AFRICAN TELECOMMUNICATIONS UNION
UNION AFRICAINE DES TÉLÉCOMMUNICATIONS

Online Meeting

1st frequency coordination meeting on GE84 Plan Optimization for Africa

Première réunion de coordination des fréquences sur l'optimisation du Plan GE84 pour l'Afrique

15 – 19 February 2021

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

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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

Can be used for interference and coverage analyses!

Rec. ITU-R P. 1546

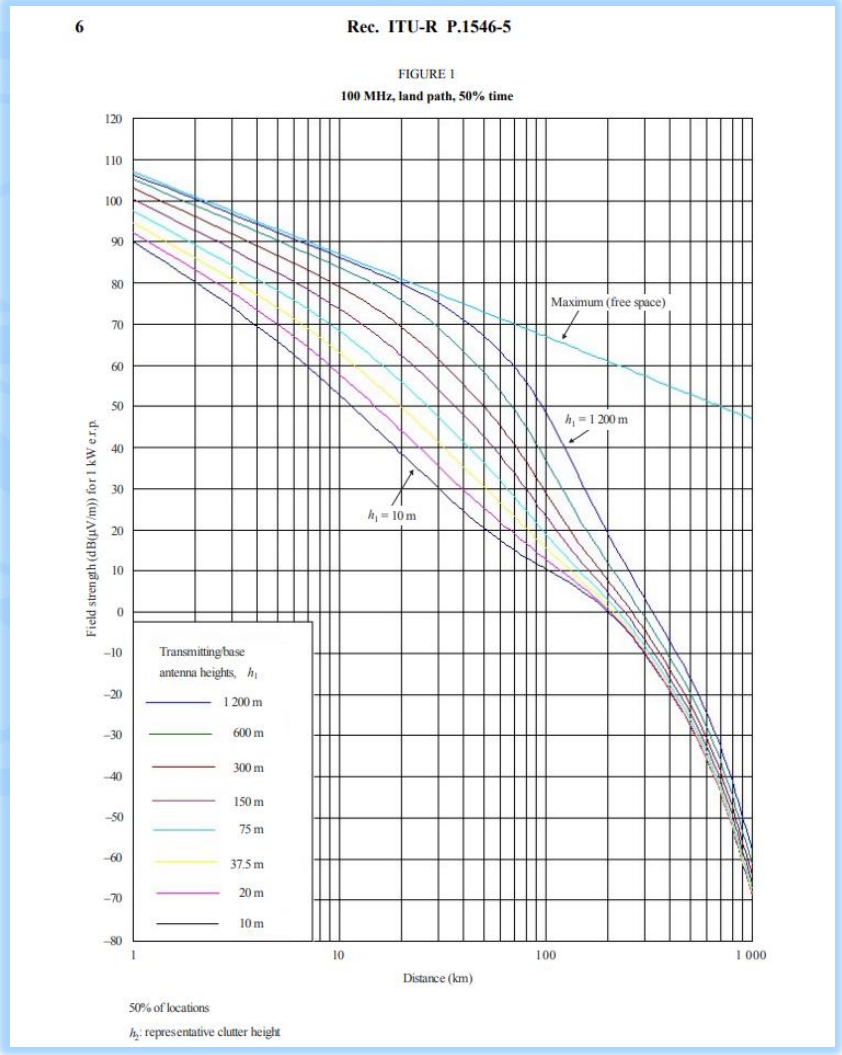
Field-strength curves as functions of *distance*, *antenna height, frequency and percentage time*

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

Method

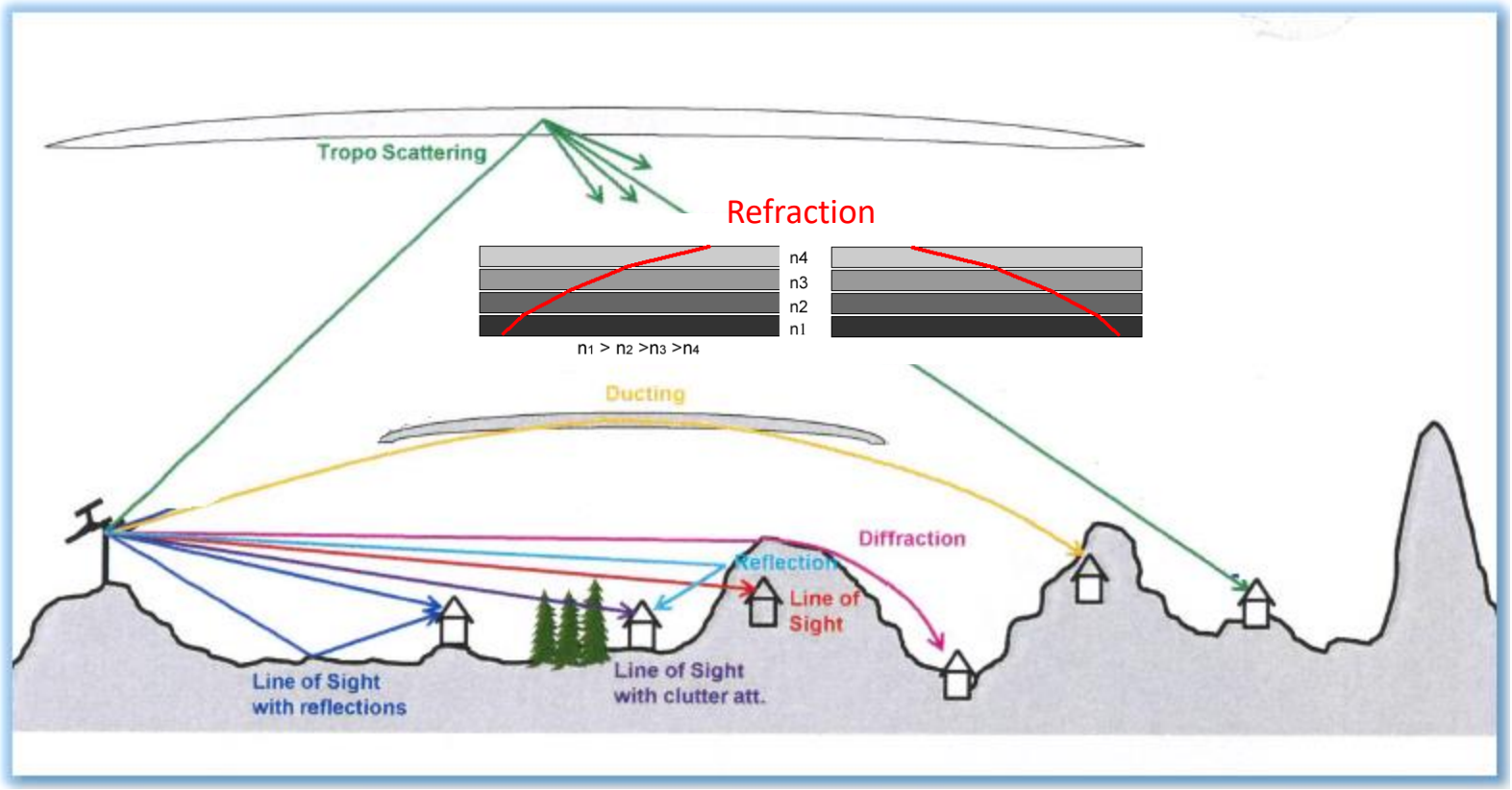
- interpolation/extrapolation
- mixed-path

Important correction for refractivity index!!



Rec. ITU-R P. 1812

Propagation mechanisms in the VHF/UHF band



Adapted from LS Telcom 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

eBCD 2.0 Broadcasting Online

eTools: Input parameters

ITU-R P.1812

Clutter Type

Water/sea ▼
- Water/sea
- Open/rural
- Suburban
- Urban/trees/forest
- Dense urban

N.B. If clutter heights are not given, the software uses the representative heights from Table 2

Reception Type

Outdoor ▼
- Outdoor
- Indoor

Polarization

Vertical ▼
- Vertical
- Horizontal

Percentage of time and location

Coverage Analyses (wanted signal)

GE84 Agreement

FM

50% locations
50% time

Interference Analyses (un wanted signal)

GE84 Agreement

FM (tropo)	FM (steady)
50% location 1% time	50% location. 50% time

Frequency spacing (kHz)	Radio-frequency protection ratio (dB) for a maximum frequency deviation of ± 75 kHz			
	Monophonic		Stereophonic	
	Steady interference	Tropospheric interference	Steady interference	Tropospheric interference
0	36	28	45	37
25	31	27	51	43
50	24	22	51	43
75	16	16	45	37
100	12	12	33	25
150	8	8	18	14
200	6	6	7	7
250	2	2	2	2
300	–7	–7	–7	–7
350	–15	–15	–15	–15
400	–20	–20	–20	–20

eTools: rec. ITU-R P.1812 calculations

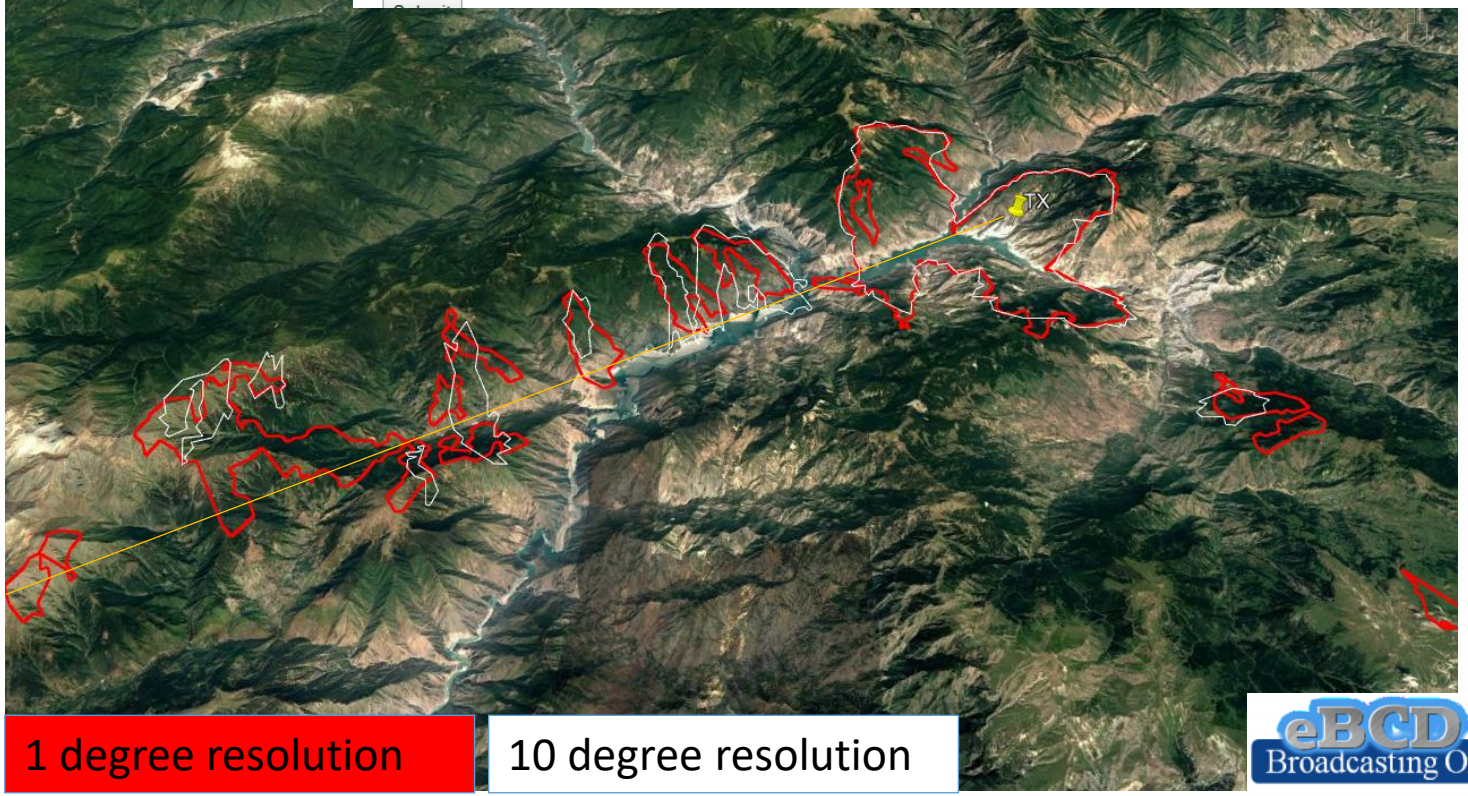
Beta Release!

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

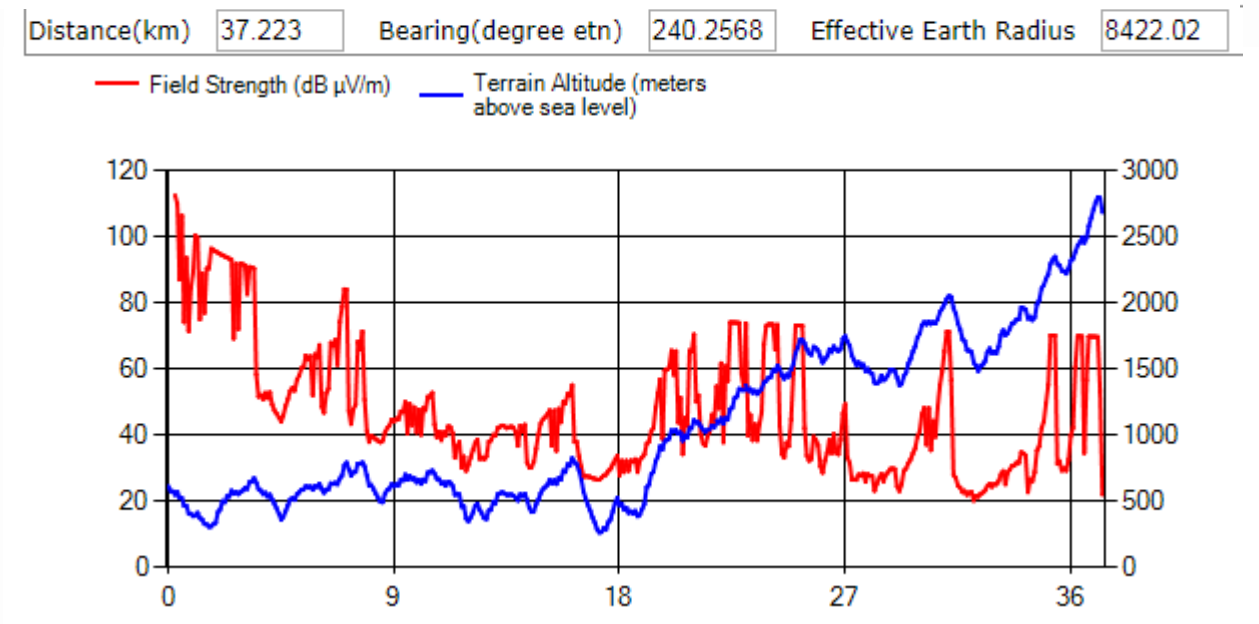
eBCD 2.0 Broadcasting Online

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



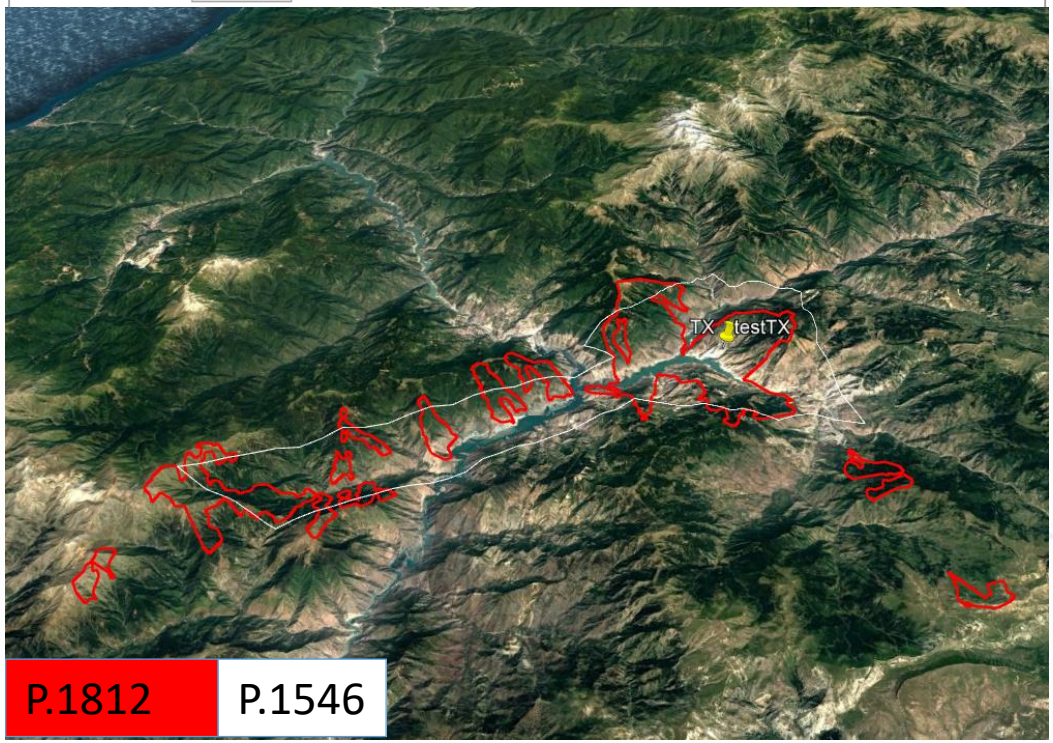
Study FS variation on the path from TX to a RX point in the contours farthest from the TX in the P2A coverage analyses

eBCD 2.0 Broadcasting Online

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		



Coverage analyses

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

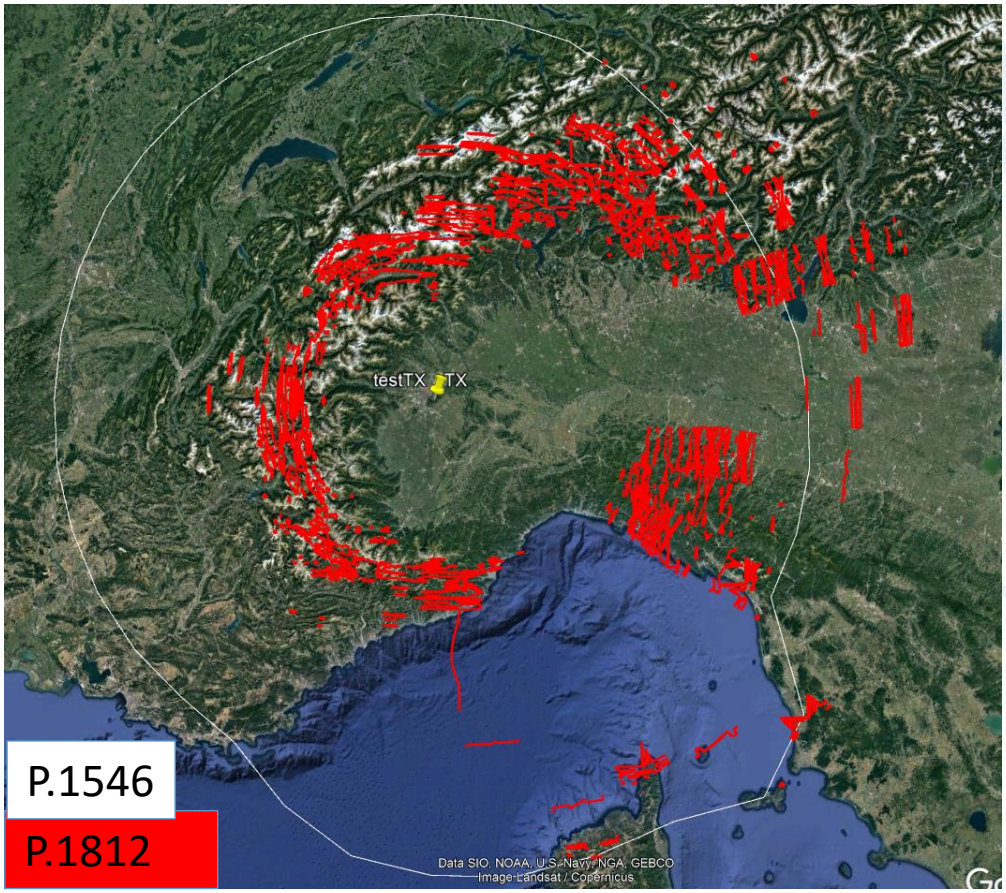
But results can change significantly!

eBCD 2.0 Broadcasting Online

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



Interference analyses

Very different results from P.1812!

eBCD 2.0 Broadcasting Online

Use case: GE84 planning activities

eTools: GE84Opt
implements GE84 propagation curves for interference analyses.

Iteration zero

Terrain information considered only via effective antenna height

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

Summary [FLEX-NIEFANG (010°15'00"E-01°48'00"N) System 4 Polarization H - Id: 2029]

Details of the requirement under consideration

GNE

Show top 5 interferers in the summary | Show top 5 affected in the summary | Show assignable frequencies on top

Frequency (MHz)	Top five affected														
	Assign ID	Adm.	Intent	Class	Freq.	Pol.	Site Name	Dist.	Cold Sea	Warm Sea	Sup. Refr.	ERP	Azim.	Prot. Ratio	NFS
FLEX	2034	GNE	ADD	BC	FLEX	H	BATA	53	0	0	0	30	282.1	45	93.51
	2027	GNE	ADD	BC	FLEX	H	MICOMESENG	58	0	0	0	30	45	45	91.13
	2025	GNE	ADD	BC	FLEX	H	RIO BENITO	74	0	16	0	30	251.1	45	85.21
	860	CME	ADD	BC	FLEX	H	MA AN	74	0	0	0	30	33.7	45	84.15
	2028	GNE	ADD	BC	FLEX	H	RIO CAMPO	74	0	0	0	30	319.1	45	84.12

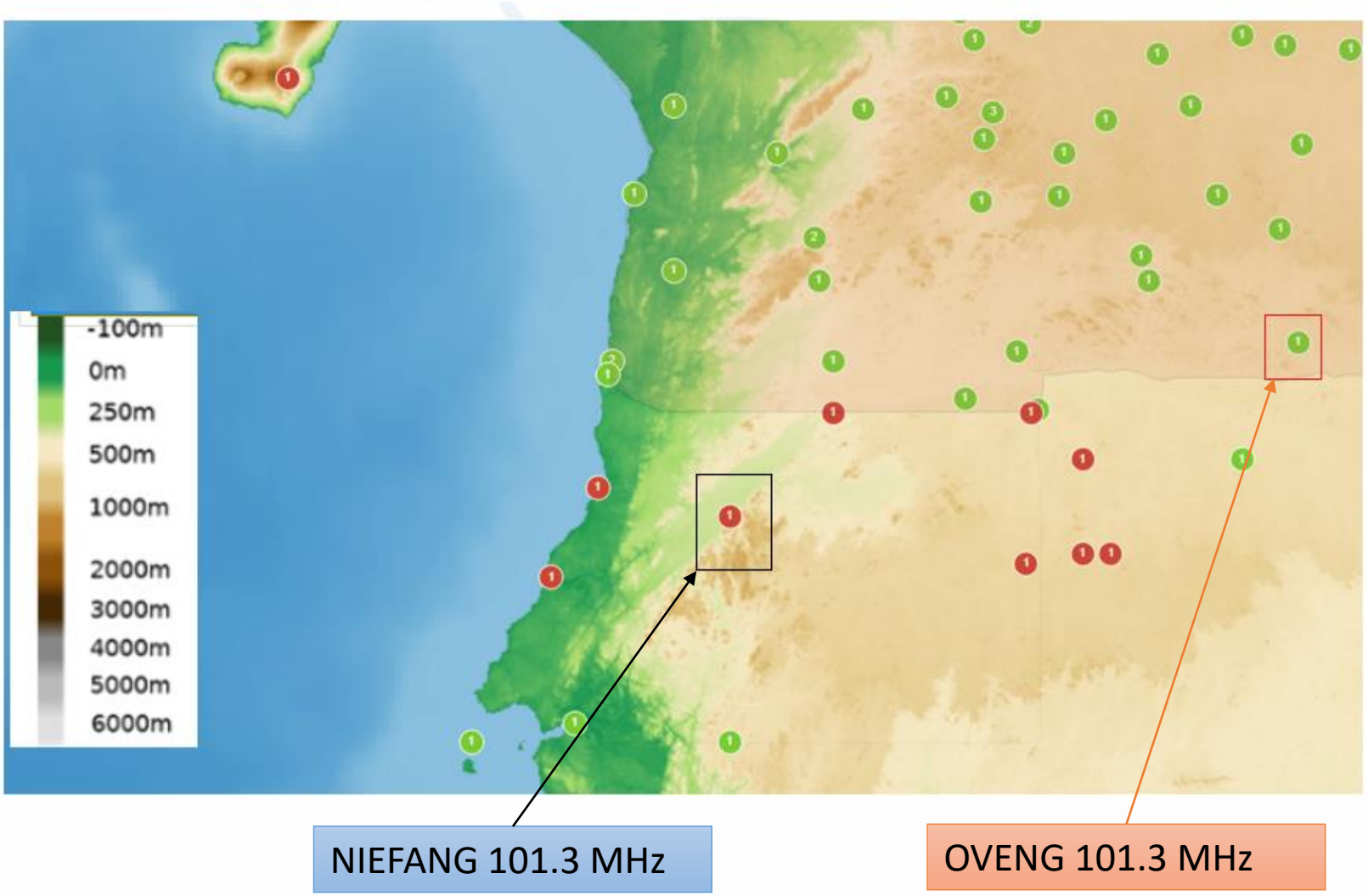
Excel

Showing 1 to 204 of 204 entries

Frequency (MHz)	Max NFS Received (dB(µV/m))	Max NFS Generated (dB(µV/m))	Top five affected													
			Assign ID	Adm.	Intent	Class	Freq.	Pol.	Site Name	Dist.	Cold Sea	Warm Sea	Sup. Refr.	ERP	Azim.	Prot. Ratio	NFS
101.3	56.37	57.89	084042725	CME	RECORDED	BC	101.3	H	OVENG	234	0	0	0	30	73	37	57.89
			084042629	CME	RECORDED	BC	101.2	H	KRIBI	132	0	0	0	30	343.4	25	57.75
			084043115	GNE	RECORDED	BC	101.5	H	MICOMESENG	58	0	0	0	30	45	7	56.37
			084042599	CME	RECORDED	BC	101.3	H	DOUALA	261	0	0	0	30	348.4	37	55.22
			118091375	CME	RECORDED	BC	101.4	V	AMBAM	129	0	0	0	30	60.8	25	48.22

$FS(1\%time,50\%loc)_{GE84\ curves} = 57.89 - 37 = 20.89\ dB(\mu V/m)$

Use case: GE84 planning activities

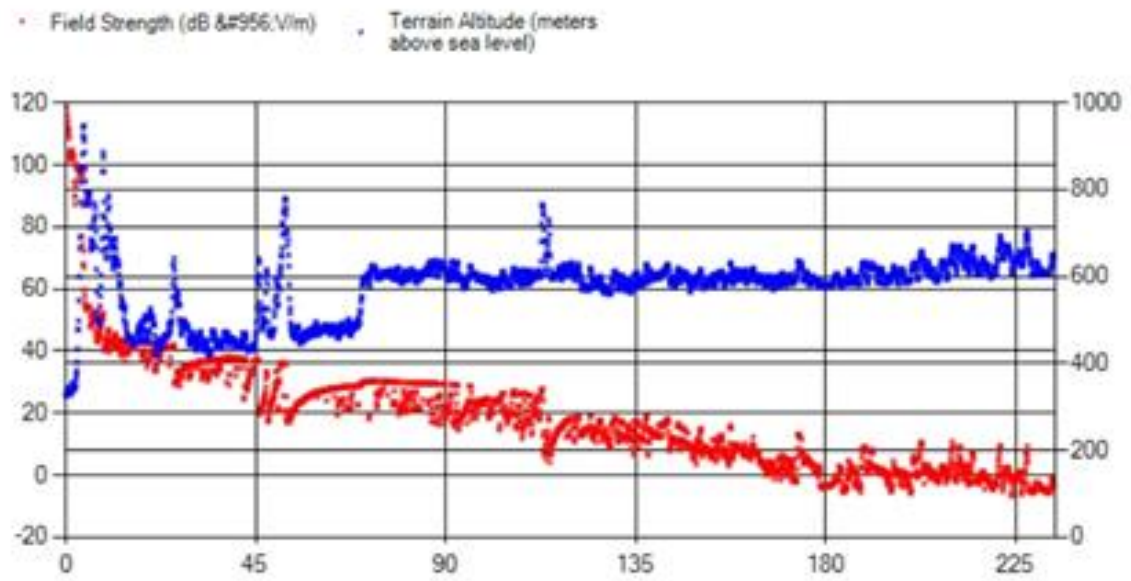


Use case: GE84 planning activities

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

101.3 MHz NIEFANG VS OVENG

Distance(km) 234.112 Bearing(degree etn) 72.99113 Effective Earth Radius 9608.91 Field Strength (dB µV/m) -3.42



Tropo Interference

FM (tropo)

50% location
1% time

Reduction of the interfering field due to terrain → 20.89 + 3.42 ~= 24.3 dB

Use case: GE84 planning activities

Summary [FLEX-NIEFANG (010°15'00"E-01°48'00"N) System 4 Polarization H - Id: 2029]

Iteration zero

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

Details of the requirement under consideration

GNE

Show top 5 interferers in the summary | Show top 5 affected in the summary | Show assignable frequencies on top

Frequency (MHz)	Top five affected														
	Assign ID	Adm.	Intent	Class	Freq.	Pol.	Site Name	Dist.	Cold Sea	Warm Sea	Sup. Refr.	ERP	Azim.	Prot. Ratio	NFS
FLEX	2034	GNE	ADD	BC	FLEX	H	BATA	53	0	0	0	30	282.1	45	93.51
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	2025	GNE	ADD	BC	FLEX	H	RIO BENITO	74	0	16	0	30	251.1	45	85.21
	860	CME	ADD	BC	FLEX	H	MA AN	74	0	0	0	30	33.7	45	84.15
	2028	GNE	ADD	BC	FLEX	H	RIO CAMPO	74	0	0	0	30	319.1	45	84.12

Excel

Showing 1 to 204 of 204 entries

Frequency (MHz)	Max NFS Received (dB(µV/m))	Max NFS Generated (dB(µV/m))	Top five affected													
			Assign ID	Adm.	Intent	Class	Freq.	Pol.	Site Name	Dist.	Cold Sea	Warm Sea	Sup. Refr.	ERP	Azim.	Prot. Ratio	NFS
101.3	56.37	57.89	084042725	CME	RECORDED	BC	101.3	H	OVENG	234	0	0	0	30	73	37	57.89
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			084043115	GNE	RECORDED	BC	101.5	H	MICOMESENG	58	0	0	0	30	45	7	56.37
			084042599	CME	RECORDED	BC	101.3	H	DOUALA	261	0	0	0	30	348.4	37	55.22
			118091375	CME	RECORDED	BC	101.4	V	AMBAM	129	0	0	0	30	60.8	25	48.22

$FS(1\%time,50\%loc)_{GE84\ curves} = 57.89 - 37 = 20.89\ dB(\mu V/m)$

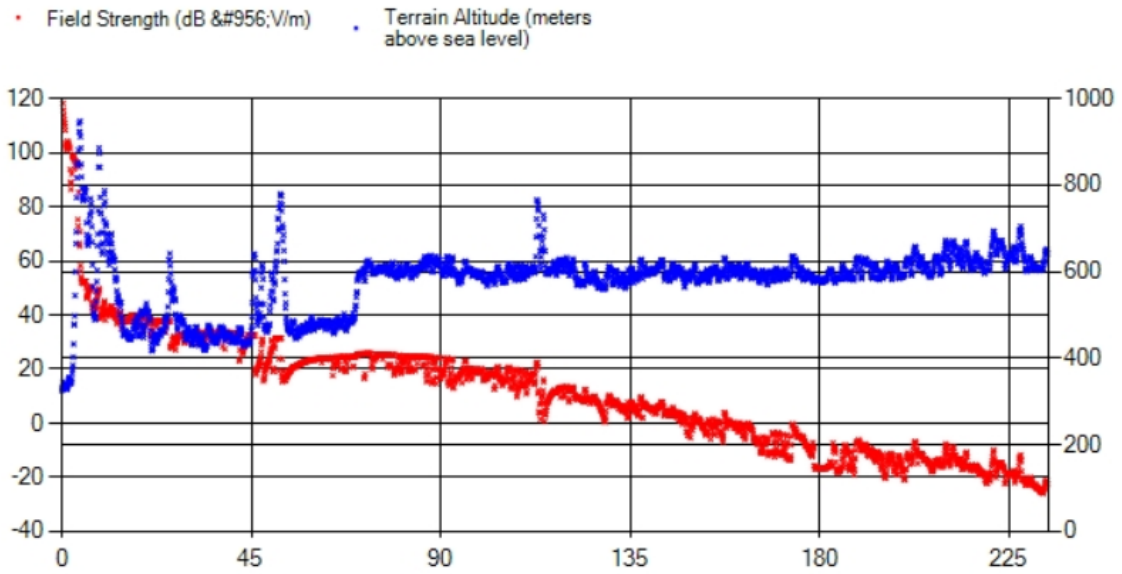
Reduction of the interfering field due to terrain → ~24.3dB
This reduction would make the NFS acceptable for this interference situation!
$NFS_{with\ terrain\ profile} = \sim -3.42 + 37 = \sim 57.89 - 24.3 = \sim 33.58\ dB(\mu V/m)$.

Use case: GE84 planning activities

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

101.3 MHz NIEFANG VS OVENG

Distance(km) 234.112 Bearing(degree etn) 72.99113 Effective Earth Radius 9608.91 Field Strength (dB µV/m) -22.46



Steady Interference

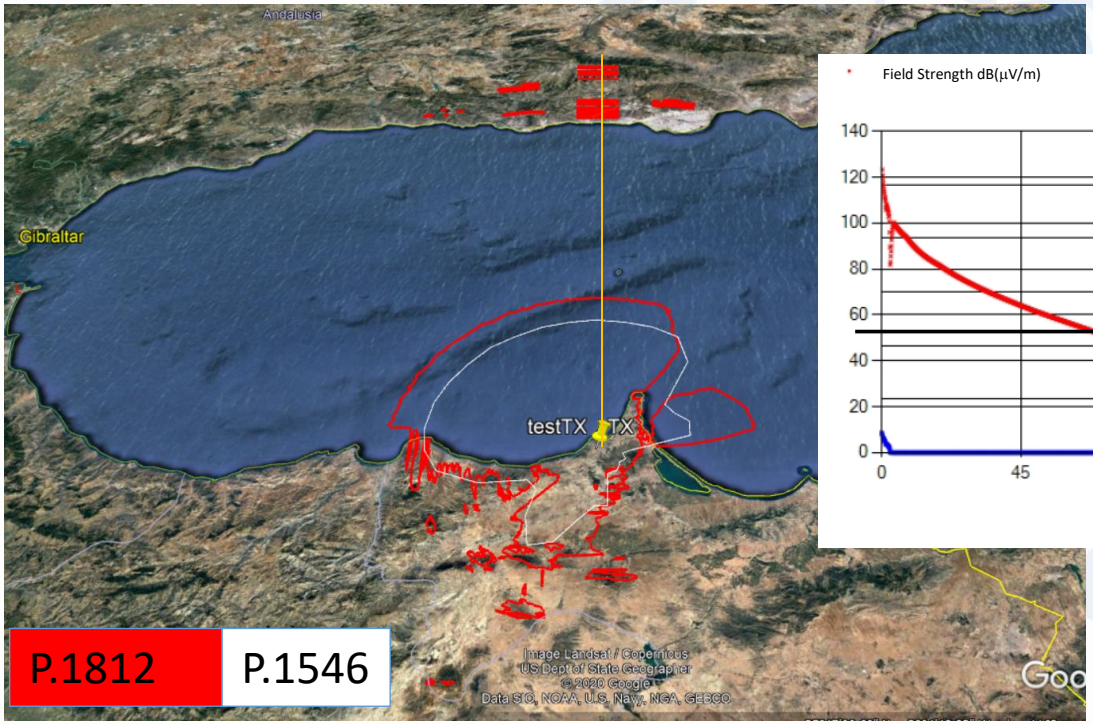
FM (steady)

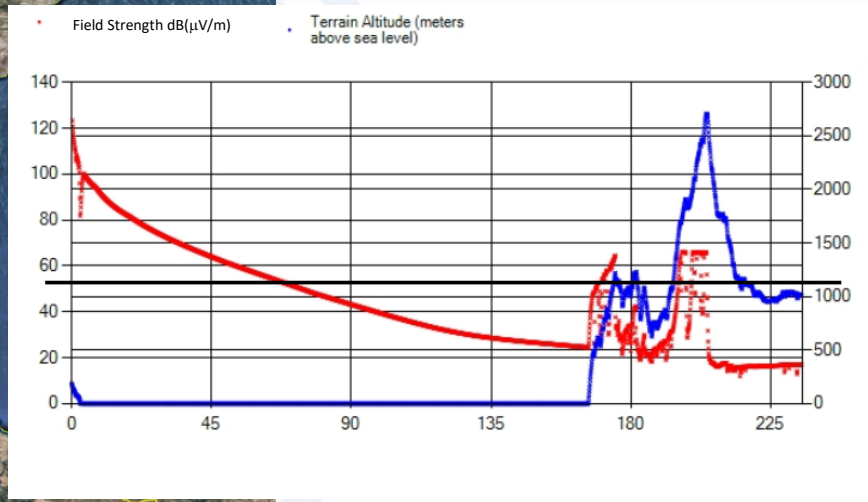
50% location
50% time

NFS $_{with}$ terrain profile = ~ -22.46 + 45 = 22.54 dB(µV/m).

Use case: FM coverage analyses

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





Thank you for your attention!

Questions?

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