MSAM

Microcomputer Spectrum Analysis Models

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MSAM

Installation CD

- MSAM Installation Setup
  - MSAM.exe
- Terrain Databases
  - Globe folder
- Geographic Map Database
  - NTIA Geo Data folder
- Installation Documentation
  - MSAM Installation Guide.doc

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- Geographic Map Database
  - Copy to C:\NTIA Geo Data
  - Unzip files (NTIAGeoData.ZIP)
  - 2 master files
    - MasterFileLevel1.txt
    - MasterFileLevel2.txt

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- Terrain Databases
  - Globe
    - World-wide coverage
    - 30 arc second spacing
    - Copy to C:\Globe
    - Unzip files
    - Globe.dat file

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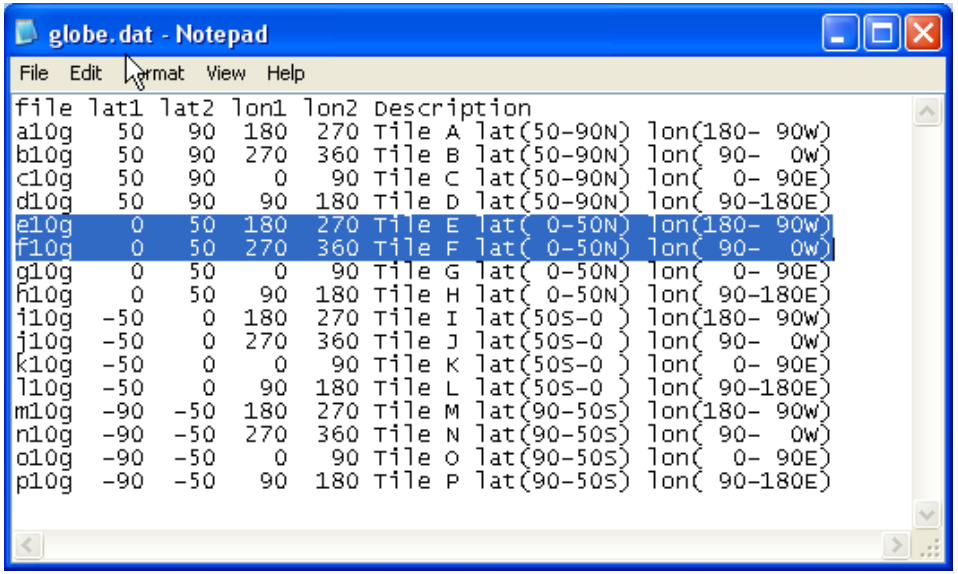
- Terrain Databases – cont'd
  - Globe
    - Globe.dat



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- 14 Models
- 7 Categories
- 3 Terrain Databases
- Help Files

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- File Menu
  - Select terrain database
- System Menu
  - INTMOD
  - SEAM
- Terrain Menu
  - BDIST
  - PROFILE
  - HORIZON
  - SHADO
- Propagation Menu
  - ITM
  - LMS

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- Receiver Menu
  - FDR
- Antenna Menu
  - APD
- Satellite Menu
  - SATAZ
  - A7
- Radar Menu
  - RSEC
- Help Menu

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Propagation Models

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ITM

Irregular Terrain Model

- Estimates radio propagation losses over irregular terrain for VHF, UHF and SHF frequencies as a function of distance and the variability of signal in time and space
- Based on electromagnetic theory and signal loss variability expressions derived from extensive sets of measurements
- Two modes:
  - Area prediction mode
  - Point-to-point mode

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ITM

- Area Mode
  - Terrain irregularity parameter is needed and the output is either a table of transmission losses in dB vs. distance for several confidence levels or graphs of dB loss vs. distance for specified confidence levels.
- Point to Point Mode
  - Requires terrain data and the path coordinates are specified.
  - Output is a list of estimated transmission losses for specifies values of reliability and confidence levels.
  - Output screen also contains a snapshot of the terrain profile.

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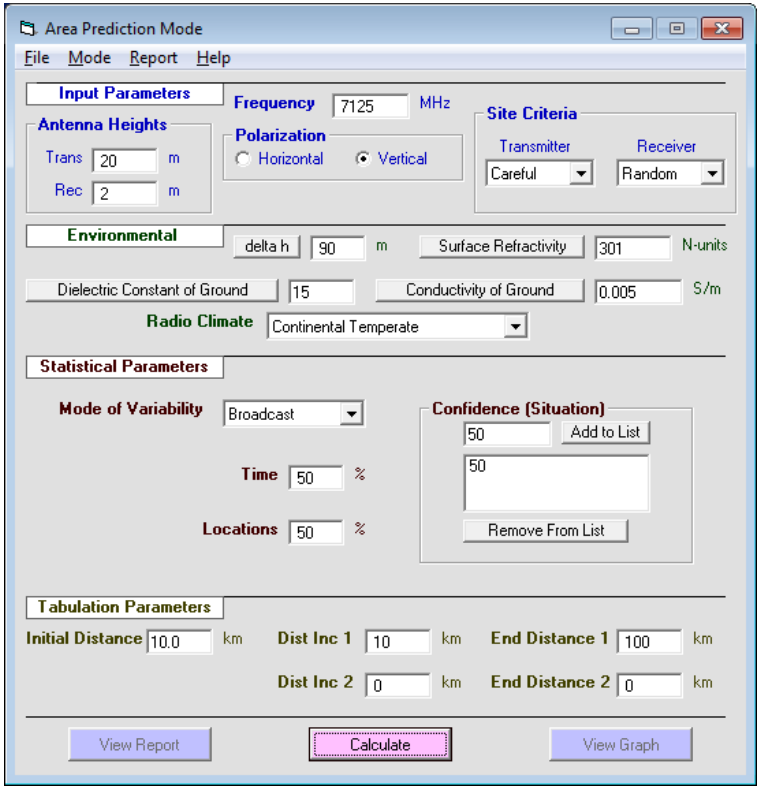
ITM Area Mode



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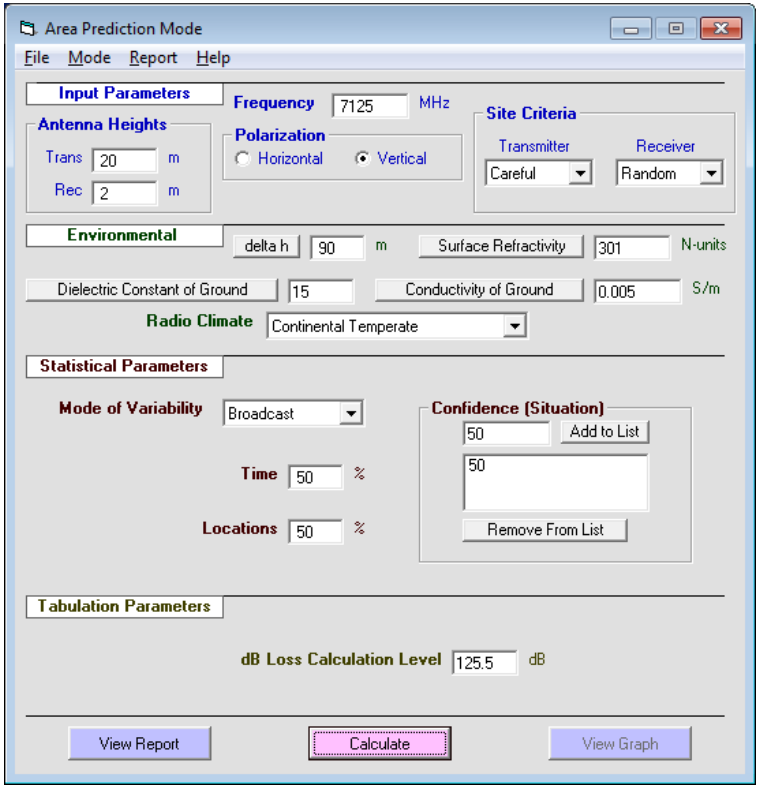
ITM Inverse Area Mode



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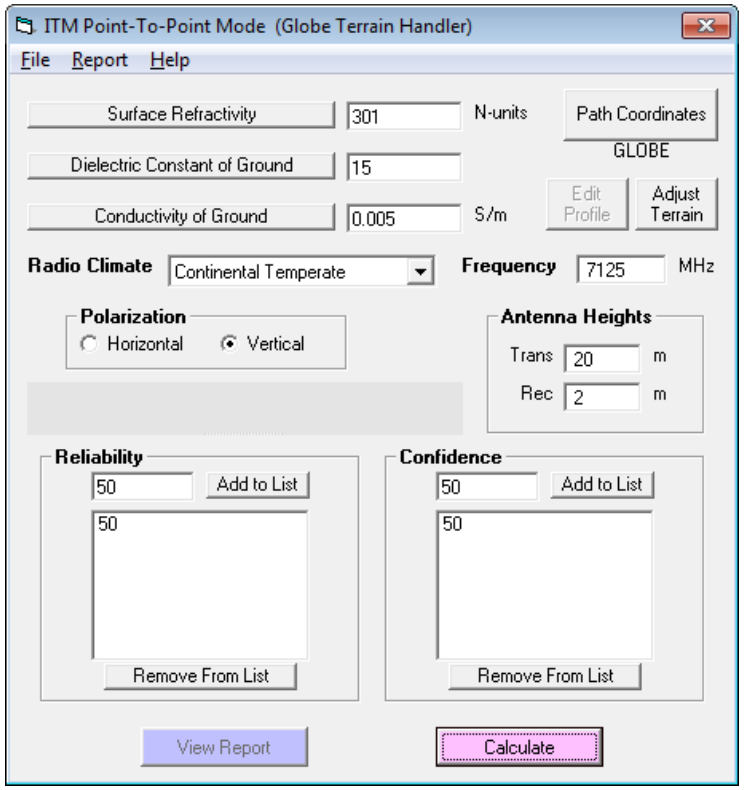
ITM Point to Point



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LMS

Land Mobile Service

- Package of empirical models for terrestrial land mobile services
- Models used
  - Okumura/Hata/ITU-R529
  - COST231
  - Okumura-Hata-Davidson
- Calculates
  - Path loss
  - Received field strength
  - Field strength vs distance

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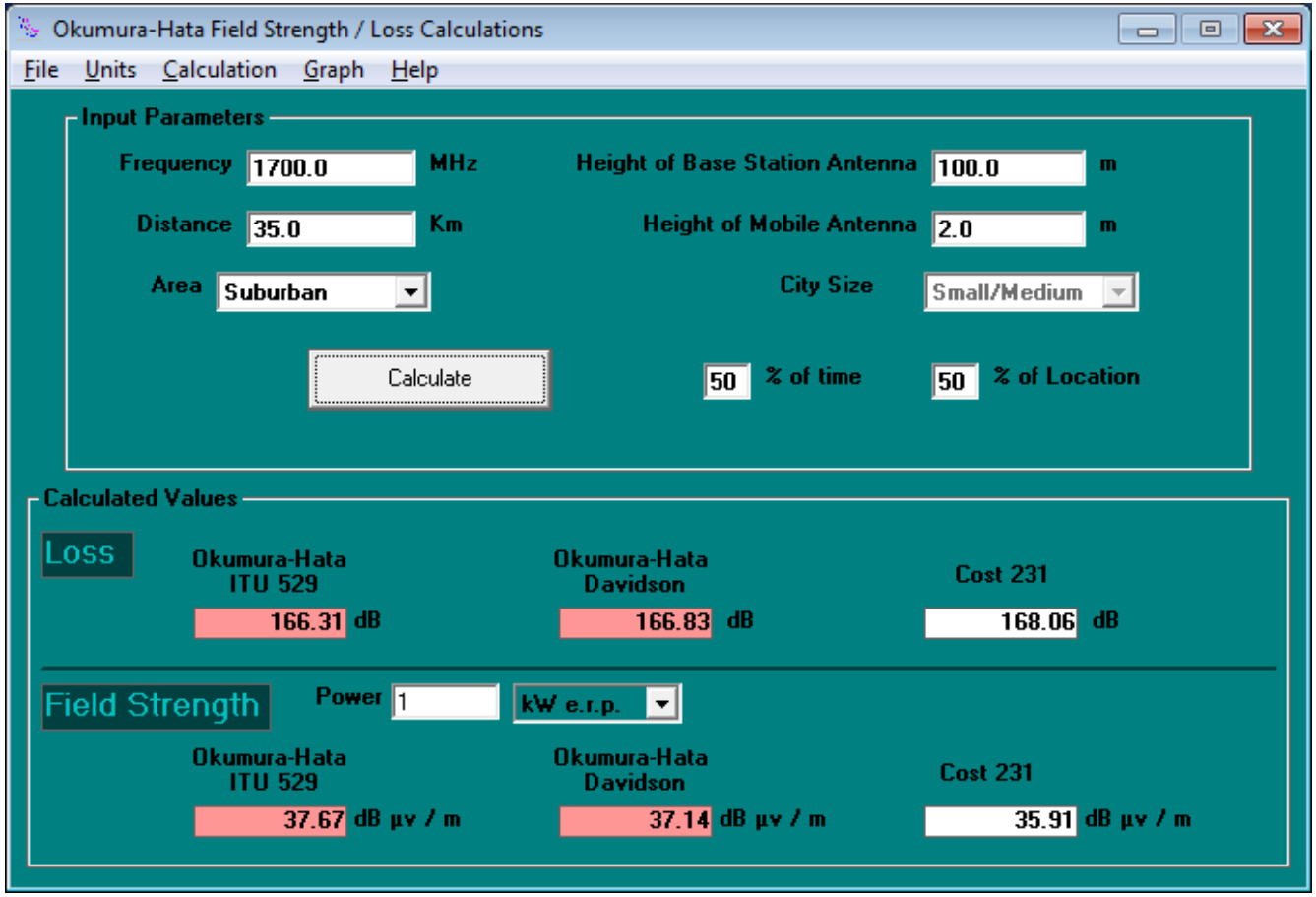
Frequency (MHz)

		30≤F<150	150≤F<1500	1500≤F ≤2000
d≤100km	hb≤200m	Davidson	ITU 529	Cost 231
d≤100km	hb>200m	Davidson	Davidson	X
d>100km	hb≤200m	Davidson	Davidson	X
d>100km	Hb>200m	Davidson	Davidson	X

Land Mobile Service



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Terrain Models

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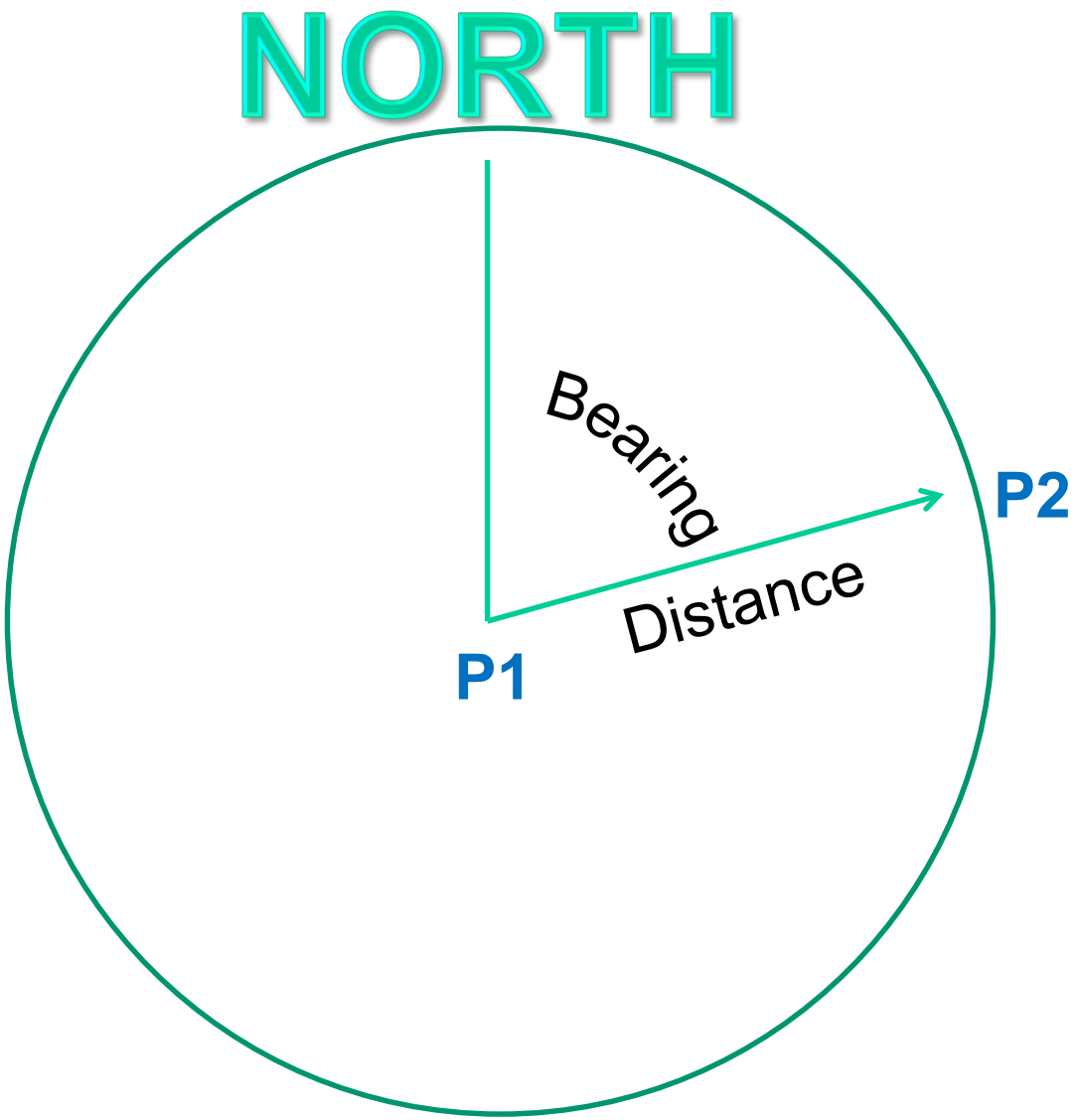
BDIST

Bearing And Distance

- Calculates bearing angles & distance between two points on the earth's surface


NORTH
Bearing
Distance
P1
P2

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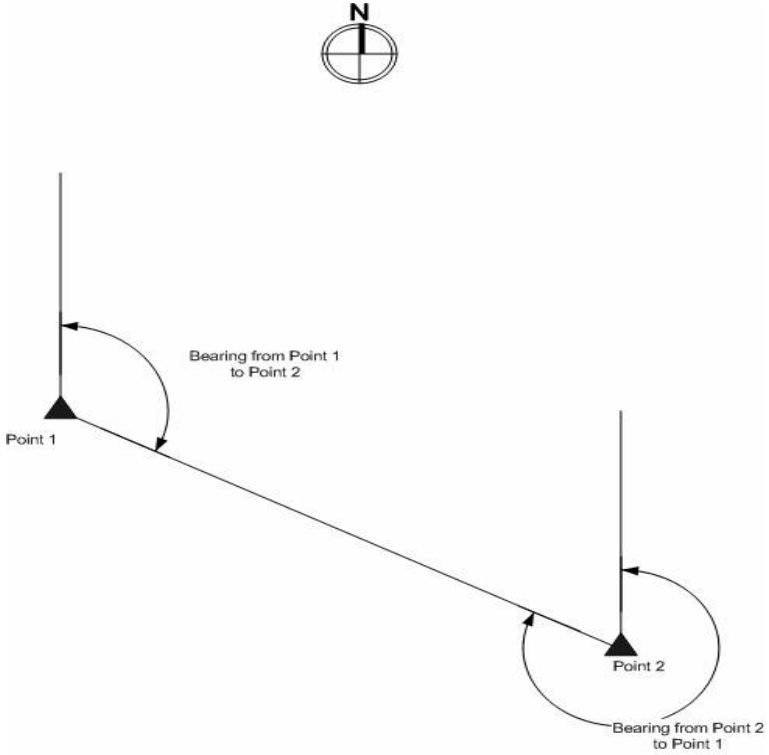
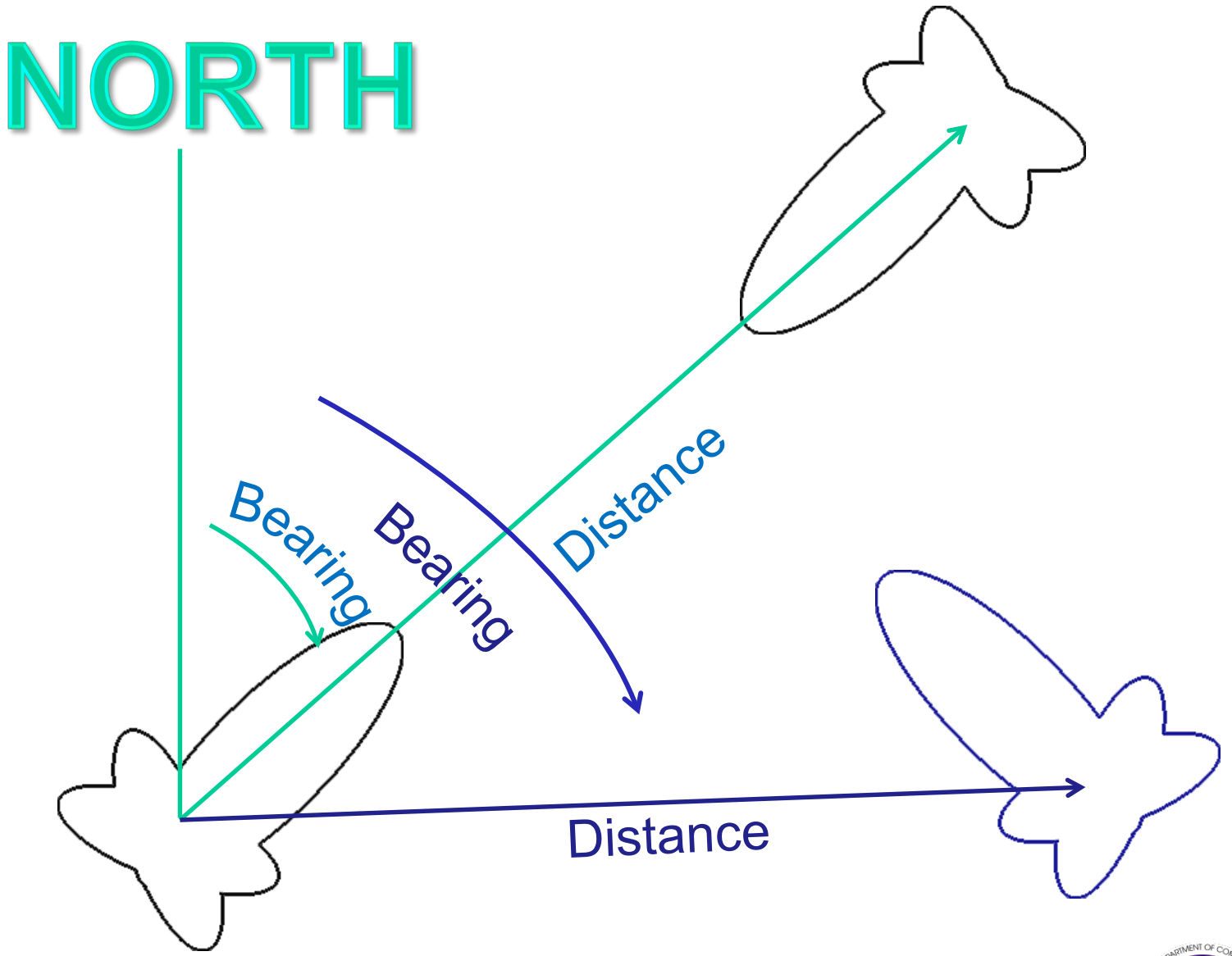


Bearing Measurements Between Two Points


NORTH
Bearing
Bearing
Distance
Distance

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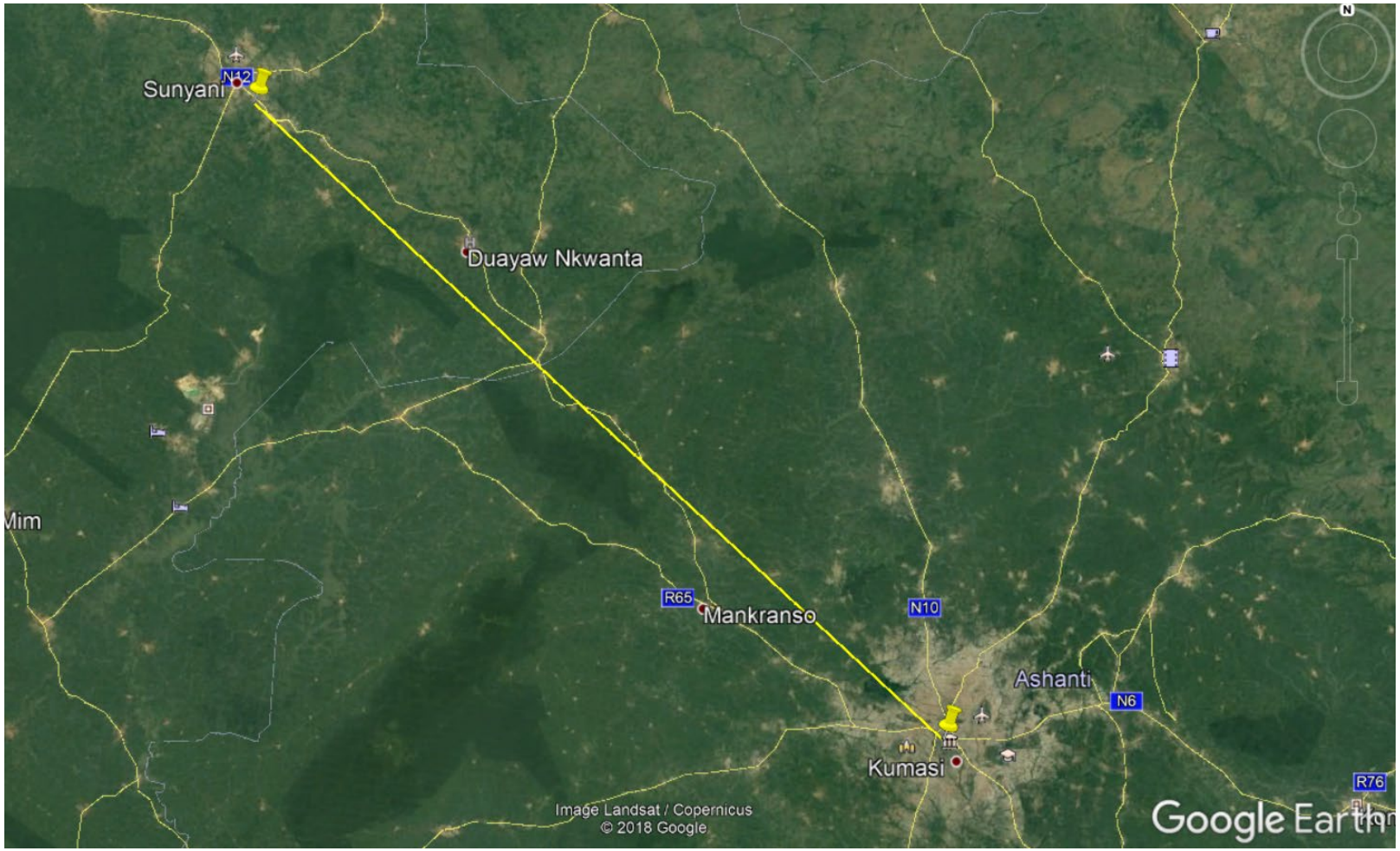
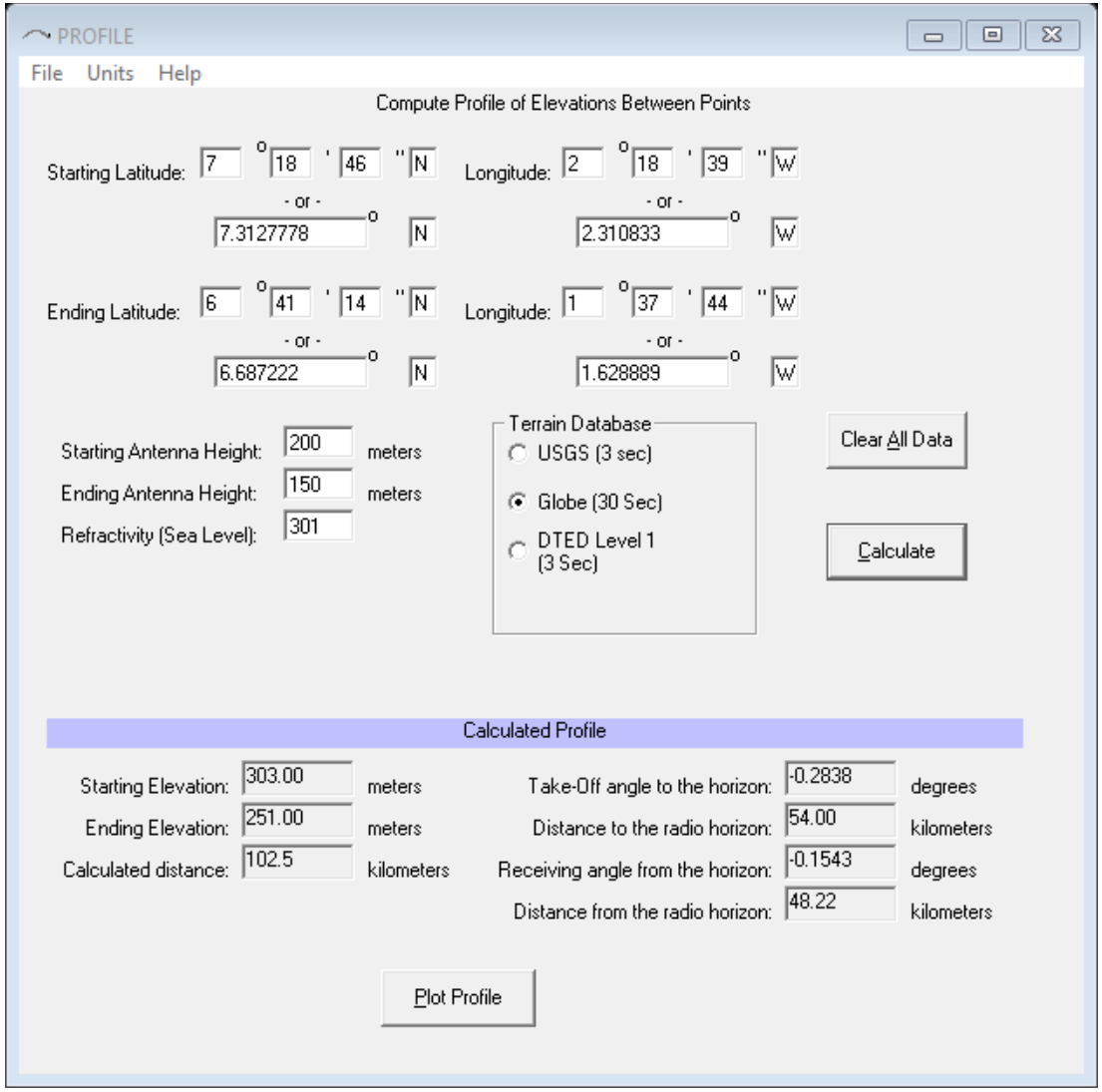
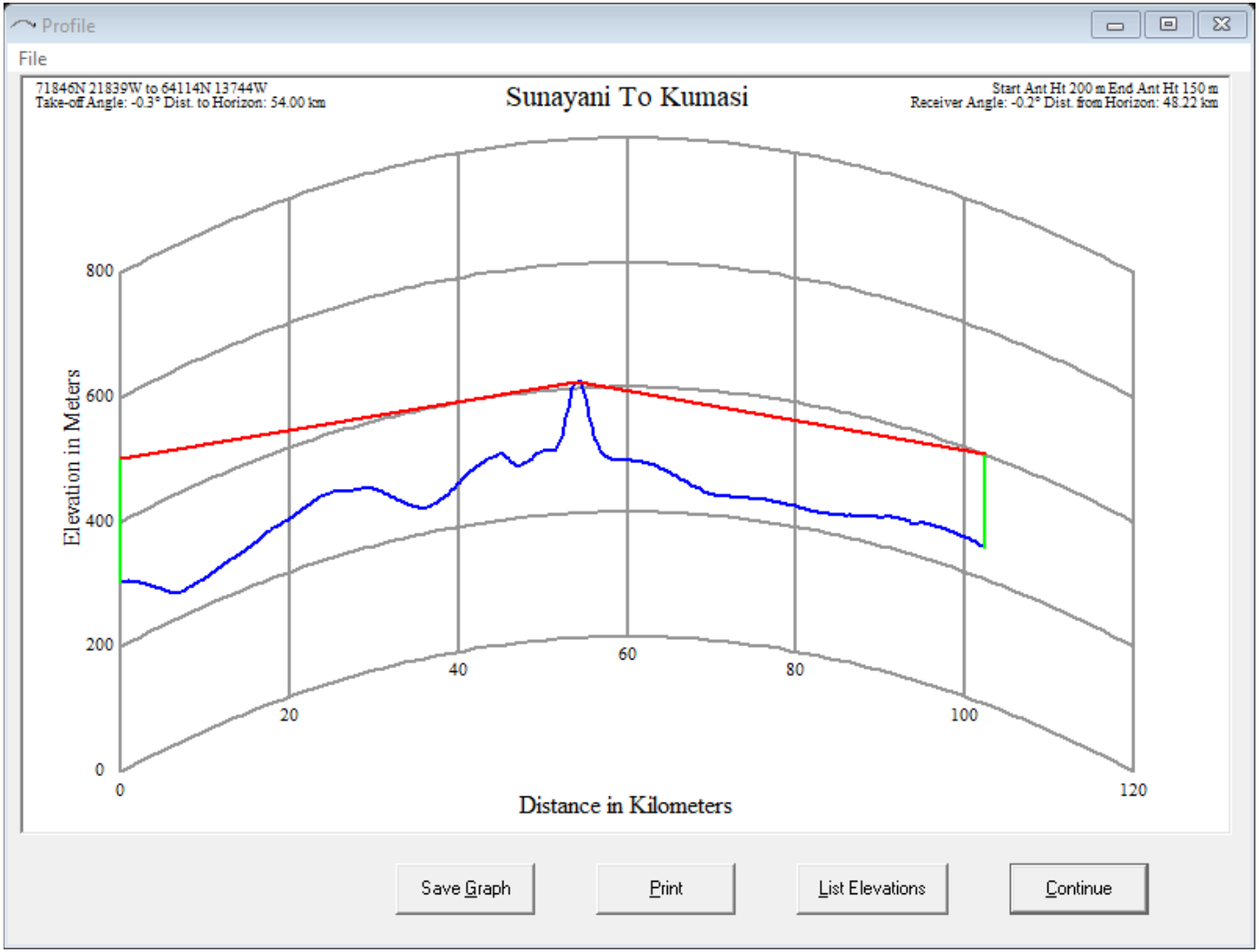
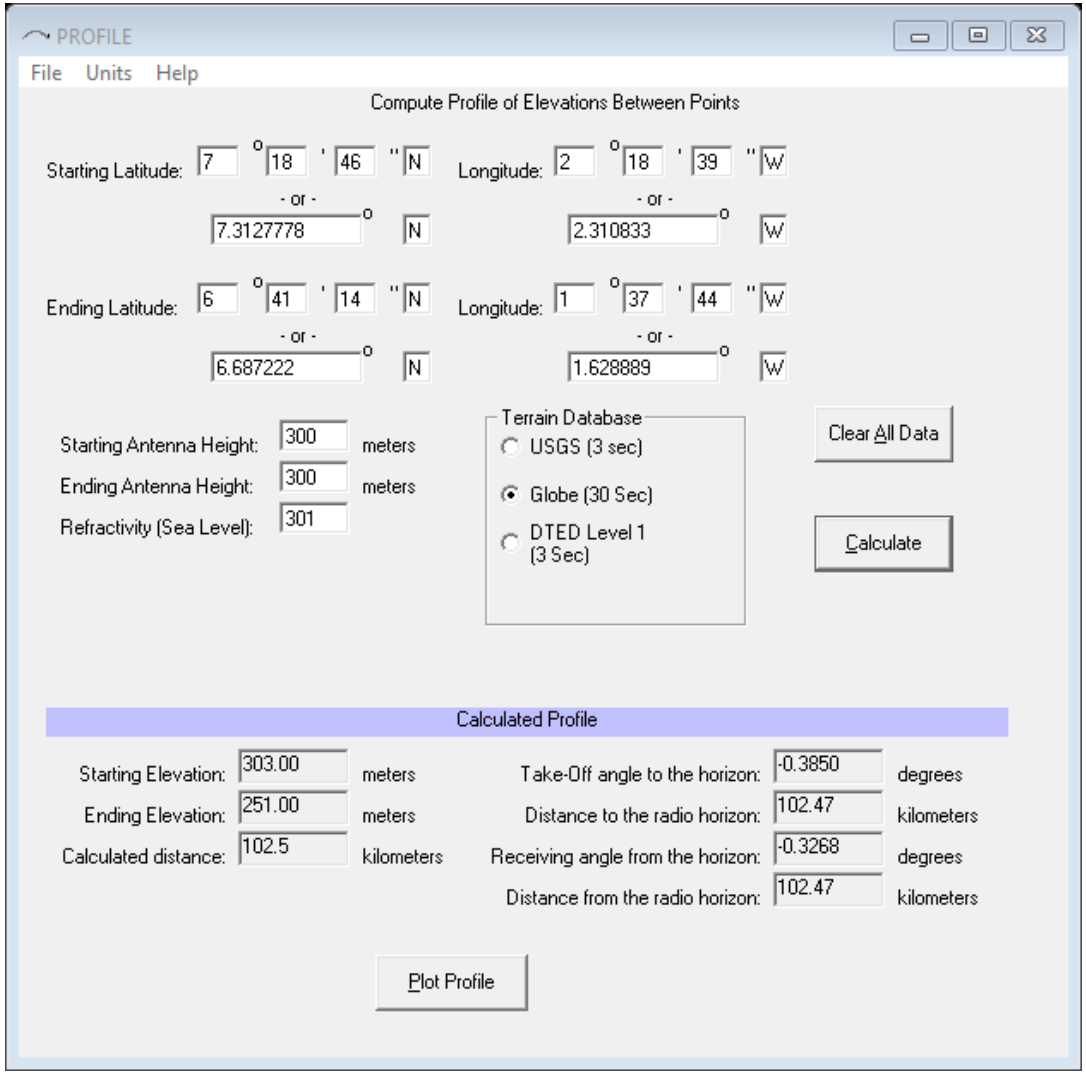
PROFILE

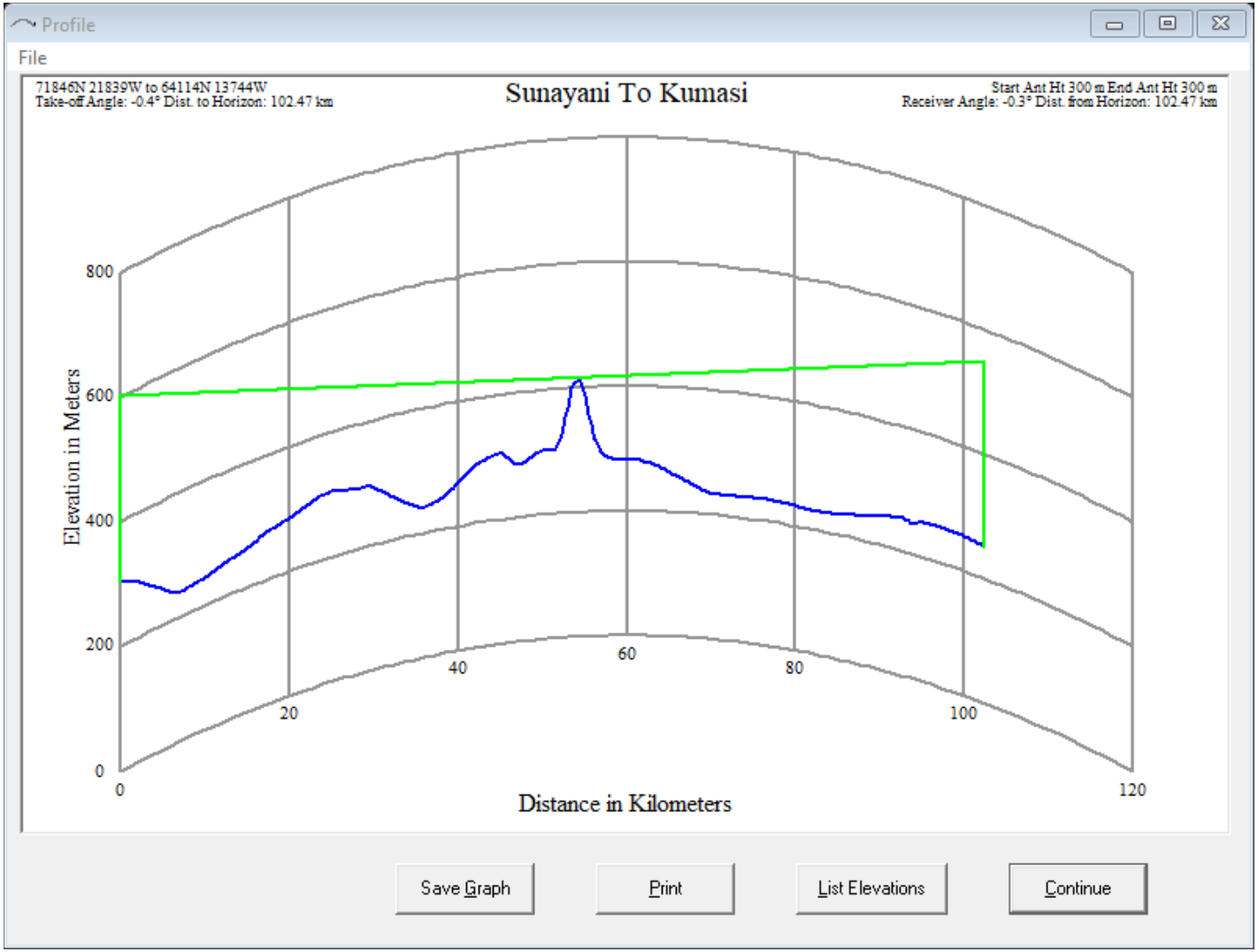
- Calculates and displays a profile of elevations between 2 locations
- Terrain databases:
  - Globe
- Displays:
  - take-off angle
  - receiving angle
  - distance to the radio horizon
  - distance from the radio horizon.


Sunyani
N12
Duayaw Nkwanta
Mim
R65
Mankranso
N10
Ashanti
N6
Kumasi
R76
Image Landsat / Copernicus
© 2018 Google
Google Earth


PROFILE
File Units Help
Compute Profile of Elevations Between Points
Starting Latitude: 7 ° 18 ' 46 " N
- or -
7.3127778 ° N
Longitude: 2 ° 18 ' 39 " W
- or -
2.310833 ° W
Ending Latitude: 6 ° 41 ' 14 " N
- or -
6.687222 ° N
Longitude: 1 ° 37 ' 44 " W
- or -
1.628889 ° W
Starting Antenna Height: 200 meters
Ending Antenna Height: 150 meters
Refractivity (Sea Level): 301
Terrain Database
USGS (3 sec)
Globe (30 Sec)
DTED Level 1 (3 Sec)
Clear All Data
Calculate
Calculated Profile
Starting Elevation: 303.00 meters
Ending Elevation: 251.00 meters
Calculated distance: 102.5 kilometers
Take-Off angle to the horizon: -0.2838 degrees
Distance to the radio horizon: 54.00 kilometers
Receiving angle from the horizon: -0.1543 degrees
Distance from the radio horizon: 48.22 kilometers
Plot Profile


Profile
File
71846N 21839W to 64114N 13744W
Take-off Angle: -0.3° Dist. to Horizon: 54.00 km
Sunayani To Kumasi
Start Ant Ht 200 m End Ant Ht 150 m
Receiver Angle: -0.2° Dist. from Horizon: 48.22 km
Elevation in Meters
800
600
400
200
0
0
20
40
60
80
100
120
Distance in Kilometers
Save Graph
Print
List Elevations
Continue


PROFILE
File Units Help
Compute Profile of Elevations Between Points
Starting Latitude: 7 ° 18 ' 46 " N
- or - 7.3127778 ° N
Longitude: 2 ° 18 ' 39 " W
- or - 2.310833 ° W
Ending Latitude: 6 ° 41 ' 14 " N
- or - 6.687222 ° N
Longitude: 1 ° 37 ' 44 " W
- or - 1.628889 ° W
Starting Antenna Height: 300 meters
Ending Antenna Height: 300 meters
Refractivity (Sea Level): 301
Terrain Database
USGS (3 sec)
Globe (30 Sec)
DTED Level 1 (3 Sec)
Clear All Data
Calculate
Calculated Profile
Starting Elevation: 303.00 meters
Ending Elevation: 251.00 meters
Calculated distance: 102.5 kilometers
Take-Off angle to the horizon: -0.3850 degrees
Distance to the radio horizon: 102.47 kilometers
Receiving angle from the horizon: -0.3268 degrees
Distance from the radio horizon: 102.47 kilometers
Plot Profile


Profile
File
71846N 21839W to 64114N 13744W
Take-off Angle: -0.4° Dist. to Horizon: 102.47 km
Sunayani To Kumasi
Start Ant Ht 300 m End Ant Ht 300 m
Receiver Angle: -0.3° Dist. from Horizon: 102.47 km
Elevation in Meters
800
600
400
200
0
0
20
40
60
80
100
120
Distance in Kilometers
Save Graph
Print
List Elevations
Continue

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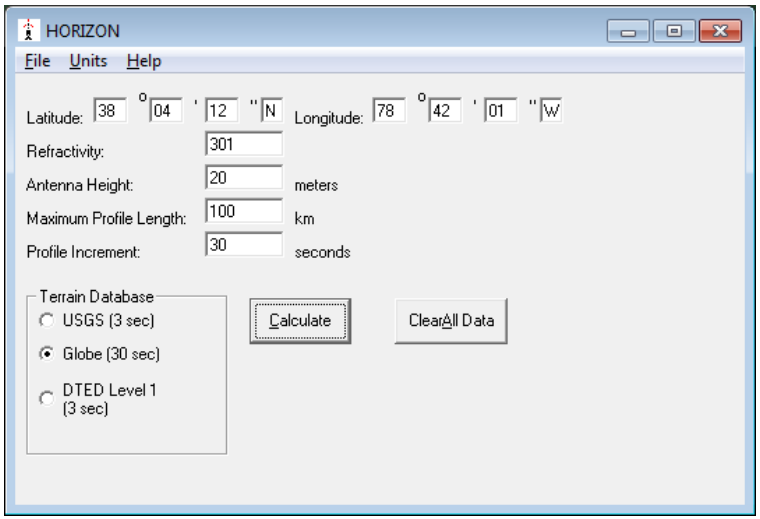
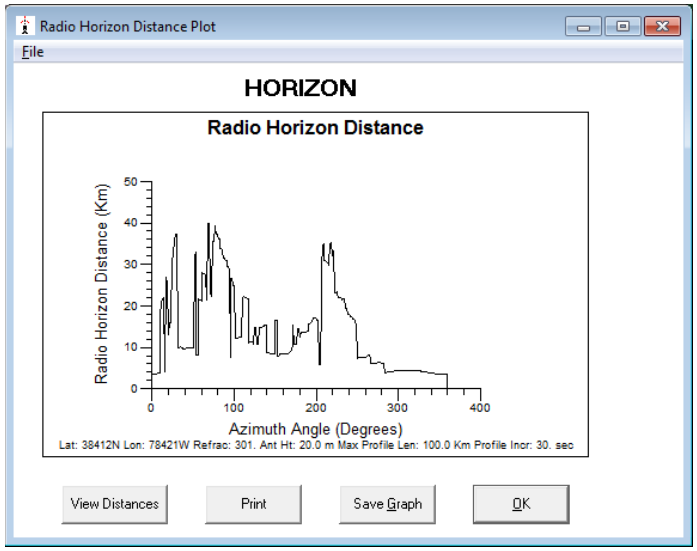
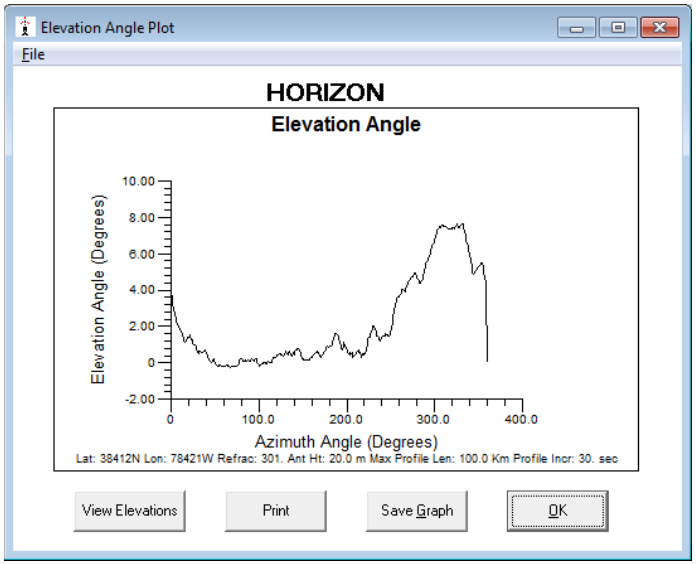
HORIZON

- Calculates the radio line of sight distances and elevation angles 360° around a transmitter or receiver site
- Terrain databases:
  - Globe
- Generates two plots:
  - Radio Horizon Distance
  - Elevation Angle

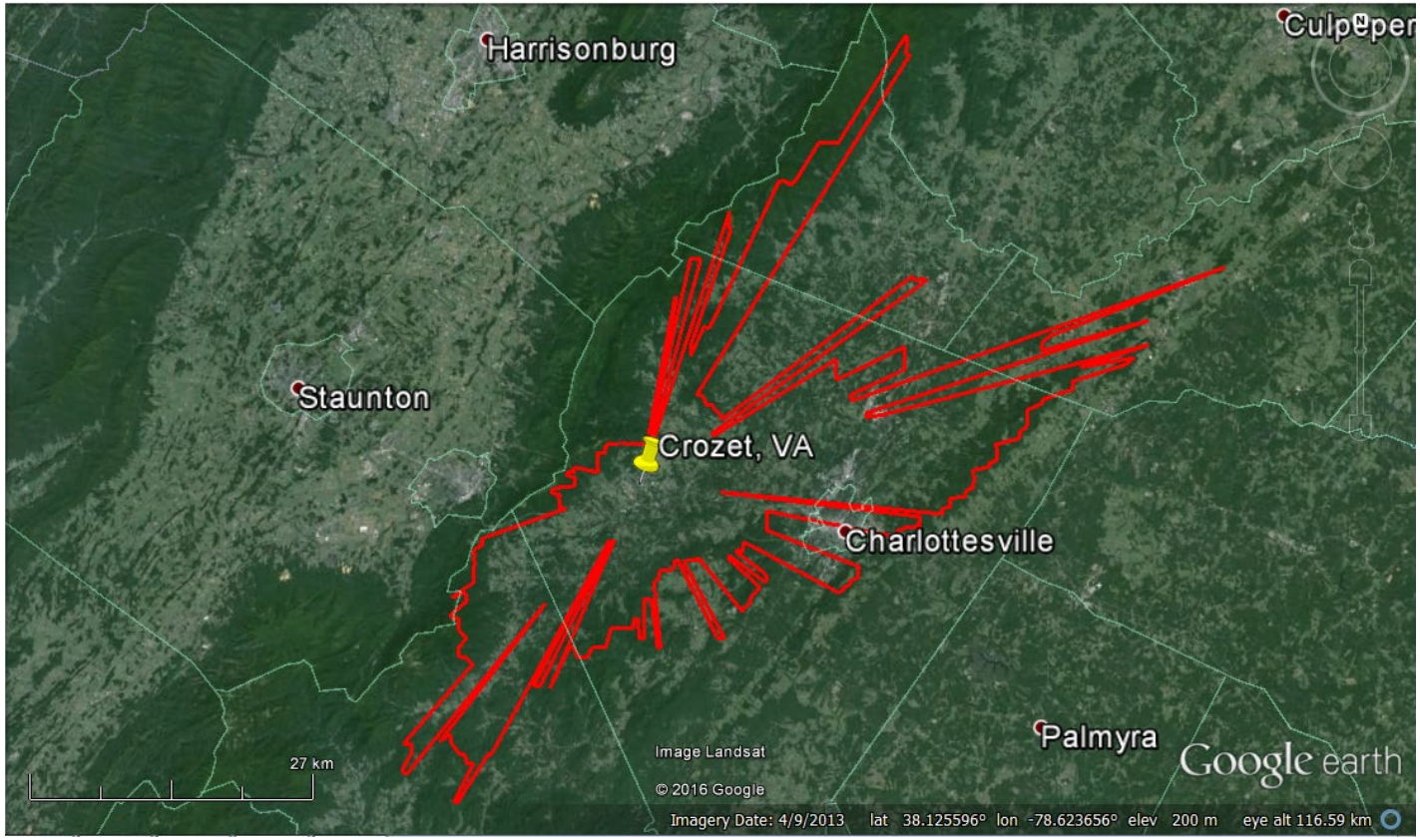
Crozet, Virginia







Line-of-Sight Around Crozet, Virginia



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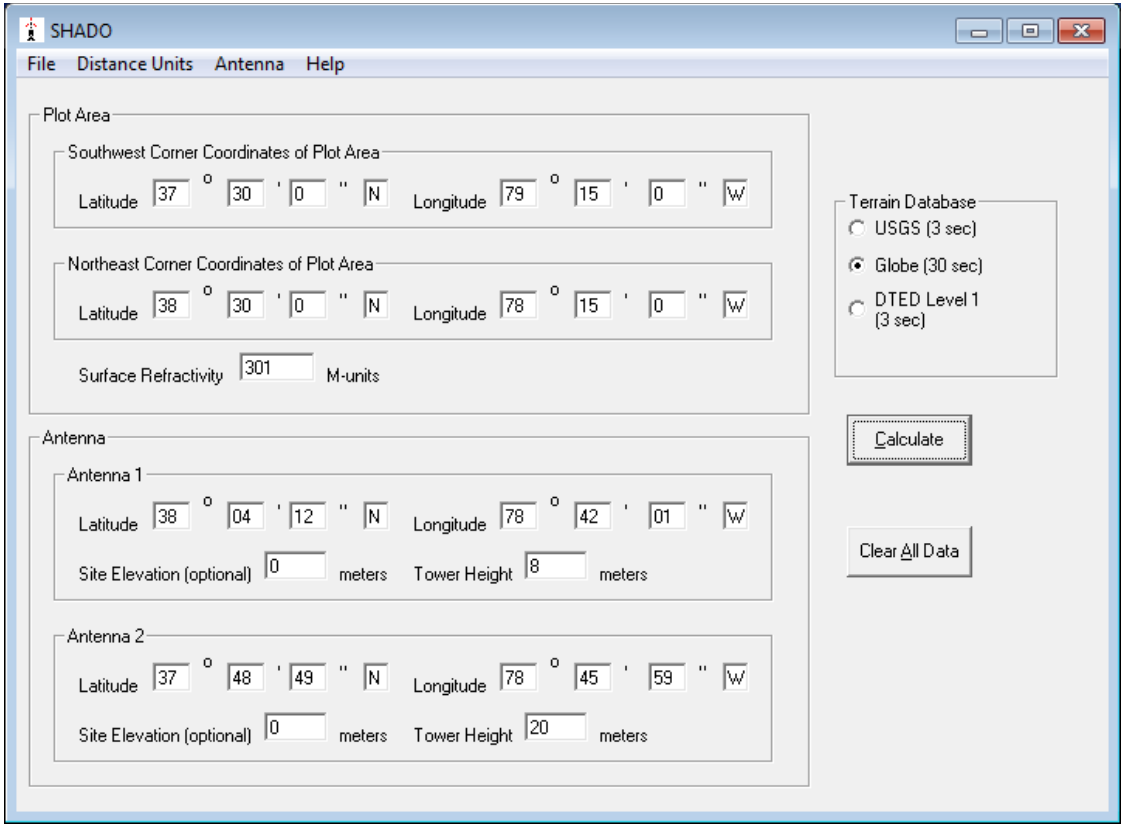
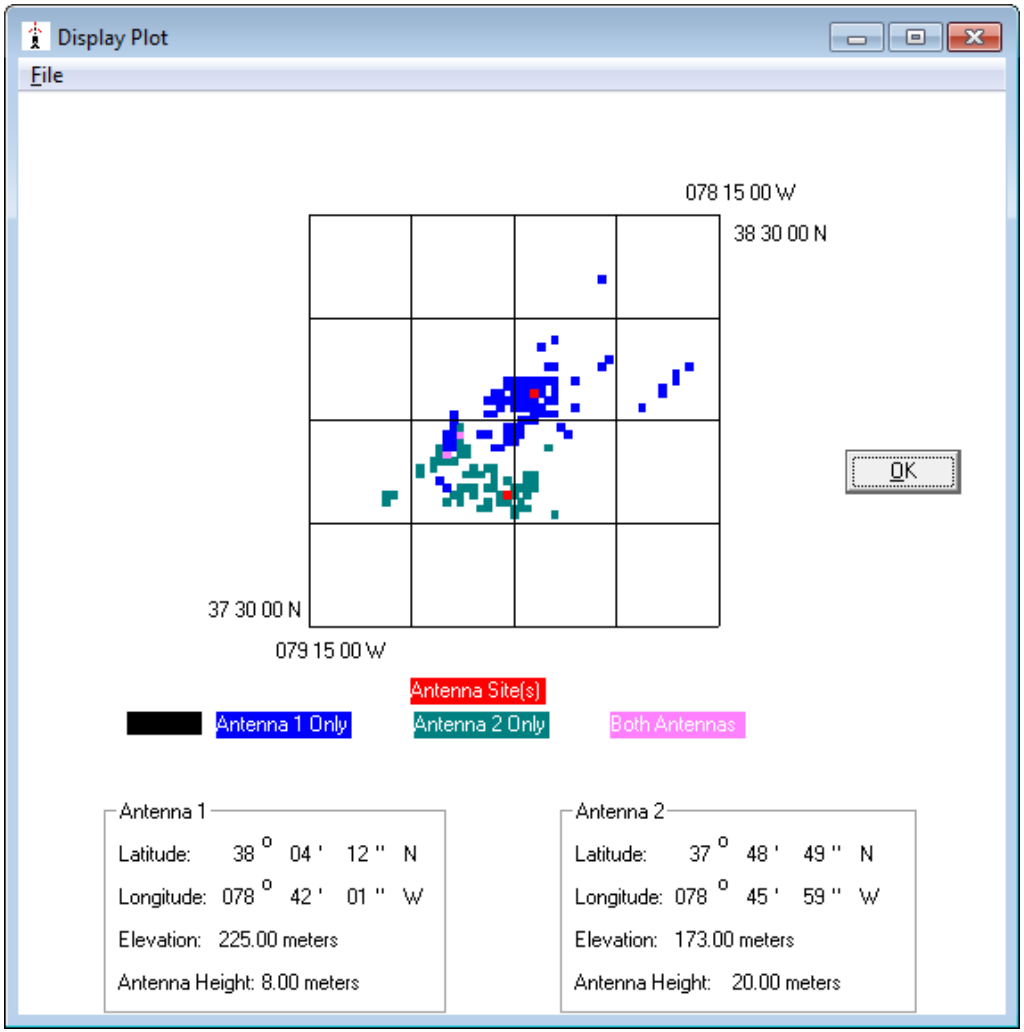
SHADO

- Antenna coverage model
- Plots areas that are within the radio line of sight of an antenna
- Terrain databases:
  - Globe
- Allows for analysis of propagation loss
- May specify 1 or 2 antennas


SHADO
File
Distance Units
Antenna
Help
Plot Area
Southwest Corner Coordinates of Plot Area
Latitude 37 ° 30 ' 0 " N
Longitude 79 ° 15 ' 0 " W
Northeast Corner Coordinates of Plot Area
Latitude 38 ° 30 ' 0 " N
Longitude 78 ° 15 ' 0 " W
Surface Refractivity 301 M-units
Antenna
Antenna 1
Latitude 38 ° 04 ' 12 " N
Longitude 78 ° 42 ' 01 " W
Site Elevation (optional) 0 meters
Tower Height 8 meters
Antenna 2
Latitude 37 ° 48 ' 49 " N
Longitude 78 ° 45 ' 59 " W
Site Elevation (optional) 0 meters
Tower Height 20 meters
Terrain Database
USGS (3 sec)
Globe (30 sec)
DTED Level 1 (3 sec)
Calculate
Clear All Data


Display Plot
File
078 15 00 W
38 30 00 N
37 30 00 N
079 15 00 W
OK
Antenna Site(s)
Antenna 1 Only
Antenna 2 Only
Both Antennas
Antenna 1
Latitude: 38 ° 04 ' 12 " N
Longitude: 078 ° 42 ' 01 " W
Elevation: 225.00 meters
Antenna Height: 8.00 meters
Antenna 2
Latitude: 37 ° 48 ' 49 " N
Longitude: 078 ° 45 ' 59 " W
Elevation: 173.00 meters
Antenna Height: 20.00 meters

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System Models

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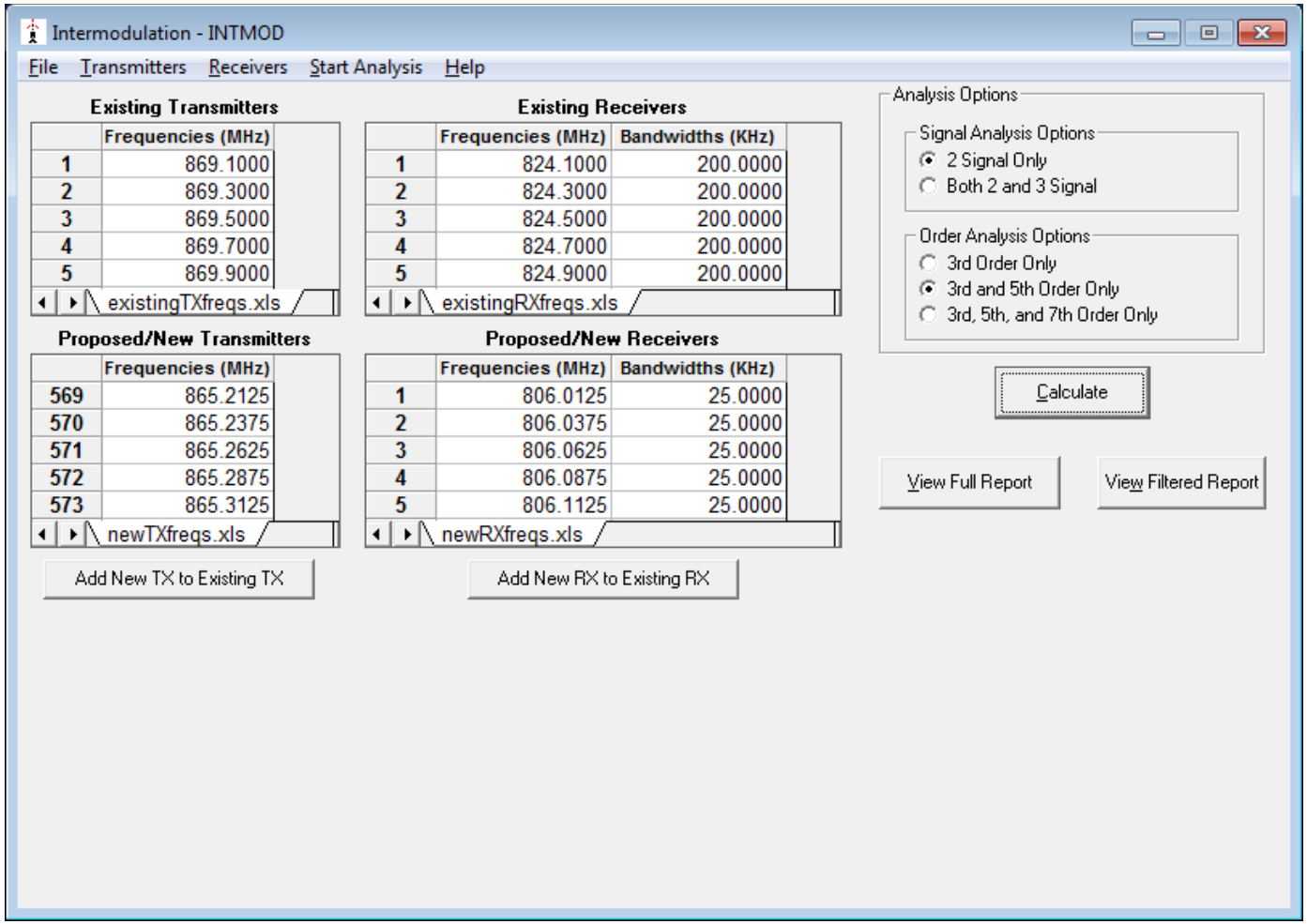
INTMOD

Intermodulation

Intermodulation products result in interference, when two or more signals combine in a nonlinear device and produce an undesired signal on or near the tuned frequency of the victim receiver. The combination process can occur in the final stage of a transmitter or in the RF of first mixer circuitry of a receiver.

- Computes intermodulation products and harmonics of a list of transmitted frequencies
- Compares them to a list of receiver frequencies to determine overlap
- Two & three signal mixing of 3^{rd}, 5^{th} & 7^{th} order can be computed


Intermodulation - INTMOD
File
Transmitters
Receivers
Start Analysis
Help
Existing Transmitters
Frequencies (MHz)
1 869.1000
2 869.3000
3 869.5000
4 869.7000
5 869.9000
existingTXfreqs.xls
Existing Receivers
Frequencies (MHz) Bandwidths (KHz)
1 824.1000 200.0000
2 824.3000 200.0000
3 824.5000 200.0000
4 824.7000 200.0000
5 824.9000 200.0000
existingRXfreqs.xls
Proposed/New Transmitters
Frequencies (MHz)
569 865.2125
570 865.2375
571 865.2625
572 865.2875
573 865.3125
newTXfreqs.xls
Proposed/New Receivers
Frequencies (MHz) Bandwidths (KHz)
1 806.0125 25.0000
2 806.0375 25.0000
3 806.0625 25.0000
4 806.0875 25.0000
5 806.1125 25.0000
newRXfreqs.xls
Add New TX to Existing TX
Add New RX to Existing RX
Analysis Options
Signal Analysis Options
2 Signal Only
Both 2 and 3 Signal
Order Analysis Options
3rd Order Only
3rd and 5th Order Only
3rd, 5th, and 7th Order Only
Calculate
View Full Report
View Filtered Report

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SEAM

Single Emitter Analysis Model

- Supports user-interactive computations & automated unit conversion in direct & inverse modes
- Two computation modes
  - Direct
    - Estimates received signal levels at a user specified propagation distance
    - Calculate propagation loss, field strength, power density, received power, received voltage
  - Inverse
    - Estimates propagation distance required to meet a user specified received threshold
- Two models
  - Free space
  - Smooth earth using the Integrated Propagation System (IPS) model

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Receiver Models

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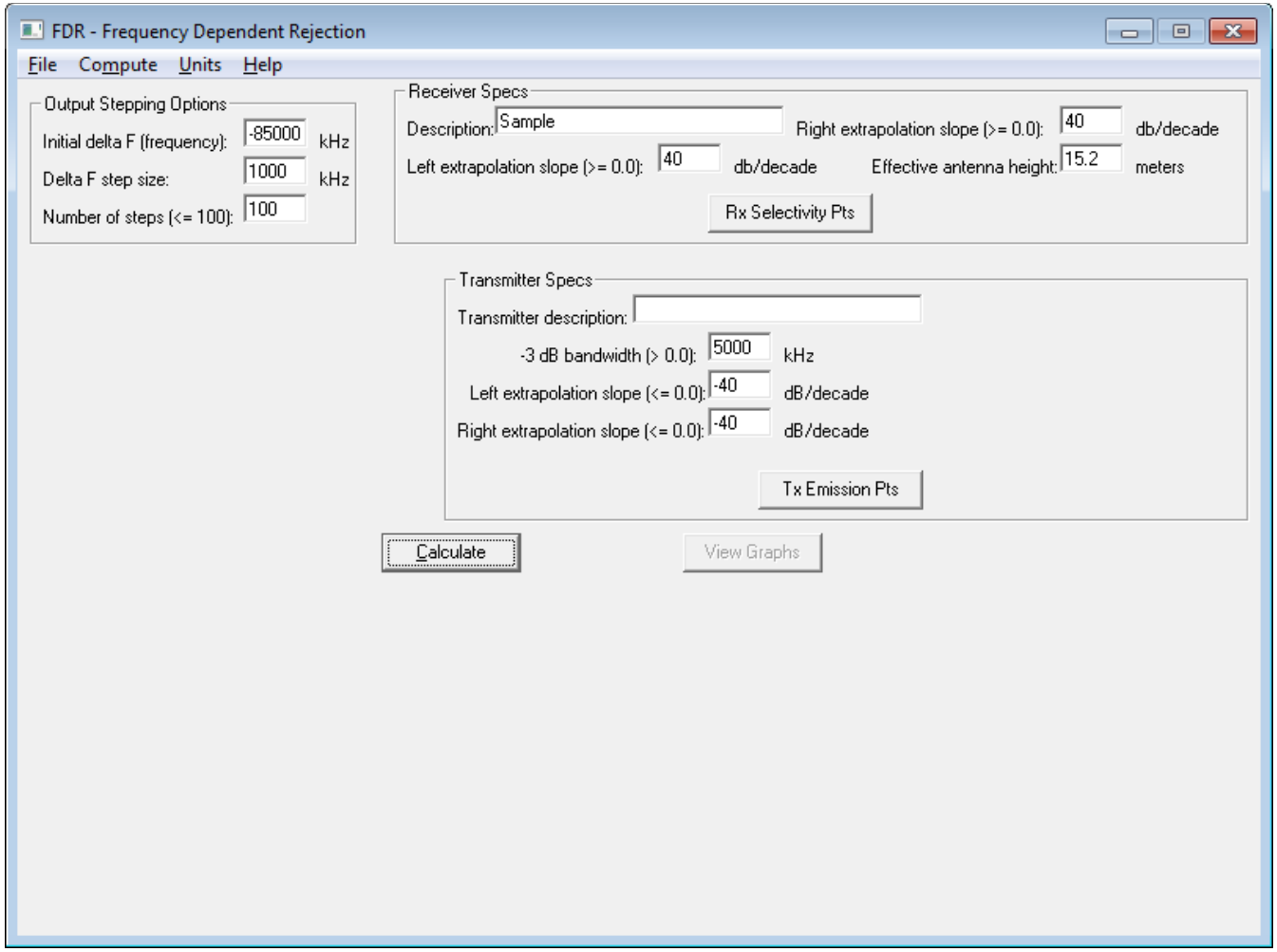
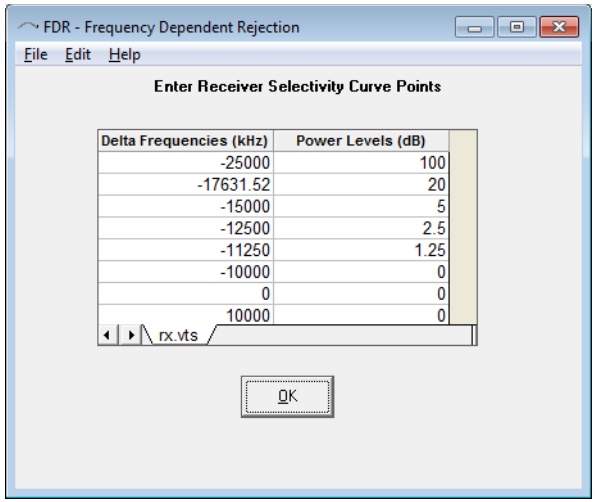
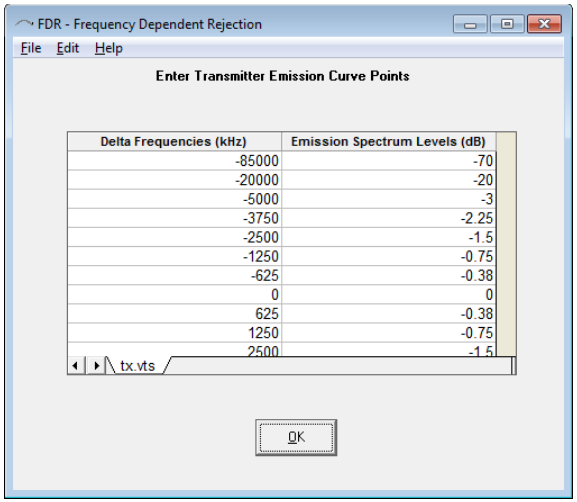
FDR

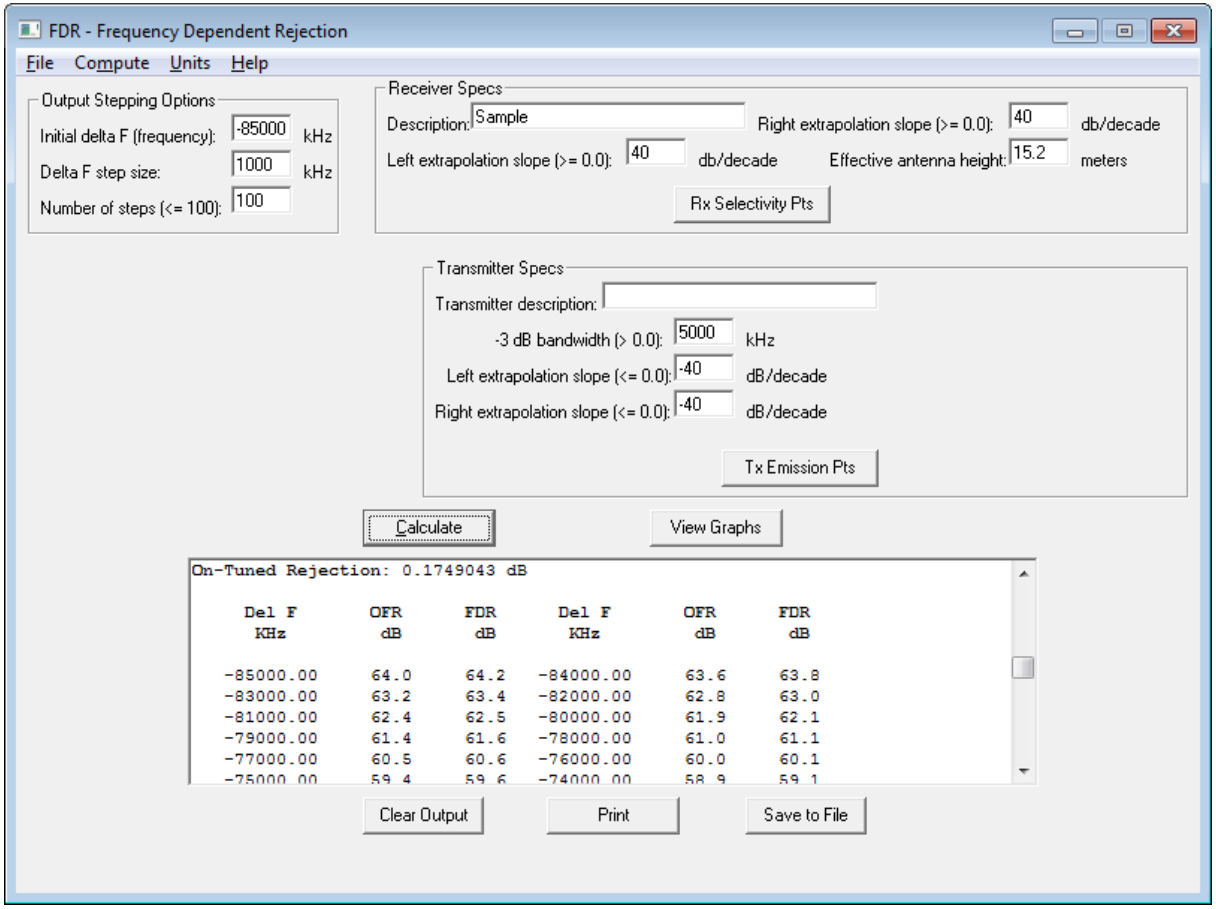
Frequency Dependent Rejection

- Amount of attenuation offered by a Rx to a transmitted signal
- Attenuation has two parts
  - On-tune rejection (OTR), emission spectrum exceeds receiver bandwidth
  - Off frequency rejection (OFR), detuning of receiver with respect to transmitter
- Performs 2 computations
  - FDR
  - Frequency-Distance (F-D) relationships between Tx and Rx
- FDR calculated using the Gauss-Legendre Quadrature integration method
- F-D distance calculated for each frequency using Smooth Curve – Smooth Earth or Free Space propagation model


FDR - Frequency Dependent Rejection
File
Compute
Units
Help
Output Stepping Options
Initial delta F (frequency):
-85000
kHz
Delta F step size:
1000
kHz
Number of steps (<= 100):
100
Receiver Specs
Description:
Sample
Right extrapolation slope (>= 0.0):
40
db/decade
Left extrapolation slope (>= 0.0):
40
db/decade
Effective antenna height:
15.2
meters
Rx Selectivity Pts
Transmitter Specs
Transmitter description:
-3 dB bandwidth (> 0.0):
5000
kHz
Left extrapolation slope (<= 0.0):
-40
dB/decade
Right extrapolation slope (<= 0.0):
-40
dB/decade
Tx Emission Pts
Calculate
View Graphs


FDR - Frequency Dependent Rejection
File Edit Help
Enter Receiver Selectivity Curve Points
Delta Frequencies (kHz)
Power Levels (dB)
-25000 100
-17631.52 20
-15000 5
-12500 2.5
-11250 1.25
-10000 0
0 0
10000 0
rx.vts
OK


FDR - Frequency Dependent Rejection
File Edit Help
Enter Transmitter Emission Curve Points
Delta Frequencies (kHz)
Emission Spectrum Levels (dB)
-85000 -70
-20000 -20
-5000 -3
-3750 -2.25
-2500 -1.5
-1250 -0.75
-625 -0.38
0 0
625 -0.38
1250 -0.75
2500 -1.5
tx.vts
OK


FDR - Frequency Dependent Rejection
File
Compute
Units
Help
Output Stepping Options
Initial delta F (frequency): -85000 kHz
Delta F step size: 1000 kHz
Number of steps (<= 100): 100
Receiver Specs
Description: Sample
Right extrapolation slope (>= 0.0): 40 db/decade
Left extrapolation slope (>= 0.0): 40 db/decade
Effective antenna height: 15.2 meters
Rx Selectivity Pts
Transmitter Specs
Transmitter description:
-3 dB bandwidth (> 0.0): 5000 kHz
Left extrapolation slope (<= 0.0): -40 dB/decade
Right extrapolation slope (<= 0.0): -40 dB/decade
Tx Emission Pts
Calculate
View Graphs
On-Tuned Rejection: 0.1749043 dB
Del F KHz | OFR dB | FDR dB | Del F KHz | OFR dB | FDR dB
-85000.00 64.0 64.2 -84000.00 63.6 63.8
-83000.00 63.2 63.4 -82000.00 62.8 63.0
-81000.00 62.4 62.5 -80000.00 61.9 62.1
-79000.00 61.4 61.6 -78000.00 61.0 61.1
-77000.00 60.5 60.6 -76000.00 60.0 60.1
-75000.00 59.4 59.6 -74000.00 58.9 59.1
Clear Output
Print
Save to File

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Antenna Models

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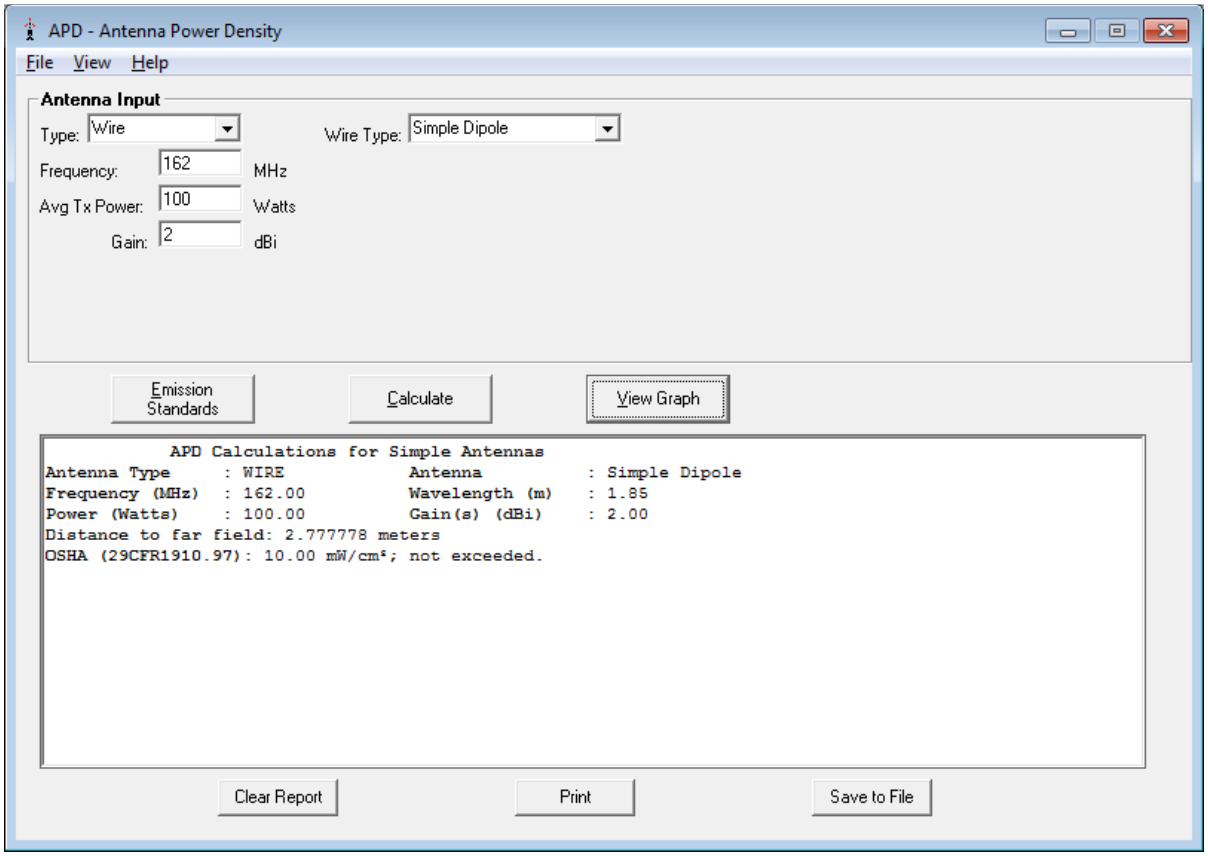
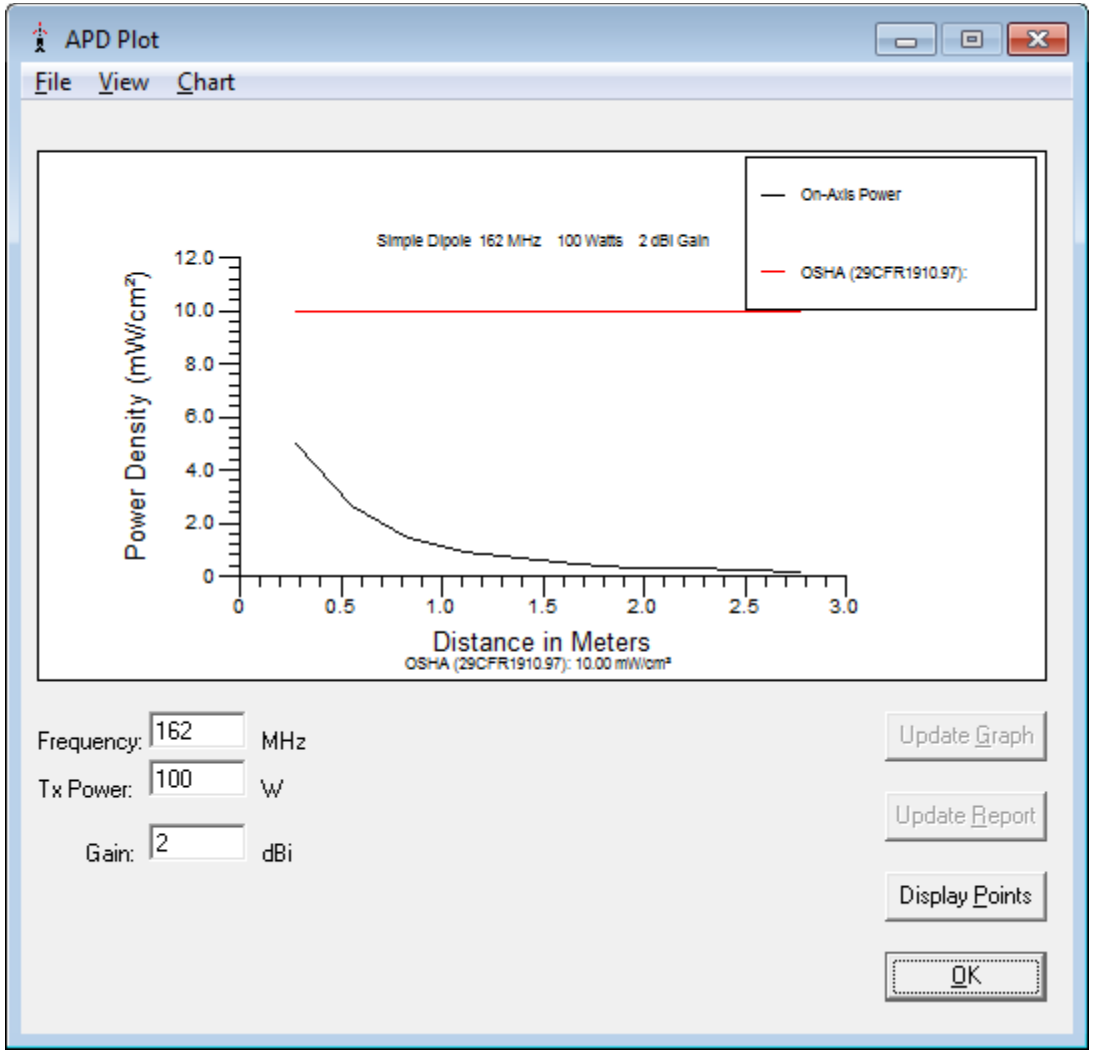
APD

Antenna Power Density

- Provides simplified procedures for estimating the near field power density of a number of common types of antennas
- Graphically checks the compliance of systems with different emission exposure standards or user-defined limits
  - OSHA
  - ANSI C95.1-1991
  - FCC 1.1310
  - NCRP (National Council on Radiation Protection)
- Output
  - Distance
  - Power density


APD - Antenna Power Density
File View Help
Antenna Input
Type: Wire
Wire Type: Simple Dipole
Frequency: 162 MHz
Avg Tx Power: 100 Watts
Gain: 2 dBi
Emission Standards
Calculate
View Graph
APD Calculations for Simple Antennas
Antenna Type : WIRE Antenna : Simple Dipole
Frequency (MHz) : 162.00 Wavelength (m) : 1.85
Power (Watts) : 100.00 Gain(s) (dBi) : 2.00
Distance to far field: 2.777778 meters
OSHA (29CFR1910.97): 10.00 mW/cm²; not exceeded.
Clear Report
Print
Save to File


APD Plot
File View Chart
On-Axis Power
OSHA (29CFR1910.97):
Simple Dipole 162 MHz 100 Watts 2 dBi Gain
Power Density (mW/cm²)
12.0
10.0
8.0
6.0
4.0
2.0
0
0 0.5 1.0 1.5 2.0 2.5 3.0
Distance in Meters
OSHA (29CFR1910.97): 10.00 mW/cm²
Frequency: 162 MHz
Tx Power: 100 W
Gain: 2 dBi
Update Graph
Update Report
Display Points
OK

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Satellite Models

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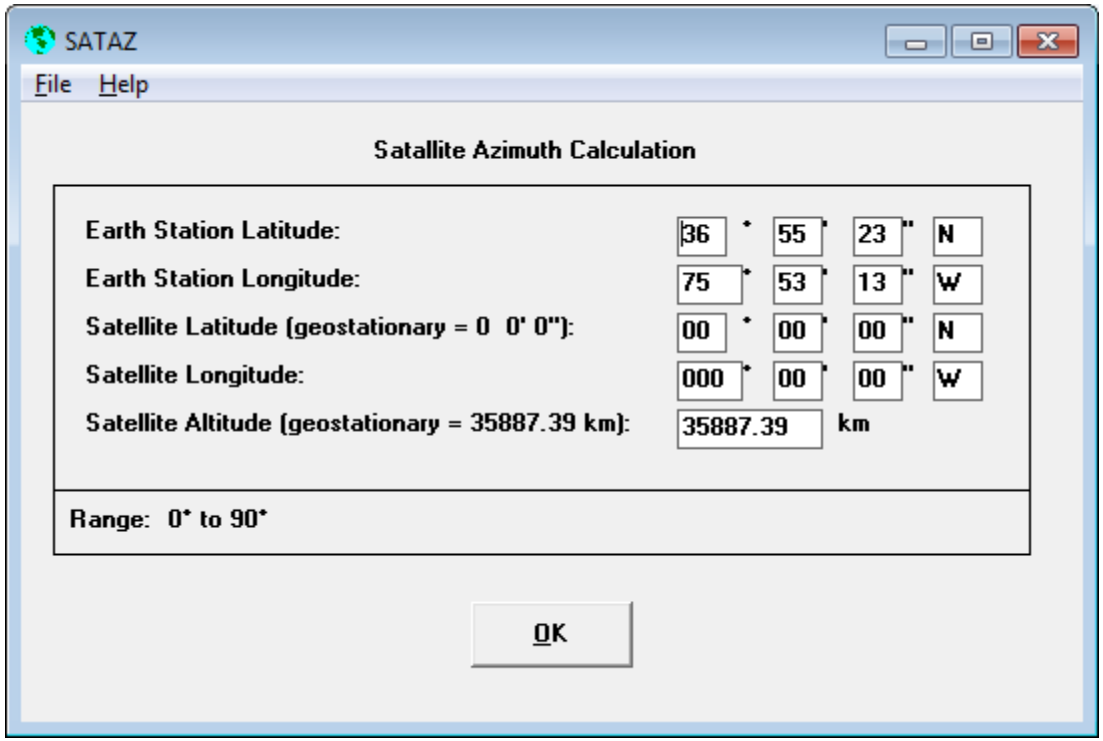
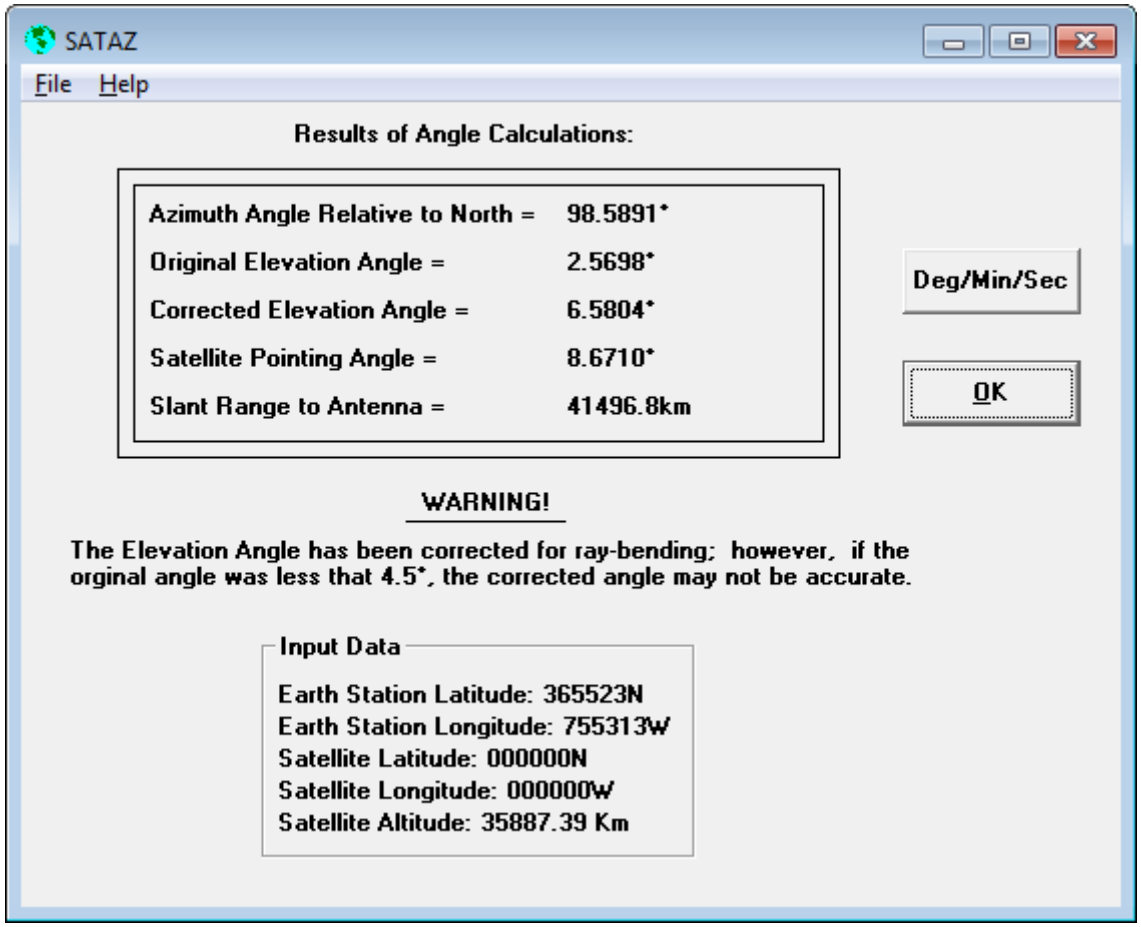
SATAZ

Satellite Azimuth

- Computes direction and distance from an earth station to a satellite (geo-stationary or non-geostationary)
- Takes into account ray bending due to the atmosphere
- Output
  - Azimuth angle
  - Elevation angle
  - Satellite pointing angle
  - Slant range from an earth station to the orbiting satellite


SATAZ
File Help
Satallite Azimuth Calculation
Earth Station Latitude: 36 ° 55 ' 23 " N
Earth Station Longitude: 75 ° 53 ' 13 " W
Satellite Latitude (geostationary = 0 0' 0"): 00 ° 00 ' 00 " N
Satellite Longitude: 000 ° 00 ' 00 " W
Satellite Altitude (geostationary = 35887.39 km): 35887.39 km
Range: 0° to 90°
OK


SATAZ
File Help
Results of Angle Calculations:
Azimuth Angle Relative to North = 98.5891°
Original Elevation Angle = 2.5698°
Corrected Elevation Angle = 6.5804°
Satellite Pointing Angle = 8.6710°
Slant Range to Antenna = 41496.8km
Deg/Min/Sec
OK
WARNING!
The Elevation Angle has been corrected for ray-bending; however, if the orginal angle was less that 4.5°, the corrected angle may not be accurate.
Input Data
Earth Station Latitude: 365523N
Earth Station Longitude: 755313W
Satellite Latitude: 000000N
Satellite Longitude: 000000W
Satellite Altitude: 35887.39 Km

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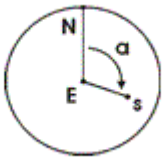
Azimuth Angle



Angle a (in the diagram) is the azimuth angle from the earth station to the satellite relative to true North (west is positive) where:

E = Earth Station

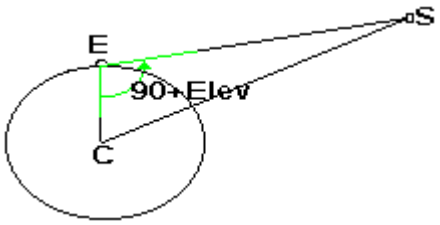
s = Sub-Satellite point

N = North Pole

a = Azimuth Angle clockwise from true north

MSAM

Original Elevation Angle



The original elevation angle (Elev) is the angle upwards that the earth antenna must point (Does not include ray-bending correction), where:

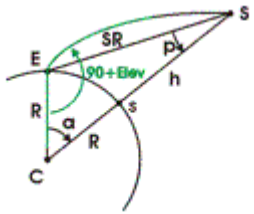
E = Earth station

S = Orbiting satellite

C = Center of earth

MSAM

Corrected Elevation Angle



The original elevation angle (Elev) is the angle upwards that the earth antenna must point (Does not include ray-bending correction), where:

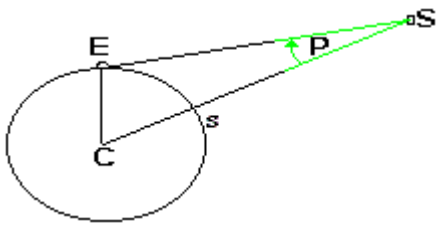
E = Earth station

S = Orbiting satellite

C = Center of earth

MSAM

Satellite Antenna Pointing Angle



The satellite antenna pointing angle (P) is the angle between the lines joining the satellite to the earth station and the satellite to the sub-satellite point where,

E = earth station

S = Orbiting satellite

C = Center of Earth

s = Sub-Satellite point

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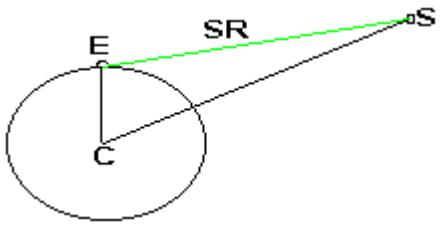
Slant Range



The slant range (SR) is the straight line distance between the earth station and the orbiting satellite where,

E = Earth station

S = Orbiting satellite

C = Center of earth

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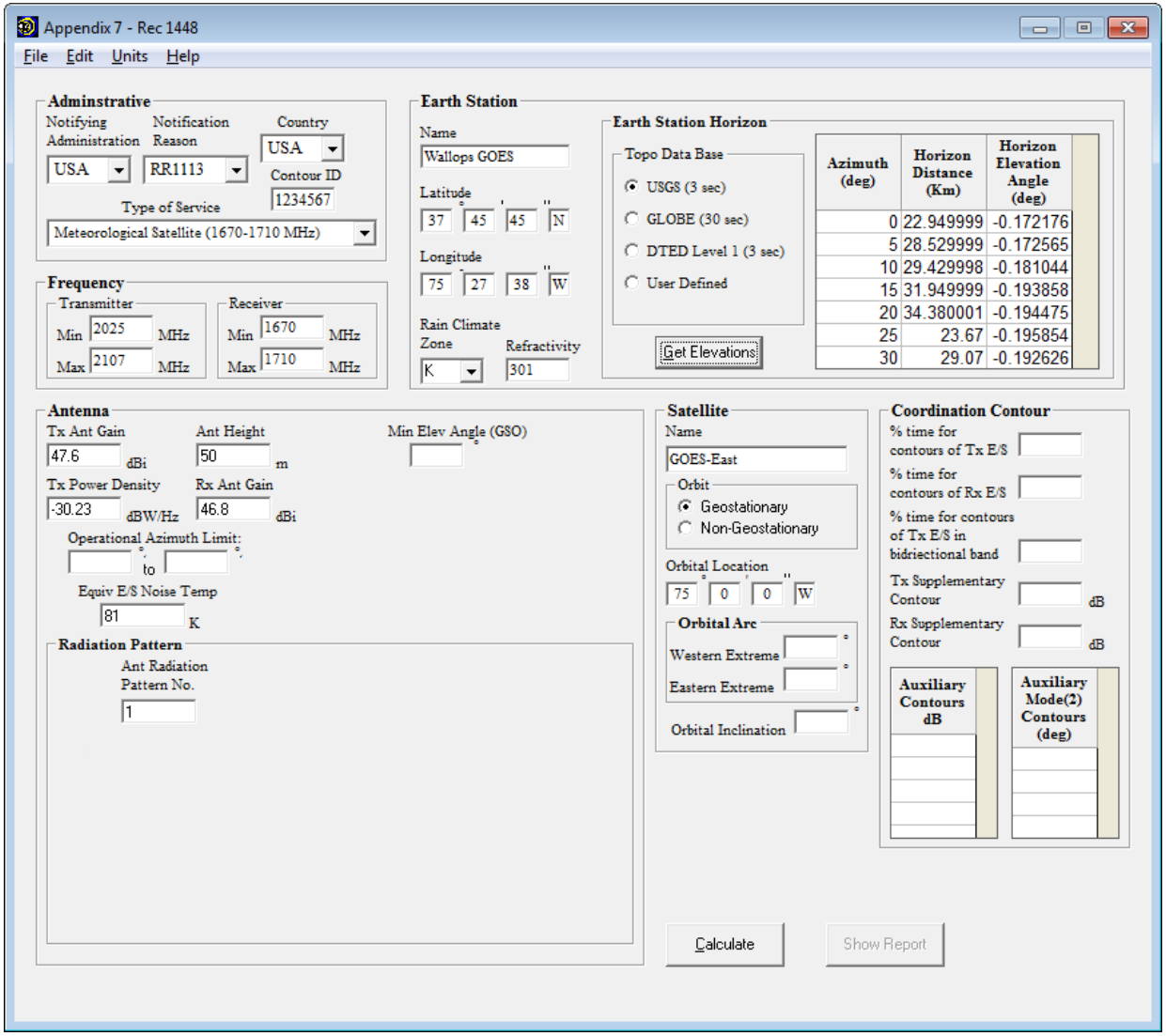
Appendix 7

- Calculates the earth station coordination contours
- Uses ITU-R Rec SM 1448
- ITU-R Rec 620-3 propagation model
- Displays contours on a map
- Uses USGS or Globe terrain data
- Uses NTIA Geographic Map data (C:\NTIA Geo Data\)


Appendix 7 - Rec 1448
File Edit Units Help
Adminstrative
Notifying Administration
USA
Notification Reason
RR1113
Country
USA
Contour ID
1234567
Type of Service
Meteorological Satellite (1670-1710 MHz)
Frequency
Transmitter
Min 2025 MHz
Max 2107 MHz
Receiver
Min 1670 MHz
Max 1710 MHz
Earth Station
Name
Wallops GOES
Latitude
37 ° 45 ' 45 " N
Longitude
75 ° 27 ' 38 " W
Rain Climate Zone
K
Refractivity
301
Earth Station Horizon
Topo Data Base
USGS (3 sec)
GLOBE (30 sec)
DTED Level 1 (3 sec)
User Defined
Get Elevations
Azimuth (deg) | Horizon Distance (Km) | Horizon Elevation Angle (deg)
0 | 22.949999 | -0.172176
5 | 28.529999 | -0.172565
10 | 29.429998 | -0.181044
15 | 31.949999 | -0.193858
20 | 34.380001 | -0.194475
25 | 23.67 | -0.195854
30 | 29.07 | -0.192626
Antenna
Tx Ant Gain
47.6 dBi
Ant Height
50 m
Min Elev Angle (GSO)
Tx Power Density
-30.23 dBW/Hz
Rx Ant Gain
46.8 dBi
Operational Azimuth Limit:
to
Equiv E/S Noise Temp
81 K
Radiation Pattern
Ant Radiation Pattern No.
1
Satellite
Name
GOES-East
Orbit
Geostationary
Non-Geostationary
Orbital Location
75 ° 0 ' 0 " W
Orbital Arc
Western Extreme
Eastern Extreme
Orbital Inclination
Coordination Contour
% time for contours of Tx E/S
% time for contours of Rx E/S
% time for contours of Tx E/S in bidirectional band
Tx Supplementary Contour
dB
Rx Supplementary Contour
dB
Auxiliary Contours dB
Auxiliary Mode(2) Contours (deg)
Calculate
Show Report

MSAM

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    - (202) 482-2608
    - edrocella@ntia.doc.gov
- Software issues
  - Sophie Zhao
    - (202) 482-4983
    - xzhao@ntia.doc.gov