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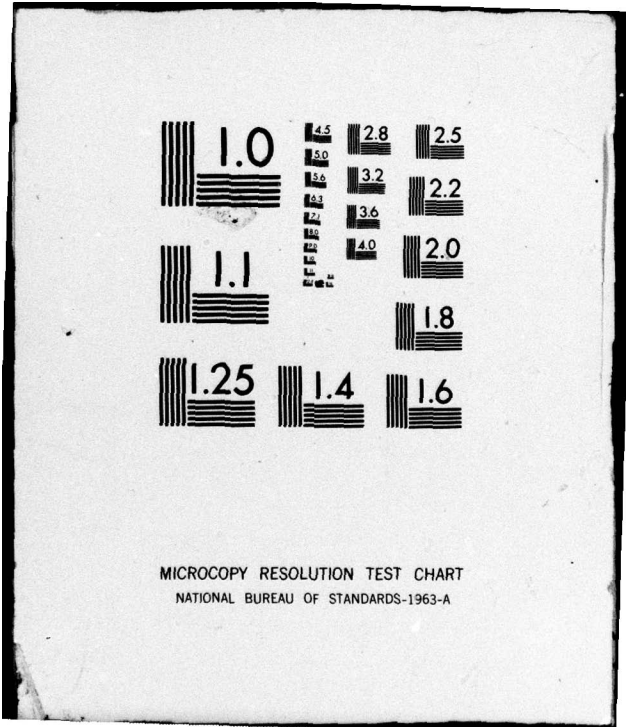
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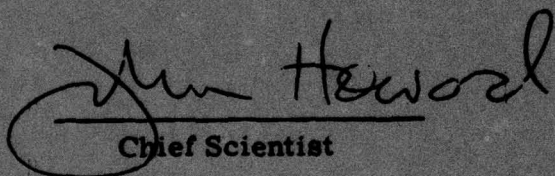
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20. Abstract (Continued)

significance of the monthly models progressively decreases with altitude, because of the small number of high-altitude measurements.

The statistical properties of winds have been calculated for altitudes up to 60 km for the midseason months. Although the information used to prepare these models is based primarily on observations made at Kwajalein, some data from other tropical locations have been considered, particularly for such items as the estimates of time and space variations.

The Kwajalein Missile Range (KMR) Reference Atmospheres contains information on the following parameters: temperature, pressure, density, speed of sound, dynamic viscosity, wind speed and direction, relative humidity, optical and radar indices of refraction, mean molecular weight, interlevel correlations of temperature, density, and wind, acceleration of gravity, and magnitudes of diurnal and semidiurnal tidal components of temperature, density, and wind.

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Foreword

The Kwajalein Reference Atmospheres, 1979, with tables and graphs of atmospheric properties to 120 km, were prepared by a working group consisting of representatives from Army and Air Force agencies and contractors associated with tests conducted on the Kwajalein Missile Range (KMR). The Air Force Geophysics Laboratory (AFGL) served as the focal point for coordination and preparation of the document. Participating organizations and the names of scientists and engineers who are members of the working group are listed below:

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Preface

The committee for a Revised Kwajalein Reference Atmosphere would like to take this opportunity to thank Mr. K. Agazarian who prepared the computer programs for the computation of the main tables and statistical arrays. We also extend our thanks to Mrs. Helen Connell who typed several drafts of the text and tables.

Contents

1. INTRODUCTION	13
2. BASIC ASSUMPTIONS AND COMPUTATIONAL EQUATIONS	14
2.1 Perfect Gas Law	14
2.2 Temperature	15
2.3 Gravity	15
2.4 Hydrostatic Equation	16
2.5 Geopotential	16
2.6 Pressure	16
2.7 Speed of Sound	17
2.8 Dynamic Viscosity	17
3. DATA	18
4. COMPARISON OF OBSERVED AND MODEL DENSITIES	25
5. DAY-TO-DAY VARIABILITY	29
6. DIURNAL VARIABILITY	33
6.1 Surface to 60 km	33
6.2 Sixty to 90 km	34
6.3 Magnitude of Density Variations	37
7. SPACE AND TIME VARIATIONS	38
8. TABLES OF THE MONTHLY AND ANNUAL KWAJALEIN REFERENCE ATMOSPHERES	42
REFERENCES	69
APPENDIX A - Kwajalein Wind Distributions	71
APPENDIX B - Kwajalein Temperature and Density Distributions	83

Contents

APPENDIX C - Index of Refraction (Mean Values)	93
APPENDIX D - KREMS - Radar Wind Data to 25 km	97
APPENDIX E - KMR Jimsphere, Rawinsonde, and ALTAIR Radar Wind Measurement Comparisons	101
SYMBOLS AND ABBREVIATIONS	109

Illustrations

1. Molecular Weights for Altitudes Between 80 and 120 km	22
2. Annual Variation of Mean Monthly Temperatures (shown by dots) for KMR Reference Atmospheres	23
3. Molecular-Scale Temperature Profiles Derived From Five ROBIN Measurements and One Hypersonic Sphere Measurement at KMR on 5 April 1978, and the Molecular- Scale Temperature Profile (solid line) Adopted for the April Reference Atmosphere	23
4. Molecular-Scale Temperature Profiles Derived From 17 ROBIN Sphere Measurements at KMR on 19-21 July 1978, and the Molecular-Scale, Temperature Profile (solid line) Adopted for the July Reference Atmosphere	24
5. Molecular-Scale Temperature Profiles Derived From Four ROBIN Sphere Measurements at KMR on 13 November 1977, and the Molecular-Scale Temperature Profile (solid line) for the November Reference Atmosphere	24
6. Molecular Scale Temperature Profiles Derived From 35 ROBIN, 2 AFGL Sphere Measurements, and 1 Hypersonic Sphere Measurement at KMR, and the Molecular-Scale Temperature Profile Adopted for the Mean Annual Reference Atmosphere for KMR	25
7. Density Profiles of the 12 Mean Monthly KMR Reference Atmospheres Given as Percent Departures From the U.S. Standard Atmosphere, 1976	26
8. Curves of the Annual Variations of the KMR Reference Atmospheres and Observed Mean Monthly Densities	26
9. Density Profiles Derived From Five ROBIN Measurements and One Hypersonic Sphere Measurement at KMR on 5 April 1978, Plotted as Percent Departures From the Densities in the KMR Reference Atmosphere for April	27
10. Density Profiles Derived From 17 ROBIN Sphere Measure- ments at KMR on 19-21 July 1978, Plotted as Percent Departures From the Densities in the KMR Reference Atmosphere for July	28

Illustrations

11. Density Profiles Derived From Four ROBIN Sphere Measurements at KMR on 13 November 1977, Plotted as Percent Departures From the Densities in the KMR Reference Atmosphere for November	28
12. Density Profiles Derived From 35 ROBIN, 2 AFGL Measurements, and 1 Hypersonic Sphere Measurement, Plotted as Percent Departures From the Densities in the Mean Annual Reference Atmosphere for KMR	29
13. Density Profile of the Mean Annual KMR Reference Atmosphere Plotted as Percent Departure From the U.S. Standard Atmosphere, 1976, With Two Standard Deviations of the Day-to-Day Variations Around the Mean Annual Profile Shown by Horizontal Arrows	33
14. Amplitude of the Diurnal Oscillations in Density, Temperature, and Wind at Altitudes of 60 to 90 km	36
15. Amplitude of the Semidiurnal Oscillations in Density, Temperature, and Wind at Altitudes of 60 to 90 km	37
16. The rms Variations in Density, Temperature, and Wind for Time Lags of 1 to 6 Hours	40
A1. Profiles of the 50, 90, 95, and 99 Percentile Values of Scalar Wind Speeds	74
C1. The Mean Annual Index of Refraction (N Values) for Radar and Optics at KMR	94
D1. Example of Turbulence Echo Spectrum	99
D2. Example of Velocity-Azimuth Display From TRADEX Measurements	99
D3. Wind Magnitude Along ALTAIR Radar LOS in the Reentry Corridor Before the ABRV-1 Mission	100
D4. Examples of Spectral Wind Component Variations Over Short Temporal Scales	100
E1. Comparison of Jimsphere and Rawinsonde Wind Measurements, TDV-1 Data	102
E2. Comparison of Jimsphere and Rawinsonde Wind Measurements, TDV-2 Data	103
E3. Comparison of Jimsphere and Rawinsonde Wind Measurements, TDV-3 Data	104
E4. Comparison of Jimsphere, Rawinsonde, and ALTAIR Radar Wind Measurements, ABRV-1 Data	105

Tables

1. Relative Humidities and Molecular-Scale Temperatures Used to Calculate Virtual Temperatures (see Eq. (2)) for Altitudes Between the Surface and 10 km for the Individual KMR Reference Atmospheres	19
2. Molecular-Scale Temperature Profiles of the KMR Reference Atmospheres	20
3. Molecular Weights for Altitudes From 85 to 120 km	21
4. Standard Deviations of the Observed Day-to-Day Variations in Density Around the Mean Monthly and Mean Annual Values at Kwajalein	30
5. Standard Deviations of the Observed Day-to-Day Variations in Temperature (K) Around the Mean Monthly and Mean Annual Values at Kwajalein	30
6. Standard Deviations of the Observed Day-to-Day Variations of Density Around the Annual Means at Altitudes of 60 to 90 km	32
7. Standard Deviations of Density Around 3-Day Means From a Series of Density Measurements at Kourou (5°N) on 19-22 September 1976 and at Kwajalein (9°N) on 19-21 July 1978	32
8. Phases and Amplitudes of Diurnal and Semidiurnal Tides Between 60 and 90 km for Density, Temperature, and Wind	35
9. Range of the Combined Diurnal and Semidiurnal Density Tides Observed Between 30 and 90 km	38
10. Estimated rms Differences (percent of mean) Between Densities at Locations 50, 100, and 200 Nautical Miles Apart During the Midseason Months	39
11. The rms Variations in Density, Temperature, and Wind With Time. Density values for altitudes 30 to 60 km are based on MRN observations at Ascension	41
12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres	43
A1. The 50, 90, 95, and 99 Percentile Values of Scalar Wind Speeds at KMR	72
A2a. Means, Standard Deviations, and Interlevel Correlations of East/West Winds, January	75
A2b. Means, Standard Deviations, and Interlevel Correlations of East/West Winds, April	76
A2c. Means, Standard Deviations, and Interlevel Correlations of East/West Winds, July	77
A2d. Means, Standard Deviations, and Interlevel Correlations of East/West Winds, October	78
A3a. Means, Standard Deviations, and Interlevel Correlations of North/South Winds, January	79
A3b. Means, Standard Deviations, and Interlevel Correlations of North/South Winds, April	80

Tables

A3c. Means, Standard Deviations, and Interlevel Correlations of North/South Winds, July	81
A3d. Means, Standard Deviations, and Interlevel Correlations of North/South Winds, October	82
B1a. Means, Standard Deviations, and Interlevel Correlations of Temperature, January	85
B1b. Means, Standard Deviations, and Interlevel Correlations of Temperature, April	86
B1c. Means, Standard Deviations, and Interlevel Correlations of Temperature, July	87
B1d. Means, Standard Deviations, and Interlevel Correlations of Temperature, October	88
B2a. Means, Standard Deviations, and Interlevel Correlations of Density, January	89
B2b. Means, Standard Deviations, and Interlevel Correlations of Density, April	90
B2c. Means, Standard Deviations, and Interlevel Correlations of Density, July	91
B2d. Means, Standard Deviations, and Interlevel Correlations of Density, October	92
C1. Index of Refraction for Radar and Optics	95
E1. Sensor Measurement Variability	108

Kwajalein Reference Atmospheres, 1979

1. INTRODUCTION

The Reference Atmospheres presented in this report were developed to provide estimates of the distributions of temperature, pressure, density, and wind to altitudes of 120 km at the Kwajalein Missile Range (KMR). KMR, located on the Kwajalein Atoll in the Marshall Islands ($8^{\circ}43'N$ and $167^{\circ}44'E$), plays an important role in the test and development of military missiles and reentry systems. Detailed information is required on the distribution of the thermodynamic properties of the atmosphere and the winds at Kwajalein for planning and evaluating future Air Force and Army programs at the range. This report updates and expands upon information contained in two earlier reports by Salah¹ and IRIG.²

This report presents information on the diurnal and day-to-day variations of temperature and density around their monthly means, and, in Section 8, presents data in tabular form on the acceleration due to gravity and the thermodynamic properties (virtual temperature, pressure, density, speed of sound, and dynamic viscosity) of a mean annual and 12 mean monthly Kwajalein atmospheres.

(Received for publication 4 October 1979)

1. Salah, J. E. (1967) Kwajalein Standard Atmosphere, Technical Note 1967-14, Lincoln Laboratory.
2. IRIG (1974) Kwajalein Missile Range, Kwajalein, Marshall Islands, Reference Atmosphere, Part I, Document 104-63, Range Commanders Council, White Sands Missile Range.

Statistical properties of the winds – including scalar wind speed distributions, mean monthly east/west and north/south components, standard deviations of each component around the means, and interlevel correlations – are given in Appendix A for midseason months at altitudes up to 60 km. Matrices of the means and standard deviations of temperature and density for 2-km intervals of altitude up to 60 km, together with interlevel coefficients of correlation of temperature with temperature and density with density, are presented in Appendix B for the mid-season months.

Standard expressions for both radar and optical refractivities along with calculated values are given in Appendix C. Comparisons of KMR Jimsphere, Rawinsonde, and ALTAIR radar wind measurements are contained in Appendix D, and KREMS (radar wind data to 25 km) are presented in Appendix E.

The basis of the tables of the thermodynamic properties of the atmosphere and the observations used in the development of the models are discussed in Sections 2 and 3.

2. BASIC ASSUMPTIONS AND COMPUTATIONAL EQUATIONS

The annual and 12 monthly atmospheres developed for KMR are defined by molecular-scale temperature-altitude profiles in which the vertical gradients of molecular-scale temperature are linear with respect to geopotential altitude. The numerical values for the various thermodynamic and physical constants used in the computations of atmospheric properties are the same as those given in the U.S. Standard Atmosphere, 1976,³ except for surface conditions of temperature, pressure, and density and the acceleration due to gravity. Humidity at altitudes up to 10 km is included in the computations. The molecular weight of air at sea level, 28.9644 kg/(kmol), is assumed constant to 85 km.

2.1 Perfect Gas Law

It is assumed that a dry air and water vapor mixture behaves in accordance with the perfect gas law:

$$\rho = \frac{MP}{R^*T_v}, \quad (1)$$

3. Committee on Extension to the Standard Atmosphere (1976) U.S. Standard Atmosphere, 1976, Government Printing Office, Washington, D.C.

where ρ is the density of air, M is the molecular weight, P is the pressure, R^* is the universal gas constant ($8.31432 \times 10^3 \text{ N} \cdot \text{m}/(\text{kmol} \cdot \text{K})$), and T_v is the virtual temperature, as defined in Section 2.2. The assumption that the mixture behaves as a perfect gas eliminates the necessity for considering minor deviations from the perfect gas law such as the compressibility factor of air, which is a function of pressure, temperature, and relative humidity. The error in computed densities resulting from the assumption that air is a perfect gas may approach 0.05 percent below 10 km but becomes less than 0.01 percent above 20 km.

2.2 Temperature

Virtual temperature (T_v) is obtained from the empirical formula

$$T_v = \frac{T}{1 - 0.379 e/p} \quad (2)$$

where virtual temperature (T_v) is the fictitious temperature that dry air must have at the given pressure (P) in order to have the same density (ρ) as a water vapor-air mixture at that pressure (P), temperature (T), and vapor pressure (e).

The molecular-scale temperature (T_M) is defined by

$$T_M = \left(\frac{M_0}{M} \right) T \quad (3)$$

where M_0 is the sea-level value of the mean molecular weight of air. Above 85 km, kinetic temperature (T) departs from T_M in accordance with Eq. (3).

2.3 Gravity

The acceleration due to gravity at sea level midway between Kwajalein Island and Roi-Namur Island in the Kwajalein Atoll (approximately $8^{\circ}43'N$, $167^{\circ}44'E$) is $9.78155 \text{ m}/\text{sec}^2$. It was obtained from the following expression by Lambert (Ref. 4) in which gravity (g_ϕ) varies with latitude (ϕ):

$$g_\phi = 9.780356 (1 + 0.0052885 \sin^2 \phi - 0.0000059 \sin^2 2 \phi) \quad (4)$$

The inverse-square law of gravitation was used to calculate the acceleration due to gravity for altitudes up to 120 km. It provides the following expression for g as a function of altitude as in the U. S. Standard Atmosphere, 1976³:

4. List, R.J., ed (1968) Smithsonian Meteorological Tables, Smithsonian Inst. Press, Washington, D.C.

$$g = g_{\phi} \left(\frac{r_{\phi}}{r_{\phi} + Z} \right)^2, \quad (5)$$

where r_{ϕ} is the effective earth radius at a specific latitude (ϕ) and Z is the geometric altitude. The value of r_{ϕ} is 6335967 m.

2.4 Hydrostatic Equation

The air is assumed to be in hydrostatic equilibrium and to satisfy the differential equation

$$dP = -\rho g dZ, \quad (6)$$

which relates air pressure (P) to density (ρ), acceleration of free fall (g), and height (Z). The perfect gas law relates air pressure to density and temperature, as shown in Eq. (1).

2.5 Geopotential

The relationship between geopotential altitude and geometric altitude is the same as that used for the U.S. Standard Atmosphere, 1976³:

$$H = \left(\frac{r_{\phi} Z}{r_{\phi} + Z} \right) \frac{g_{\phi}}{G}, \quad (7)$$

where H is the geopotential altitude in geopotential meters (m'), and G is the unit geopotential set equal to $9.80665 \text{ m}^2/(\text{sec}^2 \text{ (m')})$.

2.6 Pressure

Vertical distributions of pressure were computed from appropriate temperature-altitude profiles and associated mean monthly surface pressure, according to the following barometric equations:

$$\frac{P}{P_b} = \left(\frac{T_{Mb}}{T_{Mb} + Lh} \right)^{\frac{g_{\phi} M_o}{R^* L}} \quad (L \neq 0) \quad (8)$$

$$\frac{P}{P_b} = \exp \frac{-g_\phi M_o h}{R^* T_{Mb}} \quad (L = 0) , \quad (9)$$

where $h = H - H_b$; H_b is the geopotential altitude at the base of a particular layer characterized by a specific value of L , which is the vertical gradient of molecular-scale temperature with geopotential altitude (dT_M/dh); and T_{Mb} and P_b are the respective values of temperature and pressure at altitude (H_b). It should be noted that for altitudes of from 10 to 85 km, T was substituted for T_M ; for altitudes below 10 km, T_v was substituted for T_M .

2.7 Speed of Sound

The expression adopted for the speed of sound (C_s) is:

$$C_s = \left(\frac{\gamma R^* T_M}{M_o} \right)^{1/2} , \quad (10)$$

where γ is the ratio of specific heat of air at constant pressure to that at constant volume, and is taken to be 1.40 (dimensionless). Equation (10) applies only when the sound wave is a small perturbation on the ambient condition. The limitations of the concept of speed of sound due to extreme attenuation are also of concern. The attenuation that exists at sea level for very high frequencies applies to lower frequencies as atmospheric pressure decreases. For this reason, the concept of speed of sound (except for frequencies approaching zero) loses its range of applicability at very high altitudes. Consequently, tabular values for the speed of sound terminate at 85 km.

2.8 Dynamic Viscosity

The coefficient of dynamic viscosity is defined as a coefficient of internal friction developed when gas regions move adjacent to each other at different velocities. The following expression, basically from kinetic theory but with constants derived empirically, is used for computation:

$$\mu = \frac{\beta T^{3/2}}{T + S} , \quad (11)$$

where β is a constant equal to 1.58×10^{-6} kg/(sec · m · K^{1/2}) and S is Sutherland's constant, equal to 110.4K. Equation (11) fails for very high and very low temperatures and under conditions occurring at great altitudes. Consequently, tabular values terminate at 85 km.

3. DATA

The initial sea-level pressure, the humidity distribution to 10 km, and the temperature-altitude profile to 25 km for each atmosphere are based on surface data and radiosonde observations that were taken twice daily at Kwajalein during the period January 1956 through June 1970. Summaries and analyses of these data are provided by IRIG² and Billions.⁵ The temperature-altitude profiles for the annual and monthly atmospheres between 25 and 60 km are based on meteorological rocket network (MRN) observations⁶ that were taken at Kwajalein during the period 1969 through 1976.

The temperature profiles for altitudes between 60 and 90 km are based primarily on temperatures derived from density profiles observed at Kwajalein during the years 1976 to 1978 with 35 ALCOR-tracked ROBIN inflatable spheres, 3 hypersonic spheres, and 3 AFGL instrumented solid spheres.^{7, 8} Densities and temperatures derived from grenade and pressure gage observations⁹ taken at Kourou (5°N), Natal (6°S), and Ascension (8°S) were also examined to obtain estimates of the magnitude of the seasonal and day-to-day variability in the tropics at altitudes between 60 and 90 km.

For altitudes of 90 to 120 km, the Committee for a Revised Kwajalein Reference Atmosphere agreed that the models should be based primarily on the densities observed at Kwajalein by one hypersonic sphere and two AFGL-instrumented solid spheres. The densities from these three observations were averaged and all of the models were developed so that they conformed as closely as possible to the mean density profile. The temperatures at 120 km are the same for all months, and densities at 120 km are within a few percent of each other. If information is needed for altitudes above 120 km, it is recommended that data from the summer models in Part 6.2 of the U.S. Standard Atmosphere Supplements, 1966¹⁰ be used for altitudes up to 1000 km.

The relative humidities and associated temperatures for each atmosphere are given in Table 1 for altitudes up to 10 km. The molecular-scale temperature profiles are defined in Table 2 for altitudes from the surface to 120 km. To obtain

Because of the large number of references cited above, they will not be listed here. See References, page 69.

Table 1. Relative Humidities and Molecular-Scale Temperatures Used to Calculate Virtual Temperatures (see Eq. (2)) for Altitudes Between the Surface and 10 km for the Individual KMR Reference Atmospheres

Altitude (km)	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
	Relative Humidity (%)												
0	74	73	72	76	80	78	76	77	74	72	72	71	72
1	75	73	75	76	77	78	79	75	76	75	78	76	77
2	67	61	57	65	68	72	69	73	69	69	73	72	71
3	47	40	33	57	60	59	63	68	63	70	65	62	59
5	20	23	38	51	56	60	59	61	64	64	53	32	50
7	14	14	17	30	48	42	50	41	46	42	40	24	38
10	0	0	0	0	0	24	31	20	24	0	0	0	23
	Temperature (K)												
0	300.34	300.34	300.85	300.98	301.01	301.07	301.13	301.27	301.50	301.33	301.20	300.91	300.97
1	292.71	292.50	292.95	293.34	293.79	293.87	294.03	293.97	294.05	293.97	294.03	293.42	293.55
2	288.52	288.69	288.54	288.67	289.11	288.91	288.90	288.84	288.83	288.81	288.98	289.02	288.78
3	284.77	284.63	284.42	284.01	284.18	284.01	283.77	283.78	283.77	283.84	284.09	284.52	284.15
5	273.69	273.72	271.27	273.08	272.98	272.67	273.91	272.56	272.55	272.55	273.04	273.63	273.03
7	261.94	262.15	261.80	261.47	261.35	261.13	261.12	261.02	261.14	261.14	261.33	261.63	261.45
10	240.81	241.02	240.66	240.62	240.33	239.83	239.73	239.68	239.90	239.95	240.36	240.61	240.27

Table 2. Molecular-Scale Temperature Profiles of the KMR Reference Atmospheres

Month	Surface Pressure (mb)	Break-Points in Geopotential Kilometers and Temperature (K) (see text, Section 3)													
		Alt	Temp	Alt	Temp	Alt	Temp	Alt	Temp	Alt	Temp	Alt	Temp		
Jan	1009.78	0	303.38	1.0	294.83	2.0	290.13	3.0	285.73	5.0	273.91	7.0	262.01	10.0	240.65
		15.0	200.65	16.5	191.65	17.5	191.65	22.5	213.65	32.5	232.65	47.5	270.15	51.0	270.15
		56.0	237.15	66.0	229.15	71.0	214.15	78.5	197.65	84.0	197.65	92.0	181.65	100.0	181.65
Feb	1009.58	0	303.34	1.0	294.54	2.0	290.18	3.0	285.44	5.0	274.00	7.0	262.24	10.0	241.15
		15.0	200.65	16.5	191.65	17.5	191.65	22.5	214.15	32.5	233.15	42.5	263.15	46.5	271.15
		30.0	271.15	35.0	260.15	60.0	190.15	100.0	180.15	105.0	193.15	113.0	335.15	120.0	360.15
Mar	1010.69	0	303.94	1.0	295.10	2.0	289.90	3.0	285.08	5.0	271.64	7.0	261.80	10.0	240.65
		14.5	204.65	17.0	192.15	18.0	192.15	21.0	210.15	36.0	244.65	43.0	265.65	48.0	272.65
		50.0	272.65	57.5	236.15	67.5	223.15	75.0	197.65	80.0	185.65	100.0	180.65	105.0	195.15
Apr	1010.79	0	304.23	1.0	295.56	2.0	290.23	3.0	285.13	5.0	273.65	7.0	261.65	10.0	239.15
		15.0	199.15	17.0	196.15	18.0	196.15	22.0	214.15	34.5	244.15	42.0	265.15	47.0	271.15
		51.0	271.15	56.0	264.15	66.0	218.15	70.0	204.15	75.0	192.15	80.0	192.15	85.0	197.15
May	1011.02	0	304.44	1.0	296.12	2.0	290.80	3.0	285.39	5.0	273.63	7.0	261.69	10.0	240.15
		15.0	200.65	16.5	194.65	17.5	194.65	21.0	212.15	31.0	225.15	33.0	239.15	43.0	265.15
		47.0	269.15	50.0	269.15	55.0	263.15	55.0	263.15	70.0	203.15	80.0	194.15	90.0	180.15
June	1010.70	0	304.43	1.0	296.24	2.0	290.68	3.0	285.17	5.0	273.33	7.0	261.37	10.0	239.65
		15.0	200.15	16.0	196.15	17.0	196.15	21.5	214.15	33.5	238.15	41.5	258.15	47.0	269.15
		49.5	269.15	54.5	263.15	69.5	206.15	72.5	195.65	79.5	199.15	83.0	199.15	100.0	182.15
July	1009.96	0	304.41	1.0	296.46	2.0	290.59	3.0	284.98	5.0	274.60	7.0	261.40	10.0	239.65
		14.0	205.65	16.0	196.65	17.0	196.65	22.0	215.65	32.0	232.65	47.0	268.65	50.0	268.65
		55.0	261.15	65.0	224.15	70.0	204.15	75.0	198.15	83.0	198.15	90.0	187.15	95.0	202.15
Aug	1010.39	0	304.62	1.0	296.28	2.0	290.62	3.0	285.09	5.0	273.23	7.0	261.25	10.0	239.65
		15.0	199.65	16.0	197.15	17.0	197.15	21.0	213.15	36.0	240.15	42.0	261.15	47.0	270.15
		50.5	270.15	55.5	260.15	74.5	193.65	88.5	193.65	100.0	182.15	110.0	240.15	120.0	360.15
Sept	1010.24	0	304.77	1.0	296.40	2.0	290.51	3.0	284.99	5.0	273.25	7.0	261.39	10.0	240.15
		15.0	199.65	16.0	196.65	17.0	196.65	20.0	210.15	35.0	241.65	41.0	262.65	46.0	269.65
		50.0	269.65	60.0	243.65	74.0	194.65	79.0	194.65	100.0	184.15	110.0	240.15	120.0	360.15
Oct	1010.14	0	304.48	1.0	296.25	2.0	290.49	3.0	285.20	5.0	273.26	7.0	261.40	10.0	239.65
		15.0	200.15	16.0	195.15	17.0	195.15	22.0	214.65	32.0	235.65	42.0	264.65	47.0	270.65
		50.0	270.65	55.0	257.65	60.0	242.65	70.0	205.65	75.0	195.65	89.0	195.65	100.0	179.15
Nov	1009.85	0	304.32	1.0	296.43	2.0	290.78	3.0	285.37	5.0	273.65	7.0	261.57	10.0	240.15
		14.0	208.15	16.5	193.15	17.5	193.15	21.0	210.65	31.0	234.65	41.0	257.65	47.0	269.65
		50.0	269.65	55.0	238.15	60.0	243.65	70.0	210.65	75.0	197.15	80.0	197.15	85.0	188.15
Dec	1009.78	0	303.93	1.0	295.67	2.0	290.79	3.0	285.77	5.0	273.99	7.0	261.77	10.0	240.65
		15.0	200.15	16.5	192.65	17.5	192.65	22.0	215.15	32.0	233.15	42.0	260.15	47.0	268.65
		50.0	268.65	70.0	214.65	76.0	199.65	82.0	199.65	89.0	189.15	100.0	178.15	105.0	195.15

kinetic temperatures (T) from the molecular-scale temperatures (T_M), it is necessary to know the molecular weight of air as a function of altitude. Kinetic and molecular-scale temperatures are identical up to 85 km, since the molecular weight is assumed constant to that altitude. The molecular weights adopted for the KMR atmospheres above 85 km are provided in Table 3 and Figure 1. They are based on values given in references 3, 10, and 11. Kinetic temperatures above 85 km may be calculated using Eq. (3) and the molecular weights listed in Table 3.

Table 3. Molecular Weights for Altitudes From 85 to 120 km

Altitude (km)	Mean Molecular Weight (kg/(k mol))
84	28.9644
85	28.96
86	28.95
87	28.95
88	28.94
89	28.94
90	28.93
91	28.92
92	28.89
93	28.86
94	28.82
95	28.77
96	28.72
97	28.67
98	28.62
99	28.56
100	28.49
101	28.40
102	28.31
103	28.22
104	28.13
105	28.04
106	27.95
107	27.86
108	27.77
109	27.68
110	27.59
111	27.51
112	27.42
113	27.33
114	27.24
115	27.15
116	27.06
117	26.97
118	26.88
119	26.79
120	26.70

11. Keneshea, T.J., Zimmerman, S.P., and Philbrick, C.R. (1979) A dynamic model of the mesosphere and lower thermosphere, *Planet. Space Sci.* 27:385-401, Pergamon Press Ltd.

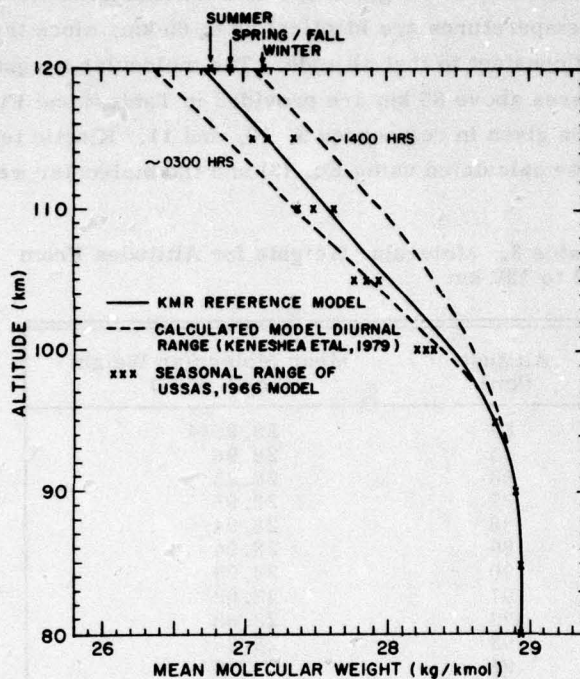


Figure 1. Molecular Weights for Altitudes Between 80 and 120 km

Curves representing the smoothed annual variation of the mean monthly temperatures of the models at altitudes of 40, 50, 60, 70, and 80 km (Figure 2) reflect the presence of a semiannual temperature oscillation in the upper stratosphere and mesosphere. This is similar to the variations found in the observed mean monthly temperatures at Ascension (8°S), Ft. Sherman (9°N), and Antigua (17°N). Vertical molecular-scale temperature profiles derived from individual ROBIN sphere measurements at KMR for altitudes between 60 and 100 km are shown with the molecular-scale temperature profiles adopted for the April, July, and November KMR Reference Atmospheres in Figures 3, 4, and 5, respectively. The individual ROBIN sphere observations provide an indication of the magnitude of the day-to-day variations around the mean monthly temperatures. Part of these variations are random measurement errors. The observed mean monthly temperature profiles and standard deviations due to day-to-day variations in the temperatures that are shown in these figures for altitudes 30 to 60 km were developed from the MRN data for Kwajalein. The 35 temperature profiles from the ROBIN

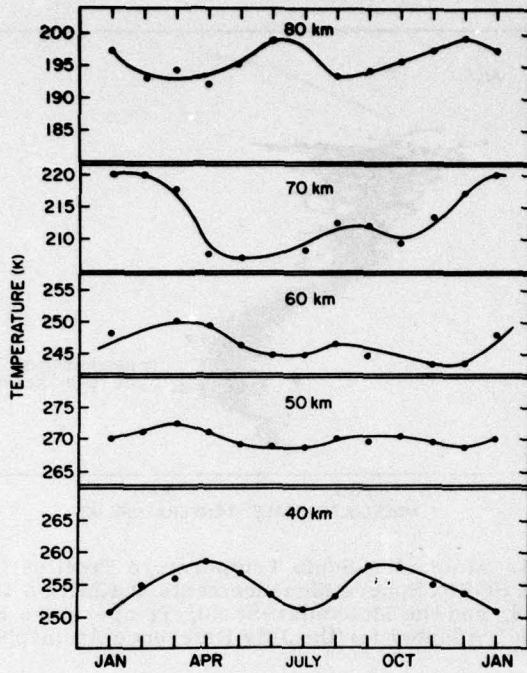


Figure 2. Annual Variation of Mean Monthly Temperatures (shown by dots) for KMR Reference Atmospheres

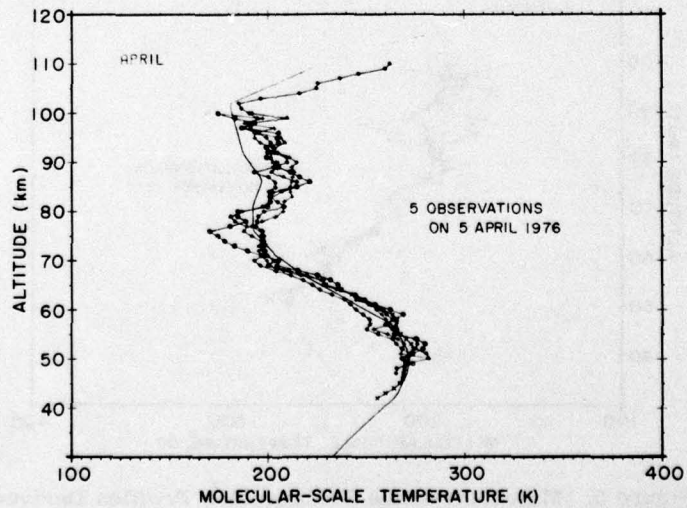


Figure 3. Molecular-Scale Temperature Profiles Derived From Five ROBIN Measurements and One Hypersonic Sphere Measurement at KMR on 5 April 1978, and the Molecular-Scale Temperature Profile (solid line) Adopted for the April Reference Atmosphere

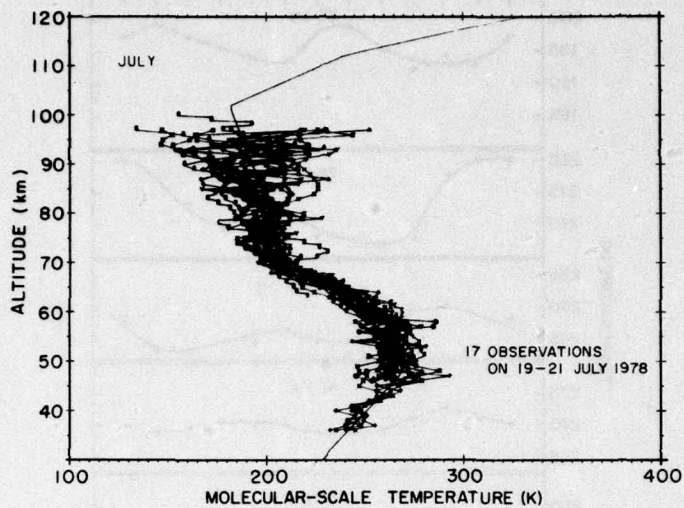


Figure 4. Molecular-Scale Temperature Profiles Derived From 17 ROBIN Sphere Measurements at KMR on 19-21 July 1978, and the Molecular-Scale Temperature Profile (solid line) Adopted for the July Reference Atmosphere

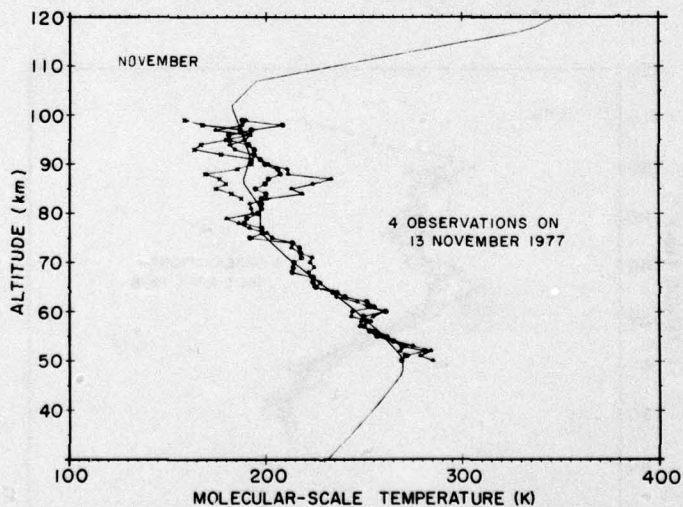


Figure 5. Molecular-Scale Temperature Profiles Derived From Four ROBIN Sphere Measurements at KMR on 13 November 1977, and the Molecular-Scale Temperature Profile (solid line) for the November Reference Atmosphere

observations considered in the preparation of the models above 60 km are plotted in Figure 6 around the molecular-scale temperature profile of the mean annual model for KMR.

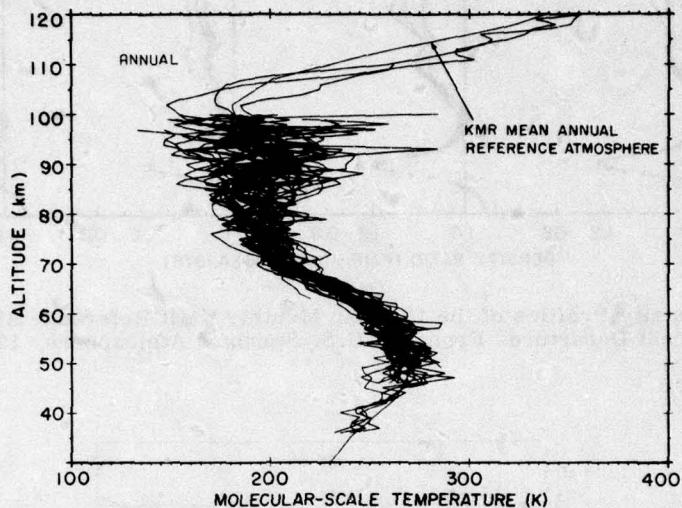


Figure 6. Molecular-Scale Temperature Profiles Derived From 35 ROBIN, 2 AFGL Sphere Measurements, and 1 Hypersonic Sphere Measurement at KMR, and the Molecular-Scale Temperature Profile Adopted for the Mean Annual Reference Atmosphere for KMR

4. COMPARISON OF OBSERVED AND MODEL DENSITIES

Density profiles, computed as outlined in Section 2 from the adopted mean monthly temperature profiles for the Kwajalein Reference Atmospheres, are compared to the densities in the U.S. Standard Atmosphere, 1976 in Figure 7. Variations in the monthly means below 30 km are too small to show in this figure. The observed mean monthly values of density at specific altitudes between 50 and 85 km are shown with the models in Figure 8. Above 60 km, many of the mean monthly values are based on only one or two observations. Densities derived from pressure-gage and grenade experiments conducted at Ascension and Natal are also included in Figure 8. The dispersion of the Ascension and Natal observations around the Kwajalein models is similar to that shown by the monthly means based on data derived from 35 ROBIN inflatable spheres, 3 AFGL accelerometer spheres, and 3 hypersonic solid spheres that were launched at Kwajalein.

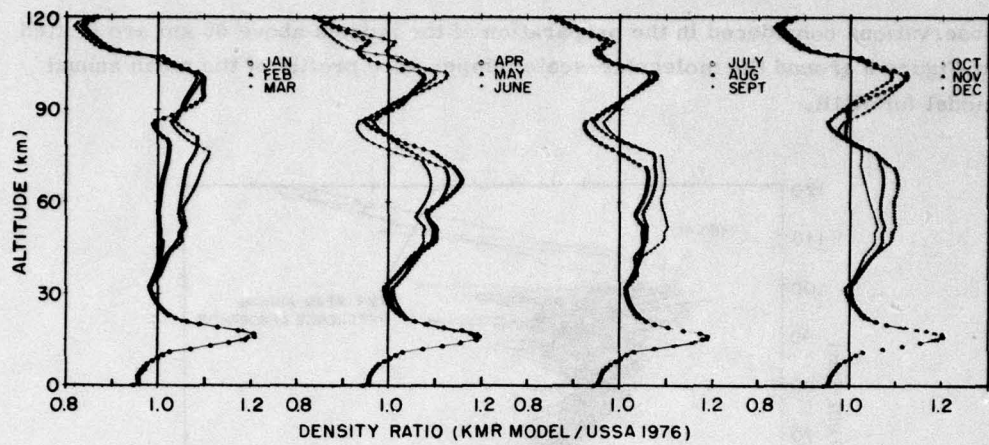


Figure 7. Density Profiles of the 12 Mean Monthly KMR Reference Atmospheres Given as Percent Departures From the U. S. Standard Atmosphere, 1976

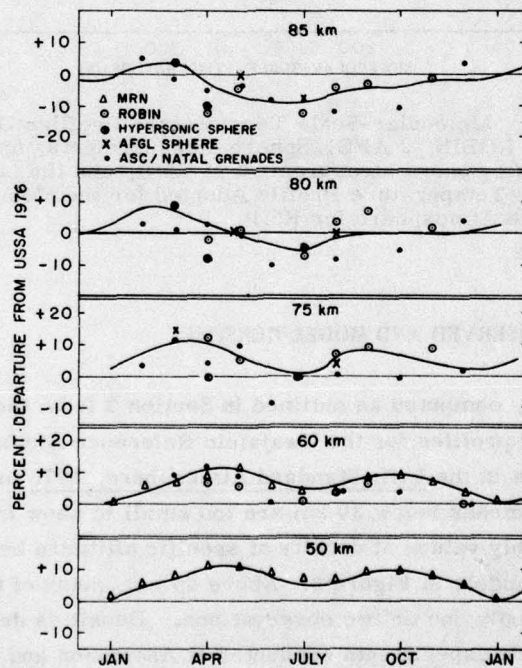


Figure 8. Curves of the Annual Variations of the KMR Reference Atmospheres and Observed Mean Monthly Densities

Individual density profiles derived from ROBIN inflatable-sphere measurements for altitudes between 60 and 100 km are compared to the mean monthly vertical density profiles for the April, July, and November reference atmospheres in Figures 9, 10, and 11, respectively. Mean monthly density profiles and two standard deviations based on MRN observations are shown in Figures 9 and 11 (April and November) for altitudes between 30 and 60 km. The individual ROBIN sphere density profiles provide an indication of the magnitude of the day-to-day variations around the mean monthly density profiles at altitudes between 60 and 100 km. However, the 17 ROBIN observations shown for July were all taken during a 3-day period, and the 5 observations for April as well as the 4 for November were taken within a 6-hour period on 1 day in April and 1 day in November. Consequently, the available ROBIN data, which are limited in most cases to scattered observations taken to support reentry tests, do not provide as good a basis for estimating the overall distribution of density between 60 and 100 km as the 8 years of routine KMR MRN observations do for altitudes 30 to 60 km.

Although there are relatively few density observations for altitudes above 60 km, the overall consistency of the observations with the model is acceptable. In order to allow for a smooth transition between the different sets of experimental

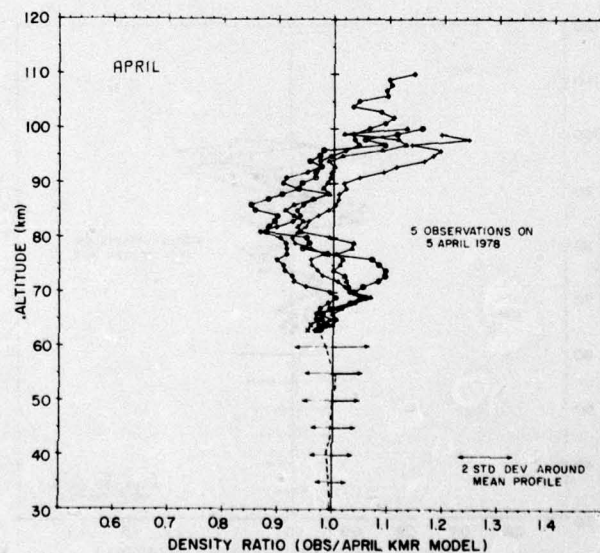


Figure 9. Density Profiles Derived From Five ROBIN Measurements and One Hypersonic Sphere Measurement at KMR on 5 April 1978, Plotted as Percent Departures From the Densities in the KMR Reference Atmosphere for April

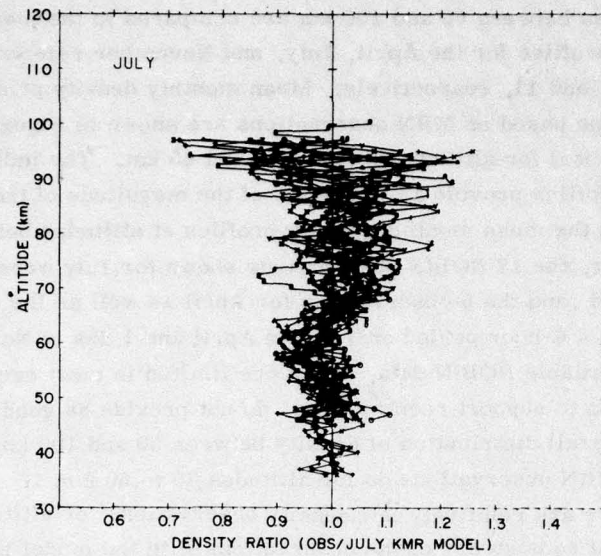


Figure 10. Density Profiles Derived From 17 ROBIN Sphere Measurements at KMR on 19-21 July 1978, Plotted as Percent Departures From the Densities in the KMR Reference Atmosphere for July

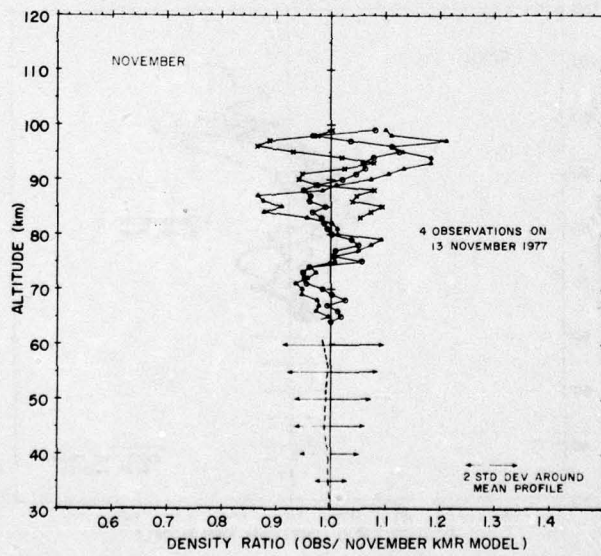


Figure 11. Density Profiles Derived From Four ROBIN Sphere Measurements at KMR on 13 November 1977, Plotted as Percent Departures From the Densities in the KMR Reference Atmosphere for November

data near 70 km, the ROBIN sphere observations, which have some experimental drag uncertainties in that altitude region, were not weighted as heavily as at other altitudes. As a result, some of the ROBIN data deviate from the model that is fitted to observations taken over the entire range of altitudes, surface to 120 km. The 35 ROBIN density profiles considered in the preparation of these models are plotted in Figure 12 as percent departure from the mean annual KMR Reference Atmosphere. From this figure it is possible to obtain the range of observed densities at all altitudes between 60 and 100 km. The portions of the profiles that extend above 100 km are from the AFGL spheres and the hypersonic solid spheres.

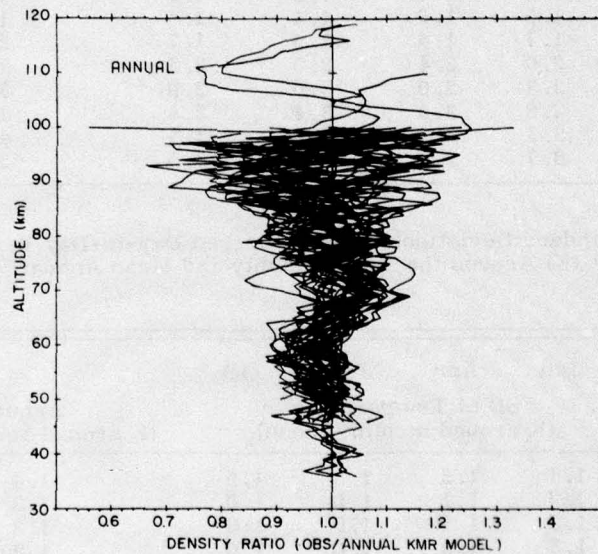


Figure 12. Density Profiles Derived From 35 ROBIN, 2 AFGL Measurements, and 1 Hypersonic Sphere Measurement, Plotted as Percent Departures From the Densities in the Mean Annual Reference Atmosphere for KMR

5. DAY-TO-DAY VARIABILITY

Sufficient radiosonde^{2, 5} and MRN observations⁶ are available for obtaining reasonably accurate estimates of the standard deviations of day-to-day variations in temperature and density around their monthly and annual means (Tables 4 and 5) for altitudes up to 60 km. The observed standard deviations include the

Table 4. Standard Deviations of the Observed Day-to-Day Variations in Density Around the Mean Monthly and Mean Annual Values at Kwajalein

Altitude (km)	Jan	Apr	July	Oct	Annual
	SD of Density (% of monthly mean)				(% of annual mean)
0	0.42	0.42	0.53	0.52	0.60
2	0.52	0.36	0.35	0.33	0.51
4	0.40	0.33	0.32	0.29	0.48
6	0.45	0.35	0.34	0.31	0.51
8	0.45	0.41	0.39	0.34	0.52
10	0.42	0.39	0.39	0.45	0.52
12	0.37	0.41	0.37	0.43	0.57
14	0.46	0.55	0.59	0.59	0.70
16	1.2	0.92	1.2	1.2	1.4
18	2.5	1.7	1.5	1.7	2.8
20	1.5	1.4	1.3	1.3	1.4
25	1.4	1.4	1.2	1.3	1.5
30	1.5	1.6	1.4	1.5	1.8
35	1.7	1.4	1.5	1.7	2.8
40	2.0	2.4	2.0	2.2	3.0
45	2.3	2.0	3.0	2.6	3.2
50	2.8	2.5	3.4	2.6	3.9
55	3.3	2.3	3.6	3.5	4.8
60	3.7	2.7	4.3	3.5	5.2

Table 5. Standard Deviations of the Observed Day-to-Day Variations in Temperature (K) Around the Mean Monthly and Mean Annual Values at Kwajalein

Altitude (km)	Jan	Apr	July	Oct	Annual
	SD of Temperature (K around monthly mean)				(K around annual mean)
Surface	1.1	1.2	1.5	1.5	1.4
2	1.7	1.1	1.0	1.0	1.2
4	1.3	1.1	1.0	1.0	1.2
6	1.3	1.0	1.0	1.0	1.2
8	1.4	1.3	1.1	1.1	1.3
10	1.6	1.3	1.3	1.4	1.5
12	1.7	1.4	1.4	1.5	1.6
14	1.8	1.7	1.5	1.5	1.7
16	1.7	1.6	1.5	1.8	1.9
18	3.5	2.4	2.2	2.4	4.6
20	2.2	2.1	2.1	2.8	2.9
25	3.0	2.8	2.1	2.7	2.6
30	3.0	3.2	3.5	3.0	2.7
35	3.6	3.3	4.1	3.7	4.0
40	4.2	3.9	3.4	3.5	5.4
45	4.5	3.7	4.4	4.3	5.4
50	6.4	3.7	4.9	4.4	5.3
55	4.3	4.3	6.7	4.1	6.0
60	5.8	6.9	6.1	6.1	7.3

root-mean-square (rms) instrumentation errors (σ_E) as well as the climatic variations (σ_A). Consequently, the observed rms variations (σ_O) are somewhat larger than the actual climatic variations, as can be seen from Eq. (12) in which independence is assumed:

$$\sigma_O = \sqrt{\sigma_A^2 + \sigma_E^2} . \quad (12)$$

The monthly temperature and density distributions in the tropics are nearly normal at the altitudes shown in the tables. Consequently, a reasonably accurate estimate of the distributions of temperature and density can be obtained from the standard deviations given in Tables 4 and 5.

The number of available observations decreases rapidly with altitude above 60 km. As a result, there are insufficient observations between 60 and 120 km at most tropical locations on which to base standard deviations of the day-to-day variations in density and temperature around monthly means. Consequently, a mean annual density profile and standard deviations of density due to day-to-day variations around the annual mean values at Kwajalein are given in Figure 13 for altitudes up to 90 km. The large variation in the magnitude of the standard deviation near 16 and 18 km coincides with the height of the tropopause. It is believed that day-to-day variations in its height account for the relatively large variability in density at these levels. The standard deviations of density for altitudes above 60 km are based on the 35 ROBIN sphere observations that were all weighted equally regardless of time of year.

Standard deviations of the day-to-day variations of density around the annual means for altitudes above 60 km at KMR are given in Table 6 along with values for Ascension/Natal. The Ascension/Natal values are based on 33 grenade and pressure-gage measurements scattered unevenly over an 11 month period, with 8 the largest number obtained in a single month. At Kwajalein, standard deviations of density around the annual mean for altitudes above 60 km were computed from the 35 ROBIN observations that were scattered over 6 months.

In Table 7, standard deviations of density are given for Kourou and Kwajalein around 3-day means for altitudes between 60 and 90 km. The values for Kourou are based on 13 grenade observations taken at nearly equally spaced time intervals during the period 19 to 22 September 1971. The standard deviations of density given for Kwajalein are based on 17 ROBIN observations taken at nearly equally spaced intervals of time during the period 19 to 21 July 1978. Consequently, diurnal variability is included in both sets of data.

Table 6. Standard Deviations of the Observed Day-to-Day Variations of Density Around the Annual Means at Altitudes of 60 to 90 km

Altitude (km)	Ascension/Natal			Kwajalein		
	Ann. Density (kg/m ³)	SD (%)	No. Obs.	Ann. Density (kg/m ³)	SD (%)	No. Obs.
60	3.24-4	4.8	33	3.18-4	3.6	35
65	1.72-4	4.7	33	1.76-4	3.7	35
70	8.74-5	6.4	32	9.25-5	4.1	35
75	4.10-5	8.6	31	4.28-5	7.1	35
80	1.78-5	7.8	30	1.82-5	7.1	35
85	7.72-6	10.2	30	7.87-6	7.7	35
90	3.45-6	12.3	29	3.31-6	10.1	30

Table 7. Standard Deviations of Density Around 3-Day Means From a Series of Density Measurements at Kourou (5°N) on 19-22 September 1976 and at Kwajalein (9°N) on 19-21 July 1978

Altitude (km)	Kourou		Kwajalein	
	SD (%)	No. Obs.	SD (%)	No. Obs.
60	2.7	13	3.5	17
65	2.2	13	2.9	17
70	3.3	13	3.9	17
75	5.5	13	3.9	17
80	8.8	13	4.7	17
85	10.5	12	6.0	17
90	8.5	12	9.0	17

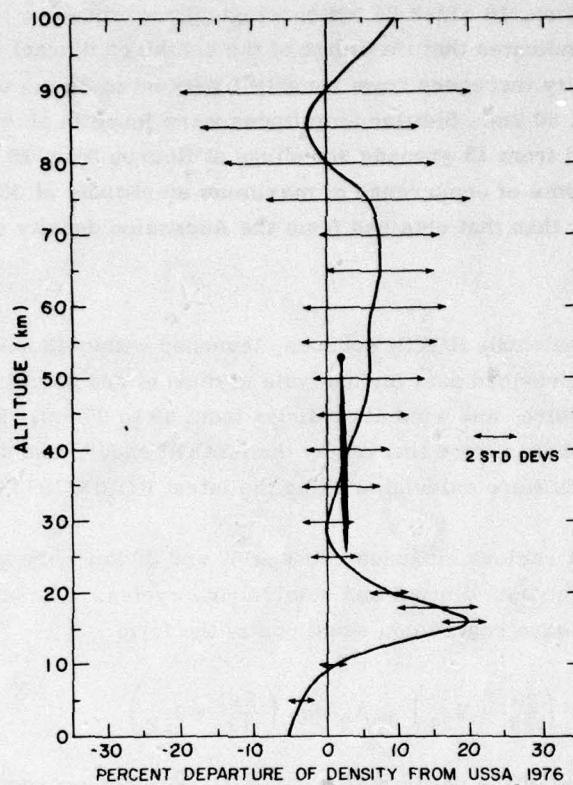


Figure 13. Density Profile of the Mean Annual KMR Reference Atmosphere Plotted as Percent Departure From the U. S. Standard Atmosphere, 1976, With Two Standard Deviations of the Day-to-Day Variations Around the Mean Annual Profile Shown by Horizontal Arrows

6. DIURNAL VARIABILITY

6.1 Surface to 60 km

Studies based on radiosonde observations taken at KMR¹² have shown that there are no significant diurnal variations in density for altitudes up to 30 km. However, an analysis of observations¹³ obtained from a diurnal experiment

12. Crowley, J. D., and Sandlin, J. R. (1964) A Summary of Kwajalein Atoll Upper Atmosphere Measurements and Techniques, MIT Lincoln Laboratory Project Report No. PPP-17 (Project Press).
13. Cole, A. E., and Kantor, A. J. (1975) Tropical Atmospheres, 0 to 90 km, AFCRL-TR-75-0527, AD A019 940.

conducted at Ascension, in which 24 meteorological rockets were launched within a 48-hour period, indicates that the range of the combined diurnal and semidiurnal oscillations in density increases from roughly 1 percent at 30 km to 7 or 8 percent of the daily mean at 50 km. Similar amplitudes were found in an analysis¹⁴ of density data derived from 13 grenade soundings at Kourou from 19 to 22 September 1971. The phase (time of occurrence of maximum amplitude) at 50 km, however, was 3 hours earlier than that obtained from the Ascension density data.

6.2 Sixty to 90 km

Seventeen high-altitude ROBIN spheres, launched within 48 hours on 19 to 21 July 1978 at KMR, provided data for analysis of diurnal and semidiurnal variations of density, temperature, and wind at altitudes from 60 to 90 km. Most of the ROBIN inflatable spheres were tracked by the ALCOR radar, and densities, temperatures, and winds were calculated using the latest ROBIN 1977 computer reduction program.

Observations at various altitudes between 60 and 90 km were subjected to harmonic analysis for both diurnal and semidiurnal cycles. The analysis, which smoothed the data, gave regression equations of the form

$$Y_t = \bar{Y} + A_1 \sin \left(\frac{2\pi t}{24} + \phi_{24} \right) + A_2 \sin \left(\frac{2\pi t}{12} + \phi_{12} \right), \quad (13)$$

where Y_t is the value of the parameter at time (t), \bar{Y} is the average of the series, t is the time in hours, and ϕ is the phase angle. The results of this analysis (Figures 14 and 15) show the amplitudes of the diurnal cycles of temperature, density, and wind as a function of altitude. The amplitude of the diurnal density oscillation generally increases in size with altitude, showing a maximum of about 3 percent at 80 to 85 km. The amplitude of the diurnal temperature oscillation is less than 4K up to at least 75 km, but it increases rapidly above 75 km to 10K near 90 km. The amplitude of the east/west wind varies from 4 to 7 meters per second (mps) between 60 and 85 km, and increases markedly at 90 km. The amplitudes of the north/south winds display a similar pattern, with the largest amplitudes occurring above 80 km. The amplitudes of the semidiurnal oscillation are generally smaller than those of the diurnal oscillation for each of the parameters.

The amplitudes and phases of the diurnal and semidiurnal tides are listed separately in Table 8 for 10-km-altitude increments, along with the percent reduction in variance that can be attributed to these tides. These percentages show that diurnal and semidiurnal tides account for less than half of the observed variance

14. Kantor, A.J., and Cole, A.E. (1979) Time and Space Variation of Density in the Tropics, AFGL-TR-79-0109, AD A074 472.

Table 8. Phases and Amplitudes of Diurnal and Semidiurnal Tides Between 60 and 90 km for Density, Temperature, and Wind

Altitude (km)	Diurnal		Semidiurnal		Reduction in Variance (%)
	Amp (%)	Phase (LST)	Amp (%)	Phase (LST)	
DENSITY (%)					
60	0.3	20.0	1.8	5.8	29
70	2.7	17.7	1.2	2.6	65
80	3.0	16.7	1.7	3.0	55
90	2.7	9.5	2.6	3.9	17
Altitude (km)	Diurnal		Semidiurnal		Reduction in Variance (%)
	Amp ($^{\circ}$ K)	Phase (LST)	Amp ($^{\circ}$ K)	Phase (LST)	
TEMPERATURE ($^{\circ}$ K)					
60	2.9	15.3	3.2	1.0	41
70	1.8	10.1	0.9	1.7	18
80	4.5	4.7	1.2	2.7	26
90	10.9	2.9	8.0	2.3	54
Altitude (km)	Diurnal		Semidiurnal		Reduction in Variance (%)
	Amp (m/sec)	Phase (LST)	Amp (m/sec)	Phase (LST)	
ZONAL WIND (M/SEC)					
60	7.4	17.4	0.2	5.0	41
70	3.7	0.6	4.3	9.9	29
80	4.7	19.1	2.7	10.1	15
90	17.2	4.9	5.5	7.7	28
Altitude (km)	Diurnal		Semidiurnal		Reduction in Variance (%)
	Amp (m/sec)	Phase (LST)	Amp (m/sec)	Phase (LST)	
MERIDIONAL WIND (M/SEC)					
60	1.0	8.2	2.0	10.0	2
70	3.8	10.8	4.0	8.7	20
80	7.5	18.3	2.6	8.5	10
90	11.1	15.2	9.2	1.5	39

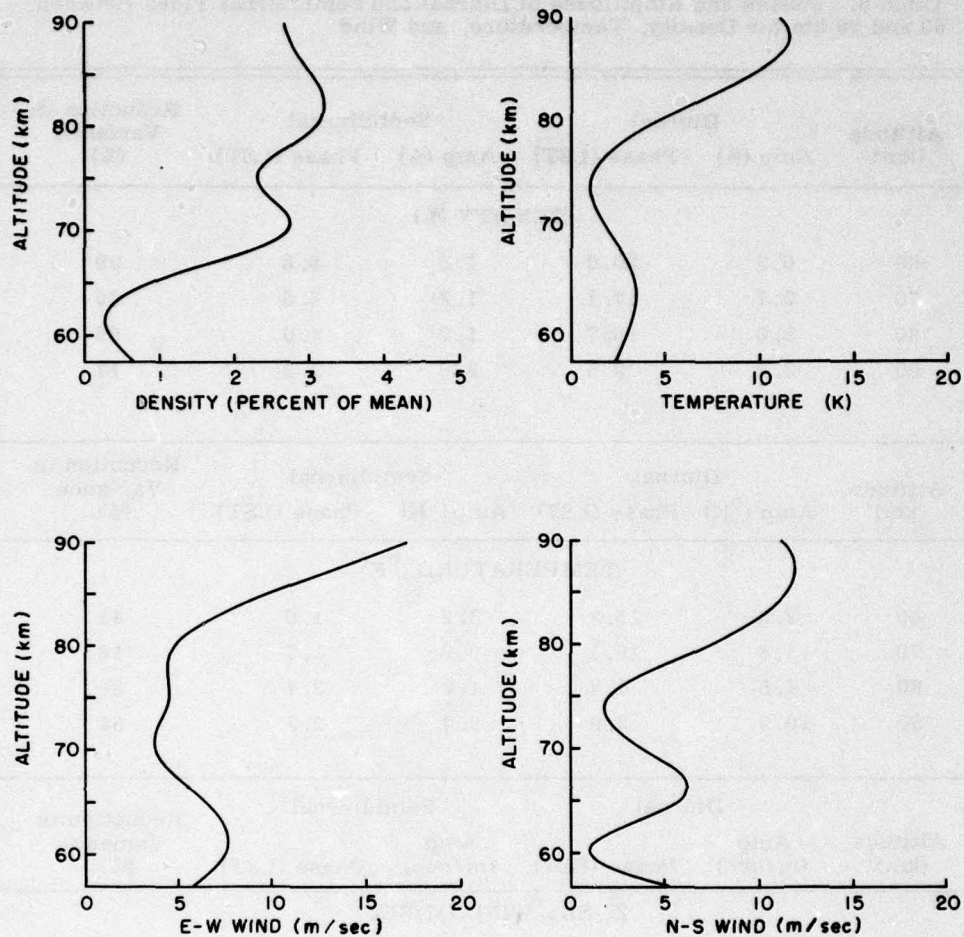


Figure 14. Amplitude of the Diurnal Oscillations in Density, Temperature, and Wind at Altitudes of 60 to 90 km

at most altitudes between 60 and 90 km. This indicates that other phenomena such as turbulence, gravity waves, and observational errors must contribute a major portion of the observed variations.

The amplitudes of the observed diurnal and semidiurnal tides between 60 and 90 km are in rough agreement with Lindzen's theoretical models,¹⁵ but the phases are considerably different.

15. Lindzen, R.S. (1967) Thermally driven diurnal tides in the atmosphere, Quart. J. Roy. Meteorol. Soc. 93:18-42.

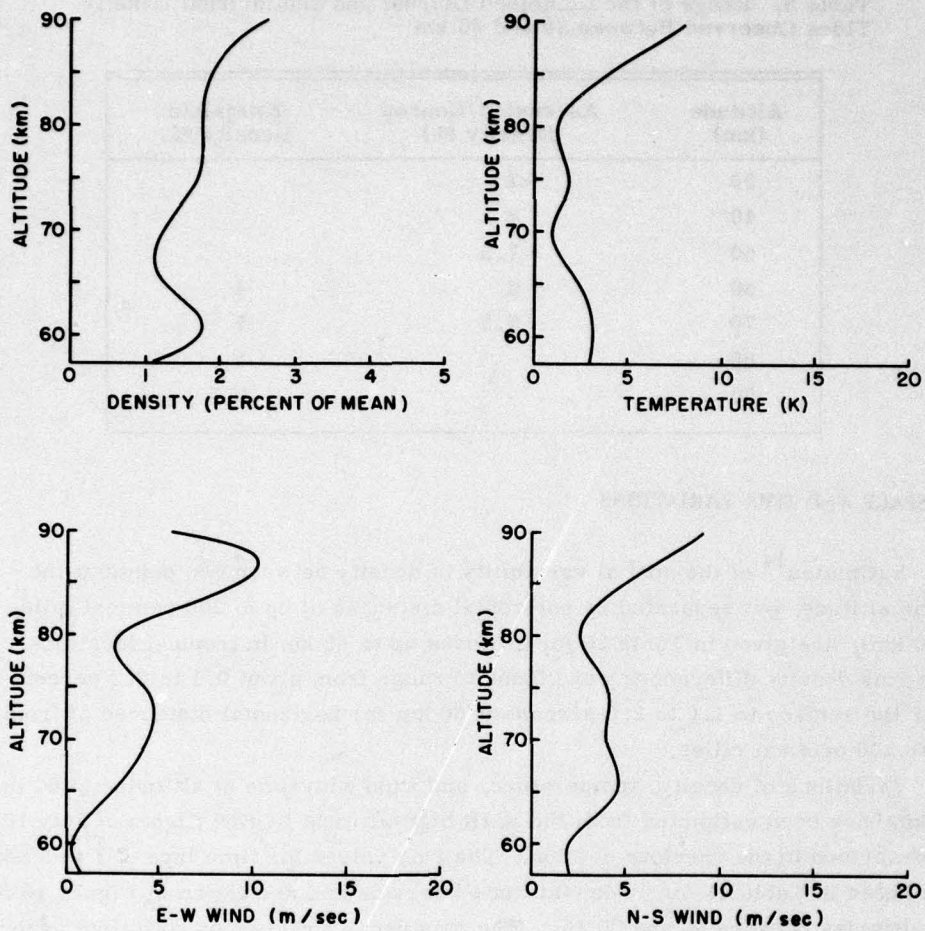


Figure 15. Amplitude of the Semidiurnal Oscillations in Density, Temperature, and Wind at Altitudes of 60 to 90 km

6.3 Magnitude of Density Variations

Table 9 shows the combined magnitude of the diurnal and semidiurnal density tides for altitudes from 30 to 90 km. The two sets of values, determined using two different sensors at different tropical locations, are consistent throughout and are in good agreement at the overlapping altitude, 60 km.

Table 9. Range of the Combined Diurnal and Semidiurnal Density Tides Observed Between 30 and 90 km

Altitude (km)	Ascension/Kourou Density (%)	Kwajalein Density (%)
30	<2	
40	2	
50	7.5	
60	6	4
70	7.5	7
80		8
90		8.5

7. SPACE AND TIME VARIATIONS

Estimates¹⁴ of the spatial variability of density between two points at the same altitude, but separated by horizontal distances of up to 200 nautical miles (370 km), are given in Table 10 for altitudes up to 60 km in tropical locations. The rms density differences were found to range from about 0.1 to 0.2 percent near the surface to 1.0 to 2.0 percent at 60 km for horizontal distances of from 50 to 200 nautical miles.

Variations of density, temperature, and wind with time at altitudes of 60 to 90 km have been estimated from the KMR high-altitude ROBIN flights of July 1978, as described in the previous section. The rms values for time lags of 1 to 6 hours are listed in Table 11 for 10-km-altitude intervals and are shown in Figure 16 for all altitudes between 60 and 90 km. The rms density variations with time generally increase with altitude, whereas the rms temperature differences appear to be smallest near 70 km. The variations in the first hour are relatively large, since the rms observation errors (shown for density in Figure 16) account for most of the observed 1-hour variability.

Estimated rms variations of density for time lags 1, 2, 4, and 6 hours are also shown in Table 11 for altitudes of 10 to 60 km. Although values from 30 to 60 km are from MRN observations taken at Ascension, the two sets of densities are consistent for all time lags and are in good agreement at the 60-km overlap.

The estimated rms observational errors for density (the first column of Table 11) are based on a graphical analysis¹³ of the time variations of density shown in Table 11 and the assumption that at time zero the rms variability should be zero. The extrapolated rms variability at zero lag was considered to be the observational error.

Table 10. Estimated rms Differences (percent of mean) Between Densities at Locations 50, 100, and 200 Nautical Miles Apart During the Midseason Months

Altitude (km)	January			April			July			October		
	50 (n miles)	100	200	50 (n miles)	100	200	50 (n miles)	100	200	50 (n miles)	100	200
10	0.10	0.13	0.18	0.10	0.13	0.18	0.10	0.13	0.18	0.10	0.13	0.18
15	0.13	0.17	0.25	0.11	0.14	0.21	0.16	0.20	0.30	0.16	0.20	0.30
18	0.50	0.61	1.00	0.34	0.42	0.68	0.30	0.37	0.60	0.34	0.42	0.68
20	0.28	0.34	0.56	0.28	0.34	0.56	0.24	0.29	0.48	0.24	0.29	0.48
25	0.28	0.34	0.56	0.28	0.34	0.56	0.24	0.29	0.48	0.26	0.32	0.52
30	0.30	0.37	0.60	0.30	0.37	0.60	0.28	0.34	0.56	0.30	0.37	0.60
35	0.34	0.42	0.68	0.30	0.37	0.60	0.30	0.37	0.60	0.36	0.44	0.72
40	0.40	0.49	0.80	0.44	0.54	0.88	0.48	0.59	0.96	0.44	0.54	0.88
45	0.46	0.56	0.92	0.40	0.49	0.80	0.60	0.73	1.20	0.52	0.64	1.04
50	0.56	0.69	1.12	0.54	0.66	1.08	0.72	0.88	1.44	0.54	0.66	1.08
55	0.66	0.81	1.32	0.56	0.69	1.12	0.84	1.03	1.68	0.78	0.96	1.56
60	0.84	1.03	1.68	0.66	0.81	1.32	1.00	1.22	2.00	0.82	1.00	1.64

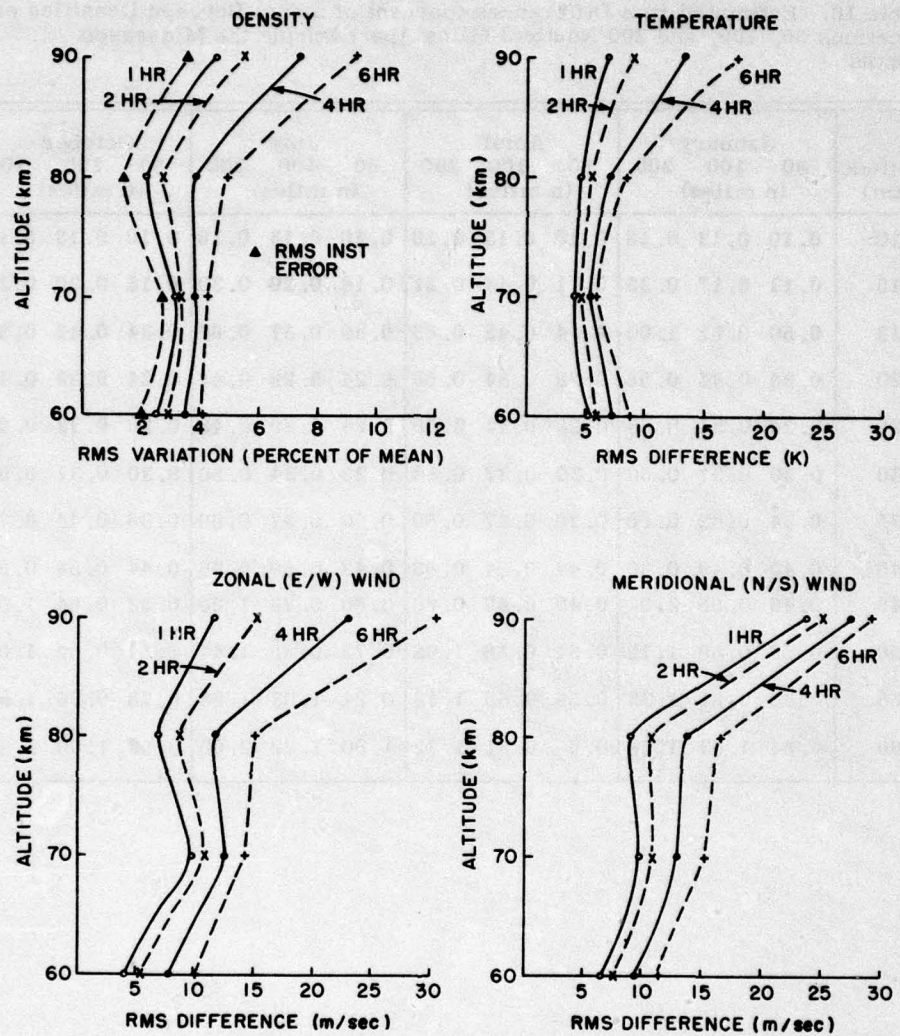


Figure 16. The rms Variations in Density, Temperature, and Wind for Time Lags of 1 to 6 Hours

Table 11. The rms Variations in Density, Temperature, and Wind With Time. Density values for altitudes 30 to 60 km are based on MRN observations at Ascension

Altitude (km)	Est rms Obs Error	Time (hrs)					
		1	2	3	4	5	6
DENSITY (%)							
10	0.2	0.2	0.2		<1.0		<1.0
20	0.3	0.6	0.8		1.0		1.2
30	0.5	0.7	1.0		1.4		1.8
40	1.0	1.1	1.2		1.6		2.0
50	1.6	1.7	1.8		3.0		4.4
60	1.9/2.0	2.0/2.5	2.2/2.9	3.2	3.2/3.5	3.8	4.0/4.1
70	2.7	3.2	3.4	3.6	3.9	4.1	4.3
80	1.5	2.2	2.8	3.3	3.9	4.4	5.0
90	3.5	4.6	5.6	6.5	7.5	8.4	9.4
Altitude (km)	Time (hrs)						
	1	2	3	4	5	6	
TEMPERATURE (°K)							
60		5.3	6.0	6.7	7.4	8.1	8.8
70		4.3	4.6	4.8	5.1	5.4	5.7
80		4.9	5.6	6.3	7.1	7.8	8.5
90		6.9	9.1	11.2	13.4	15.5	17.7
Altitude (km)	Time (hrs)						
	1	2	3	4	5	6	
ZONAL WIND (m/sec)							
60		4.1	5.4	6.7	7.9	9.2	10.5
70		9.8	10.7	11.6	12.5	13.4	14.3
80		6.9	8.6	10.2	11.9	13.5	15.1
90		11.6	15.4	19.2	23.0	26.7	30.5
Altitude (km)	Time (hrs)						
	1	2	3	4	5	6	
MERIDIONAL WIND (m/sec)							
60		6.8	7.7	8.6	9.6	10.5	11.5
70		9.9	11.0	12.1	13.2	14.3	15.4
80		9.2	10.7	12.2	13.7	15.2	16.6
90		23.6	25.0	26.4	27.7	29.1	30.5

8. TABLES OF THE MONTHLY AND ANNUAL KWAJALEIN REFERENCE ATMOSPHERES

Temperature, * pressure, density, acceleration of gravity, sound speed, and dynamic viscosity in Table 12 are given in metric units for altitudes up to 120 km. The single-digit numbers, preceded by a plus or minus sign, following the initial entry of each block indicates the power often by which that entry and each succeeding entry of that block should be multiplied. A change of power occurring within a block is indicated by a similar notation.

* Temperatures given for altitudes up to 10 km are mean virtual temperatures; the remainder are molecular-scale, temperatures. Molecular-scale temperatures and relative humidities for altitudes between the surface and 10 km are given in Table 1, which was discussed in Section 3.

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres

JAN REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M ³	ACCEL DUE TO GRAVITY M/SEC ²	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M ²	
0.000	303.38	1.0099	1.1595	+ 0	9.7816	349.17	1.8620
1.000	294.65	0.9801	1.0864	+ 2	9.7785	344.23	1.8215
2.000	285.91	0.9504	1.0133	- 1	9.7754	339.29	1.7810
3.000	277.18	0.9207	0.9402		9.7723	334.35	1.7405
4.000	268.44	0.8910	0.8671		9.7692	329.41	1.7000
5.000	259.70	0.8613	0.7940		9.7661	324.47	1.6595
6.000	250.96	0.8316	0.7209		9.7630	319.53	1.6190
7.000	242.22	0.8019	0.6478		9.7599	314.59	1.5785
8.000	233.48	0.7722	0.5747		9.7568	309.65	1.5380
9.000	224.74	0.7425	0.5016		9.7537	304.71	1.4975
10.000	216.00	0.7128	0.4285	+ 2	9.7507	311.17	1.5520
11.000	207.26	0.6831	0.3554	- 1	9.7476	306.02	1.5105
12.000	198.52	0.6534	0.2823		9.7445	300.87	1.4690
13.000	189.78	0.6237	0.2092		9.7414	295.72	1.4275
14.000	181.04	0.5940	0.1361		9.7383	290.57	1.3860
15.000	172.30	0.5643	0.0630		9.7352	285.42	1.3445
16.000	163.56	0.5346	0.0000	+ 1	9.7321	280.27	1.3030
17.000	154.82	0.5049	1.7496		9.7290	275.12	1.2615
18.000	146.08	0.4752	1.4991		9.7259	270.00	1.2200
19.000	137.34	0.4455	1.2486		9.7228	264.85	1.1785
20.000	128.60	0.4158	0.9981	+ 1	9.7197	259.70	1.1370
21.000	119.86	0.3861	0.7476	- 2	9.7166	254.55	1.0955
22.000	111.12	0.3564	0.4971		9.7135	249.40	1.0540
23.000	102.38	0.3267	0.2466		9.7104	244.25	1.0125
24.000	93.64	0.2970	0.0000		9.7073	239.10	0.9710
25.000	84.90	0.2673	0.0000		9.7042	233.95	0.9295
26.000	76.16	0.2376	0.0000		9.7011	228.80	0.8880
27.000	67.42	0.2079	0.0000		9.6980	223.65	0.8465
28.000	58.68	0.1782	0.0000		9.6949	218.50	0.8050
29.000	49.94	0.1485	0.0000		9.6918	213.35	0.7635
30.000	41.20	0.1188	0.0000	+ 1	9.6887	208.20	0.7220
31.000	32.46	0.0891	0.0000	+ 0	9.6856	203.05	0.6805
32.000	23.72	0.0594	0.0000		9.6825	197.90	0.6390
33.000	14.98	0.0297	0.0000		9.6794	192.75	0.5975
34.000	6.24	0.0000	0.0000	- 3	9.6763	187.60	0.5560
35.000	-2.50	0.0000	0.0000		9.6732	182.45	0.5145
36.000	-11.26	0.0000	0.0000		9.6701	177.30	0.4730
37.000	-20.02	0.0000	0.0000		9.6670	172.15	0.4315
38.000	-28.78	0.0000	0.0000		9.6639	167.00	0.3900
39.000	-37.54	0.0000	0.0000		9.6608	161.85	0.3485
40.000	-46.30	0.0000	0.0000	+ 0	9.6577	156.70	0.3070
41.000	-55.06	0.0000	0.0000	- 3	9.6546	151.55	0.2655
42.000	-63.82	0.0000	0.0000		9.6515	146.40	0.2240
43.000	-72.58	0.0000	0.0000		9.6484	141.25	0.1825
44.000	-81.34	0.0000	0.0000		9.6453	136.10	0.1410
45.000	-90.10	0.0000	0.0000		9.6422	130.95	0.0995
46.000	-98.86	0.0000	0.0000		9.6391	125.80	0.0580
47.000	-107.62	0.0000	0.0000		9.6360	120.65	0.0165
48.000	-116.38	0.0000	0.0000	+ 1	9.6329	115.50	0.0000
49.000	-125.14	0.0000	0.0000	- 1	9.6298	110.35	0.0000
50.000	-133.90	0.0000	0.0000	- 1	9.6267	105.20	0.0000
51.000	-142.66	0.0000	0.0000	- 3	9.6236	100.05	0.0000
52.000	-151.42	0.0000	0.0000	- 3	9.6205	94.90	0.0000
53.000	-160.18	0.0000	0.0000	- 3	9.6174	89.75	0.0000
54.000	-168.94	0.0000	0.0000	- 3	9.6143	84.60	0.0000
55.000	-177.70	0.0000	0.0000	- 3	9.6112	79.45	0.0000
56.000	-186.46	0.0000	0.0000	- 3	9.6081	74.30	0.0000
57.000	-195.22	0.0000	0.0000	- 3	9.6050	69.15	0.0000
58.000	-203.98	0.0000	0.0000	- 3	9.6019	64.00	0.0000
59.000	-212.74	0.0000	0.0000	- 3	9.5988	58.85	0.0000
60.000	-221.50	0.0000	0.0000	- 3	9.5957	53.70	0.0000

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

JAN REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M**3	ACCEL DUE TO GRAVITY M/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M**2	
60.000	247.95	2.2132	3.1095	9.5989	315.67	1.5885	
61.000	245.21	1.9326	2.7455	9.5959	313.92	1.5743	
62.000	242.47	1.6699	2.4205	9.5929	312.16	1.5600	
63.000	239.73	1.4669	2.1317	9.5899	310.39	1.5457	
64.000	237.00	1.2751	1.8744	9.5869	308.61	1.5312	
65.000	234.26	1.1066	1.6457	9.5839	306.83	1.5167	
66.000	231.52	0.9588	1.4428	9.5809	305.03	1.5022	
67.000	228.76	0.8294	1.2631	9.5779	303.21	1.4874	
68.000	226.03	0.7162	1.1088	9.5749	301.26	1.4716	
69.000	222.90	0.6172	0.9647	9.5719	299.30	1.4558	
70.000	219.98	0.5310	0.8403	9.5689	297.33	1.4398	
71.000	217.05	0.4558	0.7310	9.5659	295.35	1.4238	
72.000	214.13	0.3900	0.6358	9.5629	293.36	1.4077	
73.000	211.99	0.3340	0.5589	9.5599	291.36	1.3915	
74.000	209.84	0.2852	0.4930	9.5569	289.34	1.3752	
75.000	207.70	0.2432	0.4379	9.5539	287.31	1.3588	
76.000	205.55	0.2070	0.3900	9.5509	285.28	1.3423	
77.000	203.41	0.1759	0.3485	9.5479	283.24	1.3258	
78.000	201.27	0.1492	0.3120	9.5449	281.19	1.3093	
79.000	199.13	0.1264	0.2791	9.5419	279.14	1.2928	
80.000	197.65	1.0692	1.8844	9.5391	281.83	1.3152	
81.000	197.65	0.9037	1.5930	9.5362	281.83	1.3152	
82.000	197.65	0.7639	1.3461	9.5332	281.83	1.3152	
83.000	197.65	0.6458	1.1383	9.5302	281.83	1.3152	
84.000	197.65	0.5459	0.9623	9.5273	281.83	1.3152	
85.000	197.65	0.4615	0.8133	9.5243	281.83	1.3152	
86.000	196.39	0.3901	0.6925	9.5213	281.83	1.3152	
87.000	194.45	0.3292	0.5966	9.5184	281.83	1.3152	
88.000	192.51	0.2773	0.5208	9.5154	281.83	1.3152	
89.000	190.57	0.2333	0.4651	9.5124	281.83	1.3152	
90.000	188.63	1.9590	3.0511	9.5095	281.83	1.3152	
91.000	186.69	1.6642	2.6092	9.5065	281.83	1.3152	
92.000	184.73	1.3778	2.1907	9.5035	281.83	1.3152	
93.000	182.81	1.1474	1.8066	9.5005	281.83	1.3152	
94.000	180.81	0.9566	1.4577	9.4975	281.83	1.3152	
95.000	178.81	0.7973	1.1530	9.4945	281.83	1.3152	
96.000	176.81	0.6666	0.8947	9.4915	281.83	1.3152	
97.000	174.81	0.5540	0.6826	9.4885	281.83	1.3152	
98.000	172.81	0.4618	0.5211	9.4855	281.83	1.3152	
99.000	170.81	0.3850	0.3849	9.4825	281.83	1.3152	
100.000	168.81	3.2105	6.1571	9.4795	281.83	1.3152	
101.000	166.81	2.6769	5.1337	9.4765	281.83	1.3152	
102.000	164.81	2.2321	4.2727	9.4735	281.83	1.3152	
103.000	162.81	1.8644	3.5583	9.4705	281.83	1.3152	
104.000	160.81	1.5561	2.9952	9.4675	281.83	1.3152	
105.000	158.81	1.3106	2.4054	9.4645	281.83	1.3152	
106.000	156.81	1.1030	1.9969	9.4615	281.83	1.3152	
107.000	154.81	0.9304	1.6620	9.4585	281.83	1.3152	
108.000	152.81	0.7897	1.3225	9.4555	281.83	1.3152	
109.000	150.81	0.6775	1.0856	9.4525	281.83	1.3152	
110.000	234.99	0.8647	0.6942	9.4506	281.83	1.3152	
111.000	226.48	0.7117	0.5822	9.4476	281.83	1.3152	
112.000	218.11	0.5997	0.4924	9.4446	281.83	1.3152	
113.000	209.99	0.5255	0.4219	9.4416	281.83	1.3152	
114.000	202.00	0.4544	0.3671	9.4386	281.83	1.3152	
115.000	194.22	0.3848	0.3227	9.4356	281.83	1.3152	
116.000	186.65	0.3163	0.2877	9.4326	281.83	1.3152	
117.000	179.29	0.2587	0.2530	9.4296	281.83	1.3152	
118.000	172.14	0.2118	0.2186	9.4266	281.83	1.3152	
119.000	165.19	0.1745	0.1845	9.4236	281.83	1.3152	
120.000	347.49	1.9263	1.9311	9.4217	281.83	1.3152	

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

FEB REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M ³	ACCEL DUE TO GRAVITY M/SEC ²	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M ²	
0.000	313.34	1.00956	1.15594	9.7816	340.15	1.8618	- 5
1.000	296.256	0.98833	1.08654	9.7785	344.86	1.8222	
2.000	279.172	0.96710	1.01714	9.7754	349.57	1.7826	
3.000	262.088	0.94587	0.94774	9.7722	354.28	1.7430	
4.000	245.004	0.92464	0.87834	9.7692	358.99	1.7034	
5.000	227.920	0.90341	0.80894	9.7661	363.70	1.6638	
6.000	210.836	0.88218	0.73954	9.7631	368.41	1.6242	
7.000	193.752	0.86095	0.67014	9.7600	373.12	1.5846	
8.000	176.668	0.83972	0.60074	9.7569	377.83	1.5450	
9.000	159.584	0.81849	0.53134	9.7538	382.54	1.5054	
10.000	142.500	0.79726	0.46194	9.7507	387.25	1.4658	- 5
11.000	125.416	0.77603	0.39254	9.7477	391.96	1.4262	
12.000	108.332	0.75480	0.32314	9.7446	396.67	1.3866	
13.000	91.248	0.73357	0.25374	9.7415	401.38	1.3470	
14.000	74.164	0.71234	0.18434	9.7385	406.09	1.3074	
15.000	57.080	0.69111	0.11494	9.7354	410.80	1.2678	
16.000	40.000	0.66988	0.04554	9.7324	415.51	1.2282	
17.000	22.920	0.64865	0.01614	9.7293	420.22	1.1886	
18.000	5.840	0.62742	0.0000	9.7263	424.93	1.1490	
19.000	-11.240	0.60619	0.0000	9.7232	429.64	1.1094	
20.000	-28.320	0.58496	0.0000	9.7202	434.35	1.0698	- 5
21.000	-45.400	0.56373	0.0000	9.7171	439.06	1.0302	
22.000	-62.480	0.54250	0.0000	9.7141	443.77	0.9906	
23.000	-79.560	0.52127	0.0000	9.7110	448.48	0.9510	
24.000	-96.640	0.50004	0.0000	9.7080	453.19	0.9114	
25.000	-113.720	0.47881	0.0000	9.7049	457.90	0.8718	
26.000	-130.800	0.45758	0.0000	9.7019	462.61	0.8322	
27.000	-147.880	0.43635	0.0000	9.6988	467.32	0.7926	
28.000	-164.960	0.41512	0.0000	9.6958	472.03	0.7530	
29.000	-182.040	0.39389	0.0000	9.6927	476.74	0.7134	
30.000	-199.120	0.37266	0.0000	9.6897	481.45	0.6738	- 5
31.000	-216.200	0.35143	0.0000	9.6866	486.16	0.6342	
32.000	-233.280	0.33020	0.0000	9.6836	490.87	0.5946	
33.000	-250.360	0.30897	0.0000	9.6805	495.58	0.5550	
34.000	-267.440	0.28774	0.0000	9.6775	500.29	0.5154	
35.000	-284.520	0.26651	0.0000	9.6744	505.00	0.4758	
36.000	-301.600	0.24528	0.0000	9.6714	509.71	0.4362	
37.000	-318.680	0.22405	0.0000	9.6683	514.42	0.3966	
38.000	-335.760	0.20282	0.0000	9.6653	519.13	0.3570	
39.000	-352.840	0.18159	0.0000	9.6622	523.84	0.3174	
40.000	-369.920	0.16036	0.0000	9.6592	528.55	0.2778	- 5
41.000	-387.000	0.13913	0.0000	9.6561	533.26	0.2382	
42.000	-404.080	0.11790	0.0000	9.6531	537.97	0.1986	
43.000	-421.160	0.09667	0.0000	9.6500	542.68	0.1590	
44.000	-438.240	0.07544	0.0000	9.6470	547.39	0.1194	
45.000	-455.320	0.05421	0.0000	9.6439	552.10	0.0798	
46.000	-472.400	0.03298	0.0000	9.6409	556.81	0.0402	
47.000	-489.480	0.01175	0.0000	9.6378	561.52	0.0006	
48.000	-506.560	0.00000	0.0000	9.6348	566.23	0.0000	
49.000	-523.640	0.00000	0.0000	9.6317	570.94	0.0000	
50.000	-540.720	0.00000	0.0000	9.6287	575.65	0.0000	
51.000	-557.800	0.00000	0.0000	9.6256	580.36	0.0000	
52.000	-574.880	0.00000	0.0000	9.6226	585.07	0.0000	
53.000	-591.960	0.00000	0.0000	9.6195	589.78	0.0000	
54.000	-609.040	0.00000	0.0000	9.6165	594.49	0.0000	
55.000	-626.120	0.00000	0.0000	9.6134	599.20	0.0000	
56.000	-643.200	0.00000	0.0000	9.6104	603.91	0.0000	
57.000	-660.280	0.00000	0.0000	9.6073	608.62	0.0000	
58.000	-677.360	0.00000	0.0000	9.6043	613.33	0.0000	
59.000	-694.440	0.00000	0.0000	9.6012	618.04	0.0000	
60.000	-711.520	0.00000	0.0000	9.5982	622.75	0.0000	

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

FEB REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M ³	ACCEL DUE TO GRAVITY M/SEC ²	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M ²	
60.000	248.15	2.3151	3.2501	9.8066	315.79	1.5896	
61.000	245.41	2.2218	3.2700	9.8055	314.05	1.5754	
62.000	242.67	2.1330	3.2899	9.8044	312.29	1.5611	
63.000	239.93	2.0488	3.3098	9.8033	310.52	1.5467	
64.000	237.20	1.9695	3.3297	9.8022	308.74	1.5323	
65.000	234.46	1.8952	3.3496	9.8011	306.96	1.5178	
66.000	231.72	1.8259	3.3695	9.8000	305.16	1.5033	
67.000	228.99	1.7616	3.3894	9.7989	303.35	1.4888	
68.000	226.25	1.6923	3.4093	9.7978	301.54	1.4743	
69.000	223.52	1.6280	3.4292	9.7967	299.71	1.4599	
70.000	220.79	1.5687	3.4491	9.7956	297.87	1.4454	
71.000	218.05	1.5144	3.4690	9.7945	296.03	1.4309	
72.000	215.32	1.4651	3.4889	9.7934	294.17	1.4164	
73.000	212.58	1.4208	3.5088	9.7923	292.30	1.4019	
74.000	209.85	1.3815	3.5287	9.7912	290.42	1.3874	
75.000	207.11	1.3472	3.5486	9.7901	288.54	1.3729	
76.000	204.38	1.3179	3.5685	9.7890	286.64	1.3584	
77.000	201.64	1.2936	3.5884	9.7879	284.73	1.3439	
78.000	198.91	1.2743	3.6083	9.7868	282.80	1.3294	
79.000	196.17	1.2600	3.6282	9.7857	280.86	1.3149	
80.000	193.44	1.2507	3.6481	9.7846	278.91	1.2994	
81.000	190.70	1.2464	3.6680	9.7835	276.95	1.2849	
82.000	187.97	1.2471	3.6879	9.7824	275.00	1.2704	
83.000	185.23	1.2528	3.7078	9.7813	273.03	1.2559	
84.000	182.50	1.2635	3.7277	9.7802	271.06	1.2414	
85.000	179.76	1.2792	3.7476	9.7791	269.07	1.2269	
86.000	177.03	1.3009	3.7675	9.7780	267.07	1.2124	
87.000	174.29	1.3286	3.7874	9.7769	265.06	1.1979	
88.000	171.56	1.3623	3.8073	9.7758	263.03	1.1834	
89.000	168.82	1.4030	3.8272	9.7747	260.99	1.1689	
90.000	166.09	1.4507	3.8471	9.7736	258.94	1.1544	
91.000	163.35	1.5054	3.8670	9.7725	256.88	1.1399	
92.000	160.62	1.5681	3.8869	9.7714	254.81	1.1254	
93.000	157.88	1.6388	3.9068	9.7703	252.73	1.1109	
94.000	155.15	1.7175	3.9267	9.7692	250.64	1.0964	
95.000	152.41	1.8042	3.9466	9.7681	248.54	1.0819	
96.000	149.68	1.8989	3.9665	9.7670	246.43	1.0674	
97.000	146.94	2.0016	3.9864	9.7659	244.31	1.0529	
98.000	144.21	2.1123	4.0063	9.7648	242.18	1.0384	
99.000	141.47	2.2310	4.0262	9.7637	239.05	1.0239	
100.000	138.74	2.3577	4.0461	9.7626	236.91	1.0094	
101.000	136.00	2.4924	4.0660	9.7615	234.76	9.9949	
102.000	133.27	2.6351	4.0859	9.7604	232.60	9.9804	
103.000	130.53	2.7868	4.1058	9.7593	230.43	9.9659	
104.000	127.80	2.9475	4.1257	9.7582	228.26	9.9514	
105.000	125.06	3.1172	4.1456	9.7571	226.08	9.9369	
106.000	122.33	3.2959	4.1655	9.7560	223.90	9.9224	
107.000	119.59	3.4836	4.1854	9.7549	221.71	9.9079	
108.000	116.86	3.6803	4.2053	9.7538	219.51	9.8934	
109.000	114.12	3.8860	4.2252	9.7527	217.31	9.8789	
110.000	111.39	4.1007	4.2451	9.7516	215.10	9.8644	
111.000	108.65	4.3244	4.2650	9.7505	212.89	9.8499	
112.000	105.92	4.5571	4.2849	9.7494	210.67	9.8354	
113.000	103.18	4.8088	4.3048	9.7483	208.45	9.8209	
114.000	100.45	5.0795	4.3247	9.7472	206.22	9.8064	
115.000	97.71	5.3692	4.3446	9.7461	203.99	9.7919	
116.000	94.98	5.6779	4.3645	9.7450	201.76	9.7774	
117.000	92.24	6.0056	4.3844	9.7439	199.52	9.7629	
118.000	89.51	6.3523	4.4043	9.7428	197.28	9.7484	
119.000	86.77	6.7180	4.4242	9.7417	195.04	9.7339	
120.000	84.04	7.1027	4.4441	9.7406	192.79	9.7194	

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

MAR REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE HB	DENSITY KG/M**3	ACCEL DUE TO GRAVITY M/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/H**2	
0.000	303.94	1.01307	1.1584	+ 0	9.7816	349.49	1.8646
1.000	295.94	0.98032	1.1355	- 1	9.7785	344.73	1.8539
2.000	288.94	0.94857	1.1126	- 1	9.7754	340.00	1.8432
3.000	282.94	0.91782	1.0907	- 1	9.7723	335.34	1.8325
4.000	277.94	0.88807	1.0698	- 1	9.7692	330.75	1.8218
5.000	272.94	0.85932	1.0499	- 1	9.7661	326.24	1.8111
6.000	268.94	0.83157	1.0310	- 1	9.7630	321.80	1.8004
7.000	265.94	0.80482	1.0131	- 1	9.7600	317.42	1.7897
8.000	263.94	0.77907	0.9962	- 1	9.7570	313.10	1.7790
9.000	262.94	0.75432	0.9803	- 1	9.7540	308.85	1.7683
10.000	261.94	0.73057	0.9654	- 1	9.7510	304.66	1.7576
11.000	261.03	0.70782	0.9515	- 1	9.7480	300.54	1.7469
12.000	260.08	0.68607	0.9386	- 1	9.7450	296.48	1.7362
13.000	259.13	0.66532	0.9267	- 1	9.7420	292.48	1.7255
14.000	258.18	0.64557	0.9158	- 1	9.7390	288.54	1.7148
15.000	257.23	0.62682	0.9059	- 1	9.7360	284.66	1.7041
16.000	256.28	0.60907	0.8970	- 1	9.7330	280.84	1.6934
17.000	255.33	0.59232	0.8891	- 1	9.7300	277.08	1.6827
18.000	254.38	0.57657	0.8822	- 1	9.7270	273.38	1.6720
19.000	253.43	0.56182	0.8763	- 1	9.7240	269.74	1.6613
20.000	252.48	0.54807	0.8714	- 2	9.7210	266.16	1.6506
21.000	251.53	0.53532	0.8675	- 2	9.7180	262.64	1.6400
22.000	250.58	0.52357	0.8646	- 2	9.7150	259.18	1.6293
23.000	249.63	0.51282	0.8627	- 2	9.7120	255.78	1.6186
24.000	248.68	0.50307	0.8618	- 2	9.7090	252.44	1.6079
25.000	247.73	0.49432	0.8619	- 2	9.7060	249.16	1.5972
26.000	246.78	0.48657	0.8630	- 2	9.7030	245.94	1.5865
27.000	245.83	0.47982	0.8651	- 2	9.7000	242.78	1.5758
28.000	244.88	0.47407	0.8682	- 2	9.6970	239.68	1.5651
29.000	243.93	0.46932	0.8723	- 2	9.6940	236.64	1.5544
30.000	243.98	0.46557	0.8774	- 2	9.6910	233.66	1.5437
31.000	243.03	0.46282	0.8835	- 2	9.6880	230.74	1.5330
32.000	242.08	0.46107	0.8906	- 2	9.6850	227.88	1.5223
33.000	241.13	0.46032	0.8987	- 2	9.6820	225.08	1.5116
34.000	240.18	0.46057	0.9078	- 2	9.6790	222.34	1.5009
35.000	239.23	0.46182	0.9179	- 2	9.6760	219.66	1.4902
36.000	238.28	0.46407	0.9290	- 2	9.6730	217.04	1.4795
37.000	237.33	0.46732	0.9411	- 2	9.6700	214.48	1.4688
38.000	236.38	0.47157	0.9542	- 2	9.6670	211.98	1.4581
39.000	235.43	0.47682	0.9683	- 2	9.6640	209.54	1.4474
40.000	234.48	0.48307	0.9834	- 3	9.6610	207.16	1.4367
41.000	233.53	0.49032	0.9995	- 3	9.6580	204.84	1.4260
42.000	232.58	0.49857	1.0166	- 3	9.6550	202.58	1.4153
43.000	231.63	0.50782	1.0347	- 3	9.6520	200.38	1.4046
44.000	230.68	0.51807	1.0538	- 3	9.6490	198.24	1.3939
45.000	229.73	0.52932	1.0739	- 3	9.6460	196.16	1.3832
46.000	228.78	0.54157	1.0950	- 3	9.6430	194.14	1.3725
47.000	227.83	0.55482	1.1171	- 3	9.6400	192.18	1.3618
48.000	226.88	0.56907	1.1402	- 3	9.6370	190.28	1.3511
49.000	225.93	0.58432	1.1643	- 3	9.6340	188.44	1.3404
50.000	225.98	0.60057	1.1894	- 3	9.6310	186.66	1.3297
51.000	225.03	0.61782	1.2155	- 3	9.6280	184.94	1.3190
52.000	224.08	0.63607	1.2426	- 3	9.6250	183.28	1.3083
53.000	223.13	0.65532	1.2707	- 3	9.6220	181.68	1.2976
54.000	222.18	0.67557	1.3008	- 3	9.6190	180.14	1.2869
55.000	221.23	0.69682	1.3329	- 3	9.6160	178.66	1.2762
56.000	220.28	0.71907	1.3670	- 3	9.6130	177.24	1.2655
57.000	219.33	0.74232	1.4031	- 3	9.6100	175.88	1.2548
58.000	218.38	0.76657	1.4412	- 3	9.6070	174.58	1.2441
59.000	217.43	0.79182	1.4813	- 3	9.6040	173.34	1.2334
60.000	216.48	0.81807	1.5234	- 3	9.6010	172.16	1.2227

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

MAR REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE HE	DENSITY KG/M ³	ACCEL TO GRAVITY %	SOUND SPEED M/SEC	DYNAMIC VISCOSITY SEC/M ²	
60.000	258.25	2.3630	3.2894	- 4	9.5999	1.6005	
61.000	257.83	2.2807	3.2505	- 4	9.5999	1.5938	
62.000	257.41	2.1984	3.2116	- 4	9.5999	1.5870	
63.000	256.99	2.1161	3.1727	- 4	9.5999	1.5801	
64.000	256.57	2.0338	3.1338	- 4	9.5999	1.5731	
65.000	256.15	1.9515	3.0949	- 4	9.5999	1.5660	
66.000	255.73	1.8692	3.0560	- 4	9.5999	1.4988	
67.000	255.31	1.7869	3.0171	- 4	9.5999	1.4615	
68.000	254.89	1.7046	2.9782	- 4	9.5999	1.4242	
69.000	254.47	1.6223	2.9393	- 4	9.5999	1.4464	
70.000	217.85	5.6643	9.8578	- 5	9.5685	1.4282	
71.000	218.27	4.8550	7.8837	- 5	9.5685	1.4100	
72.000	218.69	4.0457	6.0473	- 5	9.5685	1.3916	
73.000	219.11	3.2364	4.2109	- 5	9.5685	1.3731	
74.000	219.53	2.4271	2.3745	- 5	9.5685	1.3545	
75.000	219.95	1.6178	0.5381	- 5	9.5685	1.3358	
76.000	220.37	0.8085	0.0000	- 5	9.5685	1.3170	
77.000	220.79	0.0000	0.0000	- 5	9.5685	1.2982	
78.000	221.21	0.0000	0.0000	- 5	9.5685	1.2794	
79.000	221.63	0.0000	0.0000	- 5	9.5685	1.2606	
80.000	194.61	1.8989	1.0967	- 5	9.5370	1.2977	
81.000	195.03	1.7933	1.0664	- 5	9.5370	1.2933	
82.000	195.45	1.6877	1.0361	- 5	9.5370	1.2888	
83.000	195.87	1.5821	1.0058	- 5	9.5370	1.2843	
84.000	196.29	1.4765	0.9755	- 5	9.5370	1.2798	
85.000	196.71	1.3709	0.9452	- 5	9.5370	1.2753	
86.000	197.13	1.2653	0.9149	- 5	9.5370	1.2708	
87.000	197.55	1.1597	0.8846	- 5	9.5370	1.2663	
88.000	197.97	1.0541	0.8543	- 5	9.5370	1.2618	
89.000	198.39	0.9485	0.8240	- 5	9.5370	1.2573	
90.000	186.84	1.9290	3.5967	- 6	9.5095	1.2995	
91.000	187.26	1.6150	3.0238	- 6	9.5095	1.2895	
92.000	187.68	1.3010	2.4509	- 6	9.5095	1.2795	
93.000	188.10	0.9870	1.8780	- 6	9.5095	1.2695	
94.000	188.52	0.6730	1.3051	- 6	9.5095	1.2595	
95.000	188.94	0.3590	0.7322	- 6	9.5095	1.2495	
96.000	189.36	0.0450	0.1593	- 6	9.5095	1.2395	
97.000	189.78	0.0000	0.0000	- 6	9.5095	1.2295	
98.000	190.20	0.0000	0.0000	- 6	9.5095	1.2195	
99.000	190.62	0.0000	0.0000	- 6	9.5095	1.2095	
100.000	181.55	3.1961	6.1327	- 7	9.4779	1.2795	
101.000	181.97	2.6639	5.1252	- 7	9.4779	1.2695	
102.000	182.39	2.1317	4.1177	- 7	9.4779	1.2595	
103.000	182.81	1.5995	3.1102	- 7	9.4779	1.2495	
104.000	183.23	1.0673	2.1027	- 7	9.4779	1.2395	
105.000	183.65	0.5351	1.0952	- 7	9.4779	1.2295	
106.000	184.07	0.0029	0.0877	- 7	9.4779	1.2195	
107.000	184.49	0.0000	0.0000	- 7	9.4779	1.2095	
108.000	184.91	0.0000	0.0000	- 7	9.4779	1.1995	
109.000	185.33	0.0000	0.0000	- 7	9.4779	1.1895	
110.000	234.99	5.8179	8.6248	- 8	9.4506	1.2795	
111.000	235.41	5.0771	7.1173	- 8	9.4506	1.2695	
112.000	235.83	4.3363	5.6098	- 8	9.4506	1.2595	
113.000	236.25	3.5955	4.1023	- 8	9.4506	1.2495	
114.000	236.67	2.8547	2.5948	- 8	9.4506	1.2395	
115.000	237.09	2.1139	1.0873	- 8	9.4506	1.2295	
116.000	237.51	1.3731	0.0000	- 8	9.4506	1.2195	
117.000	237.93	0.6323	0.0000	- 8	9.4506	1.2095	
118.000	238.35	0.0000	0.0000	- 8	9.4506	1.1995	
119.000	238.77	0.0000	0.0000	- 8	9.4506	1.1895	
120.000	347.49	1.9189	1.9157	- 8	9.4213	1.2795	

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

APR REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE NB	DENSITY KG/H**3	ACCEL DUE TO GRAVITY M/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/H**2	
0.000	384.23	1.0188 + 3	1.1574 + 0	9.7816	349.66	1.8659 - 5	
1.000	295.58	0.8224 + 2	1.0634	9.7785	344.66	1.8259	
2.000	229.26	0.6333	0.9639 - 1	9.7754	344.94	1.7935	
3.000	229.18	0.5133	0.8716	9.7723	344.66	1.7735	
4.000	227.75	0.4533	0.8843	9.7692	344.66	1.7499	
5.000	227.75	0.4333	0.8174	9.7661	344.66	1.7199	
6.000	226.77	0.4333	0.7774	9.7630	344.66	1.6894	
7.000	226.77	0.4333	0.7774	9.7600	344.66	1.6594	
8.000	226.77	0.4333	0.7774	9.7569	344.66	1.6216	
9.000	226.77	0.4333	0.7774	9.7538	344.66	1.5832	
10.000	239.46	2.8875 + 2	4.2008 - 1	9.7507	311.21	1.5442 - 5	
11.000	231.53	2.4997	3.7612	9.7477	305.03	1.5022	
12.000	223.58	2.1532	3.3550	9.7446	299.75	1.4594	
13.000	215.63	1.8444	2.9804	9.7415	295.37	1.4160	
14.000	207.68	1.5715	2.6361	9.7385	288.94	1.3719	
15.000	199.74	1.3304	2.3204	9.7354	283.32	1.3271	
16.000	191.77	1.1215	1.9754	9.7323	281.92	1.3159	
17.000	196.28	0.9442 + 1	1.6759	9.7293	281.86	1.3074	
18.000	196.15	0.7944	1.4110	9.7262	281.76	1.3066	
19.000	200.18	0.6549	1.1651	9.7231	281.63	1.3296	
20.000	204.64	0.5633 + 1	0.9641 - 2	9.7201	281.77	1.3542 - 5	
21.000	209.10	0.4808	0.8089	9.7170	281.88	1.3792	
22.000	213.55	0.3996	0.6682	9.7140	281.95	1.4044	
23.000	218.00	0.3333	0.5396	9.7109	281.99	1.4199	
24.000	222.46	0.2833	0.4746	9.7079	281.99	1.4333	
25.000	226.92	0.2433	0.4097	9.7048	281.99	1.4455	
26.000	231.38	0.2033	0.3447	9.7018	281.99	1.4583	
27.000	235.84	0.1633	0.2797	9.6987	281.99	1.4711	
28.000	240.30	0.1233	0.2147	9.6957	281.99	1.4833	
29.000	244.76	0.0833	0.1497	9.6926	281.99	1.4965	
30.000	249.22	0.0433 + 1	0.0847 - 2	9.6896	305.89	1.5091 - 5	
31.000	253.68	0.0033 + 0	0.0197	9.6865	307.44	1.5217	
32.000	258.14	0.0033	0.0047	9.6835	311.09	1.5344	
33.000	262.60	0.0033	0.0000	9.6804	311.52	1.5467	
34.000	267.06	0.0033	0.0000	9.6774	311.05	1.5592	
35.000	271.52	0.0033	0.0000	9.6744	311.63	1.5720	
36.000	275.98	0.0033	0.0000	9.6713	311.34	1.5863	
37.000	280.44	0.0033	0.0000	9.6683	311.15	1.6006	
38.000	284.90	0.0033	0.0000	9.6653	311.89	1.6148	
39.000	289.36	0.0033	0.0000	9.6622	321.63	1.6289	
40.000	293.82	0.0033 + 0	0.0000 - 3	9.6592	322.35	1.6429 - 5	
41.000	298.28	0.0033	0.0000	9.6562	322.06	1.6569	
42.000	302.74	0.0033	0.0000	9.6531	322.77	1.6708	
43.000	307.20	0.0033	0.0000	9.6501	322.87	1.6798	
44.000	311.66	0.0033	0.0000	9.6471	322.60	1.6857	
45.000	316.12	0.0033	0.0000	9.6441	322.32	1.6916	
46.000	320.58	0.0033	0.0000	9.6411	322.04	1.6975	
47.000	325.04	0.0033	0.0000	9.6380	321.76	1.7034	
48.000	329.50	0.0033	0.0000	9.6350	321.48	1.7092	
49.000	333.96	0.0033	0.0000	9.6320	321.20	1.7150	
50.000	338.42	0.0033 - 1	0.0000 - 3	9.6290	330.10	1.7062 - 5	
51.000	342.88	0.0033	0.0000	9.6260	330.82	1.7062	
52.000	347.34	0.0033	0.0000	9.6230	331.54	1.7062	
53.000	351.80	0.0033	0.0000	9.6200	332.26	1.7062	
54.000	356.26	0.0033	0.0000	9.6170	332.98	1.7062	
55.000	360.72	0.0033	0.0000	9.6140	333.70	1.7062	
56.000	365.18	0.0033	0.0000	9.6110	334.42	1.7062	
57.000	369.64	0.0033	0.0000	9.6080	335.14	1.7062	
58.000	374.10	0.0033	0.0000	9.6050	335.86	1.7062	
59.000	378.56	0.0033	0.0000	9.6020	336.58	1.7062	
60.000	383.02	0.0033	0.0000	9.6000	337.30	1.7062	
61.000	387.48	0.0033	0.0000	9.5970	338.02	1.7062	
62.000	391.94	0.0033	0.0000	9.5940	338.74	1.7062	
63.000	396.40	0.0033	0.0000	9.5910	339.46	1.7062	
64.000	400.86	0.0033	0.0000	9.5880	340.18	1.7062	
65.000	405.32	0.0033	0.0000	9.5850	340.90	1.7062	
66.000	409.78	0.0033	0.0000	9.5820	341.62	1.7062	
67.000	414.24	0.0033	0.0000	9.5790	342.34	1.7062	
68.000	418.70	0.0033	0.0000	9.5760	343.06	1.7062	
69.000	423.16	0.0033	0.0000	9.5730	343.78	1.7062	
70.000	427.62	0.0033	0.0000	9.5700	344.50	1.7062	
71.000	432.08	0.0033	0.0000	9.5670	345.22	1.7062	
72.000	436.54	0.0033	0.0000	9.5640	345.94	1.7062	
73.000	441.00	0.0033	0.0000	9.5610	346.66	1.7062	
74.000	445.46	0.0033	0.0000	9.5580	347.38	1.7062	
75.000	449.92	0.0033	0.0000	9.5550	348.10	1.7062	
76.000	454.38	0.0033	0.0000	9.5520	348.82	1.7062	
77.000	458.84	0.0033	0.0000	9.5490	349.54	1.7062	
78.000	463.30	0.0033	0.0000	9.5460	350.26	1.7062	
79.000	467.76	0.0033	0.0000	9.5430	350.98	1.7062	
80.000	472.22	0.0033	0.0000	9.5400	351.70	1.7062	
81.000	476.68	0.0033	0.0000	9.5370	352.42	1.7062	
82.000	481.14	0.0033	0.0000	9.5340	353.14	1.7062	
83.000	485.60	0.0033	0.0000	9.5310	353.86	1.7062	
84.000	490.06	0.0033	0.0000	9.5280	354.58	1.7062	
85.000	494.52	0.0033	0.0000	9.5250	355.30	1.7062	
86.000	498.98	0.0033	0.0000	9.5220	356.02	1.7062	
87.000	503.44	0.0033	0.0000	9.5190	356.74	1.7062	
88.000	507.90	0.0033	0.0000	9.5160	357.46	1.7062	
89.000	512.36	0.0033	0.0000	9.5130	358.18	1.7062	
90.000	516.82	0.0033	0.0000	9.5100	358.90	1.7062	
91.000	521.28	0.0033	0.0000	9.5070	359.62	1.7062	
92.000	525.74	0.0033	0.0000	9.5040	360.34	1.7062	
93.000	530.20	0.0033	0.0000	9.5010	361.06	1.7062	
94.000	534.66	0.0033	0.0000	9.4980	361.78	1.7062	
95.000	539.12	0.0033	0.0000	9.4950	362.50	1.7062	
96.000	543.58	0.0033	0.0000	9.4920	363.22	1.7062	
97.000	548.04	0.0033	0.0000	9.4890	363.94	1.7062	
98.000	552.50	0.0033	0.0000	9.4860	364.66	1.7062	
99.000	556.96	0.0033	0.0000	9.4830	365.38	1.7062	
100.000	561.42	0.0033	0.0000	9.4800	366.10	1.7062	

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

APR REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE NB	DENSITY KG/M ³	ACCEL DUE TO GRAVITY M/SEC ²	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M ²	
68.000	249.84	2.4706	3.46560	9.8066	316.38	1.5942	
69.000	248.54	2.4176	3.42778	9.8066	313.08	1.5978	
70.000	247.24	2.3646	3.39000	9.8066	309.78	1.6014	
71.000	245.94	2.3116	3.35222	9.8066	306.48	1.6050	
72.000	244.64	2.2586	3.31444	9.8066	303.18	1.6086	
73.000	243.34	2.2056	3.27666	9.8066	299.88	1.6122	
74.000	242.04	2.1526	3.23888	9.8066	296.58	1.6158	
75.000	240.74	2.0996	3.20110	9.8066	293.28	1.6194	
76.000	239.44	2.0466	3.16332	9.8066	289.98	1.6230	
77.000	238.14	1.9936	3.12554	9.8066	286.68	1.6266	
78.000	236.84	1.9406	3.08776	9.8066	283.38	1.6302	
79.000	235.54	1.8876	3.05000	9.8066	280.08	1.6338	
80.000	234.24	1.8346	3.01222	9.8066	276.78	1.6374	
81.000	232.94	1.7816	2.97444	9.8066	273.48	1.6410	
82.000	231.64	1.7286	2.93666	9.8066	270.18	1.6446	
83.000	230.34	1.6756	2.89888	9.8066	266.88	1.6482	
84.000	229.04	1.6226	2.86110	9.8066	263.58	1.6518	
85.000	227.74	1.5696	2.82332	9.8066	260.28	1.6554	
86.000	226.44	1.5166	2.78554	9.8066	256.98	1.6590	
87.000	225.14	1.4636	2.74776	9.8066	253.68	1.6626	
88.000	223.84	1.4106	2.71000	9.8066	250.38	1.6662	
89.000	222.54	1.3576	2.67222	9.8066	247.08	1.6698	
90.000	221.24	1.3046	2.63444	9.8066	243.78	1.6734	
91.000	219.94	1.2516	2.59666	9.8066	240.48	1.6770	
92.000	218.64	1.1986	2.55888	9.8066	237.18	1.6806	
93.000	217.34	1.1456	2.52110	9.8066	233.88	1.6842	
94.000	216.04	1.0926	2.48332	9.8066	230.58	1.6878	
95.000	214.74	1.0396	2.44554	9.8066	227.28	1.6914	
96.000	213.44	0.9866	2.40776	9.8066	223.98	1.6950	
97.000	212.14	0.9336	2.37000	9.8066	220.68	1.6986	
98.000	210.84	0.8806	2.33222	9.8066	217.38	1.7022	
99.000	209.54	0.8276	2.29444	9.8066	214.08	1.7058	
100.000	208.24	0.7746	2.25666	9.8066	210.78	1.7094	
101.000	206.94	0.7216	2.21888	9.8066	207.48	1.7130	
102.000	205.64	0.6686	2.18110	9.8066	204.18	1.7166	
103.000	204.34	0.6156	2.14332	9.8066	200.88	1.7202	
104.000	203.04	0.5626	2.10554	9.8066	197.58	1.7238	
105.000	201.74	0.5096	2.06776	9.8066	194.28	1.7274	
106.000	200.44	0.4566	2.03000	9.8066	190.98	1.7310	
107.000	199.14	0.4036	1.99222	9.8066	187.68	1.7346	
108.000	197.84	0.3506	1.95444	9.8066	184.38	1.7382	
109.000	196.54	0.2976	1.91666	9.8066	181.08	1.7418	
110.000	195.24	0.2446	1.87888	9.8066	177.78	1.7454	
111.000	193.94	0.1916	1.84110	9.8066	174.48	1.7490	
112.000	192.64	0.1386	1.80332	9.8066	171.18	1.7526	
113.000	191.34	0.0856	1.76554	9.8066	167.88	1.7562	
114.000	190.04	0.0326	1.72776	9.8066	164.58	1.7598	
115.000	188.74	0.0000	1.69000	9.8066	161.28	1.7634	
116.000	187.44	0.0000	1.65222	9.8066	157.98	1.7670	
117.000	186.14	0.0000	1.61444	9.8066	154.68	1.7706	
118.000	184.84	0.0000	1.57666	9.8066	151.38	1.7742	
119.000	183.54	0.0000	1.53888	9.8066	148.08	1.7778	
120.000	182.24	0.0000	1.50110	9.8066	144.78	1.7814	

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

MAY REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M**3	ACCEL DUE TO GRAVITY M/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M**2	
0.000	304.44	1.01110 + 3	1.1569 + 0	9.7816	349.78	1.8669 - 5	
1.000	296.14	0.98257 + 2	1.08617 - 1	9.7785	344.98	1.8277	
2.000	289.83	0.95404	1.02283	9.7754	341.87	1.8023	
3.000	285.44	0.92551	0.96000	9.7723	338.69	1.7763	
4.000	279.59	0.89698	0.89768	9.7692	335.28	1.7478	
5.000	273.73	0.86845	0.83541	9.7661	331.67	1.7185	
6.000	267.79	0.83992	0.77283	9.7631	327.84	1.6894	
7.000	261.84	0.81139	0.71025	9.7600	323.84	1.6596	
8.000	255.73	0.78286	0.64768	9.7569	319.75	1.6293	
9.000	247.59	0.75433	0.58510	9.7538	315.43	1.5987	
10.000	240.45	0.72580	0.52252	9.7507	310.85	1.5694	
11.000	232.62	0.69727	0.46000	9.7477	305.75	1.5380	
12.000	224.77	0.66874	0.39748	9.7446	300.55	1.5059	
13.000	216.92	0.64021	0.33496	9.7415	295.26	1.4733	
14.000	209.08	0.61168	0.27244	9.7385	289.87	1.4397	
15.000	201.23	0.58315	0.21000	9.7354	284.38	1.4056	
16.000	196.97	0.55462	0.14752	9.7323	278.81	1.3711	
17.000	194.65	0.52609	0.08500	9.7293	273.14	1.3366	
18.000	196.67	0.49756	0.02252	9.7262	267.43	1.3023	
19.000	201.62	0.46903	0.00000	9.7231	261.65	1.2687	
20.000	206.58	0.44050	0.00000	9.7201	255.85	1.2357	
21.000	211.54	0.41197	0.00000	9.7170	249.98	1.2034	
22.000	214.41	0.38344	0.00000	9.7140	244.08	1.1719	
23.000	216.98	0.35491	0.00000	9.7109	238.15	1.1413	
24.000	219.56	0.32638	0.00000	9.7079	232.18	1.1114	
25.000	222.13	0.29785	0.00000	9.7048	226.18	1.0821	
26.000	224.70	0.26932	0.00000	9.7018	220.15	1.0534	
27.000	226.78	0.24079	0.00000	9.6987	214.08	1.0253	
28.000	228.76	0.21226	0.00000	9.6957	207.98	0.9977	
29.000	230.74	0.18373	0.00000	9.6926	201.85	0.9706	
30.000	232.71	0.15520	0.00000	9.6896	195.68	0.9440	
31.000	234.69	0.12667	0.00000	9.6865	189.48	0.9179	
32.000	236.67	0.09814	0.00000	9.6835	183.25	0.8923	
33.000	238.65	0.06961	0.00000	9.6804	177.00	0.8671	
34.000	240.62	0.04108	0.00000	9.6774	170.72	0.8423	
35.000	242.60	0.01255	0.00000	9.6744	164.42	0.8179	
36.000	244.58	0.00000	0.00000	9.6714	158.10	0.7939	
37.000	246.56	0.00000	0.00000	9.6684	151.75	0.7703	
38.000	248.54	0.00000	0.00000	9.6654	145.38	0.7471	
39.000	250.52	0.00000	0.00000	9.6624	138.98	0.7243	
40.000	252.50	0.00000	0.00000	9.6594	132.55	0.7019	
41.000	254.48	0.00000	0.00000	9.6564	126.10	0.6800	
42.000	256.46	0.00000	0.00000	9.6534	119.62	0.6585	
43.000	258.44	0.00000	0.00000	9.6504	113.12	0.6374	
44.000	260.42	0.00000	0.00000	9.6474	106.60	0.6167	
45.000	262.40	0.00000	0.00000	9.6444	100.05	0.5964	
46.000	264.38	0.00000	0.00000	9.6414	93.48	0.5765	
47.000	266.36	0.00000	0.00000	9.6384	86.88	0.5570	
48.000	268.34	0.00000	0.00000	9.6354	80.25	0.5379	
49.000	269.15	0.00000	0.00000	9.6324	73.58	0.5192	
50.000	269.15	0.00000	0.00000	9.6294	66.88	0.5009	
51.000	269.15	0.00000	0.00000	9.6264	60.15	0.4830	
52.000	269.15	0.00000	0.00000	9.6234	53.38	0.4655	
53.000	269.15	0.00000	0.00000	9.6204	46.58	0.4484	
54.000	269.15	0.00000	0.00000	9.6174	39.75	0.4317	
55.000	269.15	0.00000	0.00000	9.6144	32.88	0.4154	
56.000	269.15	0.00000	0.00000	9.6114	25.98	0.3994	
57.000	269.15	0.00000	0.00000	9.6084	19.05	0.3837	
58.000	269.15	0.00000	0.00000	9.6054	12.08	0.3683	
59.000	269.15	0.00000	0.00000	9.6024	5.08	0.3532	

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

MAY REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M**3	ACCEL DUE TO GRAVITY M/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M**2	
60.000	246.01	2.4267 - 1	3.4363 - 4	9.5989	314.43	1.5785 - 5	
61.000	242.18	2.1160	3.8448	9.5959	311.92	1.5581	
62.000	238.18	1.8410	2.6927	9.5929	309.49	1.5375	
63.000	234.27	1.5982	2.3766	9.5899	306.83	1.5168	
64.000	230.36	1.3842	2.0932	9.5869	304.26	1.4960	
65.000	226.45	1.1959	1.8397	9.5839	301.67	1.4750	
66.000	222.54	1.0306	1.6134	9.5809	299.05	1.4538	
67.000	218.63	0.8894 - 2	1.4117	9.5779	296.42	1.4325	
68.000	214.73	7.5952	1.2322	9.5749	293.76	1.4110	
69.000	210.82	6.4933	1.0730	9.5719	291.07	1.3894	
70.000	206.92	5.5353 - 2	9.3192 - 5	9.5689	288.37	1.3676 - 5	
71.000	203.12	4.7845	8.0687	9.5660	285.71	1.3462	
72.000	202.24	3.9914	6.8752	9.5630	285.09	1.3413	
73.000	201.36	3.3841	5.8545	9.5600	284.47	1.3363	
74.000	200.49	2.8672	4.9821	9.5570	283.85	1.3313	
75.000	199.61	2.4277	4.2369	9.5540	283.23	1.3263	
76.000	198.73	2.0542	3.6808	9.5510	282.61	1.3214	
77.000	197.86	1.7369	3.2582	9.5481	281.99	1.3164	
78.000	196.98	1.4676	2.9395	9.5451	281.36	1.3113	
79.000	196.11	1.2392	2.6814	9.5421	280.73	1.3063	
80.000	195.23	1.0456 - 2	1.8658 - 5	9.5391	280.10	1.3013 - 5	
81.000	194.35	8.8166	1.3803	9.5362	279.47	1.2963	
82.000	194.15	7.4303	1.3332	9.5332	279.04	1.2951	
83.000	194.15	6.2623	1.1237	9.5302	278.61	1.2951	
84.000	194.15	5.2781	9.4706 - 6	9.5272	278.18	1.2951	
85.000	194.15	4.4488	7.9826	9.5242	277.75	1.2951	
86.000	194.15	3.7501	6.7288	9.5212	277.32	1.2951	
87.000	194.15	3.1612	5.6722	9.5184	276.89	1.2951	
88.000	194.15	2.6650	4.7818	9.5154	276.46	1.2951	
89.000	194.15	2.2467	4.0314	9.5124	276.03	1.2951	
90.000	194.15	1.8943 - 3	3.3989 - 6	9.5095	275.60	1.2951	
91.000	194.15	1.5972	2.8658	9.5065	275.17	1.2951	
92.000	193.52	1.3465	2.4240	9.5036	274.74	1.2951	
93.000	192.16	1.1342	2.0561	9.5006	274.31	1.2951	
94.000	190.81	0.9541 - 4	1.7421	9.4976	273.88	1.2951	
95.000	189.45	8.0177	1.4743	9.4947	273.45	1.2951	
96.000	188.09	6.7292	1.2463	9.4917	273.02	1.2951	
97.000	186.74	5.6410	1.0523	9.4888	272.59	1.2951	
98.000	185.39	4.7229	8.8751 - 7	9.4858	272.16	1.2951	
99.000	184.03	3.9493	7.4766	9.4829	271.73	1.2951	
100.000	182.68	3.2483 - 4	6.2898 - 7	9.4799	271.30	1.2951	
101.000	181.33	2.7510	5.2854	9.4770	270.87	1.2951	
102.000	180.00	2.3177	4.4461	9.4741	270.44	1.2951	
103.000	178.65	1.9339	3.7621	9.4711	270.01	1.2951	
104.000	198.44	1.6059	3.3777	9.4682	269.58	1.2951	
105.000	195.27	1.3535	2.9414	9.4652	269.15	1.2951	
106.000	190.09	1.1456	1.9945	9.4623	268.72	1.2951	
107.000	188.92	0.9735 - 5	1.6550	9.4594	268.29	1.2951	
108.000	189.74	8.3046	1.3794	9.4564	267.86	1.2951	
109.000	214.56	7.1103	1.1541	9.4535	267.43	1.2951	
110.000	219.38	6.1091 - 5	9.7810 - 8	9.4506	267.00	1.2951	
111.000	224.20	5.2664	8.1832	9.4476	266.57	1.2951	
112.000	229.01	4.5946	6.9282	9.4447	266.14	1.2951	
113.000	233.71	3.9563	5.7496	9.4418	265.71	1.2951	
114.000	238.23	3.4611	4.7803	9.4388	265.28	1.2951	
115.000	242.74	3.0476	4.0104	9.4359	264.85	1.2951	
116.000	247.25	2.6995	3.3920	9.4330	264.42	1.2951	
117.000	251.75	2.4040	2.8904	9.4301	263.99	1.2951	
118.000	256.25	2.1515	2.4798	9.4271	263.56	1.2951	
119.000	260.74	1.9342	2.1409	9.4242	263.13	1.2951	
120.000	327.23	1.7462 - 5	1.8590 - 8	9.4212	262.70	1.2951	

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

JUN REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M**3	ACCEL DUE TO GRAVITY M/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M**2	
0.000	304.43	1.0107 + 3	1.1566 + 0	9.7816	349.78	1.8669 - 5	
1.000	296.26	0.9023 + 2	1.0610 + 0	9.7785	345.05	1.8283	
2.000	290.71	0.8034	9.6278 - 1	9.7754	341.80	1.8017	
3.000	285.22	7.1384	8.7188	9.7723	338.56	1.7752	
4.000	279.33	6.3274	7.8914	9.7692	335.04	1.7465	
5.000	273.43	5.5944	7.1277	9.7661	331.44	1.7175	
6.000	267.48	4.9332	6.4255	9.7631	327.86	1.6879	
7.000	261.52	4.3380	5.7786	9.7600	324.19	1.6579	
8.000	255.35	3.8024	5.2078	9.7569	319.71	1.6215	
9.000	247.15	3.3204	4.6880	9.7538	315.16	1.5844	
10.000	239.95	2.8880 + 2	4.1930 - 1	9.7507	310.53	1.5468 - 5	
11.000	232.12	2.5040	3.7536	9.7477	305.82	1.5084	
12.000	224.27	2.1552	3.3477	9.7446	300.91	1.4693	
13.000	216.42	1.8414	2.9738	9.7415	295.80	1.4297	
14.000	208.58	1.5578	2.6303	9.7385	290.52	1.3897	
15.000	200.73	1.3342	2.3156	9.7354	284.82	1.3497	
16.000	196.47	1.1247	1.9942	9.7323	278.59	1.3084	
17.000	196.15	0.9420 + 1	1.6885	9.7293	271.76	1.2666	
18.000	195.76	7.9721	1.3983	9.7262	263.34	1.2272	
19.000	213.73	6.7397	1.1525	9.7231	258.14	1.1897	
20.000	217.69	5.7166 + 1	9.5886 - 2	9.7201	258.91	1.3710 - 5	
21.000	211.66	4.8642	8.8060	9.7170	259.65	1.3940	
22.000	214.89	4.1511	6.7297	9.7140	259.87	1.4119	
23.000	216.87	3.5489	5.7009	9.7109	259.22	1.4228	
24.000	218.85	3.0386	4.8369	9.7079	258.56	1.4337	
25.000	220.83	2.6054	4.1101	9.7048	257.90	1.4445	
26.000	222.80	2.2371	3.4978	9.7018	257.23	1.4552	
27.000	224.78	1.9236	2.9811	9.6987	256.56	1.4660	
28.000	226.76	1.6562	2.5444	9.6957	255.88	1.4766	
29.000	228.74	1.4288	2.1748	9.6926	255.19	1.4873	
30.000	230.71	1.2328 + 1	1.8615 - 2	9.6896	254.50	1.4979 - 5	
31.000	232.69	1.0657 + 0	1.5955	9.6865	253.80	1.5084	
32.000	234.67	0.9274	1.3694	9.6835	253.09	1.5189	
33.000	236.64	0.8191	1.1769	9.6804	252.38	1.5294	
34.000	238.62	0.7367	1.0129	9.6774	251.74	1.5404	
35.000	240.60	0.6756	0.8756	9.6744	251.04	1.5514	
36.000	242.58	0.6324	0.7609	9.6714	250.34	1.5624	
37.000	244.56	0.5984	0.6708	9.6684	249.64	1.5734	
38.000	246.54	0.5714	0.6007	9.6654	248.94	1.5844	
39.000	248.52	0.5486	0.5479	9.6624	248.24	1.5954	
40.000	251.52	3.8511 + 0	4.1926 - 3	9.6592	319.19	1.6172 - 5	
41.000	255.98	2.6736	3.6385	9.6562	320.74	1.6298	
42.000	258.38	2.3459	3.1629	9.6531	322.24	1.6420	
43.000	260.35	2.0607	2.7573	9.6501	323.46	1.6520	
44.000	262.32	1.8120	2.4063	9.6471	324.68	1.6620	
45.000	264.29	1.5849	2.1023	9.6441	325.90	1.6719	
46.000	266.25	1.4052	1.8385	9.6411	327.11	1.6817	
47.000	268.22	1.2392	1.6095	9.6380	328.31	1.6916	
48.000	269.15	1.0938	1.4157	9.6350	329.58	1.6962	
49.000	269.15	9.6558 - 1	1.2498	9.6320	328.88	1.6962	
50.000	269.15	8.5222 - 1	1.1033 - 3	9.6290	328.88	1.6962 - 5	
51.000	267.99	7.5233 - 1	0.9779 - 4	9.6260	328.18	1.6984	
52.000	266.82	6.6369	0.8659	9.6229	327.45	1.6984	
53.000	265.64	5.8511	0.7674	9.6199	326.73	1.6787	
54.000	264.46	5.1509	0.6833	9.6169	325.98	1.6728	
55.000	263.29	4.5422	0.6109	9.6139	325.28	1.6668	
56.000	262.13	3.9977	0.5479	9.6109	324.53	1.6608	
57.000	260.97	3.5188	0.4941	9.6079	323.73	1.6548	
58.000	259.81	3.0992	0.4479	9.6049	322.88	1.6488	
59.000	248.69	2.6926	3.7719	9.6019	316.13	1.5923	

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

JUN REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M**3	ACCEL TO GRAVITY N/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M**2	
60.000	244.97	2.3514	3.3440	9.5989	313.76	1.5730	
61.000	241.25	2.3403	3.3592	9.5989	311.97	1.5536	
62.000	237.53	1.7822	2.6130	9.5989	308.56	1.5341	
63.000	233.81	1.5466	2.3844	9.5989	304.54	1.5144	
64.000	230.10	1.3392	2.0276	9.5989	300.09	1.4946	
65.000	226.38	1.1569	1.7803	9.5989	295.63	1.4746	
66.000	222.67	9.9710	1.5600	9.5989	290.94	1.4545	
67.000	218.96	8.5724	1.3639	9.5774	286.64	1.4343	
68.000	215.25	7.3513	1.1898	9.5774	281.61	1.4139	
69.000	211.54	6.2876	1.0355	9.5774	276.57	1.3934	
70.000	207.83	5.3633	8.9900	9.5660	289.00	1.3727	
71.000	204.28	4.5622	7.7799	9.5660	286.52	1.3528	
72.000	200.87	3.8702	6.7121	9.5660	284.12	1.3335	
73.000	197.46	3.2762	5.7765	9.5660	281.70	1.3141	
74.000	194.07	2.7630	4.9140	9.5660	279.27	1.2950	
75.000	190.71	2.3317	4.1366	9.5660	276.82	1.2768	
76.000	187.38	1.9686	3.4839	9.5660	274.37	1.2596	
77.000	184.07	1.6623	2.9355	9.5660	271.91	1.2434	
78.000	180.78	1.4053	2.4746	9.5660	269.44	1.2282	
79.000	177.51	1.1881	2.0871	9.5660	266.96	1.2139	
80.000	198.88	1.0050	1.7611	9.5660	282.65	1.3217	
81.000	195.15	0.8480	1.4877	9.5660	279.27	1.3028	
82.000	191.42	0.7122	1.2592	9.5660	275.82	1.2841	
83.000	187.70	0.5928	1.0658	9.5660	272.34	1.2662	
84.000	184.00	0.4855	0.9021	9.5660	268.82	1.2491	
85.000	180.31	0.3956	0.7650	9.5660	265.27	1.2327	
86.000	176.64	0.3216	0.6509	9.5660	261.69	1.2170	
87.000	173.00	0.2595	0.5529	9.5660	258.08	1.2020	
88.000	169.38	0.2044	0.4692	9.5660	254.44	1.1877	
89.000	165.78	0.1522	0.3979	9.5660	250.77	1.1741	
90.000	193.64	1.0740	3.3715	9.5095	300.00	1.3000	
91.000	190.07	0.9287	2.8545	9.5095	296.54	1.2817	
92.000	186.53	0.7970	2.4148	9.5095	293.06	1.2641	
93.000	183.02	0.6767	2.0413	9.5095	289.56	1.2471	
94.000	179.53	0.5651	1.7241	9.5095	286.04	1.2307	
95.000	176.06	0.4606	1.4551	9.5095	282.50	1.2149	
96.000	172.61	0.3615	1.2270	9.5095	278.94	1.1996	
97.000	169.18	0.2673	1.0338	9.5095	275.36	1.1847	
98.000	165.77	0.1842	0.8703	9.5095	271.76	1.1702	
99.000	162.38	0.1101	0.7320	9.5095	268.14	1.1561	
100.000	163.96	0.2489	0.1526	9.4799	282.70	1.2799	
101.000	160.55	0.2138	0.1366	9.4799	279.27	1.2600	
102.000	157.15	0.1848	0.1230	9.4799	275.82	1.2407	
103.000	153.76	0.1609	0.1116	9.4799	272.34	1.2220	
104.000	150.38	0.1411	0.1019	9.4799	268.82	1.2039	
105.000	147.01	0.1251	0.0936	9.4799	265.27	1.1862	
106.000	143.65	0.1118	0.0864	9.4799	261.69	1.1690	
107.000	140.31	0.0999	0.0803	9.4799	258.08	1.1522	
108.000	136.98	0.0894	0.0751	9.4799	254.44	1.1359	
109.000	133.67	0.0801	0.0707	9.4799	250.77	1.1201	
110.000	130.38	0.0720	0.0670	9.4799	247.08	1.1047	
111.000	127.10	0.0650	0.0639	9.4799	243.37	1.0897	
112.000	123.83	0.0590	0.0613	9.4799	239.64	1.0751	
113.000	120.58	0.0539	0.0591	9.4799	235.89	1.0608	
114.000	117.34	0.0496	0.0573	9.4799	232.12	1.0468	
115.000	114.11	0.0460	0.0559	9.4799	228.33	1.0330	
116.000	110.89	0.0430	0.0549	9.4799	224.52	1.0194	
117.000	107.68	0.0405	0.0541	9.4799	220.69	1.0061	
118.000	104.48	0.0384	0.0535	9.4799	216.84	0.9930	
119.000	101.29	0.0366	0.0531	9.4799	212.97	0.9801	
120.000	347.49	1.9568	1.9617	9.4213			

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

JUL REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M**3	ACCEL DUE TO GRAVITY M/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M**2	
0.000	304.41	1.0100	1.1558	+ 0	9.7816	349.76	1.8668 - 5
0.100	296.48	0.9800	1.1559		9.7785	345.18	1.8223
0.200	288.55	0.9500	1.1560	- 1	9.7754	341.75	1.8013
0.300	280.62	0.9200	1.1561		9.7723	338.45	1.7743
0.400	272.69	0.8900	1.1562		9.7692	335.25	1.7491
0.500	264.76	0.8600	1.1563		9.7661	332.15	1.7237
0.600	256.83	0.8300	1.1564		9.7631	328.15	1.6992
0.700	248.90	0.8000	1.1565		9.7600	324.25	1.6752
0.800	240.97	0.7700	1.1566		9.7569	320.45	1.6516
0.900	247.16	0.7400	1.1567		9.7538	316.75	1.5844
10.000	239.95	2.0889	4.1946	- 1	9.7507	310.53	1.5468 - 5
11.000	231.55	2.5015	3.7635		9.7477	305.85	1.5023
12.000	223.10	2.9141	3.3641		9.7446	299.85	1.4589
13.000	214.65	3.3267	2.9941		9.7415	293.85	1.4166
14.000	206.20	3.7393	2.6522		9.7385	287.85	1.3757
15.000	197.75	4.1519	2.3384		9.7354	281.85	1.3337
16.000	189.30	4.5645	2.0527		9.7324	275.85	1.2911
17.000	180.85	4.9771	1.7949	+ 1	9.7293	269.85	1.2485
18.000	172.40	5.3897	1.5649		9.7263	263.85	1.2064
19.000	163.95	5.8023	1.3614		9.7232	257.85	1.1650
20.000	155.50	6.2149	1.1844		9.7202	251.85	1.1244
21.000	147.05	6.6275	1.0337	+ 1	9.7171	245.85	1.0845
22.000	138.60	7.0401	0.9081	- 2	9.7141	239.85	1.0455
23.000	130.15	7.4527	0.8075		9.7110	233.85	1.0074
24.000	121.70	7.8653	0.7219		9.7080	227.85	0.9701
25.000	113.25	8.2779	0.6503		9.7050	221.85	0.9336
26.000	104.80	8.6905	0.5927		9.7020	215.85	0.8979
27.000	96.35	9.1031	0.5491		9.6990	209.85	0.8629
28.000	87.90	9.5157	0.5195		9.6960	203.85	0.8286
29.000	79.45	9.9283	0.4939		9.6930	197.85	0.7949
30.000	71.00	1.0315	0.4723	- 2	9.6900	191.85	0.7619
31.000	62.55	1.0851	0.4547		9.6870	185.85	0.7296
32.000	54.10	1.1387	0.4411		9.6840	179.85	0.6979
33.000	45.65	1.1923	0.4315	+ 1	9.6810	173.85	0.6666
34.000	37.20	1.2459	0.4259		9.6780	167.85	0.6357
35.000	28.75	1.2995	0.4243	- 2	9.6750	161.85	0.6052
36.000	20.30	1.3531	0.4267		9.6720	155.85	0.5751
37.000	11.85	1.4067	0.4331	+ 1	9.6690	149.85	0.5454
38.000	3.40	1.4603	0.4435		9.6660	143.85	0.5161
39.000	-5.05	1.5139	0.4579	- 3	9.6630	137.85	0.4872
40.000	-13.60	1.5675	0.4763		9.6600	131.85	0.4587
41.000	-22.15	1.6211	0.4987		9.6570	125.85	0.4306
42.000	-30.70	1.6747	0.5261		9.6540	119.85	0.4029
43.000	-39.25	1.7283	0.5585		9.6510	113.85	0.3756
44.000	-47.80	1.7819	0.5969		9.6480	107.85	0.3487
45.000	-56.35	1.8355	0.6413		9.6450	101.85	0.3222
46.000	-64.90	1.8891	0.6927		9.6420	95.85	0.2961
47.000	-73.45	1.9427	0.7511		9.6390	89.85	0.2704
48.000	-82.00	1.9963	0.8175		9.6360	83.85	0.2451
49.000	-90.55	2.0499	0.8929		9.6330	77.85	0.2202
50.000	-99.10	2.1035	0.9773		9.6300	71.85	0.1957
51.000	-107.65	2.1571	1.0707		9.6270	65.85	0.1716
52.000	-116.20	2.2107	1.1741		9.6240	59.85	0.1479
53.000	-124.75	2.2643	1.2875		9.6210	53.85	0.1246
54.000	-133.30	2.3179	1.4119		9.6180	47.85	0.1017
55.000	-141.85	2.3715	1.5473		9.6150	41.85	0.0792
56.000	-150.40	2.4251	1.6947		9.6120	35.85	0.0571
57.000	-158.95	2.4787	1.8541		9.6090	29.85	0.0354
58.000	-167.50	2.5323	2.0265		9.6060	23.85	0.0141
59.000	-176.05	2.5859	2.2129		9.6030	17.85	0.0032
60.000	-184.60	2.6395	2.4143		9.6000	11.85	0.0027

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

JUL REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M ³	ACCEL DUE TO GRAVITY M/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M**2	
60.000	245.30	2.2881	3.2495	9.5085	313.97	1.5748	
61.000	241.67	1.9945	2.8750	9.5095	311.95	1.5559	
62.000	238.05	1.7351	2.5391	9.5105	309.93	1.5368	
63.000	234.44	1.5062	2.2382	9.5115	307.91	1.5177	
64.000	230.82	1.3048	1.9692	9.5125	305.89	1.4984	
65.000	227.20	1.1277	1.7277	9.5135	303.87	1.4790	
66.000	223.58	0.9728	1.5088	9.5145	301.85	1.4592	
67.000	219.96	0.8385	1.3163	9.5155	299.83	1.4390	
68.000	216.34	0.7228	1.1458	9.5165	297.81	1.4185	
69.000	211.82	0.6198	1.0008	9.5175	295.79	1.3978	
70.000	207.32	0.5280	0.8762	9.5185	293.76	1.3772	
71.000	204.11	0.4454	0.7643	9.5195	291.74	1.3568	
72.000	202.94	0.3725	0.6630	9.5205	289.71	1.3362	
73.000	201.77	0.3084	0.5739	9.5215	287.69	1.3158	
74.000	200.60	0.2519	0.4972	9.5225	285.66	1.2952	
75.000	199.43	0.2022	0.4321	9.5235	283.64	1.2748	
76.000	198.26	0.1574	0.3768	9.5245	281.61	1.2542	
77.000	198.15	0.1246	0.3294	9.5255	279.59	1.2338	
78.000	198.15	0.0920	0.2847	9.5265	277.56	1.2132	
79.000	198.15	0.0670	0.2429	9.5275	275.54	1.1928	
80.000	198.15	0.0482	0.2038	9.5285	273.51	1.1724	
81.000	198.15	0.0351	0.1671	9.5295	271.49	1.1520	
82.000	198.15	0.0272	0.1325	9.5305	269.46	1.1316	
83.000	198.15	0.0200	0.1007	9.5315	267.44	1.1112	
84.000	198.15	0.0143	0.0714	9.5325	265.41	1.0908	
85.000	197.49	0.0099	0.0493	9.5335	263.39	1.0704	
86.000	196.32	0.0063	0.0337	9.5345	261.36	1.0500	
87.000	195.15	0.0041	0.0216	9.5355	259.34	1.0296	
88.000	194.00	0.0025	0.0115	9.5365	257.31	1.0092	
89.000	193.61	0.0014	0.0047	9.5375	255.29	0.9888	
90.000	192.64	0.0007	0.0022	9.5385	253.26	0.9684	
91.000	191.57	0.0004	0.0009	9.5395	251.24	0.9480	
92.000	190.73	0.0002	0.0004	9.5405	249.21	0.9276	
93.000	189.73	0.0001	0.0002	9.5415	247.19	0.9072	
94.000	188.76	0.0000	0.0001	9.5425	245.16	0.8868	
95.000	187.99	0.0000	0.0000	9.5435	243.14	0.8664	
96.000	186.02	0.0000	0.0000	9.5445	241.11	0.8460	
97.000	185.86	0.0000	0.0000	9.5455	239.09	0.8256	
98.000	184.89	0.0000	0.0000	9.5465	237.06	0.8052	
99.000	183.92	0.0000	0.0000	9.5475	235.04	0.7848	
100.000	182.96	0.0000	0.0000	9.5485	233.01	0.7644	
101.000	181.99	0.0000	0.0000	9.5495	231.00	0.7440	
102.000	181.90	0.0000	0.0000	9.5505	228.97	0.7236	
103.000	181.60	0.0000	0.0000	9.5515	226.95	0.7032	
104.000	183.30	0.0000	0.0000	9.5525	224.92	0.6828	
105.000	198.99	0.0000	0.0000	9.5535	222.89	0.6624	
106.000	204.68	0.0000	0.0000	9.5545	220.87	0.6420	
107.000	210.38	0.0000	0.0000	9.5555	218.84	0.6216	
108.000	216.07	0.0000	0.0000	9.5565	216.82	0.6012	
109.000	221.75	0.0000	0.0000	9.5575	214.79	0.5808	
110.000	227.44	0.0000	0.0000	9.5585	212.77	0.5604	
111.000	233.13	0.0000	0.0000	9.5595	210.74	0.5400	
112.000	238.81	0.0000	0.0000	9.5605	208.72	0.5196	
113.000	244.48	0.0000	0.0000	9.5615	206.69	0.4992	
114.000	250.16	0.0000	0.0000	9.5625	204.67	0.4788	
115.000	255.84	0.0000	0.0000	9.5635	202.64	0.4584	
116.000	261.52	0.0000	0.0000	9.5645	200.62	0.4380	
117.000	267.20	0.0000	0.0000	9.5655	198.59	0.4176	
118.000	272.88	0.0000	0.0000	9.5665	196.57	0.3972	
119.000	278.56	0.0000	0.0000	9.5675	194.54	0.3768	
120.000	284.24	0.0000	0.0000	9.5685	192.52	0.3564	
120.000	329.77	1.7845	1.8852	9.4213			

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

AUG REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE ME	DENSITY KG/M**3	ACCEL DUE TO GRAVITY M/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M**2	
0.000	304.62	1.0104	1.1555	+ 0	9.7816	349.08	1.8678 - 5
1.000	296.30	0.9820	1.0606	+ 2	9.7785	345.07	1.8225
2.000	290.65	0.9522	0.9627	- 1	9.7754	341.77	1.8014
3.000	286.14	0.9204	0.8710		9.7723	338.51	1.7768
4.000	279.24	0.8866	0.7893		9.7692	334.99	1.7460
5.000	273.33	0.8509	0.7127		9.7661	331.43	1.7170
6.000	267.37	0.8133	0.6429		9.7631	327.74	1.6873
7.000	261.48	0.7738	0.5784		9.7601	324.11	1.6577
8.000	255.67	0.7324	0.5187		9.7571	320.51	1.6281
9.000	247.11	0.6891	0.4638		9.7541	315.13	1.5942
10.000	239.95	0.6430	0.4139	- 1	9.7510	310.53	1.5468
11.000	232.03	0.5941	0.3681		9.7479	305.68	1.5049
12.000	224.08	0.5424	0.3263		9.7448	300.57	1.4687
13.000	216.13	0.4880	0.2885		9.7416	295.17	1.4381
14.000	208.18	0.4309	0.2547		9.7385	289.57	1.4130
15.000	200.24	0.3711	0.2248		9.7354	283.77	1.3934
16.000	192.35	0.3087	0.1988		9.7323	277.77	1.3793
17.000	184.51	0.2438	0.1766	+ 1	9.7292	271.57	1.3707
18.000	176.76	0.1764	0.1581		9.7261	265.17	1.3676
19.000	204.73	0.1065	0.1432		9.7231	266.84	1.3703
20.000	208.69	0.7220	0.5617	- 2	9.7201	269.60	1.3775
21.000	212.66	0.8777	0.9904		9.7170	292.34	1.3996
22.000	214.71	0.1635	0.7553		9.7140	293.75	1.4109
23.000	216.49	0.3333	0.7266		9.7109	294.96	1.4208
24.000	218.28	0.4666	0.8614		9.7078	296.18	1.4303
25.000	220.06	0.6100	1.1321		9.7048	297.38	1.4403
26.000	221.84	0.7240	1.3579		9.7018	298.58	1.4507
27.000	223.62	0.8924	1.6996		9.6987	299.78	1.4615
28.000	225.40	1.0553	2.0593		9.6957	300.97	1.4727
29.000	227.18	1.2126	2.4273		9.6926	302.15	1.4842
30.000	228.96	1.2301	1.8716	- 2	9.6896	303.34	1.4884
31.000	230.74	0.0627	1.4007	+ 0	9.6866	304.53	1.4930
32.000	232.51	0.1846	1.1875		9.6836	305.72	1.5000
33.000	234.29	0.2884	0.9815		9.6806	306.91	1.5084
34.000	236.07	0.3771	0.7848		9.6776	308.10	1.5181
35.000	237.84	0.4509	0.6071	- 3	9.6746	309.29	1.5291
36.000	239.62	0.5100	0.4531		9.6716	310.48	1.5411
37.000	241.40	0.5544	0.3256		9.6686	311.67	1.5541
38.000	243.18	0.5842	0.2287		9.6656	312.86	1.5681
39.000	244.97	0.6092	0.1626		9.6626	314.05	1.5831
40.000	252.92	0.9992	0.1311	- 3	9.6596	318.81	1.6141
41.000	256.36	0.6280	0.3571		9.6566	320.98	1.6311
42.000	259.81	0.3069	0.6932		9.6536	323.13	1.6491
43.000	263.23	0.0280	0.9455		9.6506	324.71	1.6681
44.000	264.00	0.7850	0.5444		9.6476	325.72	1.6791
45.000	265.77	1.1572	0.8010		9.6446	326.73	1.6911
46.000	267.54	1.3866	1.0000		9.6416	327.74	1.6991
47.000	269.31	1.5244	1.1500		9.6386	328.75	1.7071
48.000	271.08	1.5622	1.2500		9.6356	329.76	1.7151
49.000	272.85	0.5480	1.2900	- 1	9.6326	329.76	1.7011
50.000	278.15	0.4225	0.9055	+ 3	9.6296	329.76	1.7011
51.000	277.78	0.3070	0.6500		9.6266	329.76	1.7011
52.000	277.41	0.2020	0.4500		9.6236	329.76	1.6991
53.000	277.04	0.1070	0.3000		9.6206	329.76	1.6971
54.000	276.67	0.0620	0.2000		9.6176	329.76	1.6951
55.000	276.30	0.0470	0.1400		9.6146	329.76	1.6931
56.000	275.93	0.0320	0.0900		9.6116	329.76	1.6911
57.000	275.56	0.0270	0.0600		9.6086	329.76	1.6891
58.000	275.19	0.0220	0.0400		9.6056	329.76	1.6871
59.000	274.82	0.0170	0.0300		9.6026	329.76	1.6851
60.000	274.45	0.0120	0.0200		9.6000	329.76	1.6831

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

AUG REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M**3	ACCEL DUE TO GRAVITY M/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M**2	
60.000	246.98	2.3351	1.9947	-4	315.80	1.5583	
61.000	246.98	2.0374	1.9947	-4	315.80	1.5583	
62.000	246.98	1.7400	1.9947	-4	315.80	1.5583	
63.000	246.98	1.4428	1.9947	-4	315.80	1.5583	
64.000	246.98	1.1458	1.9947	-4	315.80	1.5583	
65.000	246.98	0.8489	1.9947	-4	315.80	1.5583	
66.000	246.98	0.5521	1.9947	-4	315.80	1.5583	
67.000	246.98	0.2554	1.9947	-4	315.80	1.5583	
68.000	246.98	0.0587	1.9947	-4	315.80	1.5583	
69.000	246.98	0.0000	1.9947	-4	315.80	1.5583	
70.000	212.70	5.4470	8.9215	-5	292.37	1.3998	
71.000	212.70	4.6511	7.7421	-5	290.01	1.3808	
72.000	212.70	3.9552	6.5627	-5	287.65	1.3617	
73.000	212.70	3.2593	5.3833	-5	285.29	1.3425	
74.000	212.70	2.5634	4.2039	-5	282.93	1.3233	
75.000	212.70	1.8675	3.0245	-5	280.57	1.3041	
76.000	212.70	1.1716	1.8451	-5	278.21	1.2849	
77.000	212.70	0.4757	0.6657	-5	275.85	1.2657	
78.000	212.70	0.0000	0.0000	-5	273.49	1.2465	
79.000	212.70	0.0000	0.0000	-5	273.49	1.2465	
80.000	149.65	1.0000	1.0000	-5	278.97	1.2999	
81.000	149.65	0.9500	0.9500	-5	278.97	1.2999	
82.000	149.65	0.9000	0.9000	-5	278.97	1.2999	
83.000	149.65	0.8500	0.8500	-5	278.97	1.2999	
84.000	149.65	0.8000	0.8000	-5	278.97	1.2999	
85.000	149.65	0.7500	0.7500	-5	278.97	1.2999	
86.000	149.65	0.7000	0.7000	-5	278.97	1.2999	
87.000	149.65	0.6500	0.6500	-5	278.97	1.2999	
88.000	149.65	0.6000	0.6000	-5	278.97	1.2999	
89.000	149.65	0.5500	0.5500	-5	278.97	1.2999	
90.000	149.65	0.5000	0.5000	-5	278.97	1.2999	
91.000	149.65	0.4500	0.4500	-5	278.97	1.2999	
92.000	149.65	0.4000	0.4000	-5	278.97	1.2999	
93.000	149.65	0.3500	0.3500	-5	278.97	1.2999	
94.000	149.65	0.3000	0.3000	-5	278.97	1.2999	
95.000	149.65	0.2500	0.2500	-5	278.97	1.2999	
96.000	149.65	0.2000	0.2000	-5	278.97	1.2999	
97.000	149.65	0.1500	0.1500	-5	278.97	1.2999	
98.000	149.65	0.1000	0.1000	-5	278.97	1.2999	
99.000	149.65	0.0500	0.0500	-5	278.97	1.2999	
100.000	149.65	0.0000	0.0000	-5	278.97	1.2999	
101.000	149.65	0.0000	0.0000	-5	278.97	1.2999	
102.000	149.65	0.0000	0.0000	-5	278.97	1.2999	
103.000	149.65	0.0000	0.0000	-5	278.97	1.2999	
104.000	149.65	0.0000	0.0000	-5	278.97	1.2999	
105.000	149.65	0.0000	0.0000	-5	278.97	1.2999	
106.000	149.65	0.0000	0.0000	-5	278.97	1.2999	
107.000	149.65	0.0000	0.0000	-5	278.97	1.2999	
108.000	149.65	0.0000	0.0000	-5	278.97	1.2999	
109.000	149.65	0.0000	0.0000	-5	278.97	1.2999	
110.000	227.66	6.1234	9.3702	-8	445.06	1.4447	
111.000	227.66	5.3275	8.1908	-8	442.70	1.4257	
112.000	227.66	4.5316	7.0114	-8	440.34	1.4067	
113.000	227.66	3.7357	5.8320	-8	437.98	1.3877	
114.000	227.66	2.9398	4.6526	-8	435.62	1.3687	
115.000	227.66	2.1439	3.4732	-8	433.26	1.3497	
116.000	227.66	1.3480	2.2938	-8	430.90	1.3307	
117.000	227.66	0.5521	1.1144	-8	428.54	1.3117	
118.000	227.66	0.0000	0.0000	-8	426.18	1.2927	
119.000	227.66	0.0000	0.0000	-8	426.18	1.2927	
120.000	329.77	1.8123	1.9144	-8	9.4213		

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

SEP REFERENCE ATMOSPHERE				KWAJALEIN				
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M ³	ACCEL DUE TO GRAVITY N/SEC ²	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M ²		
0.000	304.77	1.01022	1.1548	+ 0	9.7816	349.97	1.8685	- 5
1.000	296.42	0.98192	1.0620	+ 2	9.7785	345.70	1.8290	
2.000	288.04	0.95353	0.9729	- 1	9.7754	341.44	1.8009	
3.000	279.65	0.92514	0.8891		9.7723	337.19	1.7743	
4.000	271.26	0.89675	0.8112		9.7692	332.96	1.7488	
5.000	262.87	0.86836	0.7391		9.7661	328.74	1.7241	
6.000	254.48	0.84000	0.6722		9.7631	324.54	1.6999	
7.000	246.09	0.81166	0.6105		9.7600	320.36	1.6764	
8.000	237.70	0.78332	0.5539		9.7569	316.20	1.6534	
9.000	229.31	0.75500	0.5022		9.7538	312.06	1.6309	
10.000	240.44	2.8876	4.1837	- 1	9.7507	310.85	1.5494	- 5
11.000	232.05	2.5012	3.7488		9.7477	305.63	1.5070	
12.000	223.66	2.1557	3.3469		9.7446	300.29	1.4638	
13.000	215.27	1.8479	2.9755		9.7415	294.85	1.4199	
14.000	206.88	1.5750	2.6341		9.7385	289.32	1.3753	
15.000	198.49	1.3340	2.3207		9.7354	283.70	1.3300	
16.000	190.10	1.1244	1.9894		9.7323	278.00	1.3108	
17.000	181.71	0.9463	1.6765	+ 1	9.7293	272.22	1.3095	
18.000	173.32	0.7978	1.3847		9.7262	266.37	1.3326	
19.000	164.93	0.6751	1.1463		9.7231	260.45	1.3578	
20.000	209.64	5.7344	9.5292	+ 1	9.7201	259.25	1.3828	- 5
21.000	211.99	4.8840	8.0260		9.7170	255.88	1.3959	
22.000	214.34	4.1666	6.7804		9.7140	252.53	1.4074	
23.000	216.69	3.5682	5.7372		9.7110	249.19	1.4186	
24.000	219.04	3.0465	4.8635		9.7080	245.86	1.4294	
25.000	221.39	2.5911	4.1232		9.7050	242.54	1.4401	
26.000	223.74	2.2026	3.5113		9.7020	239.23	1.4530	
27.000	226.09	1.8750	2.9985		9.6990	235.94	1.4642	
28.000	228.44	1.6111	2.5588		9.6960	232.66	1.4755	
29.000	230.79	1.4000	2.1791		9.6930	229.40	1.4866	
30.000	238.69	1.2345	1.8643	- 2	9.6896	230.48	1.4977	- 5
31.000	232.77	1.0672	1.5972		9.6865	230.85	1.5088	
32.000	236.84	0.9238	1.3704	+ 0	9.6835	230.21	1.5198	
33.000	230.91	0.8007	1.1774		9.6804	229.56	1.5308	
34.000	234.99	0.6949	1.0130		9.6774	228.91	1.5417	
35.000	229.06	0.6038	0.8725	- 3	9.6744	228.25	1.5526	
36.000	243.12	0.5255	0.7499		9.6714	227.59	1.5636	
37.000	247.19	0.4582	0.6478		9.6684	226.92	1.5745	
38.000	251.26	0.4003	0.5557		9.6654	226.26	1.5854	
39.000	255.33	0.3503	0.4796		9.6624	225.60	1.5963	
40.000	257.92	3.0726	4.1501	- 3	9.6592	321.95	1.6397	- 5
41.000	261.36	2.6991	3.5977		9.6562	324.09	1.6571	
42.000	264.80	2.3747	3.1394		9.6531	326.22	1.6745	
43.000	268.24	2.0910	2.7499		9.6501	328.36	1.6919	
44.000	266.27	1.8424	2.4105		9.6471	326.51	1.6818	
45.000	267.65	1.6224	2.1144		9.6441	324.66	1.6887	
46.000	269.02	1.4333	1.8551		9.6411	322.81	1.6956	
47.000	270.39	1.2654	1.6347		9.6380	320.96	1.7025	
48.000	271.76	1.1173	1.4473		9.6350	319.11	1.7094	
49.000	273.13	0.9864	1.2743	- 1	9.6320	317.26	1.7163	
50.000	269.65	8.7113	1.1254	- 3	9.6290	320.19	1.6587	- 5
51.000	268.45	7.6914	0.9811	- 4	9.6260	322.45	1.6927	
52.000	267.25	6.7843	0.8886		9.6230	324.71	1.6799	
53.000	266.05	5.9771	0.8070		9.6200	326.97	1.6671	
54.000	264.85	5.2698	0.7326		9.6170	329.23	1.6543	
55.000	263.65	4.6228	0.6632		9.6140	331.49	1.6415	
56.000	262.45	4.0380	0.6069		9.6110	333.75	1.6287	
57.000	261.25	3.5177	0.5599		9.6080	336.01	1.6159	
58.000	260.05	3.0551	0.5194		9.6050	338.27	1.6031	
59.000	258.85	2.6459	0.4825		9.6020	340.53	1.5903	

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

SEP REFERENCE ATMOSPHERE				KWAJALEIN		
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M**3	ACCEL DUE TO GRAVITY M/SEC**2	SCUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M**2
60.000	245.51	2.3787 - 1	3.3752 - 4	9.5989	314.11	1.5759 - 5
61.000	242.73	2.0743	2.9771	9.5959	312.32	1.5614
62.000	239.30	1.8057	2.6287	9.5929	310.11	1.5434
63.000	235.88	1.5688	2.3169	9.5899	307.89	1.5253
64.000	232.46	1.3602	2.0385	9.5869	305.64	1.5072
65.000	229.04	1.1770	1.7902	9.5839	303.39	1.4889
66.000	225.62	1.0162	1.5691	9.5809	301.11	1.4705
67.000	222.20	8.7552 - 2	1.3727	9.5779	298.82	1.4519
68.000	218.78	7.5258	1.1983	9.5749	296.52	1.4333
69.000	215.36	6.4240	1.0440	9.5719	294.19	1.4145
70.000	211.95	5.5215 - 2	9.0754 - 5	9.5689	291.85	1.3956 - 5
71.000	208.53	4.7120	7.8717	9.5660	289.49	1.3766
72.000	205.11	4.0109	6.8119	9.5630	287.11	1.3575
73.000	201.71	3.3333	5.8808	9.5600	284.71	1.3382
74.000	198.30	2.6828	5.0645	9.5570	282.29	1.3189
75.000	194.89	2.0633	4.3504	9.5540	279.86	1.2993
76.000	191.48	1.4811	3.6712	9.5510	277.42	1.2798
77.000	188.06	1.0367	3.0345	9.5480	274.97	1.2600
78.000	184.65	0.7286	2.5084	9.5450	272.51	1.2400
79.000	181.25	1.2286	2.1989	9.5420	270.05	1.2200
80.000	194.65	1.0358 - 2	1.8537 - 5	9.5391	270.69	1.2000 - 5
81.000	194.26	8.7312 - 3	1.5657	9.5362	270.41	1.2058
82.000	193.78	7.3574	1.3227	9.5332	270.06	1.2030
83.000	193.29	6.1974	1.1171	9.5302	269.71	1.2002
84.000	192.81	5.2183	9.4287 - 6	9.5273	269.36	1.2074
85.000	192.32	4.3323	7.9561	9.5243	269.01	1.2046
86.000	191.83	3.6456	6.7111	9.5214	268.66	1.2018
87.000	191.35	3.1082	5.6587	9.5184	268.31	1.1990
88.000	190.86	2.6131	4.7695	9.5154	267.96	1.1962
89.000	190.38	2.1961	4.0186	9.5124	267.61	1.1934
90.000	189.89	1.8449 - 3	3.3845 - 6	9.5095	267.26	1.1906
91.000	189.41	1.5493	2.8494	9.5065	266.91	1.1878
92.000	188.92	1.3005	2.3980	9.5035	266.56	1.1850
93.000	188.44	1.0912	2.0173	9.5005	266.21	1.1822
94.000	187.96	9.1526 - 4	1.6964	9.4975	265.86	1.1794
95.000	187.47	7.6737	1.4260	9.4945	265.51	1.1766
96.000	186.99	6.4313	1.1982	9.4915	265.16	1.1738
97.000	186.50	5.3278	1.0064	9.4885	264.81	1.1710
98.000	186.02	4.3518	8.4491 - 7	9.4855	264.46	1.1682
99.000	185.54	3.4767	7.0912	9.4825	264.11	1.1654
100.000	185.05	3.1460 - 4	5.9489 - 7	9.4795	263.76	1.1626
101.000	184.57	2.8620	4.9886	9.4765	263.41	1.1598
102.000	184.08	2.6198	4.1643	9.4735	263.06	1.1570
103.000	183.60	2.4032	3.4593	9.4705	262.71	1.1542
104.000	183.11	2.2070	2.8709	9.4675	262.36	1.1514
105.000	182.63	2.0228	2.3916	9.4645	262.01	1.1486
106.000	182.14	1.8502	1.9983	9.4615	261.66	1.1458
107.000	211.89	9.6114 - 5	1.5802	9.4585	261.31	1.1430
108.000	217.29	8.2433	1.3211	9.4555	260.96	1.1402
109.000	222.69	7.0970	1.1102	9.4525	260.61	1.1374
110.000	228.09	6.1323 - 5	9.3662 - 8	9.4495	260.26	1.1346
111.000	332.48	5.3171	7.9334	9.4465	259.91	1.1318
112.000	238.88	4.6256	6.7457	9.4435	259.56	1.1290
113.000	248.98	4.0806	5.6536	9.4405	259.21	1.1262
114.000	260.53	3.5912	4.7485	9.4375	258.86	1.1234
115.000	272.08	3.1387	4.0188	9.4345	258.51	1.1206
116.000	283.62	2.7085	3.4251	9.4315	258.16	1.1178
117.000	295.16	2.2992	2.9376	9.4285	257.81	1.1150
118.000	306.70	1.9118	2.5358	9.4255	257.46	1.1122
119.000	318.24	1.5591	2.1994	9.4225	257.11	1.1094
120.000	329.77	1.2455 - 5	1.9179 - 8	9.4195	256.76	1.1066

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

OCT REFERENCE ATMOSPHERE				KWAJALEIN		
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE ME	DENSITY KG/M**3	ACCEL DUE TO GRAVITY M/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M**2
0.000	304.48	1.0101	1.1557	+ 0	340.80	1.8671
1.000	296.48	0.9818	1.0604	- 1	345.00	1.8283
2.000	288.48	0.9535	0.9651	- 1	349.20	1.7900
3.000	280.48	0.9252	0.8700	- 1	353.40	1.7523
4.000	272.48	0.8969	0.7750	- 1	357.60	1.7151
5.000	264.48	0.8686	0.6800	- 1	361.80	1.6784
6.000	256.48	0.8403	0.5850	- 1	366.00	1.6421
7.000	248.48	0.8120	0.4900	- 1	370.20	1.6062
8.000	240.48	0.7837	0.3950	- 1	374.40	1.5707
9.000	232.48	0.7554	0.3000	- 1	378.60	1.5356
10.000	224.48	0.7271	0.2050	- 1	382.80	1.5009
11.000	216.48	0.6988	0.1100	- 1	387.00	1.4666
12.000	208.48	0.6705	0.0150	- 1	391.20	1.4327
13.000	200.48	0.6422	0.0000	- 1	395.40	1.3992
14.000	192.48	0.6139	0.0000	- 1	399.60	1.3661
15.000	184.48	0.5856	0.0000	- 1	403.80	1.3334
16.000	176.48	0.5573	0.0000	- 1	408.00	1.3011
17.000	168.48	0.5290	0.0000	- 1	412.20	1.2692
18.000	160.48	0.5007	0.0000	- 1	416.40	1.2377
19.000	152.48	0.4724	0.0000	- 1	420.60	1.2066
20.000	144.48	0.4441	0.0000	- 1	424.80	1.1759
21.000	136.48	0.4158	0.0000	- 1	429.00	1.1456
22.000	128.48	0.3875	0.0000	- 1	433.20	1.1157
23.000	120.48	0.3592	0.0000	- 1	437.40	1.0862
24.000	112.48	0.3309	0.0000	- 1	441.60	1.0571
25.000	104.48	0.3026	0.0000	- 1	445.80	1.0284
26.000	96.48	0.2743	0.0000	- 1	450.00	1.0001
27.000	88.48	0.2460	0.0000	- 1	454.20	0.9722
28.000	80.48	0.2177	0.0000	- 1	458.40	0.9447
29.000	72.48	0.1894	0.0000	- 1	462.60	0.9176
30.000	64.48	0.1611	0.0000	- 1	466.80	0.8909
31.000	56.48	0.1328	0.0000	- 1	471.00	0.8646
32.000	48.48	0.1045	0.0000	- 1	475.20	0.8387
33.000	40.48	0.0762	0.0000	- 1	479.40	0.8132
34.000	32.48	0.0479	0.0000	- 1	483.60	0.7881
35.000	24.48	0.0196	0.0000	- 1	487.80	0.7634
36.000	16.48	0.0013	0.0000	- 1	492.00	0.7391
37.000	8.48	0.0000	0.0000	- 1	496.20	0.7152
38.000	0.48	0.0000	0.0000	- 1	500.40	0.6917
39.000	0.48	0.0000	0.0000	- 1	504.60	0.6686
40.000	257.83	3.0653	4.1417	- 3	321.89	1.6392
41.000	260.68	2.6922	3.5978	- 3	323.67	1.6537
42.000	263.54	2.3191	3.1302	- 3	325.44	1.6681
43.000	266.39	1.9460	2.7377	- 3	327.21	1.6825
44.000	269.25	1.5729	2.4020	- 3	328.98	1.6968
45.000	272.10	1.2000	2.1088	- 3	330.75	1.7111
46.000	274.95	0.8271	1.8525	- 3	332.52	1.7254
47.000	277.80	0.4542	1.6383	- 3	334.29	1.7397
48.000	280.65	0.0813	1.4675	- 3	336.06	1.7540
49.000	283.50	0.0000	1.3353	- 3	337.83	1.7683
50.000	286.35	0.0000	1.2467	- 3	339.60	1.7826
51.000	289.20	0.0000	1.1971	- 3	341.37	1.7969
52.000	292.05	0.0000	1.1820	- 3	343.14	1.8112
53.000	294.90	0.0000	1.1971	- 3	344.91	1.8255
54.000	297.75	0.0000	1.2425	- 3	346.68	1.8398
55.000	300.60	0.0000	1.3253	- 3	348.45	1.8541
56.000	303.45	0.0000	1.4545	- 3	350.22	1.8684
57.000	306.30	0.0000	1.6291	- 3	351.99	1.8827
58.000	309.15	0.0000	1.8593	- 3	353.76	1.8970
59.000	312.00	0.0000	2.1451	- 3	355.53	1.9113
60.000	314.85	0.0000	2.4865	- 3	357.30	1.9256

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

OCT REFERENCE ATMOSPHERE				KWAJALEIN		
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M**3	ACCEL DUE TO GRAVITY M/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M**2
60.000	244.80	2.3833	3.3917	9.8066	317.65	1.5722
61.000	241.67	2.0773	2.9944	9.8055	311.65	1.5559
62.000	238.05	1.8071	2.6445	9.8045	306.30	1.5368
63.000	234.44	1.5688	2.3422	9.8035	300.94	1.5177
64.000	231.82	1.3599	2.0851	9.8025	295.57	1.4984
65.000	229.20	1.1744	1.8605	9.8015	290.21	1.4790
66.000	227.59	1.0129	1.6781	9.8005	284.85	1.4595
67.000	225.97	0.8713	1.5380	9.7995	279.50	1.4398
68.000	224.36	0.7478	1.4241	9.7985	274.15	1.4200
69.000	222.75	0.6401	1.3282	9.7975	268.80	1.4001
70.000	220.14	0.5465	1.2482	9.7965	263.45	1.3800
71.000	217.53	0.4653	1.1806	9.7955	258.10	1.3602
72.000	215.92	0.3953	1.1237	9.7945	252.75	1.3401
73.000	214.31	0.3360	1.0759	9.7935	247.40	1.3200
74.000	212.70	0.2870	1.0357	9.7925	242.05	1.3000
75.000	211.09	0.2479	1.0017	9.7915	236.70	1.2800
76.000	209.48	0.2184	0.9734	9.7905	231.35	1.2600
77.000	207.87	0.1982	0.9503	9.7895	226.00	1.2400
78.000	206.26	0.1779	0.9320	9.7885	220.65	1.2200
79.000	204.65	0.1572	0.9182	9.7875	215.30	1.2000
80.000	203.04	0.1361	0.9085	9.7865	210.00	1.1800
81.000	201.43	0.1146	0.9024	9.7855	204.70	1.1600
82.000	199.82	0.0927	0.9003	9.7845	199.40	1.1400
83.000	198.21	0.0704	0.9017	9.7835	194.10	1.1200
84.000	196.60	0.0477	0.9061	9.7825	188.80	1.1000
85.000	194.99	0.0246	0.9130	9.7815	183.50	1.0800
86.000	193.38	0.0011	0.9220	9.7805	178.20	1.0600
87.000	191.77	0.0000	0.9327	9.7795	172.90	1.0400
88.000	190.16	0.0000	0.9448	9.7785	167.60	1.0200
89.000	188.55	0.0000	0.9580	9.7775	162.30	1.0000
90.000	186.94	0.0000	0.9721	9.7765	157.00	0.9800
91.000	185.33	0.0000	0.9869	9.7755	151.70	0.9600
92.000	183.72	0.0000	1.0022	9.7745	146.40	0.9400
93.000	182.11	0.0000	1.0179	9.7735	141.10	0.9200
94.000	180.50	0.0000	1.0338	9.7725	135.80	0.9000
95.000	178.89	0.0000	1.0500	9.7715	130.50	0.8800
96.000	177.28	0.0000	1.0663	9.7705	125.20	0.8600
97.000	175.67	0.0000	1.0829	9.7695	119.90	0.8400
98.000	174.06	0.0000	1.0996	9.7685	114.60	0.8200
99.000	172.45	0.0000	1.1165	9.7675	109.30	0.8000
100.000	170.84	0.0000	1.1335	9.7665	104.00	0.7800
101.000	169.23	0.0000	1.1507	9.7655	98.70	0.7600
102.000	167.62	0.0000	1.1680	9.7645	93.40	0.7400
103.000	166.01	0.0000	1.1855	9.7635	88.10	0.7200
104.000	164.40	0.0000	1.2031	9.7625	82.80	0.7000
105.000	162.79	0.0000	1.2209	9.7615	77.50	0.6800
106.000	161.18	0.0000	1.2388	9.7605	72.20	0.6600
107.000	159.57	0.0000	1.2568	9.7595	66.90	0.6400
108.000	157.96	0.0000	1.2749	9.7585	61.60	0.6200
109.000	156.35	0.0000	1.2931	9.7575	56.30	0.6000
110.000	154.74	0.0000	1.3114	9.7565	51.00	0.5800
111.000	153.13	0.0000	1.3298	9.7555	45.70	0.5600
112.000	151.52	0.0000	1.3483	9.7545	40.40	0.5400
113.000	149.91	0.0000	1.3669	9.7535	35.10	0.5200
114.000	148.30	0.0000	1.3856	9.7525	29.80	0.5000
115.000	146.69	0.0000	1.4044	9.7515	24.50	0.4800
116.000	145.08	0.0000	1.4233	9.7505	19.20	0.4600
117.000	143.47	0.0000	1.4423	9.7495	13.90	0.4400
118.000	141.86	0.0000	1.4614	9.7485	8.60	0.4200
119.000	140.25	0.0000	1.4806	9.7475	3.30	0.4000
120.000	138.64	0.0000	1.5000	9.7465	0.00	0.3800
126.000	347.49	1.9509	1.9558	9.8213		

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmosphere (Cont.)

NOV REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE HE	DENSITY KG/M**3	ACCEL DUE TO GRAVITY M/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N/SEC/M**2	
0.000	314.32	1.0099	1.1560	+ 0	9.7816	349.71	1.8664 - 5
1.000	296.45	0.9015	1.0594	+ 2	9.7785	345.16	1.8292
2.000	298.81	8.0282	9.6171	- 1	9.7754	341.86	1.8022
3.000	285.62	7.1333	8.7066		9.7723	338.68	1.7762
4.000	279.58	6.3236	7.8793		9.7692	335.20	1.7478
5.000	273.75	5.5917	7.1160		9.7661	331.68	1.7190
6.000	267.74	4.9315	6.4167		9.7631	328.02	1.6892
7.000	261.72	4.3370	5.7722		9.7600	324.32	1.6590
8.000	254.65	3.8020	5.2012		9.7569	319.90	1.6230
9.000	247.55	3.3207	4.6731		9.7538	315.41	1.5864
10.000	240.45	2.8890	4.1857	- 1	9.7507	310.85	1.5494 - 5
11.000	232.53	2.5025	3.7492		9.7477	305.65	1.5075
12.000	224.58	2.1570	3.3460		9.7446	300.00	1.4648
13.000	216.63	1.8494	2.9740		9.7415	293.90	1.4225
14.000	208.68	1.5766	2.6319		9.7385	287.00	1.3775
15.000	200.69	1.3368	2.2986		9.7354	280.50	1.3433
16.000	196.64	1.1272	1.9982		9.7323	273.10	1.3094
17.000	193.15	0.9472	1.7084	+ 1	9.7292	265.80	1.2833
18.000	195.51	0.9950	1.4192		9.7262	257.30	1.3009
19.000	200.12	6.6584	1.1660		9.7231	263.50	1.3293
20.000	205.88	5.6672	9.6269	- 2	9.7201	267.00	1.3577 - 5
21.000	211.00	4.8142	7.9850		9.7171	269.00	1.3850
22.000	216.50	4.0800	6.5180		9.7140	270.00	1.4100
23.000	222.40	3.4500	5.2718		9.7110	270.00	1.4320
24.000	228.60	2.9200	4.2977		9.7079	269.00	1.4520
25.000	235.10	2.4800	3.5660		9.7048	267.00	1.4700
26.000	241.90	2.1200	3.0221		9.7018	265.00	1.4850
27.000	249.00	1.8300	2.6362		9.6987	262.00	1.4980
28.000	256.40	1.6030	2.3517		9.6957	259.00	1.4778
29.000	264.30	1.4350	2.1352		9.6926	255.00	1.4496
30.000	271.73	1.2914	1.9855	- 2	9.6896	250.00	1.5033 - 5
31.000	279.70	1.1650	1.8632		9.6865	245.00	1.5159
32.000	288.10	1.0510	1.7412	+ 0	9.6835	240.00	1.5281
33.000	296.80	0.9490	1.6226		9.6804	235.00	1.5400
34.000	305.80	0.8580	1.5098	- 3	9.6774	230.00	1.5520
35.000	315.10	0.7770	1.4038		9.6744	225.00	1.5638
36.000	324.70	0.7050	1.3048		9.6713	220.00	1.5757
37.000	334.50	0.6420	1.2128		9.6683	215.00	1.5874
38.000	344.50	0.5870	1.1280		9.6652	210.00	1.5992
39.000	354.70	0.5390	1.0498		9.6622	205.00	1.6108
40.000	365.10	0.4970	0.9772	- 3	9.6592	200.00	1.6224 - 5
41.000	375.70	0.4600	0.9100		9.6562	195.00	1.6340
42.000	386.50	0.4280	0.8480		9.6531	190.00	1.6448
43.000	397.50	0.4000	0.7910		9.6501	185.00	1.6556
44.000	408.70	0.3750	0.7390		9.6471	180.00	1.6664
45.000	420.10	0.3530	0.6910		9.6441	175.00	1.6772
46.000	431.70	0.3330	0.6470		9.6411	170.00	1.6880
47.000	443.50	0.3150	0.6080		9.6380	165.00	1.6987
48.000	455.50	0.2990	0.5730		9.6350	160.00	1.6997
49.000	467.70	0.2850	0.5420	- 1	9.6320	155.00	1.6997
50.000	480.10	0.2730	0.5150	- 1	9.6290	150.00	1.6997 - 5
51.000	492.70	0.2620	0.4910	- 4	9.6260	145.00	1.6997
52.000	505.50	0.2520	0.4690		9.6229	140.00	1.6997
53.000	518.50	0.2430	0.4490		9.6199	135.00	1.6997
54.000	531.70	0.2350	0.4310		9.6168	130.00	1.6997
55.000	545.10	0.2280	0.4150		9.6139	125.00	1.6997
56.000	558.70	0.2220	0.4000		9.6109	120.00	1.6997
57.000	572.50	0.2170	0.3860		9.6079	115.00	1.6997
58.000	586.50	0.2120	0.3730		9.6049	110.00	1.6997
59.000	600.70	0.2080	0.3610		9.6019	105.00	1.6997

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

NOV REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M**3	ACCEL DUE TO GRAVITY M/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M**2	
60.000	245.72	2.3297	3.3029	9.5989	314.25	1.5770	
61.000	242.78	2.0317	2.9154	9.5959	312.36	1.5616	
62.000	239.55	1.7688	2.5723	9.5926	310.27	1.5447	
63.000	236.32	1.5370	2.2658	9.5889	308.18	1.5277	
64.000	233.10	1.3332	1.9924	9.5856	306.07	1.5106	
65.000	229.87	1.1541	1.7490	9.5839	303.94	1.4933	
66.000	226.65	0.9970	1.5325	9.5809	301.80	1.4760	
67.000	223.42	0.8596	1.3404	9.5775	299.65	1.4586	
68.000	220.20	0.7395	1.1701	9.5745	297.48	1.4411	
69.000	216.98	0.6349	1.0194	9.5715	295.29	1.4234	
70.000	213.76	0.5438	0.8836	9.5685	293.09	1.4057	
71.000	210.54	0.4648	0.7600	9.5655	290.89	1.3879	
72.000	207.32	0.3953	0.6541	9.5630	288.69	1.3702	
73.000	204.10	0.3336	0.5624	9.5600	286.49	1.3525	
74.000	200.87	0.2785	0.4825	9.5575	284.29	1.3348	
75.000	197.65	0.2299	0.4125	9.5550	282.09	1.3171	
76.000	194.42	0.1874	0.3515	9.5525	279.89	1.2994	
77.000	191.20	0.1505	0.2980	9.5500	277.69	1.2817	
78.000	187.98	0.1187	0.2515	9.5475	275.49	1.2640	
79.000	184.76	0.0915	0.2115	9.5450	273.29	1.2463	
80.000	181.54	0.0687	0.1765	9.5425	271.09	1.2286	
81.000	178.32	0.0500	0.1460	9.5400	268.89	1.2109	
82.000	175.10	0.0353	0.1195	9.5375	266.69	1.1932	
83.000	171.87	0.0245	0.0965	9.5350	264.49	1.1755	
84.000	168.65	0.0175	0.0765	9.5325	262.29	1.1578	
85.000	165.42	0.0130	0.0590	9.5300	260.09	1.1401	
86.000	162.20	0.0095	0.0435	9.5275	257.89	1.1224	
87.000	158.98	0.0070	0.0305	9.5250	255.69	1.1047	
88.000	155.76	0.0050	0.0205	9.5225	253.49	1.0870	
89.000	152.54	0.0035	0.0140	9.5200	251.29	1.0693	
90.000	149.32	0.0025	0.0095	9.5175	249.09	1.0516	
91.000	146.10	0.0018	0.0065	9.5150	246.89	1.0339	
92.000	142.87	0.0013	0.0045	9.5125	244.69	1.0162	
93.000	139.65	0.0009	0.0030	9.5100	242.49	0.9985	
94.000	136.42	0.0006	0.0020	9.5075	240.29	0.9808	
95.000	133.20	0.0004	0.0014	9.5050	238.09	0.9631	
96.000	130.00	0.0003	0.0009	9.5025	235.89	0.9454	
97.000	126.80	0.0002	0.0006	9.5000	233.69	0.9277	
98.000	123.60	0.0001	0.0004	9.4975	231.49	0.9100	
99.000	120.40	0.0001	0.0002	9.4950	229.29	0.8923	
100.000	117.20	0.0000	0.0001	9.4925	227.09	0.8746	
101.000	114.00	0.0000	0.0000	9.4900	224.89	0.8569	
102.000	110.80	0.0000	0.0000	9.4875	222.69	0.8392	
103.000	107.60	0.0000	0.0000	9.4850	220.49	0.8215	
104.000	104.40	0.0000	0.0000	9.4825	218.29	0.8038	
105.000	101.20	0.0000	0.0000	9.4800	216.09	0.7861	
106.000	98.00	0.0000	0.0000	9.4775	213.89	0.7684	
107.000	94.80	0.0000	0.0000	9.4750	211.69	0.7507	
108.000	91.60	0.0000	0.0000	9.4725	209.49	0.7330	
109.000	88.40	0.0000	0.0000	9.4700	207.29	0.7153	
110.000	85.20	0.0000	0.0000	9.4675	205.09	0.6976	
111.000	82.00	0.0000	0.0000	9.4650	202.89	0.6799	
112.000	78.80	0.0000	0.0000	9.4625	200.69	0.6622	
113.000	75.60	0.0000	0.0000	9.4600	198.49	0.6445	
114.000	72.40	0.0000	0.0000	9.4575	196.29	0.6268	
115.000	69.20	0.0000	0.0000	9.4550	194.09	0.6091	
116.000	66.00	0.0000	0.0000	9.4525	191.89	0.5914	
117.000	62.80	0.0000	0.0000	9.4500	189.69	0.5737	
118.000	59.60	0.0000	0.0000	9.4475	187.49	0.5560	
119.000	56.40	0.0000	0.0000	9.4450	185.29	0.5383	
120.000	53.20	0.0000	0.0000	9.4425	183.09	0.5206	

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

DEC REFERENCE ATMOSPHERE				KWAJALEIN		
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE HG	DENSITY KG/M ³	ACCEL DUE TO GRAVITY N/SEC ²	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M ²
3.000	293.15	1.01325	1.1817	9.7816	349.42	1.8645
3.100	292.95	1.0081	1.1817	9.7785	349.42	1.8645
3.200	292.75	1.0029	1.1817	9.7754	349.42	1.8645
3.300	292.55	0.9977	1.1817	9.7723	349.42	1.8645
3.400	292.35	0.9925	1.1817	9.7692	349.42	1.8645
3.500	292.15	0.9873	1.1817	9.7661	349.42	1.8645
3.600	291.95	0.9821	1.1817	9.7631	349.42	1.8645
3.700	291.75	0.9769	1.1817	9.7600	349.42	1.8645
3.800	291.55	0.9717	1.1817	9.7569	349.42	1.8645
3.900	291.35	0.9665	1.1817	9.7538	349.42	1.8645
4.000	291.15	0.9613	1.1817			
4.100	290.95	0.9561	1.1817			
4.200	290.75	0.9509	1.1817			
4.300	290.55	0.9457	1.1817			
4.400	290.35	0.9405	1.1817			
4.500	290.15	0.9353	1.1817			
4.600	289.95	0.9301	1.1817			
4.700	289.75	0.9249	1.1817			
4.800	289.55	0.9197	1.1817			
4.900	289.35	0.9145	1.1817			
5.000	289.15	0.9093	1.1817			
5.100	288.95	0.9041	1.1817			
5.200	288.75	0.8989	1.1817			
5.300	288.55	0.8937	1.1817			
5.400	288.35	0.8885	1.1817			
5.500	288.15	0.8833	1.1817			
5.600	287.95	0.8781	1.1817			
5.700	287.75	0.8729	1.1817			
5.800	287.55	0.8677	1.1817			
5.900	287.35	0.8625	1.1817			
6.000	287.15	0.8573	1.1817			
6.100	286.95	0.8521	1.1817			
6.200	286.75	0.8469	1.1817			
6.300	286.55	0.8417	1.1817			
6.400	286.35	0.8365	1.1817			
6.500	286.15	0.8313	1.1817			
6.600	285.95	0.8261	1.1817			
6.700	285.75	0.8209	1.1817			
6.800	285.55	0.8157	1.1817			
6.900	285.35	0.8105	1.1817			
7.000	285.15	0.8053	1.1817			
7.100	284.95	0.8001	1.1817			
7.200	284.75	0.7949	1.1817			
7.300	284.55	0.7897	1.1817			
7.400	284.35	0.7845	1.1817			
7.500	284.15	0.7793	1.1817			
7.600	283.95	0.7741	1.1817			
7.700	283.75	0.7689	1.1817			
7.800	283.55	0.7637	1.1817			
7.900	283.35	0.7585	1.1817			
8.000	283.15	0.7533	1.1817			
8.100	282.95	0.7481	1.1817			
8.200	282.75	0.7429	1.1817			
8.300	282.55	0.7377	1.1817			
8.400	282.35	0.7325	1.1817			
8.500	282.15	0.7273	1.1817			
8.600	281.95	0.7221	1.1817			
8.700	281.75	0.7169	1.1817			
8.800	281.55	0.7117	1.1817			
8.900	281.35	0.7065	1.1817			
9.000	281.15	0.7013	1.1817			
9.100	280.95	0.6961	1.1817			
9.200	280.75	0.6909	1.1817			
9.300	280.55	0.6857	1.1817			
9.400	280.35	0.6805	1.1817			
9.500	280.15	0.6753	1.1817			
9.600	279.95	0.6701	1.1817			
9.700	279.75	0.6649	1.1817			
9.800	279.55	0.6597	1.1817			
9.900	279.35	0.6545	1.1817			
10.000	279.15	0.6493	1.1817			
10.100	278.95	0.6441	1.1817			
10.200	278.75	0.6389	1.1817			
10.300	278.55	0.6337	1.1817			
10.400	278.35	0.6285	1.1817			
10.500	278.15	0.6233	1.1817			
10.600	277.95	0.6181	1.1817			
10.700	277.75	0.6129	1.1817			
10.800	277.55	0.6077	1.1817			
10.900	277.35	0.6025	1.1817			
11.000	277.15	0.5973	1.1817			
11.100	276.95	0.5921	1.1817			
11.200	276.75	0.5869	1.1817			
11.300	276.55	0.5817	1.1817			
11.400	276.35	0.5765	1.1817			
11.500	276.15	0.5713	1.1817			
11.600	275.95	0.5661	1.1817			
11.700	275.75	0.5609	1.1817			
11.800	275.55	0.5557	1.1817			
11.900	275.35	0.5505	1.1817			
12.000	275.15	0.5453	1.1817			
12.100	274.95	0.5401	1.1817			
12.200	274.75	0.5349	1.1817			
12.300	274.55	0.5297	1.1817			
12.400	274.35	0.5245	1.1817			
12.500	274.15	0.5193	1.1817			
12.600	273.95	0.5141	1.1817			
12.700	273.75	0.5089	1.1817			
12.800	273.55	0.5037	1.1817			
12.900	273.35	0.4985	1.1817			
13.000	273.15	0.4933	1.1817			
13.100	272.95	0.4881	1.1817			
13.200	272.75	0.4829	1.1817			
13.300	272.55	0.4777	1.1817			
13.400	272.35	0.4725	1.1817			
13.500	272.15	0.4673	1.1817			
13.600	271.95	0.4621	1.1817			
13.700	271.75	0.4569	1.1817			
13.800	271.55	0.4517	1.1817			
13.900	271.35	0.4465	1.1817			
14.000	271.15	0.4413	1.1817			
14.100	270.95	0.4361	1.1817			
14.200	270.75	0.4309	1.1817			
14.300	270.55	0.4257	1.1817			
14.400	270.35	0.4205	1.1817			
14.500	270.15	0.4153	1.1817			
14.600	269.95	0.4101	1.1817			
14.700	269.75	0.4049	1.1817			
14.800	269.55	0.3997	1.1817			
14.900	269.35	0.3945	1.1817			
15.000	269.15	0.3893	1.1817			
15.100	268.95	0.3841	1.1817			
15.200	268.75	0.3789	1.1817			
15.300	268.55	0.3737	1.1817			
15.400	268.35	0.3685	1.1817			
15.500	268.15	0.3633	1.1817			
15.600	267.95	0.3581	1.1817			
15.700	267.75	0.3529	1.1817			
15.800	267.55	0.3477	1.1817			
15.900	267.35	0.3425	1.1817			
16.000	267.15	0.3373	1.1817			
16.100	266.95	0.3321	1.1817			
16.200	266.75	0.3269	1.1817			
16.300	266.55	0.3217	1.1817			
16.400	266.35	0.3165	1.1817			
16.500	266.15	0.3113	1.1817			
16.600	265.95	0.3061	1.1817			
16.700	265.75	0.3009	1.1817			
16.800	265.55	0.2957	1.1817			
16.900	265.35	0.2905	1.1817			
17.000	265.15	0.2853	1.1817			
17.100	264.95	0.2801	1.1817			
17.200	264.75	0.2749	1.1817			
17.300	264.55	0.2697	1.1817			
17.400	264.35	0.2645	1.1817			
17.500	264.15	0.2593	1.1817			
17.600	263.95	0.2541	1.1817			
17.700	263.75	0.2489	1.1817			
17.800	263.55	0.2437	1.1817			
17.900	263.35	0.2385	1.1817			
18.000	263.15	0.2333	1.1817			
18.100	262.95	0.2281	1.1817			
18.200	262.75	0.2229	1.1817			
18.300	262.55	0.2177	1.1817			
18.400	262.35	0.2125	1.1817			
18.500	262.15	0.2073	1.1817			
18.600	261.95	0.2021	1.1817			
18.700	261.75	0.1969	1.1817			
18.800	261.55	0.1917	1.1817			
18.900	261.35	0.1865	1.1817			
19.000	261.15	0.1813	1.1817			
19.100	260.95	0.1761	1.1817			
19.200	260.75	0.1709	1.1817			
19.300	260.55	0.1657	1.1817			
19.400	260.35	0.1605	1.1817			
19.500	260.15	0.1553	1.1817			
19.600	259.95	0.1501	1.1817			
19.700	259.75	0.1449	1.1817			
19.800	259.55	0.1397	1.1817			
19.900	259.35	0.1345	1.1817			
20.000	259.15	0.1293	1.1817			
20.100	258.95	0.1241	1.1817			
20.200	258.75	0.1189	1.1817			
20.300	258.55	0.1137	1.1817			
20.400	258.35	0.1085	1.1817			
20.500	258.15	0.1033	1.1817			
20.600	257.95	0.0981	1.1817			
20.700	257.75	0.0929	1.1817			
20.800	257.55	0.0877	1.1817			
20.900	257.35	0.0825	1.1817			
21.000	257.15	0.0773	1.1817			
21.100	256.95	0.0721	1.1817			
21.200	256.75	0.0669	1.1817			
21.300	256.55	0.0617	1.1817			
21.400	256.35	0.0565	1.1817			
21.500	256.15	0.0513	1.1817			
21.600	255.95	0.0461	1.1817			
21.700	255.75	0.0409	1.1817			
21.800	255.55	0.0357	1.1817			
21.900	255.35	0.0305	1.1817			
22.000	255.15	0.0253	1.1817			
22.100	254.95	0.0201	1.1817			
22.200	254.75	0.0149	1.1817			
22.300	254.55	0.0097	1.1817			
22.400	254.35	0.0045	1.1817			
22.500	254.15	0.0000	1.1817			
22.600	253.					

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

DEC REFERENCE ATMOSPHERE				KWAJALEIN			
ALTITUDE M	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M ³	ACCEL DUE TO GRAVITY M/SEC ²	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M ²	
60.000	24.55	2.225	3.223	9.806	313.87	1.5658	
61.000	24.53	2.215	3.213	9.806	313.87	1.5658	
62.000	24.51	2.205	3.203	9.806	313.87	1.5658	
63.000	24.49	2.195	3.193	9.806	313.87	1.5658	
64.000	24.47	2.185	3.183	9.806	313.87	1.5658	
65.000	24.45	2.175	3.173	9.806	313.87	1.5658	
66.000	24.43	2.165	3.163	9.806	313.87	1.5658	
67.000	24.41	2.155	3.153	9.806	313.87	1.5658	
68.000	24.39	2.145	3.143	9.806	313.87	1.5658	
69.000	24.37	2.135	3.133	9.806	313.87	1.5658	
70.000	24.35	2.125	3.123	9.806	313.87	1.5658	
71.000	217.19	5.294	8.649	9.505	295.44	1.4246	
72.000	217.17	5.284	8.639	9.505	295.44	1.4246	
73.000	217.15	5.274	8.629	9.505	295.44	1.4246	
74.000	217.13	5.264	8.619	9.505	295.44	1.4246	
75.000	217.11	5.254	8.609	9.505	295.44	1.4246	
76.000	217.09	5.244	8.599	9.505	295.44	1.4246	
77.000	217.07	5.234	8.589	9.505	295.44	1.4246	
78.000	217.05	5.224	8.579	9.505	295.44	1.4246	
79.000	217.03	5.214	8.569	9.505	295.44	1.4246	
80.000	199.65	1.849	1.583	9.505	283.26	1.3266	
81.000	199.63	1.839	1.573	9.505	283.26	1.3266	
82.000	199.61	1.829	1.563	9.505	283.26	1.3266	
83.000	199.59	1.819	1.553	9.505	283.26	1.3266	
84.000	199.57	1.809	1.543	9.505	283.26	1.3266	
85.000	199.55	1.799	1.533	9.505	283.26	1.3266	
86.000	199.53	1.789	1.523	9.505	283.26	1.3266	
87.000	199.51	1.779	1.513	9.505	283.26	1.3266	
88.000	199.49	1.769	1.503	9.505	283.26	1.3266	
89.000	199.47	1.759	1.493	9.505	283.26	1.3266	
90.000	149.88	1.033	1.033	9.806	313.87	1.5658	
91.000	149.86	1.023	1.023	9.806	313.87	1.5658	
92.000	149.84	1.013	1.013	9.806	313.87	1.5658	
93.000	149.82	1.003	1.003	9.806	313.87	1.5658	
94.000	149.80	0.993	0.993	9.806	313.87	1.5658	
95.000	149.78	0.983	0.983	9.806	313.87	1.5658	
96.000	149.76	0.973	0.973	9.806	313.87	1.5658	
97.000	149.74	0.963	0.963	9.806	313.87	1.5658	
98.000	149.72	0.953	0.953	9.806	313.87	1.5658	
99.000	149.70	0.943	0.943	9.806	313.87	1.5658	
100.000	179.96	3.233	5.223	9.806	313.87	1.5658	
101.000	179.94	3.223	5.213	9.806	313.87	1.5658	
102.000	179.92	3.213	5.203	9.806	313.87	1.5658	
103.000	179.90	3.203	5.193	9.806	313.87	1.5658	
104.000	179.88	3.193	5.183	9.806	313.87	1.5658	
105.000	179.86	3.183	5.173	9.806	313.87	1.5658	
106.000	179.84	3.173	5.163	9.806	313.87	1.5658	
107.000	179.82	3.163	5.153	9.806	313.87	1.5658	
108.000	179.80	3.153	5.143	9.806	313.87	1.5658	
109.000	179.78	3.143	5.133	9.806	313.87	1.5658	
110.000	23.99	2.225	3.223	9.806	313.87	1.5658	
111.000	23.97	2.215	3.213	9.806	313.87	1.5658	
112.000	23.95	2.205	3.203	9.806	313.87	1.5658	
113.000	23.93	2.195	3.193	9.806	313.87	1.5658	
114.000	23.91	2.185	3.183	9.806	313.87	1.5658	
115.000	23.89	2.175	3.173	9.806	313.87	1.5658	
116.000	23.87	2.165	3.163	9.806	313.87	1.5658	
117.000	23.85	2.155	3.153	9.806	313.87	1.5658	
118.000	23.83	2.145	3.143	9.806	313.87	1.5658	
119.000	23.81	2.135	3.133	9.806	313.87	1.5658	
120.000	347.49	1.9133	1.9133	9.8213			

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

MEAN ANNUAL REFERENCE ATMOSPHERE					KWAJALEIN		
ALTITUDE KM	TEMPERATURE DEG R	PRESSURE MB	DENSITY KG/M ³	ACCEL DUE TO GRAVITY M/SEC ²	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N/SEC ²	
0.000	27.7	1013.25	1.2250	9.80665	340.294	1.81E-05	- 5
0.100	27.5	1012.4	1.2235	9.80665	340.294	1.81E-05	- 5
0.200	27.3	1011.6	1.2220	9.80665	340.294	1.81E-05	- 5
0.300	27.1	1010.8	1.2205	9.80665	340.294	1.81E-05	- 5
0.400	26.9	1010.0	1.2190	9.80665	340.294	1.81E-05	- 5
0.500	26.7	1009.2	1.2175	9.80665	340.294	1.81E-05	- 5
0.600	26.5	1008.4	1.2160	9.80665	340.294	1.81E-05	- 5
0.700	26.3	1007.6	1.2145	9.80665	340.294	1.81E-05	- 5
0.800	26.1	1006.8	1.2130	9.80665	340.294	1.81E-05	- 5
0.900	25.9	1006.0	1.2115	9.80665	340.294	1.81E-05	- 5
1.000	25.7	1005.2	1.2100	9.80665	340.294	1.81E-05	- 5
1.100	25.5	1004.4	1.2085	9.80665	340.294	1.81E-05	- 5
1.200	25.3	1003.6	1.2070	9.80665	340.294	1.81E-05	- 5
1.300	25.1	1002.8	1.2055	9.80665	340.294	1.81E-05	- 5
1.400	24.9	1002.0	1.2040	9.80665	340.294	1.81E-05	- 5
1.500	24.7	1001.2	1.2025	9.80665	340.294	1.81E-05	- 5
1.600	24.5	1000.4	1.2010	9.80665	340.294	1.81E-05	- 5
1.700	24.3	999.6	1.1995	9.80665	340.294	1.81E-05	- 5
1.800	24.1	998.8	1.1980	9.80665	340.294	1.81E-05	- 5
1.900	23.9	998.0	1.1965	9.80665	340.294	1.81E-05	- 5
2.000	23.7	997.2	1.1950	9.80665	340.294	1.81E-05	- 5
2.100	23.5	996.4	1.1935	9.80665	340.294	1.81E-05	- 5
2.200	23.3	995.6	1.1920	9.80665	340.294	1.81E-05	- 5
2.300	23.1	994.8	1.1905	9.80665	340.294	1.81E-05	- 5
2.400	22.9	994.0	1.1890	9.80665	340.294	1.81E-05	- 5
2.500	22.7	993.2	1.1875	9.80665	340.294	1.81E-05	- 5
2.600	22.5	992.4	1.1860	9.80665	340.294	1.81E-05	- 5
2.700	22.3	991.6	1.1845	9.80665	340.294	1.81E-05	- 5
2.800	22.1	990.8	1.1830	9.80665	340.294	1.81E-05	- 5
2.900	21.9	990.0	1.1815	9.80665	340.294	1.81E-05	- 5
3.000	21.7	989.2	1.1800	9.80665	340.294	1.81E-05	- 5
3.100	21.5	988.4	1.1785	9.80665	340.294	1.81E-05	- 5
3.200	21.3	987.6	1.1770	9.80665	340.294	1.81E-05	- 5
3.300	21.1	986.8	1.1755	9.80665	340.294	1.81E-05	- 5
3.400	20.9	986.0	1.1740	9.80665	340.294	1.81E-05	- 5
3.500	20.7	985.2	1.1725	9.80665	340.294	1.81E-05	- 5
3.600	20.5	984.4	1.1710	9.80665	340.294	1.81E-05	- 5
3.700	20.3	983.6	1.1695	9.80665	340.294	1.81E-05	- 5
3.800	20.1	982.8	1.1680	9.80665	340.294	1.81E-05	- 5
3.900	19.9	982.0	1.1665	9.80665	340.294	1.81E-05	- 5
4.000	19.7	981.2	1.1650	9.80665	340.294	1.81E-05	- 5
4.100	19.5	980.4	1.1635	9.80665	340.294	1.81E-05	- 5
4.200	19.3	979.6	1.1620	9.80665	340.294	1.81E-05	- 5
4.300	19.1	978.8	1.1605	9.80665	340.294	1.81E-05	- 5
4.400	18.9	978.0	1.1590	9.80665	340.294	1.81E-05	- 5
4.500	18.7	977.2	1.1575	9.80665	340.294	1.81E-05	- 5
4.600	18.5	976.4	1.1560	9.80665	340.294	1.81E-05	- 5
4.700	18.3	975.6	1.1545	9.80665	340.294	1.81E-05	- 5
4.800	18.1	974.8	1.1530	9.80665	340.294	1.81E-05	- 5
4.900	17.9	974.0	1.1515	9.80665	340.294	1.81E-05	- 5
5.000	17.7	973.2	1.1500	9.80665	340.294	1.81E-05	- 5

Table 12. Tables of the Monthly and Annual Kwajalein Reference Atmospheres (Cont.)

MEAN ANNUAL REFERENCE ATMOSPHERE				KWAJALEIN		
ALTITUDE KM	TEMPERATURE DEG K	PRESSURE MB	DENSITY KG/M ³	ACCEL DUE TO GRAVITY M/SEC ²	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M ²
60.000	224.228	2.8333	3.0000	9.80665	314.68	1.5799
61.000	224.228	2.8333	3.0000	9.80665	314.68	1.5799
62.000	224.228	2.8333	3.0000	9.80665	314.68	1.5799
63.000	224.228	2.8333	3.0000	9.80665	314.68	1.5799
64.000	224.228	2.8333	3.0000	9.80665	314.68	1.5799
65.000	224.228	2.8333	3.0000	9.80665	314.68	1.5799
66.000	224.228	2.8333	3.0000	9.80665	314.68	1.5799
67.000	224.228	2.8333	3.0000	9.80665	314.68	1.5799
68.000	224.228	2.8333	3.0000	9.80665	314.68	1.5799
69.000	224.228	2.8333	3.0000	9.80665	314.68	1.5799
70.000	213.05	5.4441	8.9812	9.50565	292.61	1.4018
71.000	213.05	5.4441	8.9812	9.50565	292.61	1.4018
72.000	213.05	5.4441	8.9812	9.50565	292.61	1.4018
73.000	213.05	5.4441	8.9812	9.50565	292.61	1.4018
74.000	213.05	5.4441	8.9812	9.50565	292.61	1.4018
75.000	213.05	5.4441	8.9812	9.50565	292.61	1.4018
76.000	213.05	5.4441	8.9812	9.50565	292.61	1.4018
77.000	213.05	5.4441	8.9812	9.50565	292.61	1.4018
78.000	213.05	5.4441	8.9812	9.50565	292.61	1.4018
79.000	213.05	5.4441	8.9812	9.50565	292.61	1.4018
80.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
81.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
82.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
83.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
84.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
85.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
86.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
87.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
88.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
89.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
90.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
91.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
92.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
93.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
94.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
95.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
96.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
97.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
98.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
99.000	196.99	1.2358	2.5888	9.50565	281.35	1.3085
100.000	181.96	3.1963	6.1195	9.4799	274.79	1.2974
101.000	181.96	3.1963	6.1195	9.4799	274.79	1.2974
102.000	181.96	3.1963	6.1195	9.4799	274.79	1.2974
103.000	181.96	3.1963	6.1195	9.4799	274.79	1.2974
104.000	181.96	3.1963	6.1195	9.4799	274.79	1.2974
105.000	181.96	3.1963	6.1195	9.4799	274.79	1.2974
106.000	181.96	3.1963	6.1195	9.4799	274.79	1.2974
107.000	181.96	3.1963	6.1195	9.4799	274.79	1.2974
108.000	181.96	3.1963	6.1195	9.4799	274.79	1.2974
109.000	181.96	3.1963	6.1195	9.4799	274.79	1.2974
110.000	239.75	5.9888	8.9812	9.50565	292.61	1.4018
111.000	239.75	5.9888	8.9812	9.50565	292.61	1.4018
112.000	239.75	5.9888	8.9812	9.50565	292.61	1.4018
113.000	239.75	5.9888	8.9812	9.50565	292.61	1.4018
114.000	239.75	5.9888	8.9812	9.50565	292.61	1.4018
115.000	239.75	5.9888	8.9812	9.50565	292.61	1.4018
116.000	239.75	5.9888	8.9812	9.50565	292.61	1.4018
117.000	239.75	5.9888	8.9812	9.50565	292.61	1.4018
118.000	239.75	5.9888	8.9812	9.50565	292.61	1.4018
119.000	239.75	5.9888	8.9812	9.50565	292.61	1.4018
120.000	339.39	1.6513	1.9883	9.4213	261.35	1.3085

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Appendix A

Kwajalein Wind Distributions

1. INTRODUCTION

Wind statistics for KMR are presented for the midseason months for altitudes up to 60 km. Included are distributions of scalar wind-speed means and standard deviations of the east/west and north/south wind components and interlevel correlations of the components.

A more detailed upper wind climatology for KMR at altitudes up to 30 km is provided in a 1972 report by Edstrom and Quayle.* It describes the quasi-biennial oscillation of easterly and westerly wind regimes and provides monthly and annual tables of scalar wind speeds, zonal and meridional wind components, and wind shears.

2. SCALAR WIND SPEEDS

Selected percentile values of the scalar wind speeds for altitudes up to 60 km are given for the midseason months in Table A-1. Profiles of the 50, 90, 95, and 99 percentile scalar wind speeds for January and July are plotted versus altitude

*Edstrom, E. E., and Quayle, R. G. (1972) Wind Climatology at Kwajalein Test Site, Kwajalein, Marshall Islands, unpublished report for U.S. Army Safeguard Systems Command, Huntsville, AL.

Table A1. The 50, 90, 95, and 99 Percentile Values of Scalar Wind Speeds at KMR

Altitude (km)	January			April			July			October						
	50%	90%	95%	99%	50%	90%	95%	99%	50%	90%	95%	99%				
2	7	12	13	15	6	11	13	16	7	13	14	17	7	12	14	17
4	8	14	15	22	4	7	9	11	6	12	14	17	6	10	11	13
6	9	16	19	24	4	10	15	19	6	11	12	15	6	11	13	18
8	9	16	19	28	7	12	16	22	5	9	11	13	7	11	12	15
10	7	12	17	24	9	15	18	26	5	11	12	16	8	15	17	20
12	8	15	18	25	10	19	23	28	7	14	16	22	12	20	22	24
14	9	16	19	24	13	24	26	29	10	20	23	28	17	23	25	28
16	10	17	19	22	10	17	20	23	8	13	15	19	10	15	16	19
18	10	20	23	29	5	10	12	16	9	15	17	20	6	11	12	14
20	11	20	23	30	9	15	17	20	10	18	20	22	6	16	19	25
22	13	25	27	32	9	20	22	25	12	22	25	30	8	25	26	28
24	10	24	26	30	9	15	16	19	10	28	31	35	10	32	34	36
26	7	18	20	27	8	12	15	18	11	32	34	39	15	35	37	40
28	13	21	24	28	11	26	27	29	16	36	39	43	19	31	33	36
30	19	25	28	36	15	28	30	33	22	38	40	45	15	32	34	36
32	20	28	29	36	15	31	33	37	28	40	42	46	15	34	39	49
34	17	28	30	36	17	33	35	38	29	40	42	46	17	32	38	50
36	15	30	34	38	22	32	36	42	31	42	44	47	17	33	38	50
38	11	30	35	44	19	30	32	36	33	47	50	55	19	34	38	50
40	11	31	37	46	12	27	30	36	31	52	58	66	16	40	44	52
42	15	35	39	48	8	23	29	35	31	51	58	69	16	37	43	52
44	18	38	45	56	8	19	22	29	34	58	64	74	21	37	40	45
46	21	38	45	56	9	22	29	38	35	61	66	74	21	37	40	45
48	24	45	53	65	11	28	35	44	35	63	70	80	23	40	43	51
50	23	53	59	71	13	31	39	45	36	56	62	73	24	42	47	58
52	23	41	46	53	18	37	44	54	32	49	53	65	24	44	50	61
54	19	37	43	52	19	45	50	58	24	45	50	64	26	54	59	67
56	21	40	45	55	19	43	52	61	18	37	45	60	33	50	60	68
58	25	47	54	63	21	43	54	64	16	29	31	36	42	58	60	65
60	32	55	62	74	19	43	54	68	15	33	36	41	42	56	59	67

in Figure A-1. The 99, 95, and 90 percent values all increase with altitude up to 50 km in January, decrease from 50 to 54 km, and then increase to maximum values at 60 km. The July scalar wind speeds are greater than those in January, with the maximum speeds occurring near 48 km.

3. WIND COMPONENTS AND INTERLEVEL CORRELATIONS

Arrays of means and standard deviations of the east/west (u) and north/south (v) components of wind, together with interlevel coefficients of correlation of the u component with the u component and the v component with the v component, are presented in Tables A-2 and A-3 at 2-km intervals, surface to 60 km, for the midseason months at KMR.

The mean effect E of winds on the trajectory and impact point of ballistic re-entry vehicles can be determined for a specific location (by computer flights through mean monthly or seasonal wind profiles) if the proper influence coefficients (c_i) for the reentry vehicle at various levels are given:

$$E = \sum c_i \bar{u}_i$$

$$E = \sum c_i \bar{v}_i ,$$

where \bar{u}_i and \bar{v}_i represent the means of the east/west and north/south component wind speeds, respectively, at the ith level. The integrated standard deviation (σ_u or σ_v) of the wind effect caused by day-to-day fluctuations in the u and v component of the wind can be found from:

$$\sigma^2 = \sum_{ij} c_i \sigma_i r_{ij} c_j \sigma_j ,$$

where c_i and c_j are influence coefficients at the ith and jth levels, σ_i and σ_j are the standard deviation of the component winds at these levels, and r_{ij} is the correlation between the component wind at the ith level and that of the jth level. This yields the standard deviation for each component of the ballistic wind. These can be combined and used to determine the probability of occurrence of deviations of various magnitudes from the trajectory or impact point.

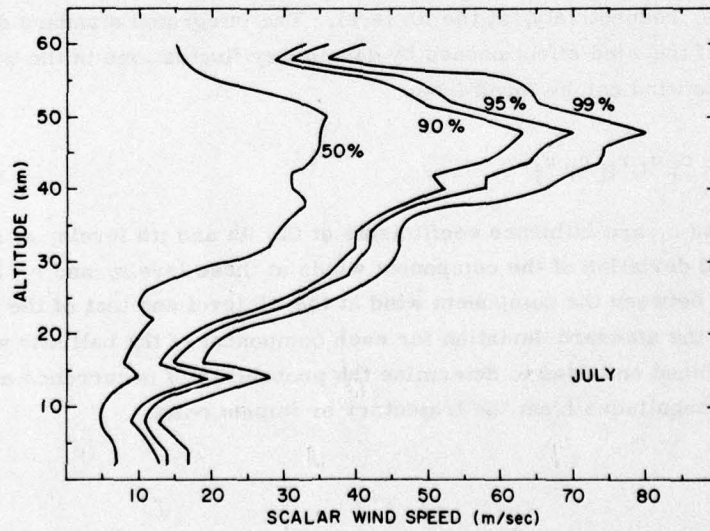
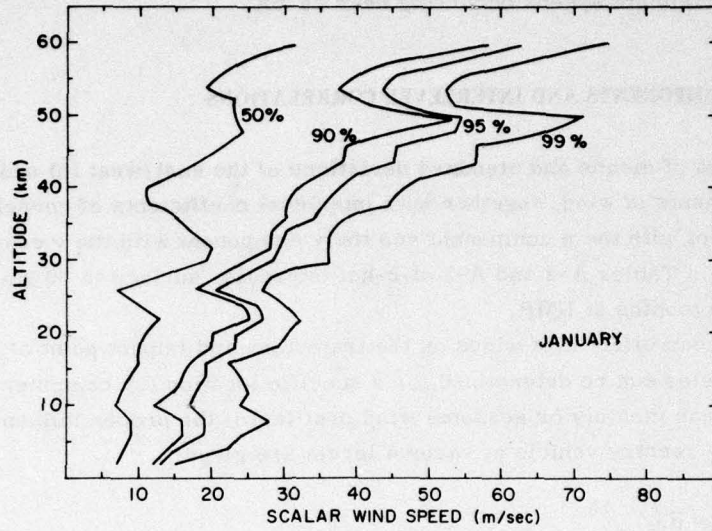


Figure A1. Profiles of the 50, 90, 95, and 99 Percentile Values of Scalar Wind Speeds

Table A2a. Means, Standard Deviations, and Interlevel Correlations of East/West Winds, January

KM	KM KILOMETERS ABOVE SEA LEVEL																														
	MEAN AVERAGE OF OBSERVED VALUES																														
	STDEV STANDARD DEVIATION OF VALUES TIMES 10																														
	N NUMBER OF VALUES AT EACH ALTITUDE																														
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	
MEAN	-6	-6	-9	-7	-3	-2	-3	-6	-9	-6	-7	-5	2	0	11	9	6	2	-2	-6	-5	-9	-11	-12	-11	-2	9	16	23	30	
STDEV	21	41	53	65	73	69	82	83	82	118	141	126	104	124	163	184	179	182	171	159	187	200	232	239	273	232	176	170	176	190	
N	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	49	48	50	51	51	51	51	50	50	49	49	46	42	38	
2	52	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	
4	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
6	12	15	15	41	81																										
8	12	15	15	41	81																										
10	12	15	15	41	81																										
12	12	15	15	41	81																										
14	12	15	15	41	81																										
16	12	15	15	41	81																										
18	12	15	15	41	81																										
20	12	15	15	41	81																										
22	12	15	15	41	81																										
24	12	15	15	41	81																										
26	12	15	15	41	81																										
28	12	15	15	41	81																										
30	12	15	15	41	81																										
32	12	15	15	41	81																										
34	12	15	15	41	81																										
36	12	15	15	41	81																										
38	12	15	15	41	81																										
40	12	15	15	41	81																										
42	12	15	15	41	81																										
44	12	15	15	41	81																										
46	12	15	15	41	81																										
48	12	15	15	41	81																										
50	12	15	15	41	81																										
52	12	15	15	41	81																										
54	12	15	15	41	81																										
56	12	15	15	41	81																										
58	12	15	15	41	81																										
60	12	15	15	41	81																										

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

Table A2b. Means, Standard Deviations, and Interlevel Correlations of East/West Winds, April

KM	KM KILOMETERS ABOVE SEA LEVEL																															
	MEAN AVERAGE OF OBSERVED VALUES																															
	STDV STANDARD DEVIATION OF VALUES TIMES 10																															
	N NUMBER OF VALUES AT EACH ALTITUDE																															
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60		
MEAN	-6	-3	-1	2	6	8	9	5	1	0	-4	-5	-6	-8	-10	-13	-17	-19	-18	-13	-6	0	4	7	10	12	16	17	15	12		
STDV	22	50	39	54	67	78	95	87	63	106	121	88	113	146	155	145	118	86	87	107	102	113	134	141	166	175	186	208	224			
N	50	50	50	50	50	50	50	50	50	50	49	50	49	49	49	49	49	49	50	50	50	50	50	50	50	50	50	49	41	39	31	
2	66	50	52	78																												
4	42	52	34																													
6	5																															
8																																
10																																
12																																
14																																
16																																
18																																
20																																
22																																
24																																
26																																
28																																
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32																																
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38																																
40																																
42																																
44																																
46																																
48																																
50																																
52																																
54																																
56																																
58																																
60																																

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

Table A2c. Means, Standard Deviations, and Interlevel Correlations of East/West Winds, July

		KM KILOMETERS ABOVE SEA LEVEL																														
		MEAN AVERAGE OF OBSERVED VALUES																														
		STDEV STANDARD DEVIATION OF VALUES TIMES 10																														
		N NUMBER OF VALUES AT EACH ALTITUDE																														
KM	.600	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	60		
MEAN	-5	-8	-7	-5	-2	0	3	5	0	-8	-12	-14	-15	-19	-22	-26	-30	-32	-33	-33	-35	-36	-37	-35	-30	-23	-13	-3	1			
STDEV	24	40	39	44	44	60	72	55	66	56	45	61	101	126	122	123	110	91	106	115	125	139	157	165	170	161	142	152	167	165	165	
N	64	58	54	50	46	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
2	64	58	54	50	46	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
4	58	54	50	46	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
6	54	50	46	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
8	50	46	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
10	46	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
12	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
14	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
16	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
18	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
20	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
22	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
24	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
26	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
28	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
30	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
32	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
34	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
36	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
38	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
40	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
44	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
46	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
48	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
50	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
52	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
54	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
56	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
58	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33
60	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	42	42	42	42	41	41	40	37	36	35	33

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

Table A3a. Means, Standard Deviations, and Interlevel Correlations of North/South Winds, January

KM	KM KILOMETERS ABOVE SEA LEVEL																													
	MEAN AVERAGE OF OBSERVED VALUES																													
	STDEV STANDARD DEVIATION OF VALUES TIMES 10																													
	N NUMBER OF VALUES AT EACH ALTITUDE																													
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	60	
MEAN	-.000	-.2	-1	-2	-3	-2	1	-3	0	-1	1	0	0	1	1	0	0	-2	-2	1	3	2	2	5	4	3	2	0	-2	
STDEV	17	38	42	43	51	48	58	71	52	41	37	27	28	25	32	32	44	49	47	57	61	68	89	105	114	102	122	119	108	139
N	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	49	48	50	51	51	51	50	50	49	49	46	42	38
	42	26	12	12	29	45	54																							
	33	10	5	34	64																									
	30	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	24	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	17	8	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
	27	16	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	1	12	34	8	10	1	2	12	22	14	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	16	4	28	4	8	11	26	17	3	18	14	-1	8	-7	23															
	5	11	7	6	12	3	1	23	5	7	2	5	24	-3	21	5	24	-3	21	5	24	-3	21	5	24	-3	21	5	24	-3
	21	18	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	12	2	3	9	16	24	20	2	13	-4	9	-15	-14	-4	3	14	1	-11	-12	38										
	16	9	23	14	1	26	22	14	1	2	12	-20	5	9	3	20	-4	3	11	-10	59									
	17	15	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	11	21	5	2	3	5	9	7	25	-4	-3	8	7	-24	11	8	-7	-22	-10	2	20	21	18	37	70					
	20	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
	4	-1	-7	-18	-6	4	16	28	-7	-12	6	2	-2	8	-16	3	11	4	13	4	12	23	29	25	37	39	44	37	44	60

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

Table A3b. Means, Standard Deviations, and Interlevel Correlations of North/South Winds, April

KM	KM KILOMETERS ABOVE SEA LEVEL																														
	MEAN AVERAGE OF OBSERVED VALUES																														
	STDV STANDARD DEVIATION OF VALUES TIMES 10																														
	N NUMBER OF VALUES AT EACH ALTITUDE																														
.000	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	
MEAN	-3	0	0	0	1	2	1	-1	-1	1	0	1	1	2	1	0	0	1	0	0	1	2	3	4	6	7	3	-1	-2		
STDV	20	27	34	47	53	61	76	55	28	24	26	26	22	31	33	35	30	40	49	47	51	53	57	64	69	79	87	95	79	82	
N	50	50	50	50	50	50	50	50	50	49	50	49	49	49	49	49	49	50	50	50	50	50	50	50	50	50	49	41	39	31	
2	43	26																													
4	18	29	27	53																											
6	20	7	15																												
8	28	4	1	25	62																										
10	16	6	13	45	75	67																									
12	13	7	14	18	47	52	22	7																							
14	11	4	-4	-11	4	2	10	10	-2	-14																					
16	-17	1	3	12	17	8	11	12	-1	-5	-4																				
18	-41	14	17	23	23	10	17	13	-2	-15	-2																				
20	-12	-5	4	23	-10	-23	32	21	-6	27	2	12	-16																		
22	1	-12	0	6	12	9	-23	32	21	-6	27	2	12	-16																	
24	8	15	-4	-9	5	-2	4	3	11	0	25	3	-15	-29	21																
26	17	15	-11	-12	-17	-15	-12	-12	0	2	-2	-12	-3	7	-39	23															
28	-4	-7	17	-12	-17	-15	-12	-12	0	2	-2	-12	-3	7	-39	23															
30	-9	-12	16	-12	-17	-15	-12	-12	0	2	-2	-12	-3	7	-39	23															
32	-11	-12	16	-12	-17	-15	-12	-12	0	2	-2	-12	-3	7	-39	23															
34	-11	-12	16	-12	-17	-15	-12	-12	0	2	-2	-12	-3	7	-39	23															
36	28	24	-2	-34	-6	-17	-15	-1	-14	2	7	-30	15	-13	14	3	-1	-21	4												
38	2	12	17	17	20	25	25	37	9	11	7	11	21	17	-9	3	24	8	18												
40	12	12	17	17	20	25	25	37	9	11	7	11	21	17	-9	3	24	8	18												
42	-24	-16	1	13	18	-15	-12	-12	-1	17	-10	-10	18	18	1	-17	-13	4	8	11	23										
44	-39	-10	13	0	-17	-43	-34	-16	-32	-11	-12	-6	-17	25	-22	4	12	-11	1	12	3	-11	6	12	48						
46	17	17	17	17	20	25	25	37	9	11	7	11	21	17	-9	3	24	8	18												
48	17	17	17	17	20	25	25	37	9	11	7	11	21	17	-9	3	24	8	18												
50	17	17	17	17	20	25	25	37	9	11	7	11	21	17	-9	3	24	8	18												
52	17	17	17	17	20	25	25	37	9	11	7	11	21	17	-9	3	24	8	18												
54	17	17	17	17	20	25	25	37	9	11	7	11	21	17	-9	3	24	8	18												
56	17	17	17	17	20	25	25	37	9	11	7	11	21	17	-9	3	24	8	18												
58	17	17	17	17	20	25	25	37	9	11	7	11	21	17	-9	3	24	8	18												
60	0	-8	6	12	45	-2	11	11	6	-6	15	-7	8	-21	16	26	18	-24	39	32	-11	-2	8	0	7	-4	11	25	38	67	

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

Table A3d. Means, Standard Deviations, and Interlevel Correlations of North/South Winds, October

KM	KM KILOMETERS ABOVE SEA LEVEL																														
	MEAN AVERAGE OF OBSERVED VALUES																														
	STDEV STANDARD DEVIATION OF VALUES TIMES 10																														
	N NUMBER OF VALUES AT EACH ALTITUDE																														
.000	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	
MEAN	-1	0	0	0	1	2	2	0	-2	-1	1	1	1	1	1	0	-2	0	0	0	-1	0	2	4	4	3	2	1	0	-1	
STDEV	23	25	23	42	52	59	83	94	52	31	24	22	20	25	23	30	24	21	39	46	41	36	58	60	67	83	64	72	96	113	99
N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	31	
2	32	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
4	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
6	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
8	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
10	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
12	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
14	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
16	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
18	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
20	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
22	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
24	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
26	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
28	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
30	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
32	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
34	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
36	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
38	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
40	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
42	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
44	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
46	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
48	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
50	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
52	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
54	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
56	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
58	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	
60	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

Appendix B

Kwajalein Temperature and Density Distributions

Arrays of means and standard deviations of temperature and density, together with interlevel correlations of temperature with temperature and density with density, are presented in Tables B1 and B2 at 2-km intervals, surface to 60 km, for January, April, July, and October at KMR.

The mean effect E of density on the trajectory and impact point of a ballistic reentry vehicle at KMR can be obtained by computer flights through the mean monthly density profiles, given proper influence coefficients (c_i) for the reentry vehicle at various levels:

$$E = \sum c_i \bar{\rho}_i$$

where $\bar{\rho}_i$ represents the mean monthly density at the i th level. The integrated standard deviation (σ) of the miss distance due to day-to-day fluctuations in the density can be found from:

$$\sigma^2 = \sum_{ij} c_i \sigma_i r_{ij} c_j \sigma_j ,$$

where c_i and c_j are influence coefficients at the i th and j th levels, σ_i and σ_j are the standard deviations of the density at these levels, and r_{ij} is the correlation between the densities at the i th and j th level.

The influence coefficients c_i and c_j for a given re-entry vehicle can be obtained by computer flight through the standard atmosphere and then again through the standard atmosphere with each 2-km layer perturbed separately (for example, perturbed by 5 percent of the standard atmosphere density).

Table B1a. Means, Standard Deviations, and Interlevel Correlations of Temperature, January

KM	KM KILMETERS ABOVE SEA LEVEL																																			
	MEAN AVERAGE OF OBSERVED VALUES																																			
	STDEV STANDARD DEVIATION OF VALUES TIMES 10																																			
	N NUMBER OF VALUES AT EACH ALTITUDE																																			
.000	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60						
MEAN	301	288	279	267	255	241	224	208	195	182	206	212	217	221	225	228	232	237	242	247	253	257	262	267	271	272	272	271	266	265	263					
STDEV	14	13	13	14	14	15	16	15	16	28	26	23	30	27	30	36	36	37	42	42	38	42	48	48	48	48	48	48	48	48	48					
N	42	42	42	42	42	42	42	42	42	42	42	42	41	40	41	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42					
2	39																																			
4	15	48																																		
6	11	25	26																																	
8	11	20	23	70																																
10	2	8	47	43	40																															
12	5	13	44	52	48	55																														
14	14	14	22	42	60	71	20																													
16	14	10	10	10	19	19	20	20																												
18	10	10	10	10	10	10	10	10	10																											
20	23	12	12	4	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
22	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	
24	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
26	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
28	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
30	3	1	9	26	1	16	19	19	1	25	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6		
32	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
34	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
36	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
38	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
40	1	1	32	40	2	12	19	20	19	24	16	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2		
42	22	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	
44	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
46	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	
48	27	6	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7		
50	5	20	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
52	17	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	
54	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	
56	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	
58	21	16	10	12	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7		
60																																				

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

Table B1d. Means, Standard Deviations, and Interlevel Correlations of Temperature, October

KM	KM KILOMETERS ABOVE SEA LEVEL																															
	MEAN AVERAGE OF OBSERVED VALUES																															
	STDV STANDARD DEVIATION OF VALUES TIMES 10																															
	N NUMBER OF VALUES AT EACH ALTITUDE																															
.000	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60		
MEAN	302	269	278	267	254	240	223	207	197	159	207	213	219	225	229	234	237	242	248	256	260	265	268	269	271	273	274	269	265	261	257	
STDV	12	8	9	11	14	13	12	19	25	27	25	18	27	27	30	36	33	41	41	35	40	41	45	47	44	43	42	39	43	61		
N	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	39	34	
2	41	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	
4	10	5	5	37	52	61																										
6	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
8	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
10	24	7	1	-11	-20	-39	-22	0	20	36																						
20	37	11	15	24	7	0	5	16	-10	31	21																					
22	44	22	20	22	19	5	23	30	28	22	2	4																				
24	5	25	5	13	5	30	28	22	2	4																						
30	5	33	2	13	14	15	21	15	-15	5	-24	-10	25	43	53																	
32	12	20	7	2	10	2	4	9	23	25	-14	-4	26	52	56	62	71															
34	12	22	10	2	10	2	4	9	23	25	-14	-4	26	52	56	62	71															
36	12	22	10	2	10	2	4	9	23	25	-14	-4	26	52	56	62	71															
40	17	19	-7	-13	-17	5	4	3	4	32	-4	22	23	29	32	34	37	30	28	34												
42	-10	-4	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	
44	-12	-4	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	
50	35	35	35	31	8	21	16	17	5	21	-10	14	31	40	59	49	71	51	58	52	43	28	36	52	63							
52	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	
54	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	
56	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	
58	15	6	7	-5	10	1	14	11	29	3	17	30	51	39	36	51	57	42	51	55	40	31	52	54	57	58	55	71	81			

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

Table B2b. Means, Standard Deviations, and Interlevel Correlations of Density, April

KM	KM KILCNETERS ABOVE SEA LEVEL																																	
	MEAN AVERAGE OF OBSERVED VALUES																																	
	STDEV STANDARD DEVIATION OF VALUES IN PERCENT OF MEAN TIMES 10																																	
N NUMBER OF VALUES AT EACH ALTITUDE																																		
.000	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60				
*MEAN	1165	968	768	648	517	417	333	262	197	139	936	653	463	343	249	182	134	988	734	543	409	311	240	186	145	113	869	700	569	433	337			
STDEV	4	3	4	5	4	5	4	5	10	15	12	11	13	20	19	16	15	17	22	24	20	20	18	19	25	23	20	23	24	27				
N	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34			
2	12	65	70																															
4	31	27	50	65																														
6	31	27	50	65																														
10	16	36	42	43	5*																													
12	35	40	25	35	61																													
14	11	10	22	25	42																													
16	11	6	22	25	42																													
20	36	7	5	22	10	13	11	31	-2																									
22	17	26	27	15	5	4	2	4	8	33	16	29	16	29	39	39	73																	
24	19	27	22	20	11	10	1	1	32	39	49	50	28	28	31	73																		
26	14	2	15	11	10	22	13	1	22	33	50	17	36	55	72																			
30	23	24	21	23	9	6	13	42	53	50	17	36	55	72																				
32	5	10	11	9	22	18	2	14	39	35	13	39	45	38	40	61																		
34	5	11	14	14	21	19	1	14	24	32	20	15	43	45	36	40	61																	
36	10	11	17	17	24	24	10	1	15	43	20	15	43	45	36	40	61																	
38	10	11	17	17	24	24	10	1	15	43	20	15	43	45	36	40	61																	
40	13	13	19	18	26	26	1	4	26	19	16	21	27	17	14	32	61	52	59	76														
42	24	25	27	26	30	30	17	17	14	10	7	13	25	22	22	19	40	44	47	75	75	67	52	71										
44	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	47	47	42	52	62	71									
46	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	45	45	42	52	62	71									
50	6	24	40	38	45	38	12	6	22	20	25	40	36	26	21	19	39	32	42	51	67	57	65	86										
52	10	35	50	45	50	45	7	11	17	20	20	20	17	31	25	21	32	35	40	52	60	60	55	73	88									
54	11	35	50	45	50	45	7	11	17	20	20	20	17	31	25	21	32	35	40	52	60	60	55	73	88									
56	11	35	50	45	50	45	7	11	17	20	20	20	17	31	25	21	32	35	40	52	60	60	55	73	88									
58	11	35	50	45	50	45	7	11	17	20	20	20	17	31	25	21	32	35	40	52	60	60	55	73	88									
60	34	18	5	4	18	36	11	31	0	-1	-26	31	10	-13	-23	-29	20	24	40	35	57	48	69	62	76	75	75	79	82	80				

* MULTIPLY MEAN BY INDICATED NEGATIVE POWER OF 10

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

Table B2c. Means, Standard Deviations, and Interlevel Correlations of Density, July

KM	KM KILOCETERS ABOVE SEA LEVEL																														
	MEAN AVERAGE OF OBSERVED VALUES																														
	STDEV STANDARD DEVIATION OF VALUES IN PERCENT OF MEAN TIMES 10																														
	N NUMBER OF VALUES AT EACH ALTITUDE																														
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	
*MEAN	1170	989	790	642	518	418	324	262	194	124	933	661	473	244	197	133	102	754	554	415	313	238	133	142	109	852	669	526	413	321	
STDEV	4	3	4	4	4	4	8	12	14	12	9	10	18	11	14	10	16	21	20	24	26	27	27	34	36	36	37	37	43		
N	31	31	31	31	31	31	31	31	31	31	30	29	26	30	30	31	31	31	31	31	31	31	31	31	31	31	31	30	29	26	
2	51	78	58	52	48	40	31	24	18	14	10	7	5	4	3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
4	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
6	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
8	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
10	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
12	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
14	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
16	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
18	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
20	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
22	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
24	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
26	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
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46	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
48	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
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60	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51

* MULTIPLY MEAN BY INDICATED NEGATIVE POWER OF 10
 ** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

Table B2d. Means, Standard Deviations, and Interlevel Correlations of Density, October

KM	KM KILOMETERS ABOVE SEA LEVEL																																
	MEAN AVERAGE OF OBSERVED VALUES																																
	STDEV STANDARD DEVIATION OF VALUES IN PERCENT OF MEAN TIMES 10																																
	N NUMBER OF VALUES AT EACH ALTITUDE																																
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60			
MEAN	1167	969	789	642	518	417	334	262	196	137	94.0	65.9	46.9	34.3	25.0	18.7	13.5	10.0	7.43	5.52	4.17	3.17	2.44	1.89	1.46	1.14	0.92	0.703	554	436	346		
STDEV	5	3	3	4	4	4	5	6	10	13	11	11	12	13	15	14	15	18	18	21	26	24	23	23	26	31	34	35	35	35			
N	40	40	40	40	40	40	40	40	40	40	40	40	38	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	38	33			
2	62	72	72	76	66																												
4	58	52	52	52	46																												
6	42	32	32	32	26																												
8	24	41	52	59	70																												
10	27	29	44	53	71																												
12	12	12	12	12	12																												
14	12	12	12	12	12																												
16	12	12	12	12	12																												
18	12	12	12	12	12																												
20	1	22	28	26	26	26	24	31	24	34																							
22	30	1	8	14	7	11	15	15	15	16																							
24	16	16	16	16	16																												
26	32	29	26	28	24	11	11	11	11	12																							
28	29	21	15	12	6	7	26	14	29	19	21	11	58	51	72																		
30	35	34	37	39	3	8	15	17	8	1	7	45	38	61																			
32	35	34	37	39	3	8	15	17	8	1	7	45	38	61																			
34	35	34	37	39	3	8	15	17	8	1	7	45	38	61																			
36	35	34	37	39	3	8	15	17	8	1	7	45	38	61																			
38	35	34	37	39	3	8	15	17	8	1	7	45	38	61																			
40	41	42	41	39	20	18	13	9	3	37	30	1	27	32	28	47	54	64															
42	46	47	47	46	4	14	11	0	2	17	13	24	3	25	36	39	57	65	67														
44	46	47	47	46	4	14	11	0	2	17	13	24	3	25	36	39	57	65	67														
46	46	47	47	46	4	14	11	0	2	17	13	24	3	25	36	39	57	65	67														
48	46	47	47	46	4	14	11	0	2	17	13	24	3	25	36	39	57	65	67														
50	29	38	19	17	28	29	17	22	10	20	2	27	26	11	33	26	25	41	53	60	72	71	64	74	81								
52	38	35	20	18	19	19	9	20	3	14	19	21	4	28	22	14	39	42	50	70	64	62	67	79	91								
54	38	35	20	18	19	19	9	20	3	14	19	21	4	28	22	14	39	42	50	70	64	62	67	79	91								
56	38	35	20	18	19	19	9	20	3	14	19	21	4	28	22	14	39	42	50	70	64	62	67	79	91								
58	38	35	20	18	19	19	9	20	3	14	19	21	4	28	22	14	39	42	50	70	64	62	67	79	91								
60	32	46	34	34	25	30	4	7	7	21	27	23	25	4	24	27	57	55	75	81	84	75	82	79	82	83	86	92	97				

* MULTIPLY MEAN BY INDICATED NEGATIVE POWER OF 10

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

Appendix C

Index of Refraction (Mean Values)

The refractive characteristics of the atmosphere should be considered if radars or optical systems are used for the tracking or guidance of high altitude vehicles. Below the ionosphere, the atmospheric index of refraction at microwave and optical frequencies is primarily a function of pressure, temperature, and water-vapor pressure. The standard expressions* used to compute atmospheric refractivity for radar and optical frequencies as functions of temperature, pressure, and humidity are as follows:

$$\text{For Optics: } N = 79.334 \frac{P}{T} - \frac{.06HT}{216.7} ,$$

$$\text{For Radar: } N = 77.6 \frac{P}{T} - \frac{11.0H}{216.7} + (3.75 \times 10^5) \frac{H}{216.7T} ,$$

where

N = refractivity = $(n - 1) \times 10^6$ where n = refractive index

P = pressure in millibars

T = temperature in degrees Kelvin

H = absolute humidity in g/m^3 .

* IRIG (1976) IRIG Standards for Range Meteorological Data Reduction, Part 1 - Rawinsonde, Document 108-72, Range Commanders Council, White Sands Missile Range.

The index of refraction (N) for various altitudes between the surface and 10 km are presented in Table C1 for each of the 12 mean monthly and the mean annual KMR Reference Atmospheres. The mean annual N values for radar and optics are plotted versus height in Figure C1. The very moist air in the lower levels of the atmosphere at KMR is reflected by the relatively high N values in the first few kilometers. As the moisture decreases with altitude, the index decreases rapidly. There is very little difference between the monthly values of N at a specific altitude (Table C1), as the monthly and seasonal changes in the atmospheric properties in the troposphere are very small in the tropics. The largest range in mean monthly N units is 22 at 1 km for radar frequencies and 1 N unit at all levels for optical frequencies.

Index of refraction profiles based on individual radiosonde observations provide a more detailed description of the vertical distribution of N units in the lower 10 km on a particular day. Variations in vertical gradients may occur due to appearance or disappearance of temperature inversions, changes in the height of the convection level, and the infusion of moisture into the higher levels by thunderstorms.

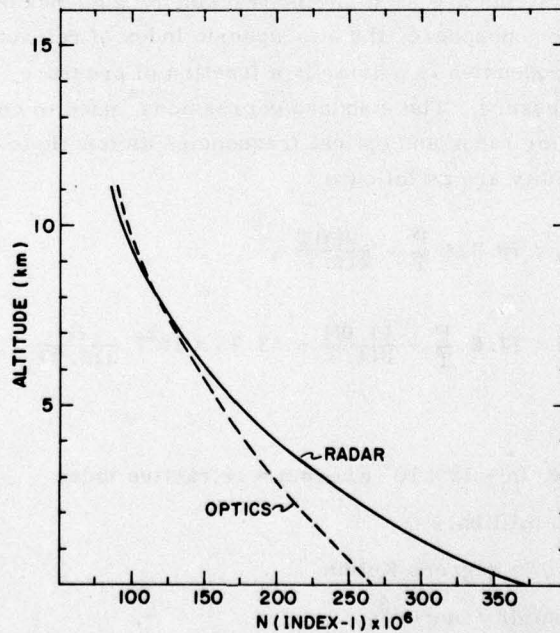


Figure C1. The Mean Annual Index of Refraction (N Values) for Radar and Optics at KMR

Table C1. Index of Refraction for Radar and Optics ($N = (\text{Index} - 1) \times 10^6$)

Altitude (km)	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual	Range
Radar														
0	371	369	371	377	384	381	378	380	377	373	372	369	371	369 to 381
1	313	310	314	316	319	320	322	318	319	318	321	316	318	310 to 322
2	268	264	260	267	271	273	271	274	271	271	274	273	272	260 to 274
3	224	219	215	229	231	230	232	235	232	237	234	232	231	215 to 235
5	165	166	170	174	176	177	177	177	178	178	175	169	174	165 to 178
7	130	130	131	133	135	135	136	134	135	134	134	132	134	130 to 136
10	093	093	093	093	093	094	094	094	094	093	093	093	094	093 to 094
Optics														
0	265	265	265	265	265	265	264	264	264	264	264	265	265	264 to 265
1	243	243	243	243	243	242	242	242	242	242	242	243	243	242 to 243
2	220	220	220	220	220	220	220	220	220	220	220	220	220	220
3	198	198	199	199	199	199	199	199	199	199	199	198	199	198 to 199
5	162	162	163	162	163	163	162	163	163	163	162	162	162	162 to 163
7	131	131	131	132	132	132	132	132	132	132	132	132	132	131 to 132
10	095	095	095	095	096	096	096	096	096	095	095	095	095	095 to 096

Appendix D

KREMS - Radar Wind Data to 25 km

The high power TRADEX (L-band) and ALTAIR (UHF) radars at KMR are being used for high resolution velocity observations of winds in the equatorial troposphere. The range resolution provided by these radars is 150 m at L-band and 240 m at UHF, and the radial velocity resolution attained for each range cell from full Doppler spectra is 0.1 m/sec. The system sensitivities are adequate to detect scattering from clear air turbulence, and this turbulence is used as a tracer of the wind velocity field.

The method of measuring the total wind vector employs measurements of the Doppler return along 10 uniformly spaced azimuth directions at a fixed radar elevation. The spectrum at each range cell position is calculated from a succession of 512 pulses, and the power spectral density data are then incoherently averaged for time intervals of 1 to 2 minutes. A sample average spectrum is shown in Figure D1, which indicates the presence of turbulence scattering as well as ground and sea clutter. A mean radial velocity value is then obtained, using the spectral, density-weighted, average velocity in the region above receiver noise near the radar wind signature. An estimate of the velocity vector is obtained by fitting a sinusoidal curve to the radial velocity at each radar azimuth position. Such a sinusoidal fit is shown in Figure D2, which reveals little variation with space over the sampled volume around the radar. The horizontal wind components are obtained with great accuracy and the vertical wind is generally found to be within the statistical uncertainty of the measurements for this case.

The advantages of this technique include its ability to detect small-scale variations and to be able to sample wind velocity in the reentry corridor near the missile reentry time. A profile of wind velocity obtained during a recent missile flight, ABRV-1, using the ALTAIR radar is shown in Figure D3, where a comparison is made between the vector measurements projected along the missile path and direct speed measurements obtained by positioning the radar line-of-sight along the missile path. Good agreement is found between the two approaches. Comparison of the radar wind measurements with conventional methods using balloons indicates general overall agreement, but the radar data generally reveal a more highly structured wind profile.

A large statistical data base on winds obtained from this technique does not yet exist. Measurements collected to date characteristically indicate a large wind variability in small volumes. For example, the spectrum displayed in Figure D1 has two apparent peaks corresponding to observations of air motion with two slightly different radial velocity values for the same radar resolution volume ($150 \times 100 \times 100$ m). The short-term (16 sec) temporal variation of the spectrum, hence of the velocity structure of the air motion within the small-resolution volume, is illustrated in Figure D4 for a single range cell. These data show the growth and decay of individual components in the spectra. When examined over time scales of the order of minutes, similar multiple line structure variations are also evident. When examined at different ranges, but at the same time, the multiple line velocity structure is found to be highly correlated from range to range. The changes in velocity across these ranges are often found to be highly variable. Wind velocities differing by as much as 4 to 5 m/sec have been observed within the same volume. On other occasions, the variations are much smoother with range. The fine detail exhibited in the data indicates the presence of high wind-shear components, associated with the turbulent mixing process, within and across thin layers in the equatorial troposphere.

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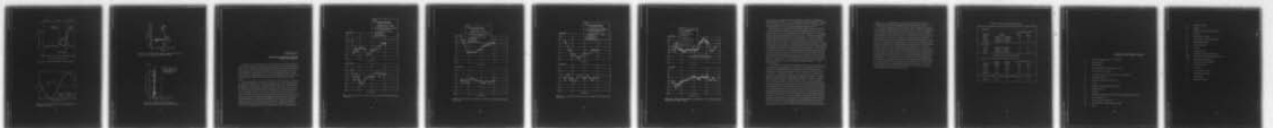
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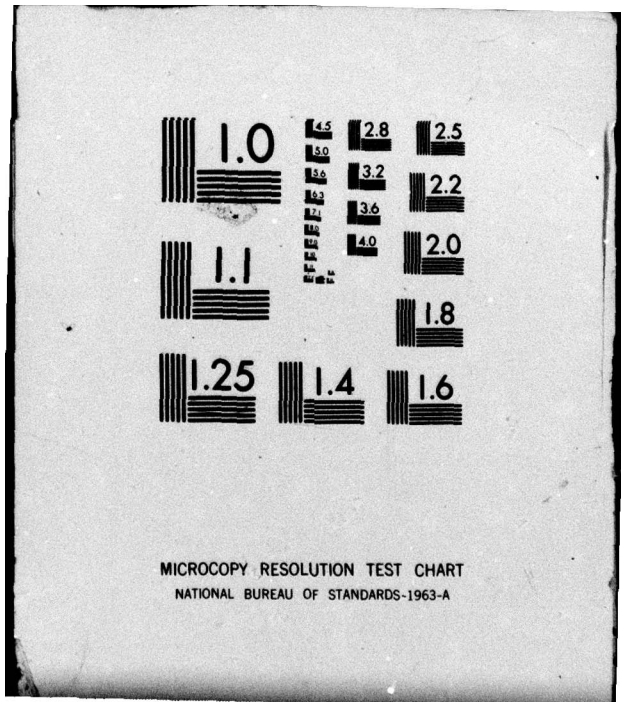
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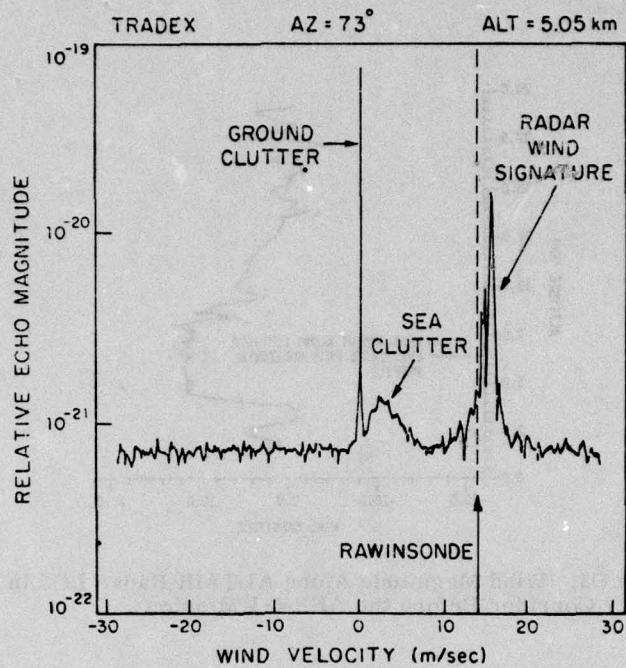


Figure D1. Example of Turbulence Echo Spectrum

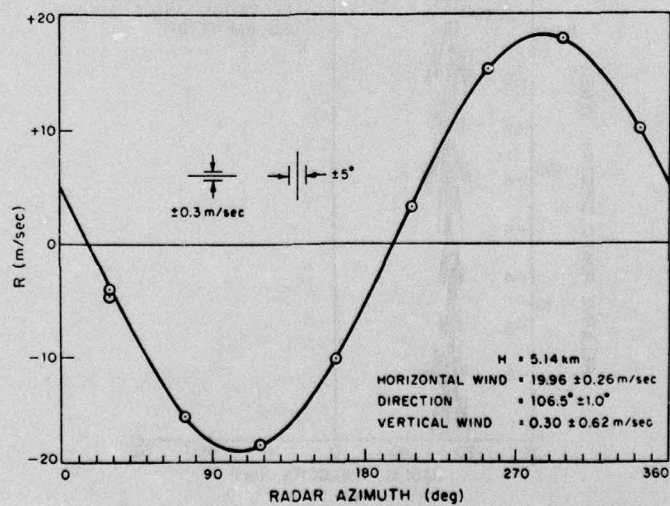


Figure D2. Example of Velocity-Azimuth Display From TRADEX Measurements

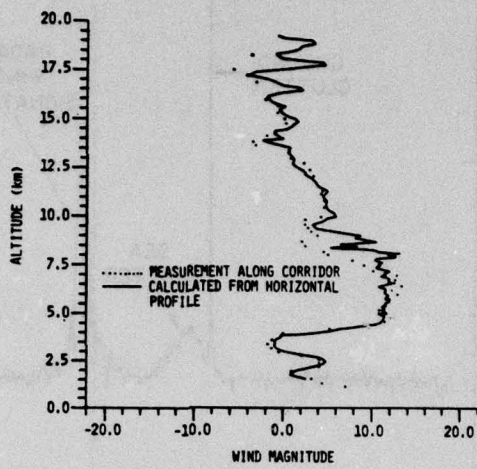


Figure D3. Wind Magnitude Along ALTAIR Radar LOS in the Reentry Corridor Before the ABRV-1 Mission

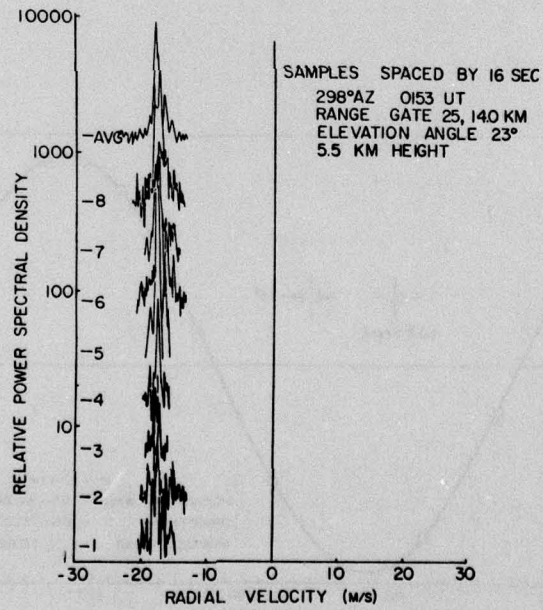
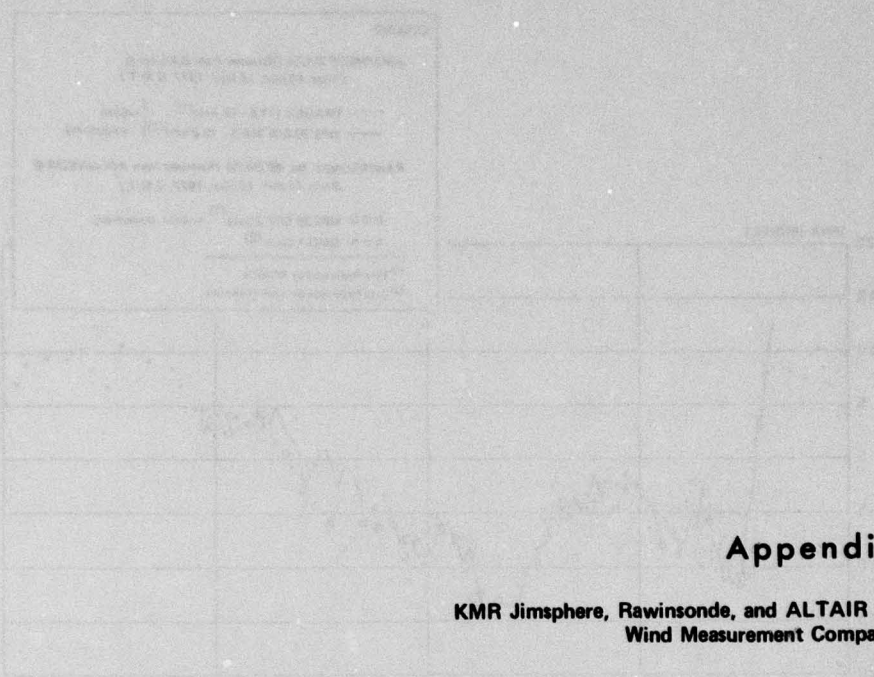


Figure D4. Examples of Spectral Wind Component Variations Over Short Temporal Scales



Appendix E

KMR Jimsphere, Rawinsonde, and ALTAIR Radar Wind Measurement Comparisons

Figures E1 through E4 provide selected comparisons of Jimsphere and rawinsonde east/west (V_{wx}) and north/south (V_{wy}) wind measurements made at KMR in support of three flight tests of the Technology Development Vehicle (TDV) Program and one flight test of the Advanced Ballistic Reentry Vehicle (ABRV) Program. These tests were conducted by the Air Force Space and Missile Systems Organization (SAMSO) Advanced Ballistic Reentry Systems (ABRES) Program. The data comparisons from ABRV also include wind estimates obtained by the ALTAIR radar.

The rawinsonde data correspond to releases from Roi-Namur Island, whereas the Jimsphere releases were from Gagan Island for the three TDV tests and from Roi-Namur for the ABRV test. Separation differences at a given altitude between the Jimsphere and rawinsonde measurements were on the order of 14 to 19 km for the TDV data and were less than 4 km for the ABRV data. Time differences between the measurements were of the order of 2 hours for the TDV-1 data, 1/2 hour for the TDV-2 data, and 1 hour for the TDV-3 and ABRV-1 data. Rawinsonde data are presented for the standard KMR GMD-1 data reduction as well as for an independent reduction of MPS-36 and TRADEX (TDV-3 only) radar track data by Xonics, which was performed for the three TDV tests. Sliding-least-squares parabolic smoothing of span lengths equivalent to 91 m altitude was used in the reduction of the rawinsonde radar wind measurements. Identical smoothing was

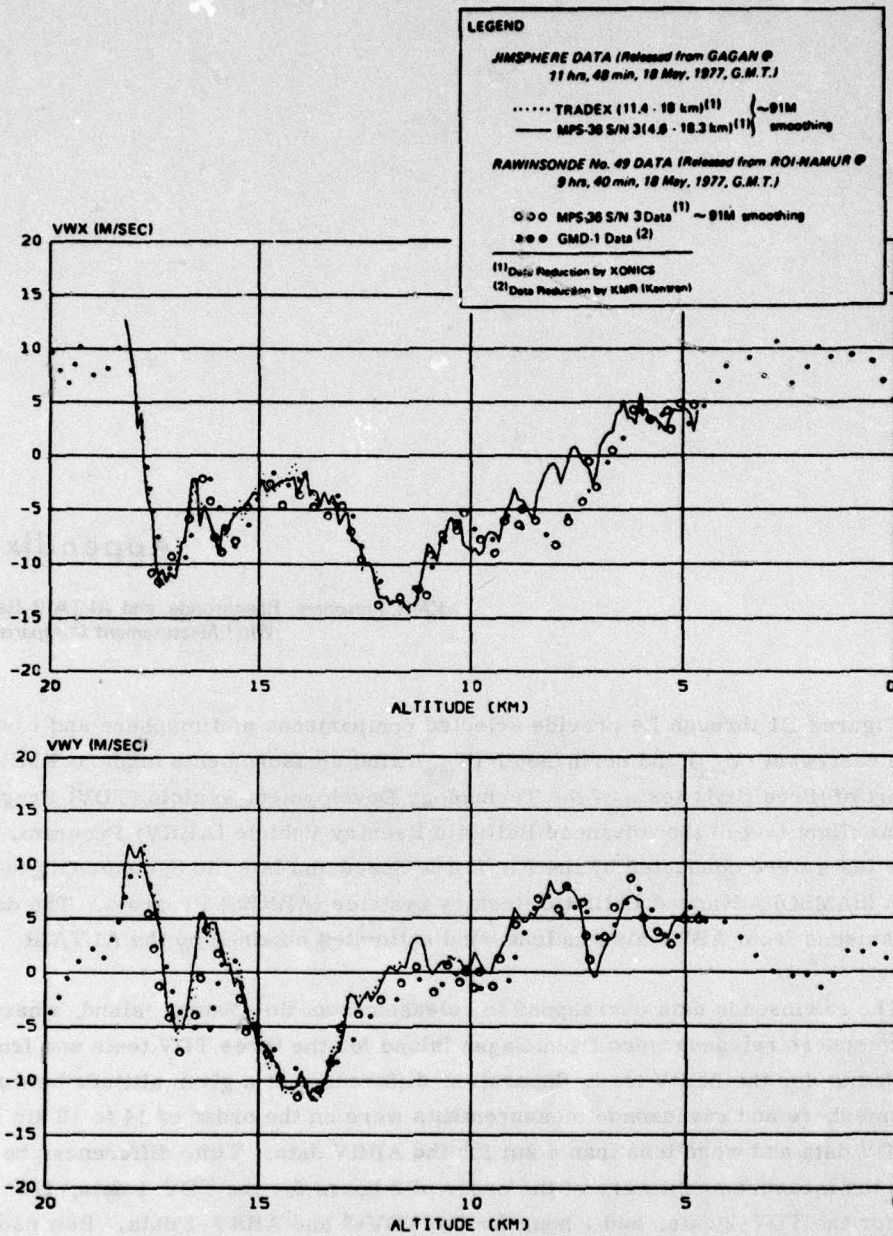


Figure E1. Comparison of Jimisphere and Rawinsonde Wind Measurements, TDV-1 Data

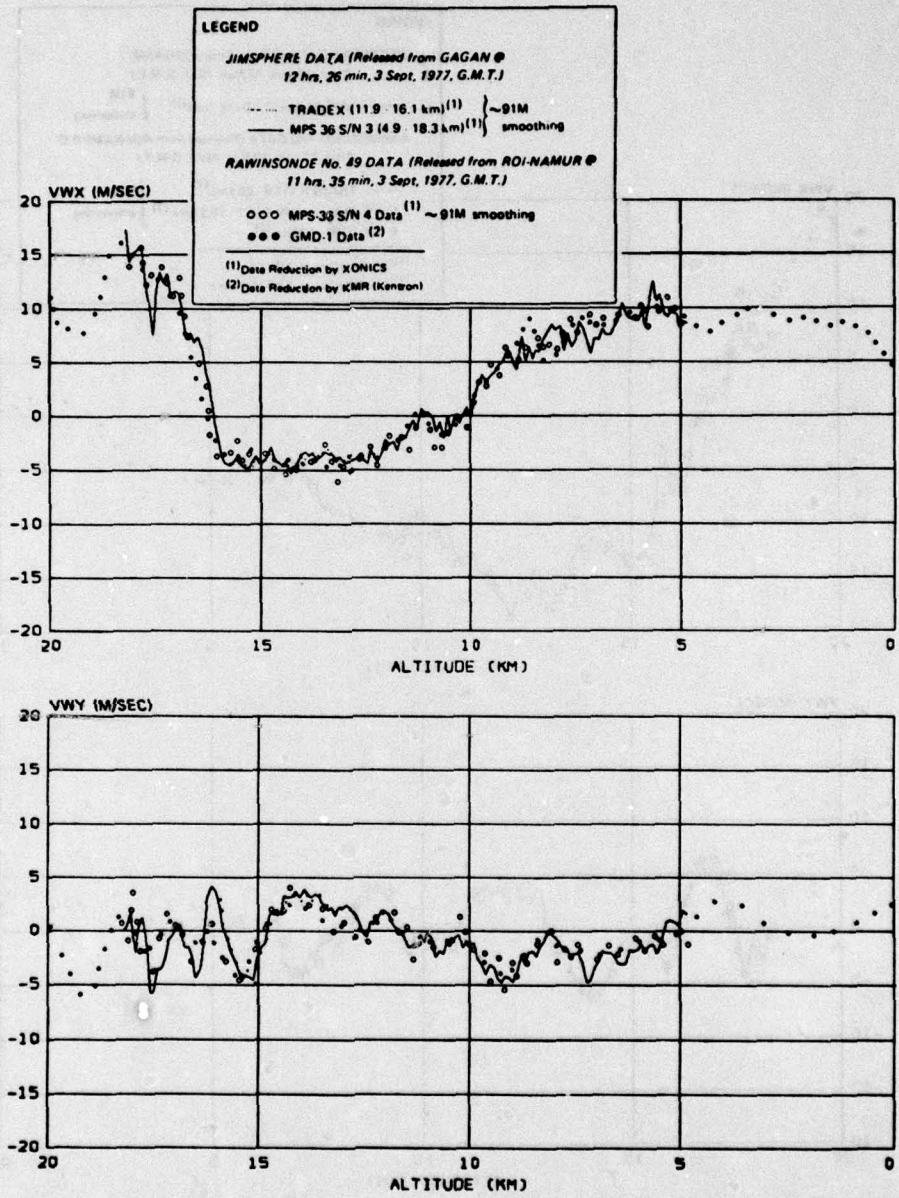


Figure E2. Comparison of Jimisphere and Rawinsonde Wind Measurements, TDV-2 Data

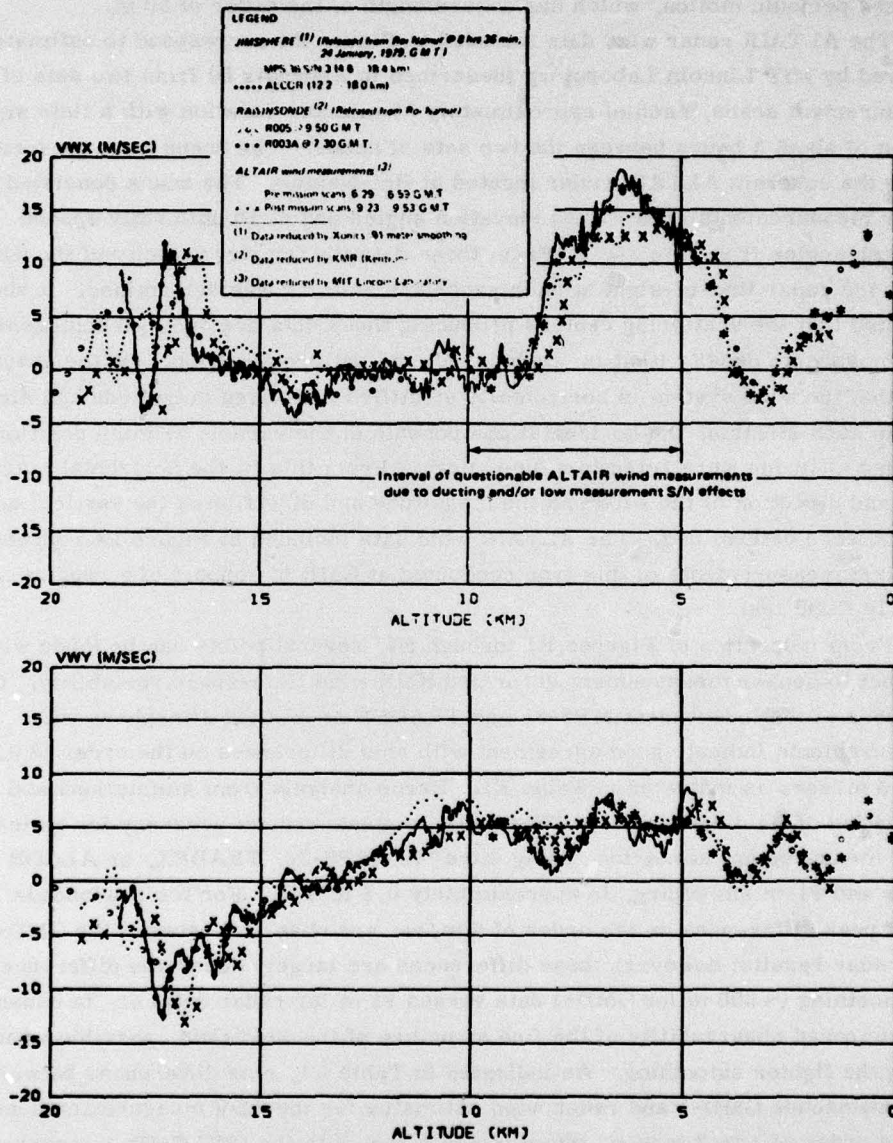


Figure E4. Comparison of Jimsphere, Rawinsonde, and ALTAIR Radar Wind Measurements, ABRV-1 Data

also applied to the Jimsphere radar measurements, which were independently made by the MPS-36 radar (~4 to 18 km altitude) for all three TDV tests. Smoothing of the Jimsphere data was selected to minimize effects of the sphere's self-induced periodic motion, which has a wavelength of the order of 30 m.

The ALTAIR radar wind data included in Figure E4 correspond to estimates derived by MIT Lincoln Laboratory (described in Appendix D) from two sets of measurement scans, each of approximately 30 minutes duration with a time separation of about 3 hours between the two sets of scans. The scans were performed using the coherent ALTAIR radar located at Roi-Namur. The scans consisted of radar measurements at two fixed elevation angles and at 10 uniformly spaced azimuth angles from 0 to 360°. From these data the Doppler velocity of the wind along the radar line-of-sight at each range and azimuth was determined. It should be noted that the scattering centers producing these data are due to inhomogeneities of atmospheric density (that is, turbulence) and not precipitation. On the assumption that the wind system is horizontally stratified with fixed magnitude and direction in each stratum, the horizontal components at the various azimuth positions at fixed altitudes were fitted to a sine curve. From this fit the horizontal magnitude and direction of the wind and the magnitude and direction of the vertical component were determined. The ALTAIR wind data included in Figure E4 represent the first measurements of this type conducted at KMR in support of a reentry vehicle flight test.

From inspection of Figures E1 through E4, several points can be made with respect to sensor measurement error and KMR wind time-space variability. Comparisons of the independent MPS-36 and TRADEX or ALCOR Jimsphere wind measurements indicate good agreement with rms differences on the order of 0.2 to 0.6 m/sec, as indicated in Table E1. Error analysis from simulations and evaluation of field data indicate Jimsphere 1 σ measurement accuracy for typical KMR measurement scenarios, using either the MPS-36, TRADEX, or ALCOR radar and 91-m smoothing, is approximately 0.3 m/sec. For the rawinsonde data, peak differences on the order of 5 m/sec are observed between the GMD-1 and radar results; however, these differences are largely due to the differences in smoothing (~600 m for GMD-1 data versus 91 m for radar data) or, in essence, the improved observability of the fine structure of the wind field, possible when using the lighter smoothing. As indicated in Table E1, rms differences between the rawinsonde GMD-1 and radar wind estimates for the TDV measurements were on the order of 1 to 2 m/sec, which is consistent with the IRIG GMD-1 accuracy statement. The Jimsphere and rawinsonde data are generally in good agreement, with rms differences of the wind speed component estimates on the order of 1 to 2 m/sec. There are, however, significant differences (as large as 8 m/sec), especially in the fine structure, which are much greater than those expected due

to sensor error. These differences are most likely indicative of time space variability effects between the Jimsphere and rawinsonde measurements.

The ALTAIR wind measurements included in Figure E4 also provide indications of temporal variability effects, since these data correspond to two sequences of measurements conducted approximately 3 hours apart. As noted in Table E1, the rms variability of the wind speed component estimates for the two ALTAIR measurements are on the order of 2 m/sec. These variability estimates are also in good agreement with those obtained for a 2-hour-measurement separation experienced on TDV-1 between the Jimsphere and the closest rawinsonde measurement. The comparisons of the Jimsphere, rawinsonde, and ALTAIR wind measurements in Figure E4 also illustrate generally good agreement of the three types of measurements that were made relatively close together in time and space. However, there are regions of significant differences in excess of 8 m/sec in the 5 to 10 km and 16 to 19 km intervals. In the low-altitude interval, the differences are most significant between the ALTAIR measurements and the Jimsphere and rawinsonde results, with the latter two measurements indicating good agreement with each other. MIT Lincoln Laboratory, which performed the ALTAIR wind data reduction on this first operational wind measurement, has noted that for the 5 to 10 km interval the ALTAIR results are more uncertain than at other altitudes due to ducting and/or low measurement-signal-to-noise effects. For the 16 to 19 km interval, the observed differences are believed to be indicative of wind variability effects and not measurement errors.

Table E1. Sensor Measurement Variability

Jimsphere				
<u>Mission</u>	<u>Sensor</u>	rms Variability (m/sec)		
		<u>V_{wx}</u>	<u>V_{wy}</u>	
TDV-1	MPS-36 w/r TRADEX	.6	.4	
TDV-2	MPS-36 w/r TRADEX	.2	.2	
ABRV-1	MPS-36 w/r ALCOR	.3	.2	
Rawinsonde				
TDV-1	MPS-36 w/r GMD-1	1.3	1.9	
TDV-2	MPS-36 w/r GMD-1	.8	.9	
TDV-3	MPS-36 w/r GMD-1	1.3	1.0	
Measurement Time-Space Variability				
Jimsphere w/r Closest Rawinsonde (4.6 to 18.3 km)				
<u>Mission</u>	<u>Δ Time (hr:min)</u>	<u>Δ Space (km)</u>	rms Variability (m/sec)	
			<u>V_{wx}</u>	<u>V_{wy}</u>
TDV-1	2:08	14-19	2.3	1.6
TDV-2	:51	14-19	1.2	1.2
TDV-3	:28	14-19	1.3	.9
ABRV-1	1:14	<4	2.0	1.6
ALTAIR Pre-Mission w/r Post-Mission Wind Scans (1.5 to 19.2 km)				
ABRV-1	2:54	0	2.2	1.9

Symbols and Abbreviations

b	subscript indicating base or reference level
C_s	speed of sound
e	vapor pressure
G	Newton's universal gravitational constant
g	acceleration due to gravity
g_ϕ	acceleration due to gravity at sea level for latitude (ϕ)
H	geopotential altitude
H_b	geopotential altitude of base of layer
h	$H - H_b$
K	degrees in thermodynamic Kelvin scale
kg	kilogram (mass)
km	kilometer
L	gradient of molecular-scale temperature with geopotential altitude
LST	Local Standard Time
M	mean molecular weight of air
M_0	sea-level value of mean molecular weight
m	meter

m'	geopotential meter
mb	millibar
o	subscript indicating sea-level value
P	pressure
R^*	universal gas constant
r_ϕ	effective earth radius at latitude (ϕ)
S	Sutherland's constant
SD	standard deviation
sec	second
T	temperature in K
T_M	molecular-scale temperature in K
T_{MV}	molecular-scale virtual temperature in K
w	east/west wind component
v	north/south wind component
Z	geometric altitude
β	a constant
γ	ratio of specific heats
μ	coefficient of viscosity
ρ	mass density
ϕ	geographic latitude

DATA
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