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ATMOSPHERIC EFFECTS UPON LASER BEAM PROPAGATION: AN ANNOTATED BIBLIOGRAPHY

INTERIM TECHNICAL REPORT

15 FEBRUARY 1979

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- ATMOSPHERIC CONDITIONS

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Results of a literature search on the effects of normally occuring atmospheric molecules, aerosols and turbulence on the propagation of low power lasers is presented in a thoroughly cross referenced bibliography. Included are references to theoretical, experimental and modeling studies that could be relevant to developing models (and their required data bases) for the purpose of establishing comprehensive safety standards for laser illumination of the human eye. Two separate computerized literature searches (with extensive manual editing) were utilized, as well as other sources, to locate these references. Current and planned efforts by several key researchers are also described.

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1
INTRODUCTION

In order to establish comprehensive laser eye safety standards, it is necessary to consider the effects of the atmosphere. Molecules and aerosols in the atmosphere will absorb and scatter laser radiation, while turbulence in the atmosphere will cause spatial and temporal redistribution of the beam's energy at the target plane. This bibliography attempts to compile theoretical and experimental information pertaining to all these effects*.

The bibliography addresses the low power laser operating in the ultraviolet, visible, or infrared spectral regions (i.e., roughly 0.2 to 11 μm), over an arbitrary atmospheric path (i.e., horizontal, vertical or slant path) up to 100 km altitude. Only normal atmospheres (i.e., no countermeasure smoke** or nuclear perturbation) were considered. Multiple scattering effects** (except relating to turbulence), and non-linear propagation effects such as thermal blooming, saturation bleaching, and aerosol vaporization or alteration were not addressed.

References were also included in the bibliography to papers containing information on peripheral areas such as the condition and composition of the atmosphere, the optical properties of aerosol materials, and the precise location of various laser lines (since they would be required in line-by-line modeling). However, because of the breadth and many facets of these subjects, it was not possible within the scope of this effort (i.e., approximately three man months were allocated to this

*This information will be evaluated in a subsequent report, in order to establish the state-of-information on these effects, and to recommend analytical models to be employed for setting more comprehensive laser eye safety standards.

**References to these subjects were included when readily available.

task) to cover the material to the same depth. For example, there is a wealth of information on the molecular, aerosol and turbulence composition of the atmosphere as a function of altitude, locale, time of day, time of year, etc. In these cases, an in-depth survey was not deemed warranted and only the principal papers were referenced. The resulting bibliography is believed to be comprehensive regarding experimental measurements on these effects and their modeling.

A summary of the bibliography and the approach taken in compiling the information is given next (Section 2). This is followed by a topic index (Section 3) to provide a finer subdivision of subject areas than the ten categories (see Table 1) allow. Discussions with key researchers regarding their current and planned work is given in Section 4, followed by the annotated bibliography in Section 5.

2
SUMMARY AND APPROACH

A total of 1050 citations to reports and papers on atmospheric effects are given in the bibliography; along with approximately fifty additional references to texts. Over eighty percent of these citations are annotated. They are arranged in ten categories as shown in Table 1. Two thirds of these citations were from journal articles and most of the others were reports. A cross reference index is provided to delineate those citations relating to a number of topic areas (see Table 2). Discussions with a number of key researchers in the field indicated several interesting new measurements and modeling efforts (see Section 4).

A number of sources were utilized to compile the information presented in this bibliography, including two different computerized searches, several earlier technical reviews of the subject, and discussions with experts in the field. The most important source was the Lockheed computerized bibliographic search service called the DIALOG Information Retrieval Service [2-1]. Basically this system employs a combination of user-specified key words or phrases to identify reports and articles of interest. The computer prints the number of papers it has found with each key word, and (at the user's command) each paper's reference mate ial. For journal articles, this reference material includes the title, authors, journal name, volume, number, date and page numbers; and for technical reports, the corporate author, report number and in most cases, ordering information (eg., NTIS number). The user can also direct the computer to print if available, the complete abstract of each paper.

The DIALOG search was performed for Nichols Research Corporation by the Infrared Information Analysis (IRIA) Center at ERIM under the direction of their experts in the field of atmospheric effects and information retrieval, A. J. LaRocca and J. Livisay. At their suggestion,

TABLE 1

BIBLIOGRAPHY SUMMARY
Atmospheric Effects on Laser Beam Propagation

CATEGORY	TOTAL NUMBER OF CITATIONS	JOURNALS	REPORTS	SYMPOSIA	OTHER	NUMBER ANNOTATED	PAGE NUMBER
1. Molecule Effects	146	60	69	11	6	120	16
2. Molecule Conditions	35	28	6	0	1	28	32
3. Aerosol Effects	142	78	45	18	1	98	36
4. Aerosol Conditions	190	158	25	5	2	122	52
5. Turbulence Effects	344	235	73	30	6	309	69
6. Turbulence Conditions	46	32	6	6	2	35	110
7. Field Measurements (Molecule & Aerosol Effects)	206	162	35	7	2	191	115
8. General	27	5	17	5	1	25	128
9. Biological Effects	19	12	5	2	0	12	132
10. Texts	47	-	-	-	-	19	134
TOTAL	1155	770	281	84	21	959	

the search was made on the SCISEARCH and COMPENDEX data bases with the keyword* combination: LASER and (PROPAGAT or TRANSMISS or TURBULEN) and not BLOOM. SCISEARCH is a multi-disciplinary index to the literature of science and technology prepared by the Institute for Scientific Information from about 2600 journals. COMPENDEX contains all the information in "The Engineering Index" which covers about 1800 journals, 1000 conference or symposia proceedings, and selected government reports and books. Using the above key word combination, the computer found 2589 papers from SCISEARCH, and 1661 papers from COMPENDEX. An earlier trial run with the same key word combination appended by: (and MODELS or EXPERIM), produced only 147 and 256 papers from SCISEARCH and COMPENDEX respectively.

The second computerized search was performed by NTIS on "Atmospheric Effects on Laser Beams" for the time periods from 1964 through 1974 [1023], and 1975 through September 1978 [1024]. Both of these searches required considerable manual review to exclude papers that were not pertinent to the present problem (i.e., less than 20% of the papers were pertinent). For example, there were a large number of papers on laser fusion, laser operation, flow diagnostics, non-linear effects, and experimental or program planning. In order to eliminate such unwanted references, it was necessary to read all the titles and many of the abstracts. The abstracts of all those deemed pertinent were read in detail to extract one or two sentences of concentrated annotation information, assign it to one of several categories (see Table 1), and decide whether to order the paper.

An explanation is required for some of the categories shown in Table 1. The categories ending in "Conditions" generally refer to the state of the atmosphere, such as the number distribution of various molecule and aerosol species, atmospheric turbulence levels, etc. However, ancillary information is also included in these 'conditions categories,' such as the index of refraction of typical aerosol materials, the spectral positions of laser lines (in molecular effects), etc. Field

*Using only the first letters of a word locates all forms of the word (eg., TURBULEN will give TURBULENT and TURBULENCE).

measurements of molecular and aerosol effects were put into another category, since these effects are very difficult to separate in the field. A general category was included to cover papers covering in detail two or more of the previous categories. A few articles were found on biological effects, so they were included for completeness in a separate category. Finally, Category 10 delineates the more important texts that have been published on this topic.

Several other sources of references were utilized during the survey, notably other earlier surveys and reviews. These included excellent texts by Zuyev [1096]*, McCartney [1028] and Strohbehn [1085]; an IRIA-IRIS Index to the DoD Conferences on Laser Technology [2-2]**, the AGARD Conference on Optical Propagation in the Atmosphere [2-3], and review articles by Fante [627], Prokorov [792] and Meredith [1019].

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*Single number in brackets indicate citations in the Bibliography (Section 5).

**Double numbers refer to the references at the end of the report.

3
TOPIC INDEX

In an attempt to improve the usefulness of this bibliography, all the references were numbered, indexed* and cross referenced. This index indicates all those references that pertain to a number of different categories that were deemed to be of primary interest (see Table 2). These include the general type of report, if a particular laser was investigated, and several topics relating primarily to molecule, aerosol or turbulence effects. Articles that give a detailed treatment of several areas in any one of these topic areas, are indexed under that general topic area.

*This indexing was based only on the title and the annotation, since a thorough review of these references will not be completed until the next phase of this contract.

TABLE 2

TOPIC INDEX

REPORT TYPE

MOLECULE TOPICS

Line Absorption:	1,8,13,22,24,26,35,43,57
Continuum Absorption:	6,9,15,20,25,34,46,50,82,84,101,107,113,116,133, 907,908,938,943,988
Scattering:	19,53,959,1056,1072,1080,1083,1096
Water Vapor (Absorption):	7,14,17,20-26,29,30,34-36,41,42,47-49,52,57,60, 64-67,82,85,92-94,96,99,102-104,107,117,[illegible],125, 132-134,147,149,153,157,159-161,168-171,1[illegible],177, 178,180,244,917,928,929,943
CO_2 Absorption:	1,7,8,21-24,26,28,35,71,81,92,129-131,135,142,148, 162,167,174,179
N_2 Absorption:	21,25,31,41,62,82,84,101,115,116,123,142,938
O_3 Absorption:	154,156,158,898
CH_4 Absorption:	96,136,155,163,166,175,176
Other Molecules (Absorption):	21,33,38,57,72,92,94,97,98,101,114,127,128,136,137, 148,150,151,166,174-176,978
Line Parameters:	11,12,28,63,81,83,123,135,136,137,139,142,164,165
Line Position:	71,172,173,181
Temperature Effects:	8,13,23-26,119,134,138

AEROSOL TOPICS:	952,962,966,982-985,988,999,1057,1063,1064,1072, 1080,1083,1090,1091,1096
Dust:	191,241,266,325,345,346,362,368,370,373,389,424, 425-428,462,463,499,502,503,507,510,511,986
Fog:	185,190,192,200,203,204,222,247,248,251,252,256, 257,261,262,263,266,269,273,290,291,295,296,301, 319-321,335,339,358,395,431,450,471,484,497,906, 909,914,917,924,926,932,946,956,971,987,993,997, 1001
Haze:	220,231,263,291,301,312,350,357,381,433,476,900, 906,914,932,946
Smoke:	185,248,252,266,301,321,343,495,926,976,977,986
Rain:	188,262,271,295,296,312,335,339,349,352,359,360, 385,386,399,400,416,434,437,439,459-461,467,494, 498,906,910,914,915,917,924,941,956,987,990,1001
Snow:	370,400,467,513,906,910,915,917,941,965,972,997 1001
Clouds:	194,197,202,204,258,263,281,283,291,301,306,310, 311,319,332,333,339,347,352,356,363,375,391,392, 305,413,420-422,438,471,474,481,497,504,512,899, 912-914,996

AEROSOL TOPICS (Continued)

Screening Agents (Camouflage):	183,234,242,255,274,326,350,351,355,357,365,382, 383,441,442,445,446,452,456,458,477,487-489,502, 508,509
Mie Calculations (and approximations):	182,215-218,236,246,265,456,928,1060
Optic Properties:	244,297,339,341,343,344,351-353,378,381-383,385, 388,390,424-428,431,469,495,500,503,507,512,903, 909,910
Size Distributions:	214,216,217,236,317,326-334,336-338,340,342-346, 348,354-356,358,362,364-367,375-377,380,382,383, 386,389,391,392,394,498,401-413,419-426,432,433, 436,437,439-443,446-455,458,462-466,470-475,479-481,483-485,487-489,496,497,499,505,506,508,509, 511,514,918,932
Multiple Scattering:	189,279,280,282,283,287,295,302,314
Angular Scattering:	234,259,335,342,418,465,466,482,905,926

TURBULENCE TOPICS:	539,967,100,1058,1073,1075-1077,1081,1082,1085-1088,1092,1093,1095
Irradiance Statistics:	515,518,520-525,537,538,540,541,553,563,564,567, 570,578-580,582-584,588,590,596,610-612,614,628, 629,633,639,644,647-652,656,665,667,669,674,676-680,682,685,686-691,696,699-700,702,703,708,711, 712,715,723-725,727,729,732-737,739,743,744,750, 755,756,759,761,769,773,774,783,785,786,789,790, 795,796,802,803,805,807,812,813,818,825,826,828, 833,839,840,850
Distribution Functions:	699,703,722,779,819,835,860,870
Beam Wander or Spread:	195,277,290,516,517,517,526,528,532,538,555,559-562,576,607,615,616,635,657,658,659,695,698,704, 713,720,721,724,734,742,758,567,783,787,805,807, 814,834,838,842,843,985
Saturation:	521-523,525,531,540,541,555,567,568,583,589,590, 603,611-613,629,633,639,664,666,668-672,676-678, 680,684,710,712,718,719,739,750,754,756,759,770, 784,820,841,846-849
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Wavelength Dependence:	582,716-721,723,770
Phase:	519,524,534-536,543-546,553,556,566,568,644,664, 665,698,706-709,745,755,760,799,830,831

TURBULENCE TOPICS (Continued)

4
DISCUSSIONS WITH RESEARCHERS IN THE FIELD

Various key researchers in the field were contacted by telephone to inquire about their latest work and future plans. New references to several very recent and soon-to-be published papers were gathered that will be included in the reference list to this report, but not in the bibliography section.

Robert A. McClatchey: AFGL is planning to continually upgrade the AFGL line parameter tape [164] as new information becomes available; no changes to the structure of the code LASER [79] are planned. They are also developing fundamental aerosol models (that can be employed in LASER), including such effects as particle growth and complex refractive index changes with relative humidity, effects of wind speed and type of air mass. They are trying to find some physical measurement to indicate the type of air mass present, (eg., maritime aerosols often are present in the heart of the continent and vice versa). The OPAQUE data will be used to validate these fundamental models rather than to develop empirical models. The analysis of the OPAQUE data just started about six months ago, so no reports are out on it yet. A report is available that describes the experiment and presents some preliminary results [4-1].

Robert W. Fenn: AFGL is preparing a report on a statistical analysis of the OPAQUE measurements of visible and infrared transmission, meteorological and natural illumination for the winter [4.2]. This does not include any laser propagation data. Other reports will be prepared on analyses for other seasons.

James A. Dowling: NRL will be making more absolute laser transmission (DF, CO_2, Nd Yag and HeNe) and FTS relative transmission measurements during March at the White Sands HELSTF (High Energy Laser Standard Test

Facility) 6.5 km path. In May they are planning the same measurements at the San Nicholas Island 4 km path. Transmissometer measurements will be done at the same time and over the same path. They are also planning similar measurements in late summer 1979 in support of: 1) the Navy Optical Signatures Program, 2) the A.S.L. battlefield aerosol environment program, and 3) measurements in Germany. They are also planning some measurements on turbulence effects at 3.8 μm. The high spatial and temporal resolution irradiance structure will be recorded simultaneously with the temperature structure statistics of the atmosphere over a 6.5 km at White Sands.

Kenneth O. White: ASL has continued their measurements on Deuterium depleted water [133] to consider the pressure dependence of the absorption [4-3]. They found the ratio of foreign-to-self contributions a factor of ten less than measured by Burch. They have also made a series of measurements on the transmission of an HF laser (2.7 - 3.1 μm) at five temperatures from ambient to -18°C, and at various ratios of self-to-foreign gases [4-4]. Significant differences from the AFGL tape [164] were observed. They are currently calibrating a spectrophone with this data to extend the measurement to -50°C. They are also planning to measure the water vapor continuum with a CO_2 laser and to determine the dimer contribution. They are also planning laser absorption measurements in the 3-5 and 8-12 μm region on the battlefield gases.

Barry S. Katz: Naval Surface Weapons Center is involved in modeling the performance of optical systems (including lasers) as it is affected by a statistical marine atmosphere, based on weather ship data using simple expressions assuming single scattering [4-5]. They model the turbulence effects with the models of Yura and Fried, which give the beam spread and tilt angle. Initial beam divergence and jitter are also modeled [4-6].

Robert E. Roberts: He has done no more work at IDA on modeling the water vapor continuum, but is currently involved with aerosol effects on optical systems. In applying the OPAQUE measurements and their statistics to slant path situations, he found large differences with the LOWTRAN predictions.

Douglas R. Woods: He has not published anything in the field recently, suggested two reports [4-7,4-8] he found recently.

Ronald K. Long: OSU has recently developed a long path (1 km) Fourier Transform Spectrometer which has a resolution of 0.05 cm^{-1} over the region from 800 to 5000 cm^{-1}, and plans to measure water vapor absorption. They also hope to measure ozone absorption (both 9.6 μm band and overtones) with the instrument in support of the ATMOS experiment planned for the Space Shuttle. Their spectrophone is currently idle, and the FTS is not fully committed.

Frederick G. Smith: Science Applications, Inc. will be starting an analysis of the European aerosol statistics measurements by the Atmospheric Sciences Laboratory in conjunction with the OPAQUE program. These balloon borne measurements were made by R. Pennick and J. D. Lindberg at ASL. There was a recent meeting in Germany in which the U.S. and the Netherlands presented papers on aerosols.

It is his feeling that the molecular effects on the propagation of DF and CO_2 lasers is well understood, with the possible exception of the temperature effects of the continuum and the ratio of the self-to-foreign broadening. For the CO laser there are still questions regarding the line shape, the existence of a 5 μm continuum, and the accuracy of the line parameters in this region, but to his knowledge no one is pursuing these problems.

Robert E. Hufnagel: Perkin Elmer has not developed any new models for the state of high altitude turbulence, since his 1974 model [873] fits the most recent measurements quite well. A model based more on physics (his is an ad hoc model), was recently developed by the Aeronomy Laboratory at NOAA [4-9]. The topic of ground level turbulence is covered well by Reference 1077.

5
BIBLIOGRAPHY

1. MOLECULE EFFECTS

1. T. G. Adiks, V. N. Aref'ev and V. I. Dianov-Klokov, "Influence of Molecular Absorption on Propagation of CO_2 Laser Radiation in Terrestrial Atmosphere," Sov. J. Quant. Electron., Vol. 15, No. 5, p. 481, May 1975. [The roles of resonant absorption by atmospheric CO_2 molecules, continuous absorption by water vapor molecules or absorption by accidental co-incidence with a gas absorption line in the atmosphere are evaluated for various atmospheric and laser parameters.]

2. B. A. Antipov, V. Ye. Zuyev and V. A. Sapozhnikova, Sov. Phys. J., No. 7, p. 142, 1967. [Experimental determination of absorption of laser radiation.]

3. B. A. Antipov, V. Ye. Zuyev and V. A. Sapozhnikova, Sov. Phys. J., No. 6, p. 158, 1967. [Experimental determination of absorption of laser radiation.]

4. B. A. Antipov, V. Ye. Zuyev, V. A. Sapozhnikova, A. V. Sosnin and S. S. Khmelertsov, Transactions of International Symposium on Radiation Processes in the Atmosphere, Bergen Norway, August 1968. [Experimental determination of absorption of laser radiation.]

5. B. A. Antipov and Yu. N. Ponomarev, "Investigation of Weak Absorption Lines of Gases with a Laser Spectrophone," J. Quant. Electron., Vol. 4, No. 6, p. 740, December 1974. [The variation of the absorption coefficient of atmospheric water vapor at $\lambda = 694.38$ nm with the power of a probing ruby laser beam was investigated.]

6. V. N. Aref'ev and V. I. Dianov-Klokov, "Estimates of the Influence of Meteorological Factors as the Attenuation of 10.6 μ Laser Radiation by the Water Vapor Continuum in 'Clean' Atmosphere," Inst. of Experimental Meteorology, Obninsk, USSR; Trans. in: Sov. J. Quant. Electron., Vol. 6, No. 4, pp. 499-501, April 1976. [Laboratory measurements to ascertain the transmission of CO_2 laser radiation by an N_2-H_2O mixture and of He-Ne laser radiation by pure water vapor.]

7. V. N. Aref'ev and V. I. Dianov-Klokov, "Molecular Absorption of CO_2 Laser Radiation in the Terrestrial Troposphere Under Stable Anticyclonal Conditions," Trans. in: Sov. J. Quant. Electron., Vol. 7, No. 6, pp. 772-774, June 1977. [Analyses of model experiments to determine the attenuation of 10.6 micron CO_2 laser radiation by CO_2 gas and water vapor are reported.]

8. V. N. Aref'ev and N. I. Sizov, "Resonance Absorption of CO_2 Laser Radiation in Carbon Dioxide Gas," Sov. J. Quant. Electron., Vol. 7, No. 6, p. 770, June 1977. [Investigated as a function of temperature. The half-width of the P20 line follows a $\theta^{-1.5}$ rule in the temperature range 293-331 K. An analysis of previously published values of the resonance absorption is presented.]

9. S. V. Ashcheulov, K. Ya. Kondrat'yev and D. B. Styro, In collection entitled: Problems of Atmospheric Physics, No. 5, Izd-vo Leningradskogo Gosudarstvennogo Universiteta, 1967." [Continuum absorption measurements in 8-25 μm.]

10. A. J. Beaulieu, The Effects of Atmospheric Propagation on Long Range Applications of Lasers (Sea Level), Rept No. DREV-4030/75, Defence Research Establishment, Valcartier, Quebec, December 1975 (N76-18434/0 ST). [Using the best available data on atmospheric propagation at different wavelength, the relative performance of ladar systems using 1.06 micrometer, 3.8 micrometers and 10.6 micrometers lasers was investigated under various conditions.]

11. W. S. Benedict, "The Strength, Width and Shapes of Infrared Lines, I, General Considerations," Can. J. Phys., Vol. 34, p. 847, 1951. [Suggested the form of modified shape used by OSU.]

12. W. S. Benedict and R. F. Calfee, Line Parameters for the 1.9 and 6.3 Micron Water Vapor Bands, ESSA Professional Paper 2, U.S. Govt Printing Office, 1967. [H_2O line data used by Long for CO calculations.]

13. W. S. Benedict and L. D. Kaplan, J. Chem. Phys., Vol. 30, No. 2, pp. 388-399. [Found power law dependence (exponent 0.62) of half-width on temperature for water lines.]

14. Ye. I. Bocharov, "Radiation Absorption by Moist Air," Geophysics, No. 1, 1959.

15. H. J. Bolle, Memoires Soc. Roy. Sci. Liege, Vol. 26, 1964. [Continuum absorption measurements in 8-25 μm.]

16. W. R. Bradford, Predicting the Molecular Absorption of Infrared Radiation over Atmospheric Paths, EMI Rept No. DMP 1422, February 1963.

17. E. Brannen and Z. Kucerovsky, "Laser Absorption Techniques for the Measurement of Atmospheric Water Vapor Concentration," J. Appl. Meteorol., Vol. 16, No. 10, pp. 1072-1076, October 1977. [Experiments were carried out in a 2 m controlled atmosphere absorption cell at conditions corresponding to ground level to high-altitude atmospheric pressures.]

18. C. A. Brau, E. R. Bressel and S. L. Glicker, Laser Atmospheric Propagation Kinetics, Final Technical Report May 1 - December 31, 1973 on Phase I, Avco Everett Research Labs, Everett, MA (AD 782 416/2). [A model has been developed to describe the kinetics of absorption of DF and CO laser radiation by the atmosphere under a variety of conditions.]

19. E. Brookner, "A Note on the Deterioration of the Coherence Properties of a Laser Beam by Molecular Scattering," Radio Sci., Vol. 6, No. 6, p. 605, June 1971. [It is shown that molecular scattering gives rise to only an inconsequential background noise in the receiver for typical communication systems.]

20. D. E. Burch, Investigation of the Absorption of Infrared Radiation by Atmospheric Gases, Philco Ford U 4784, January 1970. [Measured water vapor continuum absorption in 8-14 μm region versus wavelength for three temperatures.]

21. D. E. Burch, E. B. Singleton and D. Williams, "Absorption Line Broadening in the Infrared," Appl. Opt., Vol. 1, No. 3, pp. 359-363, May 1962. [Measured self and foreign broadening coefficients of N_2O, CO, CH_4, CO_2 and H_2O.]

22. D. E. Burch, R. R. Patty and D. A. Gryvnak, "Shapes of the Extreme Wings of CO_2 Absorption Lines," JOSA, Vol. 55, No. 5, p. 606, May 1965. [Experimental studies of spectral absorption by water vapor and CO_2 from 0.6 to 5.5 μm. Shapes of far wings depend on the band, the broadening gas, and the temperature. Abstracts only.]

23. D. E. Burch and D. A. Gryvnak, "Laboratory Investigation of the Absorption and Emission of Infrared Radiation," JQSRT, Vol. 6, No. 3, p. 229. [Experimental studies of spectral absorption by water vapor and CO_2 from 0.6 to 5.5 μm. Shapes of far wings depend on the band, the broadening gas, and the temperature.]

24. C. B. Burch, D. A. Gryvnak, R. R. Patty and C. E. Bartky, "Absorption of Infrared Radiant Energy by CO_2 and H_2O. IV. Shapes of Collision-Broadened CO_2 Lines," JOSA, Vol. 59, No. 3, pp. 267-280, March 1969. [Shapes of extreme wings of self-broadened CO_2 lines measured near 7000, 3800 and 2400 cm^{-1}.]

*25. D. E. Burch, et al., Philco Ford U 4897, 1971 (AD 882 876). [Measured water vapor and nitrogen continua absorption near 4 μm versus wavelength at four temperatures.]

26. D. E. Burch and D. A. Gryvnak, "Laboratory Measurements of the Infrared Absorption by H_2O and CO_2 in Regions of Weak Absorption," SPIE Vol. 142 Optical Properties of the Atmosphere, p. 16, 1978. [New information on the shapes of the extreme wings of the absorption lines. CO_2 lines absorb much less in the wings than Lorentz-shaped lines. H_2O lines appear to absorb more over a large portion of the wings than Lorentz-shaped lines. Absorption by the wings of all of the lines decreases unpredictably fast with increasing temperature.]

27. W. F. Caldwell, Atmospheric Attenuation of CO Laser Radiation in the Region 1720 cm^{-1} to 2080 cm^{-1}, Air University M.S. Thesis, March 1974.

28. R. F. Calfee and W. S. Benedict, Carbon Dioxide Spectral Line Positions and Intensities for the 2.05 and 2.7 Micron Regions, NBS Tech. Note 332, 1966.

29. H. R. Carlon, Introduction to Polymolecular Water Clusters and Their Infrared Activity, Rept No. ARCSL-TR-78014, Army Armament Research and Development Command, Aberdeen Proving Ground, Md, February 1978 (AD-A052 699/6ST). [Effects of polymolecular clusters of water upon infrared transmission of the atmosphere. A theoretical model for infrared absorption spectra due to intermolecular hydrogen bonding is developed. The very large differences in absorptivity between water in the vapor and liquid phases are explained, as are 'pressure-squared' and inverse temperature dependencies of water cluster absorption in the infrared.]

30. P. G. Cary, Measurements of the Attenuation of Electromagnetic Radiation by Water in the Visible Region of the Spectrum, Missouri Univ. M.S. Thesis, 1976 (PB 267 916/5 ST). [Absorption of electromagnetic radiation by water in the 418-640 nm wavelength region.]

31. R. Coulon, B. Oksengorn, S. Robin and B. Vodar, J. Phys. Radium, Vol. 14, No. 63, 1953. [Measured the molecular absorption in the 2331 cm^{-1} N_2 band, (pure N_2 up to 900 atm).]

32. W. H. Culver, A. J. Glass and J. L. Walsh, Atmospheric Propagation for Laser Applications, IDA S-229, April 1966 (AD 376 840).

33. J. A. Curcio, Absorption in the Atmosphere by the Oxygen Dimer (O) Complex at 1.06 Microns, NRL Prog. Rept. PB 173468, October 1966. [Measurements indicate $(O_2)_2$ absorption is important for long atmospheric paths (> 80 km) near sea level.]

34. E. K. Damon, J. C. Peterson, F. S. Mills and R. K. Long, Spectrophone Measurement of the Water Vapor Continuum at DF Laser Frequencies, Interim Rept. October 1 - December 30, 1974, OSU Electroscience Lab Rept No. ESL-4045-1 (AD-A016 435/OST). [Measurements are related to the absorption coefficients of CH_4, N_2O, HDO, and the known line structure of H_2O to infer the extinction coefficient arising from the water vapor continuum in the region 2550-2750/cm.]

35. E. M. Deutschman and R. F. Calfee, Two Computer Programs to Produce Theoretical Absorption Spectra of Water Vapor and Carbon Dioxide, ESSA IER 31-ITSA 31, April 1967.

36. V. I. Dianov-Klokov and V. M. Ivanov, "Mechanism of Absorption of $\lambda = 10.6\ \mu$ Laser Radiation by Atmospheric Water Vapor," Sov. J. Quant. Electron., Vol. 5, No. 7, p. 859. [These measurements are compared with the results of attenuation studies of solar radiation at ground level in the 8-12 μ. It is concluded that the dimer mechanism plays an important role in the attenuation of light by atmospheric water vapor in this spectral region.]

37. W. R. Edmonds, "Isoline Method of Portraying Atmospheric Attenuation of Laser Radiation," Appl. Opt., Vol. 14, No. 6, p. 1263, June 19[illegible]. [Described a method of portraying the effects of linear atmospheric absorption and scattering on the propagation of a laser beam from one general atmospheric point to another at almost any zenith angle.]

38. B. N. Edwards and D. E. Burch, "Absorption of 3.39 Micron He-Ne Laser Emission by Methane in the Atmosphere," JOSA, Vol. 55, No. p. 174, February 1965. [Measured in a cell as a function of pressure.]

39. Effects of the Atmosphere on the Propagation of Laser Radiation, OSU Summary Rept EES 324X-1 or North American Rockwell No. H921-SA-058136.

40. R. Farreng, C. Rossetti, F. Bourbonneux and P. Barchwitz, Compte Rend. Acad. Sc., Paris, Ser. B, Vol. 263, p. 241, 1966. [Measured absorption of CO_2-N_2 laser.]

41. D. L. Ford, Laser Absorption in the 5 Micron Band, RADC-TR-72-14[illegible], April 1972. [Shows effect of different parameters on calculation.]

*42. D. L. Ford, F. S. Mills, and R. K. Long, Laser Absorption in the 5 Micron Band, RADC-TR-72-195, July 1972. [Compares measurements and calculations for 8 CO lines at four total pressures. H_2O-N_2 mixtures. Calculations are somewhat high.]

43. P. S. Gillespie, R. L. Armstrong and K. O. White, The Spectral Characteristics and Atmospheric CO_2 Absorption of the Ho(+3): YLF Laser at 2.05 Micrometers, Army Electronics Command Rept No. ECOM-5583, December 1975. Pub. in: Appl. Opt., Vol. 15, No. 4, p. 865, April 1976 (AD-A025 618/OST). [The line center absorption coefficient at atmospheric concentrations of CO_2 (0.25 torr) determined from this work is 0.52 +/- 0.07 per km. An average value of the self-broadening coefficient is determined to be 0.44.]

44. R. B. Gomez and K. O. White, Erbium Laser Propagation in Simulated Atmospheres, I, Description of Experimental Apparatus and Preliminary Results, ASL White Sands Missile Range, NM, July 1969 (AD 69[illegible] 254). [Absorption measurements were made with path lengths varying from 400 to 1600 meters in a simulated atmosphere consisting of clean dry air. The initial experimentally measured attenuation of 1.54 micron radiation by clean dry air is less than 25% per km.]

45. K. Gullberg, Attenuation of CO_2 Laser Beams in the Atmosphere, Rept. No. FOA-2-A-2542-E3/E4/E6, Res. Inst. Natl. Def., Stockholm, Sweden (N73-11465). [Various information from the literature and measurement data have been examined and are presented in a summary. Attenuation at 10.6 microns is compared with data from two other laser wavelengths, 3.5 and 0.63 microns.]

46. J. N. Hamilton, J. A. Rowe and D. Anding, Atmospheric Transmission and Emission Program, Aerospace Rept. No. TOR-0073(3050-02)-3, 15 June 1973. [Description of Anding's band model. Discusses continuum absorption.]

47. E. L. Harris and W. J. Glowacki, Absorption of CO Laser Radiation by Water Vapor Near 5 Micrometers, Naval Ordnance Lab Rept. No. NOLTR-73-206, 26 November 1973 (AD 774 900/5).

48. L. Henry, "Interferometric Investigations of Water Vapor," Proc. Absorption of Laser Radiation in the Atmosphere, 4-5 April 1973, Mitre Corp. Rept. No. M73-86, p. 29, 1973. [Measured value 0.073 km^{-1} for P(20) line of the CO_2 laser (according to Long).]

49. I. I. Ippolitov, Yu. S. Makushkin and A. A. Orlov, "On the Calculation of the Monochromatic Absorption Coefficient in the Narrow Regions of the Oscillatory-Rotational Spectrum of H_2O," Trudy Mezh. Nauch. Sov. Spek. Proz. Atm. Vid. Inf. Obl. Sp., p. 39, 1968 (AD 759 238). [The basic absorbing component of the atmosphere in the infrared region of the spectrum is water vapor whose spectrum is characterized by the presence of a very large number of overlapped lines of absorption.]

50. I. I. Ippolitov, Optics & Spect., Vol. 27, No. 3, p. 458, 1969. [Continuum absorption at CO_2 laser (10.6 μm) due to limbs of far blue lines is 0.08 km^{-1} at humidity of 10 gm/m^3 at ground level.]

51. W. Q. Jeffers, McDonnell Douglas Res. Labs Rept. No. MDC-Q-0495, 23 May 1973. [Lowest absorption measured at 0.66 km^{-1} for P5(15) for near mid-latitude summer sea level condition. This is much worse than best calculated by Long.]

52. M. M. Johnson and A. H. LaGrone, Water Vapor Absorption Measurements Using a Ruby Laser, Texas Univ. Rept. No. P-32, 28 February 1969 (PB 183 466).

53. M. Kerker, et al., "The Range of Validity of the Rayleigh and Thomson Limits for Lorenz-Mie Scattering," JOSA, Vol. 68, No. 1, p. 135, January 1978. [The upper and lower limits are delineated for both absorbing and non-absorbing spheres.]

54. V. G. Kunde and W. G. Maguire, Direct Integration Atmospheric Slant Path Transmittance Model for Interpretation of High Spectral Resolution Planetary Thermal Emission Spectra, NASA Goddard Rept., January 1973.

55. R. M. Langer, "A Standard Optical Atmosphere for Lasers," Proc. 2nd Laser Conf., Vol. I, pp. 383-387, April 1965. [Calculated spectral attenuation for Krypton (1.7843 μm), Neon (2.10410 μm), and Argon (2.0616 μm).]

56. B. A. Lengyel and R. J. Romagnoli, Analytical Studies Pertaining to the Measurement of Light Absorption in Air, Final Rept. 1 February 1966 - 31 August 1968, San Fernando Valley State College, Northridge, CA (AD 679 590). [The effects of scattering, heat conduction, static and acoustic pressure variations are examined and are related to the problem of detecting the signals produced by the absorption of heat from the laser beam. The absorption coefficient of the 10.6 micron carbon dioxide laser beam was measured in air.]

57. R. K. Long, "Atmospheric Attenuation of Ruby Lasers," Proc. IEEE, Vol. 51, pp. 859-860, May 1963. [Indicated the absence of water vapor attenuation at 6943 A from 6933 to 6946 A (showing lines absorption by O_2 and H_2O), with corresponding laser position versus temperature.]

58. R. K. Long, Absorption of Laser Radiation in the Atmosphere, OSU PhD Thesis, Rept No. 1579-3, 1963 (AD 410 571). [Presented a study of molecular resonance absorption, over the 0.6 to 20.0 micron wavelength region. The absorption at more than one hundred laser frequencies was determined.]

59. R. K. Long, Atmospheric Absorption and Laser Radiation, OSU Bulletin 199, 1967. [Gives table of laser line positions (reproduced in Zuyev).]

60. R. K. Long, Laser Absorption in the 5 Micron Band, OSU Rept No. 3271-1, RADC-TR-71-314, November 1971. [Discusses computer codes and experimental set-up. Gives sample calculations for only H_2O, shows relative power at various CO lines.]

61. R. K. Long and T. H. Lewis, In collection entitled: Laser and Applications, Columbus, OH, p. 209, 1963. [Measured absorption of He-Ne laser at 1.15 μm. Agrees satisfactorily with those of Zuyev.]

62. R. K. Long and J. H. McCoy, "Atmospheric Absorption of 10.6 μ CO_2 Laser Radiation," JOSA, Vol. 57, No. 4, p. 570, April 1967. [Measured absorption of CO_2 laser radiation in cell with N_2.]

63. R. K. Long, F. S. Mills, Infrared Line Shape Using a Tunable 2.01 Micron He-Xe Laser, OSU Final Rept. No. ESL-2834-2, April 1972 (AD 751 230). [Line widths of CO_2 were measured in the near Doppler pressure region (0.5 to 3.0 torr) and excellent agreement with Voight profile theory was achieved.]

64. R. K. Long, et al., "Water-Vapor bsorption Measurements Using a Single Frequency CO Laser," JOSA, Vol. 62, p. 1382A, 1972. [Measured transmittance of H_2O broadened by N_2 for eleven CO laser frequencies in white cell. Abstracts only.]

*65. R. K. Long, F. S. Mills and G. L. Trusty, Experimental Studies of the Partial and Total Pressure Dependence of Water Vapor Absorption Coefficients for Highly Transmitting CO Laser Lines, OSU Rept. No. 3271-4, RADC-TR-73-125, February 1973. [Calculated versus measured eleven CO lines (calculations always ~10% high).]

66. R. K. Long, F. S. Mills and G. L. Trusty, Experimental Absorption Coefficients for Eleven CO Laser Lines, OSU Rept No. 3271-5, RADC-TR-73-126, March 1973. [Measured versus calculated for eleven CO lines. 74 F, 1 atm, H_2O pressure 1.5-15 torr. Lorentz calculation always lower ~40%. Describes modified shape. "Only accurate measurements available."]

*67. R. K. Long, F. S. Mills and G. L. Trusty, Measured Water Vapor Absorption Coefficients for Two Highly Absorbed CO Laser Lines, RADC-TR-73-225, June 1973. [P11(12) - Good agreement between two measurements (white cell and spectrophone) and Lorentz but Rice measurements are low. P9(16) - Blended 4% with P10(10); Modified 9% low; Lorentz 35% low.]

68. R. K. Long, F. S. Mills and G. L. Trusty, Calculated Absorption Coefficients for DF Laser Frequencies, RADC-TR-73-389, November 1973. [Describes calculated procedure and presents DF results.]

*69. R. K. Long and F. S. Mills, Calculated Absorption Coefficients for Lo-Vibrational CO Laser Frequencies, OSU Rept. No. 3271-8, RADC-TR-74-95, March 1974. [115 CO lines calculated using AFCRL tape. P5(1-20), P4(1-25), P3(1-25), P2(1-25), P1(6-25) for mid-latitude summer model at three altitudes (0, 3 and 6 km).]

70. R. K. Long, F. S. Mills and E. K. Damon, Molecular Absorption Studies Using Infrared Lasers (CO, DF, CO_2), Presented at Laser Radar Conf., Sendai, Japan, and 2nd High Resolution Spectroscopy Symposium, Novosikirski, USSR, July 1974.

71. A. W. Mantz, E. R. Nichols, B. D. Alpert and K. N. Rao, "CO Laser Spectra Studied with a Ten Meter Vacuum Infrared Grating Spectrograph," J. Mol. Spect., Vol. 35, No. 2, pp. 325-328, 1970. [Measured positions of CO laser lines accurately.]

*72. R. A. McClatchey, Atmospheric Attenuation of CO Laser Radiation, AFCRL-71-0370, July 1971 (AD 729 447). [On high frequency end, there is significant absorption by CO_2 and O_2, and on low end by N_2O and CH_4. Calculations for midlatitude winter. For good transmitters, these other models and altitudes given.]

*73. R. A. McClatchey, R. W. Fenn, J. E. A. Selby, F. E. Volz and J. S. Garing, Optical Properties of the Atmosphere (Revised), AFCRL-71-0279, 10 May 1971. [A selected set of laser frequencies has been defined for which monochromatic transmittance values have been given.]

*74. R. A. McClatchey and J. E. A. Selby, Atmospheric Attenuation of HF and DF Laser Radiation, AFCRL-72-0312, 23 May 1972 (AD 747 010). [A series of tables was constructed providing quantitative attenuation information for each of 97 laser lines for 10 different atmospheric models. Data based on two different aerosol scattering models are included in these tables.]

75. R. A. McClatchey, et al., Optical Properties of the Atmosphere (Third Edition), AFCRL-72-0497, 24 August 1972 (AD 753 075). [A series of tables and charts is presented from which the atmospheric transmittance between any two points in the terrestrial atmosphere can be determined.]

*76. R. A. McClatchey and J. E. A. Selby, Atmospheric Transmittance, 7-30 Micrometers: Attenuation of CO_2 Laser Radiation, AFCRL-72-0611, 12 October 1972 (AD 753 076). [High resolution calculated transmittance curves are presented for the spectral region 320-1400 wavenumbers. Attenuation coefficients of 41 CO_2 rotational laser lines in the 10.4 micrometer band system (v3 to v1).]

*77. R. A. McClatchey and J. E. A. Selby, Atmospheric Attenuation of Laser Radiation from 0.76 to 31.25 µm, AFCRL-TR-74-0003, 3 January 1974 (AD 779 726/9). [High resolution atmospheric transmittance calculations are presented (0.7575 to 31.25 micrometers).]

*78. R. A. McClatchey, J. E. A. Selby and J. S. Garing, Optical Modelling of the Atmosphere, AGARD Conf. Proc. No. 183, October 1975 (AD-A028 615). [Discusses the pertinent atmospheric properties of temperature, pressure and constituent distributions. The AFCRL atmospheric absorption line parameters compilation is then described, indicating the requirements for such a data compilation and some of the omissions and uncertainties.]

79. R. A. McClatchey and A. P. D'Agati, Atmospheric Transmission of Laser Radiation Computer Code LASER, AFGL-TR-78-0029, 31 January 1978. [Calculates monochromatic extinction coefficients for both molecular and particulate components of the atmosphere.]

80. J. H. McCoy, Atmospheric Absorption of Carbon Dioxide Laser Radiation Near Ten Microns, OSU ESL Rept. No. 2476-2, 10 September 1968 (AD 839 938).

81. J. H. McCoy and R. K. Long, "P(20) and P(16) Carbon Dioxide Line Strengths Determined from Transmittance Measurements in the Doppler Region," Appl. Opt., Vol. 8, No. 4, pp. 834-835, April 1969.

*82. J. H. McCoy, D. B. Rensch and R. K. Long, "Water Vapor Continuum Absorption of Carbon Dioxide Laser Radiation Near Ten Microns," Appl. Opt., Vol. 8, No. 7, p. 1471, July 1971. [Measured the nitrogen broadening coefficient (C_b = 0.005 C_s) of water vapor continuum absorption at room temperature at 10.6 µm.]

83. T. B. McCubbin and T. R. Mooney, "A Study of the Strengths and Widths of Lines in the 9.4 and 10.4 μ CO_2 Bands," JQSRT, Vol. 8, pp. 1255-1264, 1968.

84. J. C. F. McDonald, U. of Toronto PhD Thesis, 1951. [Pure N_2 and N_2+ foreign gas at densities up to 150 Amagat units.]

85. R. T. Menzies and M. S. Shumate, "Optoacoustic Measurements of Water Vapor Absorption at Selected CO Laser Wavelengths in the 5 μm Region," Appl. Opt., Vol. 15, No. 9, p. 2025, September 1976. [Water vapor absorption coefficients at the wavelengths of the following CO laser lines 6-5 P(15)-P(20), 7-6 P(13)-P(19), 8-7 P(14)-P(17), 9-8 P(9)-P(14) are tabulated. The measurements were made with a resonant optoacoustic detector.]

86. R. E. Meredith, T. W. Tuer and D. R. Woods, Investigation of DF Laser Propagation, SAI Final Rept. No. SAI-74-001-AA, December 1974 (AD-A005 631/7ST). [Molecular absorption coefficients are calculated in the region of 27 important DF laser wavelengths for typical sea level conditions. The important absorption mechanisms for this region are discussed and improved modeling procedures are suggested.]

87. A. Miller, R. L. Armstrong and C. W. Welch, Research in the Area of Atmospheric Modeling: High Resolution Atmospheric IR Transmittance Prediction, Rept No. NMSU-PHYS-537-74-1, June 1974 (AD 780 914/8). [The basic elements of line-by-line prediction of atmospheric transmittance at infrared wavelengths, and the quantum mechanical bases of line parameters computation are reviewed. A FORTRAN IV(G) computer program using the AFCRL Atmospheric Absorption Line Parameters Data Compilation tape for high resolution transmittance prediction under homogeneous conditions is presented together with running instructions.]

88. F. S. Mills, Absorption of Deuterium Fluoride Laser Radiation by the Atmosphere, Interim Rept. July 1 - September 30, 1975, OSU Electroscience Lab Rept. No. ESL-4054-3 (AD-A025 402/9 ST).

89. F. S. Mills, R. K. Long and C. L. Trusty, "Atmospheric Absorption Measurements Using a Single Frequency HF-DF Laser," 28th Symposium on Molecular Structure & Spectroscopy, 11-15 June 1973, Columbus, OH. [Comparison is made between the measured data and calculations based on line parameter tabulations.]

90. A. P. Modica and H. Kleiman, Statistics of Global IR Atmospheric Transmission, MIT/LL Project Rept. No. TT-7, 3 March 1976 (AD-A024 311/3ST). [Predicts seasonal probabilities for horizontal sea level transmission losses for several narrow IR bands (1.0-1.2), (3.8-4.2), (8.0-11.5 micrometers) and 4 laser lines (1.06), (3.83), (4.73) and (10.6 micrometers). The results also include cloud-free line-of-sight probabilities and attenuation losses through rain.]

91. S. A. Munjee and W. H. Christiansen, "Mixed Mode Contributions to Absorption in CO_2 at 10.6 μ," Appl. Opt., Vol. 12, No. 5, pp. 993-996, May 1973. [A rise in temperature in a molecular system causes higher energy levels to become more populated. For the case of CO_2 absorption, calculations based only on single line considerations are sometimes inappropriate as the contributions from some higher energy levels can be appreciable. The paper summarized this effect for 10.4 μ band of CO_2. Calculations are compared with measurements of others.]

92. S. S. R. Murty, Atmospheric Transmission of CO_2 Laser Radiation with Application to Laser Doppler Systems, NASA-TM-X-64987, 28 November 1975 (N76-18436/5 ST). [Molecular absorption coefficients of carbon dioxide, water vapor, and nitrous oxide are calculated at the P16, P20, P22, and P24 lines of the CO_2 laser for temperatures from 200 to 300 K and for pressures from 100 to 1100 mb.]

93. E. H. Newman and G. L. Trusty, Absorption of Five to Six Micron Carbon Monoxide Laser Radiation by Water Vapor, August 1971 (AD 887 433 L).

94. R. J. Nordstrom, et al., "Effects of Oxygen Addition on Pressure-Broadened Water-Vapor Absorption in the 10 μm Region," Appl. Opt., Vol. 17, No. 17, p. 2724, September 1978. [Measured monochromatic transmittances at five CO_2 laser frequencies in an absorption cell.]

95. U. P. Oppenheim, "Atmospheric Transmission of N_2O Laser Energy," 24th Symp. on Molecular Structure & Spectroscopy, 2-6 September 1969, Columbus, OH. [10 m long absorption cell. The strongest lines of N_2O occurring around P(19), are not obstructed by CO_2 in the atmosphere.]

96. S. Passman and L. Larmore, Proc. IRIS, Vol. 1, No. 2, p. 15, 1956. [Data on absorption by water vapor and methane.]

97. R. R. Patty, G. M. Russwurm, W. A. McClenny and D. R. Morgan, "CO_2 Laser Absorption Coefficients for Determining Ambient Levels of O_3, NH_3, and C_2H_4," Appl. Opt., Vol. 13, No. 12, P. 2850, December 1974. [Measurements of absorption coefficients for dilute absorber-air mixtures are described. The absorbers are NH_3, C_2H_4, and O_3.]

98. R. R. Patty, E. R. Manring and J. A. Gardner, "Determination of Self-Broadening Coefficients of CO, Using CO_2 Laser Radiation at 10.6 μm," Appl. Opt., Vol. 7, No. 11, pp. 2241-2245, November 1968. [Monochromatic radiation with a frequency corresponding to the frequency of the line center of P(20) line of the 961 cm^{-1} CO_2 band was obtained from a CO_2 laser. Using this radiant energy, transmittances of CO_2 samples were measured as various broadening gases were added.]

99. S. S. Penner, "Effect of Dimerization on the Transmission of Water Vapor Near-Infrared," JQRST, Vol. 13, p. 383, 1973 (AD 762 835).

100. C. M. Randall, Monochromatic Transmittance/Radiance Computations, Aerospace Rept. No. ATM 74(4647)-6, 1974. [An efficient computer program to calculate line-by-line (using AFGL compilation) through an inhomogeneous atmosphere at any zenith angle.]

101. S. P. Reddy and C. W. Cho, "Induced Infrared Absorption of Nitrogen and Nitrogen-Foreign Gas Mixtures," Can. J. Phys., Vol. 43, pp. 2331-2343, 1965. [N_2 continuum absorption was measured in the 2331 cm^{-1} band up to 1500 atm at room temperature with A, H, He.]

102. D. K. Rice, Absorption Measurements of Carbon Monoxide Laser Radiation by Water Vapor, Northrop Rept. No. NLSD 72-11R, July 1972 (AD 746 170). [Water vapor cell results indicate that the existing theoretical models are inadequate for predicting actual absorptance values for water vapor partial pressures in excess of 100 torr.]

*103. D. K. Rice, "Absorption Measurements of Carbon Monoxide Laser Radiation by Water Vapor," Appl. Opt., Vol. 12, No. 2, pp. 218-225, February 1973.

104. D. K. Rice, "Absorption Measurements of Carbon Monoxide Laser Radiation by Water Vapor," JOSA, Vol. 62, p. 1381A, 1972. [CO laser (19 lines) absorption measured in water cell. Abstracts only.]

105. D. K. Rice, "Atmospheric Attenuation Measurements for Several Highly Absorbed CO Laser Lines," Appl. Opt., Vol. 12, No. 7, pp. 1401-1403, July 1973.

106. D. K. Rice, Carbon Monoxide Spectral Line Selection Studies, Northrop Rept No. NLSD72-13R, August 1972 (AD 749 823).

*107. R. E. Roberts, J. E. A. Selby and L. M. Biberman, Infrared Continuum Absorption by Atmospheric Water Vapor in the 8-12 μm Window, Final Report October 1975 - March 1976, IDA Rept No. P-1184, April 1976 (AD-A025 377/3ST). [Detailed analysis of several long path length transmission measurements in the 8-12 micrometer atmospheric window in order to determine the extinction coefficient due to the water vapor continuum.]

108. C. Rossetti, F. Bourbonneux, R. Farreng and P. Barchwitz, Comptes Rend. Acad. Sc., Paris, Ser. B, Vol. 262, p. 1684. [Measured absorption of CO_2-N_2 laser.]

109. C. Rossetti and P. Barchwitz, Comptes Rend. Acad. Sc., Paris, Ser. B, Vol. 262, p. 1966. [Measured absorption of CO_2-N_2 laser.]

110. L. S. Rothman, "High-Resolution Atmospheric Transmittance and Transmittance," SPIE Vol. 142 Optical Properties of the Atmosphere, p. 2, 1978. [Status and updating of the AFGL Atmospheric Absorption Line Parameter Compilation is discussed. A new code has been developed which calculates absorption coefficients at equally spaced wavenumber intervals through multilayer atmospheric paths with a great deal of computational advantages realized.]

111. R. K. Seals, Jr., "Atmospheric Windows for HF Laser Radiation Between 2.7 μ and 3.2 μ," Appl. Opt., Vol. 11, No. 12, p. 2979, December 1972. [A high resolution computer model study of the atmospheric transmittance.]

112. R. K. Seals, Jr. and C. H. Bair, 2nd Joint Conf. on Sensing of Environmental Pollutants, Washington, D.C., 1973.

113. J. E. A. Selby and R. A. McClatchey, Atmospheric Transmittance from 0.25 to 28.5 Microns: Computer Code LOWTRAN 3, AFCRL-TR-75-0255, 7 May 1975 (AD-A017 734/5ST). [LOWTRAN 3 is described for calculating the transmittance of the atmosphere in the spectral region from 0.25 to 28.5 micrometers at a spectral resolution of 20 cm. Also discusses continuum model.]

114. J. E. A. Selby, et al., Atmospheric Transmittance/Radiance: Computer Code LOWTRAN 4, AFGL-TR-78-0053, 28 February 1978. [Upgrades LOWTRAN to include calculation of atmospheric radiance, and include the absorption due to HNO_3 (10-12 μm).]

115. R. C. Sepucha, N_2 Scattering Measurements at 10.6 Microns, Final Report 11 July 1972 - 31 May 1974, Aerodyne Rept No. ARI-RR-51 (AD 784 723/9)

116. M. M. Shapiro and H. P. Gush, "The Collision-Induced Fundamental and First Overtone Bands of Oxygen and Nitrogen," Can. J. Phys., Vol. 44, pp. 949-963, May 1966. [Measured nitrogen continuum absorption near 4 μm.]

117. M. S. Shumate, et al., "Water Vapor Absorption of Carbon Dioxide Laser Radiation (Optoacoustic Detector Measurement)," Appl. Opt., Vol. 15, No. 10, p. 2480, October 1976. [Reports measurements of absorption coefficients of water vapor at 49 wavelengths in the range 9.2-10.7 μm obtained from the p and r branches of both the 9.4 μm and 10.4 μm bands from a laser.]

118. R. L. Sitton, et al., "The AMC Tactical Laser Measurements Program (U)," Proc. 5th Laser Conf, Vol. II, p. 53, April 1972 (Confidential). [Defines tactical environment and presents data on laser performance.]

119. F. G. Smith, et al., Calculations and Analyses in Support of Atmospheric Sciences Laboratory DF and CO_2 Measurements, SAI-75-006-AA, Science Applications, Inc., Ann Arbor, MI, November 1975. [Monochromatic extinction (including continuum) as a function of temperature and pressure.]

*120. D. J. Spencer, G. C. Denault and H. H. Takimoto, "Atmospheric Gas Absorption at DF Laser Wavelengths," Appl. Opt., Vol. 13, No. 12, p. 2855, December 1974. [Good agreement is found between experimental and theoretical absorption coefficients.]

121. J. C. Stephenson, W. A. Haseltine and C. B. Moore, "Atmospheric Absorption of CO_2 Laser Radiation," Appl. Phys. Letter, Vol. 11, No. 5, p. 164, 1 September 1967 (AD 678 238). [Calculated from laboratory absorption coefficient measurements.]

122. J. Susskind and J. E. Searl, "Synthetic Atmospheric Transmittance Spectra Near 15 and 4.3 μm," JQSRT, Vol. 19, p. 195, 1978.

123. G. L. Trusty, Absorption Measurements of the 10.4 Micron Region Using a CO_2 Laser and a Spectrophone, OSU Rept. No. 2819-4, AFAL-TR-72-413, January 1973 (AD 907 549/0ST). [Absorption measurements of carbon dioxide and water vapor-nitrogen and mixtures were made in the 10.4 micron region.]

124. R. P. Urtz, RADC Laser Propagation Program, Proc. Laser Propagation Meeting, MIT/LL, Vol. II, October 1969.

125. R. C. Waring, M. R. Querry, P. G. Cary and R. Jordan, Measurement of Absorption Coefficients of Water in the Visible Spectral Region (Phase I and II), Mo. Water Resources Research Center, Office of Water Research & Technology, Wash. D.C., January 1978 (PB 281 500/9ST). [The attenuation coefficient of deionized filtered water was measured in the wavelength region 418-640 nm and 660-695 nm. A tunable dye laser provided a source of quasimonochromatic electromagnetic radiation.]

126. P. Wendling and H. J. Bolle, Comparison of Measured and Calculated Atmospheric Transmission Spectra in the Spectral Region of 3.9 Micrometers, Rept. No. BMVG-FBWT-73-11, Ludwig-Maxmilians-Univ., Munich, W. Ger., Inst. Fur Meteor., 1973 (N73-32297/6)

127. K. O. White and W. R. Watkins, "Erbium Laser as a Remote Sensor of Methane," Appl. Opt., Vol. 14, No. 12, p. 2812, December 1975. [Curves give the results of calculations for a homogeneous atmosphere to determine the change in a transmitted beam as a function of path length and the change in a backscattered beam as a function of range up to 10 km for various changes in the methane concentration.]

128. K. O. White, E. H. Holt, S. A. Schleusener and R. F. Calfee, "Erbium Laser Propagation in a CO_2 Atmosphere in the Near Infrared," AGARD Conf. Proc. No. 90 on Propagation Limitations in Remote Sensing, 21-25 June 1971, Colorado Springs, CO. [Data and theoretical calculations are presented for a 480 m path length.]

129. K. O. White, E. H. Holt, S. A. Schleusener and R. F. Calfee, Erbium Laser Propagation in Simulated Atmospheres. II. High Resolution Measurement Method, ASL White Sands Missile Range, August 1971 (AD 731 211). [The transmission of laser energy in a carbon dioxide medium was measured in the 1.54 micrometer spectral region with a nominal resolution of 0.02 nonameter.]

130. K. O. White, S. A. Schleusener, E. H. Holt and R. F. Calfee, "High Resolution Laser Atmospheric Transmission Measurement Method," Appl. Phys. Letter, Vol. 19, No. 10, p. 381, 15 November 1971. [Experimental results of erbium-laser propagation losses in CO_2 with a spectral resolution of 0.015 nm are compared with a theoretical calculation.]

131. K. O. White, W. R. Watkins and S. A. Schleusener, "Holmium 2.06 μm Laser Spectral Characteristics and Absorption by CO_2 Gas," Appl. Opt., Vol. 14., No. 1, p. 16, January 1975. [Absorption coefficients of CO_2 gas as a function of partial pressure at the laser wavelength.]

132. K. O. White, W. R. Watkins and C. W. Bruce, Water Vapor Absorption Measurements Using a Line Tunable Deuterium Fluoride Laser, Army Electronics Command, White Sands Missile Range, N.M., 1976 (AD-A026 165/1ST). [This study concerns DF laser propagation (3.5-4.1 micrometers).]

*133. K. O. White, W. R. Watkins, C. W. Bruce, R. E. Meredith and F. G. Smith, Water Vapor Continuum Absorption in the 3.5-4.0 Micrometers Region, Tech. Rept. No. ERADCOM/ASL-TR-0004, March 1978 (AD-A055 580/5ST). [Measurements of water vapor continuum absorption in the 3.5-4.0 micrometer region are presented. The measurements were made with both long-path absorption cell and spectrophone systems.]

134. K. O. White, et al., "Water Vapor Continuum Absorption in the 3.5-4.0 μm Region," Appl. Opt., Vol. 17, No. 17, pp. 2711-2720, September 1978. [Measurements in long path white cell and spectrophone using a tunable DF laser on normal and deuterium depleted water. At 65°C results agree with others, but factor of 2 greater at 23°C.]

135. B. H. Winters, S. Silverman and W. S. Benedict, JQRST, Vol. 4, p. 527, 1964. [Experimental studies indicate absorption coefficient for 4.3 μm CO_2 band diminishes faster than Lorentz. Proposed Benedict profile.]

136. D. R. Woods, et al., High Resolution Spectral Survey of Molecular Absorption in the DF Laser Region - Measurements and Calculations, Interim Tech. Rept. 1 August 1974 - 1 February 1975, RADC-TR-75-180 (AD-A013 736/4ST). [High resolution lab measurements of air-broadened spectra of N_2O, HDO and CH_4. Found significant discrepancies with AFGL parameters.]

*137. D. R. Woods and R. E. Meredith, Application of High Resolution Spectroscopy to DF Laser Propagation, Final Tech. Rept. 1 March - 31 August 1975, SAI-76-001-AA, Science Applications, Inc., Ann Arbor, Michigan (AD-A023 823/8ST). [Measurements have been made of the important HDO molecular absorption line parameters near a number of DF laser lines. While the line positions are in good agreement with the values given by the 'AFCRL Atmospheric Absorption Line Parameters Compilation,' there are significant differences for a number of the line strengths, and small differences for the particular line widths reported here.]

138. D. R. Woods, W. Flowers, R. E. Meredith, T. W. Tuer and J. P. Walker, DF Laser Propagation Analysis, Final Report 5 January - 3 December 1976, SAI-77-001-AA, Science Applications, Inc., Ann Arbor, MI (AD-A037 813/3ST). [A simple analytic model has been developed for each DF laser line. The model allows the laser transmission to be simply calculated for any arbitrary temperature or humidity.]

139. D. R. Woods, et al., CO Laser Atmospheric Absorption Coefficient Modeling, SAI-78-004-AA, Science Applications, Inc., Ann Arbor, MI, March 1978. [High resolution lab measurements of line parameters indicate Lorentz shape may be correct (using new parameters and larger cutoff frequency of calculation).]

140. P. K. L. Yin and R. K. Long, "Atmospheric Absorption at the Line Center of P(20) CO_2 Laser Radiation," Appl. Opt., Vol. 7, No. 8, pp. 1551-1553, August 1968. [Atmospheric CO_2 absorption at the line center of P(20) CO_2 laser radiation has been calculated at different altitudes. In the calculation, the absorption caused by water vapor has not been included.]

141. C. J. Young, "Calculation of the Absorption Coefficient for Lines with Combined Doppler and Lorentz Broadening," JQSRT, Vol. 5, pp. 549-552, 1965. [Fortran program to calculate Voigt profile.]

142. C. J. Young, R. W. Bell and R. E. Chapman, "Variation of N_2-Broadened Collisional Width with Rotational Quantum Number for the 10.4 μm CO_2 Band," Appl. Phys. Letters, Vol. 20, No. 8, pp. 278-279, April 1972.

143. V. Ye. Zuyev, Sov. Phys. J., No. 10, p. 53, 1967. [Experimental determination of absorption of laser radiation.]

144. V. Ye. Zuyev, V. V. Pokasov, Yu. A. Pkhalagov, A. V. Sosnin, and S. S. Khmelevtsov, Atm. & Ocean. Phys., Vol. 4, No. 1, p. 63, 1968. [Experimental determination of absorption of laser radiation.]

145. V. Ye. Zuyev, A. V. Sosnin and S. S. Khmelevtsov, Atm. & Ocean. Phys., Vol. 5, No. 2, p. 201, 1969. [Experimental determination of absorption of laser radiation.]

146. V. Ye. Zuyev, Paper presented at 7th All-Union Conf. on Actinometry & Atmospheric Optics, 27-31 May 1968, Leningrad. [Experimental determination of absorption of laser radiation.]

2. MOLECULE CONDITIONS

147. E. W. Barrett, L. R. Herndon and H. J. Carter, "Some Measurements of the Distribution of Water Vapor in the Stratosphere," Tellus, Vol. 2, No. 4, p. 302, 1950. [Balloon borne hygrometer measurements to 30 km are presented.]

148. R. L. Bowman and J. Shaw, "The Abundance of Nitrous Oxide, Methane, and Carbon Dioxide in Ground Level Air," Appl. Opt., Vol. 2, No. 2, p. 176, 1963. [Measured atmospheric concentration of CH_4 (1.7 ± 0.3 ppm), N_2O (0.28 ± 0.4 ppm), and CO (1 - 2 ppm). Considerable variation in CO concentration in Columbus, OH.]

149. C. J. Brasefield, "Measurements of Atmospheric Humidity Up to 35 Kilometers," J. Meteor., Vol. 11, No. 5, pp. 412-416, 1954. [Several balloon borne hygristor measurements are given.]

150. K. F. Chackett, F. A. Paneth and E. J. Wilson, "The Chemical Composition of the Stratosphere at 70 Km Height," J. Atmos. & Terr. Phys., Vol. 1, No. 1, 1950.

151. K. F. Chackett, F. A. Paneth, P. Reasbeck and B. S. Wiborg, "Variations in the Chemical Composition of Stratosphere Air," Nature, Vol. 168, 1951.

152. T. A. Chubb, H. Friedman, J. B. Kupperian and E. T. Byram, "The Use of Radiation Absorption and Luminescence in Upper Air Density Measurements," Ann. Geophys., Vol. 14, No. 1, 1958.

153. V. E. Derr, R. F. Calfee, Spectral Transmission of Water Vapor from 1 to 12000 cm^{-1} at Low Concentration and Low Temperature, Technical Memo, Rept No. NOAA-TM-ERL-WPL-24, Natl. Oceanic & Atmos. Admin., Bounder, CO, July 1977 (PB 272 137/1ST). [The transmittance at water vapor in the spectral range 0-12000/cm is presented for T = 245 K, a pressure of 0.66 atmospheres, and for five values of total precipitable water content between 2.1 and 1070 micrometers.]

154. H. U. Dutsch, "Vertical Ozone Distribution from Umkehr Observations," Archives of Meteor., Geophys., & Bioclim., Vol. All, No. 2, 1959.

155. U. Fink, D. H. Rankj and T. A. Wiggins, "Abundance of Methane in the Earth's Atmosphere," JOSA, Vol. 54, No. 4, p. 472, 1964. [Atmosphere concentration of CH_4 was measured (1.16 ± 0.16 cm-atm (NTP)) using solar spectroscopy.]

156. W. L. Godson, "Total Ozone and the Middle Stratosphere Over Arctic and Subarctic Areas in Winter and Spring," QJRMS, Vol. 86, p. 301, 1960. [Measurements at sea level are given for several European locations for several month periods.]

157. M. Gutnik, Appl. Opt., Vol. 1, No. 5, p. 670, 1962. [Summarizes measurements of humidity in the stratosphere.]

158. W. Hitschfeld and J. T. Houghton, "Radiative Transfer in the Lower Stratosphere Due to the 9.6 Micron Band of Ozone," QJRMS, Vol. 87, No. 374, 1961. [Measured ozone concentration and temperature as a function of altitude to 30 km.]

159. J. T. Houghton and J. S. Seeley, "Spectroscopic Observations of the Water-Vapor Content of the Stratosphere," QJRMS, Vol. 86, p. 358, 1960. [Inferred from solar spectrum measurements from aircraft up to 48000 ft.]

160. J. T. Houghton, In collection entitled: Meteorological Problems of the Stratosphere and the Mesosphere, Presses Univ. de France 108, Blvd. St-Germain, Paris, 1966. [Survey of humidity measurements in the stratosphere.]

161. W. Jessen, "Variations in Absolute Humidity as Influencing Atmospheric Infrared Transmission," IR Phys., Vol. 16, No. 5, p. 561, August 1976. [Statistics on absolute humidity for a meteorological station in southern Germany are presented.]

162. C. D. Keeling, "The Concentration and Isotopic Abundances of Carbon Dioxide in the Atmosphere," Tellus, Vol. 12, No. 2, p. 200, 1960. [Concentration of CO_2 in the atmosphere is shown to be highly variable (but not as high as previous measurements).]

163. V. V. Lukshin, O. A. Matveeva, I. Ya. Sklyarenko, "Determination of the Surface Concentration of Methane in the Atmosphere," Atmos. & Oceanic Phys., Vol. 13, No. 1, p. 97, January 1977. [The surface concentration of methane in the atmosphere was determined by measuring the degree of absorption by the gas of the radiation emitted by a He-Ne laser of wavelength 3.39 microns.]

*164. R. A. McClatchey, et al., AFCRL Atmospheric Absorption Line Parameters Compilation, AFCRL-TR-0096. [The most comprehensive compilation available.]

165. T. K. McCubbin, Jr. and R. Darone, "The Use of a CW Molecular Laser to Probe Line Widths and Strengths," JOSA, Vol. 56, No. 4, p. 555, 1966. [Measured absorption of CO_2-N_2 laser in a cell with various mixtures and pressures. Determined strengths and widths of absolute lines. Abstract only.]

166. M. Migeotte, L. Neven and J. Swenson, Met. Soc. Sci., Liege (Spec. issue), 1956. [Atmospheric concentration of CH_4, N_2O, and CO.]

167. Miller and Constant, Variations in the Atmospheric CO_2 Concentrations and Their Measurements, January 1961 (AD 461 770). [Review of CO_2 content variations.]

168. P. M. Moser, Annual Absolute Humidity Probabilities for Selected Marine Locations, Technical Memo, Rept. No. NADC-20303B-PMM, 24 Feb 1973 (AD-A045 248/2ST). [Provides, in the forms of histograms and graphs, percent frequencies of occurrence and cumulative percent frequencies of occurrence, respectively of the various concentrations of atmospheric water vapor for each of 21 maritime sites throughout the northern hemisphere over the entire year.]

169. D. G. Murcray, F. H. Murcray, W. J. Williams and F. E. Leslie, "Water Vapor Distribution Above 90,000 Ft.," J. Geophys. Res., Vol. 65, No. 11, p. 3641, 1960. [Humidity mixing ratio from 40 to 92 kft calculated from measured absorption in the 6.3 μm band of water vapor.]

170. R. J. Murgatroyd, P. Goldsmith and W. E. H. Hollings, "Some Recent Measurements of Humidity from Aircraft Up to Heights of About 50,000 Ft. Over Southern England," QJRMS, Vol. 81, No. 350, 1955. [The humidity of air was measured with a pressurized Dobson-Brewer hygrometer on an aircraft up to 50,000 ft.]

171. B. S. Neporent, V. F. Belov, O. D. Dmitriyevskiy, G. A. Zaytsev, V. G. Kastrov, M. S. Kiseleva, L. A. Kudryabtseva and I. V. Patalakhin, "A Test of Direct Measurement of the Vertical Distribution of Atmospheric Moisture by the Spectral Method," Geophysics, No. 4, 1957.

172. L. S. Rothman, "Update of the AFGL Atmospheric Absorption Line Parameters Compilation," Appl. Opt., Vol. 17, No. 22, pp. 3517-3518, November 1978. [Announced a new version of the compilation that updates the parameters for H_2O, CO_2, CH_4 and O_2.]

173. L. S. Rothman and R. A. McClatchey, "Updating of the AFCRL Atmospheric Absorption Line Parameters Compilation," Appl. Opt., Vol. 15, p. 2616, 1977. [Warns of error in tapes (eg., CO_2 band at 1063.734 cm^{-1}).]

174. L. S. Rothman, et al., "AFGL Trace Gas Compilation," Appl. Opt., Vol. 17, No. 4, p. 507, 1978. [Announces the available of a compilation of line parameters for various atmospheric trace gases and pollutants (NO, SO_2, NO_2 and NH_3) from 5 to 2940 cm^{-1}.]

175. J. S. Seeley and J. T. Houghton, IR Phys., Vol. 1, No. 2, p. 116, 1961. [Atmospheric concentration of CH_4, N_2O, CO.]

176. J. H. Shaw, Astrophys. J., Vol. 128, p. 428, 1958. [Atmospheric concentration of CH_4, N_2O, CO.]

177. N. Sissenwine, et al., Humidity Up to the Mesopause, AFCRL-68-0550, 1978.

178. H. U. Sverdrup, "The Humidity Gradient Over the Sea Surface," J. Meteorol., Vol. 3, pp. 1-8, March 1946.

179. P. Tomislav, Meteorol. Zpravy, Vol. 8, No. 5, 1955. [Concentration of CO_2 in the atmosphere.]

180. T. P. Toropova, "Determining Atmospheric Water Vapor Content," Astrofiz. in-ta AN Kaz SSR, Vol. 1, Nos. 1 & 2, 1955.

181. J. T. Yardley, "Laser Action in Highly-Excited Vibrational Levels of CO," J. Mol. Spect., Vol. 35, pp. 314-324, 1970. [Measured positions of CO laser lines accurately.]

3. AEROSOL EFFECTS

182. C. Acquista, "Validity of Modifying Mie Theory to Describe Scattering by Monospherical Particles," Appl. Opt., Vol. 17, No. 24, pp. 3851-3852, December 1978. [Shows that the method currently in use has serious flaws with regard to ficitious absorption.]

183. H. Anderson, G. E. Gowins and R. Jones, Effects of Tactical Aerosols on Laser Beam Propagation, Army MICOM RE-TR-72-6, February 1972.

184. S. D. Andreev, L. S. Ivlev and E. L. Yanchenko, "Optical Characteristics of Atmospheric Aerosols in the Infrared Region of the Spectrum," Rept. No. FSTC-HT-23-2478-72, Army Foreign Science & Tech. Center, Charlottesville, VA, 19 July 1973, Trans. of Problemy Fiz. Atmos., No. 9, p. 48, 1971.

185. Yu. F. Arshinov, et al., "Experimental Study of the Attenuation and Backscattering of λ-2.36 and 0.63 Micrometer Laser Radiation by Artificial Fog and Smoke," Rept. No. NISC-Trans-3534, Naval Intelligence Support Center, Wash. D.C. Trans. Div., 4 April 1974, Trans. of Izv. Vysshikh Uch. Zav. Fiz., No. 6, p. 62, 1973 (AD 782 211/7).

186. S. Asano and G. Yamamoto, "Light Scattering by a Spheroidal Particle," Appl. Opt., Vol. 14, No. 1, p. 29, January 1975. [Theoretical solution of Maxwell's equations.]

*187. E. A. Barnhardt and J. L. Streete, "A Method for Predicting Atmospheric Aerosol Scattering Coefficients in the Infrared," Appl. Opt., Vol. 9, No. 6, pp. 1337-44, June 1970.

188. V. P. Bisyarin and A. V. Sokolov, "Theoretical Estimation of the Effect of the Complex Refractive Index of Water Drops on the Amount of Attenuation of 10.6 μm Laser Radiation in Fog," Radio Eng. & Electron. Phys., Vol. 19, No. 11, p. 101, November 1974. [Studies of the propagation of laser light in the atmosphere show that over paths near the earth's surface a significant contribution to the signal attenuation is caused by hydrometers' fog, snow, rain, etc.]

189. W. G. M. Blaettner, Multiple Scattering Effects Upon Measurements with the AFGL LSRVMS Lidar System, Final Rept. 1 December 1975 - 15 December 1976, RRA Rept. No. RRA-T-7609 (AD-A038 976/7ST). [Monte Carlo calculations that were made to determine the effects of multiple scattering on the meteorological ranges (visibilities) obtained through a single-scattered analysis.]

190. W. G. M. Blaettner, B. C. Thompson and M. B. Wells, Transport of Laser Radiation in Foggy and Turbulent Atmospheres, RRA Rept. No. RRA-T712, 1 April 1971 (AD 724 200). [Calculations were performed to determine the effect of scattering on the pulse length of a laser beam as it propagates in a foggy atmosphere with a meteorological range of 132.8 meters.]

191. A. J. Blanco, E. M. D'Arcy and J. B. Gillespie, Degradation of a He-Ne Laser Beam by Atmospheric Dust During a Sand Storm, Rept No. ECOM-5535, Army Electronics Command, Ft. Monmouth, NJ, March 1974 (AD 776 909/4).

192. E. I. Bocharov, "The Attenuation of Infrared Radiation by Fogs," Izv. Akad. Nauk. Ser. Geofiz., Vol. 6, pp. 791-795, 1958 (AD 226 282).

193. R. Bruce, J. Mason, K. O. White and R. B. Gomez, An Estimate of the Atmospheric Propagation Characteristics of 1.54 Micron Laser Energy, ASL, White Sands Missile Range, March 1968 (AD 670 934).

194. E. A. Bucher, "Computer Simulation of Light Pulse Propagation for Communication Through Thick Clouds," Appl. Opt., Vol. 12, No. 10, p. 2391, October 1973 (AD 771 827/3). [The amount of multipath spreading for many scattering functions and cloud thicknesses can be predicted from a common set of data. Spatial spreading of the exit-spot diameter was found to saturate as a cloud of a given physical thickness became optically thickner and thicker.]

195. K. Bullrich, "New Aspects of Scattering and Absorbing Properties of Atmospheric Aerosol Particles," J. Colloid. Inter. Sci., Vol. 39, pp. 546-550, 1972.

196. K. Bullrich, K. Fischer and G. Hanel, Research on Atmospheric Optical Radiation Transmission, Final Report 1 January 1973 - 31 December 1973, AFCRL-TR-74-0273 (AD 781 842/0)

197. D. E. Burch, J. D. Pembrook and E. Reisman, Attenuation Measurements in Artificial Clouds, Final Technical Report, NASA-CR-86343, March 1970 (N70-42847).

198. G. E. Caledonia and K. L. Wray, Aerosol Propagation Effects, PSI Rept. No. PSI-TR-6, Wakefield, MA, 1 June 1974 (AD 782 627/4)

199. I. Cantor, Aerosol Angular Scattering Functions for Model Atmospheres, Rept. No. ECOM-5540, Army Electronics Command, Ft. Monmouth, NJ, May 1974 (AD 780 063/4).

200. H. R. Carlon, "Infrared Emission by Fine Water Aerosols and Fogs," Appl. Opt., Vol. 9, No. 9, pp. 2000-2006, September 1970.

201. D. C. Carmer and G. H. Lindquist, Quantization of Scattering of Laser Beams, Window and Atmospheric Scattering at 1.06 Micrometers, Final Report 5 June - 4 October 1973, ERIM Rept. No. ERIM-104100-2-F, (AD 783 431/0). [Calculates the laser beam scattering for a standard clear and a standard hazy atmosphere as functions of polarization and receiver position for receiver fields of view of 300, 100, 30 and 1 mr.]

*202. L. W. Carrier, G. A. Cato and K. J. von Essen, "The Backscattering and Extinction of Visible and Infrared Radiation by Selected Major Cloud Models," Appl. Opt., Vol. 6, No. 7, pp. 1209-1216, July 1967. [Volume backscattering functions and optical extinction coefficients are computed for 8 suggested major cloud models using the Mie theory for optical wavelengths of 0.488 μ, 0.694 μ, 1.06 μ, 4.0 μm and 10.6 μ. Results show that there is no clear advantage of 1 wavelength over another for improving cloud transmission; however, backscattering is significantly reduced at the longer wavelengths.]

203. L. W. Carrier and L. J. Nugent, "Application of Results of Some Recent Laser Mie Scattering Experiments for Optimized Optical System Performance," Proc. 2nd Laser Conf., Vol. I, pp. 151-161, April 1965. [Volume scattering functions measured in natural fogs at 0.6328 μm essentially independent of particle size distributions show differences between unpolarized incoherent and polarized coherent scattering.]

204. R. J. Casey, R. C. Weidler and D. A. Contini, "Cloud and Fog Discrimination Techniques for Modulated CW Optical Radiation," Proc. 4th Laser Conf., Vol. II, p. 57?, January 1970. [Calculated backscatter for laser radiation.]

205. L. W. Casperson, "Light Extinction in Polydisperse Particulate Systems," Appl. Opt., Vol. 16, No. 12, p. 3183, December 1977. [Theoretical development, good review of Soviet research.]

206. D. T. Chang and R. Wexler, Relation of Aerosols to Atmospheric Features, AFCRL-68-0360, 15 September 1968. [Presents measurements of extinction coefficient.]

207. R. J. Charlson, "Atmospheric Visibility Related to Aerosol Mass Concentration," Envir. Sci. Tech., Vol. 3, pp. 913-918, 1969.

208. R. N. Cleveland, Multipath Time Spreading of Optical Pulses Propagating Through a Scattering Medium, AF Inst. of WPAFB OH, Master's Thesis, Rept No. AFIT-CI-76-8, 1975 (AD-A025 385/6ST). [A controlled scattering experiment wherein parameters such as particle size distribution, concentration, size and shape were known precisely.]

209. D. G. Collins and M. B. Wells, Scattering and Reflectance of Light from Airborne Laser Systems, RRA Rept. No. RRA-T88, 15 June 1968 (AD 681 145). [Monte Carlo program was used to predict the ground reflected and atmospheric scattered components of the scattered light from airborne laser systems.]

210. D. G. Collins and M. B. Wells, Monte Carlo Codes for Study of Light Transport in the Atmosphere, Vols. I & II, RRA Rept. No. ECOM-00240-F, 1965.

211. R. T. H. Collins and P. B. Russell, "Lidar Measurements of Particles and Gases," in Laser Monitoring of the Atmosphere, ed. E. D. Hinkley, Springer-Verlag, NY, 1976. [Brief review of scattering and extinction literature.]

212. J. A. Curcio and K. A. Durbin, Atmospheric Transmission in the Visible Region, NRL Rept. No. NRL-5368, 1959.

213. J. V. Dave, "Meaning of Successive Iteration of the Auxiliary Equation in the Theory of Radiative Transfer," Astrophys. J., Vol. 140, No. 3, pp. 1292-1303, 1964.

214. E. de Bary, K. Bullrich, R. Eiden, G. Eschelbach and G. Hanel, Research on Atmospheric Optical Radiation Transmission, AFCRL-72-0180, February 1972 (AD 740 871). [Describes the number and the size of the atmospheric aerosol particles and the possiblities to evaluate them by optical methods. Some measurement results are given of spectral solar extinction. A survey is presented of new experimental results of some fundamental parameters of atmospheric aerosol particles.]

215. E. de Bary, B. Braun and K. Bullrich, Tables Related to Light Scattering in a Turbid Atmosphere, AFCRL-65-710 (3 volumes), September 1965. [Table of calculated Mie scattering parameters between 0.4 and 1.2 μm assuming aerosol size distribution $dn(r) = cr^{-\nu} d(\log r)$, $\nu = 2.5, 3.0, 4.0$.]

216. D. R. Deirmendjian, "The Role of Water Particles in the Atmospheric Transmission of Radiation," QJRMS, Vol. 85, p. 404, 1959. [Presents different size distribution models; uses Penndorf's equation to calculate out to 3.5 μm.]

217. D. R. Deirmendjian, "Scattering and Polarization Properties of Water Clouds and Hazes in the Visible and Infrared," Appl. Opt., Vol. 3, No. 2, pp. 187-196, February 1964. [Mie calculations are presented for various cloud and haze models (size distributions included).]

218. D. R. Deirmendjian, R. Clasen and W. Viezee, "Mie Scattering with Complex Index of Refraction," JOSA, Vol. 51, No. 6, pp. 620-633, June 1961. [Describes new set of Mie calculations and compares with models by van de Hulst.]

219. L. Dunkelman, Horizontal Attenuation of Ultraviolet and Visible Light by the Lower Atmosphere, NRL Rept. No. NRL-4031, 1952.

220. R. G. Eldridge, "A Comparison of Computed and Experimental Spectral Transmission Through Haze," Appl. Opt., Vol. 6, No. 5, pp. 929-933, May 1967. [Spectral transmission (0.2 - 7.0 μm) through haze are computed using meteorological observations to specify aerosol scattering and water vapor, carbon dioxide, and ozone absorption. The computed spectral transmission are compared with the appropriate experimental transmission to evaluate the degree to which a natural spectral transmission can be simulated by a computed spectral transmission.]

221. L. Elterman, "Relationships Between Vertical Attenuation and Surface Meteorological Range," Appl. Opt., Vol. 9, No. 8, pp. 1803-1810, August 1970. [A model is presented for attenuation in the 0.27 to 2.17 μm spectral range (based on Curcio's data extrapolated to 5 km altitude).]

222. S. P. Erkovich, et al., "Influence of Fog on the Range of Ground Communication Using an Optical Carrier," Telecom. & Radio Eng., pp. 12-16, December 1965.

223. G. P. Faraponova, Trans. Central Aerolog. Obs., No. 23, p. 52, 1957. [Measures aerosol attenuation coefficient versus altitude.]

224. G. P. Faraponova, Trans. Central Aerolog. Obs., No. 32, p. 3, 1959. [Measures aerosol attenuation coefficient versus altitude.]

225. G. P. Faraponova, "Relation of Transparency of the Free Atmosphere to Certain Meteorological Characteristics," Atmos. & Oceanic Phys., Vol. 1, No. 352, p. 607, 1965. [Model for visibility.]

226. R. W. Fenn, "Correlation Between Atmospheric Backscattering and Meteorological Range," Appl. Opt., Vol. 5, p. 293, 1966. [Since so many different processes change visibility, such a relation cannot be unique, and must change from one situation to another.]

227. K. Fischer, "Measurements of Absorption of Visible Radiation by Aerosol Particles," in German, Beitr. Phys. Atmos., Vol. 43, p. 244, 1970.

228. P. C. Fletcher, et al., "A Technique for Improved Signal-to-Noise Performance of Laser Systems," Proc. 1st Laser Conf., Vol. II, pp. 97-104, January 1964. [Measures scattering function for a 6328 Å laser.]

229. L. Foitzik and H. Zskhaeck, Zeit für Meteor., Vol. 7, No. 1, p. 1, 1953. [Measured aerosol attenuation, found Angstrom exponent of n - 1.2-1.5 for 5m > 7.5 km; and n ≈ 0.9 for 5m ≈ 2 km.]

*230. D. J. Gaubling, An Aerosol Attenuation Model for the Visible and Infrared Spectral Regions, WRE Rept. No. WRE-TN-593 (AP), March 1972. [Presents a similar but more sophisticated model than Barnhardt and Streete's. Gives results for 0.5 - 15 μm; 50, 70, 90, 95% R.H.; continental and martime. Scattering alone and total.]

231. M. G. Gibbons, "Wavelength Dependence of the Scattering Coefficient for Infrared Radiation in Natural Haze," JOSA, Vol. 48, No. 3, pp. 172-176, March 1958. [Correlates transmission at 0.61 μm to that at 2.18, 3.61, 10.01, and 11.48 μm.]

232. G. H. Goedecke, The Use of Simple Observables to Predict Infrared Extinction Coefficient of Atmospheric Aerosols, Final Report 1 October 1974 - 30 June 1975, N. Mex. State Univ. Dept. of Phys. (AD-A016 174/5ST). [Several model aerosols of a given type, having the same visibility, but different yet reasonable microstructure, exhibit very wide dispersion, as much as 700%, in values of near infrared wavelengths, from the visible to 2.0 to 10.6 micrometers.]

233. R. B. Gomez, C. Petracca, C. Querfeld and G. B. Hoidale, Atmospheric Effects for Ground Target Signature Modeling. III. Discussion and Application of the ASL Scattering Model, Rept. No. ECOM-5558, Army Electronics Command, Ft. Monmouth, NJ, March 1975 (AD-A009 722/OST). [Describes the ASL's single scattering model, which was developed for input to multiple scattering codes for the determination of EM extinction caused by the atmospheric aerosol. Sample applications will be made to the cases of haze and dust.]

234. G. E. Gowins, W. T. Naff and W. Reeves, Statistical Analysis of Aerosol Scattering Data, US Army MICOM RE-72-12, August 1972. [Angular scattering of tactical aerosols.]

235. G. Hanel, "Computation of the Extinction of Visible Radiation by Atmospheric Aerosol Particles as a Function of the Relative Humidity, Based Upon Measured Properties," J. Aerosol Sci., Vol. 3, p. 377, 1972. [Uses approximate formulae (which agrees with Mie theory within 1.5%), with six different measured size distributions (given); includes effects of humidity. Results mainly for visible region.]

236. F. S. Harris, Jr., "Calculated Mie Scattering Properties in the Visible and Infrared of Measured Los Angeles Aerosol Size Distributions," Appl. Opt., Vol. 11, No. 11, pp. 2697-2704, November 1972. [Reviews models and measurements of aerosol scattering (119 refs.). Gives a sample of eleven (out of scores) measured size distributions from Los Angeles. Also recommends indices of refraction.]

237. F. S. Harris, Jr., "Atmospheric Aerosol Measurement Problems," SPIE Vol. 142 Optical Properties of the Atmosphere, p. 38, 1978. [Presents knowledge of the atmospheric aerosols summarized briefly with respect to geographical distribution, time variations, optical properties, chemical nature, and natural and artificial sources.]

238. H. Harrison, J. Herbert and A. P. Waggoner, "Mie Theory of Lidar and Nephelometric Scattering Parameters for Power Law Aerosols," Appl. Opt., Vol. 11, No. 12, pp. 2880-2885, December 1972. [Ratios of lidar backscatter to nephelometric total scattering cross sections have been computed for power law aerosols. The general angle-resolved differential scattering problem is discussed briefly with emphasis upon derivable information from scattering measurements in the atmosphere.]

*239. J. A. Hodges, "Aerosol Extinction Contribution to Atmospheric Attenuation in Infrared Wavelengths," Appl. Opt., Vol. 11, No. 10, pp. 2304-2310, October 1972. [Estimates of attenuation in windows given in 2-14 μm, using modification of Barnhardt & Streete's model. Gives results for various relative humidities and various continental to maritime concentrations.]

240. J. R. Hodkinson, "The Optical Measurement of Aerosols," in Aerosol Science, C. N. Davies ed., Academic Press NY, 1966. [Mostly lab measurements; also results of analytical calculations.]

241. G. B. Hoidale and A. J. Blanco, "Infrared Absorption Spectra of Atmospheric Dust Over an Interior Desert Basin," Pure Appl. Geophys., Vol. 74, pp. 151, 1969. [Presents the effects of aerosols on laser beam propagation.]

242. G. C. Holst, E. W. Stuebing and R. W. Doherty, "Image and Laser Screening by Tactical Smoke," Proc. 7th Laser Conf., Vol. III, p. 59, June 1976. [Low energy laser transmission measurements at 0.6328, 1.06, 3.39 and 10.6 μm.]

243. Investigation of Linear Extinction at DF and CO_2 Frequencies with Emphasis on Aerosols, SAI-76-004-AA, Science Applications, Inc., Ann Arbor, MI, 31 May 1976. [Calculates molecular absorption coefficients versus altitude.]

244. W. M. Irvine and J. B. Pollack, "Infrared Optical Properties of Water and Ice Spheres," Icarus, Vol. 8, No. 2, pp. 324-360, March 1968. [Calculation of scattering and absorption assuming a water haze.]

245. A. I. Ivanov, et al., Light Scattering in the Atmosphere Part 2, NASA Technical Translation Publ. No. NASA TT-F-477, NTIS, Springfield, VA., 1969.

246. J. C. Johnson and J. R. Terrell, "Transmission Cross Sections for Water Spheres Illuminated by Infrared Radiation," JOSA, Vol. 45, No. 6, pp. 451-454, June 1955. [Scattering cross sections for complex index of refraction for water in infrared is calculated from Mie theory.]

247. D. R. Johnston and D. E. Burch, "Attenuation by Artificial Fogs in the Visible, Near Infrared and Far Infrared," Appl. Opt., Vol. 6, No. 9, pp. 1497-1501, September 1967. [Attenuation coefficient ratio for artificial fogs has been measured at 345 μ. The attenuation coefficient ratios at 0.436 μ, 1.01 μ, 3.5 μ, 10 μ, and 13.5 μ were also measured so that a comparison between artificial fogs and natural fogs could be made.]

248. M. V. Kabanov, "Polarization of Laser Emission Scattered by F... and Smoke," Atmos. & Oceanic Phys., Vol. 4, No. 10, p. 1116, ... (AD 695 958). [The results of experimental investigations of ... degree of polarization of scattered forward and reflected lig... are discussed, including laser-emission in artificial fog and smoke.]

249. M. V. Kabanov, B. A. Savel'yev and V. Ya. Fadeyev, Sov. Phys. ... No. 7, p. 140, 1967. [Detailed measurements of the brightness ... forward scattered laser light.]

250. M. V. Kabanov and B. A. Savel'yev, Atmos. & Oceanic Phys., Vol. ... No. 9, p. 960, 1968. [Detailed measurements of the brightness ... forward scattered laser light.]

251. M. V. Kabanov and V. I. Bukatyi, News of Institutions of Higher Learning, Physics, Vol. 10, No. 8, 1967 (Selected Articles), ... No. FTD-HT-23-251-68, 15 May 1968 (AD 679 802). [Attenuation ... collimated light beams in dispersive media; attenuation of laser beams in artificial water fogs.]

252. M. V. Kabanov, B. A. Savel'yev and I. V. Samokhvalov, "Polarization of Laser Radiation Scattered by Fog and Smoke," Atmos. & Oceanic Phys., Vol. 4, No. 10, p. 1115, 1968 (AD 706 566). [Experimental investigations of the degree of polarization of forward scattered and backward scattered (reflected) light during radi... discharge in artificial fog and smoke are given.]

253. G. W. Kattawar and G. N. Plass, "Influence of Particle Size Distribution on Reflected and Transmitted Light from Clouds," Appl. Opt., Vol. 7, No. 5, pp. 869-878, May 1968. [The light reflected and transmitted from clouds with six drop size distributions is calculated by a Monte Carlo technique. The scattering function for each model is calculated from the Mie theory.]

254. G. L. Knestrick, T. H. Cosden and J. A. Curcio, Atmospheric Attenuation Coefficients in the Visible and Infrared, NRL Rept. No. NRC-5648, 1961 (AD 263 441).

255. J. S. Kobler and W. H. Leonard, "Assessment of Battlefield Environments for Laser Terminal Homing Systems (U)," Proc. 1st Laser Conf., Vol. II, pp. 85-97, January 1964 (Confidential). [Measured data on battlefield aerosols and their effects.]

256. M. A. Kolosov, "Investigations of Laser Radiation Attenuation in Artificial Fog," 1971 Intl. Sym. on Antennas & Prop., 1-3 September 1971, Sendai, Japan. [Attenuation of the different wavelengths depending on the microphysical properties of the fog and the dependence of the attenuation on its water content and concentration of drops have been determined.]

257. V. P. Kozlov and Ye. O. Fedorova, Sov. J. Opt. Tech., Vol. 1, No. 3, p. 1, 1967. [Calculated intensities of single backscattered light from fogs.]

258. L. Kuo-Nan, "Light Scattering by Cirrus Cloud Layers," Conf. on Atmospheric Radiation, Amer. Meteor. Soc., 7-9 August 1972. [Modified two-stream approximation was employed.]

259. L. Kuo-Nan, R. Baldwin and T. Kaser, "Preliminary Experiments in the Scattering of Polarized Laser Light by Ice Crystals," J. Atmos. Sci., Vol. 33, No. 3, p. 553, March 1976. [Experimental results reveal that the angular scattering diagrams of hexagonal plates and needles in the vertical polarization direction exhibit no specific features of maximum intensities such as rainbows.]

260. S. W. Kurnick, R. N. Zitter and D. B. Williams, Atmospheric Transmission in the Infrared During Severe Weather Conditions, U. of Chi, Lab for Appl. Sci., CML-TN-P-145-3, May 1959. [Data is presented for the 1.7-12 μm spectral region.]

261. S. W. Kurnick, R. N. Zitter and D. B. Williams, "Attenuation of Infrared Radiation by Fogs," JOSA, Vol. 50, No. 6, pp. 578-582, June 1960. [Measured for wavelengths from 1-11 μm.]

262. R. K. Long, J. H. McCoy and D. B. Rensch, "Atmospheric Attenuation of Laser Beams at 10.6 μm," Proc. 4th Laser Conf., Vol. II, p. 1557, January 1970. [Significant results of previous publications of Ohio State on clear air, fog, aerosol and rain attenuation and backscatter.]

263. G. D. Lukes, Penetrability of Haze, Fog, Clouds and Precipitation by Radiant Energy Over the Spectral Range 0.1 Micron to 10 Centimeters, Center for Naval Anal., U. of Rochester, NY, Naval Warfare Anal. Group, Study No. 61, May 1968.

264. J. MacDowall, "The Propagation of Infrared Radiation Through the Lower Atmosphere," Lasers & Their Appl., IEEE Conf., London, pp. 49-1 through 49-8, 1964.

265. D. J. MacKinnon, "The Effect of Hygroscopic Particles on the Backscattered Power from a Laser Beam," J. Atm. Sci., Vol. 26, pp. 500-510, 1969. [Uses equations for the growth of aerosols with humidity (from Kohler) and Mie equations with a Junge size distribution to calculate continental and maritime scattering coefficients.]

266. J. Mason and G. B. Hoidale, Visibility as an Estimator of Infrared Transmittance, Rept. No. ECOM-5598, Army Electronics Command, Ft. Monmouth, NJ, July 1976 (AD-A031 040/9ST). [Models depicting haze, fog, smoke, and dust were constructed such that all yielded identical transmittances at 0.55 micrometers (center of the visible spectrum), and transmittances at several infrared wavelengths (due to scattering only) were calculated. Results show that significant errors occur if visibility is relied upon.]

267. R. K. McDonald, "Vertical and Horizontal Maritime Visibility Models," Proc. IRIS, Vol. 10, No. 2, pp. 47-51, June 1965 (AD 367 866-L). [Models are presented for the visible and 3-5 μm spectral regions based on given size distribution functions.]

268. V. M. Morozov, "Nonmolecular Light Scattering in the High Atmospheric Layers," Mem. Soc. Roy. Sci. Liege, Vol. 18, 1957.

269. R. H. Munis and A. Delaney, Simultaneous Measurement of Laser Extinction in Warm Fog at Wavelengths of 0.6328, 1.15 and 10.6 Microns, Rept No. CRREL-RR-343, Cold Regions Res. & Eng. Lab, Hanover, NH, October 1975 (AD-A017 943/2ST). [The warm fog generated in a 4 cu m environmental chamber. Particle sampling was carried out simultaneously with the laser measurements using an impactor. Using the same size distribution in each case the theoretical extinction coefficients were calculated and compared with the experimental coefficients.]

270. F. E. Nicodemus, Weather Effects on Infrared Systems for Point Defense, NWC TN 4056-16, May 1972.

271. A. Nistitsuji, M. Haikava, R. Saga, T. Ushizaka and M. Hoshiyama, "Calculation on Propagation Loss of He-Ne Laser Light Due to Snowfall," Bull. Res. Inst. Appl. Electr., Vol. 24, No. 3, p. 100, September 1972.

272. J. C. Norris, Effects of Weather on Forward Air Defense (U), GDC Rept. No. ERR-PO-240-1, July 1965 (Secret).

273. H. W. O'Brien and M. Kumai, Transmission of 2.0 to 3.4 Micron Infrared Radiation in Ice Fog, CRREL Rept. No. CRREL-SR-189, July 1973 (AD 766 301/6).

274. R. L. Ohlhaber and B. E. Simonson, Attenuation of Laser Radiation by HC, Fs, Wp, and Fog Oil Smokes, Technical Rept. May - October 1966, Rept. No. EATR-4100, Edgewood Arsenal, MD (AD 815 270/4ST). [Attenuation of the 6943 Angstrom laser beam was measured as the beam traversed hexachloretane (HC), sulfur trioxide-chlorosulfonic acid (FS), white phosphorous (WP), and fog oil smokes contained in a closed chamber.]

275. R. G. Otto, G. Gal, M. W. Munn, W. Wells and A. Wood, Tracker Backscatter Study, Final Rept. 3 November 1975 - 31 May 1976, LMSC Rept. No. LMSC-D50266B (AD-A025 768/3ST). [22 tests of backscatter were conducted at low power (800 W) and high power (40 kW) with 3 spectral filters in the radiometer.]

276. W. H. Paik, M. Tebyani, D. J. Epstein, R. S. Kennedy and J. H. Shapiro, IEEE J. Quant. Electr., Vol. QE-13, No. 19, p. 22, September 1977. [Measured as functions of meteorological conditions (1) the ratio of scattered to unscattered radiation collected by a receiver as a function of its field-of-view; (2) the angular spectra of pulsed and CR optical signals; (3) the multipath spread of pulsed optical signals; (4) the Doppler spread of CR optical signals.]

277. R. B. Penndorf, "New Tables of Mie Scattering Functions for Spherical Particles: Total Mie Scattering Coefficients for Real Refractive Indices," Geophys. Res. Papers, No. 45, Pt. 6, 1956. [Coarse tables assuming imaginary index is zero.]

278. R. B. Penndorf, Research on Aerosol Scattering in the Infrared, RADC-TR-61-32, October 1961. [Atlas of scattering diagrams for n = 1.33.]

279. G. N. Plass, Infrared Absorption Program, Final Rept. 1 January 1965 - 31 January 1968, SW Center for Adv. Stud., Dallas, TX, 28 February 1968 (AD 667 214). [A sophisticated Monte Carlo method was developed to follow the path of a photon as it is scattered or absorbed by collision with atmospheric molecules, aerosols, and water droplets.]

280. G. N. Plass and G. W. Kattawar, "Monte Carlo Calculations of Light Scattering from Clouds," Appl. Opt., Vol. 7, No. 3, pp. 415-419, March 1968. [The scattering of visible light by clouds is calculated from an efficient Monte Carlo code which follows the multiple scattered path of the photon. The single scattering function is obtained from the Mie theory by integration over a particle size distribution appropriate for cumulus clouds at 0.7 μ wavelength.]

281. G. N. Plass, G. W. Kattawar and C. N. Adams, Multiple Scattering of Laser Light in the Atmosphere, Final Rept. 15 December 1967 - 15 June 1968, SW Center for Adv. Stud., Dallas, TX (AD 675 155). [A Monte Carlo method if used to calculate the path of photons in a real atmosphere that were emitted by a laser source.]

282. G. N. Plass and G. W. Kattawar, "Propagation of Light Pulses Through Clouds," Prog. of 1971 Spring Meeting of OSA, 5-8 April 1971, Tuscon, AZ. [Multiple scattering of laser light within clouds is calculated by a Monte Carlo method.]

283. G. N. Plass and G. W. Kattawar, "Radiative Transfer in Water and Ice Clouds in the Visible and Infrared Region," Appl. Opt., Vol. 10, No. 4, pp. 738-748, April 1971. [Monte Carlo calculations of radiance and polarization at 6 wavelengths.]

284. J. F. Potter, "The Delta Function Approximation in Radiative Transfer Theory," J. Atm. Sci., Vol. 27, p. 943, September 1970. [Uses delta function approximation for forward peak in scattering phase function.]

285. J. F. Potter, "Scattering and Absorption in the Earth's Atmosphere," Proc. 6th Symp. Remote Sensing of Envir., U. of Mich., pp. 415-429, October 1969. [Reviews various methods; doubling most efficient.]

286. D. B. Rensch, Survey Report on Atmospheric Scattering, OSU Rept. No. TR 2476-1, May 1968 (AD 831 666).

287. R. Robley, "Multiple Scattering in the Atmosphere Inferred from Twilight Observations," Ann. de Geophys., Vol. 6, No. 3, 1950.

288. L. M. Romanova, "The Solution of the Radiative Transfer Equation for the Case When the Indicatrix of Scattering Greatly Differs From the Spherical One," Opt. i Spek., Vol. 13, pp. 238-241, 1962.

289. G. H. Ruppersberg, H. Vonredwitz and R. Schellhase, Atmospheric Light Transmissivity and Scattering in the Visible Spectral and in Windows of the Infrared Region up to 5 Micrometers. State-of-the-Art, Measuring Instruments, Measurements, Rept. No. BMVG-FBWT-71-16, Deutsche Forschungs- Und Versuch. Fur Luft- Und Raumfahrt, Inst. Für Phys. der Atmos., Oberfaffenhofen, W. Germ., 1971 (N72-15372).

290. J. S. Ryan and A. I. Carswell, "Laser Beam Broadening and Depolarization in Dense Fogs," JOSA, Vol. 68, No. 7, p. 900, July 1968. [Laboratory measurements indicate broadening strongly dependent on extinction coefficient.]

291. G. J. St. Cyr, Extinction Coefficients and Energy Scattered by Clouds, Fog, Maritime Haze and Continental Haze, Hughes Inter. Memo Ref. 2771.1/48, July 1968.

292. J. D. Sartor, "Meteorological Aspects of Infrared Operations," Proc. IRIS, Vol. 3, No. 4, pp. 154-160, December 1958 (AD 305 118).

293. B. A. Savel'yev, Sov. Phys. J., No. 12, pp. 135-136, 1967. [Detailed measurements of the brightness of forward scattered laser light.]

294. Z. Sekera, "Recent Developments in the Study of the Polarization of Skylight," Adv. in Geophys., Vol. 3, Academic Press, NY, 1956.

295. D. E. Setzer, "Influence of Scattered Radiation on Narrow Field of View Communication Links," Appl. Opt., Vol. 10, No. 1, p. 109, January 1971. [Approximates influence of the scattered radiation on reception through aerosols such as rain, fog, and mist. Define the conditions under which one should employ multiple scattering as opposed to single scattering theory.]

296. M. E. Seymour, "In Fog and Rain - Sight, Infrared or Radar," Electronics, Vol. 33, No. 5, pp. 64-66, 29 January 1960.

*297. E. P. Shettle and R. ". Fenn, "Models of the Atmospheric Aerosols and Their Optical Properties," AGARD Conf. Proc. #183, 27-31 October 1975, Lyngby, Denmark (AD-A028 615). [Several aerosol models have been developed for the boundary layer, the upper troposphere, the stratosphere, and mesosphere.]

298. E. P. Shettle and J. A. Weinman, "The Transfer of Solar Irradiance Through Inhomogeneous Turbid Atmospheric Evaluation by Eddington's Approximation," J. Atmos. Sci., Vol. 27, p. 1048, October 1970. [Describes Eddington's approximation.]

299. N. Skreien, Transmission of Infrared Radiation at Low Heights on the Coast of Northern Norway, NDRE Internal Rept. T-208, Ref. 114, August 1960.

300. I. Solomon, " Climatological Support to Infrared," Proc. IRIS, Vol. 5, No. 2, pp. 59-63, April 1960 (AD 317 416).

301. O. Steinvall, Computed Mie Scattering Properties for Laser Wavelengths in Various Atmospheric Media, Rept. No. FOA-2-C-2662-E1-E3, Res. Inst. of Natl. Def., Stockholm, Sweden (N76-14336/1ST). [Compute calculations of scattering properties of some haze, fog, cloud and smoke models were made for six laser wavelengths from 0.337 to 10.6 microns.]

302. L. B. Stotts, "The Radiance Produced by Laser Radiation Transversing a Particulate Multiple Scattering Medium," JOSA, Vol. 67, No. 6, pp. 815-819, June 1977. [Radiative transfer theory and the small-angle approximation are used to derive analytical expressions for the radiance produced by laser radiation (cw or pulsed beams) transversing a particulate multiple-scattering medium.]

303. G. M. Strelkov, "Brief Communications-Coefficient of Absorption of Laser Radiation by Water Aerosol," Radio Eng & Electron. Phys., Vol. 18, No. 7, p. 1101, July 1973.

304. E. W. Stuebing, J. J. Pinto and R. B. Gomez, PGAUSS-LT: A Program for Computing Optical Properties of Single Scattering Aerosol Clouds of Homogeneous Particles, Rept. No. FA-TM-75019, Frankford Arsenal, Phila., Pa., April 1975 (AD-A014 162/2ST). [Purpose of PGAUSS-LT is to enable the user to compute luminous transmittance over nonhomogeneous atmospheric paths containing an arbitrary size and number density of liquid and solid particles. The absorbing and scattering particles are assumed to be homogeneous, isotropic spherical particles made up of a material whose complex refractive index is known along with the real index of the surrounding medium.]

305. E. W. Stuebing, J. J. Pinto and R. B. Gomez, PGAUSS-LT: A Program for Computing Optical Properties of Single Scattering Aerosol Clouds of Homogeneous Particles, Rept. No. ECOM-5562, Army Electronics Command, Ft. Monmouth, NJ, May 1975 (AD-A010 336/6ST). [Compute luminous transmittance over nonhomogeneous atmospheric paths containing an arbitrary size and number density of liquid and solid particles. The absorbing and scattering particles are assumed to be homogeneous, isotropic, spherical particles made up of a material whose complex refractive index with respect to the surrounding medium is known.]

306. S. Twomey, H. Jacobowitz and H. B. Howell, "Light Scattering by Cloud Layers," J. Atmos. Sci., Vol. 24, pp. 70-79, 1967. [The analytical doubling method is employed.]

307. Distribution Curves of Atmospheric Transmissivity, Civil Eng. Rept. No. 4A, CG-250-4A, U. S. Coast Guard, January 1961 (AD 254 897).

308. E. E. Uthe, R. J. Allen, Tactical Considerations of Atmospheric Effects on Laser Propagation, Quarterly Status Rept. No. 2, 13 April - 12 July 1968, Stanford Res. Inst., Menlo Park, CA (AD-A008 269/3ST). [Power spectral density estimates of Mie backscatter efficiency factors computed over a range of size parameters from 0.1 to 100 in increments of 0.1 for the refractive index of 1.33 are presented.]

309. B. A. Veklenko, "The Propagation of Coherent Radiation in Gases," Sov. Phys. J., No. 4, 1973. [Expressions are obtained for the index and scattering section.]

310. O. A. Volkovitskii, N. K. Nikiforova, L. N. Pavlova and A. G. Petrushkin, "Some Data on the CO_2 Laser Beam Propagation in Ice Clouds," Atmos. & Oceanic Phys., Vol. 10, No. 11, p. 1157, November 1974. [Compare the laboratory measurements at 10-60 degrees scattering angles with the theory.]

311. O. A. Volkovitskii, E. V. Ivanov, M. P. Kolomeev, N. K. Kraskovskii and L. P. Semenov, "The 'Turbidity' Effect in a Crystalline Cloud Medium, Acted Upon by CO_2 Laser Radiation," Atmos. & Oceanic Phys., Vol. 11, No. 8, p. 861, August 1975. [Laboratory experiments of an artificial ice cloud medium of randomly oriented hexagonal ice platelets.]

312. F. E. Volz, "The Spectral Properties of the Aerosol: UV-Absorption of Precipiation and the Influence of Haze on the Long-Wave Atmospheric Radiation," in German, Ann. Meteorol., Vol. 8, p. 34, 1957.

313. G. Ward, Light Scattering from Irregular Dielectric Particles, Final Report 1 March 1975 - 28 February 1978, Dept. of Elect. Eng., Florida Univ. (AD-A055 835/3ST). [A digital polar nephelometer has been constructed to measure the intensity and polarization of light pulses scattered into 94 angles from 9 to 176 degrees. It is found that the backscatter from non-spherical particles (of size parameter about 10) differs significantly from that for the best fit sphere, so that a tumbled irregular particle is not equivalent to a sphere.]

314. J. A. Weinman and S. T. Shipley, "Effects of Multiple Scattering on Laser Pulses Transmitted Through Clouds," J. Geophys. Res., Vol. 77, No. 36, p. 7123, 20 December 1972. [The temporal response of a photoelectric detector to a delta function shaped laser pulse propagating through an optically thick cloud has been derived from a small angle scattering approximation to the equation of radiative transfer.]

315. D. P. Woodman, "Ground-Based Site Selection for Space-to-Ground Optical Communication System," Proc. 4th Laser Conf., Vol. II, p. 1333, January 1970. [Spectral volume extinction calculations for water aerosols.]

*316. D. P. Woodman, "Limitations in Using Atmospheric Models for Laser Transmission Estimates," Appl. Opt., Vol. 13, No. 10, pp. 2193-2195, October 1974. [Discusses the validity of commonly used expressions and tables when applied to practical situations. Aerosol attenuation coefficients are plotted against wavelength for several models.]

317. G. Yamamoto and M. Tanaka, "Determination of Aerosol Size Distributions from Spectral Attenuation Measurements," Appl. Opt., Vol. 8, No. 2, pp. 447-453, February 1969. [Method of evaluating the aerosol size distribution from the spectral attenuation measurements is presented.]

318. H. W. Yates, "Atmospheric Attenuation Over Slant Paths from the Ground," Proc. IRIS, Vol. 4, No. 2, pp. 361-368, May 1959.

319. G. M. Zabrodski and V. G. Morachevskii, "Study of the Transparency of Clouds and Fogs," Ark. i Ant. Nauchno-Isv. Inst., Trudy, 228(1): 68-86, 1959, Trans. for GRD AFCRL by D. Kraus, Amer. Met. Soc. (AD 287 216).

320. I. L. Zelmanovich, L. M. Lobkova and E. R. Milyutin, Calculation of the Attenuation Coefficient of 0.6-14.0 Micrometer Waves Passing Through Fog, Rept. No. FTD-HT-23-595-70, Ed. trans. of Vysokogornyi Geofiz. Inst. Nalchik, Trudy (USSR), No. 8, p. 83, 1968, by V. Merenzeffi (AD 714 786). [Precise and approximate equations are derived for use in determining the coefficient of attenuation. Comparative calculations were made for several laser wavelengths in the spectral windows of atmospheric transparency.]

321. V. E. Zuyev, M. V. Kabanov and B. A. Savel'yev, "Propagation of Laser Beams in Scattering Media," Appl. Opt., Vol. 8, No. 1, p. 137-141, January 1969. [Experimental investigations have been undertaken of some aspects of the propagation of He-Ne gas laser radiation at $\lambda = 0.63\ \mu$ for different scattering media (artificial water fogs, wood smokes, model media).]

322. V. E. Zuyev, M. V. Kabanov, B. A. Savel'yev, I. V. Samokhvalov and V. V. Sokolov, Trans. of Intl. Symp. Radiation Processes in the Atmosphere, Bergen, Norway, August 1968. [Detailed measurements of the brightness of forward scattered laser light.]

323. V. E. Zuyev, M. V. Kabanov and B. A. Savel'yev, Dokl. Akad. Nauk. SSSR, Vol. 175, No. 2, p. 327, 1967. [Detailed measurements of brightness of forward scattered laser light.]

324. V. E. Zuyev, M. V. Kabanov and B. A. Savel'yev, Atmos. & Oceanic Phys., Vol. 3, No. 7, p. 724, 1967. [Detailed measurements of the brightness of forward scattered laser light.]

4. AEROSOL CONDITIONS

325. E. K. Bigg, "Detection of Atmospheric Dust and Temperature Inversions by Twilight Scattering," Nature, Vol. 177, No. 4498, 1956.

326. D. C. Blanchard and L. Syzdek, "Variations in Aitken and Giant Nuclei in Marine Air," J. Phys. Ocean., Vol. 2, p. 255, 1972. [Aerosol measurements (Gardner countermeasure).]

327. I. H. Blifford, Jr., "Tropospheric Aerosols," J. Geophys. Res., Vol. 75, pp. 3099-3103, 1970. [Size and number distributions are measured at altitudes up to 9.1 km over the ocean and land.]

328. I. H. Blifford, Jr., Particulate Models - Their Validity and Application, NCAR-TN-PROC-68, 1971.

329. I. H. Blifford, Jr. and L. D. Ringer, "The Size and Number Distribution of Aerosols in the Continental Troposphere," J. Atm. Sci., Vol. 26, pp. 716-726, 1969. [Size distributions were measured at several altitudes up to 10 km for several seasons using a single stage impactor mounted on an aircraft.]

330. I. H. Blifford, Jr. and D. A. Gillette, "The Influence of Air Origin on the Chemical Composition and Size Distribution of Tropospheric Aerosols," Atm. Environ., Vol. 6, pp. 463-480, 1972. [Measured size distributions at several altitudes up to 9.1 km over the ocean and desert.]

331. A. R. Boilean, Scipps Inst. of Oceanography, U. of Calif., p. 1, 1959. [Aerosol size measurements.]

332. A. M. Borovikov, Trans. of Central Aerolog. Obs., No. 3, p. 3, 1948. [Measured cloud drop sizes.]

333. A. M. Borovikov, et al., In collection entitled: The Physics of Clouds, ed. A. Kh. Khrgian, Gidrometeoizdat, 1961. [Microstructure of clouds.]

334. J. R. Brock. "On the Size Distribution of Atmospheric Aerosols," Atm. Environ., Vol. 5, pp. 833-841, 1971. [Theory of asymptotic power laws (Pareto distributions) for aerosols based on condensation growth.]

335. V. I. Bukatyy, M. V. Kabanov, B. P. Koshelev, B. A. Smirnov, B. A. Savel'yev and S. S. Khmelevtsov, Sov. Phys. J., No. 8, p. 139, 1967. [Measured laser attenuation by water and fog.]

336. K. Bullrich, R. Eiden, R. Jaenicke and W. Novak, Final Technical Rept., Contract DA-91-591-EUC-3458, 1966. [Size distribution based on sky-brightness observations indicate Junge distribution with $\beta = 4$ and $a_2 = 10$ μm.]

337. T. J. Buma, Bull. Amer. Meteor. Soc., Vol. 41, p. 357, 1960. [Aerosol size measurements.]

338. W. Carnuth, "Aerosol Size Distribution at 700, 1800 and 300 m ASL," J. Geophys. Res., Vol. 75, pp. 2999-3005, 1970. [Simultaneous measurements at three altitudes (700, 1800, 3000 m) on mountain in Germany.]

339. M. Centeno V, "The Refractive Index of Liquid Water in the Near Infrared Spectrum," JOSA, Vol. 31, No. 3, pp. 244-247, March 1941. [Optical constants for liquid H_2O (1-15 μm).]

340. C. W. Chagnon and C. E. Junge, "The Vertical Distribution of Sub-Micron Particles in the Atmosphere," J. Meteor., Vol. 18, No. 6, pp. 746-752, 1961. [Aerosol concentration measurements from 6 to 27 km altitudes using balloon borne impactors (average radius of 0.15 μm).]

341. R. Chesselet, J. Morelli and P. Buat-Menard, "Variations in Ionic Ratios Between Reference Sea Water and Maritime Aerosols," J. Geophys. Res., Vol. 77, No. 27, p. 5116, 1972.

342. D. S. Covert, R. J. Charlson and N. C. Ahlquist, "A Study of the Relationship of Chemical Composition and Humidity to Light Scattering by Aerosols," J. Appl. Meteor., Vol. 11, pp. 968-976, 1972. [Growth with humidity.]

343. W. H. Dalzell and A. F. Sarofim, "Optical Constants of Soot and Their Application to Heat Flux Calculations," J. Heat Trans., Vol. 91, pp. 100-104, 1969. [Refractive index of flame soots.]

344. K. H. Danzer and K. Bullrich, "The Influence of Absorption on the Extinction of Solar and Sky Radiation," Appl. Opt., Vol. 4, No. 11, pp. 1500-1503, November 1965. [Uses the Junge Model C aerosol size distribution in their calculations.]

345. D. R. Deirmendjian, "Note on Laser Detection of Atmospheric Dust Layers," J. Geophys. Res., Vol. 70, No. 3, 1965. [Aerosol concentration versus altitude from laser measurements by others are discussed from a theoretical standpoint.]

346. D. R. Deirmendjian, "On Volcanic and Other Turbidity Anomalies," Adv. in Geophys., Vol. 16, pp. 267-296, 1973.

347. D. R. Deirmendjian and E. H. Vestire, "Some Remarks on the Nature and Origin of Noctilucent Cloud Particles," Planet & Space Sci., Vol. 1, No. 2, 1959.

348. J. J. deLuisi, I. H. Blifford, Jr. and J. A. Takamine, "Models of Tropospheric Aerosol Size Distributions Derived from Measurements at Three Locations," J. Geophys. Res., Vol. 77, pp. 4529-4538, 1972. [Observed aerosol distribution 250 km west of Santa Barbara; fit with Deirmendjian model.]

349. C. E. Dorman, Climatological Observations in the Subtropical Eastern North Pacific, Eos Trans. AGU 53(11)1025, 1972.

350. R. A. Duce and A. H. Woodcock, "Chemical Composition of Atmospheric Sea Salt," Tellus, Vol. 23, pp. 427-435, 1971. [Measured concentration of iodine, bromine and chlorine at 24 m tower.]

351. R. A. Duce, A. H. Woodcock and J. L. Moyers, "Variation of Iron Ratios with Size Among Particles in Tropical Oceanic Air," Tellus, Vol. 19, pp. 369-379, 1967. [Measured concentration of Br, Cl and I in sea salt particles of different sizes on shoreline in Hawaii.]

352. J. Dunbrack, Visibility, Cloud Cover, and Precipitation Data for Geographical Areas of Particular Interest to Navy Weapons Designers, NWC Rept. No. NWCCL-TP-838, April 1969 (AD 851 225).

353. S. Q. Duntley, R. W. Johnson and J. I. Gordon, Airborne Measurements of Optical Atmospheric Properties, Summary and Review, U. of Calif., Scripps Inst. of Oceanog., Visibility Lab., SIO Ref. 72-82, AFCRL-72-0593.

354. W. S. Durbin, Geophys. Pure & Appl., Vol. 42, No. 1, p. 11, 1959. [Measured aerosols in stratosphere. Found very few giant aerosols ($a > 1$ μm).]

355. W. S. Durbin and G. D. White, "Measurements of the Vertical Distribution of Atmospheric Chloride Particles," Tellus, Vol. 13, pp. 260-275, 1961. [Measured aerosols in stratosphere using an aircraft borne impactor, as a function of altitude, wind speed and sea state (also gives data on dust particles inadvertently collected).]

356. P. V. D'yachenko, Trans. of Main Geophys. Obs., No. 101, p. 3, 1959. [Measured cloud size distributions.]

357. A. E. J. Eggleton, "The Chemical Composition of Atmospheric Aerosols on Tees-side and its Relation to Visibility," Atm. Environ., Vol. 3, pp. 355-372, 1969. [Measurements for an industrial region in England show large concentrations of ammonium sulphate. Correlations with visibility also given.]

358. K. G. Eldridge, "A Few Fog Drop-Size Distributions," J. Meteor., Vol. 18, No. 5, pp. 671-676, October 1961. [Measured distribution for a moderately dense, wet fog in six ranges from 1 to 64 μm.]

359. W. P. Elliot, R. Egami and G. F. Rossknecht, "Rainfall at Sea," Nature, Vol. 229, pp. 108-109, 1971. [Measured off the Oregon coast during the winter of 1969-1970.]

360. W. P. Elliot and R. K. Reed, "Oceanic Rainfall Off the Pacific Northwest Coast," J. Geophys. Res., Vol. 78, No. 6, pp. 941-948, 1973. [Rain frequency (%) and amount (in.).]

361. L. Elterman, JOSA, Vol. 55, No. 11, p. 1583, 1965. [Aerosol concentration versus altitude.]

362. N. H. Farlow and G. V. Ferry, "Cosmic Dust in the Mesosphere," Space Res., Vol. 12, pp. 369-380, 1972.

363. C. R. Fean, Seasonal Survey of Average Cloudiness Conditions over the Atlantic and Pacific Oceans, Scripps Inst. of Ocean. Rept. 61-27, October 1961 (AD 267 488).

364. M. M. Fedorov, Dokl. Akad. Nauk SSSR, Vol. 118, No. 4, p. 691, 1958. [Measured urban aerosol size distributions. Approximated satisfactorily by log-normal function.]

365. R. W. Fenn, Measurement of the Concentration and Size Distribution of Particles in the Arctic Air of Greenland, US Army Signal Res. & Dev. Lab Rept. No. 2097, 1960. [Sulfate ion in various compounds primarily ammonium sulfate predominates in small size particles.]

366. R. W. Fenn, Phys. d.Atmos., Vol. 37, p. 69, 1964. [Detected several deviations from Junge distribution for aerosols.]

367. R. W. Fenn, H. R. Gerber and H. K. Weikmann, "Distribution of Aerosol Particles in the Troposphere," Proc. Intl. Conf. Cloud Phys., Tokyo, pp. 62-66, 1965. [Only measurements at altitude (Blifford & Ringer '69).]

368. W. S. Ferguson, J. J. Griffin and E. D. Goldberg, "Atmospheric Dusts from the North Pacific: A Short Note on a Long Range Eolian Transport," J. Geophys. Res., Vol. 75, pp. 1137-1139, 1970.

369. F. G. Fernald and B. G. Schuster, "Wintertime 1973 Airborne Lidar Measurements of Stratosphere Aerosols," J. Geophys. Res., Vol. 82, No. 3, p. 433, 20 January 1977. [The aerosol loading was at or near a 10 day low. These data therefore represent good 'baseline' measurements for future comparison.]

370. E. L. Fireman and G. A. Kistner, "The Nature of Dust Collected at High Altitudes," Geochem. & Cosmochem. Acta, Vol. 24, Nos 1 and 2, 1961.

371. K. Fischer, "Mass Absorption Coefficient of Natural Aerosol Particles in the 0.4 - 2.4 μm Wavelength Interval," Beitr. Phys. Atmos., Vol. 46, pp. 89-100, 1973.

372. J. W. Fitzgerald, "Approximation Formulas for the Equilibrium Size of An Aerosol Particle as a Function of Its Dry Size and Composition and the Ambient Relative Humidity," J. Appl. Meteor., Vol. 14, pp. 1044-1049, 1975. [Approximations to exact equations are given.]

373. D. F. Flanigan and H. P. de Long, "Spectral Absorption Characteristics of the Major Components of Dust Clouds," Appl. Opt., Vol. 10, No. 1, pp. 51-57, January 1971. [Results are given indicating that there are five major components which selectively absorb radiation in the 700-1300 cm^{-1} region. They are clay minerals, silica, and calcium carbonate. Absorptivity coefficient spectra of representative soil samples are given.]

374. N. A. Fuchs, Atm. Environ., Vol. 9, p. 6971, 1975. [Review paper on sampling of aerosols.]

375. N. A. Fuchs, Mechanics of Aerosols, Izd. Akad. Nauk SSSR, 1955. [Size distribution function proposed for clouds.]

376. M. Garstang, N. E. LaSeur, K. L. Walsh, R. Hadlock and J. R. Petersen, "Atmospheric-Oceanic Observations in the Tropics," Amer. Sci., Vol. 58, No. 5, pp. 482-495, September 1970. [Observations of aerosol concentrations near the Barbados.]

377. J. Y. Gilbert, Condensation Nuclei of the Los Angeles Region, U. of Calif. Dept. of Meteor., 1954. [Maritime type aerosol size distribution used by Deirmendjian in type M.]

378. J. B. Gillespie, J. D. Lindberg and M. S. Smith, "Visible and Near-Infrared Absorption Coefficients of Montmorillonite and Related Clays," Amer. Mineralog., Vol. 59, pp. 1113-1116, 1974.

379. D. A. Gillette and I. H. Blifford, Jr., "Composition of Tropospheric Aerosols as a Function of Altitude," J. Atm. Sci., Vol. 28, pp. 1199-1210, 1971. [Aircraft measurements in Nebraska, Death Valley and Pacific at altitudes up to 10 km.]

380. A. Goetz, O. Priening and T. Kallai, Geophys. Pure & Appl., Vol. 50, No. 3, p. 67, 1961. [Investigation of aerosol size distributions over USA.]

381. B. M. Golubitskiy, S. O. Mirumyants and M. V. Tantashev, Paper presented at 7th All-Union Conf. on Actinometry & Atmos. Opt., 27-31 May, 1968, Leningrad. [Measured attenuation coefficients of hazes in the winter and autumn.]

382. G. W. Grams, I. H. Blifford, Jr., B. G. Schuster and J. J. DeLuisi, "Complex Index of Refraction of Airborne Fly Ash Determined by Laser Radar and Collection of Particles at 13 km," J. Atmos. Sci., Vol. 29, No. 5, pp. 900-905, 1972. [Presents measured size distributions at 13 km and infers $n = 1.55$, $k = 0.044 \pm 0.011$.]

383. G. W. Grams, I. H. Blifford, Jr., D. A. Gillette and P. B. Russell, "Complex Index of Refraction of Airborne Soil Particles," J. Appl. Meteor., Vol. 13, pp. 459-471, 1974. [Inferred from measurements of angular scatter and size distributions to be: $n = 1.25$ (representative wide range observed), and $k < 0.005$ (with an uncertainty factor of about two), assuming spherical Mie scattering.]

384. W. D. Green, "Maritime and Mixed Maritime - Continental Aerosols Along the Cost of Southern California," J. Geophys. Res., Vol. 77, No. 27, pp. 5152-5160, September 1972.

385. G. M. Hale and M. R. Querry, "Optical Constants of Water in the 200 nm to 200 μm Wavelength Region," Appl. Opt., Vol. 13, No. 3, pp. 555-563, March 1973. [Extinction coefficients for water at 20°C were determined through a broad spectral region by manually smoothing a point by point graph of $k(\lambda)$ vs. wavelength λ that was plotted for data obtained from a review of the scientific literature on the optical constants of water.]

386. F. F. Hall, Jr. and H. Y. Ageno, Lidar Investigations of the Spatial Distribution and Sizes of Droplets in Spray Plumes from Ocean Waves, McDonnell Douglas Corp. Res. Comm. 59, Paper 5015, May 1968.

387. G. Hanel, "The Properties of Atmospheric Aerosol Particles as Function of Relative Humidity at Thermodynamic Equilibrium with the Surrounding Moist Air," Adv. in Geophys., Vol. 19, pp. 73-188, 1976. [Good treatment of theory and results of some experiments.]

388. G. Hanel, "The Real Part of the Mean Complex Refractive Index and the Mean Density of Samples of Atmospheric Aerosol Particles," Tellus, Vol. 20, No. 3, pp. 371-379, 1968. [Measured with roof-top jet impactor in Germany as a function of humidity.]

389. T. Hatch and S. J. Choate, Frankl. Inst., Vol. 207, 1929. [Log normal distribution for rock dust.]

390. W. Heller, "Remarks on Refractive Index Mixture Rules," J. Phys. Chem., Vol. 69, p. 1123, 1965.

391. C. L. Hemenway, et al., "Electron-Microscope Studies of Noctilucent Cloud Particles," Tellus, Vol. 16, p. 96, 1964. [Measured size distributions. Most particles appear extraterrestrial in origin; about 10% has a coating believed to be ice.]

392. C. L. Hemenway, et al., Investigations of Noctilucent Cloud Particles, AFCRL-65-122, February 1965. [Chemical analysis of rocket probe samples indicate probable extraterrestrial origin with coating of terrestrial ice.]

393. D. J. Hofmann, J. M. Rosen and T. J. Pepin, "Global Measurements of the Time Variations and Morphology of the Stratospheric Aerosol," Proc. 3rd Conf. on Climatic Impact Assessment Prog., 26 February - 1 March 1974, ed. A. J. Broderick & T. M. Hard, DOT-TSC-OST-74-15, 1974.

394. H. Horvath and R. J. Charlson, Am. Ind. Hyg. Assoc. J., Vol. 30, p. 500, 1969.

395. M. Huang, Geophys., No. 2, p. 362, 1963. [Cloud and fog microstructure measurements.]

396. L. S. Ivlev, "Aerosol Model of the Atmosphere," Prob. Fiz. Atmos., No. 7, Leningrad, pp. 125-160, Trans. by Foreign Sci. & Tech. Center, 1967 (AD 760 393).

397. L. S. Ivlev, "Atmospheric Aerosol," in Radiation Characteristics of the Atmosphere and the Earth's Surface, ed. K. Ya. Kondratev, Amerind Publ. Co., New Delhi, pp. 28-42, 1969 (TT-71-58003).

398. Y. Iwasaka and K. Isono, "Lidar Observation of the Stratospheric Aerosols at Two Different Wavelengths, 0.6943 μm and 1.06 μm," J. Atmos. & Terr. Phys., Vol. 39, No. 1, p. 117, January 1977. [Size distribution of the stratospheric aerosols is discussed.]

399. W. C. Jacobs, "The Energy Exchange Between the Sea and Atmosphere and Some of its consequences," Bull. Sripts Inst. Oceanog., Vol. 6, pp. 27-122, 1951.

400. W. C. Jacobs, "The Seasonal Apportionment of Precipitation Over the Ocean," in Eclectic Climatology, ed. A. Court, Ore. State U. Press, OR, pp. 63-78, 1968.

401. R. Jaenicke and C. E. Junge, "Studien zur Oberen Grensgrosse des Naturlichen Aerosols," Beitr. Phys. Atmos., Vol. 40, pp. 129-143, 1967. [Measured giant particles from 10 to 60 m with a propeller type inertial impactor.]

402. C. E. Junge, Gerlands Beit. Geophys., Vol. 46, p. 108, 1935. [Aerosol size measurements indicate little change with relative humidity up to 70%.]

403. C. E. Junge, "The Size Distribution and Aging of Natural Aerosols as Determined from Electrical and Optical Data on the Atmosphere," J. Meteor., Vol. 12, p. 13, 1955. [Large particles can be approximated by Junge's distribution: $N = Ca^{-\beta}$ with $\beta = 3$ for continental aerosols near the ground.]

404. C. E. Junge, "Chemical Analysis of Aerosol Particles and of Gas Traces on the Island of Hawaii," Tellus, Vol. 9, pp. 528-537, 1957. [Measurements indicate giant particles consist almost entirely of sea spray.]

405. C. E. Junge, "Vertical Profiles of Condensation Nuclei in the Stratosphere," J. Meteor., Vol. 18, No. 4, p. 501, 1961. [Measurements of condensation nuclei with a balloon borne Aitken counter from 6 to 27 km altitude.]

406. C. E. Junge, "Large Scale Distribution of Condensation Nuclei in the Troposphere," J. Res. Atm., Vol. 1, pp. 185-188, 1963.

407. C. E. Junge, "Our Knowledge of the Physico-Chemistry of Aerosols in the Undisturbed Marine Environment," J. Geophys. Res., Vol. 77, pp. 5183-5200, 1972. [Review of size distribution and composition of marine aerosols.]

408. C. E. Junge, C. W. Chagnon and J. E. Manson, J. Meteor., Vol. 18, No. 1, 1961. [Aerosol measurements from 6 to 27 km altitudes.]

409. C. E. Junge and J. E. Manson, J. Geophys. Res., Vol. 66, No. 7, pp. 2163-2182, 1961. [Measurements of size distributions of atmospheric aerosols from 6 to 27 km altitudes from U-2 aircraft.]

410. C. E. Junge, C. W. Chagnon and J. E. Manson, Science, Vol. 133, No. 3463, p. 1478, 1961. [Measured smallest aerosol as 0.03 μm.]

411. C. E. Junge, E. Robinson and F. L. Ludwig, "A Study of Aerosols in Pacific Air Masses," J. Appl. Meteor., Vol. 8, pp. 340-347, 1969.

412. C. E. Junge and R. Jaenicke, "New Results in Background Aerosols Studies from the Atlantic Expedition of the R.V. Meteor," Aerosol Sci., Vol. 2, pp. 305-314, 1971. [Aerosol size distributions were measured with several instruments. Saraha dust influences seen.]

413. C. E. Junge and McLaren, "Relationship of Cloud Nuclei Spectra to Aerosol Size Distribution and Composition," J. Atm. Sci., Vol. 28, p. 382, 1971. [Presents a new maritime aerosol size distribution model.]

414. F. Kasten, "Visibility Forecast in the Phase of Pre-Condensation," Tellus, Vol. 21, p. 631, 1969.

415. J. H. Keating, A Climatic Isovisic and Nephanalysis Atlas of the North Atlantic, North Pacific and Indian Oceans, MITRE Corp., April 1966.

416. V. N. Kelkar, Ind. J. Meteor. & Geophys., Vol. 13, No. 2, p. 173, 1962. [Microstructure of rainfalls.]

417. I. A. Khvostikov, The Upper Atmosphere, NASA TT F-315, 1964. [Review of primarily Russian literature on composition of the upper atmosphere.]

418. L. I. Koprova, Paper at All-Union Interdepartmental Conf. on the Scattering of Light in the Atmosphere, Chernovtsy, June 1967. [Measured aerosol attenuation coefficient versus height.]

419. A. G. Laktionov, Trans. of All-Union Scientific Meteor. Conf., Vol. VI, p. 60, 1963. [Extensive data on aerosols ($r > 4$ μm) from 0.1 to 3 km altitude.]

420. L. M. Levin, Dokl. Akad. Nauk SSSR, Vol. 94, No. 6, p. 1045, 1954. [Proposed log-normal size distribution for clouds.]

421. L. M. Levin, Akad. Nauk SSSR, seriya geofiz., No. 10, p. 1211, 1958. [Proposed gamma distribution for clouds.]

422. L. M. Levin, "Studies in the Physics of Coarse-Disperse Aerosols," Izd-vo Akad. Nauk SSSR, 1961. [Formula for cloud droplet size distribution.]

423. J. D. Lindberg, "The Composition and Optical Absorption Coefficient of Atmospheric Particulate Matter," Opt. & Quant. Electron., Vol. 7, No. 3, pp. 131-139, May 1975. [The work suggests that atmospheric dust may be composed mainly of weakly absorbing particles contaminated with small amounts of very strongly absorbing materials such as free carbon. The implications of this are discussed from the point of view of laser beam attenuation and lidar return signals.]

424. J. D. Lindberg and D. G. Snyder, "Diffuse Reflectance Spectra of Several Clay Minerals," Amer. Mineralog., Vol. 57, pp. 485-493, 1972.

425. J. D. Lindberg and D. G. Snyder, "Determination of the Optical Absorption Coefficient of Powdered Materials Whose Particle Size Distribution and Refractive Indices are Unknown," Appl. Opt., Vol. 12, No. 3, pp. 573-578, March 1973. [A method has been devised, based on the Kubelka-Munk theory of diffuse reflectance, for obtaining an estimate of the optical absorption coefficient of a finely powdered material that has been collected on the surface of a membrane filter.]

426. J. D. Lindberg and M. S. Smith, "Reflectance Spectra of Gypsum Sand from the White Sands National Monument and Basalt from a Nearby Lava Flow," Amer. Mineralog., Vol. 58, pp. 1062-1064, 1973.

427. J. D. Lindberg and M. S. Smith, "Visible and Near Infrared Absorption Coefficients of Kanolinite and Related Clays," Amer. Mineralog., Vol. 59, pp. 274-279, March/April 1974.

428. J. D. Lindberg and L. S. Laude, "Measurement of the Absorption Coefficient of Atmospheric Dust," Appl. Opt., Vol. 13, No. 8, pp. 1923-1927, August 1974. [A method for measuring the absorption coefficient of strongly absorbing powdered materials has been applied to samples of atmospheric dust in the 0.3-1.1 μm wavelength interval. Provides an estimate of the optical absorption coefficient. Corresponding imaginary refractive index is calculated from this value. Results are found to be in good agreement with those of other workers obtained by different methods.]

429. D. A. Lundgren and D. W. Cooper, J. Air Poll. Control, Vol. 17, p. 592, 1967.

430. D. A. Lundgren and D. W. Cooper, J. Air Poll. Control, Vol. 19, p. 243, 1969.

431. E. J. Mack, et al., An Investigation of the Meteorology, Physics, and Chemistry of Marine Boundary Layer Processes, Annual Summary Rept. No. 5, Rept. No. CALSPAN-CJ-6017-M-1, October 1977 (AD-A047 613/5ST). [The objective of the 4 week cruise was to investigate marine fog, aerosol characteristics, and evolutionary processes which affect optical propagation in the marine atmosphere. Measurements of visibility, scattering coefficient, winds, air and sea surface temperatures, dew point, total particulate concentration. CCN activity spectra, and fog microphysics were obtained.]

432. K. P. Makhon'ko, Akad. Nauk SSSR, seriya geofiz., No. 8, p. 1235, 1959. [Measured urban aerosol size distribution. Can be approximated by log-normal function.]

433. K. P. Makhon'ko, Akad. Nauk SSSR, seriya geofiz., No. 1, p. 183, 1963. [Measured size distribution for haze shows double peak.]

434. J. S. Malkus, "Large Scale Interactions," in The Sea, Vol. 1, pp. 88-294, ed. M. N. Hill, Wiley, NY 1962. [Presents data of Drozdov; extrapolation of continuum values. Inaccuracy is too high.]

435. J. E. Manson, Handbook of Geophysics and Space Environments, ed. S. L. Valley, AFCRL, pp. 5-22, 1965. [Maritime aerosol distribution as function of velocity.]

436. J. E. Manson, C. E. Junge and C. W. Chagnon, Chemical Reactions Lower and Upper Atmosphere, Interscience, NY-London, p. 139, 1962. [Aerosol measurements from 6 to 27 km altitude.]

437. T. S. Marshall and W. Palmer, "The Distribution of Raindrops with Size," J. Meteorol., Vol. 5, No. 4, p. 165, 1948. [Models of rain size distribution (based on measurements): $N_D = N_o \exp(-\Lambda D)$, $N_o = 0.08\ cm^{-4}$; $\Lambda = 41\ R^{-0.21}$, R rain rate (mm/hr).]

438. B. J. Mason, The Physics of Clouds, Gidrometeoizdat, 1961. [Summarizes measurements of cloud microstructure.]

439. B. J. Mason and Andrews, "Drop-Size Distributions from Various Types of Rain," QJRMS, Vol. 86, p. 346, 1960. [Microstructure of rainfalls of various types are measured.]

440. A. Meszaros, "On the Variation of the Size Distribution of Large and Giant Atmospheric Particles as a Function of the Relative Humidity," Tellus, Vol. 23, pp. 436-440, 1971. [Measured distribution using cascade impactor in Budapest Hungary during summer and winter.]

441. A. Meszaros and K. Vissy, "Concentration, Size Distribution and Chemical Nature of Atmospheric Aerosol Particles in Remote Oceanic Areas," J. Aerosol Sci., Vol. 5, pp. 101-109, 1974. [Gives distribution for various components: sea salt, ammonium sulfate, sulphuric acid.]

442. A. L. Metnieks, "The Size Spectrum of Large and Giant Sea Salt Nuclei Under Maritime Conditions," Geophys. Bull., Vol. 15, pp. 1-50, 1958.

443. E. C. Monahan, "Sea Spray as a Function of Low Elevation Wind Speed," J. Geophys. Res., Vol. 73, pp. 1127-1137, 1968.

444. R. B. Montgomery, "Observations of Vertical Humidity Distribution Above the Ocean Surface and Their Relation to Evaporation," Papers in Phys. Oceanog. & Meteor., Vol. 7, No. 4, 1940.

445. D. J. Moore, "Measurements of Condensation Nuclei Over the North Atlantic," QJRMS, Vol. 78, p. 596, 1952.

446. D. J. Moore and B. J. Mason, "The Concentration, Size Distribution and Production Rate of Large Salt Nuclei Over the Oceans," QJRMS, Vol. 80, p. 583, 1954.

447. V. I. Myukhkyurya, "The Question of Vertical Distribution of Aerosol-Formed Indicators of Atmospheric Sunlight Weakening," Trans. of Main Geophys. Obs., Issue 105, 1960.

448. G. Newkirk, Jr. and J. A. Eddy, "Light Scattering by Particles in the Upper Atmosphere," J. Atmos. Sci., Vol. 21, No. 1, pp. 35-60, 1964. [Inferred size distributions as function of altitude are determined by light scattering and compared with other measurements.]

449. K. E. Noll and M. J. Pilat, "Size Distributions of Atmospheric Giant Particles," Atm. Environ., Vol. 5, pp. 527-540, 1971. [Distributions in the range from 5-100 m were measured over the ocean and coastal regions compares well with other measurements.]

450. T. Ohtake and P. J. Huffman, "Visual Range in Ice Fog," J. Appl. Meteor., Vol. 8, p. 499, 1969. [Size distribution of ice fog in Alaska were measured at eight times and locations.]

451. C. Orr, Jr., F. K. Hurd and W. J. Corbett, "Aerosol Size and Relative Humidity," J. Coll. Sci., Vol. 13, p. 472, 1958.

452. C. Orr, Jr., F. K. Hurd, W. P. Hendrix and C. E. Junge, "The Behavior of Condensation Nuclei Under Changing Humidities," J. Meteor., Vol. 15, pp. 240-242, 1958.

453. T. Owen, Science, Vol. 167, p. 1675, 1970. [Aerosol size distributions are given.]

454. S. Passman and L. Larmore, Proc. IRIS, Vol. 1, No. 2, p. 15, 1956. [Data on absorption by water vapor and methane.]

455. R. B. Penndorf, The Vertical Distribution of Mie Particles in the Troposphere, Geophys. Res. Paper No. 25, AFCRL, Bedford, MA, 1954.

456. R. B. Penndorf, JOSA, Vol. 52, pp. 896-904, 1962. [Gives approximate formulae for Mie expressions good to within 1.5%.]

457. J. Podzimek, Studia Geophys. & Geolog., Vol. 3, No. 4, 1959. [Measured size distribution of giant chloride condensation nuclei.]

458. J. Podzimek and I. Cernoch, Geophys. Pure & Appl., Vol. 50, No. 3, p. 96, 1961. [Measured size distribution of giant sulfate condensation nuclei.]

459. Ye. A. Polyakova, Trans. of Main Geophys. Obs., No. 68, p. 92, 1957. [Microstructure of rainfalls.]

460. Ye. A. Polyakova, Trans. of Main Geophys. Obs., No. 100, p. 45, 1960. [Microstructure of rainfalls.]

461. Ye. A. Polyakova and K. S. Shifrin, Trans. of Main Geophys. Obs., No. 42, p. 84, 1953. [Microstructure of rainfalls.]

462. J. M. Prospero and E. Bonatti, "Continental Dust in the Atmosphere of the Eastern Pacific," J. Geophys. Res., Vol. 74, pp. 3362-3371, 1969.

463. J. M. Prospero and T. N. Carlon, "Vertical and Areal Distribution of Saharan Dust Over the Western Equatorial North Atlantic Ocean," J. Geophys. Res., Vol. 77, No. 27, pp. 5255-5265, 1972.

464. R. F. Pueschel and K. E. Noll, "Visibility and Aerosol Size Distribution," J. Appl. Meteor., Vol. 6, p. 1045, December 1967. [Gives measured size distributions which are used to calculate visibilities to compare with measurements to show there are large inhomogeneities in aerosol content in air.]

465. V. K. Pyldmaa and G. V. Rozenberg, Atmos. & Oceanic Phys., Vol. 2, No. 8, p. 820, 1966.

466. Yu. I. Rabinovich and L. N. Guseva, Trans. of Main Geophysical Obs., No. 118, p. 69, 1961.

467 R. K. Reed and W. P. Elliott, "Precipitation at Ocean Weather Stations in the North Pacific," J. Geophys. Res., Vol. 78, No. 30, p. 7087, 1973.

468. E. Reeger, "Atmospheric Aerosol, A Review," Acta Phys. Aust., Vol. 13, Nos. 2 & 3, 1960.

469. E. E. Remsberg, Radiative Properties of Several Probable Constituents of Atmospheric Aerosols, U. of Wisconsin PhD Thesis, Dept. of Meteor., Madison, Wisconsin, 1971.

470. E. E. Remsberg, "Stratospheric Aerosol Properties and Their Effects on Infrared Radiation," J. Geophys. Res., Vol. 78, pp. 1401-1408., 1973. [Presents a stratospheric aerosol model (composition assumed sulfuric acid with bimodal distribution) based on measurements by others.]

471. W. Rittberger, Meteor., Geophys. & Bioklim., Ser. A, Vol. 11, No. 3, p. 333, 1959. [Measured cloud and fog size distributions single peaked.]

472. G. V. Rozenberg, Usp. Fiz. Nauk, Vol. 95, No. 1, p. 157, 1968. [Constructed a summary diagram of measured aerosol attenuation coefficient vs. height by various Russian experimentalists.]

473. G. V. Rozenberg and A. B. Sandomirskiy, Atmos. & Oceanic Phys., Vol. 3, No. 2, p. 151, 1967.

474. G. V. Rozenberg, A. B. Sandomirskiy and V. K. Pyldmaa, "Noctilucent Clouds," Trans. of Intl. Symp., Tallin, 1966, Izd-vo VINITI, 1967, p. 94.

475. R. Rubio, Investigation of Abrupt Decreases in Atmospherically Backscattered Laser Energy, Rept. No. ECOM-5835, Army Electronics Command, Ft. Monmouth, NJ, December 1977 (AD-A052 231/8ST). [The sharp decreases in backscattered laser energy are attributed to a negative density gradient of the 1 micrometer to 3 micrometers radius anhydrous aerosols. This gradient was not located above a temperature inversion and therefore, in this case, the changes in laser signal were found to be unrelated to any temperature inversion trapping mechanism.]

476. E. N. Rusina, Estimating Atmosphere Turbidity According to Actinometric Data, Rept. No. FTD-HT-23-835-73, Foreign Tech. Div., WPAFB, OH, 1 October 1973, Ed. trans. of Glavnaya Geofizicheskaya Observatoriya, Leningrad, Trudy (USSR) N254, p. 190, 1971, by Paul J. Reiff (AD 768 458/2).

477. R. E. Ruskin, R. K. Jeck and H. E. Gerber, Progress Report on Sea Salt Measurement, September 1975 - January 1976, NRL Memo Rept., February 1976.

478. P. B. Russell, W. Viezee and R. D. Hake, Lidar Measurements of Stratospheric Aerosols Over Menlo Park, California, October 1972 - March 1974, Final Report, June 1974.

479. A. B. Sandomirskiy, N. P. Al'tovskaya and G. A. Trifonova, Geophys., No. 7, p. 121, 1964.

480. J. P. Shedlovsky and I. H. Blifford, Jr., Paper at the 14th General Assembly of the IUGG, Geneva, September 1967. [Real aerosol size distributions have one or more maxima.]

481. K. S. Shifrin, Trans. of Main Geophys. Obs., No. 46, p. 5, 1955. [A four parameter distribution function for cloud droplet distributions: $f(a) = Aa^{\mu} \exp(-\beta\alpha\gamma)$.]

482. K. S. Shifrin and I. N. Minin, Trans. of Main Geophys. Obs., No. 68, p. 5, 1957. [An original investigation of aerosol attenuation coefficients at 2, 4, 8 and 10 μm. Method eliminates molecular effects, but accuracy is poor.]

483. K. Spurny and J. Pich, Studia Geophys. & Geolog., Vol. 5, No. 11, p. 85, 1961. [Measured urban aerosol size distributions can be approximated by log-normal distribution.]

484. D. A. Stewart, Infrared and Submillimeter Extinction by Fog, Rept. No. DRDMI-TR-77-9, Army Missile R&D Command, Redstone Arsenal, AL, 14 July 1977 (AD-A045 181/5ST). [A thorough literature survey of fog drop-size distributions throughout the world is discussed and data from 36 references includes additional important information.]

485. K. Takahashi and S. Iwai, "Estimation of Size Distribution of Small Aerosol Particles by Light Scattering Measurement," J. Coll. Interface Sci., Vol. 23, p. 113, 1967.

486. M. Tanaka, Special Contributions, Geophysical Institute, Kyoto Univ., No. 6, p. 47, 1966.

487. Y. Toba, "On the Giant Sea Salt Particles in the Atmosphere, 1, General Features of the Distribution," Tellus, Vol. 17, pp. 131-145, 1965. [Analyzes measurements of vertical distribution of giant particles of different size ranges. Discusses effect of wind and relative humidity.]

488. Y. Toba, "On the Giant Sea Salt Particles in the Atmosphere, 2, Theory of the Vertical Distribution in the 10 m Layer Over the Ocean," Tellus, Vol. 17, pp. 365-382, 1965. [Analyzes measurements of vertical distribution of giant particles of different size ranges. Discusses effect of wind and relative humidity.]

489. Y. Toba, "On the Giant Sea Salt Particles in the Atmosphere, 3, An Estimate of the Production and Distribution Over the World Ocean," Tellus, Vol. 18, pp. 132-145, 1965. [Analyzes measurements of vertical distribution of giant particles of different size ranges. Discusses effect of wind and relative humidity.]

490. Y. Toba, Special Contributions, Geophys. Inst., Kyoto Univ., No. 6, p. 59, 1966.

491. Y. Toba and M. Tanaka, J. Meteor. Soc., Japan, Ser. II, Vol. 41, No. 3, p. 135, 1963.

492. Y. Toba and M. Tanaka, Special Contributions, Geophys. Inst., Kyoto Univ., No. 5, p. 81, 1965.

493. S. Tsunogai, O. Saito, K. Yamada and S. Nakaya, "Chemical Composition of Oceanic Aerosol," J. Geophys. Res., Vol. 77, No. 27, pp. 5283-5292, 1972.

494. G. B. Tucker, "Precipitation Over the North Atlantic," QJRMS, Vol. 87, pp. 147-158, 1961. [Measurements indicate large differences in rainfall on coast and at sea (less at sea).]

495. J. T. Twitty and J. A. Weinman, "Radiative Properties of Carbonaceous Aerosols," J. Appl. Meteorol., Vol. 10, pp. 725-731, August 1971.

496. S. Twomey and G. T. Severynse, "Size Distributions of Natural Aerosols Below 0.1 Micron," J. Atmos. Sci., Vol. 21, No. 5, pp. 558-564, 1964. [Measurements presented for different pollution levels and before and after fog. Observed double peak in haze size distributions frequently.]

497. S. Twomey and H. B. Howell, "Some Aspects of the Optical Estimation of Microstructure in Fog and Cloud," Appl. Opt., Vol. 6, No. 12, pp. 2125-2131, December 1967. [Indirect measurement of parameters related to the drop size distribution in fog and cloud is discussed. Analysis of the kernel functions in the integral equation relating physical measurements (of transmission, forward scattering and back scattering, respectively) to the drop size distribution reveals the number of useful independent inferences which can be made, with a specified error in measurement and from a given number of observations.]

498. U. S. Dept. of Commerce, Climatological and Oceanographic Atlas for Mariners: Vol. II, North Pacific Ocean, Prepared by Office of Clim. & Ocean. Anal. Div., 1961.

499. F. E. Volz, "On Dust in the Tropical and Midlatitude Stratosphere from Recent Twilight Measurements," J. Geophys. Res., Vol. 75, pp. 1641-1646, 1970. [Reviews twilight scattering data that indicates a considerable variation of the abnormally large amounts of dust due to Agung volcano.]

500. F. E. Volz, "Infrared Absorption by Atmospheric Aerosol Substances," J. Geophys. Res., Vol. 77, No. 6, pp. 1017-1031, February 1972.

501. F. E. Volz, "Infrared Refractive Index of Atmospheric Aerosol Substances," Appl. Opt., Vol. 11, No. 4, pp. 755-759, April 1972.

502. F. E. Volz, "Infrared Optical Constants of Ammonium Sulfate, Sahara Dust, Volcanic Pumice and Flyash," Appl. Opt., Vol. 12, No. 3, pp. 564-568, March 1973. [Spectra of the real and imaginary parts of the refractive index m = n' - in" from 2.5 μm to 40 μm of ammonium sulfate, Sahara dust, volcanic dust, and dust from a coal fired power plant are presented.]

503. F. E. Volz and E. P. Shettle, Optical Constants of Meteoric Dust, 1975.

504. H. Weickmann (Ed.), Proc. 1st Conf. Phys. Cloud Precip. Part., 1957.

505. W. C. Wells, G. Gal and M. W. Munn, Aerosol Distributions in Maritime Air, Lockheed LMSC/D457849 (Rev.), November 1975.

506. K. T. Whitby, R. B. Husar and B. Y. H. Liu, "The Aerosol Size Distribution of Los Angeles Smog," J. Coll. & Int. Sci., Vol. 39, pp. 177-204, 1972.

507. K. O. White and J. D. Lindberg, "Measuring the Transmittance of Atmospheric Dust in KBr Pellets Using a CO_2 Laser," Appl. Opt., Vol. 12, No. 11, pp. 2544-2545, November 1973. [This technique shows that silicate materials in atmosphere absorb "strongly" CO_2 laser radiation; no results.]

508. A. H. Woodcock, "Salt Nuclei in Marine Air as a Function of Altitude and Wind Force," J. Meteorol., Vol. 10, pp. 362-371, 1953. [Measurements of particle weight distributions as several altitudes over the ocean (mostly near Hawaii).]

509. A. H. Woodcock, "Smaller Salt Particles in Oceanic Air and Bubble Behavior in the Sea," J. Geophys. Res., Vol. 77, No. 27, pp. 5316-5321, September 1972.

510. "A World-Wide Stratospheric Aerosol Layer," Science, Vol. 133, No. 3463, 1961.

511. F. W. Wright and P. W. Hodge, "Space Density of Dust in the Stratosphere," Nature, Vol. 195, No. 4838, p. 269, 1962. [Measured aerosol concentration at 13-29 km.]

512. G. Yamamoto, "Radiative Transfer in Water Clouds in the IR Region," J. Atmos. Sci., Vol. 27, pp. 272-292, March 1970. [Gives index of refraction for water versus wavelength (1-100 μm) from three sources.]

513. I. L. Zel'manovich, Trans. of Main Geophys. Obs., No. 100, p. 58, 1960. [Microstructure of falling snow.]

514. V. E. Zuyev, Yu. M. Vorevodin, G. G. Matvienko and I. V. Samokhvalov, "Investigation of Structure and Dynamics of Aerosol Inhomogeneities in the Ground Layer of the Atmosphere," Appl. Opt., Vol. 16, No. 8, p. 2231, August 1977. [Theory of the correlation technique used to analyze the results is given.]

5. TURBULENCE EFFECTS

515. V. P. Aksenov, V. A. Banakh and V. L. Mironov, "Fluctuations of Laser Radiation Intensity Reflected from a Turbulent Atmosphere," Sov. J. Quant. Electron., Vol. 6, No. 10, p. 1233, October 1976. [Treated by applying the Huygens-Fresnel principle to a smoothly inhomogeneous medium. Numerical calculations of the statistics of the diffracted radiation show characteristics similar to those found in direct propagation.]

516. E. C. Alcaraz and P. M. Livingston, "The Beam Wander Phenomenon in the Turbulent Near-Earth Atmosphere," Proc. of Tech. Prog., Electro Optical Systems Design Conf., 18-20 May 1971, Anaheim, CA. [RMS angular deviation of a collimated laser beam. Dependence upon range and meteorological conditions is investigated.]

517. E. C. Alcaraz and P. M. Livingston, Measurements of the Beam Wander Phenomenon in a Turbulent Medium, Rept. No. BRL-MR-2103, Ballistic Res. Labs, Aberdeen Proving Ground, MD, June 1971 (AD 730 644). [Statistical computations and spectral analysis of the beam's center-of-energy motion and its correlation with measured meteorological quantities have been performed.]

518. E. C. Alcaraz, M. T. Reedy and R. G. Reitz, "Comparison of Spatial and Temporal Intensity Fluctuations of a Light Beam Propagating Through a Turbulent Atmosphere," 1971 Annual Meeting of OSA, 5-8 October 1971, Ottawa, Canada. [Scintillation of a weakly divergent He-Ne laser beam was measured simultaneously with beam-cross-section photographs and photocells.]

519. T. I. Arsen'yan, et al., "Interferometric Investigation of Phase Fluctuations of Coherent Optical Radiation in the Atmosphere," Radiophys. Quant. Electron., Vol. 15, p. 937, August 1972. [Measured using interferometer with 0.63 μm laser over a 120 m path.]

520. Yu. Kh. Ayunts, A. S. Aleksanyan and V. M. Dzhulakyan, "Fluctuations of the Intensity of a Laser Beam with $\lambda = 10.6$ μm in Turbulent Atmosphere," Izv. Akad. Nauk SSR Fiz., Vol. 12, No. 6, p. 468, 1977. [The spectral density, the probability and the autocorrelation function of the intensity fluctuations of a 14.85 km path in a turbulent atmosphere over a water surface is given.]

521. V. A. Banakh, et al., "Focused Laser Beam Scintillations in the Turbulent Atmosphere," JOSA, Vol. 64, No. 4, pp. 516-518, April, 1974. [Irradiance scintillations computed using the extended Huygens-Fresnel principle, are compared with variances of the scintillations measured along a 1360 m horizontal path. Satisfactory agreement.]

522. V. A. Banakh, et al., "Saturation Level of Intensity Fluctuations of an Optical Beam in a Turbulent Atmosphere," Izv. Viz. Fiz., No. 2, p. 31, 1975, Trans. in Sov. Phys. J. [Depends significantly on the behavior of the high frequency part of the fluctuation spectrum of the refractive index of air.]

523. V. A. Banakh and V. L. Mironov, "Spectra of Temporal Intensity Fluctuations of Laser Radiation Travelling in a Turbulent Atmosphere," Sov. J. Quant. Electron., Vol. 5, No. 10, p. 1178, October 1975. [For weak fluctuations the intensity spectrum is dominated by the transit time of inhomogeneities across the beam. The spectrum for strong fluctuations is independent of beam size and focusing.]

524. V. A. Banakh and V. L. Mironov, "Phase Approximation of the Huygens-Kirchoff Method in Problems of Laser-Beam Propagation in the Turbulent Atmosphere," Opt. Letters, Vol. 1, No. 5, pp. 172-174, November 1977. [A theoretical analysis is presented to prove the applicability of the phase approximation for propagation in a turbulent atmosphere. Results agree well with experiment.]

525. Y. Barabanenkov, et al., "Status of the Theory of Propagation of Waves in Randomly Inhomogeneous Media," Sov. Phys. Usp., Vol. 13, pp. 551-580, March 1971.

526. D. A. Beall, An Experiment to Measure Laser Beam Wander and Beam Spread in the Marine Boundary Layer Near Shore, Masters Thesis, Naval Postgraduate School, Monterey, CA, December 1973 (AD 775 027/6). [RMS values of beam wander from 4.6 to 30.2 microradians were observed.]

527. R. A. Becker, "Effects of Atmospheric Turbulence on Optical Instrumentation," IRE Trans. on Mil. Elect., Vol. MIL-5, pp. 352-356, October 1961.

528. M. S. Belen'kii, A. I. Kon and V. L. Mironov, "Turbulent Distortions of the Spatial Coherence of a Laser Beam," Sov. J. Quant. Electron., Vol. 7, No. 3, p. 287, March 1972. [Effects of partially coherent light sources are included and turbulence induced image spreading is discussed.]

529. M. J. Beran, "Propagation of a Finite Beam in a Random Medium," JOSA, Vol. 60, No. 4, pp. 518-521, Aprill 1970. [A determinate equation is derived for the propagation of a finite beam of radiation in a random medium. The radiation is described by a mutual coherence function. Analysis is restricted to beam diameters that are large compared to the characteristic correlation lengths in the random medium.]

530. M. J. Beran and T. L. Ho, "Propagation of the Fourth-Order Coherence Function in a Random Medium (A Nonperturbative Formulation)," JOSA, Vol. 59, No. 9, pp. 1134-1138, September 1969. [This paper shows how under certain conditions the perturbation solution for propagation of the 4th order coherence function in a random medium may be extended to treat the propagation problem when the field fluctuations need not be small. A differential equation governing the 4th order coherence function is derived.]

531. M. J. Beran and A. M. Whitman, "Asymptotic Theory for Beam Propagation in a Random Medium," JOSA, Vol. 61, No. 8, pp. 1044-1050, August 1971. [Derive expressions for the full coherence function. An asymptotic analytic expression for the coherence function for very large propagation distances is found. Some explicit results for an initially coherent gaussian wave are presented.]

532. M. J. Beran and A. M. Whitman, "Comments on 'Atmospheric Turbulence Induced Laser Beam Spread' (by H. Yura)," Appl. Opt., Vol. 11, No. 4, p. 956, April 1972.

533. M. Bertolotti, "Effects of Atmosphere on the Propagation of Laser Beams," Proc. of Course on Lasers & Their Applications, 31 May - 13 June 1970, Erice, Italy. [Examines the effects of the atmosphere on the propagation of coherent optical beams with emphasis on turbulence effects.]

534. M. Bertolotti, et al., "Interferometric Study of Phase Fluctuations of a Laser Beam Through the Turbulent Atmosphere," Appl. Opt., Vol. 7, No. 11, pp. 2246-2251, November 1968. [Phase fluctuations of a laser beam propagating through a turbulent atmosphere are studied as a function of the distance in a cross section of the beam. Experiments were performed in an urban center at a distance of 3.5 km and 0.5 km from the source (a He-Ne laser). Results are described and the behavior of the mean square fluctuation of the phase difference is studied.]

535. M. Bertolotti, M. Carnevale, L. Muzii and D. Sette, "The Effects of Atmospheric Turbulence on the Phase of a Laser Beam," Rend. Riunione Assoc. Elettrotec. Ital., Vol. 49, No. 3, B28/1-3, 1974. [The theoretical formulae derived by various authorities for the effect of atmospheric turbulence (variation of refractive index) on the phase structure of an initially plane wavefront from a laser, are subjected to critical examination and comparison.]

536. M. Bertolotti, M. Carnevale, L. Muzii and D. Sette, "Atmospheric Turbulence Effects on the Phase of Laser Beams," Appl. Opt., Vol. 13, No. 7, p. 1582, July 1974. [The phase structure function of a He-Ne laser beam is measured in conditions which are nearly ideal and far from ideal. Do not agree with measurements by Bouricius or 5/3 power theory of Tatarski.]

537. M. Bertolotti, et al., "Intensity Correlation of Radiation Scattered Along the Path of a Laser Beam Propagating in the Atmosphere," AGARD Conf. Proc. No. 183, 27-31 October 1975, Lyngby, Denmark. [Correlation properties of the electromagnetic field scattered away from the direction of propagating of a laser beam are studied. Correlation measurements can be connected with the scale of atmospheric turbulence.]

538. R. E. Betkher, T. O. Viltman and Kh. V. Khinrikus, "Experimental Investigation of Fluctuations of a Laser Beam in an Atmospheric Path," Sov. J. Quant. Electron., Vol. 5, No. 9, p. 1074. [Measurements of transmission at 0.63 and 10.6 μm over a 5 km atmospheric path were used to calculate fluctuations of beam width, position and intensity. Both wavelengths gave similar results.]

539. L. R. Bissonnette, A Semi-Empirical Closure Theory of Optical and IR Wave Propagation in Turbulent Media, Rept. No. DREV-R-708-74, Issued by: Defence Res. Establ., Valcartier, Quebec, Avail. from NTIS. [Equations are written in a format with which the important mechanisms contributing to light scintillation are clearly identified to specific mathematical terms.]

540. L. R. Bissonnette, "Log-Normal Probability Distribution of Strong Irradiance Fluctuations: An Asymptotic Analysis," AGARD Conf. Proc. #183, Lyngby, Denmark, 27-31 December 1975 (AD-A028 615). [Shows that the irradiance variance diverges to infinity if the irradiance probability distribution is everywhere log-normal. Using the same asymptotic solutions, it is shown that the irradiance variance tends to unity if, alternately, the wave amplitude has a normal distribution in the saturation region.]

541. L. R. Bissonnette, Probability Distribution and Asymptotic Variance of Strong Irradiance Fluctuations of Optical Waves in Turbulent Media, Rept. No. DREV-R-4042/75, Defence Res. Establ., Valcartier, Quebec, October 1975 (AD-A021 126/8ST). [The asymptotic solutions for the first- and second-order statistical moments of the amplitude of a plane optical wave propagating in a turbulent atmosphere are derived from Maxwell's equations.]

542. B. D. Borisov, Investigation of the Angle Fluctuation of Incoming Laser Emissions in the Near-Earth Layer of the Atmosphere, Rept. No. NASA-TT-F-12380, July 1969 (N69-31342).

543. G. K. Born, "Phase-Front Distortion of a Laser Beam by Atmospheric Turbulence," Phys. Lett. A, Vol. 33A, No. 6, p. 397, November 1970. [The distortion of the phase front of a laser beam propagating through the turbulent atmosphere is determined under conditions of strong turbulence.]

544. G. K. Born, "Phase-Front Distortion of Laser Radiation in a Turbulent Atmosphere," Appl. Opt., Vol. 14, No. 12, p. 2857, December 1975. [Color photographs (0.5 m sec. exposure) are taken of the center section of the fringes (60 mm dia.). The phase structure function and arrival angle fluctuations are interpreted in terms of turbulence strength and structure.]

545. G. K. Born, et al., "Phase-Front Deformation of Laser Beams by Atmospheric Turbulence," Prog. of 1971 Spring Meeting of OSA, 5-8 April 1971, Tucson, AZ. [Phase-front distortion of laser beams was studied over horizontal paths from 0.5 to 2 km, 2.5 m above ground, under conditions of inversion at high enough wind speeds (1-5 m/s).]

546. G. M. B. Bouricius and S. F. Clifford, "Experimental Study of Atmospherically Induced Phase Fluctuations in an Optical Signal," JOSA, Vol. 60, No. 11, pp. 1484-1489, November 1970. [Measured time-lagged structure function compares well with Tatarski's theory, but not with Bertolotti's measurements.]

547. H. J. Breaux, Correlation of Extended Huygens-Fresnel Turbulence Calculations for a General Class of Tilt Corrected and Uncorrected Laser Apertures, BRL Interim Tech. Rept. 600, May 1978. [Correlates Strehl ratio with effective strength of turbulence; good agreement with measurements. Develops an analytical approximation for coherence length integral for slant paths.]

548. H. Bremmer, "General Remarks Concerning Theories Dealing with Scattering and Diffraction in Random Media," Radio Sci., Vol. 8, pp. 511-534, June 1973.

549. E. Brookner, "Atmospheric Propagation and Communication Channel Model for Laser Wavelengths," IEEE Trans. Comm. Tech., Vol. COM-18, pp. 396-416, August 1970. [A review of a major part of the extensive literature pertaining to theoretical and experimental results on the propagation of laser signals in the atmosphere is given.]

550. W. Brown, "Second Moment of a Laser Beam in a Random Medium," JOSA, Vol. 61, No. 8, pp. 1051-1059, August 1971. [Quantitative results are given for a gaussian beam. The ensemble-averaged distribution of irradiance remains gaussian and gives the e-folding radius of this distribution.]

551. W. Brown, "Moment Equations for Waves Propagated in Random Media," JOSA, Vol. 62, No. 1, pp. 45-54, January 1972. [This paper applied a diagrammatic technique and shows that the partial differential equations obtained by Tatarski, Beran, and Ho for the 1st, 2nd, and 4th statistical moments of a wave propagating in a random medium are special cases of a general partial differential equation satisfied by the mth moment when the refractive index inhomogeneities are sufficiently weak.]

552. W. Brown, "Fourth Moment of a Wave Propagating in a Random Medium," JOSA, Vol. 62, No. 8, pp. 966-971, June 1972. [Starting with a partial differential equation, the general properties of the 4th moments of an initially plane wave and then present numerical results for a two-dimensional plane wave by applying a diagrammatic technique.]

553. A. L. Buck, "Effects of the Atmosphere on Laser Beam Propagation," Appl. Opt., Vol. 6, No. 4, pp. 703-708, April 1967. [An experimental study of horizontal laser beam propagation over paths up to 145 km long was made in which beam diameter and shape, intensity fluctuations, and optical phase distortion were measured.]

554. J. L. Bufton and L. S. Taylor, "Laser Beam Scintillation Beyond the Turbulent Atmosphere, A Numerical Computation," Appl. Opt., Vol. 15, No. 10, p. 2534, October 1976. [Scintillation of laser beams propagating through atmospheric turbulence is studied using the "so-called" extended Huygens-Fresnel method with a numerical integration technique. Results are compared with another gaussian beam propagation theory.]

555. F. Bunkin and K. S. Gochelashvily, "Spreading of a Light Beam in a Turbulent Medium," Radiophys. Quant. Electron., Vol. 13, pp. 811-821, July 1970. [Theoretical analysis based on method of smooth perturbations, including saturation effects.]

556. R. G. Buser, "Interferometric Determination of the Distance Dependence of the Phase Structure Function for Near-Ground Horizontal Propagation at 6328 A," JOSA, Vol. 61, No. 4, p. 488, April 1971 (AD 736 557). [Experimental results are compared with the predictions of the 2/3 power law; it is found that the unmodified Obukhov-Kolmogorov theory does not describe the results correctly, and a considerably lower value for the exponent is observed.]

557. S. J. Campanella and S. B. Sample, A Study of Laser Wave Scattering Due to Refractive Index Perturbations in the Propagating Medium, Final Report, 5 October 1965 - 15 August 1966, NASA-CR-65553 (N66-39966).

558. F. P. Carlson and A. Ishimaru, "Propagation of Spherical Waves in Locally Homogeneous Random Media," JOSA, Vol. 59, No. 3, pp. 319-327, March 1969. [The propagation of spherical waves in a turbulent medium is considered. In particular, the case of non-stationary statistics is examined in general and then applied to the specific case of vertical propagation in the atmosphere. Analysis uses the Rytov approximation and the perturbator technique of J. B. Keller.]

559. T. Chiba, "Beam Spread of Laser Light Propagating Through the Atmosphere," Electron. & Commun., Vol. 54, No. 11, p. 90, November 1971. [Propagation experiments using a He-Ne laser beam were carried out on a 1380 m path. The photographs of beam spread show good agreement with the results of the theoretical work.]

560. T. Chiba, "Spot Dancing of the Laser Beam Propagated Through the Turbulent Atmosphere," Appl. Opt., Vol. 10, No. 11, pp. 2456-2461, November 1971. [An analysis of this problem is made by using the Kolmogorov structure function of the refractive index and geometrical optics. Laser propagation experiments are carried out over 480 m and 1380 m paths. Satisfactory agreement.]

561. T. Chiba and Y. Sugiura, "Spot Dancing of Laser Beam in Atmospheric Propagation," Electron. & Commun., Vol. 54, No. 2, p. 89, February 1972. [Analysis uses Kolmogorov's structure function. Experiments carried out over 480 m and 1380 m outdoor paths show satisfactory agreement.]

562. T. Chiba and Y. Sugiura, "Characteristics of Propagation of a Laser Beam Through the Turbulent Atmosphere, I, Spot Dancing," NHK Tech. J., Vol. 24, No. 4, p. 41, 1972. [Investigated both theoretically and by experimental measurements over 480 and 1380 m paths. Good agreement.]

563. T. Chiba and Y. Sugiura, "Characteristics of Propagation of a Laser Beam Through the Turbulent Atmosphere, II, Beam Spread," NHK Tech J., Vol. 25, No. 1, p. 42, 1973. [Average irradiance distributions of a beam are measured by a photographic method. The theoretical value of the effective beam size shows good correspondance with the experimental value.]

564. T. S. Chu, "On the Wavelength Dependence of the Spectrum of Laser Beams Traversing the Atmosphere," Appl. Opt., Vol. 6, No. 1, p. 163, 1967. [Investigated intensity fluctuations of three lasers (0.63, 3.51 and 10.6 μm).]

565. S. F. Clifford, "Temporal-Frequency Spectra for a Spherical Wave Propagating through Atmospheric Turbulence," JOSA, Vol. 61, No. 10, pp. 1285-1292, October 1971. [Spectra, calculated for spherical waves, reveal contributions at higher frequencies for amplitude scintillations, nearly identical phase results, and a phase-difference spectrum with no nulls, in contrast with the plane-wave results.]

566. S. F. Clifford, G. M. B. Bouricius, G. R. Ochs and M. H. Ackley, "Phase Variations in Atmospheric Optical Propagation," JOSA, Vol. 61, No. 10, pp. 1279-1284, October 1971 (COM-73-10119-19). [Using a He-Ne laser on a 70 m propagation path, the authors measured the optical phase variations at four different spacings. Measured angle of arrival spectrum.]

567. S. F. Clifford, G. Ochs and R. S. Lawrence, "Saturation of Optical Scintillation by Strong Turbulence," JOSA, Vol. 64, No. 2, pp. 148-154, February 1974. [Physical model to calculate variance and covariance of irradiance fluctuations in non-linear region. Develops equation for short term modulation transfer function.]

568. S. F. Clifford and H. T. Yura, "Equivalence of Two Theories of Strong Optical Scintillation," JOSA, Vol. 64, pp. 1641-1644, 1974. [Develops expressions for log-amplitude covariance function in strong turbulence. Develops physical model for saturation.]

569. E. Collett and R. Alferness, "Depolarization of a Laser Beam in a Turbulent Medium," JOSA, Vol. 62, No. 4, pp. 529-533, April 1972. [The correlation function is evaluated for a turbulent medium which is characterized by (a) a gaussian spectrum or (b) a Kolmogorov spectrum.]

570. E. Collett, R. Alferness and T. Forbes, "Log-Intensity Correlations of a Laser Beam in a Turbulent Medium," Appl. Opt., Vol. 12, No. 5, p. 1067, May 1973 (AD 766 544/1). [The log-intensity correlation for any two points in the cross section of a collimated gaussian laser beam is calculated in the geometrical optics approximation. The log-intensity correlation is found to be a function of more than the separation distance between the two points.]

571. S. A. Collins, Investigation of Laser Propagation Phenomena, Final Rept. 1 January 1971 - 28 February 1972, Rept. No. ESL-3163-3, April 1972 (AD 746 053). [Efforts described are concentrated in three main areas: the examination of proper averaging times required for specific propagation experiments; the calculation of theoretical curves predicting results of various experiments along slant paths; and the calculation of predicted results for the temporal spectra of particular atmospheric effects.]

572. S. A. Collins and D. D. Duncan, Investigation of Laser Propagation Phenomena, Final Tech. Rept. No. ESL-3432-7, December 1973 (AD 775 738/8). [Temporal spectra of atmospherically induced phase difference fluctuations, an analysis of an angle-of-arrival apparatus used at RADC and a study of the Fourier transform image restoration procedure.]

573. A. Consortini, "Atmospheric Propagation," Proc. of Course on Lasers & Their Applications, 31 May - 13 June 1970, Erice, Italy. [The problem of fluctuations of wave parameters experienced by a laser beam propagating through the turbulent atmosphere is discussed.]

574. A. Consortini, "Measurements of Angle of Arrival Fluctuations of a Laser Beam Due to Turbulence," AGARD Conf. Proc. No. 183, 1976. [From these measurements the structure functions of the angles of arrival are derived.]

575. A. Consortini, L. Ronchi, A. M. Scheggi and G. Toraldo di Francia, Radio Sci. J. Res., Vol. 1, p. 523, 1966. [Estimates of turbulence effects on light beams.]

576. A. Consortini, et al., "Investigation of Atmospheric Turbulence By Narrow Laser Beams," Appl. Opt., Vol. 9, No. 11, pp. 2543-2547, November 1970. [Dancing of two parallel narrow laser beams propagating through a turbulent atmosphere has been investigated theoretically and experimentally. He-Ne laser on a 130 m path, one meter from the ground.]

577. A. Consortini and L. Ronchi, "Laser Propagation Through Atmospheric Turbulence," Alta Freq., Vol. 43, No. 10, p. 769, October 1974. [Investigating the deterioration of the properties of the laser beam after propagation and deriving information about turbulence.]

578. G. F. Cudahy, An Investigation of the Degradation of a Laser Beam by High Intensity Turbulence, Doctoral Dissertation, AF Inst. of WPAFB Ohio School of Eng., Rept. No. DS/AE/76-1, 26 May 1976 (AD-A025 658/6ST). [Intensity reduction of the far field central spot formed by a collimated laser beam traversing intense turbulence was correlated with the statistical behavior of the refractive index perturbations.]

579. W. F. Dabberdt, An Investigation of Atmospheric Effects on Laser Propagation and the Impact on Eye Safety, Final Rept. June 1971 - October 1972, Stanford Res. Inst., Menlo Pk, CA (AD 755 405). [Results are presented from an experimental study of laser beam scintillation along a slant path in the atmospheric planetary boundary layer.]

580. W. F. Dabberdt, "Slant Path Scintillation in the Planetary Boundary Layer," 1972 Annual Meeting of OSA, 17-20 October 1972, San Francisco, CA. [Experimental study to determine the influence on eye safety of atmospheric thermal turbulence in causing locally high intensities of energy in laser beams. Two 15-mw He-Ne laser beams propagating along reciprocal slant paths were measured simultaneously for a path elevation of 460 m and horizontal ranges from 0.6 to 10 km, during both daytime and nighttime periods.]

*581. W. F. Dabberdt and W. B. Johnson, Atmospheric Effects Upon Laser Eye Safety, Pt II, Stanford Res. Inst., Menlo Pk, CA, 1971.

582. W. F. Dabberdt and W. B. Johnson, "Analysis of Multiwavelength Observations of Optical Scintillation," Appl. Opt., Vol. 12, No. 7, p. 1544, July 1973. [Effects of wavelength, range and thermal turbulence intensity on the laser scintillation magnitude measured over a near-ground horizontal path; 0.4880 μm, 0.6328 μm, and 1.064 μm.]

583. I. Dagkesamanskaya and V. Shishov, "Strong Intensity Fluctuations During Wave Propagation in a Statistically Homogeneous and Isotropic Media," Radiophys. Quant. Electron., Vol. 13, pp. 9-12, January 1970. [Numerical solution for the fourth moment.]

584. F. Davidson and A. Gonzalez-del-Valle, "Measurements of Three-Parameter-Log-Normally Distributed Optical Field Irradiance Fluctuations in a Turbulent Medium," JOSA, Vol. 65, No. 6, pp. 655-663, June 1975. [Probability distribution functions for scintillations measured in water (to simulate air turbulence) was truncated three parameter log normal.]

585. K. L. Davidson and T. M. Houlihan, "Turbulence Effects Upon Laser Propagation in the Marine Boundary Layer," SPIE, Vol. 75, 22-23 22-23 March 1976, Reston, VA. [Shipboard measurements of small scale temperature and velocity fluctuations have been accomplished to determine optical wave propagation properties of the marine boundary layer. Measurements were recorded for ocean conditions in Monterey Bay and in the confines of the Pacific Missile Range.]

586. J. I. Davis, "Consideration of Atmospheric Turbulence in Laser System Design," Appl. Opt., Vol. 5, pp. 139-147, January 1966. [General discussion of beam steering and spreading, image dancing and blurring, scintillation and phase fluctuations.]

587. P. H. Deitz, "Optical Method for Analysis of Atmospheric Effects on Laser Beams," Symp. on Modern Optics, Polytech. Inst. of Brooklyn, NY, 22-24 March 1967, pp. 757-774. [The power density spectrum is derived from intensity profiles and compared to the spectral densities predicted by Tatarski and to those measured by previous techniques.]

588. P. H. Deitz, Optical Propagation in a Near Earth Environment, Rept. No. BRL-TN-1708, Ballistic Res. Labs., Aberdeen Proving Ground, MD, Proc. of Meeting of Panel on Remote Atmospheric Probing, Natl. Acad. of Sci., Chicago, IL, 18 April 1968 (AD 681 905). [Describes optical measurements of the magnitude of scintillation as a function of the range and refractive index structure coefficient. The results are compared with the Tatarski and deWolf geometrical optics saturation equations.]

589. P. H. Deitz and N. J. Wright, Saturation of Scintillation Magnitude in Near-Earth Optical Propagation, Ballistic Res. Labs., Aberdeen Proving Ground, MD, Rept. No. BRL-MR-1941-Rev., October 1968 (AD 681 352). [Both a pulsed laser and a He-Ne laser have been used as optical sources to examine the magnitude of scintillation as a function of range and strength of turbulence over a near-earth, horizontal path. Verified existence of saturation.]

590. P. H. Deitz and N. J. Wright, "Saturation of Scintillation Magnitude in Near-Earth Optical Propagation," JOSA, Vol. 59, No. 5, pp. 527-535, May 1969. [Photo-optical measurements indicate that the variance increases for ranges up to about 700 m, at which distance saturation occurs.]

591. D. A. deWolf, "Wave Propagation Through Quasi-Optical Irregularities," JOSA, Vol. 55, pp. 812-817, July 1965.

592. D. A. deWolf, "Saturation of Irradiance Fluctuations Due to Turbulent Atmosphere," JOSA, Vol. 58, pp. 461-466, April 1968. [Predicts a Rayleigh distribution.]

593. D. A. deWolf, Effects of Turbulence Instabilities on Laser Propagation, Quarterly Progress Rept. No. 2, 9 September - 8 December 1971, Rept. No. PRRL-71-CR-44, RCA Labs, Princeton, NJ, RADC-TR-72-32, January 1972 (AD 737 838).

594. D. A. deWolf, Strong Amplitude Fluctuations of Wave Fields Propagating through Turbulent Media, Rept. No. PRRL-72-CR-11, RCA Labs, Princeton, NJ, February 1972 (AD 740 632). [Presents an exhaustive survey, correction, and expansion of the results that can be obtained through selective summation of averaged products of Born-series.]

595. D. A. deWolf, Effects of Turbulence Instabilities on Laser Propagation, Quarterly Progress Rept. No. 3, 9 December 1971 - 8 March 1972, Rept No. PRRL-72-CR-12, RCA Labs, Princeton, NJ, April 1972 (AD 744 099).

596. D. A. deWolf, Effects of Turbulence Instabilities on Laser Propagation, Quarterly Technical Rept. No. 1, 19 June - 18 September 1972, Rept. No. PRRL-72-CR-45, RCA Labs, Princeton, NJ (AD 753 401). [Some remarks are presented on Furutsu's recent theoretical analysis of irradiance scintillation and the author defines and computes useful criteria for the resolution of point features on an illuminated target in turbulent air. The results are related to the work on focal-spot areas.]

597. D. A. deWolf, Effects of Turbulence Instabilities on Laser Propagation, Quarterly Techical Rept. No. 2, 19 September 1972 - 15 December 1972, Rept. No. PRRL-73-TR-1, RCA Labs, Princeton, NJ (AD 757 221). [Reports results on Furutsu's contested theory of beam wave irradiance in turbulent air.]

598. D. A. deWolf, Effects of Turbulence Instabilities on Laser Propagation, Summary Rept. June 1972 - March 1973, Rept. No. PRRL-73-CR-28, RCA Labs, Princeton, NJ, April 1973 (AD 763 109). [It appears important to make a distinction between focused and other beams. Amplitude scintillations appear to be unimportant in the former. Angle-of-arrival power spectra have been computed for a simple interferometer and these also contain the temporal information of focal-spot fluctuations.]

599. D. A. deWolf, Effects of Turbulence Instabilities on Laser Propagation (Phase II), Final Rept. April 1973 - 15 August 1973, Rept. No. PRRL-73-CR-47, RCA Labs, Princeton, NJ (AD 766 137/4). [It is shown that amplitude scintillation is unimportant in focused beams and is dominant in collimated and diverging beams.]

600. D. A. deWolf, "Strong Irradiance Fluctuations in Turbulent Air, I, Plane Waves," JOSA, Vol. 63, No. 2, pp. 171-179, February 1973. [Analytical results are found for irradiance statistics of a plane wave propagating through uniformly turbulent air.]

601. D. A. deWolf, "Strong Irradiance Fluctuations in Turbulent Air, II, Spherical Waves," JOSA, Vol. 63, No. 10, pp. 1249-1253, October 1973. [Extension of previous work. Main result is a saturation-regime asymptote for the log-amplitude variance $\langle \delta x^2 \rangle$. Comparisons with recent data are made.]

602. D. A. deWolf, "Strong Irradiance Fluctuations in Turbulent Air, III, Diffraction Cut-Off," JOSA, Vol. 64, No. 3, pp. 360-365, March 1974. [Theory is developed further to account for a saturation of the variance in the case where the Fresnel radius $(L/k)^{\frac{1}{2}}$ exceeds the microscale ℓ_o.]

603. D. A. deWolf, "Waves in Turbulent Air, A Phenomenological Model," Proc. IEEE, Vol. 62, pp. 1523-1529, November 1974. [Strong scintillation theory, presents physical model for saturation. Shows that statistics for index of refraction structure constant are gaussian since field consists of independent contributions of many off-axis eddies.]

604. D. A. deWolf, "Coherence of a Light Beam Through an Optically Dense Turbid Layer (Atmospheric Optics)," Appl. Opt., Vol. 17, No. 8, p. 1280, 15 April 1978. [Considers a plane wavefront normally incident upon a cloud and the coherence measured at two locations on the ground. The mutual coherence function at the detectors is derived.]

605. D. A. deWolf, "Waves in Random Media: Weak Scattering Reconsidered," JOSA, Vol. 68, No. 4, pp. 475-479, April 1978. [Theoretical treatment considering more terms than the "Rytov approximation."]

606. L. Dolin, "Propagation of a Narrow Light Beam in a Random Medium," Radiofiz., Vol. 7, pp. 380-391 (in Russian), May 1964. [Applies transport methods.]

607. J. A. Dowling, J. A. Curcio and H. Shenker, "Experimental Studies of Focused Laser Beams Propagating Through Near-Earth Atmospheric Turbulence," Prog. of 1971 Spring Meeting of OSA, 5-8 April 1971, Tucson, AZ. [Focal-spot diameter and beam wander have been studied at ranges up to 2 km. Results are compared with existing theory.]

608. J. A. Dowling, J. A. Curcio and H. Shenker, "Propagation of Focused Laser Beams Through Atmospheric Turbulence," Dig. of Tech. Papers of 1971 IEEE/OSA Conf., 2-4 June 1971, Washington, D.C. [Laser beams of 633 nm and 10.6 µm wavelengths over level grassy terrain at a height of 8 ft. The transmitting telescope was focused on a scanning receiver system for ranges up to 2 km.]

*609. J. A. Dowling and P. M. Livingston, "Behavior of Focused Beams in Atmospheric Turbulence - Measurements and Comments on Theory," JOSA, Vol. 63, No. 7, pp. 846-858, July 1973. [Laser beam propagation through atmospheric turbulence is analyzed theoretically and compared with measurements at 0.63 and 10.6 µm. Measurements on beam spread do not agree with theory because exposure times exceeded L_o/V.]

610. D. D. Duncan, Theoretical Study of the Turbulence Induced Scintillation of a Dirty Laser Beam, Interim Rept. January 1977 - September 1977, Rept. No. RADC-TR-77-430 (AD-A050 874/7ST). [Use is made of the extended Huygens-Fresnel principle in deriving a very general but compact mathematical expression for the temporal scintillation spectrum of an unspecified source field with an arbitrary shaped extended receiver aperture. Restricted to the weak turbulence regime.]

611. J. R. Dunphy and J. R. Kerr, "Scintillation Measurements for Large Integrated Path Turbulence," JOSA, Vol. 63, pp. 981-986, 1973. [Observed rapid dropoff in log-amplitude covariance function in strong turbulence. Measured frequency spectrum in weak and strong turbulence.]

612. J. R. Dunphy and J. R. Kerr, "Turbulence Effects on Target Illumination by Laser Sources: Unified Analysis and Experimental Verification," NATO/AGARD Conf. on Optical Propagation in the Atmosphere, Lyngby, Denmark, Paper 21, 27-31 October 1975. [Shows unity limit of saturation.]

*613. J. R. Dunphy and J. R. Kerr, "Turbulence Effects on Target Illumination by Laser Sources: Phenomenological Analysis and Experimental Results," Appl. Opt., Vol. 16, No. 5, pp. 1345-1358, May 1977. [Simple engineering model for mean and variance as function of transmitter size and focus, wavelength, pathlength, and turbulence strength (including saturation). Error in key expression (Gebhardt-Breaux). Comparison with theory.]

614. N. N. D'Yachenko, V. Ya. S'Edin and S. S. Khmelevtsov, "Fluctuations of Intensity of Focused Laser Beams During Propagation in a Turbulent Atmosphere," Izv. vuz. Fiz., No. [illegible] p. 132, 1974, Trans. in Sov. Phys. J. [Experiments are described on the measurements of intensity fluctuations in a focused laser beam ($\lambda = 0.63$ μm) over path lengths of 1.2 and 3.5 km. The results are used to calculate correlation functions and the distribution of intensity fluctuations.]

615. W. R. Edmonds, "Isoline Approach to Portraying Atmospheric Turbulence Induced Laser Beam Spread," Appl. Opt., Vol. 16, No. 6, p. 1606, June 1977. [Considers effects of turbulence on a laser beam from an airborne source and focused [illegible] receiver at any altitude at almost any zenith angle.]

616. R. L. Fante, Propagation of Electromagnetic Waves Through Turbulent Media Using Transport Theory, AFCRL-72-0733, 18 December 1972 (AD 757 491). [Transport methods have been employed to study the propagation of a narrow-angle electromagnetic beam through a turbulent medium. Results are presented for the mean-square angular divergence of the beam, cross section of the beam, and the power received by a planar aperture in the medium.]

617. R. L. Fante, Mutual Coherence Function of a Beam Propagating in a Turbulent Medium, AFCRL-TR-73-0566, 7 September 1973 (AD 772 659/9). [Using transport theory the mutual coherence function of a beam propagating in a turbulent medium has been studied in detail, including the effect of the beam size, focal length and strength of the turbulence.]

618. R. L. Fante, Mutual Coherence Function and Frequency Spectrum of a Laser Beam Propagating Through Atmospheric Turbulence, AFCRL-TR-74-0079, 6 February 1974 (AD 781 039/3). [The mutual coherence function of a laser beam propagating in turbulence with a modified von Karman spectrum for the index of refraction fluctuations, including a parametric study of the effect on the MCF of varying beam size, focal length, and the properties of the turbulence was computed.]

619. R. L. Fante, Frequency Spectrum of Optical Waves Propagating in a Moving Turbulent Atmosphere, AFCRL-TR-0135, 8 March 1974 (AD 780 623/5).

620. R. L. Fante, "Mutual Coherence Function and Frequency Spectrum of a Laser Beam Propagating Through Atmospheric Turbulence," JOSA, Vol. 64, No. 5, pp. 592-598, May 1974. [A solution for beam spreading is derived. Dependence of MCF on beam diameter, focal length and degree of turbulence are analyzed.]

621. R. L. Fante, Intensity, Coherence, and Frequency Spectrum of a Focused Beam in a Random Medium, AFCRL-TR-74-0335, 26 July 1974 (AD 787 651/9SL). [Numerical results have been obtained for the effect of the strength of turbulence on the intensity, mutual coherence function, and frequency spectrum of a focused beam propagating in a random medium having a von Karman spectrum for the index of refraction fluctuations.]

622. R. L. Fante, "Intensity of a Focused Beam in a Turbulent Medium," Proc. of IEEE, Vol. 62, No. 10, pp. 1400-1402, October 1974 (AD-A012 180/6ST). [The effect of the strength of turbulence on the intensity distribution in the focal plane of a focused laser beam is studied.]

623. R. L. Fante, Covariance of the Intensity Fluctuations of a Wave in a Random Medium, AFCRL-TR-74-0478, 27 September 1974 (AD-A003 384/5ST).

624. R. L. Fante, "Numerical Evaluation of the Mutual Coherence Function of a Laser Beam in Atmosphere Turbulence," Proc. of IEEE, Vol. 62, No. 11, pp. 1604-1606, November 1974 (AD-A004 281/2ST). [With a modified von Karman spectrum for the index of refraction fluctuations, a parametric study was performed of the effect of varying beam size, focal length, and the properties of the turbulence.]

625. R. L. Fante, Irradiance Scintillations: Comparison of Theory with Experiment, AFCRL-TR-74-0626, 20 December 1974 (AD-A006 365/1ST). [Calculations are made using a new theory for the covariance of the irradiance scintillations of an optical wave in a strong turbulent medium. These are compared with recent experimental data and found to be in good agreement.]

626. R. L. Fante, "Electric Field Spectrum and Intensity Covariance of a Wave in a Random Medium," Radio Sci., Vol. 10, pp. 77-85, January 1975. [Physical analytical model for strong turbulence that does not rely on experimentally determined parameters (like others do).]

*627. R. L. Fante, Propagation in Turbulent Media: A Review of Recent Progress, AFCRL-TR-75-0105, 24 February 1975 (AD-A010 413/3ST). [Reviewed the recent developments on beam propagation in a turbulent medium. These include the effect of the turbulence on beam intensity, spread, coherence, wander, angle of arrival, scintillation and distortion, as well as other related topics.]

628. R. L. Fante, "Some New Results on Propagation of Electromagnetic Waves in Strongly Turbulent Media," IEEE Trans. Antennas Propag., Vol. AP-23, pp. 689-695, May 1975 (AD-A003 642/6ST). [Presents new results for the covariance of the intensity fluctuations of a plane wave propagating in a strongly turbulent medium, and evaluates the consequences of these new results on aperture averaging, angle of arrival fluctuations, and the temporal frequency spectrum of the intensity scintillations. Derives phase structure function for strong turbulence region.]

629. R. L. Fante, "Some Results for the Variance of the Irradiance of a Finite Beam in a Random Medium," JOSA, Vol. 65, No. 5, pp. 608-610, May 1975. [Shows theoretically that if turbulence is sufficiently strong the properties of the variance is independent of initial beam structure as has been observed.]

630. R. L. Fante, Optical Beam Propagation in Turbulent Media, AFCRL-TR-75-0439, 13 August 1975 (AD-A018 061/2ST).

631. R. L. Fante, "Electromagnetic Beam Propagation in Turbulent Media," Proc. of IEEE, Vol. 63, No. 12, pp. 1669-1692, December 1975 (AD-A020 778/7ST). [The most recent developments on the propagation of optical beams in a turbulent medium, such as the clear atmosphere, are reviewed. Among the phenomena considered are beam spreading, beam wander, loss of coherence, scintillations, angle-of-arrival variations, and short-pulse effects.]

632. R. L. Fante, "Two Source Spherical Wave Structure Function in Atmospheric Turbulence," JOSA, Vol. 66, No. 1, p. 74, January 1976. [Evaluated the functions for the case of weak turbulence governed by the Kolmogorov spectrum.]

633. R. L. Fante, "Optical Propagation Through Strong Turbulence," SPIE Vol. 142 Optical Properties of the Atmosphere, p. 104, 1978. [In this paper, how and why turbulence distorts the irradiance distribution and coherence properties of a light beam are discussed with special emphasis on the irradiance scintillations in strong turbulence.]

634. R. L. Fante and J. L. Poirier, "Mutual Coherence Function of a Finite Optical Beam in a Turbulent Medium," Appl. Opt., Vol. 12, No. 10, p. 2247, October 1973 (AD 772 276/2). [It is demonstrated that the Markov appoximation, transport theory, the Huygens-Fresnel principle, and the Bethe-Salpeter equation all lead to identical results for the mutual coherence function of an optical beam in a turbulent medium.]

635. R. L. Fante and R. L. Taylor, Short Term Spot Size and Beam Wander in a Turbulent Medium, AFCRL-TR-74-0595, 27 November 1974 (AD-A006 032/7ST). [Calculated results have been used to calculate the probability that, due to beam wander, the beam will fail to hit a receiver aperture.]

636. Z. Feizulin and Y. Kravtsov, "Broadening of a Laser Beam in a Turbulent Medium," Radiophys. Quant. Electron., Vol. 10, pp. 33-35, January 1967. [Theoretical study of the broadening accounting for non-uniformities in medium, diffraction broadening and beam wander.]

637. A. S. Fields, Optical Phase and Intensity Fluctuations in a Refractive Index Microstructure: A Mathematical Analysis, Rept. No. NSRDC-6-196, Naval Ship R&D Center, Annapolis, MD, July 1972 (AD 746 120). [Studies have been published which extend and apply the Kolmogorov theory of turbulence to the fluctuations of optical refractive index in the ocean due to salinity and temperature microstructure.]

638. M. W. Fitzmaurice, Experimental Investigations of Optical Propagation in Atmospheric Turbulence, NASA-TR-R-370, August 1971 (N71-33222).

639. M. W. Fitzmaurice and J. L. Bufton, "Measurement of Log-Amplitude Variance," JOSA, Vol. 59, No. 4, pp. 462-463, April 1969. [Shows that the saturation effect is linear with skewness of the log amplitude.]

640. D. L. Fried, "Statistics of a Geometric Representation of Wavefront Distortion," JOSA, Vol. 55, pp. 1427-1435, November 1965. [Derives relationships between phase structure function and statistics of shape of distorted wavefront. Most important distortion due to tilting of plane wavefront.]

641. D. L. Fried, "Optical Resolution Through a Randomly Inhomogeneous Medium for Very Long and Very Short Exposures," JOSA, Vol. 56, No. 10, pp. 1372-1379, October 1966. [Theoretical study of effect of turbulence on optical resolution. Develops equation for short term irradiance statistics using Huygens-Fresnel principle.]

642. D. L. Fried, "Aperture Averaging of Scintillation," JOSA, Vol. 57, No. 2, pp. 169-175, February 1967. [Relationship between the statistics of log-amplitude fluctuations and irradiance fluctuations due to atmospheric turbulence is derived. This is used to evaluate the effect of use of a large aperture diameter in reducing the variance of a fluctuating signal.]

*643. D. L. Fried, "Propagation of a Spherical Wave in a Turbulent Medium," JOSA, Vol. 57, No. 2, pp. 175-180, February 1967. [The log-amplitude covariance and the phase-structure function, associated with the statistics of propagation of a spherical wave in a turbulent medium, are derived for a propagation path over which the statistics of turbulence are constant. Analytic and graphical representation of the results are presented.]

644. D. L. Fried, "Atmospheric Modulation Noise in an Optical Heterodyne Receiver," J. Quant. Electron., Vol. QE-3, pp. 213-221, June 1967.

645. D. L. Fried, Computer Simulation of Turbulence Induced Pointing Jitter for a Laser Designator, Rept. No. DRDMI-TE-CR-77-2, Army Missile R&D Command, Restone Arsenal, AL, Advanced Sensors Directorate, March 1976 (AD-A039 486/6ST). [Statistics of turbulence-induced, angle-of-arrival fluctuations are formulated and presented in a form suitable for computer calculations of the fluctuation power spectrum for the baseline propagation case of an aperture viewing a point source.]

646. D. L. Fried and G. E. Mevers, "Atmospheric Optical Effects - Polarization Fluctuation," JOSA, Vol. 55, p. 740L, 1965. [Polarization fluctuations in ground layer at distances from 1 to 30 km. Intensity fluctuations approximately normal.]

647. D. L. Fried and J. B. Seidman, "Laser-Beam Scintillation in the Atmosphere," JOSA, Vol. 57, No. 2, pp. 181-185, February 1967. [The variance of the log-amplitude of a laser beam is evaluated for a horizontal propagation path through the atmosphere.]

648. D. L. Fried, G. E. Mevers and M. P. Keister, "Measurements of Laser Beam Scintillation in the Atmosphere," JOSA, Vol. 57, No. 6, pp. 787-797, June 1967. [Detailed studies of intensity fluctuations of a 0.63 μm gas laser, indicated log-normal distribution regardless of collecting aperture.]

649. D. L. Fried and R. A. Schmeltzer, "Effects of Atmospheric Scintillation on an Optical Data Channel - Laser Radar and Binary Communications," Appl. Opt., Vol. 6, No. 10, pp. 1729-1737, October 1967. [Effects of scintillation on an optical data channel are analyzed and numerical results presented. Scintillation with a log normal distribution typical of atmospheric optical effects is assumed. Analysis is concerned with the target miss probability of a laser radar and the bit error probability of an optical binary communications link.]

650. Y. Furuhama and M. Fukushima, "Measurement of Log-Irradiance Fluctuation of He-Ne Laser in the Atmosphere," J. Radio Res. Lab., Vol. 19, No. 100, p. 197, 1972. [The cumulative probability distributions of log-irradiance show excellent agreement with Rice-Nakagami distribution in the region of weak fluctuations.]

651. Y. Furuhama and M. Fukushima, "Measurements of the Log-Irradiance Distribution of a Laser Wave Propagated Through the Turbulent Atmosphere," Boundary-Layer Meteorol., Vol. 4, No. 1-4, p. 433, April 1973. [Log-irradiance fluctuations of He-Ne laser light were simultaneously measured at 3 different points in the receiving plane. Excellent agreement with the Rice-Nakagami distribution in the region of weak fluctuations.]

652. Y. Furuhama, et al., "Propagation Characteristics of Laser Waves Through the Turbulent Atmosphere - Cumulative Probability Distribution," Electron. & Commun., Vol. 56, No. 4, p. 50, April 1973. [The validity of Furutsu's theory for a weak scintillation region has been confirmed by the simultaneous measurement of the logarithmic irradiance of scintillation.]

653. K. Furutsu, "On the Statistical Theory of Electromagnetic Waves in a Fluctuating Medium," J. Res., Nat. Bur. Stnd., Vol. 67D, pp. 303-310, March 1963.

654. K. Furutsu, "Statistical Theory of Wave Propagation in a Random Medium and the Irradiance Distribution Functions," JOSA, Vol. 62, No. 2, pp. 240-254, February 1972. [The complete statistical description of the waves in a random medium can be obtained from the characteristic functional or the cumulant functional of the wave function. The basic equations of these functionals are found first for the gaussian medium and then for the nongaussian medium.]

655. C. S. Gardner and M. A. Plonus, "The Effects of Atmospheric Turbulence on the Propagation of Pulsed Laser Beams," Radio Sci., Vol. 10, No. 1, p. 129, January 1975. [Using the Rytov theory, general expressions for the pulse fluctuations are derived in terms of arbitrary beam geometries and pulse shapes.]

656. S. S. Gasparyan, R. A. Kazaryan and R. G. Manucharyan, "Experimental Investigation of Fluctuations of the Laser Radiation Intensity in the Atmosphere," Sov. J. Quant. Electron., Vol. 3, No. 4, p. 355, Jan-Feb 1974. [Experimental observations are reported for a 25 km path, at heights above ground level varying between 20-500 m along its length.]

657. F. G. Gebhardt and S. A. Collins, Jr., "Log-Amplitude Mean for Laser Beam Propagation in the Atmosphere," JOSA, Vol. 59, No. 9, pp. 1139-1148, September 1969. [An integral expression is evaluated for the log-amplitude mean value of a guassian or laser-like optical beam in a turbulent atmosphere.]

658. E. Gel'fer, et al., "Measurement of the Light Intensity on the Axis at the Center of Gravity of a Focused Light Beam," Radiophys. Quant. Electron., Vol. 15, pp. 696-699, June 1972. [Beam spread agrees with theory.]

659. E. Gel'fer, et al., "Correlation of the Shift of the Center of Gravity of a Focused Light Beam in a Turbulent Medium," Radiophys. Quant. Electron., Vol. 16, pp. 182-187, February 1973. [Measured over a 1 km horizontal path 2.5 m above the ground with photographic films; compares well with theory.]

660. K. H. George and W. E. Webb, Study of Atmospheric Effects on Laser Communications Systems, Vol. 2 - Atmospheric Effects on Wave Propagation at 10.6 Microns, Interim Rept., NASA-CR-103113, March 1971 (N71-26419).

661. T. J. Gilmartin, The Propagation of a Laser Beam in a Turbulent Atmosphere Whose Refractive Index Fluctuations are Gaussian Correlated, Purdue Univ., 1968, Avail. from Univ. Microfilms, Ann Arbor, MI.

662. T. J. Gilmartin, "10.6 μm Laser Radar Propagation Experiments," Proc. 4th Laser Conf., Vol. II, pp. 1543-1555, January 1970. [Measured clear atmosphere transmission, optical turbulence at ground level and resulting beam spread.]

663. T. J. Gilmartin and J. Z. Holst, "Atmospheric Optical Coherence Measurements at 10.6 and 0.63 μm," 1972 Annual Meeting of OSA, 17-20 October 1972, San Francisco, CA. [Simultaneous measurements of the atmospheric spatial coherence have been made with 10.6 and 0.63 μm laser radiation, and with white light.]

664. K. S. Gochelashvily, "Saturation of the Fluctuations of Focused Radiation in a Turbulent Medium," Radiophys. Quant. Electron., Vol. 14, pp. 470-473, April 1971. [Computes phase structure function in linear region using Rytov method.]

665. K. S. Gochelashvily, "Focused Laser Irradiance Fluctuations in a Turbulent Medium," Opt. Acta, Vol. 20, No. 3, p. 193, March 1973. [It is shown that the spectral and correlation properties of the random field of intensity depend in an essential manner upon the magnitude of the phase structure function.]

666. K. S. Gochelashvily, "Propagation of Focused Laser Radiation in a Turbulent Medium," Sov. J. Quant. Electron., Vol. 4, No. 4, p. 465, October 1974. [The correlation theory of fluctuations in the intensity of focused radiation in a turbulent medium is extended to allow the attainment of saturation of the fluctuations at increasing propagation distances.]

667. K. S. Gochelashvily and V. I. Shishov, "Laser Beam Scintillation Beyond a Turbulent Layer," Opt. Acta, Vol. 18, p. 313, April 1971. [Analytical expression is derived for covariance of irradiance in Fresnel zone for strong and weak turbulence.]

668. K. S. Gochelashvily and V. I. Shishov, "Focused Irradiance Fluctuations Beyond a Layer of Turbulent Atmosphere," Opt. Acta, Vol. 19, p. 327, April 1972. [Theoretical treatment of spectral and correlation properties of fluctuations, including saturation, using phase-screen approximation.]

669. K. S. Gochelashvily and V. I. Shishov, "Saturated Fluctuations of Laser Radiation Intensity in a Turbulent Medium," Zh. Eksp. & Teor. Fiz., Vol. 66, No. 4, p. 1237, April 1974, Trans. in Sov. Phys. JETP. [An asymptotic theory is developed of saturated fluctuations of the intensity of quasimonochromatic radiation propagating over large distances in a turbulent medium with a power-law spectrum of refractive index fluctuation.]

670. K. S. Gochelashvily, V. G. Pevgov and V. I. Shishov, "Saturation of Fluctuations of the Intensity of a Laser Radiation at Large Distances in a Turbulent Atmosphere (Fraunhofer Zone of Transmitter)," Sov. J. Quant. Electron., Vol. 4, No. 5, p. 632, November 1974. [The analysis is based on a solution of the equation for the fourth order coherence function for initially spherical waves. A description is obtained of the mode of saturation of the relative fluctuation intensities which is in good agreement with experimental measurements.]

671. K. S. Gochelashvily and V. I. Shishov, "Saturation of Laser Irradiance Fluctuations Beyond a Turbulence Layer," Opt. & Quant. Electron., Vol. 7, No. 6, p. 524, November 1975. [An asymptotic theory of saturated fluctuations of laser irradiance diffracted by a thin layer of turbulent medium is built.]

672. K. S. Gochelashvily and V. I. Shishov, "Strong Intensity Fluctuations of Laser Radiation in a Turbulent Atmosphere, The Distribution Function," Zh. Eksp. & Teor. Fiz., Vol. 74, No. 6, p. 1974, June 1978, Trans. in Sov. Phys. JETP. [A method is proposed for calculation on the distribution function of intensity fluctuations in a medium with Kolmogorov turbulence in the region of saturated flicker.]

673. I. Goldstein, et al., "Heterodyne Measurements of Light Propagation Through Atmospheric Turbulence," Proc. IEEE, Vol. 53, pp. 1172-1180, September 1965. [Phase perturbation measured at 0.6328 and 1.15 μm in horizontal paths (4 and 23.8 km) consistent with theory.]

674. N. Ts. Gomboev, et al., "Spatial Correlation of Strong Intensity Fluctuations in a Narrow Laser Beam Travelling in the Atmophere," Sov. J. Quant. Electron., Vol. 5, No. 6, p. 684. [The spatial correlation function was measured of strong intensity fluctuations in a narrow gaussian beam from a He-Ne laser transmitted over an inclined atmospheric path. Results obtained by two methods agreed with calculations based on the Huygens-Kirchhoff method and differed from uncollimated beam results.]

675. F. E. Goodwin, "Laser Propagation in the Terrestrial Atmosphere," Proc. 1st Laser Conf., Vol. II, pp. 13-25, January 1964. [Measured beam width (3 db) vs. path length and condition. Method of Tatarski not applicable to laser turbulence effects.]

676. M. E. Gracheva, "Investigation of the Statistical Properties of Strong Fluctuations in the Intensity of Light Propagated Through the Atmosphere Near the Earth," Radiophys. Quant. Electron., Vol. 10, pp. 424-433, 1967. [Verified existence of saturation of scintillation of optical beams using mercury lamp over paths of 250, 50, 1000 and 1750 m.]

677. M. E. Gracheva and A. S. Gurvich, "Strong Fluctuations in the Intensity of Light Propagated Through the Atmosphere Close to the Earth," Radiophys. Quant. Electron., Vol. 8, p. 511, 1965. [Data on fluctuation of signal in the atmosphere. First measurement of saturation for $k^{7/6} L^{11/16} C_n^2 > 1$.]

*678. M. E. Gracheva, A. S. Gurvich and M. A. Kallistratova, "Dispersion of Strong Atmospheric Fluctuations in the Intensity of Laser Radiation," Radiophys. & Quant. Electron., Vol. 13, pp. 40-42, 1970. [First found irradiance fluctuations saturated for very strong turbulence. Rytov expression invalid for $\sigma_I^2 > 0.3$. Measured super-saturation.]

679. M. E. Gracheva, et al., "Distribution of Probabilities of Strong Light Intensity Fluctuations in the Atmosphere (Laser Beam)," Izv. vuz. Radiofiz., Vol. 17, No. 1, p. 105, 1974, Trans. in Radiophys. & Quant. Electron. [Measurements were made at daytime under the conditions of strong fluctuations of the air refractive index.]

*680. M. E. Gracheva, et al., Similarity Correlations and Their Experimental Verification in the Case of Strong Intensity Fluctuations of Laser Radiation, Translation LRG-73-T-28, Aerospace Corp. Lib. Serv., POB 92957, Los Angeles, CA 90009, 1974. [Measures frequency spectrum in weak and strong turbulence. Nearly log-normal for $\sigma_I^2 < 0.3$ and $25 < \sigma_I^2 < 100$.]

681. V. Granatstein, "Multiple Scatter of Laser Light from a Turbid Medium," Appl. Opt., Vol. 11, p. 1217, May 1972.

682. A. S. Gurvich, Light Intensity Fluctuations in Diverging Beams, Rept. No. FTD-HT-23-1863-72, Foreign Tech. Div., WPAFB, OH, 5 February 1973, Edited trans. of Izv. Vysshikh Uchebnykh Zavednii Radiofiz (USSR), Vol. 12, No. 1, p. 147, 1969 by V. Mesenzeff (AD 756 094). [Presents a calculation of the dispersion of the light intensity logarithm along the axis of a laser beam propagating in the atmosphere. General formulas, derived by Schmeltzer (1967) by a smooth perturbation technique to describe the propagation of a bounded monochromatic light beam, are used in the calculations.]

683. A. S. Gurvich and M. A. Kallistratova, Radiofiz., Vol. 11, p. 66, 1968. [Measured angle of arrival variance and behavior of structure phase function versus path and turbulence intensity.]

684. A. S. Gurvich, et al., "Fluctuation in the Parameters of a Light Wave From a Laser During Propagation in the Atmosphere," Radiophys. Quant. Electron., Vol. 11, p. 771, September 1968. [Measured angle of arrival spectrum and verified saturation phenomena.]

685. A. S. Gurvich and V. V. Pokasov, "Spectrum of Fluctuations of Laser Radiation in a Turbulent Atmosphere," Atm. & Oceanic Phys., Vol. 8, No. 8, p. 878, August 1972. [Measurements of the frequency spectra of light intensity fluctuations in a direct laser beam of wavelength 0.63 μm, traversing a 1750 m path through weak drizzle.]

686. A. S. Gurvich and V. I. Tatarski, "Statistics of Photoreadings of Light Propagation in the Turbulent Medium," Izv. vuz. Radiofiz., Vol. 16, No. 3, p. 434, 1973, Trans. in Radiophys. & Quant. Electron., Vol. 16, No. 3. [Synchronous measurements are made of the relative dispersion of light intensity fluctuations and of photocounts of light propagating in the turbulent atmosphere along the path of 2650 m. The source of light is He-Ne laser.]

687. A. S. Gurvich and V. V. Pokasov, Frequency Spectra of Strong Fluctuations of Laser Emission in a Turbulent Atmosphere, Rept. No. FTD-HT-23-585-74, Foreign Tech. Div, WPAFB, OH, 28 November 1973, Edited trans. of Izv. vuz. Radiofiz., Vol. 16, No. 6, p. 913, 1973 by V. Mesenzeff (AD 771 693/9). [Results of an experimental study done on frequency fluctuation spectra of laser emission in an atmosphere under conditions of strong and weak fluctuations.]

688. A. S. Gurvich and V. I. Tatarski, "Coherence and Intensity Fluctuations of Light in the Turbulent Atmosphere," Radio Sci., Vol. 10, No. 2, January 1975. [Measured frequency spectrum in weak and strong turbulence.]

689. A. S. Gurvich and S. S. Kashkarov, "Radiation Intensity Fluctuations in Laser Beams in the Atmosphere," Izv. vuz. Radiofiz., Vol. 18, No. 1, p. 69, 1975, Trans. in Radiophys. & Quant. Electron. [The experimental data on RMS values and the correlation coefficients of the intensity fluctuations of narrow laser beams on the near earth trace with length 16.3 km are given.]

690. A. S. Gurvich, et al., "Frequency Spectra of Laser Radiation Intensity Fluctuations at 0.63 and 10.6 Micron Wavelengths in the Atmosphere," Radiophys. & Quant. Electron., Izv. vuz. Radiofiz., Vol. 18, No. 4, p. 610, 1975. [The methods, findings and shortcomings of previous studies of fluctuations in laser radiation intensity at different wavelengths are outlined. The results of experimental measurements of the fluctuation spectra.]

691. B. C. Haagensen, Laser Beam Scintillation in the Marine Boundary Layer, Master's Thesis, Naval Postgraduate School, Monterey, CA, June 1973 (AD 765 676/2). [Intensity scintillation in a laser beam at 0.63 micrometers in the marine boundary layer has been studied over a 4.3 kilometer horizontal path across Monterey Bay and also from shore to ship at San Nicolas Island.]

692. J. L. Hayes and R. L. Kurtz, Experimental Measurement of Optical Angular Deviation Caused by Atmospheric Turbulence and Refraction, NASA-TN-D-3439, May 1966 (N66-25558).

693. J. Herrman and L. C. Bradley, Laser Propagation Through a Turbulent Medium, MIT Lincoln Lab Rept. No. ESD-TR-72-195, 19 December 1972.

694. H. Hidalgo and R. Vaglio-Laurin, Description of Atmospheric Turbulence of Linear Propagation of Laser Beams, Rept. No. RP-P-600, IDA, Arlington, VA, July 1970 (AD 709 434). [Considers the fluid mechanical aspects and data relevant to the propagation of low power-density lasers in the atmospheric boundary layer.]

695. W. R. Hinchman and A. L. Buck, "Fluctuations in a Laser Beam Over 9- and 90-Mile Paths," Proc. IEEE, Vol. 52, pp. 305-306, 1964. [Visual observations indicated broadening of He-Ne beam of 8 and 13 seconds of arc over distances of 15 and 145 km.]

696. T. L. Ho, "Log-Amplitude Fluctuations of Laser Beam in a Turbulent Atmosphere," JOSA, Vol. 59, No. 4, pp. 385-390, April 1969. [Rytov approximation is used to calculate log-amplitude fluctuations in linear region. No comparison with measurements.]

697. T. L. Ho, "Coherence Degradation of Gaussian Beams in a Turbulent Atmosphere," JOSA, Vol. 60, No. 5, pp. 667-673, May 1970. [Method of small perturbations is used with the Kolmogorov spectrum to calculate the degree of coherence.]

698. H. Hodara, "Laser Wave Propagation Through the Atmosphere," Proc. IEEE, Vol. 54, pp. 368-375, March 1966. [Simple expressions are obtained for the effects of beam scanning (quivering), phase change, cross section change (breathing), and polarization fluctuation.]

699. D. H. Höhn, "Effects of Atmospheric Turbulence on the Transmission of a Laser Beam at 6328 Å, I - Distribution of Intensity," Appl. Opt., Vol. 5, No. 9, p. 1427, 1966. [Investigated intensity distribution of 0.6328 μm laser at various distances. Log-normal fit 51 out of 68 measured distribution functions.]

700. D. H. Höhn, "Effects of Atmospheric Turbulence on the Transmission of a Laser Beam at 6328 Å, II - Frequency Spectra," Appl. Opt., Vol. 5, No. 9, p. 1433, 1966. [Investigated the frequency spectra of intensity fluctuations of a 0.6328 μm laser over 4.5 and 14.5 km paths.]

701. D. H. Höhn, "Depolarization of a Laser Beam at 6328 Å Due to Atmospheric Transmission," Appl. Opt., Vol. 8, No. 2, p. 367, February 1969. [These experimental values are very much higher than that predicted by theories regarding turbulence-induced depolarization.]

702. D. H. Höhn, "On Atmospheric Propagation of a Laser Beam," Optik, Vol. 30, No. 2, p. 161, 1969. [Laser beam at 6328 Å was used at ranges up to 4.5 km. In most cases the distribution function of the fluctuating intensity was log-normal.]

703. D. H. Höhn, "On the Propagation of a Laser Beam in the Atmosphere, II," Optik, Vol. 30, No. 3, p. 234, 1969. [This part deals with intensity fluctuations and the mean intensity profile.]

704. G. C. Holst, Laser Beam Divergence and Far Field Measurements, Rept. No. FA-R-2075, Frankford Arsenal, Phila., PA, May 1973 (AD 765 482/5). [Several methods are available for determining the divergence from the far field pattern. These methods are experimentally verified with a He-Ne laser.]

705. J. Honbolt, "Atmospheric Turbulence," AIAA J., Vol. 11, pp. 421-437, October 1973.

706. A. J. Huber, Measurements of the Temporal Power Spectral of a Propagated 10.6 Micron Wavefront, RADC-TR-74-44, February 1974 (AD 777 259/3). [Measurements of the temporal power spectral density of the phase coherence of an atmospherically degraded 10.6 micron wavelength laser beam.]

707. A. J. Huber and R. P. Urtz, "Experimental Phase Difference Spectra for 10.6 μ," 1972 Annual Meeting of OSA, 17-20 October 1972, San Francisco, CA. [Temporal frequency spectra were obtained as a function of detecting aperture separation, sensor orientation, C_T^2 (obtained using microthermal sensors), and wind speed and direction.]

708. A. Ishimaru, "Fluctuations of a Beam Propagating Through a Locally Homogeneous Medium," Radio Sci., Vol. 4, pp. 295-305, April 1969. [Calculates intensity scintillations and computed the phase structure function in linear region using Rytov method.]

709. A. Ishimaru, "Fluctuations of a Focused Beam Wave for Atmospheric Turbulence Probing," Proc. IEEE, Vol. 57, p. 407, April 1969. [Frequency spectrum of weak turbulence using log-amplitude fluctuations; computes phase structure function using Rytov's method.]

710. W. B. Johnson, Trans. Am. Geophys. Union, Vol. 50, p. 159, 1969. [Verified existence of saturation. Abstract only.]

711. W. B. Johnson, et al., Atmospheric Effects - Laser Safety Criteria (U), AFAL-TR-68-243, 1968 (Confidential).

*712. W. B. Johnson, et al., Atmospheric Effects Upon Laser Eye Safety, Pt. I, Stanford Res. Inst., April 1970. [Experimental results indicate possibility of saturation.]

713. M. A. Kallistratova and V. V. Pokasov, "Defocusing and Shift Fluctuations of the Displacement of a Focused Laser Beam in the Atmosphere," Radiophys. Quant. Electron., Vol. 14, pp. 940-945, August 1971. [Results of measuring the turbulent defocusing and shifts of the focused radiation beam of the gas laser (λ = 0.63 μ) on 250 and 1750 m traces near the earth under the conditions of strong amplitude fluctuations.]

714. M. A. Kallistratova, "On the Effect of the Size of Optical Systems on the Definition of Light Beams in a Turbulent Atmosphere," Radiophys. Quant. Electron., Vol. 15, pp. 545-549, April 1972. [Detailed measurements of beam intensity in turbulence agree with theory.]

715. S. S. Kashkarov and K. P. Pogosyan, "Investigation of Intensity Fluctuations of λ = 10.6 μ Laser Radiation in the Atmosphere," Sov. J. Quant. Electron., Vol. 5, No. 10, p. 1267. [The relative variance of the intensity of a 10.6 μm laser beam transmitted over either 13.5 km or 16.3 km atmospheric path was measured in various turbulence conditions. The relative variance was similar to that found previously at 0.63 μm and saturated in strong turbulence.]

716. J. R. Kerr, Multiwavelength Laser Propagation Study, II, Rept. No. 1154-8, Oregon Grad. Ctr. for Study & Res., Portland, OR, July 1970 (AD 709 458). [A comprehensive, multiwavelength laser-beam propagation facility was operated over a horizontal, 1 mile path in order to investigate the adequacy of a commonly-used atmospheric model and to establish the wavelength-depedence of scintillations.]

717. J. R. Kerr, Multiwavelength Laser Propagation Study, III, Rept. No. 1154-9, Oregon Grad. Ctr. for Study & Res., Portland, OR, September 1970 (AD 712 097). [Reviews activities in a comprehensive study of multiwavelength laser scintillations due to atmospheric turbulence.]

718. J. R. Kerr, Multiwavelength Laser Propagation Study, III, Rept. No. 1154-10, Oregon Grad. Ctr. for Study & Res., Portland, OR, December 1970 (AD 717 088). [An extensive experimental investigation of multiwavelength laser beam scintillations and atmospheric turbulence characteristics has been completed. Saturation phenomenon occurs at the same scintillation levels independent of wavelength, and significant fall off of scintillation 'beyond saturation' is observed.]

719. J. R. Kerr, "Multiwavelength Propagation Experiments, III," Prog. of 1971 Spring Meeting of OSA, 5-8 April 1971, Tucson, AZ. [An extensive experimental investigation of multiwavelength laser beam scintillations and atmospheric-turbulence characteristics has been completed.]

720. J. R. Kerr, Propagation of Multiwavelength Laser Radiation Through Atmospheric Turbulence, Rept. No. 1174-1, Oregon Grad. Ctr. for Study & Res., Portland, OR, September 1972 (AD 752 565). [Efforts that are underway on 3 aspects of the problem: (1) multiwavelength scintillations over a long horizontal path, (2) turbulence intermittency effects, and (3) transmitter-aperture effects including the calculation of atmospherically-induced beam wander.]

721. J. R. Kerr, Propagation of Multiwavelength Laser Radiation Through Atmospheric Turbulence, Rept. No. 1174-2, Oregon Grad. Ctr. for Study & Res., Portland, OR, December 1972 (AD 757 562). [Topics are (1) multiwavelength scintillation over a long horizontal path with a very high integrated-path turbulence level; (2) finite-beam or transmitter aperture effects including beam wander, spread, and scintillation; and (3) turbulence intermittency effects.]

722. J. R. Kerr, "Comments on 'Irradiance Fluctuations in Optical Transmission Through the Atmosphere'," JOSA, Vol. 62, No. 7, p. 916, July 1972. [Log normal statistics seem well established for saturated conditions.]

723. J. R. Kerr, "Experiments on Turbulence Characteristics and Multi-Wavelength Scintillation Phenomena," JOSA, Vol. 62, No. 9, pp. 1040-1051, September 1972. [Measurements of atmospheric turbulence structure and multiwavelength scintillation statistics are described. The scintillation measurements use coincident virtual point sources, and include log-amplitude variances and covariances, spectra and receiver-aperture smoothing.]

724. J. R. Kerr, Propagation of Multiwavelength Laser Radiation Through Atmospheric Turbulence, Final Technical Report 15 June 1972 - 31 August 1973, Rept. No. 1174-4, Oregon Grad. Ctr. for Study & Res., Portland, OR (AD 769 792/3). [The analytical and experimental study of finite-transmitter and wander-tracking effects on target irradiance; and the study of the detailed nature of microthermal turbulence fluctuations, including turbulent intermittency, as related to short-term scintillation statistics.]

725. J. R. Kerr, "Turbulence Effects on Target Illumination by Laser Transmitter: Unified Analysis and Experimental Verificiation," AGARD Conf. Proc. No. 183 Optical Propagation in the Atmosphere, Lyngby, Denmark, 27-31 October 1975 (AD-A028 615). [Mechanisms related to the mean irradiance include diffraction, wander, and wavefront distortion (beam-spread), while irradiance-fading is caused by wander, first-order scintillation, and coherent fading. The phenomenological description unifies the often fragmentary and inconsistent treatment of beam wave phenomena found in the literature, and is sufficiently accurate for engineering purposes.]

726. J. R. Kerr, P. J. Titterton and C. M. Brown, "Atmospheric Distortion of Short Laser Pulses," Appl. Opt., Vol. 8, No. 11, p. 2233, November 1969. [Experiments are described using real time pulse-comparison techniques over a 1.6 km path, with a pulse duration of 1.5 nsec, an optical thickness of 2.8, and a typical angular beamwidth and field of view, pulse distortion was not observed.]

727. J. R. Kerr and J. R. Dunphy, Propagation of Multiwavelength Laser Radiation Through Atmospheric Turbulence, Interim Technical Report 1 December 1973 - 30 April 1974, Rept. No. 1103-1, Oregon Grad. Ctr. for Study & Res., Portland, OR (AD 783 277/7). [A unified analytical and phenomenological treatment of the mean irradiance and its fluctuations is presented, with supporting experimental data. A computer simulation technique has been formulated for the generation of an ensemble of instantaneous, short propagation paths through turbulence.]

728. J. R. Kerr, et al., Propagation of Multiwavelength Laser Radiation Through Atmospheric Turbulence, RADC-TR-74-320 (AD-A003 340/7ST). [Model of intermittent turbulence is given and it is shown that the usual mathematical techniques may be applied.]

729. J. R. Kerr, et al., Propagation of Multiwavelength Laser Radiation Through Atmospheric Turbulence, Interim Report 1 April 1975 - 31 July 1975, Oregon Grad. Ctr. for Study & Res., Portland, OR (AD-A023 202/5ST). [It is found experimentally that moderately strong scintillations are not described by a bivariate log normal distribution. A study of computer simulation techniques is described which has the goal of making possible realistic models of propagation paths for the short-term, time-dependent statistics of scintillation, including the effects of localized or intermittent strength of turbulence.]

730. J. R. Kerr, et al., Propagation of Multiwavelength Laser Radiation Through Atmospheric Turbulence, RADC-TR-76-49, 1976. [Presents details of calculations given by Lee (JOSA, Vol. 66, p. 1389).]

731. J. R. Kerr, et al., Propagation of Multiwavelength Laser Radiation Through Atmospheric Turbulence, Final Report 1 February - 30 November 1976, Oregon Grad. Ctr. for Study & Res., Portland, OR (AD-A036 503/1ST). [A complete theory is presented for the statistical effects of atmospheric turbulence on coherent radiation reflected from a diffuse target.]

732. J. R. Kerr and J. R. Dunphy, "Experimental Effects of Finite Transmitter Apertures on Scintillations," JOSA, Vol. 63, No. 1, pp. 1-8, January 1973. [Photographic studies for qualitative interpretation of log-amplitude variance, covariance, probability distributions and the spectra of scintillations.]

733. H. V. Khinrikus, A. E. Puro and G. Ye. Tsyhanov, "Parameter Investigation of a Laser Beam Propagating Through a Turbulent Atmosphere," Izv. vuz. Radioelektron, Vol. 17, No. 8, p. 110, August 1974. [Fluctuations of the parameters of a collimated laser beam (λ = 0.63 μm) have been studied over a 5 km urban path, with the object of obtaining information for the design of an optical communications link.]

734. S. S. Khmelevtsov, "Propagation of Laser Radiation in a Turbulent Atmosphere," Appl. Opt., Vol. 12, No. 10, pp. 2421-2433, October 1973. [Influence of laser radiation specificity-space limitation, coherence, broadening of beams, their random wanderings, and intensity fluctuations.]

735. S. S. Khmelevtsov and R. Sh. Tsvyk, Izv. vuz. Radiofiz., No. 1, 1970. [Investigated intensity distribution of 0.6328 μm laser.]

736. S. S. Khmelevtsov and R. Sh. Tsvyk, "Experimental Investigation of Fluctuations in Light Intensity in a Turbulent Atmosphere," Izv. vuz. Radiofiz., No. 6, p. 130, 1973, Trans. in Sov. Phys. J., No. 6. [Measurements are reported of intensity fluctuations in light from a Ne-He laser source over path lengths up to 18.5 km in a turbulent atmosphere. The results are compared with various theoretical estimates currently available.]

737. S. S. Khmelevtsov and R. Sh. Tsvyk, "Intensity Fluctuations and Angle of Arrival of Light Waves in Space-Limited Collimated Beams in a Turbulent Atmosphere," Izv. vuz. Radiofiz., No. 9, p. 108, 1973, Trans. in Sov. Phys. J. [Experimental results are reported for intensity fluctuations and angle of arrival of a laser beam over path lengths between 500 and 700 m.]

738. Y. Kinoshita, T. Asakura and M. Suzuki, "Fluctuation Distribution of Gaussian Beam Propagating Through a Random Medium," JOSA, Vol. 58, No. 6, pp. 798-807, June 1968. [Obtained solution for the variance of log amplitude across the entire beam cross section.]

739. R. H. Kleen and G. R. Ochs, "Measurements of the Wavelength Dependent of Scintillation in Strong Turbulence," JOSA, Vol. 60, No. 12, p. 1695, December 1970 (COM-73-10119-17). [Observations below saturation indicated good agreement with the predicted wavelength dependence. With increasing turbulence, the scintillations for both 0.6328 and 1.084 μm wavelengths saturated at nearly the same level and then decreased, the shorter wavelength tending to decrease more rapidly.]

740. V. Klyatskin, "Applicability of the Approximation of a Markov Random Process in Problems Related to Light in a Medium with Random Inhomogeneities," Sov. Phys. JETP, Vol. 30, pp. 520-523, March 1970.

741. V. Klyatskin and V. I. Tatarski, "The Parabolic Equation Approximation for Propagation of Waves in a Medium with Random Inhomogeneities," Sov. Phys. JETP, Vol. 31, pp. 335-339, August 1970.

742. V. Klyatskin and A. I. Kon, "On the Displacement of Spatially Bounded Light Beams in a Turbulent Medium in the Markovian-Random-Process Approximation," Radiophys. Quant. Electron., Vol. 15, pp. 1056-1061, September 1972. [Beam wander is investigated theoretically using Markovian-random-process approximation.]

743. A. I. Kon, "Focusing of Light in a Turbulent Medium," Radiophys. Quant. Electron., Vol. 13, pp. 43-50, January 1970. [Develops equation for short term irradiance using Huygens-Fresnel principle.]

744. A. I. Kon and V. I. Tatarski, Izv. vuz. Radiofiz., Vol. 7, No. 2, p. 306, 1964. [Investigated strength of source flicker vs. source angular dimension.]

745. A. I. Kon and V. I. Tatarski, "Parameter Fluctuations of a Space-Limited Light Beam in a Turbulent Atmosphere," Izv. vuz. Radiofiz., Vol. 8, No. 5, p. 870, 1965, Trans. in Sov. Radiophys., Vol. 8, No. 5, p. 617, 1965. [Derived expressions for calculating fluctuations in phase and divergence of beam in turbulent atmosphere.]

746. A. I. Kon and V. I. Tatarski, "Theory of Propagation of Partially Coherent Light Beams in a Turbulent Atmosphere," Izv. vuz. Radiofiz., Vol. 10, p. 1547, 1972 (AD-A000 999/3SL). [The function of mutual coherence is considered.]

747. W. L. Kuriger, "Technique for Measuring Laser Beam Proapgation Direction Fluctuations," Appl. Opt., Vol. 10, No. 11, p. 2462, November 1971. [The far-field modulation phase distribution is shown to be relatively unaffected by turbulence, and results are given for a series of experimental measurements of beam-pointing fluctuations.]

748. R. L. Kurtz and J. L. Hayes, Experimental Measurement of Optical Angular Deviation Caused by Atmospheric Turbulence and Refraction, NASA-TN-D-3439, May 1966. [Amplitude and frequency of random position fluctuation for 6 months, paths of 165 and 3200 m, 6328 A laser.]

749. J. P. Laussade and A. Yariv, "A Theoretical Study of Optical Wave Propagation Through Random Atmospheric Turbulence," Radio Sci., Vol. 5, No. 8, p. 1119, August/September 1970 (AD 725 302). [A new method for obtaining exact analytical expressions for some statistical functions of an optical wave propagating through a randomly turbulent medium is reported. The intensity correlation function ($\langle I(L, r_1)I(L, r_2)\rangle$) is investigated, and recent experimental results regarding the behavior of the intensity fluctuations are discussed.]

750. R. S. Lawrence, "Laser-Beam Propagation Through the Clear Turbulent Atmosphere," IEEE J. Quant. Electron., Vol. QE-5, No. 6, p. 328, June 1969. [Details of what happens to the intensity distribution function and the coherence function in the saturation regime, and what special effects may occur at a wavelength of 10.6 μm as a result of the presence of CO_2 in the atmosphere.]

751. R. S. Lawrence, "Irradiance Fluctuations in Optical Transmission Through the Atmosphere," JOSA, Vol. 62, No. 5, p. 701, May 1972. [Briefly discusses failure of Torrieri's heuristic model due to not using the log-normal distribution of irradiance.]

*752. R. S. Lawrence and J. W. Strohbehn, "A Survey of Clear Air Propagation Effects Relevant to Optical Communications," Proc. IEEE, Vol. 58, pp. 1523-1545, October 1970. [Compares existing theories and measurements for variance and probability distributions of intensity, phase and angle of arrival (95 refs.).]

753. J. C. Leader, "Atmospheric Propagation of Partially Coherent Radiation," JOSA, Vol. 68, No. 2, p. 175, February 1978. [Using an extended Rayleigh-Sommerfield integral method, simplifying approximations are made which facilitate closed-form solutions and illustrate the effects of range, propagation angle, source size and coherence, and strength of turbulence on the predicted spatial coherence.]

754. M. H. Lee, "Variance and Covariance of Irradiance of a Finite Beam in Extremely Strong Turbulence," JOSA, Vol. 68, No. 2, pp. 167-169, February 1978. [Extended Huygens-Fresnel formulation of theory. No comparison with measurements.]

755. M. H. Lee, J. F. Holmes and J. R. Kerr, "Statistics of Speckle Propagation Through the Turbulent Atmosphere," JOSA, Vol. 66, No. 11, p. 1164, November 1976. [This analysis of the 1st and 2nd order statistics is based on the extended Huygens-Fresnel formulation; it includes the effect of the turbulent atmosphere on the laser beam path to the target and on the speckle on its return path to the receiver.]

756. M. H. Lee, et al., "Variance of Irradiance for Saturated Scintillations," JOSA, Vol. 66, No. 10, pp. 1389-1392, December 1976. [Shows normalized variance of irradiance approaches un'ty in the limit of strong turbulence. Uses extended Huygens-Fresnel principle. Compares results with experiments.]

757. R. Lee and J. Harp, "Weak Scattering in Random Media, with Applications to Remote Probing," Proc. IEEE, Vol. 57, pp. 375-406, April 1969. [Rytov does not adequately account for multiple scattering by turbulent eddies.]

758. A. R. Lewis and V. H. Rumsey, "Angular Spectrum Measurements of Atmospheric Turbulence," JOSA, Vol. 67, No. 2, p. 178, February 1977. [A simple experiment was performed, using a rudimentary telescope to receive light from a He-Ne laser (λ = 663 nm) at a distance of 5 km, and photographing the angular spectrum on 35 mm film. Good precision was obtained over a 1000'1 intensity range and the results were in agreement with the Kolmogorov two-thirds law.]

759. P. M. Livingston, et al., "Light Propagation Through a Turbulent Atmosphere: Measurements of the Optical Filter Function," JOSA, Vol. 60, No. 7, pp. 925-935, July 1970. [Irradiance statistics were measured for He-Ne lasers over paths of 650 and 1300 m. Saturation was observed.]

760. V. P. Lukin, et al., "Fluctuation of Phase of Oscillation Modulating the Optical Carriers Propagating in Turbulent Atmosphere," Radio Eng. & Electron. Phys., Vol. 18, No. 3, p. 370, March 1973. [Using the approximation of smooth perturbation, an integral representation is obtained for the variance of phase fluctuation of the harmonic modulating signal at various parameters.]

761. R. F. Lutomirski, "Propagation of Focused Truncated Laser Beams in the Atmosphere," AGARD Conf. Proc. No. 183 Optical Propagation in the Atmosphere, 27-31 October 1975, Lyngby, Denmark. [A formula is derived for the mean intensity distribution from a finite beam in terms of the complex disturbance in the aperture and the mutual coherence function for a spherical wave in the medium.]

762. R. F. Lutomirski and H. T. Yura, "Wave Structure Function and Mutual Coherence Function of an Optical Wave in a Turbulent Atmosphere," JOSA, Vol. 61, No. 4, pp. 482-487, April 1971. [Shows that common expression for wave structure function is in error due to improper extrapolation of Kolmogorov's turbulence spectrum in inertial range.]

763. R. F. Lutomirski and H. T. Yura, On the Phase Structure and Mutual Coherence Function of an Optical Wave in a Turbulent Atmosphere, Rept. No. RM-6266-1-ARPA, Rand Corp., Santa Monica, CA, June 1971 (AD 727 583). [Shows that the most commonly used expression for the mutual coherence function for an optical wave propagating in a turbulence atmosphere is, in general, incorrect. This expression is based on an unphysical extrapolation of the Kolmogorov spectrum.]

764. R. F. Lutomirski and H. T. Yura, "Propagation of a Finite Optical Beam in an Inhomogeneous Medium," Appl. Opt., Vol. 10, pp. 1652-1658, July 1971. [Scintillation phenomena treated by extended Huygens-Fresnel principle. Neglects log amplitude term in perturbation Green's function.]

765. R. F. Lutomirski, et al., Degradation of Laser Systems by Atmospheric Turbulence, Rept. No. R-1171-ARPA/RC (ARPA order #189-1), Rand Corp., Santa Monica, CA, June 1973.

766. P. Mandics, et al., "Spectra of Short-Term Fluctuations of Light-of-Sight Signals: Electromagnetic and Acoustic," Radio Sci., Vol. 8, p. 182, March 1973. [Measured frequency and angle of arrival spectrum in weak and strong turbulence.]

767. J. B. Mason and J. D. Lindberg, Laser Beam Behavior on a Long High Path, Rept. No. ECOM-5430, April 1972 (AD 743 849). [Path is 80 km long and 1.3 km above the surface. Correlations are discussed between temperature lapse rate at the path level and the spreading and deflection of the beam. Beam deflection and beam spread are found to be generally consistent with result obtained by others over lower and shorter paths.]

768. H. C. McDowell and G. H. Stiles, "The Effect of Atmospheric Turbulence on Laser Beam Distribution," Proc. 1st Laser Conf., Vol. II, pp. 73-83, January 1964. [Description of ruby laser experiment at sea level and limited data.]

769. G. E. Mevers, D. L. Fried and M. P. Keister, JOSA, Vol. 55, No. 11, p. 1575, November 1965. [Intensity fluctuations of 0.63 gas laser vs. receiver aperture (3.5 to 50 cm). Verified existence of saturation. Abstract only.]

770. G. E. Mevers, M. P. Keister and D. L. Fried, "Saturation of Scintillation," JOSA, Vol. 59, p. 491, 1969. [Measured super-saturation, shows wavelength dependence after saturation. Abstract only.]

771. G. E. Mevers, M. P. Keister and D. L. Fried, Optical Propagation Measurements at Emerson Lake, 1968, NASA-CR-1733, September 1971 (N71-36755).

772. J. R. Meyer-Arendt and C. B. Emmanuel, Optical Scintillation: A Survey of the Literature, NBS Tech. Note 225, April 1965. [Comprehensive literature survey.]

773. P. O. Minott, "Scintillation in an Earth-to-Space Propagation Path," JOSA, Vol. 62, No. 7, pp. 885-888, July 1972. [A detector aboard the satellite measured the incident light and telemetered the data to recording equipment on the ground, log-amplitude variance, probability distributions, and scintillation frequency distributions are derived from the data.]

774. P. O. Minott, J. L. Bufton and M. W. Fitzmaurice, Results of the Balloon Atmospheric Propagation Experiment Flights of 1970 (Bape 1), NASA-TM-X-65952, March 1972 (N72-28354). [Two laser beams, one argon (5145 Å) and one carbon dioxide (10.6 microns) were propagated over vertical path from the ground to receivers located above the atmosphere, and the scintillation of the beams was measured.]

775. V. L. Mironov and S. S. Khmelevtsov, "Broadening of a Laser Beam Propagating in a Turbulent Atmosphere Along Inclined Routes," Radiophys. Quant. Electron., Vol. 15, pp. 567-571, May 1972, Trans. of Izv. vuz. Radiofiz., Vol. 15, No. 5, pp. 743-750, 1972 (AD-A001 000/9SL). [Calculations are based on the solution of the equation for the coherence function of the second order, obtained in the approximation of a Markov process.]

776. V. L. Mironov and G. Ya. Patrushev, "Field Fluctuations of a Laser Beam Propagated in the Turbulent Atmosphere," Izv. vuz. Radiofiz., Vol. 15, No. 6, p. 865, 1972, Trans. in Radiophys. & Quant. Electron. (AD-A001 222/9SL). [Using the approximating method of smooth perturbations, the variance, correlation, and structural functions of the fluctuations of the logarithm of the amplitude and phase of a laser beam propagating in a turbulent atmosphere were analyzed numerically as a function of the dimensions of the emitting aperture, the focusing radiation conditions, and the coordinates of the observation points in the plane perpendicular to the beam axis.]

777. V. L. Mironov and G. Ya. Patrushev, "Frequency Spectrum of Fluctuations of the Difference Between Amplitudes of Optical Beams Travelling at Different Angles in the Atmosphere," Sov. J. Quant. Electron., Vol. 5, No. 8, p. 942, August 1975. [Approximate integral equations are derived for the frequency spectrum of amplitude differences between laser beams travelling on inclined paths through atmospheric turbulence. Numerical solutions are obtained.]

778. R. L. Mitchell, "Permanence of the Log-Normal Distribution," JOSA, Vol. 58, No. 9, pp. 1267-1272, September 1968. [Distribution of the sum of Log-normal variates is shown in many cases to be log-normal rather than Rayleigh as predicted by central limit theorem.]

779. J. Molyneux, "Propagation of Nth Order Coherence Functions in a Random Medium, II, General Solutions and Asymptotic Behavior," JOSA, Vol. 61, No. 3, pp. 369-377, March 1971. [Generalized Wiener integrals are used to derive the general solutions of the governing equations for all the statistical moments of the radiation field in a random medium. The asymptotic behavior of the solutions are also studied for both large and small values of propagation distance.]

780. R. J. Munick, "Turbulence-Produced Irradiance Fluctuations in Ground-to-Satellite Light Beams," JOSA, Vol. 55, No. 5, p. 594, May 1965. [Estimates of effects of atmospheric turbulence on light beams.]

781. R. J. Munick, "Turbulent Backscatter of Light," JOSA, Vol. 55, No. 7, p. 893, July 1965. [Derived a formula for intensity of light scattered backwards by a turbulent atmosphere. At 0.69 μm this was 5.9×10^{-7} of that by molecular scattering.]

782. G. R. Ochs, "Atmospheric Effects on a Laser Beam in Strong Turbulence," 1969 Annual Meeting of OSA, San Diego, CA, 12 March 1969.

783. G. R. Ochs and C. G. Little, "Studies of Atmospheric Propagation of Laser Beams on 5.5, 15, 45, and 145 km Paths," Conf. on Tropospheric Wave Propag., 30 September - 2 October 1968. [Observations of amplitude scintillations, beam width, and beam wander of laser radiation propagated over long atmospheric paths. He-Ne laser.]

784. G. R. Ochs and R. S. Lawrence, "Saturation of Laser Beam Scintillation Under Conditions of Strong Atmospheric Turbulence," JOSA, Vol. 59, No. 2, pp. 226-227, February 1969. [Measured saturation and super-saturation using He-Ne laser over horizontal 990 n path. Distribution is log-normal.]

785. G. R. Ochs, R. R. Bergman and J. R. Snyder, "Laser Beam Scintillation Over Horizontal Paths from 5.5 to 145 km," JOSA, Vol. 59, pp. 231-234, February 1969. [Measured log amplitude covariance agrees with theory for 5.5 and 15 km paths, but not for 45 km. Also measured turbulence versus altitude well with Hufnagel's model.]

786. P. A. Pincus, et al., "Conditional Fading Statistics of Scintillation," JOSA, Vol. 68, No. 6, p. 756, June 1978. [Field measurements of probability density, two point conditional density and correlation function in weak to strong turbulence.]

787. J. L. Poirier and D. Korff, "Beam Spreading in a Turbulent Medium," JOSA, Vol. 62, No. 7, pp. 893-898, July 1972 (AD 748 530). [Broadening of focused guassian beam is calculated based on modified von Karman spectrum rather than Kolmorogov outside the inertial range.]

788. A. Polushkin, Light Propagation in a Turbulent Atmosphere, Lib. of Congress, Washington DC, Aerospace Tech. Div., 19 March 1969 (AD 684 149). [Presents a comprehensive outline of Soviet research on the propagation of light in a turbulent atmosphere.]

789. D. J. Portman, et al., "Some Optical Properties of Turbulence in Stratified Flow Near the Ground," J. Geophys. Res., Vol. 67, pp. 3223-3235, July 1962. [Optical scintillation measured for 120 and 600 m paths about 1.5 m over both snow and grass. Results related to temperature profiles, wind speeds, Richardson number and path length.]

790. D. J. Portman, E. Ryznar and A. A. Wagif, Laser Scintillation Caused by Turbulence Near the Ground, 1 November 1963 - 30 May 1966, Math Dept., Univ. of Mich., Ann Arbor, MI (AD 666 798). [Laser scintillation was measured for a horizontal optical path 500 m long and 1 m high for various conditions of horizontally homogeneous turbulence, wind direction, average vertical distributions of wind speed and temperature, and, in some cases, turbulent fluctuations of wind velocity were measured simultaneously.]

791. Proceedings of the NATO Expert Conference on Laser Spectroscopy of the Atmosphere, Vol. 8, No. 2, March 1976, 15-21 June 1975, Rjukan, Norway. [The following topics were dealt with: physical properties of the atmosphere including transport and dispersion of atmospheric constituent, turbulence effects, composition and spectral characteristics; instrumentation and techniques in spectroscopic studies of the atmosphere with reference to specific applications; pattern recognition techniques as tools for data analysis.]

*792. A. M. Prokhorov, et al., "Laser Irradiance Propagation in Turbulent Media," Proc. IEEE, Vol. 63, No. 5, pp. 790-811, May 1975. [Results of recent years on propagation in random weakly inhomogeneous media with large scale index of refraction fluctuations are reviewed. Presents analytical models for saturation (127 refs.).]

793. A. M. Prokhorov, et al., "Propagation of Laser Radiation in Randomly Inhomogeneous Media," Sov. Phys. USP, Vol. 17, No. 6, pp. 826-847, May/June 1975. [Analytical methods and experimental data on laser beam propagation are reviewed. In particular the theories of beam spread, intensity fluctuation correlation characteristics and spatial intensity peaks are considered (126 refs.).]

794. B. Querzola and F. Albertin, "Propagation of Laser Beams Through the Atmosphere, II," Alta Freq., Vol. 41, No. 5, p. 350, May 1972. [Theoretical investigation of Maxwell's equations as applied to this problem, and a discussion of the validity of geometrical optics calculations and of Rytov's method.]

795. H. Raidt, "Propagation of Focused Laser Beams in the Turbulent Atmosphere," AGARD Conf. Proc. No. 183 Optical Propagation in the Atmosphere, 27-31 October 1975, Lyngby, Denmark (AD-A028 615). [Experimental results from investigations of instantaneous intensity distributions in focused laser beams at 0.63 μm and 10.6 μm at distances of approximately 1.3 km, 5 km and 8.6 km are presented and discussed.]

796. H. Raidt and D. H. Hohn, "Instantaneous Intensity Distribution in a Focused Laser Beam at 0.63 and 10.6 μm Propagating Through the Atmosphere," Appl. Opt., Vol. 14, No. 11, p. 2747, November 1975. [The measured instantaneous (4 msec - 10 msec) intensity distributions shows that the 0.63 μm beam is broken into several spots but that the 10.6 μm beam pattern remains almost uniform.]

797. T. P. Rankin, Effects of Atmospheric Turbulence on Laser Communications, Master's Thesis, Naval Postgraduate School, Monterey, CA, June 1974 (AD 783 815/4).

798. G. W. Reinhardt and S. A. Collins, Jr., "Outer-Scale Effects in Turbulence-Degraded Light Beam Spectra," JOSA, Vol. 62, No. 12, pp. 1526-1528, December 1972. [Extends temporal spectrum calculations to include outer scale effects. Log-amplitude, phase and phase difference spectra have been calculated using the Rytov approximation for both plane and spherical waves.]

799. G. W. Reinhardt and S. A. Collins, Jr., Laser Propagation Temporal Spectra, RADC-TR-73-66, February 1973 (AD 757 915). [The phase difference temporal spectrum was evaluated for arbitrary orientation of the phase observation points in a plane perpendicular to the beam axis. The calculation was based on the method of spectral expansions and the Rytov approximation but the equations were rearranged to emphasize their relationship to the physical picture using a phase screen model.]

800. R. B. Rivir, The Effect of Turbulence on Laser Beam Quality, Final Report March 1973 - August 1976, Rept. No. AFAPL-TR-76-94, AF Aero Propulsion Lab, WPAFB, OH (AD-A038 667/2ST).

801. A. K. Rogers, Laser Beams in Atmospheric Turbulence, A Review, Rept. No. MWC-TP-4752, Naval Weapons Ctr., China Lake, CA, June 1969 (AD 854 747/3ST). [Summarizes the published literature on the interactions of atmospheric turbulence with laser beams.]

802. E. Ryznar, "Dependency of Optical Scintillation Frequency on Wind Speed," Appl. Opt., Vol. 4, pp. 1416-1418, 1965. [Three measurements indicate wind normal to beam is primary determinant for the frequency spectrum of scintillation.]

803. M. Sancer and A. Varvatsis, "Saturation Calculation for Light Propagataion in the Turbulent Atmosphere," JOSA, Vol. 60, No. 5, pp. 654-659, May 1970. [The variance of the irradiance fluctuations is calculated by a method originally proposed by Keller, but is viewed in a conceptually different manner because it leads to solutions whose validity is essentially independent of distance for the coherent field and average energy flux. The calculations in this paper yield a saturation curve that agrees with the experimental data, with a saturation value that depends on both the wavelength and the length of the propagation path.]

804. A. F. Schroeder, Jr., Laser Scintillation Properties in the Marine Boundary Layer, Master's Thesis, Naval Postgraduate School, December 1973 (AD 772 843/9).

805. V. Ya. S'Edin, et al., "Intensity Fluctuations in a Pulsed Laser Beam Propagating Up to 9.8 Km in the Atmosphere," Izv. vuz. Radiofiz., Vol. 13, No. 1, p. 44, 1970, Trans. in Radiophys. Quant. Electron., Vol. 13, pp. 32-35, January 1970. [Measured using ruby lasers over a 9.8 km path, shows significant differences between horizontal and vertical planes.]

806. V. Ya. S'Edin, et al., "Intensity Fluctuations in a Focused Light Beam that Has Passed Through a Stratum of Turbulent Atmosphere," Radiophys. Quant. Electron., Vol. 15, pp. 612-613, May 1972. [Measured intensity fluctuations of ruby lasers (0.63 μm) over paths from 20 to 1360 m.]

807. B. R. Shah, "Optical Communication Atmospheric Effects," JOSA, Vol. 56, No. 4, p. 559, April 1966. [Paper abstract, reviewing the atmospheric effects on a laser beam. Scattering, absorption, beam spreading, beam bending, and low frequency modulation are all mentioned.]

808. O. P. Sharma and S. S. Penner, "Molecular Backscatter of Laser Radiation from Turbulent Air," AIAA J, Vol. 6, No. 10, p. 2035, October 1968. [For detecting clear air turbulence.]

809. H. Shenker, J. A. Dowling and J. A. Curcio, "Propagation of Focused Laser Beams," Proc. of Tech. Prog. Electrical Optical Systems Design Conf. 1971 West, 18-20 May 1971, Anaheim, CA. [Effects of atmospheric turbulence. Preliminary experiments in 0.63 μm and 10.6 μm laser beams conducted over flat, grassy land paths up to 2.2 km in length will be described.]

810. V. Shishov, "Strong Fluctuations of the Intensity of a Plane Wave Propagating in a Random Refractive Medium," Sov. Phys. JETP, Vol. 34, p. 744, April 1972.

811. V. Shishov, "Strong Fluctuations of the Intensity of a Spherical Wave Propagating in a Randomly Reflective Medium," Radiophys. & Quant. Electron., Vol. 15, pp. 689-695, 1972. [Derives integral equation for covariance of spherical wave.]

812. J. F. Spalding and K. Tomiyasu, "Laser Beam Propagation in the Atmosphere," Proc. 1st Laser Conf., Vol. II, pp. 1-12, January 1964. [Limited measurements on turbulence effects in 10 [illegible] ground wind giving modulation vs. beam diameter.]

813. I. Starobinets, "The Average Illumination and Intensity Fluctuations at the Focus of a Light Beam in a Turbulent Atmosphere," Radiophys. Quant. Electron., Vol. 15, pp. 738-742, May 1972.

814. H. W. Straub, "Coherence in Long Range Laser Beams," Appl. Opt., Vol. 4, No. 7, p. 875, 1965. [Vertical beam wander of 6m peak to peak over 3.5 km path have been observed in many localities (temperate, desert, arctic). Horizontal wander never exceeded 30 cm.]

815. J. W. Strohbehn, "Line of Sight Wave Propagation Through the Turbulent Atmosphere," Proc. IEEE, Vol. 56, pp. 1301-1318, August 1968. [Reviews major approximations in theories and discusses recent experimental results on saturation (59 refs.).]

816. J. W. Strohbehn, "Covariance Functions and Spectra for Waves Propagating in a Turbulent Medium to or From Moving Vehicles," IEEE Trans. Antennas Propag., Vol. AP-22, pp. 303-311, March 1974. [Theoretical expressions are derived for time-lag covariance functions and frequency spectra considering moving source and/or receiver.]

817. J. W. Strohbehn and S. F. Clifford, "Polarization and Angle-of-Arrival Fluctuations for a Plane Wave Propagating Through a Turbulent Medium," IEEE Trans. Antennas Propag., Vol. AP-15, pp. 416-421, May 1967. [Derives correlation function for the mean square depolarized component.]

818. J. W. Strohbehn and T. I. Wang, "Simplified Equation for Amplitude Scintillations in a Turbulent Atmosphere," JOSA, Vol. 62, No. 9, pp. 1061-1068, September 1972. [This paper is concerned with the amplitude or irradiance scintillations of a wave propagating in a clear turbulent atmosphere.]

819. J. W. Strohbehn, et al., "On the Probability Distribution of Line-of-Sight Fluctuations of Optical Signals," Radio Sci., Vol. 10, pp. 59-70, 1975. [Analytical treatment of probability distribution functions.]

820. V. I. Tatarski, "On Strong Fluctuations of Light Wave Parameters in a Turbulent Medium," Sov. Phys. JETP, Vol. 22, pp. 1083-1088, 1966.

821. V. I. Tatarski, "Light Propagation in a Medium with Random Refractive Index Inhomogeneities in the Markov Random Process Approximation," Sov. Phys. JETP, Vol. 29, pp. 1133-1138, December 1969. [Derived equation; only solutions are for limit for weak turbulence.]

822. M. T. Tavis and H. T. Yura, Short Term Average Irradiance Profile of an Optical Beam in a Turbulent Medium, Rept. No. TR-0077(2608)-1, Aerospace Corp., El Segundo, CA, 28 January 1977 (AD-A035 817/6ST). [The short term average irradiance profile of a focused laser beam transmitted through a homogeneous-isotropic medium has been determined by using the extended Huygens-Fresnel principle and by modifying the phase structure function to remove tilt.]

823. P. B. Taylor, Atmospheric Propagation Studies at Optical, Millimeter, and Microwave Frequencies, Pt. II, The Mechanism of Scintillation, Rept. For 1 January 1964 - 20 January 1965, Dayton Univ., Ohio Res. Inst. (AD 466 031/2ST). [Reviews several explanations which might account for the phenomena.]

824. N. Time, "The Spectrum of the Amplitude Fluctuations in a Bounded Light Beam," Radiophys. Quant. Electron., Vol. 14, p. 936, August 1971. [Obtained approximate expressions for frequency of weak scintillations.]

825. P. J. Titterton, "Wave-Front Curvature and Beam Waist Effects on the Scintillation of Light Beams Directed Upward Through the Atmosphere," 1972 Annual Meeting of OSA, 17-20 October 1972, San Francisco, CA. [A computer analysis is performed, based on Schmeltzer's results. It is found that turbulence at the tropopause significantly reduces transmitter aperture averaging effects as predicted by Fried for collimated beams.]

826. P. J. Titterton, "Scintillation and Transmitter-Aperture Averaging Over Vertical Paths," JOSA, Vol. 63, No. 4, p. 439, April 1973. [Analyzed as a function of turbulence profile. Zenith angle, beam waist at the transmitter, and wave-front curvature at the transmitter, turbulence at the tropopause significantly reduces transmitter-aperture-averaging effects for collimated beams.]

827. P. J. Titterton, et al., Optical Propagation Tests Study, Final Report, April - September 1972, GTE Sylvania, Inc., Mountain View, CA (AD 905 055/0ST). [The Optical Propagation Tests Study has analyzed the effects of atmospheric turbulence on atmospheric laser links.]

828. D. J. Torrieri and L. S. Taylor, "Irradiance Fluctuations in Optical Transmission Through the Atmosphere," JOSA, Vol. 62, No. 1, p. 145, January 1972. [Present heuristic model supporting Rayleigh distribution for saturated amplitude scintillations, discounted by Kerr (1972).]

829. R. P. Urtz, Jr., D. O. Tarazano and R. E. Gleba, Amplitude Scintillation Study, RADC-TR-68-416-Vol-1, December 1968 (AD 681 142). [Briefly summarizes available knowledge of scintillation.]

830. R. P. Urtz, A. J. Huber and R. E. Gleba, "Experimental Determination of Phase Structure Function at 10.6 μm," 1971 Annual Meeting of OSA, 5-8 October 1971, Ottawa, Canada. [Measurements have been obtained for a horizontal propagation path of 300 m, approximately 1.5 m above level, grass-covered terrain.

831. R. P. Urtz, A. J. Huber and W. H. Dungey, RADC Laser Propagation Program (for September 1971), RADC-TR-71-252, November 1971 (AD 733 346). [Results are presented of theoretical predictions for the phase structure function for 10.6 micron laser radiation. Experimental data are given for phase structure function measurements for path lengths of 300 meters and a wavelength of 10.6 microns.]

832. A. D. Varvatsis and M. I. Sancer, "Expansion of a Focused Laser Beam in the Turbulent Atmosphere," Can. J. Phys., Vol. 49, No. 10, p. 1233, 16 May 1971. [Formulation is based on Green's theorem and the valid assumption that the turbulent atmosphere is a forward-scatter medium for wavelengths of interest ($0.6 < \lambda < 11\ \mu$).]

833. V. E. Vikhalem, A. A. Taklaya and Kh. V. Khinrikus, "Investigation of Atmospheric Fluctuations of the Intensity of $\lambda = 0.63$ and 10.6 μ Laser Radiation," Sov. J. Quant. Electron., Vol. 5, No. 9, p. 1038. [The statistics were measured of intensity fluctuations of 0.63 μm and 10.6 μm laser beams transmitted through atmospheric turbulence over a city. Various apertures were used and it was found that saturated fluctuation parameters were independent of wavelength.]

834. M. I. Vorob'ev and A. S. Drofa, "Investigation of the Influence of an External Scale of Atmospheric Turbulence Upon Dispersion of Random Displacements of Light Beams," Radiophys. & Quant. Electron., Vol. 20, No. 11, pp. 1711-1717, 1977. [Procedure and results of measurements of the gravity center displacement of a laser beam in the lowest atmospheric layer along a 355 m horizontal path are presented. The displacement dispersion vs. the outer turbulent scale is investigated.]

835. T. I. Wang and J. W. Strohbehn, "Log-Normal Paradox in Atmospheric Scintillations," JOSA, Vol. 64, pp. 583-591, May 1974. [Shows analytically that neither Rayleigh nor log-normal statistics apply exactly.]

836. W. E. Webb, "Effects of Atmospheric Turbulence on Laser Tracking Systems," Proc. of 8th Annual 1969 IEEE Region III Convention, 19-21 November 1969, Huntsville, AL. [A Kolmogorov spectrum of atmospheric turbulence is assumed and the mean square angle of arrival fluctuations are computed. The theoretical results are shown to agree closely with the available experimental data.]

837. W. E. Webb, Study of Atmospheric Effects on Optical Communications and Optical Systems, Final Report, NASA-CR-102680, November 1969. [Expressions for the magnitude of atmospherically induced angle of arrival fluctuations have been derived. These expressions have been compared with the available experimental data and found to agree within the experimental accuracy.]

838. A. Weigandt and A. V. Appel, "Scintillation Measurements Using a Ground-Aircraft Path," 1972 Annual Meeting of OSA, 17-20 October 1972, San Francisco, CA. [Argon laser beam diameters are typically 30-46 m at altitude. Results for several flights will be presented. The observations fall into two categories, one showing a pronounced time dependence of scintillation level, the other no time dependence; a similar dependence on altitude is apparent.]

839. A. M. Whitman and M. J. Beran, "Asymptotic Theory of Irradiance Fluctuations in a Beam Propagating in a Random Medium," JOSA, Vol. 65, pp. 765-768, 1975. [Does not predict saturation.]

840. M. R. Wohlers, "Approximate Analysis of the Refractive Attenuation of Laser Beam Intensities by Turbulent Absorbing Media," Appl. Opt., Vol. 11, No. 6, pp. 1389-1398, June 1972. [Reasonably simple analytic expressions are obtained for both the transient and the steady-state effects of thermal blooming when the medium is moving relative to the laser beam, and various estimates are also obtained for the turbulence-induced attenuation of the peak intensity of a beam.]

841. A. T. Young, "Saturation of Scintillation," JOSA, Vol. 60, No. 11, pp. 1495-1501, November 1970. [Recent measured observations of stellar scintillation provide new evidence that atmospheric dispersion along is not sufficient to cause the saturation observed at large zenith angles. Saturation is produced by lateral spreading of the (initially collimated) light in traversing the turbulent atmosphere - a phenomenon called seeing by astronomers, or multiple scattering by optical physicists. The magnitude of this effect agrees well with the minimum resolution predicted by Fried and by Hulett.]

842. H. T. Yura, "Atmospheric Turbulence Induced Laser Beam Spread," Appl. Opt., Vol. 10, No. 12, pp. 2771-2773, December 1971. [Presents a general simplified prescription that enables one to estimate beam spread from a knowledge of the spherical wave modulation transfer function. Coulman's recent data of the atmospheric temperature structure constant profile have been used to obtain an estimate of the turbulence induced beam spread of an upwardly propagating 0.53 μm laser beam.]

843. H. T. Yura, "The Mutual Coherence Function of a Finite Cross Section Optical Beam Propagating in a Turbulent Medium," Appl. Opt., Vol. 11, No. 6, pp. 1399-1406, June 1972. [Scintillation phenomena treated by extended Huygens-Fresnel principle.]

844. H. T. Yura, "Optical Beam Spread in a Turbulent Medium: Effect of the Outer Scale of Turbulence," JOSA, Vol. 63, No. 1, pp. 107-109, January 1973 (AD 754 204). [Analytic and numerical results are presented such that the limitations on previous results are obtained.]

845. H. T. Yura, "Short Term Average Optical Beam Spread in a Turbulent Medium," JOSA, Vol. 63, pp. 567-572, 1973. [Develops equation for short term irradiance statistics using Huygens-Fresnel principle.]

846. H. T. Yura, "Physical Model for Strong Optical Amplitude Fluctuations in a Turbulent Medium," JOSA, Vol. 64, No. 1, pp. 59-67, January 1974.

*847. H. T. Yura, "Temporal Frequency Spectrum of an Optical Wave Propagating Under Saturation Conditions," JOSA, Vol. 64, No. 3, p. 357, March 1974. [An expression is derived for the log-amplitude temporal-frequency spectrum of a plane wave propagating in a turbulent medium, which is valid under strong scintillation conditions. Results of analysis agree with those of Tatarski and others.]

848. H. T. Yura, Irradiance Fluctuations of a Spherical Wave Propagating Under Saturation Conditions, Interim Rept., Aerospace Corp. Rept. No. TR-0075(5230-30)-1, El Segundo, CA, 17 December 1974 (AD-A003 406/6ST). [The recent physical model of strong optical scintillation of plane waves is extended to the case of spherical wave propagation.]

849. H. T. Yura, "Physical Model for Strong Optical Wave Fluctuations," AGARD Conf. No. 183, Lyngby, Denmark, 27-31 October 1975. [Derives basic phase and amplitude statistics for plane and spherical waves for saturation region. Agrees with measurements (not shown).]

850. A. F. Zhukov, "Investigation of Intensity Fluctuations in the Cross Section of a Narrow Laser Beam in a Turbulent Atmosphere," Izv. vuz. Radiofiz., No. 11, p. 122, 1974, Trans. in Sov. Phys. J. [Experimental measurements of the dispersion of intensity fluctuations in a laser beam of diameter 4.5 mm, wavelength 0.63 μm, over a path length of 260 m.]

851. L. R. Zintsmaster and S. A. Collins, Jr., Angle of Arrival Calculations at 10.6 Microns, Rept. No. ESL-3163-1, June 1971 (AD 727 798). [A survey of the literature is presented showing two approaches to angle of arrival, one for large aperture receivers and one for a single small aperture or a pair of pinholes. Pertinent defining equations are presented for both cases and values are calculated.]

6. TURBULENCE CONDITIONS

852. A. Arnold, "Turbulence in the Stratosphere," Bull. Am. Meteor. Soc., Vol. 35, No. 8, 1954.

853. R. Barletti, et al., "Mean Vertical Profile of Atmospheric Turbulence Relevant for Astronomical Seeing," JOSA, Vol. 66, pp. 1380-1383, December 1976. [Model of average refractive index structure coefficient based on 67 radiosonde flights up to 20-25 km in Europe. Compares with models of Hufnagel and Fried.]

854. B. R. Bean, "Turbulence and Irregularities of the Atmosphere," Proc. of NATO Adv. Study Inst., 29 August - 6 September 1969, p. 139, 1970.

855. S. Berman, "Near-Earth Turbulence and Coherence Measurements at Aberdeen Proving Ground, MD," Boundary-Layer Meteorol., Vol. 11, No. 4, p. 485, July 1977. [Turbulence measurements were made at Aberdeen Proving Ground, MD, for five separate 24-hour periods in August, 1971 to obtain data in support of laser beam propagation through the near-earth atmosphere.]

856. J. Bradac, "The Influence of Randomly Changing Medium on the Propagation of E. M. Waves at High Frequencies and Particularly in the Optical Range," Sdelovaci Tech., Vol. 24, No. 1, p. 12, January 1976. [Presents relations for evaluation of the refractive index for centimeter radio waves and for optical waves. Discusses the use of statistical models for evaluating the turbulence.]

857. E. Brookner, "Improved Model for Structure Constant Variations with Altitude," Appl. Opt., Vol. 10, No. 8, p. 1960, August 1971. [Index of refractive fluctuations in atmosphere.]

858. J. L. Bufton, et al., "Measurements of Turbulence Profiles in the Troposphere," JOSA, Vol. 62, No. 9, pp. 1068-1070, September 1972. [Temperature structure coefficients were measured with balloon-borne temperature sensors. Data converted to refractive-index-structure coefficients are reported. Results are discussed with reference to possible meteorological origins for turbulence.]

859. F. H. Champagne, et al., "Flux Measurements, Flux-Estimation-Techniques, and Fine-Scale Turbulence Measurements in the Unstable Surface Layer Over Land," J. Atm. Sci., Vol. 34, pp. 515-530, 1977. [Accurate measurements reveal at high wave numbers the temperature spectrum decreases less rapidly than $k^{-11/3}$ law.]

860. W. Y. Chen, "Log Normality of Small-Scale Structure of Turbulence," Phys. of Fluids, Vol. 14, No. 8, p. 1639, August 1971. [Velocity derivatives measured over open ocean squared and averaged over an interval within inertial subrange demonstrates excellent log normality.]

861. J. H. Corbin, Measurement of Near Sea Surface Turbulence and Possible Wave Influence, Master's Thesis, Naval Postgraduate School, Monterey, CA, September 1977 (AD-A049 951/7ST). [Measurements were made at 3 levels above the sea surface to observe possible wave influence on turbulence parameters.]

862. J. W. Dungey, "The Influence of the Geomagnetic Field on Turbulence in the Ionosphere," J. Atmos. & Terr. Phys., Vol. 8, Nos. 1 & 2, 1956.

863. W. H. Dungey, D. O. Tarazano and J. C. Wyngaard, "Meteorological Measurements of Turbulence Characteristics," 1971 Annual Meeting of OSA, 5-8 October 1971. [The data have been analyzed to produce power spectral curves, correlation curves leading to a value for an outer scale, and values for the temperature structure parameter.]

864. D. L. Fried, "Limiting Resolution Looking Down Through the Atmosphere," JOSA, Vol. 56, No. 10, pp. 1380-1384, October 1966. [Gives semi-empirical model for C_n^2 vs. altitude based on data given by Hufnagel.]

865. D. L. Fried, "Optical Heterodyne Detection of an Atmospherically Distorted Signal Wave Front," Proc. IEEE, Vol. 55, pp. 57-67, January 1967. [Fits the equation: $C_n^2 L_o^{2/3} = 6.7 \times 10^{-14} \exp(-h/h_o)$, $h_o = 3200$ m to Hufnagel's data.]

866. D. L. Fried, "Effects of Atmospheric Turbulence on a Laser Target Illuminator for Space Targets," Proc. Laser Propag. Meeting, MIT Lincoln Lab, Vol. II, October 1969. [A linearized version of a more complicated model for C_n^2.]

867. A. S. Frisch and G. R. Ochs, "A Note on the Behavior of the Temperature Structure Parameter in a Convective Layer Capped by a Marine Inversion," J. Appl. Meteor., Vol. 14, p. 415, 1974. [Measurements from aircraft show variation with altitude (z) up to $0.8z_i$ (the inversion heigth) as: $C_T^2 \simeq Z^{-4/3}\, 1 + 0.84\,(z/z_i) + 4.13\,(z/z_i)^2$.]

868. D. P. Greenwood and D. O. Tarazano, A Proposed Form for the Atmospheric Microtemperature Spatial Spectrum in the Input Range, RADC-TR-74-19, February 1974 (AD 776 294/1).

869. R. J. Hill, "New Models of the Refractive Index Spectra in Turbulent Media and Predictions for Laser Propagation," Proc. Lasers, to be published, 1978.

870. R. J. Hill and S. F. Clifford, "Modified Spectrum of Atmospheric Temperature Fluctuations and Its Application to Optical Propagation," JOSA, Vol. 68, No. 7, pp. 892-899, July 1978. [New model of high wave number spectrum gives good agreement with measurements.]

871. W. H. Hooke, et al., Boundary-Layer Meteor., Vol. 2, p. 371, 1972.

872. R. E. Hufnagel, "Restoration of Atmospherically Degraded Images," Woods Hole Summer Study, Natl Acad. of Sci., Vol. 2, p. 14, 1966. [Simple model for index of refraction variations in atmosphere.]

*873. R. E. Hufnagel, "Variations of Atmospheric Turbulence," OSA Topical Meeting on Propag. Through Turbulence, Boulder, CO, Paper WA 1-1, July 1974. [Statistical model for C_n^2 vs. altitude.]

874. R. E. Hufnagel and N. R. Stanley, "Modulation Transfer Function Associated with Image Transmission Through Turbulent Media," JOSA, Vol. 54, No. 1, p. 52, January 1964. [Early exponential model of C_n^2 vs. altitude based on measurements of temperature power spectra by Gossard.]

875. M. A. Kallistratova and D. F. Timanovskiy, Izv. Akad, Nauk SSSR, Atm. & Oceanic Phys., Vol. 7, p. 46, 1971.

876. Khodara, Trans. IEEE in Russian Translation, Vol. 54, No. 3, p. 36. [Effects of temperature fluctuations on refraction.]

877. R. S. Lawrence, et al., "Measurements of Atmospheric Turbulence Relevant to Optical Propagation," JOSA, Vol. 60, No. 6, pp. 826-830, June 1970. [Temperature fluctuations in the atmosphere. During day follow slope of ½ on log-log scale. Comparisons with Hufnagel's model indicate such a simple model will not show detail structure at least < 3 km altitude.]

878. H. Lettau, "Turbulence in the Stratosphere," Bull. Am. Meteor. Soc., Vol. 36, No. 4, p. 178, 1955. [Questions unusual balloon accelerations as evidence of stratospheric turbulence.]

879. N. Matuura and T. Nagata, "Turbulence in the Upper Atmosphere," Rept. Ionosphere Res. Japan, Vol. 12, No. 2, 1958.

880. G. J. Morris, "Airborne Laser-Beam Scintillation Measurements at High Altitudes," JOSA, Vol. 63, No. 3, pp. 263-270, March 1973. [The upper atmosphere is more turbulent than Hufnagel's models predicted it to be based on 0.6328 μm irradiance fluctuations which were typically log normal.]

881. L. G. McAllister, et al., "Acoustic Sounding - A New Approach to the Study of Atmospheric Structure," Proc. IEEE, Vol. 57, No. 4, p. 579, 1969. [Turbulence measurements giving fine structure. No indications of C_n^2 (only T vs. t).]

882. W. D. Neff, NOAA Tech. Rept. ERL 322-WPL-38, 1975. [Tower mounted measurements of C_n^2. Log normal distribution in early morning, $\langle C_n^2 \rangle \sim 7 \times 10^{-16}$, standard deviation 1.5×10^{-15}; in afternoon 3×10^{-15}, standard deviation 3×10^{-15}, not log normal. If extrapolated it compares with Soviet measurements.]

883. G. R. Ochs and R. S. Lawrence, NOAA Tech. Rept. ERL-251-WPL-22, 1972. [Aircraft borne measurements of C_n^2.]

884. T. H. Pries, J. Smith and M. Hamiter, Some Observations of Meteorological Effects on Optical Wave Propagation, Army Electronics Command, White Sands Missile Range, NM, April 1972 (AD 744 472). [Values for the refractive index structure coefficient, C_n^2, were determine from spaced temperature probe measurements of the log-amplitude variations in a laser beam.]

885. R. H. Paine, A Three Platform Experiment on Optical Turbulence in the Marine Boundary Layer, Master's Thesis, Naval Postgraduate School, Monterey, CA, March 1977 (AD-A039 789/3ST). [An observational experiment was conducted in the marine boundary layer off the California coast involving optical turbulence measurements. Measured values of C_n^2 from the surface to levels above the marine inversion were related to the synoptic weather situation.]

886. E. Regener, "Ozone Layer and Atmospheric Turbulence," Forschungs & Erfahrunsberichte des Reichswetter diestes, Vol. A, No. 9 (Berlin), 1941; Berichte des Deutschen Wetterdienstes in der US Zone, "Ozone", No. 11, 1949.

887. A. E. Slater, "Turbulence Above the Ozone Layer," J. Brit. Interplanet. Soc., Vol. 15, No. 1, 1956.

888. D. A. Stewart, Turbulence Measurements from the Army Gas Dynamics Laser Range, Rept. No. RR-75-8, Army Missile RD&E Lab, Redstone Arsenal, AL (AD-A016 122/4ST). [Describes wind measurements at the US Army Missile Command on test range for the Army Gas Dynamics Laser. Fast response instruments for measuring three perpendicular components of the wind were attached at 5 levels on each of 6 towers.]

889. J. W. Strohbehn, "Optical and Millimeter Line-of-Sight Propagation Effects in the Turbulent Atmosphere," Boundary Layer Meteor., Vol. 4, p. 397, 1973. [Index of refraction fluctuations in the atmosphere.]

890. M. Subramanian, "Atmospheric-Turbulence Profile in Troposphere," Prog. of 1971 Spring Meeting of OSA, 5-8 April 1971, Tucson, AZ. [Irradiance scintillation measured for several altitudes. The average turbulence profiles for the winter and summer months are presented.]

891. L. R. Tsvang, "Microstructure of Temperature Fields in the Free Atmosphere," Radio Sci., Vol. 4, p. 1175, 1969. [Aircraft borne measurements of C_T^2. Theoretical model for C_T^2 in surface layer during day ($z^{-4/3}$).]

892. T. E. Van Zant, et al., "Vertical Profiles of Refractivity Turbulence Structure Constant: Comparison of Observations by the Sunset Radar with a New Theoretical Model," Radio Sci., Vol. 13, No. 5, pp. 819-829, September 1978. [A semi-empirical model for the vertical profile of C_n^2 is determined based on radar observations.]

893. F. Y. Voyt, et al., Izv. Atm. & Oceanic Phys., Vol. 9, No. 5, p. 451, 1973. [In situ turbulence measurements in upper boundary layer (30 m $\lesssim$ h $\lesssim$ 3 km) of atmosphere.]

894. R. M. Williams and C. A. Paulson, "Microscale Temperature and Velocity Spectra in the Atmospheric Boundary Layer," J. Fluid Mech., Vol. 83, pp. 547-567, 1977. [Accurate measurements reveal at high wave numbers at temperature spectrum decreases less rapidly than $k^{-11/3}$ law.]

895. N. J. Wright and R. J. Schultz, Measurement of the Refractive Index Structure Coefficient C_N, BRL Memo Rept. 1885, December 1967.

896. J. C. Wyngaard, et al., "Behavior of the Refractive-Index-Structure Parameter near the Ground," JOSA, Vol. 61, No. 11, p. 1552, November 1971. [Develops semi-empirical theory which relates C_n^2 to wind speed, temperature and a stability parameter. Abstract only.]

897. J. C. Wyngaard and Y. Izumi, "Behavior of the Refractive-Index-Structure Parameter Near the Ground," JOSA, Vol. 61, No. 12, pp. 1646-1650, December 1971. [Semi-empirical theory for C_n^2 vs. altitude in surface layer during daytime (α $z^{-4/3}$). At night will decrease with height more slowly than $z^{-2/3}$.]

7. FIELD MEASUREMENTS (Molecular & Aerosol Effects)

898. A. Adel, "Seasonal Variation in the Absorption of Solar Radiation by Atmospheric Ozone at 9.6 Microns," Bull. of Am. Meteorol. Soc., Vol. 35, No. 6, 1954.

899. T. L. Altschuler and F. E. Elliott, Transmission of Infrared Through Cloudy Atmospheres, Rept. No. R60ELC16, GE Co., Ithaca, NY, 1 February 1960 (AD-AO-0 718/3ST).

900. A. Arnulf, J. Bricard, E. Cure and C. Veret, "Transmission by Haze and Fog in the Spectral Region, 0.35 to 10 Microns," JOSA, Vol. 47, No. 6, pp. 491-498, June 1957. [Measured transmission in windows and compared to Mie calculations based on measured aerosol size distributions.]

901. "Atmospheric Extinction Measurements of a He-Ne Laser," Appl. Opt., Vol. 17, p. 285, 1978.

902. T. Bakker and J. Vriend, Transmission of Focused Laser Beams Through the Atmosphere, Rept. No. PH.L.1973.17, Phys. Lab. RVO-TNO, s'Gravenhage, Netherlands, April 1973 (N74-10504/0). [Results of measurements performed with a He-Ne laser under various atmospheric conditions are reported.]

903. W. A. Baum and L. Dunkelman, "Horizontal Attenuation of Ultraviolet Light by the Lower Atmosphere," JOSA, Vol. 45, p. 166, 1955. [Photographic spectrometry (.23-.46 μm) on nights: quite smooth variation, except for weak O_2 absorption from 2421 to 2700 Å and sometime SO_2 solution (2800-3150 Å).]

904. M. Bertolotti, et al., "Measurement of Atmospheric Attenuation at 6328 Å," AGARD Conf. Proc. No. 183 Optical Propagation in Atmosphere, 27-31 October 1976, Lyngby, Denmark. [Atmospheric attenuation statistics have been used to study the performance of a stabilized 6328 Å He-Ne laser communication link. The effects of turbulence and atmospheric conditions are also considered.]

905. M. Bertolotti, M. Carnevale and D. Sette, "Atmospheric Extinction Measurements of a He-Ne Laser," Appl. Opt., Vol. 17, No. 2, p. 285, January 1978. [Presents statistics of measured laser attenuation from October to January as function of humidity and temperature.]

906. L. M. Biberman, R. E. Roberts and L. N. Seekamp, A Comparison of Electrooptical Technologies for Target Acquisition and Guidance, Pt 2, Analysis of the Grafenwöhr Atmospheric Transmission Data, Final Rept., Rept. No. P-1218-Pt-2, IDA, Arlington, VA (AD-A040 602/5ST). [Electrooptical sensor performance in the winter weather of Central NATO Europe. Field trails at Grafenwöhr, Germany.]

907. K. J. Bignell, QJRMS, Vol. 96, p. 390, 1970. [Attempted to measure 10 μm water vapor continuum in the field.]

908. K. J. Bignell, F. Saiedy and P. A. Sheppard, "On the Atmospheric Infrared Continuum, JOSA, Vol. 53, No. 4, p. 466, April 1963. [Field measurements of 8-13 μm continuum absorption using sun and Nernst lamp as sources.]

909. V. P. Bisyarin, I. P. Bisyarina and A. V. Sokolov, "Attenuation of 10.6 μm Laser Radiation in Artificial and Real Fog," Radio Eng. & Electron. Phys., Vol. 16, No. 10, p. 1589, October 1971. [Measurements over 15 m and 1.36 km long paths. Dependence of the attenuation at 10.6 μm and 0.63 μm on the meteorological visibility.]

910. V. P. Bisyarin, I. P. Bisyarina, V. K. Rubash and A. V. Sokolov, "Attenuation of 10.6 and 0.63 μm Laser Radiation in Atmospheric Precipiation," Radio Eng. & Electron., Vol. 16, No. 10, p. 1594, October 1971. [Simultaneous measurements in snow, rain and drizzle over a path of 1.36 km. Attenuation at 10.6 μm is larger than at 0.63 μm.]

911. V. P. Bisyarin, I. P. Bisyarina and A. V. Sokolov, "Temporal Distribution of Coefficients of Attenuation of Laser Radiation at 1.63 and 10.6 μm During Propagation in the Troposphere," Radio Eng. & Electron. Phys., Vol. 18, No. 11, p. 1632, November 1975. [For snowfalls the distribution of the attenuation coefficients at 0.63 and 10.6 μm, is compared with the distribution of the coefficients obtained directly from the measurements of attenuation in real conditions.]

912. E. A. Bucher, R. M. Lerner and C. W. Niessen, "Some Experiments on the Propagation of Light Pulses Through Clouds," Proc. IEEE, Vol. 58, No. 10, p. 1564, October 1970 (AD 721 062). [A facility for measuring the spatial and temporal impulse response of a cloud to a pulse of light from a Q-switched ruby laser is described and some experimental results are presented.]

913. E. A. Bucher and R. M. Lerner, "Experiments on Light Pulse Communication and Propagation Through Atmospheric Clouds," Appl. Opt., Vol. 12, No. 10, p. 2401, March 1973 (AD 771 845/5). [The extent of multipath pulse spreading can be shown to be comparable to that predicted from computer simulation models.]

914. C. C. Chen, Attenuation of Electromagnetic Radiation by Haze, Fog, Clouds, and Rain, Rept. No. R-1694-PR, Rand Corp., Santa Monica, CA (AD-A011 642/6ST). [The report assembles, under one cover, the values of aerosol attenuation coefficients of 'atmospheric windows'. Both calculated and available measured values are presented.]

915. Chicago Midway Labs, Univ. of Chicigo, Atmospheric Transmission in the Infrared During Severe Weather Conditions, May 1959 (AD 218 035). [Poorly controlled measurement at 4 μm in freezing rain, sleet, snow.]

916. T. S. Chu and D. C. Hogg, Bell System Tech. J., Vol. 45, No. 2, p. 301, 1966. [Measured absorption of 3.39 μm laser over 2.9 km range under natural conditions: k = 5.5 ± 0.05 db/km. Agrees well with measurements of Edwards & Burch, and Zuyev's cell measurements (but not field).]

*917. T. S. Chu and D. C. Hogg, "Effects of Precipitation on Propagation at 0.63, 3.5 and 10.6 Microns," Bell System Tech. J., Vol. 47, No. 5, pp. 723-759, May 1968. [Presents measurements in fog, rain and snow, and theory (4 fog models, 1 rain model) for both transmission and beam broadening.]

918. J. A. Curcio, "Evaluation of Atmospheric Aerosol Particle Size Distribution from Scattering Measurements in the Visible and Infrared," JOSA, Vol. 51, No. 5, p. 548, May 1961. [Measured aerosol attenuation (0.4 - 2.27 μm); found Angstrom exponent of 1.3 ± 0.6.]

919. J. A. Curcio, Experimental Observations of Forward Scattering of Light in the Lower Atmosphere, Interim Rept. 30 September 1964, NRL, Washington, DC (AD 607 487). [Experimental results from seven measurements on the forward scattering of light by the atmospheric aerosol.]

920. J. A. Curcio, L. F. Drummeter, C. C. Petty, H. S. Stewart and C. P. Butler, "An Experimental Study of Atmospheric Transmission," JOSA, Vol. 43, No. 2, pp. 97-102, February 1953. [An experimental investigation was made to determine the general characteristics of the spectral transmission of the atmosphere in the Washington DC area, in the Central Pacific, and in the Gulf of Mexico. Transmission measurements were made at the wavelengths of approximately 15 of the Hg discharge lines in the interval 2500 Å to 6000 Å. Values of the spectral atmospheric attenuation coefficients have been computed.]

921. J. S. Curcio, G. L. Knestrick and T. H. Cosden, Atmospheric Scattering in the Visible and Infrared, NRL Rept. No. 5567. [Experimental measurements of aerosol extinction.]

922. J. W. Cusack, Extinction of DF Laser Radiation Derived from Outdoor Atmospheric Measurements, RADC-TR-76-333, December 1976 (AD-A035 473/8ST). [2-1 P(8), 2-1 P(9), 3-2 P(8), and the 2-1 P(6) DF lines. The experimental results are analyzed and compared with the latest in-laboratory measurements.]

923. B. Daino, M. Galeotti and D. Sette, "Statistics of Measurements of Atmospheric Attenuation at 6328 Å (Laser Beam)," Rend. Reiunione Assoc. Elettrotec. Ital., Vol. 49, No. 3, 1974. [The statistical measurements of attenuation of a 6328 Å laser beam in the atmosphere, in horizontal propagation carried out over a 90 m path and at the height of the buildings are described.]

924. B. Daino, M. Galeotti and D. Sette, "Statistical Measurement of Atmospheric 6328 Å Attenuation Using a Sequential Laser Transmissometer," Appl. Opt., Vol. 15, No. 4, p. 996, April 1976. [Typical results are shown for transmission in mist, rain, and good conditions.]

925. L. Delbouille and G. Roland, Photometric Atlas of the Solar Spectrum from λ 7498 to λ 12,016, Liege, 1963.

926. V. A. Donchenko, M. V. Kabanov, B. A. Savel'yev and I. V. Samokhvalov, Sov. Phys. J., No. 1, p. 158, 1968. [Laboratory measurements of backscatter of 0.63 and 0.69 μm laser light from artificial fogs and smokes. Field measurements with 1.06 μm laser in natural haze and falling snow.]

927. J. A. Dowling, "Atmospheric Transmission Measurements Using IR Lasers and Fourier Spectroscopy - Techniques, Results and Comparisons to Computer Models," SPIE, Vol. 91, pp. 39-48, 1976. [Results of comparisons between experimental data and computer generated atmospheric transmission predictions are presented and discussed.]

928. J. A. Dowling, K. M. Haught, R. F. Horton, G. L. Trusty and J. A. Curcio, Atmospheric Extinction Measurements at Nd-Yag and DF Laser Wavelengths Performed in Conjunction with the JAN Propagation Tests, June - September 1975, Rept. No. NRL-8058 (AD-A053 271/3ST). [Extensive measurements of atmospheric transmission at several DF laser wavelengths between 3.6 and 4.1 micrometers were obtained as well as measurements at the Nd-Yag laser wavelength of 1.06 micrometers. MIE scattering calculations were performed using the aerosol data and were compared to aerosol extinction values derived from the optical measurements obtained using the 5 km long path. The water vapor dependence of molecular absorption for each of the 22 DF laser lines studied was compared to values obtained during earlier experiments at the Cape Canaveral Air Force Station and to theoretical predictions based on a Hi-TRAN calculation using a line atlas.]

929. J. A. Dowling, et al., Atmospheric Transmission Measurements Using IR Lasers, Fourier Transmission Spectroscopy, and Gas Filter Correlation Techniques, NRL, Washington, DC, March 1977. [Results obtained from three concurrent experiments used to generate a data base appropriate to high resolution transmission model validation are displayed. Laser extinction data, high resolution, long path atmospheric transmission spectra, and path integrated water vapor measurements are reported and discussed.]

930. J. A. Dowling, R. F. Horton, S. T. Hanely and K. M. Haught, "High Resolution Field Measurement of Atmospheric Transmission," SPIE, Vol. 142, p. 25, 1968. [Instrumentation and procedures used in three experiments will be described and selected measurement results will be presented. Application of this information to current infrared atmospheric transmission problems will be discussed together with comparisons of the experimental data to high resolution computer code calculations.]

931. S. C. Duntley, R. W. Johnson and J. I. Gordon, Airborne Measurements of Optical Atmospheric Properties of Southern Germany, AFCRL-72-0255, July 1972.

932. R. G. Eldridge, "Haze and Fog Aerosol Distributions," J. Atm. Sci., Vol. 23, pp. 605-613, 1966. [Spectral attenuation of haze and fogs were measured in the 0.3-10 μm and used to infer size distributions.]

933. L. Elterman, Atmospheric Attenuation Model, 1964, in the Ultraviolet, Visible, and Infrared Regions for Altitudes to 50 Km, AFCRL-64-740, September 1964.

934. L. Elterman, "Aerosol Measurements in the Troposphere and Stratosphere," Appl. Opt., Vol. 5, No. 11, pp. 1769-1776, November 1966. [Light scattering measurements of a searchlight beam give attenuation coefficients at 0.55 μm up to 35 km.]

935. L. Elterman, An Atlas of Aerosol Attenuation and Extinction Profiles for the Troposphere and Stratosphere, AFCRL-66-828, December 1966. [Measured extinction and derived aerosol attenuation at 0.55 μm up to 35 km.]

936. L. Elterman, UV, Visible and IR Attenuation for Altitudes to 50 Km, AFCRL-68-0153, April 1968. [Tabular values of molecular scattering, aerosol extinction and ozone absorption at 22 wavelengths between 0.27 and 4.0 μm as a function of altitude. Aerosol extinction about a factor of 20 greater than 1964 model at high altitudes.]

937. L. Elterman, Vertical-Attenuation Model with Eight Surface Meteorological Ranges 2 to 13 Kilometers, AFCRL-70-0200, March 1970. [Aerosol extinction model at 22 wavelengths between 0.27 and 4.0 μm as a function of altitude.]

938. C. B. Farmer and J. T. Houghton, "Collision-Induced Absorption in the Earth's Atmosphere," Nature, Vol. 209, p. 1341 and 5030, 1966. [Measured nitrogen continuum absorption near 4 μm in the lab and field.]

939. R. W. Fenn, OPAQUE - A Measurement Program on the Optical Atmospheric Properties in Europe, Vol. I - NATO OPAQUE, AFGL-TR-78-0011, 11 January 1978. [Describes experiment and presents some preliminary results.]

940. R. W. Fenn, OPAQUE Data Analysis (tentative title), AFGL-TR-79-___, to be published. [A statistical analysis of visible and IR transmission, meteorological and natural illumination for the winter season (no laser data).]

941. N. V. Galakhov, et al., "Experimental Investigation of the Intensity Fluctuation of Optical Radiation Propagating in the Atmospheric Surface Layer During Precipitation," Atm. & Oceanic Phys., Vol. 12, No. 12, p. 1251, December 1976. [The intensity fluctuations during rain and snow for a divergent and collimated laser beam at 130 m distance are studied. The time frequency spectrum during rain has two maxima caused by turbulence and aerosols the latter being shifted to high frequencies.]

942. M. Galeotti, B. Daino and D. Sette, "Statistical Measurements of 6328 Å Atmospheric Attenuation (Optical Communication)," Appl. Opt., Vol. 16, No. 3, p. 660, March 1977. [Measurements of atmospheric attenuation at 633 nm in Rome (1 year). Results are presented as frequency distributions.]

943. D. M. Gates, "Near Infrared Atmospheric Tranmission to Solar Radiation," JOSA, Vol. 50, No. 12, p. 1299, December 1960. [Measurements of continuum water absorption (.872-2.537 μm).]

944. H. A. Gebbie, W. R. Harding, C. Hilsum, A. W. Pryce and V. Roberts, "Atmospheric Transmission in the 1 to 14 μ Region," Proc. Roy. Soc., Vol. A206, p. 87, 1951. [Extinction measurements (due mainly to aerosols) are presented correlations with humidity and visibility studied in detail.]

945. K. H. George, P. Marrero and W. E. Webb, Atmospheric Effects on Wave Propagation at 10.6 Microns, NASA-TM-X-64513, 30 April 1970 (N70-31644).

946. R. J. Giannaris, G. C. Mooradian and W. R. Stone, CO_2 Coherent Propagation (with Reciprocal Tracking) Through the Marine Boundary Layer, January - June 1976, Rept. No. NELC-TR-1994, Naval Electronics Lab. Ctr., San Diego, CA (AD-A029 718/4ST). [Measurements of attenuation, characterized as signal loss scintillation, characterized as percent modulation, wavefront tilt, characterizes as angle-of-arrival spectra, and coherence, characterized by the angular brightness function, are made through clear air, haze and fog.]

947. A. J. Gibson and L. Thomas, "Ultraviolet Laser Sounding of the Troposphere and Lower Stratosphere," Nature, Vol. 256, No. 5518, p. 561, 14 August 1975. [Measurements made with a ground-based, ultraviolet laser operating in the wavelength range 297-308 nm are reported, which relate to the question of the atmospheric transmission between ground level and about 20 km, and particularly to the contributions of absorption by minor constitutents.]

948. T. J. Gilmartin, Semi-Annual Technical Summary, ARPA/STO Program (U), MIT Lincoln Labs, Lexington, MA, 30 June 1971 (AD 517 645L) (Secret). [An outdoor measurement of CO laser (5-4 P15) propagation.]

949. R. Gruss, "Transmission Experiments by Laser Beams in the Atmosphere," Laser, Vol. 1, No. 4, p. 23, December 1969. [Some transmission experiments with laser beams were made in order to allow the study of future use of atmospheric laser short distance systems for data transmission.]

950. R. Gruss, Propagation and Transmission of Laser Beams in the Atmosphere, Rept. No. FTZ-A-465-TBR-6, Fernmeldetechnisches Zentralamt, Darmstadt, West Germany, January 1971 (N72-31519). [Atmospheric laser beam propagation and transmission is discussed, and results of experiments are reported.]

951. K. Gullberg and H. O. Lindstrand, Measurement of CO_2 Laser Radiation Attenuation in the Atmosphere, Rept. No. FOA-2-C-2565-E3-E4-E6, Res. Inst. of Natl. Def., Stockholm, Sweden, October 1972 (N75-12299/4ST). [Atmospheric attenuation of CO_2 laser beams at 10.6 micrometer wavelength has been recorded during different weather conditions over a 3 km range.]

952. G. P. Gushchin, "Variations in the Optical Thickness of Aerosols in the Atmosphere," Trans. of Main Geophys. Obs., Vol. 105, p. 43, 1960. [Measurdd aerosol attenuation coefficient vs. altitude.]

953. G. P. Gushchin, In collection entitled: "Actinometry and Atmospheric Optics," Gidrometeoizdat, p. 218, 1961.

954. G. P. Gushchin, Investigation of Atmospheric Ozone, Gidrometeoizdat, 1963.

955. A. Gutman, et al., Data Compendium for Atmospheric Layer Propagation Studies Conducted at Cape Canaveral, Fla. on February-May 1977, Rept. No. NRL-MR-3611, Naval Res. Labs, September 1977 (AD-A050 094/2ST) [An extensive set of aerosol scattering coefficient data is reported for 15 visible wavelengths. Transmission is reported for 15 visible wavelengths. Transmission spectra included in this report were derived on the basis of Fourier transform spectroscopy (He-Ne, Nd-Yag, DF, CO, CO_2).]

956. T. Hasegawa, H. Sato and T. Sakurada, "Study on the Propagation of Carbon Dioxide Laser Beams Through the Atmosphere," Mem. Def. Acad., Vol. 13, No. 2, p. 119, September 1973. [Attenuation characteristics of the laser beams caused by water vapor, rain and fog in the atmosphere are measured and the experimental formulae of attenuation coefficient are derived from this measurement data. The attenuation characteristics are also compared with those of He-Ne laser beams at 0.6328 μm wavelength.]

957. K. M. Haught and J. A. Dowling, "Laser-Calibrated High-Resolution Atmospheric Transmission Measurements," IEEE J. Quant. Electron., Vol. QE-13, No. 9, p. 71, September 1977. [High-resolution infrared absorption spectrum of a five kilometer atmospheric path was measured with a scanning Michelson interferometer. Absolute transmission at several DF laser frequencies was also measured for the same path.]

958. K. M. Haught and J. A. Dowling, "Long-Path High-Resolution Field Measurements of Absolute Transmission in the 3.5 to 4.0 µm Atmospheric Window," Opt. Letters, Vol. 1, No. 4, pp. 121-123, October 1977. [Experimental details are given of a study of absolute atmospheric transmission in the 3.6-4.0 micron region using a DF laser and using the results to normalize relative transmission from a Fourier transform spectrometer. Calculated and measured transmission spectra are plotted over the range 2480-2800 cm^{-1} for a path of 5.1 km with excellent agreement.]

959. E. A. Johnson, R. C. Meyer, R. E. Hopkins and W. H. Mock, "The Measurement of Light Scattered by the Upper Atmosphere from a Searchlight Beam," JOSA, Vol. 29, No. 12, pp. 512-517, December 1939. [Rayleigh scattering from atmospheric gases in the path of an intense searchlight beam has been measured up to heights of 34 km.]

960. S. R. King, D. T. Hodges, T. S. Hartwick and D. H. Barker, "High-Resolution Atmospheric-Transmission Measurements Using a Laser Heterodyne Radiometer," Appl. Opt., Vol. 12, No. 6, pp. 1106-1107, June 1973. [Measured zenith transmission of entire atmosphere at P(20) line of CO_2 laser: 0.41 at 1.9 pr. cm. H_2O, 0.51 at 1.6 pr. cm. H_2O.]

961. Y. K. Kim, "Transmission Characteristics of Laser Light Communications in Water and Atmospheric Media," J. Korean Inst. Electron. Eng., Vol. 8, No. 4, p. 168, October 1971. [Laser light transmitted through one-meter water bath and one-kilometer transmission distances in atmospheric media is detected by method of direct photo-detection. The average attenuation with the conditions of weather is about -25 db, and the average attenuation coefficient of water is about 0.4 m^{-1}.]

962. G. L. Knestrick, T. H. Cosden and J. A. Curcio, "Atmospheric Scattering Coefficients in the Visible and Infrared Regions," JOSA, Vol. 52, No. 9, p. 1010, September 1962. [Measured aerosol coefficient in ten narrow spectral regions between 0.4 and 2.27 µm at the Chesapeake Bay.]

963. T. Kobayasi, M. Jyumonji and H. Inaba, "Study of Light Beam Propagation in the Atmosphere by Laser-Radar Techniques Using Raman Scattering and Absorption Spectroscopy," 1971 Intl. Sym. on Antennas & Propag. Summaries of Papers, 1-3 September 1971, Sendai, Japan. [Transmission and absorption properties of the laser beam have been studied.]

964. K. Ya. Kondrat'yev, I. Ya. Badinov, S. V. Ashcheulov and S. D. Andreyev, Atm. & Oceanic Phys., Vol. 1, No. 4, p. 363. [Continuous absorption coefficient field measurements using sun as source.]

965. O. Lillesaeter, Attenuation of a Parallel Beam of Light, Particularly by Snow, Rept. No. SR-2, McGill Univ., Montreal, Canada, April 1965 (AD 615 383). [Attenuation measurements over a 123 m path by falling snow was approximately 18 (db 1/km)/(mmw 1/hr), by rain was only 0.25 (db 1/km)/(mm 1/hr).]

966. P. M. Livingston, "Comparison of Measured 3.8 μm Scattering from Naturally Occuring Aerosols with that Predicted by Measured Particle Size Statistics," Appl. Opt., Vol. 17, No. 5, pp. 818-826, 1 March 1978. [A DF chemical laser was used over a range of 1.5 km in the experiments described.]

967. R. K. Long and D. R. Wortendyke, "Topics in the Propagation of Laser Radiation in the Atmosphere," Proc. 1st Laser Conf., Vol. II, p. 51, January 1964. [Measured absorption at 11522.76 cm^{-1} (He-Ne) vs. altitude and calculated absorption for He-Ne and ruby lasers. Night turbulence correlated with wind speed.]

968. R. K. Long and C. H. Boehnker, Measured Atmospheric Absorption at Ruby Optical Maser Wavelengths, Rept. No. 1641-10, Ohio State Univ. Res. Foundation, Columbus, OH, 1 June 1965 (AD 468 330/6ST). [Atmospheric absorption data is presented for three atmospheric water-vapor lines near 6943 Å as a function of path elevation angle.]

969. M. Migeotte, L. Neven and J. Swenson, The Solar Spectrum from 2.8 to 23.7 Microns, Final Report, Pt. 1, Univ. of Liege, Belgium, 1956.

970. M. Migeotte, L. Neven and J. Swenson, The Solar Spectrum from 2.8 to 23.7 Microns, Final Report, Pt. 2, Univ. of Liege, Belgium, 1957.

971. M. Miler and M. Chomat, "The Effect of Atmospheric Scattering on Optical Beam Intensity at Low Visibility," Trans. in: Jemna Mechanika a Optika (Czeckoslovakia), No. 12, p. 382, 1967, by H. Peck (AD 850 030/8ST). [Scattering in fog was measured using an incoherent GaAs diode emitter in the 900 nm infrared band. A formula for attenuation is given, and other experimental findings, such as the effect of size of moisture droplets, of nonhomogeneous waves of thick fog, and of homogeneous fog cover, are given.]

972. J. T. Miller, Experimental Laser Attenuation in a Snow Environment, Final Report 24 January - 4 September 1977, Rept. No. AEDC-TR-77-99 (AD-A051 586/6ST). [Laser transmission through a snowfield has been measured in a lab experiment (0.6328 and a 10.6 micrometer).]

973. M. Minnaert, G. F. Mulders and J. Houtgast, Photometric Atlas of the Solar Spectrum λ 3612 to λ 8771, Amsterdam, 1940.

974. P. O. Minott, et al., Vertical Laser Beam Propagation Through the Troposphere, NASA-TM-X-70701, April 1974 (N74-28970/3). [The characteristics of the earth's atmosphere and its effects upon laser beams was investigated in a series of balloon borne, optical propagation experiments. These experiments were designed to simulate the space to ground laser link.]

975. S. Miura, Y. Furuhama and M. Fukushima, "Some Problems of CO_2 Laser Wave Propagation Through the Atmosphere," Rev. Radio Res. Labs., Vol. 16, No. 87, p. 577, November 1970. [Available data obtained by several workers are reviewed. Results of their measurements are also reported.]

976. M. Murayama, "Laser Beam Propagation Through Falling Snow," Res. Rep. Nagaoka Tech. Coll., Vol. 7, No. 4, p. 279, December 1971. [The relation between the number of snow fractions per unit volume and the attenuation constant of electromagnetic wave propagation was investigated.]

977. S. Nakajima, T. Abe and Y. Saito, "Propagation of the Laser Light in Snowfall," Electron. & Commun., Vol. 56, No. 8, p. 79. [Attenuation and fluctuation of the laser beam propagating in snowfall are discussed and results have been obtained. Experimental and theoretical.]

978. D. C. O'Shea and L. G. Dodge, "NO_2 Concentration Measurements in an Urban Atmosphere Using Differential Absorption Techniques," Appl. Opt., Vol. 13, No. 6, p. 1481, June 1974. [Absorption coefficients of NO_2 for the wavelengths of a mercury lamp and an argon-ion laser are reported.]

979. W. H. Paik, M. Tebyani, D. J. Epstein, R. S. Kennedy and J. H. Shapiro, "Propagation Experiments in Low-Visibility Atmospheres," Appl. Opt., Vol. 17, No. 6, pp. 899-905, 15 March 1978. [A ruby laser and a holmium laser were used to investigate atmospheric transmission characteristics over a 13.6 km line-of-sight path. Multipath spread was never more than 50-350 nsec and angular spectra had a full cone angle of a few mrad at the most.]

980. P.W. Parish, Shipboard Measurements of 0.6328 Micrometer Laser Beam Extinction in the Marine Boundary Layer, Master's Thesis, Naval Postgraduate School, Monterey, CA, June 1976 (AD-A028 450/5ST). [A value on the order to 0.0005/meters was found for the extinction coefficient in clear weather.]

981. W. C. Plake and G. E. Walsh, Laser Propagation Effects Over a Half Mile Path, Rept. No. EG/G-S-416-R, EG & G Inc, Goleta, CA, March 1968 (EGG-1183-2178).

982. O. I. Popov, Optics & Spect., Vol. 3, No. 4, p. 504, 1957. [Measured aerosol attenuation in $\Delta\lambda = 0.313 - 0.546$ and $1.014 - 0.546$ μm bands. The Angstrom exponent was $n = 2$ and 1.2-1.3 respectively.]

983. Yu. I. Rabinovich, In collection entitled: "Actinometry and Atmospheric Optics," Trans. of Main Geophys. Obs., No. 118, p. 18, 1961.

984. Yu. I. Rabinovich, Trans. of Main Geophys. Obs., No. 125, p. 54, 1962.

985. H. Raidt and D. H. Hohn, "Transmission of a GaAs Laser Beam Through the Atmosphere," Appl. Opt., Vol. 12, No. 1, p. 103, January 1973. [Even at median meteorological ranges atmospheric aerosol scattering, not atmospheric turbulence, is the main reason for beam spreading. The probability distribution of the fluctuating intensity generally can be approximated with log-normal distribution functions.]

986. J. S. Randhawa, R. B. Loveland, E. E. Uthe and E. R. Murray, "Lidar Observations of Smoke & Dust Clouds at 0.7 and 10.6 Micron Wavelengths," IEEE '78 Region 6 Conf. Record Electronics for Resource Management, 12-14 April 1978. [Range dependent backscatter and range integrated attenuation were measured using a 1 km horizontal path. Smoke and dust clouds were generated so that they were blown across the observed path by the wind.]

987. D. B. Rensch and R. K. Long, "Comparative Studies of Extinction and Backscattering by Aerosols, Fog, and Rain at 10.6 μ and 0.63 μ," Appl. Opt., Vol. 9, No. 7, pp. 1563-1573, July 1970. [Theoretical calculations using continental, fog, and precipitation aerosol size distribution models are presented for extinction and backscatter coefficients along horizontal propagation paths at sea level. Coefficients are presented for various atmospheric conditions and for wavelengths between 0.34 μ and 10.6 μ. Results are confirmed by comparison with outdoor transmission studies at 10.6 μ and 0.63 μ.]

988. W. T. Roach and R. M. Goddy, "Absorption and Emission in the Atmospheric Window from 770 to 1250 cm^{-1}," QJRMS, Vol. 84, p. 319, 1958. [Quantitative experimental study of 8-13 μm continuum but could not separate aerosol effects.]

989. R. G. Roosen, R. J. Anione and C. H. Klemcke, "Worldwide Variations in Atmospheric Transmission: Baseline Results from Smithsonian Observations," Bull. Am. Meteor. Soc., Vol. 54, No. 4, pp. 307-316, April 1973. [Measured extinction coefficient at number of sites from 1904-1930; 0.4 - 1.2 μm.]

990. K. Sassen, "Backscattering Cross Sections for Hydrometeor's Measurements at 6328 A," Appl. Opt., Vol. 17, No. 5, p. 804, March 1978. [A CW He-Ne laser and receiver located 73 cm from the small scattering volume were used to determine the single particle scattering coefficients for 8 types of hydrometers (raindrops, dendritic aggregates, etc.).]

991. F. I. Shimabukuro, et al., Atmospheric Transmission Measurements at HF and DF Laser Wavelengths Using a Heterodyne Radiometer, Interim Rept., Rept. No. TR-0076(6752)-1, Aerospace Corp, El Segundo, CA, 26 February 1976 (AD-A022 057/4ST). [The field measuremed transmissions at HF lines appear less than that predicted by theoretical considerations, while for the DF lines, the measured and calculated transmissions are consistent.]

992. F. I. Shimabukuro, et al., "Atmospheric Transmission Measurements at HF and DF Laser Wavelengths," Appl. Opt., Vol. 15, No. 5, p. 1115, May 1976. [Measured zenith transmission at the HF $P_2(8)$ line are plotted against precipitable water. Transmission tabulated at the several wavelengths are for conditions designated no aerosol, clear, and hazy.]

993. D. E. Spencer, "Scattering Function for Fogs," JOSA, Vol. 50, No. 6, p. 584, June 1960. [Summarizes angular scattering coefficient measurements in the visible to show all fit single function.]

994. J. L. Streete, "Infrared Measurements of Atmospheric Transmission at Sea Level," Appl. Opt., Vol. 7, No. 8, pp. 1545-1549, August 1968. [Experimental measurements suggests liquid water absorption reason for discrepancy between his and Yates and Taylor measurements. He got much high transmission (0.56 - 10.7 μm) sea level 25 km path.]

995. J. L. Streete, J. H. Taylor and S. L. Ball, "Near Infrared Atmospheric Absorption Over a 25 km Horizontal Path at Sea Level," Appl. Opt., Vol. 6, No. 3, p. 489, March 1967. [Absorption spectra over 25 km sea level path: 0.68 - 4.8 μm (not reduced to transmission).]

996. Z. G. Sztankay and D. W. McGuire, "Backscatter in Clouds at 0.9 μm and Its Effect on Optical Fuzing Systems," Proc. 7th Laser Conf., Vol. III, p. 15, June 1976. [Measured extinction and backscatter coefficients in cumulus clouds.]

997. J. H. Taylor and H. W. Yates, "Atmospheric Transmission in the Infrared," JOSA, Vol. 47, No. 3, pp. 223-226, March 1957. [Measured over three horizontal paths (1000 ft, 3.4 mi and 10.4 mi) from 0.5 to 15 μm at 10 cm^{-1} resolution (clear, dense fog and snowstorm).]

998. A. A. Tishchenko, "Investigation of the Propagation of Laser Radiation and the Diagnostics of a Randomly Inhomogeneous Troposphere," Izv. vuz. Radiofiz., No. 7, p. 45, 1973, Trans. in Sov. Phys. J. [Results are given of an experimental study of the propagation of laser radiation along paths close to the earth's surface.]

999. T. P. Toropova, "The Application of Exponential Laws to the Water Vapor Absorption Belts," Izv. Astrofiz. Inst. Akad Nauk kaz SSR, Vol. 10, p. 71, 1960. [Measured aerosol attenuation, found Angstrom exponent of n = 1.1, 2.1 and 2.3.]

1000. G. G. Williford, Atmospheric Attenuation of He-Ne Laser Radiation, Master's Thesis, Rept. No. AFIT/GEP/PH/77-17, December 1977 (AD-A053 442/OST). [Attenuation of He-Ne laser examined theoretically and experimentally; good agreement. Field tests on turbulence over 1.23 km path with visibilities from 2 to 18 km.]

1001. R. W. Wilson and A. A. Penzias, "Effect of Precipitation on Transmission Through the Atmosphere at 10 Microns," Nature, Vol. 211, No. 5053, p. 1081, 3 September 1966. [Field measurements over 2.6 km path on fogs (50 db), snow (> 50 db) and rain (8-10 db/mile/(in/hr-prec. rate).]

1002. D. P. Woodman, "Balloon Atmospheric Propagation Experiment I (Bape I)," Dig. of Tech. Papers of 1971 IEEE/OSA Conf. on Laser Eng. & Appl., 2-4 June 1971, Washington DC. [Propagation of laser beams from the ground level to 28 km was investigated in a recent experiment.]

1003. H. W. Yates and J. H. Taylor, Infrared Transmission of the Atmosphere, NRL Rept. No. 5453, 8 June 1960 (AD 240 188). [Measured scattering beyond 2.5 μm to 4.7 μm.]

8. GENERAL

1004. F. Albertin and B. Querzola, "Propagation of Laser Beams Through the Atmosphere, I," Alta Freq., Vol. 41, No. 3, p. 121, March 1972. [A critical resume of some studies and the more significant results on the behavior of laser beams propagated through the atmosphere.]

1005. J. Boyden, L. Carrier, G. Clark, E. Harris and M. Katzman, Study of Atmospheric Degradation of Laser Beams, Final Report, 1 June 1966 - 31 May 1967, NASA-CR-86030 (N68-16369).

1006. Coherent Optical Propagation Study, Final Report, ITT Federal Labs, Nutley, NJ, November 1965 (AD 475 743/1ST). [An integrated study is presented of the properties of optical laser propagation and radiation applicable to long range communication in both an atmospheric and free space environment.]

1007. V. J. Corcoran, Workshop on Atmospheric Transmission Modeling, Final Report, Rept. No. P-1152, IDA, Science & Tech. Div., Arlington, VA, December 1975 (AD-A026 354/1ST). [Bring together those people who have contributed to computer modeling of atmospheric transmission, those who use the programs, and those who have evaluated the programs so that a consensus could be obtained concerning present models, the problem areas, and what must be done to evolve a model or models that would be acceptable in the future.]

1008. L. Elterman, "Parameters for Attenuation in the Atmospheric Windows for Fifteen Wavelengths," Appl. Opt., Vol. 3, No. 6, p. 745, June 1964 (AD 451 624/1ST). [The model is a series of tabulations for 15 wavelengths from 0.4 to 4.0 microns with molecular and aerosol parameters arrayed at kilometer intervals to an altitude of 30 km. Horizontal, vertical, and slant path transmission from sea level, transmission between two altitudes, and transmission to space are readily calculated from the model.]

1009. F. G. Gebhardt, et al., Model Development for E-O SAEL: Natural Aerosol, Contrast, Laser Transmission, and Turbulence, SAI-78-008-AA, Science Applications, Inc., Ann Arbor, MI, December 1978. [Compares existing aerosol models. Discussed modeling molecular and turbulence effects.]

1010. R. B. Gomez, Atmospheric Effects for Ground Target Signature Modeling, I, Atmospheric Transmission of 1.06 Micrometers, Army Electronics Command, White Sands Missile Range, NM, June 1972 (AD 750 084). [Results of a literature search and subsequent theoretical analysis conducted to determine the characteristics of atmospheric transmission at 1.06 micrometers wavelength are presented. The effects of molecular scattering, molecular absorption, aerosol scattering, and aerosol absorption are considered.]

1011. J. N. Hayes, P. B. Ulrich and A. H. Aitken, "Effects of the Atmosphere on the Propagation of 10.6 μ Laser Beams," Dig. of Tech. Papers of 1971 IEEE/OSA Conf. on Laser Eng. & Appl., 2-4 June 1971, Washington, DC. [Effects of beam-atmosphere interaction on the steady state propagation of 10.6 μ laser beams in air using scalar wave optics.]

1012. H. E. Henry, Definition of Optical Atmospheric Effects on Laser Propagation, Vol. III, NASA-CR-67382, 4 August 1965 (N65-35846).

1013. P. L. Kelley, R. A. McClatchey, R. K. Long and A. Snelson, "Molecular Absorption of Infrared Laser Radiation in the Natural Atmosphere," Opt. & Quant. Electron., Vol. 8, pp. 117-144, March 1976 (AD-A027 005/8ST). [Discusses the information available concerning atmospheric molecular absorption of radiation in the 1 to 25 micrometer range. Following subjects are reviewed: the content and variability of the atmosphere, calculations of transmittance and the data on which they are based, and laser measurement of molecular absorption.]

1014. R. M. Langer, Laser Beam Attenuation in the Lower Atmosphere, Rept. No. 6331, Bege (JRM) C, Arlington, MA, 22 November 1963 (AD 604 735). [An effort is made to present this difficult topic in as simple and useful a form as is compatible with observational material. The formulae are designed to make it possible to estimate in detail how the atmosphere would weaken a laser beam under a wide variety of conditions.]

1015. A. Laurens, Atmospheric Laser Beam Propagation, Evaluation of Potential Benefit to Aeronautical Field from Laser Tech., AGARD, Neuilly sur Seine, France, December 1975. [Theory of laser beam propagation as modified by absorption by scattering and by turbulence.]

1016. J. Q. Lilly, Methods for Prediction of Atmospheric Effects on Laser Guidance Systems, Tech. Rept. No. DRDMI-T-78-16, Army Missile R&D Command, Redstone Arsenal, AL (AD-A051 617/9ST). [Describes mathematical models which predict effects of atmospheric turbulence, molecular absorption and scattering, aerosol absorption and scattering, and radiative transport.]

1017. T. Lund and A. G. Kjelaas, "Atmospheric Effects Relevant to Laser Spectroscopy," AGARD Conf. No. 183, 27-31 October 1975, Lyngby, Denmark. [Qualitative discussion, including comparison of other published data for molecular and aerosol extinction.]

1018. W. H. MacInnis, Laser Test Range Propagation Model, Master's Thesis, AF Inst. of Tech., WPAFB Ohio School of Eng., Rept. No. AFIT-GEP/PH/77-6, December 1977 (AD-A055 639/9ST). [A model is described which calculates the irradiance probability distribution at the receiver; included are molecular scattering and absorption, aerosol extinction and turbulence. Common to have irradiance variations of two orders of magnitude.]

1019. R. E. Meredith and T. W. Tuer, An Assessment of Aerosol and Molecular Extinction in the Marine Environment, SAI-161-76-003-AA, Science Applications, Inc., Ann Arbor, MI, May 1976. [Reviews data base and gives resulting bounds of uncertainty in calculations.]

1020. A. Miller, R. L. Armstrong and C. W. Welch, Research in the Area of Atmospheric Modeling: High Resolution Atmospheric IR Transmittance Prediction, Rept. for 1 October 1974 - 30 June 1975, Rept. No. NMSU-PHYS-537-75-1, NM State Univ., Dept. of Phys. (AD-A017 026/6ST). [An atmospheric IR transmittance prediction model which includes the effects of high resolution molecular absorption, certain molecular continuum absorption, Rayleigh scattering and single and multiple scattering by spherical, polydisperse aerosol materials is summarized.]

1021. S. S. R. Murty, "Atmospheric Attenuation of CO_2 Laser Doppler Systems," IEEE Proc. of SE Conf. '77 on Imaginative Engineering through Education and Experience, 4-6 April 1977, Williamsburg, VA. [Molecular and aerosol absorption and scattering of the radiation, and the loss of coherence and signal power due to the atmospheric turbulence are discussed and estimated.]

1022. Z. Sekera, Atmospheric Transmission of Laser Beams, Final Tech. Rept. 1 January 1965 - 30 April 1966, Meteorol. Dept., Calif. Univ. (AD 651 388). [After a thorough survey of the existing literature and experimental facilities available in the area, the program of investigations leading to the study of atmospheric limitations to the propagation of laser beams was outlined.]

1023. M. F. Smith, Atmospheric Effects on Laser Beams, Vol. 1, 1964-1974 (A Bibliography with Abstracts), Rept. for 1964-1974, NTIS, Springfield, VA (NTIS/PS-76/0842/5ST). [The bibliography cites research on the effects of atmospheric window flows, turbulence, aerosols and molecular attenuation, infrared lasers, computer simulation, electrooptics amd optical communications.]

1024. M. F. Smith, Atmospheric Effects on Laser Beams, Vol. 2, 1975 - September 1978 (A Bibliography with Abstracts), NTIS, Springfield, VA (NTIS/PS-78/0992). [Cites recent research on molecular attenuation, turbulence, thermal blooming, atmospheric window flows, atmospheric composition, aerosols, infrared lasers and computerized simulation.]

1025. J. Stacey and J. Arnold, Atmospheric Propagation in the Middle Infrared and at 8-14 Micrometers, Rept. No. TSC-PD-B408-1, Tech. Service Corp., Santa Monica, CA, 28 September 1973 (AD 915 878/3ST). [Lower troposphere atmospheric constituents that scatter and absorb energy at these wavelengths are identified and the losses are calculated for several air-to-ground transmission paths for several passive sensor bandpasses and for 10.59 micrometers.]

1026. J. Y. Wang, "Infrared Atmospheric Transmission of Laser Radiation," Appl. Opt., Vol. 13, No. 1, p. 56, January 1974. [Transmittances are calculated and tabulated (includes HF, HBr, HCl, and DF laser lines). Molecular line and continuum absorption effects and aerosol extinction are considered.]

1027. W. E. Warren, MALAPROP User's Guide, Livermore Lab., Calif Univ., August 1977 (UCID-17561). [MALAPROP is a CDC 7600 computer program able to simulate laser light propagation represented by the complex array psi.]

1028. W. E. Webb and G. A. Emmons, A Review of the Atmospheric Effects on Laser Propagation, Rept. No. RR-TR-70-8, Army Missile Command, Redstone Arsenal, AL, 12 May 1970 (AD 871 752/2ST). [A review of the atmospheric effects on laser propagation of optical communication systems.]

1029. K. O. White, E. H. Holt and R. F. Woodcock, The Erbium Doped Glass Laser-Performance and Atmospheric Propagation Characteristics, Atmospheric Sciences Office, White Sands Missile Range, NM, March 1970 (AD 706 220). [Factors affecting the transmission of energy of this wavelength in the atmosphere are discussed.]

1030. P. J. Wright, "A Comparative Study of Atmospheric Transmission at Three Laser Wavelengths in Relation to the Meteorological Parameters," AGARD Conf. Proc. No. 183 Optical Propagation in the Atmosphere, Lyngby, Denmark, 27-31 October 1975 (AD-A028 615). [Describes work carried out to date under a contract to study experimentally and theoretically the transmission through the atmosphere of laser radiation at 0.63 μm, 1.06 μm and 10.6 μm. Results are compared with deductions from the theory of scattering of electromagnetic radiation due to Mie.]

1031. V. E. Zuyev, G. M. Krekov, I. E. Naats and V. N. Skorinov, "Separation of Molecular and Aerosol Components of Scattering During Laser Probing of the Atmosphere," Atm. & Oceanic Phys., Vol. 11, No. 12, p. 1326, December 1975. [Data from experimental microphysical measurements are used to construct a model of the vertical profile of atmospheric attenuation and backscattering.]

9. BIOLOGICAL EFFECTS

1032. A. S. Brownell, et al., U.S. Army Medical Res. Lab., Interim Rept., DA Project, No. 3A014501B71R, Fort Knox, KY, 1967. [Measured CO_2 laser power densities required for tissue damage on test animals.]

1033. W. C. Choiu and D. D. Glick, Bio-Optical Evaluation of Specialized Eyewear: Laser Safety and Dark Adaptation Devices, Final Report, Rept. No. USAARL-76-7, Army Aeromedical Research Lab, Ft. Rucker, AL, November 1975 (AD-A019 787/1ST).

1034. W. F. Dabberdt, "Atmospheric Effects Upon Laser Eye Safety," IEEE J. Quant. Electron., Vol. QE-8, No. 6, p. 612, June 1972. [Atmospheric thermal inhomogeneities increase eye damage probabilities through the resulting scintillation of the propagating laser beam.]

1035. P. H. Deitz, Twelve Eye Safety Nomographs, Rept. No. BRL-TN-1709, Ballistic Research Labs, Aberdeen Proving Ground, MD, December 1968 (AD 681 906). [A set of nomographs is given to aid in the derivation of probability of retinal damage by a pulsed laser beam, as a function of range for different conditions of atmospheric turbulence and attenuation.]

1036. P. H. Deitz, "Probability Analysis of Ocular Damage Due to Laser Radiation Through the Atmosphere," Appl. Opt., Vol. 8, pp. 371-375, 1969. [Evaluates probability of eye damage for various atmospheric conditions including the effects of strong turbulence (log-normal and Rayleigh), atmospheric attenuation versus visibility.]

1037. P. H. Deitz, "Safety Considerations in Outdoor Applications," Laser Focus, Vol. 6, No. 6, p. 40, June 1970.

1038. P. H. Deitz and P. M. Livingston, Beam Profile Effects in Laser Safety Analysis, Rept. No. BRL-TN-1710, Ballistic Research Labs, Aberdden Proving Ground, MD, December 1968 (AD 681 907). [The application of the probability of damage parameter for bounded waves with non-homogeneous wavefronts is discussed.]

1039. S. Fine, et al., NEREM Rec., pp. 166-167, 1966.

1040. S. Fine, et al., Am. J. Ophthalmol., Vol. 64, p. 209, 1967. [Measured CO_2 laser power densities required to cause tissue damage on test animals.]

1041. G. W. Flint (ed.), Proc. 1st Conf. on Laser Safety, Orlando, FL, May 1966.

1042. K. Gulberg, et al., "Carbon Dioxide Laser Hazards to the Eye," Nature, Vol. 215, p. 857, 1967. [Measured CO_2 laser power densities to cause blinking in test animals.]

1043. Loss of Vision From High Intensity Light, Advisory Group for Aerospace R&D, Paris, Rept. No. AGARD-CP-11, 1966 (AD 653 917).

1044. G. W. Mikesell and E. F. Maher, "The Effects of Severe Keratitis on Corneal Transmission, Final Report November 1975 - November 1976," J. Am. Optometric Assoc., Vol. 49, No. 1, pp. 63-67, January 1978 (AD-A052 174/0ST). [Effects of keratitis on corneal light transmission is presented. Transmission data from 9 diseased corneas are compared to those of 25 normal corneas in the 0.3 - 0.8 micron spectral range.]

1045. N. A. Peppers, et al., "Corneal Damage Threshholds for CO_2 Laser Radiation," Appl. Opt., Vol. 8, No. 2, p. 377-381, February 1969. [Measurements on rabbit cornea at times of 3.5, 10 and 55 msec. were 0.55, 0.77, and 1.2 j/cm. Theoretical model compared to data.]

1046. M. N. Stein and R. S. Smith, "Ocular Hazards of Transscleral Laser Radiation, I, Spectral Reflection and Transmission of the Sclera Choroid and Retina," Am. J. Ophthal., Vol. 66, No. 1, p. 21, July 1968 (AD 674 249).

1047. A. Vassiliadis, et al., Research on Ocular Laser Threshholds, Final Report, SRI Project 7191, Contract F41609-68-C-0041.

1048. P. W. Wyman, "Laser Radar Eye Hazard Considerations," Appl. Opt., Vol. 8, No. 2, pp. 383-392, February 1969. [Calculates safe operating range for several lasers; considers atmospheric attenuation but not turbulence.]

1049. J. A. Zuclich and J. Taboada, "Ocular Hazard from UV Laser Exhibiting Self-Mode-Locking," Appl. Opt., Vol. 17, No. 10, p. 1482, October 1978. [Describes production of retinal damage by 325 nm He-Cd laser radiation at much lower energy doses (0.36 j/cm^2) than required for corneal (67 j/cm^2) or lenticular damage.]

10. TEXTS

1050. H. J. Bolle (Ed.), Radiation in the Atmosphere, Science Press, Princeton, NH, 1977.

1051. K. Bullrich, Advances in Geophysics, Academic Press, NY, Vol. 10, pp. 99-260, 1964.

1052. K. Bullrich, Research on Optical Radiation Transmission, AFRCL-68-0186, 1968.

1053. K. S. Champion, "Mean Atmospheric Properties in the Range 30 to 300 Km," Air Force Surveys in Geophysics, AFCRL-65-443, 1965.

1054. K. S. Champion, "Atmospheric Structure in the Lower Thermosphere," Air Force Surveys in Geophysics, AFCRL-65-539, 1965.

1055. K. S. Champion, "New Model Atmospheres Giving Latitudinal and Seasonal Variations in the Thermosphere," Air Force Surveys in Geophysics, AFCRL-67-0330, 1967.

1056. S. Chandrasekhar, Radiative Transfer, Oxford Press, 1960. [An extended detailed treatment of Rayleigh and Mie theory.]

1057. R. Charlson, Stockholm Tropospheric Aerosol Seminar, U. Stockholm, AP-14, 1974.

1058. G. C. Clementson, An Investigation of the Power Spectral Density of Atmospheric Turbulence, MIT Thesis, 1950.

1059. A. E. Cole, Mean Monthly Atmospheres for 15° N, AFCRL-67-0120, 1967. [Data on atmospheric density, temperature and pressure.]

1060. D. R. Deirmendjian, Electromagnetic Scattering on Spherical Polydispersions, American Elsevier, NY, p. 290, 1969. [Calculations of scattering and absorption assumptions for water haze. Gives approximate formulae for Mie expressions good to within 1.5%.]

1061. N. B. Divari (ed.), Atmospheric Optics, Trans. by S. B. Dresner, Consultants Bureau, NY, 1970.

1062. M. Dolukhov, Fluctuation Processes in Radiowave Propagation (in Russian), Moscow, USSR, Svyaz Press, 1971. [Index of refraction fluctuations in the atmosphere.]

1063. S. K. Friedlander, Smoke, Dust and Haze: Fundamentals of Aerosol Behavior, Wiley, NY, 1977.

1064. N. A. Fuks, The Mechanics of Aerosols, Trans. by R. E. Daisley, Macmillan, NY, 1964.

1065. R. Goody, Atmospheric Radiation, Clarendon Press, Oxford, 1964.

1066. E. W. Hewson (ed.), Intl. Symp. on Atm. Turb. in Boundary Layer, MIT, 1952.

1067. G. M. Hidy (ed.), Aerosols and Atmospheric Chemistry, Academic Press, NY, 1971.

1068. E. D. Hinkley (ed.), Laser Monitoring of the Atmosphere, Springer-Verlag, Berlin, 1976.

1069. H. Israel and G. W. Israel, Trace Elements in the Atmosphere, Ann Arbor Science, 1974.

1070. A. I. Ivanov, et al., Light Scattering in the Atmosphere, Pt. 2, NASA-TT-F-477, NTIS, Springfield, VA, 1969.

1071. C. E. Junge, Air Chemistry and Radioactivity, Academic Press, NY, 1963. [Good text on molecular and aerosol composition of the atmosphere.]

1072. M. Kerker, The Scattering of Light and Other Electomagnetic Radiation, Academic Press, NY, 1969.

1073. I. H. Kolchyns'kyi, Optical Instability of the Earth's Atmosphere According to Stellar Observations, Trans. by W. L. Burton, US ACIC-TC-1395, St. Louis, MO, 1969.

1074. K. Y. Kondratyev, Radiation in the Atmosphere, Academic Press, NY, 1969.

1075. H. H. Lettau, Atmospheric Turbulence (Germ.), Edwards, Ann Arbor, 1944.

1076. H. H. Lettau, Proceedings of the Great Plains Turbulence Field Program, Pergamon Press, 1957.

1077. J. L. Lumley and H. A. Panofsky, The Structure of Atmospheric Turbulence, Wiley, NY, 1964. [Classic text on fluid dynamics of atmospheric turbulence.]

1078. E. J. McCartney, Optics of the Atmosphere, Wiley Interscience, 1976. [Excellent text on the effects of molecules and aerosols in the atmosphere.]

1079. J. E. Manson, C. E. Junge and C. W. Chagnon, Chemical Reactions in the Lower and Upper Atmospheres, Wiley Interscience, NY-London, p. 139, 1962. [Aerosol measurements from 6 to 27 km altitude.]

1080. W. E. K. Middleton, Vision Through the Atmosphere, Univ. of Toronto Press, 1952. [Survey of work from 1930-1950.]

1081. S. I. Pai, Atmospheric Turbulence, Univ. of Maryland, 1950.

1082. H. Press, Atmospheric Turbulence Environment with Special Reference to Continuous Turbulence, NATO AGARD Rept. 115, 1957.

1083. G. V. Rosenberg, Twilight, A Study of Atmospheric Optics, Plenum Press, NY, 1966. [An extended treatment of Rayleigh and Mie theory, skylight and transmission.]

1084. K. S. Shifrin, Scattering of Light in a Turbid Medium, NASA-TT-F-477, NTIS, Springfield, VA, 1968.

1085. J. W. Strohbehn (ed.), Laser Beam Propagation in the Atmosphere, Springer-Verlag, 1978. [Excellent text on modern and classical treatment of turbulence effects.]

1086. O. G. Sutton, Atmospheric Turbulence, Methuen, London, 1949.

1087. V. I. Tatarski, Wave Propagation in a Turbulent Medium, Trans. by R. A. Silverman, McGraw-Hill, NY, 1961.

1088. V. I. Tatarski, The Effect of the Turbulent Atmosphere on Wave Propagation, US Dept. of Commerce, Springfield, VA, 1971.

1089. R. A. R. Tricker, Introduction to Atmospheric Optics, American Elsevier, NY, 1970.

1090. S. Twomey, Atmospheric Aerosols, Elsevier Scientific Pub. Co., 1977.

1091. H. C. Van de Hulst, Light Scattering by Small Particles, Wiley, NY, 1957.

1092. I. Van der Hoven, Atmospheric Turbulence Characteristics at Brookhaven Between 23 and 91 Meters Height, Thesis Penn State, 1956, Avail. from Univ. Microfilms, Ann Arbor, MI, No. 16733.

1093. N. K. Vinnichenko, Turbulence in the Free Atmosphere, Consultant's Bureau, NY, 1973.

1094. F. Volz, Handbook of Geophysics, p. 8, 822, 1956. [Compiled spectral extinction measurements by several authors.]

1095. Winds and Turbulence in the Stratosphere, NATO Advanced Study Inst., Bavaria, 1968.

1096. V. E. Zuyev, Propagation of Visible and Infrared Radiation in the Atmosphere, 1974. [The book considers questions of absorption by atmospheric gases, aerosol and molecular scattering, and a systematic examination of various aspects of the propagation of narrow radiation beams.]

REFERENCES

2-1. D. E. Askey (ed.), Guide to DIALOG Data Bases, Lockheed Information Systems, Palo Alto, CA, August 1977.

2-2. Proceedings of the First Through Seventh DoD Conferences on Laser Technology, ERIM-132900-3-X, October 1978.

2-3. Optical Propagation in the Atmosphere, AGARD Conference Proceedings, AGARD-CP-183, Lyngby, Denmark, 27-31 October 1975 (AD-A028 615).

4-1. R. W. Fenn, OPAQUE - A Measurement Program on the Optical Atmospheric Properties in Europe, Vol. I - NATO OPAQUE, AFGL-TR-78-0011, 11 January 1978.

4-2. R. W. Fenn, OPAQUE Data Analysis (tentative title), AFGL-TR-79-____, to be published.

4-3. W. R. Watkins, K. O. White, et al., "Pressure Variation of Water Vapor Continuum Absorption," Appl. Opt., Accepted for Publication. [Found the ratio of foreign-to-self broadening contributions to be a factor of ten less than that measured by Burch. A third term (eg., a dimer or cluster contribution with no foreign dependency) could account for discrepancy.]

4-4. K. O. White, et al., to be published, 1979.

4-5. B. S. Katz, EO Sensitivity Study, NSWC, to be published around April 1979.

4-6. B. S. Katz, to be published in 1979.

4-7. J. Nella, Vulnerability Study, Aerosol Scattering Measurements Task, Hughes Rept. No. P 75-99, December 1974. [Made measurements at 0.4762, 0.5309, 0.5682, 0.6471, 1.06 and 10.6 μm, under contract to DARPA via NRL.]

4-8. J. Trajonis and Kung Yuan, Visibility in the Northeast, EPA-600/3-78-075. [Available through NTIS.]

4-9. T. E. Zant, et al., "Vertical Profiles of Refractivity Turbulence Structure Constant: Comparison of Observations by the Sunset Radar with a New Theoretical Model," Radio Sci., Vol. 13, No. 5, pp. 819-829, September 1978. [A semi-empirical model for the vertical profile of C_n^2 is determined based on radar observations.]

JOURNAL AND ORGANIZATIONAL ACRONYMS

Acta Phys. Aust.	Acta Physica Austriaca
Adv. in Geophys.	Advances in Geophysics
Aerosol Sci.	Aerosol Science
AFAL	Air Force Avionics Laboratory
AFCRL	Air Force Cambridge Research Laboratory
AFGL	Air Force Geophysics Laboratory
AFIT	Air Force Institute of Technology
AGARD	Advisory Group for Aerospace Research and Development
AIAA J.	American Institute of Astronautics and Aeronautics Journal
Akad Nauk SSR, seriya Geofiz.	Akademiia Nauk S.S.S.R., seriya geofizicheskii
Am. Ind. Hyg. Assoc. J.	American Industrial Hygiene Association Journal
Amer. Meteor. Soc.	American Meteorological Society
Amer. Mineralog.	American Mineralogy
Amer. Sci.	American Science
Ann. Geophys.	Annals of Geophysics
Appl. Opt.	Applied Optics
Appl. Phys. L.	Applied Physics Letter
ARPA	Advance Research Projects Agency (DoD)
ASL	Atmospheric Sciences Laboratory (Army)
Astrophys. J.	Astrophysics Journal

Atm. & Oceanic Phys.	Atmospheric and Oceanic Physics
Atm. Environ.	Atmospheric Environment
Bell. Syst. Tech. J.	Bell System Technical Journal
Bound. Lay. Meteor.	Boundary Layer Meteorology
BRL	Ballistic Research Laboratories
Can. J. Phys.	Canadian Journal of Physics
ECOM	Electronics Command (Army)
Elec. & Comm.	Electronics and Communications
EMI	EMI (England)
Envir. Sci. Tech.	Environmental Science and Technology
ERIM	Environmental Research Institute of Michigan
FTD	Foreign Technology Division (WPAFB)
GDC	General Dynamics Corporation
GE	General Electric Company
Geochem. & Cosmochem. Acta	Geochemica et Cosmochimica Acta
Geophys. Res. Papers	Geophysics Research Papers
Gerlands Beit Geophys.	Gerlands Beitraege Zur Geophysik
IDA	Institute for Defense Analysis
IRIS	Infrared Information Symposia
IR Phys.	Infrared Physics
ITT	International Telephone and Telegraph
J. Aeros. Sci.	Journal of Aerosol Sciences
J. Air Poll. Cont.	Journal of Air Pollution Control
J. Atm. Sci.	Journal of Atmospheric Sciences
J. Atm. & Terr. Phys.	Journal of Atmospheric and Terrestrial Physics
J. Colloid. Inter. Sci.	Journal of Colloidal and Interface Science
J. Geophys. Res.	Journal of Geophysical Research

J. Kor. Inst. Elec. Eng.	Journal of the Korean Institute of Electronic Engineering
J. Meteor.	Journal of Meteorology
J. Mol. Spect.	Journal of Molecular Spectroscopy
JOSA	Journal of the Optical Society of America
J. Phys. Chem.	Journal of Physical Chemistry
J. Phys. Ocean.	Journal of Physical Oceanography
JQRST	Journal of Quantitative Spectroscopy and Radiative Transfer
J. Quant. Elect.	Journal of Quantum Electronics
J. Res. Atm.	Journal of Research in the Atmosphere
J. Res., NBS	Journal of Research, National Bureau of Standards
LMSC	Lockheed Missile and Space Center
MICOM	Missile Command (Army)
MIT	Massachusetts Institute of Technology
MIT/LL	MIT/Lincoln Laboratory
NADC	Naval Air Development Center
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NBS	National Bureau of Standards
NCAR	National Center for Atmospheric Research
NDRE	Norwegian Defense Research Establishment
NELC	Naval Electronics Laboratory Center
NMSU	New Mexico State University
NOAA	National Oceanographic and Atmospheric Administration
NRL	Naval Research Laboratory
NTIS	National Technical Information Services

NWC	Naval Weapons Center
Opt. Letters	Optics Letters
Opt. & Quant. Elec.	Optical and Quantum Electronics
Oreg. State U.	Oregon State University
OSA	Optical Society of America
OSU	Ohio State University
Planet & Space Sci.	Planetary and Space Sciences
Proc. IEEE	Proceedings of the Institute of Electrical and Electronic Engineering
Proc. Roy. Soc.	Proceedings of the Royal Society
PSI	Physical Sciences, Incorporated
Pure Appl. Geophys.	Pure and Applied Geophysics
RADC	Rome Air Development Center (Air Force)
Radio Sci.	Radio Science
RCA	Radio Corporation of America
RRA	Radiation Research Associates
SAI	Science Applications, Incorporated
Sov. J. Quant. Elect.	Soviet Journal of Quantum Electronics
Sov. Phys. J.	Soviet Physics Journal
Sov. J. Opt. Tech.	Soviet Journal of Optical Technology
Space Res.	Space Research
SPIE	Society of Photo-Optical Instrumentation Engineers
SW Cen. Adv. Stud.	Southwestern Center for Advanced Studies
Stud. Geophys. & Geolog.	Studia Geophysica et Geodaetica
Telecom & Radio Eng.	Telecommunication and Radio Engineering
Trans. Am. Geophys. U.	Transactions of the American Geophysical Union
U. Chi.	University of Chicago

U. Mich.	University of Michigan
WPAFB	Wright Patterson Air Force Base
WRE	Western Research Establishment (Australia)
Zeit fur Meteor.	Zeitschrift fuer Meteorologie