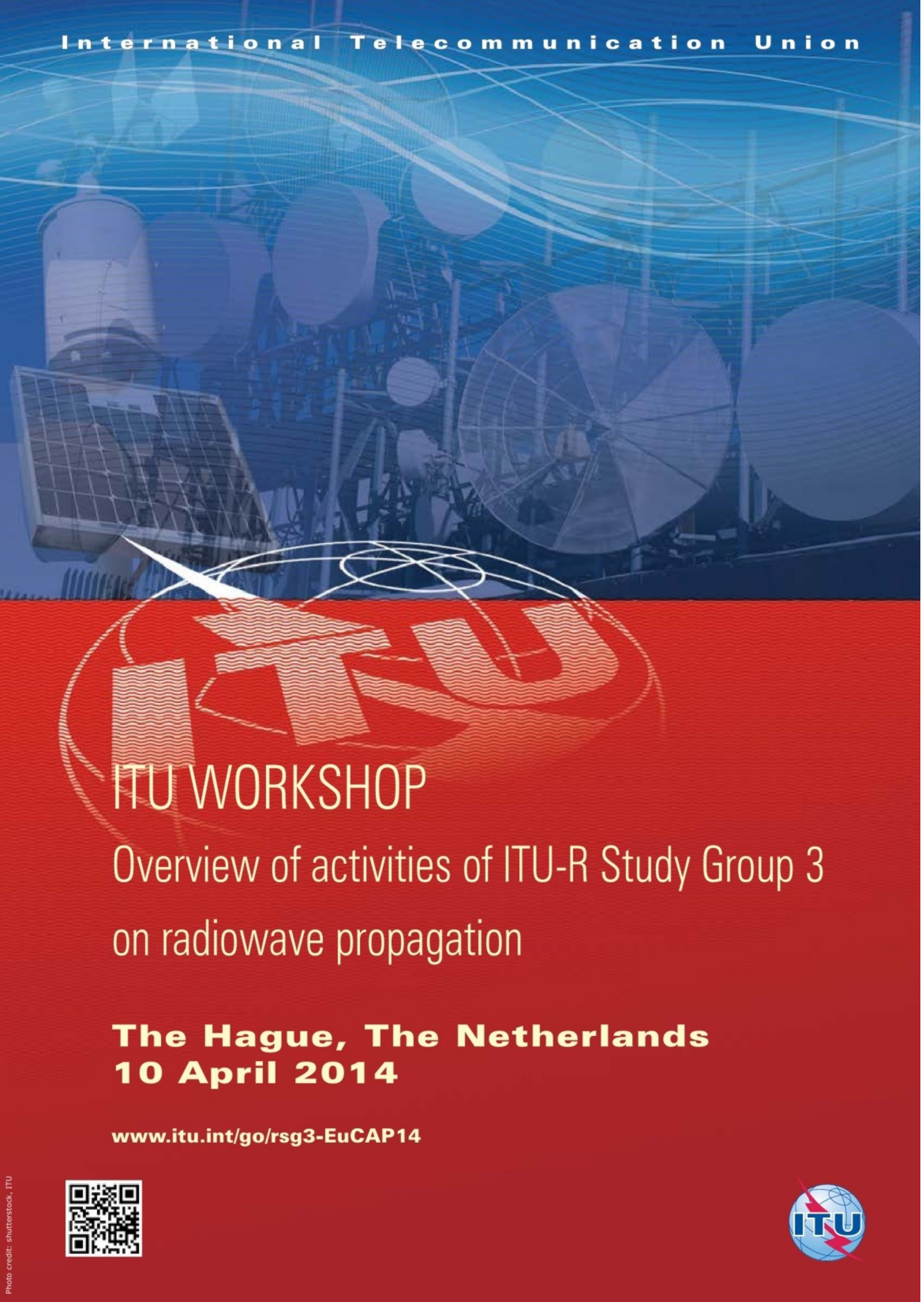

ITU WORKSHOP
Overview of activities of ITU-R
Study Group 3 on radiowave propagation:
(The Hague, 10 April 2014)

Working Party 3L

Ionospheric propagation, surface waves and radio noise

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Working Party 3L

- The Ionosphere
- Transionospheric propagation
- Terrestrial HF ionospheric propagation
- Surface Wave (ground wave) propagation
- Radio noise

The ionosphere

ITU-R Recommendation P.1239

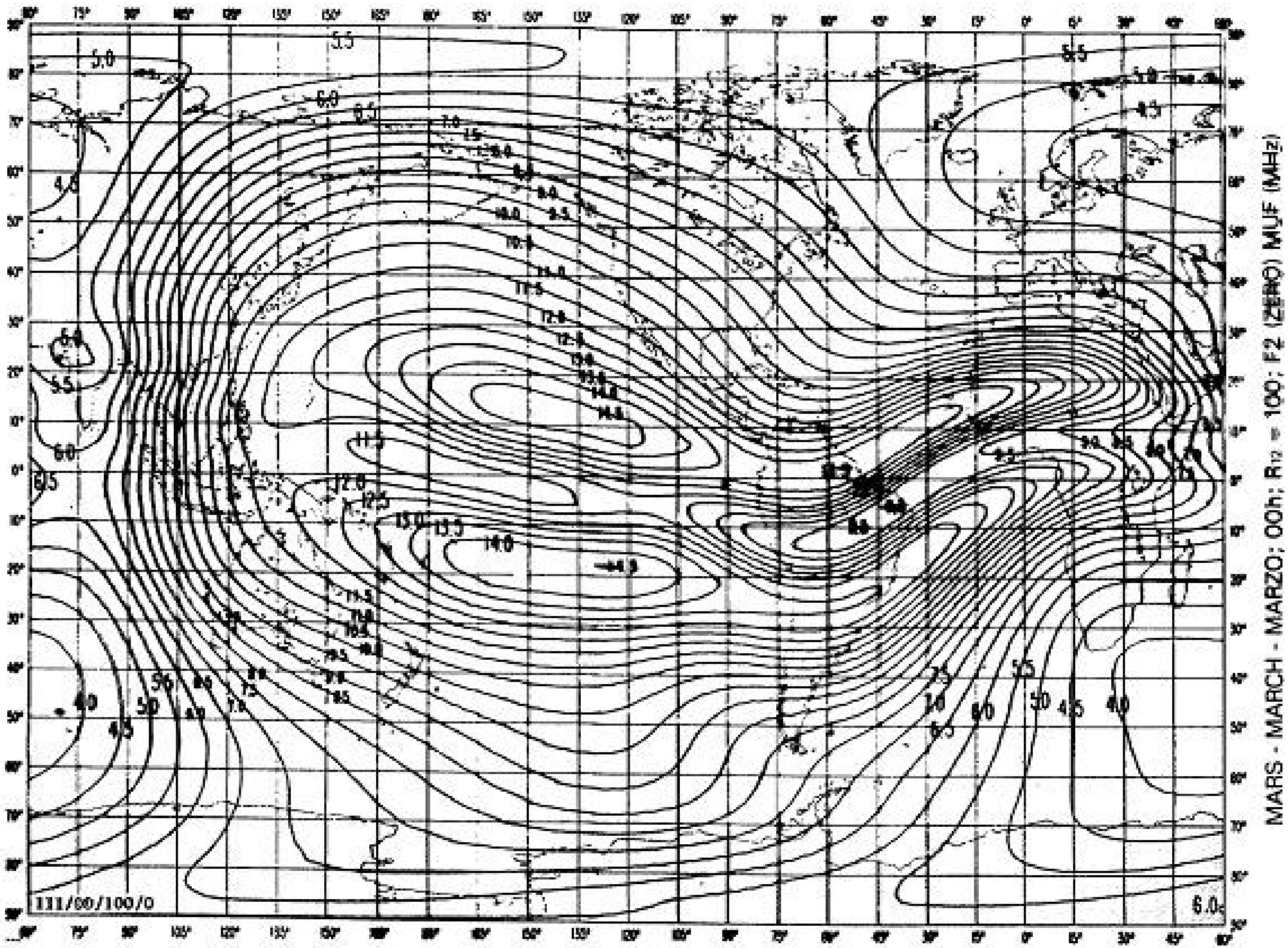
Monthly median numerical world maps of foF2 and M(3000)F2 for sunspot numbers of 0 and 100 *("the CCIR maps", Oslo 1966)*

Equation based predictions of foE and foF1

The seasonal decile variations for foF2

In addition to spherical harmonic monthly median mapping of the F2 region, the maps have also been presented as grid point maps, available amongst the SG3 software.

Example fxF2 map



Total electron content

The model for total electron content *NeQuick* is available amongst the SG3 software

http://www.itu.int/ITU-R/index.asp?category=study-groups&rlink=rsg3-software-ionospheric&lang=en

This uses the median maps of P.1239 as a basis for the electron content below the F2 maximum

New Report P.2297 describes in detail the IRI model and particularly the NeQuick model and discusses models for vertical and slant path TEC

New mapping

The maps of ITU-R Rec. P.1239 are largely based on vertical incidence ionospheric soundings from the IGY and IQSY periods (1957 – 58 and 1964 – 65) and interpolation using models for the over-ocean areas where there were no observations.

- The 1958 solar maximum may well have been anomalous.
- Since then there have been more recent ionospheric soundings (although at fewer stations)
- The Earth’s magnetic field has moved and changed.
- There are now better global ionospheric models including dynamics.
- The F2 maximum may be lower due to climate change

New mapping

- But the probable error of the medians may be of the same order as the s.d. of the within the month variability
- At least for terrestrial propagation the ray paths will not necessarily follow the great circle

Do we need updated maps?

probably yes for transionospheric paths

not so certain for terrestrial paths

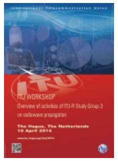
We would need new maps, with demonstrated justification, which will be valid for the next 10 years

If not, we could use the grid point representation of the current maps and apply regional updating as appropriate.

Transionospheric propagation

ITU-R Recommendation P.531 *"Ionospheric propagation data and prediction methods required for the design of satellite services and systems"*

gives guidance on the various kinds of distortion and impairment which will affect a trans-ionospheric channel.



Transionospheric propagation

Estimated maximum ionospheric effects at 1 GHz for elevation angles of about 30° one-way traversal

Effect	Magnitude	Frequency dependence
Faraday rotation	108°	$1/f^2$
Propagation delay	0.25 μs	$1/f^2$
Refraction	< 0.17 mrad	$1/f^2$
Variation in the direction of arrival	0.2 min of arc	$1/f^2$
Absorption (polar cap absorption)	0.04 dB	$\sim 1/f^2$
Absorption (auroral + polar cap absorption)	0.05 dB	$\sim 1/f^2$
Absorption (mid-latitude)	< 0.01 dB	$1/f^2$
Dispersion	0-4 ns/MHz	$1/f^3$
Scintillation	See § 4	See § 4

The Global Ionospheric Scintillation Model (GISM)

Described separately in ITU-R Report P.2097 "*The Global Ionospheric Scintillation Model (GISM)*"

The GISM algorithm is now included as a digital part of ITU-R Rec. P.531

Terrestrial HF propagation

ITU-R Recommendation P.533 "*Method for the prediction of the performance of HF circuits*" includes the prediction of path MUF, median field strength and available power, and "reliability" (the probability of achieving a specified performance)

The reliability is based on signal to noise ratio for analogue systems but also includes time and frequency spreading for digital systems. The spreading model is only for equatorial, post-sunset scattering and needs further development.

ITU-R Recommendation P.533 includes

- procedures from Rec. P.1240 "*ITU-R methods of basic MUF, operational MUF and ray-path prediction*", which also describes the way of using an equivalent mirror reflection height so as to use simple triangular ray paths.
- radio noise data from Rec. P.372 *"radio noise"*
- the reliability calculation procedure from Rec. P.842 "C*omputation of reliability and compatibility of HF radio systems"*
- antenna directivity patterns from Rec. BS.705 "*HF transmitting and receiving antennas characteristics and diagrams*", and others

ITURHFPROP

The newly rewritten program ITUHFPROP provides a prediction procedure for the method of Rec.P.533 plus all the other parts from other Recommendations.

(the previous version of the program was called REC533, but this was misleading because of the broader scope of the content)

The program is available on the SG3 website at: *http://www.itu.int/oth/R0A0400006F/en*

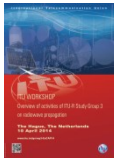
Surface wave propagation

WP3L deals with aspects of surface wave (ground wave) propagation relevant at the lower frequencies – where both ground- and sky-wave propagation may be active.

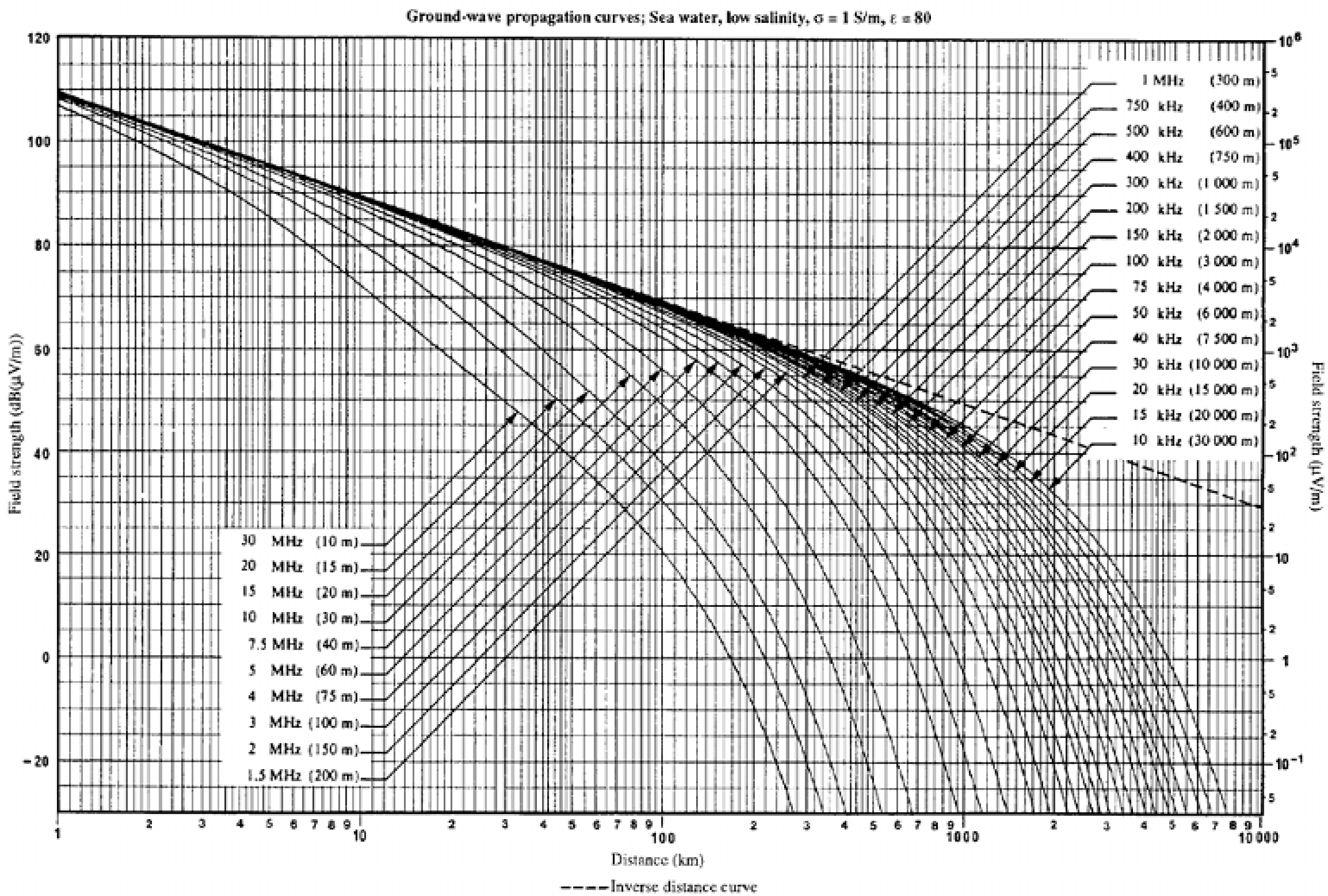
The long standing curves for propagation at MF over imperfect smooth earth are given in Rec. P.368, together with the method for paths over mixed conductivities

The program GRWAVE is available, which includes paths with elevated terminals

Effective ground conductivity maps for MF have been provided by administrations in Rec. P.832



Example from Rec. P368



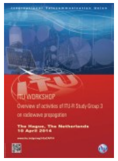
Ground Wave handbook

Recent priority has been the new

"Handbook on Ground Wave Propagation"

- to be published shortly

This includes the more "classical" material, and also brings together much information on propagation in built-up areas and the effect of obstructions, etc.



Radio noise

External radio noise, arriving at the receiver through the antenna, is often the limit to system performance.

Predictions are given for the various types of external noise in Rec. P.372 *"radio noise"*

These are:

- Noise due to lightning (at frequencies up to the HF MUF)
- Noise from the galaxy
- Noise due to tropospheric gases (at frequencies above about 10 GHz)
- Man-made noise (at frequencies up to UHF)

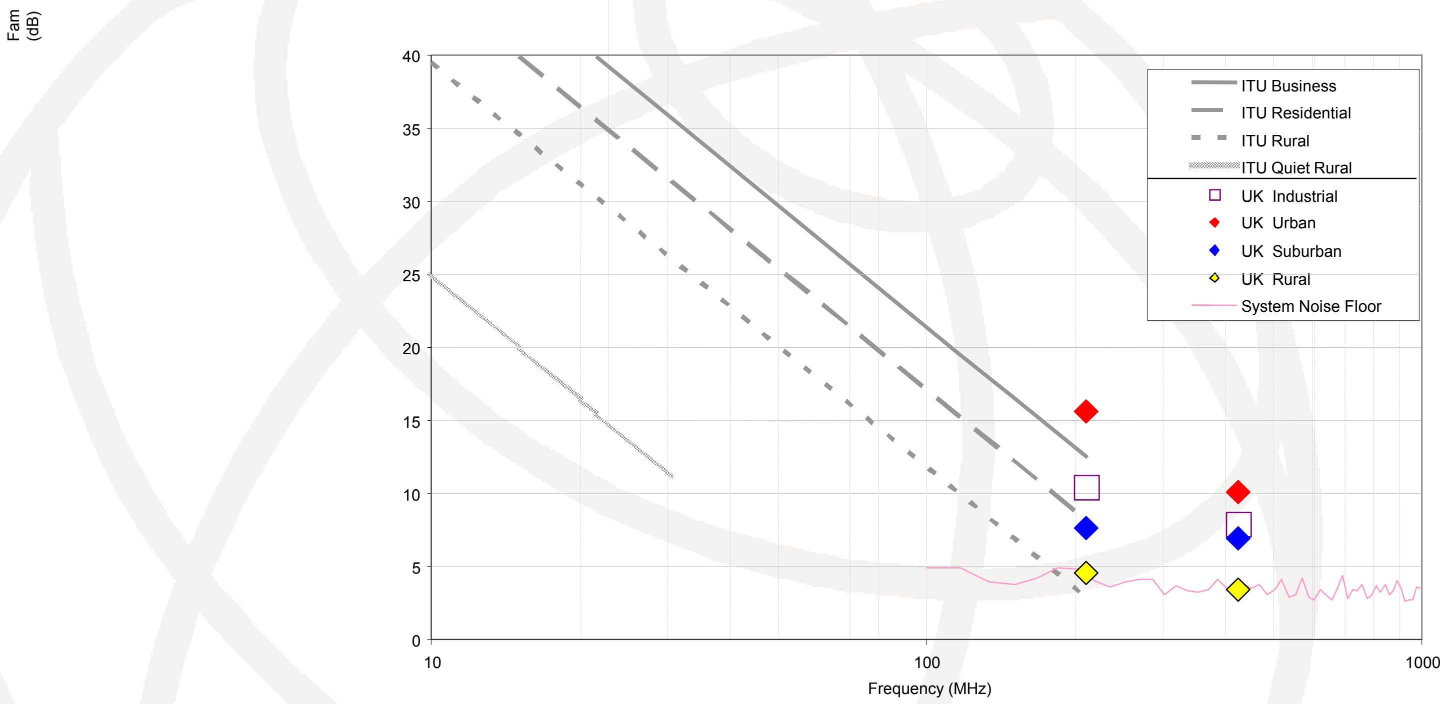
Recent activity has been in measuring man-made noise, particularly at VHF

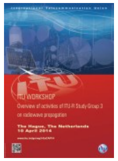
Radio noise

WP3L has established a new noise databank, with a view to a future revision of parts of Rec. P.372

Report P.2089 *"The analysis of radio noise data"* describes a procedure for characterising impulsive noise

New measurements are important because of the great increase in man-made noise sources (e.g. some telecommunication networks, and power converters), and because on the increasing pressure for spectrum usage.


Fam (dB)
40
35
30
25
20
15
10
5
0
10
100
1000
Frequency (MHz)
ITU Business
ITU Residential
ITU Rural
ITU Quiet Rural
UK Industrial
UK Urban
UK Suburban
UK Rural
System Noise Floor



ITU-R texts relevant to WP3L

Recommendations

P.368-9	Ground-wave propagation curves for frequencies between 10 kHz and 30MHz
P.371-8	Choice of indices for long-term ionospheric predictions
P.372-11	Radio noise
P.373-9	Definitions of maximum and minimum transmission frequencies
P.527-3	Electrical characteristics of the surface of the earth
P.533-12	Method for the prediction of the performance of HF circuits
P.534-5	Method for calculating sporadic-E field strength
P.684-6	Prediction of field strength at frequencies below about 150 kHz
P.832-3	World atlas of ground conductivities
P.842-5	Computation of reliability and compatibility of HF radio systems
P.843-1	Communication by meteor-burst propagation
P.844-1	Ionospheric factors affecting frequency sharing in the VHF and UHF bands
P.845-3	HF field-strength measurement
P.846-1	Measurements of ionospheric and related characteristics
P.1060	Propagation factors affecting frequency sharing in HF terrestrial systems
P.1147-4	Prediction of sky-wave field strength at frequencies between about 150 & 1700 kHz
P.1148-1	Standardized procedure for comparing predicted and observed HF sky-wave signal intensities
P.1239-3	ITU-R reference ionospheric characteristics
P.1240-1	ITU-R methods of basic MUF, operational MUF and ray-path prediction
P.1321-4	Propagation factors affecting systems using digital modulation techniques at LF & MF

Current ITU-R Reports

P.2011-1	Propagation at frequencies above the basic MUF
P.2089	The analysis of radio noise data
P.2097	Transionospheric radio propagation - The Global Ionospheric Scintillation Model GISM)
P.2287	Electron density models and data for transionospheric radio propagation

Handbooks

Curves for Radiowave Propagation over the Surface of the Earth

Ionosphere and its Effects on Radiowave Propagation

Ground Wave Propagation