Recommendation ITU-R P.837-6
(02/2012)

Characteristics of precipitation for propagation modelling

P Series
Radiowave propagation
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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.837-6

Characteristics of precipitation for propagation modelling


Scope

Recommendation ITU-R P.837 contains maps of meteorological parameters that have been obtained using the European Centre for Medium-Range Weather Forecast (ECMWF) ERA-40 re-analysis database, which are recommended for the prediction of rainfall rate statistics with a 1-min integration time, when local measurements are missing.

Rainfall rate statistics with a 1-min integration time are required for the prediction of rain attenuation in terrestrial and satellite links. Data of long-term measurements of rainfall rate may be available from local sources, but only with higher integration times. This Recommendation provides a method for the conversion of rainfall rate statistics with a higher integration time to rainfall rate statistics with a 1-min integration time.

The ITU Radiocommunication Assembly,

considering

a) that information on the statistics of precipitation intensity is needed for the prediction of attenuation and scattering caused by precipitation;

b) that the information is needed for all locations on the globe and a wide range of probabilities;

c) that rainfall rate statistics with a 1-min integration time are required for the prediction of rain attenuation and scattering in terrestrial and satellite links;

d) that long-term measurements of rainfall rate may be available from local sources with a 1-min integration time and also, with integration times of longer than 1-min,

e) that using a model to convert local measurements with integration times up to 1 hour has been observed to provide higher accuracy than the use of the global digital maps in Annex 1 of this Recommendation,

recommends

1 that the model in Annex 1 should be used to obtain the rainfall rate, \( R_p \), exceeded for any given percentage of the average year, \( p \), and for any location (with an integration time of 1 min). This model is to be applied to the data supplied in the digital files ESARAIN_xxx_v5.TXT (the data files may be obtained from that part of the ITU-R website dealing with Radiocommunication Study Group 3);

2 that, for easy reference, Figs 1 to 6 in Annex 2 should be used to select the rainfall rate exceeded for 0.01% of the average year. These figures were also derived from the model and data described in Annex 1;

3 that local long-term measurements of rainfall rate with a 1-min integration time should be used if available;
that long-term measurements of rainfall rate with longer integration times should be used if
available and the model in Annex 3 be used to convert to rainfall rate with a 1-min integration time;
that local measurements, if used, are collected over a sufficient period (typically longer than
3 years), to ensure statistical stability.

Annex 1

Model to derive the rainfall rate exceeded for a given probability of the average year and a given location

The data files ESARAIN_PR6_v5.TXT, ESARAIN_MT_v5.TXT and ESARAIN_BETA_v5.TXT contain respectively the numerical values for the variables $P_{r6}$, $M_t$ and $\beta$ while data files
ESARAINLAT_v5.TXT and ESARAINLON_v5.TXT contain the latitude and longitude of each of
the data entries in all other files. These data files were derived from 40 years of data from the
European Centre of Medium-range Weather Forecast (ECMWF).

Step 1: Extract the variables $P_{r6}$, $M_t$ and $\beta$ for the four points closest in latitude (Lat) and longitude
(Lon) to the geographical coordinates of the desired location. The latitude grid is from $+90^\circ$ N to
$-90^\circ$ S in $1.125^\circ$ steps; the longitude grid is from $0^\circ$ to $360^\circ$ in $1.125^\circ$ steps.

Step 2: From the values of $P_{r6}$, $M_t$ and $\beta$ at the four grid points, obtain the values $P_{r6}(\text{Lat},\text{Lon})$, $M_t(\text{Lat},\text{Lon})$ and $\beta(\text{Lat},\text{Lon})$ at the desired location by performing a bi-linear interpolation, as
described in Recommendation ITU-R P.1144.

Step 3: Convert $M_T$ and $\beta$ to $M_c$ and $M_s$ as follows:

\[ M_c = \beta M_T \]
\[ M_s = (1-\beta) M_T \]

Step 4: Derive the percentage probability of rain in an average year, $P_0$, from:

\[ P_0(\text{Lat},\text{Lon}) = P_{r6}(\text{Lat},\text{Lon}) \left( 1 - e^{-0.0079(M_c(\text{Lat},\text{Lon})/P_{r6}(\text{Lat},\text{Lon}))} \right) \] (1)

If $P_{r6}$ is equal to zero, the percentage probability of rain in an average year and the rainfall rate
exceeded for any percentage of an average year are equal to zero. In this case, the following steps
are unnecessary.

Step 5: Derive the rainfall rate, $R_p$, exceeded for $p\%$ of the average year, where $p \leq P_0$, from:

\[ R_p(\text{Lat},\text{Lon}) = \frac{-B + \sqrt{B^2 - 4AC}}{2A} \text{ mm/h} \] (2)

where:

\[ A = a b \] (2a)
\[ B = a + c \ln(p/P_0(\text{Lat},\text{Lon})) \] (2b)
\[ C = \ln(p/P_0(\text{Lat},\text{Lon})) \] (2c)
and

\[ a = 1.09 \] (2d)

\[ b = \frac{(M_c(\text{Lat}, \text{Lon}) + M_a(\text{Lat}, \text{Lon}))}{21797P_0} \] (2e)

\[ c = 26.02b \] (2f)

NOTE 1 – An implementation of this model and the associated data in MATLAB is also available from the ITU-R website dealing with Radiocommunication Study Group 3.
FIGURE 1
Rain rate (mm/h) exceeded for 0.01% of the average year
FIGURE 2
Rain rate (mm/k) exceeded for 0.01% of the average year
FIGURE 3
Rain rate (mm/h) exceeded for 0.01% of the average year
FIGURE 4
Rain rate (mm/h) exceeded for 0.01% of the average year
FIGURE 5

Rain rate (mm/h) exceeded for 0.01% of the average year
FIGURE 6
Rain rate (mm/h) exceeded for 0.01% of the average year
FIGURE 7
Rain rate (mm/h) exceeded for 0.01% of the average year
Annex 3

1. The cumulative distribution of rainfall rate at 1-min integration time can be obtained by converting local cumulative distributions measured at integration times of between 5 and 60 minutes.

2. The recommended method requires as input both the cumulative distribution as well as the integration time of the source rainfall statistics and the geographical coordinates of the site of interest.

3. The method is based on the simulated movement of synthetic rain cells, whose parameters derive from the local input data and ECMWF products.
The recommended method is incorporated in a computer program available from the ITU-R website dealing with Radiocommunication Study Group 3. The name of the software package implementing this part of the recommendation is CONVRRSTAT_ANNEX3_P837-6.ZIP.