B

EM.Terrano

Tutorial Lessons

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EM.Terrano Tutorial Lesson 16

Performing Link Margin Analysis above a Sea Surface Model

Table of Contents

16.1 What You Will Learn

In this tutorial lesson, you will use a wizard to create a sea surface profile. You will run margin analysis on an aerial link in the presence of the sea.

EM.Terrano Manual:

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

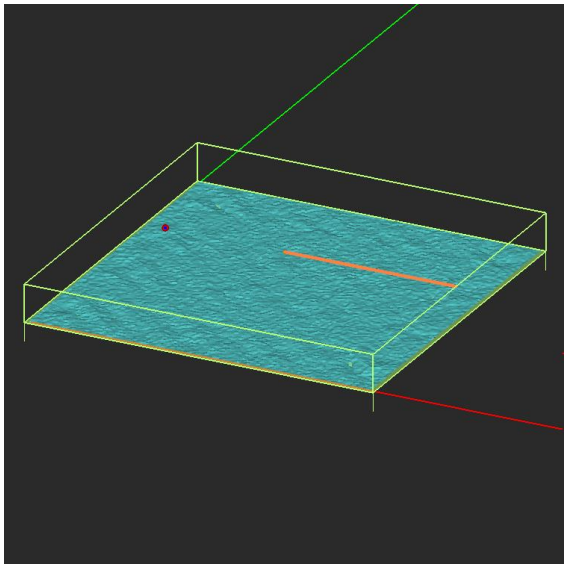
EM.Terrano Tutorial Gateway:

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_Lesson16.zip

Tutorial Project: Performing Link Margin Analysis above a Sea Surface Model



Objective: To learn how to create a sea surface profile and simulate an aerial communication link above sea level.

Concepts/Features:

- Sea Surface Model
- Aerial Link

Minimum Version Required: All versions

16.2 Getting Started

Start a new project with the following parameters.

Starting Parameters	
Name	EMTerrano_Lesson16
Length Units	Meters
Frequency Units	GHz
Center Frequency	5GHz
Bandwidth	1GHz

16.3 Creating a Sea Surface Model in Terrain Surface Group

For this tutorial lesson, you will use a wizard to create a large sea surface profile in the project workspace.

Click on the **Sea Surface Wizard** button of the **Wizard Toolbar** (Figure 1) or select the menu item **Tools → Propagation Wizards → Sea Surface Wizard**.

Figure 1. *EM.Terrano's wizard toolbar.*

A dialog opens up and asks for the total area extents and the surface (Figure 2). Select **Rough Periodic** option for the **Select surface type** section of the dialog and then click the **OK** button.

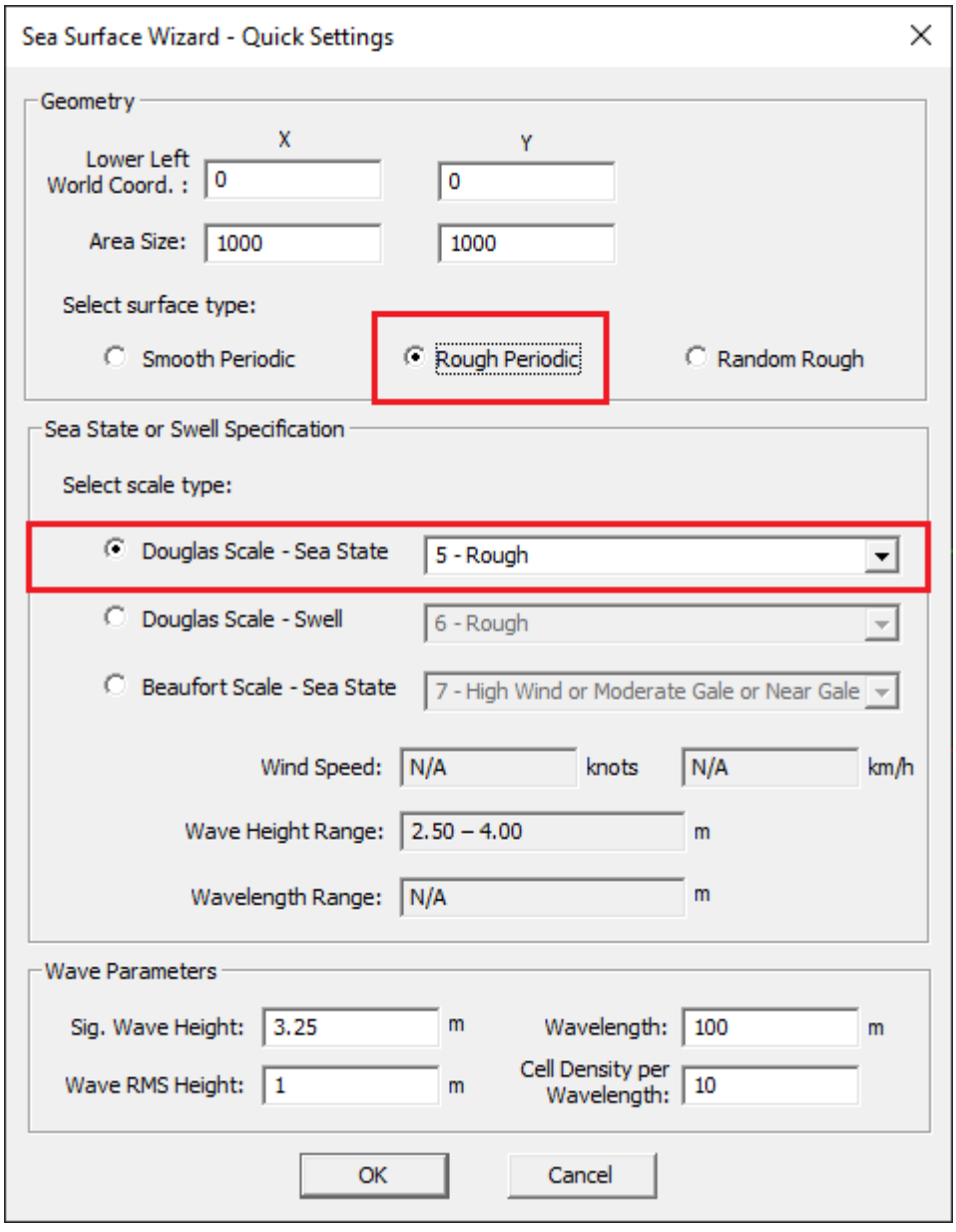


Figure 2. *EM.Terrano's default Terrain dialog.*

A large sea surface object appears with a random rough surface as shown in Figure 3.

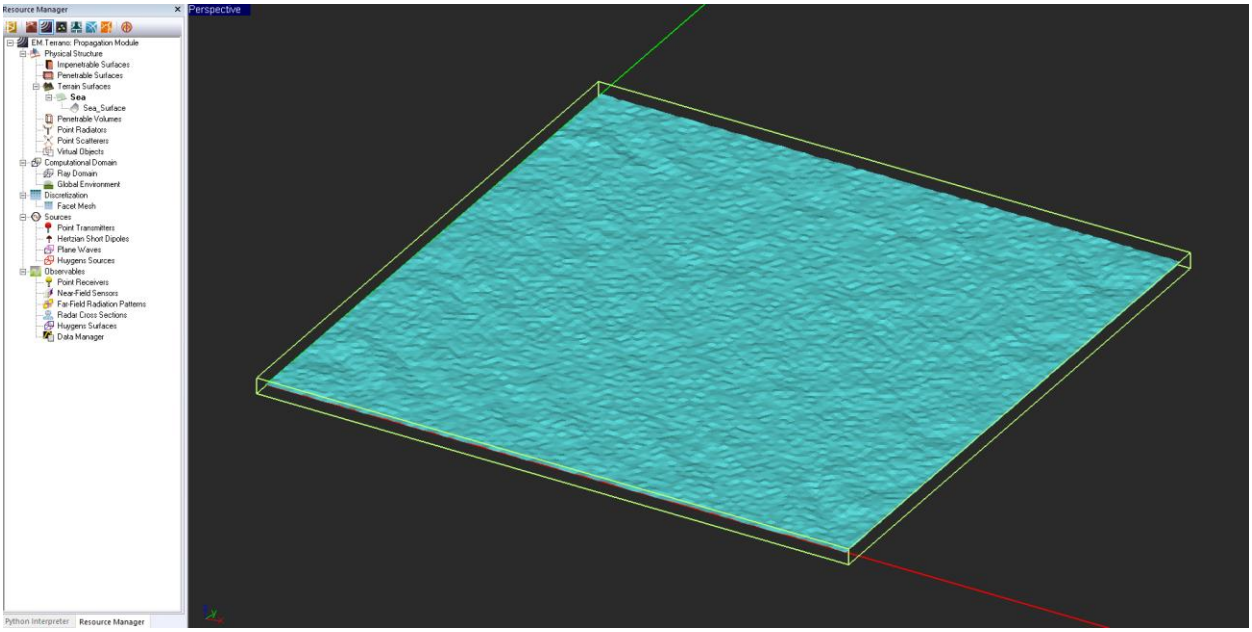
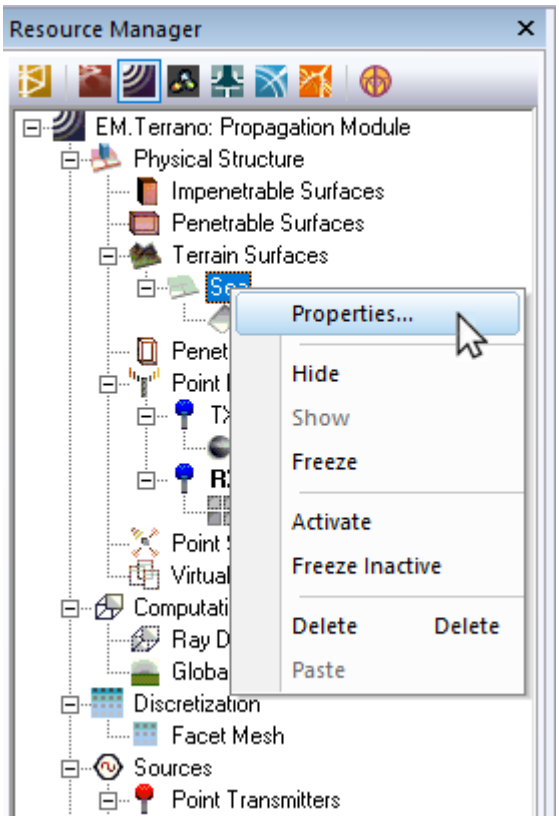


Figure 3. *The geometry of the default sea surface created by the wizard.*



An object called "Sea" is created by the wizard under the **Terrain Surface** section of the navigation tree. Open its property dialog by right-clicking on its name in the navigation tree and selecting **Properties...** from the contextual menu (Figure 4). As shown in Figure 5, the relative permittivity of the sea water is $\varepsilon_r = 81$ and $\sigma = 4$S/m.

Figure 4. *Opening the property dialog of an object from the navigation tree.*

Next, select and highlight “Water_sea” item in the table and click the **Add/Edit** button of the dialog. A new Edit Layer dialog opens up, showing the material properties of sea water (Figure 6). Click the **Material** button to open up EM.Cube's Materials Dialog (Figure 7).

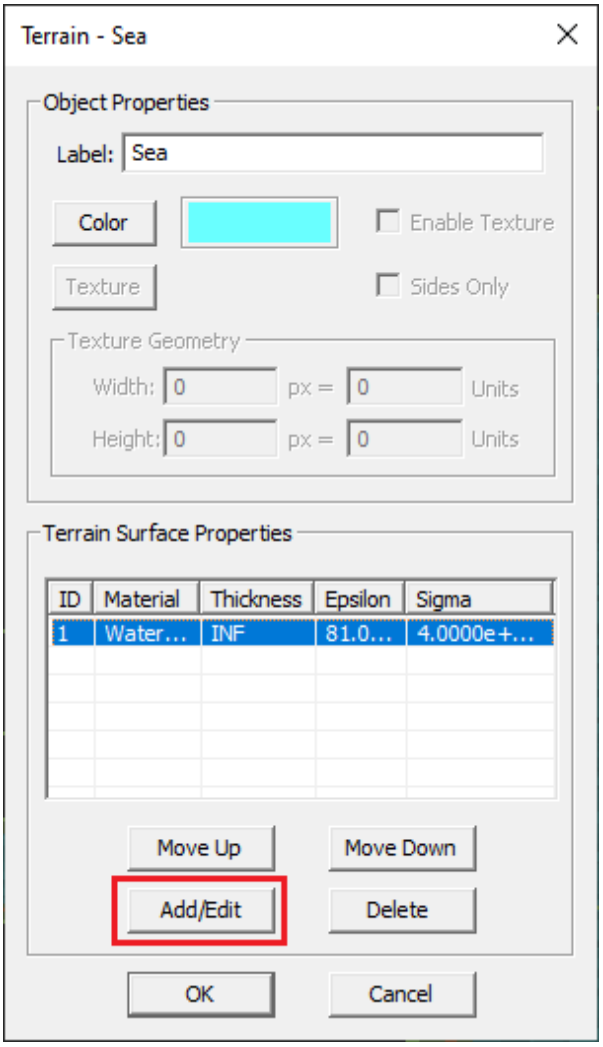


Figure 5. *EM.Terrano's Terrain - Sea dialog.*

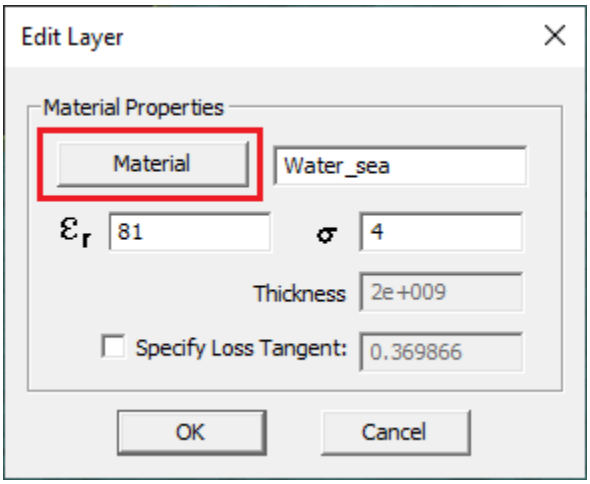


Figure 6. *EM.Terrano's Add Layer dialog*

Typing "w" on your keyboard will take you down the table where the material names start with the letter W.

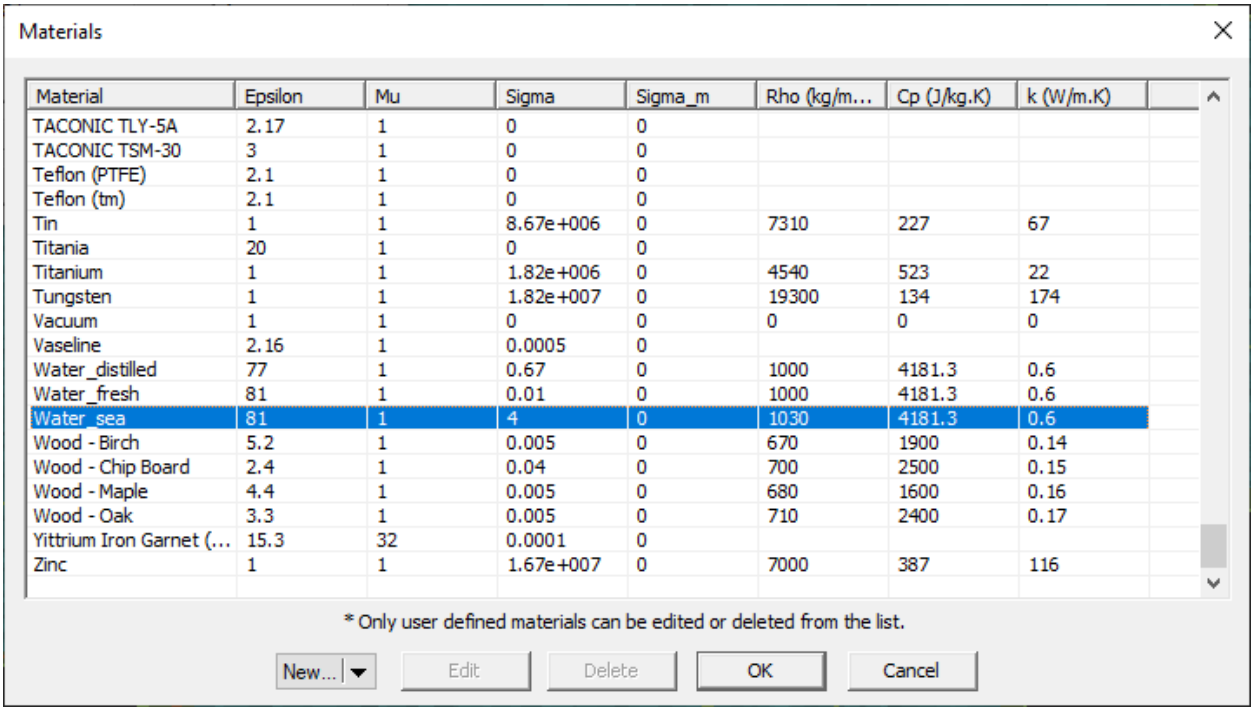


Figure 7. *EM.Terrano's Mateirals list.*

Next, open the Rough Object Properties dialog by going to the navigation tree and selecting **Sea_Surface** under Sea item as shown in Figure 8. Then, click the **Edit Primitive** button of the dialog to open the Surface Generator dialog. Change the values of the **Z** coordinate to 4m and then click the **OK** button (Figure 9).

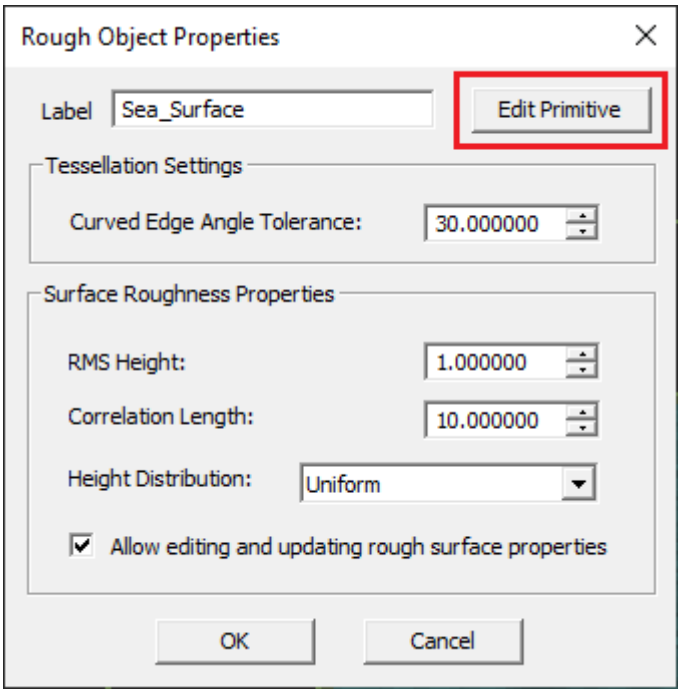


Figure 8. *Rough Object Properties dialog.*

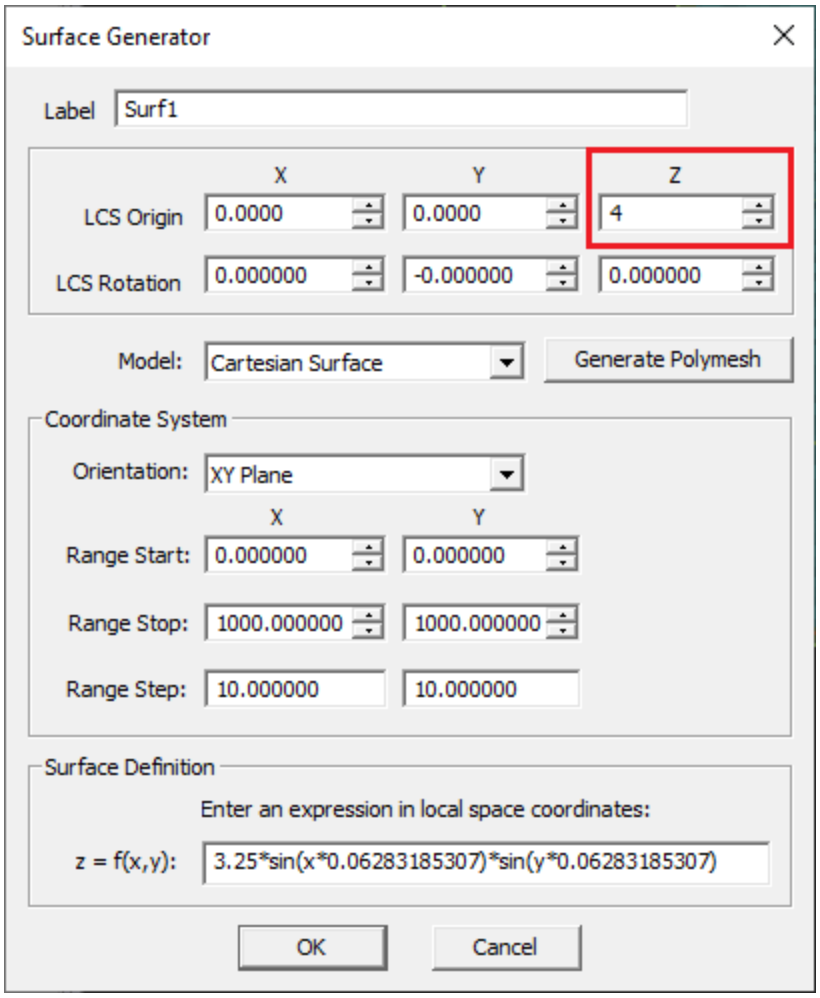


Figure 9. *Surface Generator dialog.*

Make sure the EM.Terrano's global ground is enabled. To access EM.Terrano's global ground settings dialog, right-click on the **Global Environment** item under **Computational Domain** in the navigation tree and select **Global Environment Settings...** from the contextual menu (Figure 10).

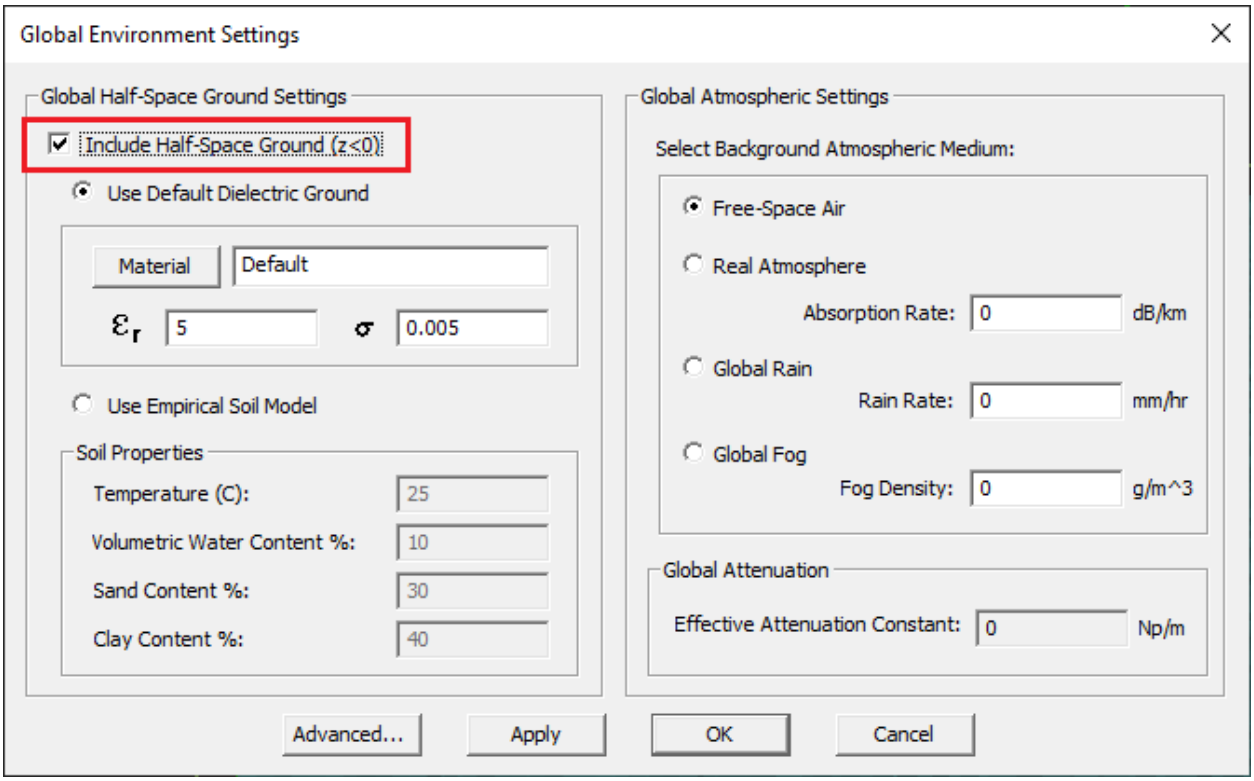


Figure 10. *EM.Terrano's Global Environment Settings dialog.*

16.4 Defining the Transmitter & Receivers

Create a vertically (Z) polarized dipole transmitter (TX_1) associated with the point radiator “TXB” and a grid of vertically (Z) polarized receivers (RX_1) associated with the point radiator “RXB”. Your transmitter will be located at Point_1(500m, 3000m, 4000m)

Object	Geometry	Block Group	Physical Structure	Location Coordinates
Point_1	Point	TXB	Point Radiators	(150m, 500m, 100m)

To create the grid of receivers, draw a point at the location (500m, 500m, 100m)

Object	Geometry	Block Group	Physical Structure	Location Coordinates
Point _2	Point	RXB	Point Radiators	(500m, 500m, 100m)

and build an array of points as indicated in the table below:

Array Object	Parent Object	Element Count X	Element Count Y	Element Count Z	X Spacing	Y Spacing	Z Spacing
Point_2_Array_2	RXB	500	1	1	1m	0	0

Next, assign a transmitter set to the first radiator set and assign a receiver set to the second radiator set. Figure 11 shows the free-space propagation scene with the transmitter and receivers.

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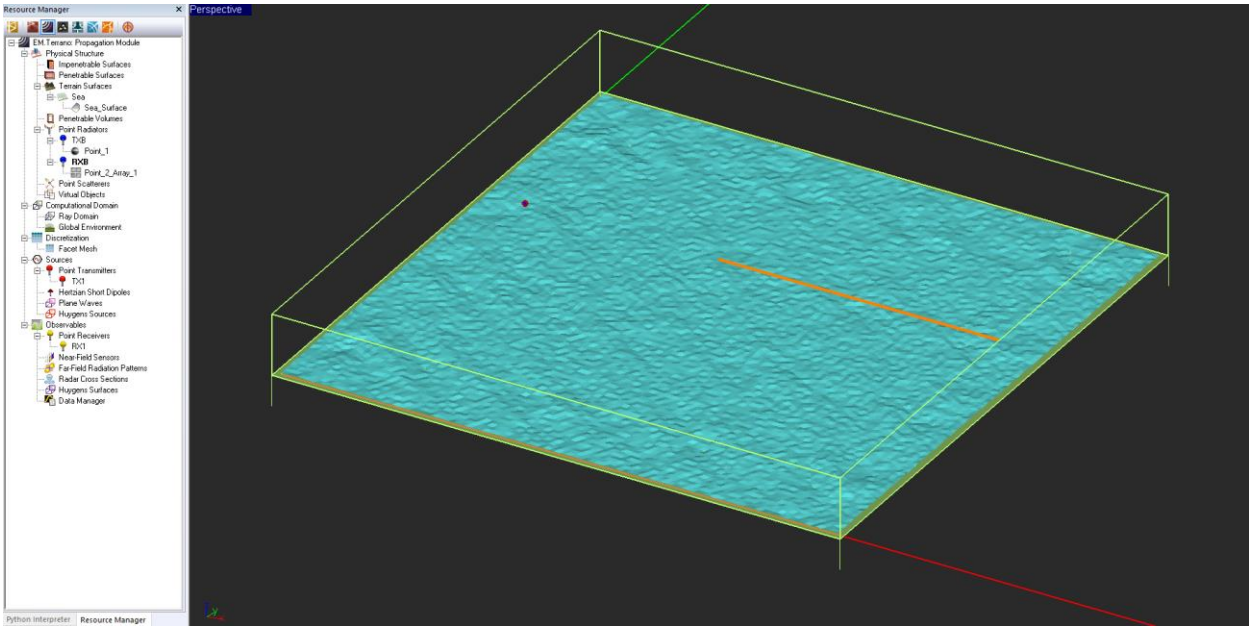

Figure 11. *The transmitter and array of receivers in the project workspace.*

16.5 Running the Simulation & Examining the Results

Run the **Long-Haul Channel Analyzer**. Next, select the **BPSK** option from the **Modulation Type dropdown list** in the property dialog of the receiver set and click the **Apply** button. You may get warning about the symbol rate as shown in Figure 12. Click the **OK** button and proceed.

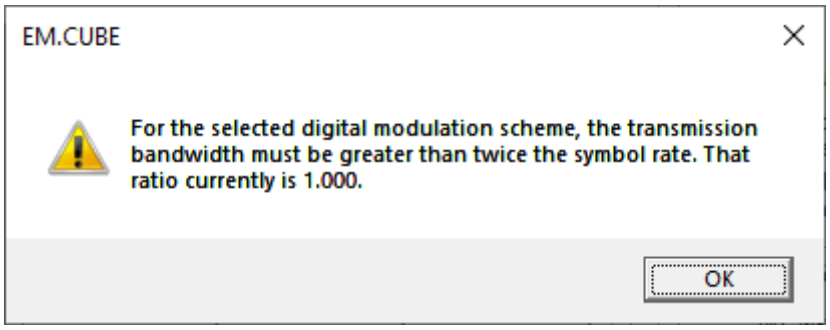

Figure 12. *EM.Terrano's warning on the ratio of the transmission bandwidth and the symbol rate.*

Run the **Communication Link Solver** and view the signal and noise power data in the property dialog of the receiver set. The table below summarizes the signal and noise power data at the first receiver:

Rx Index	Modulation	Received Power	Noise Power	SNR	Link Margin
1	None	-64.096 dBm	-94.472 dBm	20.376 dB	20.789 dB

Click the **Margin** button to plot the graph of link margin vs. range as shown in Figure 13.

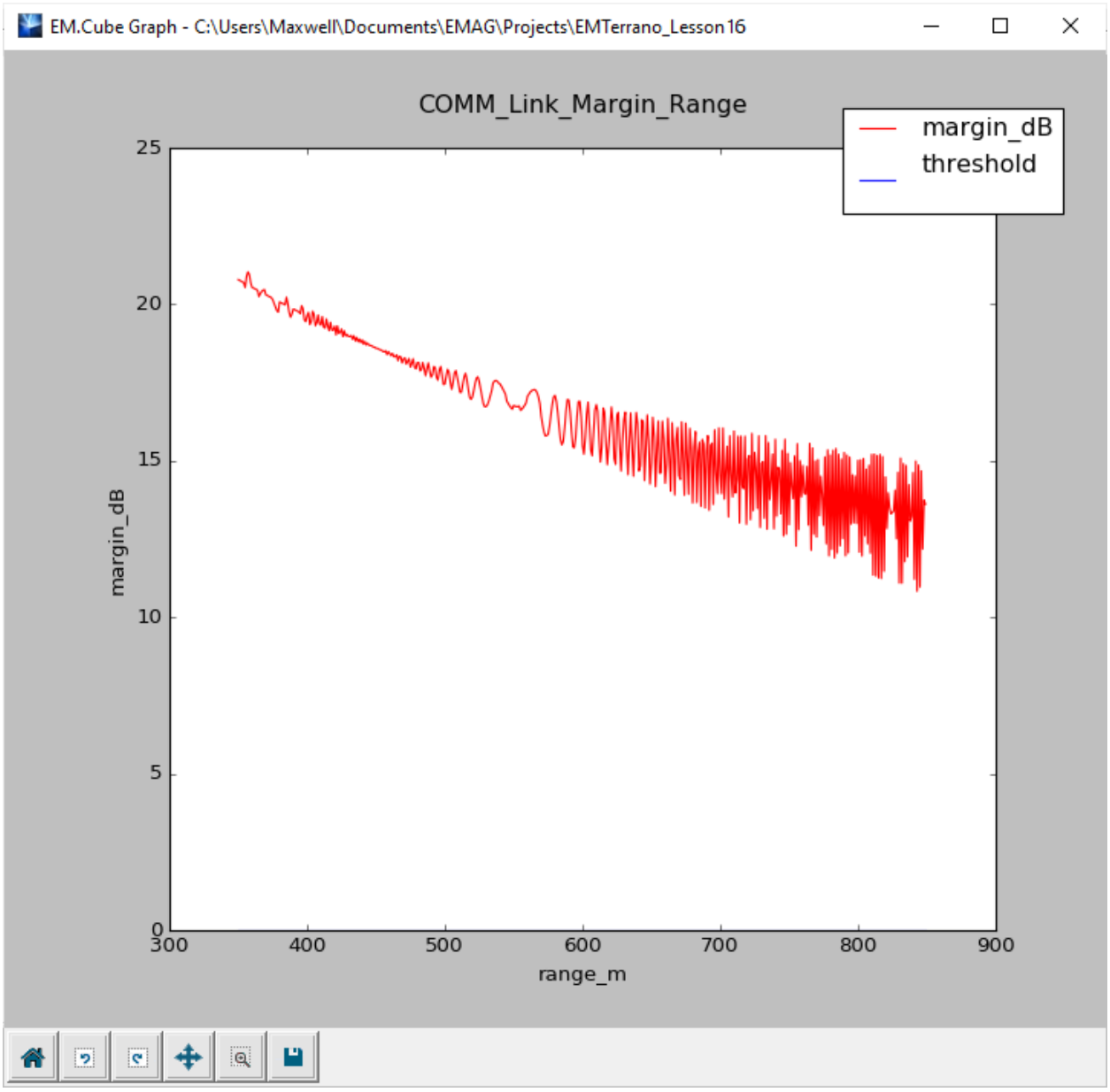

Figure 13. *A plot of the computed link margin vs. range with BPSK modulation.*

In the Data Manager, select the data file called “COMM_Link_Margin_Range.DAT” and rename it as “COMM_Link_Margin_Range_0.DAT”. Copy the renamed file in a different folder for future use.

16.6 Running the Simulation in a Rainy Weather Environment

In this section, you will run your simulation in a rainy weather environment. To do so, open EM.Terrano's global ground settings dialog. Select the **Global Rain** item under **Global Atmospheric Settings** section of the dialog and set **Rain Rate** to 200 mm/hr as shown in Figure 14. Click the **Apply** button and view the effective attenuation constant.

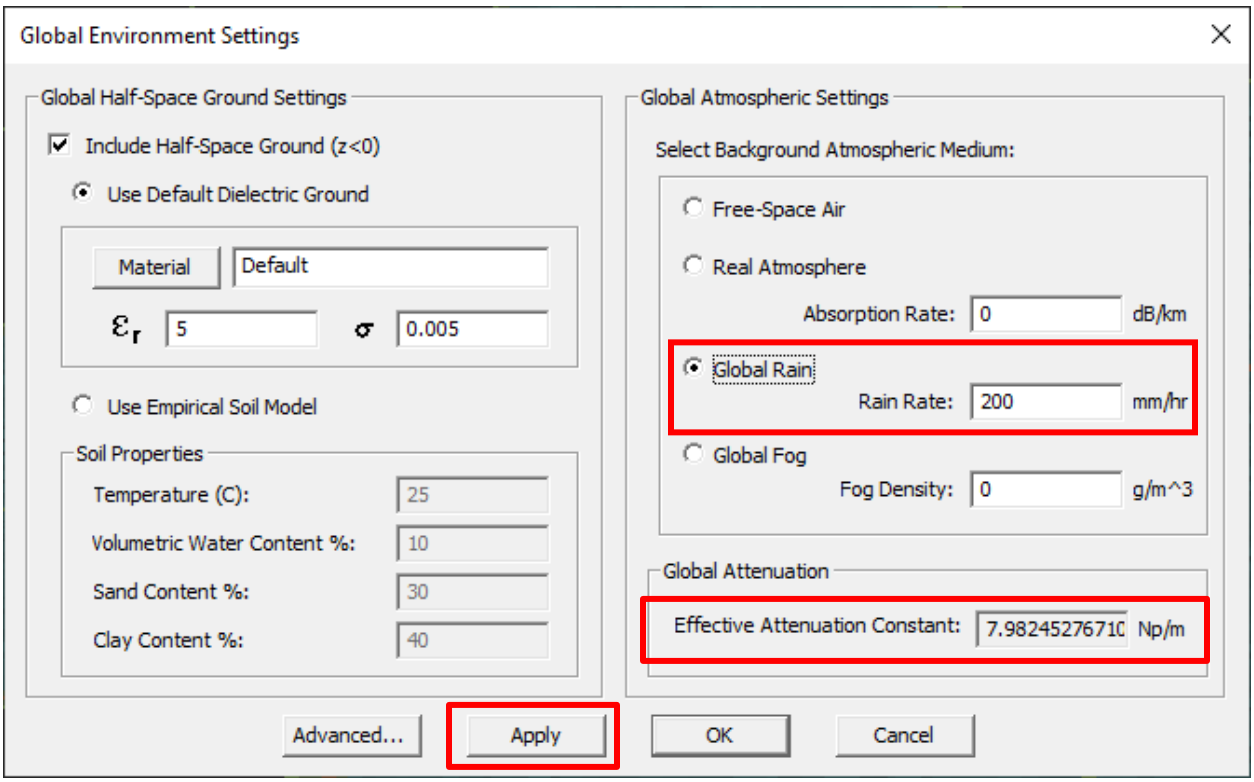

Figure 14. *Setting Global Rain in EM.Terrano's Global Environment Settings dialog.*

Run the **Long-Haul Channel Analyzer** first, and the **Communication Link Solver** next, and plot the graph of link margin vs. range as shown in Figure 15.

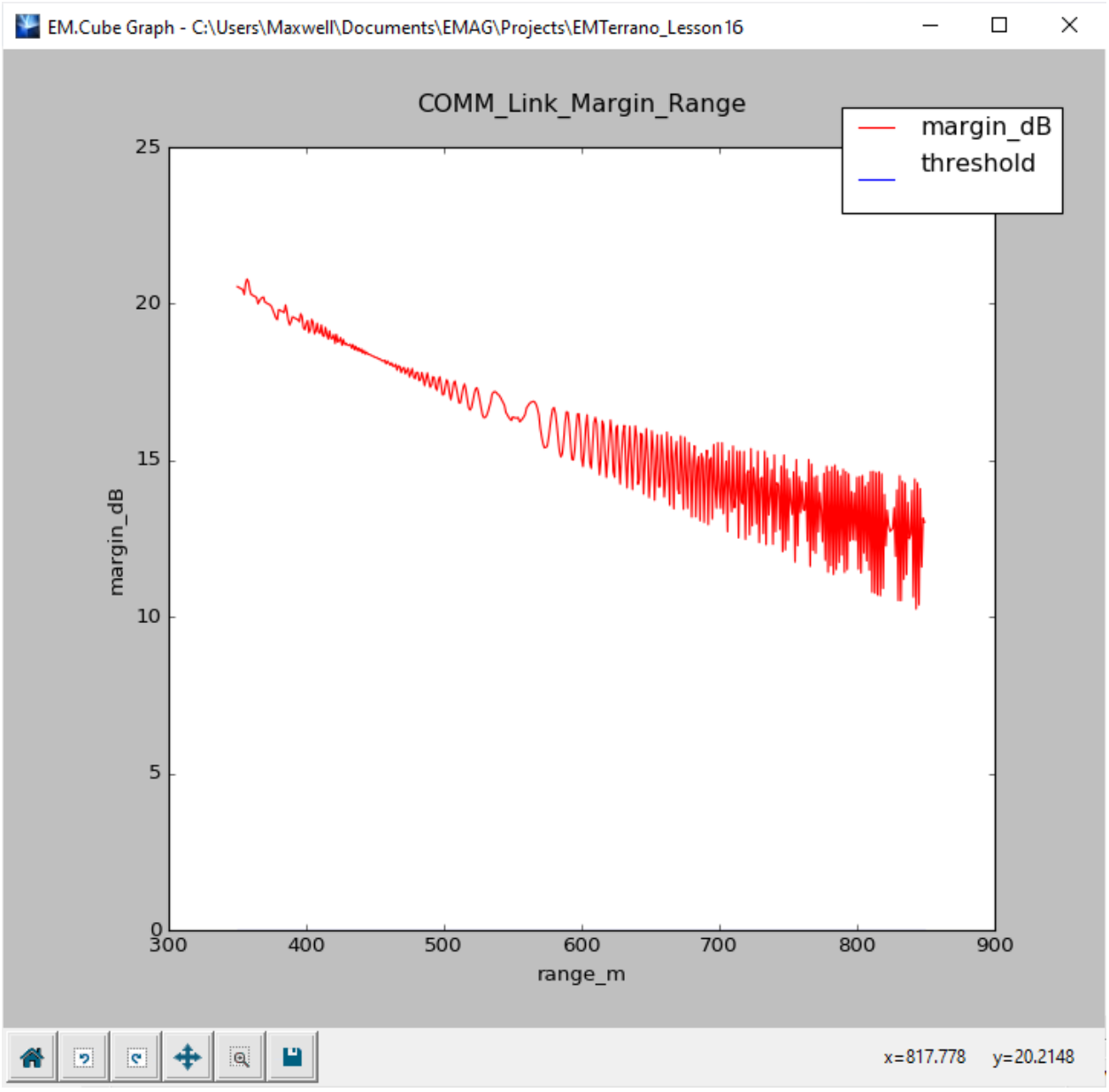

Figure 15. *A plot of the computed link margin vs. range with BPSK modulation in a rainy environment with a rain rate of 200 mm/hr.*

Finally, copy the data file “COMM_Link_Margin_Range_0.DAT” back into the current project folder. Open Data Manager and select the two files named “COMM_Link_Margin_Range.DAT” and “COMM_Link_Margin_Range0.DAT” together and plot them as shown in Figure 16.

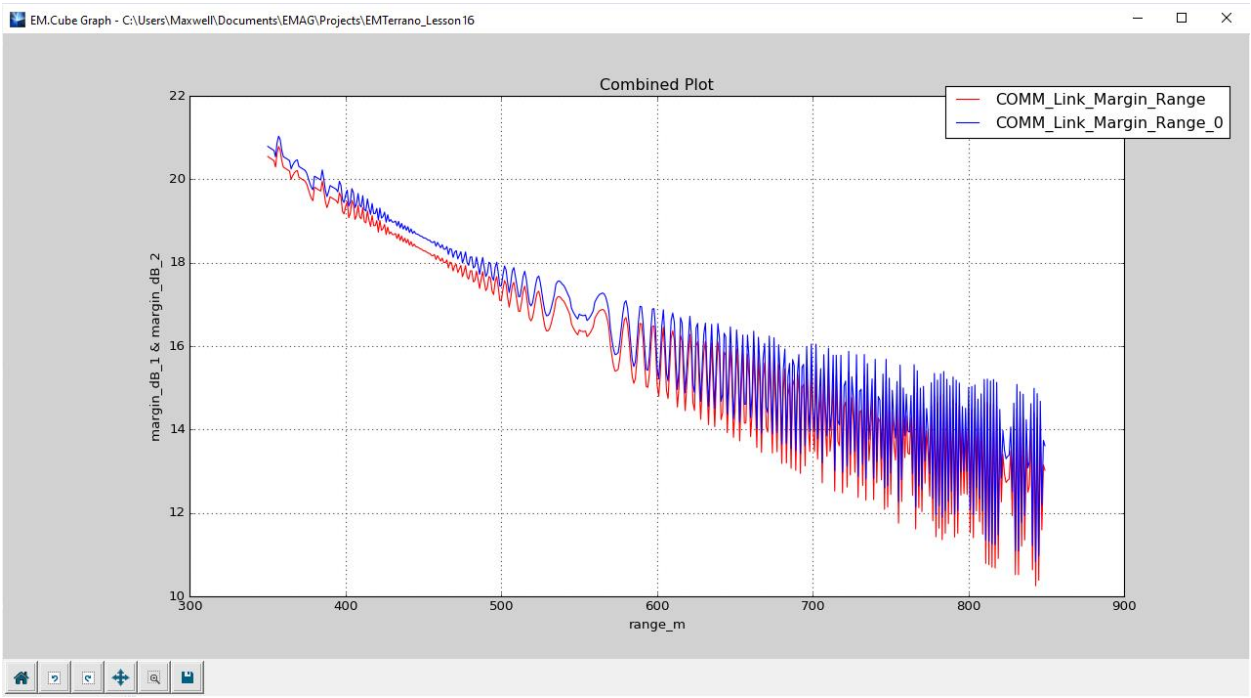

Figure 16. *A plot comparing the computed link margin vs. range with BPSK modulation in dry air and a rainy environment with a rain rate of 200 mm/hr.*