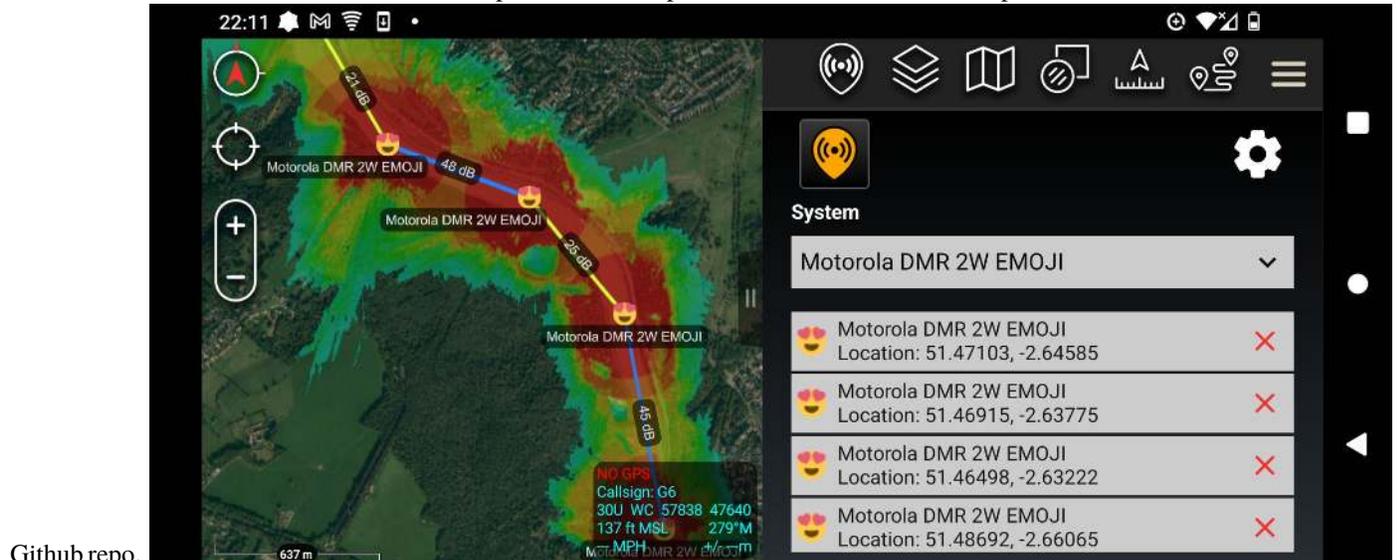
Desired radius km	Recommended max resolution m
1	2
2	4
5	10
10	20
20	40
50	100
100	200
150	300

### 6.7.4 Giant airborne calculations

The API can model out to 500km radius for aircraft. If you set 500km as the radius with 100m resolution you are generating a 10k x 10k image measuring 100 mega pixels! This will take a long time to make, a long time to download and then will crash ATAK, and any other Android map for that matter. To do this scale of calculation, use a resolution of 300m which makes a more digestible 11MP image. Better still reduce the radius to the radio horizon which is 357km for an aircraft at 10,000m (33,000ft).

### 6.7.5 Custom icons

You can insert a custom icon into a JSON template as a 48x48px base64 encoded PNG. Examples are included on the

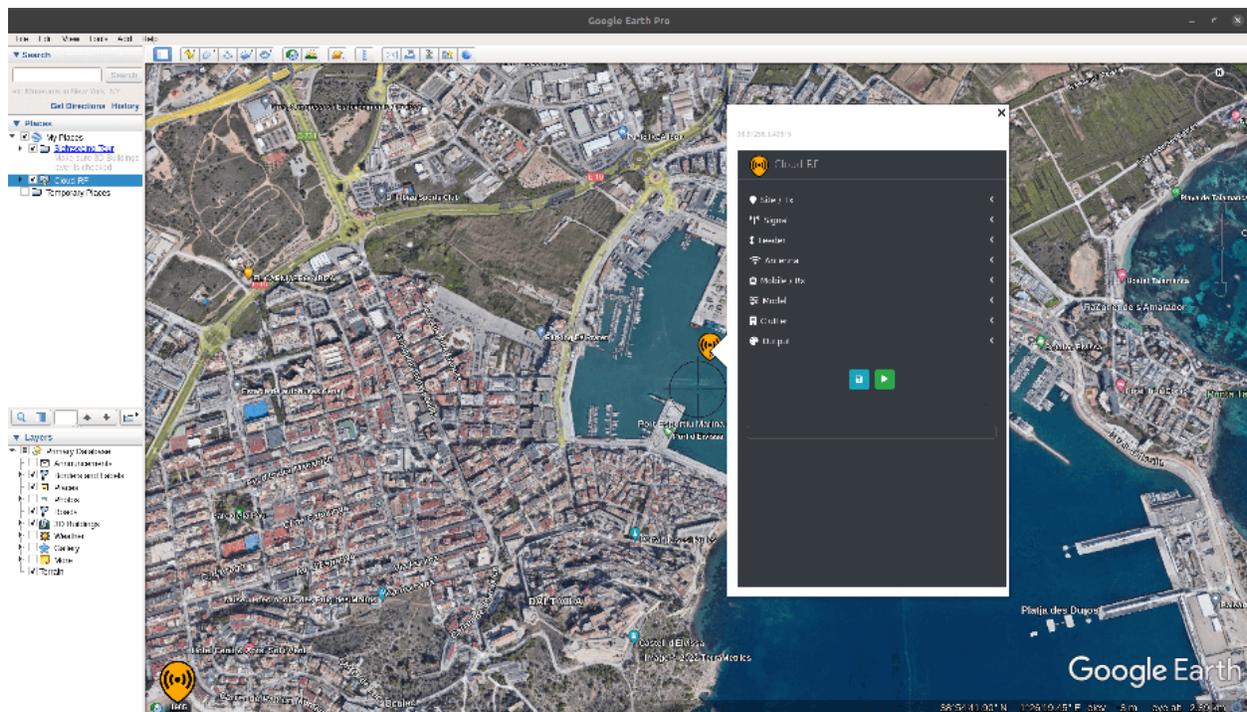


Github repo.

## GOOGLE EARTH™ INTERFACE

The Google Earth interface is a unique and powerful radio planning plugin for Google Earth™.

The software is entirely server based so end users only need to open a Keyhole Markup Language (KML) overlay in Google Earth to use it.



It's ideal for organisations already using Google Earth as it can be deployed rapidly to users as a URL and the KML output is visualised along with 3D terrain and existing data layers, for example network infrastructure.

The system's terrain data, radio templates, antenna patterns and ground clutter are all managed server side.

## 7.1 Requirements

- Windows, Linux or Mac
- Google Earth Pro
- Web browser with Javascript and cookies enabled
- Internet connection

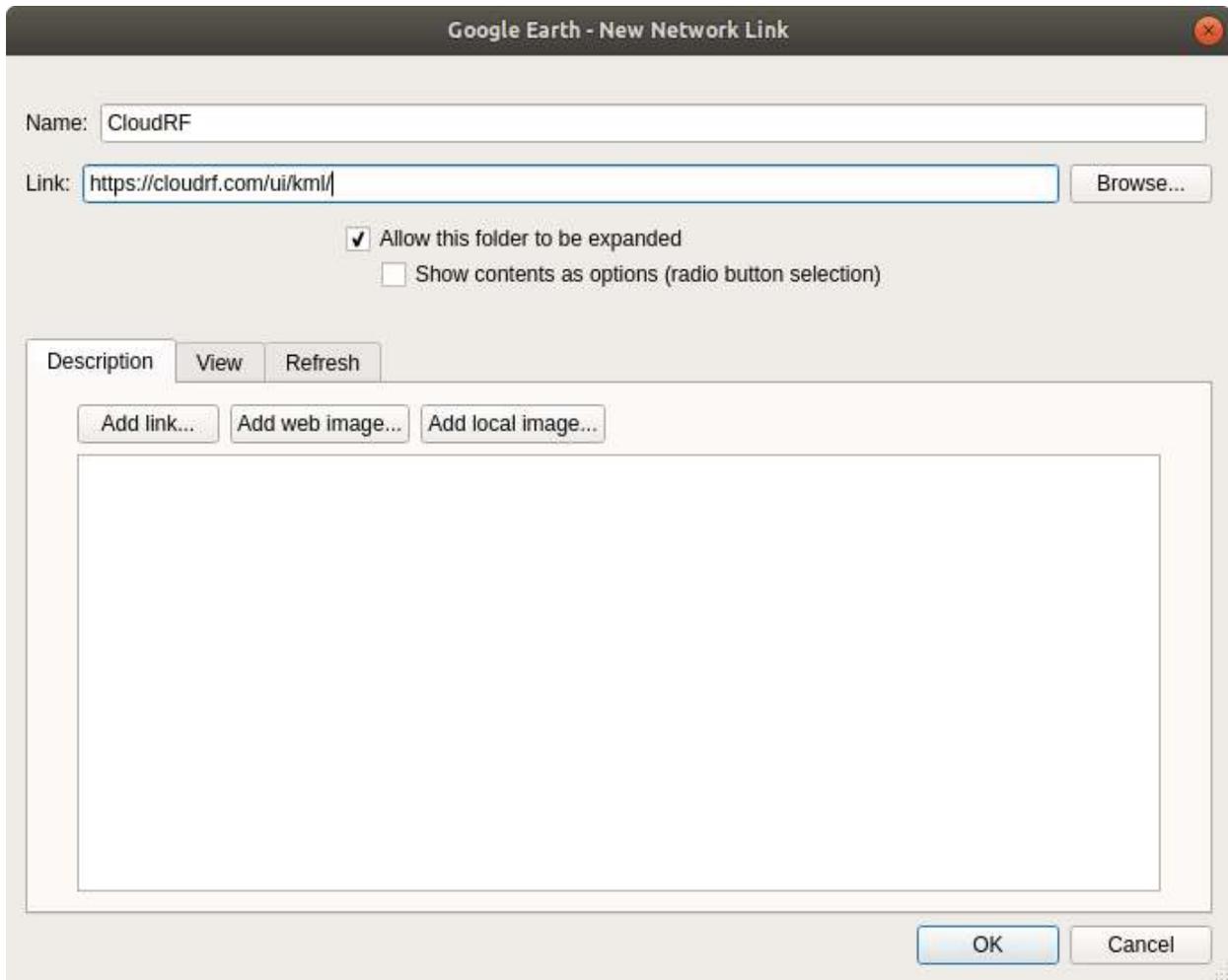
## 7.2 Google Earth Settings

Within Google Earth options, ensure the following are set:

- Memory cache: 50Mb
- Disk Cache: 2000Mb
- Errors: Show prompts for all errors
- Placemarks: Allow access to local files and data
- Cookies: Save cookies to disk

Setting a large disk cache and small memory cache means more imagery is saved to your computer so you can view layers offline.

To open it, add a network link in Google Earth for `https://SERVER/ui/kml/` where `SERVER` is either `cloudrf.com` for the public service *or* your server's IP address for a private server.



## 7.3 Authentication

Authentication is required to control access to the service and ensure a higher and more personal quality of service for all. When the layer is opened for the first time, an authentication dialogue will appear prompting the user to enter a username and password.



Once opened, you will be prompted for a username and password.

After that you will receive several sub-layers providing different functionality or reference data.

## 7.4 Operation

Crosshairs will be visible in the centre of the view and mark where your site/tower will be. To perform a new calculation, click the floating marker in the middle of the map screen to open up a pop-up form, then enter system and environmental parameters and finally click a button to initiate calculation of the result. The variables are all passed to the API for processing. The server produces the overlays and then displays a KMZ file link which needs to be clicked to be viewed.

The KMZ can also be opened in other GIS applications which support KML 2.2.

## 7.5 Inputs

The input settings for the form are exactly the same as the web interface which are described *here*.

## 7.6 Known issues

### 7.6.1 Marker is Offset

The centre of the map is determined by the screen bounds so you must be looking straight down, not an oblique angle. You can still fly around later but for accurate planning ensure your view is perpendicular.

#### Solution

In settings, ensure you **uncheck automatically tilt the view** when going close to the earth.

### 7.6.2 The Red “X” of Doom

Google Earth had an update between 7.1.8 and 7.3 which changed KMZ handling in the name of security.

KMZ and “missing files” issues feature in change-log messages around this time.

A KMZ file with zipped content would be repackaged and the content hyperlinked to the domain from where it came. This results in a big red cross.

#### Solution

Fetch your KMZ files with a browser. Download them to your computer and you can then work with them as before.

This is as simple as visiting your archive, downloading the KMZ files and then you can open them in Google Earth. Google Earth doesn't know which domain the files came from so trusts them as 'local' files.

## TAK SERVER INTERFACE



Team Awareness Kit (TAK) is a US Government situational awareness application, available for free on Android (ATAK), Windows (WinTAK) and iOS (iTAK).

As a network capability a TAK server is required to get the most benefit. The official government OG server is now in the public domain and supported by our SOOTHSAYER chatbot which provides a scalable network-plugin for all EUDs on a TAK server.

*The capability was originally designed around taky, an open source TAK server, but since OG was published it was reworked to use the Marti API so, officially, only supports the OG TAK server.*



Links

[TAK Server install with Docker](#)

[Best site analysis demo](#)

[TAK server docker](#)

## 8.1 Supported versions

- ATAK  $\geq 4.3$
- WinTAK  $\geq 4.5$
- OG TAK server  $\geq 4.5$

## 8.2 Design

A core function of TAK is instant messaging with its Cursor-on-Target XML schema 'CoT'. CoT allows users to exchange layers as well as freehand messages making it easy to interact with an End User Device (EUD) via XML messages.

The SOOTHSAYER chatbot simulates a client to marshal CoT XML commands and shapes to our JSON API. Responses are packaged as data packages which are uploaded directly to a TAK server from where clients pull them down. The client never directly interfaces with the CloudRF API since all communications are with the TAK server.

## 8.3 SOOTHSAYER chatbot setup

If you can connect an EUD to your own TAK server, you can connect the chatbot to it as a client also. You will need to create a user with certificates on the server for the bot eg. chatbot1 and then copy the certificates to use in PEM format. SSL certificates are employed to authenticate both the server and the bot and secure communication.

## 8.4 Certificate generation on TAK server

You must create a certificate pair for the secure chatbot on the TAK server. The makeCert.sh script will create the certificates in the required .pem format:

```
root@takserver:/opt/tak/certs# ./makeCert.sh client chatbot1
```

Certificates are checked for formatting and compatibility so take care to upload the correct type. Upload your files, set your server address and port and click submit. A check will be performed and if they are good, you can attempt to connect to the server by clicking “Start Chatbot”.

**SOOTHSAYER™ Chatbot 1**

Complete the form to activate an RF planning chatbot client for your TAK server

TAK Server address  
127.0.0.1  
This must match your certificate's Common Name (CN). Tested with TAK server v 1.0, other versions may have unexpected results.

CoT SSL port  
8089

Marti API Port  
8443

TAK Server CA Certificate PEM  
Browse... No file selected.

TAK Client Certificate PEM  
Browse... No file selected.

TAK Client Certificate Key  
Browse... No file selected.

TAK Client Certificate Key Passphrase  
\*\*\*\*\*

Submit

Start Chatbot

Chatbot Logs

2023-04-19 14:28:58.565 - CRITICAL - root could not connect to TAK server, TAK server address: 139

### 8.4.1 TAK Server CA certificate

This is the public certificate authority (CA) which was used to sign the server's certificates eg. ca.pem. This is needed to trust the server.

### 8.4.2 TAK client certificate

This is the user/bot public certificate with a .pem extension. Found in ../tak/certs/files/

### 8.4.3 TAK client key

This is the user/bot private key with a .key extension. Found in ../tak/certs/files/

Once connected it will be available in the chatroom for all EUDs who share the same group as SOOTHSAYER. Access control to the bot can be managed with TAK groups.

## 8.5 Testing communications

When the certificates have been uploaded and validated, communications can be started by clicking the green ‘Start chatbot’ button. The server will need to be able to communicate with the TAK server which may require a firewall rule depending on your setup. A successful connection will report messages within the console showing “Updating SOOTHSAYER bot location”. The bot will be positioned to be nearby active users based upon observed locations.

TAK Client Certificate Key Passphrase

.....

Submit

Start Chatbot

Stop Chatbot

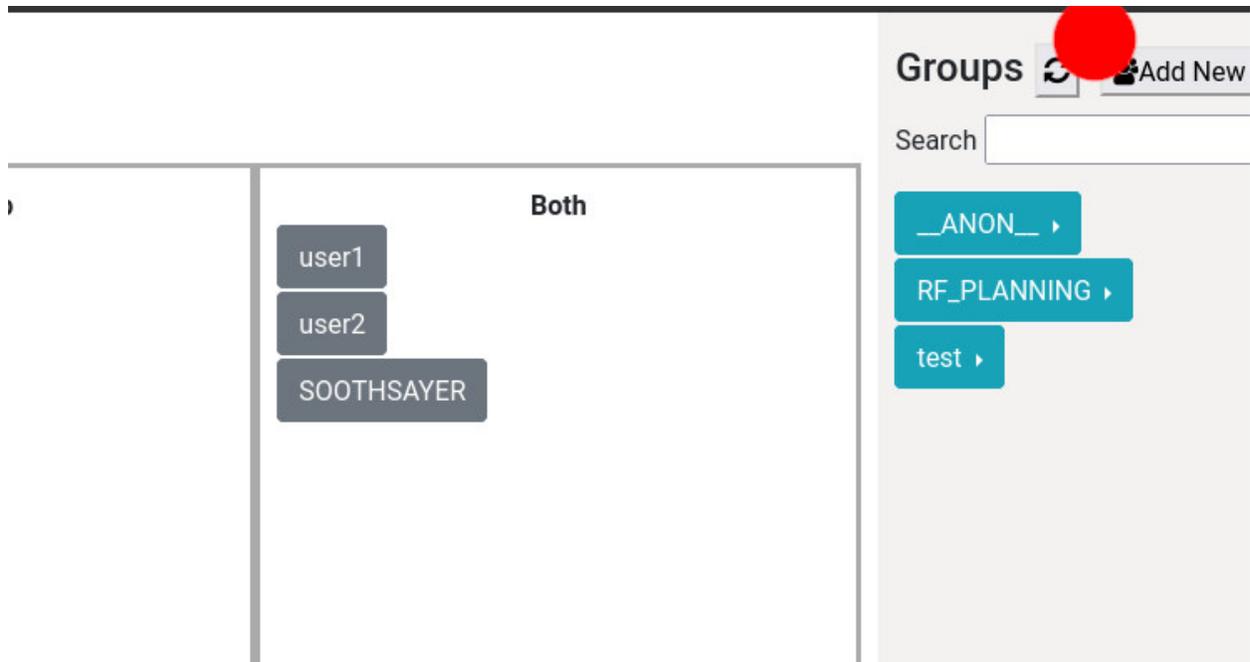
### Chatbot Logs

```
2023-04-24 20:51:01,384 - INFO:root New SOOTHSAYER location: (52.██████████, -2.██████████)
2023-04-24 20:51:01,381 - INFO:root Updating SOOTHSAYER bot location.
2023-04-24 20:50:51,355 - INFO:root New SOOTHSAYER location: (52.██████████, -2.██████████)
2023-04-24 20:50:51,352 - INFO:root Updating SOOTHSAYER bot location.
2023-04-24 20:50:41,326 - INFO:root Successfully connected to TAK server 139.██████████ Forwarding API requests to
https://api.cloudrf.com
2023-04-24 20:50:41,310 - INFO:root New SOOTHSAYER location: (52.██████████, -2.██████████)
2023-04-24 20:50:41,303 - INFO:root Updating SOOTHSAYER bot location.
2023-04-24 20:50:41,253 - INFO:root Resetting TAK UID 1
```

## 8.6 TAK server administration

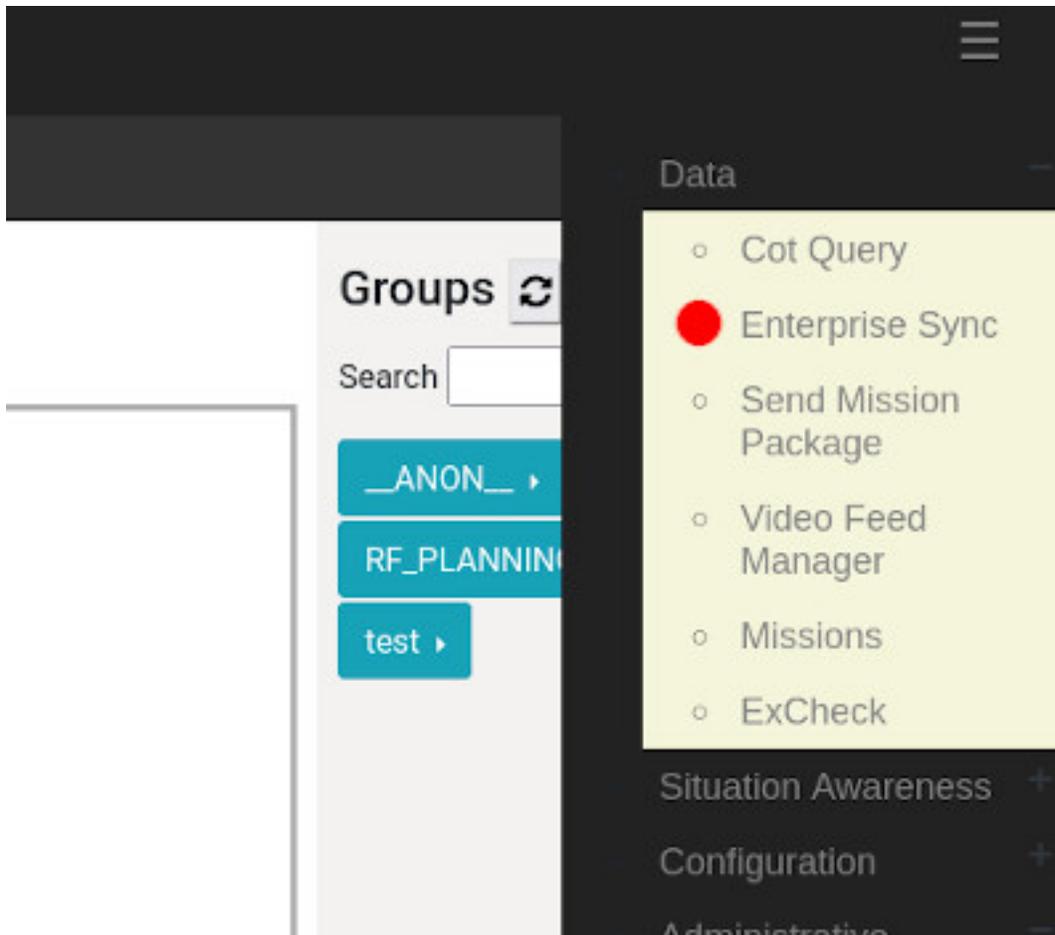
### 8.6.1 Groups

Once connected, the bot will join the default `_ANON_` group on the server and will be available to anyone in that group. This can be ok but for more control, create a group (Administration menu > Groups) for RF planning and explicitly add users to it.



### 8.6.2 Housekeeping

During use, the server will store .ZIP data packages containing RF layers like any other TAK data package. They can also be communicated to other TAK users using generic TAK server methods and sync plugins. These DP files can be found, downloaded, and deleted within the Enterprise Sync (File manager since 4.9) interface (Data > Enterprise Sync)



## 8.7 SOOTHSAYER Commands

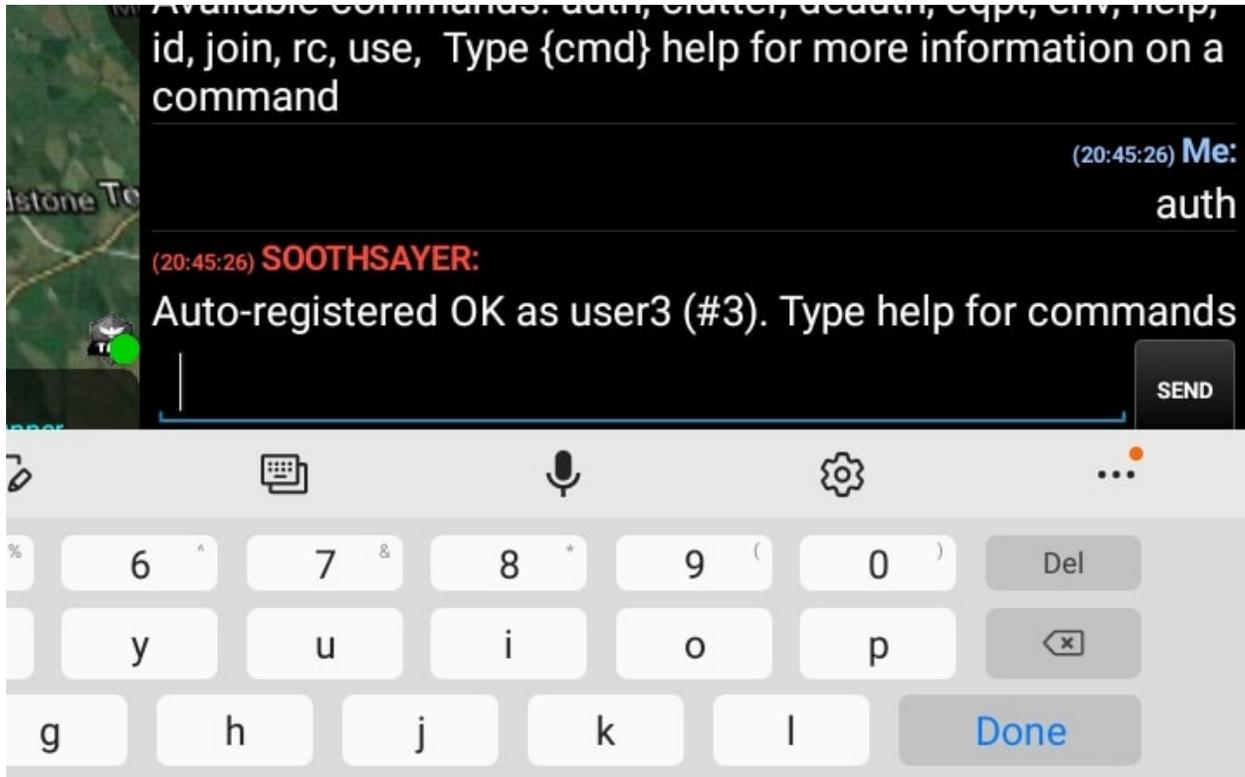
Interaction with SOOTHSAYER is done via the native ATAK chatroom. Select SOOTHSAYER and send a `help` command to test connectivity.

Commands for the bot are as follows:

### 8.7.1 auth - Authorisation

Before you can start RF planning you must authorise your device to the server. SOOTHSAYER users can just type `auth` to associate their device. This is needed so all subsequent messages can be correctly routed to the EUD.

A successful authorisation will generate a welcome user response.



### 8.7.2 clutter

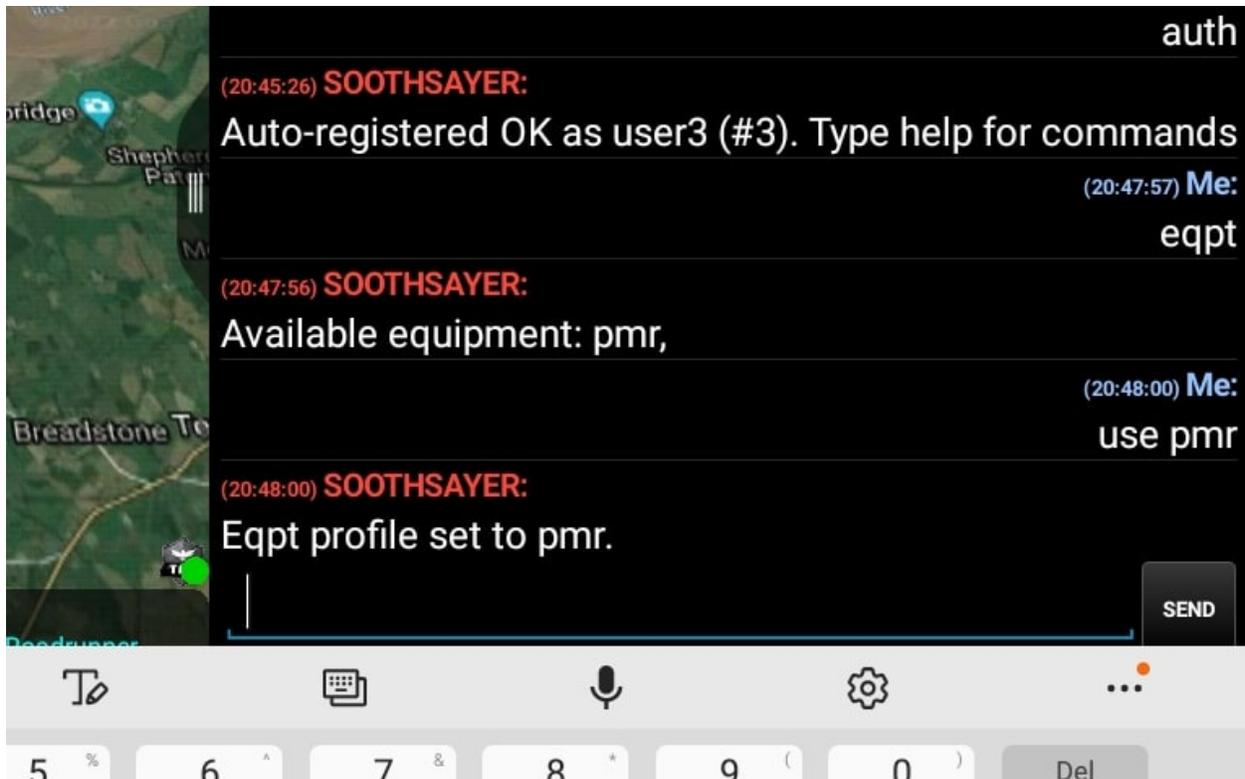
Fetch a KMZ layer with your custom clutter polygons with the `clutter` command. These must have been added to your account.

### 8.7.3 deauth

Detach this device from the account to free up a slot on the server with the `deauth` command.

### 8.7.4 eqpt

SOOTHSAYER abstracts complexity to server based templates so users need only pick their equipment. Type `eqpt` to list templates available to your account. To create a template see the saving *templates function* within the web interface. To use an item type use followed by the `eqpt` you wish to use, for example use `pmr` for example to select a `pmr` template.



### 8.7.5 env

List environmental profiles. Use one with `env {profile}`, for example `env minimal.clt`.

### 8.7.6 heat

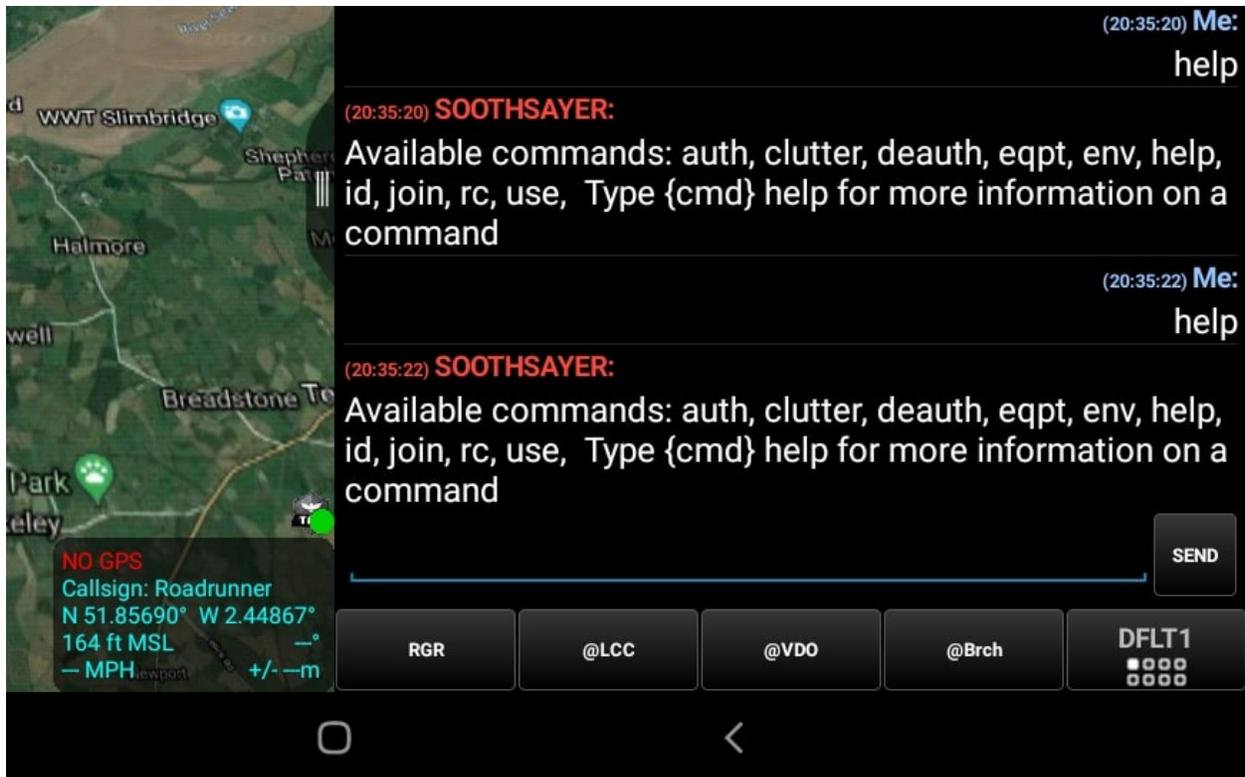
Enable or disable the network heatmap for the multisite coverage.

*This powerful feature requires a GPU so either a CloudRF Gold plan or a private server is required.*

### 8.7.7 help

For more information on a command type the command followed by `help`, for example `eqpt help` to get information about the `eqpt` command.

You can also just send `help` on its own to get a list of available commands.



### 8.7.8 id

Returns useful information about your device with the `id` command. This includes configuration and associated/followed networks.

### 8.7.9 join

Associate this device with a radio network to enable network analysis tools, for example `join blue`.

### 8.7.10 links

Enable or disable links for the multisite mode. Uses the CPU engine.

### 8.7.11 rc

Perform a radio check against a network, for example `rc blue`.

### 8.7.12 use

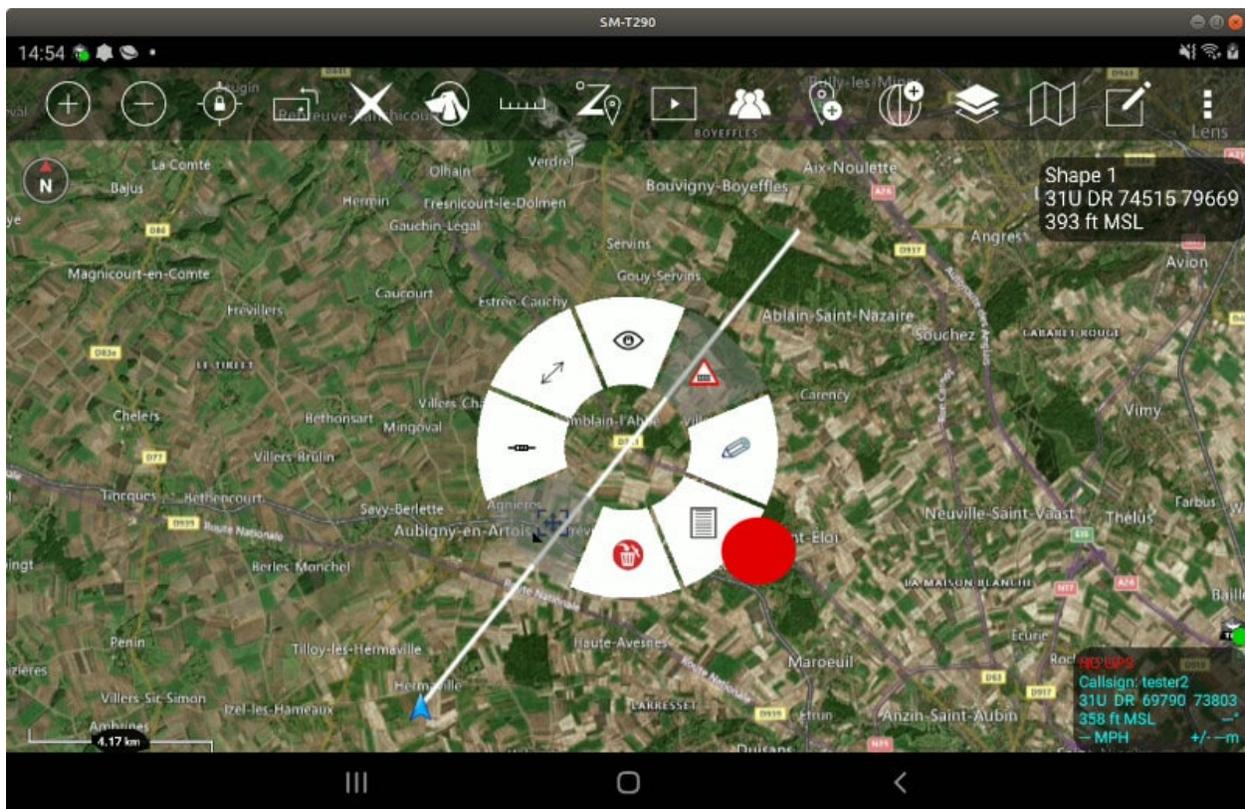
Use a piece of equipment, for example use `vhf`. List the equipment with the `eqpt` command. Not case-sensitive.

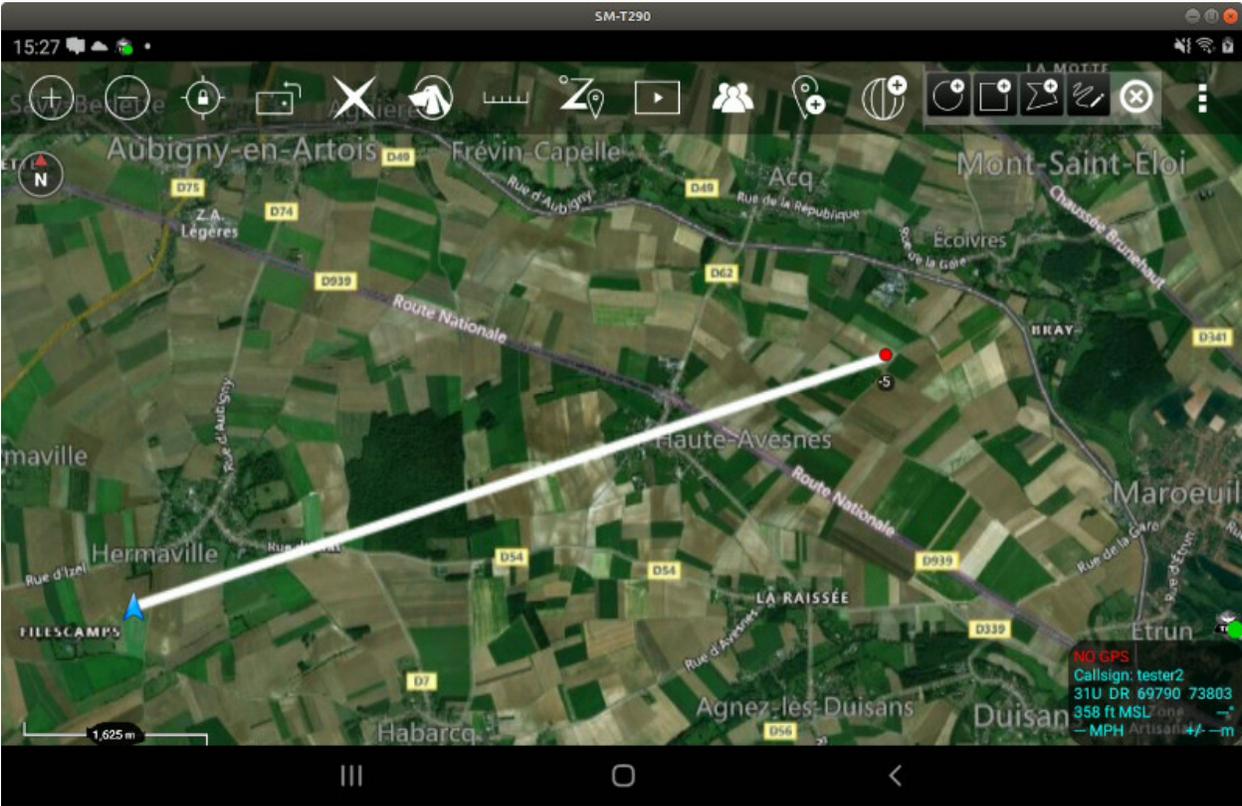
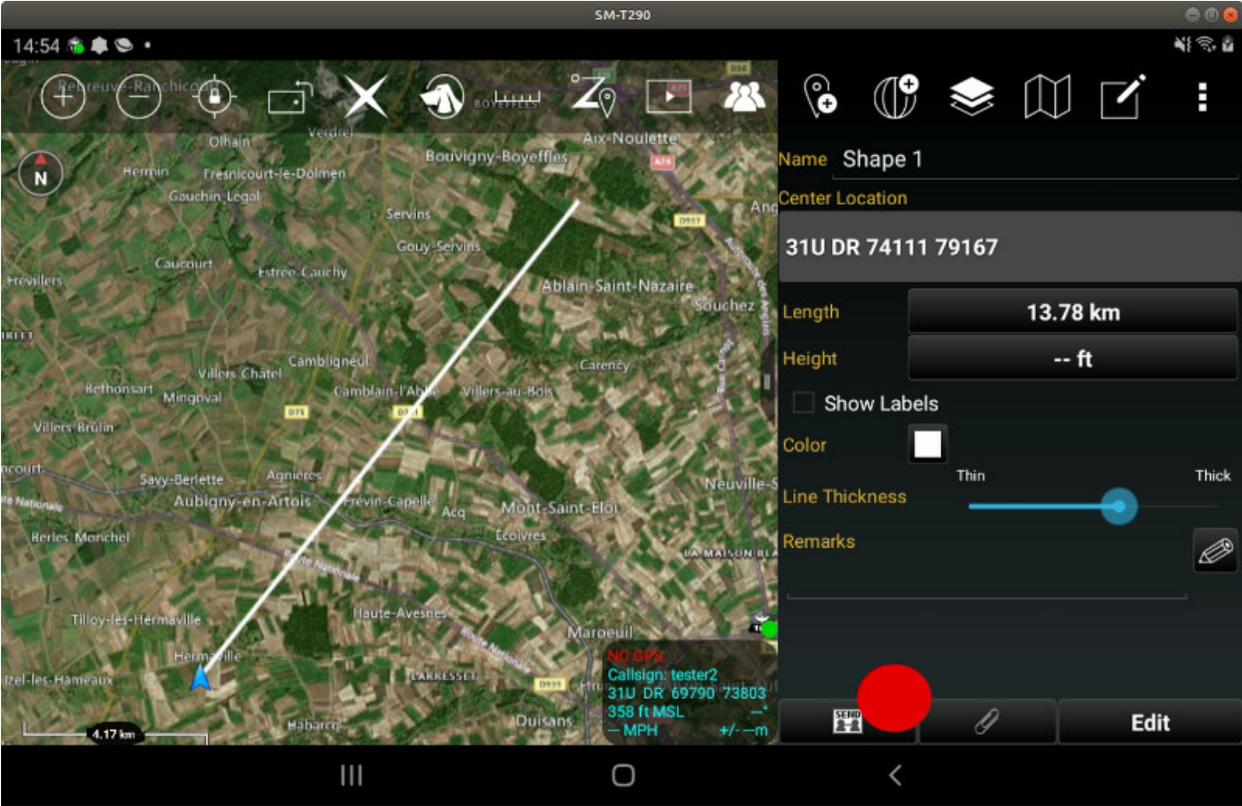
## 8.8 Functions

### 8.8.1 Point to Point (path profile)

Using the ATAK draw tool, select polygon then draw a line on the map from one point to another. Select end then click on this line to open up the radial menu.

Send the line to SOOTHSAYER which will return the signal-to-noise ratio at the distant point based upon your chosen template.

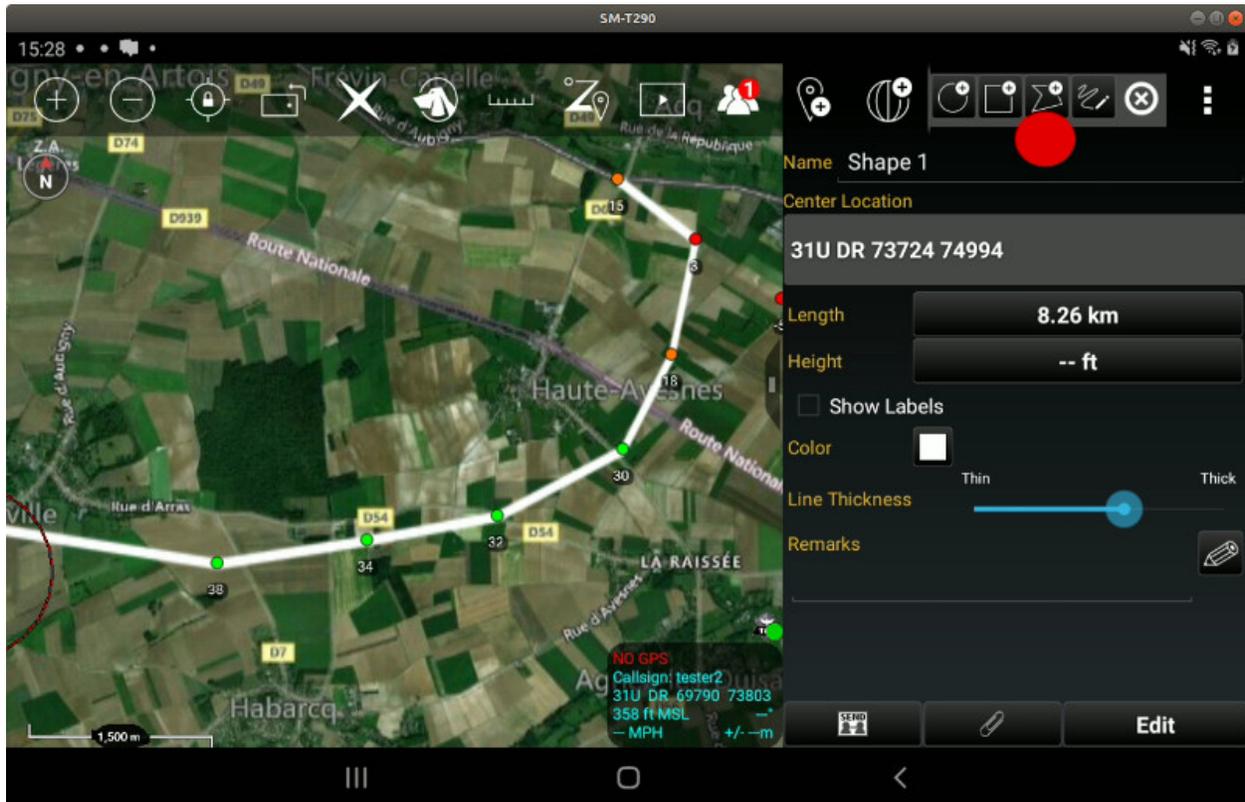




## 8.8.2 Point to Points

If you are not associated to a network or have requested to work alone (send `join self`) you will get coloured spotmap markers showing the signal as seen from the start point instead of coloured links. Using the ATAK draw tool, select polygon then draw a line on the map from one point to several other points. Select end then click on this line to open up the radial menu.

Send the line to SOOTHSAYER which will return the signal-to-noise ratio at all the points / vertices on the line. Each tested point will be simulated as the transmitter back to point 0 (receiver).



## 8.8.3 Multisite (MANET)

This feature has two outputs; links and coverage. You can toggle both these outputs using the chat commands `links` and `heatmap`. Links will reveal SNR polyline links between nodes and coverage will display the actual multipoint coverage around all the nodes as a single layer.

*The network heatmap feature requires a GPU so either a Gold CloudRF plan or a private server is needed.*

Using the ATAK polyline tool, draw a shape where each point/vertex represents a radio in the network.

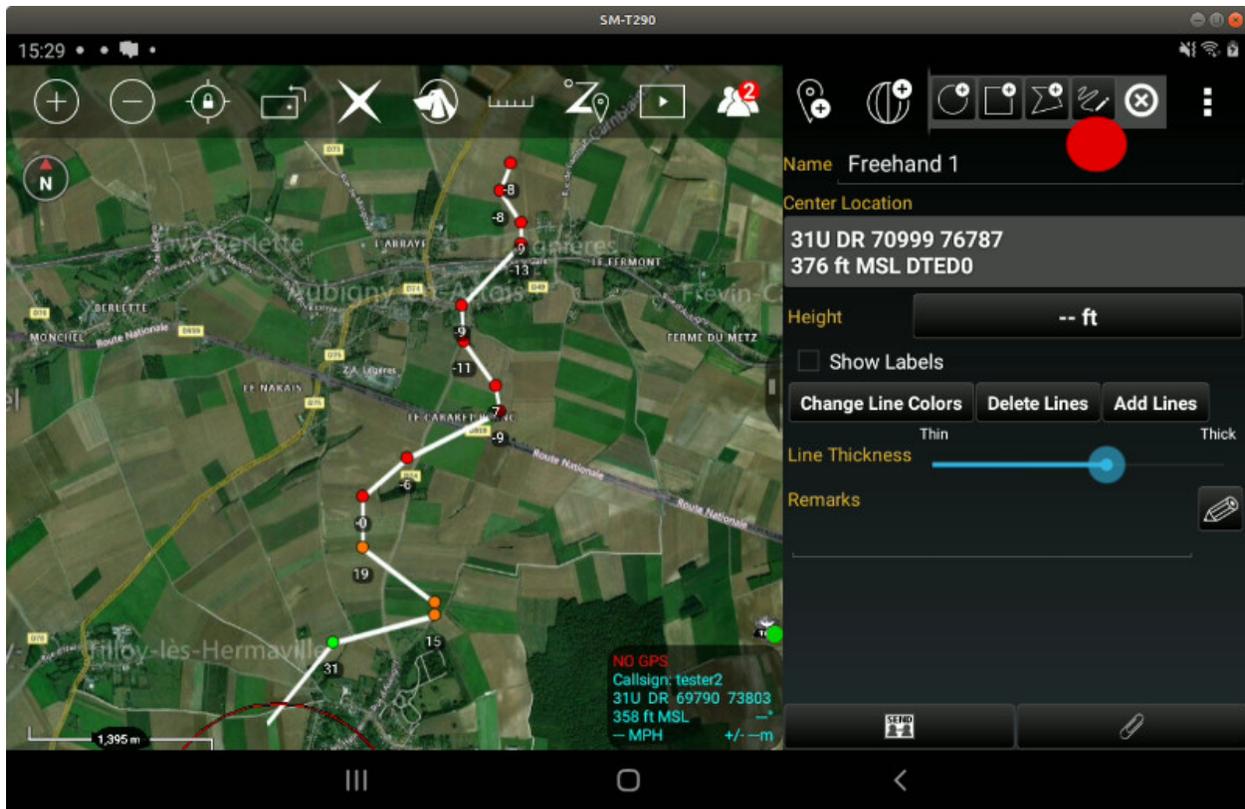
Send the polyline to SOOTHSAYER which will return a coverage layer for the network.



### 8.8.4 Route analysis

Using the ATAK telestration tool (scribble), draw a freehand route on the map from a start position. Select end then click on this line to open up the radial menu.

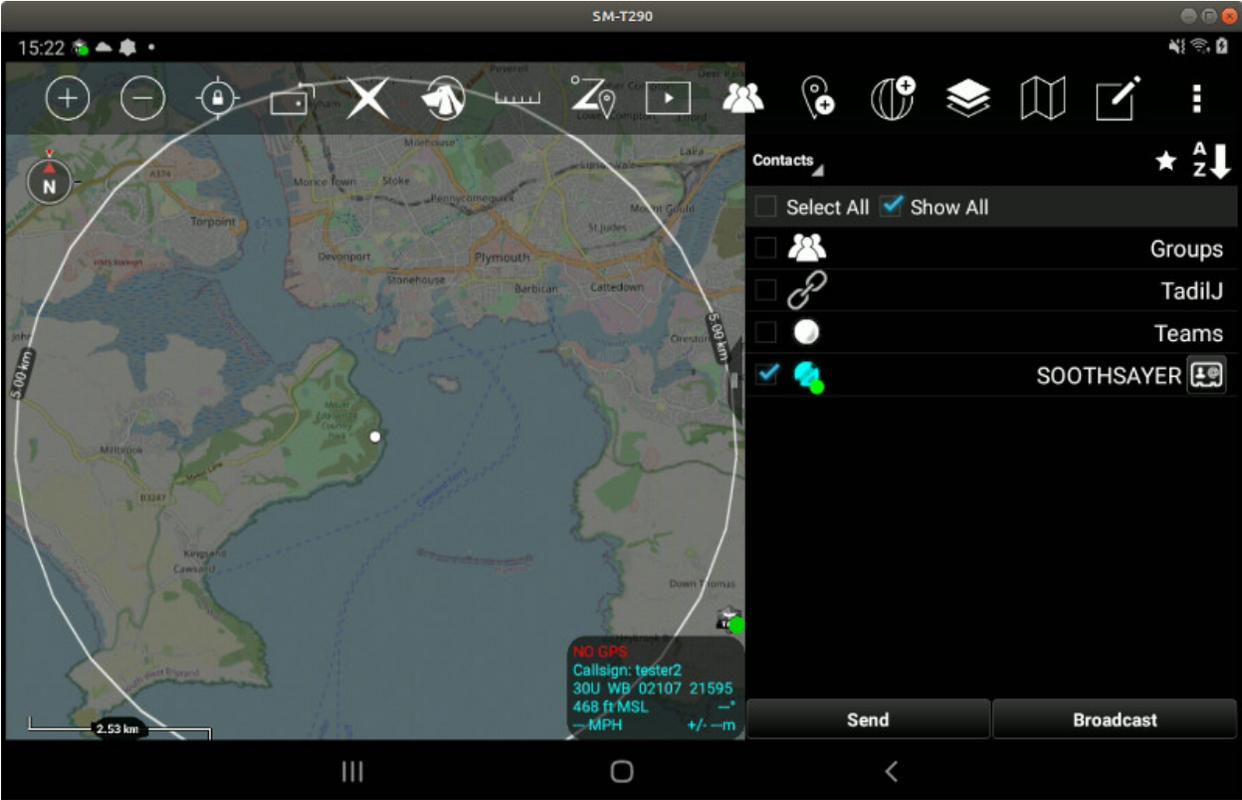
Send the line to SOOTHSAYER which will return the signal-to-noise ratio at each turn upon the route based upon your chosen template.



### 8.8.5 Point to Multipoint (area coverage)

Using the ATAK circle tool, create a circle with a desired radius representing RF coverage and send the circle to SOOTHSAYER.

This is potentially CPU intensive so can take several seconds to complete. Once complete an image overlay will appear on your map, styled according to the colour key in the template.



### 8.8.6 Best Site Analysis

Using the ATAK polygon tool, create a polygon around an area of interest then send the completed polygon to the SOOTHSAYER. For best results prepare a template which uses the free space path loss model, no diffraction and heights close to the ground eg. 2m. This will produce the dynamic range of results the algorithm needs to grade good and bad sites.

A data package will appear containing the resultant heatmap which is added as a layer.



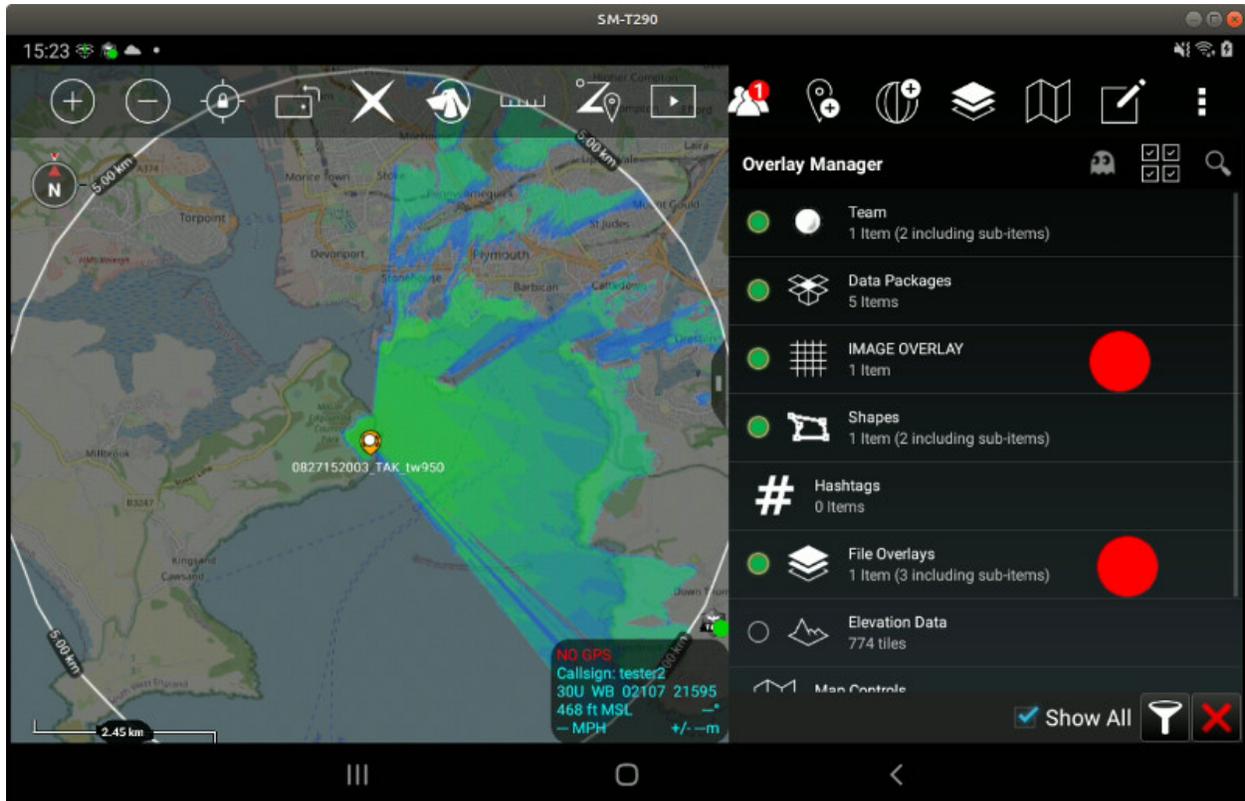
### 8.8.7 Clutter

If you have created custom clutter within the web interface AND your template has custom clutter and landcover enabled, you can use it as 3D polygons in ATAK. Send the clutter command to the bot to download a KML with your items.



## 8.8.8 Layer management

If you create lots of area coverage plots and need to hide or share some, you can manage them using the ATAK layers menu. The actual coverage layer is listed as an image overlay and the placemark is a file overlay.



## 8.8.9 Traffic light colours

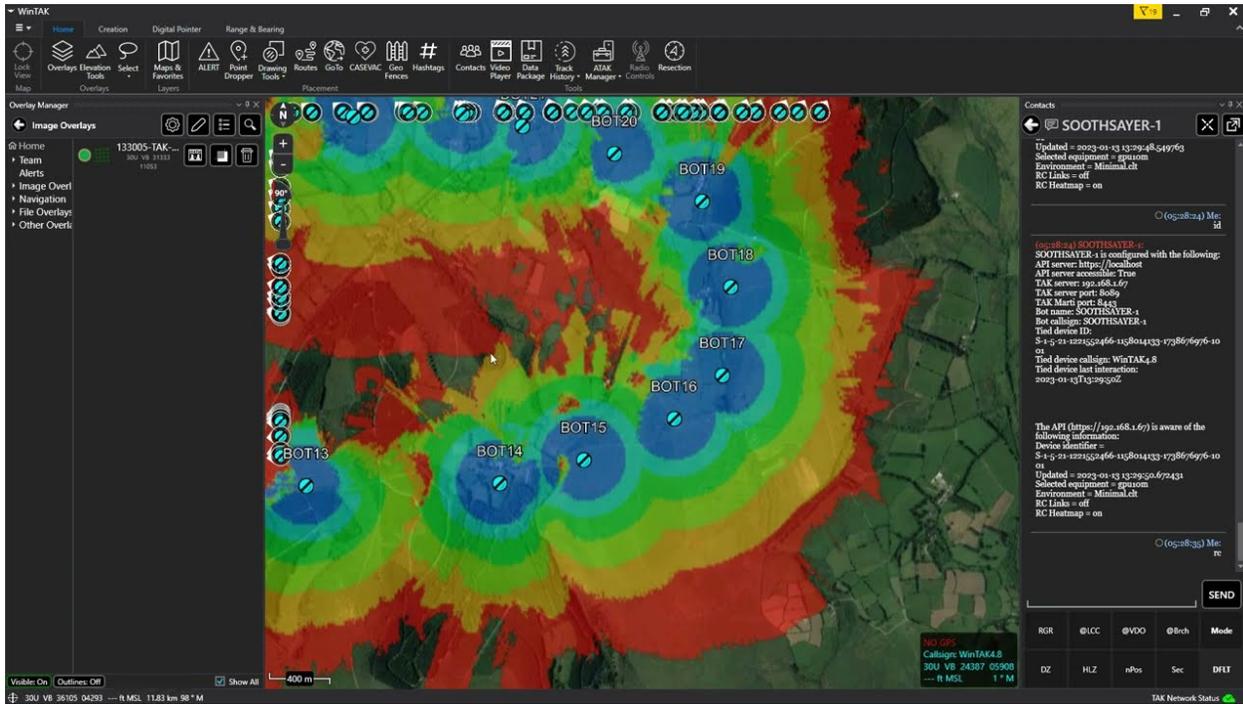
If a colour key is not defined in a template, default Signal-to-Noise ratios are represented with red, amber or green colours or lines. These correspond to up to:

- RED =  $\leq 15$ dB
- AMBER = 15dB to 30dB
- GREEN =  $> 30$ dB

Levels are all relative to the noise floor which is defined within a template. A noise floor of -100dBm will therefore have an amber threshold between -85 to -70dBm.

### 8.8.10 WinTAK

Works in WinTAK also. This may be preferable for planning larger networks and has been tested through the Multisite API with 160 simulated clients. A video is below.



[WinTAK multisite demo on YouTube](#)

The CloudRF API offers a powerful and scalable service to model almost any radio hardware, anywhere. When integrated into another system you can automate modelling to save significant time and money and realise capabilities not possible with a modest budget. The next generation performance also unlocks new analysis possibilities allowing “real time” decision making for autonomous vehicles and drones, for example.

#### Use cases

- Automate customer qualification based upon a zip code
- Robot / drone route selection
- Best site analysis for optimal & economic deployments
- Receiver modelling for signal multi-lateration
- Generation of network coverage maps for marketing or briefing rooms
- Automated regression testing for network changes
- Integration with cognitive radios for smarter site/frequency/power selection based on topography

## 9.1 OpenAPI 3 Schema

For a complete OpenAPI 3 schema of the CloudRF API please consult the [Swagger UI documentation](#).

## 9.2 API Endpoint

For CloudRF users, the API endpoint is `https://api.cloudrf.com`.

Users with a SOOTHSAYER server will have an IP address instead.

### 9.2.1 Security

All requests are encrypted at the transport layer with TLS.

## 9.3 Authentication

Each user has a unique private API key which resembles a long random string of characters. You should protect this key to prevent unauthorised use of your account.

An example of such API key is as below:

```
101-ec94622a4cb939a77101a118c6871d03cea88af3
```

### 9.3.1 API Key Security

It is important to keep your API key secure. Publicly exposing your key can compromise your account, which could result in a loss of data or unexpected charges. A key does not give access to your interface or shop login which is separate.

To keep your API keys secure, follow some best practices:

#### Keys as Environment Variables

Store API keys as environment variables. This has an added benefit of accessing your key via a friendly environment variable name rather than having to remember your full key each time.

**Do not embed API keys directly in code. API keys that are embedded in code can be accidentally exposed outside your circle of trust.**

#### Keys as Files

You can store your API key in a file and make reference to that file each time you need to use your API key.

**If you store API keys in files, store those files outside your application's source tree.**

Doing so helps to ensure that your keys do not end up in your source code version control system. This is particularly important if you use a public source code management system such as GitHub.

### 9.3.2 Using the API Key

The CloudRF API requires API key authentication in the request header. This provides a key-value pair with key as the first value and your personal key as the second, paired value.

For example, [Postman](#) allows you to enter your key from their interface.

## 9.4 API “Hello World!” Getting Started Example

Send this curl request to model coverage for a VHF radio, 2m above the water with 1W of power:

```
curl --location 'https://api.cloudrf.com/area' \  
  --header 'key: YOUR-API-KEY-GOES-HERE' \  
  --data '{  
    "site": "HelloWorld",  
    "network": "Testing",  
    "transmitter": {
```

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```
        "lat": 38.916,  
        "lon": 1.448,  
        "alt": 2,  
        "frq": 160,  
        "txw": 1,  
        "bwi": 1  
    },  
    "receiver": {  
        "lat": 0,  
        "lon": 0,  
        "alt": 2,  
        "rxg": 0,  
        "rxs": -90  
    },  
    "antenna": {  
        "txg": 0,  
        "txl": 0,  
        "ant": 1,  
        "azi": 0  
    },  
    "output": {  
        "units": "metric",  
        "col": "LTE.dBm",  
        "out": 2,  
        "res": 30,  
        "rad": 5  
    }  
}'
```

## 9.5 Example API Requests

Below lists some basic examples of some of the most common types of requests made to the CloudRF API.

For a complete list of available schemas please consult the [Swagger UI documentation](#).

With all requests some values are required and so the response will return any validation errors or any failures should your request not be able to be processed.

## 9.5.1 Area

The area endpoint accepts a JSON object in the request **body** describing your network and will run a point-to-multipoint “heatmap” calculation.

### Request

The below example is for an omni-directional antenna on an 8m mast at 446MHz. The request is sent as a POST request to <https://api.cloudrf.com/area> and it will return a JSON response containing metadata and URLs to image layers for your map.

```
{
  "site": "Harbour",
  "network": "PMR",
  "engine": "2",
  "transmitter": {
    "lat": "38.913767",
    "lon": "1.440017",
    "alt": "8",
    "frq": "446",
    "txw": "1",
    "bwi": "0.1"
  },
  "receiver": {
    "lat": 0,
    "lon": 0,
    "alt": "2",
    "rxg": "2",
    "rxs": "-90"
  },
  "antenna": {
    "txg": "2.15",
    "txl": "0",
    "ant": "1",
    "azi": "0",
    "tlt": "0",
    "hbw": "0",
    "vbw": "0",
    "fbr": "0",
    "pol": "v"
  },
  "model": {
    "pm": "1",
    "pe": "2",
    "ked": "1",
    "rel": "50"
  },
  "environment": {
    "clt": "Minimal.clt",
    "elevation": "2",
    "landcover": "1",
    "buildings": "0",
    "obstacles": "0"
  }
}
```

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```

    },
    "output": {
      "units": "m",
      "col": "RAINBOW45.dBm",
      "out": "2",
      "nf": "-124",
      "res": "20",
      "rad": "8"
    }
  }
}

```

## Response

The PNG\_Mercator image is warped for slippy maps like Mapbox, Leaflet and Google Maps. The PNG\_WGS84 is for globes like Google Earth, Cesium and WinTAK.

```

{
  "kmz": "https://api.cloudrf.com/archive/eFYyWFpUYW0zR1pxcTIyRlRKREQxUT09/kmz",
  "PNG_Mercator": "https://api.cloudrf.com/users/1/0812210016_PMR_harbour.3857.png",
  "PNG_WGS84": "https://api.cloudrf.com/users/1/0812210016_PMR_harbour.4326.png",
  "bounds": [
    39.00613,
    1.532378,
    38.82141,
    1.347656
  ],
  "id": 8191195,
  "sid": "eFYyWFpUYW0zR1pxcTIyRlRKREQxUT09",
  "area": 55.9,
  "coverage": 28.0,
  "key": [
    {
      "l": "-45dBm",
      "r": 37,
      "g": 131,
      "b": 255
    },
    {
      "l": "-55dBm",
      "r": 46,
      "g": 254,
      "b": 187
    },
    {
      "l": "-65dBm",
      "r": 98,
      "g": 254,
      "b": 55
    },
    {
      "l": "-75dBm",

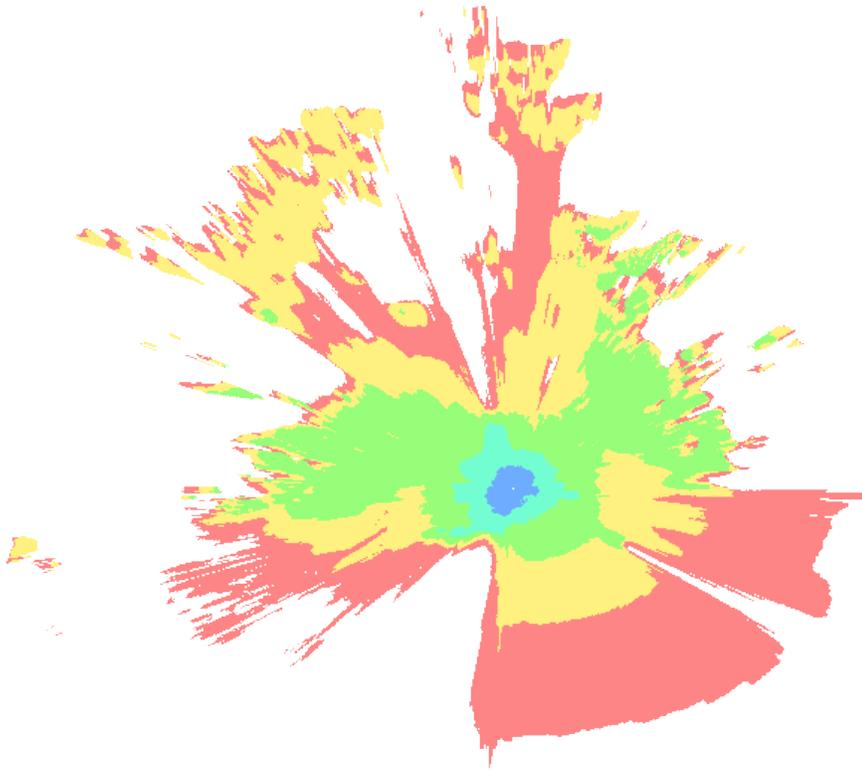
```

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```
        "r": 254,  
        "g": 234,  
        "b": 63  
    },  
    {  
        "l": "-85dBm",  
        "r": 254,  
        "g": 72,  
        "b": 72  
    }  
],  
"elapsed": 2297.0,  
"balance": 23476  
}
```

PNG image with RGB colours which map to the signal levels in the JSON output:



### Go Faster With The GPU Engine

Switch the engine parameter to 1 to use the GPU engine. All other settings are the same.

```
{  
  "site": "Harbour",  
  "network": "PMR",  
  "engine": "1",  
  ... snipped for brevity ...  
}
```

Please note that to be able to make use of the GPU engine you require an active GPU subscription or SOOTHSAYER with GPU functionality enabled.

## Multi-Azimuth Requests

You can specify an array of azimuths to model panels on a cell tower for custom patterns and templates. Pass azimuths in as a comma separated list in quotes like "0,90,180,270". The maximum number of azimuths you can pass in one API request is 90. This works for CPU and GPU engines.

```
{
  "site": "FourPanels",
  "network": "800MHZ",
  "engine": "2",
  "transmitter": {
    "lat": "38.881037",
    "lon": "1.468",
    "alt": "12",
    "frq": "800",
    "txw": "1",
    "bwi": "0.1"
  },
  "receiver": {
    "lat": 0,
    "lon": 0,
    "alt": "2",
    "rxg": "2",
    "rxs": "-90"
  },
  "antenna": {
    "txg": "21",
    "txl": "0",
    "ant": 0,
    "azi": "0,90,180,270",
    "tlt": "1",
    "hbw": "80",
    "vbw": "80",
    "fbr": "21",
    "pol": "v"
  },
  "model": {
    "pm": "11",
    "pe": "2",
    "ked": "1",
    "rel": "50"
  },
  "environment": {
    "clt": "Minimal.clt",
    "elevation": "2",
    "landcover": "0",
    "buildings": "0",
    "obstacles": "0"
  },
  "output": {
    "units": "m",
    "col": "RAINBOW45.dBm",
    "out": "2",

```

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```
"nf": "-120",  
"res": "20",  
"rad": "5"  
}  
}
```



## 9.5.2 Path

The path endpoint accepts a JSON object describing your network and will run a point-to-point calculation.

### Request

The following example includes some optional parameters and provides the required data to model a link with land cover and 3D buildings enabled at 30m resolution. *The request is similar to the area call except the receiver latitude (lat) and longitude (lon) values are populated.*

The below example is sent as a POST request to <https://api.cloudrf.com/path>.

```
{  
  "site": "HarbourLink",  
  "network": "LPWAN",  
  "transmitter": {  
    "lat": "38.9090",
```

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```
    "lon": "1.44094",
    "alt": 12,
    "freq": "868",
    "txw": "0.1",
    "bwi": "0.1"
  },
  "receiver": {
    "lat": "38.9173881",
    "lon": "1.46864923",
    "alt": 12,
    "rxg": "2",
    "rxs": "-90"
  },
  "antenna": {
    "txg": "2.15",
    "txl": "0",
    "ant": "1",
    "azi": "0",
    "tlt": "0",
    "hbw": "1",
    "vbw": "1",
    "pol": "v"
  },
  "model": {
    "pm": "1",
    "pe": "2",
    "ked": "1",
    "rel": "95"
  },
  "environment": {
    "clt": "Minimal.clt",
    "elevation": "2",
    "landcover": "1",
    "buildings": "1",
    "obstacles": "0"
  },
  "output": {
    "units": "m",
    "col": "RAINBOW45.dBm",
    "out": "2",
    "res": "30",
    "rad": "2"
  }
}
```

## Response

The response contains metadata about the link along with raw values necessary to build a chart using a graphing library such as Matplotlib or Plotly. It also contains a link to a KMZ so you can see the profile in 3D.

```
{
  "Engine": "Sleipnir 1.7.8",
  "Frequency MHz": 868,
  "Propagation model": "ITM",
  "Earth dielectric constant": 13,
  "Earth conductivity": 0.002,
  "Radio climate": "Maritime Temperate (Land)",
  "Atmospheric bending constant": 301,
  "Fraction of situations": 95,
  "Fraction of time": 95,
  "Receiver": [
    {
      "Latitude": 38.91739,
      "Longitude": 1.468649,
      "Ground elevation m": 28,
      "Antenna height m": 12,
      "Receiver gain dBd": -0.15,
      "Receiver gain dBi": 2
    }
  ],
  "Transmitters": [
    {
      "Latitude": 38.90908,
      "Longitude": 1.440943,
      "Ground elevation m": 1,
      "Antenna height m": 12,
      "Distance to receiver km": 2.572,
      "Azimuth to receiver deg": 68.92,
      "Downtilt angle deg": 0.6,
      "Antenna gain dBd": 0,
      "Antenna gain dBi": 2.15,
      "Polarisation": "Vertical",
      "Power W": 0.1,
      "Power dBm": 22.15,
      "ERP W": 0.1,
      "EIRP W": 0.164,
      "ERP dBm": 20,
      "EIRP dBm": 22.15,
      "Free space path loss dB": 95.3,
      "Bandwidth MHz": 0.1,
      "Johnson Nyquist noise dB": 0.2,
      "Noise floor dBm": -120,
      "Channel noise dBm": -119.8,
      "Signal power at receiver dBm": -88.6,
      "Signal to Noise Ratio dB": 31.2,
      "Computed path loss dB": 108.6,
      "Model attenuation dB": 13.3,
      "Field strength at receiver dBuV/m": 49.6,
    }
  ]
}
```

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```
"RX voltage 50 ohm dipole uV": 14,  
"RX voltage 50 ohm dipole dBuV": 23,  
"RX voltage 75 ohm dipole uV": 17,  
"RX voltage 75 ohm dipole dBuV": 24,  
"Raise RX antenna for LOS": 0,  
"Raise RX antenna for fresnel 60%": 0,  
"Raise RX antenna for full fresnel": 19,  
"Obstructions": [],  
"Distance": [  
    0.03,  
    0.059,  
    0.089,  
    0.119,  
    0.148,  
    ... snipped for brevity ...  
],  
"Terrain": [  
    1,  
    1,  
    1,  
    1,  
    1,  
    ... snipped for brevity ...  
],  
"Terrain_AMSL": [  
    1,  
    0,  
    0,  
    0,  
    0,  
    ... snipped for brevity ...  
],  
"Landcover distance": [  
    0.03,  
    0.059,  
    0.089,  
    0.119,  
    0.148,  
    ... snipped for brevity ...  
],  
"Landcover codes": [  
    80,  
    80,  
    80,  
    80,  
    80,  
    ... snipped for brevity ...  
],  
"Landcover heights": [  
    1,  
    1,  
    1,
```

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### 9.5.3 Points

The points endpoint accepts a JSON object describing an array of points (transmitters) which will be tested back to a single point (receiver).

#### Request

The following example is for route a boat will take. The location varies with each point but all the other values are constant.

The request is sent as a POST body to <https://api.cloudrf.com/points>.

```
{
  "site": "RIB",
  "network": "VHF",
  "transmitter": {
    "lat": 38.914381,
    "lon": 1.436988,
    "alt": "2",
    "frq": "160",
    "txw": "1",
    "bwi": "0.1"
  },
  "points": [
    {
      "lat": 38.91086406303705,
      "lon": 1.444486542453175,
      "alt": 2
    },
    {
      "lat": 38.91041372754393,
      "lon": 1.444495874752767,
      "alt": 2
    },
    {
      "lat": 38.90996339201471,
      "lon": 1.4445052069344337,
      "alt": 2
    },
    {
      "lat": 38.909513056449505,
      "lon": 1.444514538998178,
      "alt": 2
    }
  ],
  "receiver": {
    "lat": 38.914381,
    "lon": 1.436988,
    "alt": 2,
    "rxg": "2",
    "rxs": "-90"
  },
  "antenna": {
```

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```

    "txg": "2.15",
    "txl": "0",
    "ant": "1",
    "azi": "0",
    "tlt": "0",
    "hbw": "1",
    "vbw": "1",
    "fbr": "2.15",
    "pol": "v"
  },
  "model": {
    "pm": "11",
    "pe": "2",
    "ked": "1",
    "rel": "50"
  },
  "environment": {
    "elevation": "2",
    "landcover": "1",
    "buildings": "0",
    "obstacles": "0"
  },
  "output": {
    "units": "m",
    "col": "RAINBOW45.dBm",
    "out": "2",
    "nf": "-124",
    "res": "30",
    "rad": "8"
  }
}

```

## Response

The response contains JSON metadata for the points, in this case received power levels for each point.

```

{
  "Engine": "Sleipnir 1.7.8",
  "Frequency MHz": 160,
  "Propagation model": "Egli VHF/UHF",
  "Model subtype": "Suburban",
  "Receiver": [
    {
      "Latitude": 38.91438,
      "Longitude": 1.436988,
      "Ground elevation m": 1,
      "Antenna height m": 2,
      "Receiver gain dBd": -0.15,
      "Receiver gain dBi": 2
    }
  ],
}

```

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```
"Transmitters": [  
  {  
    "Latitude": 38.91086,  
    "Longitude": 1.444487,  
    "Ground elevation m": 0,  
    "Antenna height m": 2,  
    "Distance to receiver km": 0.758,  
    "Azimuth to receiver deg": 301.08,  
    "Downtilt angle deg": 0.1,  
    "Antenna gain dBd": 0,  
    "Antenna gain dBi": 2.15,  
    "Polarisation": "Vertical",  
    "Power W": 1,  
    "Power dBm": 2.15,  
    "ERP W": 0.001,  
    "EIRP W": 1.641,  
    "ERP dBm": 0,  
    "EIRP dBm": 2.15,  
    "Free space path loss dB": 70,  
    "Bandwidth MHz": 0.1,  
    "Johnson Nyquist noise dB": 0.2,  
    "Noise floor dBm": -124,  
    "Channel noise dBm": -123.8,  
    "Signal power at receiver dBm": -66.2,  
    "Signal to Noise Ratio dB": 57.6,  
    "Computed path loss dB": 96.2,  
    "Model attenuation dB": 26.2,  
    "Field strength at receiver dBuV/m": 27.3,  
    "Raise RX antenna for LOS": 5,  
    "Raise RX antenna for fresnel 60%": 77,  
    "Raise RX antenna for full fresnel": 128,  
    "server": 1  
  },  
  {  
    "Latitude": 38.91041,  
    "Longitude": 1.444496,  
    "Ground elevation m": 0,  
    "Antenna height m": 2,  
    "Distance to receiver km": 0.786,  
    "Azimuth to receiver deg": 304.18,  
    "Downtilt angle deg": 0.1,  
    "Antenna gain dBd": 0,  
    "Antenna gain dBi": 2.15,  
    "Polarisation": "Vertical",  
    "Power W": 1,  
    "Power dBm": 2.15,  
    "ERP W": 0.001,  
    "EIRP W": 1.641,  
    "ERP dBm": 0,  
    "EIRP dBm": 2.15,  
    "Free space path loss dB": 70.3,  
    "Bandwidth MHz": 0.1,  
  }  
]
```

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```
"Johnson Nyquist noise dB": 0.2,  
"Noise floor dBm": -124,  
"Channel noise dBm": -123.8,  
"Signal power at receiver dBm": -66.8,  
"Signal to Noise Ratio dB": 57,  
"Computed path loss dB": 96.8,  
"Model attenuation dB": 26.5,  
"Field strength at receiver dBuV/m": 26.7,  
"Raise RX antenna for LOS": 5,  
"Raise RX antenna for fresnel 60%": 80,  
"Raise RX antenna for full fresnel": 132,  
"server": 2  
},  
{  
  "Latitude": 38.90996,  
  "Longitude": 1.444505,  
  "Ground elevation m": 0,  
  "Antenna height m": 2,  
  "Distance to receiver km": 0.816,  
  "Azimuth to receiver deg": 307.06,  
  "Downtilt angle deg": 0.1,  
  "Antenna gain dBd": 0,  
  "Antenna gain dBi": 2.15,  
  "Polarisation": "Vertical",  
  "Power W": 1,  
  "Power dBm": 2.15,  
  "ERP W": 0.001,  
  "EIRP W": 1.641,  
  "ERP dBm": 0,  
  "EIRP dBm": 2.15,  
  "Free space path loss dB": 70.6,  
  "Bandwidth MHz": 0.1,  
  "Johnson Nyquist noise dB": 0.2,  
  "Noise floor dBm": -124,  
  "Channel noise dBm": -123.8,  
  "Signal power at receiver dBm": -67.5,  
  "Signal to Noise Ratio dB": 56.3,  
  "Computed path loss dB": 97.5,  
  "Model attenuation dB": 26.9,  
  "Field strength at receiver dBuV/m": 26,  
  "Raise RX antenna for LOS": 4,  
  "Raise RX antenna for fresnel 60%": 82,  
  "Raise RX antenna for full fresnel": 136,  
  "server": 3  
},  
{  
  "Latitude": 38.90951,  
  "Longitude": 1.444515,  
  "Ground elevation m": 0,  
  "Antenna height m": 2,  
  "Distance to receiver km": 0.848,  
  "Azimuth to receiver deg": 309.74,
```

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```
    "Downtilt angle deg": 0.1,  
    "Antenna gain dBd": 0,  
    "Antenna gain dBi": 2.15,  
    "Polarisation": "Vertical",  
    "Power W": 1,  
    "Power dBm": 2.15,  
    "ERP W": 0.001,  
    "EIRP W": 1.641,  
    "ERP dBm": 0,  
    "EIRP dBm": 2.15,  
    "Free space path loss dB": 70.9,  
    "Bandwidth MHz": 0.1,  
    "Johnson Nyquist noise dB": 0.2,  
    "Noise floor dBm": -124,  
    "Channel noise dBm": -123.8,  
    "Signal power at receiver dBm": -68.1,  
    "Signal to Noise Ratio dB": 55.7,  
    "Computed path loss dB": 98.1,  
    "Model attenuation dB": 27.2,  
    "Field strength at receiver dBuV/m": 25.3,  
    "Raise RX antenna for LOS": 4,  
    "Raise RX antenna for fresnel 60%": 85,  
    "Raise RX antenna for full fresnel": 141,  
    "server": 4  
  }  
],  
"calculation_adjusted": [],  
"elapsed": 111.0,  
"kmz": "https://api.cloudrf.com/API/archive/data?points=0812220045_mymesh_PPA_POINTS&  
→uid=1",  
"json": "https://api.cloudrf.com/users/1/0812220045_mymesh_PPA_POINTS.json"  
}
```



### 9.5.4 Best Site Analysis

The `bsa` endpoint accepts a JSON object in the request **body** describing a location with a radius, similar to an ‘area’ call except it uses a random Monte-Carlo technique to rank locations within the area to identify the best. The colour key is irrelevant for the API since the response is always a greyscale image which you must style.

#### Request

The below example is for a planned Sub GHz LPWAN gateway in the hills. The request is sent as a POST request to `https://api.cloudrf.com/bsa` and it will return a JSON response containing metadata and URLs to image layers for your map.

```
{
  "site": "BestSite",
  "network": "Ibiza",
  "engine": "1",
  "transmitter": {
    "lat": 38.938092,
    "lon": 1.389430,
  }
}
```

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```
    "alt": "2",
    "freq": "446",
    "txw": "1",
    "bwi": "0.1"
  },
  "receiver": {
    "lat": 0,
    "lon": 0,
    "alt": "2",
    "rxg": "2",
    "rxs": "-90"
  },
  "antenna": {
    "txg": "2.15",
    "txl": "0",
    "ant": "1",
    "azi": "0",
    "tlt": "0",
    "hbw": "0",
    "vbw": "0",
    "fbr": "2.15",
    "pol": "v"
  },
  "model": {
    "pm": "7",
    "pe": "2",
    "ked": "0",
    "rel": "95"
  },
  "environment": {
    "clt": "Minimal.clt",
    "elevation": "2",
    "landcover": "0",
    "buildings": "0",
    "obstacles": "0"
  },
  "output": {
    "units": "m",
    "col": "BSA8.bsa",
    "out": "7",
    "nf": "-120",
    "res": "10",
    "rad": 3
  }
}
```

## Response

The PNG\_Mercator image is warped for slippy maps like Mapbox, Leaflet and Google Maps. The PNG\_WGS84 is for globes like Google Earth, Cesium and WinTAK.

A BSA response is almost identical to an area response. The real difference is in the image which is always greyscale where white is 100% efficiency and black is 0% efficiency. The colour key returned can be used for styling by isolating only the red channel since the green and blue channels will be the same eg. RGB(254,254,254) = 95% coverage. The area and coverage fields are zero since this is not a site.

```
{
  "kmz": "https://api.cloudrf.com/archive/a2s1bWJkTDJYdGMrNUNHZVhpTUtUQT09/kmz",
  "PNG_Mercator": "https://api.cloudrf.com/output/projection/3857/1/0816125807_IBIZA_
↪BestSite",
  "PNG_WGS84": "https://api.cloudrf.com/users/1/0816125807_IBIZA_BestSite.4326.png",
  "bounds": [
    38.96563941396777,
    1.4248893862148355,
    38.91054585887422,
    1.3539723152977645
  ],
  "id": 8201477,
  "sid": "a2s1bWJkTDJYdGMrNUNHZVhpTUtUQT09",
  "area": 0,
  "coverage": 0,
  "key": [
    {
      "l": "95%",
      "r": 254,
      "g": 0,
      "b": 0
    },
    {
      "l": "90%",
      "r": 254,
      "g": 91,
      "b": 0
    },
    {
      "l": "85%",
      "r": 254,
      "g": 183,
      "b": 0
    },
    {
      "l": "80%",
      "r": 236,
      "g": 254,
      "b": 0
    },
    {
      "l": "75%",
      "r": 145,
      "g": 254,

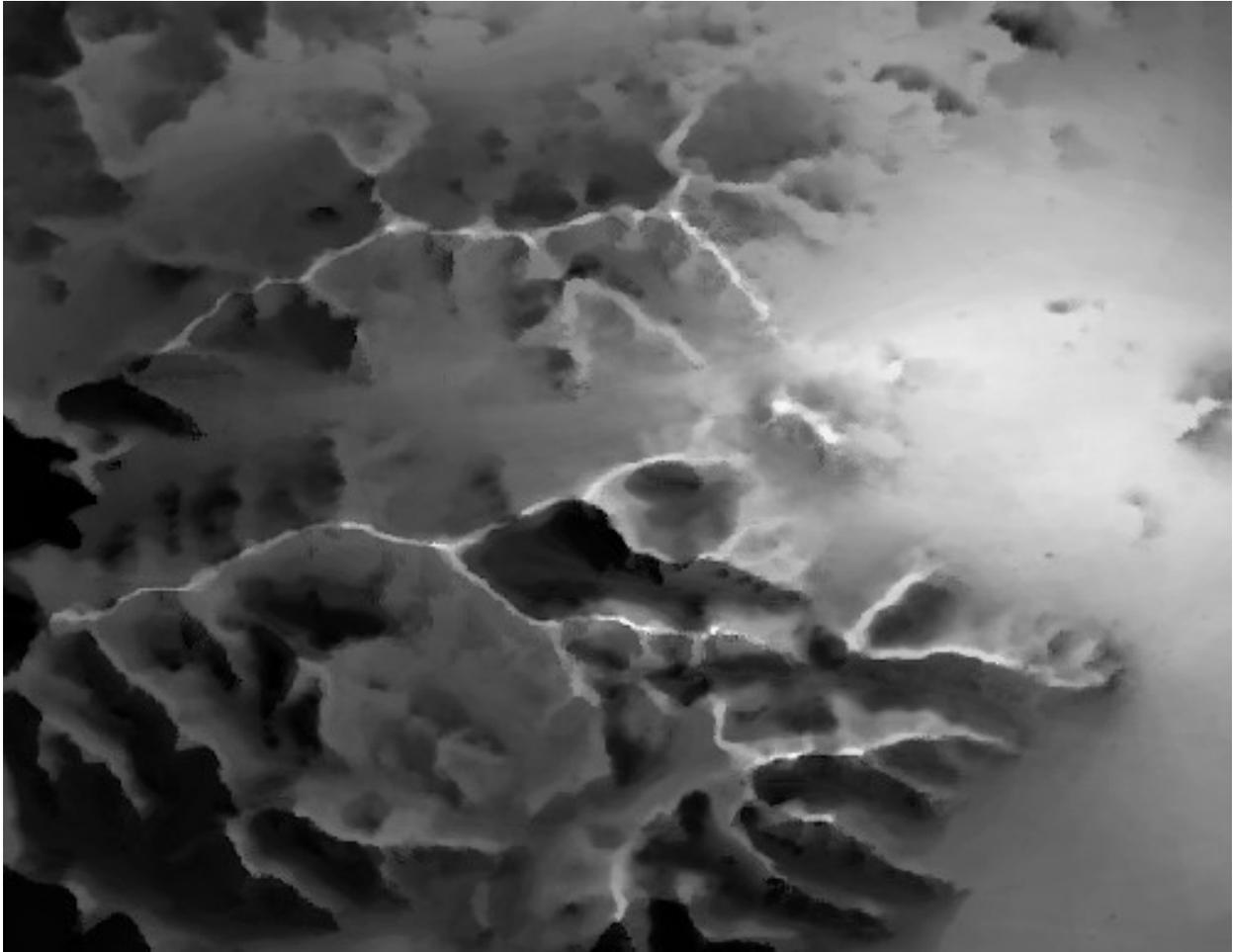
```

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```
        "b": 0
      },
      {
        "l": "70%",
        "r": 53,
        "g": 254,
        "b": 0
      },
      {
        "l": "65%",
        "r": 0,
        "g": 254,
        "b": 38
      },
      {
        "l": "60%",
        "r": 0,
        "g": 254,
        "b": 129
      },
      {
        "l": "55%",
        "r": 0,
        "g": 254,
        "b": 221
      },
      {
        "l": "50%",
        "r": 0,
        "g": 198,
        "b": 255
      }
    ],
    "elapsed": 1147.0,
    "balance": 23305
  }
}
```

A BSA response is shown below. Notice that ridgelines rank high, but not as high as the low ground to the east which has the best visibility of the entire area:



### Request With A Polygon

If you want to use a polygon shape to define boundaries, you can use the `edges` array to define each point. A minimum of 3 points are needed as `lat/lon` pairs within the `edges` array. With this you can draw political or property boundaries. A radius is automatically computed using this method so it doesn't matter what radius you request.

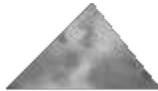
```
{
  "edges": [
    {
      "lat": 38.94,
      "lon": 1.39
    },
    {
      "lat": 38.94,
      "lon": 1.399
    },
    {
      "lat": 38.945,
      "lon": 1.395
    }
  ],
}
```

(continues on next page)

(continued from previous page)

```
"site": "Triangle",
"network": "Ibiza",
"engine": "1",
"transmitter": {
  "lat": 38.945,
  "lon": 1.392,
  "alt": "2",
  "frq": "446",
  "txw": "1",
  "bwi": "0.1"
},
... snipped for brevity ...
}
```

By defining 3 points, we have reduced the study area to a triangle:



## 9.5.5 Multisite

The `multisite` endpoint is a GPU only function for simulating many transmitters at once. It accepts a JSON object in the request **body** describing an array of `transmitters`, using familiar fields from an `area` call. An antenna is defined for every transmitter so you can have different patterns in a network. You can even model a group of distant radios with omni antennas and a long range parabolic in the same request.

It renders the legacy mesh API call obsolete (unless you only have a CPU) as it merges sites by design.

Transmitters must be within 2000km of each other. eg. You cannot request a multisite across the Ocean.

**Antenna azimuths must be between 0 and 359 degrees.**

### Request

The below example is for three local UHF radios, with omni dipoles (ant: 1) in the hills. The request is sent as a POST request to `https://api.cloudrf.com/multisite` and it will return a JSON response containing metadata and URLs to image layers for your map.

```
{
  "site": "3amigos",
  "network": "UHF",
  "transmitters": [
    {
      "lat": 38.941501808741165,
      "lon": 1.3709467181497763,
```

(continues on next page)

(continued from previous page)

```
"alt": 2,
"frq": 868,
"txw": 1,
"bwi": 0.1,
"ant": 0,
"antenna": {
  "txg": 2.15,
  "txl": 0,
  "ant": 1,
  "azi": 0,
  "tlt": 0,
  "hbw": 1,
  "vbw": 1,
  "fbr": 2.15,
  "pol": "v"
}
},
{
  "lat": 38.94210625018613,
  "lon": 1.3847431304250852,
  "alt": 2,
  "frq": 868,
  "txw": 1,
  "bwi": 0.1,
  "ant": 0,
  "antenna": {
    "txg": 2.15,
    "txl": 0,
    "ant": 1,
    "azi": 0,
    "tlt": 0,
    "hbw": 1,
    "vbw": 1,
    "fbr": 2.15,
    "pol": "v"
  }
},
{
  "lat": 38.94370157813472,
  "lon": 1.4006969012717958,
  "alt": 2,
  "frq": 868,
  "txw": 1,
  "bwi": 0.1,
  "ant": 0,
  "antenna": {
    "txg": 2.15,
    "txl": 0,
    "ant": 1,
    "azi": 0,
    "tlt": 0,
    "hbw": 1,
```

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```

        "vbw": 1,
        "fbr": 2.15,
        "pol": "v"
    }
  },
  "receiver": {
    "alt": 2,
    "rxg": 2,
    "rxs": -105
  },
  "model": {
    "pm": 11,
    "pe": 2,
    "ked": 1,
    "rel": 95
  },
  "environment": {
    "clm": 0,
    "cll": 1,
    "clt": "Minimal.clt"
  },
  "output": {
    "units": "m",
    "col": "LTE.dBm",
    "out": 2,
    "nf": -120,
    "res": 10,
    "rad": 2
  }
}

```

## Response

The PNG\_Mercator image is warped for slippy maps like Mapbox, Leaflet and Google Maps. The PNG\_WGS84 is for globes like Google Earth, Cesium and WinTAK.

```

{
  "kmz": "https://api.cloudrf.com/archive/WUMya3l4a3ZmcVFDajZ4THZVckVuQT09/kmz",
  "PNG_Mercator": "https://api.cloudrf.com/output/projection/3857/1/0816124833_UAS_PPA_
↔MULTISITE",
  "PNG_WGS84": "https://api.cloudrf.com/users/1/0816124833_UAS_PPA_MULTISITE.4326.png",
  "bounds": [
    38.96165650015791,
    1.4238207375342375,
    38.92354146204287,
    1.3478216615351617
  ],
  "id": 8201557,
  "sid": "WUMya3l4a3ZmcVFDajZ4THZVckVuQT09",
  "area": 43,

```

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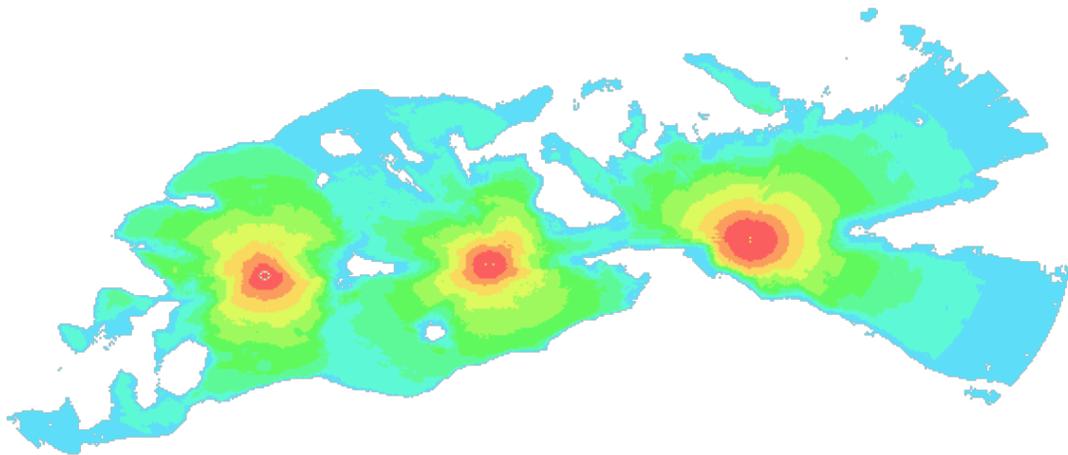
(continued from previous page)

```
"coverage": 0,  
"key": [  
  {  
    "l": "-60dBm",  
    "r": 248,  
    "g": 14,  
    "b": 14  
  },  
  {  
    "l": "-65dBm",  
    "r": 248,  
    "g": 107,  
    "b": 14  
  },  
  {  
    "l": "-70dBm",  
    "r": 247,  
    "g": 199,  
    "b": 14  
  },  
  {  
    "l": "-75dBm",  
    "r": 203,  
    "g": 247,  
    "b": 14  
  },  
  {  
    "l": "-80dBm",  
    "r": 110,  
    "g": 247,  
    "b": 14  
  },  
  {  
    "l": "-85dBm",  
    "r": 17,  
    "g": 246,  
    "b": 13  
  },  
  {  
    "l": "-90dBm",  
    "r": 13,  
    "g": 246,  
    "b": 102  
  },  
  {  
    "l": "-95dBm",  
    "r": 13,  
    "g": 246,  
    "b": 194  
  },  
  {  
    "l": "-100dBm",
```

(continues on next page)

(continued from previous page)

```
        "r": 13,  
        "g": 205,  
        "b": 245  
    },  
    {  
        "l": "-105dBm",  
        "r": 13,  
        "g": 113,  
        "b": 245  
    }  
],  
"elapsed": 430.0,  
"balance": 23248  
}
```



### RADAR With Mixed Heights Example

The below example shows how to use the `multisite` API with RADAR transmitters (`model.pm` value of 8) where the transmitters are positioned with an elevation relative to the ground (AGL), and the receiver has an elevation above sea level (AMSL). This is indicated with an `output.tx_units` value of `m` and `output.rx_units` value of `m_amsl`, respectively.

```
{  
  "site": "Multisite",  
  "network": "RADAR_TEST",  
  "transmitters": [  
    {  
      "lat": 30.510523,  
      "lon": -86.830194,  
      "alt": 5,  
      "frq": 8000,  
    }  
  ]  
}
```

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```
    "txw": 100,
    "bwi": 1.2,
    "antenna": {
      "txg": 15,
      "txl": 0,
      "ant": 1,
      "azi": 0,
      "tlt": 0,
      "hbw": 30,
      "vbw": 30,
      "fbr": 0,
      "pol": "v"
    }
  },
  {
    "lat": 30.500163,
    "lon": -86.814786,
    "alt": 5,
    "frq": 8000,
    "txw": 100,
    "bwi": 1.2,
    "antenna": {
      "txg": 15,
      "txl": 0,
      "ant": 1,
      "azi": 0,
      "tlt": 0,
      "hbw": 30,
      "vbw": 30,
      "fbr": 0,
      "pol": "v"
    }
  }
],
"receiver": {
  "alt": 500,
  "rxg": 0,
  "rxs": -100
},
"model": {
  "pm": 8,
  "pe": 2,
  "ked": 1,
  "rel": 50,
  "rcs": 100
},
"environment": {
  "elevation": 2,
  "c1l": 0,
  "clm": 0,
  "clt": "Minimal.clt"
},
},
```

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```

"output": {
  "tx_units": "m",
  "rx_units": "m_amsl",
  "col": "RAINBOW.dBm",
  "out": 2,
  "nf": -120,
  "res": 50,
  "rad": 100
}
}

```

### 9.5.6 Mesh

The mesh function is a legacy function which merges pre-calculated layers. It was made obsolete by the `multisite` function but is still useful for post-processing such as creating network coverage maps.

#### Request

The below example is a HTTP GET request for meshing the layers (max 1000) belonging to the BLUENET network and using the name `mymap` for the output. You must send your API key in the request header as normal.

```
https://api.cloudrf.com/mesh?network=BLUENET&name=mymap
```

You can also specify up to 100 sites in the URL as a list:

```
https://api.cloudrf.com/mesh?network=mymap&calcs=0816143545_BLUENET_Site,0816143541_
↪BLUENET_Site
```

#### Response

The response is a JSON object containing images and metadata about the calculations which were used to create the mesh image:

```

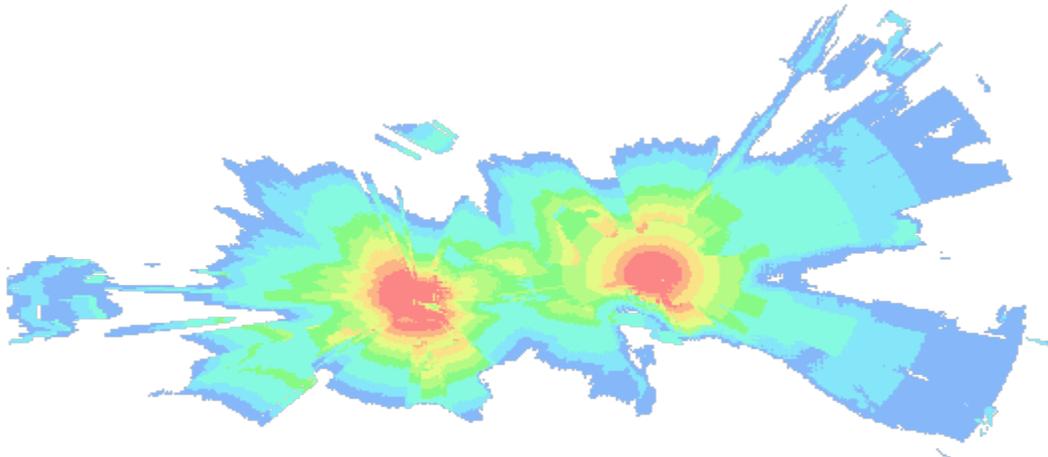
{
  "png_wgs84": "https://api.cloudrf.com/users/1/0816133557_Mesh.4326.png",
  "png_mercator": "https://api.cloudrf.com/users/1/0816133557_Mesh.3857.png",
  "kmz": "https://api.cloudrf.com/archive/WkYveUVDdmZTNG1IbDdPbjVKUVVLUT09/kmz",
  "id": 8201614,
  "sid": "WkYveUVDdmZTNG1IbDdPbjVKUVVLUT09",
  "filename": "0816133557_Mesh",
  "bounds": [
    38.96722,
    1.4228695899280575,
    38.919690503597124,
    1.363707
  ],
  "calculations": [
    8201611,
    8201612
  ]
}

```

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```
]
}
```



### 9.5.7 Interference

The `interference` function is a legacy function which merges pre-calculated layers like `mesh` to reveal the strongest signal where coverage overlaps. It makes decisions for each touched pixel and promotes the strongest signal.

At the time of writing (December 2023) this is currently a CPU-only functionality, but there are plans to enhance this functionality with GPU capabilities.

#### Request

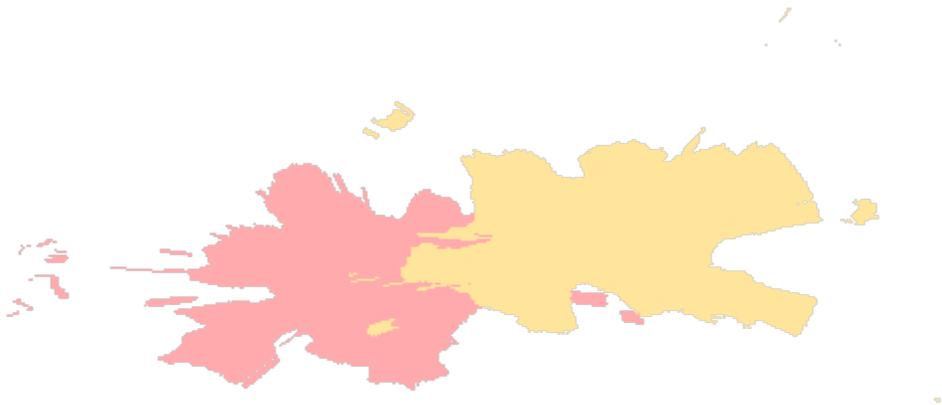
The below example is a HTTP GET request for meshing the layers (max 1000) belonging to the BLUENET network and using the name QRM for the output. You must send your API key in the request header as normal.

```
https://api.cloudrf.com/interference/?network=BLUENET&name=QRM
```

## Response

The response is a JSON object containing images and metadata about the calculations which were used to create the interference image:

```
{
  "png_wgs84": "https://api.cloudrf.com/users/1/0816134222_QRM.4326.png",
  "png_mercator": "https://api.cloudrf.com/users/1/0816134222_QRM.3857.png",
  "id": 8201623,
  "sid": "a0FTWEVXOGp2QzRyMjlgOGVhVUxzQT09",
  "filename": "0816134222_QRM",
  "bounds": [
    38.96722,
    1.42287,
    38.919691,
    1.363707
  ],
  "calculations": [
    8201611,
    8201612
  ]
}
```



## 9.5.8 Network

The `network` function is a legacy function which tests links to pre-calculated sites to reveal the strongest server(s) at the tested receiver site (eg. a customer's house).

### Request

The below example is a HTTP GET request for testing a location with receiver gain 2dBi and receiver height 2m to the BLUENET network. You must send your API key in the request header as normal.

```
https://api.cloudrf.com/network?lat=38.938322&lon=1.398755&net=BLUENET&rxg=2&rxh=2
```

### Response

The response is a verbose JSON object containing metadata about each link tested. This can be parsed to reveal the required information eg. RSSI so you can plot coloured links for example:

```
[
  {
    "Engine": "Sleipnir 1.7.8",
    "Frequency MHz": 868,
    "Propagation model": "Egli VHF/UHF",
    "Model subtype": "Suburban",
    "Receiver": [
      {
        "Latitude": 38.93832,
        "Longitude": 1.398755,
        "Ground elevation m": 91,
        "Antenna height m": 2,
        "Receiver gain dBd": -0.15,
        "Receiver gain dBi": 2
      }
    ],
    "Transmitters": [
      {
        "Latitude": 38.94411,
        "Longitude": 1.399756,
        "Ground elevation m": 92,
        "Antenna height m": 2,
        "Distance to receiver km": 0.651,
        "Azimuth to receiver deg": 187.65,
        "Downtilt angle deg": 0.1,
        "Antenna gain dBd": 0,
        "Antenna gain dBi": 2.15,
        "Polarisation": "Vertical",
        "Power W": 1,
        "Power dBm": 32.15,
        "ERP W": 1,
        "EIRP W": 1.641,
        "ERP dBm": 30,
        "EIRP dBm": 32.15,
        "Free space path loss dB": 83.3,
```

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```
"Bandwidth MHz": 0.1,
"Johnson Nyquist noise dB": 0.2,
"Noise floor dBm": -115,
"Channel noise dBm": -114.8,
"Signal power at receiver dBm": -87.2,
"Signal to Noise Ratio dB": 27.6,
"Computed path loss dB": 117.2,
"Model attenuation dB": 33.9,
"Field strength at receiver dBuV/m": 50.9,
"RX voltage 50 ohm dipole uV": 16,
"RX voltage 50 ohm dipole dBuV": 24,
"RX voltage 75 ohm dipole uV": 20,
"RX voltage 75 ohm dipole dBuV": 26,
"Raise RX antenna for LOS": 102,
"Raise RX antenna for fresnel 60%": 313,
"Raise RX antenna for full fresnel": 344,
"Obstructions": [
  [
    38.93995,
    1.399037
  ],
  [
    38.94017,
    1.399075
  ],
  [
    38.94039,
    1.399113
  ],
  ... snipped for brevity ...
],
"Distance": [
  0.012,
  0.025,
  0.037,
  0.049,
  0.062,
  ... snipped for brevity ...
],
"Terrain": [
  102,
  103,
  108,
  109,
  112,
  ... snipped for brevity ...
],
"Terrain_AMSL": [
  101,
  102,
  104,
  108,
```

(continues on next page)

(continued from previous page)

```

        109,
        [...] snipped for brevity [...],
        "Fresnel": [
            0,
            -2.04,
            -2.86,
            -3.47,
            -3.96,
            [...] snipped for brevity [...],
        ],
        "dBm": [
            -21,
            -31,
            -38,
            -42,
            -46,
            [...] snipped for brevity [...],
        ],
        "dB": [
            51,
            61,
            68,
            72,
            76,
            [...] snipped for brevity [...],
        ]
    }
],
"Chart image": "https://api.cloudrf.com/API/archive/data?ppa=5d0ffce3&uid=1",
"Network KML": "https://api.cloudrf.com/users/1/b7ce7077.kml",
"Server ID": 8201612,
"Server name": "0816143545_BLUENET_Site"
},
{
    "Engine": "Sleipnir 1.7.8",
    "Frequency MHz": 868,
    "Propagation model": "Egli VHF/UHF",
    "Model subtype": "Suburban",
    "Receiver": [
        {
            "Latitude": 38.93832,
            "Longitude": 1.398755,
            "Ground elevation m": 91,
            "Antenna height m": 2,
            "Receiver gain dBd": -0.15,
            "Receiver gain dBi": 2
        }
    ],
    "Transmitters": [
        {
            "Latitude": 38.94279,

```

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```
"Longitude": 1.386807,
"Ground elevation m": 117,
"Antenna height m": 2,
"Distance to receiver km": 1.148,
"Azimuth to receiver deg": 115.66,
"Downtilt angle deg": 1.3,
"Antenna gain dBd": 0,
"Antenna gain dBi": 2.15,
"Polarisation": "Vertical",
"Power W": 1,
"Power dBm": 32.15,
"ERP W": 1,
"EIRP W": 1.641,
"ERP dBm": 30,
"EIRP dBm": 32.15,
"Free space path loss dB": 88.3,
"Bandwidth MHz": 0.1,
"Johnson Nyquist noise dB": 0.2,
"Noise floor dBm": -115,
"Channel noise dBm": -114.8,
"Signal power at receiver dBm": -96.9,
"Signal to Noise Ratio dB": 17.9,
"Computed path loss dB": 126.9,
"Model attenuation dB": 38.6,
"Field strength at receiver dBuV/m": 41.3,
"RX voltage 50 ohm dipole uV": 5,
"RX voltage 50 ohm dipole dBuV": 14,
"RX voltage 75 ohm dipole uV": 6,
"RX voltage 75 ohm dipole dBuV": 16,
"Raise RX antenna for LOS": 80,
"Raise RX antenna for fresnel 60%": 92,
"Raise RX antenna for full fresnel": 100,
"Obstructions": [
  [
    38.93835,
    1.398676
  ],
  [
    38.93843,
    1.398467
  ],
  [
    38.93847,
    1.398363
  ]
]
... Snipped for brevity ...
],
"Distance": [
  0.01,
  0.02,
  0.03,
  0.04,
```

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```
    0.05,  
    [...] snipped for brevity [...]  
  ],  
  "Terrain": [  
    111,  
    111,  
    110,  
    110,  
    110,  
    [...] snipped for brevity [...]  
  ],  
  "Terrain_AMSL": [  
    114,  
    112,  
    112,  
    111,  
    111,  
    [...] snipped for brevity [...]  
  ],  
  "Fresnel": [  
    0,  
    -1.85,  
    -2.61,  
    -3.18,  
    -3.65,  
    [...] snipped for brevity [...]  
  ],  
  "dBm": [  
    -16,  
    -27,  
    -34,  
    -39,  
    -43,  
    [...] snipped for brevity [...]  
  ],  
  "dB": [  
    46,  
    57,  
    64,  
    69,  
    73,  
    [...] snipped for brevity [...]  
  ]  
} ]  
],  
"Chart image": "https://api.cloudrf.com/API/archive/data?ppa=3a949f40&uid=1",  
"Network KML": "https://api.cloudrf.com/users/1/b7ce7077.kml",  
"Server ID": 8201611,  
"Server name": "0816143541_BLUENET_Site"  
}  
]
```



## 9.6 Area API with bounded output

Often the study area is far away from the transmitter, for example a suburb which is served by a mountain repeater. By bounding the output area in the request, only this focus area is computed and returned.

Aside from being very fast and efficient, it allows for higher resolution calculations than would be possible by testing the entire town / valley in all directions.

For example, to test an airfield with LiDAR accuracy that is 42km away from the transmitter you would populate the “bounds” array within the “output” section of an area request.

```
{
  ... snipped for brevity ...
  "output": {
    "units": "m",
    "col": "3",
    "out": "2",
    "ber": "1",
    "mod": null,
    "nf": "-120",
    "res": "2",
    "rad": "42",
    "bounds": {
      "north": 51.677,
      "south": 51.655,
      "east": -2.039,
      "west": -2.076
    }
  }
}
```

## 9.7 More Information

For a complete OpenAPI 3 schema of the CloudRF API please consult the [Swagger UI documentation](#).

### 9.7.1 Compression

CloudRF uses gzip compression for output files. The official client handles this but if you are writing your own you should use the MIME type rather than writing raw data as a `.tiff` may actually be `.tiff.gz`.

Below shows an example of this in Python 3:

```
# WARNING: Will write a gzipped file
shutil.copyfileobj(response.raw, outputFile)

# Will handle gzip decompression
outputFile.write(response.content)
```

### 9.7.2 Verbose Environment Variables

Since v3.8, the environment block has been redesigned to replace the cryptic `c1l` and `clm` values with simpler boolean layers describing elevation, landcover, buildings and obstacles. This enables easier layering of custom clutter upon DTM for example (`elevation = 2`, `obstacles = 1`).

Both methods are supported in 3.8 but the long form is now the standard, as used in the web interface, and the old trigraph method is deprecated. It still features in places such as templates.

The following table translates old to new values:

Legacy Value	New Value (3.8)
<code>c1l = 0</code>	<code>landcover = 0</code>
<code>c1l = 1</code>	<code>landcover = 1</code>
<code>c1l = 2</code>	<code>landcover = 1, buildings = 1</code>
<code>clm = 0</code>	<code>obstacles = 0</code>
<code>clm = 1</code>	<code>obstacles = 1</code>
<code>clm = 2</code>	<code>elevation = 2, obstacles = 1</code>

## 9.8 API scripts

A list of ready-to-use scripts are available on the [CloudRF public GitHub repository](#).

- Python
- Bash
- Slippy maps

Some radio templates are [here](#) to help you pick good settings for hardware:



## REFERENCE DATA

### 10.1 Antenna Patterns

The antenna database lets you search for patterns by manufacturer, model and/or physical parameters like gain.

To access the Antenna Database:



- Under the **Antenna** Input menu, click on the **Manage my Antennas** icon.
- The **Antenna Database** dialog box will appear. You can choose to open this in a separate tab with the hyperlink at the bottom.

ADF Wizard
Add ADF file

Antenna ID: 2946  
**Manufacturer:** ALPHA WIRELESS LTD  
**Model:** AW3014\_T0.MSI  
**Gain:** 17.71 dBi  
**Centre Frequency:** 3550 MHz  
**Frequency Range:** 3450 - 3650 MHz

---

NAME AW3014  
 MAKE Alpha Wireless Ltd  
 FREQUENCY 3550.0  
 H\_WIDTH 65  
 V\_WIDTH 7  
 GAIN 17.7dBi  
 TILT ELECTRICAL

Horizontal dBi

Vertical dBi

Manufacturer	Model	> dBi	< dBi	> MHz	< MHz	Rating	Action
ALGCOM	<a href="#">AS-2500-17-65-DP_2430MHZ.ADF</a>	17		2200	2700	★★★★★(1) +	❤️ ⬇️
ALGCOM	<a href="#">AS-700-14-65-DP_825MHZ.ADF</a>	14		690	960	★★★★★(1) +	❤️ ⬇️
ALPHA WIRELESS LTD	<a href="#">AW3014_T0.MSI</a>	17.71		3450	3650	★★★★★(1) +	❤️ ⬇️
CAMBIUM NETWORKS	<a href="#">C030045A002A_3GHZ_PMP_450I_AP.ADF</a>	17		3300	3900	★★★★★(1) +	❤️ ⬇️
CAMBIUM NETWORKS	<a href="#">CAMBIUMNETWORKS_EPMP_3000_5800_90DEGREEE-SECTOR.MSI</a>	16.71		5700	5900	★★★★★(1) +	❤️ ⬇️
RADIO INNOVATION SWEDEN AB	<a href="#">RI_763_MHZ_23.2_DBI_20DEGS_LOBE.MSL.ADF</a>	23.2		663	863	★★★★★(1) +	❤️ ⬇️
RF ELEMENTS S.R.O.	<a href="#">HG3-TP-A60-V2.ADF</a>	17		5180	6000	★★★★★(1) +	❤️ ⬇️
TARANA WIRELESS INC	<a href="#">TARANA_BN_3GHZ.ADF</a>	22.5		3300	3800	★★★★☆(1) +	❤️ ⬇️

- In the table, you can search the Antenna Database by filtering on parameters.

To do so:

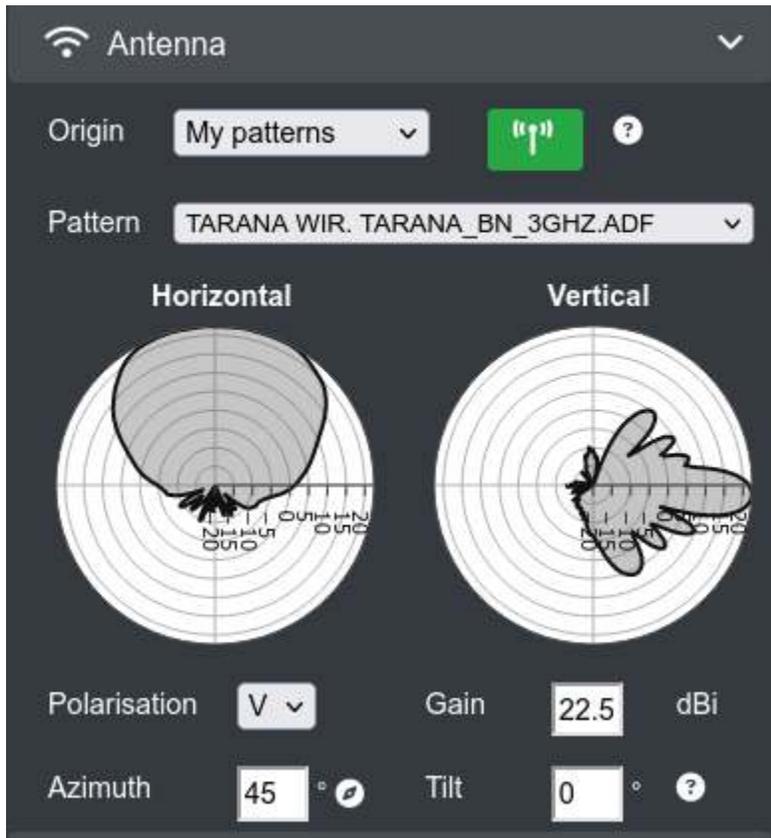
- Select the desired **Manufacturer**.

- The respective manufacturer's list of *Antenna Patterns* will be displayed.
- Select the desired **Model**.
  - The respective **Antenna Pattern's information** - *ID, Name, Description, Frequency, Gain, Polarisation* and *Polar Maps* will be displayed once a row is clicked.

### 10.1.1 Choosing a favourite pattern

Each row has a heart icon to the right. Click the heart to 'favourite' a pattern and click it again to 'unfavourite' it.   


When a pattern is a favourite, the heart will be red and it will appear on your list within 10 seconds.



### 10.1.2 Antenna pattern data

The system consumes antenna patterns in TIA/EIA-804-B (NSMA) ADF and ANT formats which can be uploaded at */API/antennas*. A link to the upload form is at the top of the antenna database interface.

All patterns should have 360 rows of horizontal data and 360 rows of elevation data.

For more information see [Antenna patterns](#).

To validate an ADF pattern use our online tool here: <https://api.cloudrf.com/API/antennas/validator/>

To convert another standard such as ANT or MSI to ADF, use the conversion wizard, linked at the top of the antenna database. This handy utility will detect the format, attempt to convert it to a standard and will report any violations.

If the data is good, you will be offered a download link for a ADF file which you can upload or keep as a souvenir.

## Antenna Pattern Wizard

Upload your ADF/ANT/MSI antenna pattern using the file upload below to process it into a clean NSMA standard ADF pattern.

Examples: [MSI](#), [ADF](#), [ANT](#)

Interpolate points

Upload Antenna  Choose file

**Success**

Your file was successfully processed. Please see below for further details.

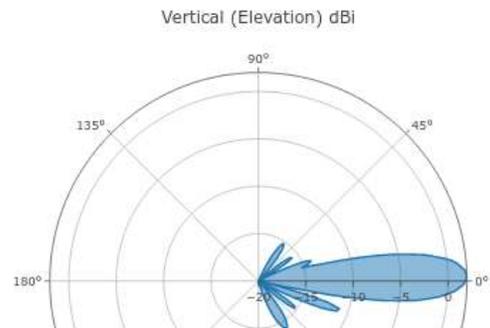
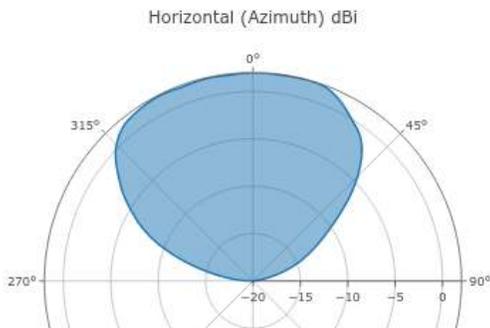
Report:

- ADFWizard/logs/20240204112701\_adfwizard.log
- reading TARANA\_BN\_3GHZ.ADF(2).ANT
- msi\_to\_adf generated 749 lines
- validating ADF
- group ANTENNA has 0 violations
- group FREQUENCY has 0 violations
- group CUT has 0 violations
- group CUT has 0 violations
- interpolation ON
- filename: TARANA\_BN\_3GHZ
- written new file: TARANA\_BN\_3GHZ.adf

Uploaded File Name	TARANA_BN_3GHZ.ADF(2).ANT
Determined Type	ANTV3

[Processing log](#)

[Download ADF File](#)



### Example TIA/EIA-804-B pattern file

This example data shows the unique colon-comma formatting this TIA standard uses. It might not make sense compared with modern information standards but it is a ratified standard and is widely supported as a result.

```

REVNUM:,TIA/EIA-804-B
COMNT1:,Standard TIA/EIA Antenna Pattern Data
ANTMAN:,RFI Antennas for Bird Technologies Group
MODNUM:,CC806-06 @ 870
DESCR1:,Corporate collinear, 746-870 MHz
DESCR2:,Omnidirectional, 5dBd, 0o Downtilt
DTDATA:,20060213
LOWFRQ:,746
HGFRQ:,870
    
```

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```
GUNITS:,DBD/DBR
MDGAIN:,4.8
AZWIDT:,360
ELWIDT:,17
CONTYP:,7/16 DIN Silver Plated
ATVSWR:,1.5
FRTOBA:,0
ELTILT:,0
MAXPOW:,500
ANTLEN:,1.85
ANTWID:,0.077
ANTWGT:,7.1
PATTYP:,Typical
NOFREQ:,1
PATFRE:,870
NUMCUT:,2
PATCUT:,V
POLARI:,V/V
NUPOIN:,360
FSTLST:,-179,180
-179,-0.053
-178,-0.179
-177,-0.374
-176,-0.639
-175,-0.971
-174,-1.376
-173,-1.857
-172,-2.425
-171,-3.089
-170,-3.866
-169,-4.772
-168,-5.831
-167,-7.069
-166,-8.515
-165,-10.202
-164,-12.146
-163,-14.296
-162,-16.376
-161,-17.699
-160,-17.679
-159,-16.748
-158,-15.657
-157,-14.757
-156,-14.132
-155,-13.777
-154,-13.665
-153,-13.770
-152,-14.066
-151,-14.532
-150,-15.146
-149,-15.888
-148,-16.736
```

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```
-147, -17.668
-146, -18.656
-145, -19.667
-144, -20.654
-143, -21.546
-142, -22.234
-141, -22.588
-140, -22.512
-139, -22.014
-138, -21.214
-137, -20.261
-136, -19.278
-135, -18.338
-134, -17.483
-133, -16.730
-132, -16.084
-131, -15.544
-130, -15.107
-129, -14.767
-128, -14.520
-127, -14.358
-126, -14.277
-125, -14.271
-124, -14.337
-123, -14.468
-122, -14.662
-121, -14.914
-120, -15.221
-119, -15.579
-118, -15.986
-117, -16.439
-116, -16.935
-115, -17.472
-114, -18.048
-113, -18.659
-112, -19.305
-111, -19.982
-110, -20.689
-109, -21.424
-108, -22.185
-107, -22.972
-106, -23.782
-105, -24.618
-104, -25.481
-103, -26.374
-102, -27.304
-101, -28.282
-100, -29.320
-99, -30.441
-98, -31.672
-97, -33.053
-96, -34.640
```

(continues on next page)

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-95	-36.507
-94	-38.739
-93	-41.001
-92	-41.317
-91	-43.387
-90	-43.536
-89	-43.387
-88	-41.317
-87	-41.001
-86	-38.739
-85	-36.507
-84	-34.640
-83	-33.053
-82	-31.672
-81	-30.441
-80	-29.320
-79	-28.282
-78	-27.304
-77	-26.374
-76	-25.481
-75	-24.618
-74	-23.782
-73	-22.972
-72	-22.185
-71	-21.424
-70	-20.689
-69	-19.982
-68	-19.305
-67	-18.659
-66	-18.048
-65	-17.472
-64	-16.935
-63	-16.439
-62	-15.986
-61	-15.579
-60	-15.221
-59	-14.914
-58	-14.662
-57	-14.468
-56	-14.337
-55	-14.271
-54	-14.277
-53	-14.358
-52	-14.520
-51	-14.767
-50	-15.107
-49	-15.544
-48	-16.084
-47	-16.730
-46	-17.483
-45	-18.338
-44	-19.278

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```
-43,-20.261
-42,-21.214
-41,-22.014
-40,-22.512
-39,-22.588
-38,-22.234
-37,-21.546
-36,-20.654
-35,-19.667
-34,-18.656
-33,-17.668
-32,-16.736
-31,-15.888
-30,-15.146
-29,-14.532
-28,-14.066
-27,-13.770
-26,-13.665
-25,-13.777
-24,-14.132
-23,-14.757
-22,-15.657
-21,-16.748
-20,-17.679
-19,-17.699
-18,-16.376
-17,-14.296
-16,-12.146
-15,-10.202
-14,-8.515
-13,-7.069
-12,-5.831
-11,-4.772
-10,-3.866
-9,-3.089
-8,-2.425
-7,-1.857
-6,-1.376
-5,-0.971
-4,-0.639
-3,-0.374
-2,-0.179
-1,-0.053
0,0.000
1,-0.080
2,-0.200
3,-0.700
4,-1.300
5,-1.987
6,-2.509
7,-3.159
8,-3.946
```

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(continued from previous page)

9, -4.882  
10, -5.982  
11, -7.264  
12, -8.756  
13, -10.498  
14, -12.551  
15, -15.021  
16, -18.110  
17, -22.259  
18, -28.598  
19, -34.203  
20, -27.412  
21, -23.162  
22, -20.560  
23, -18.783  
24, -17.499  
25, -16.553  
26, -15.866  
27, -15.396  
28, -15.122  
29, -15.033  
30, -15.127  
31, -15.406  
32, -15.876  
33, -16.547  
34, -17.431  
35, -18.537  
36, -19.862  
37, -21.359  
38, -22.862  
39, -23.992  
40, -24.280  
41, -23.680  
42, -22.631  
43, -21.539  
44, -20.590  
45, -19.839  
46, -19.287  
47, -18.922  
48, -18.725  
49, -18.682  
50, -18.776  
51, -18.997  
52, -19.333  
53, -19.771  
54, -20.300  
55, -20.905  
56, -21.568  
57, -22.264  
58, -22.963  
59, -23.627  
60, -24.216

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61, -24.695  
62, -25.041  
63, -25.251  
64, -25.343  
65, -25.345  
66, -25.294  
67, -25.220  
68, -25.146  
69, -25.091  
70, -25.066  
71, -25.076  
72, -25.125  
73, -25.214  
74, -25.343  
75, -25.509  
76, -25.711  
77, -25.945  
78, -26.210  
79, -26.502  
80, -26.818  
81, -27.154  
82, -27.506  
83, -27.871  
84, -28.243  
85, -28.617  
86, -29.000  
87, -30.000  
88, -31.000  
89, -34.000  
90, -36.000  
91, -34.000  
92, -31.000  
93, -30.000  
94, -29.000  
95, -28.617  
96, -28.243  
97, -27.871  
98, -27.506  
99, -27.154  
100, -26.818  
101, -26.502  
102, -26.210  
103, -25.945  
104, -25.711  
105, -25.509  
106, -25.343  
107, -25.214  
108, -25.125  
109, -25.076  
110, -25.066  
111, -25.091  
112, -25.146

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113,-25.220  
114,-25.294  
115,-25.345  
116,-25.343  
117,-25.251  
118,-25.041  
119,-24.695  
120,-24.216  
121,-23.627  
122,-22.963  
123,-22.264  
124,-21.568  
125,-20.905  
126,-20.300  
127,-19.771  
128,-19.333  
129,-18.997  
130,-18.776  
131,-18.682  
132,-18.725  
133,-18.922  
134,-19.287  
135,-19.839  
136,-20.590  
137,-21.539  
138,-22.631  
139,-23.680  
140,-24.280  
141,-23.992  
142,-22.862  
143,-21.359  
144,-19.862  
145,-18.537  
146,-17.431  
147,-16.547  
148,-15.876  
149,-15.406  
150,-15.127  
151,-15.033  
152,-15.122  
153,-15.396  
154,-15.866  
155,-16.553  
156,-17.499  
157,-18.783  
158,-20.560  
159,-23.162  
160,-27.412  
161,-34.203  
162,-28.598  
163,-22.259  
164,-18.110

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```
165,-15.021
166,-12.551
167,-10.498
168,-8.756
169,-7.264
170,-5.982
171,-4.882
172,-3.946
173,-3.159
174,-2.509
175,-1.987
176,-1.300
177,-0.700
178,-0.200
179,-0.080
180,0.000
PATCUT:,H
POLARI:,V/V
NUPOIN:,360
FSTLST:,-179,180
-179,-1.097
-178,-1.096
-177,-1.095
-176,-1.094
-175,-1.091
-174,-1.088
-173,-1.085
-172,-1.080
-171,-1.075
-170,-1.070
-169,-1.064
-168,-1.057
-167,-1.050
-166,-1.043
-165,-1.034
-164,-1.026
-163,-1.017
-162,-1.007
-161,-0.998
-160,-0.987
-159,-0.977
-158,-0.966
-157,-0.955
-156,-0.944
-155,-0.933
-154,-0.921
-153,-0.910
-152,-0.898
-151,-0.887
-150,-0.875
-149,-0.863
-148,-0.852
```

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```
-147,-0.841
-146,-0.829
-145,-0.818
-144,-0.807
-143,-0.797
-142,-0.786
-141,-0.776
-140,-0.766
-139,-0.756
-138,-0.747
-137,-0.738
-136,-0.730
-135,-0.721
-134,-0.713
-133,-0.706
-132,-0.699
-131,-0.692
-130,-0.685
-129,-0.679
-128,-0.673
-127,-0.668
-126,-0.662
-125,-0.658
-124,-0.653
-123,-0.649
-122,-0.644
-121,-0.640
-120,-0.637
-119,-0.633
-118,-0.630
-117,-0.627
-116,-0.623
-115,-0.620
-114,-0.617
-113,-0.614
-112,-0.611
-111,-0.608
-110,-0.605
-109,-0.602
-108,-0.599
-107,-0.595
-106,-0.592
-105,-0.588
-104,-0.584
-103,-0.580
-102,-0.576
-101,-0.571
-100,-0.566
-99,-0.561
-98,-0.556
-97,-0.550
-96,-0.544
```

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-95, -0.538  
-94, -0.531  
-93, -0.524  
-92, -0.516  
-91, -0.509  
-90, -0.501  
-89, -0.492  
-88, -0.484  
-87, -0.474  
-86, -0.465  
-85, -0.455  
-84, -0.445  
-83, -0.435  
-82, -0.424  
-81, -0.413  
-80, -0.402  
-79, -0.391  
-78, -0.379  
-77, -0.367  
-76, -0.355  
-75, -0.343  
-74, -0.330  
-73, -0.318  
-72, -0.305  
-71, -0.293  
-70, -0.280  
-69, -0.268  
-68, -0.255  
-67, -0.242  
-66, -0.230  
-65, -0.217  
-64, -0.205  
-63, -0.193  
-62, -0.181  
-61, -0.170  
-60, -0.158  
-59, -0.147  
-58, -0.136  
-57, -0.125  
-56, -0.115  
-55, -0.105  
-54, -0.096  
-53, -0.087  
-52, -0.078  
-51, -0.070  
-50, -0.062  
-49, -0.055  
-48, -0.048  
-47, -0.041  
-46, -0.035  
-45, -0.030  
-44, -0.025

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```
-43,-0.020
-42,-0.016
-41,-0.013
-40,-0.010
-39,-0.007
-38,-0.005
-37,-0.003
-36,-0.002
-35,-0.001
-34,0.000
-33,0.000
-32,0.000
-31,-0.001
-30,-0.002
-29,-0.003
-28,-0.004
-27,-0.006
-26,-0.008
-25,-0.010
-24,-0.012
-23,-0.014
-22,-0.017
-21,-0.020
-20,-0.022
-19,-0.025
-18,-0.028
-17,-0.031
-16,-0.034
-15,-0.037
-14,-0.039
-13,-0.042
-12,-0.045
-11,-0.047
-10,-0.049
-9,-0.052
-8,-0.054
-7,-0.056
-6,-0.057
-5,-0.059
-4,-0.060
-3,-0.061
-2,-0.062
-1,-0.062
0,-0.063
1,-0.063
2,-0.063
3,-0.062
4,-0.062
5,-0.061
6,-0.060
7,-0.059
8,-0.057
```

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```
9, -0.056
10, -0.054
11, -0.052
12, -0.049
13, -0.047
14, -0.045
15, -0.042
16, -0.039
17, -0.037
18, -0.034
19, -0.031
20, -0.028
21, -0.025
22, -0.022
23, -0.020
24, -0.017
25, -0.014
26, -0.012
27, -0.010
28, -0.008
29, -0.006
30, -0.004
31, -0.003
32, -0.002
33, -0.001
34, 0.000
35, 0.000
36, 0.000
37, -0.001
38, -0.002
39, -0.003
40, -0.005
41, -0.007
42, -0.010
43, -0.013
44, -0.016
45, -0.020
46, -0.025
47, -0.030
48, -0.035
49, -0.041
50, -0.048
51, -0.055
52, -0.062
53, -0.070
54, -0.078
55, -0.087
56, -0.096
57, -0.105
58, -0.115
59, -0.125
60, -0.136
```

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```
61, -0.147
62, -0.158
63, -0.170
64, -0.181
65, -0.193
66, -0.205
67, -0.217
68, -0.230
69, -0.242
70, -0.255
71, -0.268
72, -0.280
73, -0.293
74, -0.305
75, -0.318
76, -0.330
77, -0.343
78, -0.355
79, -0.367
80, -0.379
81, -0.391
82, -0.402
83, -0.413
84, -0.424
85, -0.435
86, -0.445
87, -0.455
88, -0.465
89, -0.474
90, -0.484
91, -0.492
92, -0.501
93, -0.509
94, -0.516
95, -0.524
96, -0.531
97, -0.538
98, -0.544
99, -0.550
100, -0.556
101, -0.561
102, -0.566
103, -0.571
104, -0.576
105, -0.580
106, -0.584
107, -0.588
108, -0.592
109, -0.595
110, -0.599
111, -0.602
112, -0.605
```

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```
113,-0.608
114,-0.611
115,-0.614
116,-0.617
117,-0.620
118,-0.623
119,-0.627
120,-0.630
121,-0.633
122,-0.637
123,-0.640
124,-0.644
125,-0.649
126,-0.653
127,-0.658
128,-0.662
129,-0.668
130,-0.673
131,-0.679
132,-0.685
133,-0.692
134,-0.699
135,-0.706
136,-0.713
137,-0.721
138,-0.730
139,-0.738
140,-0.747
141,-0.756
142,-0.766
143,-0.776
144,-0.786
145,-0.797
146,-0.807
147,-0.818
148,-0.829
149,-0.841
150,-0.852
151,-0.863
152,-0.875
153,-0.887
154,-0.898
155,-0.910
156,-0.921
157,-0.933
158,-0.944
159,-0.955
160,-0.966
161,-0.977
162,-0.987
163,-0.998
164,-1.007
```

(continues on next page)

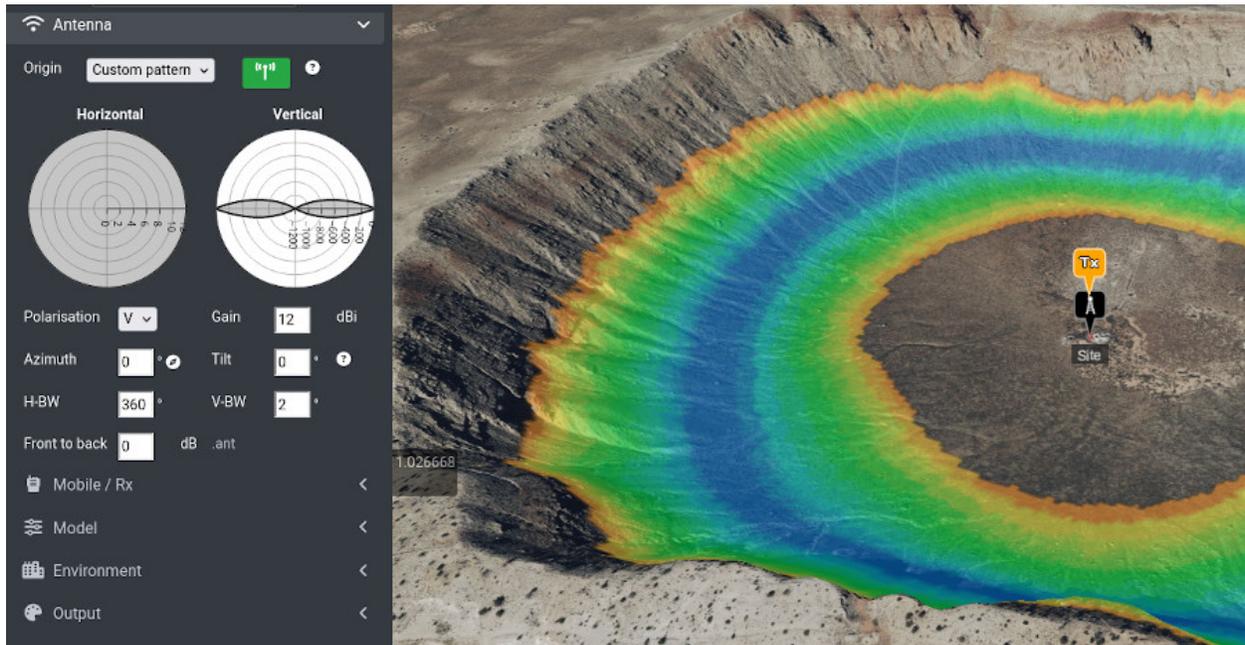
(continued from previous page)

```

165,-1.017
166,-1.026
167,-1.034
168,-1.043
169,-1.050
170,-1.057
171,-1.064
172,-1.070
173,-1.075
174,-1.080
175,-1.085
176,-1.088
177,-1.091
178,-1.094
179,-1.095
180,-1.096
ENDFIL: ,EOF
    
```

### 10.1.3 Antenna pattern test range

As well as testing over water, the Meteor crater west of Winslow, Arizona is recommended for proving vertical antenna patterns as the elevation plane can be seen clearly on the walls.



## 10.2 Terrain data

The system works with raster data in the GeoTIFF format with WGS-84 projection.

*SOOTHSAYER users with a private server can add their own tiles by placing them in the mapped /data/DEM/ folder and importing them within the admin dashboard. See the SOOTHSAYER documentation for more information on adding your own data.*

GeoTIFF tiles need to be of type Int16 in WGS-84 (EPSG:4326) projection with a pixel resolution of between 1 and 30m. LZW compression is recommended.

For a map of current CloudRF system data see [Terrain data map](#). Data is continuously added and refreshed so this is a live map.

## 10.3 Buildings and LiDAR

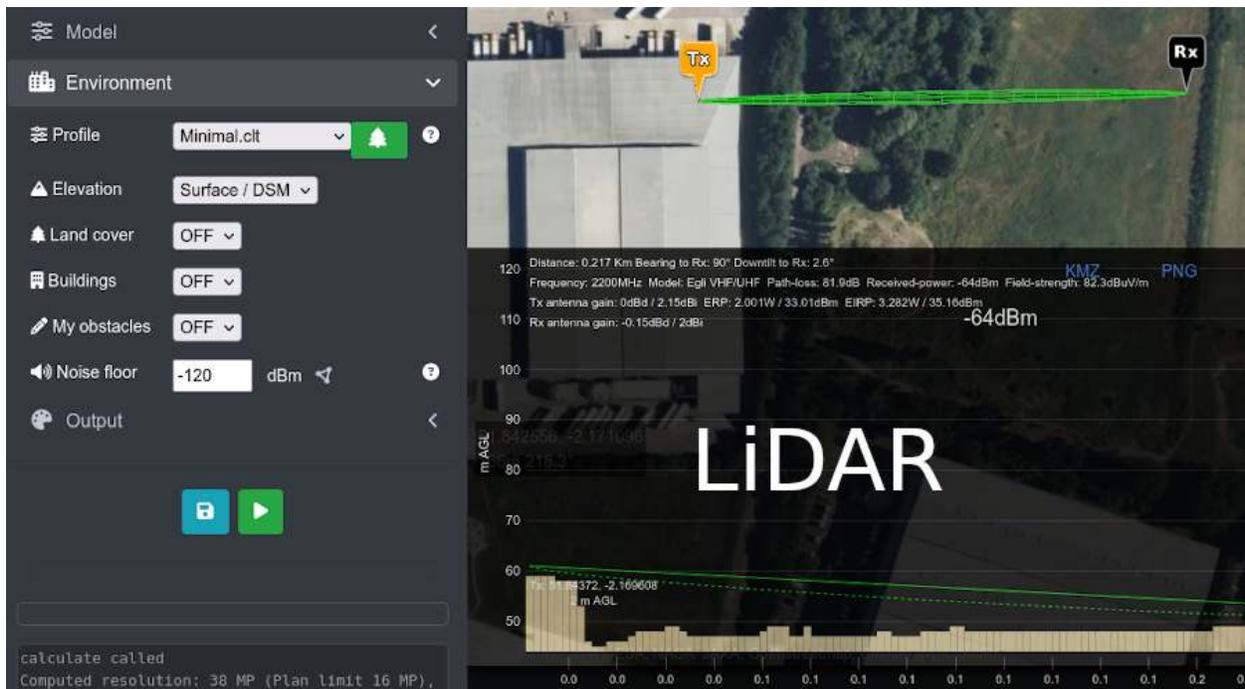
When using LiDAR data, users should be aware that it is a single surface layer (DSM) which *includes* buildings. Therefore if you need a 2m mast on top of a 9m building this is still a **relative height** of 2m for the input form.

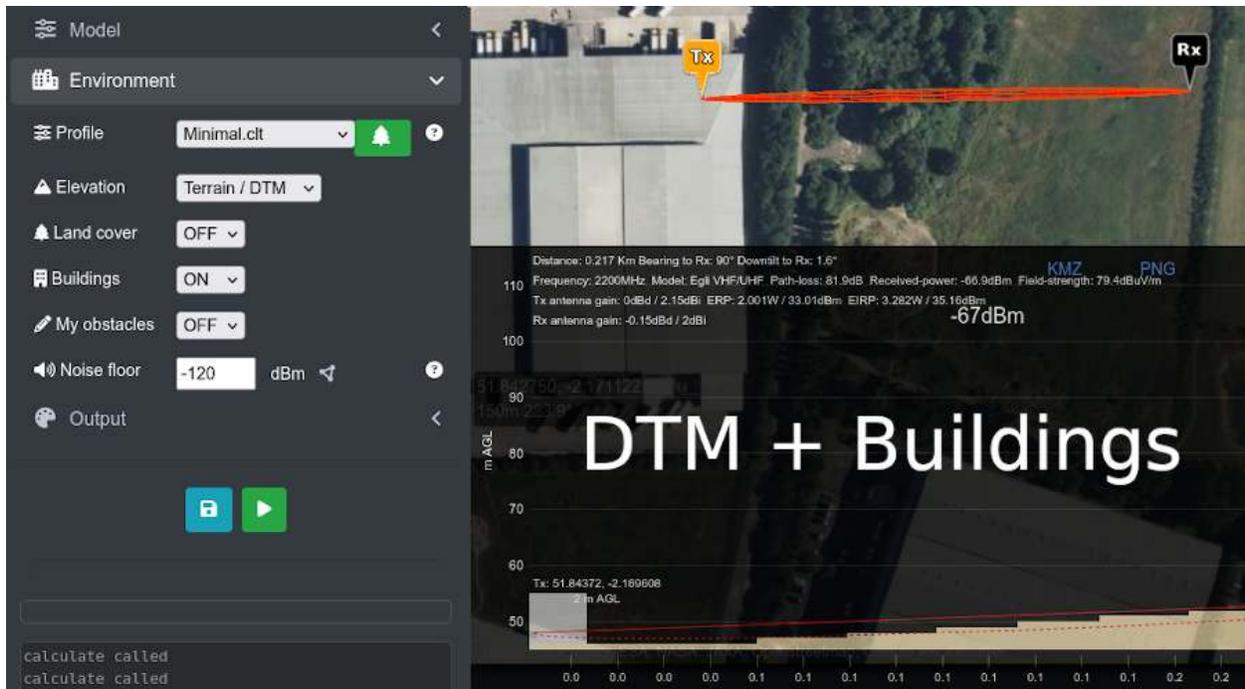
To test for LiDAR, use the path tool with DSM and without the buildings layer at high-resolution eg. 5m. If you see buildings you have LiDAR in your area.

If you do not have LiDAR, use the digital terrain model (DTM), which describes most of the earth, and enter an **absolute height** above ground of 11m to simulate a 2m mast atop a 9m building.

In the web interface, LiDAR data is used when the terrain type is DSM and the resolution is  $\leq$  30m. If it is not available, a 30m DSM model will be used. This does not contain buildings so must be enhanced with the buildings layer.

In these images, a 2m high antenna is modelled using DSM LiDAR and DTM with buildings. Note the DTM link appears obstructed since it is inside the obstacle so needs elevating to the absolute height of 11m above ground to budget for the 9m building.





## 10.4 Clutter data

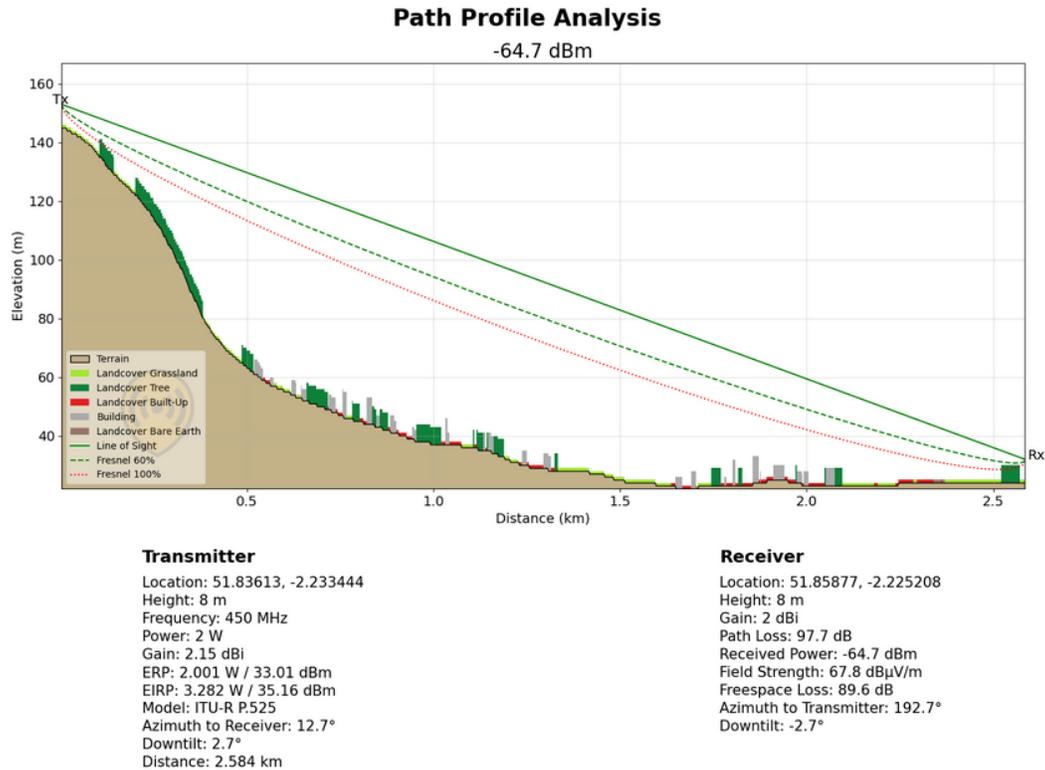
The system has several forms of landcover data to enhance above surface accuracy, especially in urban areas.

All users can draw and self-classify private clutter items in the web interface as polylines or polygons. Using this technique you can represent almost any obstacle from light trees through to concrete and solid metal.

Large numbers of obstacles can be uploaded as KML or GeoJSON in the web interface.

Uploaded clutter belongs to a user and is not visible to others.

For more information on landcover classes see [Clutter data](#).



### 10.4.1 10m Landcover

The primary clutter source is European Space Agency (ESA) 10m Landcover data, published in October 2021.

*WorldCover provides a new baseline global land cover product at 10 m resolution for 2020 based on Sentinel-1 and 2 data that was developed and validated in almost near-real time and at the same time maximizes the impact and uptake for the end users.*

*A tremendous step forward towards the joint use of Sentinel satellite data for worldwide land cover mapping.*

© ESA WorldCover project 2020 / Contains modified Copernicus Sentinel data (2020) processed by ESA WorldCover consortium

This comprehensive dataset covers the planet and has 9 bands for Trees, Shrubland, Grassland, Crops, Built-up, Bare ground, Snow/Ice, Water, Swamps and Mangroves.

**WARNING:** *Be careful when setting the 'urban' landcover height since this elevates roads (and car parks etc) as well as buildings! Keep this height low and use the buildings layer instead for urban planning.*

### 10.4.2 3D Buildings

A supplementary clutter source are 3D Buildings, derived from satellite imagery using machine learning. These are accurate to 2m and have better global coverage than crowd sourced equivalents.

The height of buildings is either estimated or crowd sourced. Where height is unknown an approximate local value is used based upon neighbour heights. The minimum height is 3m.

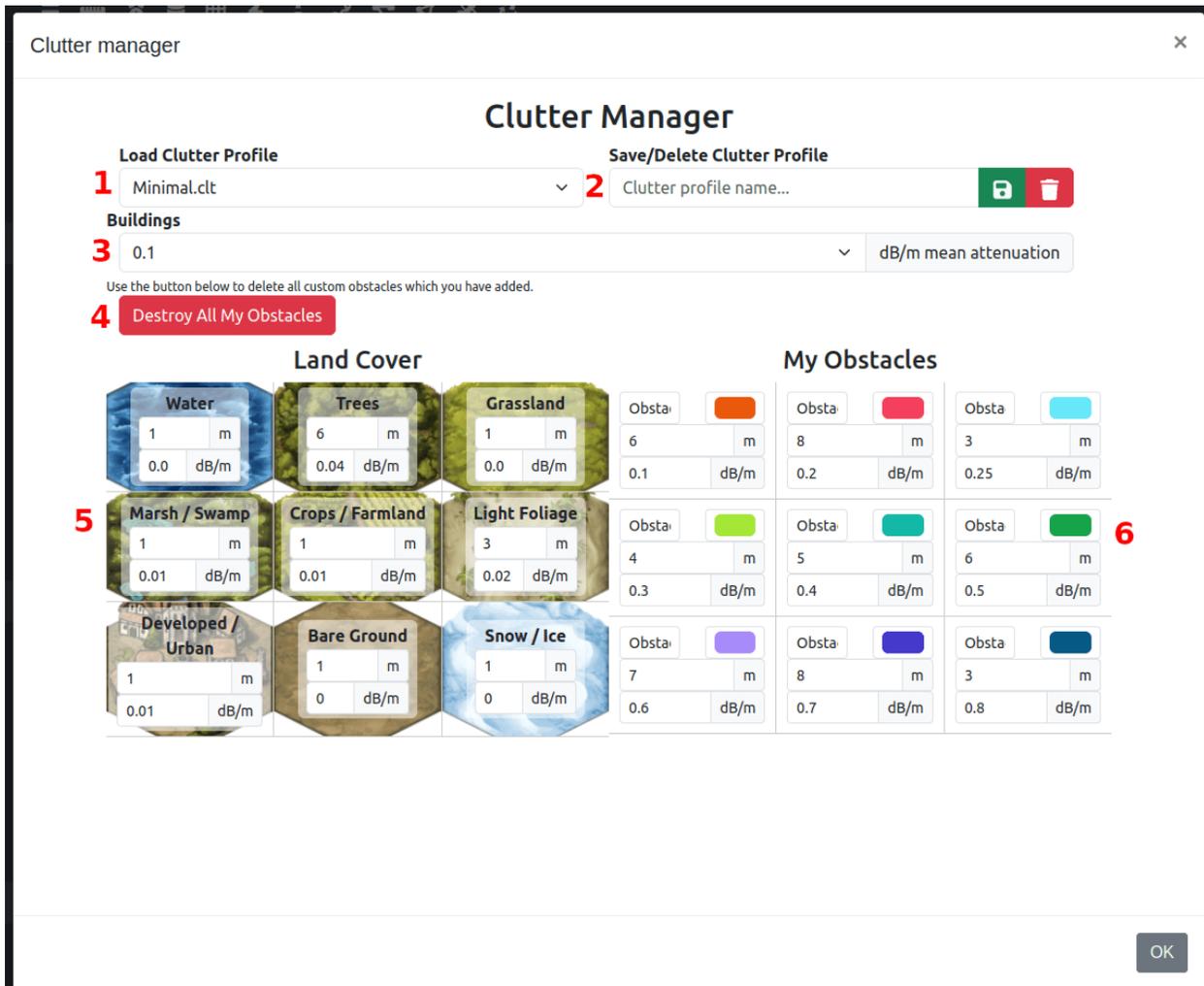
### 10.4.3 Custom Clutter

All users can draw and self-classify private clutter items in the web interface as polylines or polygons. Using this technique you can represent almost any obstacle from light trees through to concrete.

Large numbers of obstacles can be uploaded as KML or GeoJSON in the web interface.

Uploaded clutter belongs to a user or the system. VM administrators can override clutter ownership manually in the SQL clutter table to make it system clutter for the benefit of all users.

For more information on land cover classes see [Clutter data](#).



1. Selected clutter profile
2. Save/delete profile as name

3. Building attenuation
4. Delete all obstacles on your account
5. Land cover types with customisable height and attenuation values
6. My obstacle (clutter) types with customisable name, colour, height and attenuation values

#### 10.4.4 Clutter codes

In a clutter profile the codes represent different types of landcover.

##### System Landcover

- 1 Water
- 2 Trees
- 3 Grassland
- 4 Swamp
- 5 Crops
- 6 Shrubland
- 7 Built-up
- 8 Bare ground
- 9 Snow / Ice

##### Custom Clutter

Codes 11 through 19 represent “Custom Clutter”. These codes are free to be customised as per your particular usecase and environment. You have the ability to define a name and a colour for each of these clutter codes which will be represented in calculations.

For more information on how to add clutter with these codes, please consult the [clutter documentation](#).

#### 10.4.5 Clutter Profiles

Premium users can define custom clutter profiles for regions eg. `AFRICA.clt`, `POLAND.clt`. These are saved within your folder as `.clt` files. VM users can add these locally by placing `.clt` files in the folder.

A `.clt` is a simple text format with tab delimiters and 3 columns: “Code”, “Height (m)” and “Nominal Attenuation (dB/m)”.

Codes 11 through 19 represent your “My Obstacles” and also have 2 additional columns of “Name” and “Colour Code”. This allows you to customise your custom obstacles further.

The system default, `Minimal.clt`, looks like this. Code 10 is not used.

Please note that the columns are separated by tabs (`\t`).

1	1	0.0		
2	1	0.01		
3	1	0.0		
4	1	0.001		
5	1	0.002		
6	1	0.002		
7	1	0.02		
8	1	0		
9	1	0		
10	0	0		
11	6	0.1	"Obstacle 1"	"#ea580c"
12	8	0.2	"Obstacle 2"	"#f43f5e"
13	3	0.25	"Obstacle 3"	"#67e8f9"
14	4	0.3	"Obstacle 4"	"#a3e635"
15	5	0.4	"Obstacle 5"	"#14b8a6"
16	6	0.5	"Obstacle 6"	"#16a34a"
17	7	0.6	"Obstacle 7"	"#a78bfa"
18	8	0.7	"Obstacle 8"	"#4338ca"
19	3	1.0	"Obstacle 9"	"#075985"

## COMMON TASKS

The following are instructions for completing several common tasks in radio engineering. They are intended as a guide only. For detailed instructions on each component see the relevant documentation section.

### 11.1 Measure the coverage of a WISP tower

A WISP tower is going to be built and evidence is needed to justify the cost/benefit.

#### 11.1.1 1. Create the tower coverage

Create the tower coverage as a layer using the interface. If the antenna pattern is known then use that for the most accurate model, otherwise you can use custom beamwidth values from the datasheet.

#### 11.1.2 2. Upload zip code data for properties

Prepare a CSV spreadsheet for the area containing zip codes. These can be grouped by streets or neighbourhoods and the zip or address is the unique value in the id column.

##### Example property data

latitude	longitude	id	group
51.8668	-2.2066	GL43HX	Barnwood
51.8641	-2.2129	GL43HY	Barnwood

#### 11.1.3 3. Download the results

You can download results as CSV by clicking the download button in the bottom left analysis window. This download will show you if a property is covered or not with a YES or NO. If your input data can be sorted and contains the same number of rows as the output, you can paste the YES/NO column into your input CSV for a very granular report into neighbourhood coverage.

## 11.2 Model multiple sites for multiple frequencies

The problem is how to efficiently model multiple locations but with different frequencies. The locations do not change.

### 11.2.1 1. Prepare a CSV spreadsheet

Instead of entering locations manually into the user interface, enter them into a CSV spreadsheet to eliminate error with (repeat) siting. The format should as a minimum contain the fields latitude and longitude:

latitude	longitude
51.8668	-2.2066
51.8641	-2.2129

### 11.2.2 2. Save radio settings as templates

Create your radio settings in the interface form and save them as a template. You will need a template for each frequency you need to test.

### 11.2.3 3. Import data

Select a template for the first frequency eg. Frequency1, then using the data import “MANET tool” option, load in the CSV. Each site will be modelled with the chosen frequency and associated settings. Repeat by loading the next template, and loading in the same CSV.

## 11.3 Design a network that meets a coverage requirement

The requirement is for 95% coverage of a city with a LPWAN smart meter network. The network must be economical yet provide good coverage. The consultant must be able to demonstrate planned coverage meets the requirement.

### 11.3.1 1. Prepare your data

The most important aspect of this task is to prepare your data. You need CSV spreadsheets for the properties or locations you would like covered (maximum 60,000 rows per spreadsheet in the interface) and another for the gateway locations (maximum 1000 rows in the interface).

**Pay particular attention to the site name and network name fields as these will be needed later when finding, deleting or analysing the data.**

## Example property data

latitude	longitude	id	group
51.8668	-2.2066	CloudRF	Barnwood
51.8641	-2.2129	Roundabout	Barnwood

## Example gateway data

This verbose format is for the user interface “site import” feature only. If you choose to use the API directly, you can use any format so long as it conforms to the API at the point of request. Examples are here: <https://github.com/CloudRF/CloudRF-API-clients/tree/master/python>

```
Site,Latitude (degrees),Longitude (degrees),Transmitter Height (m),Receiver Height (m),
↪Receiver Gain (dBi),Receiver Sensitivity (dBm),Frequency (MHz),Bandwidth (MHz),RF
↪Power (W),Antenna Pattern,Antenna Polarization,Antenna Loss (dB),Antenna Azimuth
↪(degrees),Antenna Tilt (degrees),Antenna Gain (dBi),Noise floor (dBm),Model,Measured
↪units,Context,Diffraction,Reliability,Profile,Colour schema,Antenna Horizontal
↪Beamwidth (degrees),Antenna Vertical Beamwidth (degrees),Front to back
Site 1,38.9053686786203,1.42393869858255,10,10,8,-50,446,1.4,30,OEM Half-Wave Dipole,V,0,
↪240,10,8,-120,EgLi VHF/UHF (< 1.5GHz),Received Power (dBm),Average / Mixed,Knife edge,
↪50% / -0dB (Optimistic),Minimal.clt,RAINBOW,1,1,8
Site 2,38.9071885546264,1.43414926725016,11,1,10,-60,800,10,10,OEM Half-Wave Dipole,V,10,
↪240,10,8,-90,EgLi VHF/UHF (< 1.5GHz),Received Power (dBm),Average / Mixed,Knife edge,50
↪% / -0dB (Optimistic),Minimal.clt,RAINBOW,1,1,8
Site 3,38.9045598298649,1.43757317051595,20,5,5,-70,2400,20,1,OEM Half-Wave Dipole,H,11,
↪240,10,8,-70,EgLi VHF/UHF (< 1.5GHz),Received Power (dBm),Average / Mixed,Knife edge,50
↪% / -0dB (Optimistic),Minimal.clt,RAINBOW,1,1,8
```

### 11.3.2 2. Process the gateway data

Using either an API client or the new “site import” functionality in the user interface, push the CSV data into the API with the “Area” API. This could be CPU or GPU powered and will create heatmaps in your account for analysis. If you have labelled the network properly it will be easy to find the data in your archive.

### 11.3.3 3. Load the data in the user interface

Load the layers on the map by either clicking their names from your archive or merging them into a super layer using the super layer utility. If you processed the data using the MANET API this is unnecessary as the data is already a single layer.

### 11.3.4 4. Perform coverage analysis using the property data

Import the CSV data containing customer properties using the **Coverage Analysis** import option and expect to see coverage results displayed in the bottom left corner. Results will report coverage as a percentage so 90% would be covering 9/10 properties in an area.

### 11.3.5 5. Move or remove a gateway

If a gateway needs changing to meet the requirement (95%), remove it from the network by selecting and deleting it in the archive and then do it again at the new location.

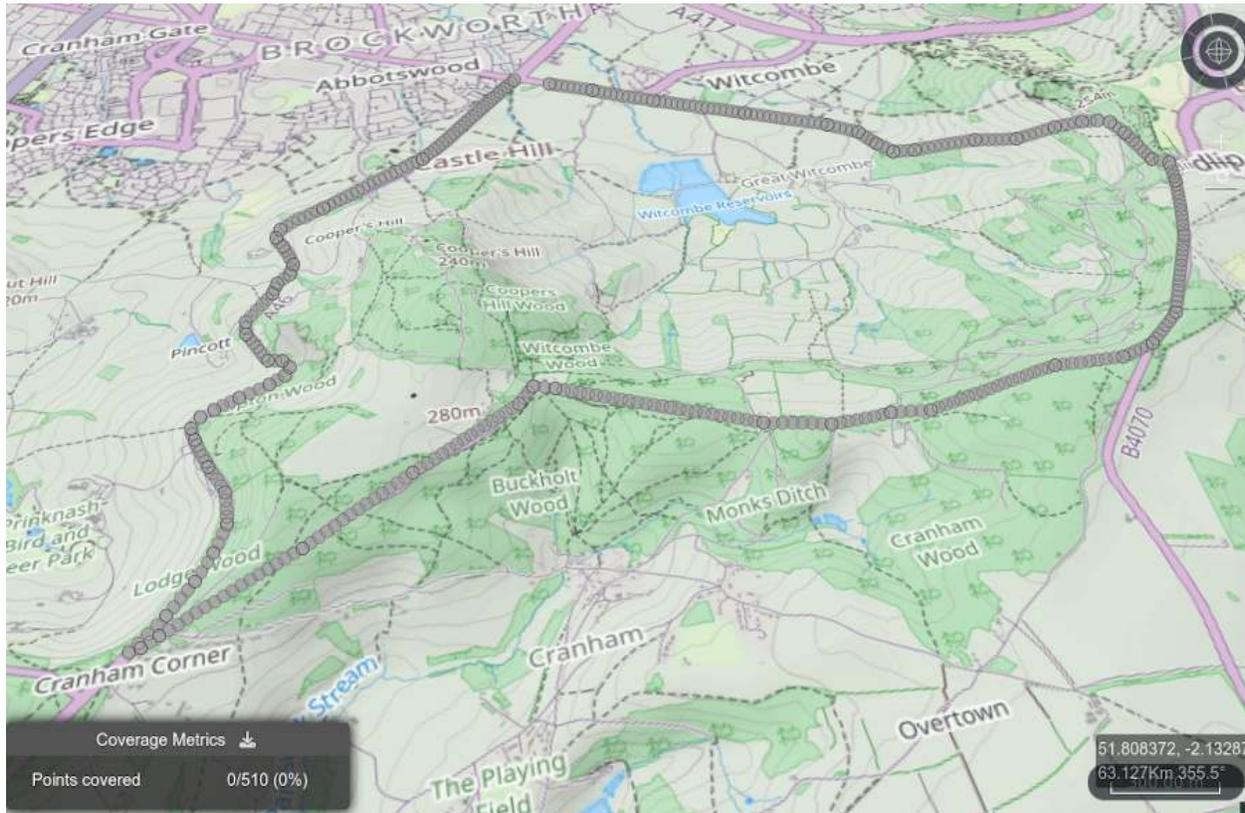
### 11.3.6 6. Download results

You can download results as CSV by clicking the download button in the bottom left analysis window. This download will show you if a property is covered or not with a YES or NO. If your input data can be sorted and contains the same number of rows as the output, you can paste the YES/NO column into your input CSV for a very granular report into neighbourhood coverage.

## 11.4 Model HF NVIS coverage

1. Enter an appropriate frequency between 2 and 8MHz and a Tx power in watts.
2. Choose the HF NVIS model in the model menu. The antenna will be automatically set although you may choose the azimuth and gain. Use 0dBi if you are not sure of the gain or it is a whip. Set diffraction off to reveal any shadows although it will likely diffract into them given the frequency.
3. Choose the context/height to match the scenario. If it's day time then the D layer will be present but will attenuate low frequencies so bear this in mind. If it's night time, use the F layer. If there's uncertainty then use the E layer for a compromise.
4. For the receiver use 0dBi for a whip antenna.
5. Use the CPU engine with 180m resolution for links out to 200km. Otherwise use the GPU engine.
6. Click the map or press play or change a value like azimuth to trigger a calculation.

## 11.5 Test a route for coverage against a network



1. Create your route as a KML linestring in Google Earth or equivalent. Save it as KML or KMZ.
2. Import the KML/KMZ file using the file import dialog as “Coverage analysis”. Lots of grey points will be added to the map.
3. Create or reload a heatmap layer to test for coverage. The coverage will be reported in the coverage analysis dialog in the bottom left corner.
4. For a MANET network, enable the MANET tool and ensure heatmaps are enabled by clicking the donut icon in the MANET dialog. Links are ignored here. Place the MANET nodes by clicking upon the map.

*Note that the settings for each node can be different but can only be defined prior to placing the node. Once placed, a node's frequency and power cannot be changed but you can change global network values such as environmental settings.*

*See the Web Interface [Import Data > Coverage Analysis](#) section for more detail on this topic*



## DOCUMENTATION CHANGELOG

### 12.1 2.8.0

- Feature: Updated documentation for SOOTHSAYER 1.8.0.
- Feature: SOOTHSAYER is no longer offered as a VM. Removed VM specific documentation.
- Feature: Added satellite update information to SOOTHSAYER documentation.
- Update: Updated SOOTHSAYER DEM importing documentation.

### 12.2 2.7.1

- Feature: Added SOOTHSAYER compatibility matrix for different operating systems.
- Feature: Added Operator / Enginer mode description.
- Feature: Added Swagger documentation for `output.bounds` and `transmitter.remote`.
- Feature: Added 'megavoxels' to swagger.
- Update: Revised SOOTHSAYER requirements.

### 12.3 2.7.0

- Feature: Added Swagger documentation for 3D API.
- Update: Swagger v5.17.14.
- Fix: Search functionality not reporting words within pages.

### 12.4 2.6.1

- Update: Support for SOOTHSAYER 1.7.1.

## 12.5 2.6.0

- Feature: Diffraction IDs added into Swagger.
- Feature: “Import Data” moved up to top-layer of hierarchy due to frequency of reference.
- Feature: Sections relating to “My Obstacles” clutter updated with custom names and colours.
- Fix: Swagger documentation brought up in line with 3.9.6.
- Fix: Screenshots of drawing “My Obstacles” brought up-to-date.
- Fix: Imagery layer brought up-to-date.
- Fix: PPA PNGs for LiDAR and clutter brought up-to-date.

## 12.6 2.5.6

- Feature: Archive tools includes details about exporting projections.
- Fix: Refreshed screenshots of receiver menu and archive tools section.
- Improvement: HF NVIS
- Improvement: Diffraction models
- Improvement: Models table with codes
- Update: ATAK 4.10 supported

## 12.7 2.5.5

- Improvement: Wording on “API” section.
- Feature: P.529 replaced with P.1546 model.
- Feature: Added `multisite` example of RADAR with mixed heights.
- Fix: Changelog missing.
- Fix: Swagger `multisite` values not respecting correct units for `receiver.alt`.
- Fix: GPU now supports ITM.

## 12.8 2.5.4

- Feature: Added details about deleting all clutter.
- Fix: Broken GitHub links on API introduction.

## 12.9 2.5.3

- Fix: Blank PDF caused by broken “micro-” symbol.
- Fix: RADAR missing for list of propagation models.
- Fix: Swagger document for API 3.9 is incorrectly named as 3.9-dev.

## 12.10 2.5.2

- Upgrade: Support for API 3.9.0, UI 3.9.0 and CPU engine 1.8.0.
- Feature: Added /noise/get and /noise/create endpoints to Swagger.
- Improvement: Updates to images.

## 12.11 2.5.1

- Improvement: Added “Multi-azimuth requests” to API introduction.

## 12.12 2.5.0

- Upgrade: Support for API 3.8.10, UI 3.8.8, CPU engine 1.4.3 and GPU engine 1.4.3.
- Improvement: API documentation included sections which needed additional detail.

## 12.13 2.4.0

- Improvement: API status light
- Improvement: LEO planning under Best Site Analysis
- Improvement: Updated TAK Interface for OG TAK Server
- Improvement: Added warning about “Line of Sight” model should have knife edge diffraction disabled.
- Fix: Plane earth loss model is no longer accepted.
- Feature: Added `remaining_calculations_since_last_purchase` to my-metrics Swagger UI.
- Feature: Added sections about new “Import reference data” functionality in the UI.
- Feature: Overview of management tools improved.
- Fix: Removed reference to clutter polylines as this is no longer used in the UI.
- Fix: Improvements to headings.
- Improvement: Added details on the `edges` array which is optional for the `bsa` endpoint and allows the definition of a bounding box to run a BSA inside.
- Fix: Load Swagger UI 3.8 by default.
- Fix: Incorrect version on Swagger UI for 3.7 API.
- Fix: Correct validation limits for bandwidth and noise floor.

## 12.14 2.3.0

- Upgrade: Support for API 3.8, UI 3.8 and GPU Engine 1.3.0.
- Improvement: Environment menu.

## 12.15 2.2.0

- Upgrade: Support for API 3.7, UI 3.7 and GPU Engine 1.2.0.
- Upgrade: Swagger UI updated to v4.15.5.
- Feature: Added heatmaps/multisite sections to MANET.
- Feature: Added new /multisite endpoint to Swagger UI.

## 12.16 2.1.2

- Upgrade: Support for API 3.5, UI 3.6, Sleipnir 1.6.1 and GPU Engine 1.1.0.
- Feature: Added details on multi-azimuth antennas.
- Feature: Updated templates section to include new details about system templates, new templates manager, and downloading templates.
- Fix: Updated the “Account Information” section in line with live and added missing “Custom Map” section.
- Fix: Removed historic mat value from API reference.

## 12.17 2.1.1

- Upgrade: Components updated for API 3.3, UI 3.4.2 and Sleipnir 1.6.1.

## 12.18 2.1.0

- Upgrade: Swagger UI updated to v4.13.0.
- Feature: Updated Swagger with better layout for “Schema” section.
- Feature: Added section on system versions.
- Feature: Updated the overview of the web interface with new screenshot and annotations for both desktop and mobile view.
- Feature: Consolidation on a number of different sections to make the documentation easier to follow and remove duplicate sections.
- Feature: New screenshots and icons added to match current systems.
- Feature: Poor quality or difficult to read screenshots, images and icons have been removed or replaced with higher quality.
- Feature: Details about “Calculation Adjusted” messages in a response.
- Feature: /bsa, /my-metrics and /clutter/delete/0 endpoints added to Swagger UI.

- Feature: Added Terrain\_AMSL, Landcover distance, Landcover codes and Landcover heights on /path request in Swagger UI.
- Feature: Added annotated overview of a number of different menus and tools.
- Feature: Added “Account Information” and API ready scripts sections.
- Feature: Minified all images to reduce page size and page load times.
- Feature: Innovation roadmap extended to current day.
- Feature: Improvements to a number of different headings to allow for better nesting.
- Fix: Removed API reference document from Sphinx/ReadTheDocs as was causing confusion. Unique contents from the old reference have been moved to Swagger UI.
- Fix: Removed “Support Ticket” section on “About Cloud-RF” page as is no longer present.
- Fix: Broken markdown styling on some icons.
- Fix: “View Home” details are incorrect.
- Fix: Updated measured units to list all available units.
- Fix: Missing or incorrect values/types on /path example response in Swagger UI.
- Fix: Swagger UI gives incomplete endpoint for retrieving clutter.
- Fix: Swagger UI updated with engine parameter for /area calculations.
- Fix: Naming of “Mesh” to “Super Layer” on “Web Interface RF Tools” page.
- Fix: Clutter section on “Web Interface Map” listing historic management of height data.
- Fix: Issue on c1m in Swagger UI with default values.
- Fix: Missing fbr option in the output “Schema” section.
- Fix: Updated noise floor accepted range in Swagger UI.
- Fix: area value from /area calculation response schema updated in Swagger UI as km2 value is no longer appended.

## 12.19 2.0.1

- Support for API 2.8, UI 2.7 and Sleipnir 1.5.9.
- Added component versions to beginning of documentation.
- Fixed PDF where everything was under a “Contents” heading.
- Improvements to internal tooling to allow for better standardisation of documentation.

## 12.20 2.0.0

- Changed to Sphinx “Read the Docs” template.
- PDF included in documentation.
- Added search functionalty.
- Added satellite and MANET tools.
- Consolidated docs.cloudrf.com & <https://cloudrf.com/documentation/developer/swagger-ui/>.
- Added “Import Multiple Points from CSV” section to `interface_map`.
- Improvements to internal tooling and processes.