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Middle atmosphere — Global model at altitudes between 30 km and 120 km, and wind model at altitudes above 30 km

Atmosphère moyenne — Modèle global aux altitudes comprises entre 30 km et 120 km, et modèle de vent aux altitudes supérieures à 30 km

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Contents

Page

Section 1 General **1**

1.1 Scope **1**

Section 2 Global model **2**

2.1 Introduction **2**

2.2 Basic assumptions and formulas **2**

Section 3 Wind model **79**

3.1 Introduction **79**

3.2 List of symbols and constants **79**

3.3 Data sources and methods of computation **79**

3.4 Tables for the wind model of the middle atmosphere **80**

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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 or electrotechnical standardization.

The main task of technical committees is to prepare International Standards. In exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 14618, which is a Technical Report of type 2, was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, sub-committee SC 6, *Standard atmosphere*.

Introduction

Since the publication of the last ISO standard atmosphere (ISO 2533:1975, *Standard atmosphere*), numerous new ground-based and satellite measurements have become available. This large influx of new data makes it possible to encompass the entire globe from the ground to the upper thermosphere and to provide information on the seasonal and latitude variability of the thermodynamic properties of the atmosphere for altitudes between 30 km and 120 km.

The detailed information on parameters distribution allows the calculation of mean wind at the middle atmosphere.

This Technical Report is based on COSPAR International Reference Atmosphere, 1986 (CIRA-86) which is the most extensive work analysing numerous satellite and ground-based measurements of the middle atmosphere.

Middle atmosphere — Global model at altitudes between 30 km and 120 km, and wind model at altitudes above 30 km

Section 1: General

1.1 Scope

This Technical Report establishes a zonal monthly mean of temperature, pressure, density and zonal wind. These data can be used as a function of geopotential/geometric height and has a latitudinal coverage from 80° S to 80° N, extending from altitudes between 30 km and 120 km.

This Technical Report was developed to serve as a mean basis for the design and operation of vehicles and provides additional information for general scientific purposes.

Section 2: Global model

2.1 Introduction

The global model described in this section accurately reproduces most of the characteristic features of the middle atmosphere, as shown by a series of investigations.

2.2 Basic assumptions and formulas

2.2.1 List of symbols and constants

Symbols and constants used in this section are defined below. Any deviations from this notation are described in the text.

T temperature in kelvins

p pressure in pascals

ρ density in kilograms per cubic metre

h geometric height in metres

H geopotential height in geopotential metres (m′)

ϕ latitude in degrees

g acceleration of gravity in metres per second squared

r earth's radius in metres

M air molar mass in kilograms per mole

$N_A = 602{,}257 \times 10^{24}$ Avogadro constant, based on the value of the nuclide ^{12}C, (atomic mass = 12,000) as adopted in 1961 by the Conference of the International Union of Pure and applied Chemistry as the basic mass unity

$R' = 8\,314{,}32\ J \cdot K^{-1} \cdot kmol^{-1}$ universal gas constant

$S = 110{,}4\ K$

$\beta_S = 1{,}458 \times 10^{-6}\ kg \cdot m^{-1} \cdot s^{-1} \cdot K^{-1/2}$ } Sutherland's empirical coefficients in the equation for dynamic viscosity

$\sigma = 0{,}365 \times 10^{-9}$ m effective collision diameter of an air molecule

$k = \frac{c_p}{c_v} = 1{,}4$ adiabatic index, the ratio of the specific heat of air at constant pressure to its specific heat at constant volume

2.2.2 Static atmosphere and the perfect gas law

The atmosphere is subject to gravity when static to the earth. The air static equilibrium conditions are determined by a static atmosphere equation which relates air pressure p, density ρ and free fall acceleration g as follows:

$$-dp = \rho g dh \tag{1}$$

The perfect gas law determines air pressure, density and temperature relation as follows:

$$p = \frac{\rho R' T}{M} \tag{2}$$

2.2.3 Geopotential/geometric height relation

The geometric height or altitude of an element is its distance above the reference sea level ellipsoid.

The geopotential height of that element can be considered to be its geometric height plus (or minus) a correction depending upon latitude and height, which allows the dynamical equations to be applied more simply without having to make additional allowance for varying values of the gravitational acceleration and centrifugal force due to the earth's rotation about its axis. Thus use of geopotential height enables a single standard value of gravitational acceleration to be used.

Geopotential height H_ϕ of a unit mass, at a given latitude ϕ, relative to the reference geopotential at the earth's surface h_0 at the same latitude, varies with geometric height h and with the altitude dependent acceleration of gravity $g_\phi(h)$ for that latitude in accordance with the following integral equation

$$H_\phi = \int_{h_0}^{h} g_\phi(h)dh \qquad (3)$$

The determination of a function of h permits the perfect integration of equation (3) and thus leads to a numerical value of H_ϕ for specified values of h. The extreme differences of H_ϕ for a given value of h as determined by various sophisticated methods are very small compared with the uncertainties of the atmospheric properties. Thus, the geopotential/geometric height relation may be obtained with sufficient accuracy for the purposes of this Technical Report by using the simplified method given below.

The analytical relationship for H_ϕ as a function of h is calculated by replacing $g_\phi(h)$ with a specialized form of the inverse-square law prior to the integration of equation (3). The resulting relationship is:

$$H_\phi(h) = \frac{r_\phi h}{r_\phi + h} \cdot \frac{g_\phi}{G} \qquad (4)$$

where

H_ϕ is the geopotential height at latitude ϕ in geopotential meters (m′) as a function of geometric height h;

$G = 9{,}806\ 65\ \mathrm{m}^2 \cdot \mathrm{s}^{-2}\ (\mathrm{m}')^{-1}$, which implicitly defines one standard geopotential meter;

g_ϕ is the sea-level value of the acceleration of gravity at latitude ϕ, $(\mathrm{m} \cdot \mathrm{s}^{-2})$;

r_ϕ is the effective earth's radius for latitude ϕ, (m).

For any latitude ϕ, the value of r_ϕ is generally not equal to the earth's radius for that latitude, but rather is a quantity calculated to meet certain boundary conditions, such that the relationships (3) and (4) retain a high degree of validity over an extended range of heights at all of the latitudes given in table 1.

Table 1 — Values of r_ϕ and g_ϕ employed in the calculation of geopotential height various latitudes

ϕ	r_ϕ m	g_ϕ $\mathrm{m} \cdot \mathrm{s}^{-2}$
0°	6 334 984	9,780 36
10°	6 336 267	9,781 91
20°	6 339 971	9,786 38
30°	6 345 653	9,793 24
40°	6 352 638	9,801 67
50°	6 360 083	9,810 65
60°	6 367 103	9,819 11
70°	6 372 821	9,826 01
80°	6 376 562	9,830 51
90°	6 377 862	9,832 08

2.2.4 Atmospheric composition and air molecular weight

The earth's atmosphere is a mixture of gas, water vapour and a certain quantity of aerosol. Under certain conditions the quantities of water vapour, carbon dioxide and ozone (as well as some additional substances of insignificant volume) may vary. The water vapour content undergoes the greatest variation. Its concentration near the surface may reach 4 % but is negligible at altitudes higher than 30 km. Dry clean air composition up to an altitude of 94 km remains practically constant and corresponds to that given in table 2. In table 2 the air molecular weight M_c is determined from the perfect gas law [equation (2)] using the adopted standard values of pressure, temperature, density and the universal gas constant at mean sea level.

The air molecular weight M_c remains a constant value up to a height of 94 km. From heights of 94 000 m to 97 500 m the air molecular weight diminishes from M_c to 28,850 kg · kmol⁻¹ in accordance with the equation

$$M = 28{,}82 + 0{,}158\left\{1 - 7{,}5 \times 10^{-8}\,(h - 94\,000)^2\right\}^{1/2} - 2{,}479 \times 10^{-4}\,(97\,000 - h)^{1/2} \qquad (5)$$

The subsequent diminishing of air molecular weight up to a height of 120 km is determined by a linear function of height where the vertical molecular weight gradient is

$$\frac{\partial M}{\partial h} = 0{,}000\,1511\,\text{kg} \cdot \text{kmol}^{-1} \cdot \text{m}^{-1}$$

Table 2 — Dry clean air composition

Gas	Content of volume %	Molecular mass, M kg · kmol⁻¹
Nitrogen (N_2)	78,084	28,013 4
Oxygen (O_2)	20,947 6	31,998 8
Argon (Ar_2)	0,934	39,948
Carbon dioxide (CO_2)	0,031 4	44,009 95
Neon (Ne)	$1{,}818 \times 10^{-3}$	20,183
Helium (He)	$524{,}0 \times 10^{-6}$	4,002 6
Krypton (Kr)	$114{,}0 \times 10^{-6}$	83,80
Xenon (Xe)	$8{,}7 \times 10^{-6}$	131,30
Hydrogen (H_2)	$50{,}0 \times 10^{-6}$	2,015 94
Nitrogen monoxide (NO)	$50{,}0 \times 10^{-6}$*	44,012 8
Methane (CH_4)	$0{,}2 \times 10^{-3}$	16,043 03
Ozone (O_3) in summer	up to $7{,}0 \times 10^{-6}$*	47,998 2
in winter	up to $2{,}0 \times 10^{-6}$*	47,998 2
Sulphur dioxide (SO_2)	up to $0{,}1 \times 10^{-3}$*	64,062 8
Nitrogen dioxide (NO_2)	up to $2{,}0 \times 10^{-6}$*	46,005 5
Iodine (I_2)	up to $1{,}0 \times 10^{-6}$*	253,808 8
Air	100	28,964 420**

* The content of the gas may undergo significant variations from time to time or from place to place.

** This value is obtained from the perfect gas law.

2.2.5 Data basis

This Technical Report presents primary thermodynamic parameter tabulations as functions of latitude and time of year for altitudes from 30 km to 120 km. To obtain the global time-space data coverage, the various empirical and theoretical models of middle atmosphere were analysed and compiled. COSPAR International Reference Atmosphere, 1986 (CIRA-86), which is the most extensive compilation of recent models based on numerous satellite and ground-based measurements of the middle atmosphere, has been taken as the basic model.

The tabulated functions have a vertical resolution of 2 km and a latitude resolution of 10 degrees. The values at intermediate points may be found by linear interpolation.

The values conform to the main natural laws. The density, pressure and temperature relation is described by the perfect gas law [equation (2)] taking into account the mean molecular weight variation with height. As shown by a series of investigations, the new model accurately reproduces most of the characteristic features of the atmosphere such as the general structure of the tropopause, stratopause and mesopause.

2.2.6 Additional thermodynamic relations

The thermodynamic relations that can be used in aerospace practical applications are given below.

2.2.6.1 Air particles concentration

The number of air particles per unit volume n is given by the equation

$$n = \frac{N_{\mathrm{A}} p}{R' T} = 7{,}243\ 611 \times 10^{22}\ \frac{p}{T} \tag{6}$$

2.2.6.2 Mean air-particle speed

The mean air-particle speed $\bar{v}$ is defined as the arithmetic average of air-particle speeds obtained from Maxwell's distribution of molecular speeds in the monatomic perfect gas under thermodynamic equilibrium conditions disregarding any exterior force, hence

$$\bar{v} = \left(\frac{\pi}{8} RT\right)^{1/2} = 145{,}506\ 85 \sqrt{\frac{T}{M}} \tag{7}$$

2.2.6.3 Mean free path of air particles

An air particle between two successive collisions moves uniformly along a straight line, passing a certain average distance l called a mean free path of air particles. Taking into account the distribution of colliding particles' relative speeds, the mean free path is defined by the expression

$$l = \frac{R'}{\sqrt{2}\pi N_{\mathrm{A}} \sigma^2} \cdot \frac{T}{p} = 2{,}332\ 376 \times 10^{-5}\ \frac{T}{p} \tag{8}$$

2.2.6.4 Air-particles collision frequency

The air-particle collision frequency ω is the mean air-particle speed divided by the mean free path of air particles at the same altitude, i.e. $\omega = \frac{\bar{v}}{l}$. Hence, taking into account equations (7) and (8),

$$\omega = 4\sigma^2 N_{\mathrm{A}} \left(\frac{\pi}{R' M}\right)^{1/2} \cdot \frac{p}{\sqrt{T}} = 6{,}238\ 629 \times 10^{-6}\ \frac{p}{\sqrt{TM}} \tag{9}$$

2.2.6.5 Speed of sound

The speed of sound a is given by the expression

$$a = (kRT)^{1/2} = 20{,}046\ 796 \sqrt{T} \tag{10}$$

where

$$k = \frac{c_p}{c_v} = 1{,}4$$

(See 3.1.)

2.2.6.6 Dynamic viscosity

The dynamic viscosity μ is defined as the value of internal friction between two neighboring air layers moving at different speeds. The following equation is based on the kinetic theory, while the constants, however, are derived from experiments.

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

where β_S and S are Sutherland's empirical coefficients (see 3.1). Equation (11) is invalid for very high or very low temperatures and under conditions occurring at altitudes above 90 km.

2.2.6.7 Kinematic viscosity

The kinematic viscosity ν is defined as the ratio of the air dynamic viscosity to the air density, i.e.

$$\nu = \frac{\mu}{\rho} \tag{12}$$

The limits for use of this equation are similar to those for the dynamic viscosity equation (11).

2.2.6.8 Thermal conductivity

The thermal conductivity λ is calculated from the following empirical formula:

$$\lambda = \frac{2{,}648\ 151 \times 10^{-3} \cdot T^{3/2}}{T + \left[245{,}4 + 10^{-12/T}\right]} \tag{13}$$

where λ is expressed in watts per square metre kelvin.

2.2.7 Tables for the global model of the middle atmosphere

Tables 3 to 5 contain zonal mean temperature, pressure and density as a function of latitude from 80° S to 80° N with 10° steps, time of year and geometric/geopotential height with a vertical resolution of 2 km.

In tables 4 and 5, a one-digit number under the heading "Exponent" (preceded by the letter "E" and a plus or minus sign) following the row indicates the power of ten by which all values in that row should be multiplied.

Table 3.1a) — Zonal mean temperature in terms of geometric height — January

Geometric height,	Zonal mean temperature, K, at latitude																
km	80° S	70° S	60° S	50° S	40° S	30° S	20° S	10° S	0°	10° N	20° N	30° N	40° N	50° N	60° N	70° N	80° N
120	391.0	390.2	389.5	388.7	386.9	384.8	383.2	381.2	379.1	376.9	374.7	372.6	371.0	369.3	367.7	368.0	366.2
118	356.8	357.4	358.3	358.7	357.4	354.7	352.1	349.0	346.3	344.2	342.7	341.5	340.4	338.4	335.7	334.4	331.3
116	328.3	329.3	330.5	330.8	328.9	325.1	321.1	316.8	313.3	311.2	310.3	310.0	309.8	308.3	305.4	303.5	299.8
114	310.5	310.7	309.5	306.6	302.6	296.7	290.2	284.3	279.8	277.4	276.9	277.8	279.3	280.0	279.3	277.3	275.7
112	301.9	299.2	293.9	286.7	278.9	270.0	261.3	253.9	248.2	245.2	244.7	246.7	250.4	254.2	256.9	257.7	258.0
110	293.6	288.1	279.2	268.5	257.8	246.9	237.1	228.8	222.7	219.3	218.9	221.6	226.9	233.2	238.9	242.6	244.8
108	278.9	271.7	261.3	250.4	239.1	228.7	219.6	212.1	206.5	203.2	202.7	205.7	211.1	218.0	224.9	230.4	233.4
106	258.0	251.1	241.6	232.2	222.8	214.4	207.4	201.7	197.5	194.9	194.5	197.0	201.6	208.0	214.8	220.5	224.0
104	234.2	229.0	222.1	215.0	208.5	203.2	198.6	195.4	192.5	190.6	190.4	192.0	196.0	201.3	207.3	212.4	216.1
102	210.7	207.7	203.7	199.9	196.6	194.2	192.2	191.0	189.4	188.2	187.9	189.0	192.1	196.4	201.5	206.2	209.6
100	189.1	188.3	187.3	186.8	186.8	187.3	187.7	188.3	187.7	187.0	186.7	187.2	189.7	193.2	197.6	201.8	204.8
98	170.8	172.1	173.9	176.2	179.1	182.3	185.1	186.5	187.1	186.6	186.3	186.6	188.4	191.6	195.4	199.5	202.3
96	157.1	159.8	163.7	168.5	174.0	179.3	183.7	186.1	187.1	186.7	186.4	186.8	188.5	191.5	195.2	199.0	201.7
94	148.6	152.0	157.5	164.4	171.7	178.6	183.8	186.8	187.6	187.5	187.1	188.0	189.9	193.4	197.3	200.8	203.2
92	144.4	148.4	155.0	163.2	171.8	179.5	185.1	187.9	188.7	188.7	188.7	190.2	192.8	196.8	200.9	204.4	206.9
90	143.0	147.5	154.8	164.0	173.3	181.5	187.2	189.7	190.5	190.7	191.3	193.5	196.7	201.4	205.7	209.2	211.6
88	143.0	148.1	155.7	165.4	175.5	184.1	189.8	192.1	192.9	193.6	194.7	197.7	201.8	206.3	210.7	214.0	216.3
86	145.4	150.5	158.1	168.1	178.6	187.4	192.9	194.9	195.9	197.0	198.6	202.1	206.6	211.3	215.6	218.5	220.5
84	151.4	155.7	162.6	172.2	182.7	191.6	196.5	198.2	199.2	200.3	202.2	205.9	210.5	215.7	219.6	221.8	223.5
82	160.7	163.8	169.0	177.7	187.6	196.3	200.7	201.7	202.5	203.5	205.2	209.0	213.5	219.0	222.4	223.6	225.1
80	171.7	173.6	176.9	184.0	192.8	200.7	204.6	204.8	205.5	206.3	207.7	211.4	215.8	221.4	224.3	224.6	225.9
78	183.2	183.9	185.8	190.9	197.9	204.4	207.8	207.4	208.0	208.5	209.8	213.5	217.6	222.8	225.5	225.1	226.2
76	194.6	194.5	195.1	198.0	202.5	207.2	210.0	209.6	210.2	210.5	211.6	215.0	218.8	223.6	226.1	225.4	226.6
74	205.6	205.0	204.5	205.1	206.6	209.5	211.5	211.6	212.1	212.3	213.0	216.2	219.6	224.0	226.5	225.8	227.1
72	216.3	215.2	213.9	212.2	210.7	211.4	213.1	214.1	214.5	214.4	214.7	217.5	220.2	224.6	227.1	226.3	227.9
70	226.3	224.8	222.7	219.0	215.1	214.2	215.8	217.8	218.3	217.7	217.5	219.5	221.2	225.0	227.7	227.3	229.3
68	235.7	233.5	230.6	225.6	220.4	218.4	220.6	223.2	224.1	223.0	222.1	222.3	223.0	225.3	228.3	228.9	231.5
66	244.3	241.5	237.9	232.1	226.5	224.2	226.9	230.0	231.3	229.6	227.8	225.9	225.2	225.8	229.1	231.2	234.5
64	252.3	249.0	245.1	239.0	233.3	231.0	234.0	237.8	238.8	236.6	233.5	229.8	227.3	226.7	230.3	234.2	238.4
62	259.8	256.2	252.1	246.1	240.5	238.1	241.2	245.6	246.2	243.6	239.0	234.0	229.5	228.2	232.3	237.9	242.8
60	266.7	262.9	258.7	252.8	247.4	245.0	247.7	252.6	252.8	250.2	244.5	238.7	232.5	230.7	235.0	241.9	247.2
58	273.1	269.0	264.7	258.7	253.4	251.0	253.0	257.9	258.6	256.0	250.2	243.8	236.8	234.4	238.2	245.7	251.3
56	278.7	274.4	269.9	263.9	258.7	256.2	257.4	261.7	263.0	260.9	255.7	249.2	242.2	239.1	242.1	249.1	254.4
54	283.2	278.9	274.1	268.5	263.5	261.1	261.3	264.7	265.9	264.6	260.6	254.6	248.3	244.4	246.4	252.2	256.1
52	286.6	282.3	277.4	272.5	268.0	265.4	264.8	266.9	267.5	266.9	264.5	259.6	254.4	249.6	250.6	254.5	256.3
50	288.5	284.4	279.7	275.4	271.4	268.7	267.4	267.8	267.8	267.9	267.0	263.4	259.2	253.5	253.5	255.5	255.4
48	288.7	285.1	280.9	276.7	273.3	270.4	268.6	267.2	266.9	267.4	267.8	265.3	261.6	255.3	254.1	254.8	253.7
46	287.3	284.3	280.7	276.5	273.4	270.3	268.1	265.3	265.0	265.7	266.9	265.2	261.5	255.1	253.1	253.0	251.9
44	284.6	282.1	278.9	274.8	271.8	268.3	265.6	262.5	262.4	263.0	264.4	263.1	259.2	253.3	251.4	251.1	250.3
42	280.8	278.6	275.5	271.7	268.5	264.8	261.4	259.0	259.2	259.5	260.6	259.2	255.0	250.3	249.4	249.1	248.8
40	276.2	274.1	271.2	267.6	264.1	260.2	256.5	254.9	255.2	255.2	255.8	254.0	250.0	246.4	246.5	246.7	246.9
38	270.9	269.1	266.2	262.7	259.0	255.1	251.7	250.2	250.6	250.3	250.3	248.0	244.8	242.0	242.6	243.3	243.8
36	264.9	263.5	260.9	257.4	253.5	249.6	246.7	245.0	245.3	244.9	244.6	242.0	239.7	237.5	238.0	238.8	239.3
34	258.5	257.4	255.3	251.8	247.7	243.9	241.3	239.5	239.6	239.3	238.9	236.7	235.2	233.4	233.4	233.6	233.5
32	251.6	250.9	249.5	246.3	241.9	238.0	235.2	233.7	233.5	233.7	233.4	232.4	231.2	229.7	229.0	227.8	226.6
30	244.5	244.1	243.7	240.7	236.1	232.0	228.9	227.8	227.2	228.0	228.1	228.5	227.5	226.2	224.7	221.7	219.1

Table 3.1b) — Zonal mean temperature in terms of geopotential height — January

Geopotential height, km	Zonal mean temperature, K, at latitude																
	80° S	70° S	60° S	50° S	40° S	30° S	20° S	10° S	0°	10° N	20° N	30° N	40° N	50° N	60° N	70° N	80° N
120	420.4	420.1	420.0	420.3	420.8	422.1	423.1	423.5	422.7	420.2	416.4	411.7	407.3	403.5	401.0	399.4	398.6
118	389.7	389.9	390.7	391.0	391.1	391.2	390.8	389.9	388.4	385.9	382.7	379.0	375.5	372.1	369.3	367.7	365.0
116	354.5	356.1	358.3	360.3	360.6	359.6	358.5	356.6	354.3	351.9	349.3	346.6	343.8	340.1	335.7	333.0	328.9
114	325.9	328.2	330.0	331.0	331.0	329.0	325.9	322.6	319.6	317.3	315.6	313.9	312.0	309.1	305.2	300.7	297.6
112	309.0	309.2	308.2	306.2	303.5	299.1	294.1	289.3	285.3	282.6	281.2	280.6	280.4	279.5	277.6	274.8	272.9
110	300.8	297.7	292.3	285.7	278.9	271.3	263.8	257.2	251.9	248.6	247.4	248.1	250.4	252.9	254.8	255.3	255.5
108	291.6	285.6	276.6	267.2	257.1	247.2	238.3	230.6	224.6	220.9	219.8	221.8	226.0	231.3	236.4	240.2	242.0
106	274.3	267.6	258.0	248.1	237.8	228.3	219.8	212.6	207.1	203.7	202.9	205.4	210.2	216.5	222.9	228.1	231.0
104	251.5	245.7	237.7	229.3	221.0	213.7	207.1	201.9	197.6	194.9	194.4	196.5	201.0	206.9	213.2	218.2	221.8
102	227.1	223.1	217.6	212.0	206.7	202.3	198.2	195.2	192.4	190.5	190.2	191.6	195.3	200.2	205.8	210.5	214.0
100	203.3	201.5	199.1	196.8	194.7	193.2	191.7	190.7	189.2	188.1	187.8	188.7	191.6	195.6	200.3	204.6	207.8
98	182.0	182.5	183.1	183.8	185.0	186.3	187.5	187.7	187.7	186.9	186.7	187.3	189.3	192.6	196.7	200.9	203.8
96	165.0	167.1	170.1	173.7	177.7	181.5	184.8	186.4	187.1	186.6	186.3	186.6	188.3	191.4	195.1	199.0	201.8
94	153.1	156.1	161.0	166.9	173.2	179.1	183.6	186.3	187.1	186.9	186.3	187.0	188.6	192.0	195.8	199.4	201.9
92	146.3	150.1	156.2	163.7	171.5	178.7	184.0	186.9	187.8	187.7	187.4	188.5	190.6	194.4	198.5	202.1	204.7
90	143.5	147.8	154.8	163.3	172.2	180.0	185.6	188.3	189.1	189.1	189.3	191.1	194.0	198.4	202.8	206.5	209.0
88	142.7	147.7	155.0	164.4	174.0	182.2	187.9	190.3	191.1	191.4	192.2	194.8	198.7	203.2	207.8	211.4	213.9
86	143.9	149.0	156.6	166.5	176.6	185.2	190.7	192.9	193.7	194.6	196.0	199.3	203.7	208.5	213.1	216.4	218.6
84	148.2	152.8	160.1	169.8	180.2	188.9	194.0	196.0	196.9	198.0	199.9	203.6	208.2	213.5	217.7	220.4	222.4
82	156.3	159.9	165.7	174.7	184.8	193.5	198.1	199.4	200.3	201.5	203.4	207.2	211.9	217.4	221.2	222.9	224.5
80	167.1	169.3	173.1	180.8	190.0	198.3	202.4	202.9	203.7	204.6	206.2	210.1	214.6	220.4	223.6	224.3	225.6
78	178.8	179.7	181.9	187.7	195.5	202.5	206.2	206.0	206.6	207.2	208.7	212.5	216.7	222.3	225.1	224.9	226.1
76	190.4	190.4	191.2	194.9	200.4	205.9	208.9	208.4	209.0	209.4	210.7	214.2	218.3	223.3	225.9	225.3	226.5
74	201.8	201.3	200.8	202.1	204.7	208.5	210.7	210.5	211.0	211.4	212.3	215.6	219.3	223.8	226.3	225.6	226.9
72	212.9	211.8	210.5	209.4	208.9	210.5	212.2	212.8	213.1	213.2	213.7	216.9	219.9	224.4	226.9	226.1	227.6
70	223.4	221.8	219.7	216.4	213.3	212.8	214.3	215.8	216.2	215.9	216.0	218.5	220.7	224.8	227.5	226.9	228.8
68	233.2	231.0	228.2	223.3	218.3	216.4	218.3	220.5	221.2	220.4	219.9	221.1	222.2	225.2	228.1	228.3	230.8
66	242.1	239.3	235.8	229.9	224.2	221.8	224.2	226.9	228.1	226.6	225.3	224.4	224.4	225.6	228.8	230.5	233.7
64	250.4	247.1	243.1	236.8	230.9	228.4	231.2	234.5	235.7	233.7	231.3	228.3	226.6	226.4	229.9	233.3	237.4
62	258.1	254.5	250.3	244.0	238.2	235.6	238.6	242.6	243.4	240.9	237.0	232.5	228.8	227.7	231.7	237.0	241.7
60	265.3	261.4	257.2	251.0	245.4	242.8	245.6	250.2	250.5	247.8	242.6	237.1	231.5	229.9	234.3	241.0	246.3
58	271.9	267.8	263.4	257.3	251.8	249.2	251.4	256.2	256.7	254.1	248.3	242.2	235.4	233.4	237.4	244.9	250.5
56	277.8	273.4	268.9	262.7	257.3	254.8	256.1	260.6	261.7	259.4	254.1	247.6	240.7	237.9	241.2	248.5	254.0
54	282.6	278.2	273.3	267.6	262.3	259.8	260.2	263.9	265.2	263.6	259.3	253.2	246.8	243.2	245.6	251.7	256.0
52	286.2	281.8	276.9	271.8	267.0	264.4	264.0	266.4	267.2	266.4	263.6	258.4	253.1	248.6	249.9	254.2	256.4
50	288.3	284.1	279.4	274.9	270.8	268.1	266.9	267.7	267.8	267.8	266.5	262.7	258.4	252.9	253.2	255.5	255.6
48	288.7	285.1	280.8	276.6	273.1	270.2	268.5	267.5	267.2	267.7	267.7	265.1	261.3	255.1	254.2	254.9	254.0
46	287.5	284.5	280.8	276.6	273.5	270.4	268.4	265.8	265.5	266.2	267.2	265.4	261.7	255.3	253.3	253.2	252.1
44	284.9	282.4	279.2	275.1	272.2	268.8	266.2	263.1	263.0	263.7	265.0	263.6	259.7	253.7	251.6	251.3	250.4
42	281.2	279.0	276.0	272.2	269.1	265.4	262.2	259.7	259.9	260.2	261.4	260.0	255.7	250.8	249.6	249.3	249.0
40	276.6	274.5	271.7	268.2	264.8	260.9	257.3	255.7	256.0	256.0	256.7	254.9	250.7	246.9	246.8	246.9	247.1
38	271.2	269.5	266.7	263.3	259.7	255.8	252.4	251.0	251.4	251.1	251.2	248.9	245.4	242.5	243.0	243.5	244.0
36	265.3	263.9	261.3	257.9	254.1	250.3	247.5	245.8	246.1	245.7	245.4	242.7	240.3	238.0	238.4	239.1	239.6
34	258.8	257.7	255.7	252.3	248.3	244.6	242.0	240.3	240.4	240.1	239.6	237.3	235.6	233.7	233.7	233.9	233.8
32	251.9	251.2	249.9	246.7	242.4	238.6	235.9	234.4	234.2	234.4	234.1	232.8	231.6	230.0	229.3	228.1	226.9
30	244.7	244.4	244.0	241.1	236.6	232.6	229.5	228.4	227.9	228.6	228.7	228.8	227.8	226.4	224.9	221.9	219.4

Table 3.2a) — Zonal mean temperature in terms of geometric height — February

Geometric height, km	Zonal mean temperature, K, at latitude																
	80° S	70° S	60° S	50° S	40° S	30° S	20° S	10° S	0°	10° N	20° N	30° N	40° N	50° N	60° N	70° N	80° N
120	391.0	391.3	390.6	389.7	389.3	387.2	386.3	384.9	383.5	381.7	380.8	379.5	377.9	376.6	376.2	375.9	375.4
118	357.0	358.6	359.4	359.6	359.5	357.0	355.0	352.6	350.7	349.2	349.0	348.7	347.6	346.0	344.4	342.6	340.8
116	327.6	329.8	331.0	331.2	330.5	326.9	323.5	320.0	317.5	316.0	316.5	317.3	317.1	315.9	314.1	311.7	309.3
114	308.4	308.4	307.6	306.4	302.2	297.7	292.3	286.9	283.5	282.3	282.2	284.7	286.7	287.9	287.7	285.9	283.9
112	295.9	293.5	289.4	284.3	276.7	269.3	261.8	255.0	250.8	249.2	249.4	253.0	257.3	261.5	264.4	265.3	265.1
110	284.2	279.6	272.4	264.3	254.0	244.7	236.3	228.9	224.3	222.3	222.6	226.9	232.8	239.4	245.1	248.5	250.0
108	267.3	262.1	254.4	244.8	235.1	225.7	217.6	211.4	206.9	205.4	206.0	209.7	215.2	222.4	228.8	233.7	236.8
106	247.2	242.2	235.3	227.0	219.1	211.7	205.6	201.0	197.6	196.4	196.7	199.6	204.1	210.3	216.3	221.2	224.6
104	226.0	222.2	217.1	211.2	205.6	201.1	197.3	194.6	192.6	191.5	191.8	193.3	196.7	201.2	206.6	211.0	214.0
102	205.6	203.4	200.6	197.4	194.6	192.8	191.3	190.4	189.4	188.6	188.6	189.1	191.3	194.4	198.7	202.4	205.0
100	187.6	186.9	186.5	185.9	186.0	186.7	187.4	187.8	187.7	187.1	186.8	186.6	187.7	189.7	192.9	195.8	197.9
98	172.7	173.6	175.0	177.0	179.7	182.4	185.2	186.6	187.2	186.4	185.8	185.3	185.5	187.1	188.9	191.1	192.8
96	161.4	163.6	166.7	170.8	175.6	180.1	184.2	186.4	187.2	186.5	185.8	185.2	185.1	186.3	187.4	189.1	190.5
94	153.6	156.6	161.3	167.5	173.5	179.4	184.1	186.8	187.5	187.2	186.5	186.2	186.8	187.3	189.0	190.7	191.6
92	149.0	152.6	158.4	166.9	173.2	180.1	185.1	187.6	188.3	188.2	188.0	188.4	190.1	190.5	192.9	194.9	196.0
90	147.6	151.6	158.0	168.2	174.9	182.4	187.3	189.7	190.3	190.4	190.8	191.8	193.2	195.2	198.4	200.7	201.9
88	149.5	153.3	159.8	170.5	178.7	186.3	191.1	193.2	193.9	194.1	194.9	196.3	195.5	201.0	204.6	206.5	207.8
86	154.3	157.6	163.6	173.9	183.7	191.3	195.5	197.3	198.2	198.6	199.5	201.1	200.8	207.0	210.5	212.1	213.0
84	161.7	164.0	168.9	178.5	189.0	196.3	199.5	200.9	201.6	202.5	203.5	205.2	213.9	212.1	215.6	216.5	217.0
82	170.8	172.1	175.2	184.1	194.0	200.6	202.8	203.5	204.1	205.2	206.6	208.3	231.3	216.1	219.6	219.8	219.8
80	180.2	180.6	182.3	189.9	198.4	204.1	205.3	205.4	205.8	207.2	209.1	210.8	241.3	219.0	222.5	222.2	221.9
78	188.9	188.9	189.6	195.6	202.3	206.6	207.1	206.6	207.2	208.7	211.1	213.0	236.1	221.3	224.7	224.0	223.8
76	197.2	196.9	197.1	201.1	205.7	208.7	208.9	208.1	208.5	210.3	212.8	214.9	224.1	223.0	226.4	225.6	225.7
74	205.7	205.0	204.9	206.7	209.1	210.6	211.1	210.4	210.5	211.9	214.3	216.7	217.2	224.3	227.9	227.1	227.6
72	214.4	213.1	212.5	212.1	212.4	213.0	213.9	213.7	213.6	214.0	215.9	218.3	218.4	225.2	229.4	229.0	230.2
70	223.2	221.2	219.8	217.4	216.0	216.1	217.7	217.9	217.6	217.1	218.1	220.0	222.5	226.2	230.7	231.3	233.6
68	231.9	229.1	226.5	222.5	220.0	220.4	222.4	222.8	222.5	221.5	221.6	222.2	225.2	227.4	232.0	234.3	238.1
66	240.3	236.7	232.8	227.9	224.7	225.6	228.0	228.5	228.2	227.0	225.7	225.1	226.5	228.7	233.4	237.8	243.1
64	247.7	243.6	239.0	233.6	230.2	231.3	234.2	234.7	234.5	233.1	230.4	228.5	227.8	230.1	235.1	241.5	248.3
62	254.1	249.8	245.2	239.7	236.4	237.2	240.6	241.5	241.1	239.5	235.5	232.6	230.0	231.7	237.4	245.3	253.4
60	259.7	255.5	251.2	245.9	242.7	243.0	246.3	248.2	248.0	246.4	241.3	237.7	233.3	234.0	240.2	249.3	258.1
58	264.7	260.9	257.0	252.0	248.6	248.4	251.0	254.4	254.9	253.4	248.0	243.8	238.0	237.5	243.6	253.2	262.3
56	269.3	265.8	262.4	257.8	254.1	253.4	255.2	259.8	261.2	260.0	254.9	250.2	243.6	241.9	247.0	256.2	265.0
54	273.4	270.2	267.0	263.3	259.5	258.1	259.5	264.4	266.2	265.4	261.2	256.2	249.8	246.7	250.0	257.4	265.0
52	276.7	273.8	270.7	268.1	264.7	262.6	263.9	267.9	269.6	269.2	266.1	261.3	255.7	251.3	252.3	256.8	262.3
50	278.8	276.1	273.3	271.5	268.6	267.1	267.4	270.0	271.4	271.4	269.5	265.1	260.3	254.9	253.3	254.7	257.9
48	279.2	276.9	274.6	272.9	270.5	271.0	269.3	270.5	271.8	272.1	271.1	267.2	262.8	256.7	252.9	251.8	252.9
46	278.0	276.1	274.3	272.4	270.6	270.8	269.2	269.4	270.7	271.2	270.9	267.5	263.0	256.5	251.3	248.5	247.9
44	275.4	273.7	272.2	270.2	269.0	262.6	266.9	267.1	268.3	268.8	268.6	265.6	261.1	254.3	248.9	245.2	243.3
42	271.7	270.1	268.5	266.8	266.0	248.9	263.0	263.5	264.6	265.0	264.7	261.8	257.2	250.4	245.7	242.0	239.6
40	267.1	265.6	264.0	262.5	261.6	239.0	258.2	259.0	259.9	260.1	259.6	256.7	252.2	245.5	242.0	239.2	236.7
38	262.1	260.8	259.2	257.7	256.2	239.3	253.3	253.6	254.3	254.3	254.0	251.0	246.6	240.2	238.0	236.6	234.5
36	256.7	255.6	254.3	252.6	250.3	244.3	248.2	247.7	248.1	248.1	248.1	245.2	240.8	234.9	233.9	233.9	232.5
34	251.1	250.3	249.2	247.4	244.6	245.5	242.6	241.5	241.6	241.7	241.9	239.5	235.3	230.1	229.9	231.0	229.9
32	245.3	244.7	244.0	242.0	239.1	240.4	236.4	235.2	234.9	235.2	235.5	234.1	230.1	225.8	226.0	227.6	226.6
30	239.4	239.1	238.6	236.7	233.8	231.9	229.9	228.9	228.2	228.8	229.0	228.8	225.1	221.9	222.2	224.0	222.9

Table 3.2b) — Zonal mean temperature in terms of geopotential height — February

Geopotential height, km	Zonal mean temperature, K, at latitude																
	80° S	70° S	60° S	50° S	40° S	30° S	20° S	10° S	0°	10° N	20° N	30° N	40° N	50° N	60° N	70° N	80° N
120	421.6	421.5	421.6	422.2	423.5	425.1	426.9	427.9	427.5	425.7	422.4	418.3	414.4	411.2	409.1	407.9	407.2
118	389.7	391.1	391.7	392.5	393.2	393.8	394.1	394.0	392.9	391.2	388.7	385.7	382.7	379.9	377.5	375.6	374.1
116	354.7	357.3	359.4	361.2	362.8	361.9	361.4	360.2	358.7	356.8	355.6	353.8	350.9	347.6	344.4	341.2	338.4
114	326.2	328.0	330.0	332.2	332.0	331.2	329.2	326.2	324.1	322.8	321.2	321.0	319.6	317.2	313.8	309.6	306.2
112	306.3	306.5	306.2	305.9	303.2	300.2	296.4	292.0	289.2	287.7	286.6	287.5	287.8	287.4	285.9	283.3	281.0
110	294.0	291.5	287.6	283.2	276.6	270.6	264.4	258.5	254.7	252.8	252.1	254.4	257.3	260.2	262.2	262.7	262.3
108	280.8	276.6	270.3	262.1	253.5	244.7	236.8	230.5	225.8	223.9	224.1	227.1	231.6	237.3	242.1	245.4	247.4
106	262.8	258.0	251.1	242.5	233.8	225.3	217.8	211.9	207.6	205.9	206.2	209.4	214.3	220.7	226.5	230.9	233.8
104	241.5	237.4	231.6	224.5	217.4	211.0	205.4	201.1	197.9	196.3	196.8	199.0	203.3	208.6	214.3	218.7	221.6
102	219.7	216.9	213.0	208.4	203.9	200.2	196.9	194.5	192.5	191.4	191.6	192.8	195.8	199.7	204.5	208.4	211.1
100	199.4	198.1	196.5	194.6	192.9	191.9	190.9	190.1	189.3	188.4	188.4	188.7	190.6	193.2	197.0	200.2	202.5
98	181.8	182.1	182.6	183.4	184.4	185.7	187.1	187.6	187.7	186.8	186.5	186.3	187.1	189.1	191.3	193.9	195.8
96	168.0	169.6	172.0	174.9	178.5	181.8	184.9	186.5	187.2	186.4	185.8	185.2	185.2	186.7	188.1	190.0	191.5
94	157.9	160.5	164.6	169.4	174.9	179.9	184.1	186.5	187.2	186.7	185.9	185.3	185.4	186.3	187.7	189.4	190.4
92	151.2	154.6	159.9	167.0	173.2	179.4	184.2	186.9	187.6	187.3	186.8	186.7	187.7	188.2	190.2	192.2	193.3
90	147.9	151.8	158.0	167.2	173.5	180.5	185.5	188.0	188.6	188.5	188.6	189.2	191.2	192.0	195.0	197.4	198.7
88	148.2	152.1	158.5	169.0	176.1	183.4	188.3	190.4	191.1	191.2	191.9	193.1	194.0	197.4	201.1	203.4	204.9
86	151.7	155.2	161.4	171.8	180.5	188.0	192.4	194.4	195.1	195.4	196.3	198.0	196.9	203.6	207.4	209.4	210.6
84	158.0	160.7	166.0	175.8	186.0	193.3	196.9	198.6	199.3	200.1	201.0	202.8	205.1	209.5	213.2	214.6	215.3
82	166.7	168.3	172.1	181.1	191.2	198.2	200.8	202.0	202.6	203.6	204.8	206.6	221.7	214.2	217.8	218.5	218.7
80	176.4	177.0	179.0	187.0	196.1	202.2	203.9	204.3	204.8	206.0	207.7	209.4	237.6	217.7	221.3	221.2	221.1
78	185.6	185.6	186.4	193.0	200.4	205.3	206.1	205.8	206.5	207.8	210.0	211.8	240.3	220.3	223.8	223.4	223.1
76	194.2	193.8	194.0	198.7	204.1	207.6	207.9	207.2	207.7	209.4	211.9	214.0	229.9	222.3	225.7	225.0	225.0
74	202.8	202.0	201.9	204.4	207.6	209.6	209.9	209.1	209.2	211.0	213.5	216.0	219.1	223.8	227.4	226.5	226.9
72	211.5	210.3	209.8	209.9	211.0	211.8	212.4	211.9	211.8	212.9	215.0	217.6	217.1	224.9	228.9	228.3	229.3
70	220.5	218.6	217.4	215.4	214.5	214.6	215.8	215.8	215.5	215.5	217.0	219.2	220.8	225.8	230.2	230.5	232.5
68	229.4	226.8	224.4	220.7	218.4	218.5	220.2	220.5	220.1	219.3	220.0	221.2	224.4	226.9	231.6	233.4	236.8
66	238.1	234.6	230.9	226.1	222.9	223.5	225.6	225.9	225.7	224.5	223.9	223.9	226.1	228.3	232.9	236.8	241.7
64	246.0	241.8	237.2	231.8	228.2	229.2	231.8	232.1	231.8	230.5	228.5	227.1	227.3	229.7	234.6	240.5	247.1
62	252.7	248.3	243.5	237.9	234.4	235.2	238.2	238.9	238.5	237.0	233.5	231.1	229.2	231.2	236.7	244.4	252.2
60	258.6	254.3	249.7	244.2	240.8	241.2	244.4	245.8	245.4	243.8	239.2	235.9	232.1	233.3	239.4	248.4	257.2
58	263.8	259.8	255.7	250.5	247.0	246.8	249.6	252.3	252.5	251.0	245.7	241.8	236.5	236.5	242.8	252.4	261.6
56	268.5	264.9	261.3	256.5	252.6	252.0	253.9	258.1	259.2	258.0	252.8	248.4	242.1	240.8	246.3	255.7	264.7
54	272.8	269.5	266.2	262.1	258.2	256.9	258.2	263.1	264.8	263.9	259.5	254.7	248.3	245.6	249.5	257.4	265.2
52	276.3	273.3	270.1	267.2	263.6	261.5	262.7	267.0	268.8	268.3	264.9	260.2	254.4	250.5	251.9	257.0	262.8
50	278.6	275.8	273.0	271.0	267.9	266.1	266.6	269.6	271.1	271.0	268.8	264.4	259.5	254.3	253.2	255.0	258.6
48	279.2	276.9	274.5	272.8	270.3	270.4	269.0	270.5	271.8	272.0	270.9	266.9	262.5	256.5	253.1	252.2	253.5
46	278.2	276.3	274.4	272.6	270.7	271.4	269.4	269.8	271.1	271.5	271.1	267.6	263.1	256.6	251.6	248.9	248.4
44	275.8	274.1	272.6	270.6	269.4	264.8	267.5	267.7	268.9	269.4	269.2	266.1	261.5	254.7	249.2	245.5	243.7
42	272.0	270.5	269.0	267.3	266.5	251.2	263.8	264.3	265.4	265.8	265.5	262.5	257.9	251.0	246.1	242.3	239.9
40	267.5	266.0	264.5	263.0	262.3	239.9	259.0	259.9	260.8	261.0	260.5	257.5	252.9	246.1	242.4	239.4	236.9
38	262.4	261.1	259.7	258.2	256.9	238.8	254.1	254.5	255.3	255.3	254.9	251.8	247.3	240.7	238.4	236.8	234.7
36	257.0	256.0	254.7	253.1	251.0	243.7	249.0	248.6	249.1	249.0	248.9	245.9	241.5	235.4	234.2	234.1	232.6
34	251.3	250.6	249.6	247.8	245.1	245.7	243.3	242.3	242.5	242.6	242.7	240.1	235.8	230.5	230.2	231.1	230.0
32	245.5	245.0	244.3	242.4	239.6	241.1	237.1	236.0	235.8	236.0	236.2	234.6	230.6	226.1	226.3	227.7	226.7
30	239.6	239.3	238.9	237.0	234.2	232.7	230.6	229.6	229.0	229.5	229.7	229.3	225.5	222.2	222.4	224.1	223.0

Table 3.3a) — Zonal mean temperature in terms of geometric height — March

Geometric height, km	Zonal mean temperature, K, at latitude																
	80° S	70° S	60° S	50° S	40° S	30° S	20° S	10° S	0°	10° N	20° N	30° N	40° N	50° N	60° N	70° N	80° N
120	387.5	386.9	387.2	387.3	386.3	387.0	385.7	385.4	385.5	385.0	384.2	384.6	384.2	383.8	383.3	383.6	383.7
118	353.4	354.1	355.9	357.2	356.5	356.6	356.9	353.1	352.7	352.5	352.7	354.1	354.3	353.6	351.9	350.7	349.5
116	322.9	324.2	326.5	328.0	326.8	326.0	324.6	320.1	319.3	319.4	320.5	323.1	324.3	324.1	322.2	320.4	318.6
114	299.6	300.4	300.7	300.3	298.2	293.9	286.0	286.4	284.9	285.5	287.7	290.8	293.9	296.5	296.5	295.3	293.6
112	282.9	281.9	279.5	275.8	270.5	263.7	244.8	253.6	251.8	252.4	255.3	259.8	265.3	270.8	274.0	275.4	275.4
110	268.3	265.4	260.6	254.1	246.4	238.0	213.5	226.7	224.8	225.3	228.4	233.7	240.7	248.5	254.4	258.2	259.9
108	251.7	248.1	243.0	235.1	227.1	219.4	200.5	209.4	207.3	207.8	210.5	215.7	222.5	229.6	236.4	241.6	244.6
106	234.1	230.7	225.9	219.1	212.6	206.6	198.6	199.5	197.9	198.2	199.9	203.8	209.1	214.9	221.0	225.9	229.0
104	217.1	214.3	210.2	205.7	201.1	197.5	197.2	193.4	192.6	192.6	193.4	195.8	199.0	203.5	207.7	211.6	214.2
102	201.4	199.6	197.0	194.5	192.1	190.7	192.1	189.6	189.3	189.1	189.2	190.0	191.3	194.0	196.6	199.2	201.2
100	188.0	187.2	186.2	185.7	185.4	186.0	187.0	187.4	187.7	187.2	186.7	186.1	185.8	186.8	187.8	189.2	190.4
98	177.7	177.8	178.4	179.5	181.0	183.1	184.3	186.7	187.2	186.5	185.3	183.9	182.6	181.7	181.7	182.0	182.5
96	170.1	171.1	173.0	175.6	178.5	181.8	184.2	186.6	187.3	186.5	185.1	183.1	181.0	179.1	177.9	177.3	177.1
94	165.1	166.9	169.7	173.5	177.8	181.9	185.1	186.7	187.4	186.9	185.6	183.4	181.2	178.6	176.4	174.8	173.9
92	162.7	165.1	169.0	173.7	178.9	183.3	186.4	187.7	188.2	187.9	187.0	185.3	183.1	180.2	177.2	174.8	173.1
90	163.3	166.2	170.8	176.3	181.8	186.2	188.9	190.1	190.6	190.4	189.8	188.6	186.6	183.9	180.6	177.5	175.2
88	167.2	170.5	175.5	181.2	186.6	190.6	192.8	194.5	195.4	194.7	194.3	193.5	191.6	189.2	186.5	183.0	180.4
86	174.1	177.4	182.0	187.4	192.3	195.4	197.2	199.5	200.9	199.9	199.4	198.9	197.1	195.6	193.7	190.5	187.7
84	183.4	186.0	189.2	193.8	197.8	199.6	201.0	203.5	205.3	204.5	203.9	203.8	202.0	202.0	201.3	198.5	195.6
82	193.7	195.0	196.1	199.4	202.3	203.2	203.7	206.0	207.9	207.3	207.2	207.9	206.4	207.6	208.3	206.1	203.5
80	202.3	202.5	201.9	203.9	205.7	205.9	205.6	207.5	209.1	208.9	209.5	211.2	210.3	212.4	214.2	212.2	209.8
78	207.5	207.2	206.1	207.0	208.1	208.1	207.4	208.5	209.4	209.6	211.1	213.9	213.8	216.4	218.3	216.2	213.8
76	210.8	210.4	209.4	209.5	209.9	210.0	209.2	209.6	209.7	210.2	212.5	216.1	216.9	219.8	221.4	218.7	216.0
74	214.2	213.6	212.8	211.8	211.8	212.1	211.7	211.2	211.0	211.3	214.4	218.1	219.5	222.5	223.8	220.8	217.8
72	218.4	217.5	216.8	214.4	214.1	214.9	215.0	213.9	213.5	213.5	216.9	220.4	221.9	224.8	225.7	222.7	219.9
70	223.4	221.8	220.9	217.3	216.6	218.5	219.1	217.7	217.2	216.8	219.9	222.8	224.2	226.8	227.2	224.7	222.1
68	228.8	226.4	224.7	220.6	219.4	223.1	223.8	222.5	221.8	221.3	223.3	225.4	226.3	229.0	228.6	226.4	224.3
66	234.2	231.0	228.4	224.3	223.6	228.0	229.0	227.9	227.0	226.4	227.0	228.3	228.6	231.0	230.1	228.5	227.0
64	239.2	235.5	232.4	228.8	230.3	232.5	234.3	233.3	232.7	231.8	231.0	231.5	231.2	233.0	232.1	231.4	230.5
62	243.3	239.7	236.9	233.9	237.3	236.7	239.5	238.9	238.8	237.4	235.3	234.9	234.0	235.3	234.7	235.2	235.1
60	247.1	243.8	241.5	239.3	238.9	241.1	244.4	244.8	245.4	243.6	240.5	239.3	237.9	238.4	238.2	239.9	240.8
58	250.7	247.8	245.9	244.8	233.9	246.2	249.0	251.4	252.3	250.6	247.0	244.9	243.1	242.7	242.6	245.4	247.4
56	254.4	252.0	250.4	250.5	240.0	251.9	253.6	257.7	258.9	257.6	253.9	251.1	249.1	247.8	247.5	251.1	253.8
54	258.2	256.5	255.5	256.5	278.1	258.0	258.6	263.2	264.6	263.5	260.2	257.1	255.1	253.2	252.7	255.9	258.7
52	261.6	260.9	260.7	262.2	335.8	263.5	263.8	267.4	268.8	267.8	265.3	262.1	260.6	258.4	257.6	259.4	261.4
50	263.6	263.8	264.5	266.3	367.3	267.3	267.8	270.2	271.5	270.7	268.8	265.9	264.7	262.4	261.1	261.2	261.9
48	263.4	264.3	265.9	267.7	341.1	268.4	269.6	271.5	272.8	272.2	270.7	268.0	266.8	264.5	262.4	260.9	260.3
46	261.3	262.6	264.8	266.8	288.2	267.3	269.2	271.3	272.4	272.1	270.7	268.2	266.8	264.4	261.5	258.5	256.8
44	257.7	259.0	261.5	264.1	253.9	264.6	267.0	269.3	270.4	270.1	268.8	266.2	264.7	262.1	258.4	254.3	251.6
42	253.1	254.1	256.7	260.0	250.3	260.9	263.4	265.8	266.8	266.5	265.1	262.3	260.8	257.9	253.6	248.8	245.7
40	247.9	248.8	251.4	255.1	256.3	256.4	258.7	260.9	261.9	261.6	260.1	257.2	255.7	252.4	247.9	243.1	240.2
38	242.5	243.6	246.4	249.7	254.5	251.4	253.2	255.1	256.0	255.9	254.5	251.6	249.9	246.1	241.8	238.1	236.3
36	237.3	238.9	241.7	244.2	246.4	246.1	247.3	248.7	249.5	249.6	248.5	245.9	243.7	239.6	235.8	233.8	233.4
34	232.9	234.6	237.2	238.9	238.5	240.7	241.5	242.3	242.9	243.1	242.3	240.3	237.5	233.3	230.4	229.8	230.6
32	229.1	230.8	232.7	233.9	233.4	235.5	236.0	236.1	236.3	236.5	236.2	234.8	231.5	227.5	225.5	226.1	227.6
30	225.7	227.1	228.3	229.1	229.8	230.2	230.5	230.0	229.7	229.8	230.1	229.3	225.5	221.9	221.0	222.4	224.4