

International Telecommunication Union

ITU-R
Radiocommunication Sector of ITU

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

**Characteristics of precipitation
for propagation modelling**

P Series
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.

Policy on Intellectual Property Right (IPR)

ITU-R policy on IPR is described in the Common Patent Policy for ITU-T/ITU-R/ISO/IEC referenced in Annex 1 of Resolution ITU-R 1. Forms to be used for the submission of patent statements and licensing declarations by patent holders are available from <http://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

(Also available online at <http://www.itu.int/publ/R-REC/en>)

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	Radiowave 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.

Electronic Publication
Geneva, 2013

© ITU 2013

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without written permission of ITU.

RECOMMENDATION ITU-R P.837-6

Characteristics of precipitation for propagation modelling

(Question ITU-R 201/3)

(1992-1994-1999-2001-2003-2007-2012)

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;

- 4 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;
- 5 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 β 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 β 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° N to -90° S in 1.125° steps; the longitude grid is from 0° to 360° in 1.125° steps.

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

Step 3: Convert M_T and β to M_c and M_s as follows:

$$\begin{aligned} M_c &= \beta M_T \\ M_s &= (1-\beta) M_T \end{aligned}$$

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

$$P_0(Lat, Lon) = P_{r6}(Lat, Lon) \left(1 - e^{-0.0079(M_s(Lat, Lon)/P_{r6}(Lat, Lon))} \right) \quad (1)$$

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:

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

where:

$$A = a b \quad (2a)$$

$$B = a + c \ln(p/P_0(Lat, Lon)) \quad (2b)$$

$$C = \ln(p/P_0(Lat, Lon)) \quad (2c)$$

and

$$a = 1.09 \quad (2d)$$

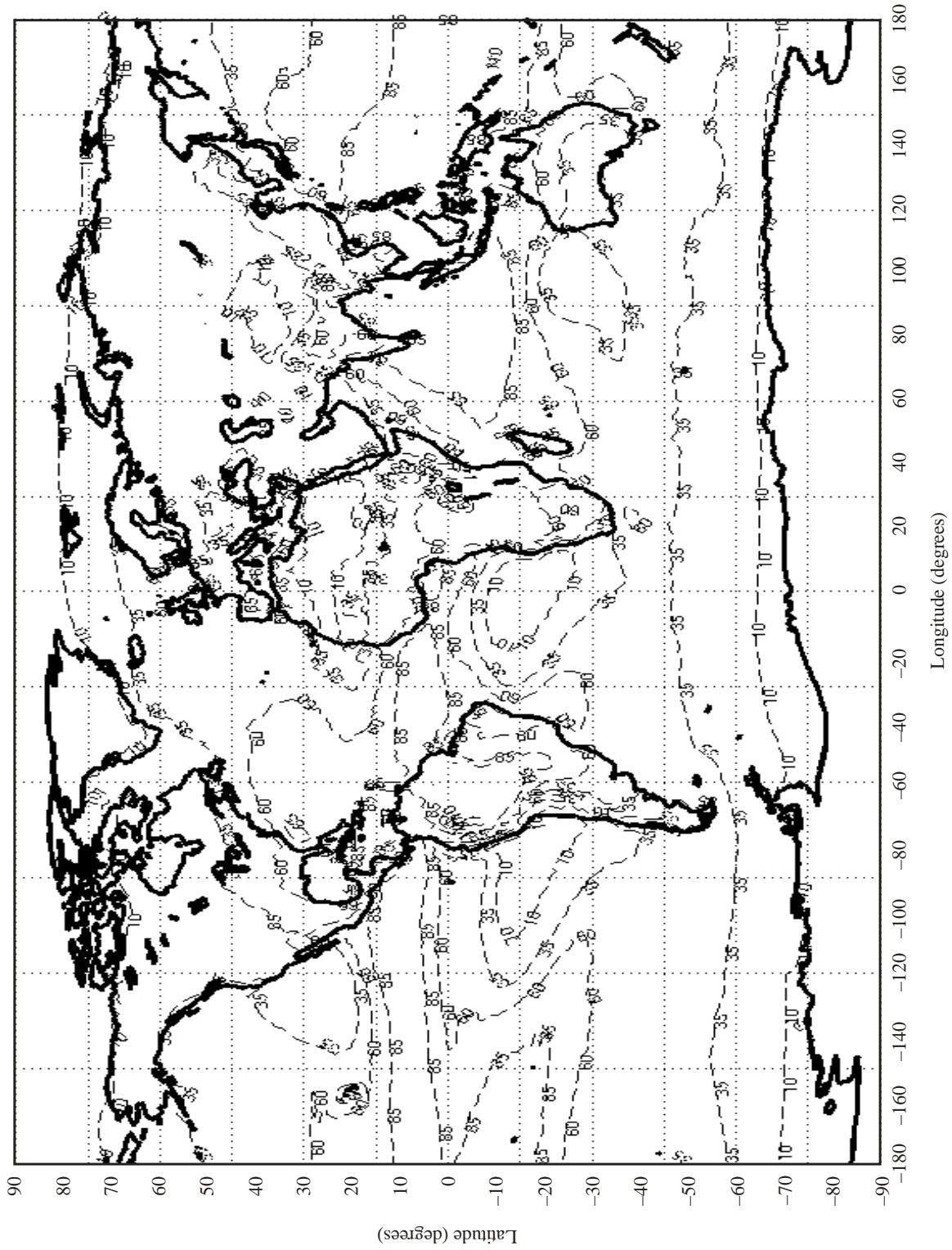
$$b = \frac{(M_c(Lat, Lon) + M_s(Lat, Lon))}{21797P_0} \quad (2e)$$

$$c = 26.02b \quad (2f)$$

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.

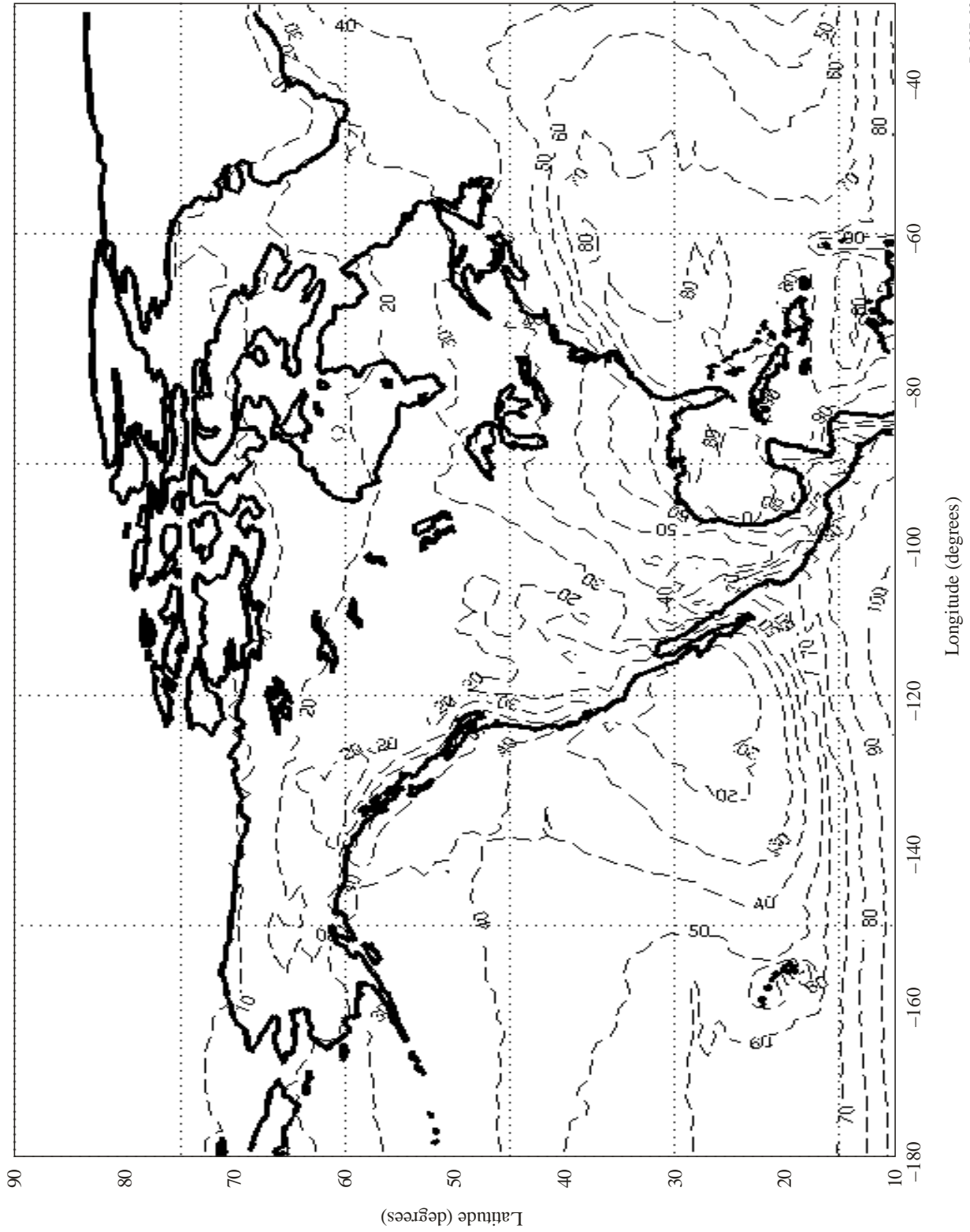
Annex 2

FIGURE 1
Rain rate (mm/h) exceeded for 0.01% of the average year



P.0837-01

FIGURE 2
Rain rate (mm/k) exceeded for 0.01% of the average year



P.0837-02

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

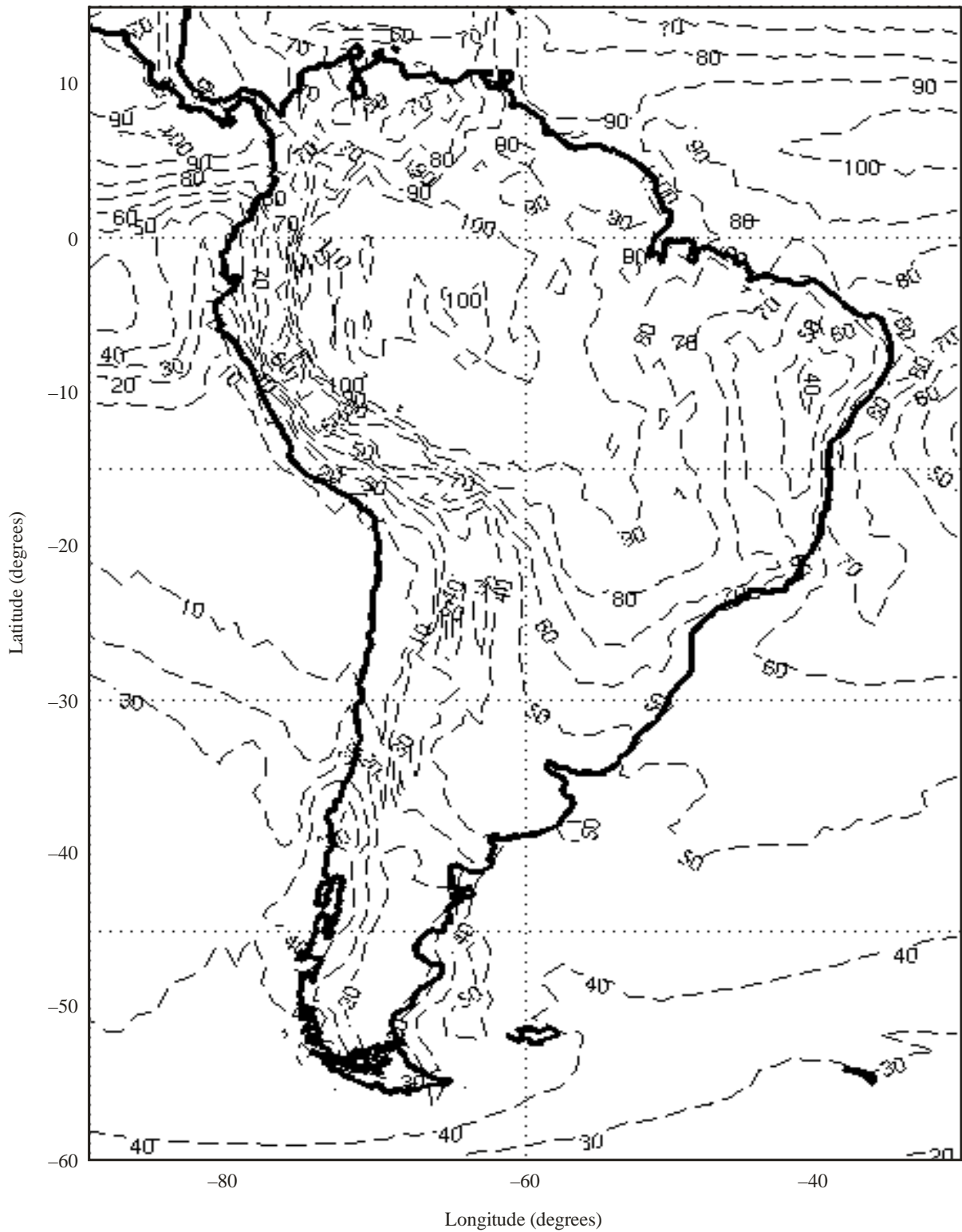


FIGURE 4
Rain rate (mm/h) exceeded for 0.01% of the average year

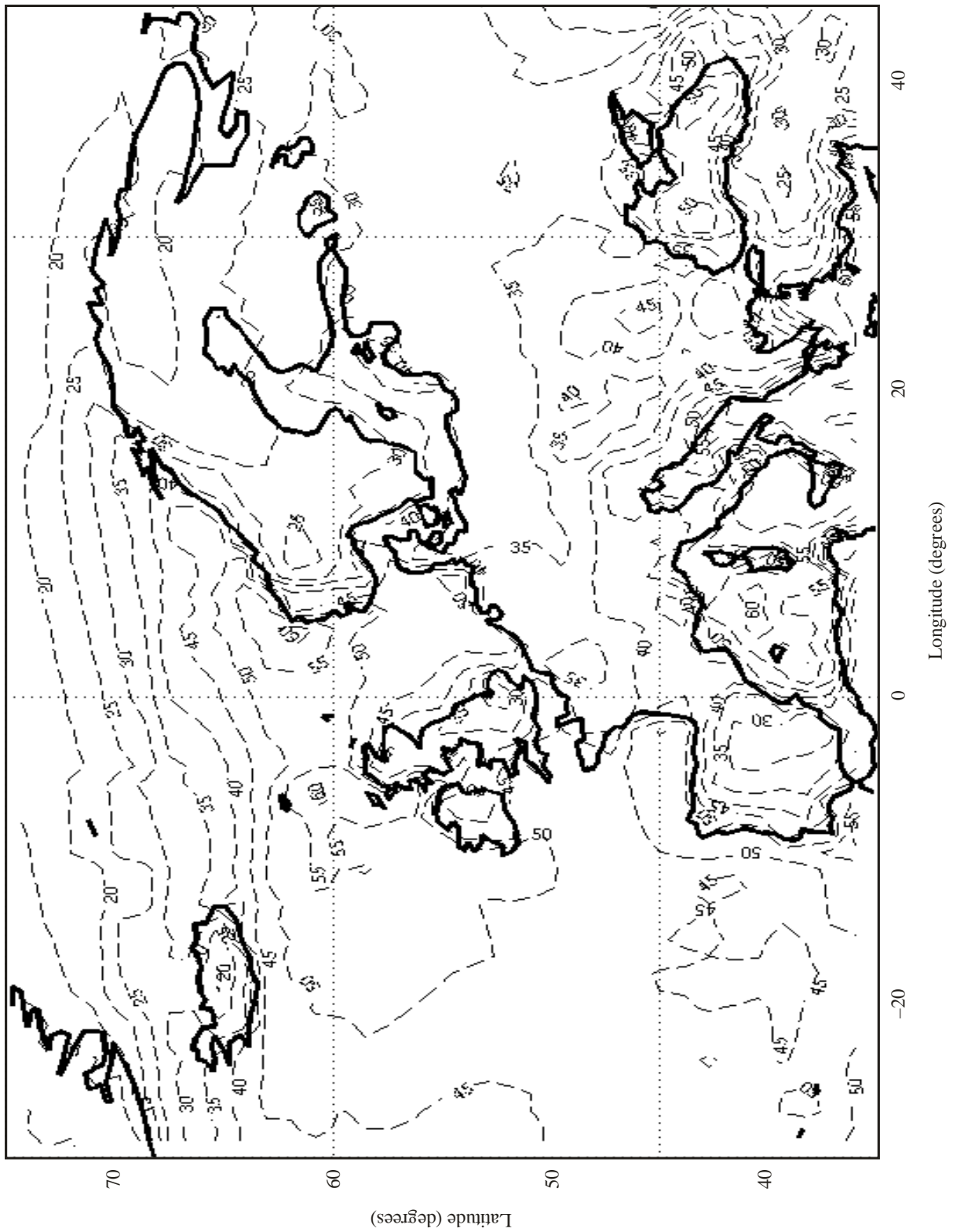


FIGURE 5
Rain rate (mm/h) exceeded for 0.01% of the average year

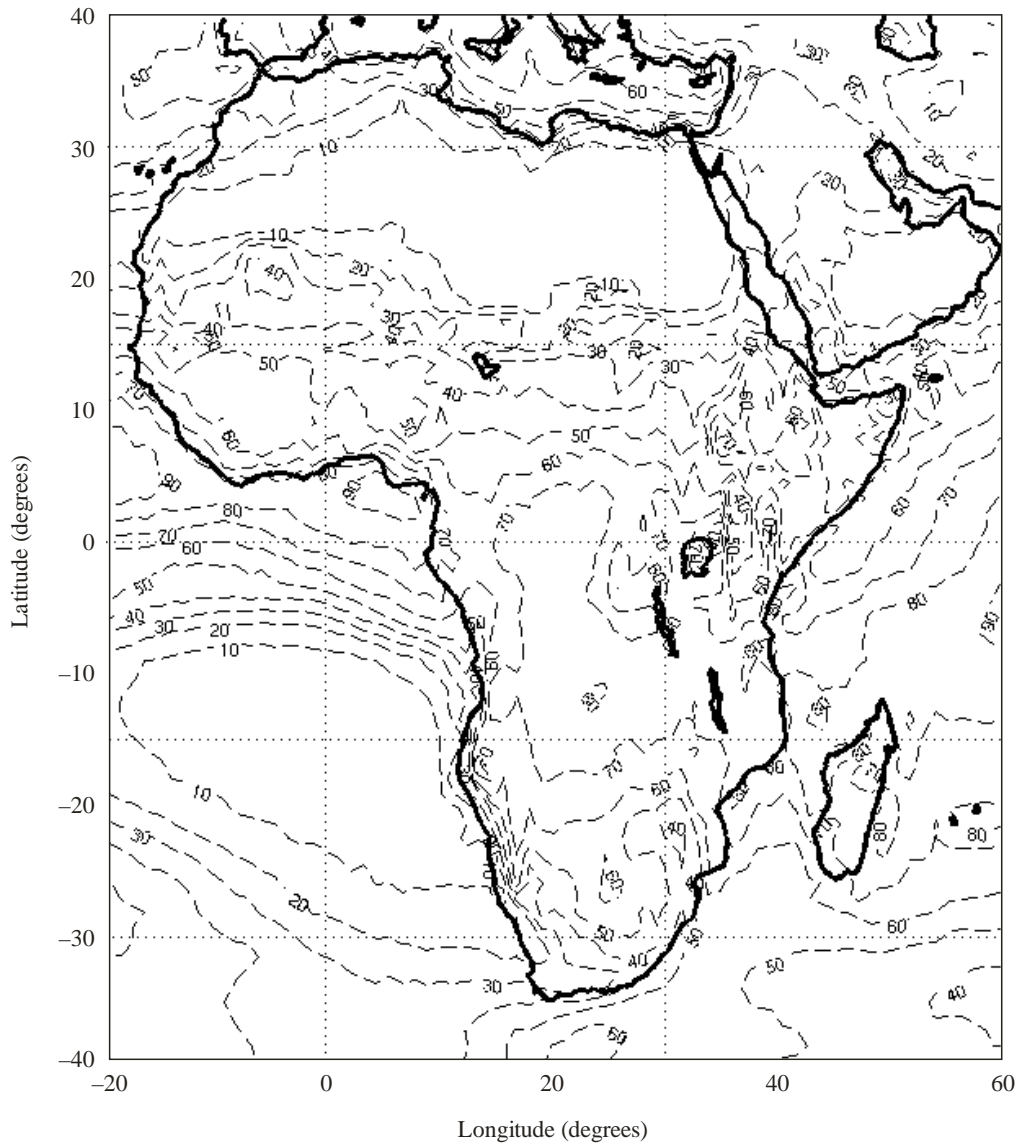
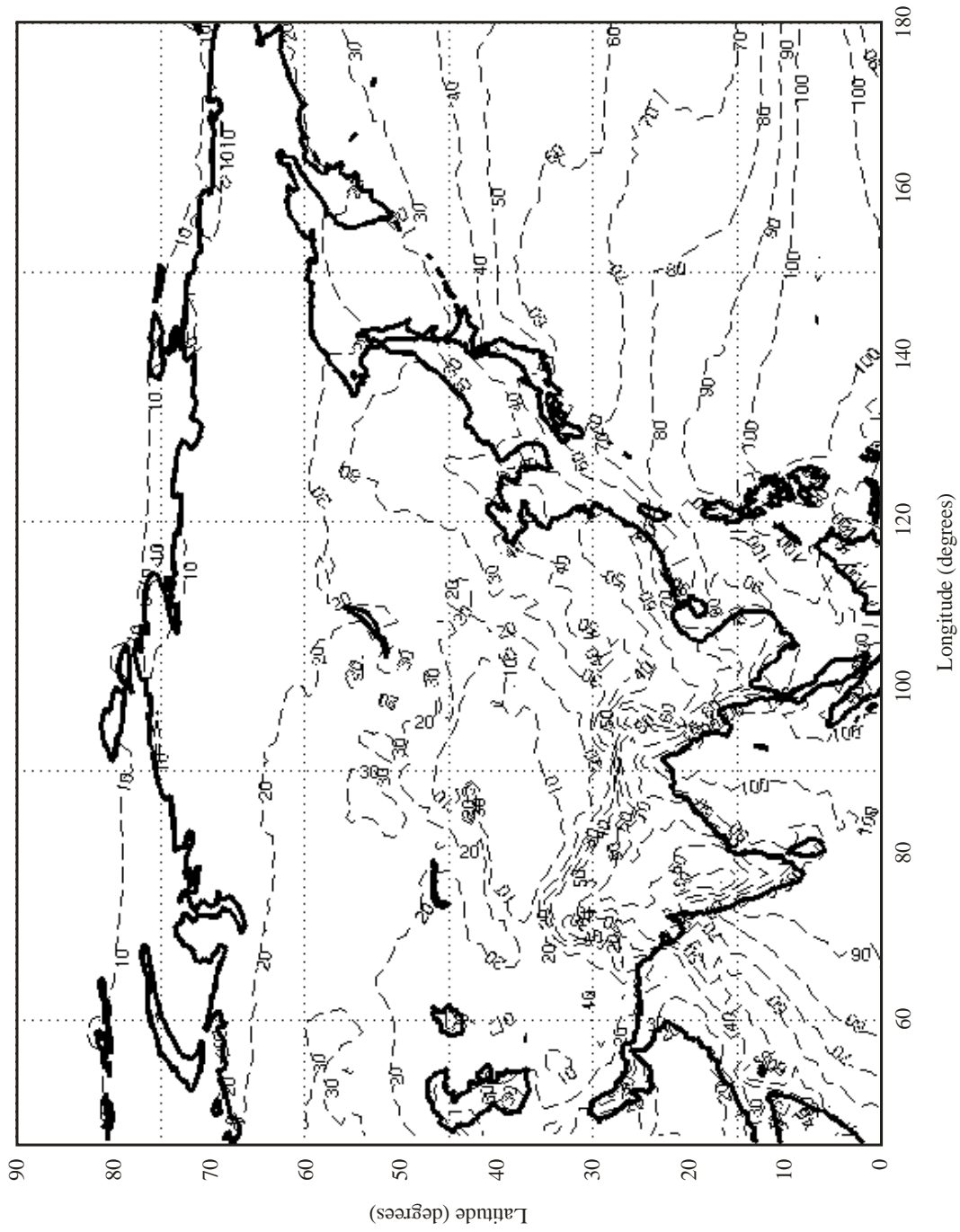
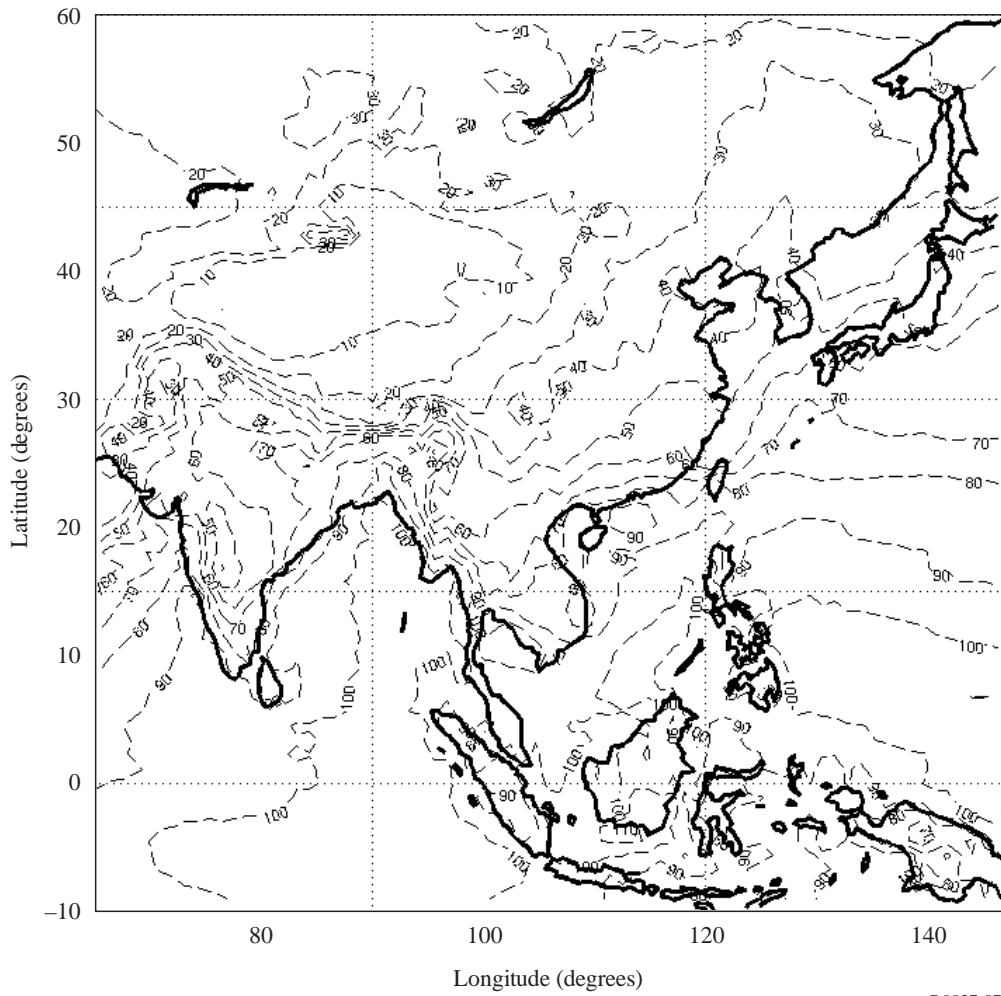


FIGURE 6
Rain rate (mm/h) exceeded for 0.01% of the average year



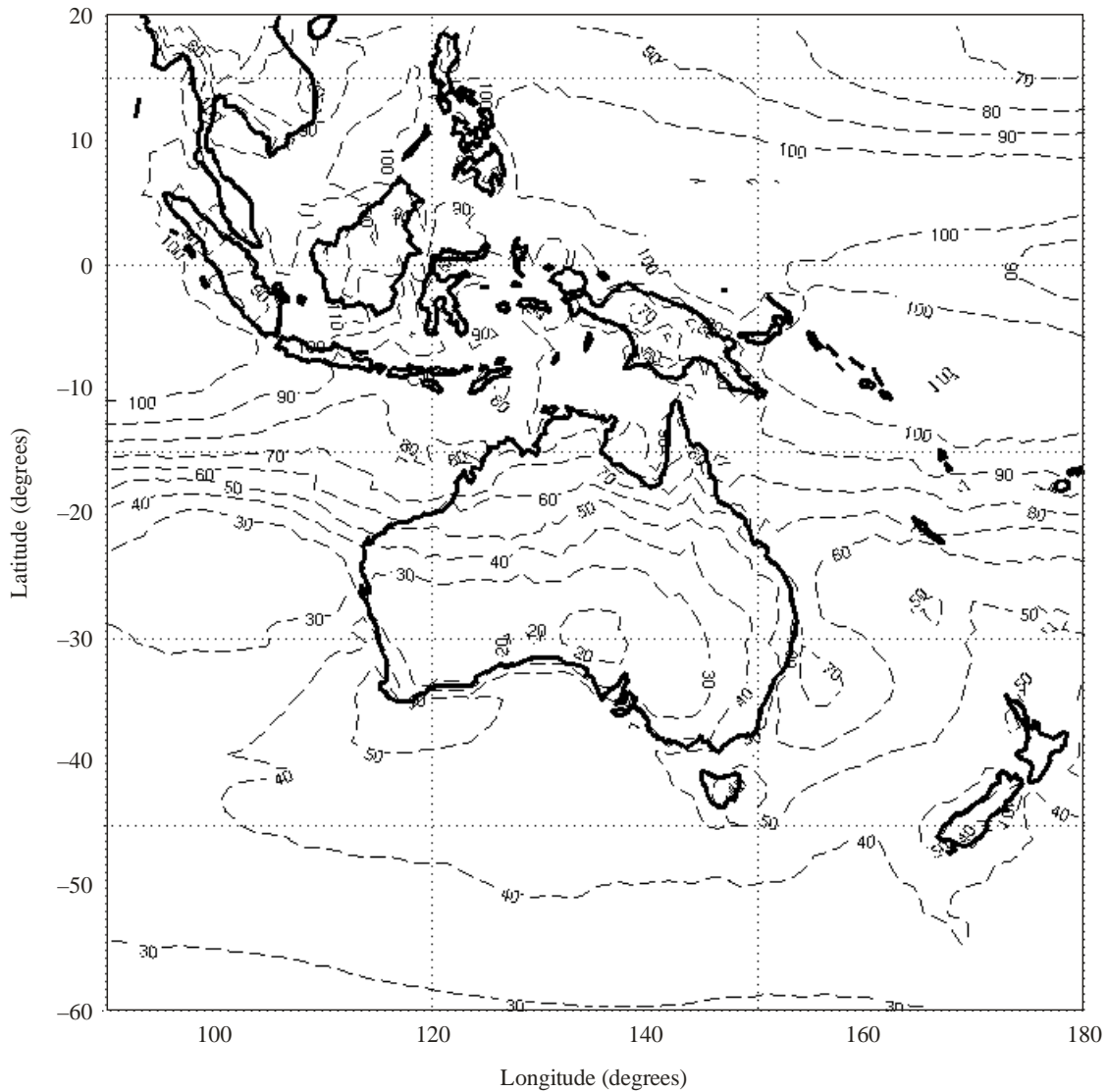
P.0837-06

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



P.0837-07

FIGURE 8
Rain rate (mm/h) exceeded for 0.01% of the average year



P0837-08

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.

4 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.
