30TH WORLD RADIOCOMMUNICATION SEMINAR

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Geneva, Switzerland

Propagation model tools using Rec. ITU-R P.1812 and P.1546

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www.itu.int/go/wrs-22
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Agenda

- Short presentation
  - Rec. ITU-R P.1812 and P.1546 propagation models
  - eTools calculations
  - Use cases
- Demonstration of propagation calculations in eTools

Comparison Rec. ITU-R P.1812 vs P.1546

Recommendation ITU-R P.1812-6
(09/2021)

A path-specific propagation prediction method for point-to-area terrestrial services in the frequency range 30 MHz to 6 000 MHz

Deterministic model

model all the physical phenomena which plays a role in VHF-UHF band

Path specific

Uses terrain profile (elevation above mean sea level).

- 30 MHz - 6 GHz
- 0.25 km - 3000 km
- 1% < time < 50%
- 1% < locations < 99%
- Rx and Tx hgt agl <= 3km

Recommendation ITU-R P.1546-6
(08/2019)

Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 4 000 MHz

Empirical model

based on extensive field measurements and statistical analysis

Path general

The effect of terrain only via:

- Effective antenna height
- Clearance Angle correction
- Tropospheric scattering correction

- 30 MHz - 4 GHz
- 1 km - 1000 km
- 1% < time < 50%
- 1% < locations < 99%
- Rx and Tx hgt agl <= 3km

Interference/coverage analyses!

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Rec. ITU-R P. 1546

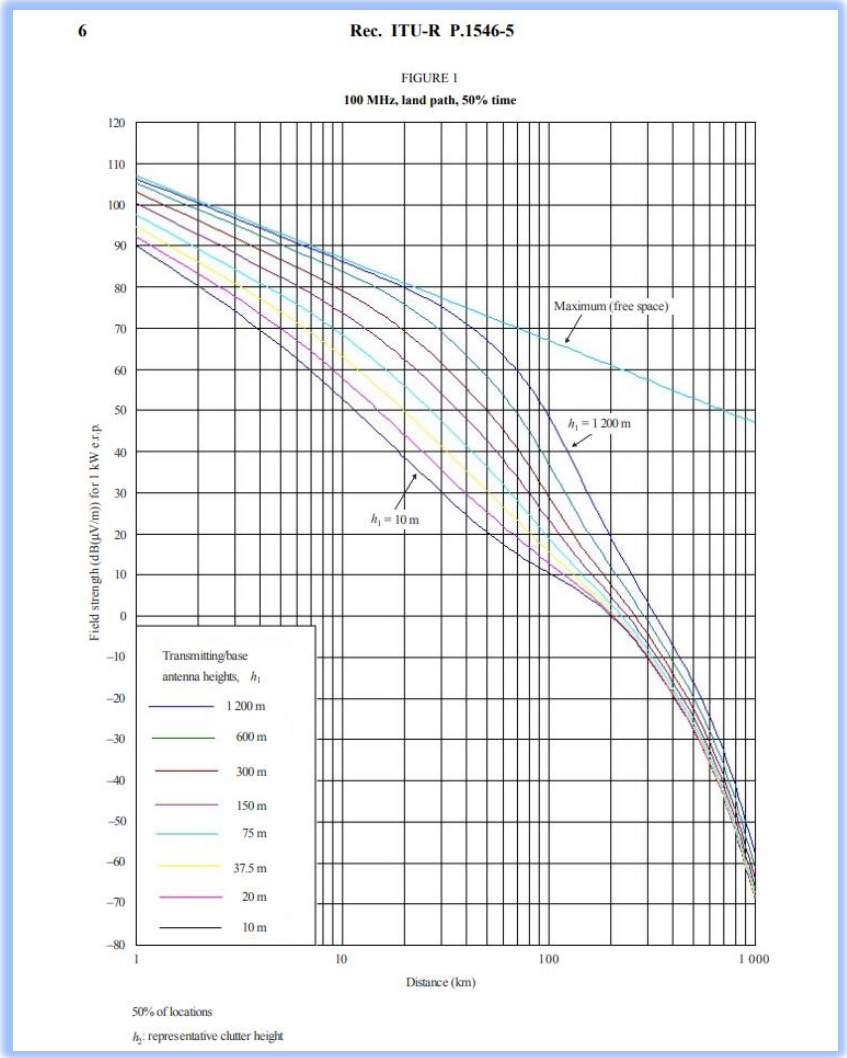
Field-strength curves as functions of *distance*, *antenna height, frequency and percentage time*

- Land, warm sea, cold sea
- 100, 600, 2000 MHz
- time percentage: 1,10,50

Method

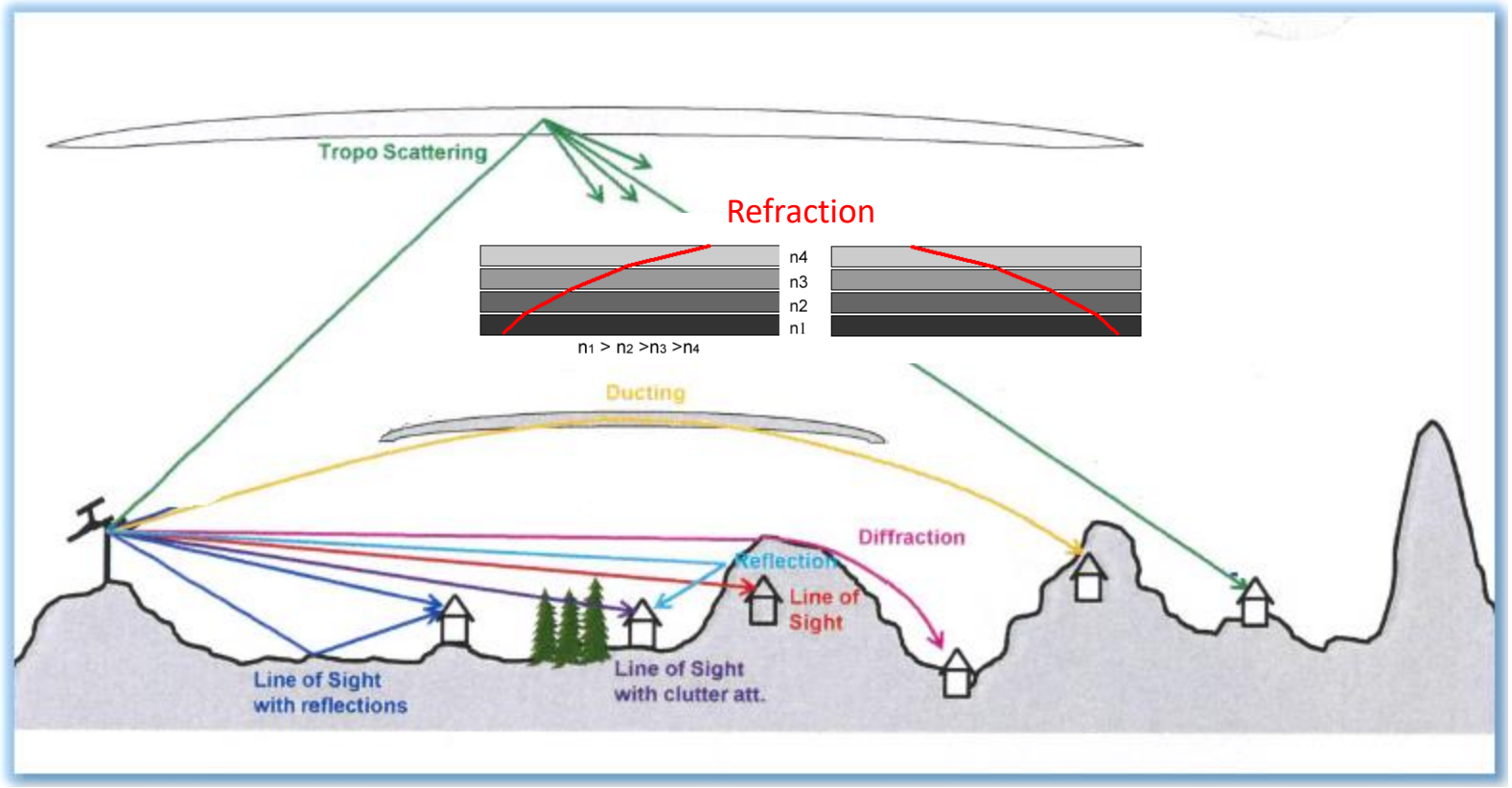
- interpolation/extrapolation
- mixed-path

Important correction for refractivity index!!



Rec. ITU-R P. 1812

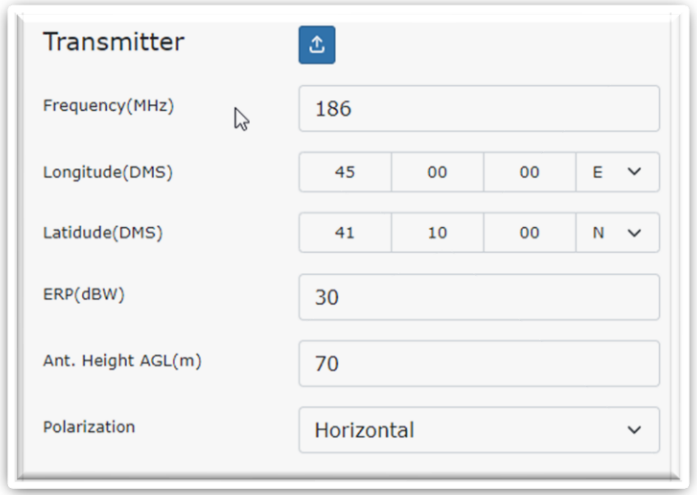
Propagation mechanisms in the VHF/UHF band

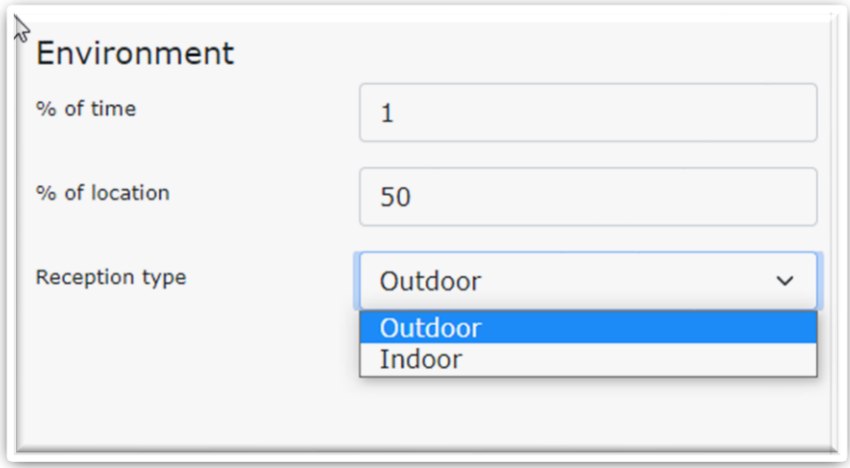


Adapted from LS Telcom Propagation training material

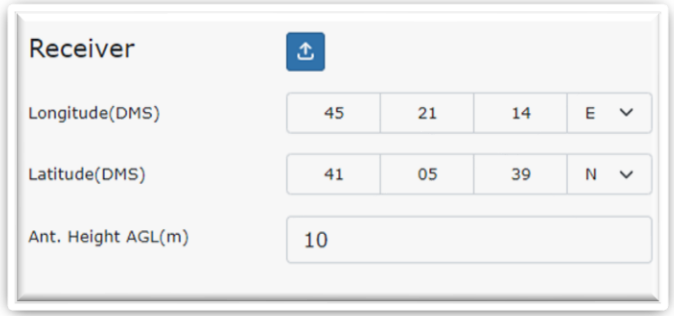
ePropagation: Input parameters

ITU-R P.1812

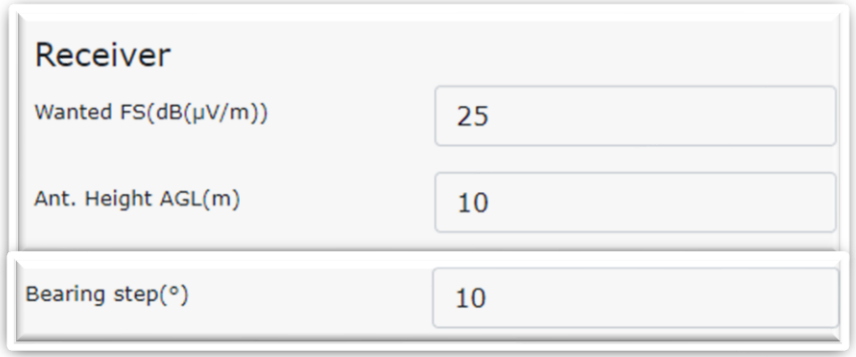




Point to Point



Point to Area



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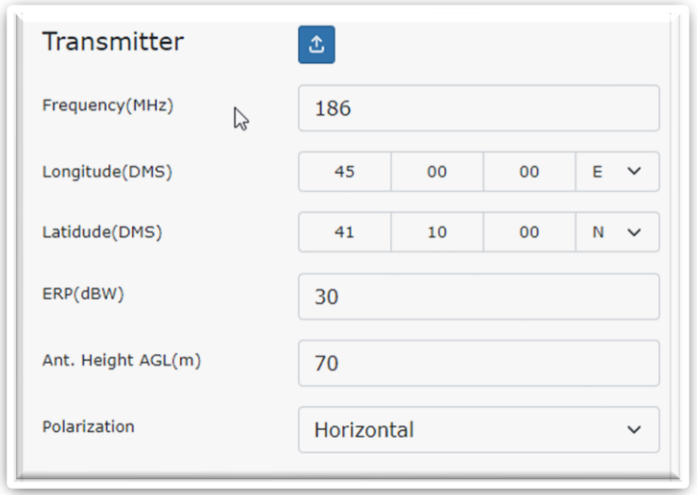
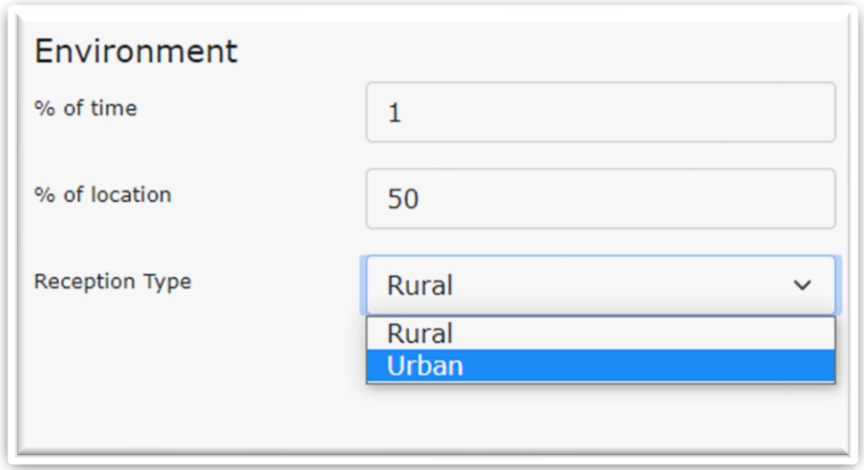
ePropagation: Input parameters

ITU-R P.1546





Point to Area

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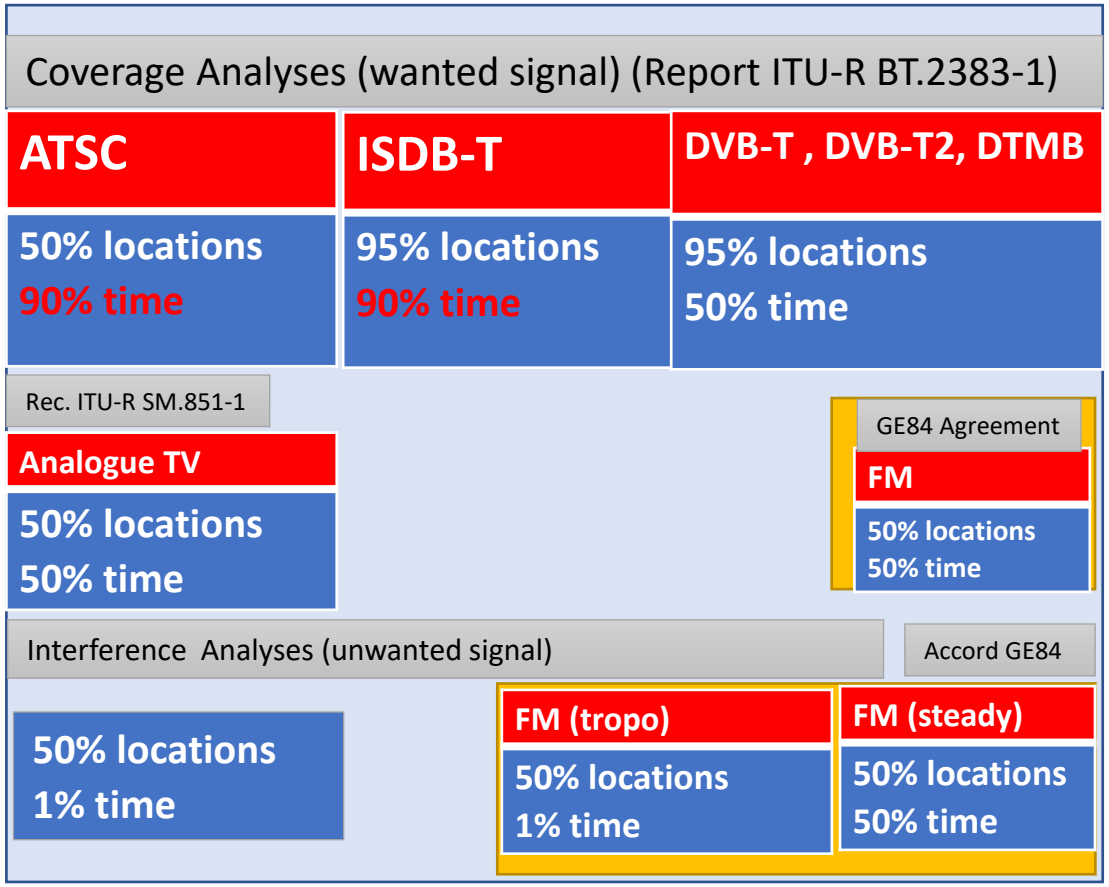
ePropagation: Input parameters

Percentage of time and location



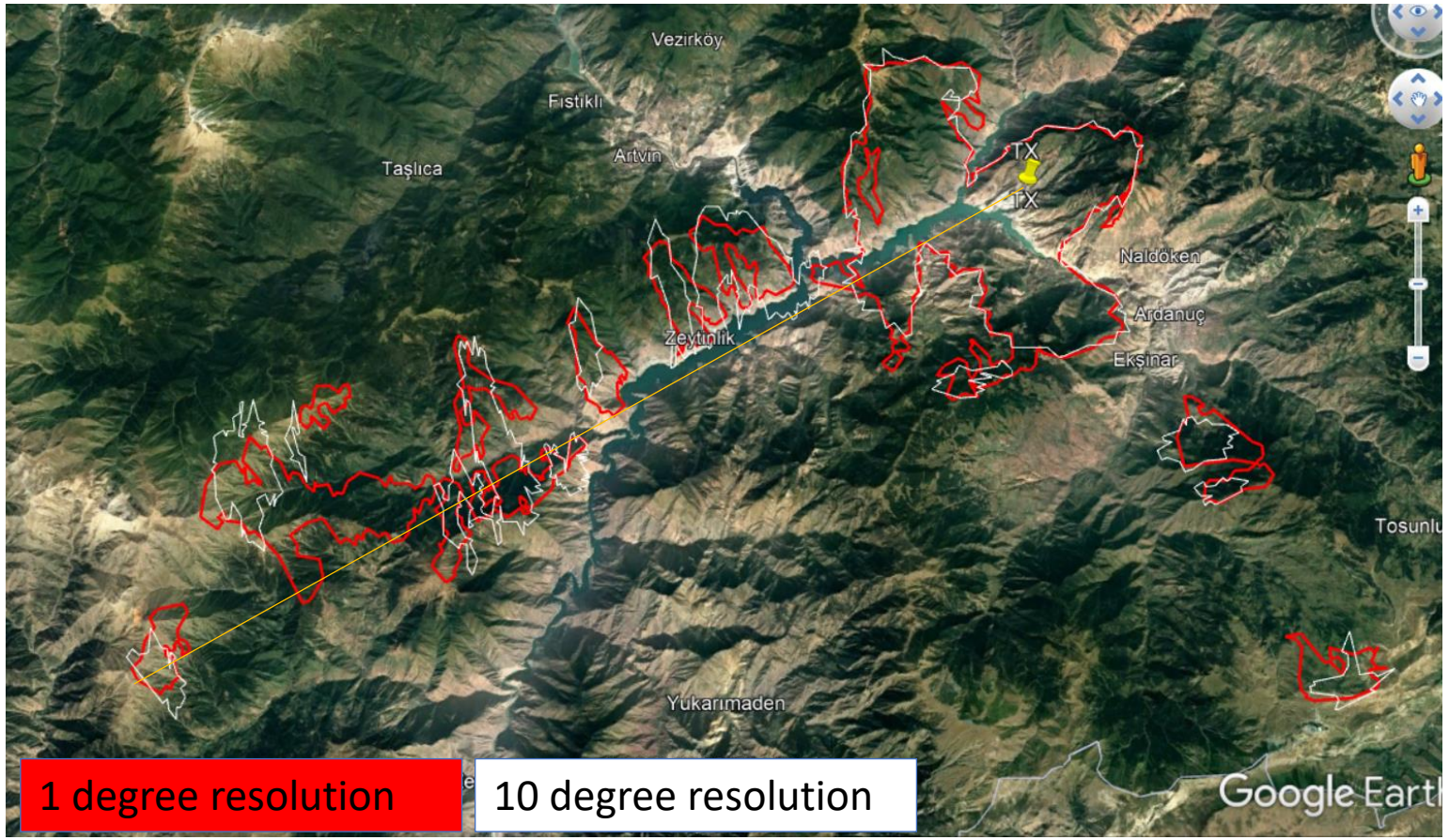
Report ITU-R BT.2383-1 (Note 19 on page 26) Provides formula for applicability of Rec. ITU-R P.1546 for 90% of time.

WP 3K Liaison Statement to the Director BR (March 2017). The 90% time formula is not generally applicable. It errs on the conservative/safe side for the desired signal in interference/compatibility analyses which compare desired-to-undesired signal ratios

ePropagation: rec. ITU-R P.1812 calculations

Point to Area

coverage analyses



1 degree resolution

10 degree resolution

Transmitter	
Frequency[MHz]	186
Longitude	E 042° 00' 00"
Latidude	N 41° 10' 00"
Ant. Height AGL(m)	70
ERP(dBW)	30
Polarization	Vertical

Receiver	
Ant. Height AGL(m)	10
Wanted FS(dB(μV/m))	54

Environment	
Bearing step(°)	10
% of time	50
% of location	50
Reception Type	Outdoor
DEM	SRTM3

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ePropagation: rec. ITU-R P.1812 calculations

Point to Point

Transmitter

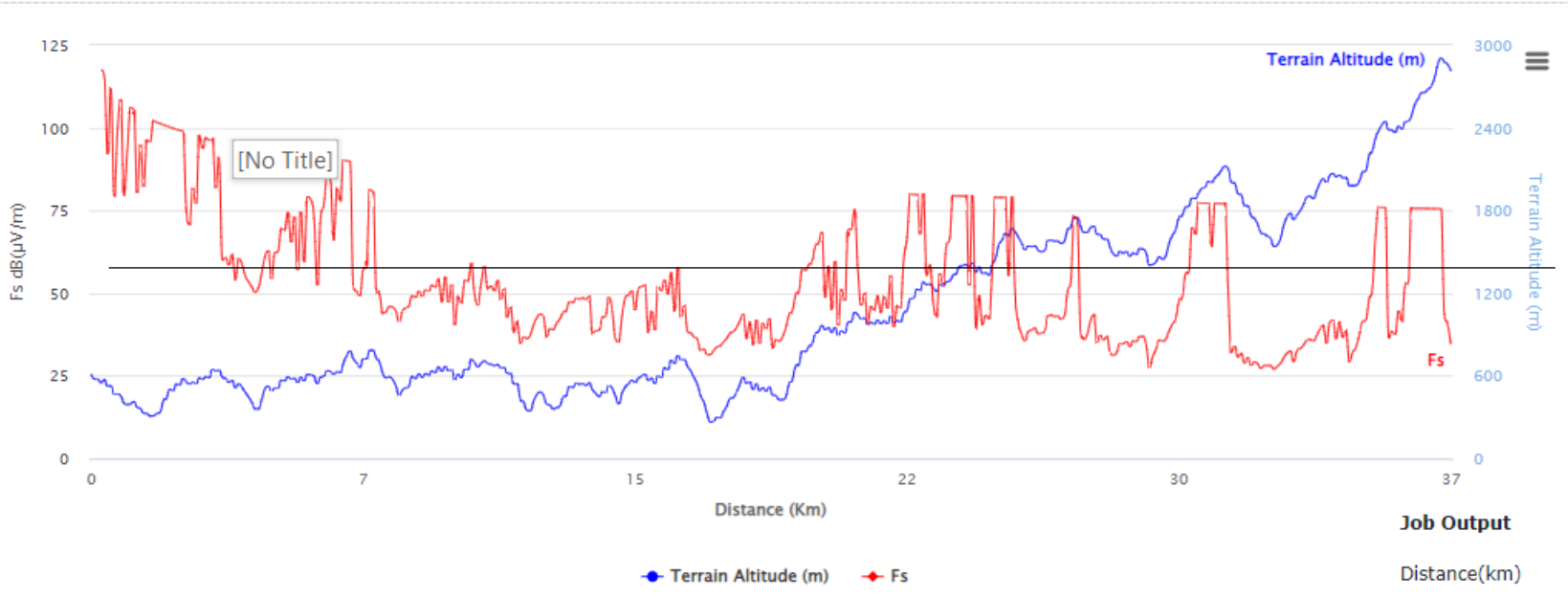
Frequency[MHz]	186
Longitude	E 042° 00' 00"
Latidude	N 41° 10' 00"
Ant. Height AGL(m)	70
ERP(dBW)	30
Polarization	Vertical

Receiver

Longitude	E 041° 36' 47"
Latidude	N 41° 00' 04"
Ant. Height AGL(m)	10
Wanted FS(dB(µV/m))	

Environment

% of time	50
% of location	50
Reception Type	Outdoor
DEM	SRTM3



Job Output

Distance(km)	37.4
Bearing(degree etn)	240.6
Effective Earth Radius (Km)	8422.16
Field Strength (dB µV/m)	34.57

Study FS variation on the path from TX to a RX point in the contours farthest from the TX in the P2A coverage analyses

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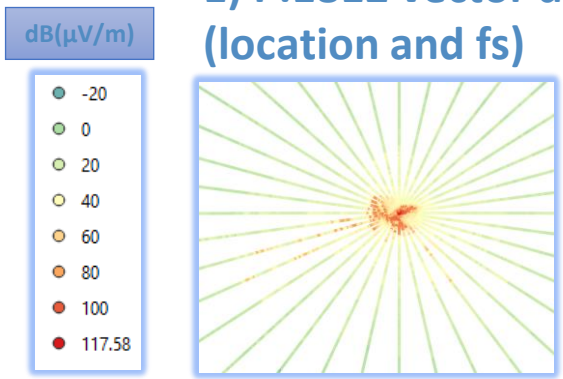
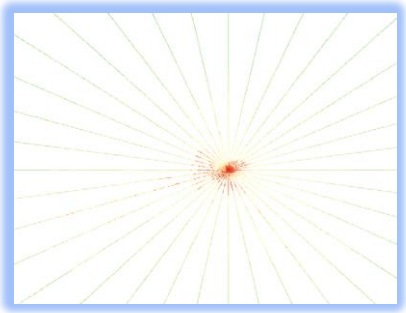
GIS Analyses
field strength contours

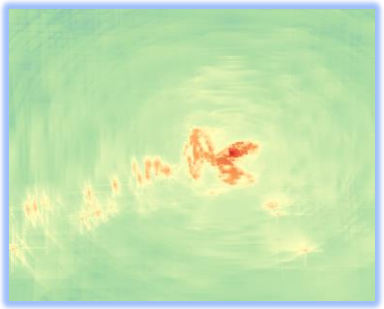
1) P.1812 vector data (location and fs)



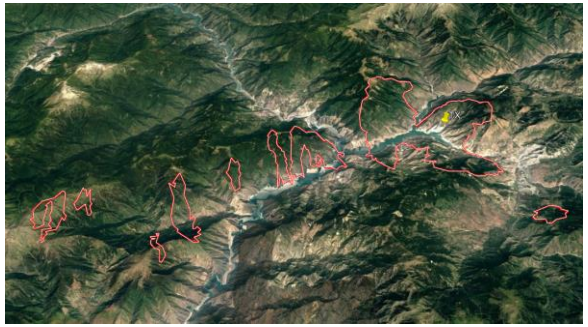
2) Convert to raster



3) Interpolate to fill voids



6) Convert to KMZ



5) Simplify geometry

4) Extract fs_wanted contour

OSGeo: GDAL/OGR open source libraries

ePropagation: rec. ITU-R P.1546 calculations

Point to Area

Coverage analyses

Transmitter

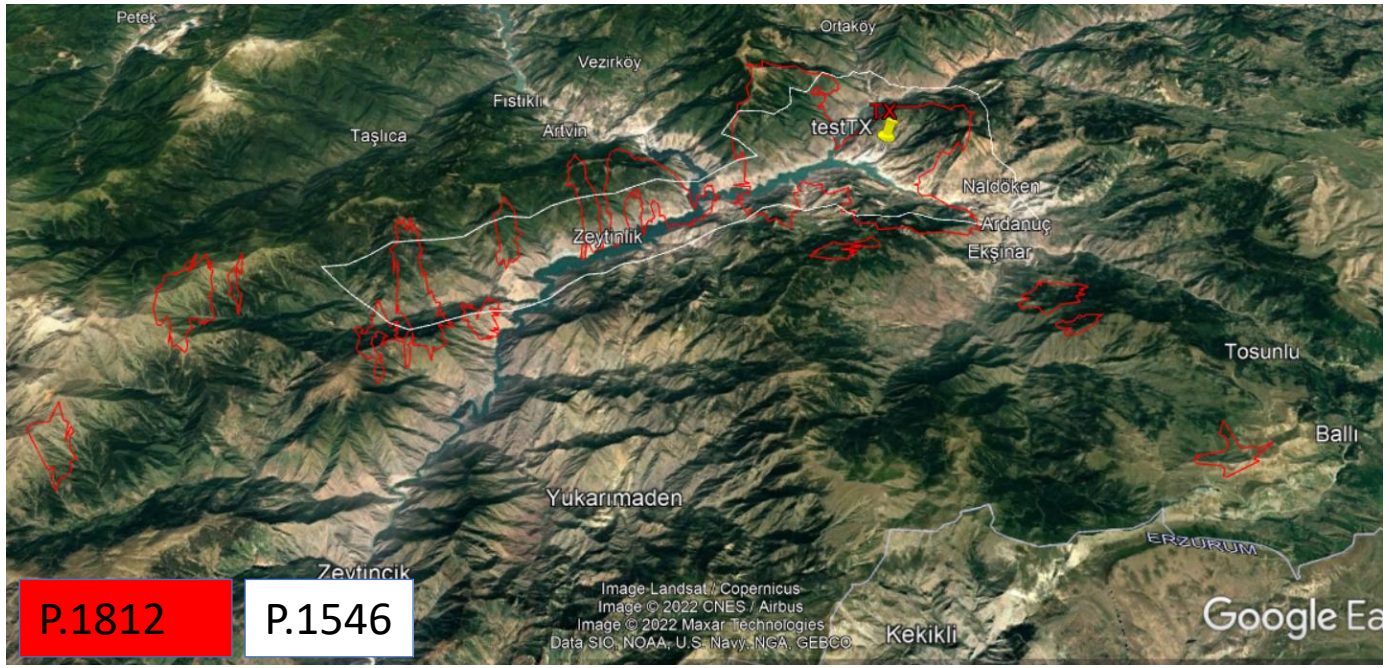
Frequency[MHz]	186
Longitude	E 042° 00' 00"
Latidude	N 41° 10' 00"
Ant. Height AGL(m)	70
ERP(dBW)	30

Receiver

Ant. Height AGL(m)	10
Wanted FS(dB(µV/m))	54

Environment

% of time	50
% of location	50
Reception Type	Rural



Good agreement with ITU-R P.1812 results in this case.
But results can be significantly different!

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ePropagation: ITU-R P.1546 calculations

Point to Area

Transmitter

Frequency[MHz]	186
Longitude	E 007° 44' 08"
Latidude	N 45° 02' 27"
Ant. Height AGL(m)	71
ERP(dBW)	30

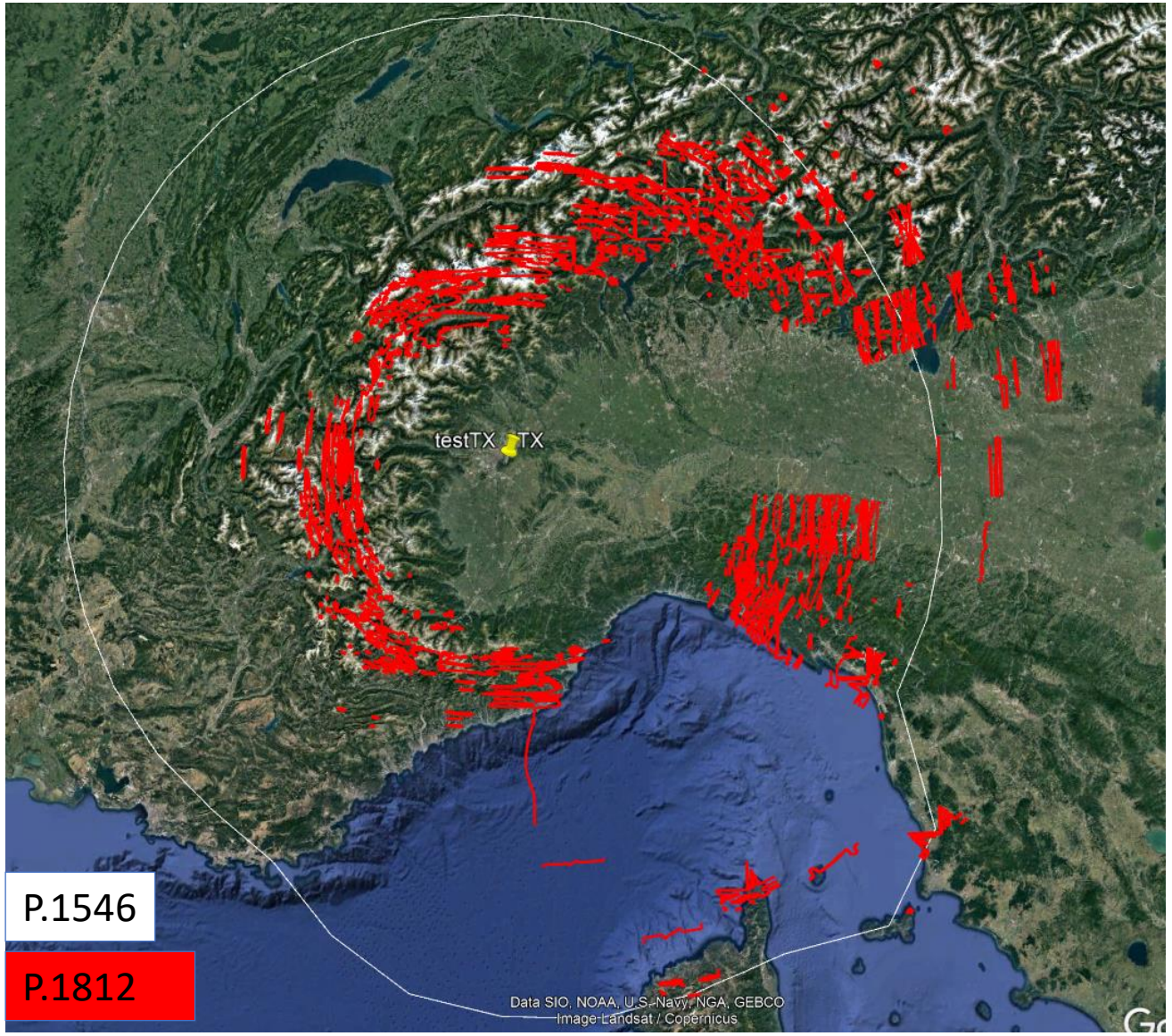
Receiver

Ant. Height AGL(m)	10
Wanted FS(dB(µV/m))	20

Environment

% of time	1
% of location	50
Reception Type	Rural

Interference analyses



P.1546

P.1812

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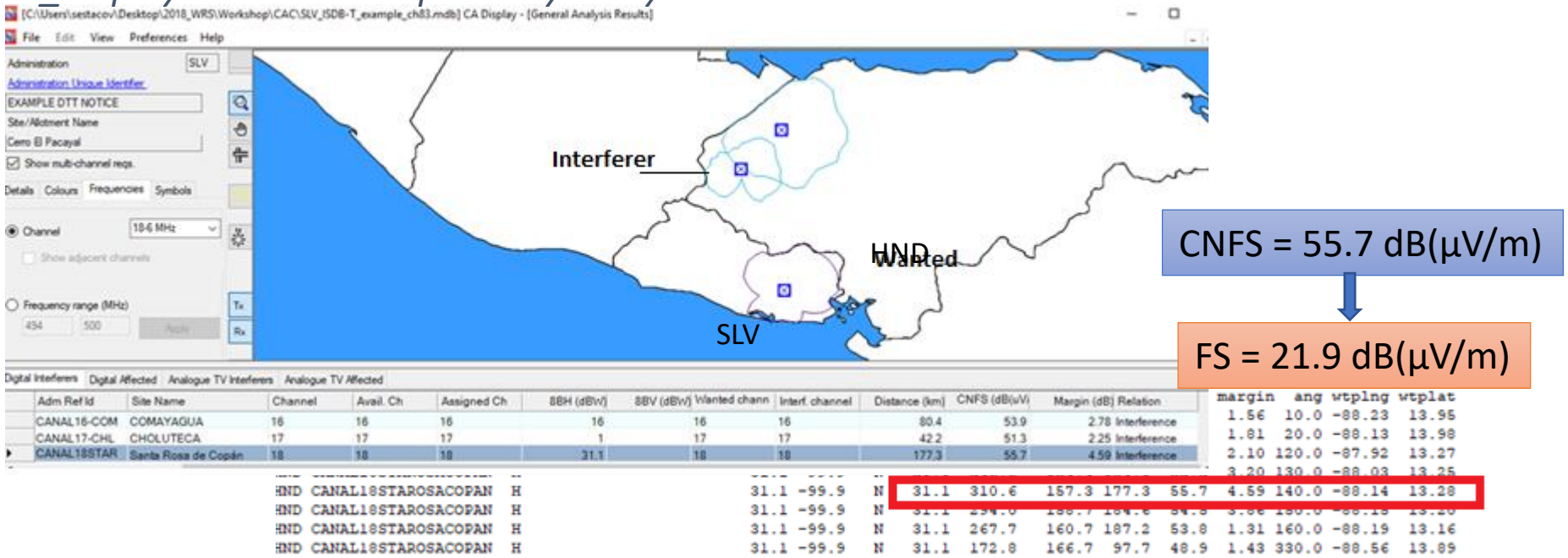
Use case: planning in Central America and Caribbean

eTools: CA_compat implements ITU-R P.1546:

- coverage analyses (wanted service area)
- interference analyses

Terrain information considered only via effective antenna height

CA_Display: visualize compatibility analyses results and run detailed calculations



Adm Ref Id	Site Name	Channel	Avail. Ch	Assigned Ch	8BH (dBW)	8BV (dBW)	Wanted chann	Interf. channel	Distance (km)	CNFS (dB(uV)	Margin (dB)	Relation
CANAL16-COM	COMAYAGUA	16	16	16	16	16	16		80.4	53.9	2.78	Interference
CANAL17-CHL	CHOLUTECA	17	17	17	1	17	17		42.2	51.3	2.25	Interference
CANAL18STAR	Santa Rosa de Copán	18	18	18	31.1	18	18		177.3	55.7	4.59	Interference

												margin	ang	wtplng	wtplat
HND	CANAL18STAROSACOPAN	H	31.1	-99.9	N	31.1	310.6	157.3	177.3	55.7	4.59	140.0	-88.14	13.28
HND	CANAL18STAROSACOPAN	H	31.1	-99.9	N	31.1	294.0	156.7	184.6	54.5	3.86	150.0	-88.15	13.20
HND	CANAL18STAROSACOPAN	H	31.1	-99.9	N	31.1	267.7	160.7	187.2	53.8	1.31	160.0	-88.19	13.16
HND	CANAL18STAROSACOPAN	H	31.1	-99.9	N	31.1	172.8	166.7	97.7	48.9	1.43	330.0	-88.56	13.89
												1.56	10.0	-88.23	13.95
												1.81	20.0	-88.13	13.98
												2.10	120.0	-87.92	13.27
												3.20	130.0	-88.03	13.25

Use case: planning in Central America and Caribbean

ePropagation: Rec. ITU-R P.1812 Point to Point field strength calculation (terrain data).

Transmitter

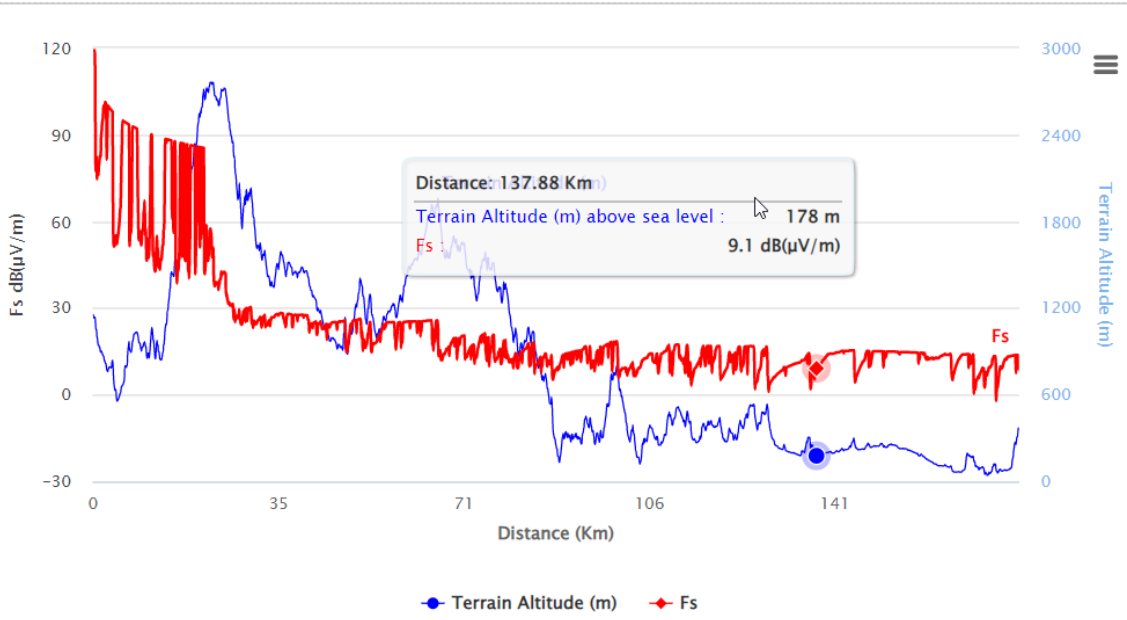
Frequency[MHz]	**497**
Longitude	**W 088° 46' 00"**
Latidude	**N 14° 45' 00"**
Ant. Height AGL(m)	**49**
ERP(dBW)	**31.1**
Polarization	**Horizontal**

Receiver

Longitude	**W 088° 08' 24"**
Latidude	**N 13° 16' 48"**
Ant. Height AGL(m)	**10**
Wanted FS(dB(µV/m))	

Environment

% of time	**1**
% of location	**50**
Reception Type	**Outdoor**
DEM	**SRTM3**



Job Output

Distance(km)	**176.2**
Bearing(degree etn)	**157.3**
Effective Earth Radius (Km)	**9905.3**
Field Strength (dB µV/m)	**8.83**

FS = 21.9 dB(µV/m) P.1546 no terrain (CA_Compat)

FS = 8.83 (13.7) dB(µV/m) P.1812 terrain

This value would bring the margin to an acceptable level!!!

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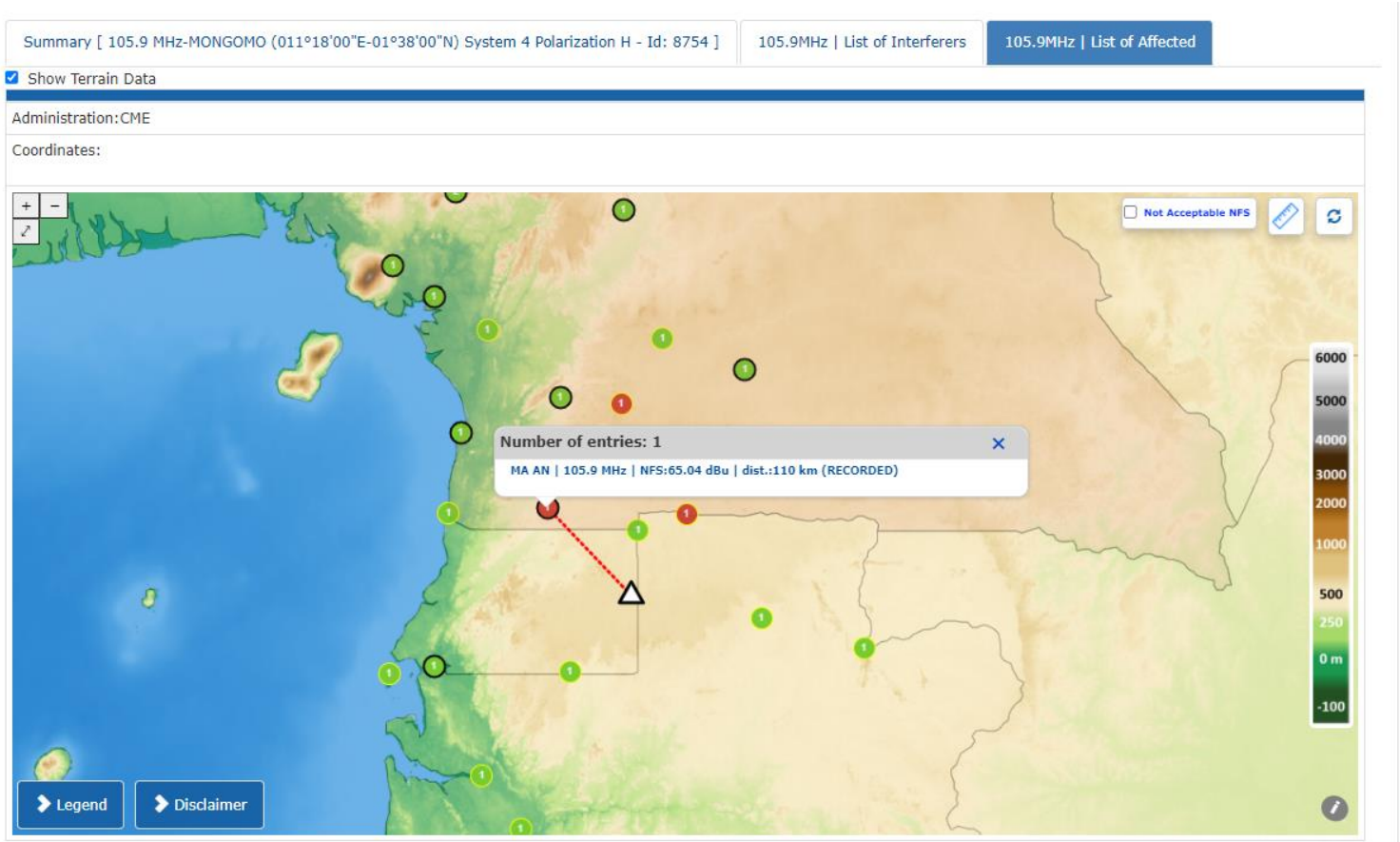
Use case: GE84 planning activities

GE84Opt
implements GE84 propagation curves (interference analyses).

Terrain information considered only via effective antenna height



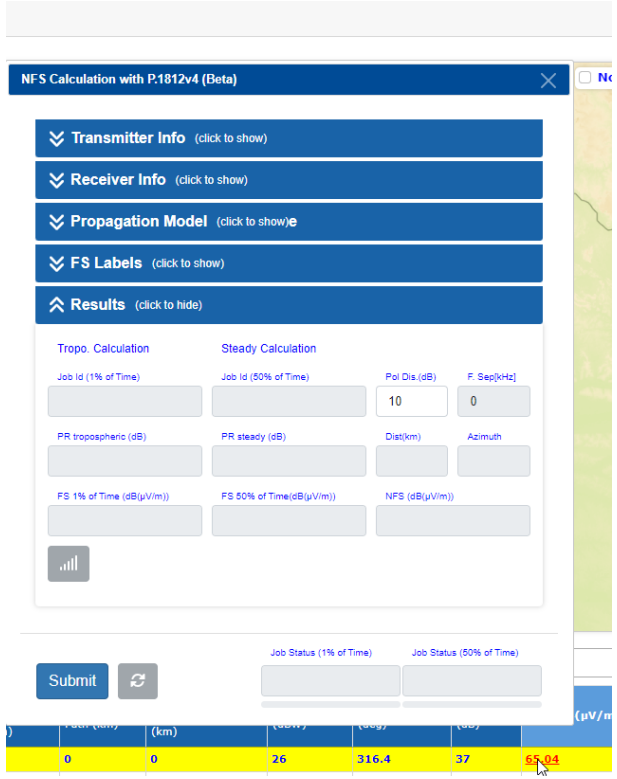
Assign ID	Adm	Intent	Stn Cls	Assigned Frequency (MHz)	Polar	Site Name	Total Distance (km)	Cold Sea Path (km)	Warm Sea Path (km)	Super refractivity Path (km)	ERP (dBW)	Azimuth (deg)	Protection Ratio (dB)	NFS (dB(µV/m))	Coord.
117092465	CME	RECORDED	BC	105.9	V	MA AN	110	0	0	0	26	316.4	37	65.04	---

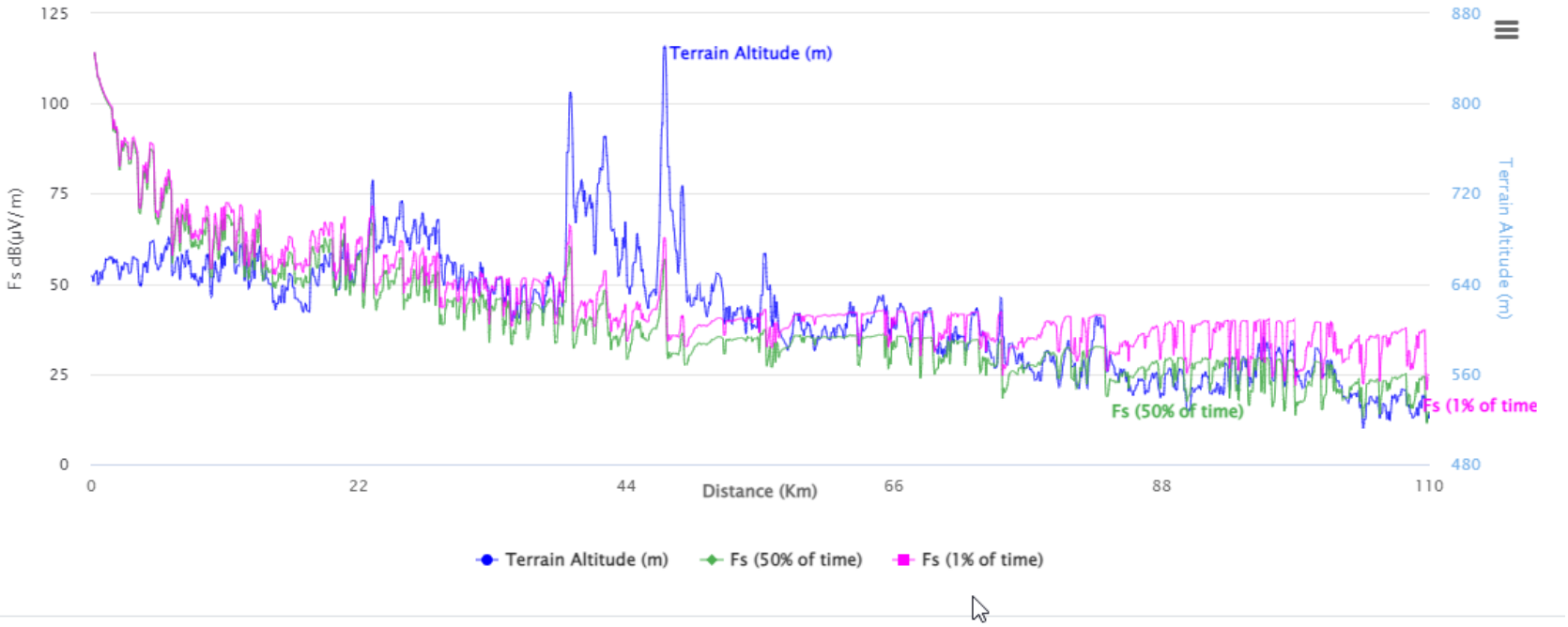
Co-channel PR:
Tropo: 37 dB
Steady: 45 dB

$FS(1\%time,50\%loc)_{GE84\ curves}$ = NFS – PR + Pol Discr =65.04 – 37 + 10= 38.04 dB(µV/m)

Use case: GE84 planning activities

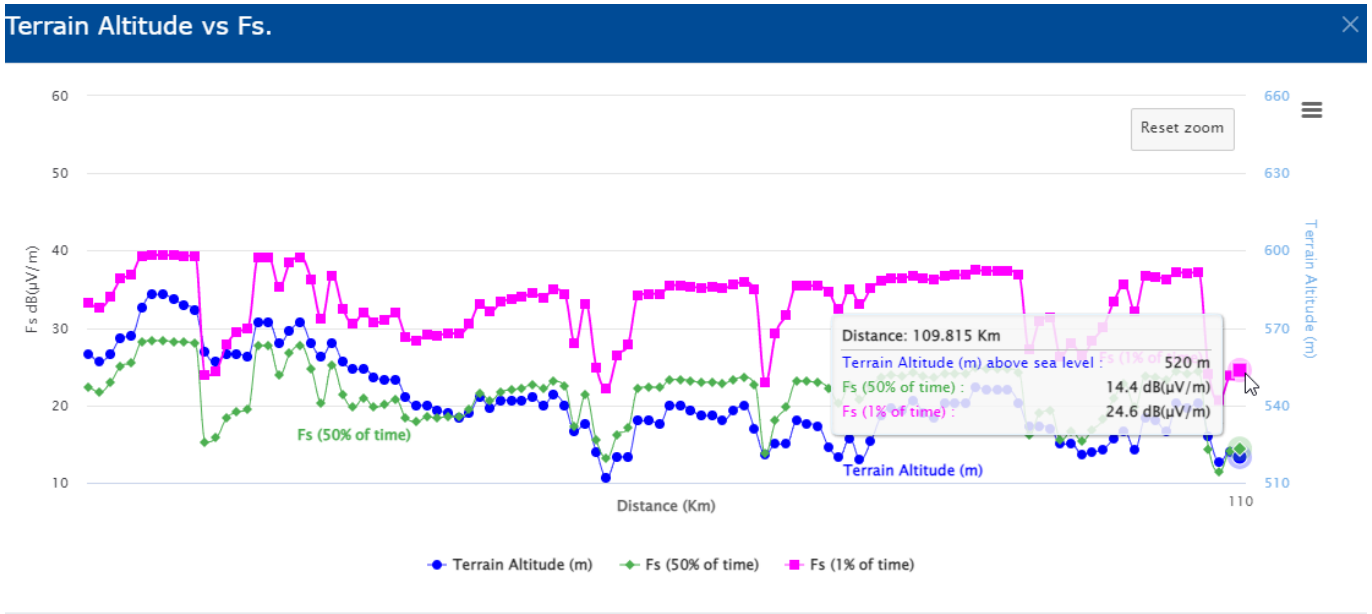
GE84Opt allows to calculate on the fly Point to Point field strength calculations (terrain data) using Rec. ITU-R P.1812





Use case: GE84 planning activities

Interpretation of results using field strength calculations using Rec. ITU-R P.1812 and comparison with GE84Opt (no terrain)



Tropo Interference

NFS = FS(1%time,50%loc) + PR - Pol Discr =24.6 + 37 - 10= 51.6 dB(µV/m)

Steady Interference

NFS = FS(1%time,50%loc) + PR - Pol Discr =14.4 + 45 - 10= 49.4 dB(µV/m)

The consideration of terrain data brings the interference to an acceptable level!!!

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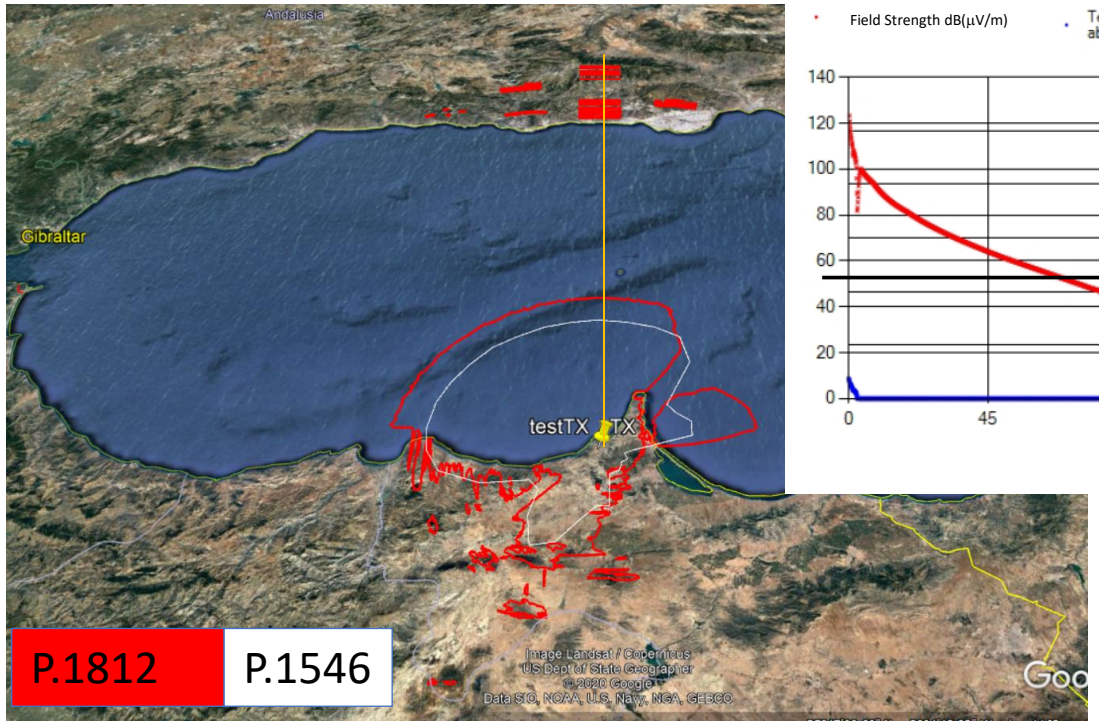
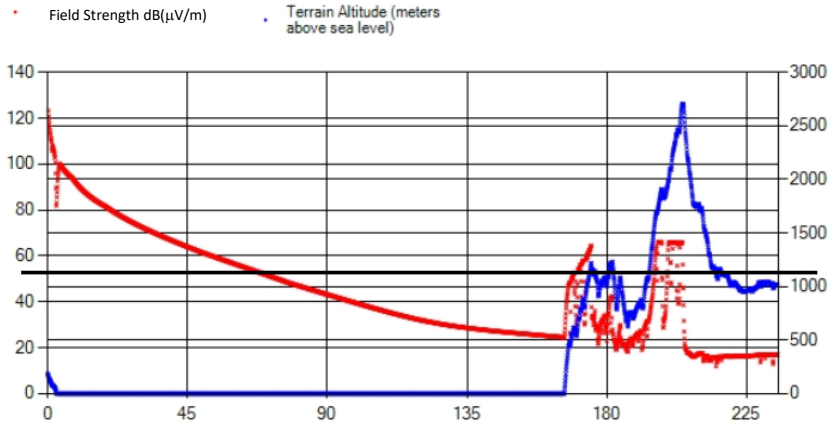
Use case: FM coverage analyses

AZAANEN: P1812P2A Wanted FS = 54 dB(μV/m)





ITU-R P.1812, P.1546 and usages of terrain data

ePropagation

SRTM3 (90m) [56 S : 60 N]

ITU-R P.1812

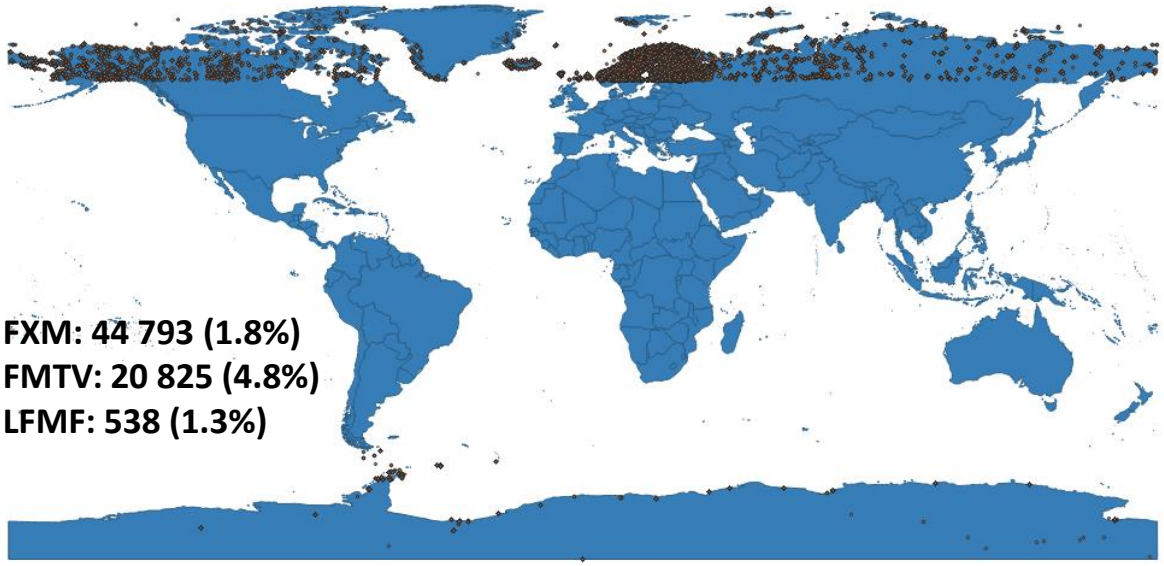
ITU-R P.1546 also can be currently run only within [56 S : 60 N] as it uses SRTM3 for the generation of effective antenna heights.

Currently BETA testing

SRTM1 (30m)

ASTER-V3 (30m) [83 S : 83 N]

Assignments outside SRTM validity range



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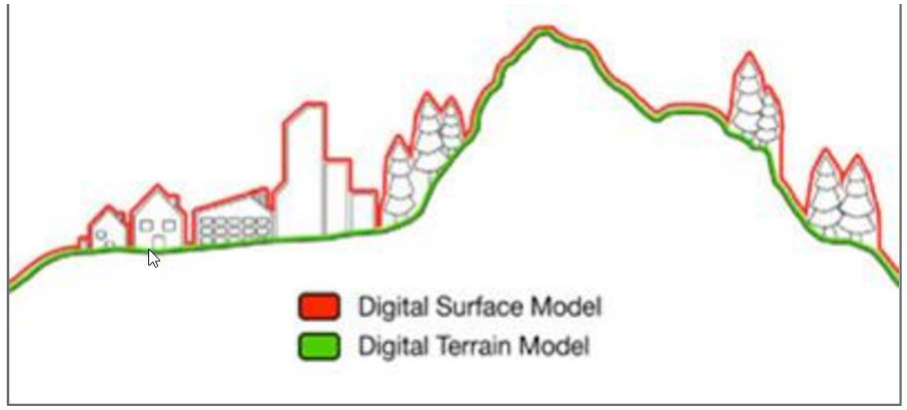
ITU-R P.1812, P.1546 and usages of terrain data



DSM: SRTM, ASTER

DTM: affordable worldwide DTM not available

ITU-R WP3M: Performance evaluation of Recommendation ITU-R P.1812 using SRTM data

Avoid additional consideration of representative clutter heights (Table 2) if SRTM(1/3)/ASTER are used.

TABLE 2

Default representative clutter height values

Clutter category	Representative clutter height (m)
	Add to profile of equation (1c) for $i = 2$ to $n - 1$
Water/sea	0
Open/rural	0
Suburban	10
Urban/trees/forest	15
Dense urban	20

P1812 and usages of terrain data

Transmitter

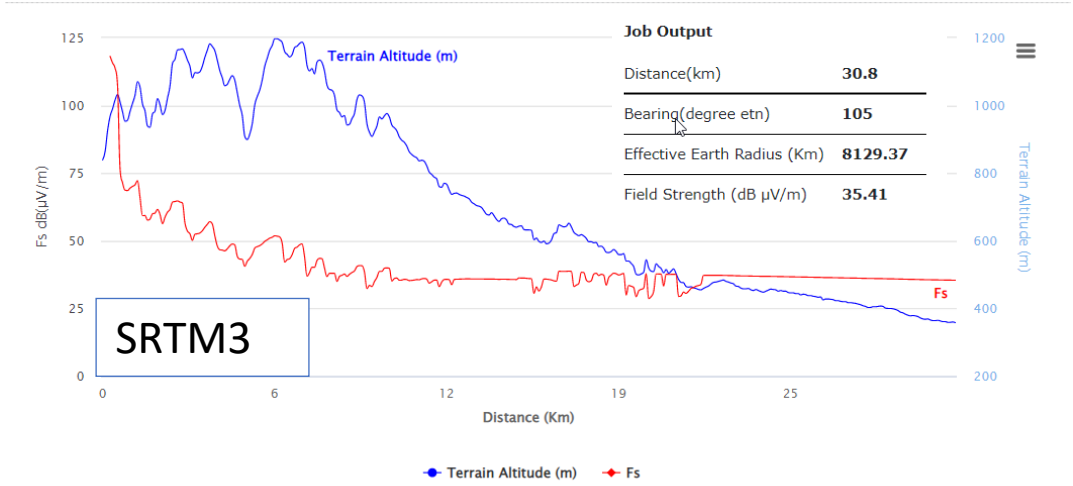
Frequency[MHz]	186
Longitude	E 045° 00' 00"
Latidude	N 41° 10' 00"
Ant. Height AGL(m)	70
ERP(dBW)	30
Polarization	Vertical

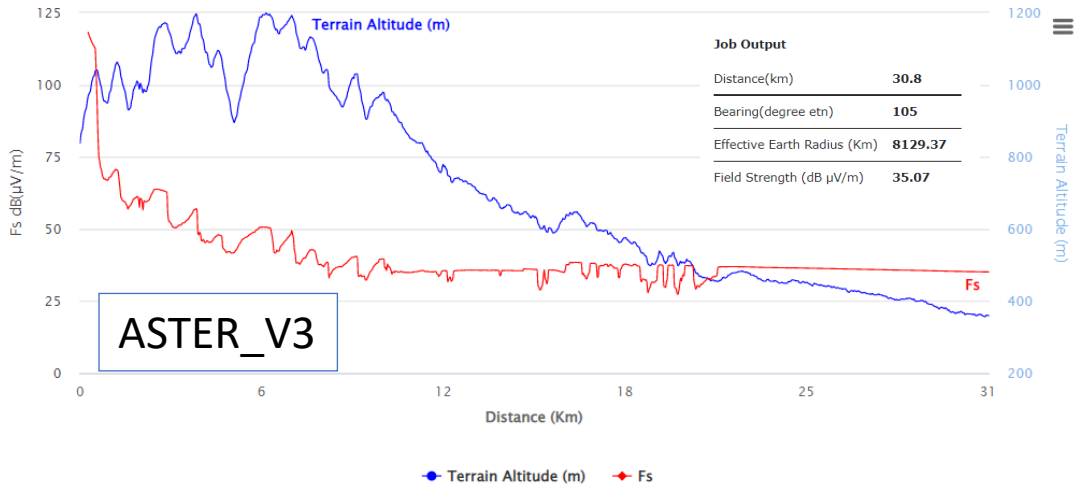
Receiver

Longitude	E 045° 21' 14"
Latidude	N 41° 05' 39"
Ant. Height AGL(m)	10
Wanted FS(dB(μV/m))	

Environment

% of time	1
% of location	50
Reception Type	Outdoor





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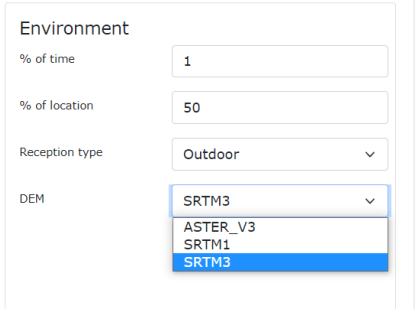
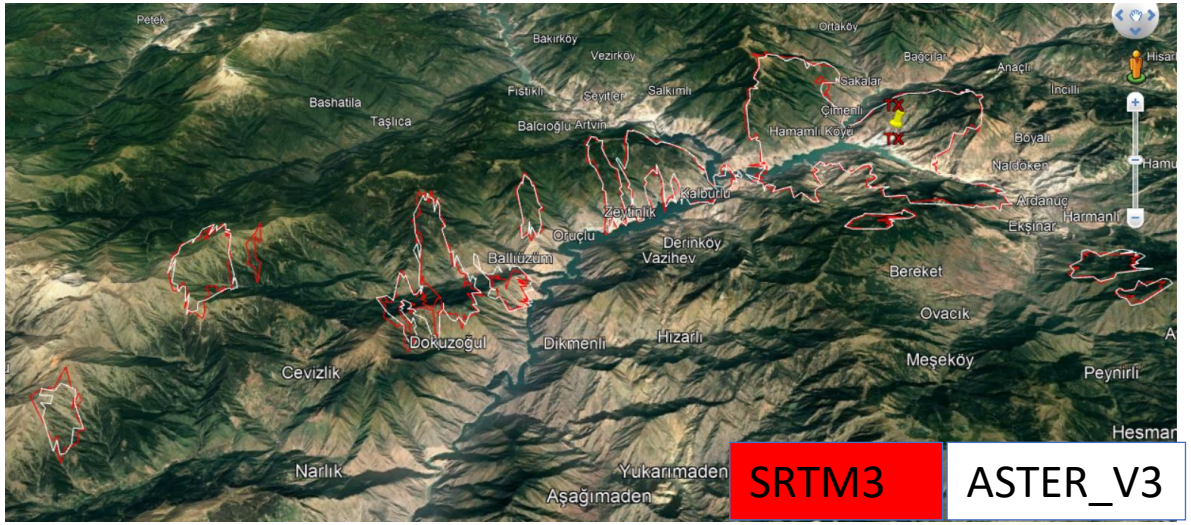
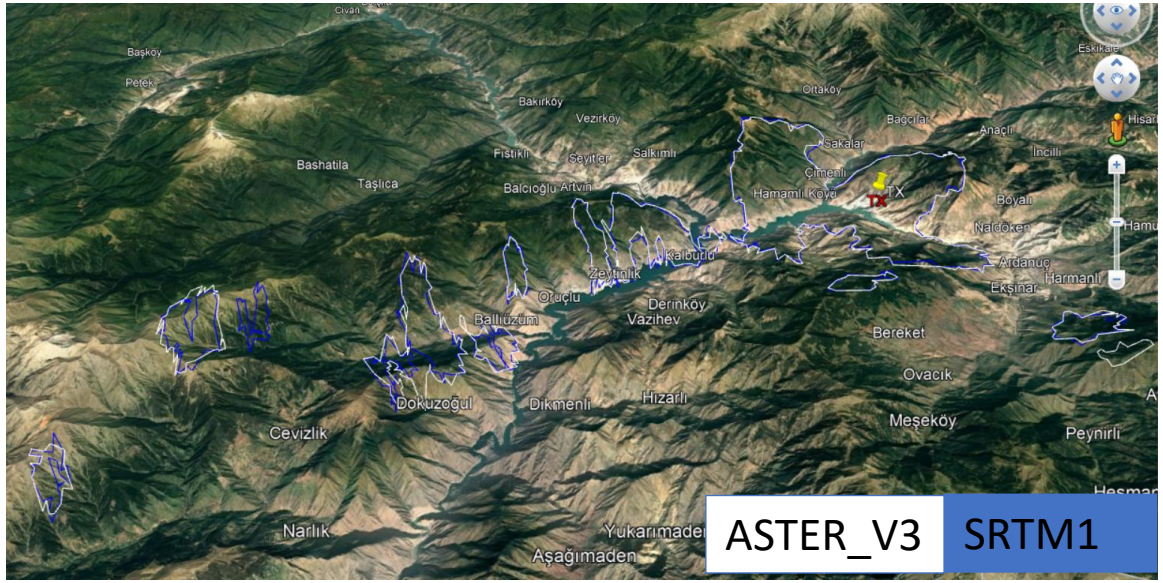
P1812 and usages of terrain data







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P1812 and usages of terrain data

ASTER-V3 (30m) [83 S : 83 N]

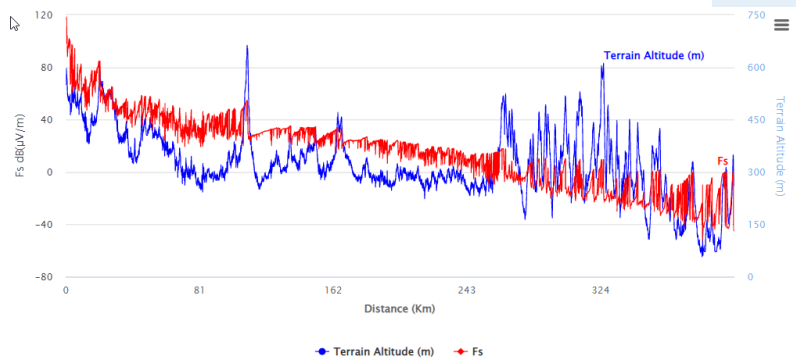
Transmitter	
Frequency[MHz]	186
Longitude	E 021° 06' 47"
Latidude	N 68° 15' 52"
Ant. Height AGL(m)	70
ERP(dBW)	30
Polarization	Horizontal

Receiver	
Longitude	E 030° 55' 47"
Latidude	N 68° 15' 20"
Ant. Height AGL(m)	10
Wanted FS(dB(μV/m))	

Environment	
% of time	1
% of location	50
Reception Type	Outdoor
DEM	ASTER_V3

Job Output

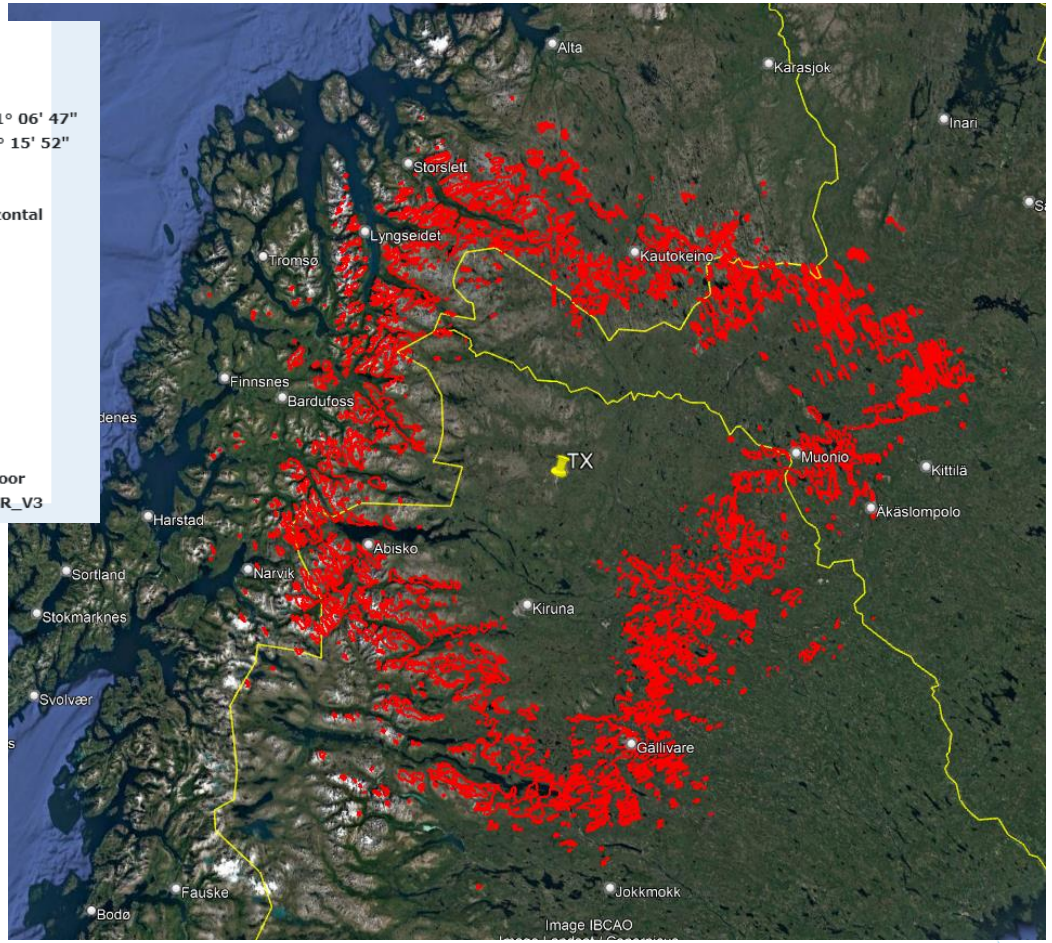
Distance(km)	405.5
Bearing(degree etn)	85.6
Effective Earth Radius (Km)	8377.14
Field Strength (dB μV/m)	-45.12



Transmitter	
Frequency[MHz]	186
Longitude	E 021° 06' 47"
Latidude	N 68° 15' 52"
Ant. Height AGL(m)	70
ERP(dBW)	30
Polarization	Horizontal

Receiver	
Ant. Height AGL(m)	10
Wanted FS(dB(μV/m))	25

Environment	
Bearing step(°)	1
% of time	1
% of location	50
Reception Type	Outdoor
DEM	ASTER_V3



Thank you!

ITU – Radiocommunication Bureau

Questions to brbcd@itu.int