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AIR FORCE CAMBRIDGE RESEARCH LABORATORIES

L. G. HANSCOM FIELD, BEDFORD, MASSACHUSETTS

**UV, Visible, and IR Attenuation
for Altitudes to 50 km, 1968**

L. ELTERMAN

**OFFICE OF AEROSPACE RESEARCH
United States Air Force**



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Abstract

An atmospheric attenuation model for the ultraviolet, visible, and infrared was developed in 1964, based on scattering (molecules and aerosols) and ozone absorption. Since then more measurements have been made and our knowledge of aerosol attenuation has widened. These circumstances result in attenuation model changes which are relatively unimportant for most exploratory calculations. They can be significant, however, for long slant-path high-altitude applications entailing large zenith angles, factors which characterize, for example, the measurement geometries of rockets and satellites. Accordingly, a revision of the 1964 Attenuation Model is warranted.

In this paper the optical parameters are computed spectrally and with altitude as follows: (1) pure air attenuation parameters are determined by utilizing Rayleigh scattering cross sections with molecular number densities from the standard atmosphere; (2) ozone absorption parameters are derived based on Vigroux's coefficients applied to a representative atmospheric ozone distribution; (3) seven sets of aerosol measurements are compared and a profile of aerosol attenuation coefficients vs altitude is developed. Attenuation coefficients and optical thickness due to molecular, aerosol, and ozone attenuation are computed and tabulated individually so that the influence of each can be compared. The newly derived tabulations permit various exploratory calculations, including horizontal, vertical, and slant-path transmission at kilometer intervals to an altitude of 50 km, individually for each attenuating component or for overall atmospheric extinction (molecular + ozone + aerosol).

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Symbols

A_v	Vigroux ozone absorption coefficient (cm^{-1})
D_3	Ozone concentration (cm/km)
d	Horizontal path length (km)
H_p	Aerosol scale height (km)
h	Altitude (km)
K	Mie scattering efficiency
m	Aerosol index of refraction
m_s	Index of refraction at sea level, air at 1013 mb and 15°C
N_3	Ozone number density (cm^{-3})
N_p	Aerosol number density (cm^{-3})
N_r	Molecular number density (cm^{-3})
N_s	Molecular number density at sea level (cm^{-3})
r	Particle radius (microns)
t_p	Turbidity (β_p/β_r)
T	Temperature °K
T_h	Horizontal transmission
T_{0-h}	Transmission between sea level and altitude h
$T_{h-\infty}$	Transmission between h and space
$T_{\Delta h}$	Transmission between two altitudes above sea level
β_3	Atmospheric ozone absorption coefficient (km^{-1})
β_p	Aerosol attenuation coefficient (km^{-1})
$\bar{\beta}_p(h, \lambda_1)$	Mean of 79 profiles for $\lambda_1 = 0.55$ microns (km^{-1})

β_r	Rayleigh attenuation coefficient (km^{-1})
β_{ext}	Extinction coefficient (km^{-1})
δ	Depolarization factor
θ	Zenith angle
λ	Wavelength (microns or cm)
λ_1	Wavelength 0.55 microns
σ_r	Rayleigh scattering cross section (cm^2)
τ_3	Ozone optical thickness from sea level to altitude h (0-h)
τ_3'	Ozone optical thickness from altitude h to space ($h-\infty$)
τ_p	Aerosol optical thickness from sea level to altitude h, (0-h)
τ_p'	Aerosol optical thickness from altitude h to space, ($h-\infty$)
τ_r	Rayleigh optical thickness from sea level to altitude h, (0-h)
τ_r'	Rayleigh optical thickness from altitude h to space, ($h-\infty$)
τ_{ext}	Extinction optical thickness (molecular + ozone + aerosol) from sea level to altitude h, (0-h)
τ_{ext}'	Extinction optical thickness (molecular + ozone + aerosol) from altitude h to infinity, ($h-\infty$)
ψ	Aerosol size distribution function

UV, Visible, and IR Attenuation for Altitudes to 50 km, 1968*

1. INTRODUCTION

In 1964, an atmospheric attenuation model was published (Elterman, 1964) which has been useful for a variety of exploratory calculations. Now a revision is warranted for reasons given in the abstract and Section 4 of this report. In this revision most of the earlier material is presented in summary form. The section on attenuation by Rayleigh scattering, however, is retained because the content leading to the derivation of the Rayleigh parameters is useful. In one instance, due to existing interest, the material is expanded, i. e., the tabulations which comprise the attenuation model now include aerosol and ozone optical thickness so that a comparison can be made of the relative importance of each attenuating component for vertical and slant paths.

The shortest wavelength considered is 0.27 microns. The use of shorter wavelengths would require a treatment of O_2 absorption. Also, attenuation is sufficiently severe so that interest in the shorter wavelength region for purposes of ultraviolet transmission below 50 km probably is limited. The longest wavelength used is 4.0 microns. Calculations for longer wavelengths are complicated by the presence of absorption bands of H_2O , CO_2 , and their wings. In between, a total of 22 wavelengths is chosen (Table 1) within the atmospheric windows and for the ultraviolet region where ozone absorption is important.

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Conceptually, the attenuation model starts with molecular densities from the latest published U.S. Standard Atmosphere (1962) followed by the addition of ozone and aerosol components. The meteorological range (M.R.) at sea level corresponds to about 25 km at 0.55 μ wavelength. This choice serves a useful function because it permits including some important measurements conducted at $\lambda = 0.55\mu$. In addition, this wavelength customarily represents the photopic region.

Table 1. Model Parameters as a Function of Wavelength

λ (microns)	m_s	σ_r (cm ²)	A_v (cm ⁻¹)
0.27	1.00029668	8.960×10^{-26}	2.10×10^2
0.28	1.00029475	7.646×10^{-26}	1.06×10^2
0.30	1.00029156	5.677×10^{-26}	1.01×10^1
0.32	1.00028902	4.310×10^{-26}	8.98×10^{-1}
0.34	1.00028699	3.334×10^{-26}	6.40×10^{-2}
0.36	1.00028531	2.622×10^{-26}	1.80×10^{-3}
0.38	1.00028392	2.091×10^{-26}	0
0.40	1.00028275	1.689×10^{-26}	0
0.45	1.00028052	1.038×10^{-26}	3.50×10^{-3}
0.50	1.00027896	6.735×10^{-27}	3.45×10^{-2}
0.55	1.00027782	4.563×10^{-27}	9.20×10^{-2}
0.60	1.00027697	3.202×10^{-27}	1.32×10^{-1}
0.65	1.00027630	2.314×10^{-27}	6.20×10^{-2}
0.70	1.00027578	1.714×10^{-27}	2.30×10^{-2}
0.80	1.00027503	9.990×10^{-28}	1.00×10^{-2}
0.90	1.00027451	6.213×10^{-28}	0
1.06	1.00027397	3.216×10^{-28}	0
1.26	1.00027357	1.606×10^{-28}	0
1.67	1.00027315	5.189×10^{-29}	0
2.17	1.00027292	1.817×10^{-29}	0
3.50	1.00027272	2.681×10^{-30}	0
4.00	1.00027269	1.571×10^{-30}	0

λ - Wavelength

m_s - Index of refraction (1013 mb, 15°C)

σ_r - Rayleigh scattering cross section

A_v - Absorption coefficient after Vigroux for pure O₃, smoothed values (1013 mb, 18°C)

2. RAYLEIGH PARAMETERS

A fundamental requirement for generating an accurate series of Rayleigh parameters is an exact determination of the index of refraction for the wavelengths of interest. With this known, the Rayleigh cross sections can be computed. This in turn permits computation of the Rayleigh attenuation coefficient and its variation with altitude as well as corresponding optical thickness values.

The index of refraction for a standard atmosphere (1013 mb, 15°C) specifically for the desired wavelengths used is determined by Edlen's (1953) expression

$$(m_s - 1)10^{-8} = 6432.8 + \frac{2949810}{146 - (\lambda^{-2})} + \frac{25540}{41 - (\lambda^{-2})} \quad (1)$$

where m_s = refractive index,
 λ = wavelength (microns).

Penndorf's (1957) computations using Eq. (1) demonstrate that the effect of water vapor can be neglected and the derived m_s values have negligible error for the spectral range from 0.2 to 20.0 microns.

The Rayleigh cross section is expressed by

$$\sigma_r(\lambda) = \frac{8\pi^3(m_s^2 - 1)^2}{3\lambda^4 N_s^2} \cdot \frac{6 + 3\delta}{6 - 7\delta} \quad (2)$$

where

- σ_r = the Rayleigh scattering cross section (cm^2),
- λ = the wavelength (cm),
- m_s = the index of refraction of air at 15°C and 1013 mb pressure,
- N_s = the molecular number density at sea level for a standard atmosphere (cm^{-3}),
- δ = the depolarization factor.

The term $(6 + 3\delta)/(6 - 7\delta)$ accounts for the degree of depolarization attributable to the anisotropy of the atmospheric molecule. The depolarization factor has been determined by calculation and by laboratory measurement. The latest work of Gucker and Basu (1953) yields $\delta = 0.035$. The wavelengths of interest with the indices of refraction and Rayleigh cross sections [computed from Eqs. (1) and (2)] are listed in Table 1, and plotted in Figures 1 and 2.

Using the scattering cross sections, the Rayleigh coefficients are obtained with

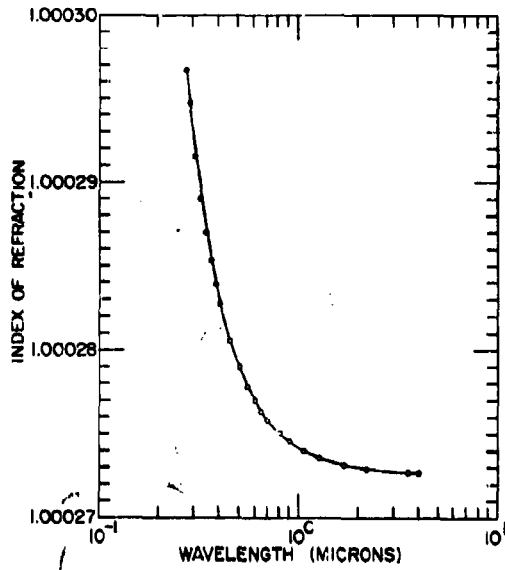


Figure 1. Index of Refraction for 1013 mb and 15°C (Table 1),
 ○○○○ Represent Attenuation Model Wavelengths

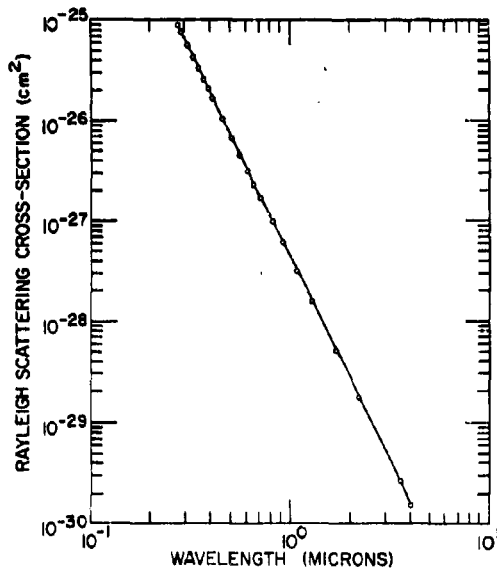


Figure 2. Rayleigh Cross Section vs Wavelength (Table 1),
 ○○○○ Represent Attenuation Model Wavelengths

$$\beta_r(h, \lambda) = \sigma_r(\lambda) \cdot N_r(h) \cdot (10^3 \text{ cm/km}) \quad (3)$$

where

- β_r = the Rayleigh attenuation coefficient (km^{-1}),
- σ_r = the Rayleigh scattering cross section (cm^2),
- N_r = the molecular number density (cm^{-3}).

The values of $N_r(h)$ needed for Eq. (3) were obtained from the U.S. Standard Atmosphere and are listed in Table 2. This expression is used to compute an array of Rayleigh attenuation coefficients as a function of altitude for each wavelength.

With the Rayleigh attenuation coefficients determined, the optical thicknesses from sea level to some altitude h are computed by

$$\tau_r(h, \lambda) = \sum_0^h \bar{\beta}_r(h, \lambda) \Delta h \quad (4)$$

where

- τ_r = Rayleigh optical thickness (0 - h),
- $\bar{\beta}_r$ = mean of the Rayleigh attenuation coefficients (km^{-1}) for each altitude increment,
- Δh = altitude increment chosen as one km for these calculations.

The Rayleigh optical thickness for altitude h to space is obtained by the relationship

$$\tau_r^!(h, \lambda) = \tau_r(\infty, \lambda) - \tau_r(h, \lambda) \quad (5)$$

where

- $\tau_r^!(h)$ = Rayleigh optical thickness ($h - \infty$),
- $\tau_r(\infty)$ = Rayleigh optical thickness (0 - ∞).

The term $\tau_r(\infty)$ was obtained by using Eq. (4) with the limits set between 0 and 80 km. Above 80 km, Stergis' (1966) calculations, based on N_2 , O_2 , and O as the principal atmospheric constituents, yield

$$\int_{80}^{\infty} \beta_r(h, \lambda) dh = \begin{cases} 3.6 \times 10^{-6}, & \lambda = 0.4 \mu \\ 6.7 \times 10^{-7}, & \lambda = 0.6 \mu \\ 2.1 \times 10^{-7}, & \lambda = 0.8 \mu \end{cases}$$

These values approximate a constant 10^{-6} , that of the Rayleigh optical thickness for unity air mass. For our purposes then the integral can be neglected because the constant is small and applies to all wavelengths of interest.

Table 2. Model Parameters as a Function of Altitude

h (km)	N_r (cm^{-3})	D_3 (cm/km)
0	2.547×10^{19}	3.56×10^{-3}
1	2.311	3.26
2	2.093	2.93
3	1.891	2.50
4	1.704	2.26
5	1.531	2.21
6	1.373	2.16
7	1.227	2.23
8	1.093	2.28
9	9.712×10^{18}	2.81
10	8.598	3.50
11	7.585	4.60
12	6.486	6.21
13	5.543	8.45
14	4.738	9.57
15	4.049	9.94
16	3.461	1.03×10^{-2}
17	2.959	1.11
18	2.529	1.22
19	2.162	1.42
20	1.849	1.64
21	1.574	1.84
22	1.341	1.97
23	1.144	1.98
24	9.760×10^{17}	1.93
25	8.335	1.80
26	7.123	1.63
27	6.092	1.41
28	5.214	1.23
29	4.466	1.07
30	3.828	9.03×10^{-3}
31	3.283	7.93
32	2.818	6.82
33	2.406	5.82
34	2.056	4.85
35	1.760	4.31
36	1.509	3.61
37	1.296	3.02
38	1.116	2.53
39	9.620×10^{16}	2.17
40	8.308	1.86
41	7.187	1.52
42	6.227	1.19
43	5.404	9.30×10^{-4}
44	4.697	7.44
45	4.088	5.76
46	3.564	4.46
47	3.112	3.53
48	2.738	2.79
49	2.418	2.23
50	2.135	1.86

h - Altitude; N_r - Molecular number density;
 D_3 - Ozone equivalent thickness

3. ABSORPTION PARAMETERS FOR ATMOSPHERIC OZONE

This section is a summary of the material used in the 1964 Attenuation Model.

The parameter for determining O_3 absorption as a function of altitude is the atmospheric ozone absorption coefficient expressed by:

$$\beta_3(h, \lambda) = A_v(\lambda) D_3(h) \quad (6)$$

- β_3 = atmospheric ozone absorption coefficient (km^{-1}),
- A_v = the pure ozone absorption coefficient (cm^{-1}) after Vigroux,
- D_3 = the ozone equivalent thickness (cm/km).

Thus, the Vigroux coefficients (1953) listed in Table 1 in conjunction with the ozone concentrations, Table 2 and Figure 3, permit the computation of an array of atmospheric ozone absorption coefficients to 50 km for each of the desired wavelengths.

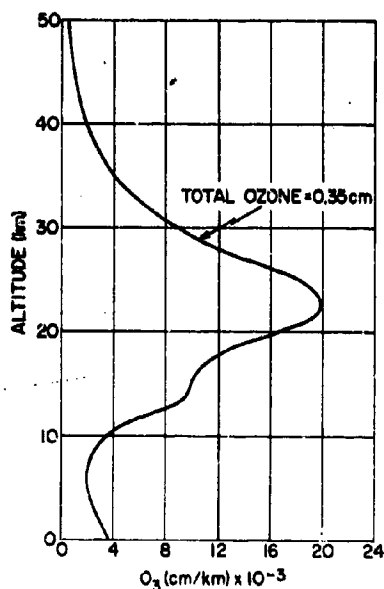


Figure 3. Representative Atmospheric Ozone Concentration Profile (Table 2). Values for: 0 to 30 km, based on Handbook of Geophysics and Space Environment (1965) 30 to 40 km, interpolated 40 to 50 km, based on London, Ooyama, and Prabhakara (1962)

The ozone optical thickness from sea level to altitude h , $\tau_3(h, \lambda)$, and the ozone optical thickness from some altitude h to space, $\tau'_3(h, \lambda)$, are included in the model tabulations. The expressions for deriving these parameters have the same form as Eqs. (4) and (5).

4. AEROSOL ATTENUATION

Of the various methods used to investigate aerosol attenuation, for the present we will consider optical techniques only because they are suited to this type of study. In this country, Newkirk and Eddy (1964) used solar aureole photometry; Penndorf (1954) analyzed solar radiation measurements from aircraft altitudes; Elterman's results (1966a, b), with searchlight probing, comprise a substantial number of profiles acquired in New Mexico for altitudes to about 34 km. In Australia, Crosby and Koerber (1962) used a balloon-borne integrating nephelometer. In the U.S.S.R., Kondratiev, et al. (1967), conducted balloon solar transmission measurements; Feoktistov (1965) analyzed photographs of the earth's horizon from the spacecraft Voschod; Rozenberg, et al. (1960) (1966), acquired their results with searchlight probing. The various results, as shown in Figure 4, were made comparable at $\lambda_1 = 0.55\mu$ by using the empirical relationship that the aerosol attenuation coefficient is inversely proportional to wavelength. For reasons of clarity, a substantial body of results was not included in Figure 4, as for example the twilight measurements by Rozenberg (1965), Volz and Goody (1962), the searchlight measurements by Spankuch (1967), analysis of twilight aureole photographs from the spacecraft Vostok-6 by Driving (1966), the aircraft measurements of sky brightness by Sandomirski, Al'tovskaia and Trifonova (1964), and aircraft nephelometry by Waldram (1945). Also, interesting results in the form of relative values have been obtained with optical techniques: the twilight measurements by Bigg (1964), the laser beam backscatter by Collis and Ligda (1966), by Clemeshaw, Kent, and Wright (1967), and by Grams and Fiocco (1967).

A consideration of all results shows, as does Figure 4, that the aerosol attenuation coefficient is a strongly fluctuating parameter and that average values based on an adequate number of measurements are necessary in order to establish a representative profile. The recent searchlight probing measurements (Elterman, 1966a and 1966b) appear representative based on several considerations. First, each profile was acquired by continuous measurement through both troposphere and stratosphere and with an altitude resolution approximating one km. In addition, a total of 119 profiles comprising absolute values of aerosol attenuation coefficients were determined for various times throughout the year. This represents a substantially larger sample than previously published. Further, such a quantity of

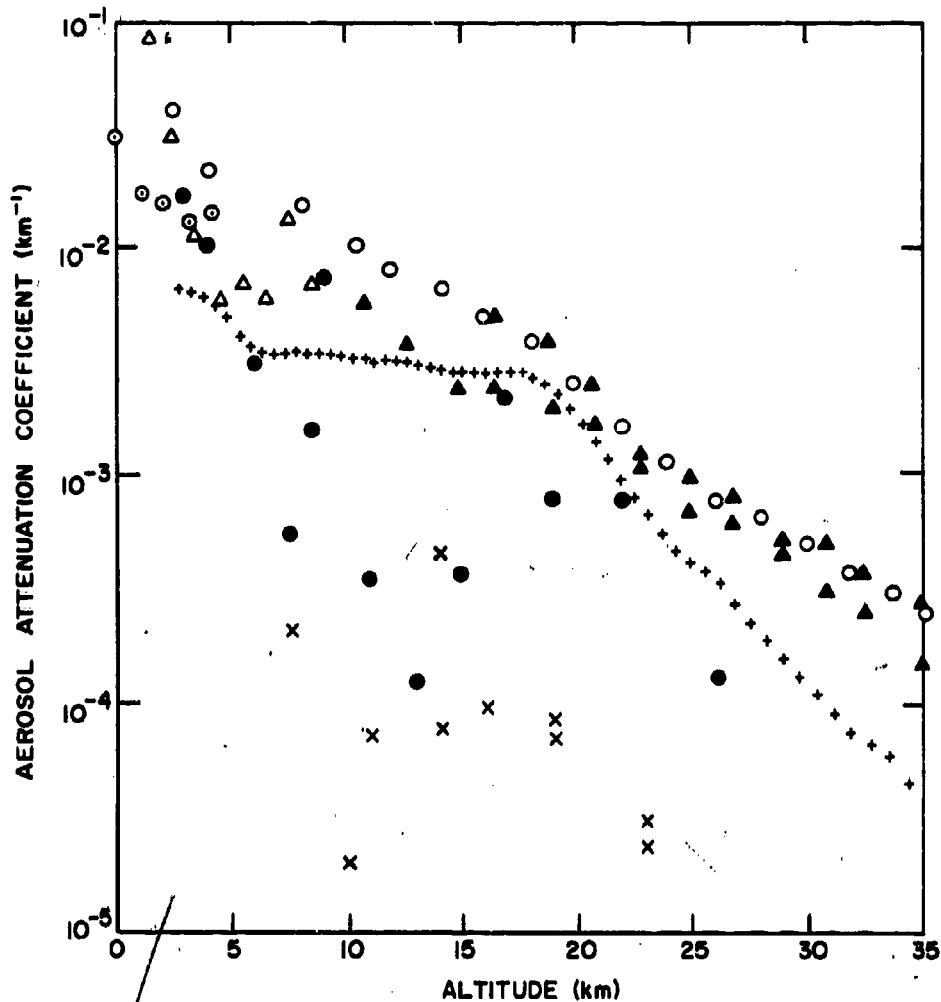


Figure 4. Aerosol Attenuation Coefficients vs Altitude at $\lambda_1 = 0.55\mu$. Comparison of results:

- ×××× solar aureole, 2 balloon flights, Newkirk and Eddy (1964);
- △△△△ solar radiation measured from aircraft, mean of 8 flights, Penndorf (1954);
- ++++ searchlight probing, mean of 105 profiles, Elterman (1966a) and (1966b);
- balloon integrating nephelometer, mean of 14 flights, Crosby and Koerber (1962);
- solar radiation measured from balloons, mean of 3 flights, Kondratiev et al. (1967);
- ▲▲▲▲ spacecraft horizon photography, analysis of 4 frames, Rozenberg (1966), Feoktistov (1965);
- ○ ○ ○ searchlight probing, mean for 5 nights, Rozenberg (1966)

results readily permits statistical treatment. Finally, we note that the mean of the 119 profiles falls reasonably well within the values determined by other researchers, a circumstance which tends to provide a measure of comfort.

In considering the suitability of the 119 profiles, extensive averaging is required and this tends to wash out features easily noted in the individual profile. We present, therefore, in Figure 5 a single profile, chosen because its properties are readily evident and also because it is similar to the overall average. The features can be made to emerge more prominently if the aerosol coefficients are used to compute a turbidity profile, $t_p(h, \lambda_1) = \beta_p(h, \lambda_1) / \beta_r(h, \lambda_1)$, where β_p and β_r are the aerosol and Rayleigh coefficients respectively and $\lambda_1 = 0.55\mu$ (Figure 6).

Since volcanic dust in the atmosphere can have a residence time of several years, the effects of the Mt. Agung eruption (March 1963) must be considered. The direct measurements of Junge, Chagnon, and Manson (1961), Friend (1965), Mossop (1964), and Rosen (1968), collectively considered, before and after this event, show evidence of change in the stratospheric aerosol content. The observations of the twilight sky by Volz (1965) and Meinel and Meinel (1964) also show augmentation of stratospheric particulates. Since the searchlight probing measurements yielded absolute values of aerosol attenuation coefficients, the most suitable parameter to use for examining this feature quantitatively is the stratospheric aerosol optical thickness for the altitude region between the tropopause and 25 km. The reason for choosing the latter altitude limit will be discussed later. Accordingly, all profiles were placed in time-sequential groups determined by the similarity of the stratospheric dust feature. Then the optical thickness was computed by

$$\bar{\tau} = \frac{1}{n} \sum_{i=1}^n \sum_{h_1}^{h_2} \bar{\beta}'(h) \Delta h \quad (7)$$

where n is the number of profiles in the group, h_1 is the altitude of the tropopause, h_2 the 25 km altitude, $\bar{\beta}'$ the mean aerosol attenuation coefficient (within each profile) for the altitude interval, and Δh the altitude intervals used for computing the profiles. The results of this computation are presented in Table 3. The tabulation demonstrates a relatively high level of stratospheric dust for the December 1963 to March 1964 period. Beginning with April 1964, dust abatement and a generally stabilized level are in evidence. The mean optical thickness of Group (B+C+D) is 26 percent less than that of Group A. Since Group A entails a period of abnormally high aerosol content, its profiles are not representative. These results are in satisfactory agreement with the findings from the direct measurements of the authors mentioned.

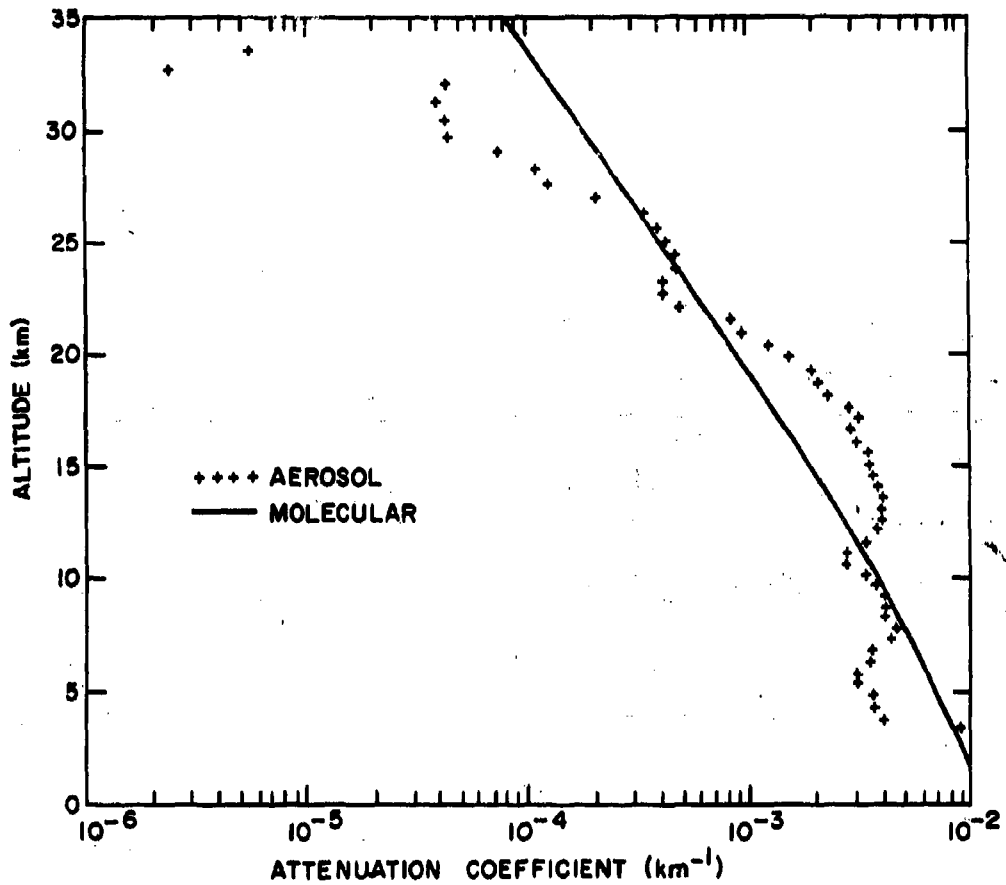


Figure 5. Single Profile $\beta_p(h, \lambda_1)$ for 11 April 1964 at 02:00 MST, Similar to Mean of 79 Profiles, $\lambda_1 = 0.55\mu$.
 Surface to 5 km - convective region;
 5 to 11.7 km - troposphere dust layer;
 11.7 to 23.8 km - stratosphere dust layer;
 25.6 km - upper altitude maximum
 + + + aerosol (measurements)
 ——— molecular (computed)

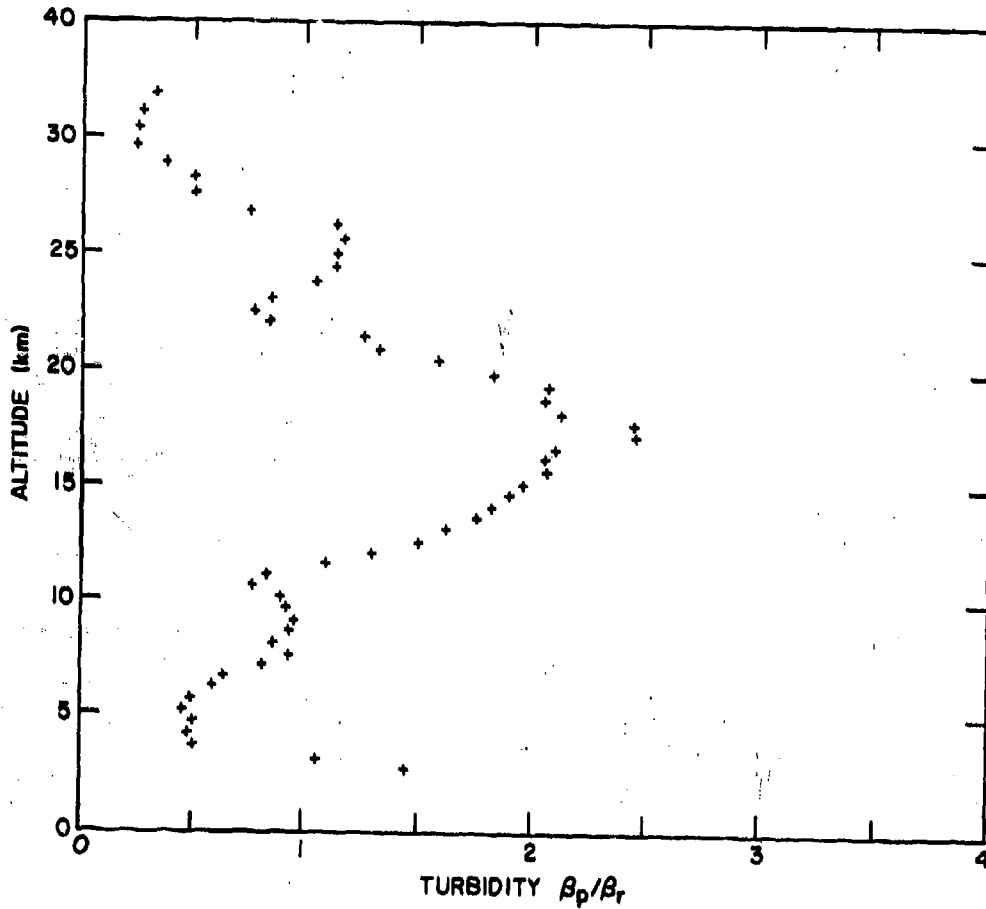


Figure 6. Single Turbidity Profile $\beta_p(h, \lambda_1)/\beta_r(h, \lambda_1)$
for 11 April at 0200 MST.
+++++ Measurements
(See caption pertaining to Figure 5)

Table 3. Aerosol Optical Thickness as a Measure of Volcanic Dust, $\lambda_1 = 0.55\mu$

Group	Period (Inclusive)	Number of Profiles	Mean Optical Thickness (approx. 12-25 km)
A	Dec 1963 - Mar 1964	40	3.1×10^{-2}
B	Apr 1964 - Sep 1964	50	2.2
C	Oct 1964 - Nov 1964	10	2.7
D	Dec 1964 - Apr 1965	19	2.4
B+C+D	Apr 1964 - Apr 1965	79	2.3

The considerations discussed above justify the selection of the Group (B+C+D) profiles as a basis for developing representative aerosol attenuation parameters. It will be convenient to designate the 79 profile average for $\lambda_1 = 0.55\mu$ as $\bar{\beta}_p(h, \lambda_1)$ (Figure 7). This profile can be extended to encompass a larger altitude range by using the scale height relationship,

$$\bar{\beta}_p(h_2, \lambda_1) = \bar{\beta}_p(h_1, \lambda_1) \exp \left[- \frac{(h_2 - h_1)}{H_p} \right] \quad (8)$$

Penndorf's study (1954) shows that for the lowest 5 km, the aerosol coefficients fall off exponentially with a scale height $0.97 < H_p < 1.4$ km. We resort to the use of his mean value, $H_p = 1.2$ km, to extend the $\bar{\beta}_p(h, \lambda_1)$ profile from 3.7 km to sea level. This results in aerosol coefficients which are identical to those of the 1964 Attenuation Model for altitudes 0 to 3 km (Table 4.11).

Above the convective region, up to the tropopause the aerosol coefficients show a moderate gradient which is in close agreement with Penndorf's analysis (1954) of the vertical distribution of aerosols in the troposphere. Also, this section of the profile is based on high signal to noise measurements and extensive averaging, factors which contribute to its reliability. Additionally, this altitude region, being above the convective layer, is characterized by aerosol conditions which tend to be independent of surface terrain. These considerations suggest that the shape and values of the $\bar{\beta}_p(h, \lambda_1)$ profile for this altitude region are realistic.

Above the tropopause, up to 25 km, the coefficients are larger than those derived for the 1964 Attenuation Model by a factor of about 20 (at 20 km for $\lambda_1 = 0.55\mu$). This difference may be attributed in part to the intrinsic difficulties of converting a size distribution to an optical parameter, that is, establishing the radii limits, particle shape, chemistry, and index of refraction. Relative to profile shape, a turbidity maximum dominates at about 19 km (Figure 8). The measurements of Rosen (1968) and those of Volz (1968) for 1964 to 1968 are in satisfactory agreement

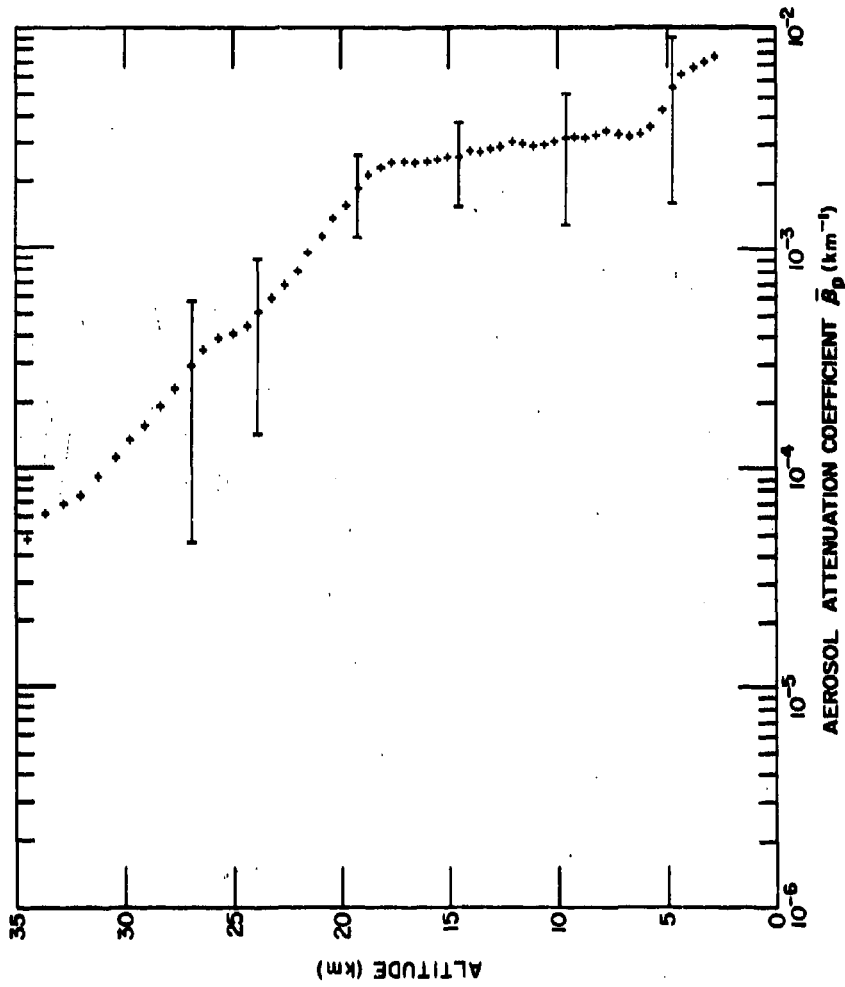


Figure 7. Mean of 79 Low Stratospheric Dust Profiles (Table 3) for April 1964 to April 1965. Aerosol attenuation coefficients, $\beta_p(h, \lambda_1)$; standard deviation limits attributable to error and atmospheric variations; $\lambda_1 = 0.55\mu$; ++++ measurements with searchlight probing

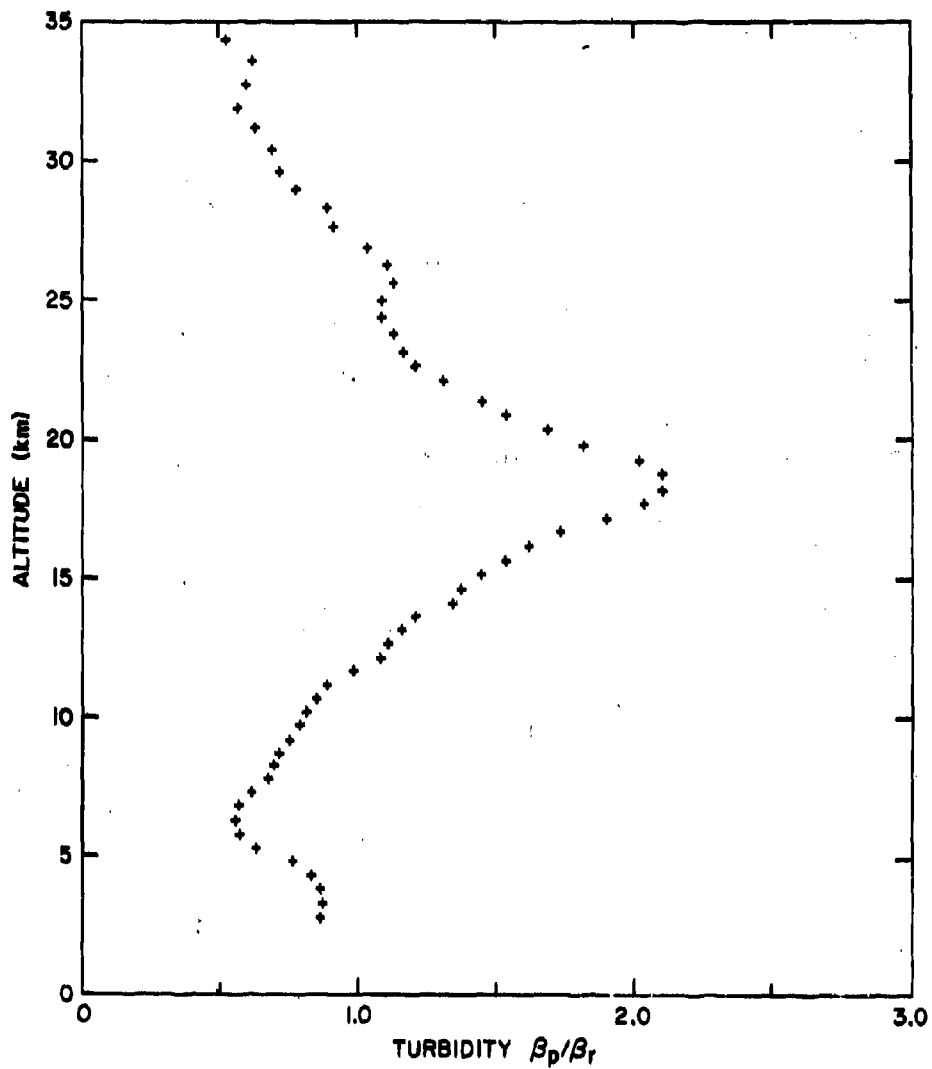


Figure 8. Mean Turbidity Profile, $\bar{\beta}_p(h, \lambda_1) / \beta_r(h, \lambda_1)$
(See caption for Figure 7)

with the mean optical thickness and shape of the Group (B+C+D) profiles, Table 3. Also their results show that the stratospheric dust level has remained approximately constant from 1964 to the time of this writing. The $\bar{\beta}_p(h, \lambda_1)$ curve (Figure 7) shows this dust feature as the knee of the profile rather than a massive layer feature indicated by the turbidity profile. This conceptual relationship suggests that over-emphasis is possible when dealing only with turbidity profiles.

The turbidity profile shows an upper stratospheric maximum with its lower terminus at 25 km. This altitude then, was the basis for choosing the upper stratospheric dust limit in Eq. (7). The maximum at 26 km occurs with sufficient frequency to be easily identified in the turbidity profile. The existence of such an aerosol concentration above 20 km is supported by the analysis of satellite photography reported by Maier, Dave, Dunkelman, and Evans (1967).

To establish upper altitude aerosol coefficients, a least square fit was computed for $\bar{\beta}_p(h, \lambda_1)$ from 26 to 32 km (Figure 9). The result, $H_p = 3.75$ km (in effect derived from 79 measurement points), was used in Eq. (8) to extend the values to 50 km. Miller (1967) obtained $H_p = 3.25$ km from a thorough analysis of rocket measurements acquired in 1964 for this altitude region. The overall profile from sea level to 50 km is presented in Figure 10 (Table 4.11). Since the

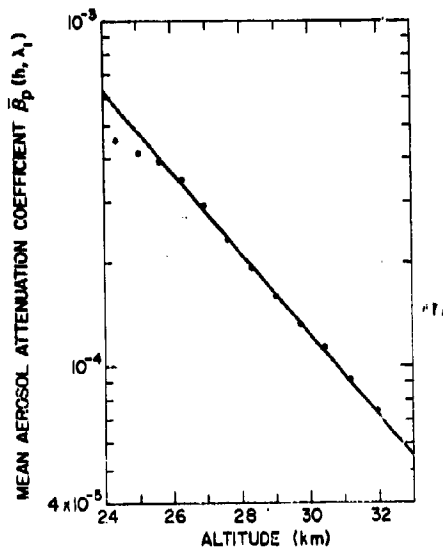


Figure 9. Expanded Scale for 26 to 32 km Altitude Region Showing $H_p = 3.75$ km for 79 Profile Mean; Aerosol Attenuation Coefficients, $\beta_p(h, \lambda_1)$ vs Altitude; Least Square Fit Used to Extrapolate to 50 km; $\lambda_1 = 0.55 \mu$

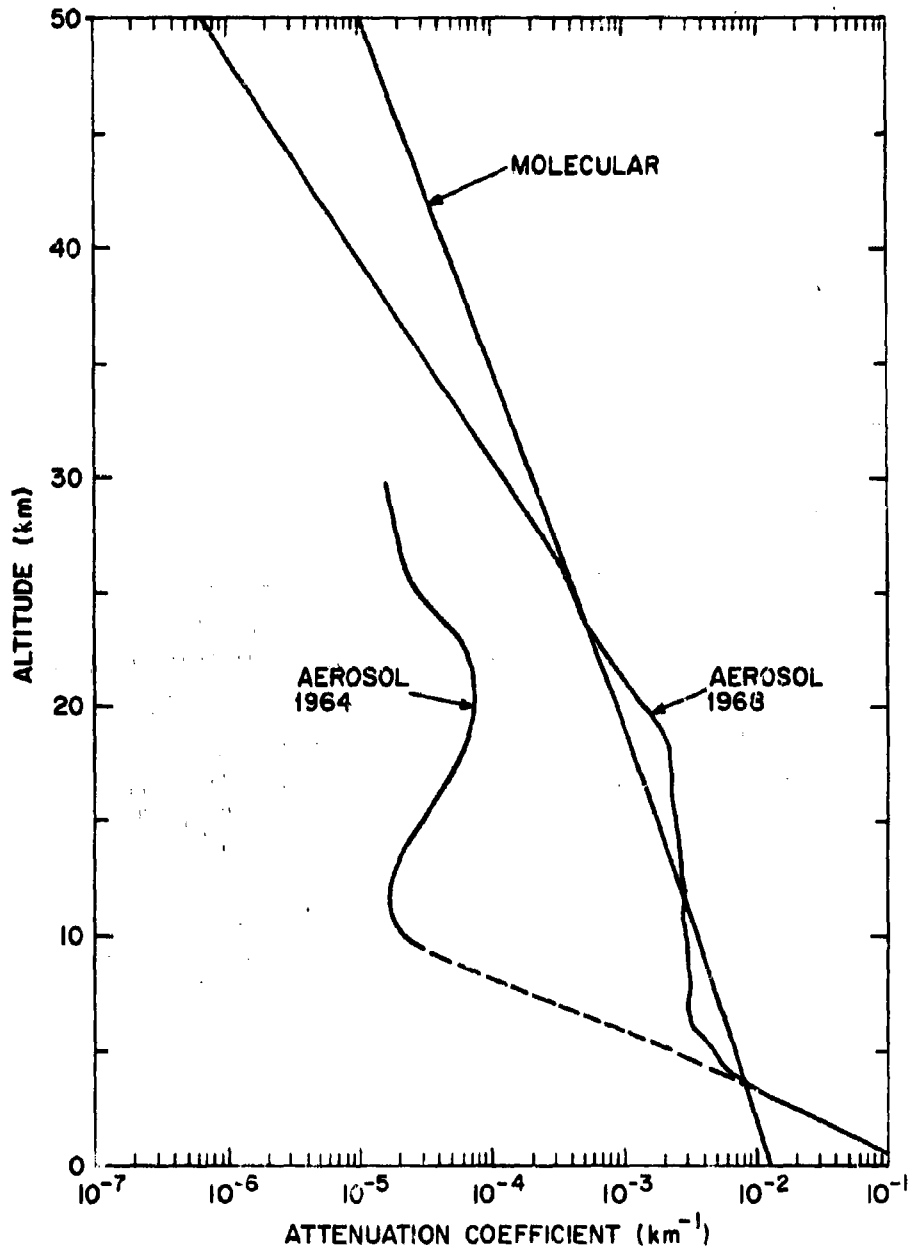


Figure 10. Comparison of Profiles. Aerosol attenuation coefficients $\beta_p(h, \lambda_1)$, with molecular $\beta_r(h, \lambda_1)$. The 1964 profile shows interpolation between 5 to 10 km; $\lambda_1 = 0.55\mu$

turbidity is proportional to the mixing ratio, the diminishing values for the extrapolation imply the aerosol source exists below 30 km. Should the source be of meteoric origin, the mixing ratio would tend to be constant or increase for altitudes 30 to 50 km.

Thus far we have selected a set of measurements for $\lambda_1 = 0.55\mu$ and provided reasons for its use. It would be in order now to examine some expressions leading to corresponding aerosol profiles for other wavelengths. If we consider a real atmosphere, the aerosol sizes within unit volume can be described by a size distribution function, $\psi(r)$. Various size distribution functions are in use: the Junge type power law (1963) with a choice of exponents discussed in detail by Bullrich (1964), a similar distribution modified by gaps observed by Fenn (1964), a log-Gaussian distribution used by Foitzik (1965), a composite distribution with components from several types. The optical-particle size relationship utilizes $\psi(r)$ such that

$$\beta_p(m, r, \lambda) = \int_{N_{r_2}}^{N_{r_1}} \sigma_p(m, r, \lambda) dN_p(r) \quad , \quad (9)$$

$$dN_p = N_o \psi(r) dr \quad , \quad (10)$$

$$N_o(h) = C N_p(h) \quad . \quad (11)$$

β_p is the aerosol attenuation coefficient, m is the index of refraction, N_{r_1} and N_{r_2} are the aerosol number density limits established by the radii limits r_1 and r_2 , σ_p is the aerosol cross section for each particle, N_p is the total number of particles between r_1 and r_2 . For a given altitude, N_o actually is proportional to the particle number density between r_1 and r_2 . Since the same size distribution function applies to all altitudes (an assumption), Eqs. (9), (10), and (11) are combined

$$\beta_p(h, \lambda) = C N_p(h) \int_{r_1}^{r_2} \sigma_p(r, \lambda) \psi(r) dr \quad . \quad (12)$$

Here, $C N_p(h)$ is placed outside the integral which now contains only factors that are independent of altitude; also, m is removed because subsequent considerations will pertain to particles without any distinction in refractive index. If Eq. (12) is normalized to sea level conditions, the integral cancels out. Then generally for the various wavelengths λ , and specifically for $\lambda_1 = 0.55\mu$, we have

$$\frac{\beta_p(h, \lambda)}{\beta_p(0, \lambda)} = \frac{\beta_p(h, \lambda_1)}{\beta_p(0, \lambda_1)} = \frac{N_p(h)}{N_p(0)} \quad (13)$$

or

$$\beta_p(h, \lambda) = \frac{\beta_p(0, \lambda)}{\beta_p(0, \lambda_1)} \cdot \beta_p(h, \lambda_1) \quad (14)$$

Equation (13) has been derived in this manner to demonstrate its compatibility with particle size considerations. Sea level conditions have been researched extensively by Curcio and Durbin (1959), Curcio, Knestrick, and Cosden (1961), Knestrick, Cosden, and Curcio (1961), Dunkelman (1952), Baum and Dunkelman (1955). The $\beta_p(0, \lambda)$ values for a 25 km M.R., based on the results of these authors, are shown in Figure 11 (see also Elterman, 1964). Utilizing these results, in conjunction with the $\tilde{\beta}_p(h, \lambda_1)$ profile (Table 4.11), all requirements for the right-hand side of Eq. (14) are satisfied and an array of aerosol attenuation coefficients can be computed for all altitudes and wavelengths of interest.

The aerosol optical thickness from sea level to altitude h , $\tau_p(h, \lambda)$, and the aerosol optical thickness from some altitude h to space, $\tau_p^i(h, \lambda)$, are included in the model tabulations. The expressions for deriving these parameters have the same form as Eqs. (4) and (5).

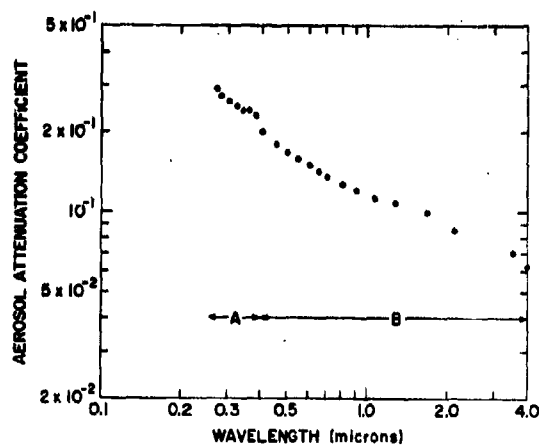


Figure 11. Aerosol Attenuation Coefficients $\beta_p(0, \lambda)$ vs Wavelength at Sea Level for a Meteorological Range Approximating 25 km.
 A - derived from Baum and Dunkelman (1955)
 B - contained in Curcio, Knestrick, and Cosden (1961)

5. ATMOSPHERIC EXTINCTION

In this section, three sets of extinction parameters are considered: extinction coefficient, extinction optical thickness from sea level to a desired altitude, and extinction optical thickness from a desired altitude to space.

The atmospheric extinction coefficient β_{ext} is the sum of all the attenuating components:

$$\beta_{\text{ext}}(h, \lambda) = \beta_r(h, \lambda) + \beta_g(h, \lambda) + \beta_p(h, \lambda) \quad (15)$$

The extinction optical thickness from sea level to altitude h , $\tau_{\text{ext}}(h, \lambda)$, and the extinction optical thickness from some altitude h to space, $\tau'_{\text{ext}}(h, \lambda)$, are included in the tabulations of the attenuation model. The expression for deriving these parameters has the same form as Eqs. (4) and (5).

6. EXPLORATORY TRANSMISSION CALCULATIONS

Using the derived tabulations that follow, some exploratory calculations with extinction parameters (for any of the wavelengths) are demonstrated. Rayleigh, aerosol, and ozone parameters can be used similarly.

For horizontal transmission (T_h) over a path (d) at any altitude (h), the extinction coefficient

$$T_h = \exp \left[- \beta_{\text{ext}}(h, \lambda) \cdot d \right] \quad (16)$$

For vertical and slant-path transmission from sea level to a given altitude, at zenith angle θ for all wavelengths of interest

$$T_{0-h} = \exp \left[- \tau_{\text{ext}}(h) \cdot \sec \theta \right] \quad (17)$$

For vertical and slant-path transmission between two altitudes above sea level

$$T_{\Delta h} = \exp - \left[\tau_{\text{ext}}(h_2) - \tau_{\text{ext}}(h_1) \right] \cdot \sec \theta \quad (18)$$

For vertical and slant-path transmission from a given altitude out into space

$$T_{h-\infty} = \exp \left[- \tau'_{\text{ext}}(h) \sec \theta \right] \quad (19)$$

7. CONCLUDING REMARKS

The procedure for developing the aerosol attenuation profile is summarized as follows:

- (1) Various studies were compared and of these a set of measurements selected.
- (2) The choice of measurements (comprising 119 profiles from 2.76 to 34.4 km) was examined statistically. This resulted in the elimination of 40 profiles (December 1963 to March 1964 inclusive) characterized by a high volcanic dust component.
- (3) The mean of the 79 remaining profiles was extended to sea level and to 50 km respectively by reasonably supported extrapolations.
- (4) The overall profile then was developed laterally to obtain 21 additional profiles for the wavelengths of interest.

A significant aspect of the procedure is that the wavelength-height array of parameters was derived independently of the assumptions associated with conversion of a size distribution to an optical parameter.

For most purposes, calculations using the new parameters will be affected only moderately. For example at $\lambda_1 = 0.55\mu$, the 1964 Attenuation Model provides an extinction optical thickness, $\tau_{ext} = 0.331$, for a vertical air mass. The new parameters yield $\tau_{ext} = 0.379$, resulting in a transmission change of about 3-1/2 percent. However, for long path horizontal transmission calculations above 5 km and for long slant-path calculations entailing large zenith angles, the new aerosol parameters can function more significantly.

As mentioned previously, the Rayleigh and ozone parameters are unchanged.

8. TABULATION OF PARAMETERS

Tables 4.1 to 4.22, which follow, comprise the atmospheric attenuation model. Exponents are in computer notation; for example, read 2.86-3 = 2.86×10^{-3} and 2.86 3 as 2.86×10^3 .

Table 4.1 Parameters at 0.27 microns

Alt. (km)	Rayleigh atten. coeff. (km^{-1})	Rayleigh optical thick. (0-h)	Rayleigh optical thick. (h-h)	Aerosol atten. coeff. (km^{-1})	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-h)	Ozone absorp. coeff. (km^{-1})	Ozone optical thick. (0-h)	Ozone optical thick. (h-h)	Ext. coeff. (km^{-1})	Ext. optical thick. (0-h)	Ext. optical thick. (h-h)
h	β_r	τ_r	τ_r	β_p	τ_p	τ_p	β_3	τ_3	τ_3	β_{ext}	τ_{ext}	τ_{ext}
0	2.242	-1	1.928	2.90	-1	.000	7.48	-1	.000	1.27	0	73.346
1	2.071	-1	1.710	1.29	-1	.209	6.85	-1	.716	1.02	0	72.203
2	1.975	-1	1.513	5.51	-2	.300	6.15	-1	1.356	8.58	-1	71.255
3	1.894	-1	1.335	2.51	-2	.336	5.25	-1	1.955	7.18	-1	70.477
4	1.825	-1	1.174	1.22	-2	.357	4.75	-1	2.435	6.39	-1	69.799
5	1.772	-1	1.030	9.21	-3	.358	4.55	-1	2.905	6.11	-1	69.174
6	1.730	-1	0.900	6.50	-3	.375	4.54	-1	3.354	5.83	-1	68.577
7	1.698	-1	0.793	6.04	-3	.388	4.69	-1	3.825	5.84	-1	67.993
8	1.674	-1	0.700	6.22	-3	.388	4.79	-1	4.239	5.83	-1	67.410
9	1.656	-2	0.630	5.97	-3	.394	5.90	-1	4.633	5.83	-1	66.826
10	1.642	-2	0.575	5.82	-3	.400	7.35	-1	5.096	8.14	-1	66.242
11	1.631	-2	0.533	5.65	-3	.405	9.65	-1	5.561	1.04	0	65.657
12	1.622	-2	0.499	5.45	-3	.405	1.77	0	6.021	1.83	0	65.072
13	1.614	-2	0.472	5.29	-3	.411	1.30	0	7.481	1.37	0	64.487
14	1.607	-2	0.451	5.18	-3	.422	1.77	0	8.941	2.06	0	63.902
15	1.601	-2	0.434	4.96	-3	.427	2.09	0	10.401	2.13	0	63.317
16	1.595	-2	0.420	4.53	-3	.432	2.16	0	11.861	2.20	0	62.732
17	1.589	-2	0.407	4.57	-3	.436	2.33	0	13.321	2.36	0	62.147
18	1.583	-2	0.395	4.62	-3	.441	2.56	0	14.781	2.59	0	61.562
19	1.577	-2	0.384	3.73	-3	.445	2.98	0	16.241	3.01	0	60.977
20	1.571	-2	0.373	2.73	-3	.448	3.66	0	17.701	3.46	0	60.392
21	1.565	-2	0.362	1.99	-3	.450	4.14	0	19.161	3.88	0	59.807
22	1.559	-2	0.351	1.60	-3	.452	4.15	0	20.621	4.15	0	59.222
23	1.553	-2	0.340	1.14	-3	.453	4.15	0	22.081	4.17	0	58.637
24	1.547	-3	0.329	9.05	-4	.454	4.05	0	23.541	4.06	0	58.052
25	1.541	-3	0.318	7.52	-4	.455	3.78	0	25.001	3.79	0	57.467
26	1.535	-3	0.307	6.64	-4	.456	3.42	0	26.461	3.43	0	56.882
27	1.529	-3	0.296	5.09	-4	.457	2.98	0	27.921	2.97	0	56.297
28	1.523	-3	0.285	3.30	-4	.457	2.58	0	29.381	2.59	0	55.712
29	1.517	-3	0.274	2.39	-4	.457	2.25	0	30.841	2.25	0	55.127
30	1.511	-3	0.263	2.29	-4	.458	1.90	0	32.301	1.90	0	54.542
31	1.505	-3	0.252	1.75	-4	.458	1.57	0	33.761	1.67	0	53.957
32	1.499	-3	0.241	1.34	-4	.458	1.43	0	35.221	1.43	0	53.372
33	1.493	-3	0.230	1.03	-4	.458	1.22	0	36.681	1.22	0	52.787
34	1.487	-3	0.219	7.37	-5	.458	1.02	0	38.141	1.02	0	52.202
35	1.481	-3	0.208	6.04	-5	.458	9.05	-1	39.601	9.07	-1	51.617
36	1.475	-3	0.197	4.53	-5	.458	7.58	-1	41.061	7.59	-1	51.032
37	1.469	-3	0.186	3.54	-5	.458	6.34	-1	42.521	6.35	-1	50.447
38	1.463	-3	0.175	2.72	-5	.458	5.31	-1	43.981	5.32	-1	49.862
39	1.457	-3	0.164	2.07	-5	.458	4.56	-1	45.441	4.57	-1	49.277
40	1.451	-3	0.153	1.50	-5	.458	3.91	-1	46.901	3.91	-1	48.692
41	1.445	-3	0.142	1.22	-5	.458	3.19	-1	48.361	3.20	-1	48.107
42	1.439	-3	0.131	0.92	-5	.458	2.50	-1	49.821	2.50	-1	47.522
43	1.433	-3	0.120	7.14	-5	.458	1.95	-1	51.281	1.96	-1	46.937
44	1.427	-3	0.109	5.47	-5	.458	1.56	-1	52.741	1.57	-1	46.352
45	1.421	-3	0.098	4.14	-6	.458	1.21	-1	54.201	1.21	-1	45.767
46	1.415	-3	0.087	3.21	-5	.458	9.37	-2	55.661	9.40	-2	45.182
47	1.409	-3	0.076	2.46	-5	.458	7.61	-2	57.121	7.64	-2	44.597
48	1.403	-3	0.065	1.99	-5	.458	5.85	-2	58.581	5.88	-2	44.012
49	1.397	-3	0.054	1.44	-5	.458	4.68	-2	60.041	4.70	-2	43.427
50	1.391	-3	0.043	1.10	-6	.458	3.91	-2	61.501	3.93	-2	42.842

Table 4.2 Parameters at 0.28 microns

Alt. (km)	Rayleigh atten. coeff. (km ⁻¹)	Rayleigh optical thick. (0-h)	Rayleigh optical thick. (h-h ₀)	Aerosol atten. coeff. (km ⁻¹)	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-h ₀)	Ozone absorp. coeff. (km ⁻¹)	Ozone optical thick. (0-h)	Ozone optical thick. (h-h ₀)	β _{ext} (km ⁻¹)	Ext. optical thick. (0-h)	Ext. optical thick. (h-h ₀)
0	1.948	-1	-0.00	2.70	-1	.427	3.77	-1	.000	8.42	-1	.000
1	1.767	-1	0.18	1.19	-1	.232	3.45	-1	.361	6.41	-1	.742
2	1.600	-1	0.34	5.13	-2	.147	3.11	-1	.630	5.22	-1	1.323
3	1.445	-1	0.50	1.13	-2	.111	2.65	-1	.977	4.31	-1	1.800
4	1.303	-1	0.63	1.14	-2	.095	2.40	-1	1.230	3.81	-1	2.206
5	1.171	-1	0.76	8.58	-3	.085	2.34	-1	1.457	3.60	-1	2.576
6	1.050	-1	0.87	6.05	-3	.077	2.29	-1	1.698	3.40	-1	2.926
7	9.390	-2	0.97	5.52	-3	.071	2.36	-1	1.931	3.36	-1	3.264
8	8.359	-2	1.06	5.79	-3	.066	2.42	-1	2.170	3.31	-1	3.598
9	7.426	-2	1.14	5.55	-3	.060	2.98	-1	2.440	3.31	-1	3.952
10	6.574	-2	1.21	4.31	-3	.054	3.71	-1	2.774	4.42	-1	4.362
11	5.800	-2	1.27	5.42	-3	.049	4.88	-1	3.203	5.51	-1	4.898
12	4.959	-2	1.32	5.33	-3	.044	6.58	-1	3.776	7.13	-1	5.490
13	4.238	-2	1.37	4.32	-3	.039	8.95	-1	4.553	9.43	-1	6.318
14	3.623	-2	1.41	4.02	-3	.034	1.01	0	5.508	1.06	0	7.317
15	3.095	-2	1.44	4.53	-3	.029	1.05	0	6.542	1.09	0	8.390
16	2.647	-2	1.47	4.31	-3	.025	1.09	0	7.615	1.12	0	9.496
17	2.262	-2	1.50	4.25	-3	.021	1.18	0	8.749	1.20	0	10.659
18	1.936	-2	1.52	4.12	-3	.017	1.29	0	9.984	1.32	0	11.919
19	1.653	-2	1.54	3.67	-3	.013	1.51	0	11.383	1.53	0	13.340
20	1.414	-2	1.55	2.55	-3	.010	1.74	0	13.035	1.76	0	14.980
21	1.204	-2	1.56	1.35	-3	.008	1.95	0	14.850	1.98	0	16.839
22	1.026	-2	1.57	1.39	-3	.006	2.10	0	15.859	2.10	0	18.872
23	9.745	-3	1.59	1.05	-3	.005	2.09	0	16.854	2.11	0	20.976
24	7.662	-3	1.59	9.42	-4	.004	2.05	0	17.781	2.05	0	23.057
25	6.373	-3	1.60	7.09	-4	.003	1.91	0	18.604	1.92	0	25.042
26	5.646	-3	1.60	6.19	-4	.003	1.73	0	19.375	1.73	0	26.866
27	4.658	-3	1.61	4.73	-4	.002	1.49	0	20.105	1.50	0	28.483
28	3.987	-3	1.61	3.62	-4	.001	1.30	0	20.840	1.31	0	29.887
29	3.415	-3	1.62	2.79	-4	.001	1.13	0	21.559	1.14	0	31.110
30	2.927	-3	1.62	2.14	-4	.001	9.57	-1	22.262	9.60	-1	32.159
31	2.511	-3	1.62	1.63	-4	.001	8.41	-1	23.012	8.43	-1	33.061
32	2.155	-3	1.63	1.25	-4	.000	7.23	-1	23.785	7.25	-1	33.845
33	1.840	-3	1.63	9.57	-5	.000	6.17	-1	24.555	6.19	-1	34.517
34	1.572	-3	1.63	7.33	-5	.000	5.14	-1	25.321	5.16	-1	35.084
35	1.346	-3	1.63	5.62	-5	.000	4.57	-1	26.076	4.58	-1	35.571
36	1.154	-3	1.63	4.31	-5	.000	3.83	-1	26.829	3.84	-1	35.992
37	9.913	-4	1.63	3.30	-5	.000	3.20	-1	27.572	3.21	-1	36.345
38	9.532	-4	1.63	2.53	-5	.000	2.68	-1	28.306	2.69	-1	36.640
39	7.356	-4	1.64	1.93	-5	.000	2.30	-1	29.029	2.31	-1	36.894
40	6.353	-4	1.64	1.48	-5	.000	1.97	-1	29.744	1.98	-1	37.105
41	5.495	-4	1.64	1.13	-5	.000	1.61	-1	30.451	1.62	-1	37.284
42	4.751	-4	1.64	8.68	-6	.000	1.26	-1	31.145	1.27	-1	37.428
43	4.132	-4	1.64	6.65	-6	.000	9.85	-2	31.829	9.90	-2	37.541
44	3.591	-4	1.64	5.09	-6	.000	7.83	-2	32.506	7.92	-2	37.630
45	3.126	-4	1.64	3.90	-6	.000	6.11	-2	33.176	6.14	-2	37.700
46	2.725	-4	1.64	2.99	-6	.000	4.73	-2	33.842	4.76	-2	37.755
47	2.379	-4	1.64	2.29	-6	.000	3.74	-2	34.504	3.77	-2	37.797
48	2.093	-4	1.64	1.76	-6	.000	2.96	-2	35.162	2.98	-2	37.831
49	1.849	-4	1.64	1.34	-6	.000	2.35	-2	35.814	2.38	-2	37.858
50	1.633	-4	1.64	1.03	-6	.000	1.97	-2	36.466	1.99	-2	37.880

Table 4.3 Parameters at 0.30 microns

Alt. (km)	Rayleigh atten. coeff. (km ⁻¹)	Rayleigh optical thick. (0-n)	Rayleigh optical thick. (h-∞)	Aerosol atten. coeff. (km ⁻¹)	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-∞)	Ozone absorp. coeff. (km ⁻¹)	Ozone optical thick. (0-h)	Ozone optical thick. (h-∞)	Ext. coeff. (km ⁻¹)	Ext. optical thick. (0-h)	Ext. optical thick. (h-∞)
h	β_r	τ_r	τ_r'	β_p	τ_p	τ_p'	β_3	τ_3	τ_3'	β_{ext}	τ_{ext}	τ_{ext}'
0	1.446	-1	-0.00	2.60	-1	-0.11	3.60	-2	-0.00	4.41	-1	5.047
1	1.312	-1	-1.38	1.14	-1	-0.24	3.23	-2	-0.34	2.79	-1	4.665
2	1.188	-1	-2.63	4.94	-2	-0.59	2.96	-2	-0.66	1.98	-1	4.450
3	1.073	-1	-4.36	2.07	-2	-1.07	2.52	-2	-0.93	1.53	-1	4.274
4	9.672	-2	-6.77	1.10	-2	-0.91	2.28	-2	-1.17	1.31	-1	4.132
5	8.693	-2	-5.69	8.26	-3	-0.91	2.23	-2	-1.40	1.18	-1	4.008
6	7.792	-2	-6.51	5.83	-3	-0.74	2.18	-2	-1.62	1.06	-1	3.897
7	6.965	-2	-7.25	5.41	-3	-0.69	2.15	-2	-1.84	9.76	-2	3.795
8	6.207	-2	-7.91	5.38	-3	-0.63	2.10	-2	-2.07	9.07	-2	3.701
9	5.513	-2	-8.49	5.35	-3	-0.58	2.04	-2	-2.32	8.89	-2	3.611
10	4.881	-2	-9.01	5.22	-3	-0.53	2.03	-2	-2.54	8.94	-2	3.522
11	4.306	-2	-9.47	4.89	-3	-0.44	1.99	-2	-2.74	9.44	-2	3.430
12	3.682	-2	-9.87	5.13	-3	-0.39	1.92	-2	-2.90	1.05	-1	3.331
13	3.147	-2	-1.021	4.74	-3	-0.38	1.85	-2	-3.04	1.22	-1	3.218
14	2.690	-2	-1.050	4.64	-3	-0.33	1.78	-2	-3.16	1.22	-1	3.093
15	2.259	-2	-1.075	4.46	-3	-0.28	1.71	-2	-3.25	1.28	-1	2.965
16	1.965	-2	-1.096	4.15	-3	-0.24	1.66	-2	-3.31	1.28	-1	2.837
17	1.680	-2	-1.114	4.10	-3	-0.20	1.62	-2	-3.34	1.33	-1	2.707
18	1.436	-2	-1.130	3.97	-3	-0.16	1.58	-2	-3.38	1.42	-1	2.569
19	1.223	-2	-1.143	3.84	-3	-0.12	1.53	-2	-3.41	1.59	-1	2.428
20	1.050	-2	-1.154	2.45	-3	-0.09	1.48	-2	-3.43	1.79	-1	2.250
21	8.937	-3	-1.164	1.78	-3	-0.07	1.42	-2	-3.44	1.97	-1	2.063
22	7.615	-3	-1.172	1.34	-3	-0.06	1.36	-2	-3.45	2.08	-1	1.860
23	6.433	-3	-1.179	1.02	-3	-0.05	1.30	-2	-3.46	2.07	-1	1.653
24	5.541	-3	-1.185	8.11	-4	-0.04	1.25	-2	-3.47	2.01	-1	1.448
25	4.732	-3	-1.191	6.83	-4	-0.03	1.20	-2	-3.48	2.01	-1	1.254
26	4.044	-3	-1.195	5.96	-4	-0.02	1.15	-2	-3.49	1.66	-1	1.076
27	3.458	-3	-1.199	4.56	-4	-0.02	1.10	-2	-3.50	1.46	-1	0.918
28	2.960	-3	-1.202	3.49	-4	-0.01	1.05	-2	-3.51	1.28	-1	0.781
29	2.535	-3	-1.205	2.66	-4	-0.01	1.00	-2	-3.52	1.11	-1	0.662
30	2.173	-3	-1.207	2.06	-4	-0.01	0.95	-2	-3.53	0.96	-2	0.560
31	1.864	-3	-1.209	1.57	-4	-0.01	0.90	-2	-3.54	0.82	-2	0.472
32	1.600	-3	-1.211	1.20	-4	-0.00	0.85	-2	-3.55	0.76	-2	0.395
33	1.366	-3	-1.212	0.92	-5	-0.11	0.80	-2	-3.56	0.70	-2	0.330
34	1.167	-3	-1.213	0.76	-5	-0.11	0.75	-2	-3.57	0.64	-2	0.273
35	9.990	-4	-1.214	5.41	-5	-0.11	0.70	-2	-3.58	0.58	-2	0.227
36	8.567	-4	-1.215	4.15	-5	-0.11	0.65	-2	-3.59	0.52	-2	0.186
37	7.300	-4	-1.216	3.18	-5	-0.11	0.60	-2	-3.60	0.46	-2	0.152
38	6.335	-4	-1.217	2.44	-5	-0.11	0.55	-2	-3.61	0.40	-2	0.123
39	5.461	-4	-1.217	1.86	-5	-0.11	0.50	-2	-3.62	0.35	-2	0.099
40	4.717	-4	-1.218	1.43	-5	-0.11	0.45	-2	-3.63	0.30	-2	0.078
41	4.080	-4	-1.218	1.09	-5	-0.11	0.40	-2	-3.64	0.25	-2	0.061
42	3.535	-4	-1.219	0.86	-6	-0.11	0.35	-2	-3.65	0.20	-2	0.046
43	3.068	-4	-1.219	0.64	-6	-0.11	0.30	-2	-3.66	0.15	-2	0.035
44	2.666	-4	-1.219	0.49	-6	-0.11	0.25	-2	-3.67	0.10	-2	0.028
45	2.321	-4	-1.220	0.37	-6	-0.11	0.20	-2	-3.68	0.05	-2	0.020
46	2.023	-4	-1.220	0.28	-6	-0.11	0.15	-2	-3.69	0.01	-2	0.014
47	1.767	-4	-1.220	0.21	-6	-0.11	0.10	-2	-3.70	0.00	-2	0.010
48	1.554	-4	-1.220	0.16	-6	-0.11	0.05	-2	-3.71	0.00	-2	0.007
49	1.373	-4	-1.220	0.12	-6	-0.11	0.01	-2	-3.72	0.00	-2	0.004
50	1.212	-4	-1.221	0.09	-7	-0.11	0.00	-2	-3.73	0.00	-2	0.002

Table 4.4 Parameters at 0.32 microns

All. (km)	h	Rayleigh atten. coeff. (km ⁻¹)	Rayleigh optical thick. (0-h)	Rayleigh optical thick. (h-∞)	Aerosol atten. coeff. (km ⁻¹)	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-∞)	Ozone absoorp. coeff. (km ⁻¹)	Ozone optical thick. (0-h)	Ozone optical thick. (h-∞)	Ext. coeff. (km ⁻¹)	Ext. optical thick. (0-h)	Ext. optical thick. (h-∞)
		β_r	τ_r	τ_r	β_p	τ_p	τ_p	β_3	τ_3	τ_3	β_{ext}	τ_{ext}	τ_{ext}
0	0	1.099	-1	-0.09	2.50	-1	-0.00	3.20	-3	-3.03	3.63	-1	1.628
1	1	9.962	-2	-1.05	1.10	-1	-0.00	2.93	-3	-3.00	2.13	-1	1.340
2	2	9.020	-2	-1.99	4.75	-2	-0.180	2.63	-3	-2.98	1.40	-1	1.163
3	3	8.168	-2	-2.85	1.39	-2	-0.292	2.44	-3	-2.95	1.04	-1	1.041
4	4	7.342	-2	-3.62	1.05	-2	-0.408	2.03	-3	-2.93	8.60	-2	0.881
5	5	6.599	-2	-4.32	7.94	-3	-0.517	1.98	-3	-2.91	7.59	-2	0.762
6	6	5.915	-2	-4.95	5.60	-3	-0.624	1.94	-3	-2.89	6.67	-2	0.666
7	7	5.287	-2	-5.50	5.21	-3	-0.729	2.00	-3	-2.87	6.01	-2	0.597
8	8	4.712	-2	-6.00	5.35	-3	-0.834	2.05	-3	-2.85	5.45	-2	0.554
9	9	4.195	-2	-6.45	5.14	-3	-0.940	2.52	-3	-2.83	4.95	-2	0.522
10	10	3.705	-2	-6.84	5.02	-3	-1.051	3.14	-3	-2.80	4.52	-2	0.503
11	11	3.269	-2	-7.13	4.70	-3	-1.166	4.13	-3	-2.76	4.15	-2	0.531
12	12	2.795	-2	-7.49	4.34	-3	-1.284	5.58	-3	-2.71	3.85	-2	0.551
13	13	2.383	-2	-7.75	4.30	-3	-1.405	7.59	-3	-2.65	3.60	-2	0.554
14	14	2.042	-2	-7.97	4.46	-3	-1.529	8.59	-3	-2.57	3.35	-2	0.419
15	15	1.745	-2	-8.16	4.19	-3	-1.656	8.93	-3	-2.48	3.06	-2	0.387
16	16	1.492	-2	-8.32	3.99	-3	-1.784	9.25	-3	-2.39	2.82	-2	0.358
17	17	1.275	-2	-8.46	3.94	-3	-1.913	9.91	-3	-2.29	2.67	-2	0.330
18	18	1.090	-2	-8.58	3.81	-3	-2.042	1.10	-2	-2.19	2.57	-2	0.304
19	19	0.919	-3	-8.68	3.21	-3	-2.171	1.28	-2	-2.07	2.53	-2	0.279
20	20	0.767	-3	-8.76	2.36	-3	-2.300	1.47	-2	-1.93	2.51	-2	0.253
21	21	0.685	-3	-8.84	1.71	-3	-2.428	1.65	-2	-1.78	2.50	-2	0.228
22	22	0.578	-3	-8.90	1.29	-3	-2.556	1.77	-2	-1.61	2.48	-2	0.203
23	23	0.499	-3	-8.95	0.84	-4	-2.684	1.78	-2	-1.43	2.37	-2	0.179
24	24	0.406	-3	-9.00	0.70	-4	-2.812	1.73	-2	-1.25	2.23	-2	0.156
25	25	0.352	-3	-9.04	0.57	-4	-2.940	1.62	-2	-1.08	2.04	-2	0.135
26	26	0.307	-3	-9.07	0.46	-4	-3.068	1.56	-2	-0.94	1.83	-2	0.115
27	27	0.265	-3	-9.10	0.38	-4	-3.196	1.27	-2	-0.79	1.57	-2	0.098
28	28	0.227	-3	-9.12	0.35	-4	-3.324	1.10	-2	-0.68	1.36	-2	0.084
29	29	0.192	-3	-9.14	0.18	-4	-3.452	0.61	-3	-0.57	1.18	-2	0.071
30	30	0.160	-3	-9.16	0.11	-4	-3.580	8.11	-3	-0.48	0.96	-3	0.060
31	31	0.141	-3	-9.18	1.51	-4	-3.708	7.12	-3	-0.41	0.69	-3	0.051
32	32	0.125	-3	-9.19	1.16	-4	-3.836	6.14	-3	-0.34	0.45	-3	0.043
33	33	0.103	-3	-9.21	0.86	-5	-3.964	5.23	-3	-0.28	0.35	-3	0.036
34	34	0.086	-4	-9.21	0.79	-5	-4.092	4.36	-3	-0.24	0.31	-3	0.030
35	35	0.075	-4	-9.22	0.51	-5	-4.220	3.87	-3	-0.20	0.28	-3	0.025
36	36	0.064	-4	-9.23	0.39	-5	-4.348	3.47	-3	-0.16	0.25	-3	0.021
37	37	0.053	-4	-9.23	0.30	-5	-4.476	3.24	-3	-0.13	0.23	-3	0.017
38	38	0.046	-4	-9.24	0.24	-5	-4.604	2.71	-3	-0.11	0.20	-3	0.014
39	39	0.041	-4	-9.24	0.19	-5	-4.732	2.27	-3	-0.08	0.18	-3	0.012
40	40	0.038	-4	-9.25	0.17	-5	-4.860	1.95	-3	-0.07	0.16	-3	0.010
41	41	0.030	-4	-9.25	0.15	-5	-4.988	1.67	-3	-0.05	0.14	-3	0.009
42	42	0.026	-4	-9.25	0.04	-6	-5.116	1.36	-3	-0.04	0.12	-3	0.007
43	43	0.022	-4	-9.25	0.06	-6	-5.244	1.07	-3	-0.03	0.10	-3	0.006
44	44	0.020	-4	-9.26	0.16	-6	-5.372	0.85	-4	-0.03	0.07	-3	0.005
45	45	0.017	-4	-9.26	0.12	-6	-5.500	0.68	-4	-0.02	0.05	-4	0.004
46	46	0.016	-4	-9.26	0.11	-6	-5.628	0.61	-4	-0.02	0.04	-4	0.003
47	47	0.014	-4	-9.26	0.12	-6	-5.756	0.41	-4	-0.01	0.03	-4	0.002
48	48	0.014	-4	-9.26	0.13	-6	-5.884	0.17	-4	-0.01	0.02	-4	0.002
49	49	0.014	-4	-9.26	0.14	-6	-6.012	0.14	-4	-0.01	0.02	-4	0.001
50	50	0.014	-4	-9.27	0.14	-6	-6.140	0.14	-4	-0.01	0.02	-4	0.001

Table 4.5 Parameters at 0.34 microns

Alt. (km)	Rayleigh atten. coeff. (km ⁻¹) β_r	Rayleigh optical thick. (0-h) τ_r	Rayleigh optical thick. (h-∞) τ_r'	Aerosol atten. coeff. (km ⁻¹) β_p	Aerosol optical thick. (0-h) τ_p	Aerosol optical thick. (h-∞) τ_p'	Ozone absorp. coeff. (km ⁻¹) β_3	Ozone optical thick. (0-h) τ_3	Ozone optical thick. (h-∞) τ_3'	Ext. coeff. (km ⁻¹) β_{ext}	Ext. optical thick. (0-h) τ_{ext}	Ext. optical thick. (h-∞) τ_{ext}'
0	8.492	2	0.00	2.40	0.00	0.379	2.28	0.00	0.22	3.25	0.00	1.120
1	7.707	2	0.01	1.68	0.173	0.297	2.09	0.00	0.21	1.83	0.254	0.666
2	6.978	2	0.02	1.54	0.248	0.241	1.88	0.00	0.21	1.61	0.403	0.717
3	6.303	2	0.24	1.91	0.281	0.099	1.60	0.00	0.21	8.23	0.502	0.618
4	5.680	2	0.20	1.01	0.295	0.084	1.45	0.01	0.21	6.71	0.577	0.543
5	5.105	2	0.34	7.63	0.304	0.075	1.41	0.01	0.21	5.88	0.640	0.480
6	4.576	2	0.38	5.38	0.311	0.069	1.38	0.01	0.21	5.13	0.695	0.425
7	4.090	2	0.46	4.57	0.316	0.063	1.43	0.01	0.20	4.60	0.743	0.376
8	3.645	2	0.64	5.15	0.321	0.058	1.46	0.01	0.20	4.17	0.787	0.332
9	3.238	2	0.99	4.34	0.326	0.053	1.80	0.01	0.20	3.75	0.827	0.293
10	2.867	2	0.59	4.82	0.331	0.049	2.24	0.02	0.20	3.37	0.863	0.257
11	2.529	2	0.56	4.51	0.336	0.044	2.94	0.02	0.20	3.01	0.894	0.225
12	2.162	2	0.80	4.74	0.340	0.039	3.97	0.02	0.19	2.68	0.923	0.197
13	1.848	2	0.60	4.37	0.345	0.035	5.41	0.03	0.19	2.34	0.948	0.172
14	1.580	2	0.617	4.28	0.349	0.030	6.12	0.03	0.18	2.07	0.970	0.150
15	1.350	2	0.631	4.03	0.353	0.026	6.36	0.04	0.18	1.82	0.989	0.130
16	1.154	2	0.644	3.83	0.357	0.022	6.59	0.05	0.17	1.60	1.007	0.113
17	9.865	3	0.654	3.78	0.361	0.018	7.10	0.05	0.16	1.44	1.022	0.098
18	8.433	3	0.664	3.66	0.365	0.015	7.81	0.06	0.16	1.29	1.035	0.084
19	7.209	3	0.671	3.08	0.368	0.011	9.09	0.07	0.15	1.12	1.047	0.072
20	6.164	3	0.678	2.26	0.371	0.009	1.05	0.08	0.14	9.48	1.058	0.062
21	5.249	3	0.684	1.64	0.373	0.007	1.18	0.09	0.13	8.07	1.067	0.053
22	4.472	3	0.689	1.23	0.374	0.005	1.26	0.10	0.11	6.97	1.074	0.046
23	3.813	3	0.693	9.45	0.375	0.004	1.27	0.11	0.10	6.03	1.081	0.039
24	3.254	3	0.696	7.49	0.376	0.003	1.24	0.13	0.09	5.24	1.086	0.034
25	2.779	3	0.699	6.30	0.377	0.003	1.15	0.14	0.08	4.56	1.091	0.029
26	2.375	3	0.702	5.50	0.378	0.002	1.04	0.15	0.07	3.97	1.095	0.024
27	2.031	3	0.704	4.21	0.378	0.002	9.02	0.16	0.06	3.35	1.099	0.021
28	1.738	3	0.706	3.22	0.378	0.001	7.87	0.17	0.05	2.85	1.102	0.018
29	1.489	3	0.707	2.48	0.378	0.001	6.85	0.18	0.04	2.42	1.105	0.015
30	1.276	3	0.709	1.90	0.379	0.001	5.78	0.18	0.03	2.04	1.107	0.013
31	1.095	3	0.710	1.45	0.379	0.000	5.08	0.19	0.03	1.75	1.109	0.011
32	9.397	4	0.711	1.11	0.379	0.000	4.36	0.19	0.02	1.49	1.110	0.009
33	8.023	4	0.712	8.51	0.379	0.000	3.72	0.20	0.02	1.26	1.112	0.008
34	6.854	4	0.713	6.52	0.379	0.000	3.10	0.20	0.02	1.08	1.113	0.007
35	5.867	4	0.713	5.00	0.379	0.000	2.76	0.20	0.02	9.13	1.114	0.006
36	5.031	4	0.714	3.83	0.379	0.000	2.31	0.20	0.01	7.72	1.115	0.005
37	4.323	4	0.714	2.93	0.379	0.000	1.93	0.21	0.01	6.55	1.116	0.004
38	3.720	4	0.715	2.25	0.379	0.000	1.62	0.21	0.01	5.56	1.116	0.004
39	3.207	4	0.715	1.72	0.379	0.000	1.39	0.21	0.01	4.77	1.117	0.003
40	2.770	4	0.715	1.32	0.379	0.000	1.19	0.21	0.00	4.09	1.117	0.003
41	2.396	4	0.716	1.01	0.379	0.000	9.73	0.21	0.00	3.47	1.117	0.002
42	2.076	4	0.716	7.72	0.379	0.000	7.62	0.21	0.00	2.91	1.118	0.002
43	1.802	4	0.716	5.91	0.379	0.000	5.95	0.21	0.00	2.46	1.118	0.002
44	1.566	4	0.716	4.53	0.379	0.000	4.76	0.21	0.00	2.09	1.118	0.001
45	1.363	4	0.716	3.46	0.379	0.000	3.69	0.22	0.00	1.77	1.118	0.001
46	1.188	4	0.716	2.66	0.379	0.000	2.85	0.22	0.00	1.50	1.119	0.001
47	1.037	4	0.717	2.04	0.379	0.000	2.26	0.22	0.00	1.28	1.119	0.001
48	9.128	5	0.717	1.56	0.379	0.000	1.79	0.22	0.00	1.11	1.119	0.001
49	8.051	5	0.717	1.19	0.379	0.000	1.43	0.22	0.00	0.61	1.119	0.001
50	7.119	5	0.717	9.14	0.379	0.000	1.19	0.22	0.00	0.40	1.119	0.001

Table 4.6 Parameters at 0.36 microns

Alt. (km)	h	Rayleigh atten. coeff. (km ⁻¹)	Rayleigh optical thick. (0-h)	Rayleigh optical thick. (h-∞)	Aerosol atten. coeff. (km ⁻¹)	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-∞)	Ozone absorp. coeff. (km ⁻¹)	Ozone optical thick. (0-h)	Ozone optical thick. (h-∞)	Ext. coeff. (km ⁻¹)	Ext. optical thick. (0-h)	Ext. optical thick. (h-∞)
		β_r	τ_r	τ_r'	β_p	τ_p	τ_p'	β_3	τ_3	τ_3'	β_{ext}	τ_{ext}	τ_{ext}'
0	0	6.678	-2	-0.00	2.40	-1	-0.00	6.41	-6	-0.00	3.07	-1	-0.00
1	1	6.060	-2	-0.64	1.06	-1	-0.173	5.87	-6	-0.00	1.66	-1	-2.36
2	2	5.487	-2	-1.21	4.56	-2	-2.68	5.27	-6	-0.00	1.00	-1	-3.70
3	3	4.957	-2	-1.73	1.91	-2	-2.81	4.50	-6	-0.00	6.87	-2	-4.54
4	4	4.467	-2	-2.20	1.01	-2	-2.95	4.07	-6	-0.00	5.48	-2	-5.16
5	5	4.015	-2	-2.63	7.63	-3	-3.04	3.98	-6	-0.00	4.78	-2	-5.67
6	6	3.599	-2	-3.01	5.38	-3	-3.11	3.83	-6	-0.00	4.14	-2	-6.12
7	7	3.216	-2	-3.35	5.00	-3	-3.16	4.01	-6	-0.00	3.72	-2	-6.51
8	8	2.866	-2	-3.62	5.15	-3	-3.21	4.10	-6	-0.00	3.36	-2	-6.87
9	9	2.546	-2	-3.92	4.94	-3	-3.26	5.06	-6	-0.00	3.04	-2	-7.19
10	10	2.254	-2	-4.16	4.82	-3	-3.31	6.30	-6	-0.00	2.74	-2	-7.48
11	11	1.989	-2	-4.37	4.51	-3	-3.36	8.28	-6	-0.00	2.44	-2	-7.74
12	12	1.701	-2	-4.56	4.74	-3	-3.40	1.12	-5	-0.00	2.18	-2	-7.97
13	13	1.453	-2	-4.71	4.37	-3	-3.45	1.52	-5	-0.00	1.89	-2	-8.17
14	14	1.242	-2	-4.85	4.28	-3	-3.49	1.72	-5	-0.00	1.67	-2	-8.35
15	15	1.062	-2	-4.96	4.03	-3	-3.53	1.79	-5	-0.00	1.47	-2	-8.51
16	16	9.075	-3	-5.06	3.83	-3	-3.57	1.85	-5	-0.00	1.29	-2	-8.64
17	17	7.758	-3	-5.15	3.78	-3	-3.61	2.00	-5	-0.00	1.16	-2	-8.77
18	18	6.632	-3	-5.22	3.65	-3	-3.65	2.20	-5	-0.00	1.03	-2	-8.89
19	19	5.669	-3	-5.28	3.68	-3	-3.68	2.56	-5	-0.00	0.88	-3	-8.97
20	20	4.847	-3	-5.33	3.31	-3	-3.71	2.95	-5	-0.00	7.14	-3	-9.05
21	21	4.127	-3	-5.38	1.64	-3	-3.73	3.31	-5	-0.00	5.80	-3	-9.11
22	22	3.517	-3	-5.41	1.23	-3	-3.74	3.55	-5	-0.00	4.79	-3	-9.17
23	23	2.999	-3	-5.45	9.45	-4	-3.75	3.56	-5	-0.00	3.98	-3	-9.21
24	24	2.559	-3	-5.49	7.49	-4	-3.76	3.47	-5	-0.00	3.34	-3	-9.25
25	25	2.185	-3	-5.50	6.30	-4	-3.77	3.24	-5	-0.00	2.85	-3	-9.28
26	26	1.867	-3	-5.52	5.50	-4	-3.77	2.93	-5	-0.00	2.45	-3	-9.31
27	27	1.597	-3	-5.54	4.21	-4	-3.78	2.54	-5	-0.00	2.04	-3	-9.33
28	28	1.367	-3	-5.55	3.22	-4	-3.78	2.21	-5	-0.00	1.71	-3	-9.35
29	29	1.171	-3	-5.56	2.48	-4	-3.78	1.93	-5	-0.00	1.44	-3	-9.36
30	30	1.004	-3	-5.57	1.90	-4	-3.79	1.63	-5	-0.00	1.21	-3	-9.38
31	31	8.609	-4	-5.58	1.45	-4	-3.79	1.43	-5	-0.00	1.02	-3	-9.39
32	32	7.389	-4	-5.59	1.11	-4	-3.79	1.23	-5	-0.00	0.86	-4	-9.40
33	33	6.309	-4	-5.60	8.51	-5	-3.79	1.05	-5	-0.00	7.26	-4	-9.40
34	34	5.390	-4	-5.60	6.52	-5	-3.79	8.73	-6	-0.00	6.13	-4	-9.41
35	35	4.614	-4	-5.61	5.00	-5	-3.79	6.50	-6	-0.00	5.19	-4	-9.42
36	36	3.957	-4	-5.61	3.83	-5	-3.79	6.70	-6	-0.00	4.40	-4	-9.42
37	37	3.369	-4	-5.62	2.93	-5	-3.79	5.44	-6	-0.00	3.75	-4	-9.43
38	38	2.926	-4	-5.62	2.25	-5	-3.79	4.55	-6	-0.00	3.20	-4	-9.43
39	39	2.522	-4	-5.62	1.72	-5	-3.79	3.91	-6	-0.00	2.73	-4	-9.43
40	40	2.178	-4	-5.63	1.32	-5	-3.79	3.35	-6	-0.00	2.34	-4	-9.43
41	41	1.884	-4	-5.63	1.01	-5	-3.79	2.74	-6	-0.00	2.01	-4	-9.44
42	42	1.633	-4	-5.63	7.72	-6	-3.79	2.14	-6	-0.00	1.73	-4	-9.44
43	43	1.417	-4	-5.63	5.91	-6	-3.79	1.67	-6	-0.00	1.49	-4	-9.44
44	44	1.231	-4	-5.63	4.53	-6	-3.79	1.34	-6	-0.00	1.29	-4	-9.44
45	45	1.072	-4	-5.63	3.46	-6	-3.79	1.04	-6	-0.00	1.12	-4	-9.44
46	46	9.345	-5	-5.63	2.56	-6	-3.79	8.03	-7	-0.00	9.69	-5	-9.44
47	47	8.158	-5	-5.63	2.04	-6	-3.79	6.35	-7	-0.00	8.43	-5	-9.44
48	48	7.178	-5	-5.64	1.56	-6	-3.79	5.02	-7	-0.00	7.38	-5	-9.45
49	49	6.339	-5	-5.64	1.19	-6	-3.79	4.01	-7	-0.00	6.50	-5	-9.45
50	50	5.598	-5	-5.64	9.14	-7	-3.79	3.35	-7	-0.00	5.72	-5	-9.45

Table 4.7 Parameters at 0.38 microns

Alt. (km)	h	Rayleigh atten. coeff. (km ⁻¹)	Rayleigh optical thick. (0-h)	Rayleigh optical thick. (h-∞)	Rayleigh atten. coeff. (km ⁻¹)	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-∞)	Ozone aborp. coeff. (km ⁻¹)	Ozone optical thick. (0-h)	Ozone optical thick. (h-∞)	Ext. coeff. (km ⁻¹)	Ext. optical thick. (0-h)	Ext. optical thick. (h-∞)
		β_r	τ_r	τ_r'	β_p	τ_p	τ_p'	β_3	τ_3	τ_3'	β_{ext}	τ_{ext}	τ_{ext}'
0	0	5.327	-2	-0.00	-0.450	-0.00	-0.00	0.	-0.00	-0.00	2.83	-1	-0.00
1	1	4.834	-2	-0.05	-0.399	-1.01	-1	0.	-0.00	-0.00	1.50	-1	-0.216
2	2	4.377	-2	-0.07	-0.353	-0.37	-2	0.	-0.00	-0.00	8.74	-2	-0.335
3	3	3.954	-2	-0.13	-0.312	-1.83	-2	0.	-0.00	-0.00	5.79	-2	-0.408
4	4	3.563	-2	-0.176	-0.274	-9.69	-3	0.	-0.00	-0.00	4.53	-2	-0.459
5	5	3.202	-2	-0.210	-0.240	7.31	-3	0.	-0.00	-0.00	3.93	-2	-0.501
6	6	2.871	-2	-0.240	-0.210	5.15	-3	0.	-0.00	-0.00	3.39	-2	-0.538
7	7	2.566	-2	-0.267	-0.183	4.79	-3	0.	-0.00	-0.00	3.04	-2	-0.570
8	8	2.286	-2	-0.291	-0.159	4.93	-3	0.	-0.00	-0.00	2.78	-2	-0.599
9	9	2.031	-2	-0.313	-0.137	4.73	-3	0.	-0.00	-0.00	2.50	-2	-0.626
10	10	1.798	-2	-0.332	-0.118	4.61	-3	0.	-0.00	-0.00	2.26	-2	-0.650
11	11	1.586	-2	-0.349	-0.101	4.32	-3	0.	-0.00	-0.00	2.02	-2	-0.671
12	12	1.356	-2	-0.364	-0.086	4.54	-3	0.	-0.00	-0.00	1.81	-2	-0.690
13	13	1.159	-2	-0.376	-0.074	4.19	-3	0.	-0.00	-0.00	1.58	-2	-0.707
14	14	9.908	-3	-0.387	-0.063	4.11	-3	0.	-0.00	-0.00	1.40	-2	-0.722
15	15	8.469	-3	-0.396	-0.054	3.86	-3	0.	-0.00	-0.00	1.23	-2	-0.735
16	16	7.239	-3	-0.404	-0.046	3.67	-3	0.	-0.00	-0.00	1.09	-2	-0.747
17	17	6.188	-3	-0.410	-0.039	3.62	-3	0.	-0.00	-0.00	0.91	-3	-0.757
18	18	5.290	-3	-0.416	-0.034	3.51	-3	0.	-0.00	-0.00	8.80	-3	-0.766
19	19	4.522	-3	-0.421	-0.029	2.96	-3	0.	-0.00	-0.00	7.48	-3	-0.775
20	20	3.866	-3	-0.425	-0.025	2.17	-3	0.	-0.00	-0.00	6.04	-3	-0.781
21	21	3.292	-3	-0.429	-0.021	1.57	-3	0.	-0.00	-0.00	4.86	-3	-0.787
22	22	2.805	-3	-0.432	-0.018	1.18	-3	0.	-0.00	-0.00	3.99	-3	-0.791
23	23	2.392	-3	-0.434	-0.016	9.05	-4	0.	-0.00	-0.00	3.30	-3	-0.795
24	24	2.041	-3	-0.437	-0.013	7.18	-4	0.	-0.00	-0.00	2.76	-3	-0.798
25	25	1.743	-3	-0.439	-0.011	6.04	-4	0.	-0.00	-0.00	2.35	-3	-0.800
26	26	1.490	-3	-0.440	-0.010	5.27	-4	0.	-0.00	-0.00	2.02	-3	-0.803
27	27	1.274	-3	-0.442	-0.008	4.03	-4	0.	-0.00	-0.00	1.68	-3	-0.804
28	28	1.090	-3	-0.443	-0.007	3.09	-4	0.	-0.00	-0.00	1.40	-3	-0.806
29	29	9.340	-4	-0.444	-0.006	2.37	-4	0.	-0.00	-0.00	1.17	-3	-0.807
30	30	8.006	-4	-0.445	-0.005	1.82	-4	0.	-0.00	-0.00	9.83	-4	-0.808
31	31	6.867	-4	-0.445	-0.005	1.39	-4	0.	-0.00	-0.00	8.26	-4	-0.809
32	32	5.894	-4	-0.446	-0.004	1.06	-4	0.	-0.00	-0.00	6.96	-4	-0.810
33	33	5.033	-4	-0.447	-0.003	8.15	-5	0.	-0.00	-0.00	5.85	-4	-0.811
34	34	4.300	-4	-0.447	-0.003	6.24	-5	0.	-0.00	-0.00	4.92	-4	-0.811
35	35	3.680	-4	-0.447	-0.003	4.79	-5	0.	-0.00	-0.00	4.16	-4	-0.812
36	36	3.156	-4	-0.448	-0.002	3.67	-5	0.	-0.00	-0.00	3.52	-4	-0.812
37	37	2.711	-4	-0.448	-0.002	2.81	-5	0.	-0.00	-0.00	2.99	-4	-0.812
38	38	2.334	-4	-0.448	-0.002	2.15	-5	0.	-0.00	-0.00	2.55	-4	-0.813
39	39	2.012	-4	-0.449	-0.001	1.64	-5	0.	-0.00	-0.00	2.18	-4	-0.813
40	40	1.738	-4	-0.449	-0.001	1.26	-5	0.	-0.00	-0.00	1.86	-4	-0.813
41	41	1.503	-4	-0.449	-0.001	9.87	-6	0.	-0.00	-0.00	1.60	-4	-0.813
42	42	1.302	-4	-0.449	-0.001	7.39	-6	0.	-0.00	-0.00	1.38	-4	-0.813
43	43	1.130	-4	-0.449	-0.001	5.86	-6	0.	-0.00	-0.00	1.19	-4	-0.814
44	44	9.823	-5	-0.449	-0.001	4.34	-6	0.	-0.00	-0.00	1.03	-4	-0.814
45	45	8.550	-5	-0.449	-0.001	3.32	-6	0.	-0.00	-0.00	8.88	-5	-0.814
46	46	7.454	-5	-0.449	-0.001	2.55	-6	0.	-0.00	-0.00	7.71	-5	-0.814
47	47	6.508	-5	-0.449	-0.001	1.95	-6	0.	-0.00	-0.00	6.70	-5	-0.814
48	48	5.726	-5	-0.450	-0.000	1.50	-6	0.	-0.00	-0.00	5.88	-5	-0.814
49	49	5.056	-5	-0.450	-0.000	1.14	-6	0.	-0.00	-0.00	5.17	-5	-0.814
50	50	4.465	-5	-0.450	-0.000	8.76	-7	0.	-0.00	-0.00	4.55	-5	-0.814

Table 4.8 Parameters at 0.40 microns

Alt. (km)	Rayleigh atten. coeff. (km ⁻¹)	Rayleigh optical thick. (0-h)	Rayleigh optical thick. (h-∞)	Rayleigh atten. coeff. (km ⁻¹)	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-∞)	Ozone absorp. coeff. (km ⁻¹)	Ozone optical thick. (0-h)	Ozone optical thick. (h-∞)	Ext. coeff. (km ⁻¹)	Ext. optical thick. (0-h)	Ext. optical thick. (h-∞)
h	β_r	τ_r	τ_r'	β_p	τ_p	τ_p'	β_3	τ_3	τ_3'	β_{ext}	τ_{ext}	τ_{ext}'
0	4.303	-2	-0.00	2.00	-1	-0.00	0.	-0.00	-0.00	2.43	-1	-0.00
1	3.905	-2	-0.41	8.80	-2	-0.16	0.	-0.00	-0.00	1.27	-1	-0.15
2	3.536	-2	-0.73	3.80	-2	-0.14	0.	-0.00	-0.00	7.35	-2	-0.25
3	3.194	-2	-1.12	1.59	-2	-0.23	0.	-0.00	-0.00	4.79	-2	-0.46
4	2.878	-2	-1.42	8.43	-3	-0.26	0.	-0.00	-0.00	3.72	-2	-0.38
5	2.587	-2	-1.69	6.35	-3	-0.25	0.	-0.00	-0.00	3.22	-2	-0.23
6	2.319	-2	-1.94	4.48	-3	-0.25	0.	-0.00	-0.00	2.77	-2	-0.23
7	2.073	-2	-2.16	4.15	-3	-0.23	0.	-0.00	-0.00	2.49	-2	-0.21
8	1.847	-2	-2.35	4.29	-3	-0.26	0.	-0.00	-0.00	2.28	-2	-0.17
9	1.641	-2	-2.53	4.11	-3	-0.27	0.	-0.00	-0.00	2.08	-2	-0.15
10	1.453	-2	-2.68	4.01	-3	-0.27	0.	-0.00	-0.00	1.85	-2	-0.13
11	1.281	-2	-2.82	3.76	-3	-0.28	0.	-0.00	-0.00	1.66	-2	-0.11
12	1.096	-2	-2.94	3.95	-3	-0.33	0.	-0.00	-0.00	1.49	-2	-0.10
13	9.365	-3	-3.04	3.65	-3	-0.28	0.	-0.00	-0.00	1.30	-2	-0.09
14	8.004	-3	-3.12	3.57	-3	-0.25	0.	-0.00	-0.00	1.16	-2	-0.09
15	6.841	-3	-3.20	3.35	-3	-0.29	0.	-0.00	-0.00	1.02	-2	-0.06
16	5.848	-3	-3.26	3.19	-3	-0.29	0.	-0.00	-0.00	9.04	-3	-0.24
17	4.999	-3	-3.32	3.15	-3	-0.30	0.	-0.00	-0.00	8.15	-3	-0.33
18	4.273	-3	-3.36	3.05	-3	-0.30	0.	-0.00	-0.00	7.32	-3	-0.41
19	3.653	-3	-3.40	2.57	-3	-0.37	0.	-0.00	-0.00	6.22	-3	-0.47
20	3.123	-3	-3.44	1.89	-3	-0.39	0.	-0.00	-0.00	5.01	-3	-0.53
21	2.660	-3	-3.46	1.37	-3	-0.31	0.	-0.00	-0.00	4.03	-3	-0.58
22	2.266	-3	-3.49	1.03	-3	-0.32	0.	-0.00	-0.00	3.30	-3	-0.61
23	1.932	-3	-3.51	7.87	-4	-0.33	0.	-0.00	-0.00	2.72	-3	-0.64
24	1.649	-3	-3.53	6.24	-4	-0.33	0.	-0.00	-0.00	2.27	-3	-0.67
25	1.408	-3	-3.54	5.25	-4	-0.34	0.	-0.00	-0.00	1.93	-3	-0.69
26	1.203	-3	-3.56	4.58	-4	-0.34	0.	-0.00	-0.00	1.66	-3	-0.71
27	1.029	-3	-3.57	3.51	-4	-0.35	0.	-0.00	-0.00	1.38	-3	-0.72
28	8.809	-4	-3.58	2.68	-4	-0.35	0.	-0.00	-0.00	1.15	-3	-0.77
29	7.545	-4	-3.58	2.06	-4	-0.31	0.	-0.00	-0.00	9.61	-4	-0.75
30	6.467	-4	-3.59	1.58	-4	-0.31	0.	-0.00	-0.00	8.05	-4	-0.75
31	5.547	-4	-3.60	1.21	-4	-0.31	0.	-0.00	-0.00	6.76	-4	-0.76
32	4.762	-4	-3.60	9.25	-5	-0.31	0.	-0.00	-0.00	5.69	-4	-0.77
33	4.065	-4	-3.61	7.09	-5	-0.31	0.	-0.00	-0.00	4.77	-4	-0.77
34	3.473	-4	-3.61	5.43	-5	-0.31	0.	-0.00	-0.00	4.02	-4	-0.78
35	2.973	-4	-3.61	4.16	-5	-0.31	0.	-0.00	-0.00	3.36	-4	-0.78
36	2.549	-4	-3.62	3.19	-5	-0.31	0.	-0.00	-0.00	2.87	-4	-0.78
37	2.190	-4	-3.62	2.44	-5	-0.31	0.	-0.00	-0.00	2.43	-4	-0.79
38	1.885	-4	-3.62	1.87	-5	-0.31	0.	-0.00	-0.00	2.07	-4	-0.79
39	1.625	-4	-3.62	1.43	-5	-0.31	0.	-0.00	-0.00	1.77	-4	-0.79
40	1.404	-4	-3.62	1.10	-5	-0.31	0.	-0.00	-0.00	1.51	-4	-0.79
41	1.214	-4	-3.63	8.41	-6	-0.31	0.	-0.00	-0.00	1.30	-4	-0.79
42	1.052	-4	-3.63	6.43	-6	-0.31	0.	-0.00	-0.00	1.12	-4	-0.80
43	9.129	-5	-3.63	4.92	-6	-0.31	0.	-0.00	-0.00	9.62	-5	-0.80
44	7.925	-5	-3.63	3.77	-6	-0.31	0.	-0.00	-0.00	8.31	-5	-0.80
45	6.907	-5	-3.63	2.89	-6	-0.31	0.	-0.00	-0.00	7.20	-5	-0.80
46	6.021	-5	-3.63	2.22	-6	-0.31	0.	-0.00	-0.00	6.24	-5	-0.80
47	5.257	-5	-3.63	1.70	-6	-0.31	0.	-0.00	-0.00	5.43	-5	-0.80
48	4.625	-5	-3.63	1.30	-6	-0.31	0.	-0.00	-0.00	4.76	-5	-0.80
49	4.085	-5	-3.63	9.95	-7	-0.31	0.	-0.00	-0.00	4.18	-5	-0.80
50	3.607	-5	-3.63	7.62	-7	-0.31	0.	-0.00	-0.00	3.68	-5	-0.80

Table 4.9 Parameters at 0.45 microns

Alt. (km)	h	Rayleigh atten. coeff. (km^{-1})	Rayleigh optical thick. (0-h)	Rayleigh optical thick. ($h-\infty$)	Rayleigh optical thick. ($h-\infty$)	Aerosol atten. coeff. (km^{-1})	Aerosol optical thick. (0-h)	Aerosol optical thick. ($h-\infty$)	Aerosol optical thick. ($h-\infty$)	Ozone absorp. coeff. (km^{-1})	Ozone optical thick. (0-h)	Ozone optical thick. ($h-\infty$)	Ext. coeff. (km^{-1})	Ext. optical thick. (0-h)	Ext. optical thick. ($h-\infty$)
		β_r	τ_r	τ_r	τ_r	β_p	τ_p	τ_p	τ_p	β_3	τ_3	τ_3	β_{ext}	τ_{ext}	τ_{ext}
0	0	2.644	-2	-0.00	-0.223	1.80	-1	-0.00	-0.285	1.25	-5	-0.00	2.06	-1	-0.00
1	1	2.400	-2	-0.025	-0.196	7.92	-2	-0.130	-0.155	1.14	-5	-0.000	1.03	-1	-0.135
2	2	2.173	-2	-0.046	-0.175	3.62	-2	-0.180	-0.098	1.03	-5	-0.001	5.59	-2	-0.234
3	3	1.963	-2	-0.069	-0.155	1.44	-2	-0.211	-0.074	8.75	-6	-0.000	3.60	-2	-0.279
4	4	1.769	-2	-0.087	-0.136	7.59	-3	-0.228	-0.056	7.91	-6	-0.000	2.33	-2	-0.309
5	5	1.590	-2	-0.104	-0.119	5.72	-3	-0.228	-0.056	7.73	-6	-0.000	2.16	-2	-0.332
6	6	1.425	-2	-0.119	-0.104	4.03	-3	-0.233	-0.052	7.50	-6	-0.000	1.83	-2	-0.352
7	7	1.274	-2	-0.133	-0.091	3.75	-3	-0.237	-0.048	7.80	-6	-0.000	1.65	-2	-0.370
8	8	1.135	-2	-0.145	-0.079	3.86	-3	-0.241	-0.048	7.98	-6	-0.000	1.52	-2	-0.386
9	9	1.008	-2	-0.155	-0.068	3.70	-3	-0.245	-0.040	9.83	-6	-0.000	1.38	-2	-0.400
10	10	8.926	-3	-0.165	-0.059	3.61	-3	-0.248	-0.036	1.22	-5	-0.000	1.25	-2	-0.413
11	11	7.874	-3	-0.173	-0.050	3.38	-3	-0.252	-0.033	1.61	-5	-0.000	1.13	-2	-0.425
12	12	6.733	-3	-0.180	-0.043	3.55	-3	-0.259	-0.029	2.17	-5	-0.000	1.03	-2	-0.436
13	13	5.755	-3	-0.187	-0.037	3.28	-3	-0.259	-0.026	2.96	-5	-0.000	9.07	-3	-0.446
14	14	4.915	-3	-0.192	-0.31	3.21	-3	-0.262	-0.023	3.35	-5	-0.000	8.16	-3	-0.454
15	15	4.204	-3	-0.197	-0.27	3.02	-3	-0.265	-0.020	3.48	-5	-0.000	7.26	-3	-0.462
16	16	3.593	-3	-0.200	-0.23	2.87	-3	-0.268	-0.017	3.60	-5	-0.000	6.50	-3	-0.469
17	17	3.072	-3	-0.204	-0.20	2.84	-3	-0.271	-0.014	3.88	-5	-0.000	5.95	-3	-0.475
18	18	2.626	-3	-0.207	-0.17	2.75	-3	-0.274	-0.011	4.27	-5	-0.000	5.41	-3	-0.481
19	19	2.265	-3	-0.209	-0.14	2.31	-3	-0.276	-0.009	4.97	-5	-0.000	4.61	-3	-0.486
20	20	1.919	-3	-0.211	-0.12	1.70	-3	-0.278	-0.007	5.74	-5	-0.000	3.87	-3	-0.490
21	21	1.634	-3	-0.213	-0.10	1.23	-3	-0.280	-0.005	6.44	-5	-0.000	2.93	-3	-0.493
22	22	1.393	-3	-0.214	-0.09	9.26	-4	-0.281	-0.004	6.89	-5	-0.001	2.39	-3	-0.496
23	23	1.187	-3	-0.216	-0.08	7.09	-4	-0.281	-0.003	6.93	-5	-0.001	1.97	-3	-0.498
24	24	1.013	-3	-0.217	-0.07	5.62	-4	-0.282	-0.003	6.75	-5	-0.001	1.64	-3	-0.500
25	25	8.652	-4	-0.218	-0.06	4.73	-4	-0.283	-0.002	6.30	-5	-0.001	1.40	-3	-0.501
26	26	7.394	-4	-0.219	-0.05	4.12	-4	-0.283	-0.002	5.70	-5	-0.001	1.21	-3	-0.503
27	27	6.324	-4	-0.219	-0.04	3.16	-4	-0.283	-0.001	4.93	-5	-0.001	9.97	-4	-0.504
28	28	5.413	-4	-0.220	-0.04	2.62	-4	-0.284	-0.001	4.30	-5	-0.001	8.26	-4	-0.505
29	29	4.634	-4	-0.220	-0.03	1.86	-4	-0.284	-0.001	3.74	-5	-0.001	6.87	-4	-0.505
30	30	3.874	-4	-0.221	-0.03	1.62	-4	-0.284	-0.001	3.16	-5	-0.001	5.71	-4	-0.506
31	31	3.409	-4	-0.221	-0.02	1.09	-4	-0.284	-0.000	2.78	-5	-0.001	4.77	-4	-0.507
32	32	2.926	-4	-0.221	-0.02	8.33	-5	-0.284	-0.000	2.39	-5	-0.001	4.00	-4	-0.507
33	33	2.499	-4	-0.222	-0.02	6.38	-5	-0.284	-0.000	2.04	-5	-0.001	3.36	-4	-0.507
34	34	2.134	-4	-0.222	-0.01	4.89	-5	-0.284	-0.000	1.70	-5	-0.001	2.79	-4	-0.508
35	35	1.827	-4	-0.222	-0.01	3.75	-5	-0.284	-0.000	1.51	-5	-0.001	2.35	-4	-0.508
36	36	1.567	-4	-0.222	-0.01	2.87	-5	-0.284	-0.000	1.26	-5	-0.001	1.98	-4	-0.508
37	37	1.365	-4	-0.222	-0.01	2.20	-5	-0.284	-0.000	1.06	-5	-0.001	1.67	-4	-0.508
38	38	1.158	-4	-0.223	-0.01	1.59	-5	-0.284	-0.000	0.85	-6	-0.001	1.42	-4	-0.509
39	39	9.987	-5	-0.223	-0.01	1.29	-5	-0.284	-0.000	7.59	-6	-0.001	1.20	-4	-0.509
40	40	8.625	-5	-0.223	-0.01	9.87	-6	-0.285	-0.000	6.51	-6	-0.001	1.03	-4	-0.509
41	41	7.461	-5	-0.223	-0.01	7.56	-6	-0.285	-0.000	5.32	-6	-0.001	0.875	-5	-0.509
42	42	6.464	-5	-0.223	-0.00	5.79	-6	-0.285	-0.000	4.16	-6	-0.001	0.76	-5	-0.509
43	43	5.610	-5	-0.223	-0.00	4.63	-6	-0.285	-0.000	3.25	-6	-0.001	0.68	-5	-0.509
44	44	4.876	-5	-0.223	-0.00	3.39	-6	-0.285	-0.000	2.60	-6	-0.001	0.61	-5	-0.509
45	45	4.244	-5	-0.223	-0.00	2.60	-6	-0.285	-0.000	2.02	-6	-0.001	0.54	-5	-0.509
46	46	3.700	-5	-0.223	-0.00	1.99	-6	-0.285	-0.000	1.56	-6	-0.001	0.48	-5	-0.509
47	47	3.230	-5	-0.223	-0.00	1.53	-6	-0.285	-0.000	1.24	-6	-0.001	0.41	-5	-0.509
48	48	2.842	-5	-0.223	-0.00	1.17	-6	-0.285	-0.000	0.976	-7	-0.001	0.36	-5	-0.509
49	49	2.510	-5	-0.223	-0.00	8.95	-7	-0.285	-0.000	7.80	-7	-0.001	0.28	-5	-0.509
50	50	2.217	-5	-0.223	-0.00	6.66	-7	-0.285	-0.000	6.51	-7	-0.001	0.23	-5	-0.509

Table 4.10 Parameters at 0.50 microns

Alt. (km)	h	Rayleigh atten. coeff. (km ⁻¹)	Rayleigh optical thick. (0-h)	Rayleigh optical thick. (h-∞)	Aerosol atten. coeff. (km ⁻¹)	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-∞)	Ozone abshp. coeff. (km ⁻¹)	Ozone optical thick. (0-h)	Ozone optical thick. (h-∞)	Ext. coeff. (km ⁻¹)	Ext. optical thick. (0-h)	Ext. optical thick. (h-∞)
		β_r	τ_r	τ_r'	β_p	τ_p	τ_p'	β_3	τ_3	τ_3'	β_{ext}	τ_{ext}	τ_{ext}'
0	1.716	-2	-0.00	-1.45	1.67	-1	-0.00	1.23	-0.00	-0.12	1.84	-1	-0.00
1	1.557	-2	-0.16	-1.29	7.35	-2	-0.12	1.12	-0.00	-0.12	8.91	-2	-0.284
2	1.410	-2	-0.31	-1.14	3.17	-2	-0.11	1.01	-0.00	-0.11	4.59	-2	-0.204
3	1.273	-2	-0.45	-1.00	1.33	-2	-0.09	8.63	-0.00	-0.11	2.61	-2	-0.181
4	1.148	-2	-0.57	-0.88	7.04	-5	-0.08	7.80	-0.00	-0.11	1.86	-2	-0.263
5	1.031	-2	-0.68	-0.77	5.31	-3	-0.07	7.62	-0.00	-0.11	1.57	-2	-0.280
6	9.245	-3	-0.77	-0.68	3.74	-3	-0.06	7.45	-0.01	-0.11	1.31	-2	-0.127
7	8.263	-3	-0.86	-0.59	3.48	-3	-0.04	7.49	-0.01	-0.11	1.18	-2	-0.307
8	7.364	-3	-0.94	-0.51	3.58	-3	-0.04	7.87	-0.01	-0.11	1.10	-2	-0.318
9	6.541	-3	-1.01	-0.44	3.44	-3	-0.03	9.69	-0.01	-0.11	1.01	-2	-0.329
10	5.791	-3	-1.07	-0.38	3.35	-3	-0.03	1.21	-0.01	-0.11	9.26	-3	-0.338
11	5.129	-3	-1.12	-0.33	3.14	-3	-0.03	1.59	-0.01	-0.11	8.41	-3	-0.347
12	4.369	-3	-1.17	-0.28	3.30	-3	-0.02	2.14	-0.01	-0.10	7.88	-3	-0.355
13	3.734	-3	-1.21	-0.24	3.04	-3	-0.02	2.92	-0.01	-0.10	7.07	-3	-0.363
14	3.191	-3	-1.25	-0.20	2.98	-3	-0.02	3.43	-0.02	-0.10	6.50	-3	-0.369
15	2.728	-3	-1.28	-0.17	2.80	-3	-0.02	3.30	-0.02	-0.10	5.87	-3	-0.376
16	2.331	-3	-1.30	-0.15	2.66	-3	-0.01	3.55	-0.02	-0.09	5.35	-3	-0.381
17	1.993	-3	-1.32	-0.13	2.63	-3	-0.01	3.83	-0.03	-0.09	5.01	-3	-0.386
18	1.704	-3	-1.34	-0.11	2.55	-3	-0.01	4.21	-0.03	-0.08	4.67	-3	-0.391
19	1.456	-3	-1.36	-0.09	2.15	-3	-0.01	4.90	-0.04	-0.08	4.09	-3	-0.396
20	1.245	-3	-1.37	-0.08	1.57	-3	-0.01	5.66	-0.04	-0.07	3.39	-3	-0.399
21	1.060	-3	-1.38	-0.07	1.14	-3	-0.01	6.35	-0.05	-0.07	2.84	-3	-0.403
22	9.035	-4	-1.39	-0.06	8.59	-4	-0.01	6.80	-0.05	-0.06	2.44	-3	-0.405
23	7.703	-4	-1.40	-0.05	6.57	-4	-0.01	6.83	-0.06	-0.05	2.11	-3	-0.407
24	6.574	-4	-1.41	-0.04	5.21	-4	-0.02	6.64	-0.07	-0.05	1.84	-3	-0.409
25	5.614	-4	-1.41	-0.04	4.39	-4	-0.02	6.21	-0.07	-0.04	1.62	-3	-0.411
26	4.798	-4	-1.42	-0.03	3.83	-4	-0.01	5.62	-0.08	-0.04	1.42	-3	-0.413
27	4.103	-4	-1.43	-0.03	2.93	-4	-0.01	4.86	-0.09	-0.03	1.19	-3	-0.414
28	3.512	-4	-1.43	-0.02	2.24	-4	-0.01	4.24	-0.09	-0.03	1.00	-3	-0.415
29	3.008	-4	-1.43	-0.02	1.72	-4	-0.01	3.69	-0.09	-0.02	8.42	-4	-0.416
30	2.578	-4	-1.43	-0.02	1.32	-4	-0.01	3.12	-0.10	-0.02	7.01	-4	-0.417
31	2.212	-4	-1.43	-0.01	1.01	-4	-0.01	2.74	-0.10	-0.02	5.96	-4	-0.417
32	1.898	-4	-1.44	-0.01	7.73	-5	-0.01	2.35	-0.10	-0.01	5.02	-4	-0.418
33	1.621	-4	-1.44	-0.01	5.92	-5	-0.01	2.01	-0.11	-0.01	4.22	-4	-0.418
34	1.385	-4	-1.44	-0.01	4.53	-5	-0.01	1.67	-0.11	-0.01	3.51	-4	-0.419
35	1.185	-4	-1.44	-0.01	3.48	-5	-0.01	1.49	-0.11	-0.01	3.02	-4	-0.419
36	1.015	-4	-1.44	-0.01	2.66	-5	-0.01	1.25	-0.11	-0.01	2.53	-4	-0.419
37	8.732	-5	-1.44	-0.01	2.04	-5	-0.01	1.04	-0.11	-0.01	2.12	-4	-0.420
38	7.516	-5	-1.44	-0.01	1.56	-5	-0.01	8.73	-0.11	-0.00	1.78	-4	-0.420
39	6.480	-5	-1.44	-0.00	1.19	-5	-0.01	7.49	-0.11	-0.00	1.52	-4	-0.420
40	5.596	-5	-1.45	-0.00	9.15	-6	-0.01	6.42	-0.11	-0.00	1.29	-4	-0.420
41	4.841	-5	-1.45	-0.00	7.02	-6	-0.01	5.24	-0.11	-0.00	1.09	-4	-0.420
42	4.194	-5	-1.45	-0.00	5.37	-6	-0.01	4.11	-0.11	-0.00	8.84	-5	-0.420
43	3.640	-5	-1.45	-0.00	4.11	-6	-0.01	3.21	-0.12	-0.00	7.26	-5	-0.420
44	3.153	-5	-1.45	-0.00	3.15	-6	-0.01	2.57	-0.12	-0.00	6.05	-5	-0.420
45	2.754	-5	-1.45	-0.00	2.41	-6	-0.01	1.99	-0.12	-0.00	4.98	-5	-0.421
46	2.401	-5	-1.45	-0.00	1.85	-6	-0.01	1.54	-0.12	-0.00	4.12	-5	-0.421
47	2.096	-5	-1.45	-0.00	1.42	-6	-0.01	1.22	-0.12	-0.00	3.46	-5	-0.421
48	1.844	-5	-1.45	-0.00	1.09	-6	-0.01	9.63	-0.12	-0.00	2.92	-5	-0.421
49	1.628	-5	-1.45	-0.00	8.31	-7	-0.01	7.69	-0.12	-0.00	2.48	-5	-0.421
50	1.438	-5	-1.45	-0.00	6.36	-7	-0.01	6.42	-0.12	-0.00	2.14	-5	-0.421

Table 4.11 Parameters at 0.55 microns

Alt. (km)	h	Rayleigh atten. coeff. (km ⁻¹)	Rayleigh optical thick. (0-h)	Rayleigh optical thick. (h-∞)	Rayleigh atten. coeff. (km ⁻¹)	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-∞)	Aerosol aborp. coeff. (km ⁻¹)	Ozone optical thick. (0-h)	Ozone optical thick. (h-∞)	Ozone coeff. (km ⁻¹)	Ext. coeff. (km ⁻¹)	Ext. optical thick. (0-h)	Ext. optical thick. (h-∞)
		β_r	τ_r	τ_r	β_p	τ_p	τ_p	β_3	τ_3	τ_3	β_{ext}	τ_{ext}	τ_{ext}	τ_{ext}
0		1.162	-2	-0.00	1.58	-1	-0.00	3.28	-4	-0.00	1.70	-1	-0.00	.379
1		1.035	-2	-0.11	6.95	-2	-1.14	3.00	-4	-0.00	8.03	-2	-0.125	.254
2		9.550	-3	-0.21	3.00	-2	-1.63	2.70	-4	-0.01	3.98	-2	-1.05	.194
3		6.627	-3	-0.30	1.26	-2	-1.85	2.30	-4	-0.01	2.15	-2	-2.15	.163
4		7.774	-3	-0.38	6.66	-3	-1.94	2.08	-4	-0.01	1.46	-2	-2.34	.145
5		6.987	-3	-0.46	5.02	-3	-2.00	2.03	-4	-0.01	1.22	-2	-2.47	.132
6		6.263	-3	-0.52	3.54	-3	-2.05	1.99	-4	-0.01	1.00	-2	-2.58	.121
7		5.598	-3	-0.58	3.29	-3	-2.08	2.05	-4	-0.02	0.99	-3	-2.68	.111
8		4.989	-3	-0.64	4.39	-3	-2.11	2.10	-4	-0.02	0.59	-3	-2.77	.102
9		4.431	-3	-0.68	3.25	-3	-2.15	2.59	-4	-0.02	7.94	-3	-2.85	.094
10		3.923	-3	-0.72	3.17	-3	-2.18	3.22	-4	-0.02	7.42	-3	-2.93	.086
11		3.461	-3	-0.76	2.97	-3	-2.21	4.23	-4	-0.03	6.85	-3	-3.00	.079
12		2.960	-3	-0.79	3.12	-3	-2.24	5.71	-4	-0.03	6.65	-3	-3.07	.073
13		2.529	-3	-0.82	2.88	-3	-2.27	7.77	-4	-0.04	6.19	-3	-3.13	.066
14		2.162	-3	-0.84	2.82	-3	-2.30	8.80	-4	-0.05	5.66	-3	-3.19	.060
15		1.848	-3	-0.86	2.65	-3	-2.33	9.14	-4	-0.06	5.41	-3	-3.25	.054
16		1.579	-3	-0.88	2.52	-3	-2.35	9.48	-4	-0.07	5.05	-3	-3.30	.049
17		1.350	-3	-0.90	2.49	-3	-2.38	1.02	-3	-0.08	4.86	-3	-3.35	.044
18		1.154	-3	-0.91	2.41	-3	-2.40	1.12	-3	-0.09	4.69	-3	-3.40	.040
19		9.867	-4	-0.92	2.03	-3	-2.42	1.31	-3	-0.10	4.52	-3	-3.44	.035
20		8.435	-4	-0.93	1.49	-3	-2.44	1.51	-3	-0.11	3.84	-3	-3.48	.031
21		7.183	-4	-0.94	1.08	-3	-2.45	1.69	-3	-0.13	3.49	-3	-3.52	.027
22		6.121	-4	-0.94	0.83	-4	-2.46	1.81	-3	-0.15	3.24	-3	-3.55	.024
23		5.219	-4	-0.95	6.22	-4	-2.47	1.82	-3	-0.16	2.97	-3	-3.58	.021
24		4.453	-4	-0.95	4.93	-4	-2.48	1.78	-3	-0.13	2.71	-3	-3.61	.018
25		3.803	-4	-0.96	4.15	-4	-2.48	1.66	-3	-0.20	2.45	-3	-3.64	.015
26		3.250	-4	-0.96	3.62	-4	-2.48	1.50	-3	-0.22	2.19	-3	-3.66	.013
27		2.780	-4	-0.96	2.77	-4	-2.49	1.30	-3	-0.23	1.85	-3	-3.68	.011
28		2.379	-4	-0.97	2.12	-4	-2.49	1.13	-3	-0.24	1.58	-3	-3.70	.009
29		2.038	-4	-0.97	1.63	-4	-2.49	0.84	-4	-0.25	1.35	-3	-3.71	.008
30		1.747	-4	-0.97	1.25	-4	-2.49	0.31	-4	-0.26	1.13	-3	-3.73	.007
31		1.498	-4	-0.97	9.55	-5	-2.49	7.30	-4	-0.27	0.75	-4	-3.74	.006
32		1.285	-4	-0.97	7.31	-5	-2.49	6.27	-4	-0.28	0.29	-4	-3.75	.005
33		1.098	-4	-0.98	5.60	-5	-2.50	5.35	-4	-0.28	7.01	-4	-3.75	.004
34		9.381	-5	-0.98	4.29	-5	-2.50	4.44	-4	-0.29	5.83	-4	-3.76	.003
35		8.030	-5	-0.98	3.29	-5	-2.50	3.97	-4	-0.29	5.10	-4	-3.77	.003
36		6.886	-5	-0.98	2.52	-5	-2.50	3.32	-4	-0.29	4.26	-4	-3.77	.002
37		5.916	-5	-0.98	2.00	-5	-2.50	2.78	-4	-0.30	3.56	-4	-3.77	.002
38		5.092	-5	-0.98	1.48	-5	-2.50	2.31	-4	-0.30	2.98	-4	-3.78	.002
39		4.390	-5	-0.98	1.13	-5	-2.50	2.00	-4	-0.30	2.55	-4	-3.78	.001
40		3.791	-5	-0.98	0.66	-6	-2.50	1.71	-4	-0.30	2.18	-4	-3.78	.001
41		3.279	-5	-0.98	6.64	-6	-2.50	1.40	-4	-0.31	1.79	-4	-3.78	.001
42		2.841	-5	-0.98	5.08	-6	-2.50	1.09	-4	-0.31	1.43	-4	-3.79	.001
43		2.466	-5	-0.98	3.89	-6	-2.50	0.56	-5	-0.31	1.14	-4	-3.79	.001
44		2.143	-5	-0.98	2.98	-6	-2.50	0.84	-5	-0.31	0.29	-5	-3.79	.000
45		1.866	-5	-0.98	2.28	-6	-2.50	5.30	-5	-0.31	7.39	-5	-3.79	.000
46		1.626	-5	-0.98	1.75	-6	-2.50	4.10	-5	-0.31	5.90	-5	-3.79	.000
47		1.420	-5	-0.98	1.44	-6	-2.50	3.25	-5	-0.31	4.80	-5	-3.79	.000
48		1.249	-5	-0.98	1.03	-6	-2.50	2.57	-5	-0.31	3.92	-5	-3.79	.000
49		1.103	-5	-0.98	7.86	-7	-2.50	2.05	-5	-0.31	3.23	-5	-3.79	.000
50		9.743	-6	-0.98	6.02	-7	-2.50	1.71	-5	-0.31	2.75	-5	-3.79	.000

Table 4.12 Parameters at 0.60 microns

All. (km)	h	Rayleigh atten. coeff. (km ⁻¹)	Rayleigh optical thick. (0-h)	Rayleigh optical thick. (h-∞)	Aerosol atten. coeff. (km ⁻¹)	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-∞)	Ozone absorp. coeff. (km ⁻¹)	τ ₃	Ozone optical thick. (0-h)	Ozone optical thick. (h-∞)	Ext. coeff. (km ⁻¹)	Ext. optical thick. (0-h)	Ext. optical thick. (h-∞)
		β _r	τ _r	τ _r	β _a	τ _a	τ _a	β ₃	τ ₃	τ ₃	τ ₃	β _{ext}	τ _{ext}	τ _{ext}
0	0	8.156	-3	-0.000	0.69	0.000	0.000	4.70	0.000	0.000	0.045	1.59	-1	0.000
1	1	7.401	-3	-0.008	0.61	0.108	0.129	4.30	0.000	0.000	0.044	7.38	-2	-0.116
2	2	6.701	-3	-0.015	0.54	0.155	0.082	3.87	0.001	0.001	0.044	3.56	-2	-0.171
3	3	6.054	-3	-0.021	0.48	0.175	0.062	3.30	0.001	0.001	0.043	1.83	-2	-0.198
4	4	5.455	-3	-0.027	0.43	0.185	0.053	2.98	0.002	0.002	0.043	1.21	-2	-0.213
5	5	4.903	-3	-0.032	0.37	0.190	0.047	2.92	0.002	0.002	0.043	9.96	-3	-0.224
6	6	4.395	-3	-0.037	0.32	0.194	0.043	2.85	0.002	0.002	0.042	8.04	-3	-0.233
7	7	3.928	-3	-0.041	0.28	0.197	0.040	2.94	0.002	0.002	0.042	7.95	-3	-0.241
8	8	3.501	-3	-0.045	0.24	0.201	0.037	3.01	0.003	0.003	0.042	7.82	-3	-0.248
9	9	3.110	-3	-0.048	0.21	0.204	0.033	3.71	0.003	0.003	0.042	6.57	-3	-0.255
10	10	2.753	-3	-0.051	0.18	0.207	0.030	4.62	0.003	0.003	0.042	6.22	-3	-0.261
11	11	2.429	-3	-0.053	0.15	0.210	0.027	6.07	0.004	0.004	0.041	5.86	-3	-0.267
12	12	2.077	-3	-0.056	0.13	0.213	0.025	8.20	0.005	0.005	0.040	5.86	-3	-0.273
13	13	1.775	-3	-0.058	0.11	0.215	0.022	1.12	0.006	0.006	0.039	5.82	-3	-0.279
14	14	1.517	-3	-0.059	0.10	0.218	0.019	1.26	0.007	0.007	0.038	5.46	-3	-0.284
15	15	1.297	-3	-0.061	0.08	0.221	0.016	1.31	0.008	0.008	0.036	5.12	-3	-0.290
16	16	1.108	-3	-0.062	0.07	0.223	0.014	1.36	0.009	0.009	0.035	4.86	-3	-0.295
17	17	9.474	-4	-0.063	0.06	0.226	0.012	1.67	0.011	0.011	0.034	4.78	-3	-0.304
18	18	8.099	-4	-0.064	0.05	0.228	0.009	1.61	0.012	0.012	0.034	4.71	-3	-0.304
19	19	6.924	-4	-0.064	0.04	0.230	0.007	1.87	0.014	0.014	0.030	4.49	-3	-0.309
20	20	5.919	-4	-0.065	0.04	0.232	0.005	2.16	0.016	0.016	0.028	4.17	-3	-0.313
21	21	5.041	-4	-0.066	0.03	0.233	0.004	2.43	0.018	0.018	0.026	3.96	-3	-0.317
22	22	4.295	-4	-0.066	0.03	0.234	0.003	2.60	0.021	0.021	0.024	3.80	-3	-0.321
23	23	3.662	-4	-0.067	0.02	0.234	0.003	2.61	0.024	0.024	0.021	3.57	-3	-0.325
24	24	3.125	-4	-0.067	0.02	0.235	0.002	2.55	0.026	0.026	0.018	3.33	-3	-0.328
25	25	2.669	-4	-0.067	0.02	0.235	0.002	2.38	0.029	0.029	0.016	3.04	-3	-0.331
26	26	2.281	-4	-0.067	0.01	0.236	0.001	2.15	0.031	0.031	0.014	2.72	-3	-0.334
27	27	1.951	-4	-0.068	0.01	0.236	0.001	1.86	0.033	0.033	0.012	2.32	-3	-0.337
28	28	1.670	-4	-0.068	0.01	0.236	0.001	1.62	0.035	0.035	0.010	1.99	-3	-0.339
29	29	1.430	-4	-0.068	0.01	0.237	0.001	1.41	0.036	0.036	0.008	1.71	-3	-0.341
30	30	1.226	-4	-0.068	0.01	0.237	0.000	1.19	0.037	0.037	0.007	1.43	-3	-0.342
31	31	1.051	-4	-0.068	0.01	0.237	0.000	1.05	0.039	0.039	0.006	1.24	-3	-0.344
32	32	9.025	-5	-0.068	0.01	0.237	0.000	9.00	0.040	0.040	0.005	1.04	-3	-0.345
33	33	7.705	-5	-0.068	0.01	0.237	0.000	7.68	0.040	0.040	0.004	8.98	-4	-0.346
34	34	6.593	-5	-0.068	0.00	0.237	0.000	6.40	0.041	0.041	0.003	7.67	-4	-0.347
35	35	5.635	-5	-0.068	0.00	0.237	0.000	5.69	0.042	0.042	0.002	6.57	-4	-0.348
36	36	4.832	-5	-0.069	0.00	0.237	0.000	4.77	0.042	0.042	0.002	5.49	-4	-0.348
37	37	4.151	-5	-0.069	0.00	0.237	0.000	3.99	0.043	0.043	0.002	4.58	-4	-0.348
38	38	3.573	-5	-0.069	0.00	0.237	0.000	3.34	0.043	0.043	0.002	3.84	-4	-0.349
39	39	3.080	-5	-0.069	0.00	0.237	0.000	2.86	0.043	0.043	0.001	3.28	-4	-0.349
40	40	2.660	-5	-0.069	0.00	0.237	0.000	2.44	0.044	0.044	0.001	2.80	-4	-0.350
41	41	2.301	-5	-0.069	0.00	0.237	0.000	2.01	0.044	0.044	0.001	2.30	-4	-0.350
42	42	1.994	-5	-0.069	0.00	0.237	0.000	1.57	0.044	0.044	0.001	1.82	-4	-0.350
43	43	1.730	-5	-0.069	0.00	0.237	0.000	1.23	0.044	0.044	0.000	1.44	-4	-0.350
44	44	1.504	-5	-0.069	0.00	0.237	0.000	9.82	0.044	0.044	0.000	1.16	-4	-0.350
45	45	1.309	-5	-0.069	0.00	0.237	0.000	7.60	0.044	0.044	0.000	9.13	-5	-0.350
46	46	1.141	-5	-0.069	0.00	0.237	0.000	5.89	0.044	0.044	0.000	7.39	-5	-0.350
47	47	9.963	-6	-0.069	0.00	0.237	0.000	4.66	0.044	0.044	0.000	5.78	-5	-0.351
48	48	8.766	-6	-0.069	0.00	0.237	0.000	3.68	0.045	0.045	0.000	4.64	-5	-0.351
49	49	7.742	-6	-0.069	0.00	0.237	0.000	2.94	0.045	0.045	0.000	3.79	-5	-0.351
50	50	6.837	-6	-0.069	0.00	0.237	0.000	2.46	0.045	0.045	0.000	3.20	-5	-0.351

Table 4.13 Parameters at 0.65 microns

Alt. (km)	Rayleigh atten. coeff. (km ⁻¹)	Rayleigh optical thick. (0-h)	Rayleigh optical thick. (h-∞)	Aerosol atten. coeff. (km ⁻¹)	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-∞)	Ozone absorp. coeff. (km ⁻¹)	Ozone optical thick. (0-h)	Ozone optical thick. (h-∞)	Ext. coeff. (km ⁻²)	Ext. optical thick. (0-h)	Ext. optical thick. (h-∞)
h	β_T	τ_T	τ'_T	β_p	τ_p	τ'_p	β_3	τ_3	τ'_3	β_{ext}	τ_{ext}	τ'_{ext}
0	5.893	-3	-0.00	1.42	-1	-0.00	2.21	-0.00	-0.21	1.48	-1	-0.00
1	5.349	-3	0.06	6.25	-2	-0.102	2.02	-0.00	-0.21	6.80	-2	-0.108
2	4.842	-3	0.11	2.70	-2	-0.147	1.82	-0.00	-0.21	3.20	-2	-0.158
3	4.374	-3	0.15	1.13	-2	-0.166	1.55	-0.01	-0.20	1.59	-2	-0.182
4	3.942	-3	0.19	5.99	-3	-0.175	1.40	-0.01	-0.20	1.04	-2	-0.195
5	3.543	-3	0.23	4.51	-3	-0.180	1.37	-0.01	-0.20	8.19	-3	-0.204
6	3.176	-3	0.27	3.18	-3	-0.184	1.34	-0.01	-0.20	6.49	-3	-0.211
7	2.838	-3	0.30	2.96	-3	-0.187	1.34	-0.01	-0.20	5.93	-3	-0.216
8	2.529	-3	0.32	3.05	-3	-0.190	1.41	-0.01	-0.20	5.72	-3	-0.223
9	2.247	-3	0.35	2.92	-3	-0.193	1.74	-0.01	-0.20	5.34	-3	-0.229
10	1.989	-3	0.37	2.85	-3	-0.196	2.17	-0.02	-0.19	5.06	-3	-0.234
11	1.755	-3	0.39	2.67	-3	-0.199	2.85	-0.02	-0.19	4.71	-3	-0.239
12	1.501	-3	0.40	2.80	-3	-0.201	3.85	-0.02	-0.19	4.69	-3	-0.244
13	1.282	-3	0.42	2.59	-3	-0.204	5.24	-0.03	-0.19	4.39	-3	-0.248
14	1.096	-3	0.43	2.53	-3	-0.207	5.93	-0.04	-0.18	4.22	-3	-0.253
15	9.369	-4	0.44	2.38	-3	-0.209	6.16	-0.04	-0.18	3.93	-3	-0.257
16	8.008	-4	0.45	2.26	-3	-0.211	8.39	-0.04	-0.16	3.70	-3	-0.261
17	6.846	-4	0.45	2.24	-3	-0.214	6.88	-0.05	-0.16	3.61	-3	-0.264
18	5.852	-4	0.46	2.17	-3	-0.216	7.56	-0.06	-0.15	3.51	-3	-0.268
19	5.003	-4	0.47	1.82	-3	-0.218	8.80	-0.07	-0.14	3.21	-3	-0.271
20	4.277	-4	0.47	1.34	-3	-0.219	1.02	-0.08	-0.14	2.78	-3	-0.274
21	3.642	-4	0.47	9.71	-4	-0.220	1.14	-0.09	-0.12	2.48	-3	-0.277
22	3.103	-4	0.48	7.31	-4	-0.221	1.22	-0.10	-0.11	2.26	-3	-0.279
23	2.646	-4	0.48	5.59	-4	-0.222	1.23	-0.11	-0.10	2.05	-3	-0.281
24	2.258	-4	0.48	4.43	-4	-0.222	1.40	-0.12	-0.09	1.87	-3	-0.283
25	1.928	-4	0.49	3.73	-4	-0.223	1.12	-0.13	-0.07	1.68	-3	-0.285
26	1.648	-4	0.49	3.25	-4	-0.224	1.01	-0.13	-0.06	1.50	-3	-0.287
27	1.409	-4	0.49	2.59	-4	-0.224	8.74	-0.15	-0.05	1.26	-3	-0.288
28	1.206	-4	0.49	1.91	-4	-0.224	7.63	-0.16	-0.05	1.07	-3	-0.289
29	1.031	-4	0.49	1.45	-4	-0.224	6.83	-0.17	-0.04	9.13	-4	-0.290
30	8.856	-5	0.49	1.12	-4	-0.224	5.60	-0.18	-0.03	7.61	-4	-0.291
31	7.537	-5	0.49	8.58	-5	-0.224	4.92	-0.18	-0.03	6.53	-4	-0.292
32	6.521	-5	0.49	6.51	-5	-0.224	4.23	-0.19	-0.02	5.54	-4	-0.292
33	5.567	-5	0.49	5.03	-5	-0.224	3.61	-0.19	-0.02	4.67	-4	-0.293
34	4.757	-5	0.49	3.86	-5	-0.224	3.01	-0.19	-0.02	3.87	-4	-0.293
35	4.071	-5	0.49	2.96	-5	-0.224	2.67	-0.20	-0.01	3.38	-4	-0.294
36	3.491	-5	0.50	2.26	-5	-0.224	2.24	-0.20	-0.01	2.81	-4	-0.294
37	3.000	-5	0.50	1.73	-5	-0.224	1.87	-0.20	-0.01	2.45	-4	-0.294
38	2.582	-5	0.50	1.33	-5	-0.224	1.57	-0.20	-0.01	1.96	-4	-0.294
39	2.226	-5	0.50	1.02	-5	-0.224	1.35	-0.20	-0.01	1.67	-4	-0.295
40	1.922	-5	0.50	7.78	-6	-0.224	1.15	-0.20	-0.01	1.42	-4	-0.295
41	1.663	-5	0.50	5.97	-6	-0.224	9.42	-0.21	-0.00	1.17	-4	-0.295
42	1.441	-5	0.50	4.57	-6	-0.224	7.38	-0.21	-0.00	9.28	-5	-0.295
43	1.250	-5	0.50	3.50	-6	-0.224	5.77	-0.21	-0.00	7.37	-5	-0.295
44	1.087	-5	0.50	2.58	-6	-0.224	4.61	-0.21	-0.00	5.97	-5	-0.295
45	9.459	-6	0.50	2.05	-6	-0.224	3.57	-0.21	-0.00	4.72	-5	-0.295
46	8.246	-6	0.50	1.57	-6	-0.224	2.77	-0.21	-0.00	3.75	-5	-0.295
47	7.199	-6	0.50	1.20	-6	-0.224	2.19	-0.21	-0.00	3.03	-5	-0.295
48	6.334	-6	0.50	9.26	-7	-0.224	1.73	-0.21	-0.00	2.46	-5	-0.295
49	5.594	-6	0.50	7.06	-7	-0.224	1.38	-0.21	-0.00	2.01	-5	-0.295
50	4.940	-6	0.50	5.41	-7	-0.224	1.15	-0.21	-0.00	1.70	-5	-0.295

Table 4.14 Parameters at 0.70 microns

Alt. (km)	Rayleigh atten. coeff. (km^{-1})	Rayleigh optical thick. (0-h)	Rayleigh optical thick. (h-∞)	Aerosol atten. coeff. (km^{-1})	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-∞)	Ozone absorp. coeff. (km^{-1})	Ozone optical thick. (0-h)	Ozone optical thick. (h-∞)	Ext. coeff. (km^{-1})	Ext. optical thick. (0-h)	Ext. optical thick. (h-∞)
h	β_r	τ_r	τ_r'	β_p	τ_p	τ_p'	β_3	τ_3	τ_3'	β_{ext}	τ_{ext}	τ_{ext}'
0	4.355 -3	0.00	0.37	1.35 -1	0.00	0.213	8.19 -5	0.00	0.08	1.39 -1	0.00	0.258
1	3.951 -3	0.04	0.53	5.94 -2	0.97	0.116	7.50 -5	0.00	0.08	6.44 -2	0.01	0.157
2	3.586 -3	0.08	0.29	2.56 -2	0.60	0.074	6.74 -5	0.00	0.08	2.95 -2	0.143	0.110
3	3.240 -3	0.11	0.26	1.08 -2	0.58	0.056	5.75 -5	0.00	0.08	1.61 -2	0.169	0.099
4	2.919 -3	0.14	0.22	5.65 -3	0.66	0.047	5.20 -5	0.00	0.08	8.66 -3	0.181	0.077
5	2.624 -3	0.17	0.20	4.29 -3	0.71	0.042	5.08 -5	0.00	0.07	6.36 -3	0.189	0.069
6	2.352 -3	0.20	0.17	3.02 -3	0.81	0.039	4.97 -5	0.00	0.07	5.43 -3	0.195	0.063
7	2.102 -3	0.22	0.15	2.81 -3	0.88	0.036	5.24 -5	0.00	0.07	4.96 -3	0.200	0.058
8	1.873 -3	0.24	0.13	2.90 -3	0.81	0.033	6.46 -5	0.00	0.07	4.82 -3	0.205	0.053
9	1.664 -3	0.26	0.11	2.78 -3	0.83	0.030	8.05 -5	0.01	0.07	4.51 -3	0.210	0.049
10	1.473 -3	0.29	0.10	2.71 -3	0.86	0.027	8.05 -5	0.01	0.07	4.26 -3	0.214	0.044
11	1.300 -3	0.27	0.08	2.54 -3	0.89	0.025	1.06 -4	0.01	0.07	3.94 -3	0.218	0.040
12	1.111 -3	0.30	0.07	2.67 -3	0.81	0.022	1.43 -4	0.01	0.07	3.92 -3	0.222	0.036
13	9.499 -4	0.31	0.06	2.46 -3	0.94	0.019	1.94 -4	0.01	0.07	3.61 -3	0.226	0.034
14	8.117 -4	0.32	0.05	2.41 -3	0.96	0.017	2.20 -4	0.01	0.07	3.44 -3	0.229	0.029
15	6.939 -4	0.32	0.04	2.26 -3	0.99	0.015	2.29 -4	0.01	0.06	3.19 -3	0.233	0.026
16	5.931 -4	0.33	0.04	2.15 -3	0.91	0.013	2.37 -4	0.02	0.06	2.98 -3	0.236	0.024
17	5.070 -4	0.34	0.03	2.13 -3	0.93	0.010	2.55 -4	0.02	0.06	2.89 -3	0.239	0.019
18	4.334 -4	0.34	0.03	2.06 -3	0.98	0.008	2.81 -4	0.02	0.06	2.77 -3	0.244	0.017
19	3.705 -4	0.35	0.02	1.73 -3	0.97	0.006	3.27 -4	0.02	0.05	2.63 -3	0.244	0.014
20	3.158 -4	0.35	0.02	1.27 -3	0.99	0.005	3.71 -4	0.03	0.05	1.97 -3	0.246	0.012
21	2.699 -4	0.35	0.02	9.23 -4	0.94	0.004	4.23 -4	0.03	0.05	1.62 -3	0.248	0.010
22	2.299 -4	0.35	0.01	6.95 -4	0.91	0.003	4.53 -4	0.04	0.04	1.38 -3	0.250	0.009
23	1.960 -4	0.36	0.01	5.31 -4	0.91	0.002	5.55 -4	0.04	0.04	1.18 -3	0.251	0.007
24	1.672 -4	0.36	0.01	4.21 -4	0.92	0.002	6.44 -4	0.05	0.04	1.03 -3	0.252	0.006
25	1.423 -4	0.36	0.01	3.55 -4	0.91	0.001	7.14 -4	0.05	0.03	9.11 -4	0.253	0.005
26	1.221 -4	0.36	0.01	3.09 -4	0.91	0.001	8.06 -4	0.05	0.02	8.06 -4	0.254	0.004
27	1.044 -4	0.36	0.01	2.37 -4	0.91	0.001	9.24 -4	0.06	0.02	6.65 -4	0.255	0.004
28	6.935 -5	0.36	0.01	1.81 -4	0.91	0.001	1.83 -4	0.06	0.02	5.53 -4	0.255	0.003
29	7.553 -5	0.36	0.00	1.39 -4	0.91	0.001	2.46 -4	0.06	0.01	4.62 -4	0.256	0.003
30	5.627 -5	0.36	0.00	8.16 -5	0.91	0.000	2.98 -4	0.07	0.01	3.80 -4	0.256	0.002
31	4.930 -5	0.37	0.00	6.25 -5	0.91	0.000	1.82 -4	0.07	0.01	3.20 -4	0.257	0.002
32	4.124 -5	0.37	0.00	4.78 -5	0.91	0.000	1.57 -4	0.07	0.01	2.68 -4	0.257	0.001
33	3.523 -5	0.37	0.00	3.67 -5	0.91	0.000	1.34 -4	0.07	0.01	2.23 -4	0.257	0.001
34	3.016 -5	0.37	0.00	2.81 -5	0.91	0.000	9.91 -5	0.07	0.01	1.83 -4	0.257	0.001
35	2.595 -5	0.37	0.00	2.15 -5	0.91	0.000	8.30 -5	0.07	0.00	1.40 -4	0.257	0.001
36	2.222 -5	0.37	0.00	1.65 -5	0.91	0.000	6.95 -5	0.07	0.00	1.08 -4	0.258	0.001
37	1.912 -5	0.37	0.00	1.26 -5	0.91	0.000	5.82 -5	0.08	0.00	9.00 -5	0.258	0.000
38	1.649 -5	0.37	0.00	9.56 -6	0.91	0.000	4.99 -5	0.08	0.00	7.61 -5	0.258	0.000
39	1.424 -5	0.37	0.00	7.40 -6	0.91	0.000	4.28 -5	0.08	0.00	6.44 -5	0.258	0.000
40	1.232 -5	0.37	0.00	5.57 -6	0.91	0.000	3.50 -5	0.08	0.00	5.29 -5	0.258	0.000
41	1.067 -5	0.37	0.00	4.34 -6	0.91	0.000	2.74 -5	0.08	0.00	4.24 -5	0.258	0.000
42	0.904 -5	0.37	0.00	3.32 -6	0.91	0.000	2.14 -5	0.08	0.00	3.40 -5	0.258	0.000
43	8.048 -5	0.37	0.00	2.55 -6	0.91	0.000	1.71 -5	0.08	0.00	2.77 -5	0.258	0.000
44	7.006 -5	0.37	0.00	1.95 -6	0.91	0.000	1.03 -5	0.08	0.00	2.22 -5	0.258	0.000
45	6.108 -6	0.37	0.00	1.50 -6	0.91	0.000	8.12 -6	0.08	0.00	1.79 -5	0.258	0.000
46	5.342 -6	0.37	0.00	1.14 -6	0.91	0.000	6.42 -6	0.08	0.00	1.46 -5	0.258	0.000
47	4.691 -6	0.37	0.00	8.60 -7	0.91	0.000	5.42 -6	0.08	0.00	1.20 -5	0.258	0.000
48	4.163 -6	0.37	0.00	6.72 -7	0.91	0.000	4.48 -6	0.08	0.00	9.94 -6	0.258	0.000
49	3.659 -6	0.37	0.00	5.14 -7	0.91	0.000	4.28 -6	0.08	0.00	8.45 -6	0.258	0.000

Table 4.15 Parameters at 0.80 microns

Alt. (km)	h	Rayleigh atten. coeff. (km ⁻¹)	Rayleigh optical thick. (0-h)	Rayleigh optical thick. (h-∞)	Aerosol atten. coeff. (km ⁻¹)	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-∞)	Ozone absoorp. coeff. (km ⁻¹)	Ozone optical thick. (0-h)	Ozone optical thick. (h-∞)	Ext. coeff. (km ⁻¹)	Ext. optical thick. (0-h)	Ext. optical thick. (h-∞)
		β_r	τ_r	τ_r	β_p	τ_p	τ_p	β_3	τ_3	τ_3	β_{ext}	τ_{ext}	τ_{ext}
0	0	2.544 -3	.000	.021	1.27 -1	.000	.201	3.56 -5	.000	.003	1.20 -1	.000	.020
1	1	2.309 -3	.002	.019	5.59 -2	.091	.109	3.26 -5	.000	.003	5.82 -2	.094	.132
2	2	2.091 -3	.005	.017	2.41 -2	.131	.069	2.93 -5	.000	.003	2.62 -2	.136	.190
3	3	1.883 -3	.007	.015	1.01 -2	.149	.052	2.50 -5	.000	.003	1.20 -2	.155	.270
4	4	1.702 -3	.009	.013	5.35 -3	.156	.044	2.26 -5	.000	.003	7.08 -3	.155	.461
5	5	1.540 -3	.010	.011	4.04 -3	.161	.040	2.21 -5	.000	.003	5.59 -3	.171	.650
6	6	1.371 -3	.011	.010	2.65 -3	.164	.036	2.16 -5	.000	.003	4.24 -3	.176	.920
7	7	1.225 -3	.013	.009	2.54 -3	.167	.034	2.23 -5	.000	.003	3.89 -3	.180	1.46
8	8	1.092 -3	.014	.008	2.72 -3	.170	.031	2.28 -5	.000	.003	3.84 -3	.184	2.42
9	9	9.702 -4	.015	.007	2.61 -3	.173	.028	2.61 -5	.000	.003	3.44 -3	.188	4.36
10	10	8.539 -4	.016	.006	2.55 -3	.175	.026	3.50 -5	.000	.003	3.61 -3	.191	7.34
11	11	7.577 -4	.017	.005	2.49 -3	.178	.023	4.60 -5	.000	.003	3.19 -3	.195	13.1
12	12	6.479 -4	.017	.004	2.51 -3	.180	.021	6.21 -5	.000	.003	3.22 -3	.198	22.8
13	13	5.538 -4	.018	.004	2.31 -3	.182	.018	8.45 -5	.000	.003	2.95 -3	.201	42.5
14	14	4.733 -4	.018	.003	2.27 -3	.185	.016	9.57 -5	.001	.003	2.84 -3	.204	82.2
15	15	4.045 -4	.019	.003	2.13 -3	.187	.014	9.74 -5	.001	.003	2.63 -3	.206	119
16	16	3.453 -4	.019	.002	2.03 -3	.189	.012	1.03 -4	.001	.003	2.47 -3	.209	177
17	17	2.956 -4	.020	.002	2.00 -3	.191	.010	1.11 -4	.001	.003	2.41 -3	.211	261
18	18	2.527 -4	.020	.002	1.94 -3	.193	.008	1.22 -4	.001	.002	2.31 -3	.214	384
19	19	2.160 -4	.020	.001	1.83 -3	.195	.006	1.82 -4	.001	.002	1.99 -3	.216	550
20	20	1.847 -4	.020	.001	1.20 -3	.196	.005	1.64 -4	.001	.002	1.55 -3	.218	808
21	21	1.573 -4	.021	.001	8.08 -4	.197	.004	1.34 -4	.001	.002	1.21 -3	.219	1150
22	22	1.340 -4	.021	.001	6.53 -4	.198	.003	1.97 -4	.002	.002	9.84 -4	.220	1650
23	23	1.143 -4	.021	.001	5.00 -4	.199	.002	1.98 -4	.002	.002	8.12 -4	.221	2300
24	24	9.750 -5	.021	.001	3.96 -4	.199	.002	1.93 -4	.002	.001	6.87 -4	.222	3200
25	25	8.226 -5	.021	.001	3.34 -4	.199	.001	1.80 -4	.002	.001	5.97 -4	.223	4400
26	26	7.115 -5	.021	.000	2.91 -4	.200	.001	1.63 -4	.002	.001	5.25 -4	.223	6000
27	27	6.036 -5	.021	.000	2.23 -4	.200	.001	1.41 -4	.002	.001	4.23 -4	.224	8200
28	28	5.269 -5	.021	.000	1.70 -4	.200	.001	1.23 -4	.003	.001	3.45 -4	.224	11200
29	29	4.451 -5	.021	.000	1.31 -4	.200	.000	1.07 -4	.003	.000	2.83 -4	.224	15500
30	30	3.824 -5	.021	.000	1.00 -4	.200	.000	9.03 -5	.003	.000	2.29 -4	.225	21000
31	31	3.230 -5	.021	.000	7.68 -5	.200	.000	7.94 -5	.003	.000	1.89 -4	.225	28500
32	32	2.815 -5	.021	.000	5.88 -5	.201	.000	6.82 -5	.003	.000	1.55 -4	.225	39000
33	33	2.404 -5	.021	.000	4.50 -5	.201	.000	5.82 -5	.003	.000	1.27 -4	.225	52500
34	34	2.054 -5	.021	.000	3.45 -5	.201	.000	4.85 -5	.003	.000	1.04 -4	.225	71000
35	35	1.758 -5	.021	.000	2.64 -5	.201	.000	4.31 -5	.003	.000	8.71 -5	.225	96000
36	36	1.504 -5	.021	.000	2.04 -5	.201	.000	3.81 -5	.003	.000	7.14 -5	.225	13000
37	37	1.295 -5	.021	.000	1.55 -5	.201	.000	3.02 -5	.003	.000	5.87 -5	.225	17500
38	38	1.115 -5	.021	.000	1.19 -5	.201	.000	2.53 -5	.003	.000	4.83 -5	.225	23500
39	39	9.610 -6	.021	.000	9.08 -6	.201	.000	2.17 -5	.003	.000	4.04 -5	.225	32000
40	40	8.300 -6	.021	.000	6.36 -6	.201	.000	1.85 -5	.003	.000	3.39 -5	.225	43500
41	41	7.179 -6	.021	.000	5.34 -6	.201	.000	1.52 -5	.003	.000	2.77 -5	.226	58500
42	42	6.221 -6	.021	.000	4.38 -6	.201	.000	1.19 -5	.003	.000	2.22 -5	.226	79000
43	43	5.498 -6	.021	.000	3.13 -6	.201	.000	9.30 -6	.003	.000	1.78 -5	.226	10700
44	44	4.692 -6	.021	.000	2.60 -6	.201	.000	7.54 -6	.003	.000	1.45 -5	.226	14500
45	45	4.084 -6	.021	.000	1.83 -6	.201	.000	5.76 -6	.003	.000	1.17 -5	.226	19500
46	46	3.551 -6	.021	.000	1.41 -6	.201	.000	4.45 -6	.003	.000	9.43 -6	.226	26500
47	47	3.106 -6	.021	.000	1.08 -6	.201	.000	3.53 -6	.003	.000	7.72 -6	.226	36000
48	48	2.735 -6	.021	.000	8.28 -7	.201	.000	2.79 -6	.003	.000	6.35 -6	.226	48500
49	49	2.415 -6	.021	.000	6.32 -7	.201	.000	2.23 -6	.003	.000	5.28 -6	.226	66000
50	50	2.133 -6	.021	.000	4.84 -7	.201	.000	1.86 -6	.003	.000	4.48 -6	.226	90000

Table 4.16 Parameters at 0.80 microns

Alt. (km)	h	Rayleigh atten. coeff. (km ⁻¹)	Rayleigh optical thick. (0-h)	Rayleigh optical thick. (h-∞)	Rayleigh atten. coeff. (km ⁻¹)	Aerosol atten. coeff. (km ⁻¹)	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-∞)	Ozone absorp. coeff. (km ⁻¹)	Ozone optical thick. (0-h)	Ozone optical thick. (h-∞)	Ext. coeff. (km ⁻¹)	Ext. optical thick. (0-h)	Ext. optical thick. (h-∞)
		β_r	τ_r	τ_r'	β_p	τ_p	τ_p'	τ_p'	β_3	τ_3	τ_3'	β_{ext}	τ_{ext}	τ_{ext}
0		1.593	-3	-0.00	1.20	-1	-0.00	-0.190	0.	-0.00	-0.00	1.22	-1	-0.00
1		1.246	-3	-0.02	5.29	-2	-0.36	-0.103	0.	-0.00	-0.00	5.42	-2	-0.08
2		1.100	-3	-0.03	2.28	-2	-1.24	-0.066	0.	-0.00	-0.00	2.41	-2	-0.17
3		1.175	-3	-0.04	9.57	-3	-1.40	-0.049	0.	-0.00	-0.00	1.07	-2	-0.144
4		1.059	-3	-0.05	5.06	-3	-1.48	-0.042	0.	-0.00	-0.00	6.12	-3	-0.153
5		9.514	-4	-0.06	3.31	-3	-1.52	-0.038	0.	-0.00	-0.00	4.76	-3	-0.158
6		8.528	-4	-0.07	2.59	-3	-1.55	-0.034	0.	-0.00	-0.00	3.54	-3	-0.162
7		7.622	-4	-0.08	2.50	-3	-1.58	-0.032	0.	-0.00	-0.00	3.26	-3	-0.166
8		6.733	-4	-0.09	2.37	-3	-1.60	-0.029	0.	-0.00	-0.00	3.25	-3	-0.169
9		5.034	-4	-0.09	2.47	-3	-1.53	-0.027	0.	-0.00	-0.00	3.07	-3	-0.172
10		5.342	-4	-0.10	2.41	-3	-1.55	-0.024	0.	-0.00	-0.00	2.94	-3	-0.175
11		4.713	-4	-0.10	2.26	-3	-1.66	-0.022	0.	-0.00	-0.00	2.73	-3	-0.178
12		4.030	-4	-0.11	2.37	-3	-1.70	-0.020	0.	-0.00	-0.00	2.77	-3	-0.181
13		3.444	-4	-0.11	2.19	-3	-1.72	-0.017	0.	-0.00	-0.00	2.53	-3	-0.184
14		2.944	-4	-0.11	2.14	-3	-1.75	-0.015	0.	-0.00	-0.00	2.44	-3	-0.186
15		2.515	-4	-0.12	2.31	-3	-1.77	-0.013	0.	-0.00	-0.00	2.26	-3	-0.188
16		2.151	-4	-0.12	1.91	-3	-1.79	-0.011	0.	-0.00	-0.00	2.13	-3	-0.191
17		1.838	-4	-0.12	1.83	-3	-1.80	-0.009	0.	-0.00	-0.00	2.07	-3	-0.193
18		1.572	-4	-0.12	1.33	-3	-1.82	-0.007	0.	-0.00	-0.00	1.99	-3	-0.195
19		1.344	-4	-0.13	1.34	-3	-1.84	-0.006	0.	-0.00	-0.00	1.88	-3	-0.197
20		1.143	-4	-0.13	1.13	-3	-1.85	-0.004	0.	-0.00	-0.00	1.85	-3	-0.198
21		9.781	-5	-0.13	8.20	-4	-1.86	-0.003	0.	-0.00	-0.00	1.25	-3	-0.199
22		8.334	-5	-0.13	6.17	-4	-1.87	-0.003	0.	-0.00	-0.00	9.18	-4	-0.200
23		7.105	-5	-0.13	4.72	-4	-1.83	-0.002	0.	-0.00	-0.00	7.01	-4	-0.200
24		6.054	-5	-0.13	3.74	-4	-1.88	-0.002	0.	-0.00	-0.00	4.35	-4	-0.201
25		5.175	-5	-0.13	3.15	-4	-1.88	-0.001	0.	-0.00	-0.00	3.67	-4	-0.201
26		4.425	-5	-0.13	2.75	-4	-1.89	-0.001	0.	-0.00	-0.00	3.19	-4	-0.202
27		3.785	-5	-0.13	2.10	-4	-1.89	-0.001	0.	-0.00	-0.00	2.48	-4	-0.202
28		3.240	-5	-0.13	1.51	-4	-1.89	-0.001	0.	-0.00	-0.00	1.93	-4	-0.202
29		2.775	-5	-0.13	1.24	-4	-1.89	-0.000	0.	-0.00	-0.00	1.52	-4	-0.202
30		2.378	-5	-0.13	9.59	-5	-1.89	-0.000	0.	-0.00	-0.00	1.19	-4	-0.203
31		2.040	-5	-0.13	7.25	-5	-1.89	-0.000	0.	-0.00	-0.00	9.29	-5	-0.203
32		1.751	-5	-0.13	5.55	-5	-1.89	-0.000	0.	-0.00	-0.00	7.30	-5	-0.203
33		1.495	-5	-0.13	4.25	-5	-1.90	-0.000	0.	-0.00	-0.00	5.75	-5	-0.203
34		1.277	-5	-0.13	3.26	-5	-1.90	-0.000	0.	-0.00	-0.00	4.54	-5	-0.203
35		1.093	-5	-0.13	2.50	-5	-1.90	-0.000	0.	-0.00	-0.00	3.59	-5	-0.203
36		9.376	-6	-0.13	1.91	-5	-1.90	-0.000	0.	-0.00	-0.00	2.85	-5	-0.203
37		8.055	-6	-0.13	1.47	-5	-1.90	-0.000	0.	-0.00	-0.00	2.27	-5	-0.203
38		6.933	-6	-0.13	1.12	-5	-1.90	-0.000	0.	-0.00	-0.00	1.82	-5	-0.203
39		5.977	-6	-0.13	8.58	-6	-1.90	-0.000	0.	-0.00	-0.00	1.45	-5	-0.203
40		5.162	-6	-0.13	6.58	-6	-1.90	-0.000	0.	-0.00	-0.00	1.17	-5	-0.203
41		4.465	-6	-0.13	5.04	-6	-1.90	-0.000	0.	-0.00	-0.00	9.51	-6	-0.203
42		3.857	-6	-0.13	3.86	-6	-1.90	-0.000	0.	-0.00	-0.00	7.73	-6	-0.203
43		3.353	-6	-0.13	2.95	-6	-1.90	-0.000	0.	-0.00	-0.00	6.31	-6	-0.203
44		2.919	-6	-0.13	2.26	-6	-1.90	-0.000	0.	-0.00	-0.00	5.18	-6	-0.203
45		2.540	-6	-0.13	1.73	-6	-1.90	-0.000	0.	-0.00	-0.00	4.27	-6	-0.203
46		2.214	-6	-0.13	1.33	-6	-1.90	-0.000	0.	-0.00	-0.00	3.54	-6	-0.203
47		1.933	-6	-0.13	1.02	-5	-1.90	-0.000	0.	-0.00	-0.00	2.95	-6	-0.203
48		1.701	-6	-0.13	7.92	-7	-1.90	-0.000	0.	-0.00	-0.00	2.48	-6	-0.203
49		1.502	-6	-0.13	5.37	-7	-1.90	-0.000	0.	-0.00	-0.00	2.10	-6	-0.203
50		1.327	-6	-0.13	4.57	-7	-1.90	-0.000	0.	-0.00	-0.00	1.78	-6	-0.203

Table 4.17 Parameters at 1.06 microns

Alt. (km)	Rayleigh atten. coeff. (km ⁻¹)	Rayleigh optical thick. (0-h)	Rayleigh optical thick. (h-∞)	Aerosol atm. coeff. (km ⁻¹)	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-∞)	Ozone absorp. coeff. (km ⁻¹)	Ozone optical thick. (0-h)	Ozone optical thick. (h-∞)	Ext. coeff. (km ⁻¹)	Ext. optical thick. (0-h)	Ext. optical thick. (h-∞)
h	β_r	τ_r	τ_r	β_p	τ_p	τ_p	β_3	τ_3	τ_3	β_{ext}	τ_{ext}	τ_{ext}
0	5.152	0.000	0.007	1.13	0.000	0.179	0.	0.000	0.000	1.14	0.000	0.186
1	7.436	0.001	0.006	4.97	0.081	0.097	0.	0.000	0.000	5.04	0.082	0.195
2	5.731	0.001	0.005	2.15	0.117	0.062	0.	0.000	0.000	2.21	0.118	0.207
3	5.081	0.002	0.005	9.01	1.52	0.46	0.	0.000	0.000	9.02	1.34	0.251
4	5.480	0.003	0.004	4.75	1.39	0.40	0.	0.000	0.000	5.31	1.42	0.244
5	4.925	0.004	0.004	3.59	1.43	0.35	0.	0.000	0.000	4.08	1.40	0.239
6	4.915	0.004	0.003	2.53	1.46	0.32	0.	0.000	0.000	2.97	1.50	0.236
7	3.945	0.004	0.003	2.35	1.63	0.30	0.	0.000	0.000	2.75	1.53	0.233
8	3.516	0.004	0.002	2.92	1.51	0.28	0.	0.000	0.000	2.78	1.50	0.230
9	3.123	0.005	0.002	2.32	1.53	0.25	0.	0.000	0.000	2.64	1.58	0.225
10	2.765	0.005	0.002	2.27	1.56	0.23	0.	0.000	0.000	2.54	1.61	0.225
11	2.640	0.005	0.002	2.12	1.58	0.21	0.	0.000	0.000	2.37	1.63	0.222
12	2.036	0.006	0.001	2.25	1.60	0.18	0.	0.000	0.000	2.44	1.66	0.220
13	1.733	0.006	0.001	2.06	1.62	0.16	0.	0.000	0.000	2.24	1.68	0.217
14	1.524	0.006	0.001	2.02	1.64	0.14	0.	0.000	0.000	2.17	1.70	0.215
15	1.302	0.006	0.001	1.90	1.66	0.12	0.	0.000	0.000	2.03	1.72	0.213
16	1.113	0.006	0.001	1.80	1.68	0.10	0.	0.000	0.000	1.91	1.74	0.211
17	5.517	0.006	0.001	1.79	1.70	0.09	0.	0.000	0.000	1.88	1.76	0.209
18	1.135	0.006	0.001	1.72	1.72	0.07	0.	0.000	0.000	1.80	1.76	0.207
19	0.925	0.006	0.000	1.65	1.73	0.05	0.	0.000	0.000	1.52	1.80	0.206
20	5.945	0.007	0.000	1.07	1.75	0.04	0.	0.000	0.000	1.15	1.81	0.204
21	5.053	0.007	0.000	7.72	1.75	0.03	0.	0.000	0.000	8.23	1.82	0.203
22	4.314	0.007	0.000	5.91	1.76	0.02	0.	0.000	0.000	6.25	1.83	0.203
23	3.673	0.007	0.000	4.65	1.77	0.02	0.	0.000	0.000	4.82	1.83	0.202
24	3.133	0.007	0.000	3.53	1.77	0.02	0.	0.000	0.000	3.84	1.84	0.201
25	2.681	0.007	0.000	2.97	1.77	0.01	0.	0.000	0.000	3.25	1.84	0.201
26	2.291	0.007	0.000	2.59	1.78	0.01	0.	0.000	0.000	2.82	1.84	0.201
27	1.953	0.007	0.000	1.38	1.78	0.01	0.	0.000	0.000	2.18	1.85	0.201
28	1.677	0.007	0.000	1.52	1.78	0.01	0.	0.000	0.000	1.68	1.85	0.201
29	1.436	0.007	0.000	1.17	1.78	0.00	0.	0.000	0.000	1.31	1.85	0.201
30	1.231	0.007	0.000	8.74	1.78	0.00	0.	0.000	0.000	1.02	1.85	0.200
31	1.056	0.007	0.000	6.83	1.78	0.00	0.	0.000	0.000	7.83	1.85	0.200
32	9.055	0.007	0.000	5.23	1.78	0.00	0.	0.000	0.000	6.13	1.85	0.200
33	7.750	0.007	0.000	4.01	1.78	0.00	0.	0.000	0.000	4.78	1.85	0.200
34	6.612	0.007	0.000	3.07	1.79	0.00	0.	0.000	0.000	3.73	1.85	0.200
35	5.663	0.007	0.000	2.35	1.79	0.00	0.	0.000	0.000	2.92	1.85	0.200
36	4.954	0.007	0.000	1.80	1.79	0.00	0.	0.000	0.000	2.29	1.85	0.200
37	4.170	0.007	0.000	1.38	1.79	0.00	0.	0.000	0.000	1.80	1.85	0.200
38	3.584	0.007	0.000	1.06	1.79	0.00	0.	0.000	0.000	1.42	1.85	0.200
39	3.094	0.007	0.000	8.08	1.79	0.00	0.	0.000	0.000	1.12	1.86	0.200
40	2.672	0.007	0.000	6.19	1.79	0.00	0.	0.000	0.000	8.87	1.86	0.200
41	2.311	0.007	0.000	4.75	1.79	0.00	0.	0.000	0.000	7.05	1.86	0.200
42	2.003	0.007	0.000	3.63	1.79	0.00	0.	0.000	0.000	5.54	1.86	0.200
43	1.736	0.007	0.000	2.78	1.79	0.00	0.	0.000	0.000	4.52	1.86	0.200
44	1.511	0.007	0.000	2.13	1.79	0.00	0.	0.000	0.000	3.84	1.86	0.200
45	1.315	0.007	0.000	1.63	1.79	0.00	0.	0.000	0.000	2.95	1.86	0.200
46	1.165	0.007	0.000	1.25	1.79	0.00	0.	0.000	0.000	2.40	1.86	0.200
47	1.001	0.007	0.000	9.56	1.79	0.00	0.	0.000	0.000	1.95	1.86	0.200
48	8.895	0.007	0.000	7.37	1.79	0.00	0.	0.000	0.000	1.62	1.86	0.200
49	7.776	0.007	0.000	5.52	1.79	0.00	0.	0.000	0.000	1.34	1.86	0.200
50	6.857	0.007	0.000	4.31	1.79	0.00	0.	0.000	0.000	1.12	1.86	0.200

Table 4. 18 Parameters at 1.26 microns

Alt. (km)	Rayleigh atten. coeff. (km ⁻¹)	Rayleigh optical thick. (0-h)	Rayleigh optical thick. (h-∞)	Aerosol atten. (km ⁻¹)	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-∞)	Ozone absorp. coeff. (km ⁻¹)	Ozone optical thick. (0-h)	Ozone optical thick. (h-∞)	Ozone optical thick. (h-∞)	Ext. coeff. (km ⁻¹)	Ext. optical thick. (0-h)	Ext. optical thick. (h-∞)
h	β_T	τ_T	τ_T	β_p	τ_p	τ_p	β_3	τ_3	τ_3	τ_3	β_{ext}	τ_{ext}	τ_{ext}
0	4.091 -4	0.000	0.003	1.08 -1	0.000	0.171	0.	0.000	0.000	0.000	1.08 -1	0.000	0.174
1	3.713 -4	0.000	0.003	4.75 -2	0.078	0.093	0.	0.000	0.000	0.000	4.75 -2	0.078	0.096
2	3.352 -4	0.001	0.003	2.05 -2	0.112	0.059	0.	0.000	0.000	0.000	2.05 -2	0.113	0.062
3	3.037 -4	0.001	0.002	8.31 -3	0.125	0.044	0.	0.000	0.000	0.000	8.31 -3	0.127	0.047
4	2.737 -4	0.002	0.002	4.55 -3	0.133	0.038	0.	0.000	0.000	0.000	4.55 -3	0.134	0.040
5	2.450 -4	0.002	0.002	3.63 -3	0.137	0.034	0.	0.000	0.000	0.000	3.63 -3	0.135	0.036
6	2.195 -4	0.002	0.002	2.64 -3	0.140	0.031	0.	0.000	0.000	0.000	2.64 -3	0.142	0.033
7	1.971 -4	0.002	0.001	2.25 -3	0.142	0.029	0.	0.000	0.000	0.000	2.25 -3	0.144	0.030
8	1.755 -4	0.002	0.001	2.32 -3	0.144	0.026	0.	0.000	0.000	0.000	2.32 -3	0.147	0.026
9	1.560 -4	0.002	0.001	2.22 -3	0.147	0.024	0.	0.000	0.000	0.000	2.22 -3	0.149	0.025
10	1.381 -4	0.003	0.001	2.17 -3	0.149	0.022	0.	0.000	0.000	0.000	2.17 -3	0.151	0.023
11	1.213 -4	0.003	0.001	2.03 -3	0.151	0.020	0.	0.000	0.000	0.000	2.03 -3	0.154	0.021
12	1.042 -4	0.003	0.001	2.13 -3	0.153	0.018	0.	0.000	0.000	0.000	2.13 -3	0.156	0.018
13	8.902 -5	0.003	0.001	1.97 -3	0.155	0.016	0.	0.000	0.000	0.000	2.06 -3	0.158	0.016
14	7.610 -5	0.003	0.000	1.93 -3	0.157	0.014	0.	0.000	0.000	0.000	2.00 -3	0.160	0.014
15	5.504 -5	0.003	0.000	1.81 -3	0.159	0.012	0.	0.000	0.000	0.000	1.88 -3	0.162	0.012
16	3.560 -5	0.003	0.000	1.72 -3	0.161	0.010	0.	0.000	0.000	0.000	1.76 -3	0.164	0.010
17	2.733 -5	0.003	0.000	1.70 -3	0.162	0.008	0.	0.000	0.000	0.000	1.75 -3	0.166	0.009
18	2.053 -5	0.003	0.000	1.65 -3	0.164	0.007	0.	0.000	0.000	0.000	1.69 -3	0.167	0.007
19	1.673 -5	0.003	0.000	1.55 -3	0.166	0.005	0.	0.000	0.000	0.000	1.62 -3	0.168	0.005
20	1.369 -5	0.003	0.000	1.42 -3	0.167	0.004	0.	0.000	0.000	0.000	1.45 -3	0.170	0.004
21	1.145 -5	0.003	0.000	1.36 -3	0.168	0.003	0.	0.000	0.000	0.000	1.39 -3	0.171	0.003
22	1.037 -5	0.003	0.000	1.25 -3	0.169	0.002	0.	0.000	0.000	0.000	1.27 -3	0.172	0.002
23	0.937 -5	0.003	0.000	1.15 -3	0.169	0.002	0.	0.000	0.000	0.000	1.18 -3	0.173	0.002
24	0.838 -5	0.003	0.000	1.07 -3	0.169	0.002	0.	0.000	0.000	0.000	1.11 -3	0.173	0.002
25	0.739 -5	0.003	0.000	1.00 -3	0.170	0.001	0.	0.000	0.000	0.000	1.04 -3	0.173	0.001
26	0.645 -5	0.003	0.000	0.94 -3	0.170	0.001	0.	0.000	0.000	0.000	0.97 -3	0.173	0.001
27	0.557 -5	0.003	0.000	0.89 -3	0.170	0.001	0.	0.000	0.000	0.000	0.91 -3	0.174	0.001
28	0.473 -5	0.003	0.000	0.85 -3	0.170	0.001	0.	0.000	0.000	0.000	0.86 -3	0.174	0.001
29	0.393 -5	0.003	0.000	0.81 -3	0.170	0.000	0.	0.000	0.000	0.000	0.81 -3	0.174	0.000
30	0.317 -5	0.003	0.000	0.77 -3	0.170	0.000	0.	0.000	0.000	0.000	0.77 -3	0.174	0.000
31	0.245 -5	0.003	0.000	0.73 -3	0.170	0.000	0.	0.000	0.000	0.000	0.73 -3	0.174	0.000
32	0.177 -5	0.003	0.000	0.69 -3	0.171	0.000	0.	0.000	0.000	0.000	0.69 -3	0.174	0.000
33	0.113 -5	0.003	0.000	0.65 -3	0.171	0.000	0.	0.000	0.000	0.000	0.65 -3	0.174	0.000
34	0.052 -5	0.003	0.000	0.61 -3	0.171	0.000	0.	0.000	0.000	0.000	0.61 -3	0.174	0.000
35	0.027 -5	0.003	0.000	0.57 -3	0.171	0.000	0.	0.000	0.000	0.000	0.57 -3	0.174	0.000
36	0.002 -5	0.003	0.000	0.53 -3	0.171	0.000	0.	0.000	0.000	0.000	0.53 -3	0.174	0.000
37	0.000 -5	0.003	0.000	0.49 -3	0.171	0.000	0.	0.000	0.000	0.000	0.49 -3	0.174	0.000
38	0.000 -5	0.003	0.000	0.45 -3	0.171	0.000	0.	0.000	0.000	0.000	0.45 -3	0.174	0.000
39	0.000 -5	0.003	0.000	0.41 -3	0.171	0.000	0.	0.000	0.000	0.000	0.41 -3	0.174	0.000
40	0.000 -5	0.003	0.000	0.37 -3	0.171	0.000	0.	0.000	0.000	0.000	0.37 -3	0.174	0.000
41	0.000 -5	0.003	0.000	0.33 -3	0.171	0.000	0.	0.000	0.000	0.000	0.33 -3	0.174	0.000
42	0.000 -5	0.003	0.000	0.29 -3	0.171	0.000	0.	0.000	0.000	0.000	0.29 -3	0.174	0.000
43	0.000 -5	0.003	0.000	0.25 -3	0.171	0.000	0.	0.000	0.000	0.000	0.25 -3	0.174	0.000
44	0.000 -5	0.003	0.000	0.21 -3	0.171	0.000	0.	0.000	0.000	0.000	0.21 -3	0.174	0.000
45	0.000 -5	0.003	0.000	0.17 -3	0.171	0.000	0.	0.000	0.000	0.000	0.17 -3	0.174	0.000
46	0.000 -5	0.003	0.000	0.13 -3	0.171	0.000	0.	0.000	0.000	0.000	0.13 -3	0.174	0.000
47	0.000 -5	0.003	0.000	0.09 -3	0.171	0.000	0.	0.000	0.000	0.000	0.09 -3	0.174	0.000
48	0.000 -5	0.003	0.000	0.05 -3	0.171	0.000	0.	0.000	0.000	0.000	0.05 -3	0.174	0.000
49	0.000 -5	0.003	0.000	0.01 -3	0.171	0.000	0.	0.000	0.000	0.000	0.01 -3	0.174	0.000
50	0.000 -5	0.003	0.000	0.00 -3	0.171	0.000	0.	0.000	0.000	0.000	0.00 -3	0.174	0.000

Table 4.19 Parameters at 1.67 microns

Alt (km)	h	Rayleigh attn. coeff. (km ⁻¹)	Rayleigh optical thick. (0-h)	Rayleigh optical thick. (h-∞)	Aerosol atten. coeff. (km ⁻¹)	Aerosol optical thick. (0-h)	Aerosol optical thick. (h-∞)	Ozone absorp. coeff. (km ⁻¹)	Ozone optical thick. (0-h)	Ozone optical thick. (h-∞)	Ext. coeff. (km ⁻¹)	Ext. optical thick. (0-h)	Ext. optical thick. (h-∞)
		β_r	τ_r	τ_r'	β_p	τ_p	τ_p'	β_3	τ_3	τ_3'	β_{ext}	τ_{ext}	τ_{ext}'
0	0	1.422 -4	.000	.001	5.30 -2	.000	.055	0.	.000	.000	9.81 -2	.000	.156
1	1	1.199 -4	.000	.001	4.31 -2	.071	.084	0.	.000	.000	4.32 -2	.071	.085
2	2	1.085 -4	.000	.001	1.35 -2	.101	.054	0.	.000	.000	1.87 -2	.102	.054
3	3	6.710 -5	.000	.001	7.42 -3	.115	.040	0.	.000	.000	7.91 -3	.115	.041
4	4	3.841 -5	.000	.001	4.13 -3	.121	.034	0.	.000	.000	4.22 -3	.121	.035
5	5	7.968 -5	.001	.001	3.11 -3	.124	.031	0.	.000	.000	3.19 -3	.125	.031
6	6	7.122 -5	.001	.001	2.20 -3	.127	.028	0.	.000	.000	2.27 -3	.127	.029
7	7	5.365 -5	.001	.001	2.04 -3	.129	.026	0.	.000	.000	2.10 -3	.130	.026
8	8	5.075 -5	.001	.000	4.10 -3	.133	.024	0.	.000	.000	2.07 -3	.134	.024
9	9	4.472 -5	.001	.000	2.02 -3	.135	.022	0.	.000	.000	2.01 -3	.136	.022
10	10	4.472 -5	.001	.000	1.97 -3	.135	.020	0.	.000	.000	2.01 -3	.136	.020
11	11	3.375 -5	.001	.000	1.36 -3	.137	.018	0.	.000	.000	1.83 -3	.138	.018
12	12	3.367 -5	.001	.000	1.74 -3	.139	.016	0.	.000	.000	1.97 -3	.140	.016
13	13	2.875 -5	.001	.000	1.79 -3	.141	.014	0.	.000	.000	1.82 -3	.142	.014
14	14	2.459 -5	.001	.000	1.75 -3	.143	.012	0.	.000	.000	1.77 -3	.143	.011
15	15	2.101 -5	.001	.000	1.54 -3	.144	.011	0.	.000	.000	1.85 -3	.145	.011
16	16	1.736 -5	.001	.000	1.55 -3	.146	.009	0.	.000	.000	1.55 -3	.147	.009
17	17	1.535 -5	.001	.000	1.54 -3	.147	.008	0.	.000	.000	1.36 -3	.148	.008
18	18	1.313 -5	.001	.000	1.49 -3	.149	.006	0.	.000	.000	1.51 -3	.150	.006
19	19	1.122 -5	.001	.000	1.25 -3	.150	.005	0.	.000	.000	1.27 -3	.151	.005
20	20	6.534 -6	.001	.000	9.24 -4	.151	.004	0.	.000	.000	5.34 -4	.152	.004
21	21	6.194 -6	.001	.000	3.70 -4	.152	.003	0.	.000	.000	6.74 -4	.153	.003
22	22	6.581 -6	.001	.000	5.04 -4	.153	.002	0.	.000	.000	5.92 -4	.154	.002
23	23	5.935 -6	.001	.000	3.35 -4	.154	.001	0.	.000	.000	3.41 -4	.155	.001
24	24	5.074 -6	.001	.000	3.06 -4	.154	.001	0.	.000	.000	2.64 -4	.155	.001
25	25	4.325 -6	.001	.000	2.57 -4	.154	.001	0.	.000	.000	2.28 -4	.155	.001
26	26	3.576 -6	.001	.000	2.25 -4	.154	.001	0.	.000	.000	1.75 -4	.155	.001
27	27	3.131 -6	.001	.000	1.72 -4	.154	.001	0.	.000	.000	1.34 -4	.155	.001
28	28	2.705 -6	.001	.000	1.31 -4	.154	.000	0.	.000	.000	1.05 -4	.156	.000
29	29	2.317 -6	.001	.000	1.01 -4	.155	.000	0.	.000	.000	7.95 -5	.156	.000
30	30	1.835 -6	.001	.000	7.75 -5	.155	.000	0.	.000	.000	6.09 -5	.156	.000
31	31	1.705 -6	.001	.000	5.92 -5	.155	.000	0.	.000	.000	4.68 -5	.156	.000
32	32	1.454 -6	.001	.000	4.53 -5	.155	.000	0.	.000	.000	3.60 -5	.156	.000
33	33	1.246 -6	.001	.000	3.47 -5	.155	.000	0.	.000	.000	2.77 -5	.156	.000
34	34	1.077 -6	.001	.000	2.56 -5	.155	.000	0.	.000	.000	2.13 -5	.156	.000
35	35	9.132 -7	.001	.000	2.04 -5	.155	.000	0.	.000	.000	1.54 -5	.156	.000
36	36	7.831 -7	.001	.000	1.56 -5	.155	.000	0.	.000	.000	1.26 -5	.156	.000
37	37	6.728 -7	.001	.000	1.20 -5	.155	.000	0.	.000	.000	9.76 -6	.156	.000
38	38	5.790 -7	.001	.000	9.18 -6	.155	.000	0.	.000	.000	7.51 -6	.156	.000
39	39	4.932 -7	.001	.000	7.01 -6	.155	.000	0.	.000	.000	5.80 -6	.156	.000
40	40	4.311 -7	.001	.000	5.37 -6	.155	.000	0.	.000	.000	4.49 -6	.156	.000
41	41	3.729 -7	.001	.000	4.12 -6	.155	.000	0.	.000	.000	3.47 -6	.156	.000
42	42	3.231 -7	.001	.000	3.15 -6	.155	.000	0.	.000	.000	2.69 -6	.156	.000
43	43	2.804 -7	.001	.000	2.41 -6	.155	.000	0.	.000	.000	2.05 -6	.156	.000
44	44	2.437 -7	.001	.000	1.95 -6	.155	.000	0.	.000	.000	1.53 -6	.156	.000
45	45	2.122 -7	.001	.000	1.41 -6	.155	.000	0.	.000	.000	1.27 -6	.156	.000
46	46	1.849 -7	.001	.000	1.09 -6	.155	.000	0.	.000	.000	9.93 -7	.156	.000
47	47	1.615 -7	.001	.000	8.31 -7	.155	.000	0.	.000	.000	7.81 -7	.156	.000
48	48	1.421 -7	.001	.000	6.34 -7	.155	.000	0.	.000	.000	6.13 -7	.156	.000
49	49	1.258 -7	.001	.000	4.84 -7	.155	.000	0.	.000	.000	4.94 -7	.156	.000
50	50	1.131 -7	.001	.000	3.73 -7	.155	.000	0.	.000	.000	3.94 -7	.156	.000

Table 4.21 Parameters at 3.50 microns

Alt. (km)	Rayleigh atten. coeff. (km^{-1}) β_r	Rayleigh optical thick. (0-h) τ_r	Rayleigh optical thick. (h- ∞) τ_r'	Aerosol atten. coeff. (km^{-1}) β_p	Aerosol optical thick. (0-h) τ_p	Aerosol optical thick. (h- ∞) τ_p'	Ozone absorp. coeff. (km^{-1}) β_3	Ozone optical thick. (0-h) τ_3	Ozone optical thick. (h- ∞) τ_3'	Ext. coeff. (km^{-1}) β_{ext}	Ext. optical thick. (0-h) τ_{ext}	Ext. optical thick. (h- ∞) τ_{ext}'
0	6.929 -2	.000	.000	7.00 -2	.000	.111	0.	.000	.000	7.00 -2	.000	.111
1	6.137 -2	.000	.000	3.00 -2	.050	.060	0.	.000	.000	3.00 -2	.050	.060
2	5.511 -3	.000	.000	1.33 -2	.072	.038	0.	.000	.000	1.33 -2	.072	.038
3	5.053 -3	.000	.000	5.56 -3	.082	.029	0.	.000	.000	5.56 -3	.082	.029
4	4.533 -3	.000	.000	2.75 -3	.060	.025	0.	.000	.000	2.75 -3	.060	.025
5	4.105 -3	.000	.000	2.22 -3	.055	.022	0.	.000	.000	2.22 -3	.055	.022
6	3.520 -3	.000	.000	1.57 -3	.031	.020	0.	.000	.000	1.57 -3	.031	.020
7	3.287 -3	.000	.000	1.49 -3	.052	.019	0.	.000	.000	1.49 -3	.052	.019
8	2.931 -3	.000	.000	1.50 -3	.094	.017	0.	.000	.000	1.50 -3	.094	.017
9	2.635 -3	.000	.000	1.44 -3	.095	.016	0.	.000	.000	1.44 -3	.095	.016
10	2.335 -3	.000	.000	1.40 -3	.097	.014	0.	.000	.000	1.40 -3	.097	.014
11	2.034 -3	.000	.000	1.32 -3	.098	.013	0.	.000	.000	1.32 -3	.098	.013
12	1.735 -3	.000	.000	1.26 -3	.099	.011	0.	.000	.000	1.26 -3	.099	.011
13	1.480 -3	.000	.000	1.25 -3	1.01	.010	0.	.000	.000	1.25 -3	1.01	.010
14	1.270 -3	.000	.000	1.25 -3	1.02	.009	0.	.000	.000	1.25 -3	1.02	.009
15	1.085 -3	.000	.000	1.17 -3	1.03	.008	0.	.000	.000	1.17 -3	1.03	.008
16	9.231 -7	.000	.000	1.12 -3	1.04	.008	0.	.000	.000	1.12 -3	1.04	.008
17	7.933 -7	.000	.000	1.10 -3	1.05	.005	0.	.000	.000	1.10 -3	1.05	.005
18	6.782 -7	.000	.000	1.07 -3	1.06	.004	0.	.000	.000	1.07 -3	1.06	.004
19	5.793 -7	.000	.000	8.95 -4	1.07	.003	0.	.000	.000	8.95 -4	1.07	.003
20	4.957 -7	.000	.000	6.79 -4	1.03	.002	0.	.000	.000	6.79 -4	1.03	.002
21	4.221 -7	.000	.000	4.78 -4	1.05	.002	0.	.000	.000	4.78 -4	1.05	.002
22	3.530 -7	.000	.000	3.50 -4	1.05	.002	0.	.000	.000	3.50 -4	1.05	.002
23	3.053 -7	.000	.000	2.75 -4	1.05	.001	0.	.000	.000	2.75 -4	1.05	.001
24	2.617 -7	.000	.000	2.18 -4	1.10	.001	0.	.000	.000	2.18 -4	1.10	.001
25	2.235 -7	.000	.000	1.94 -4	1.10	.001	0.	.000	.000	1.94 -4	1.10	.001
26	1.910 -7	.000	.000	1.50 -4	1.10	.001	0.	.000	.000	1.50 -4	1.10	.001
27	1.633 -7	.000	.000	1.23 -4	1.11	.000	0.	.000	.000	1.23 -4	1.11	.000
28	1.398 -7	.000	.000	9.35 -5	1.10	.000	0.	.000	.000	9.35 -5	1.10	.000
29	1.197 -7	.000	.000	7.22 -5	1.10	.000	0.	.000	.000	7.22 -5	1.10	.000
30	1.025 -7	.000	.000	5.54 -5	1.10	.000	0.	.000	.000	5.54 -5	1.10	.000
31	9.904 -8	.000	.000	4.23 -5	1.10	.000	0.	.000	.000	4.23 -5	1.10	.000
32	7.557 -8	.000	.000	3.24 -5	1.11	.000	0.	.000	.000	3.24 -5	1.11	.000
33	6.452 -8	.000	.000	2.48 -5	1.11	.000	0.	.000	.000	2.48 -5	1.11	.000
34	5.512 -8	.000	.000	1.90 -5	1.11	.000	0.	.000	.000	1.90 -5	1.11	.000
35	4.718 -8	.000	.000	1.46 -5	1.11	.000	0.	.000	.000	1.46 -5	1.11	.000
36	4.046 -8	.000	.000	1.12 -5	1.11	.000	0.	.000	.000	1.12 -5	1.11	.000
37	3.475 -8	.000	.000	8.55 -5	1.11	.000	0.	.000	.000	8.55 -5	1.11	.000
38	2.992 -8	.000	.000	6.55 -5	1.11	.000	0.	.000	.000	6.55 -5	1.11	.000
39	2.579 -8	.000	.000	5.01 -5	1.11	.000	0.	.000	.000	5.01 -5	1.11	.000
40	2.228 -8	.000	.000	3.84 -5	1.11	.000	0.	.000	.000	3.84 -5	1.11	.000
41	1.927 -8	.000	.000	2.94 -5	1.11	.000	0.	.000	.000	2.94 -5	1.11	.000
42	1.673 -8	.000	.000	2.25 -5	1.11	.000	0.	.000	.000	2.25 -5	1.11	.000
43	1.464 -8	.000	.000	1.72 -5	1.11	.000	0.	.000	.000	1.72 -5	1.11	.000
44	1.259 -8	.000	.000	1.32 -5	1.11	.000	0.	.000	.000	1.32 -5	1.11	.000
45	1.095 -8	.000	.000	1.01 -5	1.11	.000	0.	.000	.000	1.01 -5	1.11	.000
46	9.555 -8	.000	.000	7.75 -7	1.11	.000	0.	.000	.000	7.75 -7	1.11	.000
47	8.343 -8	.000	.000	5.94 -7	1.11	.000	0.	.000	.000	5.94 -7	1.11	.000
48	7.343 -8	.000	.000	4.59 -7	1.11	.000	0.	.000	.000	4.59 -7	1.11	.000
49	6.634 -8	.000	.000	3.45 -7	1.11	.000	0.	.000	.000	3.45 -7	1.11	.000
50	5.723 -8	.000	.000	2.57 -7	1.11	.000	0.	.000	.000	2.57 -7	1.11	.000

Table 4.22 Parameters at 4.00 microns

Alt. (km)	h	Rayleigh atten. coeff. (km^{-1})	Rayleigh optical thick. (0-h)	Rayleigh optical thick. ($h-\infty$)	Rayleigh τ_r	Aerosol atten. coeff. (km^{-1})	Aerosol β_p	Aerosol optical thick. (0-h)	Aerosol optical thick. ($h-\infty$)	Ozone absorp. coeff. (km^{-1})	Ozone β_3	Ozone optical thick. (0-h)	Ozone optical thick. ($h-\infty$)	Ext. coeff. (km^{-1})	Ext. optical thick. (0-h)	Ext. optical thick. ($h-\infty$)
		β_r	τ_r	τ_r	β_p	τ_p	τ_p	τ_p	τ_p	β_3	τ_3	τ_3	τ_3	β_{ext}	τ_{ext}	τ_{ext}
0	0	4.002	-5	-0.00	-0.00	6.43	-2	-0.00	-0.00	0	0	-0.00	-0.00	6.43	-2	-0.00
1	1	3.532	-6	-0.00	-0.00	2.77	-2	-0.05	-0.05	0	0	-0.00	-0.00	2.77	-2	-0.05
2	2	3.283	-5	-0.00	-0.00	1.20	-2	-0.05	-0.05	0	0	-0.00	-0.00	1.20	-2	-0.05
3	3	2.971	-0	-0.00	-0.00	5.02	-3	-0.74	-0.26	0	0	-0.00	-0.00	5.02	-3	-0.74
4	4	2.677	-6	-0.00	-0.00	2.55	-3	-0.78	-0.22	0	0	-0.00	-0.00	2.55	-3	-0.78
5	5	2.458	-5	-0.00	-0.00	2.50	-3	-0.80	-0.20	0	0	-0.00	-0.00	2.50	-3	-0.80
6	6	2.157	-6	-0.00	-0.00	1.41	-3	-0.82	-0.18	0	0	-0.00	-0.00	1.41	-3	-0.82
7	7	1.923	-6	-0.00	-0.00	1.31	-3	-0.83	-0.17	0	0	-0.00	-0.00	1.31	-3	-0.83
8	8	1.713	-6	-0.00	-0.00	1.35	-3	-0.84	-0.15	0	0	-0.00	-0.00	1.35	-3	-0.84
9	9	1.528	-6	-0.00	-0.00	1.30	-3	-0.85	-0.14	0	0	-0.00	-0.00	1.30	-3	-0.85
10	10	1.351	-6	-0.00	-0.00	1.25	-3	-0.87	-0.13	0	0	-0.00	-0.00	1.25	-3	-0.87
11	11	1.192	-5	-0.00	-0.00	1.18	-3	-0.88	-0.12	0	0	-0.00	-0.00	1.18	-3	-0.88
12	12	1.013	-6	-0.00	-0.00	1.24	-3	-0.89	-0.10	0	0	-0.00	-0.00	1.24	-3	-0.89
13	13	8.710	-7	-0.00	-0.00	1.15	-3	-0.90	-0.09	0	0	-0.00	-0.00	1.15	-3	-0.90
14	14	7.445	-7	-0.00	-0.00	1.12	-3	-0.92	-0.08	0	0	-0.00	-0.00	1.12	-3	-0.92
15	15	6.363	-7	-0.00	-0.00	1.06	-3	-0.93	-0.07	0	0	-0.00	-0.00	1.06	-3	-0.93
16	16	5.433	-7	-0.00	-0.00	1.00	-3	-0.94	-0.06	0	0	-0.00	-0.00	1.00	-3	-0.94
17	17	4.653	-7	-0.00	-0.00	9.35	-4	-0.95	-0.05	0	0	-0.00	-0.00	9.35	-4	-0.95
18	18	3.974	-7	-0.00	-0.00	8.51	-4	-0.95	-0.04	0	0	-0.00	-0.00	8.51	-4	-0.95
19	19	3.393	-7	-0.00	-0.00	8.05	-4	-0.97	-0.03	0	0	-0.00	-0.00	8.05	-4	-0.97
20	20	2.905	-7	-0.00	-0.00	5.34	-4	-0.97	-0.02	0	0	-0.00	-0.00	5.34	-4	-0.97
21	21	2.474	-7	-0.00	-0.00	4.34	-4	-0.96	-0.02	0	0	-0.00	-0.00	4.34	-4	-0.96
22	22	2.108	-7	-0.00	-0.00	3.24	-4	-0.98	-0.01	0	0	-0.00	-0.00	3.24	-4	-0.98
23	23	1.787	-7	-0.00	-0.00	2.54	-4	-0.98	-0.01	0	0	-0.00	-0.00	2.54	-4	-0.98
24	24	1.534	-7	-0.00	-0.00	1.97	-4	-0.99	-0.01	0	0	-0.00	-0.00	1.97	-4	-0.99
25	25	1.310	-7	-0.00	-0.00	1.55	-4	-0.99	-0.01	0	0	-0.00	-0.00	1.55	-4	-0.99
26	26	1.113	-7	-0.00	-0.00	1.44	-4	-0.99	-0.01	0	0	-0.00	-0.00	1.44	-4	-0.99
27	27	9.572	-3	-0.00	-0.00	1.10	-4	-0.99	-0.00	0	0	-0.00	-0.00	1.10	-4	-0.99
28	28	8.193	-3	-0.00	-0.00	9.45	-5	-0.95	-0.00	0	0	-0.00	-0.00	9.45	-5	-0.95
29	29	7.017	-3	-0.00	-0.00	6.50	-5	-0.99	-0.00	0	0	-0.00	-0.00	6.50	-5	-0.99
30	30	6.015	-3	-0.00	-0.00	4.35	-5	-0.99	-0.00	0	0	-0.00	-0.00	4.35	-5	-0.99
31	31	5.134	-3	-0.00	-0.00	3.81	-5	-0.99	-0.00	0	0	-0.00	-0.00	3.81	-5	-0.99
32	32	4.429	-0	-0.00	-0.00	2.91	-5	-0.99	-0.00	0	0	-0.00	-0.00	2.91	-5	-0.99
33	33	3.731	-0	-0.00	-0.00	2.23	-5	-1.00	-0.00	0	0	-0.00	-0.00	2.23	-5	-1.00
34	34	3.240	-3	-0.00	-0.00	1.71	-5	-1.00	-0.00	0	0	-0.00	-0.00	1.71	-5	-1.00
35	35	2.755	-2	-0.00	-0.00	1.31	-5	-1.00	-0.00	0	0	-0.00	-0.00	1.31	-5	-1.00
36	36	2.371	-3	-0.00	-0.00	1.00	-5	-1.00	-0.00	0	0	-0.00	-0.00	1.00	-5	-1.00
37	37	2.037	-3	-0.00	-0.00	7.70	-6	-1.00	-0.00	0	0	-0.00	-0.00	7.70	-6	-1.00
38	38	1.753	-3	-0.00	-0.00	5.30	-6	-1.00	-0.00	0	0	-0.00	-0.00	5.30	-6	-1.00
39	39	1.512	-3	-0.00	-0.00	4.51	-6	-1.00	-0.00	0	0	-0.00	-0.00	4.51	-6	-1.00
40	40	1.305	-3	-0.00	-0.00	3.35	-6	-1.00	-0.00	0	0	-0.00	-0.00	3.35	-6	-1.00
41	41	1.123	-7	-0.00	-0.00	2.55	-6	-1.00	-0.00	0	0	-0.00	-0.00	2.55	-6	-1.00
42	42	9.784	-7	-0.00	-0.00	2.33	-6	-1.00	-0.00	0	0	-0.00	-0.00	2.33	-6	-1.00
43	43	8.471	-3	-0.00	-0.00	1.55	-6	-1.00	-0.00	0	0	-0.00	-0.00	1.55	-6	-1.00
44	44	7.360	-3	-0.00	-0.00	1.15	-6	-1.00	-0.00	0	0	-0.00	-0.00	1.15	-6	-1.00
45	45	6.424	-3	-0.00	-0.00	3.07	-7	-1.00	-0.00	0	0	-0.00	-0.00	3.07	-7	-1.00
46	46	5.600	-3	-0.00	-0.00	5.94	-7	-1.00	-0.00	0	0	-0.00	-0.00	5.94	-7	-1.00
47	47	4.889	-3	-0.00	-0.00	5.34	-7	-1.00	-0.00	0	0	-0.00	-0.00	5.34	-7	-1.00
48	48	4.302	-0	-0.00	-0.00	4.11	-7	-1.00	-0.00	0	0	-0.00	-0.00	4.11	-7	-1.00
49	49	3.773	-3	-0.00	-0.00	3.13	-7	-1.00	-0.00	0	0	-0.00	-0.00	3.13	-7	-1.00
50	50	3.355	-4	-0.00	-0.00	2.40	-7	-1.00	-0.00	0	0	-0.00	-0.00	2.40	-7	-1.00

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13. ABSTRACT An atmospheric attenuation model for the ultraviolet, visible, and infrared was developed in 1964, based on scattering (molecules and aerosols) and ozone absorption. Since then more measurements have been made and our knowledge of aerosol attenuation has widened. These circumstances result in attenuation model changes which are relatively unimportant for most exploratory calculations. They can be significant, however, for long slant-path high-altitude applications entailing large zenith angles, factors which characterize, for example, the measurement geometries of rockets and satellites. Accordingly, a revision of the 1964 Attenuation Model is warranted. In this paper the optical parameters are computed spectrally and with altitude as follows: (1) pure air attenuation parameters are determined by utilizing Rayleigh scattering cross sections with molecular number densities from the standard atmosphere; (2) ozone absorption parameters are derived based on Vigroux's coefficients applied to a representative atmospheric ozone distribution; (3) seven sets of aerosol measurements are compared and a profile of aerosol attenuation coefficients vs altitude is developed. Attenuation coefficients and optical thickness due to molecular, aerosol, and ozone attenuation are computed and tabulated individually so that the influence of each can be compared. The newly derived tabulations permit various exploratory calculations, including horizontal, vertical, and slant-path transmission at kilometer intervals to an altitude of 50 km, individually for each attenuating component or for overall atmospheric extinction (molecular + ozone + aerosol).		

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