Empirical model for estimating global solar radiation for Braşov urban area

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Abstract. Physic – geographical and climatic features specific to Braşov urban area, makes necessary determination of a mathematical model to simulate in a precise manner the variation of global solar radiation.

In this way, the paper proposes a new empirical model to simulate the global solar radiation for Braşov urban area in clear sky conditions. The mathematical model was developed on the basis of 4 years database, respectively records of global solar radiation and meteorological parameters made by the meteorological weather station (starting October 2005).

Due to the interactions between the topography that characterizes Braşov area – that is a lowland situated at an altitude of over 700 meters, vegetation, the characteristic climate pattern, the dynamics of the atmosphere and aerosols - it features a series of specific variation for solar radiation, that manifests daily, monthly and seasonally.

The present approach proposes one equation specific for every month of the year to simulate the global solar radiation; thus 12 simulation equations will be determined to estimate in a good manner the real global solar radiation. In order to validate the proposed empirical model two of the most utilized statistical indicators were used: Root Mean Square Error (RMSE) and Mean Bias Error (MBE).

Key words

Global solar radiation estimation, empirical model, MBE, RMSE

1. Introduction

In the last two decades a greate interest was manifested for the transformation of solar energy in energy utilized directly by the consumers, respectively in thermal energy trough solar collectors and in electric energy trough the photovoltaic panels.

Based on these two processes new applications are being developed in order to replace the existent ones that use energy obtained from fossil fuels. As a consequence the solar radiation study is a subject of real interest everywhere on the globe, along with other sources of renewable energy.

Solar radiation is available on the entire earth surface, but the quantity of radiation received differs depending on the geographical area, relief, atmospheric conditions and season. Thus it is essential to know the quantity and the variation of available solar radiation for a specific time duration, to develop solar energy applications (systems that can contain: solar collectors, photovoltaic panels) and new applications of theses, but even to estimate their efficiency.

Based on the RES type, designers need information about the global, direct solar radiation variation and in some particular cases about the diffuse component (designing an acclimatization system for a building).

Mathematical modeling of solar radiation represents an actual theme if it is taken into account the small number of meteorologic stations that offer measurements in the solar energy subject (global, direct and diffuse solar radiation on a horizontal surface and the sunshine period).

The technical literature proposes a series of empirical models to estimate the global, direct and diffuse solar radiation variation (Kasten, Adnot), ([1], [2]). Although these models are simple from a mathematical point of view, and these are easy to use in practice, they have the disadvantage of a limited area of applicability, these being specific to a particular area. The existent empirical models have been developed based on the specific measured data specific to a geographic area (solar radiation, temperature, humidity, etc.).

In this context the paper proposes a new empirical model for estimating global solar radiation for Braşov urban area, equations specific for every month of the year are proposed.