We can compare these α values with the radiative transfer models of global atmospheric aerosols of Toon & Pollack (1976). In particular, with their Figure 8b where the contribution of different layers of the atmosphere is shown to produce a steepening in their calculated optical depth $\tau(\lambda)$ curves in the 0.1 to 10 μm interval, with values of $\alpha \sim 0.25$ for atmosphere heights between sea-level and 3 km, while $\alpha \sim 0.67$ for the 3–6 km layer. Toon & Pollack (1976) argue that most visible spectral measurements indicate an average $\beta \approx 3 \pm 0.5$. The average values of the aerosol optical depth found for the SPM site show that $\beta_{\rm OP} \sim 2.7$ and $\beta_{\rm OIR} \sim 2.3$, which are thus consistent with expected values from these models. For the visible we derive an aerosol optical depth $\tau_\lambda = 0.0001\lambda^{-0.72}$ and for the OIR $\tau_\lambda = 0.0061\lambda^{-0.31}$ for the average values for the 2000–2008 period of AOT over San Pedro Mártir. As is shown by Toon & Pollack (1976) their global calculated aerosol optical depth spans a larger wavelength interval and it is expected that the OIR one that spans from 4300 to 21300 Å would be a better representation of the mean AOT in a site. Considering all the AOT data from MODIS we derived for the SPM site an average slope $\alpha_{\rm OIR}$ of 0.31 ± 0.06 for the mean aerosol optical depth spectral data.

6.7. *AOT and Stellar Atmospheric Extinction*

In Figure 7 spectral values of our mean and seasonal AOT from MODIS data for the years 2000–2008, are compared with the SPM average atmospheric extinction curve (κ_λ) obtained by Schuster & Parrao (2001) and Schuster et al. (2002) from stellar photometric observations for the years 1973–1999. Although τ_λ due to aerosol scattering and the atmospheric extinction κ_λ cannot be directly related, since the extinction over $3200 \lesssim \lambda \lesssim 6500$ Å has the contributions from aerosol scattering, Rayleigh-Cabannes scattering and ozone absorption (see equation 1 in Schuster & Parrao 2001, and references within), we can only check trends in the wavelength dependence.

On the other hand, Schuster & Parrao (2001) obtained for SPM a slope $\alpha_{\rm OP}$ of 0.87 ± 0.04 from their stellar photometric measurements during the years 1973–1999 for wavelengths from 0.3 to 1.1 μm. Their slope is somewhat larger than our average value of 0.72 ± 0.05 for 2000–2008, but note that our seasonal values vary from 0.62 to 0.81 (c.f. Table 7). Stellar photometry measurements have been used to derive the aerosol scattering slope at several astronomical observatories. For the European Southern Observatory at La Silla (Chile) Burki et al. (1995) obtained a value of $\alpha_{\rm OP}$ of 1.39, while for Cerro Tololo Inter-American Observatory, Chile, Gutiérrez-Moreno, Cortés, & Moreno (1982) found values of $\alpha_{\rm OP}$ varying from 0.2 to 2.6 during the years 1964–1980. Hayes & Latham (1975) summarize in their Table 1 average values from stellar observations for several observatories: Le Houga 0.89, Boyden 0.78, Lick 0.49, Cerro Tololo 0.81, and Mount Hopkins 0.84, and derived a mean value of 0.81 for night-time stellar photometry.

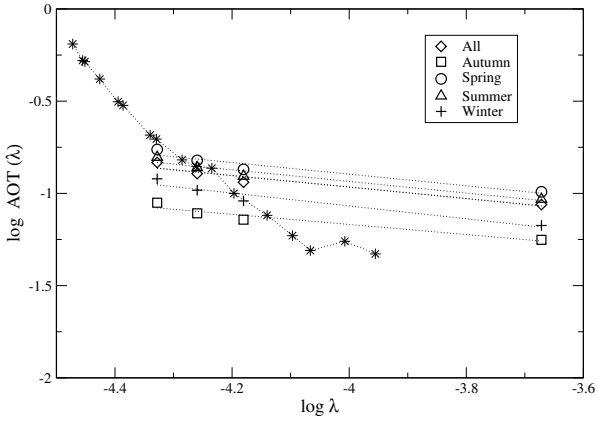

Fig. 7. Wavelength dependence of average atmospheric extinction (κ_λ) from Schuster & Parrao (2001) represented with × symbols, compared to the aerosol optical depth spectral values obtained from MODIS data for the San Pedro Mártir observatory site. The color figure can be viewed online.

If we consider the values of $\alpha_{\rm OIR}$ which probably describe somewhat better the wavelength dependence of aerosol opacity because of the larger wavelength coverage, the mean value found for SPM $\alpha_{\rm aerosol}$ of 0.31 ± 0.10 and the seasonal values 0.27 (autumn) and 0.35 (winter) compare well with the Toon & Pollack (1976) model for the atmosphere layer from 0 to 3 km, which probably indicates that at SPM this layer is dominant in the aerosol opacity.

7. CONCLUSIONS

The aerosol optical depth or thickness (AOT) values, obtained from MODIS database for the San Pedro Mártir (SPM) astronomical site in the period January 2000 to December 2008, show that the highest atmospheric transparency occurs during the autumn months, with average values AOT of 0.089 ± 0.013 at 4700 Å, 0.078 ± 0.011 at 5500 Å, 0.072 ± 0.010 at 6600 Å, and 0.056 ± 0.008 at 21300 Å. This seasonal trend is consistent with the monthly behavior that shows the best transparency conditions in October and November in all the years stud-