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International Telecommunication Union
Radiocommunication Sector

Recommendation ITU-R P.311-19

(11/2025)

P Series: Radio-wave propagation

Acquisition, presentation and analysis of data in studies of radiowave propagation

Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

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ITU-R policy on IPR is described in the Common Patent Policy for ITU-T/ITU-R/ISO/IEC referenced in Resolution ITU-R 1. Forms to be used for the submission of patent statements and licensing declarations by patent holders are available from https://www.itu.int/ITU-R/go/patents/en where the Guidelines for Implementation of the Common Patent Policy for ITU-T/ITU-R/ISO/IEC and the ITU-R patent information database can also be found.

Series of ITU-R Recommendations

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Series	Title
BO	Satellite delivery
BR	Recording for production, archival and play-out; film for television
BS	Broadcasting service (sound)
BT	Broadcasting service (television)
F	Fixed service
M	Mobile, radiodetermination, amateur and related satellite services
P	**Radio-wave propagation**
RA	Radio astronomy
RS	Remote sensing systems
S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
V	Vocabulary and related subjects

Note: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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RECOMMENDATION ITU-R P.311-19

Acquisition, presentation and analysis of data in studies of radiowave propagation

(1953-1956-1959-1970-1974-1978-1982-1990-1992-1994-1997-1999-2001-2003-2005-2009-2013-2015-2016-2017-2021-2025)

Scope

Recommendation ITU-R P.311 describes the experimental data used by Study Group 3 and the data acceptance criteria. This database is used to test propagation models considered by Study Group 3 Working Parties.

Keywords

Experimental data, radio-wave propagation, acquisition and presentation of data

The ITU Radiocommunication Assembly,

considering

a) that for the design of communication systems, propagation prediction models with global validity are necessary;

b) that propagation and radiometeorological data are of fundamental importance for the development and testing of such prediction models;

c) that, to facilitate the comparison of data and results, it is desirable to acquire and present propagation and radiometeorological data in a uniform manner,

recommends

that data on radio-wave propagation intended for studies relevant to Radiocommunication Study Group 3 should follow the principles and formats contained in Annex 1.

Annex 1

Data banks to support evaluation of prediction methods

1 Introduction

One of the essential requirements for the provision of reliable methods for prediction of radio propagation effects is the establishment of suitable computer data banks. Such data banks must:

– contain all data available that are of an adequate standard;

– be widely accepted as the source material on which to conduct testing;

– be readily available.

It is a principle of the data banks that they shall contain only such data as may be used for:

– testing prediction methods recommended by Radiocommunication Study Group 3 (and may of course be used to test other methods); and

– for the creation and updating of radiometeorological maps relevant to the prediction of radio propagation effects.

In special cases in studies on tropospheric propagation, where no prediction method has been adopted by Radiocommunication Study Group 3, tabular data remain in the annex of the relevant Recommendation to give guidance to the reader from the best measured data currently available.

The current data banks relate to:

– evaluation of prediction methods for terrestrial line-of-sight propagation;

– evaluation of prediction methods for Earth-space propagation;

– evaluation of prediction methods for interference or reliability over trans-horizon paths;

– radiometeorological data;

– evaluation of prediction methods for terrestrial land mobile services;

– evaluation of prediction methods for terrestrial broadcasting services;

– evaluation of prediction methods for mobile-satellite services;

– vegetation and building data;

– radio noise;

– trans-ionospheric data.

Administrations are urged to submit their data to Radiocommunication Study Group 3 and/or the relevant Working Party (WP) in accordance with the requirements given in this Annex. Section 2 outlines the more administrative aspects related to the data banks, and the procedure for input of the new data for inclusion in the data banks. Section 3 gives the criteria with which the data submitted must comply prior to being accepted. Section 4 lists all the tables of the data banks.

Blank pro forma for the data, showing in detail the nature and format of data required/available, are freely available from that part of the ITU-R website concerning Radiocommunication Study Group 3.

Moreover, the total data banks are available in spreadsheet form from the same website. Paper and diskette copies of the format sheets, and diskette copies of the total data bank, can be made available, on request, from the Radiocommunication Bureau (BR).

Table III-1a is currently available as a separate database. The Table currently includes approximately 100 000 measurements recorded over 1 326 paths. They were obtained from measurements lasting from 10 min to 1 h. The database is also available from the Radiocommunication Study Group 3 website.

2 Responsibilities and updates

The responsibility for the data banks lies with Radiocommunication Study Group 3, taking full advantage of the WPs for technical input and management, and the services of the BR for publication and distribution. Responsibility as to the accuracy and significance of the data remains with the authors given in the references and/or with the administrations that have submitted the data. However, in order to facilitate the transformation of the given data to computer-data, and to ensure the quality of the data banks, the data shall first be reviewed by the relevant WP according to the set of criteria explained in § 3. Non-compliant data may still be accepted after additional information and/or adequate explanations are sought and received from the relevant administration.

Ensuring adequate procedures for technical maintenance and production of the data banks will be a continuing requirement to keep under review. It is proposed that each table of the data bank be allocated to a WP to consider, and that the relevant WPs nominate, for each table for which they are responsible, an individual to coordinate updates.

3 Acceptance criteria

Data given for inclusion in the data banks will be reviewed as to their suitability according to the following criteria:

– The information on the data for the evaluation shall be provided using the template described in the blank proforma documents (defined as SG 3 Databanks – Formatted Tables).

– All the data shall be provided in computer files using the file format indicated by Study Group 3.

– Compliance of the given information with the formats described in the blank proforma. In particular, the units of measure should consistently adhere to the ones listed in the table description sheets. With few exceptions they are based on the international system of units (SI system). For the definitions of terms, see Recommendation ITU-R P.310. It is recommended to use copies of the tables in the pro forma for submission of the data and to enter additional important information under “Remarks”.

– For Tables I-1 and II-1, cumulative statistics of rainfall rate, rain attenuation and total attenuation, strictly concurrent data are requested. Strictly concurrent data means that the statistical analysis of rainfall rate and attenuation data shall only include measurements collected during identical time periods. In addition, if periods of rain attenuation or of total attenuation data are missing or are marked as invalid due to system failure or malfunction, then these periods of rainfall rate data shall be excluded from the statistical analysis for Tables I-1 and II-1. The same process shall be applied to rain attenuation or total attenuation data in the case of invalid periods of rainfall rate measurements. In any case the full statistics of valid rainfall rate data shall be provided in Table IV-1.

– For long-term, and yearly cumulative statistics the observation period shall be an integer multiple of 12 months and the equipment up-time should be at least 90% of the total time reported.

– The worst-month and monthly cumulative statistics (see Recommendation ITU-R P.581) must have been derived from all the 12 monthly statistics of the relevant year. The equipment up-time must be at least 75% of each month.
– Accuracy of interpolation: when converting the measured cumulative statistics into the format requested (for several fixed percentages), interpolation may be required. For this, a sufficiently large number of reference levels must be chosen such that for successive reference levels the ratio of the probabilities is greater than 0.8 and less than 1.25. Extrapolated values should not be submitted.
– For terrestrial wideband data the receiver dynamic range should be at least 18 dB to provide for a minimum peak-to-noise ratio of 15 dB.

For rainfall rate statistics, it is preferable that an integration time of 1 min be used for consistency with the prediction methods of Radiocommunication Study Group 3.

The reviewers of the given data shall apply the above criteria. In special cases, however, some of the criteria may be relaxed (e.g. in multipath phenomena the fade statistics show a definite linear trend in the tail of the distribution when plotted on a logarithmic-linear graph, so that interpolation becomes less of a problem). It is also appropriate to apply less stringent acceptance criteria in cases where the statistical data come from a region that is hardly represented in the respective data table. Data which are accepted in spite of not meeting the acceptance criteria (due to reasons given above) will be marked with a particular flag by the responsible table coordinator and are subject to removal from the data bank once a sufficient number of fully compliant data have been entered.

4 List of the data banks of Radiocommunication Study Group 3 concerning tropospheric propagation

4.1 Part I: Terrestrial line-of-sight path data

Table I-1: Line-of-sight rain attenuation statistics

Table I-2: Line-of-sight average worst-month multipath fading and enhancement in narrow bandwidths

Table I-3: Line-of-sight diversity data

Table I-4: Line-of-sight clear sky XPD and CPA statistics

Table I-5: Line-of-sight XPD and CPA statistics due to precipitation

Table I-6: Line-of-sight worst-month multipath channel characteristics and outage times

Table I-7: Line-of-sight multi-hop worst-month multipath fading and enhancement

Table I-8: Line-of-sight number of fade events and fade duration statistics

Table I-9: Line-of-sight annual attenuation statistics at optical wavelengths

Table I-10: Line-of-sight worst month attenuation statistics at optical wavelengths

Table I-11: Line-of-sight annual statistics of frequency diversity for millimeter wave and optical links

Table I-12: Line-of-sight worst month statistics of frequency diversity for millimeter wave and optical links

Table I-13: Line-of-sight time diversity statistics

Table I-14: Line-of-sight joint and differential rain attenuation statistics

Table I-15: Rain and fog attenuation on free-space optical terrestrial links

4.2 Part II: Earth-space path data

Table II-1: Slant path annual and monthly statistics of total attenuation, rain attenuation and rain rate

Table II-2: Slant path worst-month rain attenuation statistics

Table II-3: Slant path fade duration statistics

Table II-4: Slant path site diversity statistics

Table II-5a: Slant path annual XPD statistics

Table II-5b: Slant path annual XPD statistics conditioned to CPA

Table II-6: Slant path annual and monthly statistics of amplitude scintillations

Table II-7: Slant path standard deviations of scintillations

Table II-8: Slant path fade slope statistics

Table II-9: Slant path time diversity statistics

Table II-10: Slant path instantaneous frequency scaling statistics

Table II-11: Slant path standard deviations of differential path length

Table II-12: Slant path inter-fade duration statistics

4.3 Part III: Terrestrial trans-horizon path and rain scatter data

Table III-1: Clear-air trans-horizon basic transmission loss statistics

Table III-1a: Clear-air spot measurement data. (This table is a separate data bank (see § 1))

Table III-2: Rain scatter on terrestrial paths

Table III-3: Joint signal level probability distributions

4.4 Part IV: Radiometeorological data

Table IV-1: Annual and monthly statistics of rain intensity

Table IV-2: Rain integration time conversion factor

Table IV-3: Annual and monthly statistics of sky noise temperature

Table IV-4: Statistics of mean surface refractivity

Table IV-5: Statistics of rain event duration

Table IV-6: Statistics of evaporation ducts

Table IV-7: Statistics of cloud cover

Table IV-8: Spatial statistics dependence of rain intensity

Table IV-9: Annual and monthly statistics of total columnar water vapour content

Table IV-10: Annual and monthly statistics of total columnar cloud liquid water content

Table IV-11: Statistics of rain cell characteristics parameters

Table IV-12: Statistics rain drop size distribution

Table IV-13: Annual and monthly statistics of tropospheric excess path length

4.5 Part V: Terrestrial land mobile data

Table V-1: Terrestrial land mobile wideband statistics

Table V-2: Terrestrial land mobile narrow-band statistics

4.6 Part VI: Terrestrial point-to-area data

Table VI-1: Terrestrial point-to-area data

4.7 Part VII: Data for mobile-satellite services

Table VII-1: Wideband statistics for mobile-satellite links

Table VII-2: Narrow-band statistics of maritime mobile-satellite links

Table VII-3: Narrow-band statistics of land mobile-satellite links

Table VII-4: Narrow-band statistics of aeronautical mobile-satellite links

Table VII-5: Narrow-band statistics of broadcasting-satellite fades and fade durations

Table VII-6: Narrow-band statistics of aeronautical mobile-ground links

Table VII-7: Wideband statistics of aeronautical mobile-ground links

4.8 Part VIII: Vegetation and building data

Table VIII-1: Vegetation attenuation

Table VIII-2: Building entry loss

Table VIII-3: Loss characteristics of materials

4.9 Part IX: Noise

Table IX-1: Radio noise outdoor (additive white Gaussian noise)

Table IX-2: Radio noise indoor (cumulative distribution function)

4.10 Part X: Trans-ionospheric data

Table X-1: Trans-ionospheric scintillation index along a slant path

Table X-2: Total electron content along a slant path

4.11 Part XI: Short–range path data

Table XI-1: Indoor site-general basic transmission loss.

Table XI-2: Outdoor site-general basic transmission loss

4.12 Part XII: Clutter data

Table XII-1: Clutter loss