AA Technical Memorandum ERL WPL-174

LIDAR OBSERVATIONS OF STRATOSPHERIC AEROSOLS IN 1988 AT BOULDER, COLORADO

W. L. Eberhard
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Wave Propagation Laboratory
Boulder, Colorado
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Contents

LIDAR OBSERVATIONS OF STRATOSPHERIC AEROSOLS IN 1988 AT BOULDER, COLORADO

W. L. Eberhard and G. T. McNice

ABSTRACT

Profiles of aerosol scattering ratio measured by ruby lidar at Boulder, Colorado, during 1988 are presented. The 21 profiles were obtained during the fourth year of a continuing program. The aerosol scattering ratio in 1988 was substantially less than in any of the three previous years, continuing a trend toward a "cleaner" stratosphere. The peak in the annual-average profile was only 1.26 and was located at 20 km MSL.

1. INTRODUCTION

The Wave Propagation Laboratory began a program of regular observations of the profile of stratospheric aerosol at Boulder, Colorado, in October 1984. These measurements continue to be performed in cooperation with the Geophysical Monitoring for Climatic Change (GMCC) Division of the National Oceanic and Atmospheric Administration (NOAA), principally in support of aerosol attenuation corrections to Umkehr ozone measurements from Dobson meters. Zhou et al. (1989) reported data for 1985-1987. The 21 profiles obtained in 1988 are reported here.

2. EXPERIMENT AND ANALYSIS PROCEDURES

A ruby lidar operating at 694.3-nm wavelength obtained the profiles of backscatter while pointed at zenith. The lidar system was described by Eberhard and McNice (1986). Data acquisition procedures and a brief description of the lidar were given by Zhou et al. (1989). The site of the lidar was at 39.9° N, 105.3° W, and 1.68 km MSL.

Data were processed in a manner identical to the processing described by Zhou et al. (1989) and used for previous years in this data set. Profiles are given in terms of scattering ratio R(z), defined as

$$R(z) = \frac{B_A(z) + B_M(z)}{B_M(z)}, \qquad (1)$$

where z is the altitude (MSL), and B_A and B_M are the aerosol and molecular backscattering coefficients, respectively. The profile of molecular density given by Toolin (1965) was used to correct for attenuation by the atmospheric gases and to determine B_M. The calibration was obtained using the standard procedure (Russell et al., 1979) of examining the attenuation-corrected profile for a region where aerosol concentrations were at a minimum, and by assigning an assumed, small value to B_A at this height. Based on experience with many profiles, and to be consistent with the value used for the lidar at GMCC's Mauna Loa facility, we used R = 1.03 for the calibration reference.

In the graphs of individual profiles R(z) (Appendix A), only data from 10 to 28 km MSL are displayed for uniformity. More complete data are available from the tabulations in Appendix B, which include the model molecular profile B_M and the measured aerosol profile B_A. These tables also show the aerosol optical depth above each height. The optical depth was calculated by integrating B_A downward from the top of the profile and multiplying by an extinction-to-backscatter ratio of 50 sr. This value was assigned by the project sponsor, based on information from a wide variety of sources. Each table heading contains additional details, including the heights selected for calibration and for fixing the baseline.

At least one successful measurement was made each month in 1988 except June. Extra measurements were performed in August during extensive forest fires at Yellowstone National Park about 700 km to the northwest. The aim was more to document effects on tropospheric haziness than to observe a significant change in stratospheric aerosol loading, which was not anticipated.

3. DISCUSSION OF MEASUREMENTS

The annual-average profiles of R(z) for 1985-1988 are shown in Fig. 1. The profiles in each average were weighted by the approximate time between the preceding and following measurements. The sharp increase in the 1988 profile going downward from 11 to 10 km MSL is simply a result of including scatter from cirrus layers from the 24 March and 14 November profiles. This kind of contamination was removed from the averages for previous years. A yearly decrease in the amount of stratospheric aerosol signal (above 12 km) is very evident.

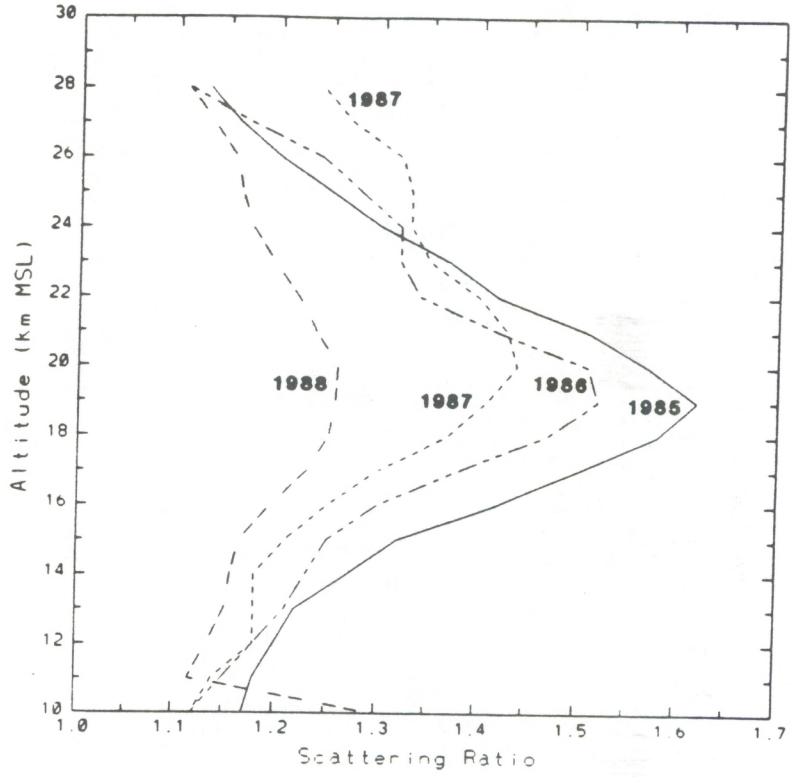

Fig. 1. Profiles of annual-mean scattering ratio R(z) at Boulder, Colorado, for 1985-1988.

The decrease in scattering ratio at heights below 16 km was quite consistent from year to year. Above 23 km MSL, where the trend in previous years was toward greater scattering, the scattering ratio for 1988 fell far below that in any of the three earlier years. Within the few kilometers below the height of the peak, the scattering ratio declined each year, but it declined by a greater amount in 1988.

The trend in peak scattering ratio (Fig. 2) was toward smaller values each year. Temporary increases near the summer of 1986, 1987, and 1988 are obvious in the time series. It should be noted that the timing shifted from early to late summer over the course of the three years.

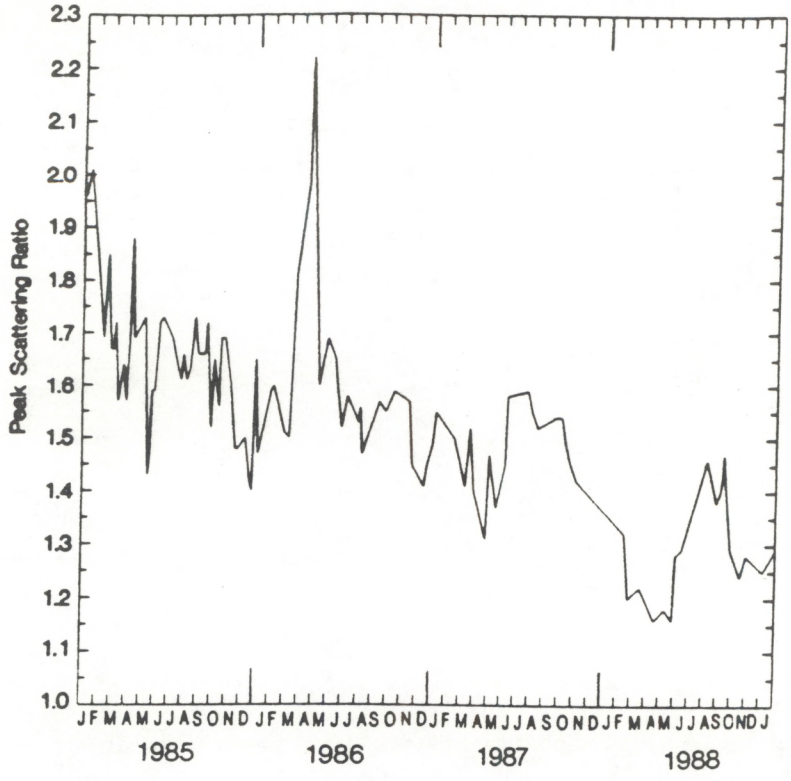

Fig. 2. Time variation of peak scattering ratio from January 1985 to December 1988.

The larger values of peak scattering ratio in mid-1988 were not at just a narrow height interval; the scattering ratios during this period were in general larger throughout the 14-28 km range of heights. The increase in 1988 was probably not connected with the Yellowstone fires, because the fires began after the increase was first observed.

The altitude of the peak scattering ratio (Fig. 3) shifted downward in 1988, after undergoing a slight upward trend from 1984 through 1987.

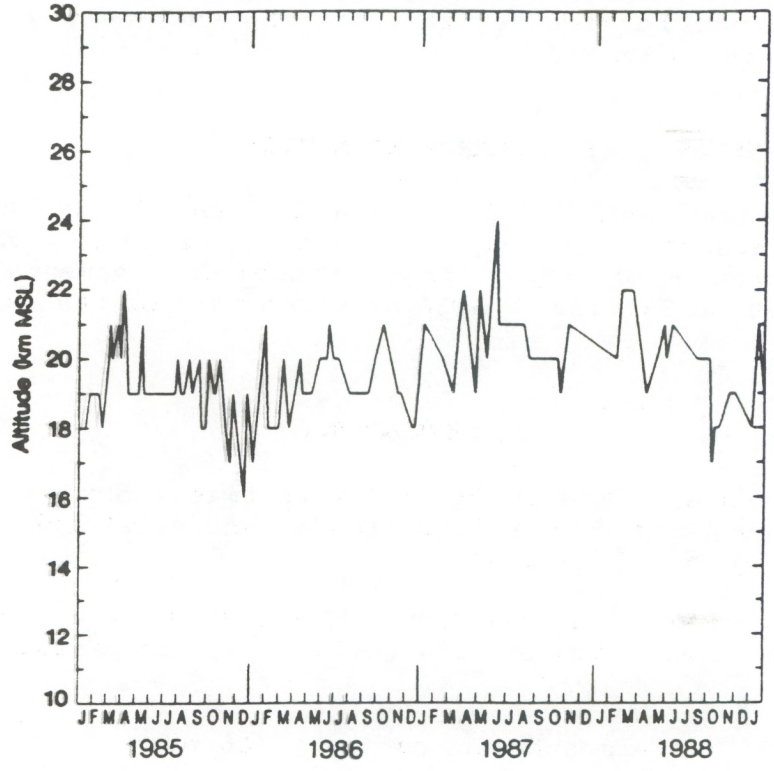

Fig. 3. Time variation of heights where peak scattering ratio values in Fig. 2 occurred.

The most important difference in 1988 compared with the preceding three years was a smaller scattering ratio at all heights between 11 and 28 km. However, the data in Fig. 2 and Appendix A suggest that the decline may have halted during 1988.

4. SUMMARY

The measurements of stratospheric aerosol backscatter in 1988 at Boulder, Colorado, showed a substantial change toward a cleaner stratosphere, compared with the three previous years. The change was most dramatic above about 23 km MSL, where a decrease in the backscatter ratio reversed an earlier trend of increasing backscatter ratio. The peak value of aerosol backscatter ratio in the 1988-average profile was 1.26 at a height of 20 km MSL.

5. ACKNOWLEDGMENTS

We express gratitude to J. J. DeLuisi and R. M. Hardesty for providing encouragement and support for this project. A. Weickmann assisted in preparation of graphs. The National Environmental Satellite, Data, and Information Service of NOAA provided part of the funds for this work.

6. REFERENCES

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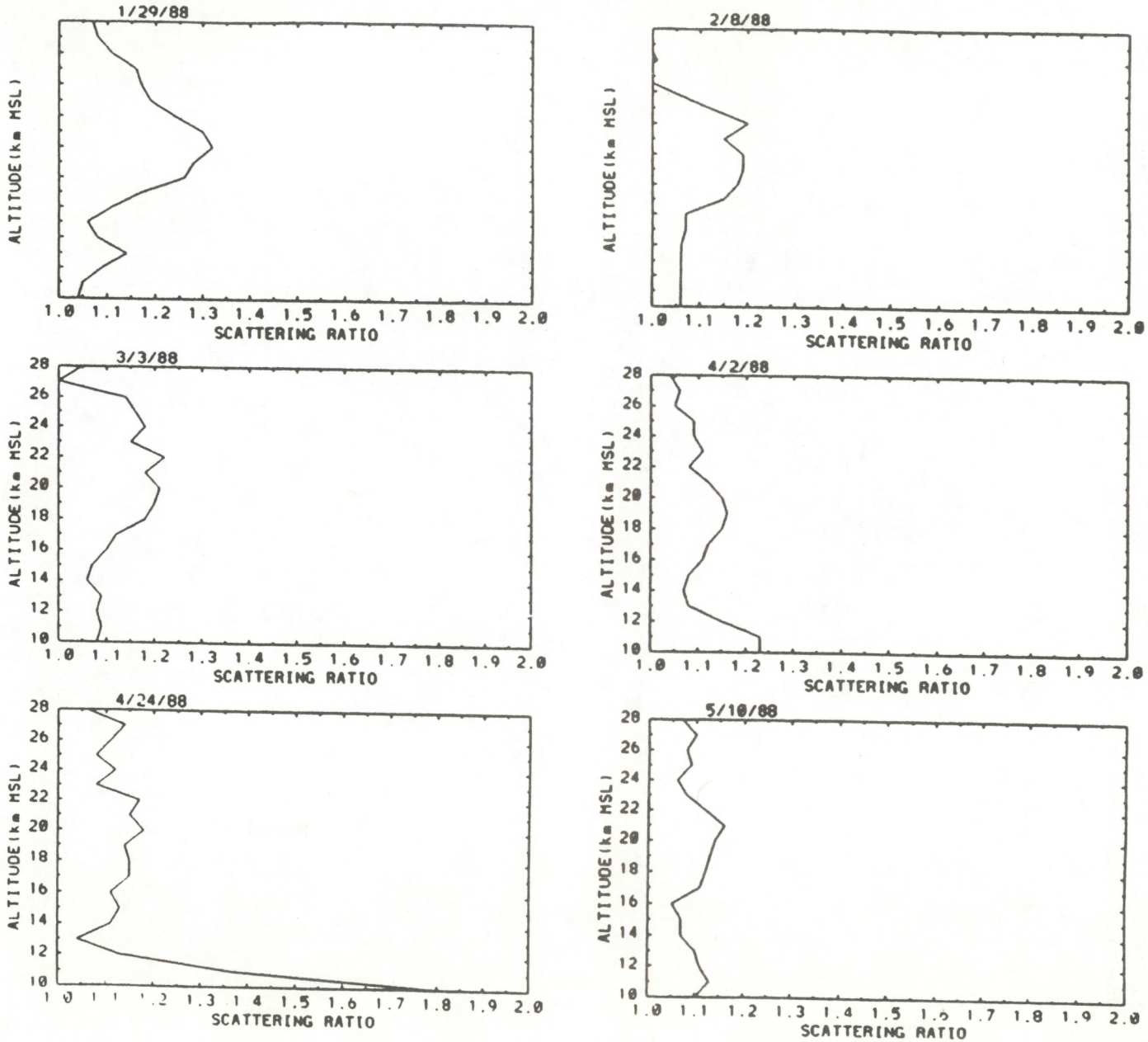
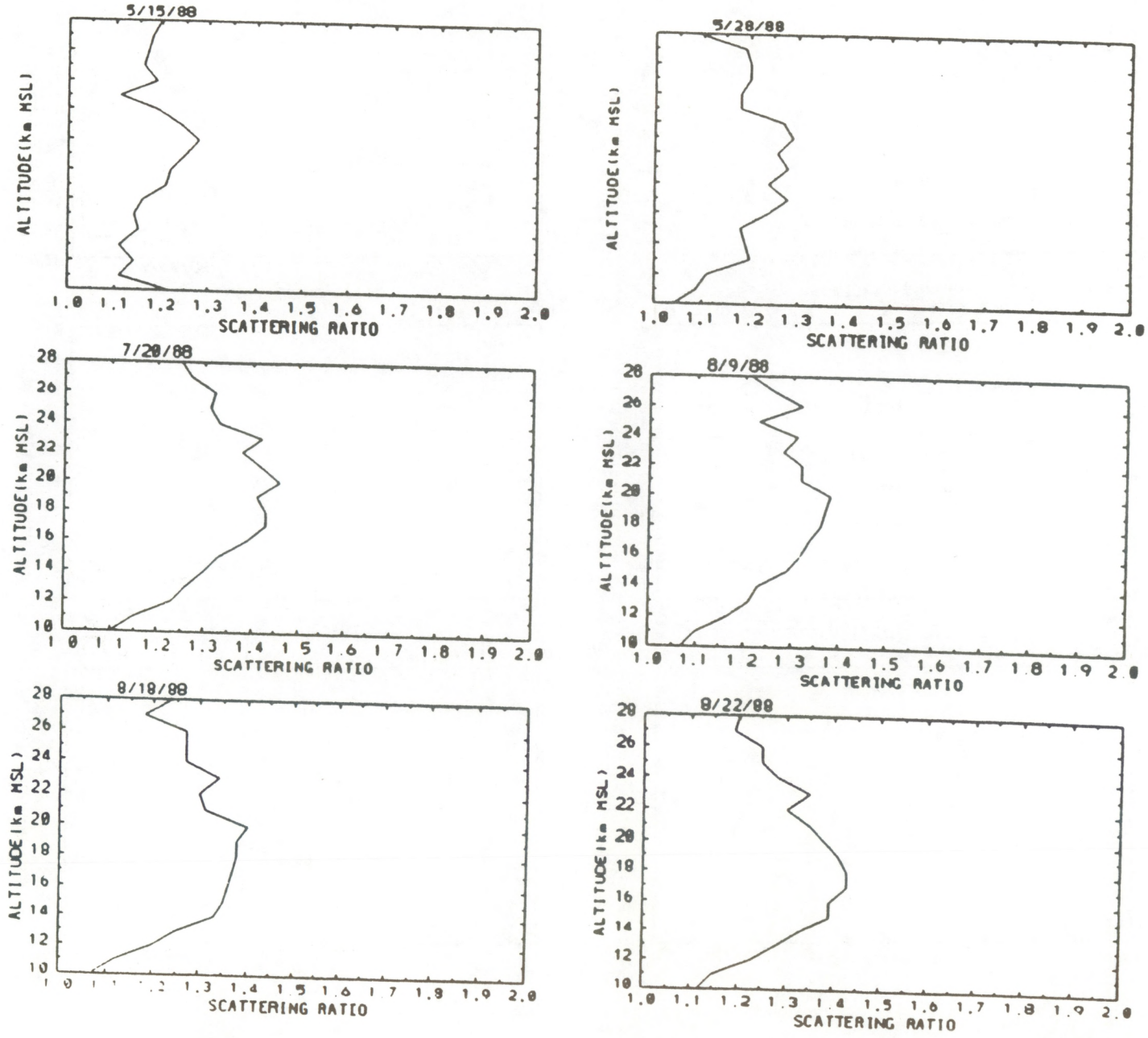
Russell, P.G., T.J. Swissler, and M.P. McCormick, 1979: Methodology for error analysis and simulation of lidar aerosol measurements. Appl. Opt., 18, 3783-3797.

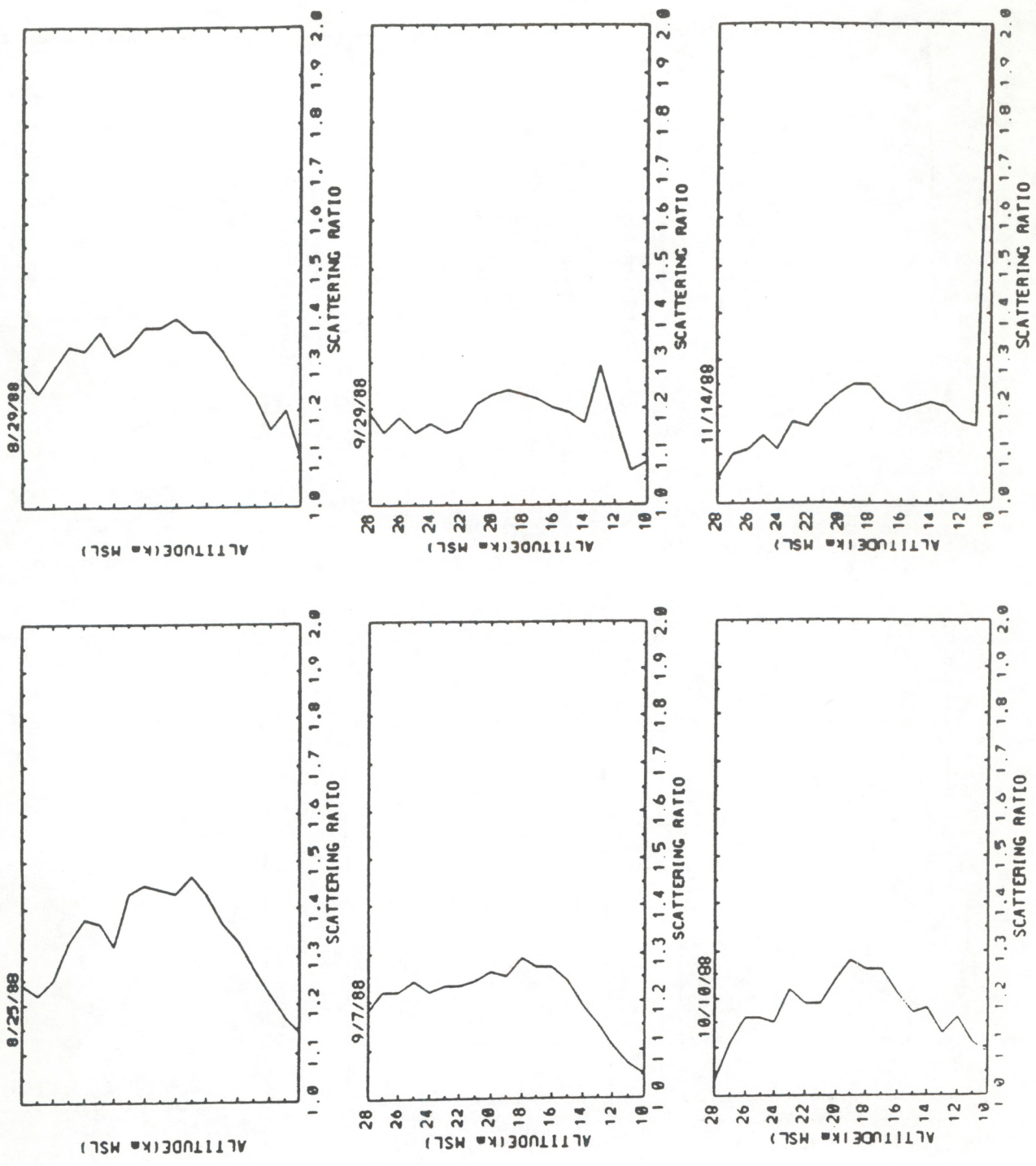
Toolin, R.B., 1965: Atmospheric optics. Chapter 7 of Handbook of Geophysics and Space Environments, S.L. Valley, ed., Air Force Cambridge Research Laboratory, Bedford, Massachusetts.

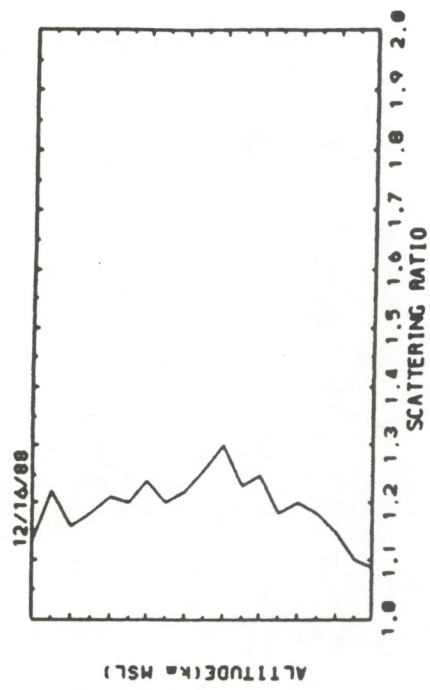
Zhou, Jun, G.T. McNice, and W.L. Eberhard, 1989: Lidar observations of the stratospheric aerosol: Boulder, Colorado, 1985 to 1987. NOAA Technical Memorandum ERL WPL-162, Environmental Research Laboratories, Boulder, Colorado, 50 pp.

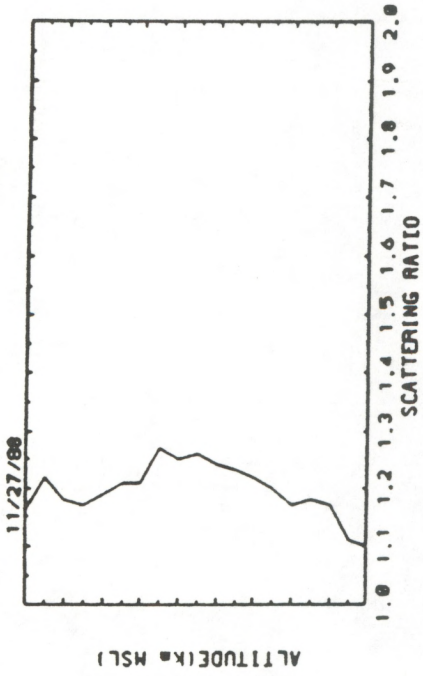
APPENDIX A: Graphs of aerosol scattering ratio profiles during 1988 at Boulder, Colorado.

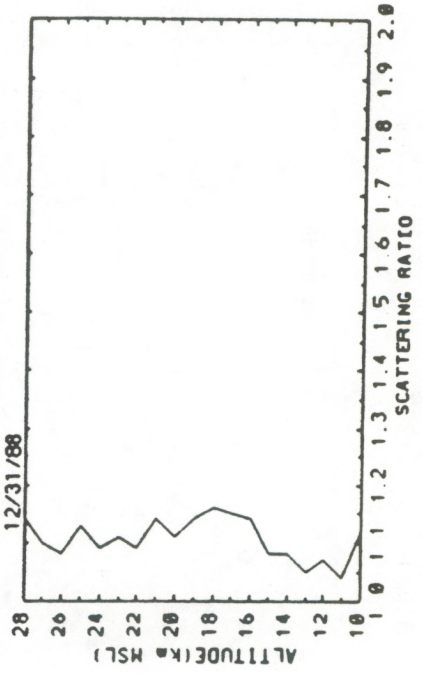

1/29/88
2/8/88
3/3/88
4/2/88
4/24/88
5/10/88
ALTITUDE(km MSL)
SCATTERING RATIO
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
10 12 14 16 18 20 22 24 26 28


5/15/88
5/20/88
7/20/88
8/9/88
8/18/88
8/22/88
ALTITUDE(km MSL)
SCATTERING RATIO
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
10 12 14 16 18 20 22 24 26 28


8/29/88
9/29/88
11/14/88
8/25/88
9/7/88
10/10/88
SCATTERING RATIO
ALTITUDE(K= MSL)


12/16/88
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
SCATTERING RATIO
ALTITUDE(K= MSL)


11/27/88
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
SCATTERING RATIO
ALTITUDE(K= MSL)


12/31/88
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0
SCATTERING RATIO
28 26 24 22 20 18 16 14 12 10
ALTITUDE(K= MSL)

APPENDIX B: Tables of aerosol scattering profiles. Data tabulations of aerosol backscatter coefficient $B_A(z)$, model Rayleigh backscatter coefficient $B_M(z)$, scattering ratio $R(z)$, and aerosol optical depth integrated downward from the top of the profile (assuming an extinction-to-backscatter ratio of 50 sr).

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 1/29/88 (DAY 29)
TIME: 18:16 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 201
CALIBRATION:
RANGE: 7.0KM TO 7.0KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 33.2KM TO 36.3KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
34.0	.129E-06	.421E-05	1.03	.140E-05
33.0	-.739E-07	.492E-05	.98	.916E-05
32.0	.741E-06	.578E-05	1.13	.259E-04
31.0	-.281E-06	.673E-05	.96	.336E-04
30.0	-.165E-06	.783E-05	.98	.373E-04
29.0	-.417E-06	.916E-05	.95	.187E-04
28.0	.698E-06	.107E-04	1.07	.360E-04
27.0	.103E-05	.125E-04	1.08	.648E-04
26.0	.165E-05	.146E-04	1.11	.124E-03
25.0	.267E-05	.171E-04	1.16	.238E-03
24.0	.330E-05	.200E-04	1.17	.388E-03
23.0	.447E-05	.235E-04	1.19	.574E-03
22.0	.655E-05	.275E-04	1.24	.832E-03
21.0	.979E-05	.322E-04	1.30	.121E-02
20.0	.120E-04	.379E-04	1.32	.176E-02
19.0	.123E-04	.443E-04	1.28	.233E-02
18.0	.133E-04	.518E-04	1.26	.305E-02
17.0	.104E-04	.607E-04	1.17	.366E-02
16.0	.772E-05	.709E-04	1.11	.412E-02
15.0	.521E-05	.828E-04	1.06	.442E-02
14.0	.818E-05	.973E-04	1.08	.474E-02
13.0	.154E-04	.114E-03	1.14	.533E-02
12.0	.126E-04	.133E-03	1.09	.603E-02
11.0	.742E-05	.156E-03	1.05	.654E-02
10.0	.774E-05	.176E-03	1.04	.693E-02
9.0	.130E-04	.199E-03	1.07	.744E-02
8.0	.136E-04	.224E-03	1.06	.808E-02
7.0	.754E-05	.251E-03	1.03	.861E-02
6.0	.346E-04	.281E-03	1.12	.948E-02
5.0	.407E-04	.314E-03	1.13	.116E-01
4.0	.104E-04	.349E-03	1.03	.127E-01
3.0	.495E-04	.387E-03	1.13	.138E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 2/ 8/88 (DAY 39)
TIME: 19:19 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 101
CALIBRATION:
RANGE: 12.6KM TO 12.6KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 26.6KM TO 28.9KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
28.0	-.185E-06	.107E-04	.98	.332E-04
27.0	-.117E-06	.125E-04	.99	.399E-04
26.0	.183E-06	.146E-04	1.01	.600E-04
25.0	-.481E-06	.171E-04	.97	.726E-04
24.0	.779E-06	.200E-04	1.04	.884E-04
23.0	.271E-05	.234E-04	1.12	.165E-03
22.0	.558E-05	.275E-04	1.20	.387E-03
21.0	.486E-05	.322E-04	1.15	.676E-03
20.0	.710E-05	.378E-04	1.19	.102E-02
19.0	.855E-05	.443E-04	1.19	.141E-02
18.0	.949E-05	.518E-04	1.18	.186E-02
17.0	.934E-05	.606E-04	1.15	.233E-02
16.0	.490E-05	.709E-04	1.07	.266E-02
15.0	.596E-05	.828E-04	1.07	.292E-02
14.0	.552E-05	.970E-04	1.06	.326E-02
13.0	.729E-05	.114E-03	1.06	.357E-02
12.0	.816E-05	.133E-03	1.06	.387E-02
11.0	.931E-05	.155E-03	1.06	.442E-02
10.0	.110E-04	.176E-03	1.06	.490E-02
9.0	.178E-04	.199E-03	1.09	.560E-02
8.0	.362E-04	.224E-03	1.16	.666E-02
7.0	.417E-04	.251E-03	1.17	.869E-02
6.0	.265E-04	.281E-03	1.09	.103E-01
5.0	.430E-04	.313E-03	1.14	.121E-01
4.0	.731E-04	.349E-03	1.21	.146E-01
3.0	.728E-04	.387E-03	1.19	.184E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 3/ 3/88 (DAY 63)
TIME: 21:08 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 201
CALIBRATION:
RANGE: 2.7KM TO 2.7KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 28.7KM TO 30.7KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
30.0	.462E-06	.783E-05	1.06	.861E-05
29.0	.850E-06	.916E-05	1.09	.271E-04
28.0	.559E-06	.107E-04	1.05	.727E-04
27.0	-.565E-07	.125E-04	1.00	.102E-03
26.0	.202E-05	.146E-04	1.14	.167E-03
25.0	.280E-05	.171E-04	1.16	.300E-03
24.0	.367E-05	.200E-04	1.18	.455E-03
23.0	.346E-05	.235E-04	1.15	.628E-03
22.0	.609E-05	.275E-04	1.22	.830E-03
21.0	.570E-05	.322E-04	1.18	.117E-02
20.0	.783E-05	.379E-04	1.21	.150E-02
19.0	.880E-05	.443E-04	1.20	.192E-02
18.0	.918E-05	.518E-04	1.18	.241E-02
17.0	.701E-05	.607E-04	1.12	.286E-02
16.0	.712E-05	.709E-04	1.10	.322E-02
15.0	.567E-05	.828E-04	1.07	.352E-02
14.0	.582E-05	.972E-04	1.06	.386E-02
13.0	.106E-04	.114E-03	1.09	.422E-02
12.0	.109E-04	.133E-03	1.08	.472E-02
11.0	.133E-04	.156E-03	1.09	.532E-02
10.0	.148E-04	.176E-03	1.08	.592E-02
9.0	.173E-04	.199E-03	1.09	.675E-02
8.0	.374E-04	.224E-03	1.17	.808E-02
7.0	.165E-03	.251E-03	1.65	.118E-01
6.0	.152E-03	.281E-03	1.54	.199E-01
5.0	.107E-03	.314E-03	1.34	.266E-01
4.0	.831E-04	.349E-03	1.24	.308E-01
3.0	.299E-04	.387E-03	1.08	.337E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 4/ 2/88 (DAY 93)
TIME: 20:19 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 201
CALIBRATION:
RANGE: 8.7KM TO 8.7KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 28.0KM TO 28.9KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
28.0	.414E-06	.107E-04	1.04	.156E-04
27.0	.696E-06	.125E-04	1.06	.380E-04
26.0	.783E-06	.146E-04	1.05	.708E-04
25.0	.153E-05	.171E-04	1.09	.120E-03
24.0	.187E-05	.200E-04	1.09	.202E-03
23.0	.267E-05	.234E-04	1.11	.300E-03
22.0	.232E-05	.275E-04	1.08	.398E-03
21.0	.401E-05	.322E-04	1.12	.570E-03
20.0	.573E-05	.378E-04	1.15	.826E-03
19.0	.700E-05	.443E-04	1.16	.113E-02
18.0	.757E-05	.518E-04	1.15	.149E-02
17.0	.747E-05	.606E-04	1.12	.190E-02
16.0	.804E-05	.709E-04	1.11	.224E-02
15.0	.667E-05	.828E-04	1.08	.262E-02
14.0	.631E-05	.970E-04	1.07	.298E-02
13.0	.948E-05	.114E-03	1.08	.334E-02
12.0	.196E-04	.133E-03	1.15	.398E-02
11.0	.364E-04	.155E-03	1.23	.528E-02
10.0	.274E-04	.176E-03	1.16	.724E-02
9.0	.739E-05	.199E-03	1.04	.813E-02
8.0	.461E-04	.224E-03	1.21	.906E-02
7.0	.645E-04	.251E-03	1.26	.109E-01
6.0	.833E-04	.281E-03	1.30	.149E-01
5.0	.549E-04	.313E-03	1.18	.179E-01
4.0	.115E-03	.349E-03	1.33	.222E-01
3.0	.118E-03	.387E-03	1.31	.285E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 4/24/88 (DAY 115)
TIME: 20:01 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 201
CALIBRATION:
RANGE: 12.9KM TO 12.9KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 28.7KM TO 31.3KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
31.0	.125E-07	.673E-05	1.00	.341E-05
30.0	-.138E-06	.783E-05	.98	.107E-04
29.0	.804E-07	.916E-05	1.01	.256E-04
28.0	.614E-06	.107E-04	1.06	.516E-04
27.0	.172E-05	.125E-04	1.14	.105E-03
26.0	.155E-05	.146E-04	1.11	.171E-03
25.0	.137E-05	.171E-04	1.08	.242E-03
24.0	.232E-05	.200E-04	1.12	.362E-03
23.0	.197E-05	.235E-04	1.08	.461E-03
22.0	.474E-05	.275E-04	1.17	.603E-03
21.0	.493E-05	.322E-04	1.15	.844E-03
20.0	.678E-05	.379E-04	1.18	.115E-02
19.0	.610E-05	.443E-04	1.14	.146E-02
18.0	.783E-05	.518E-04	1.15	.179E-02
17.0	.927E-05	.607E-04	1.15	.224E-02
16.0	.808E-05	.709E-04	1.11	.266E-02
15.0	.105E-04	.828E-04	1.13	.314E-02
14.0	.103E-04	.973E-04	1.11	.363E-02
13.0	.426E-05	.114E-03	1.04	.404E-02
12.0	.172E-04	.133E-03	1.13	.447E-02
11.0	.569E-04	.156E-03	1.37	.616E-02
10.0	.141E-03	.176E-03	1.80	.100E-01
9.0	.549E-04	.199E-03	1.28	.154E-01
8.0	.908E-04	.224E-03	1.41	.184E-01
7.0	.123E-03	.251E-03	1.49	.325E-01
6.0	.516E-04	.281E-03	1.18	.347E-01
5.0	.666E-04	.314E-03	1.21	.375E-01
4.0	.111E-03	.349E-03	1.32	.420E-01
3.0	.141E-03	.387E-03	1.36	.483E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 5/10/88 (DAY 131)
TIME: 20:05 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 201
CALIBRATION:
RANGE: 15.5KM TO 15.5KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 30.1KM TO 31.5KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
31.0	.343E-07	.673E-05	1.01	-.720E-06
30.0	.771E-06	.783E-05	1.10	.191E-04
29.0	.976E-06	.916E-05	1.11	.632E-04
28.0	.760E-06	.107E-04	1.07	.965E-04
27.0	.122E-05	.125E-04	1.10	.151E-03
26.0	.123E-05	.146E-04	1.08	.210E-03
25.0	.153E-05	.171E-04	1.09	.285E-03
24.0	.120E-05	.200E-04	1.06	.350E-03
23.0	.178E-05	.235E-04	1.08	.441E-03
22.0	.341E-05	.275E-04	1.12	.537E-03
21.0	.504E-05	.322E-04	1.16	.746E-03
20.0	.550E-05	.379E-04	1.14	.101E-02
19.0	.590E-05	.443E-04	1.13	.132E-02
18.0	.642E-05	.518E-04	1.12	.161E-02
17.0	.658E-05	.607E-04	1.11	.193E-02
16.0	.353E-05	.709E-04	1.05	.220E-02
15.0	.616E-05	.828E-04	1.07	.238E-02
14.0	.651E-05	.973E-04	1.07	.264E-02
13.0	.110E-04	.114E-03	1.10	.302E-02
12.0	.149E-04	.133E-03	1.11	.371E-02
11.0	.198E-04	.156E-03	1.13	.456E-02
10.0	.168E-04	.176E-03	1.10	.573E-02
9.0	.365E-04	.199E-03	1.18	.721E-02
8.0	.293E-04	.224E-03	1.13	.876E-02
7.0	.418E-04	.251E-03	1.17	.104E-01
6.0	.721E-04	.281E-03	1.26	.128E-01
5.0	.417E-04	.314E-03	1.13	.152E-01
4.0	.170E-03	.349E-03	1.49	.216E-01
3.0	.185E-03	.387E-03	1.48	.302E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 5/15/88 (DAY 136)
TIME: 19:57 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 201
CALIBRATION:
RANGE: 6.4KM TO 6.4KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 33.3KM TO 36.4KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
35.0	.706E-06	.361E-05	1.20	.134E-04
34.0	.281E-06	.421E-05	1.07	.230E-04
33.0	.119E-06	.492E-05	1.02	.329E-04
32.0	.164E-06	.578E-05	1.03	.399E-04
31.0	.802E-06	.673E-05	1.12	.627E-04
30.0	.134E-05	.783E-05	1.17	.108E-03
29.0	.141E-05	.916E-05	1.15	.181E-03
28.0	.209E-05	.107E-04	1.20	.256E-03
27.0	.222E-05	.125E-04	1.18	.372E-03
26.0	.244E-05	.146E-04	1.17	.479E-03
25.0	.265E-05	.171E-04	1.16	.615E-03
24.0	.382E-05	.200E-04	1.19	.782E-03
23.0	.261E-05	.235E-04	1.11	.952E-03
22.0	.523E-05	.275E-04	1.19	.116E-02
21.0	.764E-05	.322E-04	1.24	.145E-02
20.0	.108E-04	.379E-04	1.28	.188E-02
19.0	.113E-04	.443E-04	1.25	.241E-02
18.0	.114E-04	.518E-04	1.22	.295E-02
17.0	.128E-04	.607E-04	1.21	.357E-02
16.0	.112E-04	.709E-04	1.16	.415E-02
15.0	.114E-04	.828E-04	1.14	.470E-02
14.0	.149E-04	.973E-04	1.15	.532E-02
13.0	.123E-04	.114E-03	1.11	.607E-02
12.0	.183E-04	.133E-03	1.14	.680E-02
11.0	.169E-04	.156E-03	1.11	.781E-02
10.0	.394E-04	.176E-03	1.22	.920E-02
9.0	.318E-04	.199E-03	1.16	.109E-01
8.0	.215E-04	.224E-03	1.10	.124E-01
7.0	.260E-04	.251E-03	1.10	.132E-01
6.0	.104E-04	.281E-03	1.04	.139E-01
5.0	.808E-04	.314E-03	1.26	.163E-01
4.0	.114E-03	.349E-03	1.33	.212E-01
3.0	.396E-03	.387E-03	2.02	.298E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 5/28/88 (DAY 149)
TIME: 20:13 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 101
CALIBRATION:
RANGE: 9.3KM TO 9.3KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 27.4KM TO 29.0KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
29.0	.543E-06	.914E-05	1.06	.120E-05
28.0	.912E-06	.107E-04	1.09	.426E-04
27.0	.234E-05	.125E-04	1.19	.117E-03
26.0	.297E-05	.146E-04	1.20	.259E-03
25.0	.346E-05	.171E-04	1.20	.436E-03
24.0	.354E-05	.200E-04	1.18	.598E-03
23.0	.415E-05	.234E-04	1.18	.792E-03
22.0	.748E-05	.275E-04	1.27	.107E-02
21.0	.922E-05	.322E-04	1.29	.144E-02
20.0	.993E-05	.378E-04	1.26	.196E-02
19.0	.123E-04	.443E-04	1.28	.255E-02
18.0	.124E-04	.518E-04	1.24	.313E-02
17.0	.168E-04	.606E-04	1.28	.384E-02
16.0	.173E-04	.709E-04	1.24	.471E-02
15.0	.148E-04	.828E-04	1.18	.544E-02
14.0	.187E-04	.970E-04	1.19	.623E-02
13.0	.226E-04	.114E-03	1.20	.728E-02
12.0	.152E-04	.133E-03	1.11	.828E-02
11.0	.139E-04	.155E-03	1.09	.899E-02
10.0	.759E-05	.176E-03	1.04	.964E-02
9.0	.124E-04	.199E-03	1.06	.100E-01
8.0	.388E-04	.224E-03	1.17	.116E-01
7.0	.693E-04	.251E-03	1.28	.144E-01
6.0	.244E-03	.281E-03	1.87	.217E-01
5.0	.337E-03	.313E-03	2.08	.389E-01
4.0	.318E-03	.349E-03	1.91	.555E-01
3.0	.387E-03	.387E-03	2.00	.730E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 7/20/88 (DAY 202)
TIME: 20:32 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 207
CALIBRATION:
RANGE: 6.0KM TO 6.0KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 28.7KM TO 31.3KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
30.0	.497E-06	.783E-05	1.06	.194E-04
29.0	.160E-05	.916E-05	1.17	.762E-04
28.0	.272E-05	.107E-04	1.25	.159E-03
27.0	.340E-05	.125E-04	1.27	.319E-03
26.0	.469E-05	.146E-04	1.32	.524E-03
25.0	.535E-05	.171E-04	1.31	.766E-03
24.0	.665E-05	.200E-04	1.33	.106E-02
23.0	.994E-05	.235E-04	1.42	.146E-02
22.0	.105E-04	.275E-04	1.38	.197E-02
21.0	.136E-04	.322E-04	1.42	.259E-02
20.0	.173E-04	.379E-04	1.46	.335E-02
19.0	.183E-04	.443E-04	1.41	.420E-02
18.0	.221E-04	.518E-04	1.43	.520E-02
17.0	.264E-04	.607E-04	1.43	.644E-02
16.0	.278E-04	.709E-04	1.39	.776E-02
15.0	.270E-04	.828E-04	1.33	.910E-02
14.0	.291E-04	.973E-04	1.30	.105E-01
13.0	.292E-04	.114E-03	1.26	.119E-01
12.0	.303E-04	.133E-03	1.23	.134E-01
11.0	.234E-04	.156E-03	1.15	.146E-01
10.0	.176E-04	.176E-03	1.10	.157E-01
9.0	.164E-04	.199E-03	1.08	.164E-01
8.0	.162E-04	.224E-03	1.07	.172E-01
7.0	.150E-04	.251E-03	1.06	.179E-01
6.0	.842E-05	.281E-03	1.03	.186E-01
5.0	.319E-03	.314E-03	2.02	.270E-01
4.0	.486E-03	.349E-03	2.39	.433E-01
3.0	.909E-03	.387E-03	3.35	.882E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 8/ 9/88 (DAY 222)
TIME: 20:01 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 203
CALIBRATION:
RANGE: 8.1KM TO 8.1KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 28.7KM TO 31.3KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
30.0	.100E-05	.783E-05	1.13	.421E-04
29.0	.154E-05	.916E-05	1.17	.111E-03
28.0	.220E-05	.107E-04	1.21	.223E-03
27.0	.328E-05	.125E-04	1.26	.368E-03
26.0	.468E-05	.146E-04	1.32	.552E-03
25.0	.401E-05	.171E-04	1.23	.776E-03
24.0	.611E-05	.200E-04	1.31	.102E-02
23.0	.669E-05	.235E-04	1.28	.133E-02
22.0	.867E-05	.275E-04	1.32	.173E-02
21.0	.104E-04	.322E-04	1.32	.221E-02
20.0	.143E-04	.379E-04	1.38	.287E-02
19.0	.166E-04	.443E-04	1.37	.361E-02
18.0	.185E-04	.518E-04	1.36	.445E-02
17.0	.207E-04	.607E-04	1.34	.546E-02
16.0	.224E-04	.709E-04	1.32	.655E-02
15.0	.239E-04	.828E-04	1.29	.768E-02
14.0	.225E-04	.973E-04	1.23	.884E-02
13.0	.235E-04	.114E-03	1.21	.999E-02
12.0	.228E-04	.133E-03	1.17	.111E-01
11.0	.158E-04	.156E-03	1.10	.121E-01
10.0	.128E-04	.176E-03	1.07	.127E-01
9.0	.195E-04	.199E-03	1.10	.134E-01
8.0	.739E-05	.224E-03	1.03	.143E-01
7.0	.247E-04	.251E-03	1.10	.153E-01
6.0	.787E-04	.281E-03	1.28	.168E-01
5.0	.187E-03	.314E-03	1.60	.243E-01
4.0	.268E-03	.349E-03	1.77	.342E-01
3.0	.274E-03	.387E-03	1.71	.490E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 8/18/88 (DAY 231)
TIME: 19:59 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 201
CALIBRATION:
RANGE: 8.3KM TO 8.3KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 28.7KM TO 31.3KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
31.0	.571E-06	.673E-05	1.08	.388E-05
30.0	.532E-06	.783E-05	1.07	.367E-04
29.0	.114E-05	.916E-05	1.12	.849E-04
28.0	.255E-05	.107E-04	1.24	.171E-03
27.0	.229E-05	.125E-04	1.18	.299E-03
26.0	.398E-05	.146E-04	1.27	.487E-03
25.0	.469E-05	.171E-04	1.27	.700E-03
24.0	.549E-05	.200E-04	1.27	.971E-03
23.0	.788E-05	.235E-04	1.34	.131E-02
22.0	.831E-05	.275E-04	1.30	.169E-02
21.0	.992E-05	.322E-04	1.31	.217E-02
20.0	.150E-04	.379E-04	1.40	.282E-02
19.0	.167E-04	.443E-04	1.38	.360E-02
18.0	.197E-04	.518E-04	1.38	.453E-02
17.0	.223E-04	.607E-04	1.37	.561E-02
16.0	.255E-04	.709E-04	1.36	.680E-02
15.0	.292E-04	.828E-04	1.35	.813E-02
14.0	.323E-04	.972E-04	1.33	.961E-02
13.0	.284E-04	.114E-03	1.25	.111E-01
12.0	.262E-04	.133E-03	1.20	.125E-01
11.0	.181E-04	.156E-03	1.12	.136E-01
10.0	.125E-04	.176E-03	1.07	.143E-01
9.0	.913E-05	.199E-03	1.05	.149E-01
8.0	.580E-05	.224E-03	1.03	.153E-01
7.0	.718E-04	.251E-03	1.29	.172E-01
6.0	.178E-03	.281E-03	1.64	.223E-01
5.0	.316E-03	.314E-03	2.01	.375E-01
4.0	.487E-03	.349E-03	2.40	.580E-01
3.0	.843E-03	.387E-03	3.18	.858E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 8/22/88 (DAY 235)
TIME: 19:52 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 201
CALIBRATION:
RANGE: 6.4KM TO 6.4KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 29.0KM TO 31.6KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
30.0	.541E-06	.783E-05	1.07	.116E-04
29.0	.936E-06	.916E-05	1.10	.594E-04
28.0	.214E-05	.107E-04	1.20	.119E-03
27.0	.236E-05	.125E-04	1.19	.234E-03
26.0	.360E-05	.146E-04	1.25	.397E-03
25.0	.433E-05	.171E-04	1.25	.588E-03
24.0	.557E-05	.200E-04	1.28	.867E-03
23.0	.830E-05	.235E-04	1.35	.121E-02
22.0	.828E-05	.275E-04	1.30	.161E-02
21.0	.112E-04	.322E-04	1.35	.209E-02
20.0	.143E-04	.379E-04	1.38	.277E-02
19.0	.179E-04	.443E-04	1.41	.357E-02
18.0	.223E-04	.518E-04	1.43	.454E-02
17.0	.261E-04	.607E-04	1.43	.575E-02
16.0	.275E-04	.709E-04	1.39	.711E-02
15.0	.327E-04	.828E-04	1.39	.863E-02
14.0	.320E-04	.973E-04	1.33	.103E-01
13.0	.323E-04	.114E-03	1.28	.119E-01
12.0	.309E-04	.133E-03	1.23	.134E-01
11.0	.226E-04	.156E-03	1.15	.148E-01
10.0	.209E-04	.176E-03	1.12	.159E-01
9.0	.157E-04	.199E-03	1.08	.170E-01
8.0	.270E-04	.224E-03	1.12	.179E-01
7.0	.162E-04	.251E-03	1.06	.188E-01
6.0	.159E-04	.281E-03	1.06	.194E-01
5.0	.316E-03	.314E-03	2.01	.256E-01
4.0	.356E-03	.349E-03	2.02	.405E-01
3.0	.623E-03	.387E-03	2.61	.609E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 8/25/88 (DAY 238)
TIME: 19:54 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 201
CALIBRATION:
RANGE: 6.7KM TO 6.7KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 28.7KM TO 31.3KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
31.0	.259E-06	.673E-05	1.04	.663E-06
30.0	.142E-05	.783E-05	1.18	.350E-04
29.0	.259E-05	.916E-05	1.28	.128E-03
28.0	.259E-05	.107E-04	1.24	.250E-03
27.0	.278E-05	.125E-04	1.22	.408E-03
26.0	.372E-05	.146E-04	1.25	.600E-03
25.0	.564E-05	.171E-04	1.33	.846E-03
24.0	.765E-05	.200E-04	1.38	.117E-02
23.0	.872E-05	.235E-04	1.37	.157E-02
22.0	.867E-05	.275E-04	1.32	.204E-02
21.0	.138E-04	.322E-04	1.43	.260E-02
20.0	.170E-04	.379E-04	1.45	.341E-02
19.0	.196E-04	.443E-04	1.44	.432E-02
18.0	.221E-04	.518E-04	1.43	.538E-02
17.0	.283E-04	.607E-04	1.47	.665E-02
16.0	.308E-04	.709E-04	1.43	.805E-02
15.0	.310E-04	.828E-04	1.37	.957E-02
14.0	.318E-04	.972E-04	1.33	.111E-01
13.0	.312E-04	.114E-03	1.27	.127E-01
12.0	.295E-04	.133E-03	1.22	.142E-01
11.0	.261E-04	.156E-03	1.17	.157E-01
10.0	.243E-04	.176E-03	1.14	.169E-01
9.0	.199E-04	.199E-03	1.10	.180E-01
8.0	.153E-04	.224E-03	1.07	.189E-01
7.0	.955E-05	.251E-03	1.04	.195E-01
6.0	.109E-02	.281E-03	4.87	.296E-01
5.0	.122E-02	.314E-03	4.90	.844E-01
4.0	.202E-02	.349E-03	6.80	.157E 00
3.0	.227E-02	.387E-03	6.87	.276E 00

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 8/29/88 (DAY 242)
TIME: 19:23 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 201
CALIBRATION:
RANGE: 7.0KM TO 7.0KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 28.7KM TO 31.3KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
31.0	.314E-06	.673E-05	1.05	.653E-05
30.0	.700E-06	.783E-05	1.09	.470E-04
29.0	.183E-05	.916E-05	1.20	.127E-03
28.0	.297E-05	.107E-04	1.28	.234E-03
27.0	.294E-05	.125E-04	1.24	.384E-03
26.0	.420E-05	.146E-04	1.29	.567E-03
25.0	.576E-05	.171E-04	1.34	.798E-03
24.0	.649E-05	.200E-04	1.33	.107E-02
23.0	.871E-05	.235E-04	1.37	.142E-02
22.0	.891E-05	.275E-04	1.32	.184E-02
21.0	.111E-04	.322E-04	1.34	.233E-02
20.0	.144E-04	.379E-04	1.38	.297E-02
19.0	.170E-04	.443E-04	1.38	.372E-02
18.0	.207E-04	.518E-04	1.40	.463E-02
17.0	.222E-04	.607E-04	1.37	.571E-02
16.0	.264E-04	.709E-04	1.37	.691E-02
15.0	.273E-04	.828E-04	1.33	.819E-02
14.0	.263E-04	.972E-04	1.27	.956E-02
13.0	.264E-04	.114E-03	1.23	.109E-01
12.0	.217E-04	.133E-03	1.16	.121E-01
11.0	.309E-04	.156E-03	1.20	.137E-01
10.0	.172E-04	.176E-03	1.10	.147E-01
9.0	.149E-04	.199E-03	1.07	.154E-01
8.0	.151E-04	.224E-03	1.07	.161E-01
7.0	.754E-05	.251E-03	1.03	.166E-01
6.0	.196E-03	.281E-03	1.70	.186E-01
5.0	.626E-03	.314E-03	2.99	.410E-01
4.0	.118E-02	.349E-03	4.37	.842E-01
3.0	.115E-02	.387E-03	3.98	.144E 00

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 9/ 7/88 (DAY 251)
TIME: 20:18 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 201
CALIBRATION:
RANGE: 6.7KM TO 6.7KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 33.3KM TO 36.4KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
35.0	.296E-06	.361E-05	1.08	.754E-05
34.0	.185E-06	.421E-05	1.04	.144E-04
33.0	.499E-06	.492E-05	1.10	.343E-04
32.0	.656E-06	.578E-05	1.11	.802E-04
31.0	.999E-06	.673E-05	1.15	.120E-03
30.0	.210E-05	.783E-05	1.27	.194E-03
29.0	.199E-05	.916E-05	1.22	.298E-03
28.0	.196E-05	.107E-04	1.18	.402E-03
27.0	.280E-05	.125E-04	1.22	.524E-03
26.0	.325E-05	.146E-04	1.22	.682E-03
25.0	.412E-05	.171E-04	1.24	.860E-03
24.0	.430E-05	.200E-04	1.22	.106E-02
23.0	.550E-05	.235E-04	1.23	.132E-02
22.0	.627E-05	.275E-04	1.23	.160E-02
21.0	.776E-05	.322E-04	1.24	.193E-02
20.0	.970E-05	.379E-04	1.26	.241E-02
19.0	.113E-04	.443E-04	1.25	.293E-02
18.0	.150E-04	.518E-04	1.29	.356E-02
17.0	.165E-04	.607E-04	1.27	.435E-02
16.0	.195E-04	.709E-04	1.27	.525E-02
15.0	.196E-04	.828E-04	1.24	.622E-02
14.0	.188E-04	.973E-04	1.19	.724E-02
13.0	.173E-04	.114E-03	1.15	.813E-02
12.0	.142E-04	.133E-03	1.11	.891E-02
11.0	.109E-04	.156E-03	1.07	.953E-02
10.0	.966E-05	.176E-03	1.05	.100E-01
9.0	.139E-04	.199E-03	1.07	.107E-01
8.0	.898E-05	.224E-03	1.04	.113E-01
7.0	.753E-05	.251E-03	1.03	.117E-01
6.0	.220E-04	.281E-03	1.08	.123E-01
5.0	.187E-04	.314E-03	1.06	.131E-01
4.0	.894E-03	.349E-03	3.56	.357E-01
3.0	.109E-02	.387E-03	3.82	.852E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 9/29/88 (DAY 273)
TIME: 19:18 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 201
CALIBRATION:
RANGE: 6.4KM TO 6.4KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 30.3KM TO 31.4KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
31.0	.996E-07	.673E-05	1.01	.211E-05
30.0	.990E-06	.783E-05	1.13	.139E-04
29.0	.973E-06	.916E-05	1.11	.579E-04
28.0	.206E-05	.107E-04	1.19	.119E-03
27.0	.188E-05	.125E-04	1.15	.195E-03
26.0	.262E-05	.146E-04	1.18	.300E-03
25.0	.259E-05	.171E-04	1.15	.432E-03
24.0	.337E-05	.200E-04	1.17	.576E-03
23.0	.357E-05	.235E-04	1.15	.768E-03
22.0	.428E-05	.275E-04	1.16	.957E-03
21.0	.691E-05	.322E-04	1.21	.128E-02
20.0	.871E-05	.379E-04	1.23	.163E-02
19.0	.106E-04	.443E-04	1.24	.210E-02
18.0	.117E-04	.518E-04	1.23	.265E-02
17.0	.134E-04	.607E-04	1.22	.329E-02
16.0	.143E-04	.709E-04	1.20	.393E-02
15.0	.155E-04	.828E-04	1.19	.468E-02
14.0	.170E-04	.973E-04	1.17	.551E-02
13.0	.332E-04	.114E-03	1.29	.652E-02
12.0	.234E-04	.133E-03	1.18	.808E-02
11.0	.115E-04	.156E-03	1.07	.902E-02
10.0	.160E-04	.176E-03	1.09	.956E-02
9.0	.163E-04	.199E-03	1.08	.103E-01
8.0	.132E-04	.224E-03	1.06	.110E-01
7.0	.117E-04	.251E-03	1.05	.119E-01
6.0	.218E-04	.281E-03	1.08	.124E-01
5.0	.646E-04	.314E-03	1.21	.146E-01
4.0	.171E-03	.349E-03	1.49	.204E-01
3.0	.246E-03	.387E-03	1.64	.306E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 10/10/88 (DAY 284)
TIME: 20:13 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 201
CALIBRATION:
RANGE: 7.6KM TO 7.6KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 30.7KM TO 31.5KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
31.0	.149E-06	.673E-05	1.02	.542E-05
30.0	.903E-06	.783E-05	1.12	.283E-04
29.0	.111E-05	.916E-05	1.12	.659E-04
28.0	.326E-06	.107E-04	1.03	.101E-03
27.0	.131E-05	.125E-04	1.11	.145E-03
26.0	.234E-05	.146E-04	1.16	.236E-03
25.0	.279E-05	.171E-04	1.16	.349E-03
24.0	.297E-05	.200E-04	1.15	.492E-03
23.0	.521E-05	.235E-04	1.22	.661E-03
22.0	.523E-05	.275E-04	1.19	.898E-03
21.0	.602E-05	.322E-04	1.19	.118E-02
20.0	.899E-05	.379E-04	1.24	.158E-02
19.0	.122E-04	.443E-04	1.28	.209E-02
18.0	.133E-04	.518E-04	1.26	.269E-02
17.0	.161E-04	.607E-04	1.26	.346E-02
16.0	.148E-04	.709E-04	1.21	.424E-02
15.0	.143E-04	.828E-04	1.17	.495E-02
14.0	.172E-04	.973E-04	1.18	.569E-02
13.0	.153E-04	.114E-03	1.13	.650E-02
12.0	.216E-04	.133E-03	1.16	.732E-02
11.0	.174E-04	.156E-03	1.11	.824E-02
10.0	.155E-04	.176E-03	1.09	.901E-02
9.0	.140E-04	.199E-03	1.07	.977E-02
8.0	.920E-05	.224E-03	1.04	.104E-01
7.0	.975E-05	.251E-03	1.04	.108E-01
6.0	.215E-04	.281E-03	1.08	.117E-01
5.0	.124E-04	.314E-03	1.04	.127E-01
4.0	.266E-03	.349E-03	1.76	.215E-01
3.0	.536E-03	.387E-03	2.39	.408E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 11/14/88 (DAY 319)
TIME: 17:18 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 101
CALIBRATION:
RANGE: 6.7KM TO 6.7KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 26.7KM TO 29.1KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
29.0	.103E-05	.914E-05	1.11	.188E-05
28.0	.582E-06	.107E-04	1.05	.264E-04
27.0	.121E-05	.125E-04	1.10	.861E-04
26.0	.166E-05	.146E-04	1.11	.144E-03
25.0	.243E-05	.171E-04	1.14	.233E-03
24.0	.221E-05	.200E-04	1.11	.333E-03
23.0	.387E-05	.234E-04	1.17	.491E-03
22.0	.439E-05	.275E-04	1.16	.708E-03
21.0	.638E-05	.322E-04	1.20	.953E-03
20.0	.854E-05	.378E-04	1.23	.136E-02
19.0	.111E-04	.443E-04	1.25	.185E-02
18.0	.132E-04	.518E-04	1.25	.242E-02
17.0	.126E-04	.606E-04	1.21	.304E-02
16.0	.136E-04	.709E-04	1.19	.370E-02
15.0	.162E-04	.828E-04	1.20	.442E-02
14.0	.204E-04	.970E-04	1.21	.539E-02
13.0	.225E-04	.114E-03	1.20	.649E-02
12.0	.226E-04	.133E-03	1.17	.757E-02
11.0	.248E-04	.155E-03	1.16	.872E-02
10.0	.760E-03	.176E-03	5.32	.354E-01
9.0	.167E-04	.199E-03	1.08	.385E-01
8.0	.142E-04	.224E-03	1.06	.394E-01
7.0	.932E-05	.251E-03	1.04	.399E-01
6.0	.184E-04	.281E-03	1.07	.405E-01
5.0	.235E-04	.313E-03	1.08	.415E-01
4.0	.362E-04	.349E-03	1.10	.429E-01
3.0	.955E-04	.387E-03	1.25	.468E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 11/27/88 (DAY 332)
TIME: 18:37 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 201
CALIBRATION:
RANGE: 4.5KM TO 4.5KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 31.1KM TO 31.6KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
31.0	.925E-06	.673E-05	1.14	.702E-05
30.0	.154E-05	.783E-05	1.20	.542E-04
29.0	.145E-05	.916E-05	1.16	.127E-03
28.0	.166E-05	.107E-04	1.16	.217E-03
27.0	.274E-05	.125E-04	1.22	.328E-03
26.0	.257E-05	.146E-04	1.18	.456E-03
25.0	.290E-05	.171E-04	1.17	.602E-03
24.0	.375E-05	.200E-04	1.19	.778E-03
23.0	.496E-05	.235E-04	1.21	.100E-02
22.0	.578E-05	.275E-04	1.21	.128E-02
21.0	.868E-05	.322E-04	1.27	.164E-02
20.0	.966E-05	.379E-04	1.25	.207E-02
19.0	.114E-04	.443E-04	1.26	.259E-02
18.0	.126E-04	.518E-04	1.24	.319E-02
17.0	.141E-04	.607E-04	1.23	.390E-02
16.0	.159E-04	.709E-04	1.22	.462E-02
15.0	.163E-04	.828E-04	1.20	.537E-02
14.0	.165E-04	.973E-04	1.17	.626E-02
13.0	.206E-04	.114E-03	1.18	.710E-02
12.0	.232E-04	.133E-03	1.17	.819E-02
11.0	.164E-04	.156E-03	1.11	.921E-02
10.0	.172E-04	.176E-03	1.10	.100E-01
9.0	.204E-04	.199E-03	1.10	.109E-01
8.0	.216E-04	.224E-03	1.10	.121E-01
7.0	.178E-04	.251E-03	1.07	.131E-01
6.0	.185E-04	.281E-03	1.07	.140E-01
5.0	.139E-04	.314E-03	1.04	.149E-01
4.0	.167E-04	.349E-03	1.05	.156E-01
3.0	.409E-04	.387E-03	1.11	.168E-01

BOULDER, COLORADO, USA
POSITION: 39.9910N, 105.2650W, 1.68 KM MSL
DATE: 12/16/88 (DAY 351)
TIME: 17:50 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 201
CALIBRATION:
RANGE: 6.7KM TO 6.7KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 29.3KM TO 31.5KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
31.0	.162E-06	.673E-05	1.02	.848E-05
30.0	.486E-06	.783E-05	1.06	.635E-05
29.0	.676E-06	.916E-05	1.07	.440E-04
28.0	.143E-05	.107E-04	1.13	.953E-04
27.0	.271E-05	.125E-04	1.22	.184E-03
26.0	.238E-05	.146E-04	1.16	.279E-03
25.0	.300E-05	.171E-04	1.18	.404E-03
24.0	.420E-05	.200E-04	1.21	.590E-03
23.0	.472E-05	.235E-04	1.20	.797E-03
22.0	.665E-05	.275E-04	1.24	.103E-02
21.0	.655E-05	.322E-04	1.20	.132E-02
20.0	.850E-05	.379E-04	1.22	.170E-02
19.0	.116E-04	.443E-04	1.26	.218E-02
18.0	.154E-04	.518E-04	1.30	.283E-02
17.0	.142E-04	.607E-04	1.23	.358E-02
16.0	.175E-04	.709E-04	1.25	.437E-02
15.0	.152E-04	.828E-04	1.18	.518E-02
14.0	.193E-04	.973E-04	1.20	.606E-02
13.0	.208E-04	.114E-03	1.18	.708E-02
12.0	.199E-04	.133E-03	1.15	.815E-02
11.0	.162E-04	.156E-03	1.10	.907E-02
10.0	.155E-04	.176E-03	1.09	.989E-02
9.0	.151E-04	.199E-03	1.08	.107E-01
8.0	.130E-04	.224E-03	1.06	.114E-01
7.0	.821E-05	.251E-03	1.03	.119E-01
6.0	.129E-04	.281E-03	1.05	.123E-01
5.0	.193E-04	.314E-03	1.06	.130E-01
4.0	.254E-04	.349E-03	1.07	.141E-01
3.0	.560E-04	.387E-03	1.14	.160E-01

BOULDER, COLORADO, USA
POSITION: 39.991ON, 105.2650W, 1.68 KM MSL
DATE: 12/31/88 (DAY 366)
TIME: 17:54 MST
WAVELENGTH: 694.3 NM
SAMPLING INTERVAL: 15M
SMOOTHING INVERVAL: 300M
NUMBER OF SHOTS AVERAGED: 201
CALIBRATION:
RANGE: 7.2KM TO 7.2KM
SCATTERING RATIO: 1.03
BACKGROUND CORRECTION:
RANGE: 28.7KM TO 31.3KM
SCATTERING RATIO: 1.03
NO EXTINCTION CORRECTION

HEIGHT KM MSL	AEROSOL BACKSCATTER COEFFICIENT 1/(KM-STER)	RAYLEIGH BACKSCATTER COEFFICIENT 1/(KM-STER)	SCATTERING RATIO	AEROSOL OPTICAL DEPTH
31.0	.213E-06	.673E-05	1.03	.244E-05
30.0	.576E-06	.783E-05	1.07	.120E-04
29.0	.600E-06	.916E-05	1.07	.345E-04
28.0	.153E-05	.107E-04	1.14	.104E-03
27.0	.125E-05	.125E-04	1.10	.173E-03
26.0	.115E-05	.146E-04	1.08	.241E-03
25.0	.223E-05	.171E-04	1.13	.329E-03
24.0	.172E-05	.200E-04	1.09	.435E-03
23.0	.264E-05	.235E-04	1.11	.587E-03
22.0	.259E-05	.275E-04	1.09	.724E-03
21.0	.448E-05	.322E-04	1.14	.903E-03
20.0	.403E-05	.379E-04	1.11	.111E-02
19.0	.606E-05	.443E-04	1.14	.137E-02
18.0	.818E-05	.518E-04	1.16	.171E-02
17.0	.906E-05	.607E-04	1.15	.212E-02
16.0	.963E-05	.709E-04	1.14	.259E-02
15.0	.702E-05	.828E-04	1.08	.298E-02
14.0	.784E-05	.973E-04	1.08	.334E-02
13.0	.609E-05	.114E-03	1.05	.367E-02
12.0	.938E-05	.133E-03	1.07	.404E-02
11.0	.626E-05	.156E-03	1.04	.446E-02
10.0	.218E-04	.176E-03	1.12	.512E-02
9.0	.143E-04	.199E-03	1.07	.594E-02
8.0	.169E-04	.224E-03	1.08	.667E-02
7.0	.123E-04	.251E-03	1.05	.725E-02
6.0	.169E-04	.281E-03	1.06	.807E-02
5.0	.280E-04	.314E-03	1.09	.902E-02
4.0	.983E-05	.349E-03	1.03	.104E-01
3.0	.175E-04	.387E-03	1.05	.111E-01