B

EM.Terrano

Tutorial Lessons

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EM.Terrano Tutorial Lesson 5

Simulating A Dense Urban Canyon Propagation Scene

Table of Contents

5.1 What You Will Learn

In this this tutorial you will use the random city wizard to create an urban canyon propagation scene. You will learn how to import a propagation scene to your project.

EM.Terrano Manual:

http://www.emagtech.com/wiki/index.php/EM.Terrano

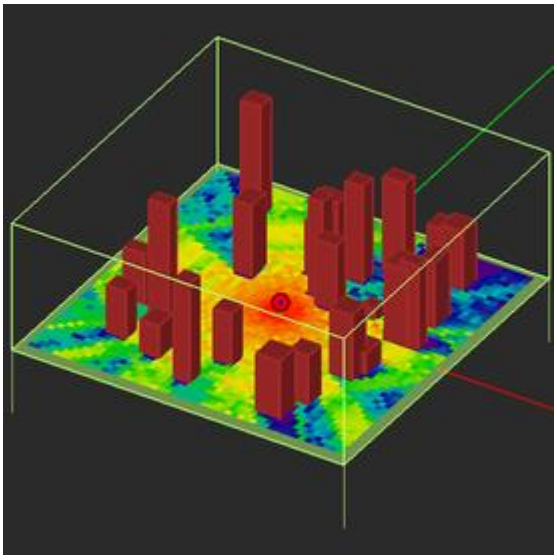
EM.Terrano Tutorial Gateway:

http://www.emagtech.com/wiki/index.php/EM.Cube#EM.Terrano_Documentation

Download projects related to this tutorial lesson:

http://www.emagtech.com/downloads/ProjectRepo/EMTerrano_Lesson5.zip

Tutorial Project: Simulating A Dense Urban Canyon Propagation Scene



Objective: In this project, you will build and analyze a fairly large urban propagation scene made up of a large set of imported buildings.

Concepts/Features:

- Wizard
- Impenetrable Surfaces
- SBR Analysis
- Received Power Coverage Map
- CAD File Import

Minimum Version Required: All versions

5.2 Getting Started

Start a new project with the following parameters:

Starting Parameters	
Name	EMTerrano_Lesson5
Length Units	Meters
Frequency Units	GHz
Center Frequency	2.4GHz
Bandwidth	0.1GHz

5.3 Creating & Analyzing a Semi-Random City Propagation Scene

For this tutorial lesson, you will use a wizard to build the geometry of an urban environment. Click on the **Random City Wizard**  button of the **Wizard Toolbar** (Figure 1) or select the menu item **Tools** → **Propagation Wizards** → **Random City**.

Figure 1*. Selecting the random city wizard on EM.Terrano's wizard toolbar.*

A dialog opens up and asks for the total city extents and number of buildings (Figure 2). Select **Custom** option for the **Select Scene Type** section of the dialog. Reduce the **City Extents** size to 250m and accept the default value of 25 for the total number of buildings (**No. of Buildings**) in the scene. Change the **Max Building Base Size** to 20 and then click the **OK** button.

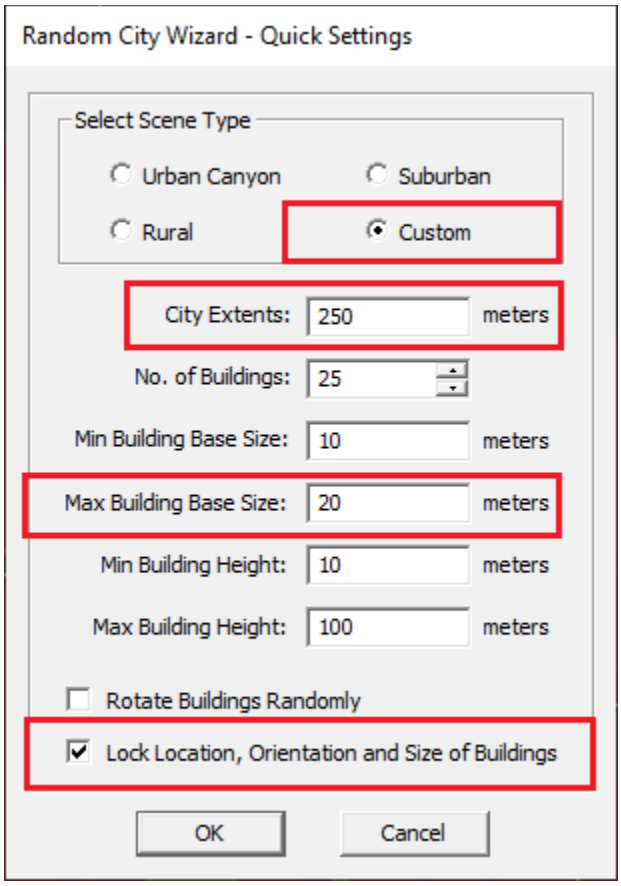


***Figure 2**. The Random City Wizard dialog.*

The wizard creates 25 buildings with random locations and random dimensions in an area of 250m × 250m centered at the origin of coordinates as shown in Figure 3.

Note that since the locations and dimensions of all the buildings were created using random variables, you may get a different scene than the one shown in this tutorial.

Since the location of the buildings is totally random, there is a chance that your transmitter may fall inside an **impenetrable** building – e.g., when there is a building at the location (0,0,0) – and becomes useless (see Figure 4). Remember that the **Basic Link Wizard** creates a single transmitter at the location (0,0,0). In that case, you may change the location of your transmitter or repeat this process until you get an acceptable scene.

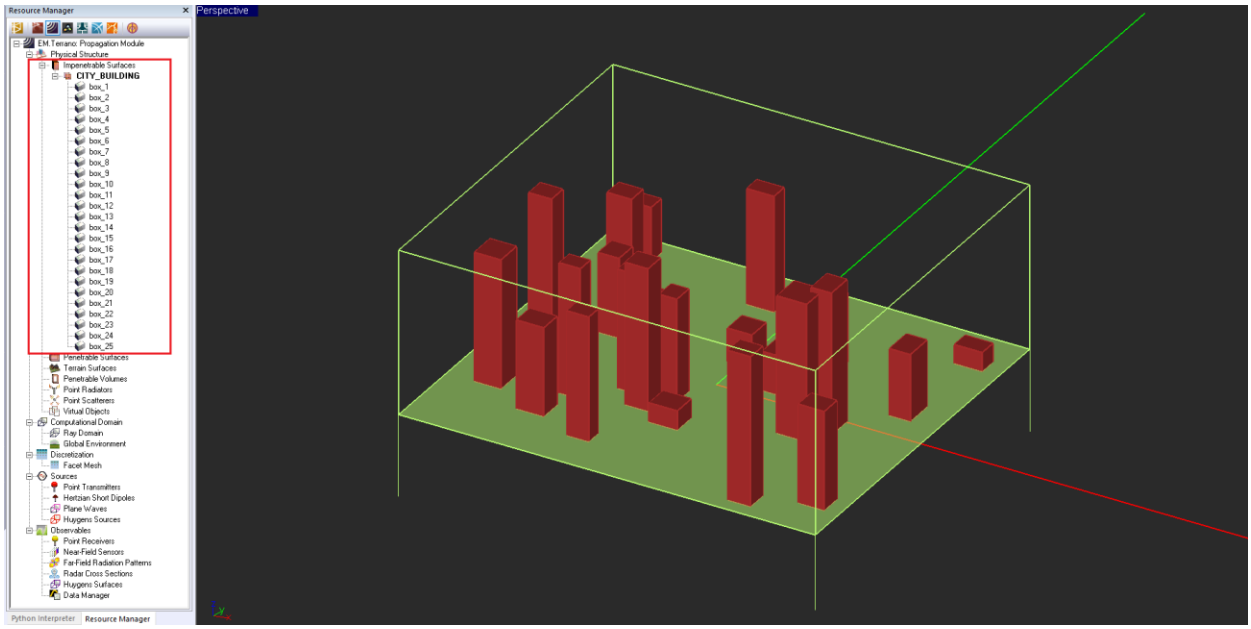


***Figure 3**. The geometry of the semi-random city created by the wizard.*

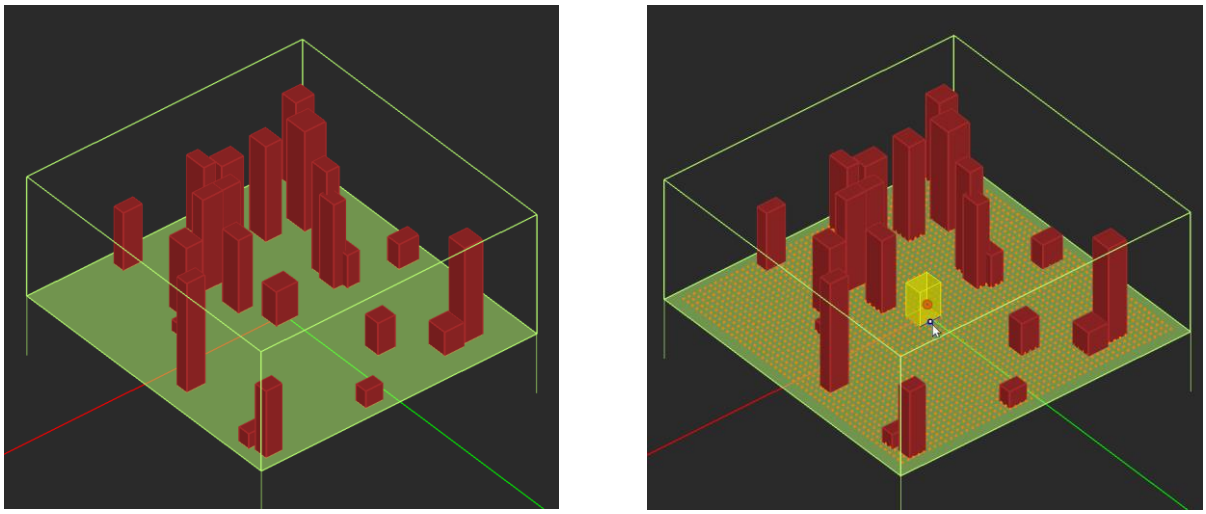


***Figure 4**. A situation that a transmitter falls inside an impenetrable building. Hovering the mouse over the building at the center to view the transmitter inside it (right).*

When you first created your scene, by default, the box labeled **Lock Location, Orientation and Size of Buildings** was checked in the Random City Wizard dialog (see Figure 2). This creates a semi-random scene, meaning all the LCS coordinates and dimensions of the buildings are picked randomly at the time of creation. But they are all then fixed afterwards. Now, select and highlight the first building called "box_1" (Figure 5) and open its property dialog (Figure 6). You will see some arbitrary numeric values for the coordinates and dimensions of the box object. That is also true for all of the other 24 box objects in your project workspace.

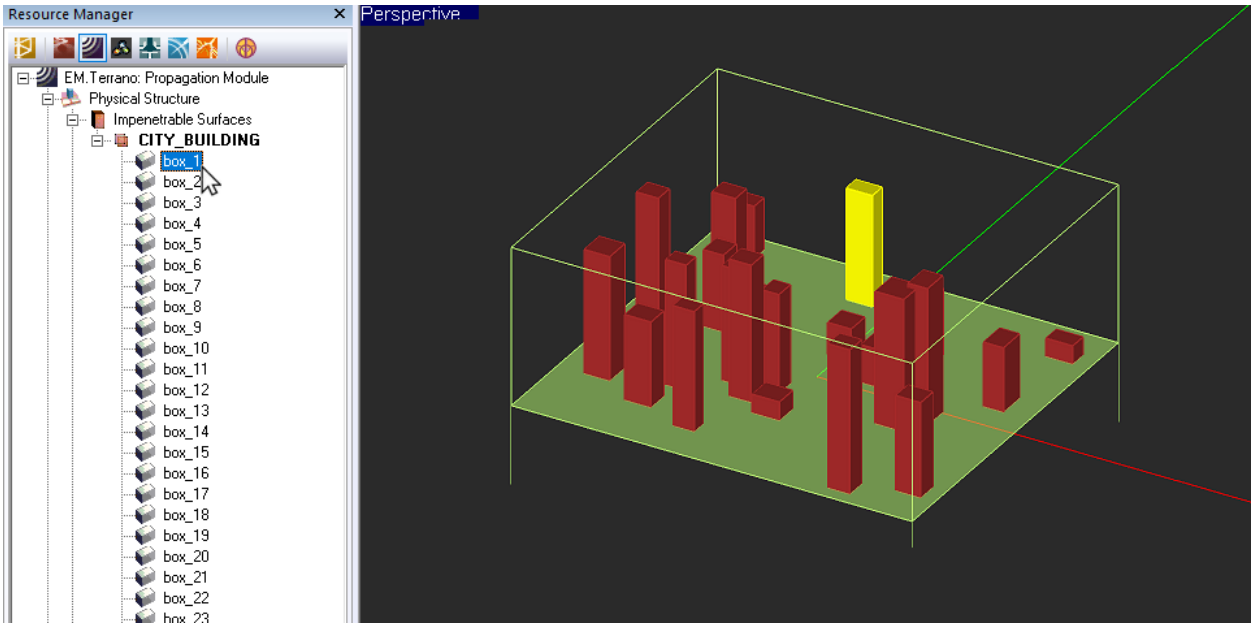


Figure 5. *Selecting and highlighting a box_1 (building) from the semi-random city scene.*

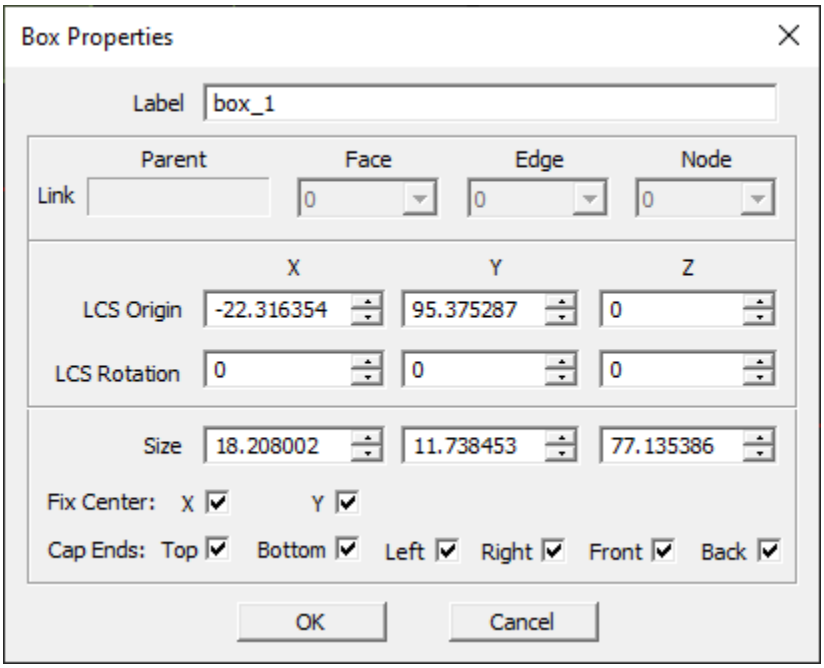


Figure 6*. The property dialog of the first building box object.*

Next, click on the **Basic Link Wizard**  button of the **Wizard Toolbar** (Figure 7) or select the menu item **Tools** → **Propagation Wizards** → **Basic Link**. In the dialog window, change the **Grid Extents** to 250m and receiver **Rx spacing** to 5m as shown in Figure 8. Keep all the other default values.

***Figure 7**. Selecting the Basic Link wizard on EM.Terrano's wizard toolbar.*

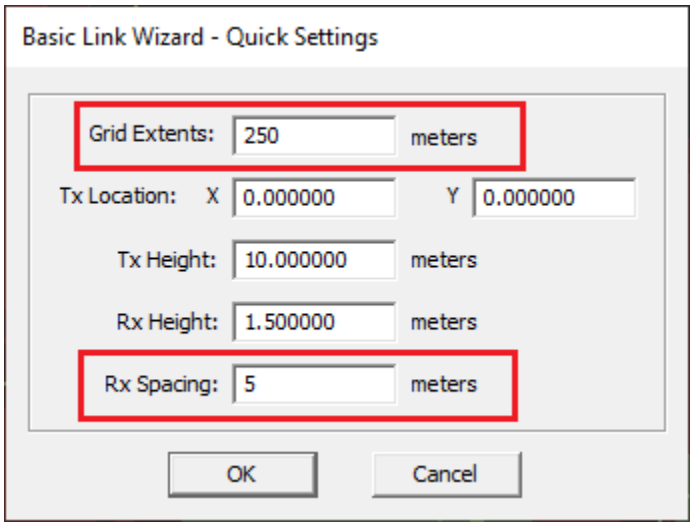


***Figure 8.** The Basic Link Wizard dialog.*

The wizard creates a single transmitter and a very dense grid of 51×51 receivers centered at the origin of coordinates (see Figure 9).

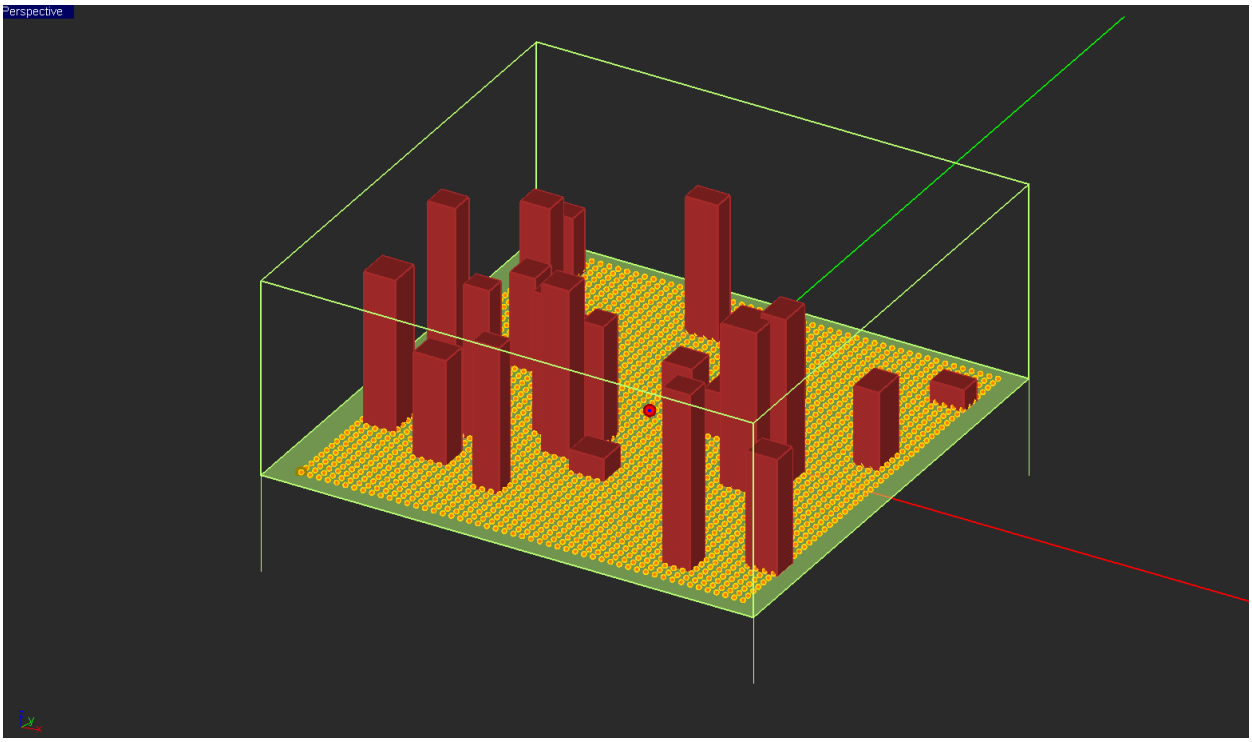


***Figure 9.** The geometry of the urban propagation scene after establishing the transmitter and receiver gird.*

Run an SBR analysis of the random city scene and visualize its received power coverage map (Figure 10).

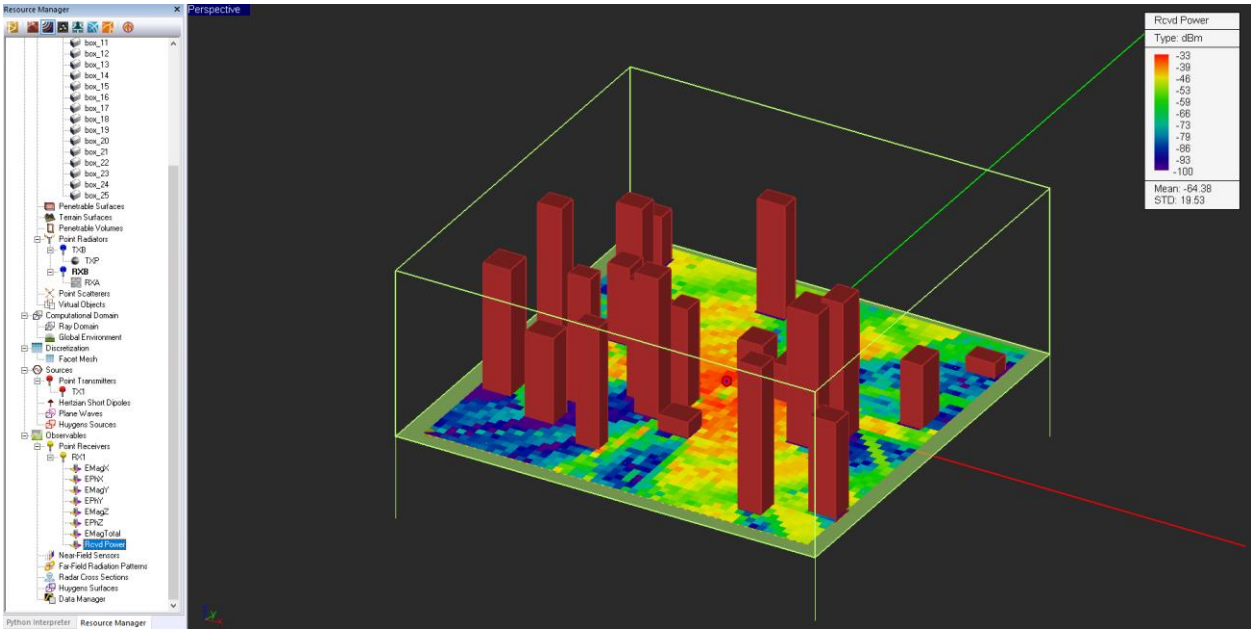


***Figure 10**. The received power coverage map of the semi-random city scene.*

5.4 Importing a Scene to a New Project

EM.Cube allows you to import physical structure to a number of popular CAD file formats such as STEP, IGES, STL, etc. The STEP and IGES options import all the solid, surface, curve and point objects. The STL format imports only solid and surface objects as sets of interconnected triangles and ignores all the curve or point objects. Make sure your project **Units** is compatible with the length units of the model to be imported. CubeCAD is the module where import operations will take place (Figure 11). In EM.Cube, external objects are always imported to CubeCAD first. From CubeCAD you can transfer an imported object to any of the other computational modules.

You can import external CAD models to CubeCAD only. From CubeCAD you can move objects to other modules like EM.Terrano.

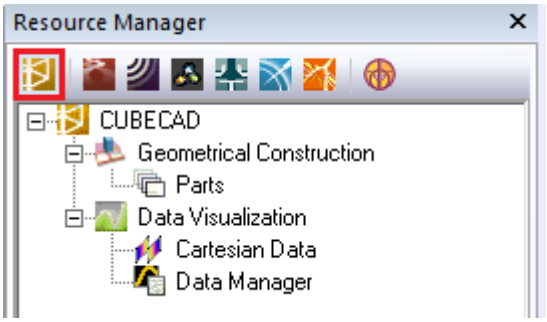
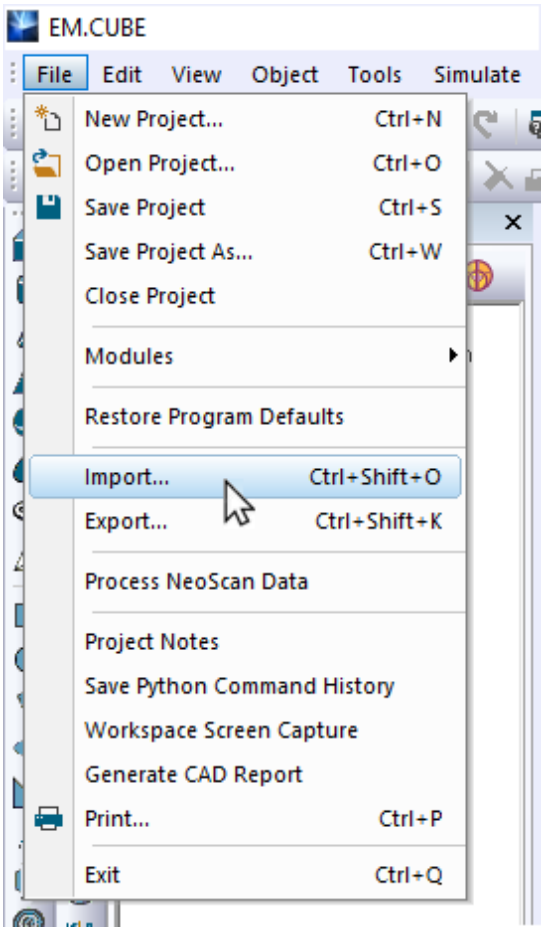


***Figure 11**. CubeCAD module in EM.Cube.*



For this section of the tutorial lesson, you need to download the STL and STP model files containing the CAD models of the buildings. The files are called " Random_City_1.stl" and “Random_City_2.stp”. You can download the files from the following link:

http://www.emagtech.com/downloads/ProjectRepo/Random_City.zip

While in CubeCAD, select the menu item **File → Import...** or use the keyboard shortcut **Ctrl+Shift+O** (Figure 12). The Windows Open dialog opens up. From the **File Type** drop-down list, select STL. Use the Windows Explorer to go to the folder where your STL file was saved. Select "Random_City_1.stl" and click the **Open** button of the dialog (Figure 13).

***Figure 12**. Selecting the import item from the menu.*

Your imported scene appears on the screen in cyan color as shown in Figure 14. When you import a very large model, it may full up the entire screen. You can zoom to fit your structure into the screen by clicking the **Zoom Extents** button of **View Toolbar** or using the keyboard shortcut **Ctrl+E**. From Figure 14, you can see that the imported buildings are "polymesh" objects consisting of sets of triangular patches.

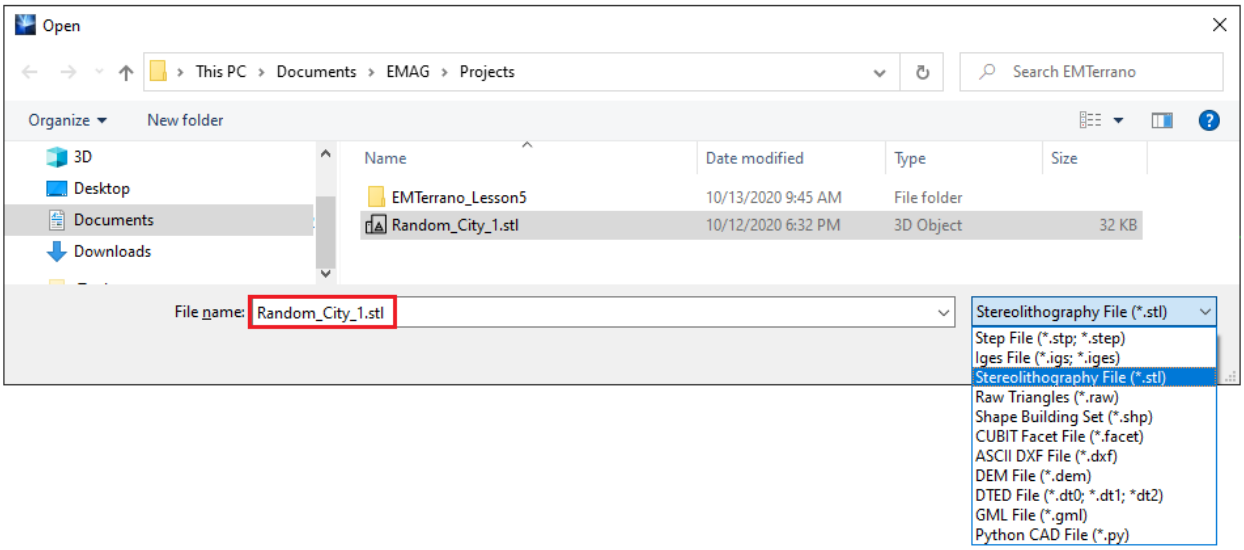


***Figure 13**. The Windows Open dialog with the file type set to ".STL".*

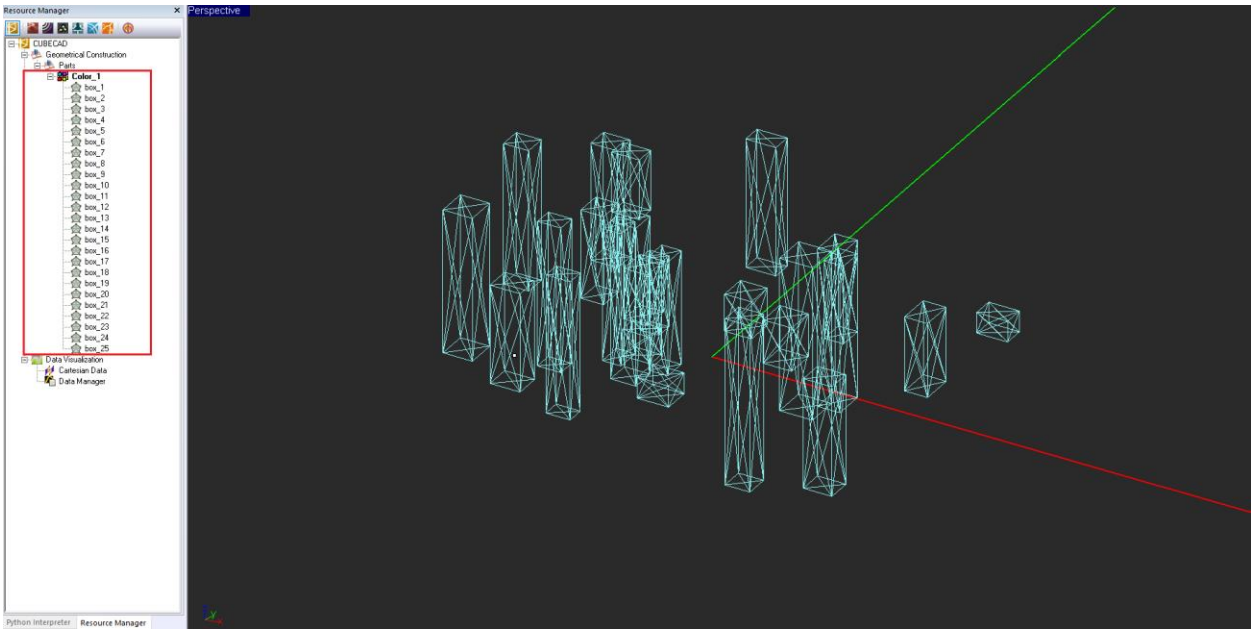


***Figure 14**. The geometry of the imported STL model in CubeCAD.*

Similarly, let's import the STP model "Random_City_2.stp" into EM.Cube. Your imported model appears as solid box objects (see Figure 15).

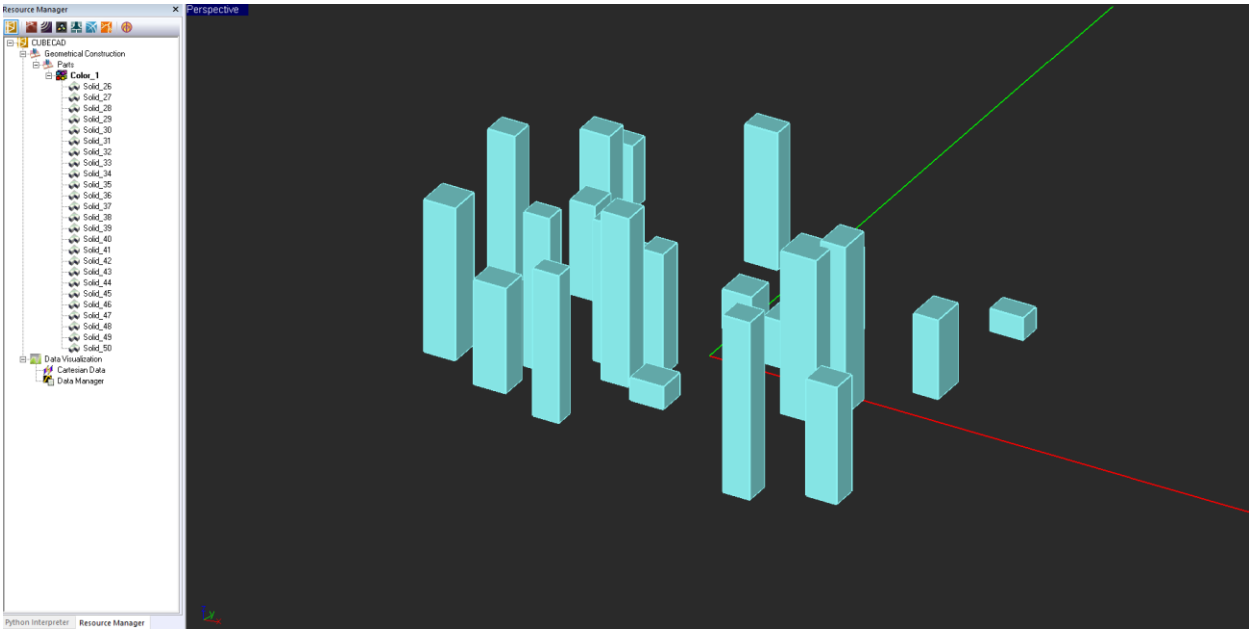


***Figure 15**. The geometry of the imported STP model in CubeCAD.*

You can cut, copy or paste these buildings to EM.Terrano. Or you can move some of them or all of them directly from CubeCAD to EM.Terrano. You can select any building from the navigation tree. To make a multiple selection, hold down your keyboard's **Ctrl** key while clicking on the buildings' names in the navigation tree as shown in Figure 16.

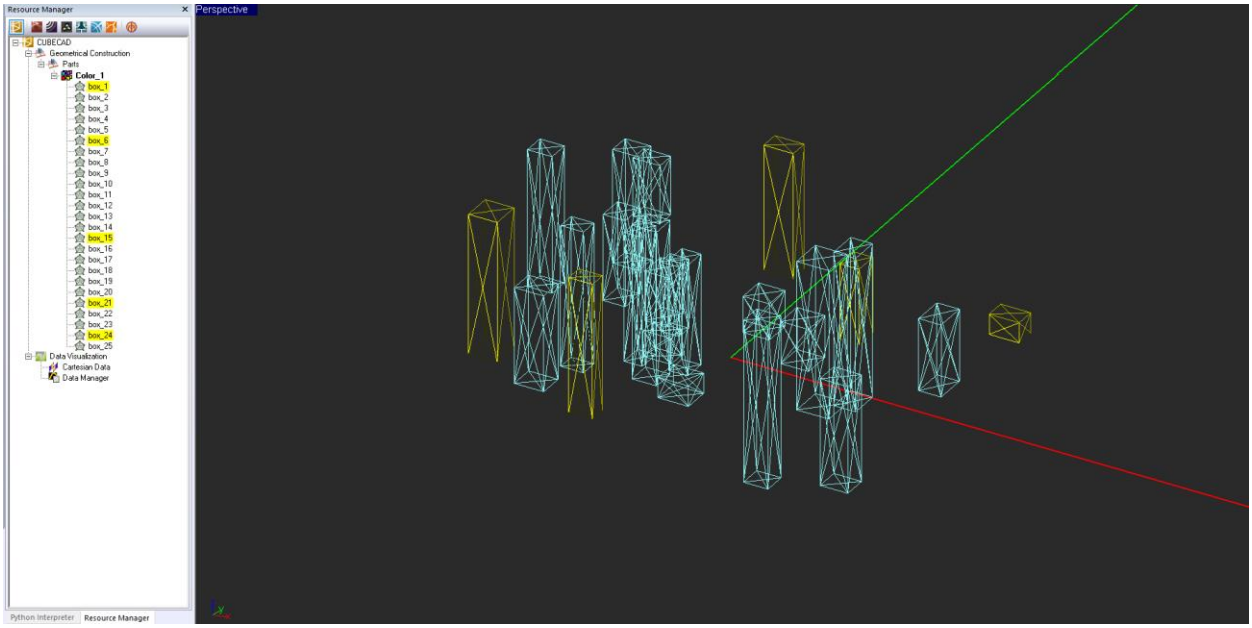


***Figure 16**. Selecting a few imported objects from the navigation tree.*

5.5 Creating & Analyzing a Fully Random City Propagation Scene

At this point, start a brand-new project all over again and repeat the same steps of the previous section. First, create a random city scene using the **Random City Wizard**. However, this time, select **Urban Canyon** option for **Select Scene Type** and remove check mark from the box labeled **Lock Location, Orientation and Size of Buildings** as shown in Figure 17. Using the basic link wizard to place a transmitter and a 51×51 receiver grid with the default parameters. Figure 18 shows the geometry of the fully random urban propagation scene.

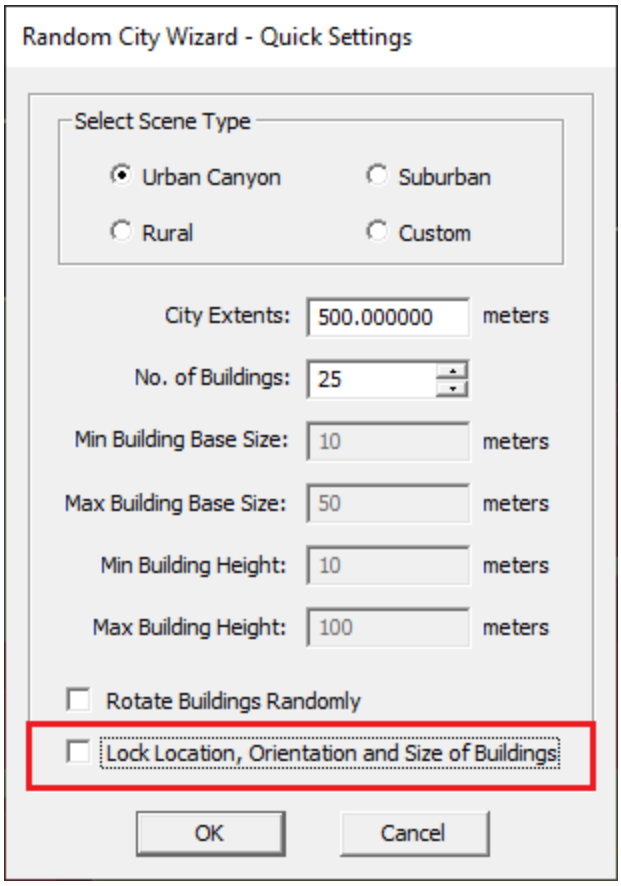


***Figure 17**. The Random City Wizard dialog.*

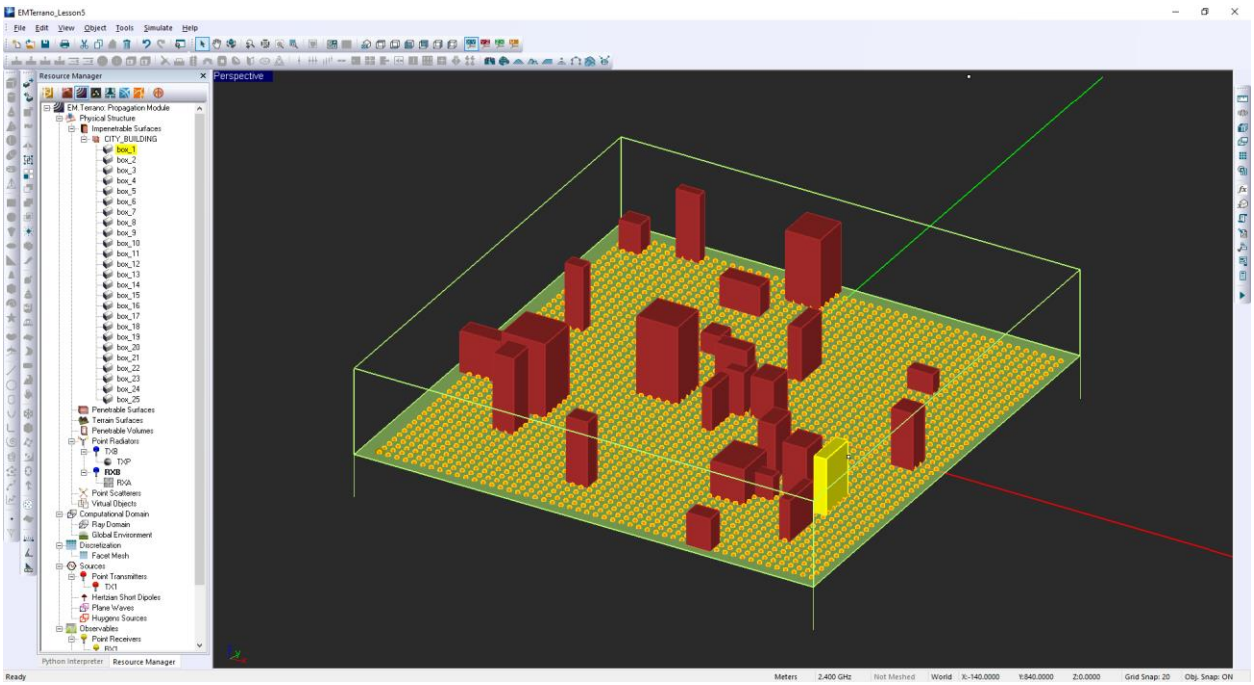


***Figure 18**. The geometry of the fully random urban propagation scene.*

Select the first building called "box_1" and open its property dialog (Figure 19). This time you will find that the coordinates and dimensions of the box object are defined by a number of functions given in the table below:

Parameter Name	Value/Definition
X-Coordinate	random.uniform(-0.5*city_size,0.5*city_size)
Y-Coordinate	random.uniform(-0.5*city_size,0.5*city_size)
Z-Coordinate	0
X-Size	random.uniform(building_base_min,building_base_max)
Y-Size	random.uniform(building_base_min,building_base_max)
Z-Size	random.uniform(building_height_min,building_height_max)

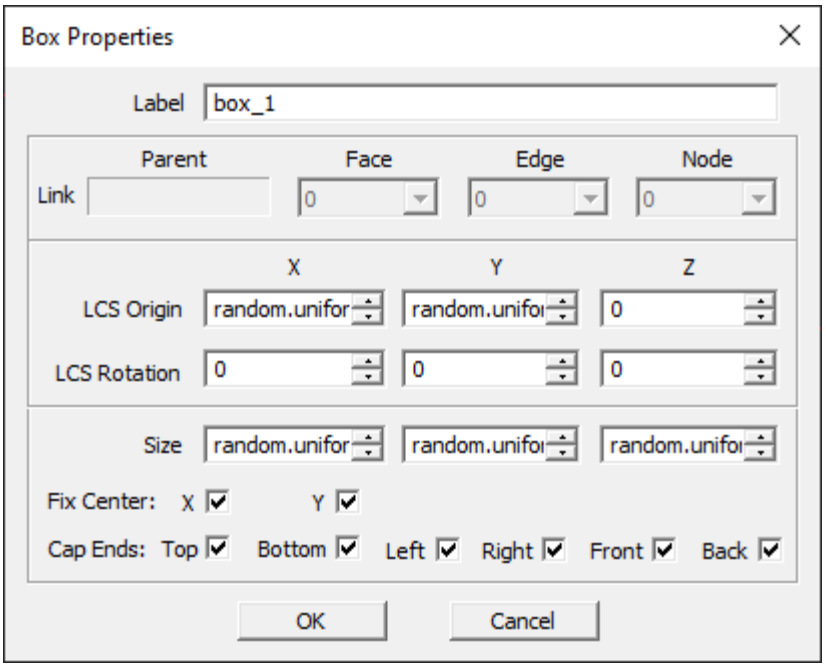


Figure 19. *The property dialog of the first building box object with random function definitions.*

The function random.uniform(a,b) is a Python function that generates a random number with a uniform distribution between the two values a and b. In the above table, "city_size", "building_base_min", "building_base_max", "building_height_min" and "building_height_max" are project variables that were defined and initiated by the random city wizard.

The transmitter is located at (0, 0, 10m) by default. Since the location of the buildings is totally random, there is a chance that your transmitter may fall inside an "impenetrable" building and becomes useless. In that case, open the Variables dialog and click its **Update** button consecutively (Figure 20). Every time a new random city scene is generated. Repeat this process until you get an acceptable scene. Run an SBR analysis of the random city scene and visualize its received power coverage map (see Figure 21).

In the case of a fully random city scene, every time you update the variables, or regenerate the mesh, or run a simulation, the building parameters will be updated, and your physical scene will change completely.

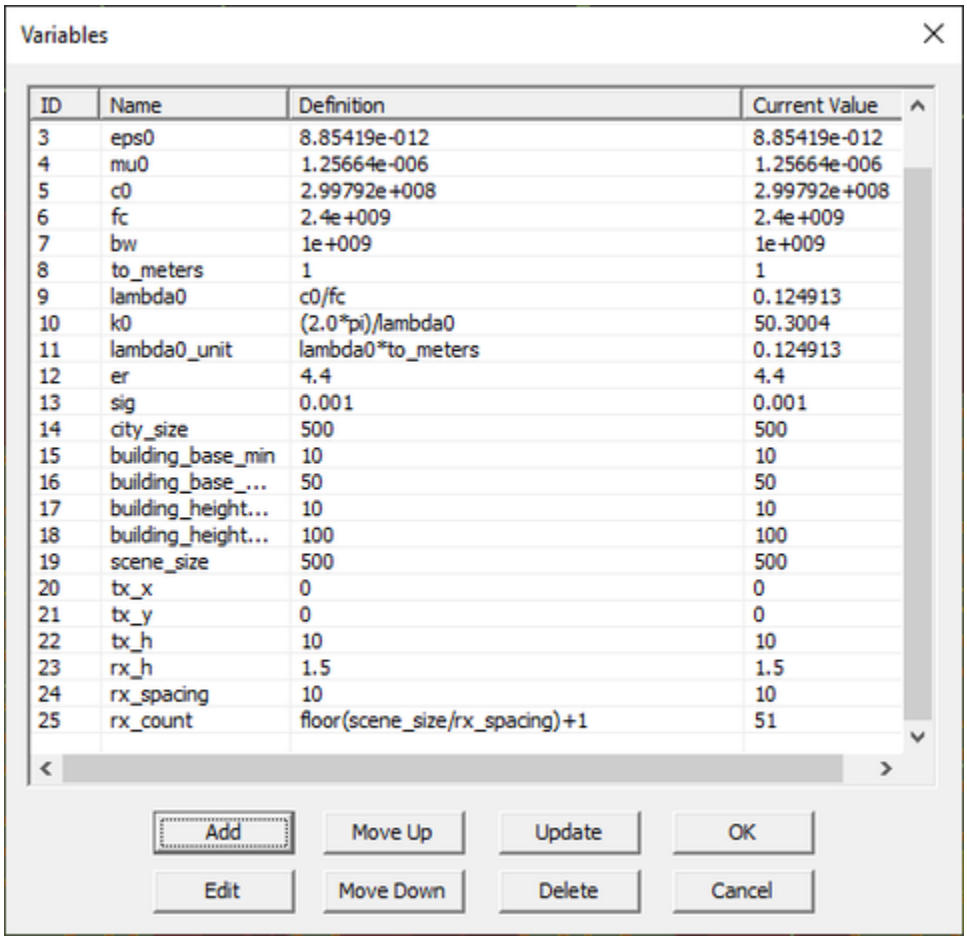


***Figure 20**. EM.Terrano's variables dialog.*

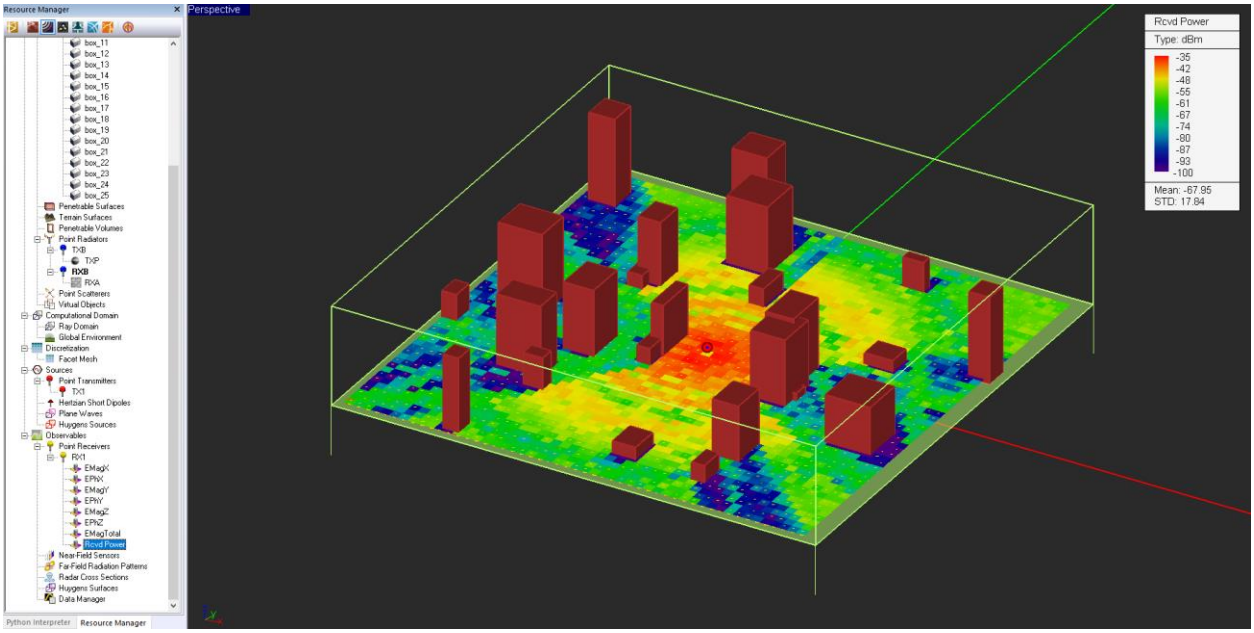


***Figure 21**. The received power coverage map of the fully random city scene.*