20.9 IRRADIATION ON MOST WIDELY STUDIED SURFACES

This section analyses some important features of the radiation available on commonly studied surfaces. As already mentioned, the methods presented before conform to a complete package, allowing the calculation of the irradiation incident over any arbitrary surface over any period of time, using the horizontal data as input. This can no doubt be a tedious task, so specific commercial software packages have been developed [42, 43]. However, for many practical engineering problems, more direct and simple tools can be developed. In particular, it is possible to develop analytical expressions that can be simply solved by only hand calculations. In order to apply the discussion in the previous sections, let us analyse the particular case of the yearly mean daily irradiation collected at four different places on a fixed surface, tilted towards the equator ($\alpha = 0$) and inclined at an angle β to the horizontal, $G_{dy}(\beta)$. Figure 20.19 plots, for each place, such value in relation to its maximum and versus the inclination angle referred to as the absolute value of the latitude, that is, $G_{dy}(\beta - |\phi|)/G_{dy}(\beta_{opt})$, being β_{opt} the inclination angle associated to the maximum value of $G_{dy}(\beta)$. The calculation procedure had followed the lines described in Figure 20.16. Solar radiation data has been obtained from Reference [7]. Several aspects need to be outlined.

On the one hand, a great similarity between all the curves is noticeable. Despite large differences in latitude and clearness index of the selected locations, the shape of the curve and also the inclination angle maximising the collection of radiation are very similar for the four selected places. Furthermore, this angle is relatively close to the latitude. It is important to mention that the extension of this exercise to many other places all around the world verifies that this great similarity is nearly universal. In fact, we have performed a specific exercise covering 30 different places distributed from $\phi = 80^\circ$ to $\phi = -78.2^\circ$ (see list in Table 20.5). We limit Figure 20.19 to only four curves for presentation purposes. A physical explanation of this similitude can be argued observing that, irrespective of the latitude, all the surfaces tilted towards the equator and inclined at an angle equal to the absolute value of the latitude are parallel all over the Earth, and also parallel to the Earth's rotation axis. Therefore, in the absence of the atmosphere, on

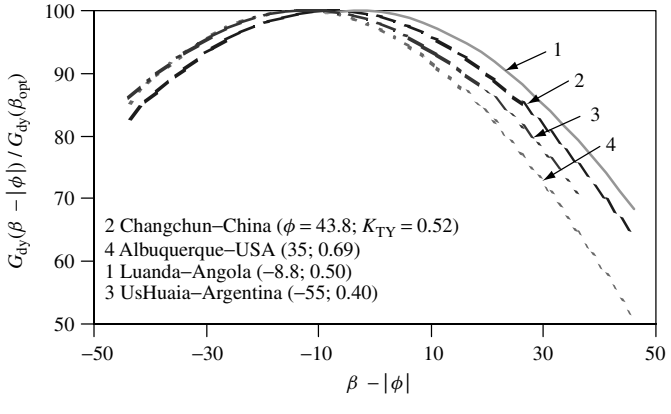

Figure 20.19 Yearly energy collection versus inclination angle for surfaces tilted towards the equator. The percentage of relative collection, with respect to the maximum, $G_{dy}(\beta - |\phi|)/G_{dy}(\beta_{opt})$ is plotted against the difference between the tilt angle and the latitude $\beta - |\phi|$