International Standard ISO 5878

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Reference atmospheres for aerospace use

Atmosphères de référence pour l'application aérospatiale

First edition — 1982-04-15

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UDC 551.51/54 **Ref. No. ISO 5878-1982 (E)**

Descriptors : aerodynamics, atmospheres, standard atmosphere, characteristics, meteorological data, computation.

Price based on 39 pages

ISO 5878-1982 (E)

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 5878 was developed by Technical Committee ISO/TC 20, *Aircraft and space vehicles,* and was circulated to the member bodies in November 1978.

It has been approved by the member bodies of the following countries:

Austria	France	Romania
Belgium	Germany, F.R.	South Africa, Rep. of
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Canada	Japan	USA
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Reference atmospheres for aerospace use

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1 Scope and field of application

This International Standard presents information on the seasonal, latitudinal, longitudinal and day-to-day variability of atmospheric properties at levels between the surface and 80 km.

2 Basis

The systematic (latitudinal and seasonal) variation of atmospheric properties is shown for altitudes up to 80 km by a family of models, comprising the following reference atmospheres:

Title	Latitude	Time of year
Tropical	15°	Annual average
Sub-tropical	30° N	June-July and December-January
Mid-latitude	45° N	June-July and December-January
Sub-Arctic	60° N	June-July and December-January Cold and warm stratospheric-mesospheric regimes for December-January
Arctic	80° N	Same as sub-Arctic

Some special considerations employed in the development of this family of reference atmospheres are listed below.

a) With the exception of the 15° latitude model, the reference atmospheres are considered applicable to the northern hemisphere only. However, it is believed that they closely approximate mid-latitude conditions in the southern hemisphere.

b) The models are defined by temperature-altitude profiles in which the vertical gradients of temperature are constant with respect to geopotential altitude within each of a number of layers.

c) The air is assumed to be a perfect gas, free from moisture and dust.

d) The molar mass of dry air, $M = 28{,}964\ 420$ kg·kmol^{-1}, is assumed to be constant at altitudes up to 80 km. The specific gas constant of dry air R, is equal to 287,052 87 J·K^{-1}·kg^{-1} (table 1).

e) Characteristics such as the trade inversion in the tropics and the winter surface inversion in Arctic and sub-Arctic regions are included in the models.

Table 1 — Main values used for the calculation of the reference atmospheres

Symbol	Value	SI units of measurement
g_n	9,806 65	m·s^{-2}
M	28,964 420	kg·kmol^{-1}
N_A	602,257 × 10^{24}	kmol^{-1}
R^*	8 314,32	J·K^{-1}·kmol^{-1} or kg·m^2·s^{-2}·K^{-1}·kmol^{-1}
R	287,052 87	J·K^{-1}·kg^{-1} or m^2·K^{-1}·s^{-2}

2.1 Basic principles

The numerical values for the various thermodynamic and physical quantities used in the computations of atmospheric properties are the same as those used for ISO 2533, "Standard Atmosphere", with two exceptions: surface conditions for each for the reference atmospheres are based on sea-level values of temperature, pressure and density for the appropriate season and latitude, and the values of the acceleration of free fall at sea level for latitudes other than 45° were obtained from Lambert's equation[1], in which gravity varies with latitude φ:

$$g_{0\varphi} = 9{,}806\,16\,(1 - 0{,}002\,637\,3\cos 2\varphi + 0{,}000\,005\,9\cos^2 2\varphi)\ [\mathrm{m \cdot s^{-2}}]$$

Values from this relationship, along with surface temperatures and pressures, are given in table 2. For 45° N, values of $g_{0\varphi}$ and r_φ are taken from ISO 2533.

2.2 The hydrostatic equation and the perfect gas law

Being static with respect to the earth, the atmosphere is subject to gravitational forces. The conditions of air in static equilibrium are specified by the hydrostatic equation, which relates air pressure p, density ϱ, acceleration of free fall g and geometric altitude h as follows:

$$-\mathrm{d}p = \varrho\, g\, \mathrm{d}h \qquad \ldots (1)$$

The perfect gas law relates air pressure to density and temperature as follows:

$$p = \frac{\varrho R^* T}{M} \qquad \ldots (2)$$

At the altitudes of interest, $\dfrac{R^*}{M}$ = constant = R; hence

$$p = \varrho R T \qquad \ldots (3)$$

2.3 Geopotential and geometric altitudes; acceleration of free fall

In considering pressure distribution in the atmosphere, it is convenient to introduce the gravity potential or geopotential Φ, which specifies the potential energy of an air particle at a given point.

Any point having coordinates x, y, z may be characterized by a single value of the geopotential $\Phi(x, y, z)$. The surface defined by the equation $\Phi(x, y, z)$ = constant has the same geopotential at all points and is called a geopotential surface. When moving along an external normal from any point on the surface Φ_1, to an infinitely close point on a second surface where the geopotential is $\Phi_2 = \Phi_1 + \mathrm{d}\Phi$, the work performed in shifting a unit mass from the first surface to the second will be

$$\mathrm{d}\Phi = g(h)\mathrm{d}h \qquad \ldots (4)$$

hence

$$\Phi = \int_0^h g(h)\mathrm{d}h \qquad \ldots (5)$$

By dividing the geopotential Φ by the standard acceleration of free fall g_n, a quantity H with a dimension of length is obtained, where

$$H = \frac{\Phi}{g_n} = \frac{1}{g_n}\int_0^h g(h)\mathrm{d}h \qquad \ldots (6)$$

Expressed in metres, the value H is numerically equal to the geopotential altitude, which in meteorology is measured in so-called standard geopotential metres; hence this value is called the geopotential altitude. Mean sea level is taken as a reference for both geopotential and geometric altitudes.

From equation (6) it can be seen that in order to relate geopotential and geometric altitude it is necessary first to find a relation between the acceleration of free fall g, and the geometric altitude h.

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Table 2 — Acceleration of free fall at sea level $g_{0\varphi}$, nominal earth's radius r_φ from [1] and sea-level temperature and pressure for each latitudinal and seasonal model

Latitude φ	Acceleration of free fall $g_{0\varphi}$, $\mathrm{m \cdot s^{-2}}$	Nominal earth's radius r_φ, km	Temperature T, K		Pressure p, kPa, mbar	
			December-January	June-July	December-January	June-July
15°	9,783 81	6 337,84	299,650	299,650	1,013 250 × 10^3	1,013 250 × 10^3
30° N	9,793 24	6 345,65	283,150	297,150	1,020 500	1,014 000
45° N	9,806 65	6 356,77	272,650	291,150	1,018 000	1,013 500
60° N	9,819 11	6 367,10	256,150	282,150	1,013 000	1,010 200
80° N	9,830 51	6 376,56	248,950	276,650	1,013 800	1,012 000

Gravity is the vector sum of the gravitational attraction and the centrifugal force induced by the earth's rotation; it is therefore a complicated function of latitude and the radial distance from the centre of the earth, and the expression for the acceleration of free fall is generally awkward and impractical. However, allowance can be made for the centrifugal forces, with sufficient accuracy for these reference atmospheres, by using a fictitious or nominal value of the earth's radius, r_φ, at each latitude. The acceleration of free fall $g_\varphi(h)$ may be found for each height and latitude by use of r_φ with Newton's law of gravitation:

$$g_\varphi(h) = g_{0\varphi}\left(\frac{r_\varphi}{r_\varphi + h}\right)^2 \qquad \ldots (7)$$

where

r_φ is the nominal radius of the earth at a specific latitude and is taken from table 2;

$g_{0\varphi}$ is the acceleration of free fall at sea level for latitude φ.

Integration of equation (6), after substituting for $g_\varphi(h)$ from equation (7), gives the following relationship between geopotential and geometric altitudes:

$$H = \frac{r_\varphi h}{r_\varphi + h} \cdot \frac{g_{0\varphi}}{g_n} \qquad \ldots (8)$$

$$h = \frac{r_\varphi H}{\dfrac{g_{0\varphi}}{g_n} r_\varphi - H} \qquad \ldots (9)$$

The radius r_φ is a fictitious quantity, the meaning of which may be explained in the following way: gravity, being the vector sum of the gravitational attraction and the centrifugal force induced by the earth's rotation, has a certain potential, the geopotential. This potential may be replaced by the potential of a non-rotating homogeneous sphere in such a way that the gravitational attraction at the surface of the sphere is equal to that at the earth's surface both in magnitude and direction.

This condition is satisfied if the partial derivatives of g_φ with respect to h for $h = 0$ in equation (7) and in the more precise equation (10) from reference [1] are equal.

$$g_\varphi(h) = g_{0\varphi} - (3{,}085\,462 \times 10^{-6} + 2{,}27 \times 10^{-9} \cos 2\varphi)h + (7{,}254 \times 10^{-13} + 1{,}0 \times 10^{-15} \cos 2\varphi)h^2 - (1{,}517 \times 10^{-19} + 6{,}0 \times 10^{-22} \cos 2\varphi)h^3, \qquad \ldots (10)$$

where h is expressed in metres and g in metres per second squared.

The partial derivatives of g_φ with respect to h for $h = 0$ are, from equation (10):

$$\left(\frac{\partial g_\varphi}{\partial h}\right)_{h=0} = -3{,}085\,462 \times 10^{-6} - 2{,}27 \times 10^{-9} \cos 2\varphi \qquad \ldots (11)$$

and, from equation (7):

$$\left(\frac{\partial g_\varphi}{\partial h}\right)_{h=0} = -\frac{2\,g_{0\varphi}}{r_\varphi} \qquad \ldots (12)$$

Equating the right-hand sides of (11) and (12), we have

$$r_\varphi = g_{0\varphi} \frac{2}{3{,}085\,462 \times 10^{-6} + 2{,}27 \times 10^{-9} \cos 2\varphi} \qquad \ldots (13)$$

where r_φ is expressed in metres and $g_{o\varphi}$ in metres per second squared.

The values of r_φ for the latitudes of the reference atmospheres are given in table 2.

3 Atmospheric models to 80 km altitude

The reference atmospheres are defined by the vertical temperature profiles for each latitude and season [see clause 2, paragraph b)]. Vertical pressure and density distributions were calculated from the temperature-altitude profiles using the hydrostatic equation (1) and the perfect gas law (3) from clause 2 and the appropriate mean sea-level values of pressure. Tables 3-15 of the temperature and other properties of the reference atmospheres are given in clause 6. Brief descriptions of seasonal, latitudinal, longitudinal and day-to-day variations of temperature and density are included in clause 4.

3.1 Annual model for 15° latitude

A mean annual atmosphere was adopted for 15° latitude as available observations indicate that the seasonal variability of vertical profiles of temperature in the tropics is relatively small. A mean annual temperature profile (figure 1) is based on observations taken at Ascension (8° S, 14° W), Natal (6° S, 35° W), Ft. Sherman (9° N, 80° W), Kwajalein (9° N, 168° E), Antigua (17° N, 62° W), Guam (14°, 145° E), Grand Turk (21° N, 71° W) and research vessels Voyeikov and Shokalsky (20° S).

Features typical of the thermal structure of the tropical atmosphere are shown in figure 1 and in table 3. For example, routine averaging of monthly temperature-altitude data indicates as isothermal layer about 2 km thick from 16 to 18 km. An examination of daily observations, however, reveals a sharp inversion at the tropopause. The sharp inversion, a feature typical of the tropical atmosphere, has been retained and appears at 16,5 km, the mean annual altitude of the tropopause at 15° latitude.

The average altitude and magnitude of the trade wind inversion, a characteristic of the temperature structure between 2 and 3 km, over tropical ocean areas, have also been included in the 15° latitude temperature-altitude profile.

3.2 Seasonal models for 30, 45, 60 and 80° N

Temperature-altitude profiles for the mean December-January and June-July atmospheres for 30, 45, 60 and 80° N are presented in figure 1 and table 16. They are based on the temperature-altitude cross-sections in figure 2. The temperature distributions shown in figure 2 for levels below

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30 km were derived from routine radiosonde observations. Mean northern hemisphere values were computed at various latitudes from available summaries[2] by giving equal weight to observed and interpolated temperature data at each 10 degrees of longitude. The initial pressures (sea-level values for each atmosphere) were obtained from monthly normal sea-level charts[3, 4] of the northern hemisphere.

The temperature field between 30 and 50 km is based on meteorological rocket measurements taken at locations shown in table 17. Instrumentation consists primarily of parachute-borne telemetering sets with temperature-sensing elements (bead thermistors or resistance wires). Thermistor measurements are subject to large corrections and uncertainties above 50 km. Consequently the thermistor data are used only for altitudes up to 50 km. The temperature distributions between 50 and 80 km are based primarily on grenade, falling sphere and pressure gauge experiments taken at locations shown in table 18.

Median rather than mean values are used since bimodal distributions of temperature occur at high latitudes in winter in the upper stratosphere and mesosphere. At other times distributions are nearly normal. Dates of observation for the southern hemisphere were adjusted by six months to conform to northern hemisphere seasons.

3.3 Cold and warm stratospheric and mesospheric regimes for 60 and 80° N in December-January

In Arctic and sub-Arctic regions, sudden warmings and coolings of the winter stratosphere and mesosphere produce large changes in the vertical structure of the atmosphere. The magnitude and altitude of maximum temperature change during major warmings and coolings vary considerably. Some of the largest changes have been observed in the upper stratosphere. The winter temperature distributions in this region are bimodal and temperatures are normally much lower or much higher than the seasonal mean. Observed 35 km temperatures, for example, have a range of roughly 75 K in winter compared with 20 K in summer. Consequently, mean monthly or seasonal atmospheric models for the winter months are of limited value for specifiyng the temperature in Arctic and sub-Arctic regions as the day-to-day variations in temperature at many levels in the stratosphere are as great as or greater than seasonal or latitudinal changes.

Vertical temperature profiles representative of the cold and warm stratospheric regimes that occur at 60 and 80° N in December and January are shown in figure 3 and table 19. The profiles for the warm and cold models at 60° N were constructed from temperatures derived from radiosonde, rocketsonde and grenade observations taken at Ft. Greely, Alaska (64° N, 146° W), Ft. Churchill, Canada (59° N, 94° W) and West Geirinish, Scotland (57° N, 7° W). The 80° N models are based on observations taken at Heiss Island (81° N, 58° E).

The warm regimes are arbitrarily defined as periods when the observed temperature at 45 km is within $\pm$ 2 K of 267 K, a value which is equalled or exceeded in 1, 5, 20 and 30% of the observations at Ft. Greely, Ft. Churchill, West Geirinish and Heiss Island, respectively.

The cold regimes are defined as periods when the observed temperature at 45 km at 60° N is within $\pm$ 2 K of 223 K, and that at 80° N is within $\pm$ 2 K of 232 K. The temperature of 223 K is equalled or exceeded in 98, 95, and 93% of the observations at West Geirinish, Ft. Churchill and Ft. Greely respectively, and 232 K is exceeded in 80% of the observations from Heiss Island (223 K is equalled or exceeded 90% of the time at Heiss Island).

Individual temperature soundings taken at Ft. Churchill, Ft. Greely, West Geirinish and Heiss Island which satisfied the temperature requirements for a particular model at 45 km were averaged together to obtain a mean temperature-altitude profile between 8 and 80 km. Mean seasonal conditions were assumed below 9 km as the vertical temperature profiles that emerged at these levels were not significantly different from those for the mean seasonal conditions at 60 and 80° N. Locations and dates of soundings used in the construction of the warm and cold models are given in table 20. Due to the sparsity of data above 30 km in Arctic and sub-Arctic regions, the frequencies of occurrence of the warm and cold models at the various locations are *rough estimates.*

4 Temporal and spatial variations

4.1 Seasonal and latitudinal variations

Maximum and minimum mean monthly temperatures between the surface and 80 km do not occur at all latitudes and levels in the same month or season. Consequently, the tabulated temperatures for the December-January and June-July reference atmospheres for 30, 45, 60 and 80° N (table 21) do not represent extreme seasonal temperatures at all altitudes. Nevertheless, they do provide a good indication of the magnitude of the seasonal and latitudinal temperature variability that can be expected at levels between the surface and 80 km.

The maximum and minimum mean seasonal densities and pressures between the surface and 80 km, however, normally occur in the June-July and December-January periods respectively between latitudes 30 and 80° N (table 22).

At locations between 30 and 80° N, maximum mean monthly temperatures at levels below 25 km usually occur in June or July, and the minima in December or January. In the upper stratosphere, however, semi-annual and biennial cycles complicate the annual temperature cycle. The magnitude of the annual cycle is largest near the poles, decreasing toward the equator. The semi-annual and biennial cycles are greatest near the equator, decreasing toward the poles. The phases as well as the amplitudes of these temperature oscillations change with latitude and altitude. At middle and high latitudes, the annual and semi-annual cycles tend to obscure the biennial oscillations.

Observations show that the semi-annual oscillation produces two pronounced maxima and minima within the annual stratospheric temperature cycle in tropical and sub-tropical regions. North of 25° latitude, the combined annual and semi-annual components occasionally shift the time of maximum temperature in the upper stratosphere to early June or May, and the minimum temperature to early December or November.

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However, in cases where the maximum mean monthly stratospheric temperatures occur in May rather than June or July and the minimum in November rather than December or January, the differences between May and June and November and December values are only a few degrees. In the mesosphere, above 60 – 65 km, the maximum mean monthly temperatures generally occur in December or January, and the minimum in June or July. An exception occurs at Heiss Island, where maximum temperatures are observed in late November and early December.

The vertical distribution of density is shown for the 15° latitude mean annual atmosphere and the December-January and June-July atmospheres for 30, 45, 60 and 80° N in figure 4 as percentage departures from the ISO standard densities. The maximum mean monthly densities at levels between 10 and 80 km and latitudes 30 to 80° N occur in June or July, and minimum values in December or January. Near the surface, pressures are usually highest in winter and lowest in summer.

The level of minimum seasonal variability of density near 8 km represents the first isopycnic level where density remains relatively constant throughout the year regardless of geographic location. The levels of maximum seasonal and latitudinal variability in density and pressure are between 65 and 75 km, and the variability is greatest at high latitudes.

4.2 Longitudinal variations

In summer, longitudinal variations in the structure of the atmosphere are relatively small at all latitudes compared with seasonal and latitudinal changes for levels up to 80 km. Isotherms and contour lines of constant-pressure charts in the stratosphere and mesosphere parallel the latitude circles, and the associated circulation pattern is symmetrical about the poles. During the winter season, changes with longitude remain small at low latitudes but become as important as those with latitude and season in Arctic and sub-Arctic regions[13].

At latitudes between 60 and 80° N, longitudinal variations in the mean monthly altitudes of pressure surfaces in the lower mesosphere are greater than 2 500 m, mean monthly temperatures vary by 15 to 20 K at levels between 20 and 35 km, and mean monthly densities change by 15 to 20% at levels between 40 and 60 km[14]. These differences reflect the longitudinal asymmetry in the winter circulation pattern at high latitudes. The Aleutian anticyclone and the displacement of the polar low toward the Eurasian continent are important features of the mean monthly circulation patterns up to at least 80 km during the northern hemisphere winter[15].

5 Frequency distributions of observed temperatures and densities

The distributions of observed temperatures and densities around median*) values for December-January and June-July for 30, 45, 60 and 80° N and annual medians at 15° are shown in tables 21 and 22 respectively, for levels up to 80 km. Medians and high and low values which are equalled or exceeded in 1, 10 and 20% of cases are given at 5 km altitude increments. Densities are given as percentage departures from the ISO standard densities. Distributions for levels below 30 km are based on radiosonde observations taken in the northern hemisphere, and those above on meteorological and experimental rocket observations from locations shown in tables 17 and 18.

Data are only provided for levels up to 50 km at 15° as there are insufficient observations on which to base temperature and density distributions above 50 km in tropical areas. Confidence in the distributions decreases rapidly above 50 km, where data are relatively sparse and instrumentation errors relatively large.

*) The median is the percentile of 50%.

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6 Tables of properties of the reference atmospheres

NOTE — A one- or two-digit number preceded by a plus of minus sign following each of pressure and density indicates the power of ten by which that entry should be multiplied.

Table 3 — Mean annual values of characteristics at 15°

h	*H*	*T*	*t*	*p*		*ϱ*	
m	m	K	°C	hPa, mbar		$kg \cdot m^{-3}$	
0	0	299,650	26,50	1,013 250	03	1,177 987	00
1 000	998	293,665	21,52	9,032 869	02	1,071 548	00
2 000	1 995	287,682	14,53	8,033 849	02	9,728 581	−01
3 000	2 992	283,656	10,50	7,132 021	02	8,759 075	−01
4 000	3 988	276,979	5,83	6,316 301	02	7,944 263	−01
5 000	4 984	270,304	−1,15	5,577 544	02	7,188 330	−01
6 000	5 980	263,632	−9,52	4,910 097	02	6,488 298	−01
7 000	6 976	256,961	−16,19	4,308 599	02	5,841 269	−01
8 000	7 971	250,292	−22,86	3,767 974	02	5,244 434	−01
9 000	8 966	243,626	−29,52	3,283 418	02	4,695 060	−01
10 000	9 961	236,961	−36,19	2,850 398	02	4,190 503	−01
12 000	11 949	223,639	−49,51	2,122 104	02	3,305 654	−01
14 000	13 937	210,325	−62,82	1,551 827	02	2,570 343	−01
16 000	15 923	197,019	−76,13	1,112 046	02	1,966 313	−01
18 000	17 907	198,779	−74,37	7,864 157	01	1,378 225	−01
20 000	19 891	206,713	−66,44	5,629 715	01	9,487 626	−02
22 000	21 873	214,641	−58,51	4,082 017	01	6,625 209	−02
24 000	23 854	218,858	−54,59	2,987 766	01	4,755 795	−02
26 000	25 833	222,817	−50,33	2,199 570	01	3,438 964	−02
28 000	27 812	226,774	−46,38	1,628 370	01	2,501 488	−02
30 000	29 789	230,728	−42,42	1,212 014	01	1,829 974	−02
32 000	31 765	236,092	−37,06	9,075 227	00	1,339 103	−02
34 000	33 740	241,621	−31,53	6,842 101	00	9,864 886	−03
36 000	35 713	247,147	−26,00	5,192 440	00	7,319 035	−03
38 000	37 686	252,670	−20,48	3,965 297	00	5,467 150	−03
40 000	39 657	258,188	−14,96	3,046 371	00	4,110 401	−03
42 000	41 626	262,728	−10,82	2,352 931	00	3,119 903	−03
44 000	43 595	267,059	−6,09	1,825 355	00	2,381 105	−03
46 000	45 562	271,387	−1,76	1,422 088	00	1,825 475	−03
48 000	47 528	272,350	−0,80	1,111 163	00	1,421 309	−03
50 000	49 493	272,350	−0,80	8,684 371	−01	1,110 834	−03
52 000	51 457	271,254	−1,90	6,787 593	−01	8,717 218	−04
54 000	53 419	266,544	−6,61	5,289 756	−01	6,913 604	−04
56 000	55 380	261,009	−12,14	4,103 663	−01	5,477 140	−04
58 000	57 340	255,129	−18,02	3,165 824	−01	4,322 791	−04
60 000	59 299	249,253	−23,90	2,427 992	−01	3,393 472	−04
62 000	61 256	242,753	−30,40	1,850 269	−01	2,655 271	−04
64 000	63 213	235,906	−37,24	1,399 430	−01	2,066 572	−04
66 000	65 168	229,063	−44,09	1,049 963	−01	1,596 823	−04
68 000	67 121	222,786	−50,36	7,812 449	−02	1,221 626	−04
70 000	69 074	216,928	−56,22	5,767 794	−02	9,262 593	−05
72 000	71 025	211,074	−62,08	4,223 868	−02	6,971 309	−05
74 000	72 976	205,223	−67,93	3,066 854	−02	5,206 007	−05
76 000	74 925	203,225	−69,92	2,213 526	−02	3,794 413	−05
78 000	76 872	201,278	−71,87	1,592 946	−02	2,757 042	−05
80 000	78 819	199,331	−73,82	1,142 926	−02	1,997 473	−05

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Table 4 — Mean values of characteristics during December-January at 30° N

h	H	T	t	p		ϱ	
m	m	K	°C	hPa, mbar		kg·m^{-3}	
0	0	283,150	10,00	1,020 500	03	1,255 552	00
1 000	998	281,652	8,50	9,043 877	02	1,118 611	00
2 000	1 997	280,155	7,00	8,010 013	02	9,960 310	−01
3 000	2 994	273,785	0,63	7,082 381	02	9,011 710	−01
4 000	3 992	267,401	−5,75	6,244 260	02	8,134 969	−01
5 000	4 989	261,019	−12,13	5,488 819	02	7,325 630	−01
6 000	5 986	254,639	−18,51	4,809 595	02	6,579 944	−01
7 000	6 983	248,261	−24,89	4,200 502	02	5,894 291	−01
8 000	7 979	241,884	−31,27	3,655 799	02	5,265 173	−01
9 000	8 975	235,510	−37,64	3,170 092	02	4,689 215	−01
10 000	9 971	229,138	−44,01	2,738 311	02	4,163 165	−01
12 000	11 961	216,400	−56,75	2,017 829	02	3,248 372	−01
14 000	13 950	212,250	−60,90	1,469 359	02	2,411 675	−01
16 000	15 938	208,274	−64,88	1,063 783	02	1,779 327	−01
18 000	17 925	207,150	−66,00	7,667 844	01	1,289 515	−01
20 000	19 910	210,970	−62,18	5,542 683	01	9,152 460	−02
22 000	21 894	214,938	−52,21	4,031 617	01	6,534 376	−02
24 000	23 877	218,904	−54,25	2,950 204	01	4,695 014	−02
26 000	25 858	222,495	−50,66	2,170 892	01	3,399 035	−02
28 000	27 839	226,060	−47,09	1,605 556	01	2,474 229	−02
30 000	29 818	229,622	−45,53	1,193 281	01	1,810 366	−02
32 000	31 796	233,183	−39,97	8,910 929	00	1,331 266	−02
34 000	33 773	236,741	−36,41	6,685 021	00	9,837 124	−03
36 000	35 748	241,520	−31,63	5,040 774	00	7,270 803	−03
38 000	37 722	246,456	−26,69	3,823 344	00	5,404 346	−03
40 000	39 695	251,388	−21,76	2,916 373	00	4,041 448	−03
42 000	41 667	256,317	−16,83	2,236 656	00	3,039 905	−03
44 000	43 637	261,243	−11,91	1,724 332	00	2,299 398	−03
46 000	45 606	266,166	−6,98	1,336 047	00	1,748 667	−03
48 000	47 574	269,650	−3,50	1,040 365	00	1,344 075	−03
50 000	49 541	269,650	−3,50	8,111 550	−01	1,047 952	−03
52 000	51 507	265,732	−7,42	6,331 020	−01	8,299 806	−04
54 000	53 471	260,625	−12,52	4,896 510	−01	6,544 986	−04
56 000	55 434	255,521	−17,63	3,777 460	−01	5,150 029	−04
58 000	57 396	250,420	−22,73	2,899 100	−01	4,032 813	−04
60 000	59 357	245,323	−27,83	2,213 370	−01	3,143 082	−04
62 000	61 316	240,228	−32,92	1,080 647	−01	2,437 199	−04
64 000	63 274	235,137	−38,01	1,268 919	−01	1,879 963	−04
66 000	65 231	230,049	−43,10	9,522 370	−02	1,441 992	−04
68 000	67 187	224,964	−48,19	7,101 800	−02	1,099 749	−04
70 000	69 142	219,882	−53,27	5,261 760	−02	8,336 456	−05
72 000	71 095	215,241	−57,91	3,873 080	−02	6,268 586	−05
74 000	73 047	210,947	−62,20	2,833 610	−02	4,679 558	−05
76 000	74 998	206,655	−66,50	2,059 990	−02	3,472 637	−05
78 000	76 948	202,365	−70,78	1,487 932	−02	2,561 462	−05
80 000	78 896	198,079	−75,07	1,067 686	−02	1,877 773	−05

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Table 5 — Mean values of characteristics during June-July at 30° N

h	H	T	t	p		ϱ	
m	m	K	°C	hPa, mbar		$kg \cdot m^{-3}$	
0	0	297,150	24,00	1,014 000	03	1,188 777	00
1 000	998	292,657	19,51	9,032 389	02	1,075 182	00
2 000	1 997	288,165	15,01	8,031 678	02	9,709 637	– 01
3 000	2 994	282,183	9,03	7,126 716	02	8,798 254	– 01
4 000	3 992	276,198	3,05	6,307 772	02	7,955 980	– 01
5 000	4 989	270,215	– 2,93	5,568 245	02	7,178 729	– 01
6 000	5 986	264,233	– 8,92	4,901 913	02	6,462 735	– 01
7 000	6 983	258,254	– 14,90	4,302 921	02	5,804 369	– 01
8 000	7 979	252,276	– 20,87	3,765 769	02	5,200 150	– 01
9 000	8 975	245,325	– 27,82	3,284 424	02	4,663 963	– 01
10 000	9 971	238,356	– 34,79	2,853 462	02	4,170 466	– 01
12 000	11 961	224,423	– 48,73	2,126 718	02	3,301 264	– 01
14 000	13 950	210,499	– 62,65	1,555 791	02	2,574 770	– 01
16 000	15 938	206,650	– 66,50	1,120 965	02	1,889 708	– 01
18 000	17 925	209,054	– 64,10	8,078 713	01	1,346 239	– 01
20 000	19 910	214,216	– 58,93	5,863 399	01	9,535 340	– 02
22 000	21 894	219,374	– 53,78	4,288 995	01	6,810 950	– 02
24 000	23 877	222,465	– 50,68	3,156 591	01	4,943 040	– 02
26 000	25 858	225,438	– 47,71	2,333 098	01	3,605 326	– 02
28 000	27 839	228,408	– 44,74	1,731 603	01	2,641 037	– 02
30 000	29 818	232,113	– 41,04	1,290 625	01	1,937 039	– 02
32 000	31 796	236,860	– 36,29	9,674 904	00	1,422 960	– 02
34 000	33 773	241,604	– 31,55	7,295 464	00	1,051 930	– 02
36 000	35 748	246,345	– 26,80	5,532 453	00	7,823 695	– 03
38 000	37 722	251,083	– 22,07	4,218 382	00	5,852 837	– 03
40 000	39 695	255,818	– 17,33	3,233 311	00	4,403 055	– 03
42 000	41 667	260,550	– 12,60	2,490 793	00	3,330 307	– 03
44 000	43 637	265,279	– 7,87	1,928 131	00	2,532 043	– 03
46 000	45 606	270,006	– 3,14	1,499 575	00	1,934 788	– 03
48 000	47 574	273,350	0,20	1,171 338	00	1,492 798	– 03
50 000	49 541	273,350	0,20	9,160 719	– 01	1,167 478	– 03
52 000	51 507	271,982	– 1,17	7,164 314	– 01	9,176 418	– 04
54 000	53 471	266,678	– 6,47	5,584 194	– 01	7,294 768	– 04
56 000	55 434	261,378	– 11,77	4,331 538	– 01	5,773 137	– 04
58 000	57 396	256,081	– 17,07	3,342 986	– 01	4,547 745	– 04
60 000	59 357	250,787	– 22,36	2,566 539	– 01	3,565 178	– 04
62 000	61 316	243,785	– 29,36	1,958 440	– 01	2,798 599	– 04
64 000	63 274	235,953	– 37,20	1,481 758	– 01	2,187 714	– 04
66 000	65 231	228,125	– 45,02	1,110 795	– 01	1,696 288	– 04
68 000	67 187	220,302	– 52,85	8,245 235	– 02	1,303 836	– 04
70 000	69 142	212,484	– 60,67	6,055 874	– 02	9,928 629	– 05
72 000	71 095	207,079	– 66,07	4,402 212	– 02	7,405 810	– 05
74 000	73 047	203,565	– 69,58	3,181 313	– 02	5,444 279	– 05
76 000	74 998	200,054	– 73,10	2,286 524	– 02	3,981 684	– 05
78 000	76 948	196,544	– 76,61	1,634 168	– 02	2,896 502	– 05
80 000	78 896	193,037	– 80,11	1,161 134	– 02	2,095 460	– 05

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Table 6 — Mean values of characteristics during December-January at 45° N

h	H	T	t	p		ϱ	
m	m	K	°C	hPa, mbar		$kg \cdot m^{-3}$	
0	0	272,650	– 0,50	1,018 000	03	1,300 710	00
1 000	1 000	268,651	– 4,50	8,972 965	02	1,163 553	00
2 000	1 999	264,653	– 8,50	7,894 410	02	1,039 158	00
3 000	2 999	260,656	– 12,49	6,932 257	02	9,265 002	– 01
4 000	3 997	254,665	– 18,48	6,072 291	02	8,306 561	– 01
5 000	4 996	248,674	– 24,48	5,302 482	02	7,428 269	– 01
6 000	5 994	242,684	– 30,47	4,615 185	02	6,625 005	– 01
7 000	6 992	236,696	– 36,45	4,003 243	02	5,891 946	– 01
8 000	7 990	230,710	– 42,44	3,459 967	02	5,224 480	– 01
9 000	8 987	224,726	– 48,42	2,979 117	02	4,618 188	– 01
10 000	9 984	218,744	– 54,41	2,554 879	02	4,068 852	– 01
12 000	11 977	217,859	– 55,29	1,870 175	02	2,990 506	– 01
14 000	13 969	217,062	– 56,09	1,367 674	02	2,195 008	– 01
16 000	15 960	216,266	– 56,88	9,992 378	01	1,609 602	– 01
18 000	17 949	215,470	– 57,68	7,293 541	01	1,179 204	– 01
20 000	19 937	215,450	– 57,70	5,321 437	01	8,604 398	– 02
22 000	21 924	215,450	– 57,70	3,883 336	01	6,279 089	– 02
24 000	23 910	215,450	– 57,70	2,834 438	01	4,583 091	– 02
26 000	25 894	215,450	– 57,70	2,069 257	01	3,345 847	– 02
28 000	27 877	215,450	– 57,70	1,510 942	01	2,443 089	– 02
30 000	29 859	219,726	– 53,42	1,106 675	01	1,754 596	– 02
32 000	31 840	224,281	– 48,87	8,159 176	00	1,267 334	– 02
34 000	33 819	228,834	– 44,32	6,053 611	00	9,215 780	– 03
36 000	35 797	233,623	– 39,53	4,518 989	00	6,738 512	– 03
38 000	37 774	238,763	– 34,39	3,395 100	00	4,953 632	– 03
40 000	39 750	243,900	– 29,25	2,566 753	00	3,666 157	– 03
42 000	41 724	249,033	– 24,12	1,952 186	00	2,730 876	– 03
44 000	43 698	254,164	– 18,99	1,493 329	00	2,046 823	– 03
46 000	45 670	259,291	– 13,86	1,148 646	00	1,543 253	– 03
48 000	47 640	262,750	– 10,40	8,879 803	– 01	1,177 331	– 03
50 000	49 610	262,750	– 10,40	6,873 676	– 01	9,113 484	– 04
52 000	51 578	261,825	– 11,32	5,320 918	– 01	7,079 676	– 04
54 000	53 545	258,678	– 14,47	4,110 013	– 01	5,535 059	– 04
56 000	55 511	255,532	– 17,62	3,165 179	– 01	4,315 095	– 04
58 000	57 476	252,389	– 20,76	2,430 079	– 01	3,354 193	– 04
60 000	59 439	249,248	– 23,90	1,859 846	– 01	2,599 465	– 04
62 000	61 401	245,408	– 27,74	1,418 451	– 01	2,013 559	– 04
64 000	63 362	241,290	– 31,86	1,077 094	– 01	1,555 081	– 04
66 000	65 322	237,174	– 35,98	8,141 625	– 02	1,195 864	– 04
68 000	67 280	233,061	– 40,09	6,125 179	– 02	9,155 594	– 05
70 000	69 238	228,951	– 44,20	4,585 691	– 02	6,977 505	– 05
72 000	71 194	224,843	– 48,31	3,415 810	– 02	5,292 389	– 05
74 000	73 148	220,738	– 52,41	2,531 081	– 02	3,994 538	– 05
76 000	75 102	216,636	– 56,51	1,865 337	– 02	2,999 616	– 05
78 000	77 055	212,536	– 60,61	1,366 971	– 02	2,240 608	– 05
80 000	79 006	208,438	– 64,71	9,959 045	– 03	1,664 481	– 05

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Table 7 — Mean values of characteristics during June-July at 45° N

h	H	T	t	p		ϱ	
m	m	K	°C	hPa, mbar		$kg \cdot m^{-3}$	
0	0	291,150	18,00	1,013 500	03	1,212 677	00
1 000	1 000	286,651	13,50	9,004 805	02	1,094 357	00
2 000	1 999	282,153	9,00	7,985 996	02	9,860 133	− 01
3 000	2 999	276,158	3,01	7,066 750	02	8,914 549	− 01
4 000	3 997	270,165	− 2,98	6,236 801	02	8,042 124	− 01
5 000	4 996	264,174	− 8,98	5,489 141	02	7,238 575	− 01
6 000	5 994	258,184	− 14,97	4,817 178	02	6,499 823	− 01
7 000	6 992	252,196	− 20,95	4,214 714	02	5,821 939	− 01
8 000	7 990	246,210	− 26,94	3,675 938	02	5,201 158	− 01
9 000	8 987	240,226	− 32,92	3,195 402	02	4,633 881	− 01
10 000	9 984	234,244	− 38,91	2,768 012	02	4,116 585	− 01
12 000	11 977	222,286	− 50,86	2,053 950	02	3,218 967	− 01
14 000	13 969	216,150	− 57,00	1,502 602	02	2,421 737	− 01
16 000	15 960	216,150	− 57,00	1,096 999	02	1,768 028	− 01
18 000	17 949	217,289	− 55,86	8,013 558	01	1,284 771	− 01
20 000	19 937	219,675	− 53,47	5,872 381	01	9,312 628	− 02
22 000	21 924	222,059	− 51,09	4,318 617	01	6,775 082	− 02
24 000	23 910	224,442	− 48,71	3,187 007	01	4,946 723	− 02
26 000	25 894	227,538	− 45,61	2,360 416	01	3,613 868	− 02
28 000	27 877	231,504	− 41,65	1,757 078	01	2,644 051	− 02
30 000	29 859	235,468	− 37,68	1,314 769	01	1,945 161	− 02
32 000	31 840	240,165	− 32,98	9,891 545	00	1,434 802	− 02
34 000	33 819	244,916	− 28,23	7,484 711	00	1,064 624	− 02
36 000	35 797	249,663	− 23,49	5,694 896	00	7,946 373	− 03
38 000	37 774	254,408	− 18,74	4,356 168	00	5,965 020	− 03
40 000	39 750	259,150	− 14,00	3,349 228	00	4,502 277	− 03
42 000	41 724	263,888	− 9,26	2,587 762	00	3,416 191	− 03
44 000	43 698	268,624	− 4,53	2,008 934	00	2,605 307	− 03
46 000	45 670	273,357	0,21	1,566 736	00	1,996 659	− 03
48 000	47 640	276,550	3,40	1,227 015	00	1,545 661	− 03
50 000	49 610	276,550	3,40	9,620 223	− 01	1,211 852	− 03
52 000	51 578	275,047	1,90	7,542 266	− 01	9,552 852	− 04
54 000	53 545	269,933	− 3,22	5,893 773	− 01	7,606 347	− 04
56 000	55 511	264,821	− 8,33	4,584 636	− 01	6,031 006	− 04
58 000	57 476	259,713	− 13,44	3,549 443	− 01	4,761 061	− 04
60 000	59 439	254,609	− 18,54	2,734 507	− 01	3,741 485	− 04
62 000	61 401	246,985	− 26,16	2,093 902	− 01	2,953 411	− 04
64 000	63 362	238,357	− 34,79	1,588 737	− 01	2,322 001	− 04
66 000	65 322	229,734	− 43,42	1,193 453	− 01	1,809 747	− 04
68 000	67 280	221,117	− 52,03	8,869 240	− 02	1,397 343	− 04
70 000	69 238	212,505	− 60,64	6,515 194	− 02	1,068 063	− 04
72 000	71 194	205,569	− 67,58	4,730 012	− 02	8,015 719	− 05
74 000	73 148	199,705	− 73,44	3,401 890	− 02	5,934 311	− 05
76 000	75 102	193,844	− 79,31	2,423 285	− 02	4,355 028	− 05
78 000	77 055	187,986	− 85,16	1,708 683	− 02	3,166 453	− 05
80 000	79 006	182,133	− 91,02	1,191 828	− 02	2,279 625	− 05

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Table 8 — Mean values of characteristics during December-January at 60° N

h	H	T	t	p		ϱ	
m	m	K	°C	hPa, mbar		kg·m^{-3}	
0	0	256,150	–17,00	1,013 000	03	1,377 695	00
1 000	1 001	258,146	–15,00	8,868 449	02	1,196 798	00
2 000	2 002	254,142	–19,01	7,760 259	02	1,063 744	00
3 000	3 002	250,137	–23,01	6,776 458	02	9,437 636	–01
4 000	4 003	244,636	–28,51	5,902 222	02	8,404 919	–01
5 000	5 002	239,137	–34,01	5,124 874	02	7,465 779	–01
6 000	6 002	233,639	–39,51	4,435 517	02	6,613 581	–01
7 000	7 001	228,143	–45,01	3,825 879	02	5,841 997	–01
8 000	8 000	222,649	–50,50	3,288 318	02	5,145 059	–01
9 000	8 999	217,157	–55,99	2,815 750	02	4,517 084	–01
10 000	9 997	217,150	–56,00	2,406 499	02	3,860 682	–01
12 000	11 993	217,150	–56,00	1,758 055	02	2,820 401	–01
14 000	13 987	217,150	–56,00	1,284 591	02	2,060 834	–01
16 000	15 980	216,660	–56,49	9,386 566	01	1,509 268	–01
18 000	17 972	215,664	–57,49	6,851 527	01	1,106 746	–01
20 000	19 963	214,669	–58,48	4,994 837	01	8,105 706	–02
22 000	21 952	213,674	–59,48	3,636 671	01	5,929 124	–02
24 000	23 940	212,680	–60,47	2,644 420	01	4,331 538	–02
26 000	25 927	212,799	–60,37	1,921 169	01	3,145 098	–02
28 000	27 913	214,189	–58,96	1,398 203	01	2,274 108	–02
30 000	29 897	215,578	–57,57	1,019 889	01	1,648 110	–02
32 000	31 880	216,966	–56,18	7,455 902	00	1,197 143	–02
34 000	33 862	218,354	–54,80	5,462 602	00	8,715 197	–03
36 000	35 843	221,089	–52,06	4,012 477	00	6,322 421	–03
38 000	37 823	225,642	–47,51	2,964 307	00	4,576 586	–03
40 000	39 801	230,192	–42,96	2,203 638	00	3,334 944	–03
42 000	41 778	234,739	–38,41	1,647 996	00	2,445 733	–03
44 000	43 754	239,283	–33,87	1,239 565	00	1,804 660	–03
46 000	45 728	243,825	–29,32	9,375 287	–01	1,339 508	–03
48 000	47 701	248,363	–24,79	7,128 723	–01	9,999 140	–04
50 000	49 673	251,350	–21,80	5,446 827	–01	7,549 232	–04
52 000	51 644	250,706	–22,44	4,166 374	–01	5,789 381	–04
54 000	53 614	248,736	–24,41	3,182 256	–01	4,456 916	–04
56 000	55 582	246,768	–26,38	2,425 802	–01	3,424 563	–04
58 000	57 549	244,801	–28,35	1,845 465	–01	2,626 223	–04
60 000	59 515	242,835	–30,31	1,401 113	–01	2,010 021	–04
62 000	61 480	240,870	–32,28	1,061 557	–01	1,535 319	–04
64 000	63 444	238,906	–32,24	8,026 052	–02	1,170 341	–04
66 000	65 406	236,944	–36,21	6,055 290	–02	8,902 811	–05
68 000	67 367	234,983	–38,17	4,558 557	–02	6,758 167	–05
70 000	69 327	233,023	–40,13	3,424 239	–02	5,119 209	–05
72 000	71 285	231,065	–42,08	2,566 429	–02	3,869 314	–05
74 000	73 243	229,107	–44,04	1,919 143	–02	2,918 143	–05
76 000	75 199	227,151	–46,00	1,431 797	–02	2,195 861	–05
78 000	77 154	225,196	–47,95	1,065 701	–02	1,648 590	–05
80 000	79 108	223,242	–49,91	7,913 192	–03	1,234 847	–05

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Table 9 — Values of characteristics for cold stratospheric and mesospheric regime in December-January at 60° N

h	*H*	*T*	*t*	*p*		*ϱ*	
m	m	K	°C	hPa, mbar		$kg \cdot m^{-3}$	
0	0	256,150	− 17,00	1,013 000	03	1,377 695	00
1 000	1 001	258,146	− 15,00	8,868 449	02	1,196 798	00
2 000	2 002	254,142	− 19,01	7,760 259	02	1,063 744	00
3 000	3 002	250,137	− 23,01	6,776 458	02	9,437 636	− 01
4 000	4 003	244,636	− 28,51	5,902 222	02	8,404 919	− 01
5 000	5 002	239,137	− 34,01	5,124 874	02	7,465 779	− 01
6 000	6 002	233,639	− 39,51	4,435 517	02	6,613 581	− 01
7 000	7 001	228,143	− 45,01	3,825 879	02	5,841 997	− 01
8 000	8 000	222,649	− 50,50	3,288 318	02	5,145 059	− 01
9 000	8 999	217,157	− 55,99	2,815 750	02	4,517 084	− 01
10 000	9 997	218,147	− 55,00	2,407 363	02	3,844 417	− 01
12 000	11 993	220,143	− 53,01	1,763 716	02	2,791 018	− 01
14 000	13 987	222,137	− 51,01	1,296 041	02	2,032 524	− 01
16 000	15 980	223,150	− 50,00	9,548 707	01	1,490 685	− 01
18 000	17 972	223,150	− 50,00	7,038 933	01	1,098 874	− 01
20 000	19 963	223,150	− 50,00	5,189 817	01	8,102 020	− 02
22 000	21 952	222,174	− 50,98	3,824 683	01	5,997 089	− 02
24 000	23 940	221,180	− 51,97	2,815 320	01	4,434 251	− 02
26 000	25 927	220,186	− 52,96	2,069 876	01	3,274 854	− 02
28 000	27 913	219,194	− 53,96	1,519 991	01	2,415 746	− 02
30 000	29 897	218,201	− 54,95	1,114 842	01	1,779 894	− 02
32 000	31 880	217,210	− 55,94	8,166 893	00	1,309 832	− 02
34 000	33 862	216,219	− 56,93	5,975 400	00	9,627 457	− 03
36 000	35 843	216,887	− 56,26	4,371 443	00	7,021 484	− 03
38 000	37 823	217,679	− 55,47	3,202 279	00	5,124 845	− 03
40 000	39 801	218,470	− 54,68	2,348 920	00	3,745 536	− 03
42 000	41 778	219,261	− 53,89	1,725 232	00	2,741 095	− 03
44 000	43 754	220,051	− 53,10	1,268 798	00	2,008 660	− 03
46 000	45 728	228,099	− 45,05	9,383 599	− 01	1,433 124	− 03
48 000	47 701	237,176	− 35,97	7,022 675	− 01	1,031 500	− 03
50 000	49 673	243,150	− 30,00	5,311 022	− 01	7,609 252	− 04
52 000	51 644	243,150	− 30,00	4,026 413	− 01	5,768 755	− 04
54 000	53 614	243,150	− 30,00	3,053 046	− 01	4,374 185	− 04
56 000	55 582	243,150	− 30,00	2,315 385	− 01	3,317 318	− 04
58 000	57 549	243,150	− 30,00	1,756 256	− 01	2,516 238	− 04
60 000	59 515	243,150	− 30,00	1,332 378	− 01	1,908 935	− 04
62 000	61 480	243,150	− 30,00	1,010 977	− 01	1,448 456	− 04
64 000	63 444	243,150	− 30,00	7,672 377	− 02	1,099 243	− 04
66 000	65 406	245,962	− 27,19	5,830 224	− 02	8,257 637	− 05
68 000	67 367	249,884	− 23,27	4,449 631	− 02	6,203 316	− 05
70 000	69 327	253,804	− 19,35	3,410 843	− 02	4,681 685	− 05
72 000	71 285	252,965	− 20,18	2,621 460	− 02	3,610 115	− 05
74 000	73 243	249,637	− 23,51	2,008 982	− 02	2,803 526	− 05
76 000	75 199	246,312	− 26,84	1,534 373	− 02	2,170 121	− 05
78 000	77 154	242,988	− 30,16	1,167 802	− 02	1,674 257	− 05
80 000	79 108	239,667	− 33,48	8,856 248	− 03	1,287 300	− 05

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Table 10 — Values of characteristics for warm stratospheric and mesospheric regime in December-January at 60° N

h	H	T	t	p		ϱ	
m	m	K	°C	hPa, mbar		kg·m^{-3}	
0	0	256,150	– 17,00	1,013 000	03	1,377 695	00
1 000	1 001	258,146	– 15,00	8,868 449	02	1,196 798	00
2 000	2 002	254,142	– 34,01	7,760 259	02	1,063 744	00
3 000	3 002	250,137	– 23,01	6,776 458	02	9,437 636	– 01
4 000	4 003	244,636	– 28,51	5,902 222	02	8,404 919	– 01
5 000	5 002	239,137	– 34,01	5,124 874	02	7,465 779	– 01
6 000	6 002	233,639	– 39,51	4,435 517	02	6,613 581	– 01
7 000	7 001	228,143	– 45,01	3,825 879	02	5,841 997	– 01
8 000	8 000	222,649	– 50,50	3,288 318	02	5,145 059	– 01
9 000	8 999	217,157	– 55,99	2,815 750	02	4,517 084	– 01
10 000	9 997	217,150	– 56,00	2,406 499	02	3,860 682	– 01
12 000	11 993	217,150	– 56,00	1,758 055	02	2,820 401	– 01
14 000	13 987	217,150	– 56,00	1,284 591	02	2,060 834	– 01
16 000	15 980	216,170	– 56,98	9,384 925	01	1,512 425	– 01
18 000	17 972	214,178	– 58,97	6,840 422	01	1,112 618	– 01
20 000	19 963	213,150	– 60,00	4,973 827	01	8,129 118	– 02
22 000	21 952	213,150	– 60,00	3,615 873	01	5,909 707	– 02
24 000	23 940	213,150	– 60,00	2,629 192	01	4,297 097	– 02
26 000	25 927	220,859	– 52,29	1,922 591	01	3,032 568	– 02
28 000	27 913	228,801	– 44,35	1,421 792	01	2,164 789	– 02
30 000	29 897	236,739	– 36,41	1,062 516	01	1,563 521	– 02
32 000	31 880	244,672	– 28,48	8,018 305	00	1,141 660	– 02
34 000	33 862	252,600	– 20,55	6,106 657	00	8,421 882	– 03
36 000	35 843	260,522	– 12,63	4,690 837	00	6,272 541	– 03
38 000	37 823	262,973	– 10,18	3,623 584	00	4,800 274	– 03
40 000	39 801	264,951	– 8,20	2,805 074	00	3,688 223	– 03
42 000	41 778	266,928	– 6,22	2,175 935	00	2,839 817	– 03
44 000	43 754	267,150	– 6,00	1,690 096	00	2,203 913	– 03
46 000	45 728	267,150	– 6,00	1,312 957	00	1,712 117	– 03
48 000	47 701	267,150	– 6,00	1,020 135	00	1,330 273	– 03
50 000	49 673	262,966	– 10,18	7,914 038	– 01	1,048 422	– 03
52 000	51 644	258,039	– 15,11	6,111 471	– 01	8,250 838	– 04
54 000	53 614	253,115	– 20,03	4,696 791	– 01	6,464 293	– 04
56 000	55 582	248,194	– 24,96	3,591 563	– 01	5,051 153	– 04
58 000	57 549	243,276	– 28,97	2,732 166	– 01	3,912 419	– 04
60 000	59 515	238,362	– 34,79	2,067 193	– 01	3,021 225	– 04
62 000	61 480	233,450	– 39,70	1,555 282	– 01	2,320 886	– 04
64 000	63 444	228,541	– 44,61	1,163 292	– 01	1,773 220	– 04
66 000	65 406	223,635	– 49,51	8,647 901	– 02	1,347 127	– 04
68 000	67 367	218,733	– 54,42	6,387 914	– 02	1,017 381	– 04
70 000	69 327	213,833	– 59,32	4,687 159	– 02	7,636 122	– 05
72 000	71 285	208,937	– 64,21	3,415 310	– 02	5,694 477	– 05
74 000	73 243	204,043	– 69,11	2,470 465	– 02	4,217 887	– 05
76 000	75 199	199,153	– 74,00	1,773 386	– 02	3,102 097	– 05
78 000	77 154	194,265	– 78,88	1,262 818	– 02	2,264 560	– 05
80 000	79 108	189,381	– 83,77	8,916 933	– 03	1,640 279	– 05

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Table 11 — Mean values of characteristics during June-July at 60° N

h	H	T	t	p		ϱ	
m	m	K	°C	hPa, mbar		kg·m^{-3}	
0	0	282,150	9,00	1,010 200	03	1,247 284	00
1 000	1 001	277,945	4,79	8,940 617	02	1,120 588	00
2 000	2 002	273,742	0,59	7,898 345	02	1,005 155	00
3 000	3 002	269,540	−3,61	6,964 484	02	9,001 273	−01
4 000	4 003	265,339	−7,81	6,129 159	02	8,047 065	−01
5 000	5 002	261,133	−12,02	5,383 253	02	7,181 598	−01
6 000	6 002	254,136	−19,01	4,714 969	02	6,463 242	−01
7 000	7 001	247,142	−26,01	3,576 765	02	5,799 844	−01
8 000	8 000	240,149	−33,00	3,576 768	02	5,188 570	−01
9 000	8 999	233,159	−39,99	3,096 557	02	4,626 632	−01
10 000	9 997	226,171	−46,98	2,669 209	02	4,111 344	−01
12 000	11 993	226,150	−47,00	1,974 494	02	3,041 566	−01
14 000	13 987	226,150	−47,00	1,460 868	02	2,250 363	−01
16 000	15 980	226,150	−47,00	1,081 056	02	1,665 289	−01
18 000	17 972	226,150	−47,00	8,001 425	01	1,232 562	−01
20 000	19 963	226,150	−47,00	5,923 363	01	9,124 517	−02
22 000	21 952	226,150	−47,00	4,385 823	01	6,756 046	−02
24 000	23 940	227,560	−45,59	3,249 429	01	4,974 490	−02
26 000	25 927	230,541	−42,61	2,416 029	01	3,650 837	−02
28 000	27 913	233,519	−39,63	1,803 554	01	2,690 572	−02
30 000	29 897	236,496	−36,65	1,351 586	01	1,990 940	−02
32 000	31 880	239,471	−33,68	1,016 721	01	1,479 066	−02
34 000	33 862	245,237	−27,91	7,688 101	00	1,092 122	−02
36 000	35 843	251,179	−21,97	5,853 488	00	8,118 375	−03
38 000	37 823	257,118	−16,03	4,485 908	00	6,077 942	−03
40 000	39 801	263,052	−10,10	3,459 350	00	4,581 318	−03
42 000	41 778	268,983	−4,17	2,683 643	00	3,475 661	−03
44 000	43 754	274,911	1,76	2,093 759	00	2,653 219	−03
46 000	45 728	280,834	7,68	1,642 454	00	2,037 423	−03
48 000	47 701	281,650	8,50	1,292 772	00	1,599 006	−03
50 000	49 673	281,650	8,50	1,017 738	00	1,258 822	−03
52 000	51 644	280,168	7,02	8,011 716	−01	9,961 963	−04
54 000	53 614	275,638	2,49	6,288 803	−01	7,948 167	−04
56 000	55 582	271,111	−2,04	4,917 392	−01	6,318 678	−04
58 000	57 549	266,586	−6,56	3,829 753	−01	5,004 621	−04
60 000	59 515	262,065	−11,08	2,970 419	−01	3,948 639	−04
62 000	61 480	253,845	−19,30	2,290 874	−01	3,143 909	−04
64 000	63 444	244,421	−28,73	1,750 061	−01	2,494 327	−04
66 000	65 406	235,002	−38,15	1,323 071	−01	1,961 327	−04
68 000	67 367	225,589	−47,56	9,890 623	−02	1,527 370	−04
70 000	69 327	216,182	−56,97	7,304 009	−02	1,177 012	−04
72 000	71 285	206,780	−66,37	5,322 648	−02	8,967 201	−05
74 000	73 243	197,385	−75,77	3,822 869	−02	6,747 054	−05
76 000	75 199	187,995	−85,15	2,702 313	−02	5,007 575	−05
78 000	77 154	178,611	−94,54	1,876 990	−02	3,660 932	−05
80 000	79 108	169,233	−103,92	1,278 648	−02	2,632 109	−05

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Table 12 — Mean values of characteristics during December-January at 80° N

h	H	T	t	p		ϱ	
m	m	K	°C	hPa, mbar		$kg \cdot m^{-3}$	
0	0	248,950	−24,20	1,013 800	03	1,418 660	00
1 000	1 002	253,044	−20,11	8,845 174	02	1,217 724	00
2 000	2 004	250,238	−22,91	7,720 217	02	1,074 767	00
3 000	3 006	247,412	−25,74	6,728 301	02	9,473 777	−01
4 000	4 007	240,903	−32,95	5,848 615	02	8,457 631	−01
5 000	5 008	234,396	−38,75	5,064 699	02	7,527 325	−01
6 000	6 009	227,892	−45,26	4,368 327	02	6,677 662	−01
7 000	7 009	221,389	−51,76	3,751 780	02	5,903 625	−01
8 000	8 009	214,940	−58,21	3,207 829	02	5,199 144	−01
9 000	9 009	213,890	−59,26	2,735 459	02	4,455 302	−01
10 000	10 009	212,841	−60,31	2,330 938	02	3,815 168	−01
12 000	12 007	210,743	−62,41	1,688 744	02	2,791 571	−01
14 000	14 003	208,647	−64,50	1,219 791	02	2,036 632	−01
16 000	15 999	206,551	−66,60	8,783 552	01	1,481 428	−01
18 000	17 993	204,457	−68,69	6,305 091	01	1,074 303	−01
20 000	19 986	202,365	−70,78	4,511 508	01	7,766 495	−02
22 000	21 978	202,350	−70,80	3,223 166	01	5,549 036	−02
24 000	23 968	205,286	−67,86	2,307 322	01	3,915 492	−02
26 000	25 957	209,265	−63,88	1,662 315	01	2,767 293	−02
28 000	27 945	213,241	−59,91	1,205 276	01	1,969 039	−02
30 000	29 932	217,214	−55,94	8,792 735	00	1,410 177	−02
32 000	31 918	221,185	−51,96	6,452 494	00	1,016 271	−02
34 000	33 902	224,593	−48,56	4,760 890	00	7,384 648	−03
36 000	35 885	227,766	−45,38	3,528 605	00	5,396 998	−03
38 000	37 867	230,937	−42,21	2,626 618	00	3,962 249	−03
40 000	39 847	234,106	−39,04	1,963 440	00	2,921 754	−03
42 000	41 827	237,273	−35,88	1,473 719	00	2,163 740	−03
44 000	43 805	240,438	−32,71	1,110 555	00	1,609 072	−03
46 000	45 782	243,601	−29,55	8,401 313	−01	1,201 453	−03
48 000	47 757	246,762	−26,39	6,379 577	−01	9,006 423	−04
50 000	49 732	247,150	−26,00	4,855 713	−01	6,844 323	−04
52 000	51 705	247,150	−26,00	3,696 574	−01	5,210 470	−04
54 000	53 677	246,405	−26,74	2,814 220	−01	3,978 742	−04
56 000	55 648	244,238	−28,91	2,138 795	−01	3,050 666	−04
58 000	57 617	242,071	−31,08	1,621 783	−01	2,333 929	−04
60 000	59 585	239,906	−33,24	1,226 907	−01	1,781 593	−04
62 000	61 552	237,742	−35,41	9,259 942	−02	1,356 875	−04
64 000	63 518	235,580	−37,57	6,972 114	−02	1,031 013	−04
66 000	65 483	233,419	−39,73	5,236 749	−02	7,815 628	−05
68 000	67 446	231,259	−41,89	3,923 568	−02	5,910 446	−05
70 000	69 408	229,101	−44,05	2,932 263	−02	4,458 764	−05
72 000	71 369	226,944	−46,21	2,185 783	−02	3,355 266	−05
74 000	73 329	224,788	−48,36	1,625 073	−02	2,518 476	−05
76 000	75 288	222,634	−50,52	1,204 978	−02	1,885 500	−05
78 000	77 245	220,481	−52,67	8,910 540	−03	1,407 900	−05
80 000	79 201	218,329	−54,82	6,570 902	−03	1,048 460	−05

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Table 13 — Values of characteristics for cold stratospheric and mesospheric regime in December-January at 80° N

h	*H*	*T*	*t*	*p*		*ϱ*	
m	m	K	°C	hPa, mbar		kg·m⁻³	
0	0	248,950	−24,20	1,013 800	03	1,418 660	00
1 000	1 002	253,044	−20,11	8,845 174	02	1,217 724	00
2 000	2 004	250,238	−22,91	7,720 217	02	1,074 767	00
3 000	3 006	247,412	−25,74	6,728 301	02	9,473 777	−01
4 000	4 007	240,903	−32,95	5,848 615	02	8,457 631	−01
5 000	5 008	234,396	−38,75	5,064 699	02	7,527 325	−01
6 000	6 009	227,892	−45,26	4,368 327	02	6,677 662	−01
7 000	7 009	221,389	−51,76	3,751 780	02	5,903 625	−01
8 000	8 009	214,949	−58,20	3,207 829	02	5,198 928	−01
9 000	9 009	214,849	−58,30	2,736 448	02	4,437 023	−01
10 000	10 009	214,749	−58,40	2,334 267	02	3,786 668	−01
12 000	12 007	214,549	−58,60	1,698 431	02	2,757 775	−01
14 000	14 003	214,350	−58,80	1,235 672	02	2,008 253	−01
16 000	15 999	214,150	−59,00	8,989 100	01	1,462 298	−01
18 000	17 993	213,951	−59,20	6,538 634	01	1,064 661	−01
20 000	19 986	213,751	−59,40	4,755 711	01	7,750 765	−02
22 000	21 978	215,134	−58,02	3,462 642	01	5,607 069	−02
24 000	23 968	216,528	−56,62	2,526 826	01	4,065 368	−02
26 000	25 957	217,920	−55,23	1,848 014	01	2,954 241	−02
28 000	27 945	219,312	−53,84	1,354 518	01	2,151 597	−02
30 000	29 932	220,703	−52,45	9,949 498	00	1,570 479	−02
32 000	32 918	222,092	−51,06	7,323 893	00	1,148 805	−02
34 000	33 902	223,481	−49,67	5,402 505	00	8,421 549	−03
36 000	35 885	224,869	−48,28	3,993 455	00	6,186 662	−03
38 000	37 867	226,257	−46,89	2,957 953	00	4,554 364	−03
40 000	39 847	227,643	−45,51	2,195 386	00	3,359 654	−03
42 000	41 827	229,029	−44,12	1,632 664	00	2,483 391	−03
44 000	43 805	230,413	−42,74	1,216 572	00	1,838 367	−03
46 000	45 782	232,360	−40,79	9,083 331	−01	1,361 824	−03
48 000	47 757	237,695	−35,45	6,815 869	−01	9,989 411	−04
50 000	49 732	243,026	−30,12	5,148 024	−01	7,379 496	−04
52 000	51 705	248,353	−24,80	3,912 713	−01	5,488 409	−04
54 000	53 677	249,150	−24,00	2,985 521	−01	4,174 432	−04
56 000	55 648	249,150	−24,00	2,278 576	−01	3,185 963	−04
58 000	57 617	249,150	−24,00	1,739 321	−01	2,431 963	−04
60 000	59 585	248,448	−24,70	1,327 760	−01	1,861 757	−04
62 000	61 552	246,087	−27,06	1,011 787	−01	1,432 313	−04
64 000	63 518	243,728	−29,42	7,691 214	−02	1,099 328	−04
66 000	65 483	241,371	−31,78	5,832 001	−02	8,417 270	−05
68 000	67 446	239,015	−34,13	4,410 993	−02	6,429 099	−05
70 000	69 408	236,660	−36,49	3,327 592	−02	4,898 278	−05
72 000	71 369	234,307	−38,84	2,503 669	−02	3,722 460	−05
74 000	73 329	231,955	−41,19	1,878 687	−02	2,821 555	−05
76 000	75 288	229,605	−43,54	1,405 851	−02	2,133 027	−05
78 000	77 245	227,256	−45,89	1,049 079	−02	1,608 165	−05
80 000	79 201	224,909	−48,24	7,806 135	−03	1,209 115	−05

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Table 14 — Values of characteristics for warm stratospheric and mesospheric regime in December-January at 80° N

h	H	T	t	p		ϱ	
m	m	K	°C	hPa, mbar		kg·m^{-3}	
0	0	248,950	−24,20	1,013 800	03	1,418 660	00
1 000	1 002	253,044	−20,11	8,845 174	02	1,217 724	00
2 000	2 004	250,238	−22,91	7,720 217	02	1,074 767	00
3 000	3 006	247,412	−25,74	6,728 301	02	9,473 777	−01
4 000	4 007	240,903	−32,95	5,848 615	02	8,457 631	−01
5 000	5 008	234,396	−38,75	5,064 699	02	7,527 325	−01
6 000	6 009	227,892	−45,26	4,368 327	02	6,677 662	−01
7 000	7 009	221,389	−51,76	3,751 780	02	5,903 625	−01
8 000	8 009	214,940	−58,21	3,207 829	02	5,199 144	−01
9 000	9 009	213,890	−59,26	2,735 459	02	4,455 302	−01
10 000	10 009	212,640	−60,51	2,330 586	02	3,818 195	−01
12 000	12 007	210,342	−62,81	1,687 714	02	2,795 182	−01
14 000	14 003	208,046	−65,10	1,218 098	02	2,039 674	−01
16 000	15 999	205,751	−67,40	8,761 615	01	1,483 472	−01
18 000	17 993	203,458	−69,69	6,280 179	01	1,075 314	−01
20 000	19 986	201,166	−71,98	4,485 517	01	7,767 759	−02
22 000	21 978	201,150	−72,00	3,198 174	01	5,538 858	−02
24 000	23 968	201,150	−72,00	2,280 781	01	3,950 041	−02
26 000	25 957	204,673	−68,48	1,631 573	01	2,777 048	−02
28 000	27 945	208,252	−64,90	1,174 197	01	1,964 221	−02
30 000	29 932	223,807	−49,34	8,572 848	00	1,334 409	−02
32 000	31 918	232,788	−40,36	6,369 991	00	9,532 717	−03
34 000	33 902	241,519	−31,63	4,786 120	00	6,903 528	−03
36 000	35 885	250,244	−22,91	3,633 383	00	5,058 080	−03
38 000	37 867	258,964	−14,19	2,784 913	00	3,746 368	−03
40 000	39 847	267,678	−5,47	2,153 803	00	2,803 049	−03
42 000	41 827	268,350	−4,80	1,674 015	00	2,173 181	−03
44 000	43 805	268,350	−4,80	1,301 343	00	1,689 383	−03
46 000	45 782	267,223	−5,93	1,011 718	00	1,318 934	−03
48 000	47 757	260,003	−13,15	7,829 460	−01	1,049 040	−03
50 000	49 732	257,337	−15,81	6,032 288	−01	8,166 154	−04
52 000	51 705	254,673	−18,48	4,635 800	−01	6,341 313	−04
54 000	53 677	252,011	−21,14	3,553 344	−01	4,911 965	−04
56 000	55 648	249,351	−23,80	2,716 415	−01	3,795 102	−04
58 000	57 617	246,692	−26,46	2,070 988	−01	2,924 561	−04
60 000	59 585	243,928	−29,22	1,574 547	−01	2,248 701	−04
62 000	61 552	238,814	−34,34	1,191 895	−01	1,738 667	−04
64 000	63 518	233,703	−39,45	8,969 743	−02	1,337 071	−04
66 000	65 483	228,595	−44,55	6,709 207	−02	1,022 452	−04
68 000	67 446	223,490	−49,66	4,986 471	−02	7,772 729	−05
70 000	69 408	218,388	−54,76	3,681 461	−02	5,872 581	−05
72 000	71 369	213,844	−59,31	2,699 293	−02	4,397 355	−05
74 000	73 329	211,688	−61,46	1,970 559	−02	3,242 883	−05
76 000	75 288	209,534	−63,62	1,434 221	−02	2,384 518	−05
78 000	77 245	207,381	−65,77	1,040 648	−02	1,748 130	−05
80 000	79 201	205,229	−67,92	7,527 056	−03	1,277 688	−05

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Table 15 — Mean values of characteristics during June-July at 80° N

h	*H*	*T*	*t*	*p*		*ϱ*	
m	m	K	°C	hPa, mbar		$kg \cdot m^{-3}$	
0	0	276,650	3,50	1,012 000	03	1,274 348	00
1 000	1 002	272,541	− 0,61	8,933 562	02	1,141 908	00
2 000	2 004	268,433	− 4,72	7,871 607	02	1,021 565	00
3 000	3 006	264,326	− 8,82	6,922 646	02	9,123 690	− 01
4 000	4 007	260,204	− 12,95	6,076 103	02	8,134 851	− 01
5 000	5 008	253,797	− 19,35	5,319 028	02	7,301 017	− 01
6 000	6 009	247,393	− 25,76	4,640 669	02	6,534 791	− 01
7 000	7 009	240,990	− 32,16	4,034 539	02	5,832 202	− 01
8 000	8 009	234,590	− 38,56	3,494 542	02	5,189 427	− 01
9 000	9 009	228,255	− 44,89	3,014 951	02	4,601 494	− 01
10 000	10 009	228,754	− 44,40	2,596 485	02	3,954 163	− 01
12 000	12 007	229,753	− 43,40	1,927 883	02	2,923 190	− 01
14 000	14 003	230,752	− 42,40	1,433 564	02	2,164 265	− 01
16 000	15 999	231,500	− 41,65	1,067 467	02	1,606 357	− 01
18 000	17 993	231,998	− 41,15	7,955 759	01	1,194 634	− 01
20 000	19 986	232,496	− 40,65	5,934 204	01	8,891 688	− 02
22 000	21 978	232,994	− 40,16	4,429 914	01	6,623 505	− 02
24 000	23 968	234,460	− 38,69	3,310 591	01	4,918 973	− 02
26 000	25 957	236,947	− 36,20	2,481 345	01	3,648 166	− 02
28 000	27 945	239,432	− 33,72	1,865 749	01	2,714 623	− 02
30 000	29 932	241,915	− 31,23	1,407 258	01	2,026 510	− 02
32 000	31 918	244,397	− 28,75	1,064 684	01	1,517 619	− 02
34 000	33 902	249,635	− 23,50	8,091 035	00	1,129 110	− 02
36 000	35 885	254,989	− 18,16	6,185 713	00	8,450 952	− 03
38 000	37 867	260,340	− 12,81	4,756 301	00	6,364 525	− 03
40 000	39 847	265,688	− 7,46	3,677 391	00	4,821 766	− 03
42 000	41 827	271,032	− 2,12	2,858 277	00	3,673 853	− 03
44 000	43 805	276,373	3,23	2,232 914	00	2,814 586	− 03
46 000	45 782	279,600	6,45	1,752 271	00	2,183 244	− 03
48 000	47 757	279,600	6,45	1,376 464	00	1,715 006	− 03
50 000	49 732	279,600	6,45	1,081 418	00	1,347 393	− 03
52 000	51 705	279,600	6,45	8,497 426	− 01	1,058 738	− 03
54 000	53 677	275,775	2,62	6,671 375	− 01	8,427 486	− 04
56 000	55 648	269,370	− 3,78	5,211 209	− 01	6,739 484	− 04
58 000	57 617	262,970	− 10,18	4,047 148	− 01	5,361 442	− 04
60 000	59 585	256,573	− 16,58	3,124 100	− 01	4,241 823	− 04
62 000	61 552	248,759	− 24,39	2,395 291	− 01	3,354 420	− 04
64 000	63 518	239,716	− 33,43	1,819 386	− 01	2,644 025	− 04
66 000	65 483	230,679	− 42,47	1,367 656	− 01	2,065 412	− 04
68 000	67 446	221,647	− 51,50	1,016 615	− 01	1,597 834	− 04
70 000	69 408	212,622	− 60,53	7,465 535	− 02	1,223 184	− 04
72 000	71 369	203,601	− 69,55	5,410 490	− 02	9,257 517	− 05
74 000	73 329	195,113	− 78,04	3,865 461	− 02	6,901 661	− 05
76 000	75 288	189,237	− 83,91	2,728 861	− 02	5,023 576	− 05
78 000	77 245	183,365	− 89,78	1,905 855	− 02	3,620 852	− 05
80 000	79 201	177,497	− 95,65	1,315 907	− 02	2,582 691	− 05

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Table 16 — Temperature structure of mean seasonal and mean annual reference atmospheres

15° Annual mean

Geopotential altitude H, km	Temperature T, K	Gradient K/km
0,000	299,65	−6,0
2,250	286,15	+3,2
2,500	286,95	−6,7
16,500	193,15	+4,0
22,000	215,15	+2,0
30,000	231,15	+2,8
40,000	259,15	+2,2
46,000	272,35	0,0
51,000	272,35	−2,4
54,000	265,15	−3,0
60,000	247,15	−3,5
66,000	226,15	−3,0
73,000	205,15	−1,0
80,000	198,15	

30° N

December-January			June-July		
Geopotential altitude H, km	Temperature T, K	Gradient K/km	Geopotential altitude H, km	Temperature T, K	Gradient K/km
0,000	283,15	−1,5	0,000	297,15	−4,5
2,000	280,15	−6,4	2,000	288,15	−6,0
12,000	216,15	−2,0	8,000	252,15	−7,0
16,500	207,15	0,0	14,500	206,65	0,0
18,000	207,15	+2,0	17,000	206,65	+2,6
24,000	219,15	+1,8	22,000	219,65	+1,5
34,000	237,15	+2,5	29,000	230,15	+2,4
47,000	269,65	0,0	47,000	273,35	0,0
50,000	269,65	−2,6	51,000	273,35	−2,7
70,000	217,65	−2,2	60,000	249,05	−4,0
80,000	195,65		70,000	209,05	−1,8
			80,000	191,05	

45° N

0,000	272,62	−4,0	0,000	291,15	−4,5
3,000	260,65	−6,0	2,000	282,15	−6,0
10,000	218,65	−0,4	13,000	216,15	0,0
18,000	215,45	0,0	17,000	216,15	+1,2
28,000	215,45	+2,3	25,000	225,75	+2,0
35,000	231,55	+2,6	30,000	235,75	+2,4
47,000	262,75	0,0	47,000	276,55	0,0
51,000	262,75	−1,6	51,000	276,55	−2,6
60,000	248,35	−2,1	60,000	253,15	−4,4
80,000	206,35		70,000	209,15	−3,0
			80,000	179,15	

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Table 16 — Temperature structure of mean seasonal and mean annual reference atmospheres *(concluded)*

60° N

December-January			June-July		
Geopotential altitude *H*, km	Temperature *T*, K	Gradient K/km	Geopotential altitude *H*, km	Temperature *T*, K	Gradient K/km
0,000	256,15	+2,0	0,000	282,15	−4,2
1,000	258,15	−4,0	5,000	261,15	−7,0
3,000	250,15	−5,5	10,000	226,15	0,0
9,000	217,15	0,0	23,500	226,15	+1,5
15,000	217,15	−0,5	32,000	239,65	+3,0
25,000	212,15	+0,7	46,000	281,65	0,0
35,000	219,15	+2,3	51,000	281,65	−2,3
49,000	251,35	0,0	60,000	260,95	−4,8
51,000	251,35	−1,0	80,000	164,95	
80,000	222,35				

80° N

December-January			June-July		
Geopotential altitude *H*, km	Temperature *T*, K	Gradient K/km	Geopotential altitude *H*, km	Temperature *T*, K	Gradient K/km
0,000	248,95	+4,10	0,000	276,65	−4,10
1,000	253,05	−2,80	4,000	260,25	−6,40
3,000	247,45	−6,50	9,000	228,25	+0,50
8,000	214,95	−1,05	15,000	231,25	+0,25
20,000	202,35	0,00	23,000	233,25	+1,25
22,500	202,35	+2,00	32,000	244,50	+2,70
32,500	222,35	+1,60	45,000	279,60	0,00
48,000	247,15	0,00	52,500	279,60	−3,25
53,000	247,15	−1,10	60,500	253,60	−4,60
80,000	217,45		73,000	196,10	−3,00
			80,000	175,10	

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Table 17 — List of stations used for temperature analysis, 30 to 50 km

Station	Latitude	Longitude	Number of launchings	References
Ascension	7° 59′ S	14° 25′ W	(444)	[5] [6]
Kwajalein	8° 44′ N	167° 44′ E	(17)	[7] [8]
Ft. Sherman	9° 26′ N	80° 00′ W	40/38 (245)	[5]
Antigua	17° 09′ N	61° 47′ W	48/44 (206)	[5]
Grand Turk	21° 26′ N	71° 09′ W	32/31 (168)	[5]
Barking Sands	21° 54′ N	159° 35′ W	73/86 (204)	[5]
Cape Kennedy	28° 27′ N	80° 32′ W	202/131	[5]
White Sands	32° 23′ N	106° 29′ N	112/127	[5]
Point Mugu	34° 07′ N	119° 07′ W	123/145	[5]
Wallops Island	37° 50′ N	75° 29′ W	44/54	[5] [6]
Volgograd	48° 41′ N	44° 21′ E	55/59	[12]
Primrose Lake	54° 45′ N	110° 03′ W	23/22	[5]
West Geirinish	57° 21′ N	7° 22′ W	79/0	[5]
Ft. Churchill	58° 44′ N	93° 49′ W	157/83	[5] [6]
Ft. Greely	64° 00′ N	145° 44′ W	60/72	[5]
Thule	76° 33′ N	68° 49′ W	18/71	[5]
Heiss Island	80° 37′ N	58° 03′ E	77/59	[12]

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Table 18 — List of stations used for temperature analysis, 50 to 80 km

Station	Latitude	Longitude	Number of launchings	References
Natal	5° 55′ S	35° 10′ W	3/3 (24)*	[6]
Ascension	7° 59′ S	14° 25′ W	0/0 (9)	[6]
Kwajalein	8° 44′ N	167° 44′ E	1/5 (17)	[7] [8]
Guam	13° 30′ N	145° E	0/0 (5)	[6]
Eglin	30° 23′ N	86° 42′ W	(7)	[9]
Woomera	30° 57′ S	136° 31′ E	4/4 (42)	[10] [11]
White Sands	32° 23′ N	160° 29′ W	4/0	[9]
Wallops Island	37° 50′ N	75° 29′ W	13/9 (85)	[6]
Volgograd	48° 41′ N	44° 21′ E	31/34	[12]
Ft. Churchill	58° 44′ N	93° 49′ W	9/4 (63)	[6]
Pt. Barrow	71° 21′ N	156° 59′ W	8/2 (19)	[6]
Heiss Island	80° 37′ N	58° 03′ E	43/40	[12]

* Numerator: number of launchings in December-January; denominator: number of launchings in June-July; in brackets: total number of launchings.

Table 19 — Temperature structure of warm and cold winter stratospheric models for 60 and 80° latitude

60° N

Warm stratosphere			Cold stratosphere		
Geopotential altitude H, km	Temperature T, K	Gradient K/km	Geopotential altitude H, km	Temperature T, K	Gradient K/km
0,00	256,15	+2,0	0,00	256,15	+2,0
1,00	258,15	−4,0	1,00	258,15	−4,0
3,00	250,15	−5,5	3,00	250,15	−5,5
9,00	217,15	0,0	9,00	217,15	+1,0
15,00	217,15	−1,0	15,00	223,15	0,0
19,00	213,15	0,0	20,00	223,15	−0,5
24,00	213,15	+4,0	34,00	216,15	+0,4
36,00	261,15	+1,0	44,00	220,15	+4,6
42,00	267,15	0,0	49,00	243,15	0,0
48,00	267,15	−2,5	64,00	243,15	+2,0
80,00	187,15		70,00	255,15	−1,7
			80,00	238,15	

80° N

Warm stratosphere			Cold stratosphere		
Geopotential altitude H, km	Temperature T, K	Gradient K/km	Geopotential altitude H, km	Temperature T, K	Gradient K/km
0,00	248,95	+4,10	0,00	248,95	+4,10
1,00	253,05	−2,80	1,00	253,05	−2,80
3,00	247,45	−6,50	3,00	247,45	−6,50
8,00	214,95	−1,15	8,00	214,95	−0,10
20,00	201,15	0,00	20,00	213,75	+0,70
24,00	201,15	+1,80	45,50	231,60	+2,70
28,00	208,35	+8,00	52,00	249,15	0,00
30,00	224,35	+4,40	59,00	249,15	−1,20
40,00	268,35	0,00	80,00	223,95	
45,50	268,35	−4,00			
47,50	260,35	−1,35			
59,50	244,15	−2,60			
71,00	214,25	−1,10			
80,00	204,35				

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Table 20 — Dates and locations of soundings used to prepare warm and cold models for 60 and 80° N

A) Warm and cold winter models, 60° N	
Cold stratosphere	**Warm stratosphere**
Ft. Churchill	
9 December 1968 13 December 1968 13 December 1968*	17-18-19 January 1967 27-28-29 December 1967 20 January 1969 10 February 1966*
Ft. Greely	
5 February 1967 17 January 1966	5 February 1969
West Geirinish	
12 January 1968	19 December 1967 28 February 1968 31 December 1968
B) Warm and cold winter models, Heiss Island, 80° N	
Cold stratosphere	**Warm stratosphere**
20 January 1968 22-23 January 1969 14-21-25 January 1970	16 December 1967 18 January 1966 31 January 1966 31 January 1968 30-31 January 1969

* Grenade observations.

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Table 21 — Median and high and low percentile values of temperature for the year at 15° latitude and for December-January and June-July at 30, 45, 60 and 80° N

15°

Season	Geometric altitude h, km	Median temperature, T, K	Percentiles, K					
			1 %		10 %		20 %	
			high	low	high	low	high	low
Annual	5	270	276	265	273	267	272	268
	10	237	244	230	241	233	239	235
	15	204	212	196	208	200	207	201
	20	207	215	199	212	202	210	204
	25	220	228	212	226	215	225	217
	30	231	243	226	239	229	236	230
	35	244	256	236	253	240	250	242
	40	258	270	251	265	254	263	256
	45	269	278	258	274	263	272	265
	50	272	285	263	277	267	275	269

Table 21 — Median and high and low percentile values of temperature for the year at 15° latitude and for December-January and June-July at 30, 45, 60 and 80° N *(continued)*

30° N

Season	Geometric altitude *h*, km	Median temperature, *T*, K	Percentiles, K					
			1 %		10 %		20 %	
			high	low	high	low	high	low
December-January	5	261	271	252	267	256	265	258
	10	229	239	219	235	223	233	225
	15	210	221	199	216	203	214	203
	20	211	220	202	216	206	214	208
	25	221	231	211	226	216	224	217
	30	230	239	222	236	225	234	224
	35	239	253	231	248	235	245	237
	40	251	268	243	262	249	258	250
	45	264	283	254	277	261	274	263
	50	270	285	260	280	264	276	266
	55	258	272	231	267	243	263	248
	60	245	255	231	248	240	246	242
	65	233	254	218	242	226	238	228
	70	220	235	198	227	204	225	210
	75	209	253	197	237	203	227	208
	80	198	243	187	230	194	217	197
June-July	5	270	278	262	274	266	275	268
	10	238	249	227	246	232	242	234
	15	209	218	198	213	202	212	204
	20	214	223	204	219	207	217	208
	25	224	230	216	227	219	226	220
	30	232	240	227	237	230	235	231
	35	244	254	237	250	240	247	242
	40	256	267	250	263	253	261	254
	45	268	276	261	273	265	270	266
	50	273	282	262	278	266	276	268
	55	264	273	247	269	253	267	256
	60	251	265	235	257	243	254	245
	65	232	240	218	236	222	234	225
	70	212	222	186	218	194	214	199
	75	202	218	178	214	192	209	196
	80	193	207	182	200	189	198	191

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Table 21 — Median and high and low percentile values of temperature for the year at 15° latitude and for December-January and June-July at 30, 45, 60 and 80° N *(continued)*

45° N

Season	Geometric altitude h, km	Median temperature, T, K	Percentiles, K					
			1 %		10 %		20 %	
			high	low	high	low	high	low
December-January	5	248	263	233	257	239	254	242
	10	219	232	206	226	212	224	214
	15	216	230	202	224	208	221	211
	20	215	227	203	222	208	220	210
	25	215	233	197	226	205	224	209
	30	220	235	214	230	217	226	219
	35	231	257	218	251	224	243	226
	40	244	270	232	263	238	256	240
	45	257	290	241	282	251	271	254
	50	263	284	250	275	256	270	258
	55	257	275	229	267	239	263	245
	60	249	266	220	263	230	257	241
	65	239	255	214	246	223	243	228
	70	229	246	206	238	211	234	217
	75	219	261	197	245	205	235	210
	80	208	248	185	237	197	228	202
June-July	5	264	275	254	271	259	269	261
	10	234	246	222	240	228	238	230
	15	216	227	205	222	206	220	212
	20	220	233	207	227	213	225	215
	25	226	233	217	229	218	228	222
	30	235	246	231	243	233	240	234
	35	247	255	241	251	245	250	246
	40	259	270	253	267	257	264	258
	45	271	282	263	279	266	275	268
	50	277	288	268	283	272	281	274
	55	267	275	251	271	257	269	260
	60	255	270	233	265	240	260	244
	65	234	245	216	241	223	238	220
	70	213	226	188	219	196	216	202
	75	197	210	175	205	186	201	190
	80	182	203	154	195	163	191	170

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Table 21 — Median and high and low percentile values of temperature for the year at 15° latitude and for December-January and June-July at 30, 45, 60 and 80° N *(continued)*

60° N

Season	Geometric altitude h, km	Median temperature, T, K	Percentiles, K					
			1 %		10 %		20 %	
			high	low	high	low	high	low
December-January	5	239	254	223	248	230	245	233
	10	217	231	203	224	209	222	211
	15	217	231	203	225	209	222	212
	20	215	236	194	226	204	222	208
	25	213	241	185	229	197	223	203
	30	216	253	203	235	203	225	210
	35	219	277	204	259	204	238	214
	40	230	300	206	278	211	246	219
	45	242	303	219	282	225	255	231
	50	251	289	227	280	240	271	245
	55	248	283	225	275	233	256	238
	60	243	271	210	261	224	253	234
	65	238	262	208	258	218	249	222
	70	233	264	212	253	219	249	225
	75	228	255	180	249	203	246	213
	80	223	248	173	243	195	239	204
June-July	5	260	271	250	266	254	264	256
	10	226	238	214	233	219	231	221
	15	226	235	217	231	221	229	223
	20	226	233	219	230	222	229	223
	25	229	236	222	233	225	232	226
	30	238	245	232	243	234	241	235
	35	249	258	243	256	247	253	248
	40	263	272	259	269	261	268	262
	45	278	287	271	283	274	280	275
	50	282	290	273	286	277	284	279
	55	272	278	257	275	264	273	266
	60	262	273	242	265	250	263	253
	65	240	259	225	253	230	248	233
	70	216	239	202	226	208	222	211
	75	192	202	178	196	182	194	186
	80	169	180	140	176	153	174	155

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Table 21 — Median and high and low percentile values of temperature for the year at 15° latitude and for December-January and June-July at 30, 45, 60 and 80° N *(concluded)*

80° N

Season	Geometric altitude h, km	Median temperature, T, K	Percentiles, K 1 % high	1 % low	10 % high	10 % low	20 % high	20 % low
December-January	5	234	246	222	241	227	238	230
	10	213	224	202	219	207	217	209
	15	207	219	195	213	201	211	203
	20	202	225	179	215	189	210	194
	25	207	233	181	221	193	216	198
	30	210	255	194	231	198	224	202
	35	223	256	199	244	210	236	213
	40	235	284	207	256	219	248	224
	45	250	281	203	264	224	260	233
	50	242	282	201	265	225	259	229
	55	241	291	208	262	221	253	226
	60	241	303	206	263	213	255	219
	65	233	210	186	277	202	263	209
	70	233	297	166	277	201	261	207
	75	233	289	183	259	201	251	207
	80	223	277	165	254	194	240	201
June-July	5	254	264	244	259	248	257	250
	10	229	238	219	234	223	232	225
	15	231	237	225	234	228	233	229
	20	232	237	227	235	229	234	230
	25	235	240	230	238	232	237	233
	30	242	252	233	246	234	244	236
	35	253	260	238	256	246	255	249
	40	265	275	243	272	261	270	263
	45	276	288	269	286	273	284	275
	50	277	312	252	293	266	288	272
	55	264	278	221	275	238	272	249
	60	244	259	208	255	219	253	228
	65	232	253	200	243	217	236	219
	70	202	241	175	220	184	212	189
	75	182	246	153	202	164	196	171
	80	181	239	128	219	140	197	154

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Table 22 — Median and high and low percentile values of density, given as percentage departures from ISO standard density, for the year at 15° latitude and for December-January and June-July at 30, 45, 60 and 80° N

15°

Season	Geometric altitude *h*, km	Median density % departure from standard	Percentiles, % departure from standard						ISO 2533 density $kg \cdot m^{-3}$
			1 %		10 %		20 %		
			high	low	high	low	high	low	
Annual	5	− 3	− 1	− 5	− 2	− 4	− 2	− 4	$7,364\ 3 \times 10^{-1}$
	10	+ 1	+ 2	− 1	+ 2	0	+ 2	0	$4,135\ 1 \times 10^{-1}$
	15	+ 19	+ 22	+ 15	+ 21	+ 17	+ 20	+ 17	$1,947\ 6 \times 10^{-1}$
	20	+ 7	+ 10	+ 3	+ 9	+ 5	+ 8	+ 6	$8,891\ 0 \times 10^{-2}$
	25	+ 1	+ 5	− 3	+ 4	− 1	+ 3	0	$4,008\ 4 \times 10^{-2}$
	30	− 1	+ 4	− 6	+ 1	− 3	0	− 2	$1,841\ 01 \times 10^{-2}$
	35	+ 1	+ 7	− 4	+ 5	− 1	+ 3	0	$8,463\ 4 \times 10^{-3}$
	40	+ 4	+ 10	− 2	+ 7	+ 1	+ 6	+ 3	$3,995\ 7 \times 10^{-3}$
	45	+ 6	+ 13	+ 1	+ 10	+ 4	+ 8	+ 5	$1,966\ 3 \times 10^{-3}$
	50	+ 9	+ 17	+ 4	+ 15	+ 6	+ 12	+ 7	$1,026\ 9 \times 10^{-4}$

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Table 22 — Median and high and low percentile values of density, given as percentage departures from ISO standard density, for the year at 15° latitude and for December-January and June-July at 30, 45, 60 and 80° N *(continued)*

30° N

Season	Geometric altitude h, km	Median density % departure from standard	Percentiles, % departure from standard 1 % high	1 % low	10 % high	10 % low	20 % high	20 % low	ISO 2533 density kg·m^{-3}
December-January	5	– 1	+ 1	– 3	0	– 2	0	– 2	$7{,}364\ 3 \times 10^{-1}$
	10	+ 1	+ 4	– 3	+ 3	– 1	+ 2	0	$4{,}135\ 1 \times 10^{-1}$
	15	+ 8	+ 15	0	+ 12	+ 5	+ 10	+ 6	$1{,}947\ 6 \times 10^{-1}$
	20	+ 3	+ 7	– 2	+ 5	+ 1	+ 4	+ 2	$8{,}891\ 0 \times 10^{-2}$
	25	+ 1	+ 4	– 2	+ 3	– 1	+ 2	0	$4{,}008\ 4 \times 10^{-2}$
	30	– 3	+ 2	– 10	0	– 7	– 1	– 6	$1{,}841\ 0 \times 10^{-2}$
	35	– 2	+ 5	– 8	+ 3	– 4	+ 1	– 2	$8{,}463\ 4 \times 10^{-3}$
	40	+ 1	+ 6	– 9	+ 4	– 4	+ 3	– 2	$3{,}995\ 7 \times 10^{-3}$
	45	+ 1	+ 11	– 8	+ 5	– 4	+ 4	– 4	$1{,}966\ 3 \times 10^{-3}$
	50	+ 3	+ 12	– 9	+ 8	– 1	+ 7	+ 1	$1{,}026\ 9 \times 10^{-3}$
	55	+ 3	+ 17	– 11	+ 12	– 6	+ 6	– 2	$5{,}681\ 0 \times 10^{-4}$
	60	0	+ 17	– 12	+ 9	– 7	+ 4	– 4	$3{,}096\ 8 \times 10^{-4}$
	65	+ 2	+ 21	– 22	+ 13	– 10	+ 7	– 2	$1{,}632\ 1 \times 10^{-4}$
	70	+ 2	+ 16	– 24	+ 9	– 15	+ 6	– 10	$8{,}282\ 8 \times 10^{-5}$
	75	+ 2	+ 21	– 23	+ 13	– 13	+ 8	– 8	$3{,}992\ 1 \times 10^{-5}$
	80	+ 2	+ 21	– 19	+ 15	– 11	+ 7	– 5	$1{,}845\ 8 \times 10^{-5}$
June-July	5	– 2	0	– 4	– 1	– 3	– 1	– 3	$7{,}364\ 3 \times 10^{-1}$
	10	+ 1	+ 3	– 1	+ 2	0	+ 2	0	$4{,}135\ 1 \times 10^{-1}$
	15	+ 14	+ 19	+ 10	+ 15	+ 13	+ 15	+ 13	$1{,}947\ 6 \times 10^{-1}$
	20	+ 7	+ 10	+ 4	+ 9	+ 6	+ 8	+ 6	$8{,}891\ 0 \times 10^{-2}$
	25	+ 6	+ 9	+ 3	+ 7	+ 4	+ 7	+ 5	$4{,}008\ 4 \times 10^{-2}$
	30	+ 5	+ 10	0	+ 7	+ 3	+ 6	+ 4	$1{,}841\ 0 \times 10^{-2}$
	35	+ 7	+ 11	+ 2	+ 9	+ 4	+ 8	+ 5	$8{,}463\ 4 \times 10^{-3}$
	40	+ 9	+ 15	– 2	+ 13	+ 6	+ 12	+ 7	$3{,}995\ 7 \times 10^{-3}$
	45	+ 13	+ 21	+ 6	+ 17	+ 9	+ 15	+ 11	$1{,}966\ 3 \times 10^{-3}$
	50	+ 14	+ 28	– 2	+ 22	+ 4	+ 18	+ 7	$1{,}026\ 9 \times 10^{-3}$
	55	+ 13	+ 22	+ 4	+ 17	+ 6	+ 15	+ 9	$5{,}681\ 0 \times 10^{-4}$
	60	+ 13	+ 43	– 9	+ 34	– 1	+ 27	+ 4	$3{,}096\ 8 \times 10^{-4}$
	65	+ 18	+ 43	– 6	+ 38	0	+ 30	+ 6	$1{,}632\ 1 \times 10^{-4}$
	70	+ 18	+ 32	– 9	+ 23	+ 1	+ 20	+ 8	$8{,}282\ 8 \times 10^{-5}$
	75	+ 12	+ 24	– 11	+ 20	– 6	+ 15	+ 1	$3{,}992\ 1 \times 10^{-5}$
	80	+ 12	+ 22	– 12	+ 17	– 5	+ 15	+ 3	$1{,}845\ 8 \times 10^{-5}$

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Table 22 — Median and high and low percentile values of density, given as percentage departures from ISO standard density, for the year at 15° latitude and for December-January and June-July at 30, 45, 60 and 80° N *(continued)*

45° N

Season	Geometric altitude h, km	Median density % departure from standard	Percentiles, % departure from standard						ISO 2533 density kg·m⁻³
			1 %		10 %		20 %		
			high	low	high	low	high	low	
December-January	5	+ 1	+ 4	− 2	+ 3	− 2	+ 2	0	$7{,}364\,3 \times 10^{-1}$
	10	− 2	+ 6	− 10	+ 3	− 6	+ 1	− 4	$4{,}135\,1 \times 10^{-1}$
	15	− 5	+ 2	− 12	− 1	− 8	− 2	− 7	$1{,}947\,6 \times 10^{-1}$
	20	− 3	+ 1	− 8	− 1	− 6	− 2	− 5	$8{,}891\,0 \times 10^{-2}$
	25	− 4	0	− 8	− 2	− 6	− 3	− 5	$4{,}008\,4 \times 10^{-2}$
	30	− 5	+ 5	− 14	+ 2	− 11	− 1	− 9	$1{,}841\,0 \times 10^{-2}$
	35	− 6	+ 7	− 17	+ 2	− 12	− 2	− 10	$8{,}463\,4 \times 10^{-3}$
	40	− 8	+ 6	− 17	+ 2	− 12	− 2	− 10	$3{,}995\,7 \times 10^{-3}$
	45	− 8	+ 11	− 20	+ 6	− 16	− 1	− 14	$1{,}966\,3 \times 10^{-3}$
	50	− 12	+ 9	− 24	+ 4	− 18	− 2	− 16	$1{,}026\,9 \times 10^{-3}$
	55	− 15	+ 6	− 31	− 1	− 26	− 6	− 22	$5{,}681\,0 \times 10^{-4}$
	60	− 15	+ 5	− 28	− 4	− 25	− 8	− 22	$3{,}096\,8 \times 10^{-4}$
	65	− 18	− 3	− 38	− 8	− 34	− 12	− 28	$1{,}632\,1 \times 10^{-4}$
	70	− 14	+ 1	− 38	− 10	− 30	− 12	− 26	$8{,}282\,8 \times 10^{-5}$
	75	− 16	− 3	− 37	− 8	− 30	− 12	− 26	$3{,}992\,1 \times 10^{-5}$
	80	− 12	− 2	− 37	− 8	− 31	− 9	− 26	$1{,}845\,8 \times 10^{-5}$
June-July	5	− 2	+ 1	− 4	− 1	− 4	− 1	− 3	$7{,}364\,3 \times 10^{-1}$
	10	0	+ 3	− 1	+ 2	− 2	+ 1	− 1	$4{,}135\,1 \times 10^{-1}$
	15	+ 11	+ 18	+ 4	+ 15	+ 7	+ 13	+ 8	$1{,}947\,6 \times 10^{-1}$
	20	+ 5	+ 9	0	+ 7	+ 2	+ 6	+ 3	$8{,}891\,0 \times 10^{-2}$
	25	+ 6	+ 9	+ 4	+ 8	+ 5	+ 7	+ 5	$4{,}008\,4 \times 10^{-2}$
	30	+ 5	+ 10	− 1	+ 8	+ 2	+ 7	+ 3	$1{,}841\,0 \times 10^{-2}$
	35	+ 9	+ 14	+ 4	+ 12	+ 6	+ 11	+ 7	$8{,}463\,4 \times 10^{-3}$
	40	+ 13	+ 18	+ 6	+ 15	+ 10	+ 14	+ 12	$3{,}995\,7 \times 10^{-3}$
	45	+ 16	+ 22	+ 9	+ 19	+ 13	+ 18	+ 14	$1{,}966\,3 \times 10^{-3}$
	50	+ 19	+ 25	+ 12	+ 22	+ 16	+ 21	+ 17	$1{,}026\,9 \times 10^{-3}$
	55	+ 18	+ 28	+ 10	+ 24	+ 14	+ 22	+ 15	$5{,}681\,0 \times 10^{-4}$
	60	+ 20	+ 42	+ 4	+ 35	+ 10	+ 30	+ 13	$3{,}096\,8 \times 10^{-4}$
	65	+ 24	+ 45	+ 7	+ 39	+ 12	+ 34	+ 17	$1{,}632\,1 \times 10^{-4}$
	70	+ 26	+ 37	+ 1	+ 32	+ 12	+ 30	+ 16	$8{,}282\,8 \times 10^{-5}$
	75	+ 25	+ 40	+ 1	+ 30	+ 9	+ 28	+ 15	$3{,}992\,1 \times 10^{-5}$
	80	+ 22	+ 32	− 1	+ 30	+ 7	+ 26	+ 12	$1{,}845\,8 \times 10^{-5}$

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Table 22 — Median and high and low percentile values of density, given as percentage departures from ISO standard density, for the year at 15° latitude and for December-January and June-July at 30, 45, 60 and 80° N *(continued)*

60° N

Season	Geometric altitude h, km	Median density % departure from standard	Percentiles, % departure from standard 1 % high	1 % low	10 % high	10 % low	20 % high	20 % low	ISO 2533 density kg·m^{-3}
December-January	5	+ 2	+ 6	− 2	+ 4	0	+ 3	+ 1	$7,364\,3 \times 10^{-1}$
	10	− 7	+ 3	− 17	+ 2	− 14	− 3	− 10	$4,135\,1 \times 10^{-1}$
	15	− 9	− 2	− 15	− 5	− 12	− 6	− 11	$1,947\,6 \times 10^{-1}$
	20	− 9	− 1	− 15	− 8	− 11	− 9	− 10	$8,891\,0 \times 10^{-2}$
	25	− 4	+ 3	− 11	0	− 7	− 1	− 6	$4,008\,4 \times 10^{-2}$
	30	− 9	+ 7	− 32	+ 2	− 25	− 2	− 15	$1,841\,0 \times 10^{-2}$
	35	− 12	+ 8	− 35	+ 3	− 32	− 3	− 19	$8,463\,4 \times 10^{-3}$
	40	− 16	+ 10	− 36	+ 7	− 32	− 4	− 20	$3,995\,7 \times 10^{-3}$
	45	− 20	+ 12	− 39	+ 5	− 34	− 10	− 24	$1,966\,3 \times 10^{-3}$
	50	− 24	+ 15	− 42	+ 2	− 36	− 14	− 28	$1,026\,9 \times 10^{-3}$
	55	− 28	+ 9	− 48	− 4	− 40	− 19	− 38	$5,681\,0 \times 10^{-4}$
	60	− 34	− 1	− 54	− 17	− 39	− 24	− 38	$3,096\,8 \times 10^{-4}$
	65	− 37	− 4	− 50	− 15	− 45	− 24	− 43	$1,632\,1 \times 10^{-4}$
	70	− 37	− 17	− 51	− 26	− 47	− 30	− 43	$8,282\,8 \times 10^{-5}$
	75	− 36	− 17	− 49	− 19	− 41	− 25	− 39	$3,992\,1 \times 10^{-5}$
	80	− 31	− 11	− 50	− 17	− 44	− 21	− 38	$1,845\,8 \times 10^{-5}$
June-July	5	− 1	+ 3	− 3	+ 2	− 2	+ 1	− 2	$7,364\,3 \times 10^{-1}$
	10	− 1	+ 7	− 8	+ 4	− 5	+ 2	− 3	$4,135\,1 \times 10^{-1}$
	15	− 2	+ 3	− 7	+ 1	− 5	0	− 4	$1,947\,6 \times 10^{-1}$
	20	+ 3	+ 7	− 2	+ 5	0	+ 4	+ 1	$8,891\,0 \times 10^{-2}$
	25	+ 7	+ 10	+ 4	+ 9	+ 5	+ 8	+ 6	$4,008\,4 \times 10^{-2}$
	30	+ 7	+ 12	− 1	+ 9	+ 2	+ 8	+ 4	$1,841\,0 \times 10^{-2}$
	35	+ 10	+ 17	+ 1	+ 14	+ 6	+ 12	+ 7	$8,463\,4 \times 10^{-3}$
	40	+ 14	+ 23	+ 5	+ 18	+ 10	+ 16	+ 11	$3,995\,7 \times 10^{-3}$
	45	+ 19	+ 33	+ 6	+ 25	+ 11	+ 23	+ 14	$1,966\,3 \times 10^{-3}$
	50	+ 24	+ 37	+ 9	+ 33	+ 17	+ 30	+ 22	$1,026\,9 \times 10^{-3}$
	55	+ 22	+ 34	+ 8	+ 30	+ 17	+ 24	+ 18	$5,681\,0 \times 10^{-4}$
	60	+ 26	+ 36	+ 9	+ 32	+ 14	+ 28	+ 17	$3,096\,8 \times 10^{-4}$
	65	+ 31	+ 46	+ 12	+ 40	+ 18	+ 35	+ 21	$1,632\,1 \times 10^{-4}$
	70	+ 38	+ 55	+ 14	+ 46	+ 22	+ 42	+ 29	$8,282\,8 \times 10^{-5}$
	75	+ 43	+ 65	+ 20	+ 52	+ 29	+ 48	+ 39	$3,992\,1 \times 10^{-5}$
	80	+ 39	+ 56	+ 14	+ 50	+ 23	+ 43	+ 25	$1,845\,8 \times 10^{-5}$

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