

RECOMMENDATION ITU-R P.1148-1

**STANDARDIZED PROCEDURE FOR COMPARING PREDICTED AND
OBSERVED HF SKY-WAVE SIGNAL INTENSITIES AND THE
PRESENTATION OF SUCH COMPARISONS***

(Question ITU-R 222/3)

(1995-1997)

The ITU Radiocommunication Assembly,

considering

- a) that the overall accuracy of prediction procedures needs to be assessed;
- b) that the effect of proposed changes to prediction procedures needs to be determined;
- c) that detailed information regarding the modal, spatial, temporal and related accuracies will assist with the future development of such procedures,

recommends

- 1 that the following procedure given in Annex 1 be adopted for the comparison of predicted and observed HF sky-wave signal intensities;
- 2 that such comparisons be presented in the manner shown in Annex 2.

ANNEX 1

1 Introduction

The method described is a standardized procedure for comparing predicted and observed sky-wave signal intensities at frequencies between 2 and 30 MHz. Such comparisons provide information on the accuracy of prediction methods and on desirable improvements to them. It is important that administrations and organizations keep the ITU-R informed on the current status of their comparisons. Some sample results of comparisons are contained in this Recommendation.

2 General

In order to obtain comparable results, the same data set and the same procedure should be applied when making comparisons between predicted and observed signal intensities. The most recent data base should be used. This is an ITU-R-agreed data set and provides a wide range of observations with respect to distance, month, sunspot number, frequency and geographical zone.

The output from the comparisons should be:

- count,
- mean difference (dB),
- standard deviation (dB).

“Count” indicates the number of samples used in the comparisons. The “mean difference” provides a measure of the deviation between predicted and observed monthly median signal intensities. The most important parameter for assessing the accuracy of the monthly median signal intensities given by a particular prediction method is the standard deviation (see equations (1) and (2)) but it should be noted that this provides no information about the accuracy on individual days.

* A computer program associated with the procedure described in this Recommendation is available; for details, contact the ITU Radiocommunication Bureau.

In order to find systematic deviations (e.g. as a function of distance or geographical zone) of a particular prediction method, comparisons should be made for a variety of different subsets or combinations of subsets of data. The purpose of the detailed subsets of comparisons is to give hints for the detection of systematic weaknesses of the method under consideration. The choice of a certain prediction method should not be based on favourable results obtained for a particular subset (e.g. distance range).

3 Subsets for which comparisons should be made

Different comparisons, i.e. the calculation of mean difference and standard deviation (see Annex 2), should be made for the following parameters:

3.1 Frequencies, f

- single frequency,
- all frequencies of the same circuit,
- frequency groups:

$$\begin{aligned} & \leq f \leq 5 \text{ MHz} \\ & < f \leq 10 \text{ MHz} \\ 1 & < f \leq 15 \text{ MHz} \\ 1 & < f \leq 30 \text{ MHz} \end{aligned}$$

3.2 Path great-circle distance, D

$$\begin{aligned} & < D < 1\,000 \text{ km} \\ 100 & \leq D < 2\,000 \text{ km} \\ 200 & \leq D < 3\,000 \text{ km} \\ 300 & \leq D < 4\,000 \text{ km} \\ 400 & \leq D < 5\,000 \text{ km} \\ 500 & \leq D < 7\,000 \text{ km} \\ 700 & \leq D < 9\,000 \text{ km} \\ 900 & \leq D < 12\,000 \text{ km} \\ 1200 & \leq D < 15\,000 \text{ km} \\ 1500 & \leq D < 18\,000 \text{ km} \\ 1800 & \leq D < 22\,000 \text{ km} \\ 2200 & \leq D \leq 40\,000 \text{ km} \end{aligned}$$

3.3 Geomagnetic latitude, Φ (North or South, at path midpoint)

$$\begin{aligned} 0 & \leq \Phi \leq 20^\circ \\ 20 & < \Phi \leq 40^\circ \\ 40 & < \Phi \leq 60^\circ \\ & \Phi > 60^\circ \end{aligned}$$

3.4 Sunspot numbers, R_{12}

$$\begin{aligned} 0 & < R_{12} < 1 \\ 15 & \leq R_{12} < 4 \\ 45 & \leq R_{12} < 7 \\ 75 & \leq R_{12} < 10 \\ 105 & \leq R_{12} < 15 \\ & R_{12} \geq 15 \end{aligned}$$

3.5 Season (at path midpoint)

Month	Season	
	Northern Hemisphere	Southern Hemisphere
November, December, January, February	Winter	Summer
March, April	Spring	Autumn
May, June, July, August	Summer	Winter
September, October	Autumn	Spring

3.6 Local time h (at path midpoint)

Intervals of 1 h throughout the 24 h; e.g. $00 < h \leq 01$ etc.

3.7 Solar zenith angle χ (at path midpoint)

Intervals of 30° from 0° to 180° ; e.g. $0^\circ \leq \chi < 30^\circ$ etc.

3.8 Predicted modes

E modes

F2 modes

3.9 Origin of data

This information can be helpful in finding a possible geographical dependence.

3.10 Ratio of transmitted frequency to predicted monthly median basic MUF

This ratio should also be calculated for all subsets as indicated in § 3.1 to 3.9:

- only below path monthly median basic MUF,
- only above path monthly median basic MUF,
- below and above path monthly median basic MUF.

4 Comparison procedure

4.1 Prediction program requirements for parameters to be predicted

If the prediction computer program allows a minimum elevation angle to be specified as an input parameter, it is set to 3° to be consistent with the data bank.

The following parameters are transferred from the prediction program to the comparison program:

- general information: month, year, sunspot number;
- circuit information: circuit identifier, frequency, great-circle distance, geographical coordinates, geomagnetic latitude at path midpoint;
- 24 predicted hourly values (always monthly median values) of:
 - a) signal intensity;
 - b) path basic MUF (in tenths of a MHz in order to store 24 values in an 80 column line with three digits each);
 - c) the percentage of days per month when the frequency is below the path basic MUF (in order to store 24 values in an 80 column line with three digits each) if the predictions do not give monthly median signal intensity for all days of the month.