

## ESTIMATION OF GLOBAL SOLAR RADIATION IN SERBIA

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**Abstract):** The most commonly used parameter for estimating global solar radiation is sunshine duration because it can be easily and reliably measured and data are widely available. This study presents an analysis of the relationship between global solar radiation and the sunshine duration at different locations in Serbia. Several regression methods, which were previously used by researchers, were used to analyze. The global solar radiations estimated from the twelve models were compared with the measured values. The estimated values are compared with the measured values in terms of percent error, mean bias error (MBE), root mean square error (RMSE), and mean percent error (MPE). Comparisons show that the second and the third model performed better than the other models used in the paper, but the second model is preferred due to its simplicity and wider application. Further a general formula which estimates the global radiation over Serbia is suggested. The proposed model shows a good agreement (less than 6 % deviation) and could be used to other locations in Serbia where solar data are not available.

**Key words:** solar radiation, sunshine duration, measured values, regression models

### INTRODUCTION

In the design and study of solar energy, information on solar radiation and its components at a given location is very essential. A global study of the world distribution of global solar radiation requires knowledge of the radiation data in various countries and for the purpose of worldwide marketing, the designers and manufacturers of solar equipment will need to know the global solar radiation available in different and specific regions. Since the solar radiation reaching the earth's surface depends upon the climatic conditions of the place, a study of solar radiation under local climatic conditions is essential. The measurement of solar radiation requires pyranometers, but this instrument is not easily available due to cost, the maintenance and the calibration. The measured data are the best form of this knowledge, but there are few meteorological stations that measured solar radiation, especially in developing countries. In Serbia, global solar radiation data on a horizontal surface is recorded at only 4 stations.

For stations where no measured data are available the practice is to estimate global solar radiation from other measured meteorological parameters. Several empirical models have been used to calculate solar radiation, using variables such as extraterrestrial irradiance and measured and theoretical sunshine duration, air temperature, relative humidity, and wind speed and moisture. In this paper the global solar radiation models available in the literature for the selected locations are presented. The first purpose of the present paper is to validate those models for the prediction of monthly average daily global radiation on a horizontal surface from sunshine duration that can be used later in estimating global solar radiation over Serbia. The second objective is to test the performance of the presented models against the measured global radiation for selected locations and determine the general model for evaluating solar global radiation over Serbia.

### MATERIAL AND METHODS

#### Models and data

For this analysis the measured data of monthly average daily solar radiation, sunshine duration and temperature are used from the Study of Energy Potential of Serbia, published by the Serbian Ministry of Science. The study was based on data collected over 34 years (1957-1991). Measurements of global solar radiation on three different locations were performed with Moll-Gorczynsky pyranometers. For the recording of sunshine duration Campbell-Stokes heliographs were used. The geographical location of stations is presented in Table 1.









