Characterization of sky conditions over Ile-Ife, Nigeria, based on 1992–1998 solar radiation observations

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Abstract

Daily global and diffuse irradiance data monitored on a horizontal surface at Ile-Ife (7.5°N, 4.5°E), Nigeria, during the period 1992–1998, have been used to calculate values of the clearness index Kₐ, and diffuse ratio Kₐ/d and the diffuse coefficient Kᵰ for the station. A characterisation of the sky conditions over the station, based on the calculated Kᵰ values for the 7 years of data is presented. The annual sky conditions at the station have been shown to exhibit five characteristic patterns comprising of one distinct dry season and four distinct wet (rainy) seasons. Statistical monthly Kᵰ curves have also been established for Ile-Ife after LIU and JORDAN (1960). The possibility of using these monthly Kᵰ curves to establish approximate statistical distribution of the daily global radiation for other cities within similar latitude and longitude underscores their importance.

1 Introduction

Information on solar radiation and related meteorological parameters are crucial for application fields and studies dealing with the exploitation of solar energy, thermal loading on buildings, description of atmospheric phenomena and large-scale weather analysis and prediction. Such information is rather difficult to obtain in tropical Africa, despite the fact that it is a region of the world endowed with abundant availability of solar energy all the year round. Hence there is the need to develop ways of estimating the incident solar radiation in tropical Africa in general and Nigeria in particular. One such way is by establishing the sky conditions at the locality. These conditions can be quantified or determined by the clearness index Kᵰ, which gives the percentage depletion of the incoming solar radiation by the sky, the diffuse ratio Kᵰ/d and the diffuse coefficient Kᵰ, which depict the effectiveness of the sky in scattering the incoming radiation. LIU and JORDAN (1960) carried out the pioneering study on sky conditions at various locations, in terms of the clearness index Kᵰ, Kᵰ/d and Kᵰ. They established from their work, which was done for twenty-seven cities drawn from Canada and the United States of America, the generalized monthly variation of the clearness index (Kᵰ) as a function of its cumulative frequency (f) within the month, known as the ‘monthly Kᵰ curves’. These curves are very useful in radiation and allied studies in that the annual trends of the distribution of solar radiation for cities within the same region can be deduced from them. Other studies on sky conditions using solar radiation include those of CHOUDHURY (1963), BARBO et al. (1978, 1981), and more recently, ZANGVIL and LAMB (1997).

In Nigeria, only a few studies have been carried out on sky conditions. Notable among these are those of IDEHIAH and SULEMAN (1989); and KUYE and JAG-TAP (1992). However a number of other studies have been conducted on the measurement and estimation of solar radiation and these include: EZEKWE and EZEILO (1981); IDEHIAH (1981, 1983 and 1985); BAMIRO (1983) and ADEDOKUN et al. (1994). At Ile-Ife daily