20.4.1 Clearness Index

The relation between the solar radiation at the Earth's surface and the Extraterrestrial radiation gives a measure of the atmospheric transparency. This way, a *clearness index*, K_{Tm}, is calculated for each month:

$$K_{\mathrm{Tm}} = \frac{G_{\mathrm{dm}}(0)}{B_{0\mathrm{dm}}(0)} \tag{20.17}$$

Note that the clearness index is physically related not only to the radiation path through the atmosphere, that is, with the AM value, but also with the composition and the cloud content of the atmosphere. Liu and Jordan [19] have demonstrated that, irrespective of latitude, the fractional time during which daily global radiation is equal to or less than a certain value is directly dependent on this parameter. Because of that, K_{Tdm} can properly characterise the solar climate of a particular location. This provides the basis for estimating solar radiation on inclined surfaces.

20.5 RADIATION ON INCLINED SURFACES

To eliminate the effects of varying local features, such as obstructions that cast shadows and the specific ground covering, solar radiation is routinely measured on horizontal surfaces free of obstacles. Consequently, solar radiation data are most often given in the form of global radiation on a horizontal surface. Since PV modules are usually positioned at an angle to the horizontal plane, the radiation input to the system must be calculated from the data.

The assessment of radiation arriving on an inclined surface, using as input global horizontal data, raises two main problems: to separate the global horizontal radiation into their direct and diffuse components; and, from them, to estimate the radiation components falling on an inclined surface. In general, these problems may be posed for different time scales, for example, daily irradiation, hourly irradiation and so on. Individual or time-averaged values may be sought. Here, we will first focus on the monthly average daily irradiation values. This is not only convenient for presentation purposes, but also coherent with solar radiation data availability, and particularly suited to afford most PV engineering practical problems. Additional comments for other cases will also be given afterwards.

20.5.1 Estimation of the Direct and Diffuse Components of Horizontal Radiation, Given the Global Radiation

The underlying concept is the one originally proposed by Liu and Jordan [19]. It consists of establishing empirical correlation between the *diffuse fraction of horizontal radiation*, $F_{\mathrm{Dm}} = D_{\mathrm{dm}}(0)/G_{\mathrm{dm}}(0)$, (diffuse radiation/global radiation) and the *clearness index* (global radiation/extraterrestrial radiation) defined in equation (20.17). Note that the clearer the atmosphere, the higher the radiation and the lower the diffuse content. Hence, F_{Ddm} and K_{Tdm} are expected to be negatively correlated. Actual analytical expressions are established from the comparison of simultaneous measurements of global and diffuse radiation