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AMENDMENT 1
1990-12-01

Reference atmospheres for aerospace use

AMENDMENT 1

Atmosphères de référence pour l'application aérospatiale
AMENDEMENT 1

Reference number
ISO 5878 : 1982/Amd.1 : 1990 (E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Amendment 1 to ISO 5878 : 1982 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles,* Sub-Committee SC 6, *Standard atmosphere.*

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Reference atmospheres for aerospace use

AMENDMENT 1

Page 2, table 2

Replace the unit kPa by hPa.

Page 3, 3.1, second paragraph

Replace the first phrase by the following:

Features typical of the thermal structure of the tropical atmosphere are shown in figure 1 and in table 16.

Page 6

Replace the note by the following:

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

Page 7, table 4

— For h = 50 000 m, replace ϱ = 1,047 952 × 10^{-3} kg·m^{-3} by ϱ = 1,047 852 × 10^{-3} kg·m^{-3}.

— For h = 56 000 m, replace T = 255,521 K by T = 255,525 K.

— For h = 58 000 m, replace ϱ = 4,032 813 × 10^{-4} kg·m^{-3} by ϱ = 4,082 813 × 10^{-4} kg·m^{-3}.

— For h = 62 000 m, replace p = 1,080 647 × 10^{-1} hPa by p = 1,680 647 × 10^{-1} hPa.

— For h = 64 000 m, replace ϱ = 1,879 963 × 10^{-4} kg·m^{-3} by ϱ = 1,875 963 × 10^{-4} kg·m^{-3}.

— For h = 70 000 m, replace p = 5,261 760 × 10^{-2} hPa by p = 5,264 760 × 10^{-2} hPa.

— For h = 80 000 m, replace ϱ = 1,877 773 × 10^{-5} kg·m^{-3} by ϱ = 1,877 743 × 10^{-5} kg·m^{-3}.

Page 13, table 10

For h = 56 000 m, replace ϱ = 5,051 153 × 10^{-4} kg·m^{-3} by ϱ = 5,041 153 × 10^{-4} kg·m^{-3}.

Page 16, table 13

For h = 32 000 m, replace H = 32 918 m by H = 31 918 m.

Page 20, table 16, 60° N, *June-July, 4th line*

Replace H = 23,500 km by H = 23,000 km.

Page 21, table 17

— 3rd line, 4th column, replace 40/38 (245) by 40/38 (245)*.

— Add the following note:

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

Page 21, table 18

— 6th line, 2nd column, replace 30° 57′ S by 31° 09′ S.

— 6th line, 3rd column, replace 136° 31′ E by 136° 48′ E.

— 7th line, 3rd column, replace 160° 29′ W by 106° 29′ W.

Page 24, table 21

— 6th line, 9th column, replace 224 by 226.

— 17th line, 6th column, replace 274 by 276.

Page 25, table 21

29th line, 9th column, replace 220 by 225.

Page 26, table 21

— 22nd line, 3rd column, replace 238 by 234.

— 22nd line, 9th column, replace 235 by 234.

Page 27, table 21

— 13th line, 4th column, replace 210 by 310.

— 22nd line, 3rd column, replace 242 by 240.

— 22nd line, 4th column, replace 252 by 262.

— 22nd line, 8th column, replace 244 by 241.

Page 28, table 22

— 6th line, 10th column, replace 1,841 01 × 10^{-2} by 1,841 0 × 10^{-2}.

— 10th line, 10th column, replace 1,026 9 × 10^{-4} by 1,026 9 × 10^{-3}.

Pages 34 to 37

Replace the term "geometrical" by "geometric".

Page 34, figure 1, 60° N

Modify the December-January curve between the 35 km and 80 km altitudes so that it shows a constant temperature of 251,35 K for the layer between 49,3 km and 51,3 km.

Page 36, figure 3, 60° N *Winter*

Modify the "warm" curve between the 35 km and 80 km altitudes so that it shows a constant temperature of 267,15 K for the layer between 42,2 km and 48,3 km.

UDC 551.51/54

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

Price based on 1 page

INTERNATIONAL STANDARD ISO 5878-1982/ADDENDUM 2

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

Reference atmospheres for aerospace use

ADDENDUM 2 : Air humidity in the Northern Hemisphere

Addendum 2 to International Standard ISO 5878-1982 was developed by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, and was circulated to the member bodies in April 1982.

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

Australia	Egypt, Arab Rep. of	South Africa, Rep. of
Austria	France	Spain
Belgium	Germany, F.R	Sweden
Brazil	Ireland	United Kingdom
Canada	Italy	USA
China	Netherlands	USSR
Czechoslovakia	Romania	

No member body expressed disapproval of the document.

0 Introduction

The moisture content of air is very small, about 4 % by mass being the maximum. Nevertheless it has a strong influence upon the earth's biosphere, on meteorological processes and also upon the operation of aircraft. A knowledge of the distribution and variations of this important meteorological quantity is required for the design and operation of aerospace vehicles.

Water in the atmosphere is found in three states, as vapour, liquid and solid. Water vapour is of greatest interest in the present context, although the other states of water are important for aviation, for example as in clouds and fog, with the consequent poor visibility, icing, and so on.

The moisture content of the atmosphere decreases rapidly with increasing height, the main mass of water being contained in the atmospheric boundary layer. On average over the Northern Hemisphere, 60 % of the total water content is in the lowest 2 km of the atmosphere, and 99 % in the lowest 10 km.

This International Standard gives values of the humidity at heights up to 10 km above sea level, the region for which reasonably reliable radiosonde data are available.

To satisfy most potential users, the humidity of the atmosphere is expressed in three measures, namely

— humidity mixing ratio, r;

— vapour pressure (partial pressure), e';

— dew-point temperature, t_d.

CDU 551.571 Ref. No. ISO 5878-1982/Add. 2-1983 (E)

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

1 General aspects of the humidity distribution in the atmosphere

Moisture enters the atmosphere as a result of evaporation from oceans, lakes, rivers, vegetation and moist surfaces. The main sources are the oceans of the tropics, where the high temperature leads to intense evaporation. Air currents then transport the moisture to all parts of the globe.

In the troposphere the moisture content of the air is largely dependent upon the temperature. For a given temperature, there is a definite maximum quantity of water vapour that can be held in a given volume. The amount of water vapour required to saturate a given volume increases with increasing temperature. If the amount of water vapour in a given volume remains constant, a change of temperature alters only the degree of saturation — the relative humidity. During the course of the year, the moisture content of the atmosphere increases from winter to summer as a result of rising temperatures and consequently increase of evaporation rates. The largest annual variation appears above the continents, where the moisture influx into the atmosphere increases considerably in the summer as a result of evaporation from vegetation and water surfaces.

The moistest zone of the Northern Hemisphere lies between the equator and latitude 10 to 15° N. Very high humidity values occur locally over South America, the north coast of the Indian Ocean (the Indian subcontinent, Indo-China) and the near-equatorial islands of the Pacific Ocean. Very low values of humidity in the Northern Hemisphere occur over Algeria, Jakutija (north-east Siberia, and northern Canada in the winter.

2 Definitions and formulae for calculation of humidity characteristics

The water vapour content of the air can be expressed by a number of physical terms which are related to each other — humidity mixing ratio, vapour pressure, dew-point temperature, and others.

It is convenient to use the humidity mixing ratio as the main humidity characteristic, since it is the most conservative. It remains invariable during vertical or horizontal air movements unless condensation or evaporation occurs, and it determines uniquely the water vapour content in the air.

2.1 The humidity mixing ratio, r, of moist air is the ratio of water vapour mass, m_v, to the mass of dry air, m_a, in the same volume. Since in practice $m_v \ll m_a$, the humidity mixing ratio is often reduced by a factor of 10^3 and is expressed in terms of grams per kilogram. The equation is

$$r = \frac{m_v}{m_a} \qquad \ldots (1)$$

where m_v is expressed in grams and m_a in kilograms.

2.2 The vapour pressure, or partial pressure of water vapour, e', is that part of the total atmospheric pressure which is exerted by water vapour. It is measured in the same units as the atmospheric pressure.

The vapour pressure, e', in moist air at total pressure p, and with mixing ratio r is defined by the equation

$$e' = \frac{r}{621{,}98 + r} \times p \qquad \ldots (2)$$

The unit of e' and p is millibars or another pressure unit, r is given in grams per kilogram.

Before dew-point temperature and relative humidity can be defined, the concept of saturation must be introduced. Moist air at a given temperature and pressure is said to be saturated if its mixing ratio, r_w, is such that the moist air can exist in neutral equilibrium with the associated liquid phase at the same temperature and pressure, the surface of separation being plane. An analogous statement applies to saturation with respect to ice, but this addendum deals only with relationships with respect to the liquid phase.

The saturation vapour pressure with respect to water e'_w, of moist air at pressure p and temperature t is defined by the equation

$$e'_w = \frac{r_w}{621{,}98 + r_w} \times p \qquad \ldots (3)$$

The unit of e'_w and p is millibars or another pressure unit, r_w is given in grams per kilogram.

The saturation vapour pressure may be conveniently expressed as a function of the air temperature. The following approximation gives satisfactory accuracy for saturation vapour pressure over a flat surface for the air temperature $-20\ °C < t < 30\ °C$:

$$e'_w = 6{,}107 \times 10^{\frac{a\,t}{b + t}} \qquad \ldots (4)$$

where $a = 7{,}5$ K, $b = 237{,}3$ K; if $t < 0$ °C, then over an ice surface $a = 9{,}5$ K, $b = 265{,}5$ K.

2.3 The dew-point temperature, t_d, of moist air at pressure p and with mixing ratio r is the temperature at which moist air, saturated with respect to water at the given pressure, has a saturation mixing ratio, r_w, equal to the given mixing ratio, r.

The dew-point temperature may be calculated with reasonable accuracy by the use of the equation

$$t_d = \frac{237{,}3 \times \log_{10} \dfrac{e'}{6{,}107\,0}}{7{,}5 - \log_{10} \dfrac{e'}{6{,}107\,0}} \qquad \ldots (5)$$

The unit of t_d is degrees Celsius, e' is given in millibars.

2.4 Relative humidity, U, is a percentage of the actual vapour pressure in the moist air to the saturated vapour pressure at the same temperature and pressure. Relative humidity is calculated by the equation

$$U = 100 \times \left(\frac{e'}{e'_w} \right)_{p,\,t} \qquad \ldots (6)$$

where the subscripts indicate that each term is subject to identical conditions of pressure, p, and temperature, t.

3 Humidity models

3.1 The humidity distribution at heights up to 10 km in the atmosphere of the Northern Hemisphere is depicted in four sets of tables :

a) the median values of humidity mixing ratio, vapour pressure and dew-point temperature for latitudes 10°, 30°, 50° and 70° N for January, July and the whole year (see table 1);

b) the median values of mixing ratio for January and July along the 0°, 80° E, 180° and 80° W meridians (see table 2);

c) the values of humidity mixing ratio, vapour pressure and dew-point temperature exceeded on 20 %, 10 %, 5 % and 1 % of occasions in the most humid areas, and the values not attained on 20 %, 10 %, 5 % and 1 % of occasions in the driest areas (see table 3);

d) the humidity characteristics of the atmosphere above two very dry and two very moist stations in the Northern Hemisphere (see table 4).

Three measures of humidity are given in table 1 and are averaged round each latitude circle for January, July and the whole year from data given in [1-10]. The tabulated values above a height of 8 km should be regarded as approximate because the amount of data here is insufficient. Meridional cross-sections (see table 2) are based on data from [1-3].

Percentiles of mixing ratio, vapour pressure and dew-point temperatures extremes for stations within the areas of high and low humidity, defined according to [4], and taking into account data from [10], are given in table 3. For the areas of low humidity, the values which are not reached on 1 %, 5 %, 10 % and 20 % of occasions are given. For low humidity associated with very low temperatures, a relative humidity of 90 % was assumed. The dry one-percentile values of humidity for heights up to 8 km, and the five- and ten-percentile values at heights of 1 and 2 km were found in January over northern Canada. The moist one-percentile values at the surface occur in July and August around the Persian Gulf, particularly at Abadan, Iran, and the five- and ten-percentile values at the surface were found in Honduras (Central America) during August. The moist extremes for all levels occurred over northern India.

The mean values of humidity for four stations representative of dry and moist regions of the Northern Hemisphere are given in table 4. They are Tamanrasset (North Africa) — January; Zhigansk (East Siberia) — January; Calcutta (India) — July and Truk (Pacific Islands) — January. In this table moisture values are given for isobaric levels.

Table 1 — Median values of humidity characteristics in the Northern Hemisphere

h, km	10° N								
	January			July			Annual		
	r, g/kg	e′, mbar	t_d, °C	r, g/kg	e′, mbar	t_d, °C	r, g/kg	e′, mbar	t_d, °C
0	12,63	20,10	17,6	16,96	26,89	22,2	14,87	23,66	20,2
1	8,82	12,60	10,4	12,11	17,24	15,1	10,70	15,27	13,3
2	5,85	7,48	2,8	8,73	11,12	8,5	7,66	9,77	6,7
3	3,95	4,50	− 4,1	6,26	7,11	2,1	5,23	5,94	− 0,5
4	2,78	2,81	− 10,3	4,23	4,26	− 4,9	3,51	3,55	− 7,3
5	1,99	1,78	− 15,9	2,87	2,56	− 11,4	2,40	2,14	− 13,6
6	1,40	1,10	− 21,5	1,94	1,53	− 17,7	1,71	1,35	− 19,1
7	0,97	0,67	− 26,6	1,34	0,93	− 23,5	1,19	0,82	− 24,8
8	0,63	0,38	− 33,0	0,84	0,53	− 29,8	0,76	0,48	− 30,6
9	0,40	0,21	− 39,0	0,51	0,27	− 35,8	0,45	0,24	− 37,0
10	0,25	0,10	− 45,4	0,31	0,14	− 42,0	0,27	0,12	− 43,1

h, km	30° N								
	January			July			Annual		
	r, g/kg	e′, mbar	t_d, °C	r, g/kg	e′, mbar	t_d, °C	r, g/kg	e′, mbar	t_d, °C
0	6,05	9,83	6,7	14,80	23,56	20,1	9,55	15,38	13,4
1	3,96	5,72	− 0,9	8,50	12,18	9,9	6,41	9,22	5,8
2	2,69	3,45	− 7,6	5,82	7,44	2,7	4,30	5,51	− 1,4
3	1,91	2,17	− 13,4	4,21	4,79	− 3,3	2,99	3,40	− 7,8
4	1,30	1,30	− 19,5	3,07	3,10	− 9,0	2,06	2,08	− 14,0
5	0,83	0,73	− 26,1	2,26	2,01	− 14,4	1,39	1,24	− 20,1
6	0,50	0,39	− 32,8	1,65	1,30	− 19,6	0,96	0,75	− 25,8
7	0,34	0,23	− 38,1	1,22	0,84	− 24,6	0,66	0,45	− 31,3
8	0,23	0,14	− 43,1	0,84	0,53	− 29,6	0,42	0,25	− 37,3
9	0,17	0,09	− 48,0	0,56	0,30	− 35,5	0,24	0,14	− 42,6
10	0,12	0,06	− 49,2	0,37	0,16	− 40,7	0,15	0,08	− 48,0

Table 1 — Median values of humidity characteristics in the Northern Hemisphere *(concluded)*

h, km	50° N								
	January			July			Annual		
	r, g/kg	e', mbar	t_d, °C	r, g/kg	e', mbar	t_d, °C	r, g/kg	e', mbar	t_d, °C
0	1,97	3,22	− 8,5	8,47	13,62	11,5	4,84	7,85	3,5
1	1,64	2,36	−12,4	6,41	9,19	5,8	3,69	5,29	− 2,0
2	1,23	1,56	−17,4	4,82	6,15	0,1	2,67	3,39	− 7,8
3	0,89	0,99	−22,7	3,51	3,97	− 5,8	1,86	2,09	−13,9
4	0,59	0,58	−28,6	2,47	2,46	−11,9	1,25	1,24	−20,1
5	0,42	0,36	−33,6	1,72	1,52	−17,7	0,87	0,75	−25,8
6	0,29	0,22	−38,5	1,30	1,01	−22,5	0,58	0,44	−31,5
7	0,20	0,13	−43,5	0,84	0,57	−28,8	0,41	0,27	−36,5
8	0,16	0,09	−46,9	0,52	0,31	−35,1	0,27	0,15	−42,2
9	0,16	0,08	−47,8	0,29	0,16	−41,6	0,23	0,12	−44,7
10	0,23	0,10	−45,6	0,16	0,08	−48,0	0,20	0,09	−46,8

h, km	70° N								
	January			July			Annual		
	r, g/kg	e', mbar	t_d, °C	r, g/kg	e', mbar	t_d, °C	r, g/kg	e', mbar	t_d, °C
0	0,67	1,09	−21,6	5,24	8,45	4,6	2,18	3,55	− 7,2
1	0,80	1,14	−21,1	4,72	6,73	1,3	1,97	2,81	−10,2
2	0,59	0,72	−27,2	3,51	4,42	− 4,4	1,44	1,80	−15,7
3	0,41	0,44	−31,5	2,23	2,48	−11,8	0,93	1,02	−22,4
4	0,25	0,24	−37,7	1,54	1,50	−17,9	0,63	0,60	−28,2
5	0,12	0,10	−46,0	1,07	0,91	−23,7	0,44	0,37	−33,3
6	0,09	0,06	−50,5	0,71	0,53	−29,8	0,29	0,21	−39,0
7	0,11	0,07	−48,8	0,48	0,31	−35,1	0,18	0,11	−45,1
8	0,16	0,08	−47,6	0,34	0,19	−40,0	0,21	0,11	−42,7
9	0,21	0,09	−46,5	0,23	0,11	−45,4	0,22	0,10	−46,0
10	0,28	0,10	−45,6	0,16	0,07	−50,6	0,22	0,08	−48,1

Table 2 — Median values of the mixing ratio (in grams per kilogram), for January and July along 0°, 80° E and 180°, 80° W

h, km	0°							
	January				July			
	10° N	30° N	50° N	70° N	10° N	30° N	50° N	70° N
0	7,06	3,60	3,43	1,84	15,85	7,67	8,36	5,39
1	5,43	2,53	2,34	1,26	9,70	5,62	6,31	3,73
2	4,07	1,76	1,67	0,79	6,24	4,02	4,42	2,71
3	2,90	1,28	0,94	0,54	4,77	3,34	2,84	2,02
4	1,59	0,92	0,60	0,33	3,46	2,37	1,87	1,38
5	1,25	0,68	0,37	0,26	1,88	1,69	1,22	0,85
6	0,91	0,50	0,27	0,23	1,37	1,15	0,73	0,57
7	0,57	0,33	0,22	0,20	0,90	0,74	0,43	0,35
8	0,29	0,23	0,20	0,18	0,52	0,40	0,28	0,18
9	0,21	0,18	0,16	0,19	0,29	0,24	0,20	0,15
10	0,19	0,16	0,15	0,20	0,09	0,09	0,07	0,04

h, km	80° E							
	January				July			
	10° N	30° N	50° N	70° N	10° N	30° N	50° N	70° N
0	12,09	—	—	0,42	18,47	—	—	7,40
1	9,54	—	—	0,52	13,20	—	—	4,58
2	6,65	2,32	1,82	0,53	10,20	9,44	4,97	3,46
3	3,85	1,75	0,81	0,31	7,64	8,17	4,21	2,59
4	2,77	1,26	0,69	0,20	4,95	6,70	3,26	1,90
5	2,32	0,80	0,56	0,11	3,67	5,12	2,20	1,41
6	1,90	0,46	0,43	0,07	2,67	3,75	1,55	0,95
7	1,56	0,30	0,25	0,08	1,96	2,61	1,16	0,59
8	0,98	0,22	0,16	0,14	1,48	1,73	0,81	0,32
9	0,57	0,16	0,16	0,15	1,06	1,08	0,38	0,15
10	0,52	0,15	0,16	0,15	0,96	0,60	0,17	0,15

Table 2 — Median values of the mixing ratio (in grams per kilogram), for January and July along 0°, 80° E and 180°, 80° W (*concluded*)

h, km	180°							
	January				July			
	10° N	30° N	50° N	70° N	10° N	30° N	50° N	70° N
0	13,45	6,05	2,52	0,58	15,85	14,24	8,26	5,10
1	10,45	5,70	1,99	0,71	11,94	9,50	5,81	4,14
2	6,91	3,53	1,14	0,66	8,58	6,55	4,32	3,31
3	4,02	1,90	0,71	0,41	5,64	4,01	3,34	2,54
4	2,43	1,30	0,44	0,26	3,65	2,64	2,27	1,77
5	2,09	0,83	0,33	0,17	2,58	1,73	1,64	1,22
6	1,73	0,59	0,29	0,17	1,78	1,20	1,27	0,75
7	1,01	0,37	0,21	0,16	1,16	0,78	0,78	0,43
8	0,67	0,29	0,16	0,17	0,75	0,52	0,43	0,28
9	0,33	0,20	0,16	0,17	0,53	0,28	0,22	0,16
10	—	—	—	0,16	0,26	0,09	0,09	0,09

h, km	80° W							
	January				July			
	10° N	30° N	50° N	70° N	10° N	30° N	50° N	70° N
0	12,42	4,78	0,50	0,25	17,46	15,25	7,07	4,16
1	10,45	4,97	0,86	0,27	12,63	11,19	5,52	3,34
2	6,83	3,27	0,84	0,30	8,83	7,76	4,32	2,40
3	3,85	2,38	0,68	0,33	6,30	5,59	3,14	1,77
4	2,69	1,76	0,42	0,23	4,39	3,96	2,37	1,23
5	2,08	1,33	0,32	0,12	3,01	2,66	1,59	0,81
6	1,57	0,91	0,17	0,07	1,95	1,66	0,89	0,53
7	1,15	0,59	0,11	0,06	1,39	1,09	0,61	0,31
8	0,66	0,35	0,16	0,09	0,95	0,73	0,37	0,16
9	0,31	0,20	0,16	0,15	0,64	0,54	0,15	0,11
10	0,08	0,08	0,08	0,20	0,58	0,51	0,14	0,10

Table 3 — Percentiles of humidity in extremely dry and moist areas and seasons

h, km	Low percentiles in extremely dry regimes											
	1 %			5 %			10 %			20 %		
	r, g/kg	e', mbar	t_d, °C	r, g/kg	e', mbar	t_d, °C	r, g/kg	e', mbar	t_d, °C	r, g/kg	e', mbar	t_d, °C
0	0,005 9	0,008 2	−62	0,008 7	0,014 1	−58	0,012 9	0,020 9	−55	0,018 9	0,030 7	−52
1	0,044 2	0,063 4	−50	0,107 0	0,153 0	−42	0,132 0	0,188 9	−40	0,179 0	0,256 7	−37
2	0,045 4	0,057 7	−51	0,087 3	0,110 8	−45	0,121 0	0,153 0	−42	0,165 0	0,208 8	−39
4	0,032 1	0,032 1	−56	0,041 2	0,040 6	−54	0,046 4	0,045 8	−53	0,052 2	0,051 3	−52
6	0,013 6	0,010 3	−65	0,015 6	0,011 8	−64	0,017 7	0,013 4	−63	0,020 1	0,015 2	−62
8	0,003 9	0,002 1	−76	0,044 9	0,002 6	−75	0,005 2	0,003 0	−74	0,006 0	0,003 4	−73

h, km	High percentiles in extremely moist regimes											
	1 %			5 %			10 %			20 %		
	r, g/kg	e', mbar	t_d, °C	r, g/kg	e', mbar	t_d, °C	r, g/kg	e', mbar	t_d, °C	r, g/kg	e', mbar	t_d, °C
0	29,0	44,8	31	27,3	42,3	30	25,7	39,9	29	24,2	37,8	28
1	27,4	37,8	28	25,8	35,5	27	24,3	33,5	26	22,8	31,7	25
2	22,9	28,1	23	21,5	26,3	22	18,9	23,3	20	16,6	20,6	18
4	17,7	17,0	15	15,5	14,9	13	13,6	13,1	11	11,8	11,5	9
6	8,8	6,56	1	8,18	6,09	0	7,59	5,67	− 1	7,05	5,27	− 2
8	5,92	3,35	−8	4,66	2,63	−11	4,30	2,43	−12	3,90	2,25	−13

Table 4 — Mean values of atmospheric humidity in dry and moist stations of the Northern Hemisphere

Station			Month	Isobaric levels, mbar	r, g/kg	e', mbar	t_d, °C
				Dry areas			
Tamanrasset			January	—	—	—	—
φ	λ	h, m		850	0,81	1,11	−21,4
22° 47′ N	05° 31′ E	1378		700	0,34	0,38	−33,0
				500	0,28	0,23	−38,1
				300	0,08	0,04	−54,0
				200	—	—	—
Zhigansk			January	1000	0,07	0,11	−42,7
φ	λ	h, m		850	0,35	0,48	−30,5
66° 46′ N	123° 24′ E	58		700	0,29	0,33	−34,5
				500	0,09	0,07	−49,2
				300	0,02	0,01	−64,9
				200	0,02	0,01	−64,9
				Moist areas			
Calcutta			July	1000	19,78	30,83	24,5
φ	λ	h, m		850	14,44	19,29	16,9
22° 39′ N	88° 27′ E	6		700	9,70	10,74	8,0
				500	2,52	2,01	−14,4
				300	0,09	0,04	−54,0
				200	0,09	0,03	−56,3
Truk			January	1000	15,36	24,01	20,5
φ	λ	h, m		850	9,96	13,39	11,3
07° 28′ N	151° 51′ E	2		700	4,61	5,15	− 2,3
				500	1,73	1,39	−18,8
				300	0,16	0,08	−48,0
				200	—	—	—

Bibliography

[1] *Materialy po klimatu i cirkuljacii svobodnoj atmosfery nad SSSR.* Tom I : *Osnovnye statističeskie harakteristiki vetra. Srednie značenija temperatury i vlažnosti vozduha.* Pod red. I. G. Gutermana. Moskva, Gidrometeoizdat, 1970.

[2] *Materialy po klimatu i cirkuljacii svobodnoj atmosfery nad zarubežnymi stranami severnogo polušarija.* Tom I : *Osnovnye statističeskie harakteristiki vetra. Srednie značenija temperatury i vlažnosti vozduha.* Vypusk 1 : *Evropa, Azija, Atlantičesky-jokean.* Pod red. I. G. Gutermana. Moskva, Gidrometeoizdat, 1972.

[3] *Materialy po klimatu i cirkuljacii svobodnoj atmosfery nad zarubežnymi stranami severnogo polušarija.* Tom I : *Osnovnye statističeskie harakteristiki vetra. Srednie značenija temperatury i vlažnosti vozduha.* Vypusk 2 : *Amerika, Afrika, Tihij okean.* Pod red. I. G. Gutermana. Moskva, Gidrometeoizdat, 1974.

[4] GRINGORTEN, I.I., et al. *Atmospheric Humidity Atlas — Northern Hemisphere*, Air Force Surveys in Geophysics, No. 186, Air Force Cambridge Research Laboratories, Bedford, MA, 1966.

[5] ROACH, W.T., and MURGATROYD, R.J. *Meridional cross sections of humidity mixing ratio in winter and summer* (not published).

[6] TUCKER, G.B. *An Analysis of humidity measurements in the upper troposphere and lower stratosphere over S. England.* Met. Res. Paper No. 1052, Meteorological Office, London, 1957.

[7] Mc KINNON, D., and MOREWOOD, H.W. *Water vapour distribution in the lower stratosphere over N. and S. America.* J. Atmos. Aci. 27, 1970.

[8] NEWELL, KIDSON, VINCENT and BOER. *General circulation of the tropical atmosphere.* Vol. I, M.I.T. Press, 1972.

[9] MURGATROYD, R.J. WMO Technical Note No. 68, 1965.

[10] SALMELA, N.A., and GRANTHAM, D.D. *Diurnal cycles of high absolute humidity at the Earth's Surface.* Environmental Research Papers, No. 16, 146, Air Force Cambridge Research Laboratories, Bedford, MA, 1972.

[11] BRIGGS, J. *Model of the distribution of atmosphere humidity.* Doc. 52 (U.K.-4), September, 1971, ISO/TC 20/SC 6.

[12] *Draft Proposal of Humidity to Reference Atmosphere.* Doc. 85 (USA-8), ISO/TC 20/SC 6.

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

Reference atmospheres

ADDENDUM 1 : Wind supplement

Addendum 1 to International Standard ISO 5878 was developed by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, and was circulated to the member bodies in March 1979.

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

Austria	India	Romania
Belgium	Italy	South Africa, Rep. of
Brazil	Japan	Spain
Canada	Korea, Rep. of	Turkey
Czechoslovakia	Libyan Arab Jamahiriya	United Kingdom
France	Mexico	USA
Germany, F.R.	Netherlands	USSR

No member body expressed disapproval of the document.

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Contents

Reference atmospheres

ADDENDUM 1 : Wind supplement

0 Introduction

A specification summarizing the characteristics of the wind is required for many practical problems, such as aircraft design, the planning and operation of air routes and airfields, estimates of the global transport of atmospheric contaminants, etc., in which the wind is one of the primary factors.

Air motions in the atmosphere occur as a result of phenomena related to air temperature and atmospheric pressure, the nature of the surface over which the air is moving, the rotation of the earth, etc. Such a complex relationship leads to large wind variations in time and space, including the seasonal variation of the general circulation of the atmosphere and the formation of disturbances on a wide range of scales from that of cyclones and anticyclones to that of small-scale turbulence.

The observed features of the wind distribution in the meridional plane are as follows :

a) a predominantly easterly component in the airflow of the lower and middle troposphere of tropical latitudes, and in the whole of the atmosphere in equatorial latitudes;

b) the existence of systematic meridional components in the zone 0 to 30° N — a northerly component in the lower troposphere and a southerly component in the middle troposphere;

c) a predominantly westerly flow in sub-tropical latitudes (30 to 40°); the wind speed increases sharply with altitude, reaching a maximum at altitudes of 10 to 13 km in the sub-tropical jet stream;

d) in temperate latitudes (40 to 60°), a generally westerly flow having a wave-like form; jet streams with axes at altitudes of about 8 to 9 km are associated with systems of mobile cyclones and are therefore more variable than the sub-tropical jet stream and much of the detail of their structure and location is lost in the averaging process;

e) in the stratosphere, the air flow is characterized by a seasonal of monsoon-type of direction change; to the north of 30° N, westerly winds occur in winter, changing to easterly in summer, with negative wind shears (wind speed decreasing with height) prevailing in the altitude range 9 to 20 km; to the north of 60 to 65° N, abrupt positive wind shears prevail in winter, and there is a strong westerly jet stream in the polar stratosphere.

The World Meteorological Organization (WMO) and several countries have published detailed tables and atlases of the wind characteristics[1, 2, 7], and these can be used to provide information in the form required for a given purpose. However, it would probably be wrong to expect the specialist user, who may not be a meteorologist, to extract the required information from the huge store of climatological material available.

It seems reasonable, therefore, the present wind data, averaged over major regions, in the form of this addendum to ISO 5878.

1 Scope and field of application

The addendum presents data on spatial distribution of wind characteristics, for use in estimating the performance of aircraft in the design stage or of aircraft already in service, for planning air routes and for estimating the global transport of atmospheric contaminants.

2 Methodological aspects and analysis of the data

The tables and graphs given are based on a comprehensive study and statistical analysis of wind data for the earth's surface and eight isobaric surfaces over the northern hemisphere.

The analysis is based on a large and uniform statistical sample, the major part of which has been published[3, 4]. About two million observations from 369 aerological stations for the nine-year period 1957 to 1965 were processed. In addition, statistical data from 50 further stations[5, 6] were included in the analyses. Other works[1, 2] were also used.

The following maps were compiled on the basis of the average monthly wind characteristics at the main isobaric surfaces :

a) mean scalar wind speed, $\overline{V}_s$;

b) mean zonal component (zonal component of the vector mean wind), $\overline{V}_x$;

c) mean meridional component (meridional component of the vector mean wind), $\overline{V}_y$;

d) standard deviation of the zonal component of the wind, σ_x;

e) standard deviation of the meridional component of the wind, σ_y.

The seasonal changes of the wind characteristics at the different isobaric surfaces and the effects of topography and surface roughness were taken into account in the analysis of the maps and in drawing isotachs.

The information read off at the grid points at intervals of 10° of longitude and 10° of latitude for the earth's surface and for the 850, 700, 500, 300, 200, 100, 50 and 30 mbar isobaric surfaces served as a basis for the calculation of the average wind characteristics within each of the latitude zones.

Thus the mean value for a zone, $\overline{V}$, of a characteristic is given by the equation :

$$\overline{V} = \frac{1}{n} \sum_{i=1}^{n} \overline{V}_i \qquad \ldots (1)$$

and the corresponding standard deviation, σ, by

$$\sigma = \sqrt{\frac{1}{n} \sum_{i=1}^{n} \sigma_i^2 + \frac{1}{n} \sum_{i=1}^{n} (\overline{V}_i - \overline{V})^2} \qquad \ldots (2)$$

where

$\overline{V}_i$ is the monthly mean value of the characteristic at the i-th grid point;

σ_i is the standard deviation at the i-th grid point;

n is the number of grid points within the region of averaging; for each latitude circle, $n = 36$.

For each isobaric surface the mean values of the zonal and meridional components of the wind and the values of the scalar mean wind speed were calculated from equation (1), and the standard deviations of the components from equation (2). Then each of the wind characteristics was plotted as a function of the geopotential altitude H, using the mean value of H for each isobaric surface. The values interpolated from these plots for the required values of H were used in constructing the tables.

3 Wind models

Taking into account the features of the atmospheric circulation over the northern hemisphere, namely the presence of long waves within certain latitude zones and the existence of jet streams in certain locations, the wind fields may be represented by the following models :

a) For latitude zones; in addition, within each latitude zone data derived from actual observations are given for two selected stations, one with very strong winds and the other with very light winds (tables 1, 2, 3; figures 1 to 4).

b) For meridional cross-sections (tables 4, 5; figures 5 to 8) supplement the models and illustrate the global circulation over the northern hemisphere.

Specifically, models are presented for the following latitude zones and meridians :

1) tropical zone, 0 – 20° N (zone of the trade-wind circulation and easterly jet streams in the near-equatorial upper troposphere and stratosphere);

2) sub-tropical zone, 20 – 40° N (region of the strong westerly sub-tropical jet stream (at altitudes of 10 to 13 km);

3) temperate zone, 40 – 60° N (zone of strong cyclonic activity and maximum horizontal turbulent exchange);

4) polar zone, 60 – 80° N (zone of the polar-night stratospheric westerly jet stream of winter);

5) meridional cross-section along 140° E : this illustrates the circulation near the east Asian coastline of the Pacific Ocean, where the sub-tropical jet stream reaches its maximum intensity;

6) meridional cross-section along 80° E : this illustrates the circulation over the Siberian anticyclone in winter, the jet streams over Tibet, the monsoon circulation over India and the easterly jet stream over the northern parts of the Indian Ocean;

7) meridional cross-section along 20° E : the meridian crosses eastern Europe and central Africa, and the cross-section is characteristic of the area of cyclonic activity over Europe and the Mediterranean and of the sub-tropical jet stream over northern Africa;

8) meridional cross-section along 80° W : the meridian crosses the eastern regions of North America and the Caribbean Sea, and the profile illustrates the jet streams over the western Atlantic.

The values of the quantities describing the wind fields, obtained for the altitude range 0 to 25 km from actual observations and by estimation using the circular normal distribution, are presented for the above models for January and July.

The following quantities were obtained from the actual observations :

- mean zonal component of the wind, $\overline{V}_x$, and mean meridional component of the wind, $\overline{V}_y$;
- vector mean wind, $\vec{\overline{V}}_r$, magnitude of the vector mean wind, $\overline{V}_r$, and direction of the vector mean wind, θ; the scalar mean wind speed, $\overline{V}_s$';
- standard deviation of the vector mean wind, σ_r;
- maximum wind speed observed once in ten years, v_{max}.

The speeds equalled or exceeded on 1, 10, 20, 80, 90 and 99 % of occasions were calculated using the circular normal distribution. The scalar mean wind speed, $\overline{V}_s$, for each zone was both obtained from the actual observations, $\overline{V}_{sa}$, and calculated using the law of circular normal distribution, $\overline{V}_{sc}$.

For four meridional sections the mean speed $\overline{V}_s$ is given only based on actual observations — $\overline{V}_{sa}$.

4 Calculation of wind characteristics by use of the circular normal distribution

Wind is a vector. In a sample of a large number of winds observed over a long period of time, each individual vector is a stochastic, or random, value, and for estimating wind distributions, probability theory may be used. For the calculation of the characteristics, the circular normal distribution may be used, the probability density, $f(v)$, being given by the equation :

$$f(v) = \frac{2\,v}{\sigma_r^2} e^{-(v^2 + \overline{V}_r^2)/\sigma_r^2} \times I_o \left(\frac{2\,v\,\overline{V}_r}{\sigma_r^2} \right) \qquad \ldots (3)$$

where :

v is the wind speed;

$\overline{V}_r$ is the magnitude of the vector mean wind;

σ_r is the standard deviation of the vector mean wind;

$I_o(x)$ is the zero-order Bessel function of imaginary argument.

The circular normal distribution law may be regarded as valid for the four latitude zones, since $\sigma_x = \sigma_y = \sigma_r/\sqrt{2}$, taking into account that $\sigma_r = \sqrt{\sigma_x^2 + \sigma_y^2}$, with an accuracy acceptable for most practical purposes. In addition, for calculating the mean characteristics for latitude zones above 20° N, where $\overline{V}_y$ does not exceed 6 % of $\overline{V}_x$, and the absolute value is not more than 1 m/s, it is assumed that $\overline{V}_y = 0$, so that $\overline{V}_r = |\vec{V}_r| = |\overline{V}_x|$. This allows the basic parameters of the distribution for zones 20 – 40°, 40 – 60° and 60 – 80° N to be determined by $\overline{V}_x$ and σ_r only.

The values of wind speed which are likely to be equalled or exceeded on 1, 10, 20, 80, 90 and 99 % of occasions may be estimated from equation (3). The expected scalar mean speed, $\overline{V}_{sc}$ is given by equation (4) (mathematical expectation) :

$$\overline{V}_{sc} = \int_0^{\infty} f(v)\, V \mathrm{d}v \qquad \ldots (4)$$

The analysis of the scalar mean speed derived from observations, and calculated from the circular normal distribution for each zone confirms that the circular normal distribution may be used to calculate the values of wind speed with an accuracy sufficient for most practical purposes.

Table 1 — Parameters of the observed wind distribution in selected latitude zones, and calculated values of the scalar mean wind speed and of high and low percentile values of wind speed, in metres per second

0 – 20° N, January

Geopotential altitude H, km	Actual observations					Based on circular normal law of distribution						
	$\overline{V}_x$	$\overline{V}_y$	$\overline{V}_{sa}$	σ_r	v_{max}	$\overline{V}_{sc}$	1 %		10 %		20 %	
							low	high	low	high	low	high
0	−2,9	−1,6	5,5	3,0	—	3,1	—	—	—	—	—	—
1	−3,9	−1,2	7,6	5,9	—	6,0	1,0	14,7	3,0	11,0	3,0	9,0
2	−2,7	−0,7	7,2	6,4	—	6,2	1,0	15,2	3,0	10,7	3,0	8,8
3	−1,6	−0,3	7,2	7,0	60	6,3	1,0	16,0	3,0	11,0	3,0	9,0
4	−0,7	−0,2	7,7	7,7	59	7,0	1,0	17,0	2,8	11,6	3,3	9,7
5	0,2	−0,1	8,5	8,5	59	7,6	1,0	18,5	3,0	12,7	3,5	10,8
6	1,2	−0,1	9,6	9,4	61	8,5	1,0	20,7	3,0	14,3	4,3	12,2
7	2,9	0,0	10,9	10,5	67	9,7	1,4	23,5	3,4	16,4	5,0	13,8
8	4,8	0,2	12,3	11,6	76	11,0	1,7	26,5	4,0	18,8	6,2	15,8
9	6,8	0,4	13,7	12,7	80	12,6	2,0	30,3	4,5	21,7	7,4	18,0
10	8,9	1,0	15,4	13,7	78	14,3	2,0	34,5	5,5	25,0	8,5	20,8
11	10,5	2,2	17,2	14,9	73	15,9	2,0	38,2	6,5	27,5	9,4	23,2
12	11,5	2,9	18,8	15,9	70	16,9	2,0	40,5	7,0	29,5	9,8	25,8
13	11,2	2,8	18,6	15,7	73	16,5	1,7	40,2	6,5	28,7	9,4	25,0
14	9,7	2,3	16,9	14,5	85	15,0	1,4	37,7	5,7	26,0	8,3	22,5
15	8,0	1,8	15,1	13,4	94	13,7	1,2	34,0	5,0	23,5	7,3	20,3
16	6,1	0,9	13,6	12,4	100	12,2	1,0	29,8	4,5	21,2	6,5	18,0
17	4,6	0,4	12,1	11,5	96	10,9	1,0	25,6	4,0	19,0	5,9	16,0
18	3,3	0,3	10,8	10,8	82	10,0	1,0	23,2	3,6	17,4	5,5	14,3
19	1,9	0,2	9,7	10,1	65	9,3	1,0	22,0	3,4	16,2	5,2	13,0
20	0,7	0,1	8,7	9,7	54	8,7	1,0	21,3	3,2	15,4	5,0	12,3
21	−0,4	0,0	8,4	9,4	48	8,5	1,0	21,0	3,0	15,0	5,0	12,0
22	−1,3	−0,1	8,6	9,4	44	8,6	1,0	21,0	3,0	15,2	5,0	12,2
23	−2,1	−0,2	9,2	9,7	42	8,7	1,0	21,5	3,0	15,6	5,0	12,6
24	−2,9	−0,2	9,9	10,3	39	9,5	1,0	22,3	3,0	16,3	5,0	13,3
25	−3,5	−0,2	10,9	11,4	38	10,7	1,0	23,3	3,0	17,0	5,0	14,2

Table 1 — Parameters of the observed wind distribution in selected latitude zones, and calculated values of the scalar mean wind speed and of high and low percentile values of wind speed, in metres per second (*continued*)

0 – 20° N, July

Geopotential altitude H, km	Actual observations					Based on circular normal law of distribution						
	$\overline{V}_x$	$\overline{V}_y$	$\overline{V}_{sa}$	σ_r	v_{max}	$\overline{V}_{sc}$	1 % low	1 % high	10 % low	10 % high	20 % low	20 % high
0	– 0,6	0,2	5,2	3,4	—	3,0	—	—	—	—	—	—
1	– 1,4	0,3	7,8	7,0	—	6,4	1,0	15,8	2,3	12,0	4,0	10,0
2	– 2,2	0,2	7,9	7,4	—	6,8	1,0	16,4	2,5	12,0	4,0	10,0
3	– 2,8	–0,1	8,0	7,6	60	7,2	1,0	16,8	3,0	12,0	4,0	10,0
4	– 3,2	0,0	7,9	7,6	61	7,4	1,0	17,5	3,0	12,7	4,0	10,2
5	– 3,6	0,1	7,8	7,4	61	7,3	1,0	18,3	3,0	13,3	4,0	10,5
6	– 3,9	0,2	7,8	7,4	60	7,4	1,0	19,0	3,0	14,0	4,0	11,0
7	– 4,1	0,2	8,0	7,6	58	7,5	1,0	19,5	3,0	14,1	4,0	11,2
8	– 4,3	0,2	8,3	7,9	58	8,1	1,0	20,0	3,0	14,4	4,2	11,7
9	– 4,4	0,1	8,8	8,4	59	8,4	1,0	20,5	3,0	14,5	4,5	12,5
10	– 4,5	–0,1	10,2	9,4	61	9,2	1,0	22,0	3,2	15,8	5,2	14,0
11	– 4,8	–0,5	12,4	12,4	65	11,8	1,0	26,8	3,4	19,0	6,0	17,0
12	– 5,4	–0,8	13,6	14,0	69	13,4	1,1	31,2	4,7	22,3	6,7	19,5
13	– 6,5	–0,7	13,8	14,3	73	14,2	1,2	33,0	5,4	23,5	7,4	20,2
14	– 7,6	–0,3	13,7	14,0	76	13,7	1,4	33,5	5,7	24,0	7,8	20,1
15	– 8,8	0,0	13,6	13,5	79	15,0	1,6	33,5	6,0	24,0	8,0	20,0
16	– 9,9	0,2	13,4	12,8	80	15,5	1,8	33,2	6,0	24,0	8,2	20,0
17	–10,8	0,3	13,2	11,9	78	16,3	2,0	32,5	6,2	23,8	8,2	20,0
18	–11,6	0,3	14,0	10,8	70	15,4	2,3	31,5	6,5	23,4	8,5	20,0
19	–12,3	0,2	14,8	10,0	61	14,2	2,5	30,7	7,0	23,0	9,0	20,3
20	–13,1	0,2	15,7	9,6	53	13,7	2,8	30,0	7,5	22,8	9,5	20,6
21	–14,1	0,2	16,7	9,4	51	13,8	3,1	30,5	8,2	23,5	10,5	21,3
22	–15,2	0,3	17,9	9,9	51	14,7	3,5	32,4	8,9	25,0	11,3	22,7
23	–16,5	0,4	19,2	10,5	63	16,0	3,8	34,7	9,5	27,0	12,2	24,3
24	–17,8	0,7	20,5	11,1	70	17,4	4,0	37,3	10,0	29,0	13,0	27,3
25	–19,2	1,0	21,9	11,9	77	18,7	4,5	40,2	10,7	31,5	14,0	28,3

Table 1 — Parameters of the observed wind distribution in selected latitude zones, and calculated values of the scalar mean wind speed and of high and low percentile values of wind speed, in metres per second (*continued*)

20 – 40° N, January

Geopotential altitude H, km	Actual observations				Based on circular normal law of distribution						
	$\overline{V}_x$	$\overline{V}_{sa}$	σ_r	v_{max}	$\overline{V}_{sc}$	1 %		10 %		20 %	
						low	high	low	high	low	high
0	1,0	6,4	5,5	–	5,1	–	–	–	–	–	–
1	1,8	8,5	9,4	–	8,5	1,0	20,0	2,5	15,0	4,5	11,7
2	4,7	10,0	10,4	–	10,3	1,0	24,4	3,5	17,5	5,5	14,5
3	8,0	11,8	11,5	70	12,6	1,0	29,2	4,5	20,8	6,7	17,5
4	10,5	14,2	13,1	72	15,8	1,3	34,0	6,0	24,5	8,1	21,0
5	13,2	17,0	15,0	76	17,3	1,6	39,5	7,0	28,8	9,8	25,0
6	16,0	20,6	17,0	84	21,8	2,2	46,0	8,5	33,7	12,0	29,5
7	18,8	24,2	19,2	102	24,7	2,8	53,5	10,2	39,5	14,7	35,0
8	21,5	27,0	21,3	124	28,1	3,7	62,5	12,2	47,0	17,5	41,0
9	24,3	29,5	22,7	140	31,6	4,4	70,0	13,8	53,8	19,7	45,5
10	26,8	31,6	23,4	142	34,6	4,7	72,5	15,0	55,7	21,0	48,0
11	28,7	33,2	23,4	132	35,6	5,0	72,2	15,7	55,5	21,7	48,0
12	29,7	34,0	22,8	124	36,1	5,0	70,0	16,0	54,0	22,0	47,0
13	28,5	33,0	21,5	118	32,9	4,9	64,0	15,5	51,3	21,2	44,7
14	26,5	31,1	19,9	112	29,6	4,7	58,5	14,7	47,7	20,0	41,6
15	24,3	28,4	17,8	107	26,6	4,5	53,0	13,4	43,5	18,2	38,0
16	21,8	25,0	15,7	102	24,7	4,0	48,3	11,5	38,7	15,7	33,5
17	18,1	21,0	14,0	96	21,4	3,5	43,2	9,3	33,5	12,8	29,0
18	14,2	17,2	12,8	88	18,0	2,5	38,5	7,3	28,0	10,2	24,5
19	10,4	13,6	11,6	80	14,7	1,8	33,8	5,6	23,5	8,0	20,6
20	7,0	11,1	10,9	73	11,9	1,3	29,4	4,5	20,3	6,2	17,3
21	5,3	10,0	10,6	68	10,8	1,0	26,2	4,0	18,6	5,4	15,7
22	4,4	9,6	10,8	65	10,6	1,0	25,4	3,8	18,2	5,4	15,2
23	3,5	9,4	11,1	62	10,5	1,0	25,0	3,8	18,0	5,6	15,0
24	2,9	9,6	11,6	60	10,8	1,0	25,0	4,1	18,0	6,1	15,0
25	2,3	9,8	12,4	60	11,3	1,4	25,0	4,5	18,3	6,7	15,0

Table 1 — Parameters of the observed wind distribution in selected latitude zones, and calculated values of the scalar mean wind speed and of high and low percentile values of wind speed, in metres per second (*continued*)

20 – 40° N, July

Geopotential altitude H, km	Actual observations				Based on circular normal law of distribution						
	$\overline{V}_x$	$\overline{V}_{sa}$	σ_r	v_{max}	$\overline{V}_{sc}$	1 %		10 %		20 %	
						low	high	low	high	low	high
0	– 0,3	4,9	5,0	—	4,5	—	—	—	—	—	—
1	0,5	6,9	7,4	—	6,7	1,0	15,5	2,2	11,7	4,0	9,8
2	0,9	7,2	7,8	—	7,1	1,0	16,5	2,5	12,2	4,0	10,3
3	1,4	7,5	8,1	61	7,4	1,0	17,7	2,9	12,7	4,0	10,8
4	2,1	8,0	8,4	58	7,7	1,0	18,8	3,0	13,5	4,3	11,3
5	2,7	8,5	8,7	58	8,2	1,0	19,8	3,0	14,0	4,5	11,7
6	3,3	9,3	9,2	62	8,7	1,0	21,2	3,1	15,0	5,0	12,3
7	4,5	10,3	9,8	70	9,5	1,0	23,5	3,5	16,8	5,4	13,7
8	5,6	11,6	10,8	79	10,6	1,0	26,5	4,0	19,0	5,9	15,6
9	6,6	13,0	12,1	87	12,2	1,0	29,7	4,5	21,3	6,5	17,6
10	7,3	14,3	13,7	93	13,8	1,2	33,0	5,0	23,6	7,2	19,5
11	7,8	15,2	15,6	96	15,7	1,5	36,2	5,5	25,8	8,5	21,8
12	8,0	15,7	16,5	92	16,7	1,8	38,6	6,0	27,8	9,0	23,6
13	7,3	15,5	16,4	88	16,1	1,6	38,5	5,7	27,3	8,5	23,5
14	5,3	14,3	15,3	87	14,4	1,5	34,5	5,0	24,0	7,3	20,0
15	3,0	12,8	14,0	89	12,8	1,2	30,3	4,5	20,7	6,0	17,0
16	0,8	11,8	12,4	91	11,2	1,0	26,5	4,3	18,0	5,2	14,7
17	– 1,8	11,6	10,7	88	9,8	1,0	23,2	4,2	16,7	5,0	13,8
18	– 4,4	11,9	9,4	79	8,9	1,1	22,4	4,5	16,5	5,5	14,0
19	– 6,7	12,4	8,4	70	8,6	1,3	22,5	4,7	16,7	6,2	14,4
20	– 8,8	13,0	7,8	64	8,8	1,5	23,0	5,2	17,2	7,0	15,0
21	– 10,5	13,7	7,5	60	9,4	2,0	24,0	6,0	18,0	8,5	16,0
22	– 11,9	14,7	7,6	62	10,5	2,3	25,5	6,7	19,3	9,0	17,2
23	– 13,1	15,7	7,8	65	11,1	2,6	27,0	7,7	21,0	10,0	18,9
24	– 14,3	16,9	8,2	69	12,2	3,0	28,7	8,9	22,6	11,0	20,7
25	– 15,4	18,2	8,8	74	13,1	3,2	30,5	10,2	24,5	12,0	22,5

Table 1 — Parameters of the observed wind distribution in selected latitude zones, and calculated values of the scalar mean wind speed and of high and low percentile values of wind speed, in metres per second (*continued*)

40 – 60° N, January

Geopotential altitude H, km	Actual observations				Based on circular normal law of distribution						
	$\overline{V}_x$	$\overline{V}_{sa}$	σ_r	v_{max}	$\overline{V}_{sc}$	1 %		10 %		20 %	
						low	high	low	high	low	high
0	1,2	6,2	8,9	—	8,2	—	—	—	—	—	—
1	3,4	10,2	11,8	—	10,8	1,0	26,0	4,0	18,5	6,0	15,2
2	5,3	11,5	12,7	—	12,5	1,0	28,8	4,3	20,5	6,5	17,2
3	7,1	13,2	13,8	77	14,2	1,0	32,3	5,0	23,0	7,2	19,5
4	8,8	15,1	15,4	88	16,0	1,5	36,5	5,7	26,4	8,1	22,3
5	10,2	17,2	17,2	97	18,0	2,0	41,5	6,7	30,4	9,5	25,5
6	11,5	19,5	19,3	101	20,2	2,3	47,4	7,5	34,5	10,8	29,5
7	12,7	21,8	21,2	102	22,2	2,6	53,0	8,3	38,0	12,3	32,5
8	14,0	23,7	23,0	101	24,1	3,0	57,5	8,7	40,8	13,5	35,0
9	15,1	24,8	23,8	99	25,2	3,0	59,0	9,1	42,0	14,0	36,0
10	16,2	24,5	22,2	98	24,0	3,0	57,5	9,4	41,2	14,0	35,3
11	17,0	23,9	20,7	100	23,9	3,0	55,3	9,2	39,7	13,5	34,5
12	17,4	23,1	19,4	99	23,9	3,0	52,7	9,0	38,0	12,7	33,5
13	17,6	22,3	18,1	96	23,8	3,2	50,3	9,2	37,1	12,5	32,5
14	17,6	21,4	17,0	93	23,5	3,2	48,0	9,3	35,2	12,4	31,3
15	17,3	20,6	16,1	91	23,4	3,1	45,7	9,2	34,0	12,3	30,1
16	16,7	19,9	15,3	89	22,1	3,0	44,0	9,0	33,0	12,0	28,7
17	16,0	19,4	14,8	88	20,7	2,5	43,0	8,6	32,3	11,5	27,7
18	15,5	19,0	14,6	89	20,1	2,3	42,5	8,2	31,8	11,2	27,0
19	15,0	18,9	14,9	90	19,7	2,0	42,5	8,0	31,5	11,0	26,8
20	14,6	19,0	15,5	91	17,6	2,0	42,8	8,0	32,0	11,0	27,0
21	14,5	19,5	16,5	93	20,0	2,2	44,4	8,1	32,7	11,0	27,5
22	14,7	20,3	17,5	96	20,7	2,5	46,7	8,4	34,4	11,2	29,0
23	15,1	21,4	18,9	99	22,0	2,8	49,5	8,8	36,2	11,6	31,0
24	15,6	23,0	20,4	103	23,0	3,3	52,5	9,2	38,3	12,2	33,0
25	16,1	24,8	22,2	107	24,0	3,8	55,5	9,7	40,5	12,8	35,5

Table 1 — Parameters of the observed wind distribution in selected latitude zones, and calculated values of the scalar mean wind speed and of high and low percentile values of wind speed, in metres per second (*continued*)

40 – 60° N, July

Geopotential altitude H, km	Actual observations				Based on circular normal law of distribution						
	$\overline{V}_x$	$\overline{V}_{sa}$	σ_r	v_{max}	$\overline{V}_{sc}$	1 %		10 %		20 %	
						low	high	low	high	low	high
0	0,8	4,5	6,0	—	5,5	—	—	—	—	—	—
1	1,8	7,5	8,4	—	7,6	1,0	18,5	3,0	13,5	3,6	10,5
2	2,9	8,0	8,9	—	8,4	1,0	19,5	3,0	14,5	4,2	11,4
3	4,1	8,9	9,5	70	9,3	0,9	20,8	3,0	15,9	5,0	12,7
4	5,3	10,0	10,2	69	10,4	0,8	23,2	3,7	17,5	5,7	14,4
5	6,5	11,4	11,1	69	11,5	0,8	26,5	4,5	19,5	6,5	16,4
6	7,8	13,1	12,6	70	13,3	1,0	31,5	5,0	21,8	7,3	18,5
7	9,0	15,4	14,4	73	15,0	1,2	36,7	5,5	25,0	8,2	21,2
8	10,5	17,5	16,2	76	16,8	1,5	41,3	6,0	28,5	9,3	24,0
9	11,5	19,0	17,9	79	18,9	1,9	45,0	6,5	31,5	10,4	26,6
10	12,7	20,0	18,8	82	20,6	2,0	47,0	7,5	33,8	11,5	28,5
11	13,6	20,3	18,8	83	21,3	2,0	47,5	8,0	34,5	12,0	29,4
12	14,3	20,3	18,1	81	20,9	2,0	47,0	8,0	33,8	11,9	29,0
13	14,0	18,0	16,5	80	21,4	1,7	43,5	7,2	31,5	10,5	27,0
14	12,0	15,0	14,2	83	18,9	1,5	37,2	6,3	27,0	8,8	22,8
15	9,0	12,0	12,0	86	14,8	1,2	31,0	5,4	22,0	7,2	18,5
16	6,0	9,8	10,2	89	11,0	1,1	25,5	4,5	18,5	5,8	15,5
17	4,0	8,4	9,0	88	8,9	1,0	21,5	3,7	16,0	4,7	13,2
18	2,2	7,8	8,2	79	7,6	1,0	19,2	3,3	14,4	4,3	11,8
19	0,1	7,2	7,6	70	6,8	1,0	17,6	3,0	13,3	4,0	10,7
20	−1,8	6,8	7,2	63	6,7	1,0	16,8	3,0	12,5	4,0	10,1
21	−3,1	6,8	7,2	60	7,2	1,0	16,8	3,0	12,0	4,0	10,0
22	−4,5	7,2	7,3	62	7,9	1,0	17,5	3,1	12,5	4,3	10,7
23	−5,5	7,8	7,4	66	8,6	1,0	18,5	3,4	13,5	4,5	11,5
24	−6,5	8,9	7,4	68	8,9	1,0	19,6	3,8	14,5	4,9	12,5
25	−7,2	10,4	7,5	72	8,6	1,0	21,0	4,2	15,8	5,5	14,0

Table 1 — Parameters of the observed wind distribution in selected latitude zones, and calculated values of the scalar mean wind speed and of high and low percentile values of wind speed, in metres per second (*continued*)

60 – 80° N, January

Geopotential altitude H, km	Actual observations				Based on circular normal law of distribution						
						1 %		10 %		20 %	
	$\overline{V}_x$	$\overline{V}_{sa}$	σ_r	v_{max}	$\overline{V}_{sc}$	low	high	low	high	low	high
0	0,0	5,3	7,3	—	6,8	—	—	—	—	—	—
1	1,6	8,8	10,3	—	9,4	1,0	22,5	3,0	15,5	5,0	13,8
2	2,5	10,6	11,4	—	10,4	1,0	24,5	3,5	17,2	5,3	14,6
3	3,5	12,2	12,6	84	11,6	1,0	27,5	4,2	19,5	6,0	16,5
4	4,8	13,8	14,3	93	13,5	1,4	31,4	5,0	23,0	7,0	19,0
5	5,7	15,2	16,4	100	15,5	1,8	36,0	5,8	26,5	7,8	21,6
6	6,3	16,6	18,1	102	17,0	2,0	39,8	6,5	29,0	8,2	24,0
7	6,9	17,8	19,6	101	18,5	2,0	43,0	6,8	31,0	9,4	26,0
8	7,5	19,0	20,5	100	19,4	2,0	45,3	7,0	32,6	9,8	27,5
9	8,0	19,0	20,0	99	19,3	2,0	45,4	7,0	32,3	10,0	27,3
10	8,7	17,8	18,7	98	18,5	2,0	43,5	7,0	31,0	9,7	26,0
11	9,4	17,0	17,6	100	18,1	2,0	42,4	7,0	30,2	9,0	25,1
12	10,1	17,0	16,9	102	17,7	2,0	41,8	6,9	30,0	9,2	25,0
13	10,9	17,2	16,5	102	18,0	2,0	41,7	6,8	30,3	9,7	25,1
14	11,9	17,8	16,3	102	18,4	2,0	41,8	6,9	30,8	10,2	25,5
15	12,9	18,6	16,4	101	18,7	2,0	42,5	7,0	31,5	10,6	26,5
16	14,0	19,6	16,7	98	19,4	2,1	44,0	7,3	32,7	11,3	27,5
17	15,5	21,0	17,3	94	20,9	2,3	46,0	8,0	34,3	12,0	28,8
18	17,0	22,6	18,0	91	22,2	2,5	48,8	8,6	36,5	13,0	30,5
19	18,7	24,4	19,0	90	23,8	2,7	52,4	9,5	39,0	14,0	33,0
20	20,5	26,4	20,3	94	25,8	3,0	56,5	10,4	42,0	15,4	36,0
21	22,5	28,6	22,2	99	28,8	3,4	61,3	11,3	46,0	16,5	39,2
22	24,4	31,0	24,0	106	31,1	3,7	67,0	12,2	50,0	18,0	43,0
23	26,0	34,0	26,0	112	32,6	4,1	72,8	13,3	54,5	19,5	47,5
24	27,5	37,0	28,0	119	34,0	4,5	79,4	14,3	59,5	21,0	52,0
25	28,8	40,4	30,0	126	35,0	5,0	86,0	15,5	65,0	22,5	57,0

Table 1 — Parameters of the observed wind distribution in selected latitude zones, and calculated values of the scalar mean wind speed and of high and low percentile values of wind speed, in metres per second (*concluded*)

60 – 80° N, July

Geopotential altitude H, km	Actual observations				Based on circular normal law of distribution						
	$\overline{V}_x$	$\overline{V}_{sa}$	σ_r	v_{max}	$\overline{V}_{sc}$	1 %		10 %		20 %	
						low	high	low	high	low	high
0	0,2	4,4	5,0	—	4,6	—	—	—	—	—	—
1	0,6	6,8	7,6	—	7,1	1,0	16,0	3,0	11,3	3,7	9,5
2	1,6	7,5	8,4	—	7,6	1,0	18,5	3,0	13,1	4,5	10,6
3	2,4	8,4	9,3	61	8,6	1,0	21,0	3,1	15,0	5,0	12,1
4	3,0	9,5	10,5	64	9,8	1,0	23,5	3,4	17,0	5,3	14,0
5	3,6	10,8	11,6	67	11,1	1,0	26,0	3,7	19,0	5,7	16,0
6	4,5	12,3	13,7	74	12,9	1,0	28,5	4,1	21,5	6,3	18,5
7	5,3	14,0	15,9	85	15,0	1,2	32,5	4,7	24,4	7,0	21,5
8	6,1	15,9	17,7	99	16,7	1,6	37,5	5,3	27,9	8,0	24,0
9	6,5	17,1	18,6	109	17,6	2,0	41,0	5,9	30,0	8,8	25,0
10	6,7	16,7	17,9	107	17,0	1,6	39,6	5,7	27,5	8,4	23,2
11	6,5	14,9	15,6	96	15,2	1,2	35,5	5,5	23,6	7,5	20,2
12	6,0	12,3	12,5	83	12,4	1,0	29,2	4,7	20,6	6,7	17,5
13	5,2	10,3	10,5	76	10,5	1,0	25,0	4,0	18,0	5,7	15,2
14	4,3	8,7	8,9	71	8,9	1,0	21,5	3,5	15,5	4,7	13,0
15	3,4	7,3	7,8	65	7,7	1,0	18,5	2,7	13,5	4,0	11,3
16	2,5	6,3	7,0	61	6,8	1,0	15,8	2,2	11,7	3,2	9,6
17	1,5	5,6	6,4	59	5,9	1,0	14,1	2,0	10,4	2,7	8,5
18	0,6	5,2	5,9	58	5,3	1,0	13,0	2,0	9,5	2,6	7,6
19	−0,3	4,9	5,6	60	5,1	1,0	12,4	1,9	9,1	2,6	7,1
20	−1,3	4,8	5,3	60	4,9	1,0	12,0	1,9	9,0	2,7	6,9
21	−2,2	4,8	5,2	60	5,2	1,0	12,0	2,0	9,0	3,0	7,0
22	−3,0	5,1	5,0	57	5,3	1,0	12,3	2,0	9,1	3,0	7,4
23	−3,6	5,5	5,0	54	5,6	1,0	12,9	2,0	9,4	3,0	7,9
24	−4,3	6,1	5,0	50	5,9	1,0	13,6	2,0	9,6	3,0	8,5
25	−4,8	6,9	5,1	47	6,0	1,0	14,5	2,0	10,0	3,0	9,3

Table 2 — Parameters of the observed wind distributions at four stations with strong winds, m/s

January

Station	H, km	$\overline{V}_s$	$\overline{V}_x$	$\overline{V}_y$	v_{max}	σ_x	σ_y
Dakar φ = 14°44′ N λ = 17°30′ W h = 23 m	Surface	3,2	− 1,0	− 1,5	—	—	—
	2	5,7	− 1,5	− 0,2	48	5,8	4,0
	4	7,0	2,3	1,3	50	6,3	5,2
	6	10,5	7,4	2,3	30	6,3	6,3
	8	17,9	15,2	3,1	52	7,6	8,0
	10	25,3	22,8	3,2	72	9,8	10,1
	12	33,0	30,4	1,6	72	12,4	11,4
	14	28,3	26,0	2,4	67	11,7	10,9
	16	20,7	18,5	3,4	58	10,0	9,0
	18	14,2	10,9	2,4	45	9,5	6,8
	20	9,9	3,2	1,0	31	9,4	5,2
	22	9,2	− 1,0	0,5	22	9,6	4,8
	24	10,7	− 2,0	0,5	20	10,3	5,8
	25	11,6	− 2,2	− 0,5	19	10,8	6,6
Kagoshima φ = 31°38′ N λ = 130°36′ E h = 280 m	Surface	6,5	0,5	− 3,1	—	—	—
	2	13,4	11,2	− 3,4	31	6,4	6,7
	4	23,6	22,4	− 1,1	52	8,3	7,4
	6	35,5	33,6	0,9	72	10,9	9,1
	8	57,4	53,6	4,8	113	13,5	12,8
	10	70,0	68,2	9,0	124	15,5	15,2
	12	67,4	65,2	10,6	99	16,6	14,3
	14	59,6	57,2	9,3	104	15,3	11,6
	16	47,2	45,6	6,2	102	13,3	8,2
	18	29,0	26,0	3,2	84	11,0	6,9
	20	13,6	11,0	1,8	62	9,4	6,4
	22	10,5	3,6	0,9	52	10,0	5,8
	24	9,3	− 0,8	0,4	48	11,4	5,1
	25	9,0	− 2,4	0,4	46	12,4	4,8

Table 2 — Parameters of the observed wind distributions at four stations with strong winds, m/s (*concluded*)

January

Station	H, km	$\overline{V}_s$	$\overline{V}_x$	$\overline{V}_y$	v_{max}	σ_x	σ_y
New York φ = 40°39′ N λ = 73°47′ W h = 7 m	Surface	3,7	3,3	−1,6	—	—	—
	2	15,8	12,0	−2,1	44	8,4	9,5
	4	23,3	19,5	−0,5	55	11,4	12,0
	6	31,0	26,5	0,0	74	15,2	15,6
	8	38,1	32,8	−0,1	89	18,8	18,5
	10	42,8	38,3	−0,1	92	19,2	18,8
	12	39,8	36,2	0,2	82	16,4	16,3
	14	33,5	32,1	0,2	69	12,9	12,5
	16	27,4	26,0	0,1	55	9,5	8,6
	18	21,2	20,4	0,8	42	7,5	5,3
	20	14,8	14,4	1,5	37	6,7	3,7
	22	13,1	12,3	2,2	37	7,1	3,6
	24	13,3	12,5	2,8	40	8,1	4,8
	25	13,7	12,8	3,1	41	8,8	5,6
Jan Mayen φ = 70°57′ N λ = 8°40′ W h = 9 m	Surface	8,5	1,2	−2,0	—	—	—
	2	12,1	4,2	−0,1	48	9,1	10,3
	4	14,6	7,1	−1,0	76	11,3	11,7
	6	19,2	9,9	−2,8	94	14,0	14,7
	8	24,0	13,2	−4,7	94	17,2	17,9
	10	23,5	14,3	−4,6	95	18,3	17,9
	12	22,8	15,6	−4,2	95	16,4	16,5
	14	24,2	18,5	−4,7	94	15,6	15,6
	16	25,8	19,8	−5,2	87	16,1	14,4
	18	26,8	19,5	−4,0	74	18,4	12,3
	20	27,2	18,3	−2,0	69	21,3	9,5
	22	—	—	—	—	—	—
	24	—	—	—	—	—	—
	25	—	—	—	—	—	—

Table 3 — Parameters of the observed wind distributions at four stations with light winds, m/s

January

Station	H, km	$\overline{V}_s$	$\overline{V}_x$	$\overline{V}_y$	v_{max}	σ_x	σ_y
Guam φ = 13°33′ N λ = 144°50′ E h = 111 m	Surface	6,2	−5,0	−3,0	—	—	—
	2	8,8	−7,5	−0,6	34	4,8	3,9
	4	7,8	−5,7	0,4	34	5,0	4,4
	6	7,8	−5,0	1,8	27	4,9	4,8
	8	6,9	−3,4	1,6	24	5,2	4,5
	10	6,3	−1,5	1,3	24	5,5	4,5
	12	7,3	0,0	3,9	27	5,2	5,1
	14	8,2	−2,3	5,0	58	5,2	5,7
	16	9,2	−5,0	5,2	73	5,3	5,9
	18	8,2	−4,0	3,1	63	5,6	4,6
	20	6,3	−1,5	0,5	48	6,1	3,1
	22	7,1	−3,1	0,1	39	7,1	2,6
	24	9,3	−6,5	0,2	33	8,6	2,9
	25	10,3	−8,1	0,3	30	9,6	3,1
Ajan φ = 56°27′ N λ = 138°09′ E h = 304 m	Surface	1,9	0,3	0,1	—	—	—
	2	7,5	−0,2	−4,7	29	4,6	5,5
	4	8,8	−0,4	−3,2	30	6,6	6,8
	6	10,6	0,0	−2,3	36	8,5	8,4
	8	11,8	0,4	−0,6	40	10,4	9,5
	10	11,0	1,3	0,5	40	9,8	8,4
	12	9,6	3,5	1,4	38	8,3	6,6
	14	11,2	5,7	2,9	44	8,6	6,8
	16	13,0	7,6	4,8	50	9,3	7,2
	18	15,0	8,4	6,9	50	10,3	7,7
	20	17,0	8,6	9,3	48	11,5	8,5
	22	19,3	9,6	10,8	51	13,3	9,9
	24	22,8	12,9	11,6	60	16,0	11,6
	25	25,0	15,2	11,9	66	17,8	12,5

Table 3 — Parameters of the observed wind distributions at four stations with light winds, m/s (*concluded*)

July

Station	H, km	$\overline{V}_s$	$\overline{V}_x$	$\overline{V}_y$	v_{max}	σ_x	σ_y
Muharraq $\varphi = 26°16'$ N $\lambda = 50°37'$ E $h = 2$ m	Surface	—	—	—	—	—	—
	2	9,2	2,8	−6,0	30	4,8	5,8
	4	6,8	− 0,7	−1,6	33	5,3	5,6
	6	6,8	− 3,4	−0,4	31	5,3	5,5
	8	7,2	− 4,6	−0,4	40	5,5	4,8
	10	8,1	− 5,9	−0,3	46	6,1	4,5
	12	9,9	− 7,7	0,7	47	6,6	4,9
	14	13,0	−10,9	1,6	49	7,2	5,6
	16	16,5	−14,9	2,1	53	7,6	6,4
	18	18,2	−16,4	1,6	57	7,5	7,0
	20	18,3	−16,4	0,3	58	6,6	7,4
	22	18,8	−16,9	0,1	51	6,1	6,9
	24	20,3	−18,9	0,3	32	6,1	5,7
	25	21,1	−19,9	0,4	26	6,1	5,0
Clyde $\varphi = 70°27'$ N $\lambda = 68°33'$ W $h = 0$ m	Surface	4,1	− 0,3	−1,0	—	—	—
	2	6,0	1,0	0,3	31	4,9	5,3
	4	8,1	1,9	0,9	43	6,1	7,0
	6	10,2	2,6	1,3	47	8,0	8,3
	8	12,3	3,0	1,3	46	10,6	9,7
	10	11,2	3,1	1,1	37	8,8	9,0
	12	7,3	2,7	0,9	25	5,4	5,9
	14	5,2	1,6	0,7	18	4,1	4,3
	16	4,0	0,5	0,4	12	3,3	3,4
	18	3,6	− 0,5	0,4	9	2,8	3,1
	20	3,8	− 1,6	0,4	9	2,6	2,9
	22	4,4	− 2,7	0,5	11	2,7	2,9
	24	5,5	− 4,1	0,4	15	3,2	3,0
	25	6,1	− 4,9	0,3	17	3,4	3,0

Table 4 — Parameters of the observed wind distributions at selected meridians

140° E, January

Geopotential altitude H, km	$\varphi = 0°$				$\varphi = 10°$				$\varphi = 20°$				$\varphi = 30°$				$\varphi = 40°$			
	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*
0	30	18	351	—	55	37	59	—	67	53	50	—	80	37	305	—	—	36	304	—
1	57	15	53	74	87	65	79	62	70	32	49	64	107	75	278	84	100	73	285	93
2	73	24	83	70	100	75	84	64	73	12	340	70	141	120	271	92	135	108	281	107
3	80	32	90	66	98	64	86	67	80	44	274	76	185	170	269	100	170	137	280	121
4	80	38	92	66	97	66	89	72	110	80	266	91	255	238	267	113	210	173	275	141
5	78	45	93	66	95	71	93	77	142	116	263	108	322	309	266	125	248	209	272	161
6	80	52	93	66	92	74	96	81	177	149	261	123	396	374	265	139	282	246	270	177
7	89	67	95	65	92	72	99	81	201	166	261	126	464	434	264	156	310	283	268	191
8	98	81	96	65	90	68	102	80	227	183	260	129	530	495	263	174	343	322	266	205
9	108	95	96	65	88	65	104	80	252	200	260	131	600	555	262	191	375	354	265	214
10	118	106	98	68	88	63	109	81	280	219	259	134	640	586	262	205	396	366	264	208
11	130	107	104	79	88	66	118	85	300	240	259	137	650	600	262	218	404	378	263	202
12	141	108	109	90	90	71	125	90	306	261	259	140	638	616	262	231	390	374	263	192
13	150	111	108	94	92	78	125	91	285	256	258	137	588	572	262	214	372	359	263	179
14	155	113	104	95	100	86	121	90	256	231	256	129	540	524	262	194	354	343	263	166
15	160	115	101	95	110	95	118	88	228	208	255	122	490	475	261	175	336	328	263	153
16	158	119	97	95	125	103	115	86	200	183	252	114	440	427	261	155	317	310	263	141
17	150	111	95	97	130	99	113	86	170	153	250	108	380	363	261	143	278	265	261	139
18	138	89	95	100	120	77	114	86	138	116	249	104	310	291	260	133	240	222	259	137
19	127	68	96	104	98	55	113	86	108	78	246	100	243	219	259	124	200	178	256	136
20	116	47	96	107	85	34	114	86	78	40	237	96	175	146	257	115	162	135	251	134
21	108	42	95	111	82	28	107	88	56	16	200	93	123	91	252	108	133	106	246	133
22	108	58	94	115	84	47	97	94	50	16	134	89	106	56	247	105	121	85	240	133
23	114	74	94	119	92	66	93	100	52	30	105	86	95	24	225	101	111	66	232	134
24	122	90	93	124	102	86	92	106	58	46	95	82	90	21	124	97	107	48	217	134
25	134	106	93	128	116	105	90	112	68	63	91	79	90	52	97	94	105	38	190	134

* The $\overline{V}_{sa}$, $\overline{V}_r$ and σ_r, in metres per second, are multiplied by 10.

** The Θ values are given in degrees.

Table 4 — Parameters of the observed wind distributions at selected meridians (*continued*)

140° E, January

Geopotential altitude H, km	φ = 50°				φ = 60°				φ = 70°				φ = 80°		
	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**
0	—	—	—	—	—	—	—	—	—	—	—	—	45	11	225
1	93	47	329	84	57	11	5	61	72	8	230	84	73	22	77
2	104	58	324	97	72	29	15	71	82	17	200	95	91	23	165
3	109	55	311	110	80	24	19	84	91	23	187	107	105	32	192
4	120	56	300	124	93	15	37	106	105	36	193	122	117	38	208
5	135	61	290	138	113	10	84	127	127	49	196	138	130	48	217
6	149	68	283	146	123	9	126	134	142	57	194	148	140	50	216
7	160	75	277	153	125	11	158	139	153	64	191	158	148	50	212
8	167	83	272	160	122	15	177	145	160	73	188	167	155	51	210
9	167	93	269	158	112	23	189	138	160	79	192	162	160	59	211
10	160	103	267	147	105	36	197	123	151	86	200	147	162	73	213
11	153	114	265	136	102	48	202	108	140	93	206	132	162	86	215
12	154	121	262	135	110	60	212	111	140	110	212	135	158	87	216
13	158	128	260	135	120	72	218	114	149	127	217	139	155	88	218
14	167	134	258	134	132	85	223	117	165	145	221	143	153	90	219
15	174	141	256	134	149	99	227	120	190	163	224	146	153	90	221
16	179	143	253	136	164	115	227	129	225	189	225	159	159	101	225
17	178	140	249	139	176	134	226	141	257	217	226	176	170	116	230
18	175	137	244	142	188	152	225	153	280	246	226	193	194	131	233
19	170	135	240	146	200	170	224	166	300	274	226	211	215	147	235
20	168	134	235	149	213	189	224	177	311	291	226	229	250	157	231
21	163	133	231	151	227	203	223	166	313	279	222	251	273	166	219
22	162	132	226	153	242	219	223	156	313	268	218	272	295	181	209
23	165	133	221	154	257	234	222	146	312	259	213	294	318	202	200
24	170	134	216	155	279	246	222	136	308	251	208	316	343	225	193
25	178	136	211	157	286	264	222	126	310	246	203	337	359	252	188

* The $\overline{V}_{sa}$, $\overline{V}_r$ and σ_r, in metres per second, are multiplied by 10.

** The Θ values are given in degrees.

Table 4 — Parameters of the observed wind distributions at selected meridians (*continued*)

140° E, July

Geopotential altitude H, km	φ = 0°				φ = 10°				φ = 20°				φ = 30°				φ = 40°			
	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*
0	35	9	238	—	43	6	218	—	52	28	132	—	40	22	193	—	—	—	—	—
1	50	6	211	56	60	10	114	75	80	26	129	77	64	18	270	86	65	38	235	76
2	60	8	145	65	70	20	101	74	87	26	118	74	76	26	286	84	86	60	255	79
3	65	18	106	74	73	29	100	72	73	31	103	71	78	28	270	82	98	74	269	83
4	72	26	101	75	77	36	101	74	77	33	101	74	80	29	272	83	115	89	273	88
5	80	33	99	74	80	42	101	77	78	34	98	77	81	29	278	85	132	105	274	93
6	84	40	97	73	86	47	102	79	82	35	98	80	84	30	285	88	148	122	276	101
7	85	49	96	74	83	50	100	77	80	32	94	80	85	27	298	94	170	139	276	121
8	85	58	95	74	81	52	98	75	78	30	88	80	88	27	315	99	194	155	277	140
9	86	66	94	75	79	54	96	73	77	28	84	79	91	28	330	105	216	171	277	160
10	90	74	92	79	81	56	93	76	79	31	75	83	96	30	345	113	240	189	278	179
11	100	78	89	88	90	58	85	89	97	47	69	96	107	31	360	127	264	207	281	199
12	110	82	84	98	100	60	78	101	117	64	65	109	116	35	13	140	278	225	283	219
13	118	78	83	98	105	66	77	102	130	81	66	110	120	42	28	141	264	212	285	211
14	99	65	84	92	104	73	77	94	136	99	69	101	119	55	41	128	234	180	286	186
15	76	53	85	85	103	81	78	87	145	116	70	92	117	69	47	116	198	149	289	162
16	68	41	86	79	102	88	78	79	152	134	72	83	116	85	52	104	160	119	293	137
17	73	35	87	79	100	98	80	75	158	147	74	76	114	96	51	92	123	87	300	116
18	82	36	88	85	119	115	82	77	169	153	78	73	114	100	66	81	102	55	312	103
19	90	36	90	92	136	132	85	79	177	161	82	69	114	106	74	69	86	32	349	90
20	100	37	92	98	154	148	86	81	188	168	86	65	120	113	81	58	77	38	50	77
21	110	49	93	106	170	165	88	85	196	178	89	63	130	123	86	48	80	66	74	64
22	120	84	93	115	186	183	89	95	203	192	90	69	147	133	88	49	96	80	80	66
23	132	119	92	124	202	201	90	105	210	205	91	75	162	144	89	51	114	93	85	68
24	149	148	92	133	220	219	90	115	220	219	91	81	178	154	90	53	130	108	88	70
25	172	171	92	141	240	238	91	126	235	233	92	88	195	165	91	55	148	122	90	72

* The $\overline{V}_{sa}$, $\overline{V}_r$ and σ_r, in metres per second, are multiplied by 10.

** The Θ values are given in degrees.

Table 4 — Parameters of the observed wind distributions at selected meridians *(continued)*

140° E, July

Geopotential altitude H, km	$\varphi = 50°$				$\varphi = 60°$				$\varphi = 70°$				$\varphi = 80°$		
	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**
0	—	—	—	—	—	—	—	—	—	—	—	—	55	11	235
1	66	10	233	71	—	4	315	73	60	7	286	70	73	20	260
2	77	21	253	82	64	7	304	79	72	20	288	80	76	31	268
3	86	31	272	92	75	17	287	85	81	31	285	89	79	43	271
4	96	41	276	100	88	24	289	99	92	45	282	107	105	58	270
5	109	52	279	107	100	32	288	113	108	58	280	125	132	73	269
6	122	63	281	119	112	40	289	128	129	70	279	145	165	80	269
7	140	75	283	138	130	50	290	145	151	80	280	169	183	79	269
8	159	88	285	158	149	59	290	163	167	91	281	192	185	79	269
9	180	100	286	178	164	69	290	180	172	101	281	216	177	78	269
10	207	115	285	190	171	74	290	179	168	95	283	195	150	67	268
11	220	133	284	196	168	77	289	167	155	87	284	161	119	55	268
12	218	150	282	202	155	80	288	156	125	77	287	130	92	44	267
13	193	136	284	183	135	68	290	136	103	66	290	118	74	39	267
14	164	115	286	159	115	56	291	116	89	55	292	106	60	35	267
15	135	96	289	136	95	44	294	97	78	44	298	94	50	30	266
16	109	77	293	112	76	32	298	77	69	34	306	83	42	25	265
17	86	58	300	96	59	21	311	64	63	26	320	74	39	20	267
18	75	37	311	90	49	14	348	61	60	21	344	68	39	13	274
19	71	21	344	85	47	17	31	58	60	22	13	63	40	7	286
20	71	23	45	79	51	26	55	55	60	26	36	57	40	4	360
21	72	41	72	74	56	36	66	52	62	33	51	51	40	9	49
22	82	53	78	76	67	46	72	53	66	41	62	52	43	14	58
23	94	65	80	78	75	57	75	55	70	48	69	53	46	19	61
24	106	77	82	81	84	67	78	58	76	56	74	53	48	24	63
25	120	90	84	84	92	77	80	60	83	65	78	54	51	29	64

* The $\overline{V}_{sa}$, $\overline{V}_r$ and σ_r, in metres per second, are multiplied by 10.

** The Θ values are given in degrees.

Table 4 — Parameters of the observed wind distributions at selected meridians *(continued)*

80° E, January

Geopotential altitude H, km	$\varphi = 0°$				$\varphi = 10°$				$\varphi = 20°$				$\varphi = 30°$				$\varphi = 40°$			
	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*
0	42	6	239	—	43	19	90	—	—	—	—	—	—	—	—	—	—	—	—	—
1	55	35	301	51	61	48	72	38	50	12	9	57	—	—	—	—	—	—	—	—
2	61	47	298	53	65	52	70	45	61	14	278	60	—	—	—	—	—	—	—	—
3	64	42	284	54	50	33	72	52	78	42	280	63	—	—	—	3	50	29	272	52
4	66	24	289	57	55	28	71	60	107	72	276	72	80	39	270	37	76	52	272	63
5	69	8	346	59	64	25	66	68	137	103	274	83	141	81	270	76	100	76	272	73
6	73	18	68	62	72	22	66	77	166	134	273	94	195	128	270	111	128	100	274	88
7	80	33	92	64	81	11	90	88	193	160	269	108	239	186	271	134	158	125	277	110
8	86	49	102	66	91	8	173	99	219	188	266	121	283	244	272	157	188	150	279	131
9	93	66	106	68	100	19	205	110	245	214	264	135	328	302	272	180	217	175	281	153
10	103	77	108	75	110	32	210	120	270	236	261	146	373	340	271	189	244	203	281	145
11	117	75	111	89	121	49	205	127	287	245	258	152	413	368	271	191	260	231	280	135
12	130	73	115	103	133	65	203	135	294	255	256	158	430	396	270	193	258	248	280	127
13	131	65	115	106	134	63	201	135	279	246	256	157	393	360	270	179	250	240	280	123
14	126	54	112	102	128	49	199	130	260	225	257	151	355	323	269	165	241	230	280	119
15	120	43	108	98	123	34	193	125	242	204	258	146	320	286	268	151	233	222	280	115
16	114	33	101	94	117	21	180	120	223	184	260	140	282	249	267	137	226	213	280	111
17	118	23	95	93	113	12	176	115	203	159	261	135	251	213	266	125	217	198	278	118
18	124	13	99	98	108	13	208	110	186	127	261	130	225	177	265	114	208	182	275	126
19	129	4	135	103	105	16	235	106	168	97	260	126	200	140	265	103	198	165	271	134
20	134	7	248	107	100	22	248	101	150	67	259	122	174	104	263	92	189	150	267	147
21	137	8	245	107	97	21	255	99	132	42	259	116	150	79	264	88	182	140	266	147
22	138	10	114	98	98	6	256	103	114	25	267	109	128	67	268	93	175	132	267	151
23	140	25	100	89	105	9	72	107	96	11	300	101	107	55	275	97	170	125	268	155
24	140	41	97	80	118	25	73	111	78	14	24	94	85	45	285	102	164	117	269	159
25	141	56	96	71	131	40	74	115	60	29	47	86	64	37	300	106	158	109	270	163

* The $\overline{V}_{sa}$, $\overline{V}_r$ and σ_r, in metres per second, are multiplied by 10.

** The Θ values are given in degrees.

Table 4 — Parameters of the observed wind distributions at selected meridians (*continued*)

80° E, January

Geopotential altitude H, km	φ = 50°				φ = 60°				φ = 70°				φ = 80°		
	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**
0	—	—	—	—	—	—	—	—	—	—	—	—	42	12	125
1	70	21	221	65	100	62	249	95	80	21	259	97	78	17	79
2	89	43	249	91	129	92	261	106	104	44	277	109	95	18	81
3	101	60	266	117	144	108	269	117	122	62	280	123	105	12	51
4	118	68	271	128	158	118	273	129	140	78	287	140	116	17	343
5	140	76	275	139	178	129	276	140	160	95	291	157	129	33	320
6	153	88	280	150	197	137	279	154	171	106	293	166	140	37	317
7	162	102	285	162	213	144	281	169	178	116	294	175	148	42	314
8	167	117	290	174	224	150	283	184	182	127	296	184	152	46	312
9	172	132	292	182	230	160	285	190	180	129	294	176	150	44	314
10	184	145	290	171	230	171	285	180	170	123	291	156	136	40	320
11	202	158	288	159	228	182	285	169	160	118	287	137	112	36	324
12	212	166	286	150	230	189	284	166	153	122	283	136	103	33	312
13	214	171	284	144	232	195	284	165	148	126	280	136	100	33	297
14	214	177	281	138	238	200	283	163	148	130	277	135	103	34	284
15	214	182	280	132	244	205	283	161	150	134	274	135	110	37	272
16	214	188	277	130	256	214	280	163	160	143	269	146	117	47	260
17	218	194	275	139	273	226	277	168	178	154	264	160	120	58	253
18	225	200	274	147	295	239	275	172	205	166	260	174	122	71	248
19	235	207	272	156	317	252	272	177	234	178	256	189	128	83	245
20	247	214	270	165	331	260	270	184	255	165	251	208	143	68	219
21	254	216	269	183	326	251	270	201	263	133	241	230	191	74	176
22	256	218	267	201	313	242	270	217	262	108	227	252	243	109	151
23	247	220	265	219	296	234	270	234	249	93	205	274	292	154	139
24	246	222	264	238	273	224	270	250	230	94	181	297	320	203	132
25	246	224	262	256	276	215	270	267	215	111	160	319	335	253	129

* The $\overline{V}_{sa}$, $\overline{V}_r$ and σ_r, in metres per second, are multiplied by 10.

** The Θ values are given in degrees.

Table 4 — Parameters of the observed wind distributions at selected meridians (*continued*)

80° E, July

Geopotential altitude H, km	φ = 0°				φ = 10°				φ = 20°				φ = 30°				φ = 40°			
	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*
0	40	13	193	—	56	56	291	—	62	40	241	—	—	—	—	—	—	—	—	—
1	73	25	254	46	109	93	290	66	85	60	275	70	—	—	—	—	—	—	—	—
2	87	42	267	55	127	107	287	72	91	72	284	71	—	—	—	—	—	—	—	—
3	81	56	273	63	115	99	281	78	87	63	284	73	—	—	—	—	53	13	328	46
4	77	48	272	66	100	80	278	80	77	40	277	72	44	1	225	23	69	35	286	56
5	72	37	270	68	83	59	272	82	69	20	252	71	55	4	236	49	84	63	276	64
6	67	23	268	69	70	37	262	83	61	14	168	70	66	6	239	71	105	94	273	73
7	75	12	66	72	70	4	243	82	65	27	110	69	74	15	262	74	142	141	271	91
8	85	46	75	74	73	28	88	81	74	47	95	68	82	24	268	77	197	171	271	109
9	101	80	77	77	84	61	86	80	90	68	89	68	91	33	268	81	245	209	270	127
10	140	117	76	81	123	103	84	84	115	93	86	70	100	38	270	86	288	244	270	140
11	186	160	73	87	181	160	80	97	144	126	85	82	113	31	270	94	320	272	271	146
12	235	203	72	93	234	218	79	110	175	158	83	93	128	24	268	102	344	300	272	152
13	232	202	73	98	280	248	80	120	204	187	84	101	133	13	279	105	318	289	272	148
14	200	173	76	101	293	258	82	127	233	213	84	107	130	10	29	103	277	255	271	139
15	169	146	80	105	299	267	84	134	261	238	84	113	127	27	54	101	241	222	271	130
16	137	119	87	108	297	277	86	141	290	264	85	120	122	47	59	99	203	188	271	121
17	119	108	91	109	284	276	87	143	311	280	85	123	122	64	63	96	169	152	270	113
18	115	111	91	105	269	257	87	136	293	264	85	116	131	77	73	89	153	107	271	114
19	114	113	90	101	252	238	87	130	277	248	86	109	139	93	79	82	140	62	271	115
20	115	114	89	97	236	219	87	123	260	231	86	102	150	109	84	75	131	17	275	115
21	120	119	89	94	224	209	87	116	246	219	87	96	157	124	88	68	130	29	86	116
22	143	132	87	91	239	231	89	112	264	237	89	92	168	142	90	69	137	59	89	116
23	168	142	88	89	253	252	90	107	280	254	90	88	178	160	92	69	143	88	90	115
24	195	152	88	86	272	270	91	102	295	272	92	84	189	178	93	70	152	117	90	114
25	224	160	88	84	290	289	92	98	313	290	93	81	200	197	94	71	161	146	91	114

* The $\overline{V}_{sa}$, $\overline{V}_r$ and σ_r, in metres per second, are multiplied by 10.

** The Θ values are given in degrees.

Table 4 — Parameters of the observed wind distributions at selected meridians *(continued)*

80° E, July

Geopotential altitude H, km	φ = 50°				φ = 60°				φ = 70°				φ = 80°		
	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**
0	—	—	—	—	—	—	—	—	—	—	—	—	60	5	14
1	58	11	292	55	64	12	24	81	71	4	206	83	76	20	227
2	72	26	268	70	78	10	355	87	85	13	257	92	88	32	244
3	83	40	267	84	83	19	302	93	97	28	291	101	91	41	270
4	94	50	264	93	90	20	301	105	110	31	289	117	104	49	270
5	106	61	262	102	101	21	299	118	121	34	287	133	125	57	270
6	117	71	262	111	122	23	299	130	133	40	288	151	157	66	271
7	127	80	263	124	140	29	299	141	156	48	292	171	190	77	271
8	139	89	264	137	153	35	297	153	180	58	294	190	203	88	272
9	148	98	264	150	154	41	298	165	188	67	296	210	196	99	273
10	160	112	265	168	146	42	294	161	175	64	295	195	169	83	273
11	172	130	267	190	134	41	290	150	152	56	293	168	147	62	275
12	180	149	268	213	120	40	284	139	130	49	291	142	128	46	276
13	177	140	269	190	109	34	285	129	107	41	292	125	111	44	275
14	167	129	270	163	101	29	286	119	89	33	293	109	96	43	275
15	150	118	270	136	91	24	287	110	76	24	294	92	84	42	274
16	132	107	272	109	82	18	289	100	64	16	297	75	70	41	273
17	115	90	273	91	79	12	294	93	55	8	320	65	63	36	272
18	102	64	273	91	80	5	307	89	52	6	31	63	56	29	270
19	95	37	273	90	82	4	56	85	51	13	72	60	51	22	265
20	91	10	277	90	83	11	83	82	52	20	81	58	47	15	258
21	90	16	90	89	84	18	89	78	55	28	86	56	43	9	238
22	98	37	91	90	85	32	89	80	60	36	87	55	39	4	159
23	108	57	92	90	85	47	88	84	65	44	87	54	37	11	102
24	119	77	92	91	86	63	88	88	71	52	88	53	35	21	93
25	130	92	93	91	86	78	88	91	78	60	88	52	33	30	89

* The $\overline{V}_{sa}$, $\overline{V}_r$ and σ_r, in metres per second, are multiplied by 10.

** The Θ values are given in degrees.

Table 4 — Parameters of the observed wind distributions at selected meridians (*continued*)

20° E, January

Geopotential altitude H, km	$\varphi = 0°$				$\varphi = 10°$				$\varphi = 20°$				$\varphi = 30°$				$\varphi = 40°$			
	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	40	4	33	50	60	37	51	41	55	12	31	46	77	39	276	77	75	18	313	77
2	61	30	42	49	80	44	62	45	71	11	338	65	98	61	279	91	88	29	282	93
3	82	70	54	47	78	27	84	50	85	34	284	84	126	81	280	104	100	42	277	108
4	82	64	63	50	70	26	90	59	118	64	274	95	156	111	275	117	123	58	277	128
5	82	51	77	54	63	27	88	68	152	95	270	104	184	142	272	130	146	75	276	147
6	82	45	93	57	64	24	70	77	185	128	268	114	214	176	270	144	169	92	276	167
7	87	42	97	63	76	6	211	83	218	169	268	124	249	216	271	162	192	108	276	187
8	93	41	101	69	88	32	252	89	250	211	267	134	284	256	271	179	215	124	276	206
9	98	39	105	74	100	50	255	94	282	252	267	144	319	296	272	196	238	140	276	226
10	105	42	112	81	115	81	251	102	314	282	266	154	355	325	271	207	254	166	277	218
11	118	54	122	88	136	95	239	114	338	298	263	164	382	348	271	216	258	192	277	209
12	128	68	127	95	150	114	230	126	342	315	261	174	395	368	270	224	241	206	278	198
13	121	69	125	97	139	108	227	126	319	297	261	166	379	348	270	209	223	194	278	183
14	107	63	116	96	125	86	227	120	294	267	262	151	358	328	270	195	206	182	278	168
15	94	60	107	95	112	64	227	113	268	237	263	136	330	307	269	181	188	160	277	152
16	88	57	96	94	103	41	227	107	243	207	264	121	300	287	269	167	170	157	277	137
17	93	50	88	93	100	27	231	104	213	175	264	114	250	246	269	150	158	146	277	128
18	104	32	83	94	100	26	240	105	181	140	263	114	204	199	269	133	147	136	277	120
19	114	16	68	94	100	27	250	107	148	105	262	115	158	152	268	117	140	125	276	114
20	125	7	333	94	100	27	260	109	115	70	259	115	110	105	268	100	142	114	276	112
21	136	12	322	97	100	22	271	112	91	36	251	115	85	76	268	90	143	111	276	114
22	150	14	51	105	101	9	319	117	80	29	169	114	80	63	268	88	146	111	277	120
23	168	30	75	112	104	17	33	121	68	13	96	113	76	49	268	85	150	111	278	126
24	187	48	82	120	110	33	50	126	58	1	90	111	75	36	269	83	153	111	278	132
25	210	66	85	127	120	50	55	131	48	1	88	110	74	22	270	80	157	111	278	138

* The $\overline{V}_{sa}$, $\overline{V}_r$ and σ_r, in metres per second, are multiplied by 10.

** The Θ values are given in degrees.

Table 4 — Parameters of the observed wind distributions at selected meridians (*continued*)

20° E, January

Geopotential altitude H, km	$\varphi = 50°$				$\varphi = 60°$				$\varphi = 70°$				$\varphi = 80°$		
	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**
0	—	—	—	—	64	15	274	—	71	15	320	—	—	14	225
1	98	32	292	94	110	35	288	119	100	30	307	123	80	14	298
2	115	51	295	109	126	50	295	127	116	46	311	128	95	22	334
3	123	60	292	125	130	61	300	137	127	63	313	136	106	36	321
4	140	69	291	146	146	75	300	155	142	77	313	150	120	52	317
5	156	77	291	167	170	89	300	172	160	91	312	165	138	69	315
6	176	85	291	188	188	100	302	190	178	105	312	181	156	81	317
7	196	94	291	209	201	109	302	208	195	120	311	197	172	91	319
8	218	102	292	230	211	118	304	226	209	135	312	214	185	102	320
9	235	110	292	248	217	126	304	236	214	142	311	219	190	106	318
10	230	110	294	231	216	137	302	220	206	136	310	209	178	106	315
11	206	109	296	215	210	147	300	204	183	131	310	199	164	106	311
12	188	119	296	200	205	155	299	193	180	137	307	194	156	106	310
13	182	116	295	187	205	161	299	184	185	146	305	189	154	106	309
14	180	121	293	173	208	168	298	175	194	155	303	184	152	106	307
15	180	126	292	160	210	175	297	167	210	165	301	179	149	106	306
16	182	131	292	150	218	186	295	164	235	173	299	178	147	107	301
17	188	140	290	153	231	200	295	170	254	180	297	178	143	110	295
18	197	150	289	158	250	215	293	177	268	189	296	180	139	115	289
19	207	159	288	165	273	230	292	183	278	196	294	181	136	120	284
20	220	169	286	175	297	245	292	191	281	199	292	188	163	94	290
21	229	179	288	193	308	251	291	210	280	190	291	204	205	54	324
22	234	189	290	215	314	256	291	229	274	183	291	220	267	61	23
23	237	201	292	236	314	261	290	249	261	176	290	236	306	106	50
24	240	216	293	257	310	266	290	268	245	170	290	252	333	158	59
25	240	223	295	278	298	272	290	287	220	164	290	268	350	213	64

* The $\overline{V}_{sa}$, $\overline{V}_r$ and σ_r, in metres per second, are multiplied by 10.

** The Θ values are given in degrees.

Table 4 — Parameters of the observed wind distributions at selected meridians (*continued*)

20° E, July

Geopotential altitude H, km	φ = 0°				φ = 10°				φ = 20°				φ = 30°				φ = 40°			
	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*
0	—	—	—	—	44	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	52	22	227	28	48	18	248	51	48	3	162	54	58	46	358	50	47	26	339	54
2	66	23	189	39	54	3	72	54	59	17	69	62	63	56	347	66	74	46	322	69
3	74	42	134	50	62	41	64	56	73	50	53	69	69	61	334	82	86	60	312	83
4	67	36	124	53	63	45	69	58	76	50	55	71	72	60	327	85	100	71	302	93
5	58	27	110	55	63	43	75	60	78	43	61	72	77	58	321	86	115	85	296	104
6	58	22	90	58	63	42	82	62	80	38	67	73	81	57	314	87	128	100	290	115
7	72	32	85	66	75	54	87	63	80	41	77	72	88	58	298	93	150	116	285	131
8	86	43	82	74	86	66	90	63	82	44	85	71	94	62	284	99	169	133	280	147
9	100	54	81	82	100	77	92	64	84	49	91	69	100	70	272	105	190	151	277	163
10	114	68	78	92	120	91	93	69	92	59	98	72	108	79	261	110	213	171	273	173
11	126	93	74	106	149	111	92	86	116	83	105	84	122	89	243	114	243	195	269	178
12	137	117	71	120	180	131	90	102	140	107	109	96	138	105	230	117	272	220	266	183
13	136	118	72	124	204	145	91	109	162	130	110	101	140	108	222	116	254	210	263	174
14	124	103	75	122	216	154	92	108	176	150	110	101	132	96	213	111	230	189	261	161
15	114	89	80	120	220	164	93	107	191	171	110	100	124	88	203	107	205	168	258	148
16	103	75	87	118	222	175	95	106	206	191	110	100	116	82	191	103	180	149	255	136
17	93	69	92	119	216	179	95	107	218	205	109	99	110	77	176	98	159	121	251	124
18	91	73	91	124	210	174	97	109	212	197	105	96	118	69	155	90	140	80	246	116
19	92	76	90	129	203	170	98	112	208	191	102	92	124	72	130	82	115	41	232	107
20	98	80	89	135	197	165	100	115	203	184	97	89	130	86	111	74	95	20	150	99
21	112	87	89	137	190	166	100	117	198	182	93	86	138	106	99	66	80	52	101	90
22	133	103	89	134	210	184	96	118	214	194	92	86	157	120	96	61	80	67	96	83
23	156	120	89	132	230	203	92	119	230	207	92	85	174	135	93	56	90	83	94	76
24	177	138	89	129	250	222	90	120	244	219	91	84	193	151	91	50	106	99	92	69
25	180	153	89	126	273	242	87	121	260	232	90	83	212	166	90	45	116	115	90	62

* The $\overline{V}_{sa}$, $\overline{V}_r$ and σ_r, in metres per second, are multiplied by 10.

** The Θ values are given in degrees.

Table 4 — Parameters of the observed wind distributions at selected meridians (*continued*)

20° E, July

Geopotential altitude H, km	$\varphi = 50°$				$\varphi = 60°$				$\varphi = 70°$				$\varphi = 80°$		
	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**
0	—	—	—	—	40	10	253	—	48	5	281	—	—	—	—
1	56	24	287	59	69	19	235	82	63	16	256	77	67	7	225
2	79	39	285	73	85	30	236	88	74	24	240	84	85	16	240
3	86	46	283	86	93	41	238	95	84	32	226	90	91	22	238
4	93	55	273	97	101	50	239	108	98	41	229	105	104	33	232
5	105	66	266	107	115	58	239	121	113	50	230	119	120	43	231
6	122	76	262	119	135	68	238	139	130	58	229	136	145	49	229
7	137	83	262	136	164	79	237	165	143	67	227	155	175	51	225
8	155	91	262	153	188	90	236	192	150	75	226	175	189	55	221
9	172	98	262	169	202	101	235	219	150	83	224	194	180	57	218
10	185	104	263	174	194	102	237	208	143	80	224	177	150	56	218
11	190	109	265	171	179	101	241	182	131	75	225	153	119	54	219
12	186	114	267	168	160	99	244	157	118	70	224	130	99	53	219
13	174	105	265	151	142	85	242	139	104	64	222	117	88	47	215
14	152	95	262	133	125	71	239	122	94	58	218	104	78	42	211
15	126	85	258	115	107	57	235	104	83	52	215	91	72	38	205
16	102	74	253	98	88	44	227	87	75	47	211	78	66	34	199
17	83	61	247	86	70	34	216	75	67	41	204	71	60	31	191
18	70	41	239	84	56	27	200	70	60	36	196	71	55	28	184
19	64	23	218	82	49	23	178	65	55	31	185	70	50	26	173
20	61	17	154	80	46	24	152	60	54	29	172	69	46	25	164
21	64	31	113	78	50	29	131	55	55	28	156	69	45	24	152
22	70	45	108	75	58	39	120	56	56	34	137	65	45	26	140
23	78	59	105	71	66	51	114	57	58	43	125	62	45	30	128
24	85	72	104	67	75	63	110	58	60	53	117	58	44	35	121
25	91	86	103	63	81	75	107	59	65	64	112	54	44	40	115

* The $\overline{V}_{sa}$, $\overline{V}_r$ and σ_r, in metres per second, are multiplied by 10.

** The Θ values are given in degrees.

Table 4 — Parameters of the observed wind distributions at selected meridians (*continued*)

80° W, January

Geopotential altitude H, km	φ = 0°				φ = 10°				φ = 20°				φ = 30°				φ = 40°			
	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*
0	—	—	—	—	38	22	0	—	60	33	55	—	68	14	339	—	—	—	—	—
1	63	24	27	46	66	47	29	53	66	36	77	76	91	94	266	94	110	66	275	105
2	75	39	21	45	72	54	40	52	68	33	90	77	120	83	261	102	155	125	275	121
3	75	10	29	44	60	43	58	51	68	18	103	79	158	119	263	110	188	163	274	137
4	83	10	90	51	64	43	74	59	78	9	206	87	190	153	264	121	225	193	273	158
5	93	18	112	59	71	47	86	67	90	29	243	96	220	187	264	133	260	225	273	179
6	96	24	120	68	78	46	97	76	102	51	252	104	255	222	264	145	294	253	272	200
7	96	18	149	78	88	19	122	87	120	73	258	113	290	263	265	160	324	279	270	220
8	96	18	192	89	98	21	223	99	140	97	261	122	330	304	265	175	354	304	269	240
9	96	26	218	99	108	48	247	110	158	119	263	131	367	344	266	190	384	329	268	260
10	100	37	225	110	118	74	249	119	180	144	264	138	400	373	266	197	398	344	269	244
11	111	50	217	119	138	96	244	123	203	166	263	143	424	392	265	197	400	359	269	237
12	122	64	214	129	174	119	241	127	226	190	262	147	442	413	265	198	382	360	269	222
13	117	59	205	126	163	114	241	123	220	186	262	142	408	385	265	181	358	338	269	200
14	105	44	185	115	145	93	244	115	198	168	263	133	373	353	265	163	333	315	269	179
15	93	39	155	104	126	73	251	107	176	151	264	124	340	322	266	145	307	293	269	158
16	81	46	125	93	107	52	253	100	155	134	265	115	305	290	267	127	280	271	269	137
17	79	52	110	85	88	36	260	93	133	111	265	105	260	245	267	112	253	241	270	125
18	74	48	102	81	76	20	264	89	113	83	266	95	214	194	268	99	226	211	272	114
19	78	45	93	77	70	5	281	85	93	55	267	84	165	143	269	85	195	182	275	103
20	85	42	82	72	67	11	64	81	73	27	270	74	118	92	272	72	167	153	279	92
21	95	44	77	70	73	22	71	79	54	10	287	69	86	61	275	63	155	150	280	84
22	110	50	81	71	82	28	72	80	54	10	307	70	79	53	273	60	150	145	280	76
23	130	54	84	72	90	34	73	81	56	10	327	72	76	45	271	56	150	141	280	69
24	154	60	87	73	98	40	74	82	58	12	343	74	74	38	269	53	149	139	290	61
25	180	65	89	74	108	46	74	83	62	15	355	76	74	30	265	50	149	137	310	54

* The $\overline{V}_{sa}$, $\overline{V}_r$ and σ_r, in metres per second, are multiplied by 10.

** The Θ values are given in degrees.

Table 4 — Parameters of the observed wind distributions at selected meridians *(continued)*

80° W, January

Geopotential altitude H, km	φ = 50°				φ = 60°				φ = 70°				φ = 80°		
	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**
0	—	—	—	—	60	10	264	—	40	38	329	—	—	—	—
1	94	54	284	87	88	23	270	88	72	19	345	90	—	28	—
2	122	80	287	103	102	31	270	102	90	9	0	104	40	21	—
3	144	98	287	119	110	37	270	115	104	1	45	118	94	22	98
4	162	111	286	139	119	42	270	129	114	7	180	131	112	20	123
5	176	125	286	158	130	47	270	142	126	15	180	144	132	22	150
6	202	132	282	175	144	48	266	150	134	20	183	150	149	26	169
7	233	137	277	191	161	48	263	158	138	25	184	154	156	31	181
8	265	143	273	206	177	49	259	165	138	30	187	159	151	38	192
9	278	152	270	212	180	52	261	162	129	28	198	155	141	33	192
10	264	163	272	198	157	60	266	151	118	25	225	145	125	20	185
11	242	175	273	184	131	68	270	139	110	29	250	135	112	9	162
12	236	180	273	176	127	78	272	142	111	35	270	135	104	4	315
13	232	182	273	172	131	88	275	146	116	44	282	136	103	17	332
14	228	184	273	168	144	100	276	150	122	53	290	136	105	30	335
15	226	186	273	163	161	110	227	153	130	64	295	137	110	43	336
16	225	189	274	158	185	130	281	156	146	86	300	147	120	66	332
17	224	195	277	151	210	160	285	157	167	114	303	162	131	91	330
18	223	200	280	144	238	191	288	158	195	142	305	178	145	116	330
19	222	206	282	137	273	221	290	159	233	170	306	193	161	142	329
20	222	214	280	130	300	252	292	161	300	211	307	207	201	172	328
21	224	216	281	125	324	278	296	165	344	272	308	220	229	206	328
22	228	218	280	121	342	306	298	168	373	333	309	233	255	247	327
23	231	220	280	116	358	334	301	172	440	393	310	246	291	274	327
24	240	221	285	112	370	347	303	176	500	454	310	259	320	309	327
25	254	224	290	107	377	360	305	180	530	515	310	272	360	343	327

* The $\overline{V}_{sa}$, $\overline{V}_r$ and σ_r, in metres per second, are multiplied by 10.

** The Θ values are given in degrees.

Table 4 — Parameters of the observed wind distributions at selected meridians (*continued*)

80° W, July

Geopotential altitude H, km	$\varphi = 0°$				$\varphi = 10°$				$\varphi = 20°$				$\varphi = 30°$				$\varphi = 40°$			
	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*
0	—	—	—	—	32	19	3	—	70	62	75	—	51	22	193	—	—	—	—	—
1	56	10	336	27	85	48	70	43	73	69	93	43	56	21	217	60	52	23	265	70
2	76	18	41	31	106	65	82	41	78	71	101	47	58	24	234	60	79	55	278	72
3	78	35	85	36	102	57	93	40	80	64	100	51	57	23	239	60	90	73	281	73
4	80	45	36	44	97	59	97	43	76	57	98	52	58	23	247	62	107	86	281	81
5	84	57	118	51	92	64	98	47	70	52	94	51	60	23	255	65	126	98	279	90
6	88	66	125	59	88	67	99	50	65	46	91	51	61	23	265	68	144	111	279	100
7	92	56	118	63	89	55	98	52	70	41	91	61	62	21	278	78	162	131	279	117
8	94	48	108	68	90	44	98	54	76	35	90	70	65	21	293	87	182	150	280	134
9	97	41	94	72	92	33	97	55	82	29	90	79	70	21	309	97	200	169	280	151
10	98	39	73	75	90	23	90	59	88	21	85	88	88	21	321	107	220	185	280	167
11	95	43	51	75	85	15	67	67	92	13	42	97	108	20	336	116	237	196	282	179
12	90	53	33	74	80	13	23	75	96	17	353	106	127	19	354	125	242	207	283	192
13	86	53	30	72	77	16	40	76	98	19	12	102	130	21	19	119	222	186	284	175
14	82	46	33	71	78	25	72	72	96	28	55	90	113	28	41	102	184	153	286	148
15	76	39	36	69	78	39	84	68	94	44	72	78	97	36	54	85	144	121	287	121
16	70	32	41	67	80	54	91	64	93	61	80	66	82	46	61	67	111	88	291	94
17	65	26	47	67	85	64	91	62	101	83	83	58	78	58	70	56	85	60	296	75
18	58	23	50	69	99	68	87	62	122	109	85	56	91	74	77	53	76	35	309	67
19	50	20	57	70	114	72	84	62	143	137	86	54	104	91	83	51	68	18	357	59
20	44	18	64	72	128	78	81	62	164	164	87	52	117	109	87	48	65	29	61	51
21	40	21	76	76	144	87	81	64	185	184	88	52	133	126	89	46	70	51	79	43
22	55	37	84	85	158	109	86	74	196	191	89	59	148	137	90	47	80	62	82	43
23	69	54	87	94	172	132	89	85	207	195	90	67	164	148	90	48	90	73	83	43
24	83	73	88	103	195	194	90	95	220	200	91	74	179	158	90	49	100	82	84	43
25	97	89	89	113	223	222	91	105	232	205	91	81	194	165	90	49	111	95	85	43

* The $\overline{V}_{sa}$, $\overline{V}_r$ and σ_r, in metres per second, are multiplied by 10.

** The Θ values are given in degrees.

Table 4 — Parameters of the observed wind distributions at selected meridians (*concluded*)

80° W, July

Geopotential altitude H, km	φ = 50°				φ = 60°				φ = 70°				φ = 80°		
	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**	σ_r*	$\overline{V}_{sa}$*	$\overline{V}_r$*	Θ**
0	—	—	—	—	53	10	0	—	62	10	16	—	—	—	—
1	79	37	287	79	74	17	328	96	70	7	297	77	—	—	—
2	97	63	287	87	86	27	315	97	76	12	290	86	40	23	25
3	113	82	288	94	94	39	390	99	85	16	308	96	74	10	233
4	126	91	289	105	104	46	312	109	92	21	315	106	88	14	245
5	140	99	291	116	113	53	314	119	98	27	318	116	100	19	254
6	156	110	291	130	124	59	313	130	105	31	315	125	113	21	259
7	182	126	289	149	133	63	309	143	117	35	311	133	134	24	263
8	205	140	287	169	140	69	306	156	126	40	307	141	150	26	268
9	220	156	286	188	147	74	304	168	129	46	303	149	144	29	270
10	224	166	287	190	145	73	302	157	120	44	303	129	110	29	274
11	218	172	287	185	128	69	298	140	97	41	302	107	88	28	278
12	200	179	288	179	111	65	297	125	82	39	303	89	70	27	283
13	175	157	288	155	98	57	299	110	70	33	305	81	60	21	284
14	152	135	289	131	85	49	302	96	57	28	309	73	52	15	290
15	128	113	290	107	73	42	305	82	48	23	317	65	44	9	302
16	106	92	291	83	60	35	312	68	40	19	326	57	38	5	346
17	87	70	294	72	50	27	321	59	36	15	340	52	31	6	45
18	72	49	301	74	47	21	337	55	36	12	9	49	31	9	63
19	66	29	319	77	45	16	7	51	36	14	39	45	31	13	72
20	60	18	9	79	44	18	40	47	38	19	62	42	32	16	75
21	60	29	59	81	46	25	61	43	41	25	74	39	35	20	79
22	62	41	69	80	50	35	67	44	44	30	73	39	38	23	78
23	68	53	74	80	56	45	70	46	48	36	71	38	40	25	77
24	73	66	78	79	60	54	73	48	52	41	70	38	45	26	76
25	79	72	80	78	65	64	74	49	55	45	72	37	48	28	75

* The $\overline{V}_{sa}$, $\overline{V}_r$ and σ_r, in metres per second, are multiplied by 10.

** The Θ values are given in degrees.

Table 5 — High and low percentile values of wind speed, in metres per second, **for selected meridians**

140° E, January

Geopotential altitude H, km	φ = 0°				φ = 10°				φ = 20°				φ = 30°				φ = 40°			
	1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	16	2	11	1	19	5	16	1	14	2	10	0	25	3	16	1	25	5	19
2	1	16	2	11	1	19	4	15	1	16	2	12	2	28	5	21	2	30	5	22
3	1	16	2	11	1	18	3	14	1	18	2	14	4	35	9	27	2	34	7	26
4	1	16	2	11	1	19	3	14	1	24	4	18	8	43	14	34	3	42	9	32
5	1	16	2	11	1	21	4	15	2	32	6	23	12	53	20	43	4	50	11	38
6	1	17	3	12	1	22	4	16	2	36	8	28	16	62	27	51	5	58	13	44
7	1	18	4	13	1	22	4	16	2	39	9	30	20	73	32	60	6	65	15	49
8	2	20	5	14	1	22	4	16	3	41	10	32	23	83	37	68	7	70	18	54
9	2	21	6	16	1	21	3	15	4	44	11	34	26	89	41	75	8	73	20	58
10	2	22	6	17	1	21	3	15	4	47	12	36	28	93	42	81	9	75	22	59
11	2	25	6	19	1	22	3	16	6	50	14	40	28	95	43	84	10	75	24	58
12	2	27	6	20	1	24	4	18	7	52	16	41	27	95	43	85	11	72	25	58
13	2	28	6	22	1	24	4	19	7	51	16	39	25	90	40	80	12	68	24	55
14	2	29	6	22	1	25	5	19	6	48	14	36	24	84	37	73	12	64	23	52
15	2	29	6	22	2	27	5	20	4	44	12	33	22	75	33	65	12	60	22	48
16	2	29	6	22	2	26	6	20	4	40	11	30	20	68	30	59	10	55	18	45
17	2	29	6	22	2	26	6	20	2	36	9	26	15	60	24	50	8	51	15	40
18	2	28	6	21	2	22	5	18	2	32	7	23	11	53	19	40	6	46	12	35
19	1	27	5	19	1	20	4	16	1	27	6	19	7	45	14	34	5	42	10	32
20	1	26	4	18	1	19	3	14	1	22	4	16	3	38	8	26	2	38	7	29
21	1	26	4	18	1	20	3	14	1	20	3	15	2	30	5	21	2	34	6	26
22	1	27	4	20	1	22	3	16	1	19	3	14	1	25	4	18	2	32	5	24
23	1	29	5	21	1	24	4	18	1	20	3	14	1	22	3	16	1	32	5	23
24	1	31	5	23	1	27	5	20	1	20	3	15	1	21	3	15	1	31	5	22
25	2	33	6	25	2	30	5	22	1	20	3	15	1	23	4	17	1	30	5	21

Table 5 — High and low percentile values of wind speed, in metres per second, **for selected meridians** (*continued*)

140° E, January

Geopotential altitude H, km	φ = 50°				φ = 60°				φ = 70°				φ = 80°			
	1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	21	4	16	1	15	2	10	1	18	3	13	1	21	3	15
2	1	23	3	17	1	16	3	12	1	20	3	15	1	22	3	15
3	1	26	3	18	1	20	3	14	1	23	3	17	1	24	3	16
4	1	29	4	20	1	24	3	16	1	27	3	18	1	27	4	19
5	1	32	5	22	1	27	4	19	1	30	4	21	1	30	5	22
6	1	34	5	25	1	29	4	21	1	34	5	24	2	32	5	23
7	1	37	6	26	1	30	4	22	2	37	6	27	2	33	5	24
8	2	38	6	28	1	31	5	22	2	39	6	27	2	34	5	25
9	2	39	6	28	1	30	5	21	2	38	6	27	2	33	5	24
10	2	38	6	27	1	26	4	19	2	36	6	24	1	31	5	23
11	2	36	6	26	1	24	4	18	2	33	5	24	1	29	5	22
12	2	36	6	24	1	25	4	19	2	33	6	26	1	29	5	22
13	2	36	6	23	1	27	4	20	2	36	6	27	1	30	5	22
14	2	36	7	21	2	29	5	22	3	39	7	30	1	30	5	22
15	2	37	8	20	2	31	6	23	3	42	8	33	1	32	5	22
16	2	38	8	20	2	34	6	26	3	48	10	36	1	33	5	24
17	2	39	8	22	2	39	7	29	3	54	11	40	1	34	6	25
18	2	40	8	25	2	43	8	32	4	60	13	44	1	36	6	26
19	2	40	7	28	3	47	9	36	4	65	15	48	2	38	6	28
20	2	40	7	30	3	50	10	38	5	72	16	54	2	41	7	31
21	2	40	7	30	3	49	11	38	5	72	15	55	2	48	8	34
22	2	41	7	31	4	50	12	39	4	76	14	57	3	52	9	38
23	2	41	7	31	5	49	13	39	4	79	14	59	3	59	10	44
24	2	42	7	31	6	48	15	39	4	82	14	61	4	65	12	50
25	2	42	8	31	8	49	16	40	4	85	14	62	4	72	13	58

Table 5 — High and low percentile values of wind speed, in metres per second, **for selected meridians** (*continued*)

140° E, July

Geopotential altitude H, km	φ = 0°				φ = 10°				φ = 20°				φ = 30°				φ = 40°			
	1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	12	2	8	1	16	2	12	1	17	3	12	1	19	3	13	1	19	2	14
2	1	15	2	10	1	16	2	12	1	17	3	12	1	19	3	13	1	21	3	15
3	1	17	2	12	1	17	3	12	1	17	3	12	1	19	3	13	2	23	4	16
4	1	17	2	12	1	18	3	13	1	18	3	12	1	19	3	13	2	25	5	18
5	1	17	3	13	1	19	3	14	1	19	3	13	1	20	3	14	2	27	5	21
6	1	17	3	13	1	19	3	14	1	19	3	13	1	20	3	14	2	30	6	23
7	1	18	4	13	1	18	3	14	1	20	3	13	1	21	4	15	2	36	7	28
8	1	19	4	14	1	18	3	13	1	19	3	12	1	22	4	15	3	42	8	31
9	1	20	5	15	1	18	3	14	1	18	3	13	1	23	4	16	3	46	8	35
10	1	22	5	16	1	20	3	15	1	18	3	14	1	25	4	17	4	52	10	39
11	1	24	6	17	1	25	3	17	1	22	3	16	1	28	5	18	4	57	11	44
12	1	27	5	20	1	26	4	19	1	27	4	19	1	30	5	20	4	63	12	48
13	1	26	5	20	1	26	4	19	1	28	5	20	1	31	5	23	4	60	9	44
14	1	24	4	16	1	23	4	18	1	28	6	21	1	30	4	22	3	52	9	36
15	1	23	4	14	1	22	5	17	2	28	7	21	1	29	4	22	3	44	8	30
16	1	18	3	13	1	22	5	17	2	28	8	22	1	28	5	21	2	33	6	25
17	1	17	3	13	2	23	5	18	3	28	10	22	1	27	5	20	2	39	5	22
18	1	18	3	14	2	24	7	19	4	27	11	23	2	25	6	18	2	27	4	20
19	1	19	3	15	4	27	8	21	7	27	12	23	3	23	7	18	2	23	4	17
20	1	22	4	16	5	29	9	23	10	28	13	24	4	21	8	17	2	21	3	16
21	1	25	4	18	4	31	10	25	8	28	13	24	5	21	9	17	2	18	3	13
22	1	29	5	21	5	35	11	28	9	31	14	26	7	23	10	16	2	20	4	15
23	2	34	6	26	5	38	12	31	9	33	14	28	7	23	10	20	2	22	5	17
24	3	40	9	30	6	42	13	34	10	36	15	30	7	24	11	21	2	23	6	18
25	3	43	10	33	6	44	14	35	10	38	16	32	8	26	12	22	3	25	7	20

Table 5 — High and low percentile values of wind speed, in metres per second, **for selected meridians** (*continued*)

140° E, July

Geopotential altitude H, km	φ = 50°				φ = 60°				φ = 70°				φ = 80°			
	1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	16	2	11	1	16	2	12	1	15	2	10	1	16	3	11
2	1	18	2	13	1	17	2	12	1	18	2	12	1	19	3	13
3	1	21	3	15	1	18	3	13	1	20	3	14	1	22	3	15
4	1	23	3	16	1	22	3	15	1	26	4	18	1	25	4	18
5	2	26	4	18	1	24	4	18	1	30	5	22	1	28	5	20
6	2	29	4	20	1	28	4	21	1	36	6	26	1	32	5	23
7	2	34	5	24	2	36	5	25	1	41	6	30	2	36	6	25
8	2	40	6	27	2	40	6	27	1	46	7	34	2	39	6	28
9	3	44	6	31	2	41	7	30	2	51	8	37	2	42	6	30
10	3	49	7	35	2	41	7	30	2	45	7	32	2	36	5	25
11	3	51	8	38	2	40	7	29	2	38	6	27	1	28	4	22
12	3	52	9	39	2	37	6	26	1	32	5	22	1	25	4	19
13	3	46	8	33	2	32	5	22	1	28	4	19	1	23	4	17
14	2	38	7	28	2	26	4	18	1	25	4	17	1	20	4	15
15	2	32	5	24	1	21	3	14	1	22	3	15	1	19	3	14
16	2	27	4	20	1	17	2	12	1	19	3	13	1	17	3	12
17	1	22	4	16	1	14	2	11	1	17	2	12	1	15	3	11
18	1	20	3	15	1	13	2	10	1	16	2	11	1	13	2	9
19	1	19	3	14	1	13	2	10	1	15	2	10	1	12	2	8
20	1	18	3	14	1	13	2	10	1	14	2	9	1	10	2	7
21	1	18	3	13	1	13	1	10	1	12	2	9	1	9	2	6
22	1	19	3	14	1	14	3	11	1	13	2	10	1	10	2	6
23	1	20	3	15	1	15	3	11	1	14	3	11	1	11	2	7
24	1	23	4	17	1	17	4	13	1	15	3	12	1	12	2	9
25	2	24	5	18	1	18	4	14	1	16	3	12	1	14	2	10

Table 5 — High and low percentile values of wind speed, in metres per second, **for selected meridians** (*continued*)

80° E, January

Geopotential altitude H, km	φ = 0°				φ = 10°				φ = 20°				φ = 30°				φ = 40°			
	1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	14	3	11	1	14	3	11	1	12	2	8	—	—	—	—	—	—	—	—
2	1	14	2	11	1	14	2	10	1	14	2	10	—	—	—	—	—	—	—	—
3	1	14	2	10	1	13	2	9	1	16	3	12	—	—	—	—	1	13	2	9
4	1	14	2	10	1	14	2	10	2	20	4	15	1	18	3	14	1	17	3	12
5	1	14	2	10	1	16	3	11	2	24	6	19	2	23	5	18	1	21	4	16
6	1	14	2	10	1	17	3	12	2	30	7	23	3	33	7	25	1	26	5	20
7	1	15	2	11	1	20	3	14	3	36	9	28	4	45	12	33	2	33	7	24
8	1	17	3	13	1	22	4	15	4	41	10	32	6	55	15	43	2	39	8	30
9	1	19	4	14	1	24	4	17	5	46	12	36	7	64	18	50	3	45	9	34
10	1	21	4	17	1	26	4	19	5	49	14	39	10	67	23	54	5	46	11	36
11	1	24	4	19	2	29	5	22	6	52	15	41	11	71	24	58	6	47	14	37
12	1	27	4	20	2	32	5	24	6	54	15	42	12	73	25	59	7	47	16	38
13	1	27	4	19	2	33	5	23	6	53	15	41	10	70	23	56	7	46	16	37
14	1	26	4	18	2	31	5	22	5	50	13	39	8	65	21	49	7	44	15	35
15	1	23	3	15	1	28	4	20	4	47	11	36	7	55	17	42	6	42	14	34
16	1	20	3	14	1	26	4	18	3	42	9	33	6	47	15	38	6	41	13	33
17	1	20	3	14	1	24	4	17	2	39	8	30	4	40	12	32	5	41	11	32
18	1	21	3	16	1	24	3	16	2	35	7	26	3	35	9	26	4	41	10	32
19	1	23	4	17	1	23	3	16	2	32	5	22	2	30	7	32	3	40	9	31
20	1	24	4	17	1	22	3	15	1	29	4	20	2	25	5	18	2	40	8	30
21	1	23	4	16	1	22	3	15	1	27	4	19	1	24	4	18	2	41	8	31
22	1	21	3	15	1	22	3	16	1	24	4	17	1	23	4	17	2	40	7	30
23	1	20	3	14	1	23	4	16	1	22	3	15	1	24	4	17	2	40	7	30
24	1	19	3	14	1	24	4	17	1	21	3	15	1	23	4	17	2	40	7	29
25	1	18	3	14	1	26	4	19	1	19	3	14	1	24	4	17	2	41	7	30

Table 5 — High and low percentile values of wind speed, in metres per second, **for selected meridians** (*continued*)

80° E, January

Geopotential altitude H, km	φ = 50°				φ = 60°				φ = 70°				φ = 80°			
	1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	16	3	11	1	25	5	18	1	21	3	16	1	21	3	16
2	1	22	3	15	2	27	6	20	1	25	4	18	1	24	4	17
3	1	28	4	20	2	33	6	23	1	30	4	22	1	27	4	19
4	2	31	4	22	2	36	6	26	2	35	5	25	2	31	5	23
5	2	34	5	24	2	39	7	27	2	38	6	27	2	34	5	25
6	2	38	6	27	2	43	7	31	2	43	7	30	2	36	6	27
7	2	42	6	31	3	46	7	34	2	45	7	33	2	38	6	28
8	2	46	7	33	3	49	8	36	2	47	7	34	2	39	6	28
9	2	47	8	34	3	50	9	36	2	45	6	33	2	38	6	27
10	2	46	8	34	3	49	10	36	2	40	6	30	1	34	5	25
11	3	44	8	34	3	47	10	35	2	37	6	27	1	32	5	24
12	3	43	8	33	3	47	10	36	2	36	6	26	1	32	5	23
13	3	42	8	32	3	47	10	37	2	36	6	26	1	31	5	23
14	4	42	9	32	3	48	11	37	2	37	6	27	1	31	5	22
15	4	41	9	32	3	49	11	37	2	37	6	28	1	31	5	22
16	4	41	10	32	4	50	12	38	2	40	7	30	1	30	5	21
17	4	43	10	33	4	53	13	40	3	44	7	33	1	29	5	21
18	4	46	11	35	4	54	13	43	3	47	9	35	1	29	5	21
19	4	48	11	37	4	57	14	44	3	53	9	38	1	29	5	21
20	4	51	11	39	5	62	15	46	3	57	11	43	1	30	5	22
21	4	55	12	42	4	60	13	46	3	56	9	41	1	35	6	24
22	4	58	12	44	4	63	13	47	3	58	9	42	2	39	7	28
23	4	61	11	46	4	65	12	49	3	61	9	44	2	43	8	32
24	3	64	11	48	4	67	12	50	3	67	10	47	3	51	9	38
25	4	69	12	51	3	69	12	51	4	73	11	53	3	57	10	44

Table 5 — High and low percentile values of wind speed, in metres per second, **for selected meridians** *(continued)*

80° E, July

Geopotential altitude H, km	φ = 0°				φ = 10°				φ = 20°				φ = 30°				φ = 40°			
	1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	12	2	8	2	22	5	18	1	20	4	15	—	—	—	—	—	—	—	—
2	1	14	3	10	2	24	5	18	1	20	4	15	—	—	—	—	—	—	—	—
3	1	19	3	13	2	24	5	18	1	19	3	14	—	—	—	—	1	11	2	8
4	1	19	3	13	2	23	4	17	1	18	3	13	1	15	2	10	1	14	3	10
5	1	17	2	12	1	22	4	15	1	16	3	12	1	15	2	11	1	17	4	13
6	1	17	2	11	1	20	3	14	1	15	3	11	1	15	3	11	1	22	5	17
7	1	18	2	12	1	19	3	14	3	15	3	11	1	16	2	12	2	28	8	21
8	1	19	3	14	1	19	3	14	1	16	3	12	1	17	3	13	3	34	10	27
9	2	21	4	17	1	21	4	15	1	18	4	14	1	18	3	13	4	43	12	33
10	3	25	7	20	1	24	4	18	1	22	4	17	1	19	3	14	6	49	16	39
11	7	30	13	25	4	33	9	25	1	27	6	21	1	21	3	15	8	55	18	43
12	8	38	16	30	7	41	14	33	2	33	9	25	1	22	3	16	9	58	20	47
13	7	37	13	30	9	47	17	39	3	38	11	29	1	24	3	16	9	57	19	45
14	5	35	11	28	9	50	19	43	5	43	15	34	1	25	3	17	7	53	17	41
15	4	33	9	26	9	53	19	44	6	48	17	38	1	25	3	17	6	47	15	36
16	2	31	7	24	8	54	19	44	8	53	19	41	1	25	4	17	4	41	12	32
17	2	30	6	23	8	53	17	42	10	52	19	41	1	24	4	17	3	33	8	27
18	2	30	6	22	7	50	15	39	10	47	17	38	1	23	5	18	2	31	6	23
19	2	29	6	22	6	46	14	37	9	43	15	35	2	23	6	18	2	28	5	20
20	2	29	6	22	5	42	12	34	8	40	14	32	2	23	7	19	1	26	4	18
21	2	29	7	22	5	41	13	33	8	39	15	31	3	24	7	19	1	25	4	18
22	2	29	7	22	8	43	15	35	10	40	17	33	5	27	9	22	1	27	4	20
23	3	30	8	24	10	44	17	37	12	41	18	34	6	28	11	22	1	30	5	22
24	4	31	9	25	12	45	19	38	14	42	20	36	7	30	12	25	2	32	6	24
25	4	31	10	25	15	46	22	39	17	43	22	37	9	32	14	27	3	35	8	27

Table 5 — High and low percentile values of wind speed, in metres per second, **for selected meridians** *(continued)*

80° E, July

Geopotential altitude H, km	φ = 50°				φ = 60°				φ = 70°				φ = 80°			
	1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	12	2	8	1	18	3	13	1	18	3	12	1	18	3	13
2	1	17	3	12	1	19	3	14	1	20	3	14	1	21	4	15
3	1	20	3	14	1	20	3	14	1	22	3	16	1	24	4	17
4	1	23	4	16	1	22	3	16	1	25	4	19	1	27	4	20
5	1	25	4	18	1	25	4	18	1	29	4	21	1	30	5	22
6	1	27	4	19	1	28	4	20	1	33	6	24	1	33	5	25
7	1	31	5	22	2	31	5	22	1	38	7	28	1	36	6	29
8	2	34	6	24	2	34	6	24	2	43	7	32	2	43	7	33
9	2	38	7	27	2	37	6	26	2	47	7	34	2	49	8	35
10	2	42	8	31	2	37	6	26	2	46	7	32	2	48	8	33
11	2	48	9	35	1	34	6	24	1	39	6	26	1	39	7	26
12	3	54	9	39	1	31	5	22	1	30	5	22	1	30	5	22
13	3	53	7	37	1	29	4	20	1	25	4	19	1	26	4	19
14	3	46	7	32	1	26	4	19	1	21	3	16	1	22	3	17
15	2	37	6	27	1	23	3	17	1	18	3	13	1	19	3	14
16	2	30	5	22	1	21	3	16	1	15	2	11	1	16	2	12
17	2	24	4	19	1	19	3	15	1	13	2	10	1	14	2	11
18	2	22	4	17	1	18	3	13	1	12	2	10	1	13	2	9
19	2	20	3	15	1	17	3	13	1	12	2	10	1	12	2	8
20	1	19	3	14	1	17	3	12	1	12	2	10	1	11	2	7
21	1	19	3	14	1	17	3	12	1	13	2	10	1	10	2	7
22	1	21	3	15	1	18	3	13	1	13	2	10	1	10	2	7
23	1	22	3	16	1	21	3	15	1	14	3	11	1	10	2	7
24	1	24	4	17	1	22	4	16	1	15	3	11	1	11	2	7
25	1	25	5	19	1	24	4	18	1	15	3	12	1	11	2	8

Table 5 — High and low percentile values of wind speed, in metres per second, **for selected meridians** *(continued)*

20° E, January

Geopotential altitude H, km	φ = 0°				φ = 10°				φ = 20°				φ = 30°				φ = 40°			
	1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	0	9	0	6	1	13	4	10	1	12	2	6	1	18	3	13	1	16	3	11
2	2	13	3	10	1	12	3	9	1	20	2	11	1	23	4	16	1	20	4	16
3	2	16	4	13	1	12	2	9	1	24	3	14	1	27	5	20	1	26	4	18
4	2	16	3	12	1	13	2	10	1	28	4	18	2	33	6	25	2	31	5	23
5	1	15	2	11	1	14	2	11	2	32	6	22	3	38	8	29	2	36	6	26
6	1	15	2	11	1	16	2	12	2	36	8	24	3	45	10	34	2	40	7	30
7	1	16	2	12	1	20	3	14	4	40	10	30	4	55	12	40	3	46	8	34
8	1	16	3	12	1	22	3	16	5	46	14	34	5	62	15	45	3	52	8	37
9	1	17	3	13	1	26	4	18	6	52	16	40	6	66	17	50	3	56	9	40
10	1	19	3	13	1	30	4	20	8	56	18	46	7	72	18	56	3	58	10	42
11	1	23	4	14	1	34	5	24	8	61	19	50	8	75	20	58	3	58	10	43
12	1	25	4	17	1	36	6	26	8	63	19	50	9	76	21	60	4	56	11	43
13	1	25	4	18	1	35	5	25	8	60	18	46	10	74	21	57	4	52	10	40
14	1	25	4	18	1	32	5	22	6	52	15	42	9	70	21	55	3	48	9	36
15	1	24	4	18	1	28	4	18	6	46	14	37	8	65	19	50	3	44	8	34
16	1	24	4	18	1	24	3	16	4	40	12	33	7	60	18	45	3	40	8	30
17	1	22	4	17	1	23	3	16	4	36	10	28	6	50	14	37	3	38	7	26
18	1	21	3	16	1	23	3	16	3	33	8	25	5	43	10	32	3	35	6	24
19	1	20	3	15	1	23	4	16	2	30	6	22	3	35	8	25	2	33	6	23
20	1	20	3	15	1	24	4	17	1	28	4	20	1	27	5	20	2	31	6	23
21	1	21	3	15	1	25	4	17	1	26	4	18	1	23	4	17	2	32	6	24
22	1	23	3	16	1	25	4	18	1	25	4	18	1	22	4	16	2	32	6	24
23	1	25	4	18	1	26	4	19	1	24	4	17	1	21	3	15	2	34	6	25
24	1	28	4	20	1	28	4	20	1	24	4	17	1	19	3	14	2	34	6	25
25	1	30	4	22	1	30	5	22	1	24	4	17	1	18	3	13	2	36	6	26

Table 5 — High and low percentile values of wind speed, in metres per second, **for selected meridians** (*continued*)

20° E, January

Geopotential altitude H, km	φ = 50°				φ = 60°				φ = 70°				φ = 80°			
	1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	22	4	16	1	26	3	20	1	26	3	20	1	22	3	16
2	1	27	4	19	1	30	4	21	1	28	4	21	1	24	4	17
3	2	32	4	20	1	33	5	23	1	32	5	23	1	27	4	19
4	2	36	4	26	2	38	6	26	2	36	5	26	2	32	4	23
5	2	40	6	29	2	42	7	30	2	40	6	28	2	35	5	26
6	2	46	7	32	2	48	7	32	2	45	7	32	2	37	5	28
7	2	52	8	36	3	53	8	36	3	50	8	35	2	38	6	28
8	3	57	9	40	3	55	9	40	3	54	8	38	2	39	6	28
9	3	56	9	41	3	57	9	41	3	55	8	40	2	40	6	28
10	3	54	8	40	3	55	9	40	2	52	8	38	2	40	6	28
11	2	50	8	36	3	53	9	38	2	49	7	36	2	39	6	28
12	2	48	7	32	3	49	9	35	2	48	8	35	2	38	6	28
13	2	44	7	28	3	48	9	34	3	48	8	35	2	38	6	28
14	2	42	7	24	3	48	9	34	3	48	8	36	2	37	6	27
15	2	40	7	21	3	47	9	35	3	48	8	36	2	37	6	27
16	2	40	7	20	3	47	10	36	3	49	8	37	2	36	6	27
17	2	42	8	24	3	48	11	37	3	50	9	38	2	36	6	27
18	2	44	8	28	3	51	12	40	3	51	9	38	2	36	7	27
19	3	46	8	32	4	55	12	42	3	53	10	40	2	36	7	27
20	3	48	9	36	4	60	13	45	4	55	11	42	2	36	7	27
21	3	52	9	39	4	63	13	48	3	55	10	41	2	37	7	27
22	3	58	10	43	4	66	13	50	3	57	10	42	2	38	7	28
23	3	61	10	45	4	69	13	52	3	59	10	43	2	40	7	29
24	3	67	11	49	4	75	14	56	3	63	10	46	2	40	7	30
25	4	72	12	53	5	80	15	60	3	65	10	47	2	40	7	31

Table 5 — High and low percentile values of wind speed, in metres per second, **for selected meridians** *(continued)*

20° E, July

Geopotential altitude H, km	φ = 0°				φ = 10°				φ = 20°				φ = 30°				φ = 40°			
	1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	8	2	6	1	11	1	7	1	12	3	8	1	15	3	11	1	14	2	10
2	1	10	2	8	1	13	2	9	1	14	3	10	1	18	3	13	1	17	3	13
3	1	14	2	10	1	15	3	11	1	18	3	13	1	22	4	16	1	22	4	16
4	1	14	2	10	1	16	3	11	1	18	3	13	1	22	4	16	1	24	4	18
5	1	13	2	9	1	16	2	11	1	18	3	12	1	22	3	16	2	27	5	21
6	1	13	2	9	1	16	2	11	1	17	3	12	1	22	3	16	2	31	5	23
7	1	14	2	10	1	16	2	12	1	17	3	12	1	23	3	17	2	36	6	26
8	1	16	3	12	1	18	3	12	1	17	3	12	1	25	4	18	3	40	6	30
9	1	20	4	14	1	19	4	14	1	17	3	12	1	27	5	19	3	45	7	34
10	1	23	4	17	1	21	5	16	1	19	3	14	1	29	5	20	3	49	9	37
11	1	28	5	21	1	24	6	18	1	24	4	18	1	30	6	22	4	53	11	40
12	2	32	6	24	2	31	7	23	2	29	5	21	2	32	6	24	4	55	12	42
13	2	35	7	26	2	35	8	27	2	32	7	24	2	33	6	24	4	55	12	42
14	2	33	7	24	3	36	8	29	4	34	9	27	2	32	5	24	4	51	11	39
15	1	31	6	22	4	37	9	30	5	36	11	29	2	30	5	22	3	46	9	35
16	1	28	5	20	4	37	10	30	6	38	12	31	1	28	4	20	2	40	8	30
17	1	29	4	20	4	37	11	29	6	38	13	31	1	26	4	19	2	35	6	26
18	1	30	4	21	4	36	10	28	6	37	13	30	1	24	4	18	1	30	5	22
19	2	32	5	22	3	36	10	28	6	36	13	29	1	23	4	17	1	27	5	19
20	2	33	5	23	3	36	9	28	6	34	12	27	1	22	5	17	1	24	4	17
21	2	33	5	24	3	37	9	29	6	33	12	27	3	23	7	18	1	22	3	16
22	2	35	6	26	4	40	11	32	7	35	13	28	4	23	8	19	1	21	3	16
23	2	35	6	26	5	41	12	33	8	35	14	29	5	23	9	19	1	22	4	17
24	2	37	7	28	5	43	13	34	9	36	15	31	8	24	11	20	2	22	5	17
25	3	38	8	29	7	45	15	37	11	37	17	32	10	24	13	21	3	22	7	18

Table 5 — High and low percentile values of wind speed, in metres per second, **for selected meridians** (*continued*)

20° E, July

Geopotential altitude H, km	φ = 50°				φ = 60°				φ = 70°				φ = 80°			
	1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	15	2	10	1	19	3	12	1	18	3	13	1	13	3	9
2	1	18	2	12	1	19	3	14	1	19	3	13	1	16	3	11
3	1	21	3	15	1	21	3	16	1	20	3	14	1	18	3	13
4	1	24	4	17	1	24	4	18	1	23	3	16	1	22	4	16
5	1	26	4	19	1	28	4	20	1	26	3	19	1	25	4	18
6	1	29	5	21	1	32	5	24	1	31	4	22	1	28	4	20
7	1	32	6	23	1	40	7	28	2	36	6	26	2	31	5	22
8	2	37	6	27	2	48	8	33	2	40	7	30	2	34	5	24
9	2	41	7	30	2	52	8	38	2	45	7	33	2	35	5	25
10	2	44	7	33	2	50	8	37	2	44	6	32	2	34	5	23
11	2	45	7	33	2	44	7	33	1	39	6	26	1	28	4	19
12	2	42	7	31	2	38	6	27	1	31	5	22	1	21	3	15
13	2	38	7	28	2	33	5	23	1	26	5	20	1	18	3	13
14	2	34	6	25	1	29	4	19	1	22	4	18	1	16	2	11
15	1	29	5	22	1	24	4	16	1	20	4	16	1	15	2	10
16	1	25	4	19	1	19	3	14	1	19	3	14	1	14	2	9
17	1	22	4	16	1	17	3	12	1	18	3	12	1	13	2	9
18	1	20	3	15	1	15	3	11	1	17	3	12	1	13	2	9
19	1	18	3	14	1	14	2	10	1	17	2	11	1	12	2	9
20	1	18	3	14	1	13	2	9	1	16	2	11	1	12	2	9
21	1	18	3	13	1	13	2	9	1	16	2	11	1	12	2	9
22	1	18	3	13	1	14	2	10	1	15	2	11	1	12	2	9
23	1	18	3	14	1	15	3	11	1	16	3	11	1	12	2	9
24	1	19	4	15	1	17	3	13	1	16	3	12	1	12	2	9
25	2	20	5	16	1	18	4	14	1	16	3	12	1	12	2	9

Table 5 — High and low percentile values of wind speed, in metres per second, **for selected meridians** *(continued)*

80° W, January

Geopotential altitude H, km	φ = 0°				φ = 10°				φ = 20°				φ = 30°				φ = 40°			
	1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	13	3	10	1	16	3	12	1	18	3	13	1	25	4	18	2	27	5	20
2	2	11	2	9	1	15	3	10	1	18	3	12	2	27	4	20	3	34	6	25
3	1	10	2	7	1	14	2	10	1	17	3	12	3	32	6	24	3	40	8	31
4	1	12	2	8	1	16	2	12	1	19	3	14	3	37	7	28	3	48	10	36
5	1	14	2	10	1	18	3	13	1	22	4	16	4	44	10	33	4	55	13	43
6	1	16	2	12	1	20	3	15	1	25	4	18	5	49	13	37	4	64	14	47
7	1	18	3	14	1	23	3	16	2	29	5	21	7	55	16	44	5	71	15	53
8	1	21	3	15	1	26	3	18	2	33	6	24	8	62	18	49	5	76	16	58
9	1	23	4	17	1	28	3	19	2	37	7	27	9	68	21	55	6	79	17	61
10	1	26	4	18	1	31	4	21	3	40	8	30	10	73	23	59	7	80	18	63
11	1	29	5	20	2	35	5	23	4	43	9	32	12	77	24	62	8	78	20	61
12	1	32	5	23	2	36	6	25	4	46	10	34	13	76	26	61	8	74	21	57
13	1	30	5	22	2	35	6	24	4	44	10	33	14	72	26	57	9	67	20	53
14	1	28	4	20	2	33	5	22	3	41	9	31	14	65	25	54	9	62	19	48
15	1	25	4	18	1	28	5	20	3	36	8	28	13	57	23	47	8	57	18	44
16	1	22	3	16	1	23	3	18	6	33	7	25	10	52	20	42	7	52	17	40
17	1	20	3	14	1	20	3	15	2	29	6	22	7	48	14	33	6	46	14	35
18	1	19	3	14	1	19	3	14	2	25	5	18	5	37	10	24	5	42	12	31
19	1	18	3	13	1	18	3	12	1	20	4	14	3	27	7	19	4	36	9	27
20	1	17	3	12	1	17	3	12	1	16	2	10	2	21	4	14	3	31	7	23
21	1	15	2	11	1	18	3	13	1	17	3	12	1	19	4	14	3	29	8	23
22	1	15	2	11	1	17	3	12	1	16	2	12	1	17	3	13	3	26	8	21
23	1	17	3	12	1	18	3	12	1	16	2	11	1	16	3	12	3	25	7	20
24	1	18	3	13	1	18	3	13	1	16	3	12	1	14	2	10	3	22	7	18
25	1	19	3	14	1	20	3	14	1	17	3	13	1	13	2	9	3	20	7	16

Table 5 — High and low percentile values of wind speed, in metres per second, **for selected meridians** (*continued*)

80° W, January

Geopotential altitude H, km	φ = 50°				φ = 60°				φ = 70°				φ = 80°			
	1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	24	4	17	1	20	3	14	1	20	3	14	—	—	—	—
2	2	27	5	19	1	23	4	16	1	23	4	16	1	23	4	16
3	2	31	6	23	1	26	4	19	1	26	4	18	1	25	4	20
4	2	36	6	27	1	29	5	21	1	28	5	20	1	29	5	21
5	2	42	7	31	1	31	5	23	1	31	5	23	1	32	5	24
6	3	46	8	35	2	33	5	24	2	33	5	24	2	34	5	25
7	3	50	8	37	2	35	6	26	2	34	5	24	2	36	6	26
8	3	53	9	39	2	36	6	27	2	35	5	25	2	37	6	27
9	3	54	9	39	2	34	6	26	1	34	4	25	2	37	6	27
10	3	52	9	38	1	32	6	24	1	32	4	24	2	36	6	26
11	3	50	9	37	1	32	5	23	1	29	4	21	2	34	6	25
12	3	49	9	36	1	34	5	24	1	29	4	20	2	33	6	24
13	3	48	9	36	1	36	6	25	1	29	4	20	2	33	6	24
14	3	47	9	36	2	38	6	27	1	30	4	22	2	34	6	25
15	3	47	10	36	2	40	7	29	1	32	5	23	2	36	6	26
16	3	46	10	35	3	42	8	31	1	36	6	26	2	39	7	28
17	4	45	11	35	4	45	9	34	2	42	7	30	3	43	8	32
18	4	45	11	35	4	48	11	37	2	47	8	34	3	47	9	34
19	5	44	12	35	5	52	13	39	3	53	10	39	4	50	11	38
20	5	44	12	35	6	54	15	41	3	57	11	43	5	53	12	41
21	5	43	13	35	5	54	14	42	3	54	8	39	5	54	12	40
22	5	43	13	35	4	53	13	42	3	55	8	40	4	54	11	40
23	6	42	14	34	4	55	13	42	3	57	9	41	3	52	9	38
24	7	42	14	34	4	54	12	42	3	60	9	43	2	50	8	37
25	7	41	13	34	4	54	12	41	3	63	10	45	2	49	8	36

Table 5 — High and low percentile values of wind speed, in metres per second, **for selected meridians** *(continued)*

80° W, July

Geopotential altitude H, km	φ = 0°				φ = 10°				φ = 20°				φ = 30°				φ = 40°			
	1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	6	2	4	1	6	3	4	3	16	4	12	1	14	2	10	1	18	3	12
2	1	8	2	6	1	8	3	6	2	16	4	12	1	14	2	10	1	19	3	14
3	1	11	3	8	1	11	3	8	1	16	3	12	1	14	2	10	1	21	4	16
4	1	13	3	10	1	13	3	10	1	15	3	12	1	14	2	10	1	23	5	17
5	1	15	4	12	1	15	4	12	1	15	2	11	1	14	2	10	2	26	5	19
6	1	17	4	13	1	17	4	13	1	14	2	10	1	15	2	11	2	29	6	22
7	1	18	4	13	1	18	4	14	1	15	2	10	1	17	2	12	2	34	7	25
8	1	18	4	13	1	18	3	13	1	16	2	11	1	19	2	14	3	39	8	28
9	1	18	3	13	1	18	2	13	1	17	3	12	1	21	3	15	3	44	9	32
10	1	18	3	13	1	18	2	13	1	20	3	13	1	23	3	16	3	49	9	36
11	1	18	3	14	1	18	2	13	1	21	4	15	1	25	4	18	3	54	10	40
12	1	19	3	14	1	19	3	14	1	23	4	17	1	27	4	20	3	56	11	42
13	1	19	3	14	1	19	3	14	1	24	4	17	1	28	4	20	3	54	11	41
14	1	18	3	13	1	18	3	13	1	23	4	16	1	24	3	17	2	45	9	35
15	1	17	3	12	1	17	3	12	1	20	4	14	1	19	3	14	2	35	7	27
16	1	16	2	11	1	16	3	12	1	18	4	13	1	15	3	12	1	26	5	19
17	1	15	2	11	1	15	3	11	1	19	4	14	1	16	4	12	1	19	4	14
18	1	14	2	10	1	14	3	11	3	21	6	16	2	17	5	13	1	16	3	12
19	1	14	2	10	1	14	3	10	5	23	9	18	3	18	7	14	1	14	3	11
20	1	15	2	11	1	15	4	10	8	25	12	21	4	20	8	16	1	13	3	10
21	1	17	3	12	2	20	5	16	11	27	14	24	6	20	9	17	1	13	3	10
22	1	20	3	14	3	26	7	20	10	30	14	25	7	22	10	18	1	14	3	11
23	1	23	4	17	5	32	11	26	9	31	14	26	8	23	11	20	2	15	4	12
24	1	26	4	19	7	37	14	31	9	33	14	28	8	24	12	21	2	16	5	13
25	1	29	5	22	9	42	16	34	8	34	14	29	9	25	13	21	3	17	6	14

Table 5 — High and low percentile values of wind speed, in metres per second, **for selected meridians** (*concluded*)

80° W, July

Geopotential altitude H, km	φ = 50°				φ = 60°				φ = 70°				φ = 80°			
	1 %		10 %		1 %		10 %		1 %		10 %		1 %		10 %	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	19	3	14	1	21	3	15	1	16	3	11	—	—	—	—
2	1	22	3	17	1	22	3	15	1	19	3	13	1	18	3	13
3	1	25	4	19	1	23	3	16	1	21	3	15	1	20	3	14
4	1	28	5	21	1	24	3	17	1	23	3	17	1	23	4	16
5	1	31	6	23	1	26	4	19	1	25	4	18	1	25	4	18
6	1	34	6	25	1	30	4	23	1	27	4	20	1	27	4	20
7	1	40	7	28	1	36	5	27	1	29	5	21	1	30	5	23
8	2	45	8	32	2	40	6	29	1	31	5	23	2	33	6	25
9	2	50	9	37	2	39	6	29	1	32	5	24	2	36	6	26
10	2	53	9	40	2	36	6	26	1	30	4	22	2	36	6	24
11	1	52	9	40	1	32	6	24	1	24	3	17	1	30	6	21
12	1	49	9	36	1	29	5	21	1	19	3	15	1	23	5	17
13	1	43	8	30	1	26	4	19	1	17	3	13	1	17	4	13
14	1	35	6	25	1	22	3	16	1	15	2	11	1	14	3	11
15	1	28	5	20	1	19	3	14	1	14	2	10	1	13	3	9
16	1	22	4	17	1	15	2	12	1	13	2	9	1	11	2	8
17	1	20	4	15	1	13	2	10	1	12	2	8	1	11	2	8
18	1	19	3	14	1	11	2	9	1	12	2	8	1	10	2	7
19	1	18	3	13	1	10	2	8	1	11	2	8	1	10	1	7
20	1	18	3	13	1	10	2	8	1	11	2	7	1	9	1	6
21	1	19	3	13	1	10	2	8	0	10	1	7	1	9	1	6
22	1	19	3	14	1	11	2	8	1	10	2	7	1	9	1	6
23	1	20	3	15	1	13	2	10	1	11	2	8	1	8	1	5
24	1	20	3	15	1	14	3	10	1	11	2	8	1	7	1	5
25	1	21	4	20	1	15	3	12	1	11	2	8	1	7	1	5

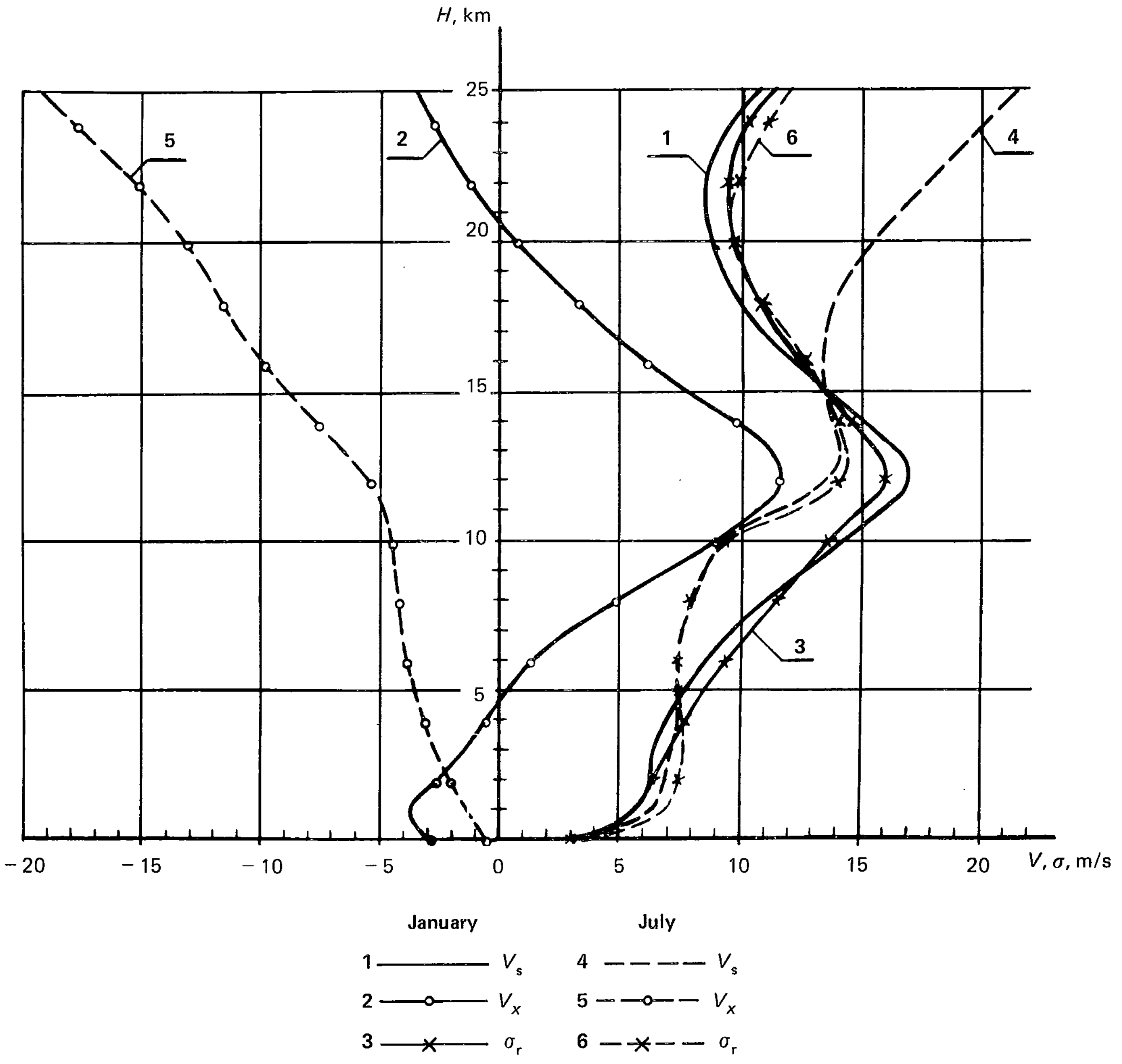

Figure 1 — Mean profiles of the wind characteristics for the latitude zone 0 – 20° N

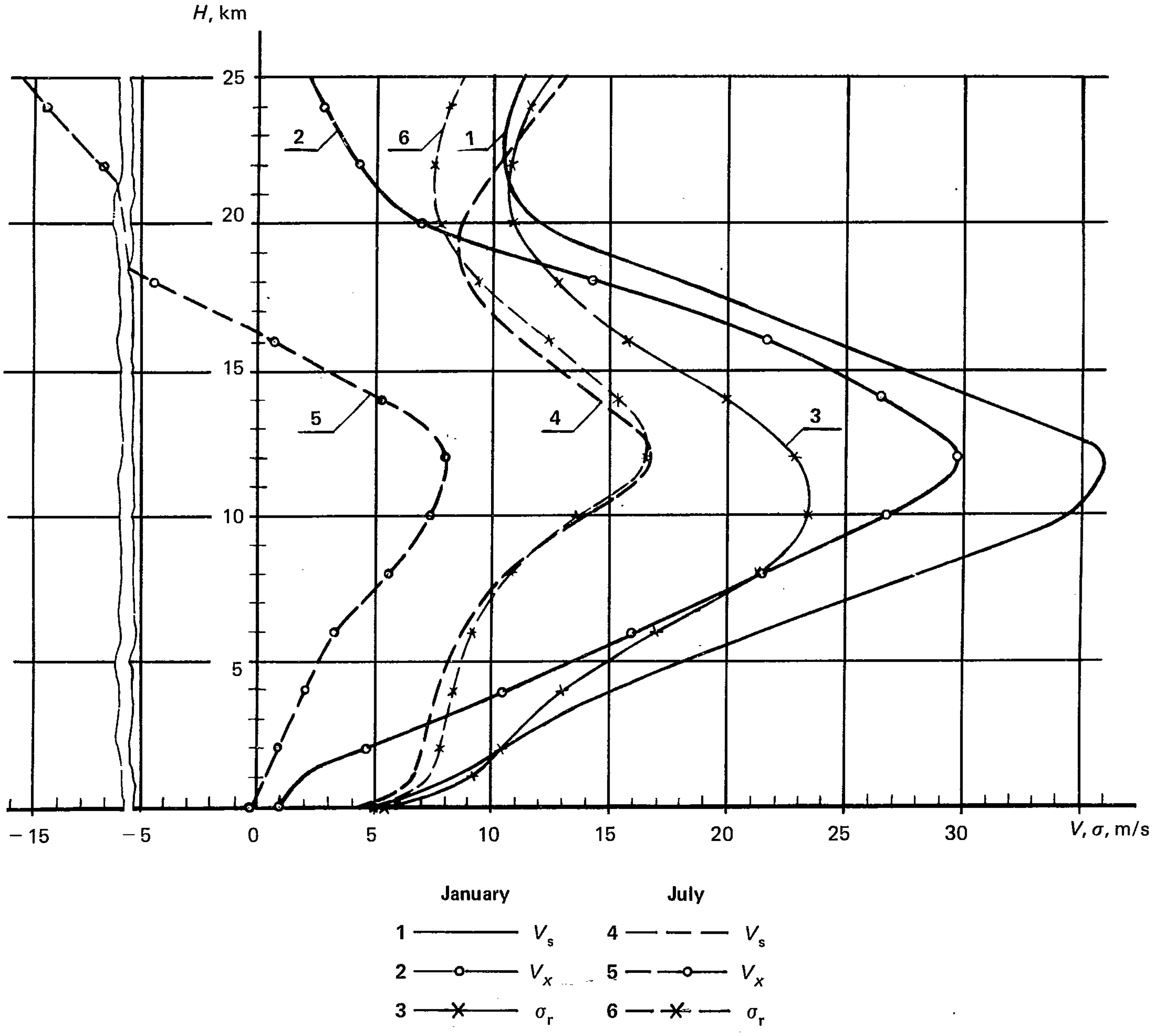

Figure 2 — Mean profiles of the wind characteristics for the latitude zone 20 – 40° N

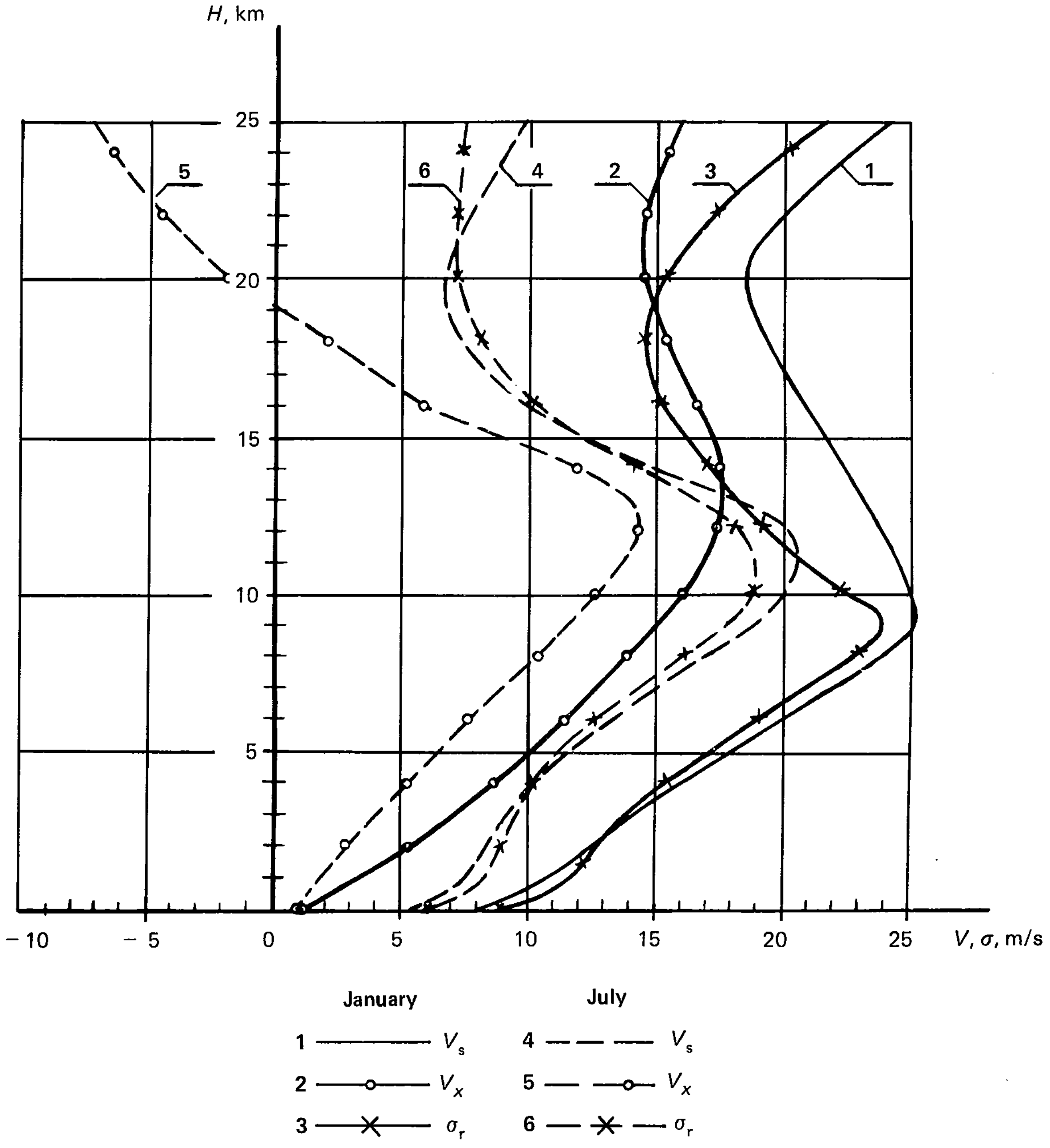

Figure 3 — Mean profiles of the wind characteristics for the latitude zone 40 – 60° N

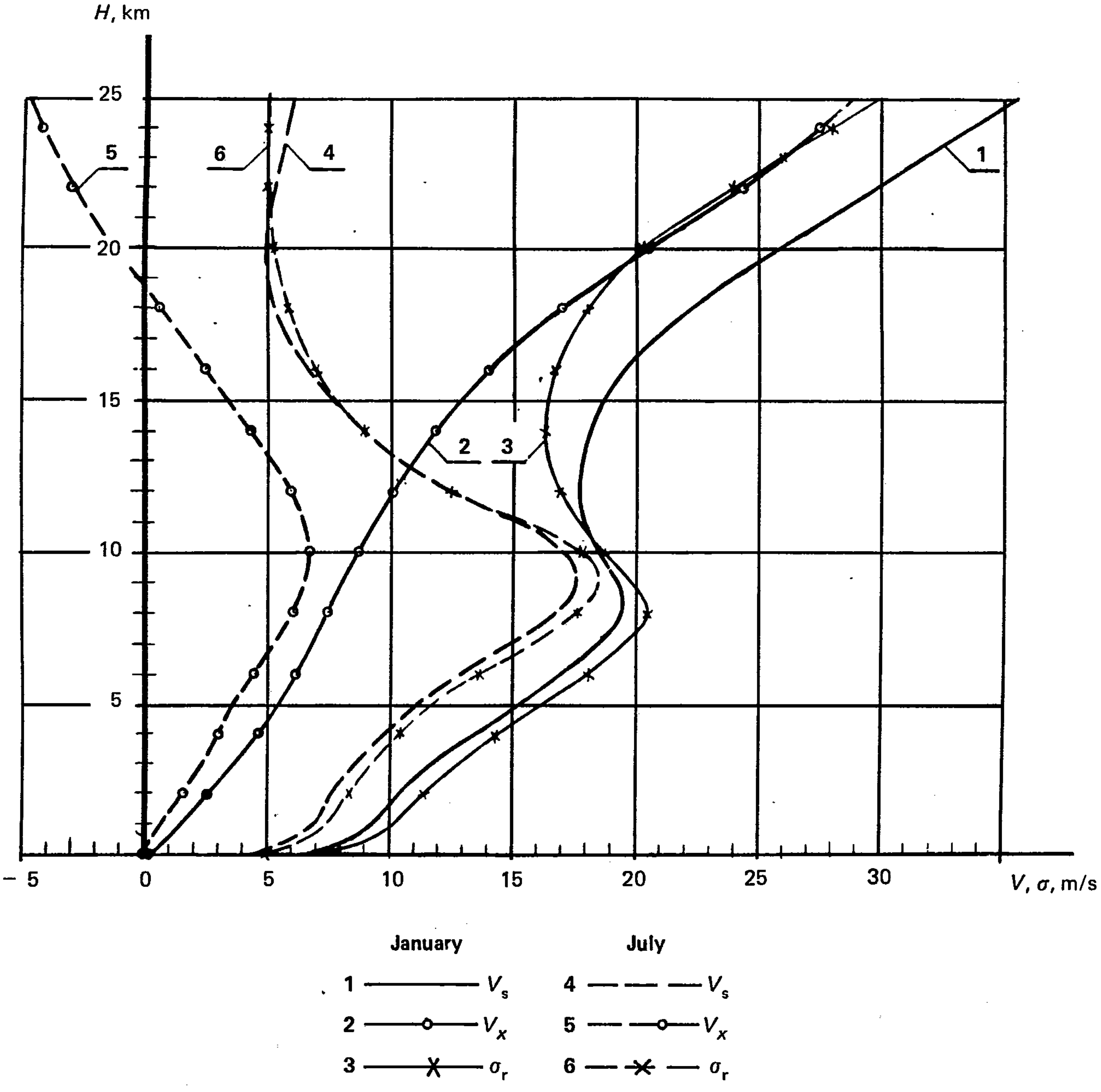

Figure 4 — Mean profiles of the wind characteristics for the latitude zone 60 – 80° N

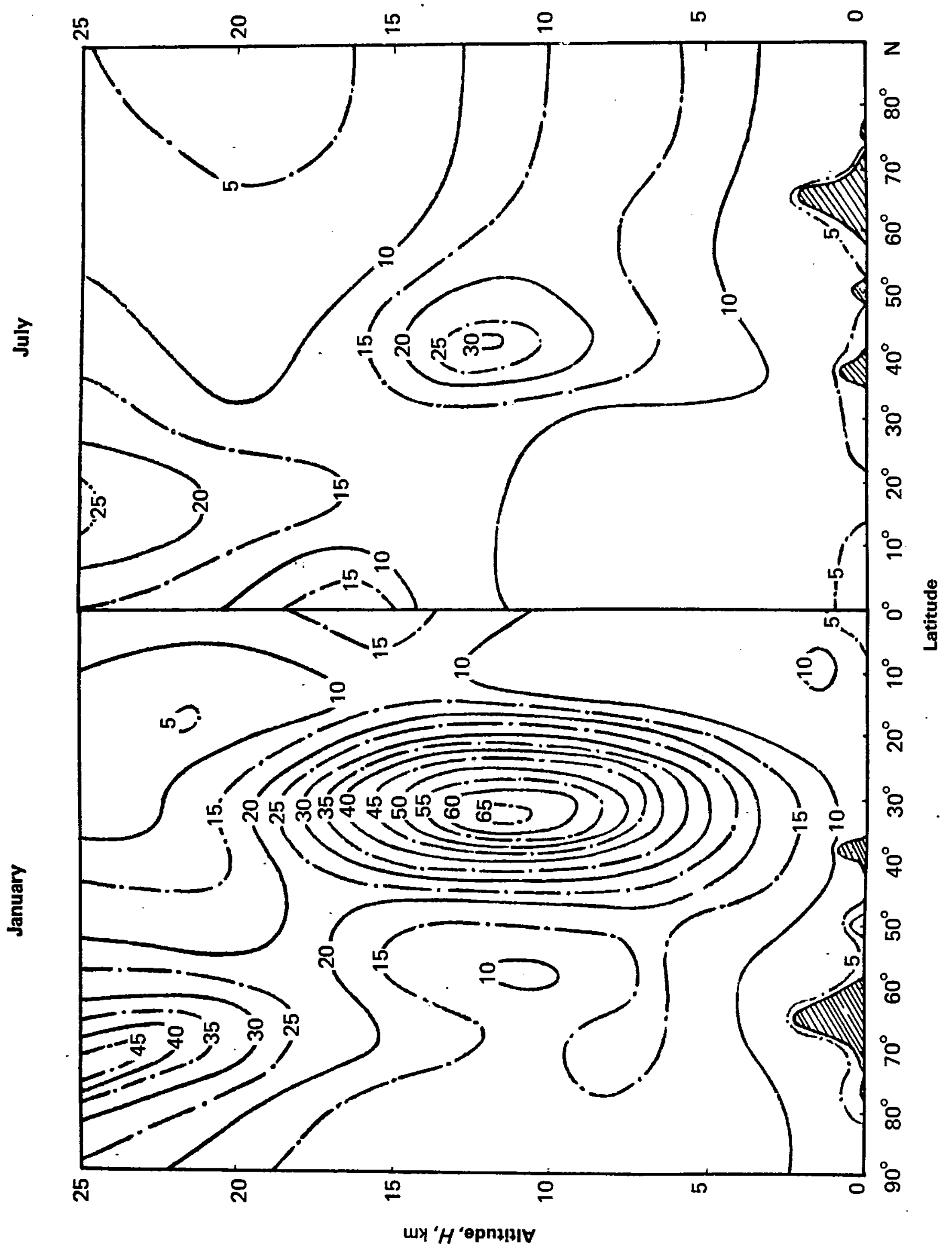

Figure 5 — Distribution of mean wind speeds (m/s) along 140° E

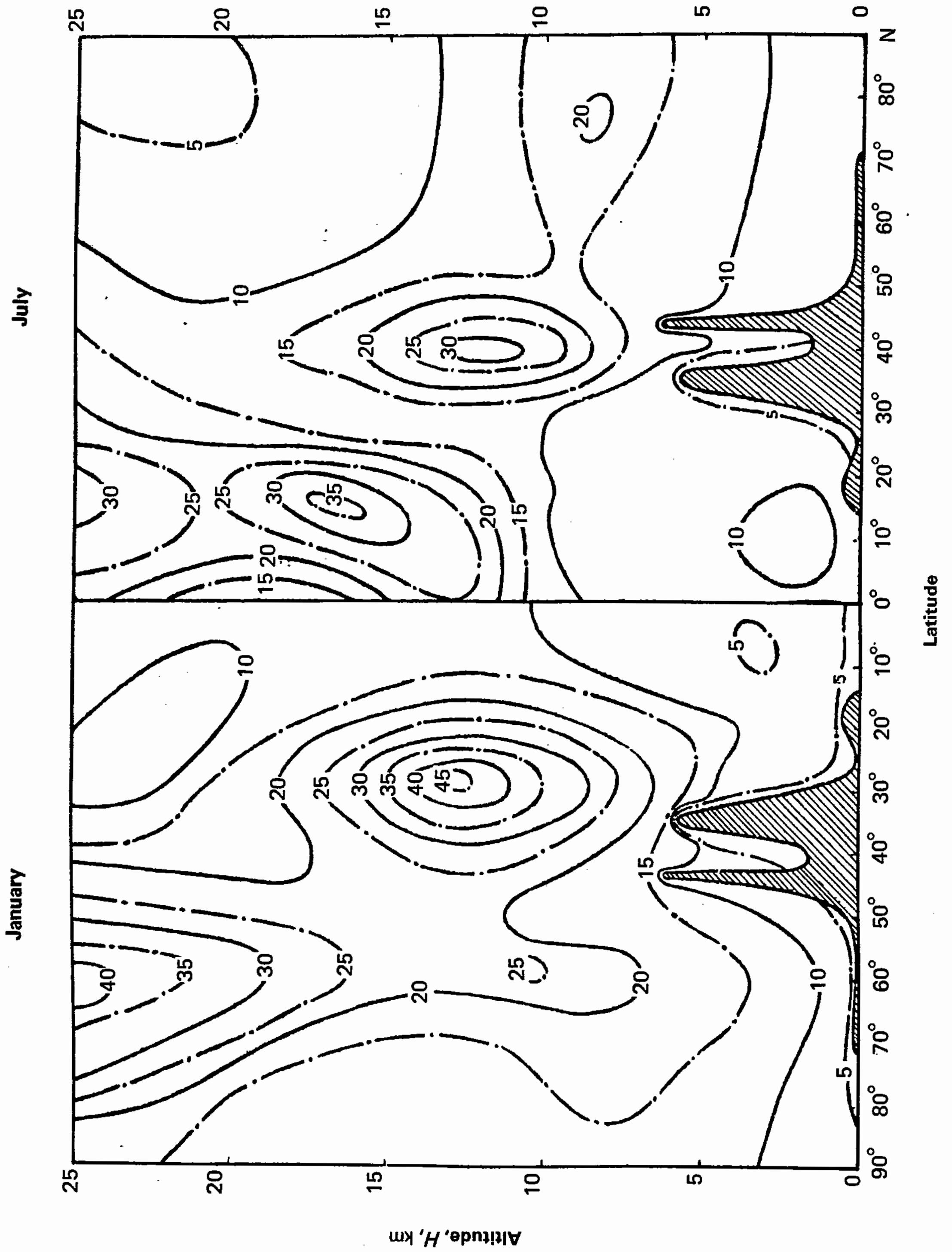

Figure 6 — Distribution of mean wind speeds (m/s) along 80° E

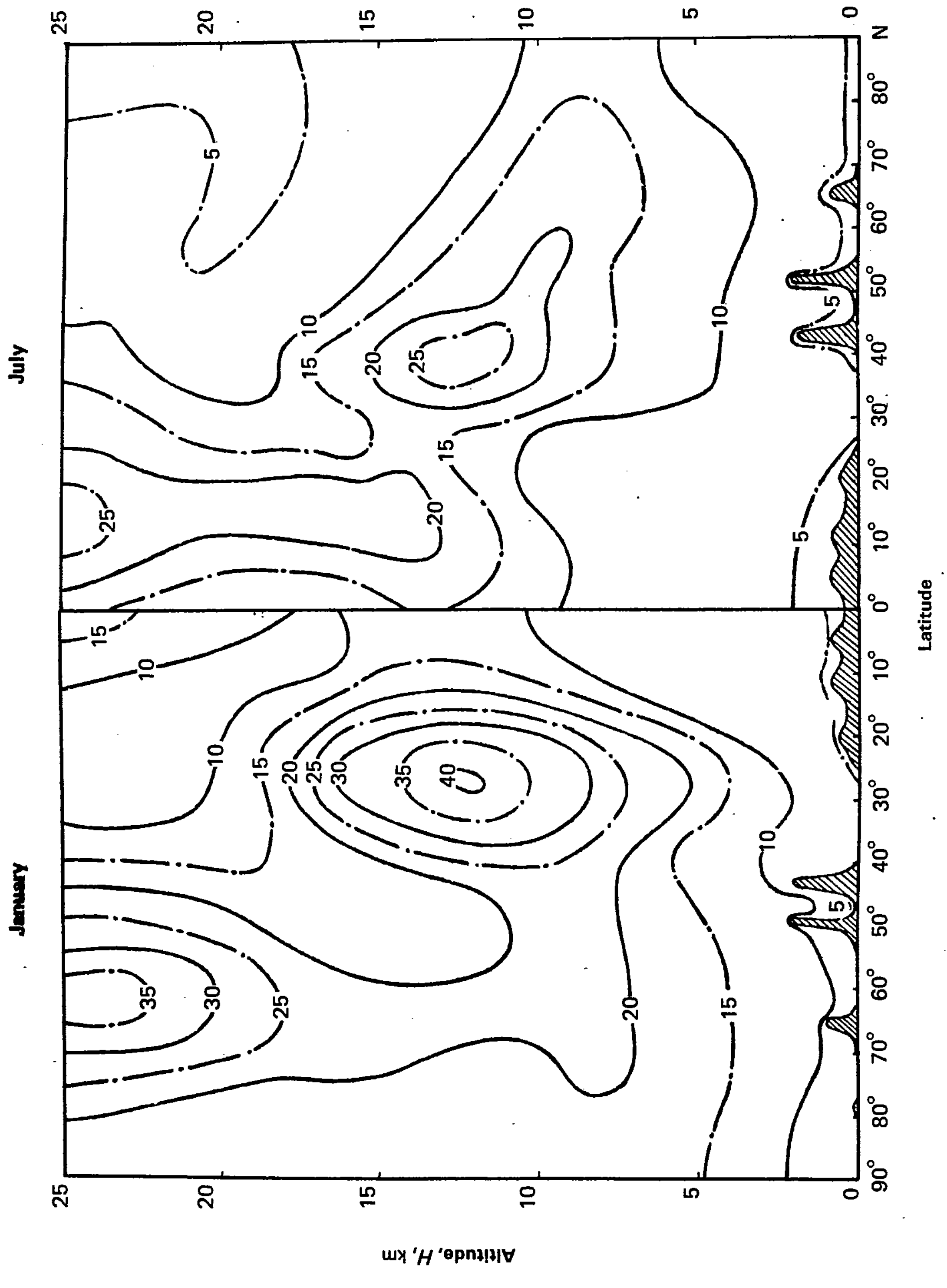

Figure 7 — Distribution of mean wind speeds (m/s) along 20° E

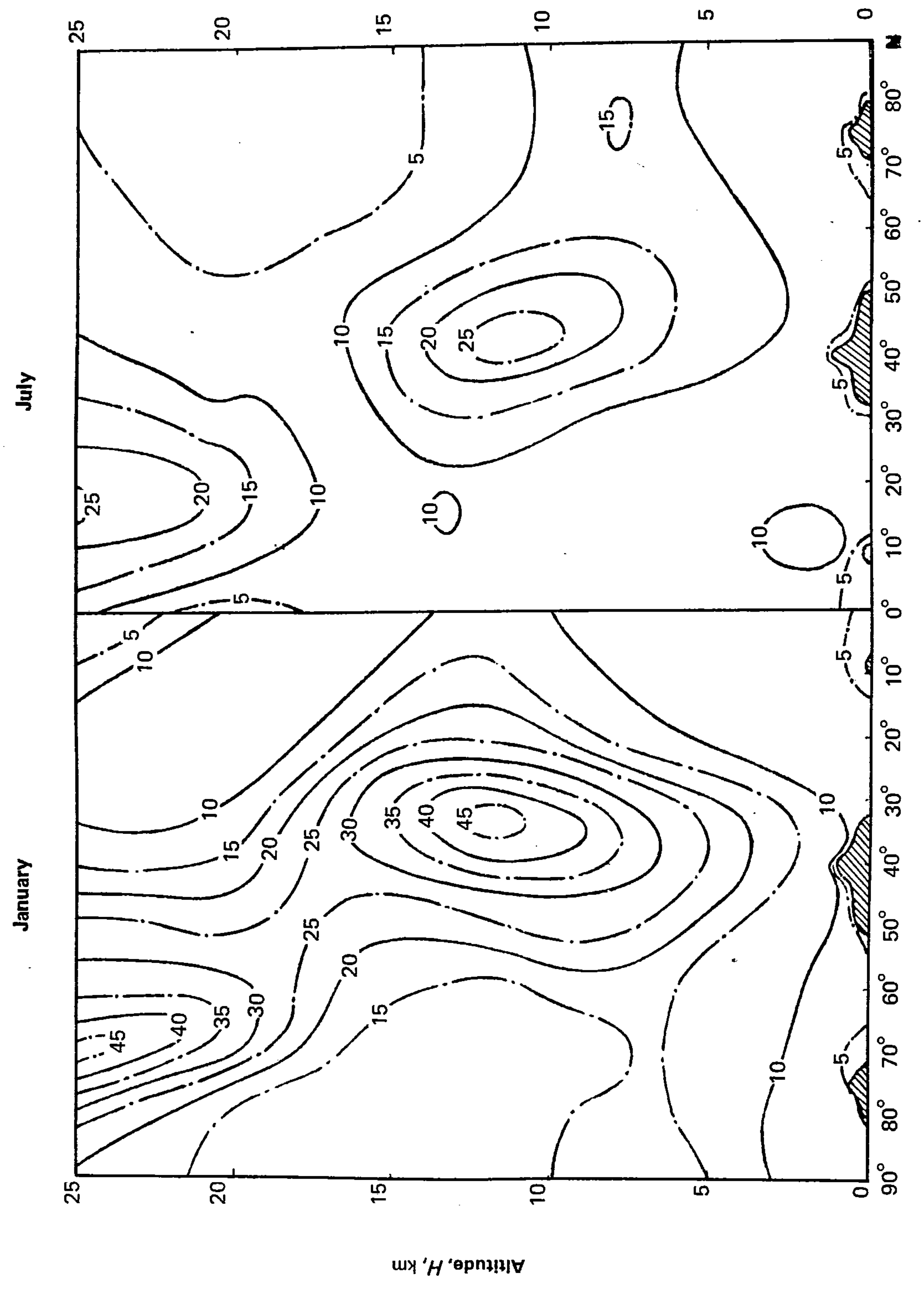

Figure 8 — Distribution of mean wind speeds (m/s) along 80° W

Bibliography

[1] *Atlas klimatičeskih harakteristik temperatury, plotnosti i davlenija vozduha, vetra i geopotenciala v troposfere i nižnej stratosfere severnogo polyšarija.* Vypusk VI. *Veter na glavnyh izobaričeskih poverhnostjah.* Čast' pervaja, pod red. J.G. Gutermana. Moskva, Gidrometeoizdat, 1975.

[2] CRUTCHER, H.L. *Upper wind statistics charts of the northern hemisphere,* vol. 1,2. Issued by the Office of the Chief of Naval Operations, 1959.

[3] *Material po klimatu i cirkuljacii svobodnoj atmosfery nad SSSR.* Tom pervyi. *Statističkie harakteristiki vetra.* Pod. red. J.G. Gutermana. Moskva, Gidrometeoizdat, 1970.

[4] *Materialy po klimatu i circuljacii svobodnoj atmosfery nad zarubežnymi stranami.* Tom pervyi. *Statističeskie harakteristiki vetra.* Vyp.I. Evropa, Asija, Atlantičeskij okean. Pod red. J.G. Gutermana. Moskva, Gidrometeoizdat, 1972. Vyp.II, Amerika, Afrika, Tihij okean. Pod red. J.G. Gutermana. Moskva, Gidrometeoizdat, 1974.

[5] *Monthly climatic data for the World,* USA, 1957-1965.

[6] STARR, V.P., PEIXETO, S.P., and GAUT, N.E. *Momentum and zonal kinetic energy balance of the atmosphere from five years of hemisphere data.* Tellus, Vol. 22, No. 3, 1970.

[7] TUCKER, G.B. *Upper winds over the World.* Part III. *Standard vector deviations of wind up to 100-millibar level over the World.* Geophys. Mem. No. 105, London, 1960.

[8] GUTERMAN, J.G. *Raspredelenie vetra nad severnym polušariem.* L. Gidrometeoizdat, 1965.

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

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

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

Price based on 39 pages

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

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
Brazil	Italy	Spain
Canada	Japan	USA
Chile	Korea, Rep. of	USSR
Czechoslovakia	Poland	

The number bodies of the following countries expressed disapproval of the document on technical grounds:

Ireland
United Kingdom

Contents

Reference atmospheres for aerospace use

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, $M = 28{,}964\ 420\ \mathrm{kg \cdot kmol^{-1}}$, 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 $\mathrm{J \cdot K^{-1} \cdot kg^{-1}}$ (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	$\mathrm{m \cdot s^{-2}}$
M	28,964 420	$\mathrm{kg \cdot kmol^{-1}}$
N_A	$602{,}257 \times 10^{24}$	$\mathrm{kmol^{-1}}$
R^*	8 314,32	$\mathrm{J \cdot K^{-1} \cdot kmol^{-1}}$ or $\mathrm{kg \cdot m^2 \cdot s^{-2} \cdot K^{-1} \cdot kmol^{-1}}$
R	287,052 87	$\mathrm{J \cdot K^{-1} \cdot kg^{-1}}$ or $\mathrm{m^2 \cdot K^{-1} \cdot s^{-2}}$

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, $\frac{R^*}{M}$ = 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.

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 $g_{0\varphi}$, m·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 × 10³	1,013 250 × 10³
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:

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

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

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.

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

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

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.

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%.

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·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

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

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·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

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

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·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

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

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

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

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

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·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	1,625 079	−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

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

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

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·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

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	

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	

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]

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				

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	17-18-19 January 1967
13 December 1968	27-28-29 December 1967
13 December 1968*	20 January 1969
	10 February 1966*
Ft. Greely	
5 February 1967	5 February 1969
17 January 1966	
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	16 December 1967
22-23 January 1969	18 January 1966
14-21-25 January 1970	31 January 1966
	31 January 1968
	30-31 January 1969

* Grenade observations.

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

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

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

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 %		10 %		20 %	
			high	low	high	low	high	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

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·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	$1{,}026\,9 \times 10^{-4}$

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

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 $kg \cdot m^{-3}$
			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	$1{,}845\ 8 \times 10^{-5}$

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						ISO 2533 density kg·m⁻³
			1 %		10 %		20 %		
			high	low	high	low	high	low	
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	$1,845\ 8 \times 10^{-5}$

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 *(concluded)*

80° 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	+ 4	+ 8	+ 1	+ 7	+ 2	+ 6	+ 3	$7,364\,3 \times 10^{-1}$
	10	− 5	+ 5	− 14	0	− 10	− 2	− 8	$4,135\,1 \times 10^{-1}$
	15	− 8	− 1	− 16	− 4	− 12	− 6	− 11	$1,947\,6 \times 10^{-1}$
	20	− 12	− 1	− 22	− 6	− 17	− 8	− 15	$8,891\,0 \times 10^{-2}$
	25	− 4	+ 19	− 28	+ 9	− 17	+ 4	− 13	$4,008\,4 \times 10^{-2}$
	30	− 23	− 8	− 39	− 12	− 31	− 17	− 18	$1,841\,0 \times 10^{-2}$
	35	− 25	+ 1	− 44	− 12	− 35	− 17	− 32	$8,463\,4 \times 10^{-3}$
	40	− 27	+ 4	− 50	− 10	− 40	− 15	− 38	$3,995\,7 \times 10^{-3}$
	45	− 27	+ 9	− 51	− 8	− 45	− 14	− 39	$1,966\,3 \times 10^{-3}$
	50	− 31	0	− 55	− 15	− 47	− 21	− 44	$1,026\,9 \times 10^{-3}$
	55	− 37	+ 4	− 59	− 22	− 54	− 26	− 52	$5,681\,0 \times 10^{-4}$
	60	− 42	− 7	− 66	− 21	− 60	− 31	− 56	$3,096\,8 \times 10^{-4}$
	65	− 47	+ 1	− 69	− 27	− 64	− 36	− 60	$1,632\,1 \times 10^{-4}$
	70	− 50	+ 5	− 69	− 24	− 63	− 34	− 60	$8,282\,8 \times 10^{-5}$
	75	− 47	− 2	− 72	− 27	− 65	− 35	− 60	$3,992\,1 \times 10^{-5}$
	80	− 46	+ 18	− 78	− 19	− 68	− 30	− 62	$1,845\,8 \times 10^{-5}$
June-July	5	+ 1	+ 4	− 2	+ 3	− 1	+ 2	− 0	$7,364\,3 \times 10^{-1}$
	10	− 1	+ 7	− 9	+ 3	− 5	+ 2	− 4	$4,135\,1 \times 10^{-1}$
	15	− 1	+ 5	− 6	+ 3	− 4	+ 1	− 3	$1,947\,6 \times 10^{-1}$
	20	+ 3	+ 8	− 2	+ 6	0	+ 5	+ 1	$8,891\,0 \times 10^{-2}$
	25	+ 7	+ 16	− 2	+ 12	+ 3	+ 11	+ 4	$4,008\,4 \times 10^{-2}$
	30	+ 8	+ 18	+ 5	+ 15	+ 6	+ 13	+ 7	$1,841\,0 \times 10^{-2}$
	35	+ 13	+ 30	+ 3	+ 20	+ 10	+ 18	+ 11	$8,463\,4 \times 10^{-3}$
	40	+ 20	+ 32	+ 6	+ 26	+ 13	+ 24	+ 15	$3,995\,7 \times 10^{-3}$
	45	+ 25	+ 41	+ 7	+ 33	+ 17	+ 30	+ 18	$1,966\,3 \times 10^{-3}$
	50	+ 30	+ 47	+ 2	+ 42	+ 16	+ 39	+ 22	$1,026\,9 \times 10^{-3}$
	55	+ 36	+ 51	0	+ 49	+ 17	+ 46	+ 25	$5,681\,0 \times 10^{-4}$
	60	+ 38	+ 58	+ 8	+ 56	+ 20	+ 51	+ 26	$3,096\,8 \times 10^{-4}$
	65	+ 39	+ 68	+ 10	+ 63	+ 18	+ 56	+ 23	$1,632\,1 \times 10^{-4}$
	70	+ 35	+ 81	+ 7	+ 71	+ 17	+ 62	+ 23	$8,282\,8 \times 10^{-5}$
	75	+ 28	+ 80	− 12	+ 60	+ 3	+ 48	+ 8	$3,992\,1 \times 10^{-5}$
	80	+ 24	+ 57	− 13	+ 45	+ 3	+ 40	+ 8	$1,845\,8 \times 10^{-5}$

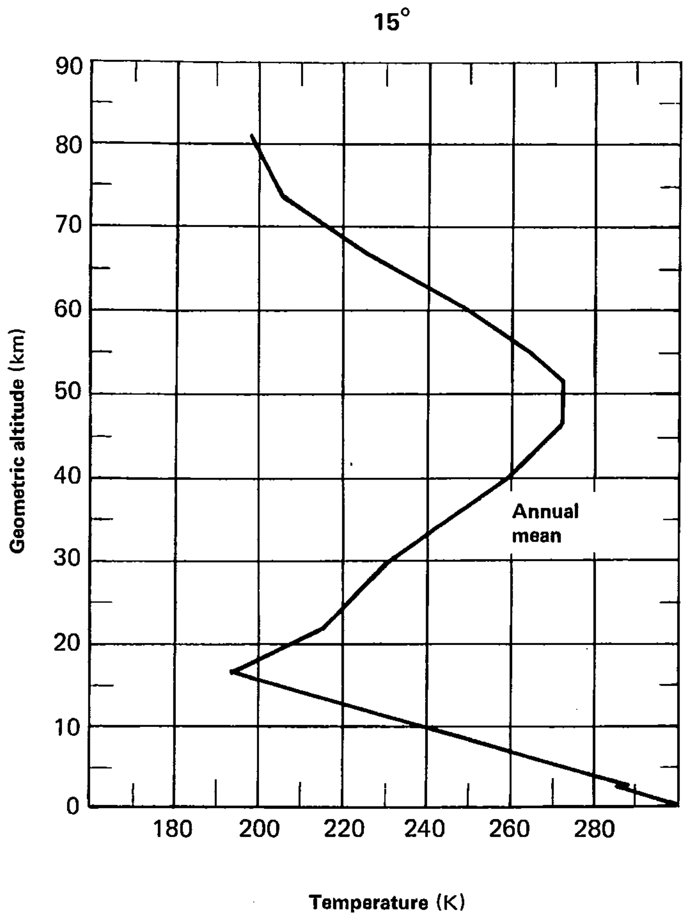

Figure 1 — Temperature-altitude profiles for the mean annual atmosphere for 15° latitude and for mean December-January and June-July atmospheres for 30, 45, 60 and 80° N

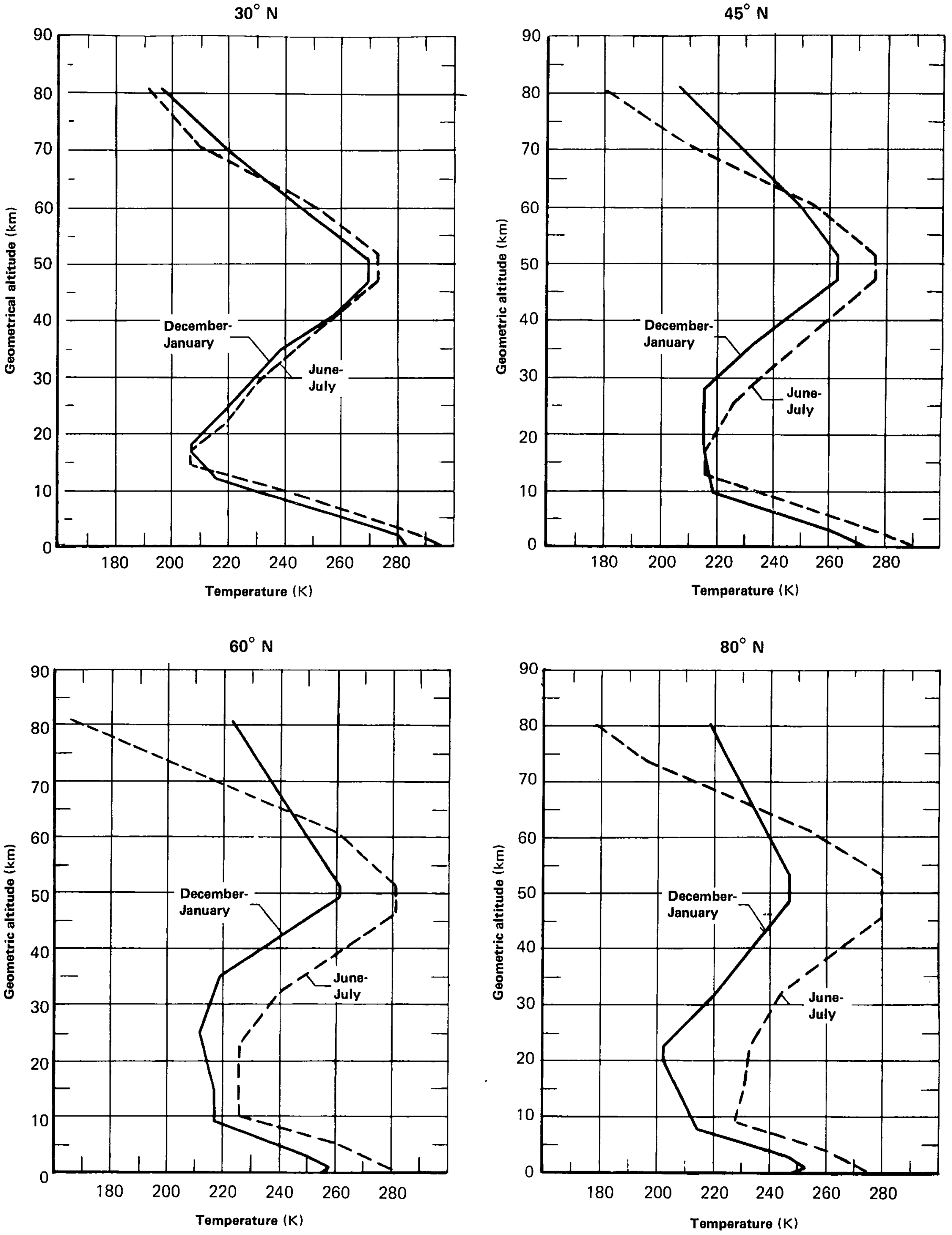

Figure 1 — Temperature-altitude profiles for the mean annual atmosphere for 15° latitude and for mean December-January and June-July atmospheres for 30, 45, 60 and 80° N ***(concluded)***

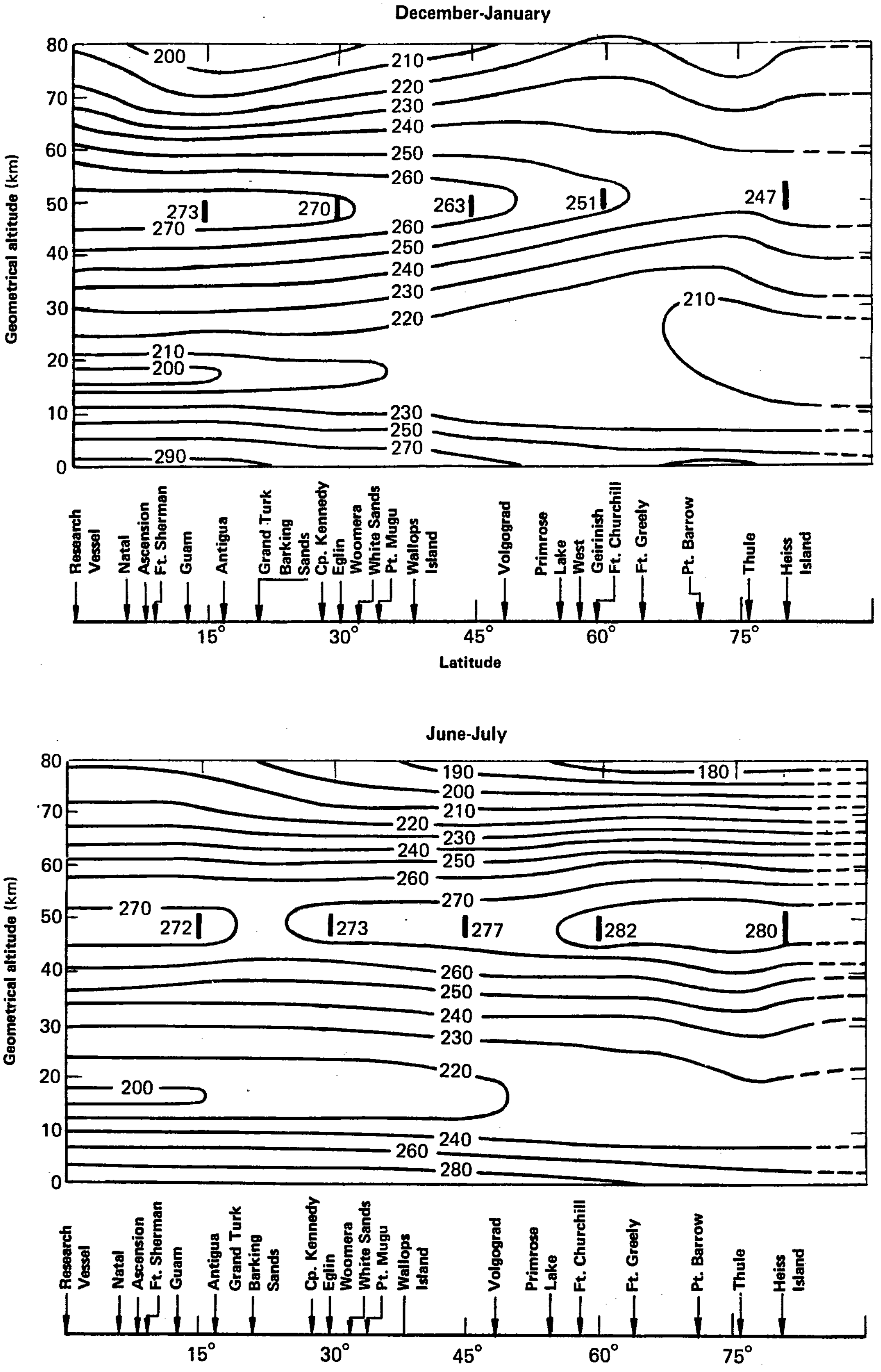

Figure 2 — Temperature-altitude cross-sections for December-January and June-July

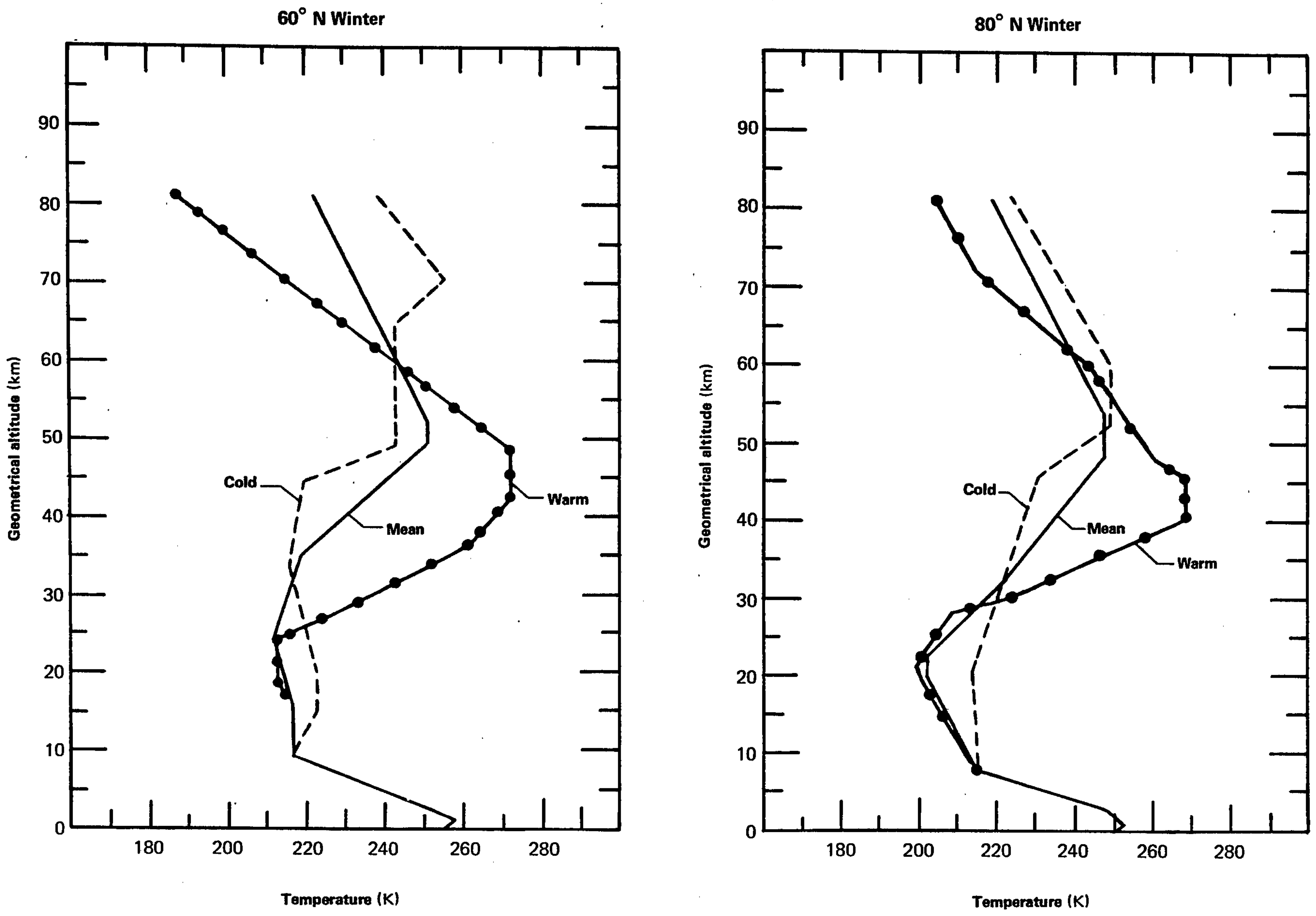

Figure 3 — Temperature-altitude profiles for warm and cold December-January atmospheres at 60 and 80° N

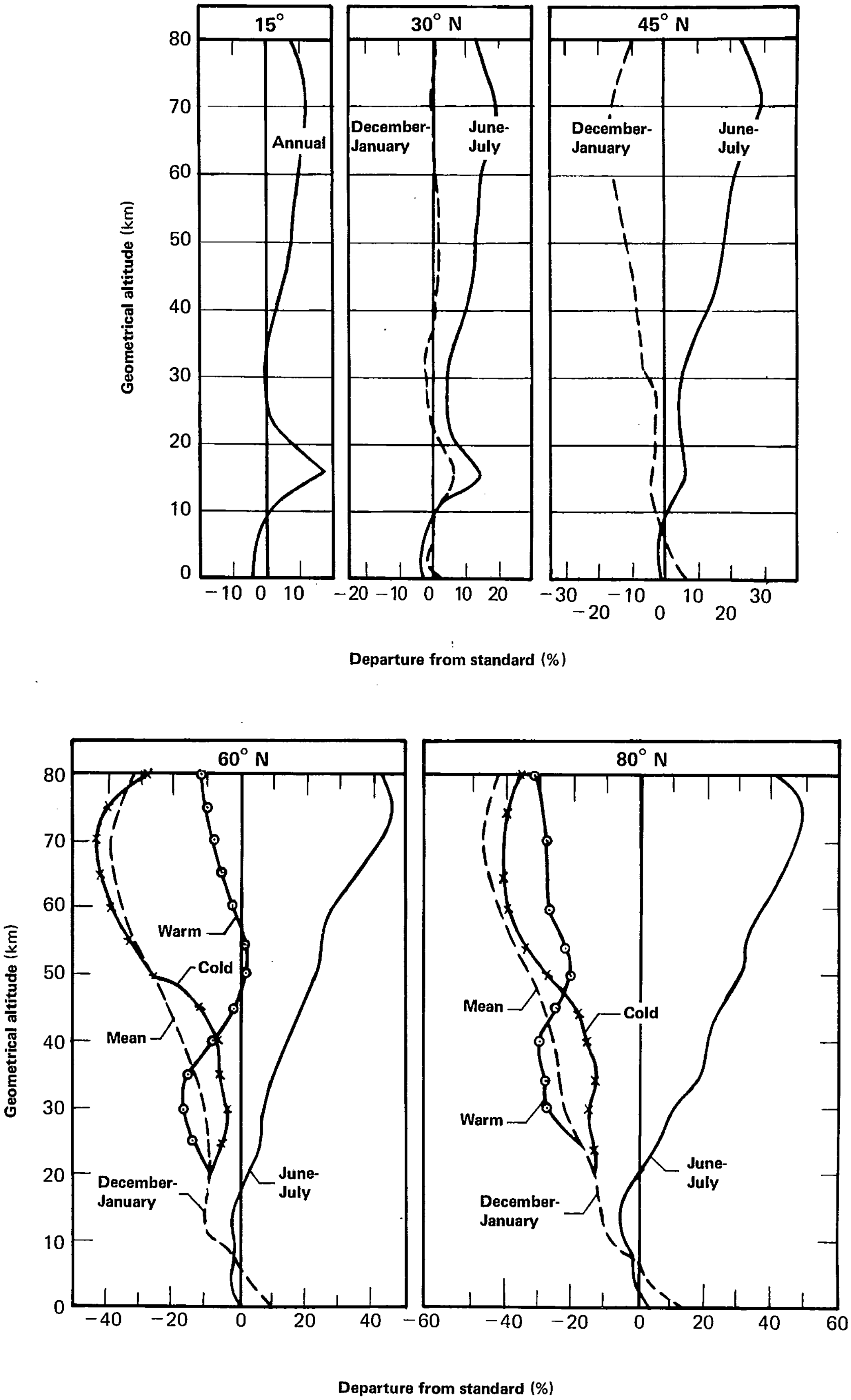

Figure 4 — Departures of reference atmosphere densities (mean values from tables 3-15) from standard

7 Bibliography

[1] LIST, R. J., ed. (1963) *Smithsonian meteorological tables,* Sixth Revised Edition, Washington, D.C., USA.

[2] WORLD METEOROLOGICAL ORGANIZATION in cooperation with U.S. WEATHER BUREAU (1956-1966) *Monthly climatic data of the World.*

[3] *Normal weather charts for the northern hemisphere,* USWB Tech. Paper No. 21, U.S. Department of Commerce, Ashville, USA.

[4] LAHEY, J. F., BRYSON, R. A., and WAHL, E. W. (1958) *Atlas of five-day normal sea level pressure charts for northern hemisphere,* Univ. Wisconsin Press, Madison, Wisconsin, USA.

[5] *Data reports, Meteorological rocket network* Vol. I to VI (1964-1970) World Data Center A for Meteorology, National Weather Records Center, Ashville, North Carolina, USA.

[6] SMITH, W., KATCHEN, L., SACHER, P., SWARTZ, P., and THEON, J. (1964) *Temperature, pressure, density and wind measurements with the rocket grenade experiment, 1960-1963,* NASA TR R-211 Washington, D.C., USA.

SMITH, W., THEON, J., KATCHEN, L., and SWARTZ, P. (1966) *Temperature, pressure, density and wind measurements in the upper stratosphere and mesosphere, 1964,* NASA TR R-245, Washington, D.C., USA.

SMITH, W., THEON, J., SWARTZ, P., and KATCHEN, L. *Temperature, pressure, density and wind measurements in the upper stratosphere and mesosphere, 1965,* NASA TR R-263, Washington, D.C., USA.

SMITH, W., THEON, J., SWARTZ, P., and KATCHEN, L.(1968) *Temperature, pressure, density and wind measurements in the stratosphere and mesosphere, 1966,* NASA TR R-288, Washington, D.C., USA.

SMITH, W., THEON, J., and SWARTZ, P. (1968) *Temperature, pressure, density and wind measurements in the stratosphere and mesosphere, 1967,* NASA TR R-306, Washington, D.C., USA.

SMITH, W., THEON, J., CASEY, J., and HORVATH, J. (1970) *Temperature, pressure, density and wind measurements in the upper stratosphere and mesosphere, 1968,* NASA TR R-..., Washington, D.C., USA.

SMITH, W., THEON, J., CASEY, J., AZCARRAGA, A., and HORVATH, J., (1971) *Temperature, pressure, density and wind measurements in the upper stratosphere and mesosphere, 1969,* NASA TR R-360, Washington, D.C., USA.

[7] PETERSON, J., HANSEN, W., McWATTERS, K., and BONFANTI, G. (1965) *Atmospheric measurements over Kwajalein using falling spheres,* NASA CR-218, Washington, D.C., USA.

[8] SALAH, J. E. (1967) "Density measurements at Kwajalein", *Journal Geophysic., Research* vol. 72.

[9] FAIRE, A. C., and CHAMPION, K. W. S. (1965) "Falling sphere measurement of atmospheric density, temperature and pressure up to 115 km", *Space Research* **V**, North-Holland and Publishing Co., Amsterdam.

FAIRE, A. C., and CHAMPION, K. W. S. (1967) "High-altitude rocket density measurements at Eglin AFB, Florida", *Space Research* **VI**, North-Holland Publishing Co., Amsterdam.

FAIRE, A. C., and CHAMPION, K. W. S. (1967) "Falling sphere measurements of atmospheric density, temperature, and pressure at Fort Churchill, Canada and Eglin, Florida", *Space Research* **VII**, North-Holland Publishing Co., Amsterdam.

FAIRE, A. C., and CHAMPION, K. W. S. (1968) "Recent density, temperature and pressure obtained at White Sands Missile Range compared with IQSY results", *Space Research* **VIII**, North-Holland Publishing Co., Amsterdam.

FAIRE, A. C., and CHAMPION, K. W. S. (1969) "Upper atmospheric parameters from recent falling sphere measurements at Eglin, Florida", *Space Research* **IX**, North-Holland Publishing Co., Amsterdam.

[10] ROFE, B. (1966) *The stratosphere and mesosphere circulation at mid-latitudes of the southern hemisphere* W.R.E. Tech. Note PAD, Salisbury S.A.

[11] GROVES, G. V. (1966) "Seasonal variations of temperature, pressure, density and winds to 80 km altitude at Woomera, 1957-1963", *Space Research* **VI**, Spartan Books, Inc.

GROVES, G. V. (1965) "Diurnal variations in upper atmosphere wind and temperature structure of Woomera, 15-16 October 1963", *Space Research* **V**, North-Holland Publishing Co., Amsterdam.

GROVES, G. V. (1967) "Variations in upper atmosphere wind, temperature and pressure at Woomera during the night of 29/30 April 1965", *Space Research* **VII**, North-Holland Publishing Co., Amsterdam.

[12] "Results of rocket probing of the atmosphere", Центральная Аэрологическая Обсерватория, Бюллетень, Moscow 1968-1971.

[13] Staff, Upper Air Branch, National Meteorological Center, *Weekly synoptic analyses,* 5, 2 *and* 0,4 mb *surfaces for 1964, 65, 66, 67,* ESSA Tech. Rpt. WB-2, WB-3 and WB-9, Environmental Sciences Administration, Silver Springs, Maryland, USA.

[14] COLE, A. E. (1969) "Longitudinal variations in the structure of the stratosphere and mesosphere", *Space Research* **X**, North-Holland Publishing Co., Amsterdam.

[15] KIDIYAROVA, V. G., TARASENKO, D., A., and SCHERBA, I. A. (1973) "Influence of longitudinal variations of the structure of the temperature, pressure and wind fields in the stratosphere and mesosphere of the northern hemisphere", *Space Research* **XIV** Akademie-Verlag, Berlin.