Table 20.4 Recommended parameters for angular losses calculation

Dirtiness degree	$T_{dirt}(0)/T_{clean}(0)$	a_r	c_2
Clean	1	0.17	−0.069
Low	0.98	0.20	−0.054
Medium	0.97	0.21	−0.049
High	0.92	0.27	−0.023

and

$$FT_R(\beta) = 1 - \exp\left[-\frac{1}{a_r}\left[c_1\left(\sin\beta + \frac{\beta\cdot\frac{\pi}{180} - \sin\beta}{1-\cos\beta}\right) + c_2\left(\sin\beta + \frac{\beta\cdot\frac{\pi}{180} - \sin\beta}{1-\cos\beta}\right)^2\right]\right] \tag{20.48}$$

where $c_1 = 4/(3\pi)$ and c_2 is linearly related to a_r. Table 20.4 also presents some values of these parameters for several dirtiness degrees.

It must be noted that $FT_B(0) = 1$. That means, this function does not include the dirt effect on the relative normal transmittance but only the angular losses relative to normal incidence. In other words, the "effective" direct irradiance reaching the solar cells of a PV module, should be computed as

$$B_{eff}(\beta, \alpha) = B(\beta, \alpha) \times \frac{T_{dirt}(0)}{T_{clean}(0)} \times FT_B(\theta_S) \tag{20.49}$$

and similar expressions should be used for the diffuse and albedo irradiance (or hourly irradiation) components.

Following the example of 15 April in Portoalegre-Brazil, we can now calculate the effective irradiances over a surface tilted to the latitude, neglecting the albedo, supposing a medium dirtiness degree and by applying $FT_B(\theta_S)$ not only to the direct radiation but also to the circumsolar component of the diffuse radiation. Obviously, $FT_D(\beta)$ is applied to the isotropic component of the diffuse radiation. The results are as follows:

$$FT_D(\phi) = 0.934$$

ω°	$FT_B(\theta_S)$	$B_{eff}(\phi)$, [Wm^{-2}]	$D_{eff}(\phi)$ [Wm^{-2}]	$G_{eff}(\phi)$ [Wm^{-2}]	ΔG_{eff} [%]
ω_S	0	0	0	0	0
±60	0.913	80.84	126.39	207.23	−11.3
±30	0.991	249.63	249.74	499.37	−6.8
0	0.999	332.13	296.37	628.50	−6.1