3rd and final frequency coordination meeting
on the GE84 Plan Optimization for Africa

3ème et dernière réunion de coordination
des fréquences sur l'optimisation
du Plan GE84 pour l'Afrique

24 - 28 January 2022

AFRICAN TELECOMMUNICATIONS UNION
UNION AFRICAINE DES TÉLÉCOMMUNICATIONS

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

By Andrea Manara
Broadcasting Service Division

Agenda

- Rec. ITU-R P.1812 and P.1546 propagation models
- eTools calculations
- Use cases

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

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

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

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

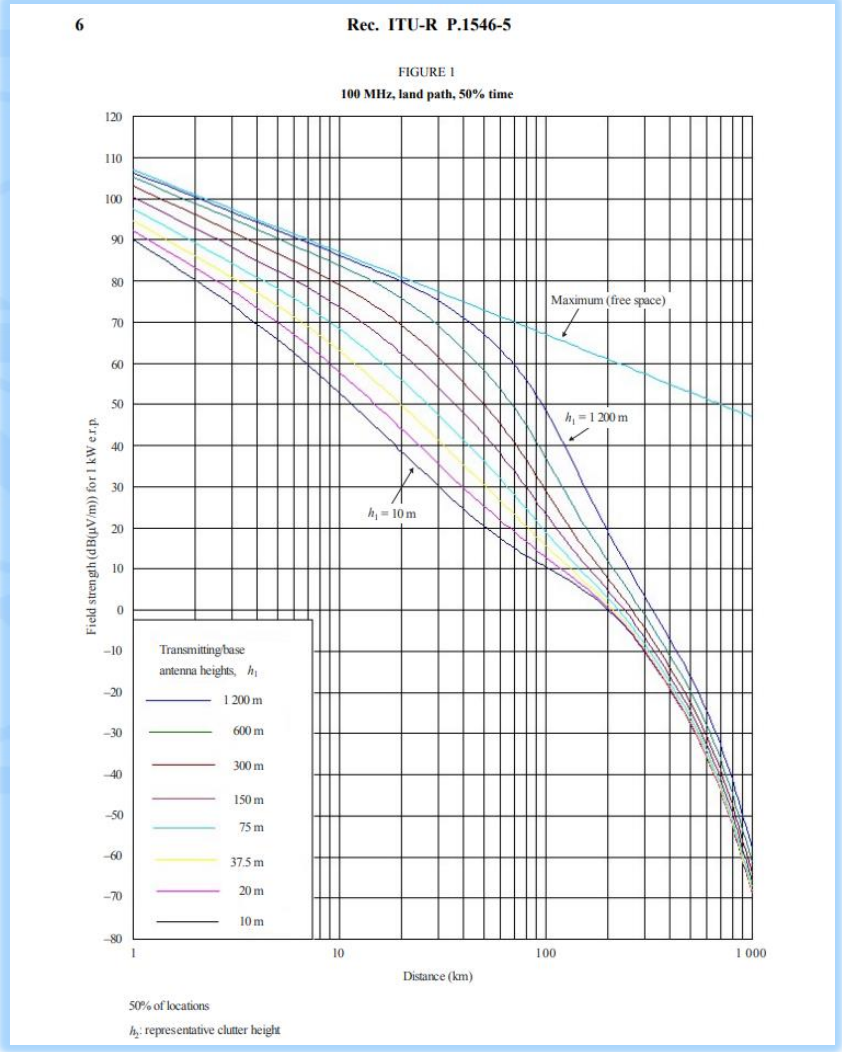
Field-strength curves as functions of *distance*, *antenna height, frequency and percentage time*

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

Method

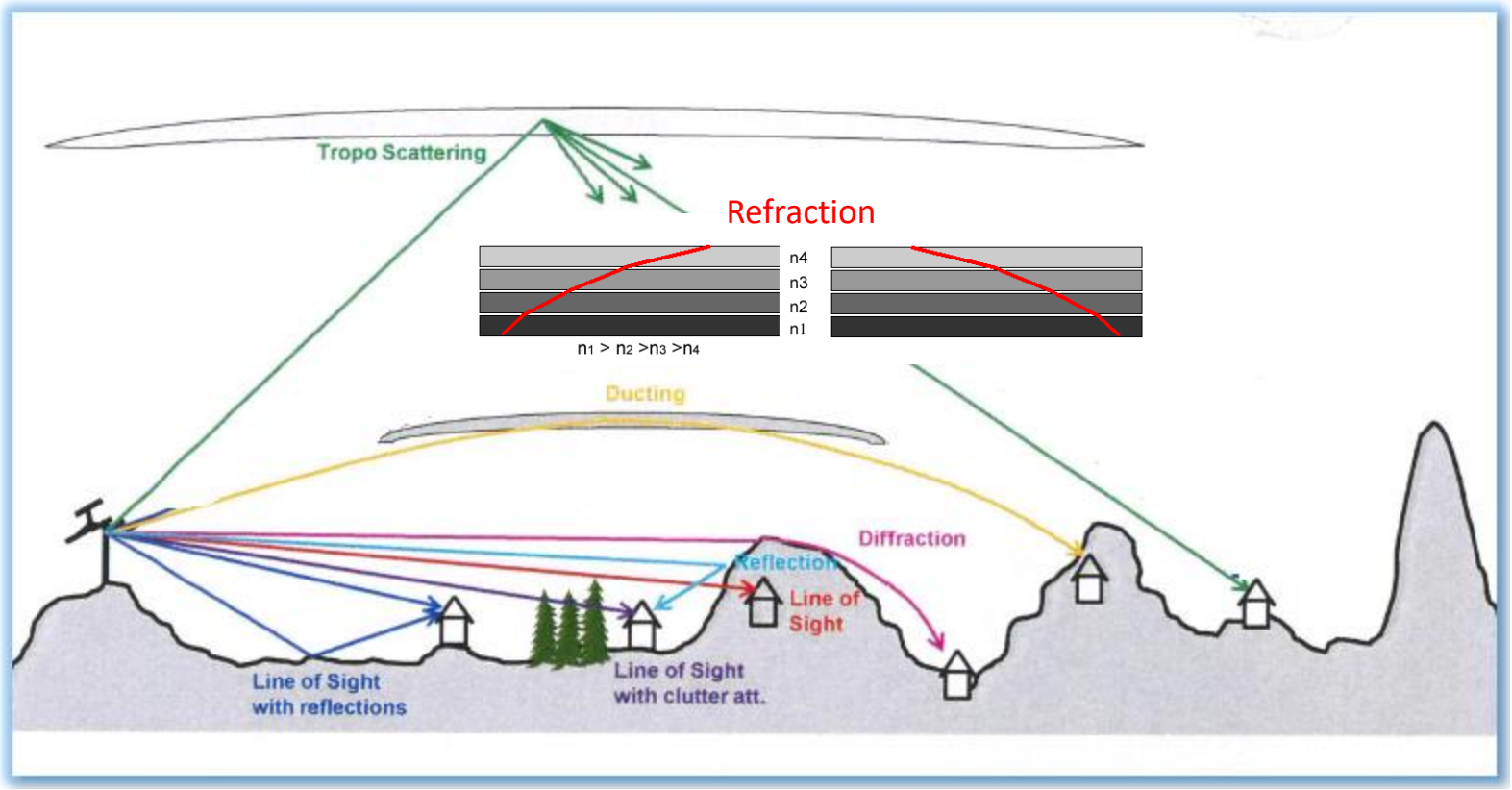
- interpolation/extrapolation
- mixed-path

Important correction for refractivity index!!



Rec. ITU-R P. 1812

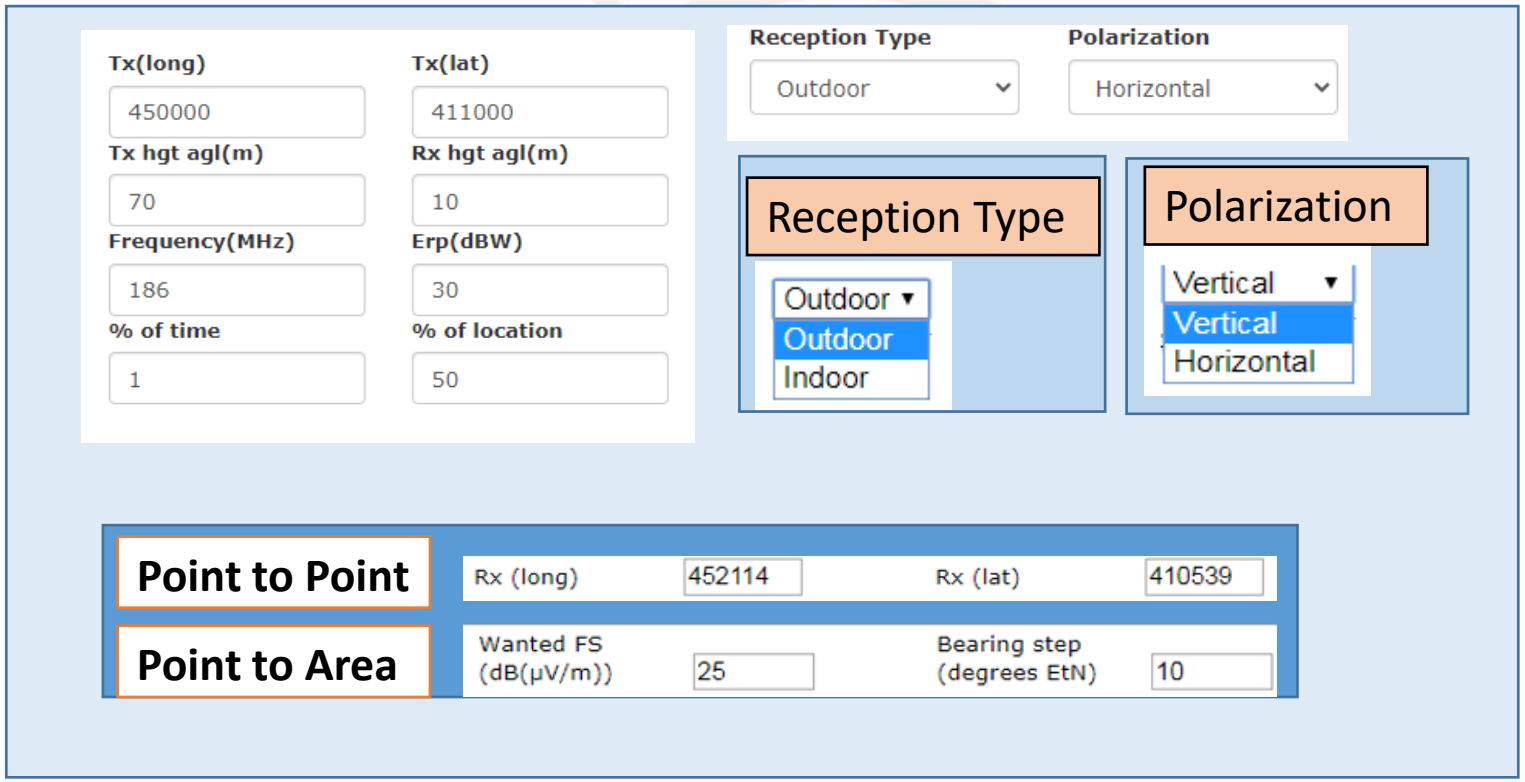
Propagation mechanisms in the VHF/UHF band



Adapted from LS Telcom Propagation training material

eTools: Input parameters

ITU-R P.1812



eBroadcasting

eTools: Input parameters

ITU-R P.1546

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

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

Protection Ratio

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

eBroadcasting

eTools: rec. ITU-R P.1812 calculations

coverage analyses

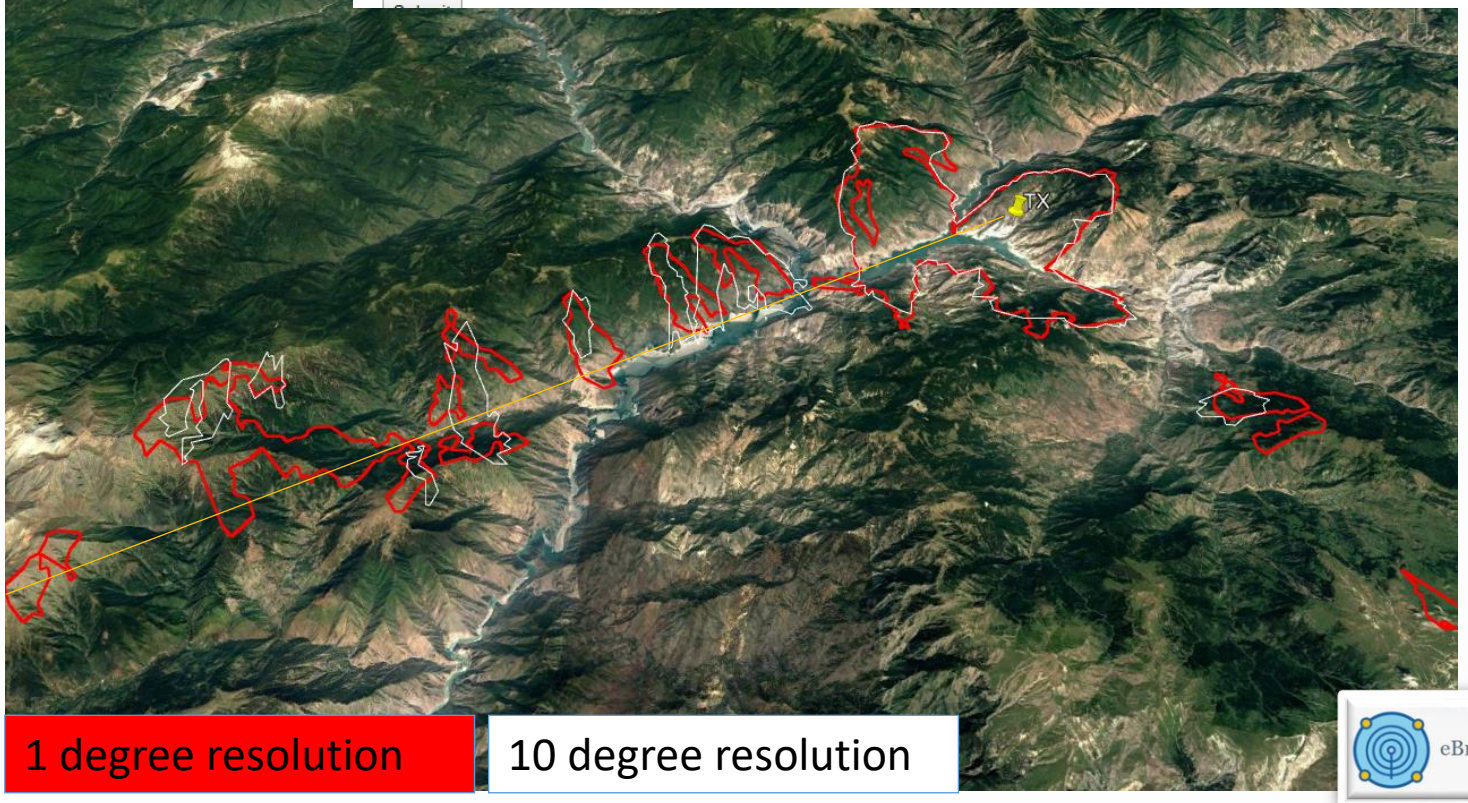
NEW

SRTM 90m

Point to Area

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

SRTM is a DEM, includes already the clutter information on it.



1 degree resolution

10 degree resolution

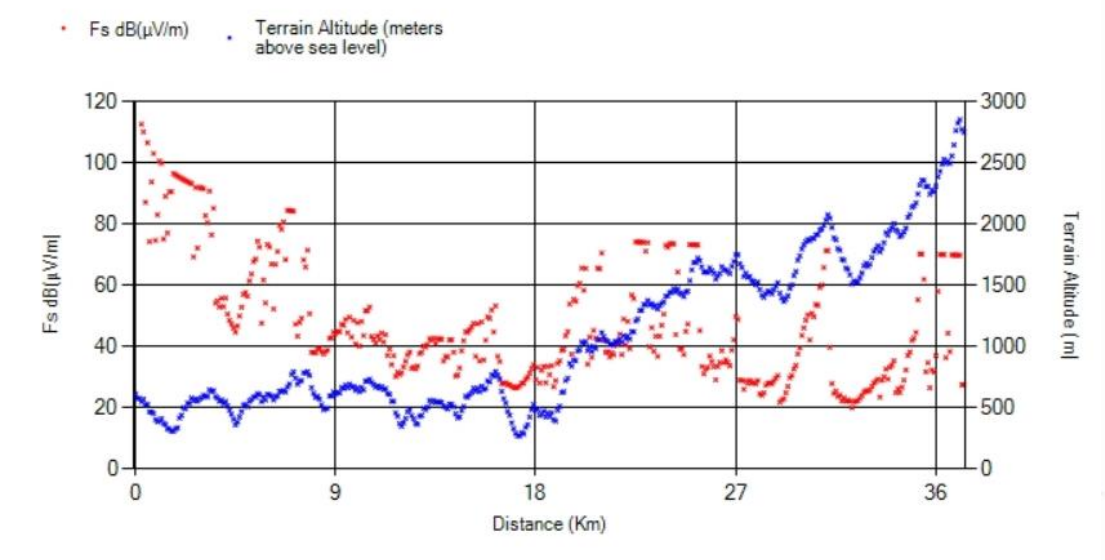
eBroadcasting

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				
% of time	50	% of location	95				

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



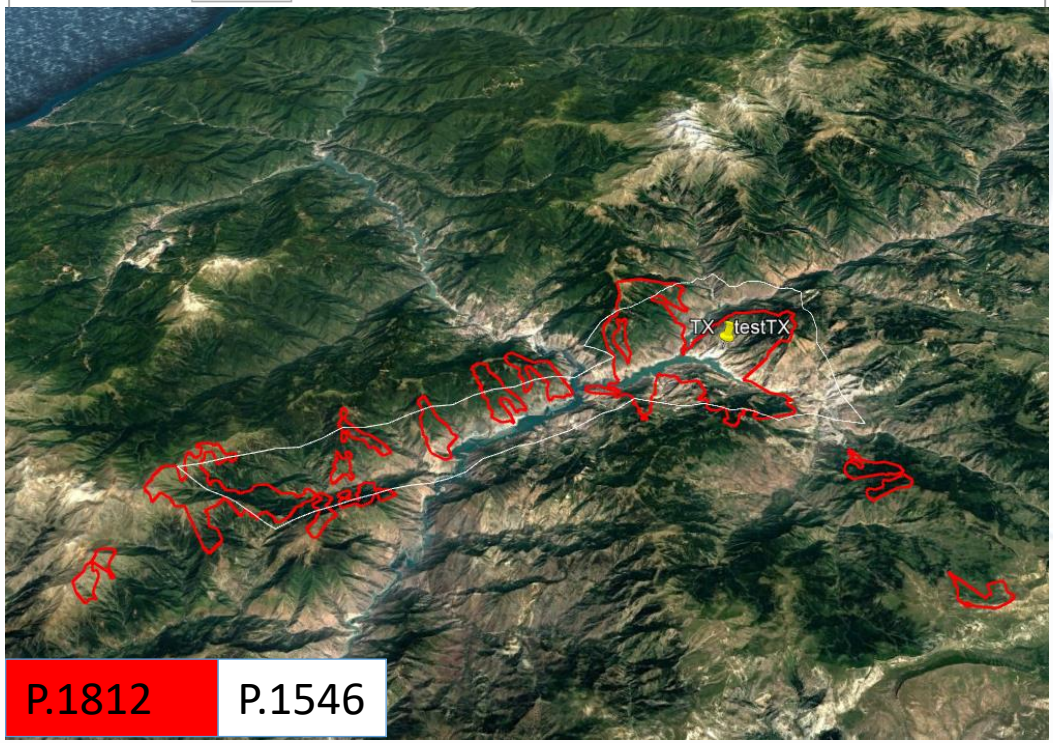
Study FS variation on the path from TX to a RX point in the contours farthest from the TX in the P2A coverage analyses

eBroadcasting

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.

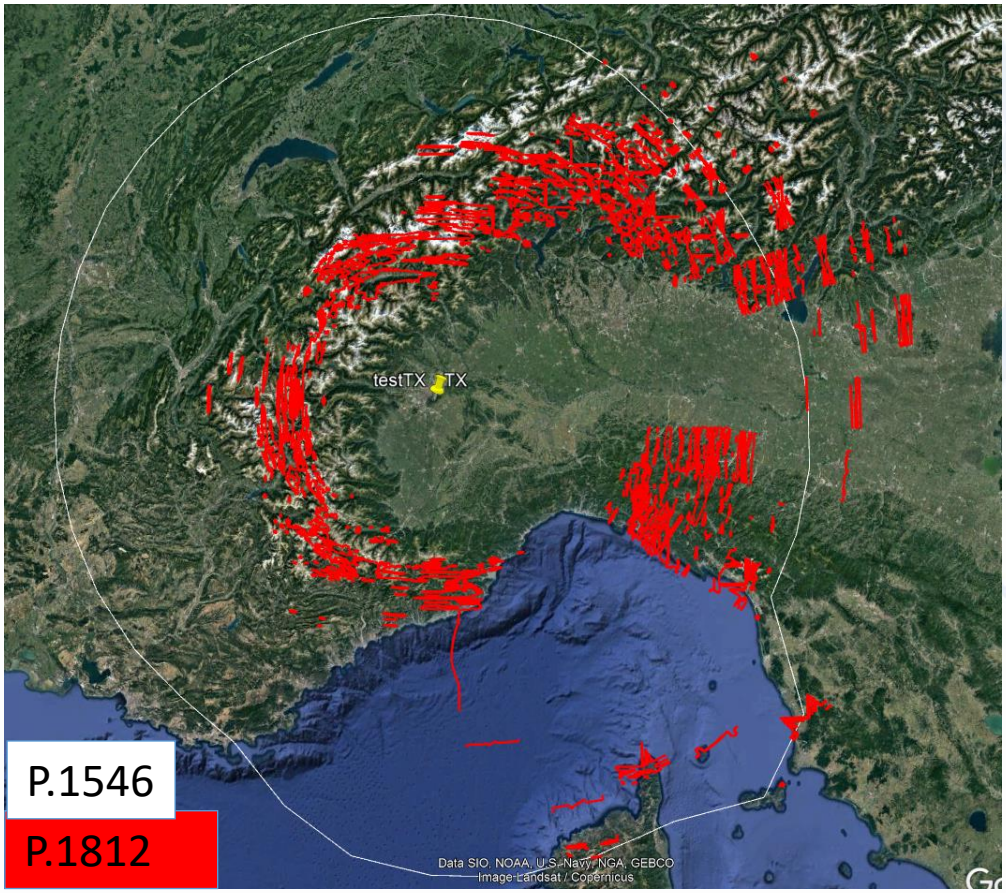
But results can change significantly!

eBroadcasting

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!

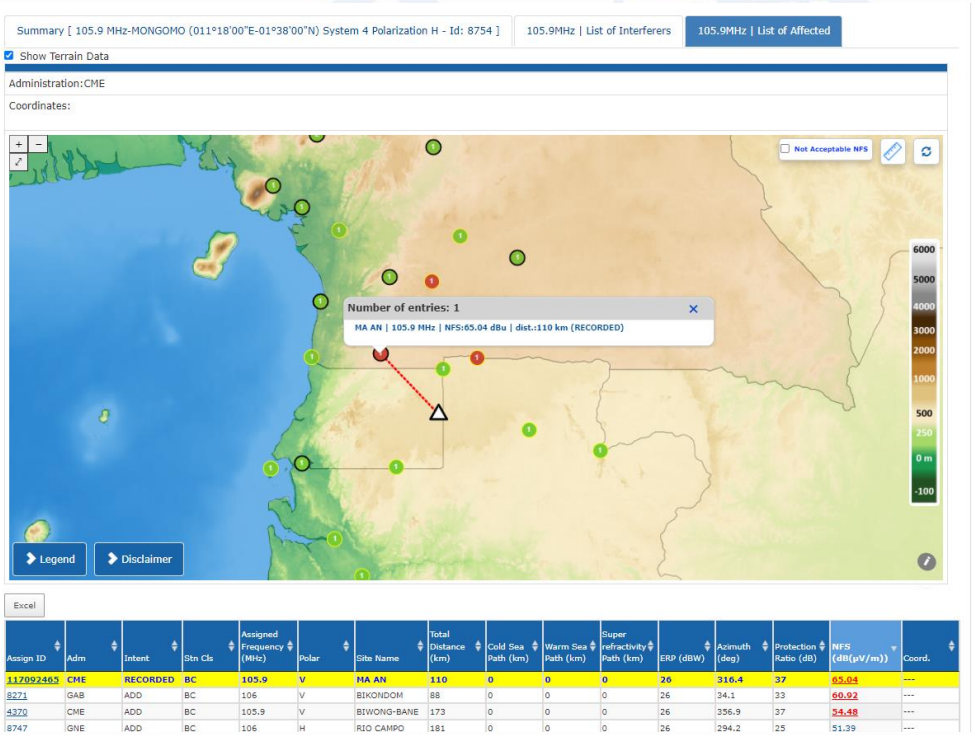
eBroadcasting

Use case: GE84 planning activities

Iteration 28

eTools: GE84Opt
implements GE84 propagation curves for 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	---
8271	GAB	ADD	BC	106	V	BIKONDOM	88	0	0	0	26	34.1	33	60.92	---
4370	CME	ADD	BC	105.9	V	BIWONG-BANE	173	0	0	0	26	356.9	37	54.48	---
8747	GNE	ADD	BC	106	H	RIO CAMPO	181	0	0	0	26	294.2	25	51.39	---

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

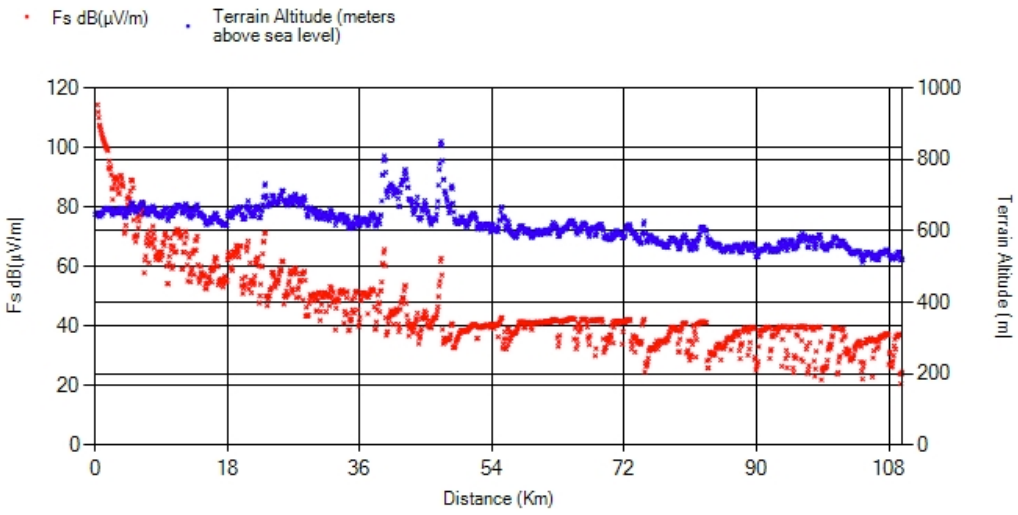
eBroadcasting

Use case: GE84 planning activities

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

105.9 MHz Mongomo VS Ma An

Distance(km)	109.8	Bearing(degree etn)	316.2	Effective Earth Radius	9611.95	Field Strength (dB µV/m)	24.55



Tropo Interference

FM (tropo)

50% location
1% time

Reduction of the interfering field due to terrain → 38.04 - 24.55 = 13.49 dB

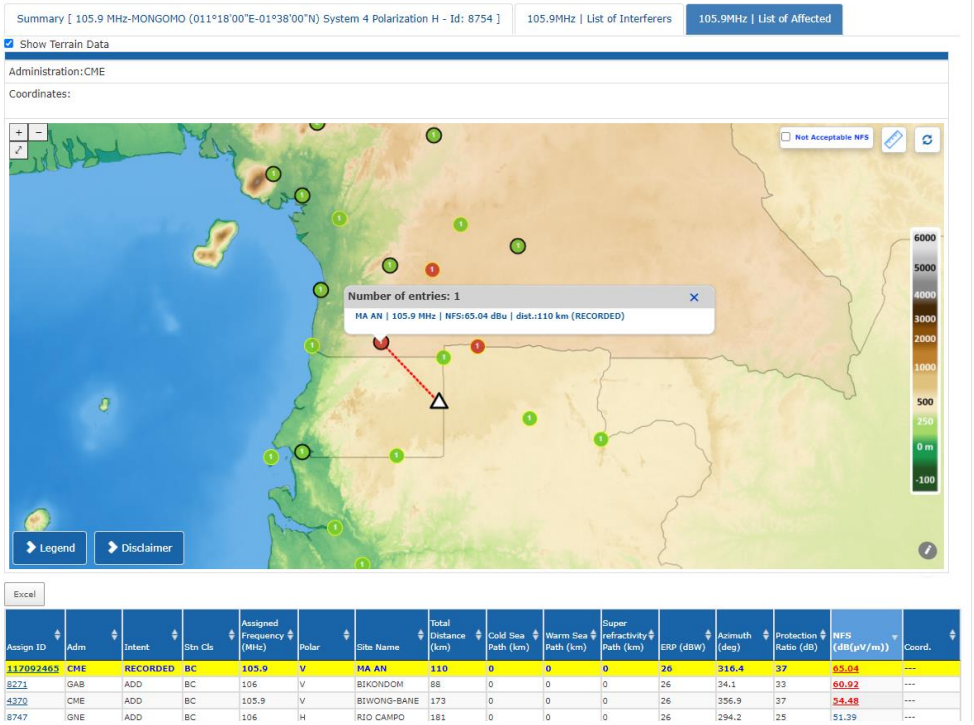
eBroadcasting

Use case: GE84 planning activities

Iteration 28

eTools: GE84Opt
implements GE84 propagation curves for 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	---
8271	GAB	ADD	BC	106	V	BIKONDOM	88	0	0	0	26	34.1	33	60.92	---
4370	CME	ADD	BC	105.9	V	BIWONG-BANE	173	0	0	0	26	356.9	37	54.48	---
8747	GNE	ADD	BC	106	H	RIO CAMPO	181	0	0	0	26	294.2	25	51.39	---

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

Reduction of the interfering field due to terrain → 13.49 dB
This reduction would make the NFS acceptable for this interference situation!
$NFS_{\ with}$ terrain profile = 65.04 – 13.49 = 51.55 dB(µV/m).

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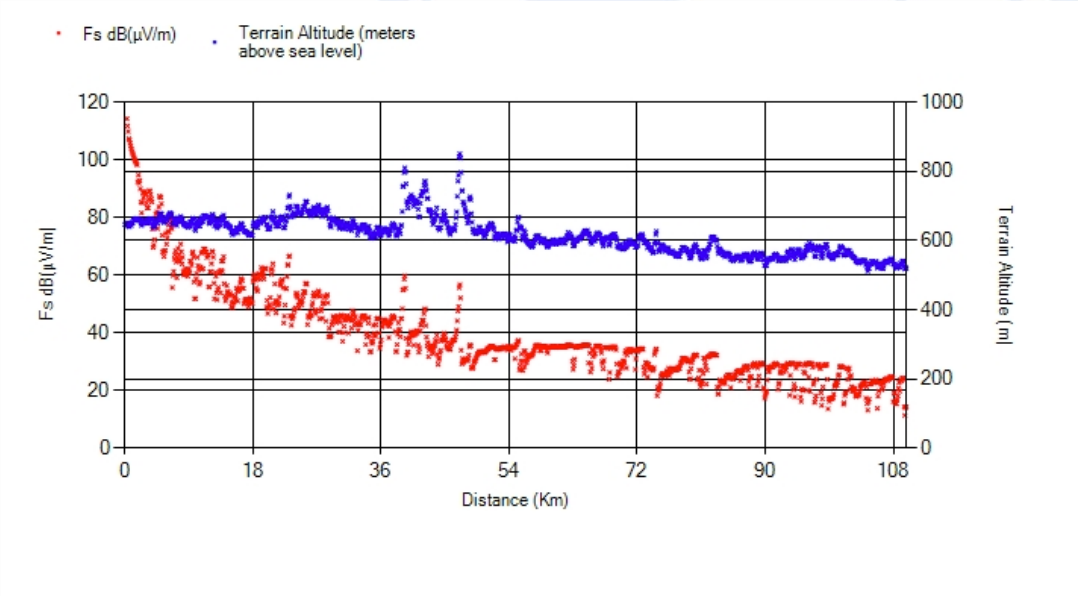
Use case: GE84 planning activities

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

105.9 MHz Mongomo VS Ma An

Distance(km)	Bearing(degree etn)	Effective Earth Radius	Field Strength (dB µV/m)
109.8	316.2	9611.95	14.39



Steady Interference

FM (steady)

50% location
50% time

NFS $_{with}$ terrain profile = 14.39 + 45 - 10 = 49.39 dB(µV/m).

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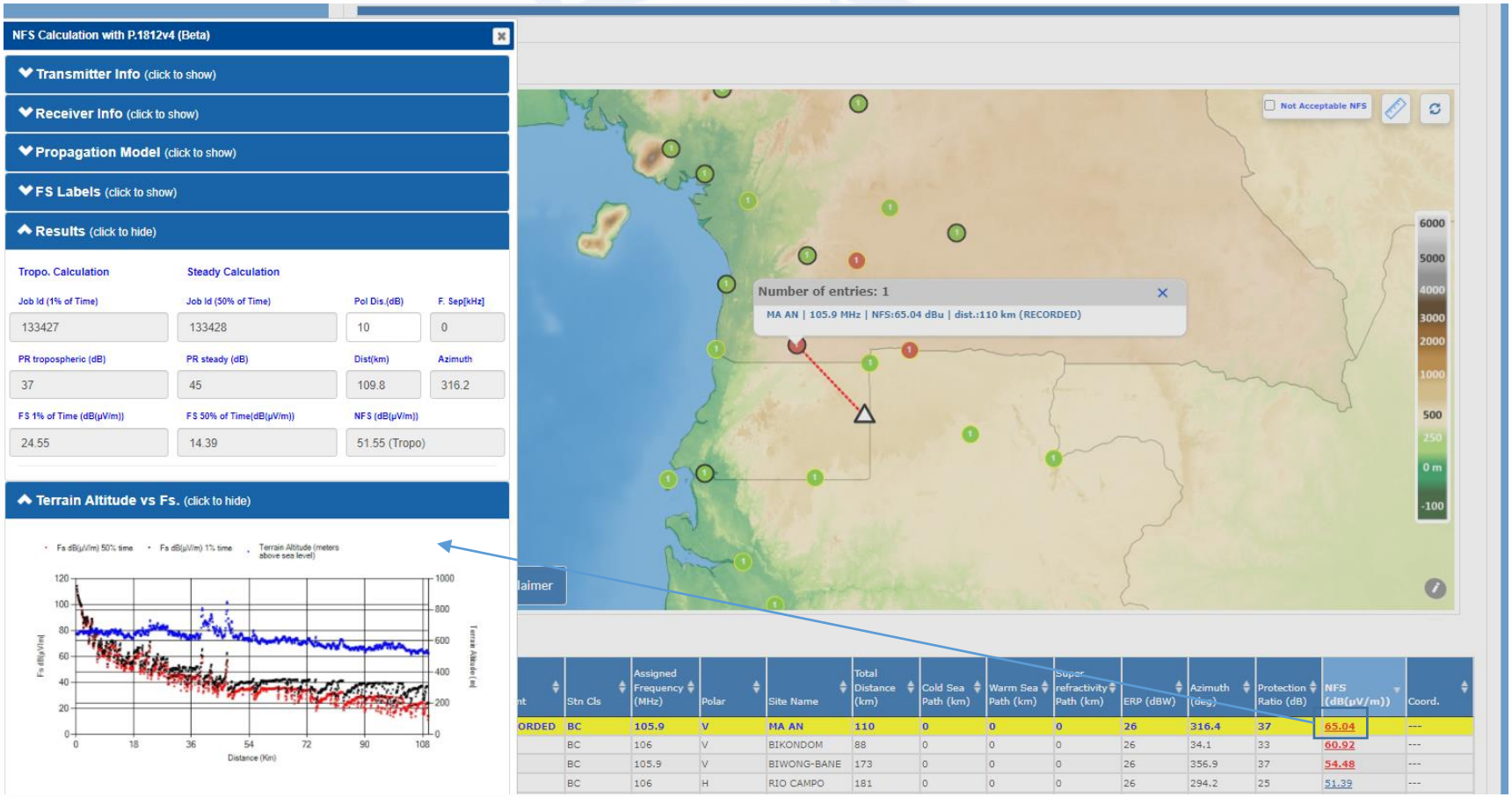
GE84 Optimization

P1812 calculation on the fly for 1% and 50% of time!



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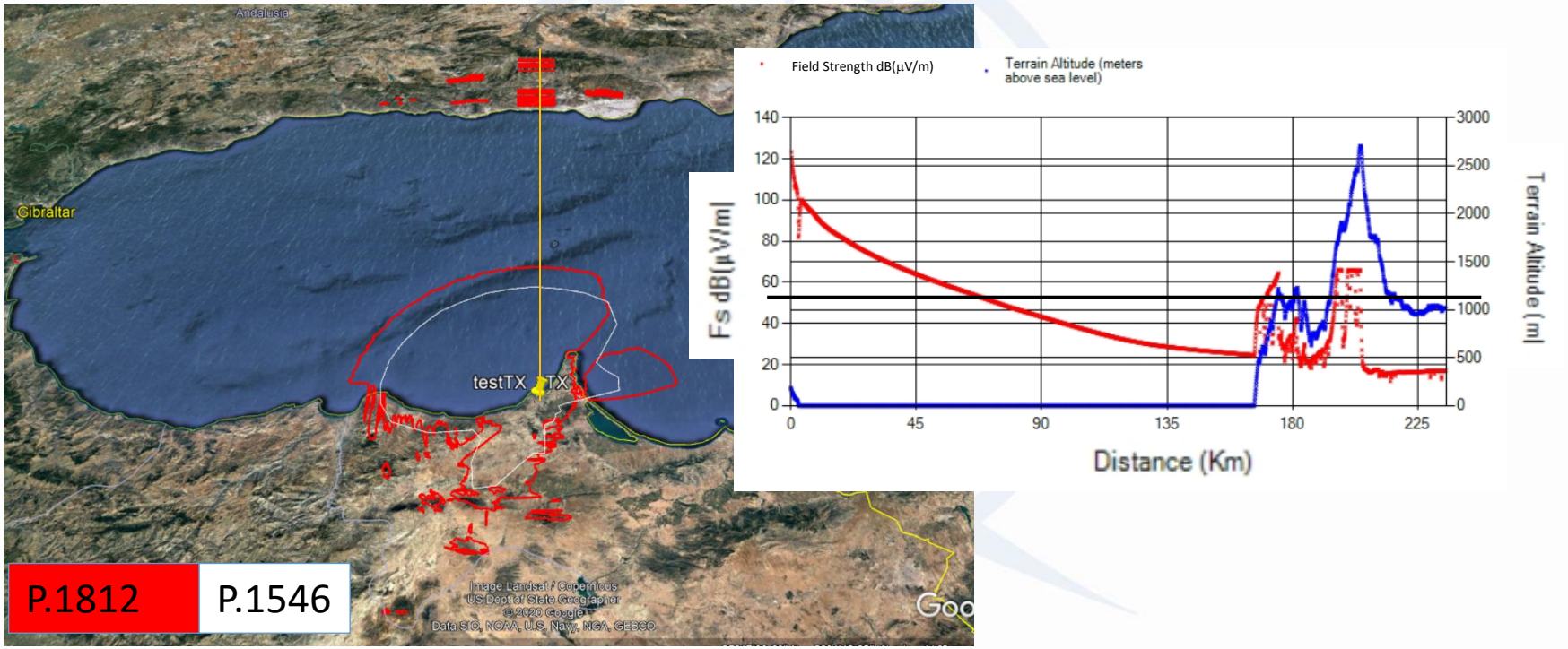
Use case: FM coverage analyses

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



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Thank you for your attention!

Questions?

brbcd@itu.int