29TH WORLD RADIOCOMMUNICATION SEMINAR

30 November - 11 December 2020

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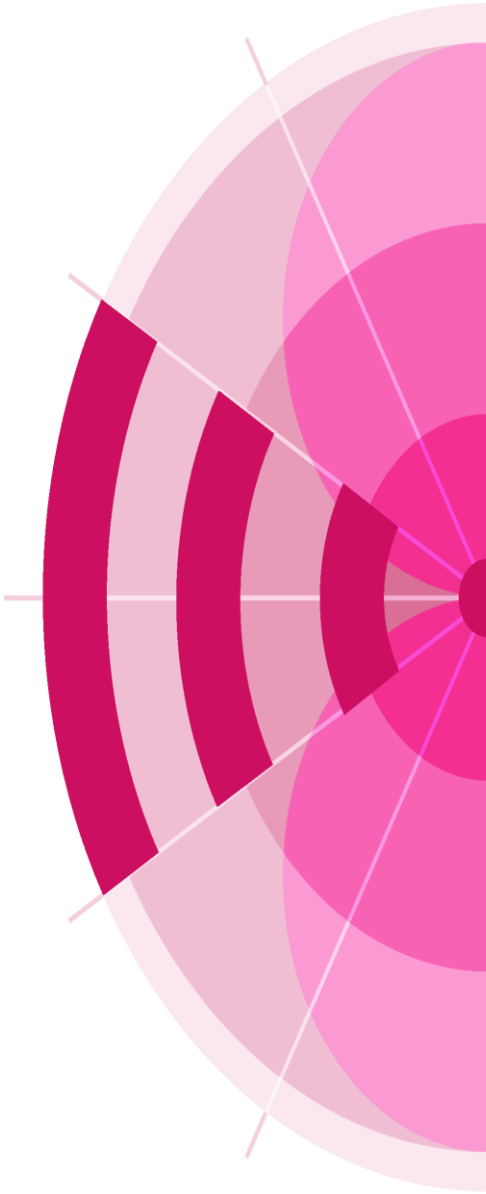
Propagation model tools using Rec. ITU-R P.1812 and P.1546

By Andrea Manara
Broadcasting Service Division



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Agenda

- Short presentation
  - Rec. ITU-R P.1812 and P.1546 propagation models
  - eTools calculations (new P.1812 fs contours!)
  - Use cases
- Demonstration of propagation calculations in eTools

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

Recommendation ITU-R P.1812-5
(08/2019)

A path-specific propagation prediction method for point-to-area terrestrial services in the VHF and UHF bands

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 - 3 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

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Interference/coverage analyses!

Rec. ITU-R P. 1546

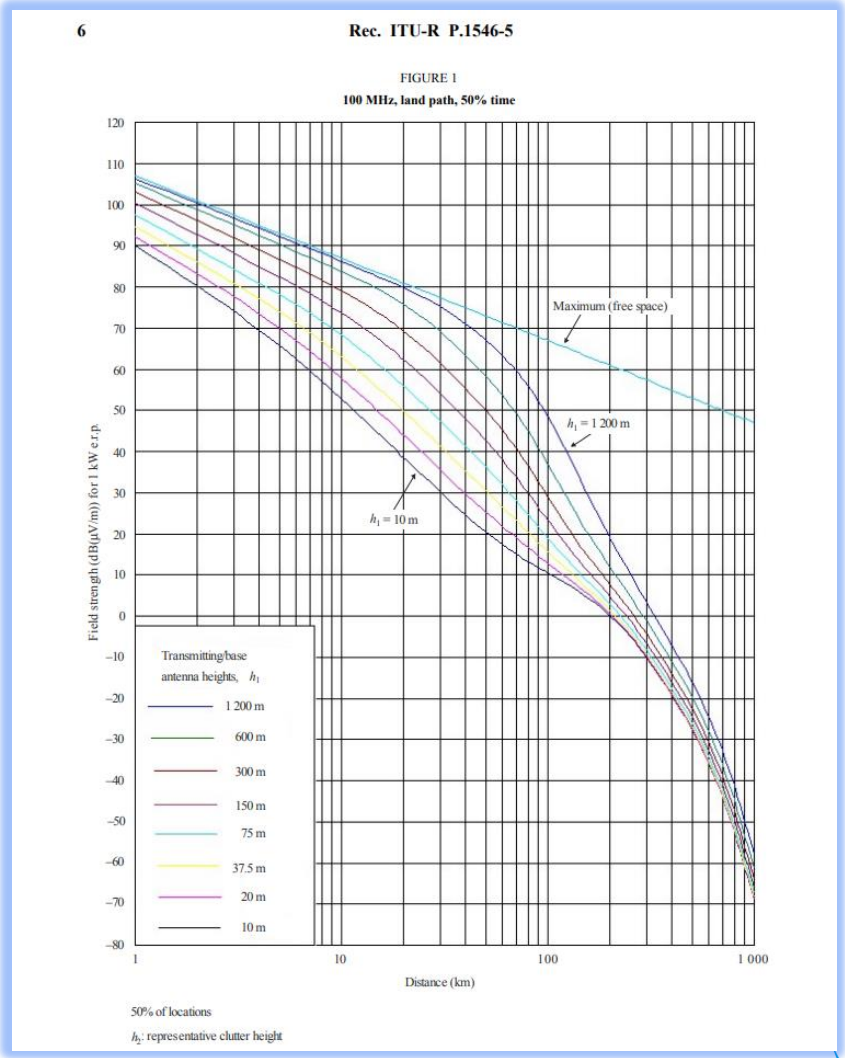
Field-strength curves as functions of *distance*, *antenna height, frequency and percentage time*

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

Method

- interpolation/extrapolation
- mixed-path

Important correction for refractivity index!!



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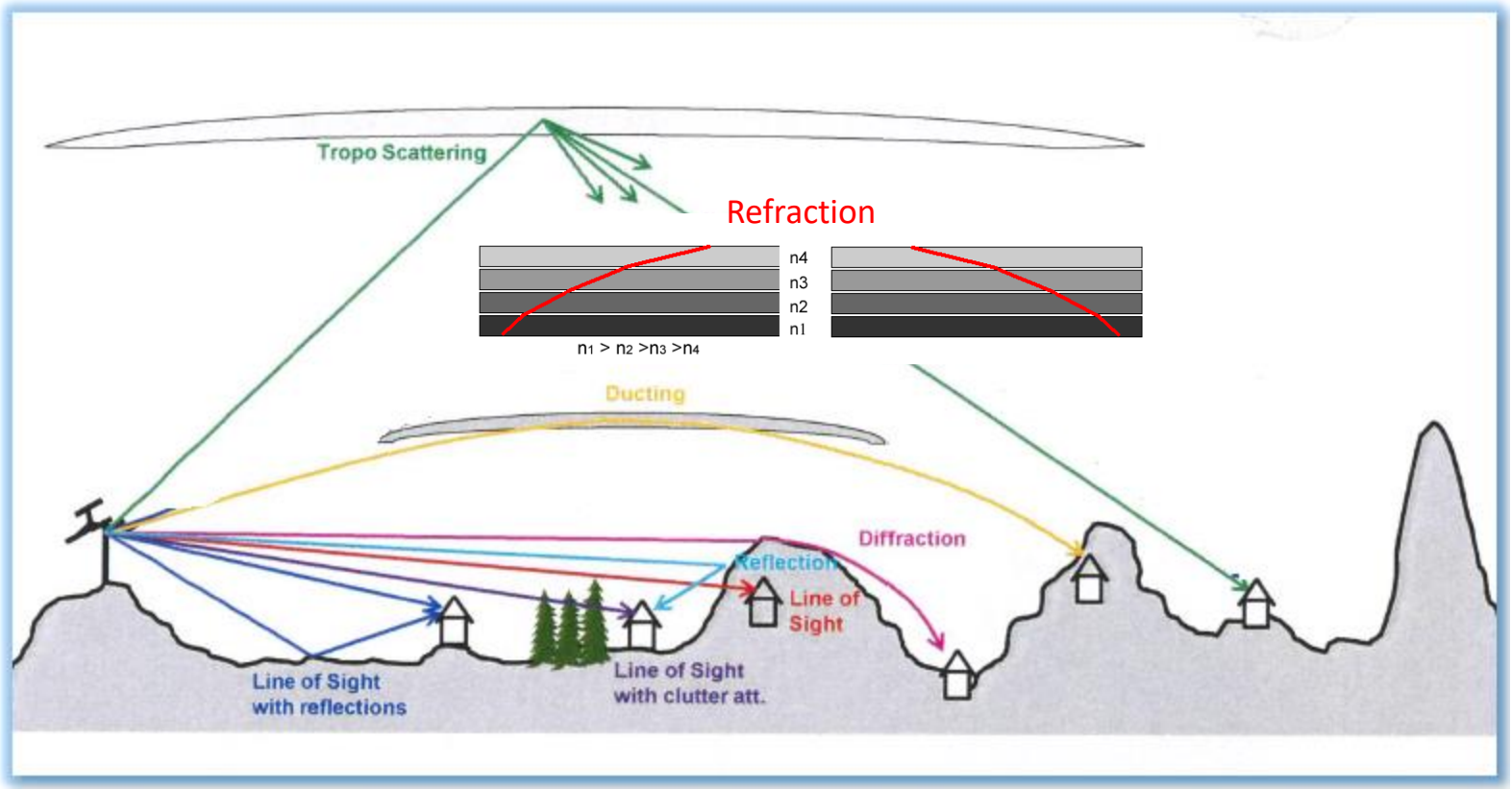
Rec. ITU-R P. 1812

Propagation mechanisms in the VHF/UHF band



Adapted from LS Telecom Propagation training material

eTools: Input parameters

ITU-R P.1812

Tx (long)	450000	Tx (lat)	411000		
Tx hgt agl(m)	70	Rx hgt agl(m)	10	Reception type: Outdoor	Polarization: Vertical
Frequency(MHz)	186	Erp(dBW)	10	Tx Clutter Type: Water/sea	Rx Clutter Type: Water/sea
% of time	1	% of location	50	Use Tx clutter height (m)	Use Rx clutter height (m)

Point to Point

Point to Area

Rx (long)	452114	Rx (lat)	410539
Wanted FS (dB(μV/m))	25	Bearing step (degrees EtN)	10

ITU-R P.1546

Point to Area

Tx (long)	0074408	Tx (lat)	450227	Environment type: Rural	
Tx hgt agl(m)	70	Rx hgt agl(m)	10	Wanted FS (dB(μV/m))	20
Frequency(MHz)	186	Erp(dBW)	30		
% of time	1	% of location	50		

Environment Type

Rural

Urban

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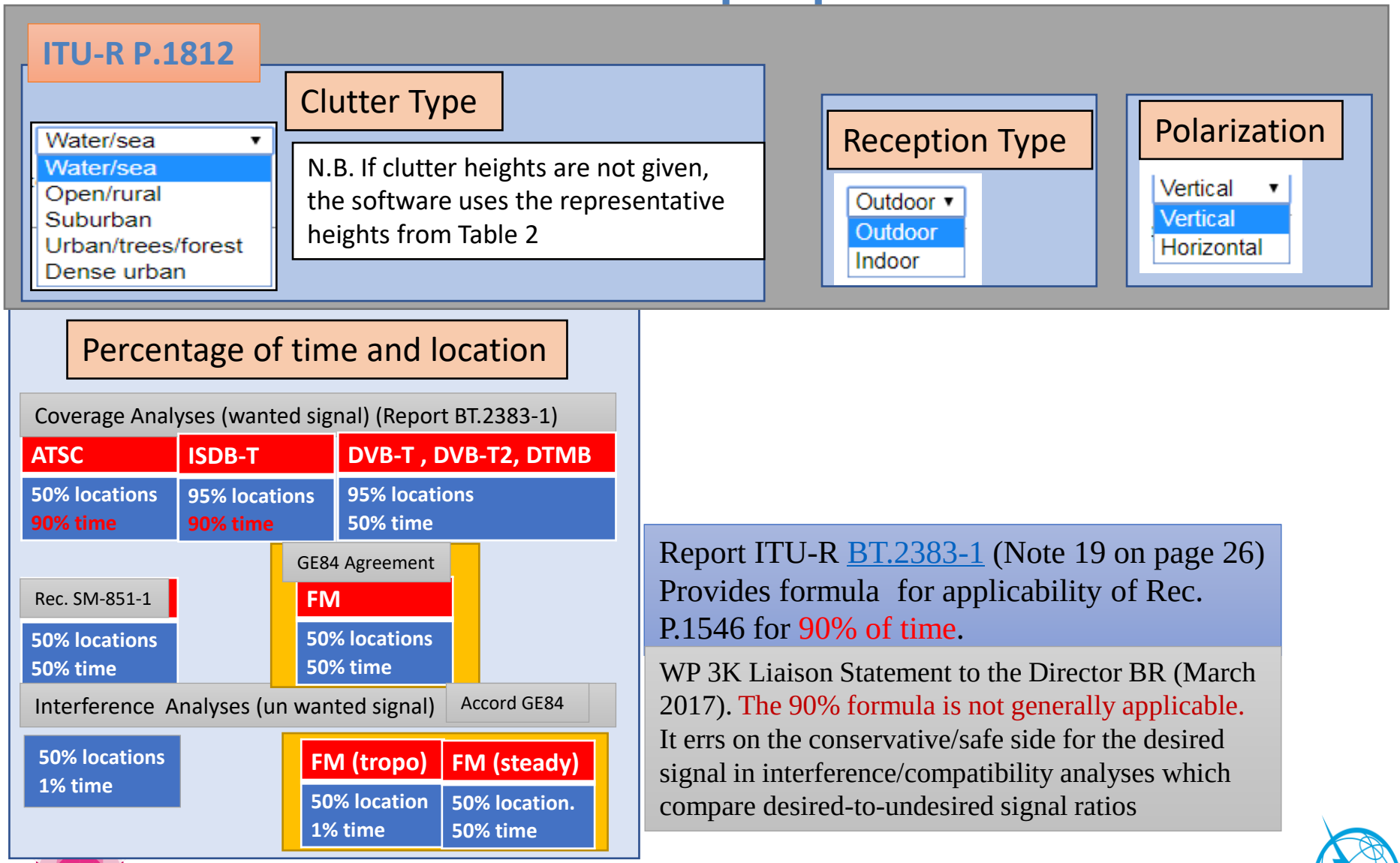
eTools: Input parameters



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

WP 3K Liaison Statement to the Director BR (March 2017). The 90% 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

eTools: rec. ITU-R P.1812 calculations

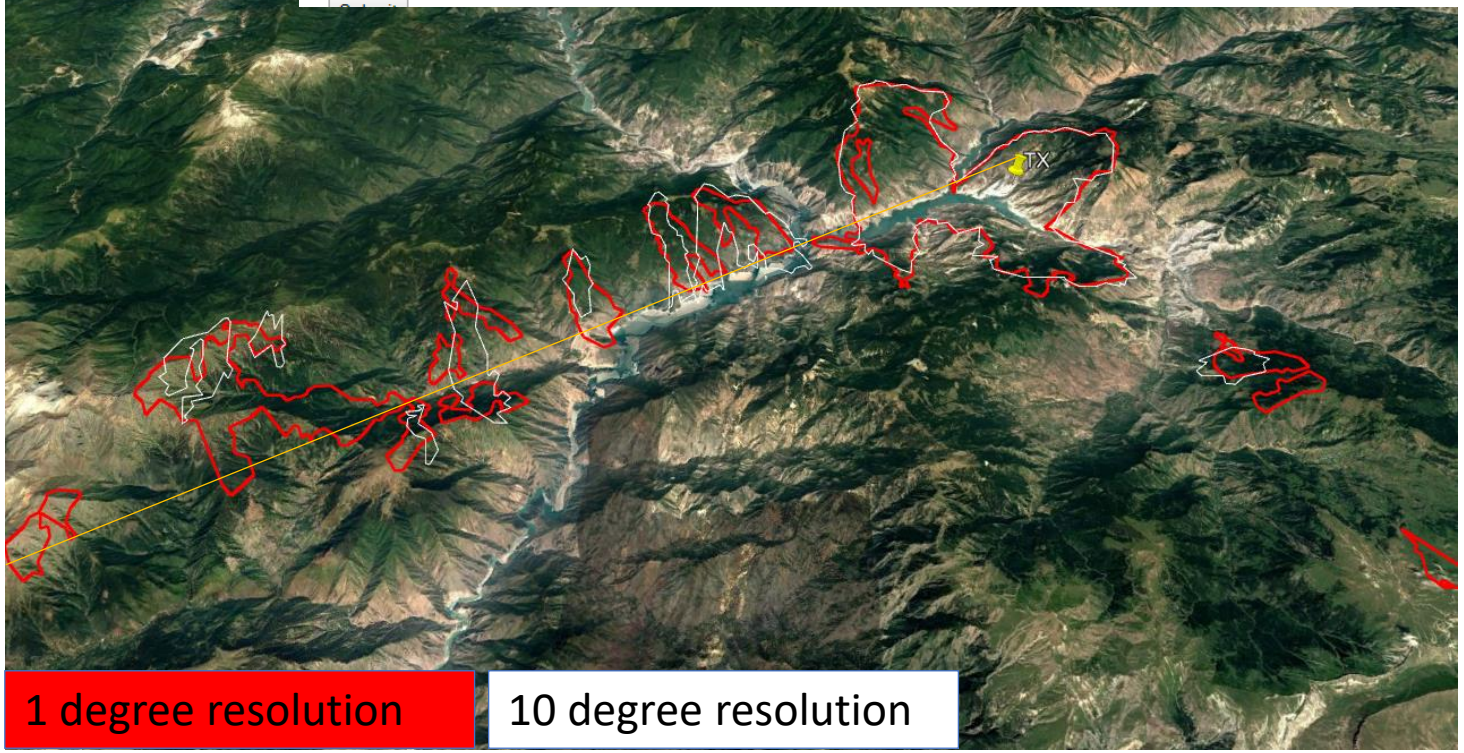
Beta Release!

coverage analyses

NEW

Point to Area

Tx (long)	420000	Tx (lat)	411000	Wanted FS (dB(μV/m))	50	Bearing step (degrees EtN)	10
Tx hgt agl(m)	70	Rx hgt agl(m)	10	Reception type	Outdoor	Polarization	Horizontal
Frequency(MHz)	186	Erp(dBW)	30	Tx Clutter Type	Open/rural	Rx Clutter Type	Open/rural
% of time	50	% of location	95	Use Tx clutter height (m)		Use Rx clutter height (m)	



1 degree resolution

10 degree resolution

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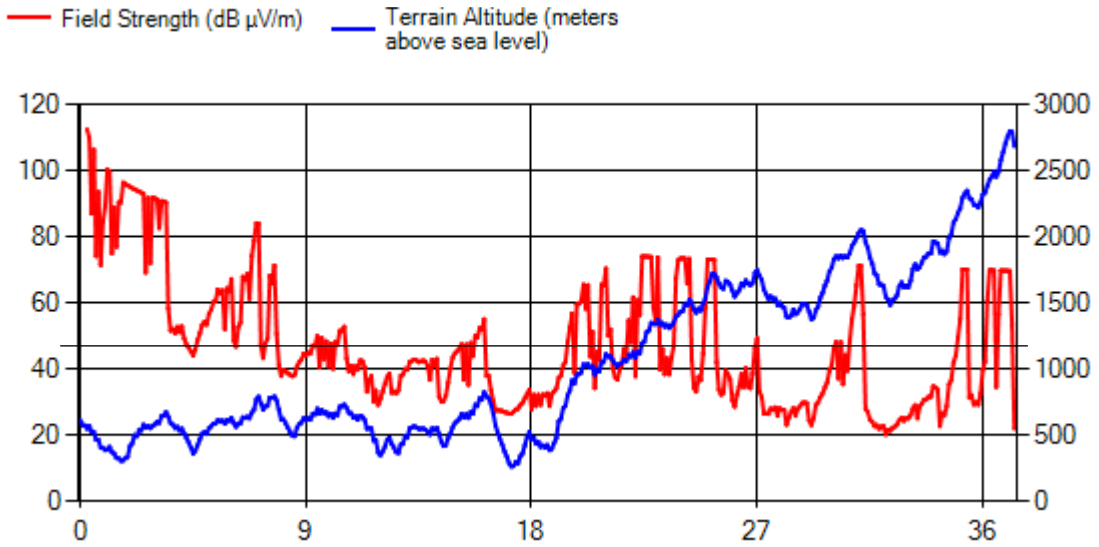
eTools: rec. ITU-R P.1812 calculations

Point to Point

Tx (long)	420000	Tx (lat)	411000	Rx (long)	0413654	Rx (lat)	410000
Tx hgt agl(m)	70	Rx hgt agl(m)	10	Reception type	Outdoor	Polarization	Horizontal
Frequency(MHz)	186	Erp(dBW)	30	Tx Clutter Type	Open/rural	Rx Clutter Type	Open/rural
% of time	50	% of location	95	Use Tx clutter height (m)		Use Rx clutter height (m)	

Distance(km)	37.223	Bearing(degree etn)	240.2568	Effective Earth Radius	8422.02



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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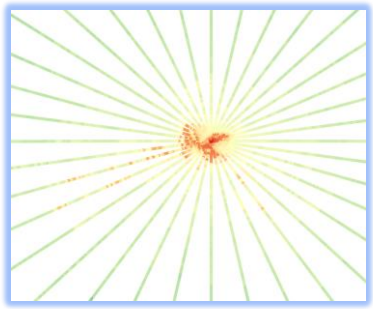
GIS Analyses
field strength contours

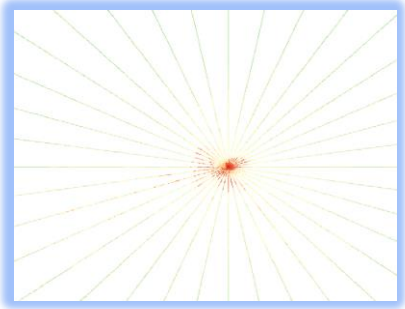
Beta Release! NEW

dB(µV/m)
-20
0
20
40
60
80
100
117.58

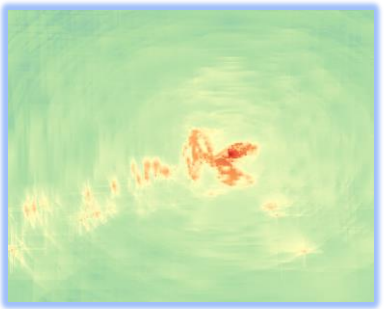
1) P.1812 vector data (location and fs)



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

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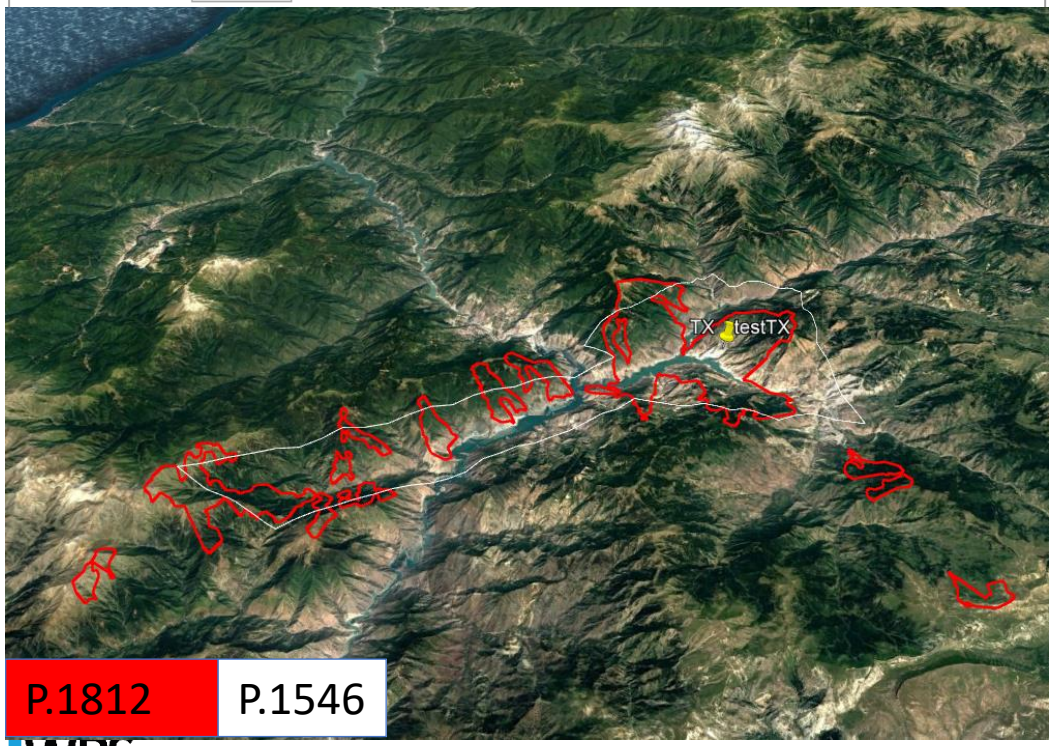
eTools: rec. ITU-R P.1546 calculations

Point to Area

Tx (long)	420000	Tx (lat)	411000
Tx hgt agl(m)	70	Rx hgt agl(m)	10
Frequency(MHz)	186	Erp(dBW)	30
% of time	50	% of location	50
Environment type	Rural		
Wanted FS (dB(µV/m))	50		



P.1812 P.1546

Coverage analyses

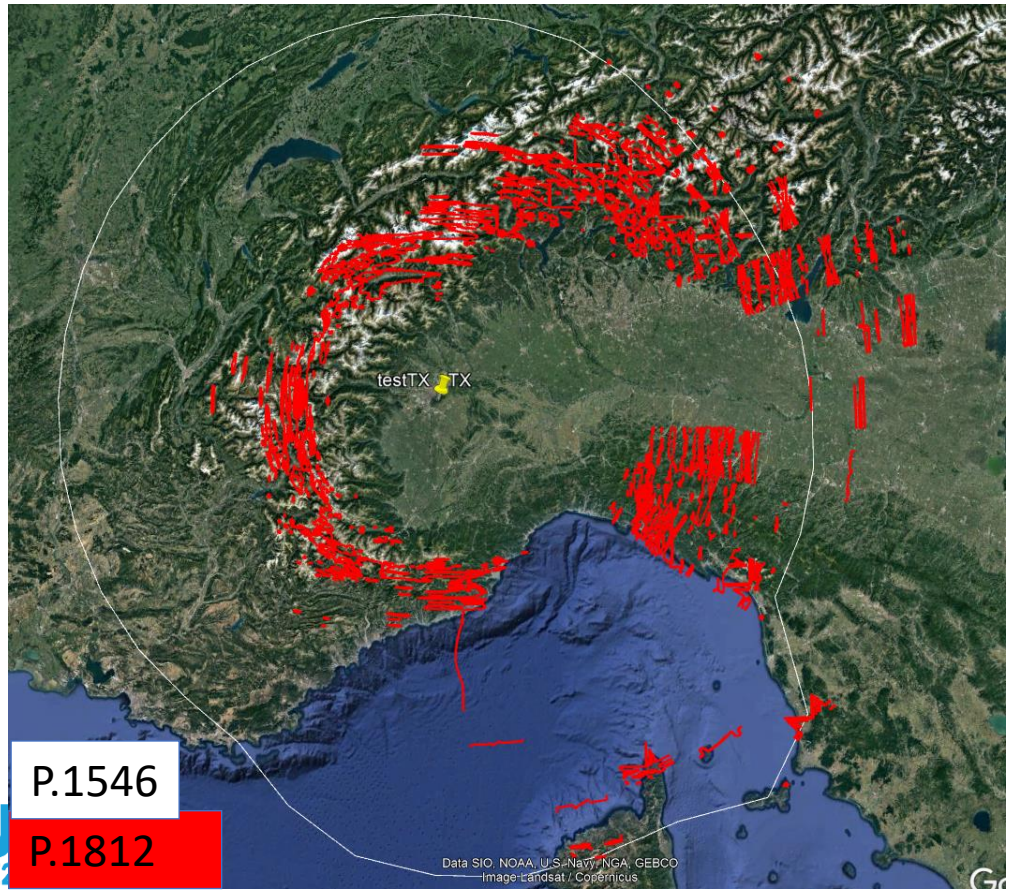
Very good agreement with P.1812 results in this case.

But results can change significantly!

eTools: rec. ITU-R P.1546 calculations

Tx (long)	0074408	Tx (lat)	450227	Environment type	Rural
Tx hgt agl(m)	70	Rx hgt agl(m)	10	Wanted FS (dB(μV/m))	20
Frequency(MHz)	186	Erp(dBW)	30		
% of time	1	% of location	50		

Point to Area



P.1546

P.1812

Interference analyses

Very different results from P.1812!

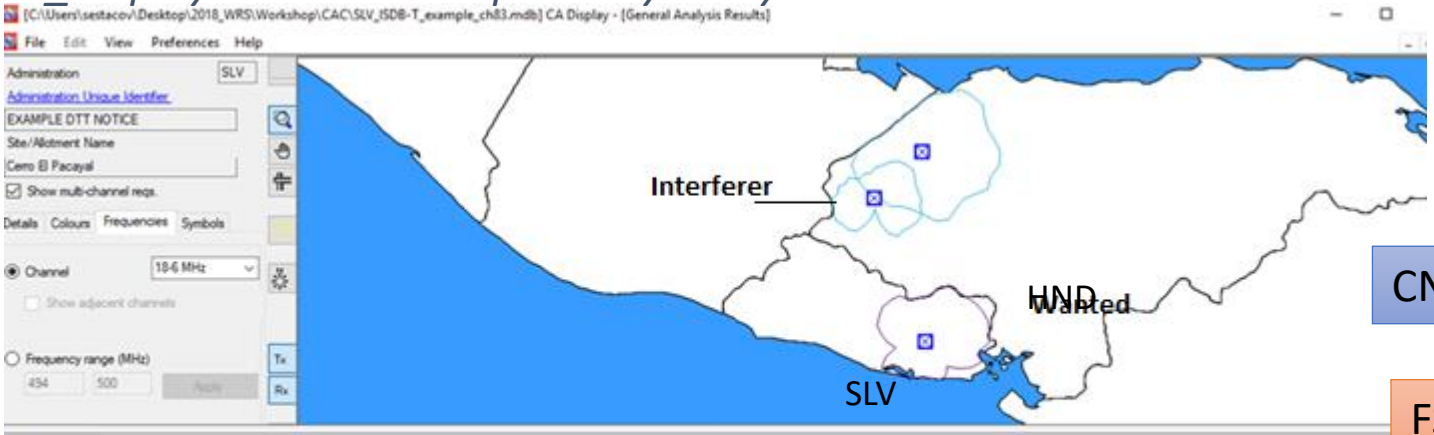
Use case: planning in Central America and Caribbean

eTools: CA_compat implements 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



CNFS = 55.7 dB(µV/m)

FS = 21.9 dB(µV/m)

Adm Ref Id	Site Name	Channel	Avail. Ch	Assigned Ch	8BH (dBW)	8BV (dBW)	Wanted chann	Interf. channel	Distance (km)	CNFS (dB(µV)	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
												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
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	54.8	3.86	150.0	-88.18	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

Use case: planning in Central America and Caribbean

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

Please select the calculation type

Propagation | P1812v4 Point to Point (BETA)

Back to calculation history

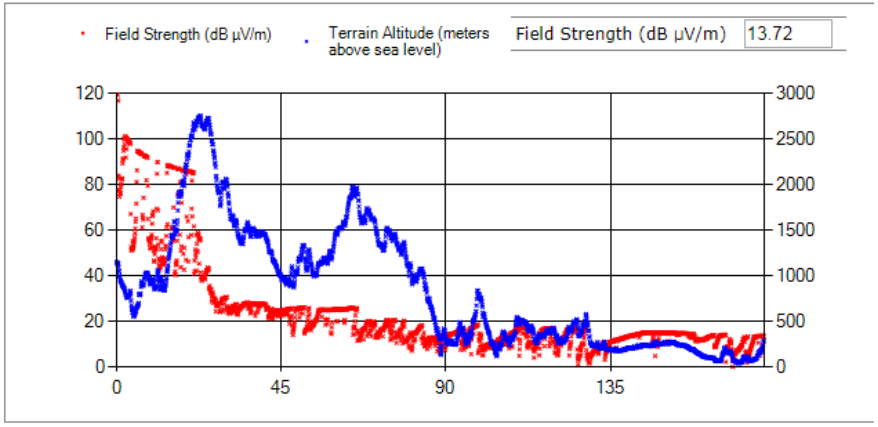
Please label your submission: test

Propagation prediction method for terrestrial services in the VHF and UHF bands

Tx (long)	-0884600	Tx (lat)	144500	Rx (long)	-0880824	Rx (lat)	131648
Tx hgt agl(m)	49	Rx hgt agl(m)	10	Reception type	Outdoor	Polarization	Horizontal
Frequency(MHz)	497	Erp(dBW)	31.1	Tx Clutter Type	Open/rural	Rx Clutter Type	Open/rural
% of time	1	% of location	50	Use Tx clutter height (m)		Use Rx clutter height (m)	

Job Output

Distance(km)	176.941	Bearing(degree etn)	157.4526	Effective Earth Radius	9905.3



FS = 21.9 dB(µV/m) P.1546 no terrain

FS = 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

eTools: GE84Opt
implements GE84 propagation curves for interference analyses.

Terrain information considered only via effective antenna height

Showing results for submitted requirements from MRC

Select requirement:

FLEX-AAZANEN (003°07'03"W-35°15'07"N) System 4 Polarization V

GE84 Optimization Description

Summary [FLEX-AAZANEN (003°07'03"W-35°15'07"N) System 4 Polarization V] | 87.7MHz | List of Interferers | 87.7MHz | List of Affected

Excel

Assign ID	Adm	Intent	Stn Cls	Assigned Frequency (MHz)	Polar	Site Name	Total Distance	Cold Sea Path (Km)	Warm Sea Path (Km)	Super refractivity Path (Km)	ERP (dBW)	Azimuth (deg)	Protection Ratio (dB)	NFS (dB(µV/m))	Coord.
107105285	MRC	ADD	BC	87.7	V	AL HOCEIMA VILLE	74	0	74	0	35	270.5	37	94.43	---
093005085	E	RECORDED	BC	87.7	M	EL EJIDO	167	0	153	0	35	8.7	37	81.37	---
107105266	MRC	ADD	BC	87.7	V	AKNOUL	111	0	11	0	35	221.1	37	75	---
107106776	MRC	ADD	BC	87.7	V	TAHAR SOUK	125	0	28	0	35	238.2	37	72.44	---
107106988	MRC	ADD	BC	87.8	V	TARGUIST VILLE	114	0	58	0	35	253	25	69.18	---
120146601	MRC	ADD	BC	87.7	V	SAR SAR	250	0	143	0	35	261.3	37	68.9	---
105097287	MRC	RECORDED	BC	87.8	V	HAFA SAFA	203	0	195	0	35	277.9	25	66.69	---
117124793	ALG	ADD	BC	87.7	V	SIDI MEDJAHED	147	0	61	0	34.56	111.1	37	66.19	---
084105732	E	RECORDED	BC	87.7	M	JEREZ DE LA FRONTERA	315	0	224	0	35	301.3	37	65.58	---

87.7 MHz
Non assignable
Acceptable NFS
54 (dB (µV/m))

$FS(1\%time,50\%loc)_{GE84\ curves} = 66.19 - 37 = 29.19\ dB(\mu V/m)$

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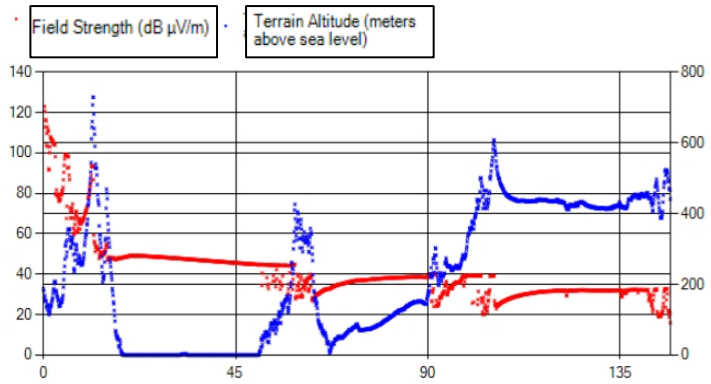
Use case: GE84 planning activities

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

87.7 MHz AAZANEN VS SIDI MEDJAHED

Distance(km) 146.681 Bearing(degree etn) 111.1218 Effective Earth Radius 8969.89 Field Strength (dB µV/m) 16.01



Distance (km)	Fs (dB(µV/m))	Alt.(m asl)
0	NaN	187
0.09	NaN	181
0.18	NaN	160
0.27	122.96	160
0.36	120.5	168
0.45	112.76	153
0.54	116.43	152
0.63	115.75	153
0.72	103.79	136
0.81	109.65	137
0.9	112.77	141
0.99	103.07	127
1.08	111.25	136
1.17	110.59	143
1.26	92.09	122
1.35	91.5	114
1.44	100.14	123
1.53	103.09	125
1.62	107.94	134

Showing 1 to 1,631 of 1,631 entries

Reduction of the interfering field due to terrain → ~13dB

Use case: GE84 planning activities

eTools: GE84Opt
implements GE84 propagation curves for interference analyses.

Terrain information considered only via effective antenna height

Showing results for submitted requirements from MRC

Select requirement:

FLEX-AAZANEN (003°07'03"W-35°15'07"N) System 4 Polarization V

GE84 Optimization Description

Summary [FLEX-AAZANEN (003°07'03"W-35°15'07"N) System 4 Polarization V] | 87.7MHz | List of Interferers | 87.7MHz | List of Affected

Excel

Assign ID	Adm	Intent	Stn Cls	Assigned Frequency (MHz)	Polar	Site Name	Total Distance	Cold Sea Path (Km)	Warm Sea Path (Km)	Super refractivity Path (Km)	ERP (dBW)	Azimuth (deg)	Protection Ratio (dB)	NFS (dB(µV/m))	Coord.
107105285	MRC	ADD	BC	87.7	V	AL HOCEIMA VILLE	74	0	74	0	35	270.5	37	94.43	---
093005085	E	RECORDED	BC	87.7	M	EL EJIDO	167	0	153	0	35	8.7	37	81.37	---
107105266	MRC	ADD	BC	87.7	V	AKNOUL	111	0	11	0	35	221.1	37	75	---
107106776	MRC	ADD	BC	87.7	V	TAHAR SOUK	125	0	28	0	35	238.2	37	72.44	---
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87.7 MHz
Non assignable
Acceptable NFS
54 (dB (µV/m))

$FS(1\%temps,50\%loc)_{GE84\ curves} = 66.19 - 37 = 29.19\ dB(\mu V/m)$

Reduction of the interfering field due to terrain → ~13dB
This reduction would make the NFS acceptable for this interference situation!
NFS_{with} terrain profile = ~ 16 + 37 =~ 66 - 13 = 53 dB(µV/m).

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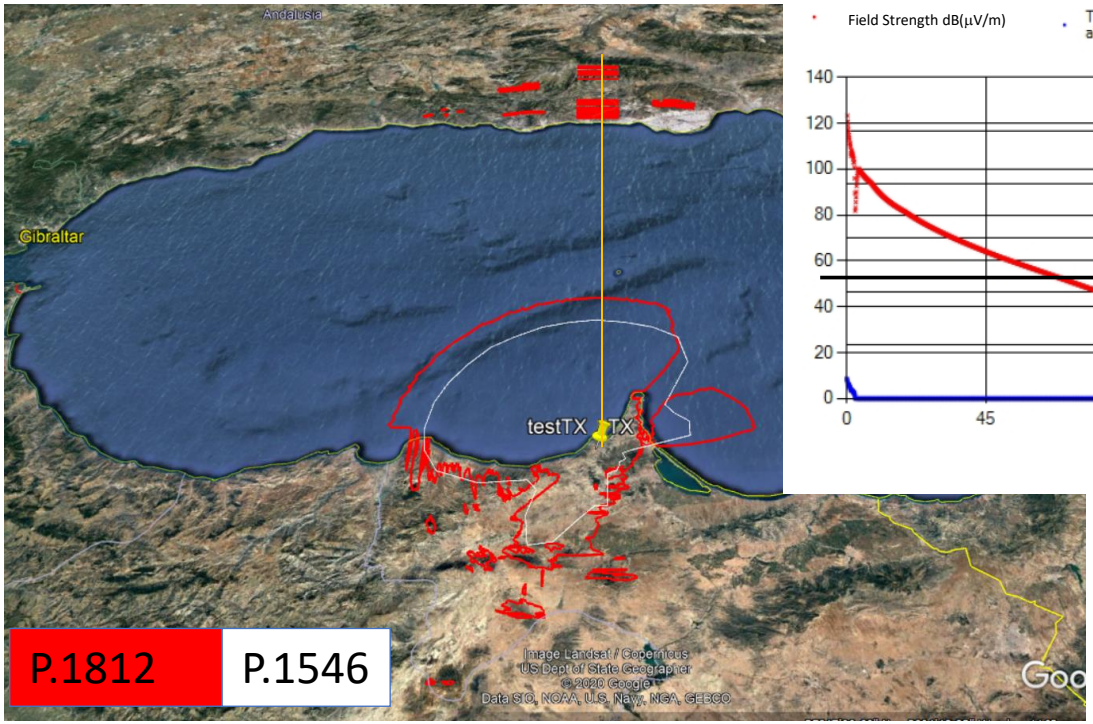
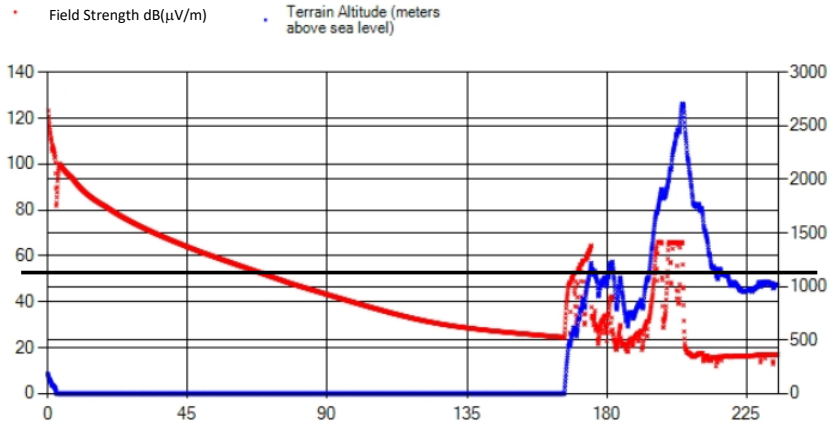
Use case: FM coverage analyses

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





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Thank you!

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Questions to brbcd@itu.int

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