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KWAJALEIN REFERENCE ATMOSPHERES, 1979

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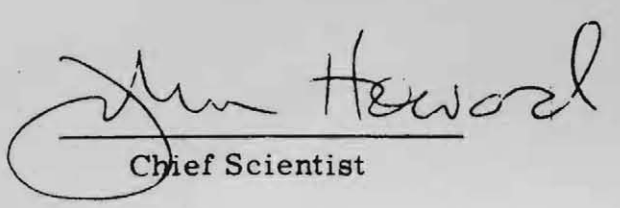

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Measurements of atmospheric temperature, density, and wind have been used to derive consistent hydrostatic models representative of the atmospheric properties at Kwajalein Atoll, Marshall Islands. A mean annual model and 12 monthly models of thermodynamic properties have been constructed between altitudes of 0 and 120 km, using data available up to 1979. Below an altitude of 60 km, the models are based on a data base that is large enough for the monthly variations to be statistically significant. Above 60 km the

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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.

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.

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Illustrations

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 Salah[1] 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 midseason 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:

$$\rho = \frac{MP}{R^{*}T_{v}} , \qquad (1)$$

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 (8.31432×10^3 N · m/(kmol · 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

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

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

$$T_M = \left(\frac{M_o}{M}\right) T \quad , \tag{3}$$

where M_o 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 m/sec^2. It was obtained from the following expression by Lambert (Ref. 4) in which gravity (g_ϕ) varies with latitude (ϕ):

$$g_\phi = 9.780356\,(1 + 0.0052885 \sin^2 \phi - 0.0000059 \sin^2 2\phi) \quad . \tag{4}$$

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, 1976[3]:

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

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

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

$$dP = -\rho g dZ , \tag{6}$$

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, 1976[3]:

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

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

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:

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

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

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:

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

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:

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

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 IRIG[2] 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) observations[6] 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 observations[9] 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, 1966[10] 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 moledular-scale temperature profiles are defined in Table 2 for altitudes from the surface to 120 km. To obtain

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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	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	257.15	66.0	229.15	71.0	214.15	78.5	197.65	84.0	197.65	92.0	181.65	100.0	181.65
		105.0	195.15	115.0	335.15	120.0	360.15								
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	235.15	42.5	263.15	46.5	271.15
		50.0	271.15	55.0	260.15	80.0	190.15	100.0	180.15	105.0	195.15	115.0	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	256.15	67.5	223.15	75.0	197.65	90.0	185.65	100.0	180.65	105.0	195.15
		115.0	335.15	120.0	360.15										
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
		90.0	187.15	100.0	180.15	110.0	240.15	120.0	360.15						
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	26.0	225.15	33.0	239.15	43.0	265.15
		47.0	269.15	50.0	269.15	55.0	263.15	70.0	203.15	80.0	194.15	90.0	194.15	100.0	180.15
		110.0	230.15	120.0	360.15										
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
		105.0	195.15	115.0	335.15	120.0	360.15								
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
		97.0	182.15	100.0	181.15	110.0	240.15	120.0	360.15						
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
		105.0	195.15	115.0	335.15	120.0	360.15								
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	258.15	60.0	243.65	70.0	210.65	75.0	197.15	80.0	197.15	85.0	188.15
		90.0	192.15	100.0	182.15	105.0	195.15	115.0	335.15	120.0	360.15				
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
		115.0	335.15	120.0	360.15										

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.

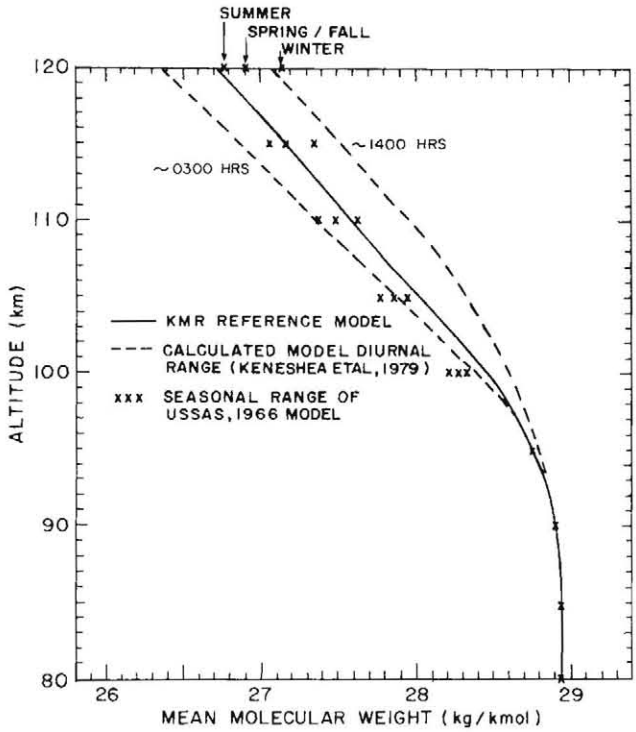

Figure 1. Molecular Weights for Altitudes Between 80 and 120 km

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^{o}S), Ft. Sherman (9^{o}N), and Antigua (17^{o}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

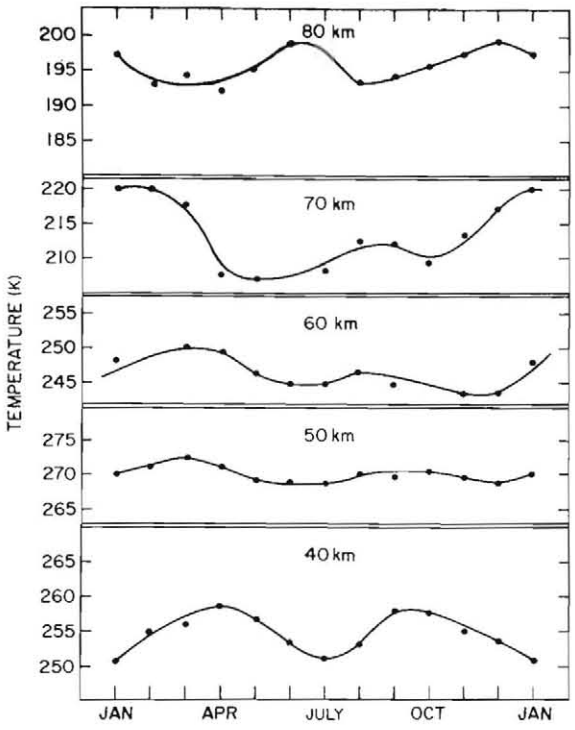

Figure 2. Annual Variation of Mean Monthly Temperatures (shown by dots) for KMR Reference Atmospheres

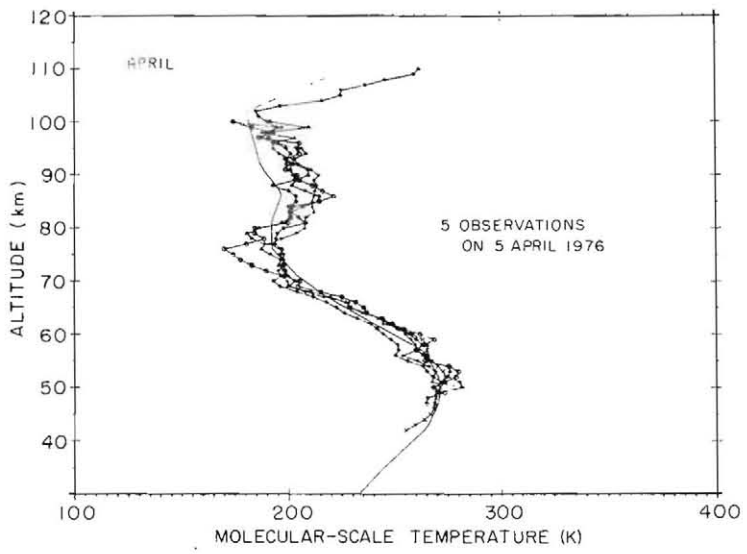

Figure 3. Molecular-Scale Temperature Profiles Derived From Five ROBIN Measurements and One Hypersonic Sphere Measurement at KMR on 5 April 1978, and the Molecular-Scale Temperature Profile (solid line) Adopted for the April Reference Atmosphere

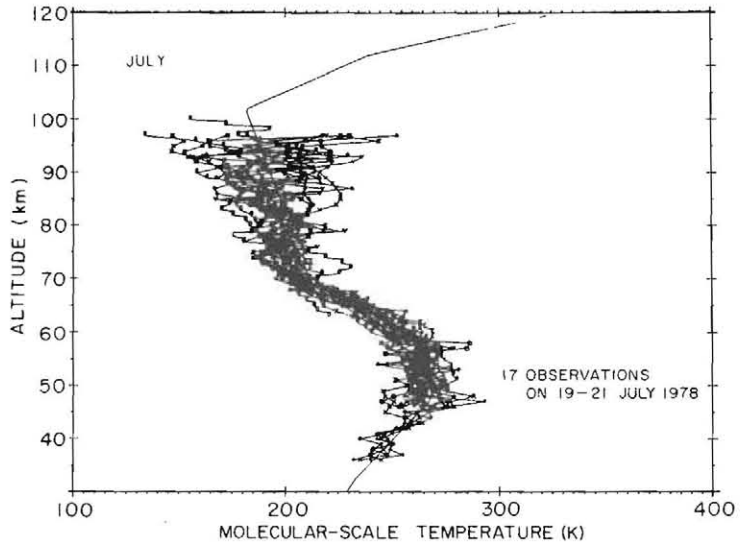

Figure 4. Molecular-Scale Temperature Profiles Derived From 17 ROBIN Sphere Measurements at KMR on 19-21 July 1978, and the Molecular-Scale, Temperature Profile (solid line) Adopted for the July Reference Atmosphere

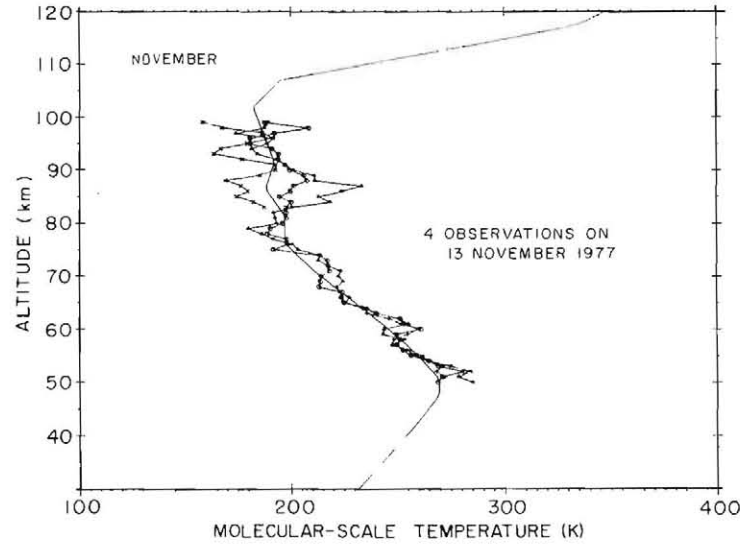

Figure 5. Molecular-Scale Temperature Profiles Derived From Four ROBIN Sphere Measurements at KMR on 13 November 1977, and the Molecular-Scale Temperature Profile (solid line) for the November Reference Atmosphere

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.

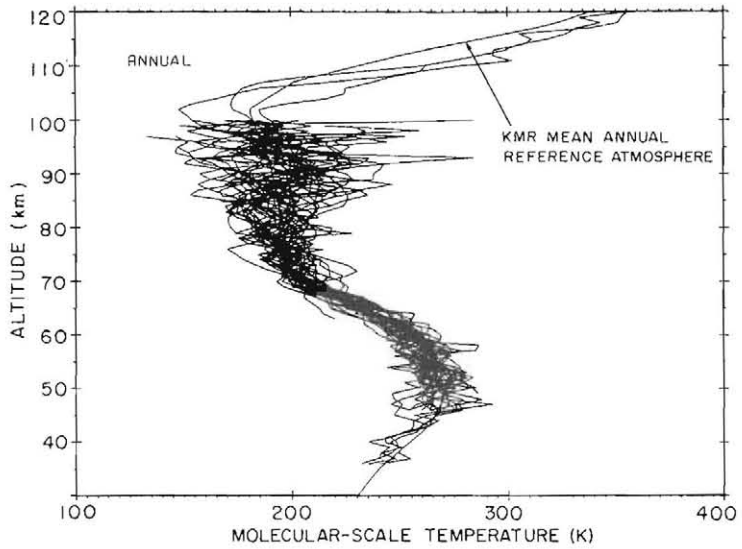

Figure 6. Molecular-Scale Temperature Profiles Derived From 35 ROBIN, 2 AFGL Sphere Measurements, and 1 Hypersonic Sphere Measurement at KMR, and the Molecular-Scale Temperature Profile Adopted for the Mean Annual Reference Atmosphere for KMR

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.

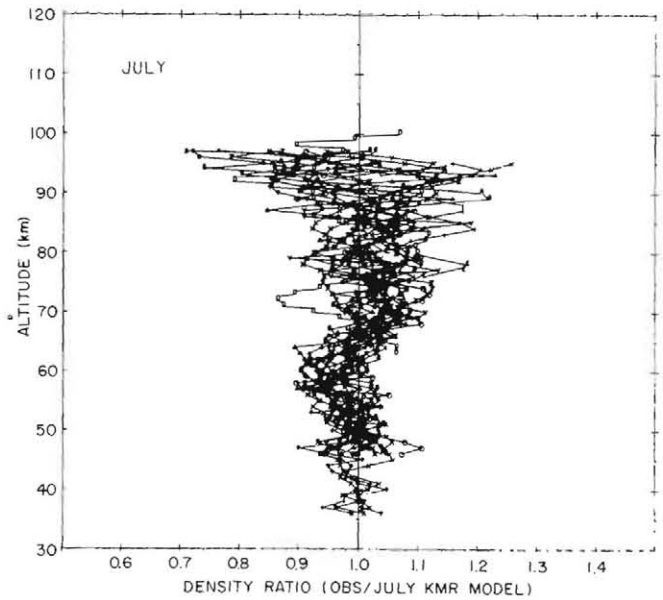

Figure 10. Density Profiles Derived From 17 ROBIN Sphere Measurements at KMR on 19-21 July 1978, Plotted as Percent Departures From the Densities in the KMR Reference Atmosphere for July

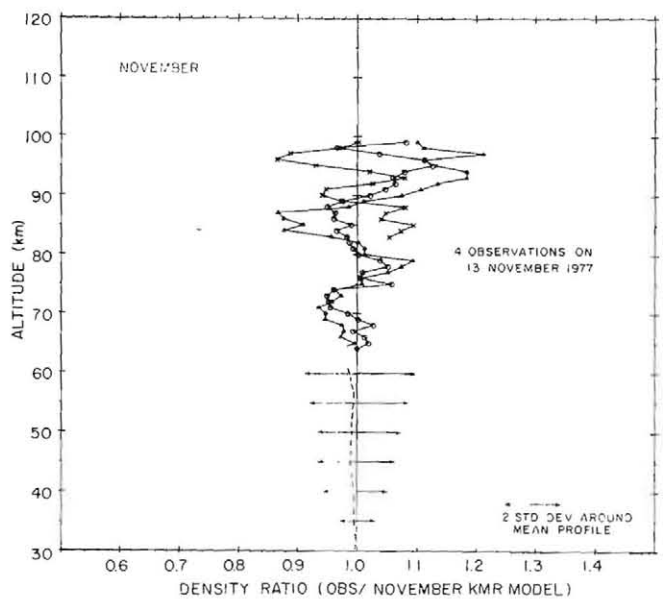

Figure 11. Density Profiles Derived From Four ROBIN Sphere Measurements at KMR on 13 November 1977, Plotted as Percent Departures From the Densities in the KMR Reference Atmosphere for November

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.

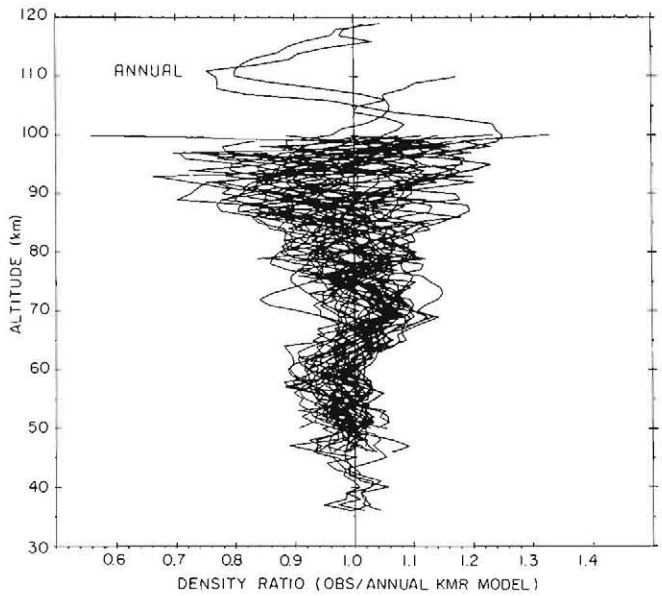

Figure 12. Density Profiles Derived From 35 ROBIN, 2 AFGL Measurements, and 1 Hypersonic Sphere Measurement, Plotted as Percent Departures From the Densities in the Mean Annual Reference Atmosphere for KMR

5. DAY-TO-DAY VARIABILITY

Sufficient radiosonde[2, 5] and MRN observations[6] 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:

$$\sigma_o = \sqrt{\sigma_A^2 + \sigma_E^2} \quad . \tag{12}$$

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 Ann. Density (kg/m^3)	SD (%)	No. Obs.	Kwajalein 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 SD (%)	Kourou No. Obs.	Kwajalein SD (%)	Kwajalein 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

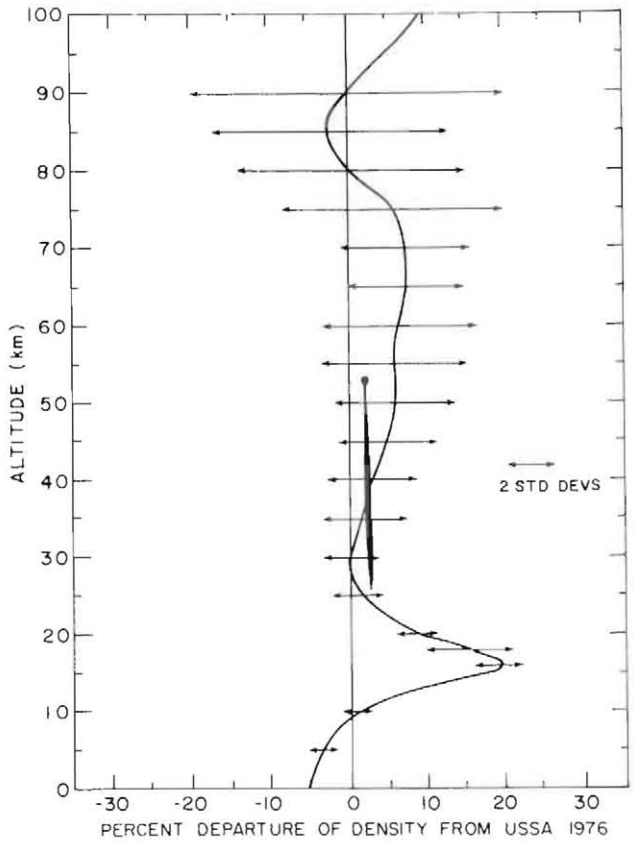

Figure 13. Density Profile of the Mean Annual KMR Reference Atmosphere Plotted as Percent Departure From the U.S. Standard Atmosphere, 1976, With Two Standard Deviations of the Day-to-Day Variations Around the Mean Annual Profile Shown by Horizontal Arrows

6. DIURNAL VARIABILITY

6.1 Surface to 60 km

Studies based on radiosonde observations taken at KMR[12] have shown that there are no significant diurnal variations in density for altitudes up to 30 km. However, an analysis of observations[13] 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 analysis[14] 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

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

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 Amp (%)	Diurnal Phase (LST)	Semidiurnal Amp (%)	Semidiurnal Phase (LST)	Reduction in Variance (%)
			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 Amp (^{o}K)	Diurnal Phase (LST)	Semidiurnal Amp (^{o}K)	Semidiurnal Phase (LST)	Reduction in Variance (%)
			TEMPERATURE (^{o}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 Amp (m/sec)	Diurnal Phase (LST)	Semidiurnal Amp (m/sec)	Semidiurnal Phase (LST)	Reduction in Variance (%)
			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 Amp (m/sec)	Diurnal Phase (LST)	Semidiurnal Amp (m/sec)	Semidiurnal Phase (LST)	Reduction in Variance (%)
			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

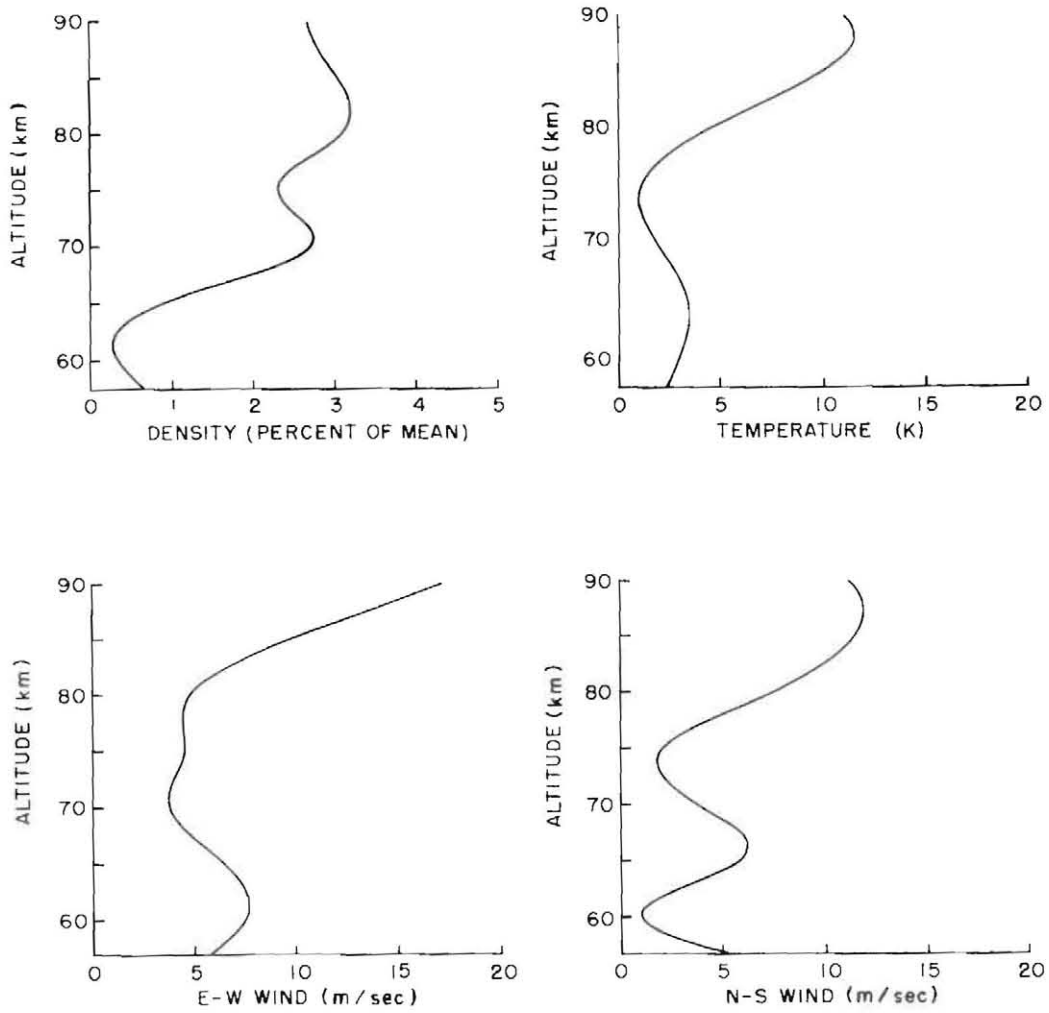

Figure 14. Amplitude of the Diurnal Oscillations in Density, Temperature, and Wind at Altitudes of 60 to 90 km

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.

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

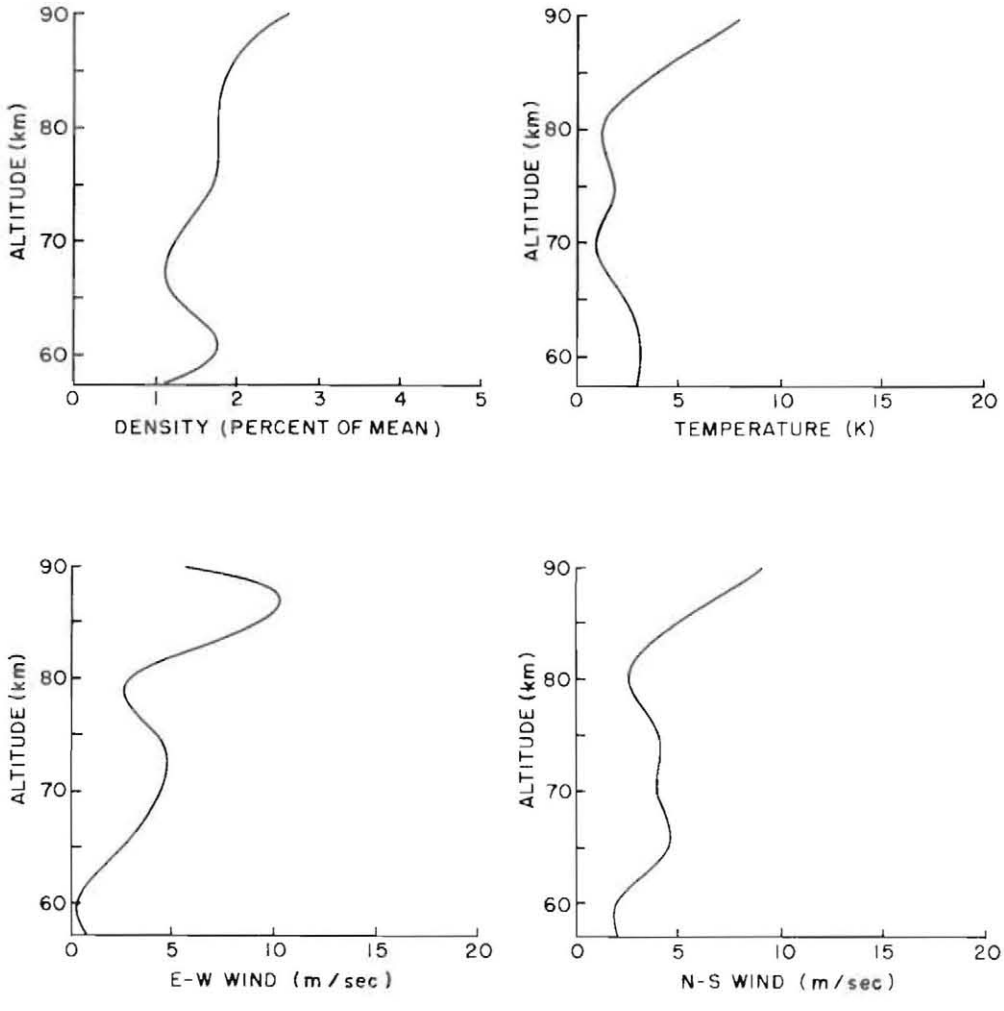

Figure 15. Amplitude of the Semidiurnal Oscillations in Density, Temperature, and Wind at Altitudes of 60 to 90 km

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

Estimates[14] 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 analysis[13] 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	100	200	50	100	200	50	100	200	50	100	200
	(n miles)			(n miles)			(n miles)			(n miles)		
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

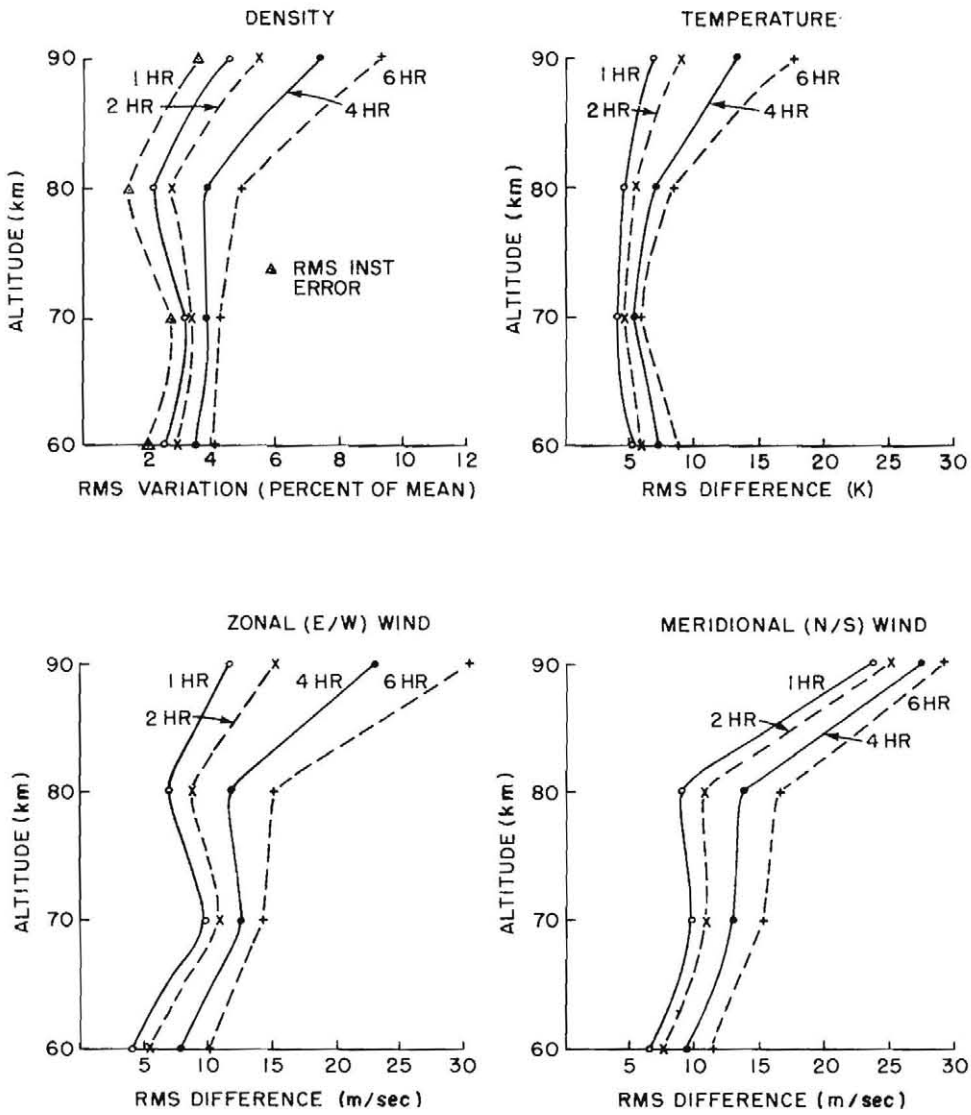

Figure 16. The rms Variations in Density, Temperature, and Wind for Time Lags of 1 to 6 Hours

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	1.0098 + 3	1.1595 + 0	9.7816	349.17	1.8620 - 5
1.000	294.85	9.0106 + 2	1.0646	9.7785	344.23	1.8215
2.000	290.16	8.0202	9.6292 - 1	9.7754	341.48	1.7990
3.000	285.77	7.1258	8.6867	9.7723	338.89	1.7779
4.000	279.90	6.3178	7.8634	9.7692	335.38	1.7493
5.000	274.01	5.5873	7.1036	9.7661	331.84	1.7203
6.000	268.09	4.9283	6.4042	9.7631	328.23	1.6909
7.000	262.16	4.3350	5.7605	9.7600	324.59	1.6612
8.000	255.11	3.8011	5.1906	9.7569	320.19	1.6253
9.000	248.02	3.3207	4.6642	9.7538	315.71	1.5889
10.000	240.94	2.8899 + 2	4.1783 - 1	9.7507	311.17	1.5520 - 5
11.000	233.03	2.5040	3.7434	9.7477	306.02	1.5102
12.000	225.08	2.1590	3.3417	9.7446	300.75	1.4675
13.000	217.13	1.8517	2.9710	9.7415	295.40	1.4242
14.000	209.18	1.5792	2.6300	9.7385	289.94	1.3803
15.000	201.24	1.3386	2.3172	9.7354	284.38	1.3356
16.000	195.14	1.1280	2.0137	9.7323	280.04	1.3008
17.000	191.65	9.4600 + 1	1.7196	9.7293	277.52	1.2807
18.000	193.42	7.9294	1.4281	9.7262	278.80	1.2909
19.000	197.79	6.6684	1.1745	9.7231	281.93	1.3159
20.000	202.15	5.6295 + 1	9.7014 - 2	9.7201	285.02	1.3407 - 5
21.000	206.51	4.7698	8.0464	9.7170	288.08	1.3653
22.000	210.87	4.0557	6.7003	9.7140	291.11	1.3897
23.000	214.33	3.4597	5.6233	9.7109	293.49	1.4088
24.000	216.21	2.9567	4.7639	9.7079	294.77	1.4192
25.000	218.09	2.5303	4.0418	9.7048	296.05	1.4295
26.000	219.97	2.1684	3.4342	9.7018	297.32	1.4398
27.000	221.85	1.8609	2.9221	9.6987	298.59	1.4501
28.000	223.73	1.5991	2.4899	9.6957	299.85	1.4603
29.000	225.61	1.3759	2.1245	9.6926	301.11	1.4704
30.000	227.49	1.1854 + 1	1.8153 - 2	9.6896	302.36	1.4805 - 5
31.000	229.36	1.0226	1.5531	9.6865	303.60	1.4906
32.000	231.24	8.8322 + 0	1.3306	9.6835	304.84	1.5007
33.000	233.26	7.6380	1.1407	9.6804	306.17	1.5114
34.000	235.73	6.6151	9.7759 - 3	9.6774	307.79	1.5245
35.000	238.20	5.7376	8.3919	9.6744	309.39	1.5376
36.000	240.66	4.9846	7.2154	9.6713	310.99	1.5505
37.000	243.13	4.3366	6.2138	9.6683	312.58	1.5635
38.000	245.59	3.7783	5.3595	9.6653	314.16	1.5763
39.000	248.06	3.2966	4.6297	9.6622	315.73	1.5891
40.000	250.52	2.8803 + 0	4.0053 - 3	9.6592	317.30	1.6018 - 5
41.000	252.98	2.5200	3.4701	9.6562	318.85	1.6145
42.000	255.44	2.2077	3.0108	9.6531	320.40	1.6271
43.000	257.90	1.9366	2.6159	9.6501	321.94	1.6396
44.000	260.36	1.7010	2.2760	9.6471	323.47	1.6521
45.000	262.82	1.4960	1.9829	9.6441	324.99	1.6645
46.000	265.28	1.3173	1.7298	9.6411	326.51	1.6769
47.000	267.74	1.1613	1.5110	9.6380	328.02	1.6892
48.000	270.15	1.0250	1.3218	9.6350	329.49	1.7012
49.000	270.15	9.0529 - 1	1.1674	9.6320	329.49	1.7012
50.000	270.15	7.9957 - 1	1.0311 - 3	9.6290	329.49	1.7012 - 5
51.000	270.15	7.0622	9.1069 - 4	9.6260	329.49	1.7012
52.000	268.99	6.2371	8.0776	9.6229	326.79	1.6954
53.000	266.44	5.5031	7.1952	9.6199	327.23	1.6827
54.000	263.89	4.8499	6.4024	9.6169	325.66	1.6699
55.000	261.34	4.2691	5.6907	9.6139	324.08	1.6570
56.000	258.80	3.7533	5.0524	9.6109	322.50	1.6441
57.000	256.18	3.2958	4.4818	9.6079	320.86	1.6308
58.000	253.44	2.8901	3.9727	9.6049	319.14	1.6168
59.000	250.69	2.5309	3.5170	9.6019	317.41	1.6027

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 - 1	3.1095 - 4	9.5989	315.67	1.5885 - 5
61.000	245.21	1.9326	2.7455	9.5959	313.92	1.5743
62.000	242.47	1.6850	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	9.5886 - 2	1.4428	9.5809	305.03	1.5022
67.000	228.76	8.2944	1.2631	9.5779	303.21	1.4874
68.000	225.83	7.1621	1.1048	9.5749	301.26	1.4716
69.000	222.90	6.1729	9.6473 - 5	9.5719	299.30	1.4558
70.000	219.98	5.3100 - 2	8.4093 - 5	9.5689	297.33	1.4398 - 5
71.000	217.05	4.5588	7.3170	9.5660	295.34	1.4238
72.000	214.13	3.9060	6.3546	9.5630	293.35	1.4077
73.000	211.99	3.3407	5.4899	9.5600	291.88	1.3959
74.000	209.84	2.8528	4.7360	9.5570	290.40	1.3839
75.000	207.70	2.4323	4.0797	9.5540	288.91	1.3720
76.000	205.55	2.0705	3.5090	9.5510	287.41	1.3600
77.000	203.41	1.7596	3.0136	9.5481	285.91	1.3479
78.000	201.27	1.4929	2.5840	9.5451	284.40	1.3358
79.000	199.13	1.2645	2.2121	9.5421	282.89	1.3236
80.000	197.65	1.0692 - 2	1.8846 - 5	9.5391	281.83	1.3152 - 5
81.000	197.65	9.0378 - 3	1.5930	9.5362	281.83	1.3152
82.000	197.65	7.6397	1.3465	9.5332	281.83	1.3152
83.000	197.65	6.4583	1.1383	9.5302	281.83	1.3152
84.000	197.65	5.4598	9.6232 - 6	9.5273	281.83	1.3152
85.000	197.65	4.6159	8.1358	9.5243	281.83	1.3152
86.000	196.39	3.9014	6.9205	9.5212		
87.000	194.45	3.2924	5.8986	9.5184		
88.000	192.51	2.7739	5.0198	9.5154		
89.000	190.57	2.3331	4.2651	9.5124		
90.000	188.63	1.9590 - 3	3.6181 - 6	9.5095		
91.000	186.69	1.6420	3.0642	9.5065		
92.000	184.75	1.3739	2.5907	9.5036		
93.000	182.81	1.1474	2.1866	9.5006		
94.000	181.65	9.5667 - 4	1.8347	9.4976		
95.000	181.65	7.9738	1.5292	9.4947		
96.000	181.65	6.6466	1.2747	9.4917		
97.000	181.65	5.5406	1.0626	9.4888		
98.000	181.65	4.6189	8.8581 - 7	9.4858		
99.000	181.65	3.8507	7.3849	9.4829		
100.000	181.65	3.2105 - 4	6.1571 - 7	9.4799		
101.000	181.65	2.6769	5.1337	9.4770		
102.000	181.99	2.2321	4.2727	9.4741		
103.000	184.60	1.8644	3.5183	9.4711		
104.000	187.21	1.5612	2.9052	9.4682		
105.000	189.81	1.3106	2.4054	9.4652		
106.000	192.42	1.1030	1.9969	9.4623		
107.000	195.02	9.3041 - 5	1.6620	9.4594		
108.000	208.00	7.8987	1.3229	9.4564		
109.000	221.50	6.7752	1.0656	9.4535		
110.000	234.99	5.8647 - 5	8.6942 - 8	9.4506		
111.000	248.48	5.1179	7.1752	9.4476		
112.000	261.97	4.4987	5.9824	9.4447		
113.000	275.45	3.9802	5.0339	9.4418		
114.000	288.93	3.5423	4.2710	9.4388		
115.000	302.40	3.1694	3.6512	9.4359		
116.000	315.87	2.8497	3.1429	9.4330		
117.000	329.33	2.5737	2.7225	9.4301		
118.000	337.88	2.3331	2.4055	9.4271		
119.000	342.69	2.1185	2.1536	9.4242		
120.000	347.49	1.9263 - 5	1.9311 - 8	9.4213		

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	303.34	1.0096 + 3	1.1594 + 0	9.7816	349.15	1.8618 - 5
1.000	294.56	9.0083 + 2	1.0654	9.7785	344.06	1.8202
2.000	290.21	8.0177	9.6246 - 1	9.7754	341.51	1.7993
3.000	285.48	7.1232	8.6923	9.7723	338.72	1.7765
4.000	279.79	6.3150	7.8628	9.7692	335.32	1.7488
5.000	274.10	5.5848	7.0982	9.7661	331.89	1.7208
6.000	268.24	4.9264	6.3979	9.7631	328.33	1.6917
7.000	262.39	4.3337	5.7538	9.7600	324.73	1.6623
8.000	255.42	3.8005	5.1834	9.7569	320.39	1.6270
9.000	248.43	3.3209	4.6567	9.7538	315.97	1.5910
10.000	241.44	2.8907 + 2	4.1710 - 1	9.7507	311.49	1.5546 - 5
11.000	233.43	2.5054	3.7391	9.7477	306.28	1.5123
12.000	225.38	2.1607	3.3398	9.7446	300.96	1.4692
13.000	217.33	1.8535	2.9711	9.7415	295.54	1.4254
14.000	209.29	1.5809	2.6315	9.7385	290.01	1.3809
15.000	201.25	1.3401	2.3198	9.7354	284.39	1.3356
16.000	195.14	1.1293	2.0161	9.7323	280.04	1.3008
17.000	191.65	9.4708 + 1	1.7215	9.7293	277.52	1.2807
18.000	193.46	7.9385	1.4295	9.7262	278.83	1.2912
19.000	197.93	6.6766	1.1751	9.7231	282.03	1.3167
20.000	202.39	5.6372 + 1	9.7034 - 2	9.7201	285.19	1.3421 - 5
21.000	206.85	4.7775	8.0463	9.7170	288.32	1.3672
22.000	211.30	4.0635	6.6993	9.7140	291.41	1.3921
23.000	214.90	3.4676	5.6242	9.7109	293.88	1.4120
24.000	216.98	2.9649	4.7601	9.7079	295.30	1.4234
25.000	219.06	2.5389	4.0376	9.7048	296.71	1.4348
26.000	221.14	2.1774	3.4302	9.7018	298.11	1.4462
27.000	223.21	1.8702	2.9188	9.6987	299.51	1.4575
28.000	225.29	1.6087	2.4875	9.6957	300.90	1.4687
29.000	227.37	1.3857	2.1231	9.6926	302.28	1.4799
30.000	229.44	1.1953 + 1	1.8146 - 2	9.6896	303.66	1.4910 - 5
31.000	231.52	1.0325	1.5536	9.6865	305.03	1.5021
32.000	233.59	8.9303 + 0	1.3318	9.6835	306.39	1.5132
33.000	235.84	7.7346	1.1425	9.6804	307.86	1.5251
34.000	238.60	6.7098	9.7966 - 3	9.6774	309.66	1.5397
35.000	241.36	5.8305	8.4154	9.6744	311.44	1.5542
36.000	244.12	5.0748	7.2418	9.6713	313.22	1.5687
37.000	246.88	4.4241	6.2427	9.6683	314.99	1.5830
38.000	249.64	3.8629	5.3905	9.6653	316.74	1.5973
39.000	252.40	3.3781	4.6624	9.6622	318.49	1.6115
40.000	255.16	2.9585 + 0	4.0392 - 3	9.6592	320.22	1.6256 - 5
41.000	257.92	2.5949	3.5049	9.6562	321.95	1.6397
42.000	260.68	2.2792	3.0460	9.6531	323.67	1.6537
43.000	263.35	2.0048	2.6520	9.6501	325.32	1.6672
44.000	265.32	1.7654	2.3180	9.6471	326.53	1.6771
45.000	267.29	1.5561	2.0282	9.6441	327.74	1.6869
46.000	269.25	1.3730	1.7764	9.6411	328.95	1.6967
47.000	271.15	1.2125	1.5578	9.6380	330.10	1.7062
48.000	271.15	1.0713	1.3764	9.6350	330.10	1.7062
49.000	271.15	9.4661 - 1	1.2162	9.6320	330.10	1.7062
50.000	271.15	8.3644 - 1	1.0746 - 3	9.6290	330.10	1.7062 - 5
51.000	270.13	7.3904	9.5309 - 4	9.6260	329.48	1.7011
52.000	267.97	6.5245	8.4820	9.6229	328.16	1.6903
53.000	265.81	5.7545	7.5417	9.6199	326.84	1.6795
54.000	263.66	5.0703	6.6994	9.6169	325.51	1.6687
55.000	261.50	4.4631	5.9457	9.6139	324.18	1.6578
56.000	259.12	3.9245	5.2761	9.6109	322.70	1.6458
57.000	256.38	3.4465	4.6831	9.6079	320.99	1.6318
58.000	253.64	3.0226	4.1515	9.6049	319.26	1.6178
59.000	250.89	2.6472	3.6756	9.6019	317.53	1.6037

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 - 1	3.2501 - 4	9.5989	315.79	1.5896 - 5
61.000	245.41	2.0218	2.8700	9.5959	314.05	1.5754
62.000	242.67	1.7630	2.5309	9.5929	312.29	1.5611
63.000	239.93	1.5350	2.2288	9.5899	310.52	1.5467
64.000	237.20	1.3345	1.9595	9.5869	308.74	1.5323
65.000	234.46	1.1583	1.7210	9.5839	306.96	1.5178
66.000	231.72	1.0037	1.5090	9.5809	305.16	1.5032
67.000	228.99	8.6635 - 2	1.3211	9.5779	303.36	1.4886
68.000	226.25	7.4997	1.1547	9.5749	301.54	1.4739
69.000	223.52	6.4660	1.0078	9.5719	299.71	1.4591
70.000	220.79	5.5649 - 2	8.7805 - 5	9.5689	297.87	1.4443 - 5
71.000	218.06	4.7807	7.6376	9.5660	296.03	1.4293
72.000	215.33	4.0993	6.6321	9.5630	294.17	1.4143
73.000	212.60	3.5083	5.7489	9.5600	292.30	1.3992
74.000	209.87	2.9966	4.9743	9.5570	290.41	1.3841
75.000	207.14	2.5544	4.2961	9.5540	288.52	1.3688
76.000	204.41	2.1730	3.7034	9.5510	286.61	1.3535
77.000	201.68	1.8446	3.1862	9.5481	284.70	1.3381
78.000	198.96	1.5624	2.7358	9.5451	282.77	1.3226
79.000	196.23	1.3205	2.3442	9.5421	280.82	1.3071
80.000	193.51	1.1134 - 2	2.0044 - 5	9.5391	278.87	1.2914 - 5
81.000	190.79	9.3660 - 3	1.7102	9.5362	276.90	1.2757
82.000	189.78	7.8644	1.4436	9.5332	276.16	1.2698
83.000	189.29	6.6005	1.2147	9.5302	275.81	1.2670
84.000	188.81	5.5376	1.0218	9.5273	275.46	1.2642
85.000	188.32	4.6440	8.5908 - 6	9.5243	275.10	1.2614
86.000	187.83	3.8930	7.2202	9.5213		
87.000	187.35	3.2622	6.0659	9.5184		
88.000	186.86	2.7325	5.0941	9.5154		
89.000	186.38	2.2878	4.2763	9.5124		
90.000	185.89	1.9148 - 3	3.5883 - 6	9.5095		
91.000	185.41	1.6019	3.0098	9.5065		
92.000	184.92	1.3396	2.5236	9.5036		
93.000	184.44	1.1198	2.1150	9.5006		
94.000	183.96	9.3564 - 4	1.7719	9.4976		
95.000	183.47	7.8146	1.4838	9.4947		
96.000	182.99	6.5241	1.2420	9.4917		
97.000	182.50	5.4444	1.0392	9.4888		
98.000	182.02	4.5415	8.6919 - 7	9.4858		
99.000	181.54	3.7867	7.2666	9.4829		
100.000	181.05	3.1560 - 4	6.0725 - 7	9.4799		
101.000	180.57	2.6292	5.0724	9.4770		
102.000	180.53	2.1894	4.2250	9.4741		
103.000	183.43	1.8263	3.4686	9.4711		
104.000	186.33	1.5279	2.8566	9.4682		
105.000	189.22	1.2818	2.3598	9.4652		
106.000	192.12	1.0782	1.9552	9.4623		
107.000	195.01	9.0941 - 5	1.6246	9.4594		
108.000	208.00	7.7204	1.2930	9.4564		
109.000	221.50	6.6222	1.0415	9.4535		
110.000	234.99	5.7324 - 5	8.4980 - 8	9.4506		
111.000	248.48	5.0024	7.0133	9.4476		
112.000	261.97	4.3972	5.8474	9.4447		
113.000	275.45	3.8904	4.9203	9.4418		
114.000	288.93	3.4623	4.1746	9.4388		
115.000	302.40	3.0979	3.5688	9.4359		
116.000	315.87	2.7854	3.0720	9.4330		
117.000	329.33	2.5156	2.6610	9.4301		
118.000	337.88	2.2805	2.3513	9.4271		
119.000	342.69	2.0707	2.1050	9.4242		
120.000	347.49	1.8828 - 5	1.8876 - 8	9.4213		

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

	MAR 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/M**2
0.000	303.94	1.0107 + 3	1.1584 + 0	9.7816	349.49	1.8646 - 5
1.000	295.12	9.0202 + 2	1.0648	9.7785	344.39	1.8228
2.000	289.93	8.0287	9.6478 - 1	9.7754	341.34	1.7980
3.000	285.12	7.1321	8.7141	9.7723	338.50	1.7747
4.000	278.45	6.3206	7.9076	9.7692	334.51	1.7422
5.000	271.75	5.5851	7.1598	9.7661	330.47	1.7092
6.000	266.82	4.9223	6.4266	9.7631	327.46	1.6846
7.000	261.93	4.3282	5.7566	9.7600	324.44	1.6600
8.000	254.97	3.7947	5.1849	9.7569	320.10	1.6246
9.000	247.95	3.3150	4.6575	9.7538	315.67	1.5885
10.000	240.94	2.8848 + 2	4.1711 - 1	9.7507	311.17	1.5520 - 5
11.000	233.03	2.4997	3.7369	9.7477	306.02	1.5102
12.000	225.08	2.1552	3.3358	9.7446	300.75	1.4675
13.000	217.13	1.8485	2.9658	9.7415	295.40	1.4242
14.000	209.18	1.5765	2.6254	9.7385	289.94	1.3803
15.000	202.52	1.3365	2.2991	9.7354	285.28	1.3428
16.000	197.56	1.1281	1.9093	9.7323	281.77	1.3146
17.000	192.59	9.4817 + 1	1.7151	9.7293	278.21	1.2861
18.000	192.15	7.9488	1.4411	9.7262	277.89	1.2836
19.000	197.52	6.6785	1.1779	9.7231	281.74	1.3144
20.000	203.47	5.6404 + 1	9.6574 - 2	9.7201	285.95	1.3482 - 5
21.000	209.41	4.7872	7.9638	9.7170	290.10	1.3815
22.000	212.15	4.0777	6.6960	9.7140	291.59	1.3967
23.000	214.42	3.4795	5.6530	9.7109	293.55	1.4094
24.000	216.70	2.9742	4.7813	9.7079	295.10	1.4219
25.000	216.98	2.5466	4.0513	9.7048	296.65	1.4344
26.000	221.25	2.1840	3.4388	9.7018	298.19	1.4468
27.000	223.53	1.8762	2.9240	9.6987	299.72	1.4592
28.000	225.80	1.6142	2.4904	9.6957	301.24	1.4715
29.000	228.08	1.3910	2.1247	9.6926	302.75	1.4837
30.000	230.35	1.2005 + 1	1.8156 - 2	9.6896	304.26	1.4959 - 5
31.000	232.62	1.0376	1.5540	9.6865	305.75	1.5080
32.000	234.89	8.9818 + 0	1.3321	9.6835	307.24	1.5201
33.000	237.16	7.7858	1.1436	9.6804	308.72	1.5321
34.000	239.43	6.7585	9.8334 - 3	9.6774	310.20	1.5441
35.000	241.70	5.8749	8.4675	9.6744	311.66	1.5560
36.000	243.97	5.1137	7.3019	9.6713	313.12	1.5679
37.000	246.72	4.4574	6.2938	9.6683	314.88	1.5822
38.000	249.68	3.8919	5.4302	9.6653	316.76	1.5975
39.000	252.64	3.4037	4.6934	9.6622	318.63	1.6127
40.000	255.59	2.9815 + 0	4.0637 - 3	9.6592	320.49	1.6278 - 5
41.000	258.55	2.6157	3.5244	9.6562	322.34	1.6429
42.000	261.50	2.2983	3.0618	9.6531	324.18	1.6578
43.000	264.45	2.0225	2.6643	9.6501	326.00	1.6727
44.000	266.47	1.7821	2.3298	9.6471	327.24	1.6828
45.000	267.85	1.5715	2.0439	9.6441	328.09	1.6897
46.000	269.22	1.3867	1.7944	9.6411	328.93	1.6966
47.000	270.60	1.2245	1.5764	9.6380	329.77	1.7034
48.000	271.97	1.0820	1.3859	9.6350	330.60	1.7103
49.000	272.65	9.5657 - 1	1.2222	9.6320	331.02	1.7136
50.000	272.65	8.4582 - 1	1.0807 - 3	9.6290	331.02	1.7136 - 5
51.000	271.63	7.4784	9.5911 - 4	9.6260	330.40	1.7086
52.000	269.47	6.6067	8.5411	9.6229	329.08	1.6978
53.000	267.31	5.8311	7.5992	9.6199	327.76	1.6870
54.000	265.16	5.1415	6.7551	9.6169	326.43	1.6762
55.000	263.00	4.5290	5.9991	9.6139	325.10	1.6654
56.000	260.84	3.9855	5.3228	9.6109	323.77	1.6545
57.000	258.69	3.5036	4.7182	9.6079	322.43	1.6436
58.000	256.53	3.0767	4.1782	9.6049	321.08	1.6326
59.000	253.49	2.6986	3.7086	9.6019	319.17	1.6171

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

MAR 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
60.000	250.26	2.3630 - 1	3.2894 - 4	9.5989	317.13	1.6005 - 5
61.000	247.03	2.0857	2.9131	9.5959	315.08	1.5838
62.000	243.80	1.8027	2.5758	9.5929	313.01	1.5670
63.000	240.57	1.5704	2.2740	9.5899	310.93	1.5501
64.000	237.35	1.3655	2.0042	9.5869	308.84	1.5331
65.000	234.12	1.1851	1.7635	9.5839	306.74	1.5160
66.000	230.90	1.0266	1.5489	9.5809	304.62	1.4988
67.000	227.67	8.8758 - 2	1.3581	9.5779	302.48	1.4815
68.000	224.45	7.6580	1.1886	9.5749	300.34	1.4642
69.000	221.17	6.5934	1.0385	9.5719	298.13	1.4464
70.000	217.85	5.6643 - 2	9.0578 - 5	9.5689	295.89	1.4282 - 5
71.000	214.54	4.8550	7.8837	9.5660	293.63	1.4100
72.000	211.22	4.1516	6.8473	9.5630	291.35	1.3916
73.000	207.91	3.5415	5.9342	9.5600	289.05	1.3731
74.000	204.59	3.0135	5.1312	9.5570	286.74	1.3545
75.000	201.28	2.5576	4.4266	9.5540	284.41	1.3358
76.000	197.97	2.1648	3.8095	9.5510	282.06	1.3170
77.000	196.95	1.8290	3.2353	9.5481	281.33	1.3111
78.000	196.17	1.5443	2.7425	9.5451	280.77	1.3067
79.000	195.39	1.3031	2.3234	9.5421	280.22	1.3022
80.000	194.61	1.0989 - 2	1.9671 - 5	9.5391	279.66	1.2977 - 5
81.000	193.83	9.2611 - 3	1.6645	9.5362	279.10	1.2933
82.000	193.05	7.7999	1.4075	9.5332	278.54	1.2888
83.000	192.28	6.5651	1.1895	9.5302	277.98	1.2843
84.000	191.50	5.5222	1.0046	9.5273	277.41	1.2798
85.000	190.72	4.6419	8.4788 - 6	9.5243	276.85	1.2753
86.000	189.95	3.8995	7.1518	9.5213		
87.000	189.17	3.2736	6.0285	9.5184		
88.000	188.39	2.7463	5.0784	9.5154		
89.000	187.62	2.3024	4.2752	9.5124		
90.000	186.84	1.9290 - 3	3.5967 - 6	9.5095		
91.000	186.06	1.6150	3.0238	9.5065		
92.000	185.42	1.3513	2.5387	9.5036		
93.000	184.94	1.1301	2.1287	9.5006		
94.000	184.46	9.4472 - 4	1.7842	9.4976		
95.000	183.97	7.8942	1.4948	9.4947		
96.000	183.49	6.5938	1.2519	9.4917		
97.000	183.00	5.5053	1.0480	9.4888		
98.000	182.52	4.5946	8.7694 - 7	9.4858		
99.000	182.04	3.8328	7.3350	9.4829		
100.000	181.55	3.1961 - 4	6.1327 - 7	9.4799		
101.000	181.07	2.6639	5.1252	9.4770		
102.000	181.02	2.2195	4.2714	9.4741		
103.000	183.82	1.8522	3.5102	9.4711		
104.000	186.62	1.5500	2.8935	9.4682		
105.000	189.42	1.3006	2.3921	9.4652		
106.000	192.22	1.0943	1.9832	9.4623		
107.000	195.02	9.2298 - 5	1.6488	9.4594		
108.000	208.00	7.8356	1.3123	9.4564		
109.000	221.50	6.7211	1.0571	9.4535		
110.000	234.99	5.8179 - 5	8.6248 - 8	9.4506		
111.000	248.48	5.0771	7.1179	9.4476		
112.000	261.97	4.4628	5.9346	9.4447		
113.000	275.45	3.9484	4.9937	9.4418		
114.000	288.93	3.5140	4.2369	9.4388		
115.000	302.40	3.1441	3.6221	9.4359		
116.000	315.87	2.8270	3.1178	9.4330		
117.000	329.33	2.5532	2.7008	9.4301		
118.000	337.88	2.3145	2.3863	9.4271		
119.000	342.69	2.1016	2.1364	9.4242		
120.000	347.49	1.9109 - 5	1.9157 - 8	9.4213		

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

APR 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	304.23	1.0108 + 3	1.1574 + 0	9.7816	349.66	1.8659 - 5
1.000	295.58	9.0224 + 2	1.0634	9.7785	344.66	1.8250
2.000	290.26	8.0319	9.6399 - 1	9.7754	341.54	1.7995
3.000	285.18	7.1355	8.7166	9.7723	338.53	1.7750
4.000	279.46	6.3250	7.8845	9.7692	335.13	1.7472
5.000	273.75	5.5929	7.1174	9.7661	331.68	1.7190
6.000	267.78	4.9325	6.4171	9.7631	328.04	1.6894
7.000	261.80	4.3380	5.7724	9.7600	324.36	1.6594
8.000	254.38	3.8027	5.2077	9.7569	319.73	1.6216
9.000	246.92	3.3205	4.6847	9.7538	315.01	1.5832
10.000	239.46	2.8875 + 2	4.2008 - 1	9.7507	310.21	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	1.8448	2.9804	9.7415	294.37	1.4160
14.000	207.68	1.5715	2.6361	9.7385	288.96	1.3719
15.000	199.74	1.3304	2.3204	9.7354	283.32	1.3271
16.000	197.77	1.1215	1.9756	9.7323	281.92	1.3159
17.000	196.28	9.4427 + 1	1.6759	9.7293	280.86	1.3074
18.000	196.15	7.9445	1.4110	9.7262	280.76	1.3066
19.000	200.18	6.6949	1.1651	9.7231	283.63	1.3296
20.000	204.64	5.6633 + 1	9.6411 - 2	9.7201	286.77	1.3548 - 5
21.000	209.10	4.8083	8.0109	9.7170	289.88	1.3798
22.000	213.55	4.0967	6.6829	9.7140	292.95	1.4045
23.000	216.21	3.5002	5.6396	9.7109	294.77	1.4192
24.000	218.59	2.9958	4.7746	9.7079	296.38	1.4322
25.000	220.96	2.5686	4.0497	9.7048	297.99	1.4452
26.000	223.34	2.2060	3.4411	9.7018	299.59	1.4581
27.000	225.71	1.8978	2.9291	9.6987	301.18	1.4710
28.000	228.08	1.6353	2.4976	9.6957	302.76	1.4837
29.000	230.46	1.4113	2.1334	9.6926	304.33	1.4965
30.000	232.83	1.2199 + 1	1.8252 - 2	9.6896	305.89	1.5091 - 5
31.000	235.20	1.0560	1.5642	9.6865	307.44	1.5217
32.000	237.57	9.1557 + 0	1.3426	9.6835	308.99	1.5343
33.000	239.94	7.9495	1.1542	9.6804	310.52	1.5467
34.000	242.31	6.9120	9.9376 - 3	9.6774	312.05	1.5592
35.000	244.76	6.0185	8.5661	9.6744	313.63	1.5720
36.000	247.52	5.2485	7.3867	9.6713	315.39	1.5863
37.000	250.28	4.5841	6.3805	9.6683	317.15	1.6006
38.000	253.04	4.0100	5.5205	9.6653	318.89	1.6148
39.000	255.80	3.5130	4.7841	9.6622	320.63	1.6289
40.000	258.56	3.0821 + 0	4.1525 - 3	9.6592	322.35	1.6429 - 5
41.000	261.32	2.7079	3.6099	9.6562	324.06	1.6569
42.000	264.08	2.3825	3.1429	9.6531	325.77	1.6708
43.000	265.87	2.0987	2.7499	9.6501	326.87	1.6798
44.000	267.05	1.8500	2.4133	9.6471	327.60	1.6857
45.000	268.23	1.6317	2.1192	9.6441	328.32	1.6916
46.000	269.41	1.4400	1.8621	9.6411	329.04	1.6975
47.000	270.59	1.2716	1.6371	9.6380	329.76	1.7034
48.000	271.15	1.1235	1.4434	9.6350	330.10	1.7062
49.000	271.15	9.9269 - 1	1.2754	9.6320	330.10	1.7062
50.000	271.15	8.7716 - 1	1.1270 - 3	9.6290	330.10	1.7062 - 5
51.000	271.15	7.7511	9.9584 - 4	9.6260	330.10	1.7062
52.000	270.53	6.8491	8.8198	9.6229	329.72	1.7031
53.000	269.15	6.0490	7.8293	9.6199	328.89	1.6962
54.000	267.78	5.3393	6.9461	9.6169	328.05	1.6894
55.000	266.41	4.7099	6.1589	9.6139	327.20	1.6825
56.000	265.04	4.1523	5.4578	9.6109	326.36	1.6756
57.000	262.55	3.6580	4.8536	9.6079	324.83	1.6631
58.000	258.05	3.2167	4.3426	9.6049	322.03	1.6403
59.000	253.54	2.8223	3.8779	9.6019	319.21	1.6173

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

APR 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	249.04	2.4706 - 1	3.4560 - 4	9.5989	316.36	1.5942 - 5
61.000	244.54	2.1576	3.0737	9.5959	313.49	1.5708
62.000	240.04	1.8796	2.7278	9.5929	310.59	1.5473
63.000	235.54	1.6332	2.4155	9.5899	307.66	1.5236
64.000	231.04	1.4153	2.1340	9.5869	304.71	1.4996
65.000	226.54	1.2231	1.8808	9.5839	301.73	1.4755
66.000	222.05	1.0539	1.6535	9.5809	298.72	1.4511
67.000	217.70	9.0548 - 2	1.4490	9.5779	295.78	1.4274
68.000	214.28	7.7589	1.2614	9.5749	293.45	1.4086
69.000	210.86	6.6322	1.0957	9.5719	291.10	1.3896
70.000	207.45	5.6550 - 2	9.4964 - 5	9.5689	288.73	1.3706 - 5
71.000	204.07	4.8092	8.2098	9.5660	286.37	1.3516
72.000	201.73	4.0809	7.0473	9.5630	284.73	1.3384
73.000	199.39	3.4564	6.0389	9.5600	283.07	1.3251
74.000	197.05	2.9219	5.1657	9.5570	281.41	1.3117
75.000	194.71	2.4652	4.4107	9.5540	279.73	1.2983
76.000	192.37	2.0758	3.7591	9.5510	278.05	1.2849
77.000	192.15	1.7458	3.1652	9.5481	277.89	1.2836
78.000	192.15	1.4684	2.6621	9.5451	277.89	1.2836
79.000	192.15	1.2351	2.2392	9.5421	277.89	1.2836
80.000	192.15	1.0389 - 2	1.8835 - 5	9.5391	277.89	1.2836 - 5
81.000	192.15	8.7392 - 3	1.5844	9.5362	277.89	1.2836
82.000	192.90	7.3538	1.3281	9.5332	278.42	1.2879
83.000	193.87	6.1935	1.1129	9.5302	279.12	1.2935
84.000	194.84	5.2211	9.3352 - 6	9.5273	279.82	1.2991
85.000	195.81	4.4053	7.8375	9.5243	280.52	1.3046
86.000	196.78	3.7203	6.5862	9.5213		
87.000	195.95	3.1431	5.5880	9.5184		
88.000	194.01	2.6516	4.7614	9.5154		
89.000	192.07	2.2333	4.0507	9.5124		
90.000	190.13	1.8778 - 3	3.4406 - 6	9.5095		
91.000	188.19	1.5761	2.9177	9.5065		
92.000	186.83	1.3208	2.4627	9.5036		
93.000	186.16	1.1060	2.0697	9.5006		
94.000	185.48	9.2557 - 4	1.7384	9.4976		
95.000	184.80	7.7411	1.4593	9.4947		
96.000	184.12	6.4706	1.2242	9.4917		
97.000	183.45	5.4053	1.0265	9.4888		
98.000	182.77	4.5126	8.6013 - 7	9.4858		
99.000	182.09	3.7650	7.2031	9.4829		
100.000	181.41	3.1394 - 4	6.0285 - 7	9.4799		
101.000	180.74	2.6161	5.0424	9.4770		
102.000	180.91	2.1787	4.1954	9.4741		
103.000	186.71	1.8207	3.3971	9.4711		
104.000	192.50	1.5299	2.7686	9.4682		
105.000	198.29	1.2923	2.2703	9.4652		
106.000	204.08	1.0969	1.8725	9.4623		
107.000	209.87	9.3546 - 5	1.5528	9.4594		
108.000	215.66	8.0125	1.2943	9.4564		
109.000	221.44	6.8914	1.0841	9.4535		
110.000	227.23	5.9506 - 5	9.1231 - 8	9.4506		
111.000	233.01	5.1574	7.7108	9.4476		
112.000	238.79	4.4859	6.5445	9.4447		
113.000	244.98	3.9186	5.4828	9.4418		
114.000	260.53	3.4439	4.6051	9.4388		
115.000	272.08	3.0439	3.8974	9.4359		
116.000	283.62	2.7043	3.3216	9.4330		
117.000	295.16	2.4140	2.8491	9.4301		
118.000	306.70	2.1644	2.4584	9.4271		
119.000	318.24	1.9484	2.1329	9.4242		
120.000	329.77	1.7607 - 5	1.8600 - 8	9.4213		

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	1.0110 + 3	1.1569 + 0	9.7816	349.78	1.8669 - 5
1.000	296.14	9.0257 + 2	1.0617	9.7785	344.98	1.8277
2.000	290.83	8.0367	9.6267 - 1	9.7754	341.87	1.8023
3.000	285.44	7.1410	8.7153	9.7723	338.69	1.7763
4.000	279.59	6.3304	7.8878	9.7692	335.20	1.7478
5.000	273.73	5.5977	7.1241	9.7661	331.67	1.7189
6.000	267.79	4.9368	6.4224	9.7631	328.05	1.6894
7.000	261.84	4.3419	5.7766	9.7600	324.39	1.6596
8.000	254.73	3.8064	5.2056	9.7569	319.95	1.6234
9.000	247.59	3.3247	4.6780	9.7538	315.43	1.5867
10.000	240.45	2.8925 + 2	4.1908 - 1	9.7507	310.85	1.5494 - 5
11.000	232.62	2.5056	3.7523	9.7477	305.75	1.5080
12.000	224.77	2.1599	3.3476	9.7446	300.55	1.4659
13.000	216.92	1.8522	2.9745	9.7415	295.26	1.4231
14.000	209.08	1.5794	2.6316	9.7385	289.87	1.3797
15.000	201.23	1.3387	2.3175	9.7354	284.38	1.3356
16.000	196.97	1.1289	1.9966	9.7323	281.35	1.3113
17.000	194.65	9.4904 + 1	1.6985	9.7293	279.69	1.2980
18.000	196.67	7.9769	1.4130	9.7262	281.13	1.3095
19.000	201.62	6.7290	1.1626	9.7231	284.65	1.3378
20.000	206.58	5.7001 + 1	9.6124 - 2	9.7201	288.13	1.3657 - 5
21.000	211.54	4.8478	7.9837	9.7170	291.57	1.3934
22.000	214.41	4.1359	6.7200	9.7140	293.54	1.4093
23.000	216.98	3.5354	5.6762	9.7109	295.30	1.4234
24.000	219.56	3.0275	4.8043	9.7079	297.04	1.4375
25.000	222.13	2.5980	4.0745	9.7048	298.78	1.4516
26.000	224.70	2.2332	3.4623	9.7018	300.50	1.4655
27.000	226.78	1.9228	2.9537	9.6987	301.89	1.4768
28.000	228.76	1.6578	2.5245	9.6957	303.20	1.4874
29.000	230.74	1.4311	2.1607	9.6926	304.51	1.4980
30.000	232.71	1.2371 + 1	1.8519 - 2	9.6896	305.81	1.5085 - 5
31.000	234.69	1.0708	1.5894	9.6865	307.11	1.5190
32.000	236.67	9.2793 + 0	1.3659	9.6835	308.40	1.5295
33.000	238.64	8.0515	1.1754	9.6804	309.68	1.5399
34.000	241.05	6.9954	1.0110	9.6774	311.24	1.5526
35.000	243.62	6.0870	8.7042 - 3	9.6744	312.90	1.5660
36.000	246.18	5.3045	7.5063	9.6713	314.54	1.5794
37.000	248.75	4.6294	6.4834	9.6683	316.17	1.5927
38.000	251.31	4.0460	5.6087	9.6653	317.80	1.6059
39.000	253.87	3.5412	4.8593	9.6622	319.41	1.6190
40.000	256.43	3.1036 + 0	4.2163 - 3	9.6592	321.02	1.6321 - 5
41.000	258.99	2.7237	3.6637	9.6562	322.62	1.6451
42.000	261.55	2.3936	3.1880	9.6531	324.21	1.6581
43.000	264.11	2.1061	2.7780	9.6501	325.79	1.6710
44.000	265.73	1.8553	2.4323	9.6471	326.79	1.6791
45.000	266.72	1.6353	2.1360	9.6441	327.39	1.6841
46.000	267.70	1.4422	1.8767	9.6411	328.00	1.6890
47.000	268.68	1.2724	1.6498	9.6380	328.60	1.6939
48.000	269.15	1.1232	1.4537	9.6350	328.88	1.6962
49.000	269.15	9.9149 - 1	1.2833	9.6320	328.88	1.6962
50.000	269.15	8.7530 - 1	1.1329 - 3	9.6290	328.88	1.6962 - 5
51.000	268.59	7.7270	1.0022	9.6260	328.54	1.6934
52.000	267.42	6.8183	8.8824 - 4	9.6229	327.82	1.6876
53.000	266.24	6.0135	7.8685	9.6199	327.10	1.6817
54.000	265.06	5.3008	6.9668	9.6169	326.38	1.6758
55.000	263.89	4.6702	6.1654	9.6139	325.65	1.6699
56.000	261.68	4.1121	5.4743	9.6109	324.29	1.6587
57.000	257.76	3.6148	4.8855	9.6079	321.85	1.6389
58.000	253.84	3.1715	4.3525	9.6049	319.39	1.6189
59.000	249.93	2.7771	3.8709	9.6019	316.92	1.5987

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	3.0448	9.5959	311.92	1.5581
62.000	238.18	1.8410	2.6927	9.5929	309.39	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	8.8594 - 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	4.7045	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	3.6008	9.5510	282.61	1.3214
77.000	197.86	1.7369	3.0582	9.5481	281.98	1.3164
78.000	196.98	1.4676	2.5955	9.5451	281.36	1.3113
79.000	196.11	1.2392	2.2014	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 - 3	1.5803	9.5362	279.47	1.2963
82.000	194.15	7.4303	1.3332	9.5332	279.33	1.2951
83.000	194.15	6.2623	1.1237	9.5302	279.33	1.2951
84.000	194.15	5.2781	9.4706 - 6	9.5273	279.33	1.2951
85.000	194.15	4.4488	7.9826	9.5243	279.33	1.2951
86.000	194.15	3.7501	6.7288	9.5213		
87.000	194.15	3.1612	5.6722	9.5184		
88.000	194.15	2.6650	4.7818	9.5154		
89.000	194.15	2.2467	4.0314	9.5124		
90.000	194.15	1.8943 - 3	3.3989 - 6	9.5095		
91.000	194.15	1.5972	2.8658	9.5065		
92.000	193.52	1.3465	2.4240	9.5036		
93.000	192.16	1.1342	2.0561	9.5006		
94.000	190.81	9.5415 - 4	1.7421	9.4976		
95.000	189.45	8.0177	1.4743	9.4947		
96.000	188.09	6.7292	1.2463	9.4917		
97.000	186.74	5.6410	1.0523	9.4888		
98.000	185.39	4.7229	8.8751 - 7	9.4858		
99.000	184.03	3.9493	7.4760	9.4829		
100.000	182.68	3.2983 - 4	6.2898 - 7	9.4799		
101.000	181.33	2.7510	5.2854	9.4770		
102.000	181.78	2.2917	4.4161	9.4741		
103.000	185.61	1.9139	3.5921	9.4711		
104.000	190.44	1.6059	2.9377	9.4682		
105.000	195.27	1.3535	2.4147	9.4652		
106.000	200.09	1.1456	1.9945	9.4623		
107.000	204.92	9.7350 - 5	1.6550	9.4594		
108.000	209.74	8.3046	1.3794	9.4564		
109.000	214.56	7.1103	1.1545	9.4535		
110.000	219.38	6.1091 - 5	9.7010 - 8	9.4506		
111.000	224.20	5.2664	8.1832	9.4476		
112.000	229.01	4.5546	6.9282	9.4447		
113.000	233.71	3.9563	5.7496	9.4418		
114.000	252.23	3.4611	4.7803	9.4388		
115.000	264.74	3.0476	4.0104	9.4359		
116.000	277.25	2.6995	3.3920	9.4330		
117.000	289.75	2.4040	2.8904	9.4301		
118.000	302.25	2.1515	2.4798	9.4271		
119.000	314.74	1.9342	2.1409	9.4242		
120.000	327.23	1.7462 - 5	1.8590 - 8	9.4213		

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	9.0231 + 2	1.0610	9.7785	345.05	1.8283
2.000	290.71	8.0344	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	331.49	1.7175
6.000	267.48	4.9332	6.4252	9.7631	327.86	1.6879
7.000	261.52	4.3380	5.7786	9.7600	324.19	1.6579
8.000	254.35	3.8024	5.2078	9.7569	319.71	1.6215
9.000	247.15	3.3204	4.6802	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	2.5010	3.7534	9.7477	305.42	1.5054
12.000	224.27	2.1552	3.3477	9.7446	300.21	1.4632
13.000	216.42	1.8475	2.9738	9.7415	294.91	1.4204
14.000	208.58	1.5748	2.6303	9.7385	289.52	1.3769
15.000	200.73	1.3342	2.3156	9.7354	284.02	1.3327
16.000	196.47	1.1247	1.9942	9.7323	280.99	1.3084
17.000	196.15	9.4620 + 1	1.6805	9.7293	280.76	1.3066
18.000	199.76	7.9721	1.3903	9.7262	283.34	1.3272
19.000	203.73	6.7397	1.1525	9.7231	286.14	1.3497
20.000	207.69	5.7166 + 1	9.5886 - 2	9.7201	288.91	1.3719 - 5
21.000	211.66	4.8642	8.0060	9.7170	291.65	1.3940
22.000	214.89	4.1511	6.7297	9.7140	293.87	1.4119
23.000	216.87	3.5489	5.7009	9.7109	295.22	1.4228
24.000	218.85	3.0386	4.8369	9.7079	296.56	1.4337
25.000	220.83	2.6054	4.1101	9.7048	297.90	1.4445
26.000	222.80	2.2371	3.4978	9.7018	299.23	1.4552
27.000	224.78	1.9236	2.9811	9.6987	300.56	1.4660
28.000	226.76	1.6562	2.5444	9.6957	301.88	1.4766
29.000	228.74	1.4280	2.1748	9.6926	303.19	1.4873
30.000	230.71	1.2328 + 1	1.8615 - 2	9.6896	304.50	1.4979 - 5
31.000	232.69	1.0657	1.5955	9.6865	305.80	1.5084
32.000	234.67	9.2243 + 0	1.3694	9.6835	307.09	1.5189
33.000	236.64	7.9941	1.1769	9.6804	308.38	1.5294
34.000	238.73	6.9367	1.0122	9.6774	309.74	1.5404
35.000	241.20	6.0276	8.7059 - 3	9.6744	311.34	1.5534
36.000	243.66	5.2454	7.4994	9.6713	312.92	1.5662
37.000	246.13	4.5713	6.4702	9.6683	314.50	1.5791
38.000	248.59	3.9894	5.5907	9.6653	316.07	1.5919
39.000	251.06	3.4865	4.8379	9.6622	317.64	1.6046
40.000	253.52	3.0511 + 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	1.5949	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	328.88	1.6962
49.000	269.15	9.6556 - 1	1.2498	9.6320	328.88	1.6962
50.000	269.15	8.5242 - 1	1.1033 - 3	9.6290	328.88	1.6962 - 5
51.000	267.99	7.5235	9.7799 - 4	9.6260	328.18	1.6904
52.000	266.82	6.6369	8.6655	9.6229	327.45	1.6846
53.000	265.64	5.8518	7.6743	9.6199	326.73	1.6787
54.000	264.46	5.1569	6.7930	9.6169	326.01	1.6728
55.000	263.29	4.5421	6.0099	9.6139	325.28	1.6668
56.000	259.85	3.9965	5.3579	9.6109	323.15	1.6495
57.000	256.13	3.5102	4.7743	9.6079	320.83	1.6306
58.000	252.41	3.0773	4.2472	9.6049	318.49	1.6115
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 DUE TO GRAVITY M/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M**2
60.000	244.97	2.3514 - 1	3.3440 - 4	9.5989	313.76	1.5730 - 5
61.000	241.25	2.0493	2.9592	9.5959	311.37	1.5536
62.000	237.53	1.7822	2.6139	9.5929	308.96	1.5341
63.000	233.81	1.5466	2.3044	9.5899	306.54	1.5144
64.000	230.10	1.3392	2.0276	9.5869	304.09	1.4946
65.000	226.38	1.1569	1.7803	9.5839	301.63	1.4746
66.000	222.67	9.9710 - 2	1.5600	9.5809	299.14	1.4545
67.000	218.96	8.5724	1.3639	9.5779	296.64	1.4343
68.000	215.25	7.3513	1.1898	9.5749	294.11	1.4139
69.000	211.54	6.2876	1.0355	9.5719	291.57	1.3934
70.000	207.83	5.3633 - 2	8.9900 - 5	9.5689	289.00	1.3727 - 5
71.000	204.28	4.5622	7.7799	9.5660	286.52	1.3528
72.000	200.87	3.8702	6.7121	9.5630	284.12	1.3335
73.000	197.46	3.2742	5.7765	9.5600	281.70	1.3141
74.000	195.88	2.7630	4.9140	9.5570	280.57	1.3050
75.000	196.37	2.3317	4.1366	9.5540	280.92	1.3078
76.000	196.85	1.9686	3.4839	9.5510	281.27	1.3106
77.000	197.34	1.6629	2.9355	9.5481	281.61	1.3134
78.000	197.83	1.4053	2.4746	9.5451	281.96	1.3162
79.000	198.31	1.1881	2.0871	9.5421	282.31	1.3190
80.000	198.80	1.0050 - 2	1.7611 - 5	9.5391	282.65	1.3217 - 5
81.000	199.15	8.5048 - 3	1.4877	9.5362	282.90	1.3237
82.000	199.15	7.1987	1.2592	9.5332	282.90	1.3237
83.000	199.15	6.0928	1.0658	9.5302	282.90	1.3237
84.000	199.15	5.1573	9.0216 - 6	9.5273	282.90	1.3237
85.000	198.49	4.3649	7.6609	9.5243	282.43	1.3200
86.000	197.52	3.6916	6.5109	9.5213		
87.000	196.55	3.1197	5.5295	9.5184		
88.000	195.58	2.6344	4.6924	9.5154		
89.000	194.61	2.2228	3.9790	9.5124		
90.000	193.64	1.8740 - 3	3.3715 - 6	9.5095		
91.000	192.67	1.5787	2.8545	9.5065		
92.000	191.70	1.3288	2.4148	9.5036		
93.000	190.73	1.1176	2.0413	9.5006		
94.000	189.76	9.3917 - 4	1.7241	9.4976		
95.000	188.79	7.8856	1.4551	9.4947		
96.000	187.82	6.6155	1.2270	9.4917		
97.000	186.86	5.5453	1.0338	9.4888		
98.000	185.89	4.6442	8.7034 - 7	9.4858		
99.000	184.92	3.8861	7.3208	9.4829		
100.000	183.96	3.2489 - 4	6.1526 - 7	9.4799		
101.000	182.99	2.7138	5.1664	9.4770		
102.000	182.48	2.2648	4.3238	9.4741		
103.000	184.99	1.8925	3.5639	9.4711		
104.000	187.50	1.5853	2.9454	9.4682		
105.000	190.01	1.3312	2.4406	9.4652		
106.000	192.52	1.1204	2.0274	9.4623		
107.000	195.03	9.4515 - 5	1.6883	9.4594		
108.000	208.80	8.0238	1.3438	9.4564		
109.000	221.50	6.8825	1.0825	9.4535		
110.000	234.99	5.9577 - 5	8.8320 - 8	9.4506		
111.000	248.48	5.1990	7.2885	9.4476		
112.000	261.97	4.5700	6.0772	9.4447		
113.000	275.45	4.0433	5.1136	9.4418		
114.000	288.93	3.5984	4.3387	9.4388		
115.000	302.40	3.2197	3.7091	9.4359		
116.000	315.87	2.8949	3.1927	9.4330		
117.000	329.33	2.6145	2.7656	9.4301		
118.000	337.88	2.3701	2.4437	9.4271		
119.000	342.69	2.1521	2.1878	9.4242		
120.000	347.49	1.9568 - 5	1.9617 - 8	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 + 3	1.1558 + 0	9.7816	349.76	1.8668 - 5
1.000	296.48	9.0168 + 2	1.0595	9.7765	345.18	1.8293
2.000	290.62	8.0290	9.6243 - 1	9.7754	341.75	1.8013
3.000	285.03	7.1332	8.7183	9.7723	338.45	1.7743
4.000	279.86	6.3233	7.8713	9.7692	335.36	1.7491
5.000	274.69	5.5930	7.0933	9.7661	332.25	1.7237
6.000	268.14	4.9342	6.4105	9.7631	328.27	1.6912
7.000	261.57	4.3396	5.7796	9.7600	324.22	1.6582
8.000	254.37	3.8038	5.2094	9.7569	319.73	1.6216
9.000	247.16	3.3217	4.6818	9.7538	315.16	1.5844
10.000	239.95	2.8892 + 2	4.1946 - 1	9.7507	310.53	1.5468 - 5
11.000	231.55	2.5015	3.7639	9.7477	305.05	1.5023
12.000	223.10	2.1544	3.3641	9.7446	299.43	1.4569
13.000	214.66	1.8449	2.9941	9.7415	293.71	1.4106
14.000	206.22	1.5702	2.6529	9.7385	287.88	1.3637
15.000	201.48	1.3293	2.2984	9.7354	284.55	1.3370
16.000	197.02	1.1213	1.9827	9.7323	281.38	1.3115
17.000	196.65	9.4375 + 1	1.6719	9.7292	281.12	1.3095
18.000	200.08	7.9543	1.3850	9.7262	283.56	1.3290
19.000	203.85	6.7260	1.1494	9.7231	286.22	1.3504
20.000	207.62	5.7051 + 1	9.5727 - 2	9.7201	288.85	1.3719 - 5
21.000	211.38	4.8537	7.9991	9.7170	291.46	1.3925
22.000	215.15	4.1414	6.7058	9.7140	294.04	1.4133
23.000	217.11	3.5416	5.6827	9.7109	295.38	1.4241
24.000	218.79	3.0325	4.8284	9.7079	296.52	1.4334
25.000	220.47	2.5998	4.1079	9.7048	297.66	1.4426
26.000	222.16	2.2315	3.4993	9.7018	298.80	1.4517
27.000	223.84	1.9177	2.9847	9.6987	299.92	1.4608
28.000	225.52	1.6500	2.5489	9.6957	301.05	1.4699
29.000	227.20	1.4213	2.1793	9.6926	302.17	1.4790
30.000	228.88	1.2257 + 1	1.8657 - 2	9.6896	303.28	1.4880 - 5
31.000	230.56	1.0583	1.5990	9.6865	304.39	1.4970
32.000	232.24	9.1468 + 0	1.3721	9.6835	305.50	1.5060
33.000	234.44	7.9155	1.1762	9.6804	306.94	1.5177
34.000	236.81	6.8600	1.0092	9.6774	308.49	1.5302
35.000	239.17	5.9541	8.6724 - 3	9.6744	310.03	1.5427
36.000	241.54	5.1752	7.4641	9.6713	311.56	1.5552
37.000	243.91	4.5046	6.4338	9.6683	313.08	1.5675
38.000	246.27	3.9263	5.5539	9.6653	314.60	1.5798
39.000	248.64	3.4269	4.8014	9.6622	316.10	1.5921
40.000	251.00	2.9950 + 0	4.1567 - 3	9.6592	317.60	1.6043 - 5
41.000	253.37	2.6209	3.6036	9.6562	319.10	1.6164
42.000	255.73	2.2965	3.1284	9.6531	320.58	1.6285
43.000	258.09	2.0148	2.7195	9.6501	322.06	1.6406
44.000	260.45	1.7698	2.3672	9.6471	323.53	1.6525
45.000	262.81	1.5565	2.0632	9.6441	324.99	1.6645
46.000	265.17	1.3705	1.8005	9.6411	326.45	1.6763
47.000	267.53	1.2082	1.5732	9.6380	327.89	1.6881
48.000	268.65	1.0661	1.3825	9.6350	328.58	1.6937
49.000	268.65	9.4093 - 1	1.2201	9.6320	328.58	1.6937
50.000	268.65	8.3046 - 1	1.0769 - 3	9.6290	328.58	1.6937 - 5
51.000	267.96	7.3294	9.5289 - 4	9.6260	328.15	1.6903
52.000	266.48	6.4651	8.4517	9.6229	327.25	1.6829
53.000	265.01	5.6990	7.4916	9.6199	326.35	1.6755
54.000	263.54	5.0204	6.6363	9.6169	325.44	1.6681
55.000	262.07	4.4196	5.8749	9.6139	324.53	1.6607
56.000	259.79	3.8878	5.2133	9.6109	323.12	1.6492
57.000	256.17	3.4146	4.6437	9.6079	320.85	1.6307
58.000	252.54	2.9937	4.1296	9.6049	318.57	1.6122
59.000	248.92	2.6197	3.6664	9.6019	316.28	1.5935

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 - 1	3.2495 - 4	9.5989	313.97	1.5748 - 5
61.000	241.67	1.9945	2.8750	9.5959	311.65	1.5559
62.000	238.05	1.7351	2.5391	9.5929	309.30	1.5368
63.000	234.44	1.5062	2.2382	9.5899	306.94	1.5177
64.000	230.82	1.3048	1.9692	9.5869	304.57	1.4984
65.000	227.20	1.1277	1.7291	9.5839	302.17	1.4790
66.000	223.54	9.7248 - 2	1.5155	9.5809	299.73	1.4592
67.000	219.63	8.3651	1.3268	9.5779	297.09	1.4380
68.000	215.73	7.1765	1.1589	9.5749	294.44	1.4165
69.000	211.82	6.1398	1.0098	9.5719	291.76	1.3950
70.000	207.92	5.2380 - 2	8.7762 - 5	9.5689	289.06	1.3732 - 5
71.000	204.11	4.4554	7.6043	9.5660	286.40	1.3518
72.000	202.94	3.7825	6.4931	9.5630	285.58	1.3452
73.000	201.77	3.2084	5.5396	9.5600	284.76	1.3386
74.000	200.60	2.7190	4.7219	9.5570	283.93	1.3320
75.000	199.43	2.3022	4.0214	9.5540	283.10	1.3253
76.000	198.26	1.9474	3.4218	9.5510	282.27	1.3187
77.000	198.15	1.6464	2.8946	9.5481	282.19	1.3180
78.000	198.15	1.3920	2.4473	9.5451	282.19	1.3180
79.000	198.15	1.1770	2.0693	9.5421	282.19	1.3180
80.000	198.15	9.9526 - 3	1.7498 - 5	9.5391	282.19	1.3180 - 5
81.000	198.15	8.4161	1.4796	9.5362	282.19	1.3180
82.000	198.15	7.1172	1.2513	9.5332	282.19	1.3180
83.000	198.15	6.0191	1.0582	9.5302	282.19	1.3180
84.000	198.15	5.0907	8.9500 - 6	9.5273	282.19	1.3180
85.000	197.49	4.3049	7.5938	9.5243	281.72	1.3143
86.000	196.52	3.6377	6.4486	9.5213		
87.000	195.55	3.0716	5.4720	9.5184		
88.000	194.58	2.5915	4.6397	9.5154		
89.000	193.61	2.1847	3.9310	9.5124		
90.000	192.64	1.8402 - 3	3.3279 - 6	9.5095		
91.000	191.67	1.5489	2.8151	9.5065		
92.000	190.70	1.3025	2.3791	9.5036		
93.000	189.73	1.0945	2.0096	9.5006		
94.000	188.76	9.1891 - 4	1.6959	9.4976		
95.000	187.79	7.7084	1.4300	9.4947		
96.000	186.82	6.4608	1.2047	9.4917		
97.000	185.86	5.4104	1.0141	9.4888		
98.000	184.89	4.5269	8.5295 - 7	9.4858		
99.000	183.92	3.7843	7.1678	9.4829		
100.000	182.96	3.1607 - 4	6.0184 - 7	9.4799		
101.000	181.99	2.6375	5.0488	9.4770		
102.000	181.90	2.1991	4.2116	9.4741		
103.000	187.60	1.8393	3.4156	9.4711		
104.000	193.30	1.5468	2.7877	9.4682		
105.000	198.99	1.3074	2.2888	9.4652		
106.000	204.68	1.1103	1.8898	9.4623		
107.000	210.38	9.4728 - 5	1.5686	9.4594		
108.000	216.07	8.1165	1.3086	9.4564		
109.000	221.75	6.9826	1.0969	9.4535		
110.000	227.44	6.0304 - 5	9.2366 - 8	9.4506		
111.000	233.13	5.2271	7.8110	9.4476		
112.000	238.81	4.5467	6.6325	9.4447		
113.000	248.98	3.9717	5.5572	9.4418		
114.000	260.53	3.4906	4.6675	9.4388		
115.000	272.08	3.0852	3.9502	9.4359		
116.000	283.62	2.7409	3.3666	9.4330		
117.000	295.16	2.4467	2.8878	9.4301		
118.000	306.70	2.1937	2.4917	9.4271		
119.000	318.24	1.9748	2.1618	9.4242		
120.000	329.77	1.7845 - 5	1.8852 - 8	9.4213		

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
0.000	304.62	1.0104 + 3	1.1555 + 0	9.7816	349.88	1.8678 - 5
1.000	296.30	9.0207 + 2	1.0606	9.7785	345.07	1.8285
2.000	290.65	8.0322	9.6272 - 1	9.7754	341.77	1.8014
3.000	285.14	7.1363	8.7187	9.7723	338.51	1.7748
4.000	279.24	6.3253	7.8913	9.7692	334.99	1.7460
5.000	273.33	5.5923	7.1276	9.7661	331.43	1.7170
6.000	267.37	4.9311	6.4251	9.7631	327.79	1.6873
7.000	261.40	4.3359	5.7784	9.7600	324.12	1.6573
8.000	254.27	3.8003	5.2067	9.7569	319.66	1.6211
9.000	247.11	3.3185	4.6784	9.7538	315.13	1.5842
10.000	239.95	2.8864 + 2	4.1908 - 1	9.7507	310.53	1.5468 - 5
11.000	232.03	2.4995	3.7527	9.7477	305.36	1.5049
12.000	224.08	2.1537	3.3483	9.7446	300.08	1.4621
13.000	216.13	1.8459	2.9753	9.7415	294.71	1.4187
14.000	208.18	1.5730	2.6323	9.7385	289.25	1.3747
15.000	200.24	1.3323	2.3178	9.7354	283.67	1.3299
16.000	197.35	1.1232	1.9826	9.7323	281.62	1.3135
17.000	197.15	9.4573 + 1	1.6711	9.7293	281.48	1.3123
18.000	200.76	7.9750	1.3838	9.7262	284.04	1.3329
19.000	204.73	6.7478	1.1482	9.7231	286.84	1.3553
20.000	208.69	5.7280 + 1	9.5617 - 2	9.7201	289.60	1.3775 - 5
21.000	212.66	4.8777	7.9904	9.7170	292.34	1.3996
22.000	214.71	4.1635	6.7553	9.7140	293.75	1.4109
23.000	216.49	3.5588	5.7266	9.7109	294.96	1.4208
24.000	218.28	3.0460	4.8614	9.7079	296.18	1.4305
25.000	220.06	2.6105	4.1326	9.7048	297.38	1.4403
26.000	221.84	2.2402	3.5179	9.7016	298.58	1.4500
27.000	223.62	1.9248	2.9986	9.6987	299.78	1.4597
28.000	225.40	1.6559	2.5593	9.6957	300.97	1.4693
29.000	227.18	1.4264	2.1873	9.6926	302.15	1.4789
30.000	228.96	1.2301 + 1	1.8716 - 2	9.6896	303.34	1.4884 - 5
31.000	230.74	1.0621	1.6036	9.6865	304.51	1.4980
32.000	232.51	9.1814 + 0	1.3756	9.6835	305.68	1.5075
33.000	234.29	7.9460	1.1815	9.6804	306.85	1.5169
34.000	236.07	6.8847	1.0166	9.6774	308.01	1.5263
35.000	237.84	5.9718	8.7468 - 3	9.6744	309.17	1.5357
36.000	239.62	5.1856	7.5391	9.6713	310.32	1.5451
37.000	242.57	4.5089	6.4756	9.6683	312.22	1.5605
38.000	246.02	3.9283	5.5626	9.6653	314.43	1.5785
39.000	249.47	3.4292	4.7887	9.6622	316.63	1.5964
40.000	252.92	2.9992 + 0	4.1311 - 3	9.6592	318.81	1.6141 - 5
41.000	256.36	2.6280	3.5711	9.6562	320.98	1.6318
42.000	259.81	2.3069	3.0932	9.6531	323.13	1.6493
43.000	262.23	2.0282	2.6945	9.6501	324.63	1.6615
44.000	264.00	1.7850	2.3554	9.6471	325.72	1.6704
45.000	265.77	1.5723	2.0610	9.6441	326.81	1.6793
46.000	267.54	1.3862	1.8050	9.6411	327.90	1.6882
47.000	269.31	1.2232	1.5823	9.6380	328.98	1.6970
48.000	270.15	1.0802	1.3929	9.6350	329.49	1.7012
49.000	270.15	9.5400 - 1	1.2302	9.6320	329.49	1.7012
50.000	270.15	8.4259 - 1	1.0865 - 3	9.6290	329.49	1.7012 - 5
51.000	270.15	7.4421	9.5969 - 4	9.6260	329.49	1.7012
52.000	268.26	6.5707	8.5329	9.6229	328.34	1.6918
53.000	266.30	5.7963	7.5826	9.6199	327.14	1.6820
54.000	264.34	5.1086	6.7326	9.6169	325.93	1.6721
55.000	262.38	4.4985	5.9728	9.6139	324.72	1.6622
56.000	260.42	3.9576	5.2942	9.6109	323.50	1.6523
57.000	257.19	3.4775	4.7104	9.6079	321.49	1.6359
58.000	253.76	3.0505	4.1879	9.6049	319.34	1.6184
59.000	250.33	2.6713	3.7176	9.6019	317.18	1.6008

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

AUG 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/M**2
60.000	246.90	2.3351 - 1	3.2947 - 4	9.5989	315.00	1.5831 - 5
61.000	243.48	2.0374	2.9152	9.5959	312.81	1.5653
62.000	240.05	1.7744	2.5750	9.5929	310.60	1.5474
63.000	236.63	1.5423	2.2705	9.5899	308.38	1.5293
64.000	233.21	1.3378	1.9985	9.5869	306.14	1.5112
65.000	229.79	1.1581	1.7558	9.5839	303.88	1.4929
66.000	226.37	1.0004	1.5396	9.5809	301.61	1.4745
67.000	222.95	8.6234 - 2	1.3475	9.5779	299.33	1.4560
68.000	219.53	7.4164	1.1769	9.5749	297.02	1.4374
69.000	216.11	6.3635	1.0258	9.5719	294.70	1.4187
70.000	212.70	5.4470 - 2	8.9215 - 5	9.5689	292.37	1.3998 - 5
71.000	209.28	4.6611	7.7421	9.5660	290.01	1.3808
72.000	205.87	3.9913	6.7033	9.5630	287.63	1.3617
73.000	202.46	3.3650	5.7901	9.5600	285.24	1.3425
74.000	199.05	2.8507	4.9892	9.5570	282.83	1.3231
75.000	195.64	2.4082	4.2882	9.5540	280.39	1.3036
76.000	193.65	2.0290	3.6500	9.5510	278.97	1.2922
77.000	193.65	1.7087	3.0739	9.5481	278.97	1.2922
78.000	193.65	1.4391	2.5888	9.5451	278.97	1.2922
79.000	193.65	1.2120	2.1804	9.5421	278.97	1.2922
80.000	193.65	1.0209 - 2	1.8365 - 5	9.5391	278.97	1.2922 - 5
81.000	193.65	8.5993 - 3	1.5470	9.5362	278.97	1.2922
82.000	193.65	7.2439	1.3031	9.5332	278.97	1.2922
83.000	193.65	6.1024	1.0978	9.5302	278.97	1.2922
84.000	193.65	5.1411	9.2487 - 6	9.5273	278.97	1.2922
85.000	193.65	4.3315	7.7921	9.5243	278.97	1.2922
86.000	193.65	3.6495	6.5653	9.5213		
87.000	193.65	3.0751	5.5320	9.5184		
88.000	193.65	2.5912	4.6615	9.5154		
89.000	193.65	2.1836	3.9282	9.5124		
90.000	193.64	1.8402 - 3	3.3107 - 6	9.5095		
91.000	192.67	1.5502	2.8030	9.5065		
92.000	191.70	1.3049	2.3713	9.5036		
93.000	190.73	1.0975	2.0045	9.5006		
94.000	189.76	9.2224 - 4	1.6931	9.4976		
95.000	188.79	7.7435	1.4289	9.4947		
96.000	187.82	6.4963	1.2049	9.4917		
97.000	186.86	5.4453	1.0152	9.4888		
98.000	185.89	4.5604	8.5465 - 7	9.4858		
99.000	184.92	3.8160	7.1889	9.4829		
100.000	183.96	3.1903 - 4	6.0417 - 7	9.4799		
101.000	182.99	2.6649	5.0733	9.4770		
102.000	182.89	2.2241	4.2365	9.4741		
103.000	188.49	1.8619	3.4413	9.4711		
104.000	194.09	1.5670	2.8125	9.4682		
105.000	199.69	1.3253	2.3121	9.4652		
106.000	205.29	1.1262	1.9111	9.4623		
107.000	210.88	9.6118 - 5	1.5878	9.4594		
108.000	216.47	8.2382	1.3258	9.4564		
109.000	222.07	7.0891	1.1121	9.4535		
110.000	227.66	6.1234 - 5	9.3702 - 8	9.4506		
111.000	233.25	5.3083	7.9283	9.4476		
112.000	238.83	4.6175	6.7352	9.4447		
113.000	248.98	4.0336	5.6437	9.4418		
114.000	260.53	3.5450	4.7402	9.4388		
115.000	272.08	3.1332	4.0118	9.4359		
116.000	283.62	2.7836	3.4191	9.4330		
117.000	295.18	2.4848	2.9327	9.4301		
118.000	306.70	2.2279	2.5305	9.4271		
119.000	318.24	2.0056	2.1955	9.4242		
120.000	329.77	1.8123 - 5	1.9146 - 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 M/SEC**2	SOUND SPEED M/SEC	DYNAMIC VISCOSITY N SEC/M**2
0.000	304.77	1.0102 + 3	1.1548 + 0	9.7816	349.97	1.8685 - 5
1.000	296.42	9.0198 + 2	1.0600	9.7785	345.14	1.8290
2.000	290.54	8.0315	9.6299 - 1	9.7754	341.70	1.8009
3.000	285.04	7.1353	8.7205	9.7723	338.45	1.7743
4.000	279.19	6.3243	7.8912	9.7692	334.96	1.7458
5.000	273.35	5.5914	7.1259	9.7661	331.44	1.7171
6.000	267.44	4.9304	6.4222	9.7631	327.84	1.6877
7.000	261.54	4.3355	5.7748	9.7600	324.20	1.6580
8.000	254.53	3.8003	5.2015	9.7569	319.82	1.6224
9.000	247.48	3.3191	4.6721	9.7538	315.37	1.5861
10.000	240.44	2.8876 + 2	4.1837 - 1	9.7507	310.85	1.5494 - 5
11.000	232.43	2.5012	3.7488	9.7477	305.63	1.5070
12.000	224.38	2.1557	3.3469	9.7446	300.29	1.4638
13.000	216.33	1.8479	2.9758	9.7415	294.85	1.4199
14.000	208.29	1.5750	2.6341	9.7385	289.32	1.3753
15.000	200.25	1.3340	2.3207	9.7354	283.68	1.3300
16.000	196.89	1.1244	1.9894	9.7323	281.29	1.3108
17.000	196.65	9.4635 + 1	1.6765	9.7293	281.12	1.3095
18.000	200.71	7.9782	1.3847	9.7262	284.01	1.3326
19.000	205.18	6.7516	1.1463	9.7231	287.15	1.3578
20.000	209.64	5.7344 + 1	9.5292 - 2	9.7201	290.25	1.3828 - 5
21.000	211.99	4.8840	8.0260	9.7170	291.88	1.3959
22.000	214.07	4.1666	6.7804	9.7140	293.31	1.4074
23.000	216.15	3.5602	5.7378	9.7109	294.73	1.4189
24.000	218.23	3.0467	4.8636	9.7079	296.14	1.4303
25.000	220.31	2.6113	4.1292	9.7048	297.55	1.4417
26.000	222.39	2.2415	3.5113	9.7018	298.95	1.4530
27.000	224.46	1.9269	2.9905	9.6987	300.34	1.4642
28.000	226.54	1.6588	2.5508	9.6957	301.73	1.4755
29.000	228.62	1.4300	2.1791	9.6926	303.11	1.4866
30.000	230.69	1.2345 + 1	1.8643 - 2	9.6896	304.48	1.4977 - 5
31.000	232.77	1.0672	1.5972	9.6865	305.85	1.5088
32.000	234.84	9.2380 + 0	1.3704	9.6835	307.21	1.5198
33.000	236.91	8.0071	1.1774	9.6804	308.56	1.5308
34.000	238.99	6.9492	1.0130	9.6774	309.91	1.5417
35.000	241.06	6.0387	8.7269 - 3	9.6744	311.25	1.5526
36.000	244.12	5.2551	7.4993	9.6713	313.22	1.5686
37.000	247.57	4.5822	6.4478	9.6683	315.42	1.5866
38.000	251.02	4.0032	5.5557	9.6653	317.61	1.6044
39.000	254.47	3.5039	4.7969	9.6622	319.79	1.6221
40.000	257.92	3.0726 + 0	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	263.51	2.3747	3.1394	9.6531	325.42	1.6680
43.000	264.89	2.0910	2.7499	9.6501	326.27	1.6749
44.000	266.27	1.8424	2.4105	9.6471	327.12	1.6818
45.000	267.65	1.6245	2.1144	9.6441	327.96	1.6887
46.000	269.02	1.4333	1.8561	9.6411	328.81	1.6956
47.000	269.65	1.2654	1.6348	9.6380	329.19	1.6987
48.000	269.65	1.1173	1.4435	9.6350	329.19	1.6987
49.000	269.65	9.8654 - 1	1.2745	9.6320	329.19	1.6987
50.000	269.65	8.7113 - 1	1.1254 - 3	9.6290	329.19	1.6987 - 5
51.000	268.45	7.6914	9.9813 - 4	9.6260	328.45	1.6927
52.000	265.89	6.7843	8.8886	9.6229	326.89	1.6799
53.000	263.34	5.9771	7.9070	9.6199	325.32	1.6671
54.000	260.79	5.2598	7.0260	9.6169	323.74	1.6543
55.000	258.24	4.6228	6.2362	9.6139	322.15	1.6413
56.000	255.70	4.0580	5.5288	9.6109	320.56	1.6283
57.000	253.15	3.5577	4.8959	9.6079	318.96	1.6153
58.000	250.60	3.1151	4.3304	9.6049	317.35	1.6022
59.000	248.05	2.7239	3.8255	9.6019	315.73	1.5891

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	SOUND 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	6.4540	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	205.12	4.0109	6.8119	9.5630	287.11	1.3575
73.000	201.71	3.4050	5.8808	9.5600	284.71	1.3382
74.000	198.30	2.8828	5.0645	9.5570	282.29	1.3189
75.000	194.89	2.4337	4.3504	9.5540	279.86	1.2993
76.000	194.65	2.0513	3.6712	9.5510	279.69	1.2980
77.000	194.65	1.7290	3.0945	9.5481	279.69	1.2980
78.000	194.65	1.4575	2.6084	9.5451	279.69	1.2980
79.000	194.65	1.2286	2.1989	9.5421	279.69	1.2980
80.000	194.65	1.0358 - 2	1.8537 - 5	9.5391	279.69	1.2980 - 5
81.000	194.26	8.7312 - 3	1.5657	9.5362	279.41	1.2958
82.000	193.78	7.3574	1.3227	9.5332	279.06	1.2930
83.000	193.29	6.1974	1.1170	9.5302	278.71	1.2902
84.000	192.81	5.2183	9.4287 - 6	9.5273	278.36	1.2874
85.000	192.32	4.3923	7.9561	9.5243	278.01	1.2846
86.000	191.83	3.6956	6.7111	9.5213		
87.000	191.35	3.1082	5.6587	9.5184		
88.000	190.86	2.6131	4.7695	9.5154		
89.000	190.38	2.1961	4.0186	9.5124		
90.000	189.89	1.8449 - 3	3.3845 - 6	9.5095		
91.000	189.41	1.5493	2.8494	9.5065		
92.000	188.92	1.3005	2.3980	9.5036		
93.000	188.44	1.0912	2.0173	9.5006		
94.000	187.96	9.1526 - 4	1.6964	9.4976		
95.000	187.47	7.6737	1.4260	9.4947		
96.000	186.99	6.4313	1.1982	9.4917		
97.000	186.50	5.3878	1.0064	9.4888		
98.000	186.02	4.5118	8.4491 - 7	9.4858		
99.000	185.54	3.7767	7.0912	9.4829		
100.000	185.05	3.1600 - 4	5.9489 - 7	9.4799		
101.000	184.57	2.6430	4.9886	9.4770		
102.000	184.86	2.2098	4.1643	9.4741		
103.000	190.27	1.8532	3.3931	9.4711		
104.000	195.68	1.5620	2.7809	9.4682		
105.000	201.08	1.3228	2.2916	9.4652		
106.000	206.49	1.1252	1.8983	9.4623		
107.000	211.89	9.6114 - 5	1.5802	9.4594		
108.000	217.29	8.2433	1.3216	9.4564		
109.000	222.69	7.0970	1.1102	9.4535		
110.000	228.09	6.1323 - 5	9.3662 - 8	9.4506		
111.000	233.48	5.3171	7.9334	9.4476		
112.000	238.88	4.6256	6.7457	9.4447		
113.000	244.28	4.0406	5.6536	9.4418		
114.000	249.53	3.5512	4.7485	9.4388		
115.000	255.08	3.1387	4.0188	9.4359		
116.000	260.62	2.7885	3.4251	9.4330		
117.000	266.16	2.4892	2.9379	9.4301		
118.000	271.70	2.2318	2.5350	9.4271		
119.000	277.24	2.0091	2.1994	9.4242		
120.000	282.77	1.8155 - 5	1.9179 - 8	9.4213		

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
0.000	304.48	1.0101 + 3	1.1557 + 0	9.7816	349.80	1.8671 - 5
1.000	296.27	9.0182 + 2	1.0604	9.7785	345.06	1.8283
2.000	290.52	8.0297	9.6285 - 1	9.7754	341.69	1.8008
3.000	285.25	7.1340	8.7126	9.7723	338.58	1.7753
4.000	279.31	6.3236	7.8872	9.7692	335.03	1.7464
5.000	273.36	5.5909	7.1250	9.7661	331.45	1.7171
6.000	267.45	4.9300	6.4215	9.7631	327.85	1.6877
7.000	261.55	4.3352	5.7742	9.7600	324.21	1.6581
8.000	254.37	3.7999	5.2041	9.7569	319.73	1.6216
9.000	247.16	3.3183	4.6771	9.7538	315.16	1.5844
10.000	239.95	2.8862 + 2	4.1903 - 1	9.7507	310.53	1.5468 - 5
11.000	232.12	2.4994	3.7511	9.7477	305.42	1.5054
12.000	224.27	2.1538	3.3456	9.7446	300.21	1.4632
13.000	216.42	1.8463	2.9720	9.7415	294.91	1.4204
14.000	208.58	1.5738	2.6286	9.7385	289.52	1.3769
15.000	200.73	1.3334	2.3141	9.7354	284.02	1.3327
16.000	195.56	1.1236	2.0016	9.7323	280.34	1.3032
17.000	195.15	9.4443 + 1	1.6859	9.7293	280.05	1.3009
18.000	198.67	7.9499	1.3940	9.7262	282.56	1.3210
19.000	202.54	6.7146	1.1549	9.7231	285.30	1.3430
20.000	206.41	5.6896 + 1	9.6029 - 2	9.7201	288.01	1.3647 - 5
21.000	210.27	4.8362	8.0125	9.7170	290.69	1.3863
22.000	214.13	4.1232	6.7079	9.7140	293.35	1.4078
23.000	216.45	3.5238	5.6714	9.7109	294.93	1.4205
24.000	218.53	3.0163	4.8084	9.7079	296.35	1.4319
25.000	220.61	2.5858	4.0832	9.7048	297.75	1.4433
26.000	222.69	2.2200	3.4730	9.7018	299.15	1.4546
27.000	224.76	1.9088	2.9585	9.6987	300.54	1.4659
28.000	226.84	1.6436	2.5241	9.6957	301.93	1.4771
29.000	228.92	1.4172	2.1567	9.6926	303.31	1.4882
30.000	230.99	1.2237 + 1	1.8455 - 2	9.6896	304.68	1.4993 - 5
31.000	233.07	1.0580	1.5814	9.6865	306.05	1.5104
32.000	235.14	9.1601 + 0	1.3571	9.6835	307.40	1.5214
33.000	237.81	7.9421	1.1634	9.6804	309.14	1.5355
34.000	240.67	6.8981	9.9848 - 3	9.6774	311.00	1.5506
35.000	243.53	6.0015	8.5850	9.6744	312.84	1.5656
36.000	246.39	5.2302	7.3948	9.6713	314.67	1.5805
37.000	249.25	4.5658	6.3809	9.6683	316.49	1.5953
38.000	252.11	3.9916	5.5155	9.6653	318.30	1.6100
39.000	254.97	3.4952	4.7756	9.6622	320.10	1.6246
40.000	257.83	3.0653 + 0	4.1417 - 3	9.6592	321.89	1.6392 - 5
41.000	260.68	2.6922	3.5978	9.6562	323.67	1.6537
42.000	263.54	2.3680	3.1302	9.6531	325.44	1.6681
43.000	265.37	2.0855	2.7377	9.6501	326.57	1.6773
44.000	266.55	1.8379	2.4020	9.6471	327.29	1.6832
45.000	267.73	1.6207	2.1088	9.6441	328.02	1.6891
46.000	268.91	1.4300	1.8525	9.6411	328.74	1.6950
47.000	270.09	1.2624	1.6283	9.6380	329.46	1.7009
48.000	270.65	1.1151	1.4353	9.6350	329.80	1.7037
49.000	270.65	9.8506 - 1	1.2679	9.6320	329.80	1.7037
50.000	270.65	8.7021 - 1	1.1201 - 3	9.6290	329.80	1.7037 - 5
51.000	269.45	7.6869	9.9384 - 4	9.6260	329.06	1.6977
52.000	266.89	6.7835	8.8543	9.6229	327.50	1.6849
53.000	264.34	5.9793	7.8799	9.6199	325.93	1.6722
54.000	261.79	5.2642	7.0051	9.6169	324.36	1.6593
55.000	259.24	4.6290	6.2204	9.6139	322.77	1.6464
56.000	256.55	4.0655	5.5205	9.6109	321.09	1.6327
57.000	253.61	3.5654	4.8976	9.6079	319.25	1.6177
58.000	250.67	3.1223	4.3392	9.6049	317.39	1.6026
59.000	247.73	2.7300	3.8390	9.6019	315.53	1.5874

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 - 1	3.3917 - 4	9.5989	313.65	1.5722 - 5
61.000	241.67	2.0773	2.9944	9.5959	311.65	1.5559
62.000	238.05	1.8071	2.6445	9.5929	309.30	1.5368
63.000	234.44	1.5688	2.3312	9.5899	306.94	1.5177
64.000	230.82	1.3589	2.0510	9.5869	304.57	1.4984
65.000	227.20	1.1746	1.8009	9.5839	302.17	1.4790
66.000	223.59	1.0129	1.5781	9.5809	299.76	1.4595
67.000	219.97	8.7136 - 2	1.3800	9.5779	297.32	1.4398
68.000	216.36	7.4780	1.2041	9.5749	294.87	1.4200
69.000	212.75	6.4014	1.0482	9.5719	292.40	1.4001
70.000	209.14	5.4655 - 2	9.1042 - 5	9.5689	289.91	1.3800 - 5
71.000	205.58	4.6539	7.8862	9.5660	287.43	1.3601
72.000	203.63	3.9545	6.7652	9.5630	286.07	1.3491
73.000	201.68	3.3551	5.7954	9.5600	284.69	1.3381
74.000	199.73	2.8422	4.9573	9.5570	283.32	1.3270
75.000	197.78	2.4039	4.2342	9.5540	281.93	1.3159
76.000	195.84	2.0300	3.6110	9.5510	280.54	1.3048
77.000	195.65	1.7126	3.0493	9.5481	280.40	1.3037
78.000	195.65	1.4448	2.5726	9.5451	280.40	1.3037
79.000	195.65	1.2191	2.1706	9.5421	280.40	1.3037
80.000	195.65	1.0286 - 2	1.8315 - 5	9.5391	280.40	1.3037 - 5
81.000	195.65	8.6795 - 3	1.5454	9.5362	280.40	1.3037
82.000	195.65	7.3242	1.3041	9.5332	280.40	1.3037
83.000	195.65	6.1809	1.1006	9.5302	280.40	1.3037
84.000	195.65	5.2164	9.2881 - 6	9.5273	280.40	1.3037
85.000	195.65	4.4026	7.8391	9.5243	280.40	1.3037
86.000	195.65	3.7159	6.6165	9.5213		
87.000	195.65	3.1366	5.5848	9.5184		
88.000	195.65	2.6476	4.7143	9.5154		
89.000	195.65	2.2351	3.9797	9.5124		
90.000	195.65	1.8869 - 3	3.3597 - 6	9.5095		
91.000	194.93	1.5928	2.8465	9.5065		
92.000	193.47	1.3431	2.4183	9.5036		
93.000	192.02	1.1311	2.0521	9.5006		
94.000	190.57	9.5145 - 4	1.7393	9.4976		
95.000	189.11	7.9926	1.4724	9.4947		
96.000	187.66	6.7060	1.2449	9.4917		
97.000	186.21	5.6190	1.0512	9.4888		
98.000	184.76	4.7019	8.8655 - 7	9.4858		
99.000	183.31	3.9292	7.4672	9.4829		
100.000	181.86	3.2789 - 4	6.2811 - 7	9.4799		
101.000	180.41	2.7325	5.2765	9.4770		
102.000	179.56	2.2740	4.4120	9.4741		
103.000	182.65	1.8952	3.6148	9.4711		
104.000	185.74	1.5844	2.9718	9.4682		
105.000	188.83	1.3286	2.4512	9.4652		
106.000	191.91	1.1173	2.0282	9.4623		
107.000	195.00	9.4231 - 5	1.6834	9.4594		
108.000	208.00	7.9997	1.3398	9.4564		
109.000	221.50	6.8618	1.0792	9.4535		
110.000	234.99	5.9397 - 5	8.8054 - 8	9.4506		
111.000	248.48	5.1834	7.2670	9.4476		
112.000	261.97	4.5562	6.0589	9.4447		
113.000	275.45	4.0311	5.0982	9.4418		
114.000	288.93	3.5876	4.3257	9.4388		
115.000	302.40	3.2100	3.6979	9.4359		
116.000	315.87	2.8862	3.1831	9.4330		
117.000	329.33	2.6066	2.7573	9.4301		
118.000	337.88	2.3630	2.4363	9.4271		
119.000	342.69	2.1456	2.1812	9.4242		
120.000	347.49	1.9509 - 5	1.9558 - 8	9.4213		

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

NOW 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	304.32	1.0099 + 3	1.1560 + 0	9.7816	349.71	1.8664 - 5
1.000	296.45	9.0156 + 2	1.0594	9.7785	345.16	1.8292
2.000	290.81	8.0282	9.6171 - 1	9.7754	341.86	1.8022
3.000	285.42	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	5.7728	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 + 2	4.1857 - 1	9.7507	310.85	1.5494 - 5
11.000	232.53	2.5025	3.7492	9.7477	305.69	1.5075
12.000	224.58	2.1570	3.3460	9.7446	300.42	1.4648
13.000	216.63	1.8494	2.9740	9.7415	295.06	1.4215
14.000	208.68	1.5766	2.6319	9.7385	289.59	1.3775
15.000	202.59	1.3368	2.2986	9.7354	285.34	1.3433
16.000	196.64	1.1279	1.9982	9.7323	281.11	1.3094
17.000	193.15	9.4723 + 1	1.7084	9.7293	278.61	1.2893
18.000	195.17	7.9509	1.4192	9.7262	280.06	1.3009
19.000	200.12	6.6984	1.1660	9.7231	283.59	1.3293
20.000	205.08	5.6672 + 1	9.6269 - 2	9.7201	287.08	1.3573 - 5
21.000	210.04	4.8142	7.9850	9.7170	290.53	1.3850
22.000	212.73	4.1024	6.7180	9.7140	292.39	1.4000
23.000	215.11	3.5022	5.6718	9.7109	294.02	1.4131
24.000	217.49	2.9952	4.7977	9.7079	295.64	1.4262
25.000	219.86	2.5661	4.0660	9.7048	297.25	1.4392
26.000	222.24	2.2022	3.4521	9.7018	298.85	1.4521
27.000	224.61	1.8931	2.9362	9.6987	300.44	1.4650
28.000	226.98	1.6300	2.5017	9.6957	302.02	1.4778
29.000	229.36	1.4058	2.1352	9.6926	303.60	1.4906
30.000	231.73	1.2143 + 1	1.8255 - 2	9.6896	305.16	1.5033 - 5
31.000	234.10	1.0505	1.5632	9.6865	306.72	1.5159
32.000	236.39	9.1012 + 0	1.3412	9.6835	308.22	1.5281
33.000	238.66	7.8964	1.1526	9.6804	309.70	1.5400
34.000	240.93	6.8606	9.9198 - 3	9.6774	311.17	1.5520
35.000	243.20	5.9688	8.5498	9.6744	312.63	1.5638
36.000	245.47	5.1999	7.3795	9.6713	314.08	1.5757
37.000	247.74	4.5359	6.3784	9.6683	315.53	1.5874
38.000	250.01	3.9619	5.5206	9.6653	316.97	1.5992
39.000	252.27	3.4648	4.7846	9.6622	318.41	1.6108
40.000	254.54	3.0339 + 0	4.1523 - 3	9.6592	319.83	1.6224 - 5
41.000	256.80	2.6598	3.6082	9.6562	321.25	1.6340
42.000	258.88	2.3346	3.1416	9.6531	322.55	1.6446
43.000	260.85	2.0513	2.7395	9.6501	323.77	1.6545
44.000	262.82	1.8041	2.3914	9.6471	324.99	1.6645
45.000	264.79	1.5884	2.0897	9.6441	326.21	1.6744
46.000	266.75	1.3998	1.8260	9.6411	327.42	1.6842
47.000	268.72	1.2348	1.6008	9.6380	328.62	1.6941
48.000	269.65	1.0901	1.4083	9.6350	329.19	1.6987
49.000	269.65	9.6254 - 1	1.2435	9.6320	329.19	1.6987
50.000	269.65	8.4994 - 1	1.0981 - 3	9.6290	329.19	1.6987 - 5
51.000	268.58	7.5044	9.7336 - 4	9.6260	328.54	1.6934
52.000	266.33	6.6202	8.6596	9.6229	327.15	1.6821
53.000	264.07	5.8342	7.6967	9.6199	325.77	1.6708
54.000	261.81	5.1362	6.8342	9.6169	324.37	1.6594
55.000	259.56	4.5169	6.0623	9.6139	322.97	1.6480
56.000	257.08	3.9678	5.3767	9.6109	321.43	1.6354
57.000	254.24	3.4809	4.7695	9.6079	319.65	1.6209
58.000	251.40	3.0493	4.2254	9.6049	317.86	1.6064
59.000	248.56	2.6673	3.7383	9.6019	316.06	1.5917

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 - 1	3.3029 - 4	9.5989	314.25	1.5770 - 5
61.000	242.78	2.0317	2.9154	9.5959	312.36	1.5616
62.000	239.55	1.7688	2.5723	9.5929	310.27	1.5447
63.000	236.32	1.5370	2.2658	9.5899	308.18	1.5277
64.000	233.10	1.3332	1.9924	9.5869	306.07	1.5106
65.000	229.87	1.1541	1.7490	9.5839	303.94	1.4933
66.000	226.65	9.9705 - 2	1.5325	9.5809	301.80	1.4760
67.000	223.42	8.5963	1.3404	9.5779	299.65	1.4586
68.000	220.20	7.3959	1.1701	9.5749	297.48	1.4411
69.000	216.98	6.3493	1.0194	9.5719	295.29	1.4234
70.000	213.76	5.4387 - 2	8.8636 - 5	9.5689	293.09	1.4057 - 5
71.000	210.56	4.6480	7.6900	9.5660	290.89	1.3879
72.000	207.93	3.9638	6.6410	9.5630	289.07	1.3732
73.000	205.29	3.3736	5.7247	9.5600	287.23	1.3585
74.000	202.66	2.8655	4.9256	9.5570	285.39	1.3436
75.000	200.03	2.4288	4.2299	9.5540	283.53	1.3287
76.000	197.40	2.0543	3.6253	9.5510	281.66	1.3137
77.000	197.15	1.7353	3.0664	9.5481	281.48	1.3123
78.000	197.15	1.4660	2.5904	9.5451	281.48	1.3123
79.000	197.15	1.2385	2.1884	9.5421	281.48	1.3123
80.000	197.15	1.0463 - 2	1.8489 - 5	9.5391	281.48	1.3123 - 5
81.000	197.15	8.8405 - 3	1.5621	9.5362	281.48	1.3123
82.000	195.81	7.4664	1.3284	9.5332	280.52	1.3046
83.000	194.06	6.2970	1.1304	9.5302	279.26	1.2946
84.000	192.31	5.3029	9.6060 - 6	9.5273	278.00	1.2845
85.000	190.56	4.4589	8.1513	9.5243	276.73	1.2744
86.000	188.81	3.7434	6.9068	9.5213		
87.000	188.63	3.1393	5.7977	9.5184		
88.000	189.41	2.6343	4.8451	9.5154		
89.000	190.18	2.2122	4.0521	9.5124		
90.000	190.96	1.8591 - 3	3.3916 - 6	9.5095		
91.000	191.74	1.5636	2.8410	9.5065		
92.000	191.70	1.3159	2.3913	9.5036		
93.000	190.73	1.1067	2.0214	9.5006		
94.000	189.76	9.3000 - 4	1.7073	9.4976		
95.000	188.79	7.8087	1.4409	9.4947		
96.000	187.82	6.5510	1.2150	9.4917		
97.000	186.86	5.4912	1.0237	9.4888		
98.000	185.89	4.5988	8.6185 - 7	9.4858		
99.000	184.92	3.8482	7.2494	9.4829		
100.000	183.96	3.2172 - 4	6.0926 - 7	9.4799		
101.000	182.99	2.6873	5.1160	9.4770		
102.000	182.48	2.2428	4.2816	9.4741		
103.000	184.99	1.8740	3.5291	9.4711		
104.000	187.50	1.5698	2.9167	9.4682		
105.000	190.01	1.3182	2.4167	9.4652		
106.000	192.52	1.1095	2.0076	9.4623		
107.000	195.03	9.3593 - 5	1.6718	9.4594		
108.000	208.00	7.9455	1.3307	9.4564		
109.000	221.50	6.8154	1.0719	9.4535		
110.000	234.99	5.8995 - 5	8.7458 - 8	9.4506		
111.000	248.48	5.1483	7.2178	9.4476		
112.000	261.97	4.5254	6.0179	9.4447		
113.000	275.45	4.0038	5.0637	9.4418		
114.000	288.93	3.5633	4.2964	9.4388		
115.000	302.40	3.1883	3.6729	9.4359		
116.000	315.87	2.8666	3.1616	9.4330		
117.000	329.33	2.5890	2.7386	9.4301		
118.000	337.88	2.3470	2.4198	9.4271		
119.000	342.69	2.1311	2.1664	9.4242		
120.000	347.49	1.9377 - 5	1.9426 - 8	9.4213		

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

DEC 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	303.93	1.0098 + 3	1.1574 + 0	9.7816	349.49	1.8645 - 5
1.000	295.69	9.0130 + 2	1.0619	9.7785	344.72	1.8255
2.000	290.82	8.0247	9.6127 - 1	9.7754	341.87	1.8022
3.000	285.82	7.1308	8.6914	9.7723	338.91	1.7781
4.000	279.96	6.3224	7.8674	9.7692	335.42	1.7496
5.000	274.09	5.5916	7.1069	9.7661	331.89	1.7207
6.000	268.01	4.9321	6.4109	9.7631	328.19	1.6905
7.000	261.93	4.3380	5.7696	9.7600	324.44	1.6600
8.000	254.95	3.8033	5.1970	9.7569	320.09	1.6245
9.000	247.94	3.3224	4.6682	9.7538	315.66	1.5885
10.000	240.94	2.8913 + 2	4.1804 - 1	9.7507	311.17	1.5520 - 5
11.000	232.93	2.5052	3.7467	9.7477	305.96	1.5097
12.000	224.88	2.1598	3.3458	9.7446	300.62	1.4665
13.000	216.83	1.8521	2.9756	9.7415	295.20	1.4226
14.000	208.79	1.5791	2.6348	9.7385	289.67	1.3781
15.000	200.75	1.3380	2.3219	9.7354	284.03	1.3328
16.000	195.56	1.1275	2.0085	9.7323	280.34	1.3032
17.000	192.65	9.4627 + 1	1.7111	9.7293	278.25	1.2865
18.000	194.67	7.9393	1.4208	9.7262	279.70	1.2981
19.000	199.62	6.6857	1.1667	9.7231	283.24	1.3264
20.000	204.58	5.6541 + 1	9.6281 - 2	9.7201	286.73	1.3545 - 5
21.000	209.54	4.8012	7.9824	9.7170	290.18	1.3822
22.000	214.49	4.0928	6.6474	9.7140	293.59	1.4097
23.000	216.69	3.4988	5.6248	9.7109	295.10	1.4219
24.000	218.48	2.9950	4.7757	9.7079	296.31	1.4316
25.000	220.26	2.5672	4.0604	9.7048	297.52	1.4414
26.000	222.04	2.2033	3.4569	9.7018	298.72	1.4511
27.000	223.82	1.8934	2.9470	9.6987	299.91	1.4607
28.000	225.60	1.6291	2.5157	9.6957	301.10	1.4704
29.000	227.38	1.4035	2.1502	9.6926	302.29	1.4800
30.000	229.16	1.2105 + 1	1.8402 - 2	9.6896	303.47	1.4895 - 5
31.000	230.94	1.0453	1.5769	9.6865	304.64	1.4990
32.000	232.71	9.0374 + 0	1.3529	9.6835	305.81	1.5085
33.000	235.16	7.8236	1.1590	9.6804	307.42	1.5215
34.000	237.83	6.7840	9.9372 - 3	9.6774	309.15	1.5356
35.000	240.49	5.8921	8.5352	9.6744	310.88	1.5496
36.000	243.15	5.1257	7.3437	9.6713	312.60	1.5636
37.000	245.82	4.4660	6.3291	9.6683	314.30	1.5775
38.000	248.48	3.8971	5.4637	9.6653	316.00	1.5913
39.000	251.14	3.4057	4.7243	9.6622	317.69	1.6050
40.000	253.80	2.9807 + 0	4.0913 - 3	9.6592	319.37	1.6186 - 5
41.000	256.46	2.6124	3.5487	9.6562	321.03	1.6322
42.000	259.11	2.2929	3.0827	9.6531	322.69	1.6458
43.000	261.17	2.0150	2.6877	9.6501	323.97	1.6562
44.000	262.84	1.7724	2.3491	9.6471	325.01	1.6646
45.000	264.52	1.5603	2.0549	9.6441	326.04	1.6730
46.000	266.19	1.3748	1.7992	9.6411	327.07	1.6814
47.000	267.86	1.2123	1.5767	9.6380	328.09	1.6898
48.000	268.65	1.0698	1.3873	9.6350	328.58	1.6937
49.000	268.65	9.4419 - 1	1.2244	9.6320	328.58	1.6937
50.000	268.65	8.3334 - 1	1.0806 - 3	9.6290	328.58	1.6937 - 5
51.000	267.40	7.3543	9.5812 - 4	9.6260	327.81	1.6875
52.000	264.75	6.4836	8.5314	9.6229	326.18	1.6742
53.000	262.10	5.7090	7.5880	9.6199	324.55	1.6609
54.000	259.45	5.0206	6.7412	9.6169	322.90	1.6475
55.000	256.80	4.4096	5.9818	9.6139	321.25	1.6340
56.000	254.16	3.8679	5.3016	9.6109	319.59	1.6205
57.000	251.51	3.3882	4.6930	9.6079	317.93	1.6069
58.000	248.87	2.9640	4.1491	9.6049	316.25	1.5933
59.000	246.22	2.5893	3.6635	9.6019	314.56	1.5796

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

DEC 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	243.58	2.2588 - 1	3.2305 - 4	9.5989	312.87	1.5658 - 5
61.000	240.94	1.9676	2.8449	9.5959	311.17	1.5520
62.000	238.30	1.7114	2.5019	9.5929	309.46	1.5381
63.000	235.66	1.4864	2.1973	9.5899	307.74	1.5242
64.000	233.02	1.2889	1.9269	9.5869	306.01	1.5101
65.000	230.38	1.1159	1.6874	9.5839	304.27	1.4960
66.000	227.74	9.6456 - 2	1.4755	9.5809	302.53	1.4819
67.000	225.10	8.3238	1.2882	9.5779	300.77	1.4677
68.000	222.46	7.1709	1.1229	9.5749	299.00	1.4534
69.000	219.83	6.1671	9.7731 - 5	9.5719	297.23	1.4390
70.000	217.19	5.2944 - 2	8.4919 - 5	9.5689	295.44	1.4246 - 5
71.000	214.57	4.5369	7.3661	9.5660	293.65	1.4101
72.000	212.13	3.8809	6.3735	9.5630	291.97	1.3966
73.000	209.69	3.3140	5.5056	9.5600	290.29	1.3831
74.000	207.25	2.8247	4.7480	9.5570	288.60	1.3695
75.000	204.82	2.4033	4.0877	9.5540	286.90	1.3558
76.000	202.38	2.0409	3.5131	9.5510	285.19	1.3421
77.000	199.95	1.7298	3.0139	9.5481	283.47	1.3283
78.000	199.65	1.4644	2.5553	9.5451	283.26	1.3266
79.000	199.65	1.2398	2.1633	9.5421	283.26	1.3266
80.000	199.65	1.0497 - 2	1.8315 - 5	9.5391	283.26	1.3266 - 5
81.000	199.65	8.8873 - 3	1.5507	9.5362	283.26	1.3266
82.000	199.65	7.5252	1.3131	9.5332	283.26	1.3266
83.000	199.65	6.3721	1.1119	9.5302	283.26	1.3266
84.000	198.62	5.3944	9.4616 - 6	9.5273	282.52	1.3207
85.000	197.18	4.5616	8.0600	9.5243	281.48	1.3124
86.000	195.70	3.8527	6.8582	9.5213		
87.000	194.25	3.2501	5.8288	9.5184		
88.000	192.79	2.7384	4.9482	9.5154		
89.000	191.34	2.3044	4.1956	9.5124		
90.000	189.88	1.9367 - 3	3.5531 - 6	9.5095		
91.000	188.67	1.6257	3.0017	9.5065		
92.000	187.70	1.3634	2.5304	9.5036		
93.000	186.73	1.1424	2.1313	9.5006		
94.000	185.76	9.5645 - 4	1.7937	9.4976		
95.000	184.79	8.0005	1.5082	9.4947		
96.000	183.82	6.6863	1.2671	9.4917		
97.000	182.86	5.5831	1.0637	9.4888		
98.000	181.89	4.6577	8.9207 - 7	9.4858		
99.000	180.92	3.8821	7.4750	9.4829		
100.000	179.96	3.2327 - 4	6.2581 - 7	9.4799		
101.000	178.99	2.6895	5.2345	9.4770		
102.000	178.58	2.2355	4.3609	9.4741		
103.000	181.87	1.8614	3.5656	9.4711		
104.000	185.15	1.5552	2.9261	9.4682		
105.000	188.43	1.3035	2.4098	9.4652		
106.000	191.71	1.0959	1.9914	9.4623		
107.000	194.99	9.2413 - 5	1.6510	9.4594		
108.000	208.00	7.8453	1.3139	9.4564		
109.000	221.50	6.7294	1.0584	9.4535		
110.000	234.99	5.8251 - 5	8.6359 - 8	9.4506		
111.000	248.48	5.0834	7.1264	9.4476		
112.000	261.97	4.4683	5.9420	9.4447		
113.000	275.45	3.9533	4.9999	9.4418		
114.000	288.93	3.5184	4.2422	9.4388		
115.000	302.40	3.1480	3.6266	9.4359		
116.000	315.87	2.8305	3.1217	9.4330		
117.000	329.33	2.5563	2.7041	9.4301		
118.000	337.88	2.3174	2.3893	9.4271		
119.000	342.69	2.1042	2.1391	9.4242		
120.000	347.49	1.9133 - 5	1.9181 - 8	9.4213		

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
0.000	304.04	1.0103 + 3	1.1576 + 0	9.7816	349.55	1.8651 - 5
1.000	295.87	9.0160 + 2	1.0618	9.7785	344.82	1.8264
2.000	290.55	8.0290	9.6267 - 1	9.7754	341.71	1.8009
3.000	285.39	7.1336	8.7079	9.7723	338.66	1.7760
4.000	279.54	6.3237	7.8806	9.7692	335.17	1.7476
5.000	273.70	5.5918	7.1173	9.7661	331.65	1.7188
6.000	267.76	4.9315	6.4162	9.7631	328.03	1.6893
7.000	261.81	4.3371	5.7709	9.7600	324.37	1.6594
8.000	254.71	3.8022	5.2003	9.7569	319.94	1.6233
9.000	247.58	3.3209	4.6729	9.7538	315.43	1.5866
10.000	240.45	2.8893 + 2	4.1861 - 1	9.7507	310.85	1.5494 - 5
11.000	232.53	2.5027	3.7496	9.7477	305.69	1.5075
12.000	224.58	2.1572	3.3463	9.7446	300.42	1.4648
13.000	216.63	1.8495	2.9743	9.7415	295.06	1.4215
14.000	208.68	1.5767	2.6322	9.7385	289.59	1.3775
15.000	202.13	1.3367	2.3037	9.7354	285.01	1.3406
16.000	195.68	1.1271	2.0067	9.7323	280.42	1.3039
17.000	195.15	9.4742 + 1	1.6913	9.7293	280.05	1.3009
18.000	196.80	7.9663	1.4101	9.7262	281.23	1.3103
19.000	200.87	6.7183	1.1652	9.7231	284.12	1.3335
20.000	204.93	5.6855 + 1	9.6648 - 2	9.7201	286.98	1.3565 - 5
21.000	209.00	4.8275	8.0468	9.7170	289.81	1.3792
22.000	213.06	4.1121	6.7236	9.7140	292.61	1.4018
23.000	216.37	3.5132	5.6565	9.7109	294.88	1.4201
24.000	218.35	3.0069	4.7974	9.7079	296.22	1.4309
25.000	220.33	2.5773	4.0751	9.7048	297.56	1.4417
26.000	222.30	2.2122	3.4667	9.7018	298.90	1.4525
27.000	224.28	1.9015	2.9536	9.6987	300.22	1.4633
28.000	226.26	1.6367	2.5200	9.6957	301.54	1.4739
29.000	228.24	1.4107	2.1532	9.6926	302.86	1.4846
30.000	230.21	1.2175 + 1	1.8424 - 2	9.6896	304.17	1.4952 - 5
31.000	232.19	1.0521	1.5786	9.6865	305.47	1.5057
32.000	234.17	9.1041 + 0	1.3544	9.6835	306.77	1.5162
33.000	236.14	7.8876	1.1636	9.6804	308.06	1.5267
34.000	238.11	6.8421	1.0011	9.6774	309.34	1.5371
35.000	240.09	5.9424	8.6225 - 3	9.6744	310.62	1.5475
36.000	242.76	5.1680	7.4161	9.6713	312.35	1.5616
37.000	245.72	4.5022	6.3828	9.6683	314.24	1.5770
38.000	248.68	3.9288	5.5037	9.6653	316.13	1.5923
39.000	251.64	3.4341	4.7542	9.6622	318.00	1.6076
40.000	254.59	3.0065 + 0	4.1140 - 3	9.6592	319.87	1.6227 - 5
41.000	257.55	2.6364	3.5660	9.6562	321.72	1.6378
42.000	260.50	2.3153	3.0963	9.6531	323.56	1.6528
43.000	263.29	2.0364	2.6945	9.6501	325.28	1.6669
44.000	264.67	1.7930	2.3600	9.6471	326.13	1.6738
45.000	266.05	1.5797	2.0685	9.6441	326.98	1.6807
46.000	267.42	1.3928	1.8144	9.6411	327.83	1.6876
47.000	268.80	1.2288	1.5926	9.6380	328.67	1.6945
48.000	270.15	1.0849	1.3990	9.6350	329.49	1.7012
49.000	270.15	9.5815 - 1	1.2356	9.6320	329.49	1.7012
50.000	270.15	8.4625 - 1	1.0913 - 3	9.6290	329.49	1.7012 - 5
51.000	269.22	7.4738	9.6708 - 4	9.6260	328.93	1.6966
52.000	267.26	6.5956	8.5972	9.6229	327.73	1.6868
53.000	265.30	5.8155	7.6364	9.6199	326.52	1.6770
54.000	263.34	5.1231	6.7773	9.6169	325.31	1.6671
55.000	261.38	4.5090	6.0097	9.6139	324.10	1.6572
56.000	259.42	3.9649	5.3244	9.6109	322.88	1.6473
57.000	256.27	3.4823	4.7337	9.6079	320.92	1.6313
58.000	252.94	3.0534	4.2053	9.6049	318.63	1.6142
59.000	249.61	2.6727	3.7302	9.6019	316.72	1.5971

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	246.28	2.3355 - 1	3.3035 - 4	9.5989	314.60	1.5799 - 5
61.000	242.95	2.0371	2.9210	9.5959	312.47	1.5625
62.000	239.63	1.7736	2.5784	9.5929	310.32	1.5451
63.000	236.30	1.5412	2.2722	9.5899	308.16	1.5276
64.000	232.98	1.3367	1.9988	9.5869	305.99	1.5099
65.000	229.65	1.1570	1.7552	9.5839	303.80	1.4922
66.000	226.33	9.9945 - 2	1.5383	9.5809	301.59	1.4743
67.000	223.01	8.6150	1.3458	9.5778	299.37	1.4564
68.000	219.69	7.4096	1.1750	9.5749	297.13	1.4383
69.000	216.37	6.3586	1.0238	9.5719	294.88	1.4201
70.000	213.05	5.4441 - 2	8.9018 - 5	9.5689	292.61	1.4018 - 5
71.000	209.74	4.6500	7.7235	9.5660	290.32	1.3834
72.000	206.88	3.9623	6.6722	9.5630	288.34	1.3674
73.000	204.44	3.3698	5.7422	9.5600	286.63	1.3537
74.000	202.00	2.8605	4.9331	9.5570	284.92	1.3399
75.000	199.57	2.4235	4.2305	9.5540	283.20	1.3261
76.000	197.95	2.0495	3.6069	9.5510	282.05	1.3169
77.000	197.46	1.7321	3.0558	9.5481	281.70	1.3141
78.000	196.97	1.4633	2.5880	9.5451	281.35	1.3113
79.000	196.49	1.2358	2.1910	9.5421	281.00	1.3085
80.000	196.00	1.0432 - 2	1.8542 - 5	9.5391	280.66	1.3057 - 5
81.000	195.51	8.8037 - 3	1.5686	9.5362	280.31	1.3029
82.000	195.03	7.4266	1.3266	9.5332	279.96	1.3001
83.000	194.54	6.2626	1.1215	9.5302	279.61	1.2974
84.000	194.06	5.2791	9.4770 - 6	9.5273	279.26	1.2946
85.000	193.57	4.4483	8.0057	9.5243	278.91	1.2918
86.000	193.08	3.7469	6.7603	9.5213		
87.000	192.60	3.1549	5.7065	9.5184		
88.000	192.11	2.6554	4.8152	9.5154		
89.000	191.63	2.2342	4.0615	9.5124		
90.000	191.14	1.8790 - 3	3.4246 - 6	9.5095		
91.000	190.66	1.5797	2.8864	9.5065		
92.000	189.70	1.3273	2.4374	9.5036		
93.000	188.73	1.1143	2.0567	9.5006		
94.000	187.76	9.3463 - 4	1.7341	9.4976		
95.000	186.79	7.8329	1.4606	9.4947		
96.000	185.82	6.5589	1.2296	9.4917		
97.000	184.86	5.4873	1.0341	9.4888		
98.000	183.89	4.5868	8.6894 - 7	9.4858		
99.000	182.92	3.8306	7.2953	9.4829		
100.000	181.96	3.1963 - 4	6.1195 - 7	9.4799		
101.000	180.99	2.6645	5.1287	9.4770		
102.000	180.68	2.2193	4.2790	9.4741		
103.000	184.74	1.8526	3.4935	9.4711		
104.000	188.80	1.5526	2.8649	9.4682		
105.000	192.85	1.3062	2.3595	9.4652		
106.000	196.90	1.1029	1.9513	9.4623		
107.000	200.96	9.3449 - 5	1.6200	9.4594		
108.000	210.70	7.9615	1.3164	9.4564		
109.000	220.72	6.8339	1.0786	9.4535		
110.000	230.75	5.9062 - 5	8.9168 - 8	9.4506		
111.000	240.77	5.1364	7.4319	9.4476		
112.000	250.79	4.4927	6.2408	9.4447		
113.000	262.86	3.9520	5.2375	9.4418		
114.000	275.57	3.4974	4.4214	9.4388		
115.000	288.27	3.1124	3.7612	9.4359		
116.000	300.97	2.7838	3.2222	9.4330		
117.000	313.67	2.5015	2.7783	9.4301		
118.000	323.63	2.2569	2.4294	9.4271		
119.000	331.51	2.0416	2.1455	9.4242		
120.000	339.39	1.8513 - 5	1.9003 - 8	9.4213		

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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%	50%	90%	95%	99%
	(m/sec)				(m/sec)				(m/sec)				(m/sec)			
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	7	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	26	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 reentry 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:

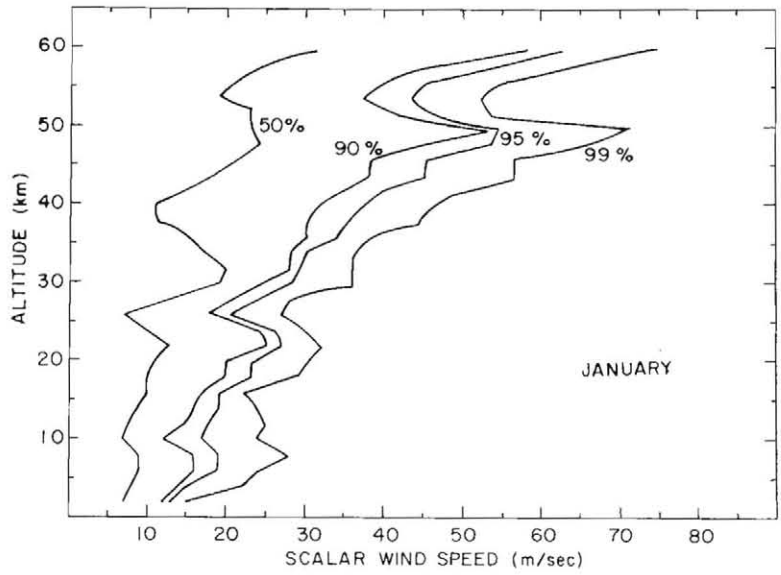
$$E = \Sigma\, c_i \bar{u}_i$$

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

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:

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

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.



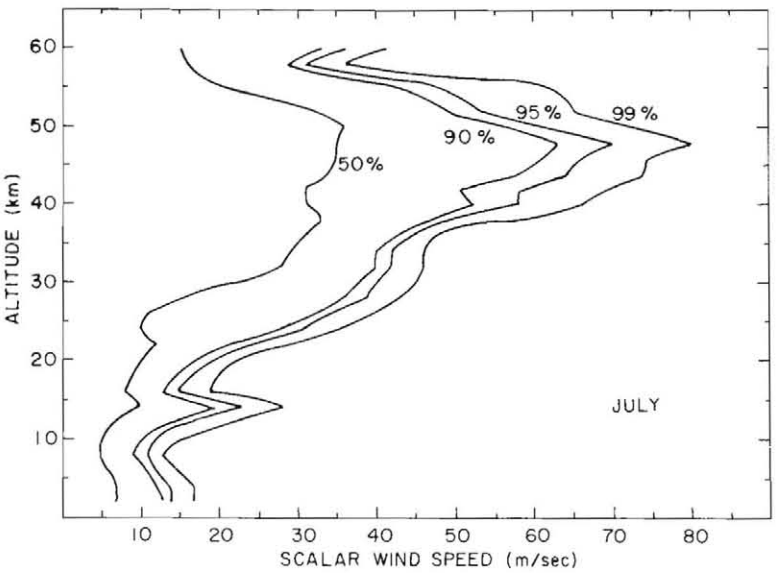


Figure A1. Profiles of the 50, 90, 95, and 99 Percentile Values of Scalar Wind Speeds

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

KM KILOMETERS ABOVE SEA LEVEL
MEAN AVERAGE OF OBSERVED VALUES
STDV STANDARD DEVIATION OF VALUES TIMES 10
N NUMBER OF VALUES AT EACH ALTITUDE

KM	.008	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	-6	-9	-7	-3	-2	-3	-6	-9	-6	-7	-5	2	8	11	9	6	2	-2	-6	-9	-9	-11	-12	-11	-2	9	16	23	30
STDV	21	41	53	65	73	69	82	83	82	82	110	141	136	104	124	163	184	179	182	171	159	187	200	202	239	273	232	176	170	176	190
N	51	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	29	**																													
4	23	52																													
6	24	27	58																												
8	13	21	17	64																											
10	12	15	-5	41	81																										
12	4	19	-13	26	70	88																									
14	7	13	-7	16	56	71	85																								
16	10	29	-1	19	53	66	78	87																							
18	22	36	8	18	41	38	32	34	44																						
20	29	10	2	-26	-14	-17	-13	1	-2	33																					
22	27	17	13	-8	-12	-27	-34	-26	-23	36	74																				
24	18	28	24	13	-4	-21	-34	-39	-31	31	31	77																			
26	-8	35	16	35	19	15	10	-7	5	28	-30	5	55																		
28	-14	28	9	30	22	36	37	22	31	3	-62	-51	-8	69																	
30	-17	12	5	28	19	35	40	26	29	-20	-75	-76	-36	44	89																
32	-15	7	0	23	20	34	40	27	30	-25	-76	-85	-49	29	79	95															
34	-10	-1	-10	8	31	42	47	35	36	-18	-54	-83	-63	-4	51	76	88														
36	-6	-3	-12	7	38	46	49	37	33	-5	-36	-70	-62	-18	28	52	69	82													
38	1	-5	-10	11	46	51	54	41	37	0	-24	-55	-56	-20	18	38	53	78	92												
40	-1	-23	-21	-4	35	44	45	38	36	7	-5	-34	-50	-29	0	14	27	53	72	96											
42	8	-28	-30	-17	22	34	35	33	30	13	10	-16	-42	-36	-15	-6	4	31	51	66	91										
44	2	-24	-21	-15	15	26	26	26	22	16	17	-6	-34	-44	-28	-16	-11	13	34	51	75	89									
46	2	-32	-21	-18	-1	7	5	14	9	16	28	7	-22	-42	-35	-27	-23	-2	16	29	58	72	86								
48	9	-32	-14	-13	-5	0	-7	6	9	22	35	16	-9	-33	-35	-30	-29	-13	-2	9	36	51	68	88							
50	6	-24	-12	-14	-9	-5	-10	1	4	24	42	30	13	-10	-25	-29	-33	-24	-17	-6	18	35	49	73	89						
52	10	-20	-8	-6	1	-1	-5	5	10	32	52	45	27	-4	-34	-41	-46	-34	-26	-10	17	33	46	69	79	90					
54	17	-18	-8	5	16	15	12	24	32	29	35	29	13	-7	-23	-25	-26	-16	-13	3	22	29	33	41	57	59	77				
56	19	-17	-20	8	14	24	19	26	35	21	7	3	-7	-5	-2	-2	-4	-7	-1	15	30	32	33	35	45	43	54	84			
58	12	-17	-23	20	32	37	30	30	35	25	-7	-2	-2	8	10	7	3	-2	2	13	24	26	25	27	33	37	50	73	90		
60	18	-6	-11	36	48	49	41	38	42	32	-21	-12	-2	29	35	27	16	4	6	13	14	14	8	9	19	26	36	54	75	88	

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

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

KM KILOMETERS ABOVE SEA LEVEL
MEAN AVERAGE OF OBSERVED VALUES
STDV STANDARD DEVIATION OF VALUES TIMES 10
N NUMBER OF VALUES AT EACH ALTITUDE

KM	.008	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	-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	67	78	95	87	63	106	121	88	113	146	155	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	50	49	50	49	49	49	49	49	50	50	50	50	50	50	50	50	50	49	41	39	31
2	68	**																													
4	43	50																													
6	25	-14	52																												
8	5	-22	34	78																											
10	-11	-31	7	60	77																										
12	8	-18	10	55	67	85																									
14	19	-17	16	53	59	74	89																								
16	1	-30	15	49	57	69	74	80																							
18	37	5	32	49	31	26	29	35	35																						
20	33	27	46	41	22	8	1	-7	-15	58																					
22	15	27	39	30	24	17	7	0	-12	33	78																				
24	-26	-5	1	-11	8	11	0	-5	0	-5	17	60																			
26	-47	-23	-34	-49	-17	-11	-15	-13	-3	-59	-67	-31	49																		
28	-45	-24	-43	-54	-27	-19	-18	-16	-5	-66	-81	-53	24	93																	
30	-40	-21	-42	-52	-27	-18	-16	-14	-2	-66	-84	-62	12	87	97																
32	-36	-23	-41	-44	-22	-12	-10	-9	0	-62	-86	-68	3	82	93	97															
34	-35	-24	-39	-43	-20	-12	-8	-8	-2	-61	-84	-67	2	79	89	93	97														
36	-34	-25	-41	-45	-32	-19	-14	-13	-3	-55	-82	-76	-14	68	80	86	88	93													
38	-29	-30	-26	-17	-27	-5	-6	-1	10	-34	-55	-52	-32	21	36	44	47	52	68												
40	-12	-30	-10	16	6	15	10	15	25	24	21	33	22	-22	-24	-27	-29	-23	-18	22											
42	5	-7	10	17	15	15	10	11	22	33	43	59	50	-15	-29	-38	-44	-41	-38	-16	74										
44	-4	2	21	21	33	33	22	9	6	7	45	62	50	-9	-22	-27	-33	-29	-33	-17	40	69									
46	-5	9	18	17	19	15	6	-13	-19	-7	44	52	38	-11	-19	-22	-28	-25	-27	-23	18	39	77								
48	-9	6	13	13	7	9	-4	-22	-30	-3	49	51	40	-8	-20	-24	-29	-26	-24	-19	8	32	65	85							
50	-13	2	4	-5	-10	-14	-16	-36	-47	-5	39	32	28	-6	-14	-14	-17	-14	-11	-20	-6	13	42	68	86						
52	-16	3	-1	-9	-17	-24	-27	-45	-55	-15	35	30	22	-6	-11	-12	-15	-15	-14	-22	-8	10	37	69	79	93					
54	-18	2	-1	-7	-10	-13	-21	-44	-52	-11	44	43	39	-1	-13	-15	-21	-19	-22	-34	-4	16	47	71	82	89	90				
56	-16	4	-4	-11	-11	-12	-17	-42	-52	-10	44	43	37	-8	-17	-18	-23	-21	-20	-30	-7	17	54	73	80	88	86	94			
58	-15	7	6	-11	-13	-14	-28	-50	-49	-13	46	39	30	-14	-22	-19	-24	-26	-20	-25	-4	20	58	71	74	78	77	83	92		
60	-39	12	6	-27	-20	-19	-40	-60	-57	-35	27	30	35	16	7	7	0	-1	1	-6	-2	16	55	61	65	69	65	74	83	92	

** 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
STDV STANDARD DEVIATION OF VALUES TIMES 10
N NUMBER OF VALUES AT EACH ALTITUDE

KM	.008	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	-5	-8	-7	-5	-2	0	3	5	0	-8	-12	-12	-14	-15	-19	-22	-26	-28	-30	-32	-33	-33	-35	-36	-37	-35	-30	-23	-13	-3	1
STDV	24	40	39	44	44	69	72	95	66	56	45	61	101	126	122	123	110	91	106	115	125	139	157	165	170	161	142	152	167	165	165
N	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	42	41	41	42	42	42	41	41	40	37	36	35	33
2	64	**																													
4	11	58																													
6	-4	13	60																												
8	-24	-14	20	66																											
10	-41	-35	-2	41	84																										
12	-46	-46	-18	21	61	89																									
14	-50	-49	-17	11	56	81	90																								
16	-10	-20	10	27	43	46	48	58																							
18	2	18	39	30	17	13	15	14	16																						
20	23	20	5	12	17	-1	-6	-3	8	36																					
22	-2	-8	-8	4	20	33	38	47	29	-6	32																				
24	-20	-40	-28	-5	27	47	54	58	31	-22	7	79																			
26	-24	-43	-34	-8	25	46	53	55	22	-28	-6	64	93																		
28	-22	-41	-29	-5	29	45	48	50	23	-32	-11	62	89	96																	
30	-22	-38	-21	-2	28	46	47	49	26	-31	-18	50	83	90	93																
32	-20	-44	-16	-3	23	41	44	45	31	-24	-26	30	66	73	75	90															
34	2	-18	8	0	11	17	12	13	33	6	-16	-21	-2	10	14	35	64														
36	11	9	17	13	0	-6	-11	-10	16	33	16	-30	-35	-36	-38	-25	-2	60													
38	24	35	25	7	-19	-21	-23	-24	9	39	7	-22	-41	-45	-47	-45	-36	15	72												
40	31	36	31	23	-18	-25	-23	-28	11	35	19	-16	-38	-44	-45	-44	-37	5	55	86											
42	22	28	28	18	-17	-30	-25	-27	9	35	27	-19	-39	-46	-46	-47	-39	8	57	76	89										
44	9	19	30	21	-5	-16	-14	-18	10	36	19	-18	-35	-41	-41	-44	-31	15	61	71	76	92									
46	4	19	28	17	2	-10	-9	-9	12	42	17	-24	-41	-49	-51	-54	-41	9	58	73	69	83	94								
48	12	18	20	14	-5	-18	-18	-22	1	34	0	-42	-57	-61	-61	-64	-48	-1	44	69	64	69	75	87							
50	9	21	14	-4	-19	-26	-19	-21	-3	20	-14	-48	-62	-63	-64	-66	-53	-12	24	55	51	56	55	67	85						
52	8	21	-1	-29	-38	-43	-30	-21	-28	-1	-9	-45	-57	-50	-54	-56	-50	-26	-8	5	7	13	5	13	30	57					
54	7	20	16	-17	-30	-34	-22	-10	-16	12	21	1	-24	-24	-31	-35	-37	-31	-14	-22	-14	-5	-17	-16	-14	10	71				
56	10	26	34	13	12	-6	-16	-11	-12	8	23	2	-23	-18	-18	-26	-34	-20	-9	-22	-17	-9	-16	-15	-17	-1	42	76			
58	13	38	55	38	31	11	-12	-6	2	-6	15	9	-17	-15	-11	-11	-17	1	4	-11	-5	-1	-1	-7	-16	-16	18	43	76		
60	17	36	45	30	27	17	-5	-12	-5	-13	-8	-6	-31	-25	-17	-12	-10	20	15	21	20	7	12	10	5	-4	-4	0	35	72	

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

Table A2d. Means, Standard Deviations, and Interlevel Correlations of East/West Winds, October

KM KILOMETERS ABOVE SEA LEVEL
MEAN AVERAGE OF OBSERVED VALUES
STDV STANDARD DEVIATION OF VALUES TIMES 10
N NUMBER OF VALUES AT EACH ALTITUDE

KM	.008	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	-5	-7	-6	-4	-1	3	7	11	3	-4	-5	-9	-13	-16	-16	-15	-14	-12	-10	-6	0	8	14	18	22	22	22	24	30	37	37
STDV	21	43	38	44	57	72	86	96	83	90	82	113	134	137	124	131	148	158	174	205	232	210	186	157	139	143	165	213	197	191	186
N	36	36	36	36	36	36	36	36	36	35	35	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	34	33	31
2	48	**																													
4	11	72																													
6	-6	14	24																												
8	-10	1	9	77																											
10	-27	11	27	51	66																										
12	-35	6	23	47	57	90																									
14	-34	-4	28	50	51	58	72																								
16	-16	13	29	55	46	47	51	65																							
18	5	48	45	22	7	24	32	25	38																						
20	-33	-5	26	46	32	57	61	64	51	42																					
22	-39	-17	11	44	30	44	56	67	46	31	86																				
24	-34	-25	0	49	38	37	53	66	38	19	77	93																			
26	-30	-29	-13	44	30	33	48	56	31	5	66	84	95																		
28	-20	-36	-19	33	26	11	22	28	21	-12	36	55	73	83																	
30	2	-33	-26	10	13	-16	-19	-19	-14	-45	-14	-2	17	32	73																
32	13	-12	-20	-13	-1	-29	-35	-43	-24	-47	-47	-42	-29	-13	35	83															
34	20	9	-1	-31	-15	-27	-39	-57	-29	-33	-55	-66	-63	-52	-8	50	85														
36	5	17	13	-42	-23	-11	-23	-48	-22	-15	-41	-63	-70	-63	-38	10	51	84													
38	-11	16	18	-40	-23	11	-1	-30	-17	3	-17	-42	-57	-54	-48	-18	18	55	89												
40	-20	15	17	-23	-5	27	18	-19	-13	7	-3	-23	-39	-35	-36	-16	11	45	79	94											
42	-25	7	12	-11	8	36	32	-6	-11	0	9	-3	-14	-9	-9	2	19	40	66	77	91										
44	-24	2	9	2	21	37	36	2	-11	-5	17	7	0	8	10	17	28	37	53	59	76	94									
46	-19	-7	2	6	26	39	42	12	-1	-7	24	17	15	25	28	31	36	37	44	47	64	84	93								
48	-19	-3	11	20	33	50	54	23	12	6	34	27	26	32	33	28	28	27	35	39	57	77	85	94							
50	-37	-16	6	21	37	54	61	39	25	12	49	42	39	41	38	24	19	12	17	23	37	59	70	81	87						
52	-32	-18	1	23	38	47	56	34	25	8	47	49	46	50	50	34	24	13	13	17	33	58	69	82	86	94					
54	-27	-24	-1	29	36	33	37	25	27	-5	33	38	40	48	63	57	47	31	21	14	29	50	61	74	80	81	91				
56	-22	-14	3	17	25	24	29	21	22	-3	41	40	38	45	61	59	54	39	23	13	24	47	62	76	75	81	87	93			
58	-17	-17	-6	2	10	10	11	0	6	-14	33	28	23	31	50	56	60	48	34	22	29	48	62	70	64	67	72	78	93		
60	-22	-17	-1	3	4	6	3	-3	5	-13	37	35	27	31	46	52	54	46	34	21	29	49	61	70	61	64	69	75	89	95	

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

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

KM KILOMETERS ABOVE SEA LEVEL
MEAN AVERAGE OF OBSERVED VALUES
STDV STANDARD DEVIATION OF VALUES TIMES 10
N NUMBER OF VALUES AT EACH ALTITUDE

KM	.008	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	-2	-1	-2	-3	-2	1	-1	-3	0	-1	1	0	0	1	1	0	0	-2	-2	1	3	3	2	2	5	4	3	2	0	-2
STDV	17	30	42	43	51	48	58	71	52	41	37	27	20	25	32	32	44	49	47	57	61	68	89	105	114	102	122	119	115	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	51	50	50	49	49	46	42	38
2	43	**																													
4	12	26																													
6	13	29	45																												
8	-22	7	11	54																											
10	-33	-10	-5	34	64																										
12	-30	8	9	22	53	68																									
14	-16	4	1	19	32	40	68																								
16	-20	21	8	33	36	38	42	57																							
18	28	20	41	53	32	34	25	25	33																						
20	-6	9	-1	7	9	9	10	20	29	-11																					
22	17	8	-7	7	-20	-7	-1	6	14	2	25																				
24	9	4	-26	-14	-6	-13	-9	6	-15	-15	-7	-7																			
26	-27	-16	-7	-11	0	2	-1	-4	9	-11	-11	-26	11																		
28	1	-12	34	9	8	10	1	-2	-12	22	-14	-13	3	-17																	
30	16	-4	20	-4	8	11	26	17	3	18	14	-1	8	-7	23																
32	5	11	-7	-6	1	3	1	-6	5	-7	-2	5	20	-3	-21	31															
34	-21	0	6	9	12	8	-4	23	31	-3	5	-14	27	23	9	1	47														
36	-24	-8	1	-6	-14	-1	12	26	25	-10	28	9	11	17	-7	21	15	20													
38	-12	-11	-2	16	5	17	7	10	9	-7	8	5	1	-14	5	6	9	-12	43												
40	-14	-2	3	9	16	24	20	2	13	-4	9	-15	-14	-4	3	14	1	-11	-12	38											
42	-16	-9	-2	-14	1	26	33	29	10	2	12	-2	-5	-9	-3	20	-4	4	1	-10	53										
44	-27	-35	-3	-14	11	28	26	14	-7	-4	-2	-20	1	17	4	29	-14	3	11	5	39	65									
46	-14	-21	-9	-16	7	9	2	-9	-18	-14	-24	-8	22	26	-4	9	0	9	18	-3	7	30	63								
48	11	6	-23	-18	-1	1	5	-1	-22	-17	-2	-7	10	7	-6	13	-3	-5	18	-10	0	18	35	60							
50	12	21	-5	2	3	5	9	-7	-25	-4	-3	-8	7	-24	11	8	-7	-22	-10	2	20	21	18	37	70						
52	-20	-8	-18	-32	-18	-12	-4	0	-21	-42	-3	-22	17	-4	9	-1	-6	-2	26	11	7	10	15	30	47	51					
54	-26	-12	-24	-26	-5	-12	0	1	-6	-38	2	-10	6	7	1	-14	5	-4	13	7	11	12	4	8	23	23	69				
56	-22	-15	-36	-36	-14	-8	-1	-3	-8	-29	-9	-4	-8	-4	-17	-17	28	1	13	7	7	19	3	6	30	28	54	78			
58	-10	-9	-26	-11	-7	-4	-3	-8	-23	-40	4	-13	-3	-3	-18	-3	17	1	20	23	29	17	20	24	51	49	69	62	72		
60	-4	-1	-7	-10	-6	4	16	20	-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 KILOMETERS ABOVE SEA LEVEL
MEAN AVERAGE OF OBSERVED VALUES
STDV STANDARD DEVIATION OF VALUES TIMES 10
N NUMBER OF VALUES AT EACH ALTITUDE

KM	.008	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	0	1	2	1	-1	-1	1	0	1	1	2	1	0	0	1	0	0	1	2	3	4	6	7	7	3	-1	-2
STDV	20	27	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	50	50	49	50	49	49	49	49	49	50	50	50	50	50	50	50	50	50	49	41	39	31
2	43	**																													
4	16	20																													
6	18	-9	27																												
8	29	-7	15	53																											
10	28	4	1	29	62																										
12	18	6	-6	13	45	70																									
14	6	-7	-4	15	35	45	67																								
16	30	15	6	18	47	60	52	49																							
18	8	24	-3	-1	18	20	23	22	7																						
20	11	4	-4	-11	4	2	10	10	-2	-14																					
22	-17	-5	1	-3	-12	17	8	11	-2	-1	-5																				
24	41	-1	14	17	17	23	23	10	17	-10	5	-24																			
26	-12	2	-5	4	-23	-18	-29	-7	2	-15	-15	2	-7																		
28	1	-12	0	6	12	9	23	32	21	-6	27	2	12	-16																	
30	8	15	-4	-9	5	-2	4	3	11	0	25	3	-15	-29	21																
32	8	17	15	-11	-7	-6	-17	-12	0	2	-2	-13	-3	7	-26	23															
34	-4	-3	1	-22	-17	-15	0	-4	-14	-8	-4	-11	1	0	-3	-25	18														
36	-6	-3	13	6	19	-8	19	16	-12	14	-16	6	2	2	10	-4	3	25													
38	9	8	-11	18	19	0	2	11	13	6	0	-14	-14	11	15	31	-4	-44	3												
40	28	24	-2	-34	-8	-13	-15	-1	-14	2	7	-30	15	-15	-13	14	3	-1	-21	4											
42	-2	-3	13	-11	17	20	25	25	37	9	11	-7	11	-21	17	-9	-3	-24	8	-2	18										
44	15	-5	15	9	3	15	18	8	15	-13	3	13	6	-6	28	3	-11	-20	-6	14	-18	11									
46	12	0	6	8	13	-2	5	27	17	-3	17	-19	3	18	1	5	16	-1	8	6	-10	4	23								
48	-24	-16	1	13	18	-15	-13	11	-3	-1	17	-9	-13	34	1	8	-7	-13	4	9	-17	-16	1	59							
50	-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						
52	-37	0	13	-23	-24	-3	-21	-16	-16	-9	-10	-20	-21	2	-14	7	11	-5	11	4	18	29	-6	-15	0	58					
54	-27	7	15	1	10	-4	2	-3	9	-12	-6	-27	-1	-8	-14	20	25	-6	11	8	12	18	-31	-17	3	28	62				
56	-27	-14	20	13	33	-17	-16	8	-7	1	-9	-34	-3	-7	18	0	20	20	33	15	12	3	-27	-10	16	16	25	64			
58	-8	0	12	14	38	-22	-12	12	8	5	-15	-28	-2	-2	27	8	17	-1	41	29	8	10	-10	7	9	13	19	39	72		
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 A3c. Means, Standard Deviations, and Interlevel Correlations of North/South Winds, July

KM KILOMETERS ABOVE SEA LEVEL
MEAN AVERAGE OF OBSERVED VALUES
STDV STANDARD DEVIATION OF VALUES TIMES 10
N NUMBER OF VALUES AT EACH ALTITUDE

KM	.008	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	1	1	1	0	-1	0	0	-1	1	1	1	1	1	0	-1	-1	0	1	3	3	4	4	3	1	4	4	2	1
STDV	18	24	22	31	37	38	60	69	65	30	22	24	18	20	19	23	30	33	36	46	49	56	51	59	59	59	75	75	98	99	122
N	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	42	41	41	42	42	42	41	41	40	37	36	35	33
2	44	**																													
4	15	32																													
6	-5	-18	38																												
8	-9	-9	34	84																											
10	4	2	18	36	55																										
12	31	20	1	12	20	69																									
14	12	2	-18	1	20	50	70																								
16	3	7	1	23	31	36	38	51																							
18	-19	2	-7	-7	-11	-18	-13	-1	4																						
20	27	15	-12	-2	16	14	7	18	-14	-44																					
22	-15	5	24	9	6	13	9	9	8	34	-35																				
24	-11	-16	16	-2	2	21	15	8	18	12	-16	21																			
26	3	-9	-29	-18	-18	-1	6	8	23	-10	3	0	7																		
28	14	2	-11	0	3	-9	0	20	6	9	-16	20	-37	1																	
30	-12	-11	1	22	14	-19	-45	-40	-23	18	-24	12	-25	-19	25																
32	-19	-10	12	25	16	21	-3	-15	6	5	-8	6	13	0	-36	13															
34	13	3	9	12	-1	-4	3	-7	19	0	-1	-18	25	37	-31	-4	43														
36	8	17	13	-14	-14	-26	-16	-3	1	-25	-13	1	-9	-10	27	-4	-31	7													
38	-11	-11	-11	-14	6	3	-8	9	-27	-6	19	3	6	-14	-4	1	-22	-44	2												
40	-7	-8	-15	7	30	28	17	10	30	-4	2	0	3	21	1	2	7	-17	-38	26											
42	-4	-15	-26	-4	-12	-3	-4	11	43	-1	-10	-11	-5	35	5	12	12	8	-21	-34	21										
44	-18	-22	-10	-8	-16	0	-6	12	2	-1	-6	-3	-6	-1	20	17	16	4	-8	-22	-25	51									
46	5	3	13	-6	-16	1	14	11	-12	10	-26	7	9	-24	27	5	14	10	9	-11	-34	-17	47								
48	32	24	27	-15	-14	-10	17	22	9	-5	-13	-7	15	-13	14	1	1	25	19	-20	-28	-18	14	53							
50	-16	15	6	-42	-33	-31	-10	3	-9	11	-8	-16	22	-26	-23	-8	-19	-4	13	9	-21	-24	0	18	46						
52	-20	10	-2	-14	-5	-7	-6	-9	-5	-3	8	-18	-15	-5	-9	6	-32	-31	-5	12	22	14	-15	-31	-35	33					
54	5	10	13	10	2	17	9	-8	3	-6	18	-16	-17	-4	-22	6	3	-7	-10	-23	2	17	2	-29	-33	2	57				
56	5	-10	21	2	-22	-18	-16	-25	-11	-5	8	-24	-23	-6	-14	-2	-5	-17	-1	-15	-9	20	18	-12	-10	16	31	61			
58	-9	-29	13	32	12	-32	-35	-27	-6	10	-3	6	2	9	-9	21	14	13	2	-7	-10	8	-6	-23	2	0	-18	5	47		
60	-4	-23	-29	13	9	-27	-5	-1	-10	5	8	28	12	16	7	11	29	18	3	-10	-3	8	-10	-17	-2	-26	-33	-37	-29	48	

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

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

KM KILOMETERS ABOVE SEA LEVEL
MEAN AVERAGE OF OBSERVED VALUES
STDV STANDARD DEVIATION OF VALUES TIMES 10
N NUMBER OF VALUES AT EACH ALTITUDE

KM	.008	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	0	0	0	1	1	1	0	-2	0	0	0	-1	0	2	4	4	3	2	1	0	-1
STDV	23	25	23	42	52	59	83	94	62	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	35	35	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	34	33	31
2	33	**																													
4	0	27																													
6	6	10	65																												
8	27	18	45	67																											
10	22	8	3	35	68																										
12	19	-10	-21	15	45	83																									
14	6	-15	-9	28	61	75	87																								
16	12	-1	18	39	57	54	44	52																							
18	8	39	18	7	-8	-3	-3	-11	8																						
20	11	30	6	-2	19	-4	-13	-11	-11	-35																					
22	-3	23	-16	-1	13	16	8	8	26	35	10																				
24	6	4	3	23	15	6	-1	12	11	7	2	2																			
26	13	1	-9	-7	-8	10	13	-1	10	26	-27	-15	4																		
28	17	12	19	5	16	17	3	8	-8	-10	11	-1	0	5																	
30	-8	20	37	13	0	-11	-17	-12	-4	9	16	-5	-22	-31	22																
32	14	10	-27	-31	-25	0	1	-11	8	5	-5	10	1	-9	-34	-1															
34	-16	-35	-10	-3	-7	-5	9	15	-25	-20	-11	-8	23	-12	-10	-13	19														
36	-7	-12	-10	-15	-2	-7	0	3	-16	-14	-9	-12	0	-11	-10	-20	-2	39													
38	-7	-1	17	4	9	17	2	1	1	9	-28	-21	7	8	-2	13	26	17	37												
40	18	11	19	19	14	25	8	-3	9	38	-53	8	-4	15	11	-4	-9	-24	2	38											
42	11	1	-2	-12	-17	-4	6	-8	-19	-11	21	-18	-19	2	0	8	6	-17	11	-29	-4										
44	3	-15	2	18	-3	-6	16	10	22	12	-6	-4	-6	4	-23	-4	16	0	-7	-23	-23	36									
46	-12	17	16	24	9	3	10	8	6	6	17	-2	14	13	-11	7	-14	-20	-24	-26	-21	21	45								
48	4	-11	4	11	30	23	8	17	-5	-16	-2	12	13	5	17	-20	-27	1	0	15	12	-15	-24	25							
50	-1	-15	9	-9	3	-4	-17	-10	-15	-11	-25	14	-20	-11	31	-2	-10	-10	6	32	41	-23	-40	-26	59						
52	-18	-23	10	-2	-5	-22	-27	-16	-30	-14	-30	1	3	-23	17	2	-12	9	6	10	28	-25	-44	-25	20	59					
54	0	-5	0	12	8	-1	-6	-10	-18	-9	-3	-22	17	-11	1	-13	-1	8	6	-12	-11	7	-12	11	8	-7	38				
56	23	25	-7	10	28	30	30	15	18	4	-2	10	4	5	-7	-33	22	10	25	8	18	1	7	8	-6	-21	-8	42			
58	29	17	-32	-16	0	10	16	5	3	-1	15	12	7	-3	2	-32	35	2	6	-1	7	17	10	-16	-25	-17	-22	-3	65		
60	16	-22	-23	-12	-6	8	32	30	11	-17	16	-12	-5	-6	-9	-21	20	-7	-11	-25	-16	37	32	-7	-27	-21	-31	-31	14	67	

** 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:

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

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

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

where c_i and c_j are influence coefficients at the ith and jth levels, σ_i and σ_j are the standard deviations of the density at these levels, and r_{ij} is the correlation between the densities at the ith and jth 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 KILOMETERS ABOVE SEA LEVEL
MEAN AVERAGE OF OBSERVED VALUES
STDV STANDARD DEVIATION OF VALUES TIMES 10
N NUMBER OF VALUES AT EACH ALTITUDE

KM	.008	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	192	206	212	217	221	225	228	232	237	242	247	253	257	262	267	271	272	272	271	268	265	263
STDV	14	13	13	13	14	14	15	16	15	46	28	26	23	30	27	30	36	36	37	42	42	38	42	48	63	64	51	41	44	49	58
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	41	38	34
2	-3	**																													
4	15	39																													
6	11	15	48																												
8	-1	-20	23	28																											
10	-2	8	47	43	70																										
12	5	13	44	52	48	85																									
14	5	-4	22	43	60	71	80																								
16	14	10	-13	6	19	8	15	28																							
18	-6	3	-16	-34	-41	-57	-52	-63	1																						
20	-23	-18	-12	0	4	1	-9	-6	-21	10																					
22	-13	-3	-15	-27	-21	-21	-27	-34	-33	33	37																				
24	-14	3	-12	7	-5	-26	-21	-7	-19	16	3	31																			
26	-4	-15	-1	-18	-2	-7	-18	-15	8	11	-28	-11	6																		
28	0	4	5	-9	1	-12	-18	-21	4	17	-9	-3	15	51																	
30	3	-1	9	-26	1	-16	-29	-19	1	25	-6	-6	-8	50	53																
32	16	-3	24	-13	0	-2	-14	-19	-2	24	-1	6	1	28	32	39															
34	20	19	-11	-25	-22	-23	-26	-29	43	29	-27	-20	-30	34	6	29	39														
36	11	31	6	-17	-10	-16	-27	-38	27	38	0	-1	-25	19	19	29	37	47													
38	13	-9	-7	-28	6	3	-10	-19	17	26	25	-8	-39	24	-1	30	26	57	54												
40	-1	-1	-32	-40	-8	-12	-19	-28	19	24	-16	2	-2	23	8	18	21	44	29	47											
42	-22	32	-3	-8	-7	-13	-18	-32	26	24	-4	-3	5	8	34	24	30	33	34	24	51										
44	-1	7	-33	-23	-22	-25	-22	-29	19	29	-3	-2	-11	18	14	25	9	51	15	43	54	64									
46	7	-20	-22	-43	-10	-24	-30	-19	-10	16	-6	-2	8	36	1	41	15	35	-4	32	7	8	37								
48	25	-10	-12	-22	-3	-21	-21	-16	26	23	-25	-26	4	32	32	33	38	58	28	49	33	35	42	53							
50	27	8	8	-7	-7	-9	-12	-22	26	11	-26	-43	-33	20	21	32	32	48	43	48	30	36	39	17	63						
52	9	20	13	4	-6	-6	-11	-22	18	18	5	-31	-32	6	27	33	21	49	45	55	24	35	32	6	53	77					
54	17	12	-9	-4	-8	-7	-26	-34	15	13	2	1	-24	3	14	7	11	39	42	38	31	24	30	1	44	54	64				
56	28	22	25	-9	2	-7	-21	-27	-4	21	-2	12	-8	7	14	31	20	29	32	30	36	25	26	19	35	29	46	59			
58	33	6	32	-16	-4	-12	-20	-31	1	26	-28	-10	-17	26	25	30	13	23	27	19	16	3	1	16	31	39	48	47	65		
60	21	16	10	-2	-7	-7	-14	-24	13	18	-21	-42	-17	19	14	9	2	32	28	23	11	4	5	2	29	50	64	56	32	71	

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

Table B1b. Means, Standard Deviations, and Interlevel Correlations of Temperature, April

KM KILOMETERS ABOVE SEA LEVEL
MEAN AVERAGE OF OBSERVED VALUES
STDV STANDARD DEVIATION OF VALUES TIMES 10
N NUMBER OF VALUES AT EACH ALTITUDE

KM	.008	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	289	279	267	255	240	224	207	195	195	206	214	220	223	228	237	236	242	248	256	262	267	269	271	272	271	270	267	265	260	255
STDV	14	9	11	13	12	13	14	14	15	27	23	22	19	28	34	32	26	30	36	42	39	36	39	35	36	37	47	44	42	57	69
N	34	34	34	34	34	34	34	34	34	34	34	33	32	35	35	36	36	36	36	36	36	36	36	36	36	36	36	36	35	34	22
2	17	**																													
4	46	48																													
6	24	22	62																												
8	42	12	48	68																											
10	23	13	53	64	67																										
12	27	16	64	56	58	71																									
14	57	22	61	54	54	62	71																								
16	25	4	11	-3	-3	-17	-16	18																							
18	-1	-3	-33	-35	-10	-14	-10	3	-3																						
20	-6	3	8	16	-1	-11	7	-8	19	-26																					
22	35	-8	9	14	38	26	18	33	0	13	-25																				
24	1	-1	19	27	42	70	23	45	-9	-16	-14	19																			
26	-39	-24	-23	-8	-6	-15	0	-19	-25	4	11	-17	6																		
28	-27	-42	-29	5	-5	8	-9	-11	-9	-8	20	-13	-6	48																	
30	-30	-17	-34	-5	-17	-13	-28	-14	5	13	40	-22	-14	35	63																
32	1	-6	-5	-5	12	-11	-13	0	20	4	-2	-17	-8	12	27	52															
34	9	-9	3	10	31	19	30	23	5	4	-1	20	-8	26	17	15	31														
36	1	-5	-5	7	15	11	16	-1	-17	10	14	-34	-22	28	31	21	28	55													
38	-13	13	-10	-10	-8	-5	4	-21	-24	23	-6	-24	-36	27	-6	7	10	44	66												
40	12	9	12	-27	-31	-32	-8	-24	16	5	2	-20	-42	-16	-30	-12	3	12	19	51											
42	-29	-15	6	-1	-3	11	17	-16	14	-14	0	-29	-24	15	10	-1	-2	24	10	12	37										
44	-28	-9	-8	21	12	40	20	4	-11	-1	4	-17	-5	-9	34	30	26	27	36	17	-11	37									
46	-18	10	4	9	8	16	6	-5	19	2	8	-27	-17	-4	6	13	25	31	36	37	9	23	49								
48	4	-2	-1	10	19	3	8	5	1	2	10	-18	-17	-1	1	20	44	42	59	46	20	15	28	53							
50	-27	-35	-58	-34	-29	-42	-32	-43	-17	10	13	-15	-27	20	12	23	24	30	35	48	19	7	22	6	43						
52	-18	-24	-23	-8	-21	-16	3	-15	-18	4	27	-33	-25	31	25	26	15	39	48	53	36	31	32	2	25	70					
54	-26	-24	-28	-11	-24	-10	-10	-14	-2	5	27	-52	-25	38	49	45	29	38	64	57	24	26	44	30	41	52	76				
56	-34	-12	-21	-13	-31	1	-2	-3	-15	10	6	-4	-27	28	37	48	26	47	32	38	30	26	53	30	21	37	52	62			
58	-19	-13	-8	-10	-16	9	8	3	-12	21	3	-13	-32	22	31	41	28	43	40	42	43	36	48	41	34	27	45	58	88		
60	-23	-19	-19	-25	-20	3	4	-2	-10	26	-8	-23	-46	34	28	43	35	30	45	47	46	51	42	28	46	39	56	65	77	90	

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

Table B1c. Means, Standard Deviations, and Interlevel Correlations of Temperature, July

KM KILOMETERS ABOVE SEA LEVEL
MEAN AVERAGE OF OBSERVED VALUES
STDV STANDARD DEVIATION OF VALUES TIMES 10
N NUMBER OF VALUES AT EACH ALTITUDE

KM	.008	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	278	266	254	239	222	206	198	203	210	215	219	222	227	230	233	237	241	248	254	259	262	265	266	268	268	265	261	257	253
STDV	12	8	10	12	14	17	16	17	17	24	17	15	20	20	21	34	31	43	42	55	34	35	37	50	48	49	58	69	65	69	61
N	31	31	31	31	31	31	31	31	31	31	31	30	29	25	30	31	32	32	32	32	32	32	32	32	32	32	32	31	31	30	27
2	33	**																													
4	38	72																													
6	23	66	78																												
8	2	49	44	52																											
10	-4	57	50	52	77																										
12	4	64	52	54	72	94																									
14	22	66	48	57	38	52	66																								
16	26	6	11	0	-39	-30	-20	9																							
18	-7	-11	-26	0	-7	-10	-5	7	-22																						
20	-14	-1	12	22	-7	-11	-15	-20	-15	-37																					
22	32	-4	-6	12	-34	-29	-12	20	40	9	15																				
24	28	18	43	42	0	-6	-3	20	18	2	25	14																			
26	-2	-3	-1	17	26	4	8	31	7	36	-40	10	9																		
28	-7	35	12	25	33	23	24	45	9	6	-38	-20	-19	45																	
30	12	30	19	31	15	8	26	44	7	-6	-15	13	-6	34	47																
32	28	46	32	42	10	24	27	52	5	17	-24	19	22	46	39	52															
34	24	46	43	44	20	27	32	43	5	2	-1	23	5	49	28	42	74														
36	6	32	24	40	23	32	34	39	18	-14	14	29	-10	33	13	38	50	72													
38	-2	23	29	34	31	20	23	25	7	4	-7	10	5	36	29	28	44	55	53												
40	24	16	18	37	29	19	20	44	11	-6	-10	24	34	37	38	36	46	39	38	52											
42	29	14	17	30	16	2	14	39	26	32	-29	33	49	37	10	19	39	24	25	42	49										
44	1	27	24	31	20	31	40	33	2	17	-23	2	23	25	6	26	42	27	27	33	9	49									
46	0	16	23	27	9	15	23	23	1	-5	-8	7	9	20	13	35	36	27	27	44	18	29	76								
48	6	6	9	21	4	-4	1	18	22	0	-23	39	-18	53	20	39	32	43	54	44	36	26	36	61							
50	-1	-4	-8	17	13	3	5	12	12	24	-29	25	-21	60	29	21	19	23	32	21	15	24	33	46	79						
52	11	-22	-1	7	10	7	6	6	-1	25	-29	0	-1	36	0	6	4	14	9	16	12	18	31	48	48	64					
54	21	-5	5	7	12	16	21	31	-11	33	-38	1	8	24	1	25	21	25	25	16	26	27	42	43	43	42	76				
56	17	1	2	11	17	22	24	35	-19	33	-51	0	-2	36	25	27	27	18	15	18	41	30	47	42	53	55	59	77			
58	25	20	23	44	9	12	11	37	2	18	-34	20	14	28	50	38	40	28	28	28	46	35	40	53	65	62	47	55	76		
60	34	26	21	43	4	23	21	48	9	18	-22	21	20	24	44	34	36	24	37	22	38	36	43	46	43	50	46	59	72	89	

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

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

KM KILOMETERS ABOVE SEA LEVEL
MEAN AVERAGE OF OBSERVED VALUES
STDV STANDARD DEVIATION OF VALUES TIMES 10
N NUMBER OF VALUES AT EACH ALTITUDE

KM	.008	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	289	278	267	254	240	223	207	197	199	207	213	219	225	229	234	237	242	248	256	260	265	268	269	271	273	271	269	265	261	257
STDV	12	8	9	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	38	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	39	34
2	41	**																													
4	51	57																													
6	33	10	70																												
8	3	8	39	51																											
10	5	5	37	53	61																										
12	4	16	37	51	65	84																									
14	17	23	28	24	40	14	43																								
16	11	13	-11	-17	-9	-21	-1	17																							
18	27	17	1	-12	-19	-21	-22	-12	21																						
20	24	-7	1	-11	-20	-39	-32	0	20	36																					
22	37	11	15	24	-7	0	5	16	-10	31	21																				
24	48	32	17	7	-8	4	15	21	-14	4	2	32																			
26	27	31	20	22	19	23	30	41	15	3	-19	18	39																		
28	5	25	5	13	5	30	28	22	2	4	-38	-4	20	49																	
30	5	33	2	13	14	15	21	15	-15	5	-24	-10	25	43	53																
32	17	28	-7	2	6	4	9	14	23	25	-14	-8	26	52	56	62															
34	13	22	-5	-10	-2	-9	3	23	25	7	3	-4	14	52	36	54	71														
36	29	12	13	16	1	2	-4	1	20	20	-11	15	8	44	48	34	45	38													
38	42	17	12	19	0	10	13	19	34	8	-5	10	19	66	41	26	48	33	53												
40	17	19	-7	-13	-17	5	4	3	4	32	-4	22	23	29	32	38	37	30	28	36											
42	-2	-8	-11	-15	-4	-5	-11	1	-3	13	-8	-1	1	6	5	17	27	23	35	17	60										
44	-10	-4	-9	2	34	11	19	32	13	21	-3	0	3	47	15	20	40	31	32	29	16	27									
46	11	4	0	10	16	19	24	17	-3	22	8	19	29	45	12	24	45	41	41	37	27	43	69								
48	28	37	23	14	13	18	17	11	6	19	-8	8	44	50	29	31	61	46	42	42	39	27	44	65							
50	35	35	25	31	8	21	16	17	5	21	-20	14	31	48	59	49	71	51	58	52	43	28	36	52	63						
52	23	26	20	34	19	28	26	18	24	19	-37	-5	29	47	51	42	51	40	33	46	39	12	22	25	45	64					
54	27	28	15	26	-3	6	10	12	28	23	-23	10	37	33	30	39	43	39	23	28	38	13	15	22	45	54	82				
56	26	16	19	24	0	22	6	3	8	24	-24	7	15	33	50	36	39	32	42	32	44	20	2	20	42	60	69	73			
58	30	15	9	11	3	15	2	3	10	28	-12	8	21	42	34	29	46	46	38	41	46	35	23	43	45	52	65	63	81		
60	43	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	91	

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

Table B2a. Means, Standard Deviations, and Interlevel Correlations of Density, January

KM KILOMETERS ABOVE SEA LEVEL
MEAN AVERAGE OF OBSERVED VALUES
STDV STANDARD DEVIATION OF VALUES IN PERCENT OF MEAN TIMES 10
N NUMBER OF VALUES AT EACH ALTITUDE

KM	.008	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 -3	969 -3	786 -3	639 -3	516 -3	416 -3	332 -3	261 -3	199 -3	141 -3	934 -4	654 -4	464 -4	342 -4	248 -4	182 -4	133 -4	980 -5	725 -5	539 -5	401 -5	303 -5	230 -5	175 -5	134 -5	105 -5	818 -6	640 -6	504 -6	397 -6	310 -6
STDV	15	5	4	4	5	4	5	5	10	28	15	13	12	18	15	15	17	18	16	18	21	20	23	28	22	28	26	33	34	37	37
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	41	36	34
2	17	**																													
4	17	37																													
6	-4	7	22																												
8	-9	-24	2	14																											
10	9	10	17	9	58																										
12	7	17	1	21	44	74																									
14	9	-9	-23	3	23	27	49																								
16	6	7	-36	-11	-7	-10	4	29																							
18	-3	2	-22	-32	-37	-37	-14	-9	52																						
20	-1	9	8	19	7	28	17	7	12	15																					
22	1	-2	-22	-28	-25	1	-4	6	21	38	42																				
24	-30	0	-12	16	-6	-16	-5	27	14	7	5	31																			
26	-6	-4	6	-13	-4	4	-2	11	31	15	-5	14	41																		
28	16	14	10	2	-14	-9	1	9	23	3	9	16	37	66																	
30	29	4	13	-14	-10	-8	-5	17	17	4	6	8	21	61	67																
32	15	-6	17	-14	-24	-8	-25	0	-4	-2	7	10	14	30	39	51															
34	0	5	-21	-10	-33	-8	-11	10	27	-5	-2	-3	10	30	24	41	48														
36	8	21	-1	3	-32	-7	-12	-2	7	-7	10	3	-6	3	18	31	35	52													
38	10	-9	-3	12	3	33	16	16	-9	-18	32	0	-1	8	5	32	35	61	55												
40	-1	-16	-24	7	-12	16	14	23	-5	-20	0	18	36	-1	8	14	24	45	36	57											
42	-4	14	4	34	-14	7	11	17	-18	-30	6	10	31	-12	24	15	27	33	39	42	70										
44	2	-3	-18	23	-20	8	12	29	-14	-33	9	16	26	-2	13	19	21	40	34	50	72	83									
46	-5	-15	-5	5	-6	4	3	31	-31	-66	6	16	32	3	4	22	22	31	19	44	47	58	72								
48	9	-20	-12	19	-15	-8	-3	29	-28	-30	-8	-4	34	-1	19	14	33	39	26	42	45	54	61	70							
50	3	-1	12	26	-22	-3	-5	5	-32	-37	-4	-11	14	-1	22	25	34	37	52	44	50	64	63	56	67						
52	-3	7	18	40	-17	5	15	9	-43	-42	14	-1	5	-30	3	-1	7	18	40	35	45	64	62	58	58	82					
54	-2	-8	0	28	-16	0	0	6	-41	-43	9	15	5	-34	-14	-16	2	9	32	25	52	60	63	62	53	67	88				
56	-3	-5	24	26	-14	-3	2	11	-40	-35	6	14	2	-31	-16	-18	-3	-7	19	14	42	56	55	62	41	52	79	90			
58	-9	-6	24	14	-19	5	0	12	-40	-28	7	27	4	-18	-11	-20	0	-6	20	14	35	50	55	67	43	62	81	88	92		
60	-27	5	7	27	-20	6	1	7	-37	-29	4	14	4	-25	-20	-32	-1	6	38	14	29	49	51	58	45	64	83	87	80	91	

* MULTIPLY MEAN BY INDICATED NEGATIVE POWER OF 10

** MULTIPLY TABULAR VALUES BY 0.01 TO OBTAIN CORRELATION COEFFICIENTS

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

KM KILOMETERS ABOVE SEA LEVEL
MEAN AVERAGE OF OBSERVED VALUES
STDV STANDARD DEVIATION OF VALUES IN PERCENT OF MEAN TIMES 10
N NUMBER OF VALUES AT EACH ALTITUDE

KM	.008	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 -3	968 -3	788 -3	640 -3	517 -3	417 -3	333 -3	262 -3	197 -3	139 -3	936 -4	653 -4	463 -4	343 -4	249 -4	182 -4	134 -4	988 -5	734 -5	543 -5	409 -5	311 -5	240 -5	186 -5	145 -5	113 -5	869 -6	700 -6	549 -6	433 -6	337 -6
STDV	6	3	4	5	4	4	5	5	10	15	12	11	13	20	19	16	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	33	32	32	32	33	33	33	33	33	33	33	33	33	33	33	33	33	32	31	21
2	12	**																													
4	31	65																													
6	18	46	70																												
8	31	27	50	69																											
10	16	36	42	43	57																										
12	8	35	40	29	35	61																									
14	15	18	5	4	1	19	43																								
16	-1	-9	-31	-30	-22	-34	-23	33																							
18	-10	6	-33	-36	-5	5	19	23	18																						
20	-36	7	-7	-5	-22	-10	13	-11	31	-2																					
22	17	-28	-27	-15	5	4	2	4	8	33	1																				
24	-19	-8	-21	-23	-29	-1	1	9	3	13	16	29																			
26	-34	-7	-22	-16	-11	12	19	-1	32	39	49	33	39																		
28	-14	-2	-15	-12	-10	22	13	1	27	33	50	28	31	73																	
30	-23	24	-21	-21	-23	9	6	13	42	53	50	17	36	55	72																
32	-5	10	-11	-29	-22	-18	-2	14	39	55	13	30	45	38	40	61															
34	-4	0	-14	-19	-14	-5	21	0	14	32	7	39	26	45	26	33	61														
36	-16	-1	-17	-28	-39	-24	9	-13	5	33	20	15	43	45	35	34	59	68													
38	-20	11	-20	-29	-40	-12	10	1	15	43	12	26	41	42	21	38	61	69	82												
40	-13	-13	-19	-40	-52	-28	-1	4	28	19	16	21	27	17	14	32	61	52	59	76											
42	-24	-33	-25	-31	-38	-15	-3	-17	14	4	7	13	25	22	22	19	40	40	44	47	75										
44	-18	-17	-27	-19	-38	-11	-8	-1	-7	10	1	19	33	-2	20	18	35	22	45	39	50	67									
46	-9	-26	-28	-38	-46	-36	-24	-2	20	12	1	11	31	5	4	6	41	22	39	42	55	60	72								
48	3	-26	-37	-36	-39	-42	-17	8	12	16	7	28	37	10	8	14	44	23	44	46	58	52	56	71							
50	-6	-34	-48	-38	-45	-38	-12	6	22	20	25	40	36	26	21	19	39	32	42	51	67	57	57	65	86						
52	-16	-25	-29	-26	-44	-19	4	7	11	17	28	28	37	31	25	21	32	35	48	53	69	60	55	53	68	88					
54	-9	-33	-33	-38	-52	-27	-19	3	18	9	17	19	30	24	24	15	23	9	38	39	60	60	64	74	73	81	84				
56	8	-25	-27	-36	-45	-19	-13	9	4	12	-3	40	26	-2	3	6	20	9	13	26	56	54	66	67	65	71	65	79			
58	9	-21	-15	-34	-37	-16	-8	7	-2	19	-10	30	17	-7	-2	3	21	6	14	28	60	58	56	66	62	64	58	73	93		
60	34	-18	5	-4	-18	-36	11	31	0	-1	-26	31	10	-13	-23	-29	20	24	40	35	57	48	49	62	76	75	75	79	82	88	

* 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 KILOMETERS ABOVE SEA LEVEL
MEAN AVERAGE OF OBSERVED VALUES
STDV STANDARD DEVIATION OF VALUES IN PERCENT OF MEAN TIMES 10
N NUMBER OF VALUES AT EACH ALTITUDE

KM	.008	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 -3	969 -3	790 -3	642 -3	518 -3	418 -3	334 -3	262 -3	194 -3	134 -3	933 -4	661 -4	473 -4	349 -4	254 -4	187 -4	139 -4	102 -4	754 -5	554 -5	415 -5	313 -5	238 -5	183 -5	142 -5	109 -5	852 -6	669 -6	526 -6	413 -6	321 -6
STDV	4	3	4	4	4	4	4	8	12	14	12	9	10	18	11	14	10	16	16	21	20	24	26	27	27	34	36	36	37	37	43
N	31	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	30	30	29	26
2	51	**																													
4	66	78																													
6	32	56	71																												
8	0	32	27	40																											
10	14	49	35	30	73																										
12	25	35	24	32	19	21																									
14	4	15	16	26	-20	-14	-4																								
16	-36	-34	-35	-34	-50	-61	-39	-1																							
18	-35	-51	-52	-23	-8	-15	-8	4	7																						
20	-24	-20	-9	2	-11	-15	-8	-11	20	6																					
22	-33	-57	-44	-29	-41	-55	-6	15	35	38	56																				
24	-28	-43	-9	-11	-19	-28	-12	-3	29	32	50	30																			
26	-28	-50	-31	-34	7	7	-39	-37	25	46	15	29	38																		
28	-55	-18	-25	-14	14	4	-31	4	32	25	15	14	2	41																	
30	-29	-20	-14	-3	-6	-7	-18	21	12	8	32	31	3	1	52																
32	-22	-21	-17	-19	-24	-1	-12	-17	12	35	31	33	26	36	32	31															
34	-9	4	8	3	4	12	-4	-10	14	13	36	37	5	28	26	24	47														
36	-34	-30	-25	-18	0	-4	-13	-27	31	11	52	45	12	22	15	17	26	62													
38	-38	-31	-17	-15	18	-6	-13	-31	23	27	37	33	37	44	34	13	20	40	54												
40	-34	-58	-50	-44	-6	-41	-6	-33	37	30	45	42	48	37	16	-4	-1	3	41	49											
42	-35	-55	-46	-44	-9	-33	-6	-18	37	45	29	38	48	27	12	-4	5	5	47	45	81										
44	-28	-36	-34	-42	-6	-15	2	-29	24	31	31	29	32	20	14	6	8	9	46	35	66	83									
46	-28	-36	-28	-32	-5	-19	-3	-26	24	36	44	38	33	27	24	16	9	16	59	46	69	74	92								
48	-36	-44	-42	-40	-10	-25	-19	-27	42	29	40	54	18	43	22	8	9	24	57	35	76	73	76	81							
50	-38	-40	-41	-34	2	-19	-8	-29	34	34	32	38	20	39	24	-3	2	16	48	29	75	78	77	77	91						
52	-26	-46	-39	-44	-3	-17	-14	-36	27	32	29	24	26	32	10	-3	-1	13	43	31	78	77	79	79	82	89					
54	-15	-41	-34	-50	-6	-18	-8	-29	20	31	27	19	31	19	3	-7	0	5	36	26	77	79	80	72	70	78	92				
56	-24	-48	-39	-47	-4	-25	-10	-36	20	30	33	24	29	27	19	-6	3	0	33	29	85	81	80	70	76	81	82	87			
58	-29	-38	-32	-29	-20	-47	-16	-27	39	23	44	39	34	15	29	1	13	2	39	29	78	75	69	69	75	77	70	72	87		
60	-51	-51	-43	-36	-10	-30	-10	-32	31	29	54	44	37	20	43	27	13	7	59	44	81	82	75	74	73	77	75	77	87	95	

* 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 KILOMETERS ABOVE SEA LEVEL
MEAN AVERAGE OF OBSERVED VALUES
STDV STANDARD DEVIATION OF VALUES IN PERCENT OF MEAN TIMES 10
N NUMBER OF VALUES AT EACH ALTITUDE

KM	.008	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 -3	969 -3	789 -3	642 -3	518 -3	417 -3	334 -3	262 -3	196 -3	137 -3	940 -4	659 -4	469 -4	343 -4	250 -4	183 -4	135 -4	100 -4	743 -5	552 -5	417 -5	317 -5	244 -5	189 -5	146 -5	114 -5	892 -6	703 -6	554 -6	436 -6	340 -6
STDV	5	3	3	4	4	4	5	6	10	13	13	11	11	12	13	15	14	15	18	19	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	39	38	33
2	62	**																													
4	56	73																													
6	42	51	76																												
8	15	32	44	66																											
10	24	41	52	59	70																										
12	5	27	36	44	53	51																									
14	12	2	-15	-9	-4	-28	12																								
16	-15	-16	-42	-40	-37	-42	-32	30																							
18	19	-4	-11	-22	-25	-28	-19	13	25																						
20	1	-23	-28	-26	-26	-45	-24	31	24	34																					
22	30	1	8	14	2	-11	11	37	-15	15	11																				
24	-1	-20	-15	-12	-1	3	15	6	-41	-15	0	27																			
26	-6	-13	-9	-1	20	19	25	18	-16	-19	-17	4	55																		
28	-32	-29	-26	-20	-4	11	11	-12	-21	-12	-11	4	58	48																	
30	-29	-21	-15	-12	6	7	26	-14	-29	-19	-21	11	58	51	72																
32	-36	-34	-37	-29	-3	-8	3	1	17	8	1	7	45	38	61	66															
34	-33	-34	-30	-25	0	-14	7	15	12	-27	8	27	39	41	41	55	63														
36	-38	-53	-24	-25	-22	-38	-25	-7	4	-9	9	20	16	12	34	34	31	50													
38	-25	-49	-29	-21	-23	-21	-14	-1	17	-23	16	20	27	14	16	18	29	41	57												
40	-41	-42	-31	-29	-20	-18	13	-9	-3	-10	3	37	30	-1	27	32	28	47	54	64											
42	-46	-47	-27	-20	-4	-14	11	0	-2	-17	13	32	24	-3	25	36	39	57	65	67	87										
44	-48	-50	-30	-18	8	-18	1	-6	-11	-26	5	10	18	3	15	20	26	47	50	54	62	73									
46	-40	-45	-23	-17	-7	-14	-10	-15	-22	-28	13	21	26	-8	14	23	26	52	52	59	70	80	84								
48	-28	-36	-15	-22	-22	-23	-20	-25	-10	-30	2	18	32	-6	21	20	26	38	44	60	68	66	68	80							
50	-29	-38	-19	-17	-28	-29	-17	-22	-18	-30	-2	27	26	-11	33	26	25	41	53	60	72	71	64	74	81						
52	-28	-35	-20	-12	-19	-19	-9	-20	-2	-34	-14	19	21	-4	26	22	14	39	42	60	70	64	62	67	79	91					
54	-28	-37	-22	-17	-28	-31	-9	-12	3	-29	0	26	19	-11	19	22	14	42	45	59	74	70	65	73	81	91	95				
56	-28	-39	-20	-21	-27	-27	-14	-14	-5	-27	9	24	14	-7	25	20	11	41	53	60	73	71	63	73	80	93	91	94			
58	-26	-40	-24	-22	-21	-26	-9	-9	3	-23	15	26	16	-6	20	18	18	51	56	66	78	79	69	78	78	85	87	90	95		
60	-32	-46	-34	-34	-25	-30	-4	-7	7	-21	27	23	25	-4	24	27	32	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:

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

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

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.

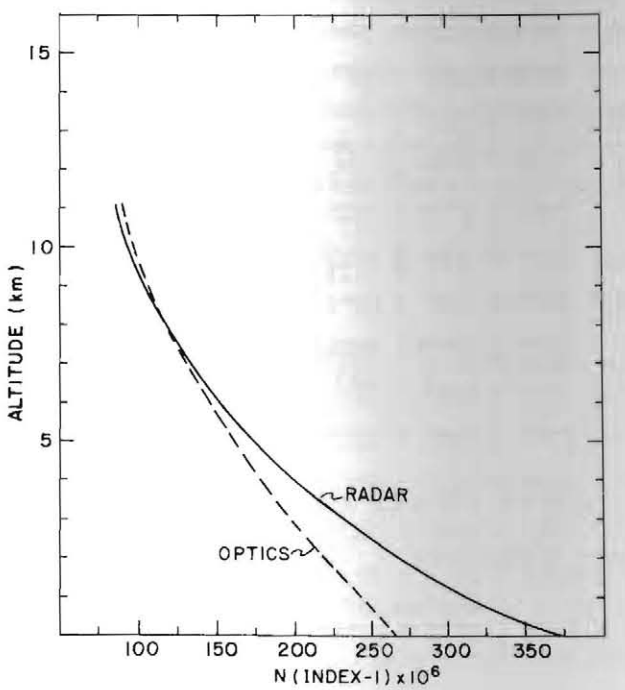


Figure C1. The Mean Annual Index of Refraction (N Values) for Radar and Optics at KMR

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.

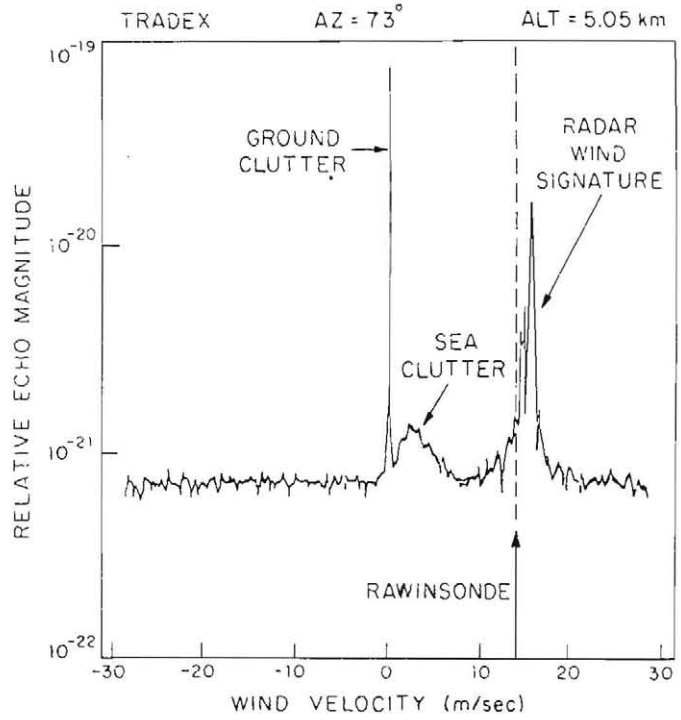


Figure D1. Example of Turbulence Echo Spectrum

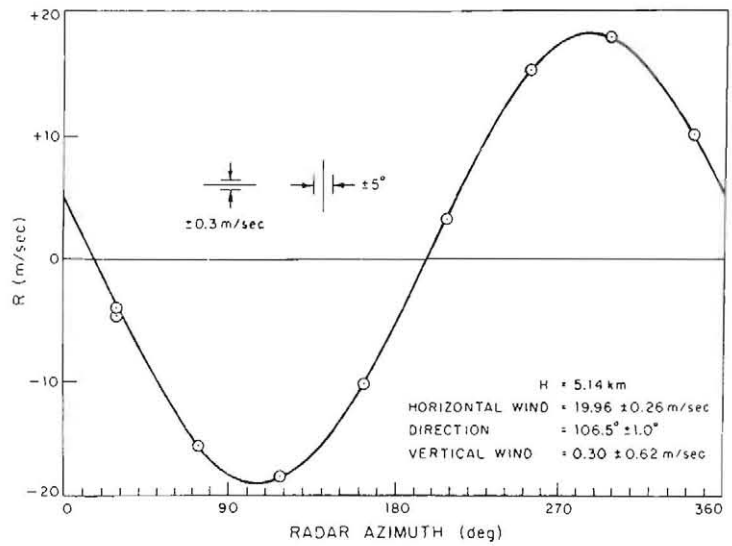


Figure D2. Example of Velocity-Azimuth Display From TRADEX Measurements

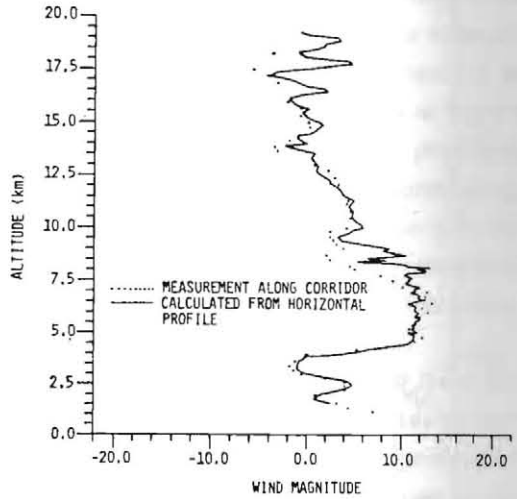


Figure D3. Wind Magnitude Along ALTAIR Radar LOS in the Reentry Corridor Before the ABRV-1 Mission

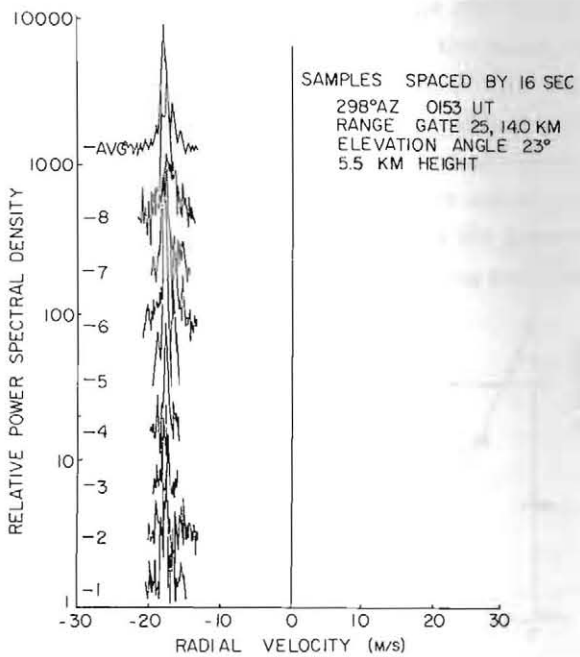


Figure D4. Examples of Spectral Wind Component Variations Over Short Temporal Scales

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

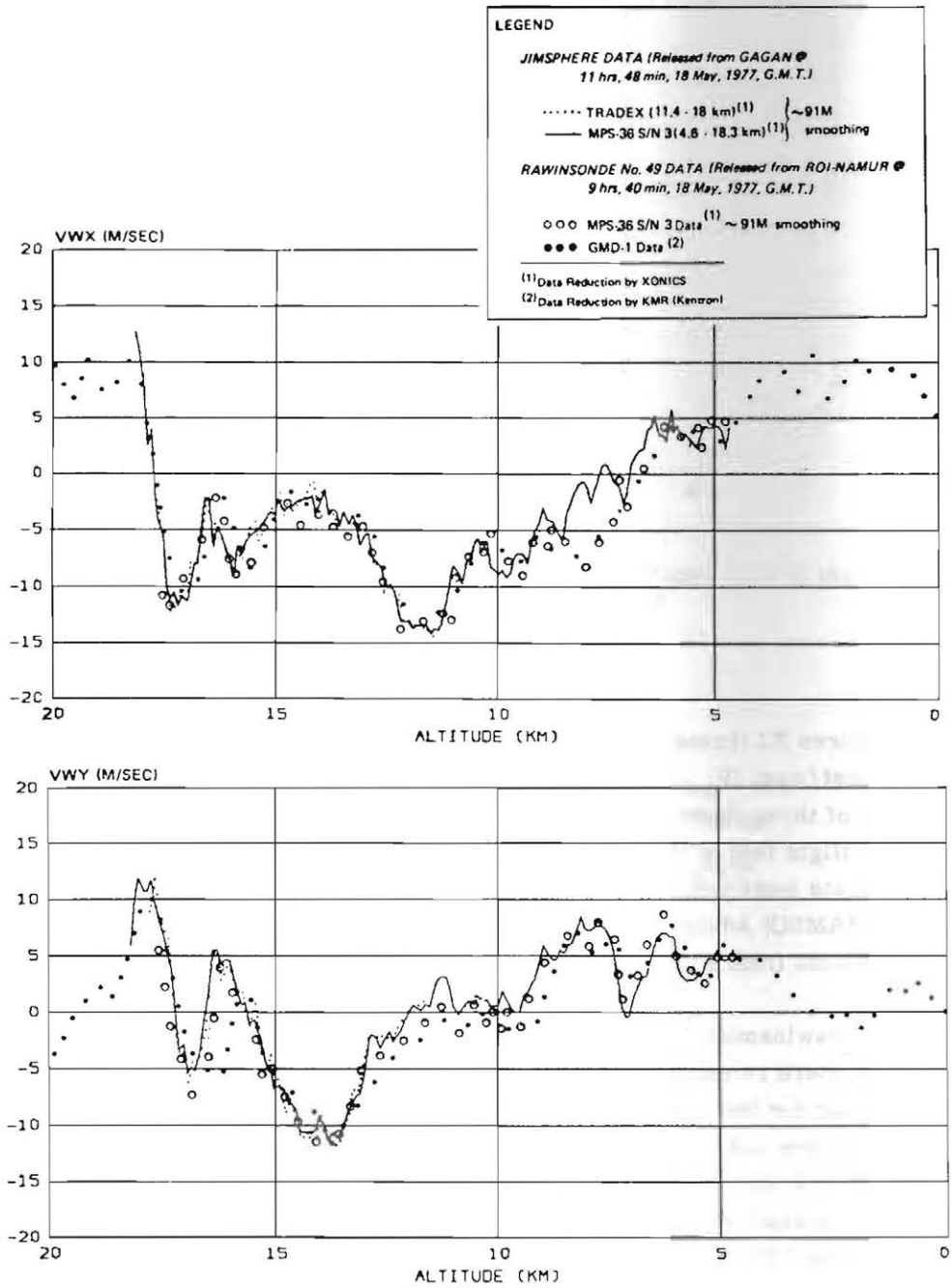


Figure E1. Comparison of Jimsphere and Rawinsonde Wind Measurements, TDV-1 Data

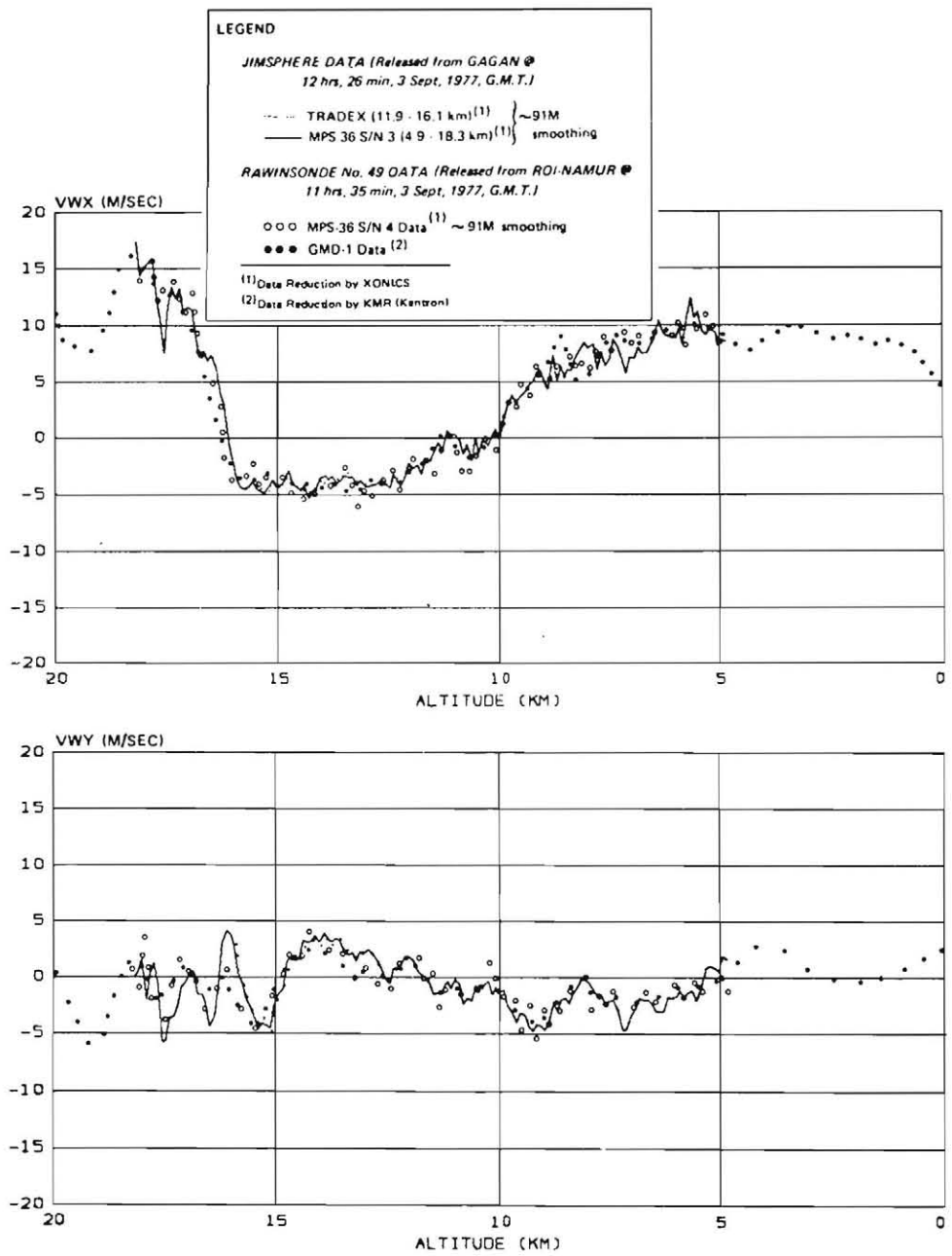


Figure E2. Comparison of Jimsphere and Rawinsonde Wind Measurements, TDV-2 Data

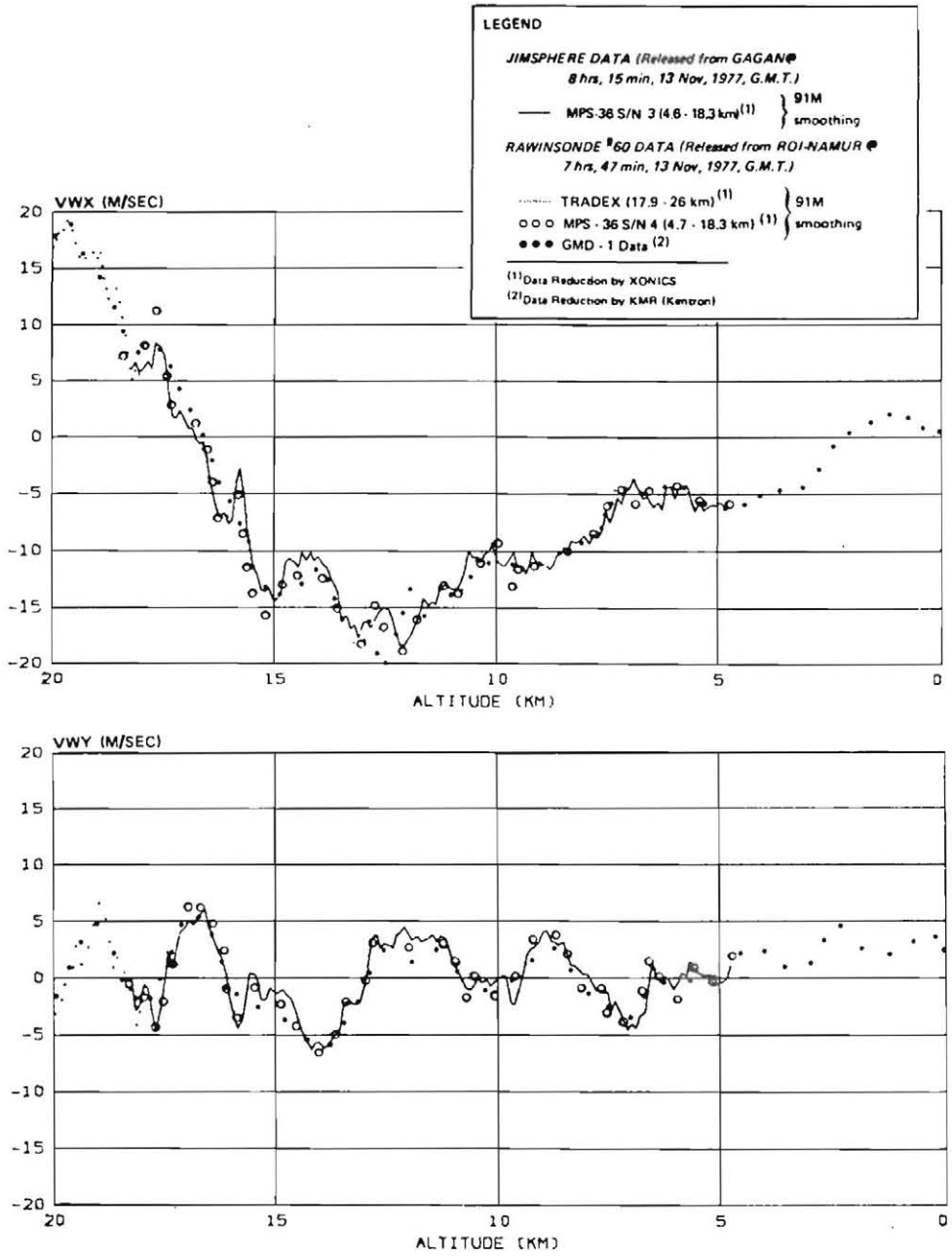


Figure E3. Comparison of Jimsphere and Rawinsonde Wind Measurements, TDV-3 Data

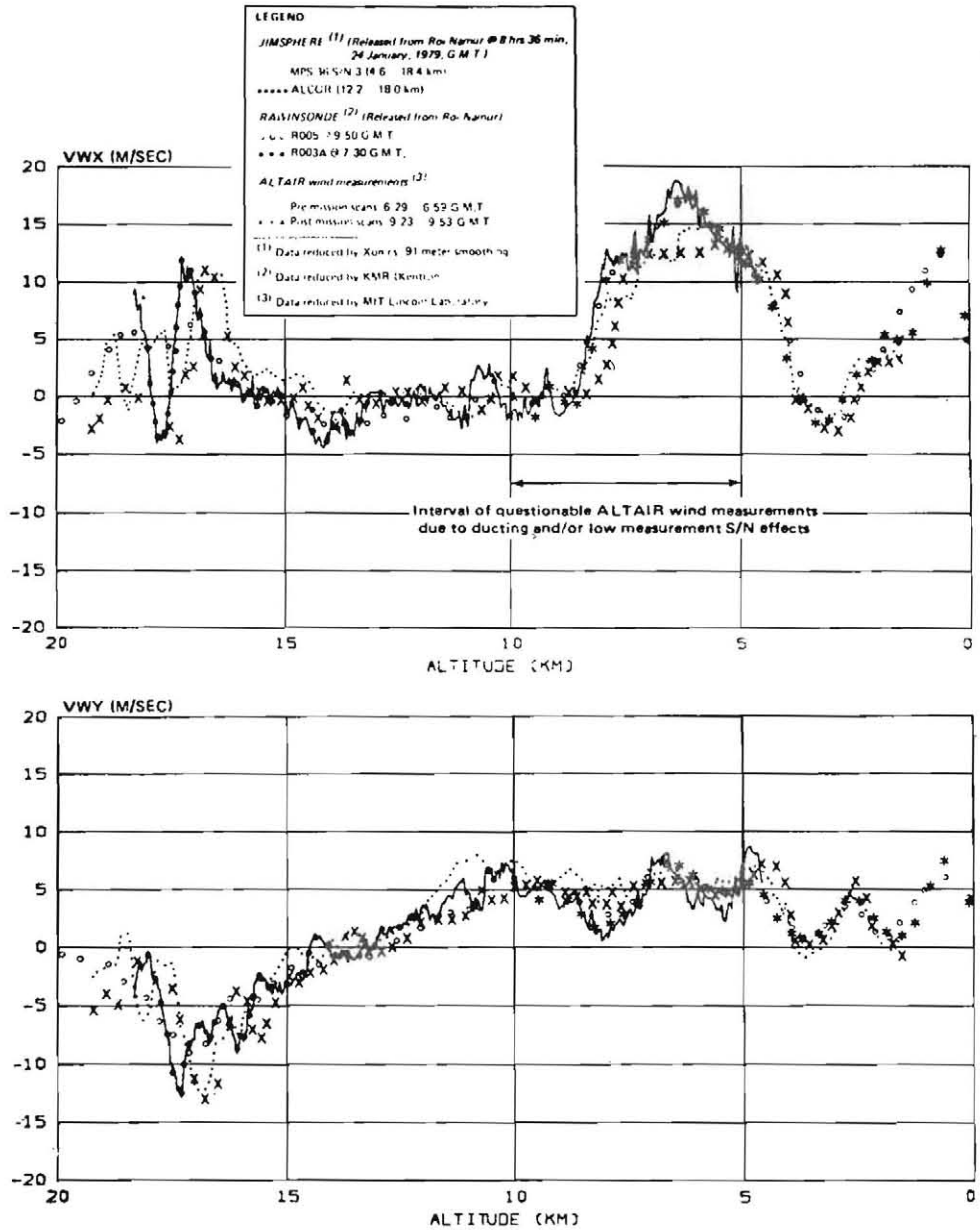


Figure E4. Comparison of Jimsphere, Rawinsonde, and ALTAIR Radar Wind Measurements, ABRV-1 Data

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 1σ 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 mucn 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

Mission	Sensor	rms Variability (m/sec) V_{wx}	V_{wy}
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)

Mission	Δ Time (hr:min)	Δ Space (km)	rms Variability (m/sec) V_{wx}	V_{wy}
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_o	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

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