9. *The magnitude of the error in sound ranging.*—Let us consider the reduced problem in which the time is given for two stations A and B, then G lies on one branch of a hyperbola with A and B as foci. Let a be the semi-major axis of this hyperbola and let $AB=2c$, then the equation of the hyperbola, when the origin is taken at 0, the middle point of AB, is—

$$\frac{x^2}{a^2}-\frac{y^2}{c^2-a^2}=1. \tag{8}$$

If the times vary slightly on account of errors in timing, while A and B remain fixed, a varies and the hyperbola is changed into a confocal hyperbola while the increments of x,y,a, are connected by the relation

$$\frac{2xdx}{a^2}-\frac{2ydy}{c^2-a^2}=2ada\left[\frac{x^2}{a^4}+\frac{y^2}{(c^2-a^2)^2}\right]=2\frac{da}{a}\left[1+\frac{c^2y^2}{(c^2-a^2)^2}\right].$$

The total displacement of G is least when

$$dx=\lambda\frac{x}{a^2},\ dy=-\frac{\lambda y}{c^2-a^2},\ \lambda=ada,$$

and then

$$ds=\sqrt{(dx)^2+(dy)^2}=ada\left[\frac{x^2}{a^4}+\frac{y^2}{(c^2-a^2)^2}\right]^{\frac{1}{2}}=da\left[1+\frac{c^2y^2}{(c^2-a^2)^2}\right]^{\frac{1}{2}}.$$

If, on the other hand, $dx=0$, we have

$$dy=-\frac{c^2-a^2}{ay}da\left[1+\frac{c^2y^2}{(c^2-a^2)^2}\right].$$

To get an idea of the magnitude of these quantities let us take the case when $c^2=2a^2$,

$$\text{then}\quad ds=da\left[1+\frac{4y^2}{c^2}\right]^{\frac{1}{2}},\qquad dy=-\frac{a}{y}da\left[1+\frac{4y^2}{c^2}\right].$$

If $V=1{,}100$ feet a second, an error in timing of 1/100 second may mean an error in $2a$ of 11 feet.

The following table then gives the magnitude of the error in ranging for different values of the ratio $y:c$.

TABLE 2.—*Magnitude of error in ranging.*

$y:c$	ds	dy
	Feet.	*Feet.*
$\sqrt{2}$	16½	24¾
$\sqrt{12}$	38½	55
$\sqrt{42}$	71½	101
$\sqrt{420}$	225½	315

When the wind is blowing, the points A and B are displaced slightly from their true positions on account of the error in timing, but if the wind velocity is as large as 20 feet a second the displacement caused by an error of 1/100 second in timing is only 2 feet.

Let us now estimate the magnitude of the error introduced when the asymptote of the hyperbola is used instead of the hyperbola. Since the equation of the asymptotes is

$$\frac{x^2}{a^2}-\frac{y^2}{c^2-a^2}=0,$$

we find on subtracting from (8) that $2ydy=c^2-a^2$. Writing $c^2=2a^2$ as before, we find that if $AB=2c=1{,}000$ feet, $y=10{,}000$ feet, $dy=6\frac{1}{4}$ feet.

The error introduced by using the asymptote of the circular cubic, in the method in which the velocity of sound is eliminated, is more difficult to determine; it is probably larger than in the case just discussed but still not large enough to be important.

To get some idea of the error in time arising from the circumstance that sound may travel through the upper air instead of along a horizontal path, let us consider the simple case in which there is no wind and the velocity of sound increases upward. The range is now given by the formula

$$R=\frac{2V_0}{\sigma}\sinh\frac{\sigma t}{2}$$

Taking $\sigma=0.04$, $t=10$ seconds, we have

$$\frac{\sigma t}{2}=0.2,\ \sinh\frac{\sigma t}{2}=0.20134,\ R=55{,}000\times0.20134,$$

$$\frac{R}{V_0}-t=50\times0.00134=0.067.$$

The difference in time is thus about 7/100 second in a range of about 2 miles and may cause a serious error in sound ranging if no attention is paid to the effect of the meteorological conditions.

MEAN VALUES OF FREE-AIR BAROMETRIC AND VAPOR PRESSURES, TEMPERATURES, AND DENSITIES OVER THE UNITED STATES.

By WILLIS RAY GREGG, Meteorologist in Charge.

[Dated: Division of Aerological Investigations, Weather Bureau, Jan. 31, 1918.]

Although numerous free-air observations have been made, and are being made, in different parts of the United States, mean values of certain reduced data have thus far not been published. Temperature, humidity, and wind data, as observed at Mount Weather, Va., have been summarized in the Bulletin of the Mount Weather Observatory, 1913, v. 6, pts. 4 and 5, and similar summaries of observations by means of sounding balloons at different points in this country have been presented in the same publication, v. 4, pt. 4, and in the MONTHLY WEATHER REVIEW, July, 1914, and May, 1916. A paper on "The Planetary System of Convection" by Dr. (now Major) Wm. R. Blair, appeared in the MONTHLY WEATHER REVIEW, April, 1916. The conclusions reached in the latter paper were based on all available free-air observations made in the United States and in other parts of the world. More recently a brief summary, with special reference to the needs of aeronauts, has been prepared by Maj. W. R. Blair and published by the National Advisory Committee for Aeronautics as Report No. 13. None of these summaries has included free-air pressures and densities. As a knowledge of these data is of great importance in connection with aviation and the firing of projectiles, it has been thought best to publish in brief tabular form their average values as determined from all available observations thus far made by the U. S. Weather Bureau in this country. At a later time similar tables will be furnished for additional stations which are now being established.

Table 1, below, gives mean monthly, seasonal, and annual free-air pressures, temperatures, vapor pressures, and densities as observed at Mount Weather, Va. Pressures and vapor pressures are expressed in both metric and dynamic units, temperatures on the centigrade and approximate absolute (273+ t°C) scale, and

densities in percentages of standard density (dry air at 760 mm. pressure, 0° C., and latitude 45°, =1.293 kgm. per cu. m., approximately) and in kilograms per cubic meter. The temperatures have been published in the Bulletin of the Mount Weather Observatory, v. 6, pt. 4, and are repeated here for convenience in considering them in connection with the other data. They are based on five years' observations. The pressures are based on three years', and the vapor pressures on one year's observations. The vapor pressures are given only to 3 kilometers, observations at higher levels being too few in number to be accepted as reliable means. The values in the first column under "Density" have been computed from the formula

$$\rho=\frac{b-0.378e}{T}\times K,$$

in which

ρ = density,
b and e = barometric and vapor pressures, respectively,
T = approximate absolute temperature ($273+t$°C),
K = a constant, depending upon the conditions of pressure and temperature that are accepted as standard, viz, 760 mm. pressure and 0° C., or $K = 0.35921$.

The values in the second column are obtained by multiplying those in the first column by 1.293 kgm. per cu. m. Values at sealevel and at an altitude of 500 meters have been estimated by extrapolation. In computing densities above 3 kilometers estimated values of vapor pressure, based on those in Table 3, have been used. The correction due to vapor pressure at these altitudes is, however, small.

For the convenience of those who prefer these values in English units Table 2 has been prepared. In this table altitudes are expressed in feet, barometric and vapor pressures in inches of mercury, temperatures in Fahrenheit degrees, and densities in percentages of standard density (dry air at 29.92 in. pressure, 32°F., and latitude 45°, = 0.08071 lbs. per cu. ft.) and in pounds per cubic foot.

Tables 3 and 4 give data similar to those in Tables 1 and 2, respectively, but are based on sounding balloon observations at Fort Omaha, Nebr., Indianapolis, Ind., Huron, S. Dak., and Avalon, Cal. These observations are too few in number to give reliable monthly means, but the seasonal and especially the annual means are considered fairly representative of conditions in the Central and Western States.

It should, of course, be understood that the figures published in all of these tables are not strictly average values, as they are based for the most part upon observations made in the daytime. The temperatures in the lower levels are somewhat higher than the 24-hour means and the densities therefore slightly lower. In general they may be said to represent very closely daytime conditions up to about 2,000 meters (1¼ miles) above sealevel and both day and night conditions at higher altitudes.

Table 5 presents the mean annual atmospheric pressures, temperatures, and densities at various heights above sea level as observed in England. This table was published by Capt. H. T. Tizard, R. F. C., in The Aeronautical Journal, April-June, 1917, page 109, and contains "the mean results of a long series of actual observations made by Mr. W. H. Dines, F. R. S."

For convenience of comparison the annual values of density, given in Tables 1, 3, and 5 are presented in Table 6. This table shows that, at low altitudes, higher densities obtain over England than over the United States. The former are not corrected for vapor pressure, but this correction would be small. The difference is due mainly to the lower temperatures in England. At altitudes above 3 kilometers the agreement is close. So far as is known to the writer free-air densities have not been published for other countries, and further comparisons are therefore not possible at this time.

Much assistance in the preparation of Tables 1 to 4, inclusive, has been rendered by Mr. William S. Cloud, of this division.

TABLE 1.—*Mean free-air pressures, temperatures, vapor pressures, and densities, as observed at Mount Weather, Va.*

Altitudes above M. S. L.	Pressures.		Temperatures.		Vapor pressures.		Densities.	
m.	*mm.*	*mb.*	°*C.*	°*A.*	*mm.*	*mb.*	%	*kg./cu.m.*
January.								
0	761.2	1014.9	− 0.2	272.8	2.09	2.79	100.1	1.295
500	718.7	958.2	− 1.3	271.7	2.06	2.75	94.9	1.227
526	716.5	955.3	− 1.3	271.7	2.06	2.75	94.6	1.224
1000	675.1	900.1	− 2.0	271.0	1.98	2.64	89.4	1.156
1500	634.9	846.5	− 2.9	270.1	1.80	2.40	84.3	1.091
2000	595.2	793.6	− 4.0	269.0	1.67	2.23	79.4	1.027
2500	559.1	745.5	− 5.7	267.3	1.42	1.89	75.1	0.971
3000	524.3	699.1	− 8.2	264.8	1.10	1.47	71.1	0.919
3500	491.8	655.7	−10.9	262.1	.....	.....	67.4	0.871
4000	462.0	616.0	−13.6	259.4	.....	.....	64.0	0.827
4500	* 439.9	* 586.5	−16.4	256.6	.....	.....	* 61.6	* 0.796
5000	.....	.....	−19.4	253.6	.....	.....	.....	.....
February.								
0	762.0	1016.0	1.1	274.1	3.18	4.24	99.7	1.289
500	717.5	956.6	− 0.7	272.3	2.41	3.21	94.5	1.222
526	715.5	954.0	− 0.8	272.2	2.40	3.20	94.3	1.219
1000	674.1	898.8	− 2.4	270.6	1.95	2.60	89.4	1.156
1500	632.8	843.7	− 3.4	269.6	1.76	2.35	84.2	1.089
2000	593.7	791.6	− 4.8	268.2	1.50	2.00	79.4	1.027
2500	558.0	744.0	− 6.8	266.2	0.93	1.24	75.2	0.973
3000	523.7	698.3	− 9.0	264.0	0.74	0.99	71.2	0.921
3500	491.6	655.5	−12.0	261.0	.....	.....	67.6	0.874
4000	463.3	617.7	−14.8	258.2	.....	.....	64.4	0.833
4500	434.5	579.3	−17.7	255.3	.....	.....	61.1	0.790
5000	.....	.....	−21.1	251.9	.....	.....	.....	.....
March.								
0	761.7	1015.6	6.9	279.9	4.93	6.57	97.5	1.261
500	718.8	958.4	4.7	277.7	4.19	5.59	92.8	1.200
526	716.1	954.8	4.6	277.6	4.13	5.51	92.5	1.195
1000	675.4	900.5	2.5	275.5	3.46	4.61	87.9	1.136
1500	634.9	846.5	0.7	273.7	2.75	3.67	83.2	1.076
2000	596.6	795.4	− 1.3	271.7	2.14	2.85	78.8	1.018
2500	560.2	746.9	− 3.6	269.4	1.43	1.91	74.6	0.965
3000	526.3	701.7	− 6.2	266.8	0.89	1.19	70.8	0.916
3500	495.0	660.0	− 8.9	264.1	.....	.....	67.3	0.870
4000	464.6	619.5	−11.8	261.2	.....	.....	63.9	0.826
4500	435.8	581.1	−15.1	257.9	.....	.....	60.7	0.785
5000	414.7	552.9	−18.1	254.9	.....	.....	58.4	0.756
April.								
0	761.0	1014.6	13.9	286.9	7.92	10.56	94.9	1.227
500	718.6	958.1	10.5	283.5	6.68	8.91	90.7	1.173
526	716.2	954.9	10.4	283.4	6.62	8.83	90.5	1.170
1000	676.5	902.0	7.4	280.4	5.48	7.31	86.4	1.117
1500	636.5	848.6	4.6	277.6	4.52	6.03	82.1	1.062
2000	598.5	798.0	1.7	274.7	3.63	4.84	78.1	1.010
2500	562.5	750.0	− 0.9	272.1	2.85	3.80	74.1	0.958
3000	528.6	704.8	− 3.6	269.4	2.17	2.89	70.4	0.910
3500	496.1	661.5	− 6.7	266.3	.....	.....	66.8	0.864
4000	464.8	619.7	− 9.7	263.3	.....	.....	63.4	0.819
4500	433.8	578.4	−13.0	260.0	.....	.....	59.9	0.774
5000	402.2	536.3	−16.0	257.0	.....	.....	56.2	0.727
6000	* 362.8	* 483.7	−22.7	250.3	.....	.....	* 52.1	* 0.673
7000	.....	.....	−29.3	243.7	.....	.....	.....	.....

* Based on few observations; figures not regarded as reliable.

TABLE 1.—*Mean free-air pressures, temperatures, vapor pressures, and densities, as observed at Mount Weather, Va.*—Continued.

May.

Altitudes above M. S. L.	Pressures.		Temperatures.		Vapor pressures.		Densities.	
m.	*mm.*	*mb.*	°*C.*	°*A.*	*mm.*	*mb.*	%	*kg./cu.m.*
0	760.2	1013.6	20.9	293.9	11.32	15.09	92.4	1.195
500	718.7	958.2	17.1	290.1	9.40	12.53	88.5	1.145
526	716.4	955.2	17.0	290.0	9.30	12.40	88.3	1.142
1000	677.6	903.4	13.4	286.4	7.49	9.99	84.6	1.094
1500	638.4	851.2	9.9	282.9	5.58	7.44	80.8	1.045
2000	601.0	801.3	6.6	279.6	4.02	5.36	77.0	0.996
2500	565.5	754.0	3.5	276.5	2.83	3.77	73.3	0.948
3000	531.7	708.9	0.5	273.5	2.18	2.91	69.7	0.902
3500	499.9	666.5	− 2.6	270.4	.....	.....	66.3	0.858
4000	468.5	624.8	− 5.7	267.3	.....	.....	62.9	0.813
4500	438.6	584.9	− 9.1	263.9	.....	.....	59.7	0.771
5000	409.6	546.1	−13.1	259.9	.....	.....	56.6	0.732
6000	352.9	470.5	−19.5	253.5	.....	.....	50.0	0.647
7000	.....	.....	−25.1	247.9	.....	.....	.....	.....

June.

0	758.9	1011.8	23.2	296.2	14.30	19.07	91.4	1.182
500	718.1	957.4	19.9	292.9	12.00	16.00	87.5	1.132
526	716.0	954.6	19.7	292.7	11.88	15.84	87.3	1.129
1000	677.5	903.3	16.7	289.7	9.70	12.93	83.5	1.080
1500	638.7	851.6	13.7	286.7	7.41	9.88	79.7	1.030
2000	601.6	802.1	10.8	283.8	5.63	7.51	75.9	0.981
2500	566.5	755.3	8.0	281.0	4.02	5.36	72.2	0.934
3000	533.1	710.8	5.1	278.1	2.90	3.87	68.7	0.888
3500	501.6	668.8	1.9	274.9	.....	.....	65.4	0.846
4000	471.6	628.9	−1.5	271.5	.....	.....	62.3	0.806
4500	443.2	590.9	−4.9	268.1	.....	.....	59.3	0.767
5000	416.5	555.4	−7.7	265.3	.....	.....	56.4	0.729

July.

0	759.0	1012.0	26.6	299.6	17.05	22.73	90.2	1.167
500	717.8	957.0	23.0	296.0	13.87	18.49	86.5	1.118
526	716.4	955.2	22.8	295.8	13.74	18.32	86.4	1.117
1000	678.4	904.5	19.3	292.3	10.91	14.55	82.9	1.072
1500	640.1	853.4	15.9	288.9	8.54	11.38	79.2	1.024
2000	603.2	804.2	12.7	285.7	6.28	8.37	75.5	0.977
2500	568.1	757.5	9.7	282.7	4.52	6.02	72.0	0.930
3000	535.4	713.9	6.8	279.8	3.04	4.05	68.6	0.887
3500	503.7	671.6	3.5	276.5	.....	.....	65.3	0.845
4000	474.0	632.1	0.1	273.1	.....	.....	62.3	0.805
4500	444.3	592.5	− 3.2	269.8	.....	.....	59.1	0.764
5000	417.8	557.2	− 6.3	266.7	.....	.....	56.2	0.727
6000	*372.0	*496.1	−12.1	260.9	.....	.....	*51.2	*0.662
7000	.....	.....	−17.9	255.1	.....	.....	.....	.....

August.

0	762.3	1016.4	25.2	298.2	20.35	27.13	90.9	1.175
500	720.2	960.2	21.7	294.7	15.82	21.09	87.1	1.126
526	717.7	956.9	21.5	294.5	15.59	20.78	86.8	1.123
1000	679.6	906.1	18.3	291.3	11.51	15.35	83.3	1.077
1500	640.9	854.5	15.3	288.3	8.99	11.99	79.4	1.027
2000	604.3	805.7	12.5	285.5	6.63	8.84	75.7	0.979
2500	569.4	759.2	9.8	282.8	4.73	6.30	72.1	0.932
3000	536.3	715.1	6.8	279.8	3.48	4.64	68.7	0.888
3500	504.5	672.7	3.8	276.8	.....	.....	65.3	0.845
4000	474.9	633.3	0.7	273.7	.....	.....	62.2	0.804
4500	446.0	594.8	− 2.7	270.3	.....	.....	59.2	0.765
5000	.....	.....	− 6.8	266.2	.....	.....	.....	.....
6000	.....	.....	−16.2	256.8	.....	.....	.....	.....

September.

0	762.6	1016.8	22.5	295.5	15.21	21.28	92.0	1.190
500	721.0	961.3	19.2	292.2	12.68	17.91	88.0	1.138
526	718.5	958.0	19.0	292.0	12.52	16.70	87.8	1.135
1000	679.8	906.4	16.1	289.1	10.16	13.54	84.0	1.086
1500	641.5	855.3	13.5	286.5	8.47	11.29	80.3	1.038
2000	604.1	805.4	11.4	284.4	5.76	7.68	76.0	0.983
2500	569.0	758.7	9.0	282.0	4.82	6.43	72.2	0.934
3000	535.8	714.4	6.2	279.2	3.98	5.31	68.7	0.889
3500	504.4	672.5	3.1	276.1	.....	.....	65.5	0.846
4000	474.7	633.0	− 0.2	272.8	.....	.....	62.4	0.806
4500	444.9	593.3	− 3.7	269.3	.....	.....	59.2	0.766
5000	417.4	556.6	− 6.6	266.4	.....	.....	56.2	0.726
6000	.....	.....	−11.1	261.9	.....	.....	.....	.....

*Based on few observations; figures not regarded as reliable.

TABLE 1.—*Mean free-air pressures, temperatures, vapor pressures, and densities, as observed at Mount Weather, Va.*—Continued.

October.

Altitudes above M. S. L.	Pressures.		Temperatures.		Vapor pressures.		Densities.	
m.	*mm.*	*mb.*	°*C.*	°*A.*	*mm.*	*mb.*	%	*kg./cu.m.*
0	761.2	1014.9	14.8	287.8	9.68	13.91	94.5	1.222
500	720.3	960.4	11.9	284.9	8.30	12.07	90.4	1.169
526	717.5	956.6	11.7	284.7	8.25	11.00	90.1	1.166
1000	677.9	903.8	9.0	282.0	6.98	9.30	86.0	1.112
1500	640.5	854.0	7.1	280.1	5.83	7.77	81.9	1.058
2000	600.7	800.9	5.5	278.5	4.67	6.23	77.2	0.999
2500	565.0	753.3	3.5	276.5	4.65	6.20	73.2	0.946
3000	531.4	708.5	1.0	274.0	3.20	4.27	69.5	0.899
3500	498.7	664.9	− 1.9	271.1	.....	.....	66.1	0.854
4000	469.0	625.4	− 4.7	268.3	.....	.....	62.7	0.811
4500	439.7	586.4	− 7.5	265.5	.....	.....	59.4	0.768
5000	411.4	548.6	−10.9	262.1	.....	.....	56.3	0.728
6000	*369.3	*492.5	−17.2	255.8	.....	.....	*51.8	*0.670
7000	.....	.....	−26.0	247.0	.....	.....	.....	.....

November.

0	762.0	1016.0	7.9	280.9	4.24	5.65	97.2	1.257
500	718.9	958.5	5.2	278.2	3.60	4.80	92.6	1.198
526	716.1	954.8	5.1	278.1	3.56	4.75	92.3	1.194
1000	675.6	900.8	2.8	275.8	2.97	3.96	87.8	1.136
1500	634.9	846.5	0.7	273.7	2.36	3.15	83.2	1.076
2000	596.5	795.3	− 0.9	272.1	2.00	2.66	78.6	1.017
2500	560.1	746.8	− 2.9	270.1	1.70	2.26	74.4	0.962
3000	526.1	701.5	− 5.5	267.5	1.67	2.23	70.6	0.912
3500	493.5	658.0	− 8.3	264.7	.....	.....	66.9	0.865
4000	464.8	619.8	−11.4	261.6	.....	.....	63.8	0.825
4500	435.6	580.9	−14.5	258.5	.....	.....	60.5	0.783
5000	408.1	544.2	−17.5	255.5	.....	.....	57.4	0.742
6000	.....	.....	−23.0	250.0	.....	.....	.....	.....

December.

0	762.2	1016.2	2.0	275.0	4.18	5.57	99.4	1.285
500	718.2	957.6	− 0.2	272.8	4.07	5.43	94.4	1.220
526	715.9	954.5	− 0.3	272.7	4.07	5.43	94.1	1.217
1000	674.5	899.3	− 1.9	271.1	3.92	5.23	89.2	1.153
1500	633.2	844.2	− 2.6	270.4	3.58	4.77	83.9	1.085
2000	594.4	792.5	− 3.7	269.3	3.09	4.12	79.1	1.023
2500	557.8	743.7	− 5.6	267.4	2.40	3.20	74.8	0.967
3000	522.9	697.2	− 8.1	264.9	1.66	2.21	70.8	0.916
3500	491.3	655.1	−10.9	262.1	.....	.....	67.3	0.870
4000	460.8	614.5	−13.6	259.4	.....	.....	63.7	0.824
4500	431.4	575.3	−16.7	256.3	.....	.....	60.4	0.781
5000	*397.5	*530.1	−19.4	253.6	.....	.....	*56.3	*0.727

Spring.

0	760.0	1013.3	14.0	287.0	7.91	10.55	94.7	1.225
500	718.1	957.4	10.8	283.8	6.62	8.83	90.6	1.171
526	716.2	954.9	10.7	283.7	6.56	8.75	90.4	1.170
1000	676.5	902.0	7.8	280.8	5.39	7.19	86.3	1.116
1500	636.6	848.8	5.2	278.2	4.25	5.66	82.0	1.060
2000	598.7	798.2	2.6	275.6	3.26	4.35	77.9	1.007
2500	562.7	750.3	0.0	273.0	2.39	3.18	73.9	0.956
3000	528.9	705.2	− 2.8	270.2	1.78	2.37	70.2	0.908
3500	497.0	662.7	− 5.8	267.2	.....	.....	66.7	0.863
4000	466.0	621.3	− 8.8	264.2	.....	.....	63.3	0.819
4500	436.1	581.5	−12.1	260.9	.....	.....	60.0	0.776
5000	408.8	545.1	−15.5	257.5	.....	.....	57.0	0.737
6000	*357.8	*477.1	−22.1	250.9	.....	.....	*51.2	*0.662
7000	.....	.....	−28.4	244.6	.....	.....	.....	.....

Summer.

0	758.9	1011.8	25.0	298.0	17.14	22.85	90.7	1.173
500	718.0	957.3	21.6	294.6	13.76	18.35	86.9	1.124
526	716.7	955.6	21.4	294.4	13.58	18.10	86.8	1.123
1000	678.5	904.6	18.2	291.2	10.66	14.21	83.2	1.076
1500	639.9	853.2	15.1	288.1	8.24	10.98	79.4	1.027
2000	603.0	804.0	12.1	285.1	6.14	8.19	75.7	0.979
2500	568.0	757.3	9.3	282.3	4.31	5.74	72.1	0.932
3000	534.9	713.2	6.4	279.4	3.10	4.13	68.6	0.887
3500	503.3	671.1	3.2	276.2	.....	.....	65.3	0.845
4000	473.5	631.3	− 0.1	272.9	.....	.....	62.2	0.805
4500	444.5	592.7	− 3.4	269.6	.....	.....	59.2	0.765
5000	417.2	556.3	− 6.4	266.6	.....	.....	56.2	0.726
6000	*372.0	*496.0	−13.5	259.5	.....	.....	*51.5	*0.666
7000	.....	.....	−19.3	253.7	.....	.....	.....	.....

*Based on few observations; figures not regarded as reliable.

TABLE 1.—*Mean free-air pressures, temperatures, vapor pressures, and densities, as observed at Mount Weather, Va.*—Continued.

Fall.

Altitudes above M. S. L.	Pressures.		Temperatures.		Vapor pressures.		Densities.	
m.	*mm.*	*mb.*	°*C.*	°*A.*	*mm.*	*mb.*	%	*kg./cu.m.*
0	762.0	1016.0	15.1	288.1	9.03	12.04	94.6	1.223
500	720.0	960.0	12.1	285.1	7.65	10.20	90.4	1.168
526	717.4	956.5	12.0	285.0	7.58	10.10	90.1	1.164
1000	677.8	903.7	9.4	282.4	6.28	8.37	85.9	1.111
1500	639.0	852.0	7.3	280.3	5.14	6.85	81.6	1.056
2000	600.4	800.5	5.6	278.6	4.03	5.37	77.2	0.998
2500	564.7	752.9	3.5	276.5	3.59	4.79	72.9	0.943
3000	531.1	708.1	0.9	273.9	3.08	4.11	69.5	0.898
3500	498.9	655.2	−2.0	271.0	.....	.....	66.0	0.854
4000	469.5	626.0	−5.0	268.0	.....	.....	62.8	0.813
4500	440.1	586.8	−8.1	264.9	.....	.....	59.6	0.771
5000	412.3	549.7	−11.2	261.8	.....	.....	56.5	0.731
6000	*369.3	*492.4	−17.1	255.9	.....	.....	*51.8	*0.670
7000	.....	.....	−27.4	245.6	.....	.....	.....	.....

Winter.

0	765.0	1020.0	0.7	273.7	3.18	4.24	100.2	1.296
500	720.0	960.0	−0.7	272.3	2.89	3.85	94.8	1.226
526	718.0	957.3	−0.8	272.2	2.87	3.83	94.6	1.223
1000	674.6	899.4	−2.1	270.9	2.54	3.39	89.3	1.155
1500	633.6	844.8	−3.0	270.0	2.24	2.99	84.2	1.089
2000	594.4	792.5	−4.2	268.8	2.03	2.71	79.3	1.026
2500	558.3	744.4	−6.0	267.0	1.58	2.10	75.0	0.970
3000	523.6	698.1	−8.4	264.6	1.21	1.61	71.0	0 918
3500	491.6	655.5	−11.2	261.8	.....	.....	67.4	0.871
4000	462.0	616.0	−13.9	259.1	.....	.....	64.0	0.828
4500	435.3	580.4	−16.8	256.2	.....	.....	61.0	0.789
5000	*397.5	*530.0	−19.7	253.3	.....	.....	*56.3	*0.728

Year.

0	760.0	1013.3	13.7	286.7	8.62	11.49	94.8	1.226
500	718.5	958.0	11.0	284.0	7.23	9.64	90.5	1.171
526	716.6	955.4	10.9	283.9	7.14	9.52	90.3	1.168
1000	676.8	902.4	8.4	281.4	5.87	7.82	86.1	1.113
1500	637.3	849.7	6.2	279.2	4.55	6.07	81.8	1.057
2000	599.2	798.9	4.0	277.0	3.60	4.80	77.5	1.002
2500	563.4	751.2	1.7	274.7	2.80	3.73	73.5	0.951
3000	529.6	706.1	−1.0	272.0	2.15	2.87	69.8	0.903
3500	497.7	663.6	−4.0	269.0	.....	.....	66.4	0.858
4000	467.8	623.7	−7.0	266.0	.....	.....	63.1	0.816
4500	439.0	585.3	−10.2	262.8	.....	.....	60.0	0.775
5000	409.0	545.3	−13.3	259.7	.....	.....	56.6	0.731
6000	*366.4	*488.5	−19.8	253.2	.....	.....	*52.0	*0.672
7000	.....	.....	−27.1	245.9	.....	.....	.....	.....

*Based on few observations; figures not regarded as reliable.

TABLE 2.—*Mean free-air pressures, temperatures, vapor pressures, and densities, as observed at Mount Weather, Va. (English measures).*

January.

Altitudes above M. S. L.	Pressures.	Temperatures.	Vapor pressures.	Densities.	
Feet.	*Inches.*	°*F.*	*Inches.*	%	*Lbs./cu.ft.*
0	29.97	31.6	0.08	100.2	0.0808
1000	28.96	30.4	.08	97.0	.0783
2000	27.94	29.5	.08	93.8	.0757
3000	26.92	28.6	.08	90.5	.0730
4000	25.90	27.7	.08	87.2	.0704
5000	24.93	26.6	.07	84.1	.0679
6000	23.99	25.5	0.07	81.2	0.0655
7000	23.08	24.1	.06	78.3	.0632
8000	22.20	22.3	.06	75.6	.0610
9000	21.34	19.6	.05	73.1	.0590
10000	20.50	16.7	.04	70.6	.0570
11000	19.71	13.8	.....	68.3	0.0552
12000	18.96	10.9	.....	66.2	.0534
13000	18.28	7.9	.....	64.2	.0518
14000	*17.71	5.0	.....	*62.6	*.0505
15000	.....	1.8	.....	.....	.....
16000	.....	−1.5	.....	.....	.....
17000	.....	−4.9	.....	.....	.....
18000	.....	−8.1	.....	.....	.....

*Based on few observations; figures not regarded as reliable.

TABLE 2.—*Mean free-air pressures, temperatures, vapor pressures, and densities, as observed at Mount Weather, Va. (English measures)*—Con.

February.

Altitudes above M. S. L.	Pressures.	Temperatures.	Vapor pressures.	Densities.	
Feet.	*Inches.*	°*F.*	*Inches.*	%	*Lbs./cu.ft.*
0	30.00	34.0	0.13	99.7	0.0805
1000	28.94	32.0	.11	96.6	.0780
2000	27.87	30.0	.09	93.4	.0754
3000	26.84	28.2	.08	90.3	.0729
4000	25.82	26.8	.07	87.1	.0703
5000	24.84	25.7	.07	84.0	.0678
6000	23.91	24.3	0.06	81.1	0.0655
7000	23.02	22.5	.05	78.4	.0633
8000	22.16	20.5	.04	75.8	.0612
9000	21.30	18.0	.03	73.2	.0591
10000	20.48	15.3	.03	70.8	.0572
11000	19.70	12.2	.....	68.6	0.0554
12000	18.98	9.0	.....	66.5	.0537
13000	18.30	5.7	.....	64.6	.0522
14000	17.63	2.5	.....	62.7	.0506
15000	.....	−0.9	.....	.....	.....
16000	.....	−4.5	.....	.....	.....
17000	.....	−8.3	.....	.....	.....

March.

0	29.99	44.4	0.19	97.5	0.0787
1000	28.97	41.9	.18	94.7	.0764
2000	27.92	39.6	.16	91.7	.0740
3000	26.91	37.2	.14	88.8	.0717
4000	25.90	35.1	.12	85.9	.0693
5000	24.92	32.9	.11	83.0	.0670
6000	23.98	30.9	0.09	80.2	0.0648
7000	23.09	28.6	.08	77.6	.0626
8000	22.24	26.1	.06	75.2	.0607
9000	21.41	23.4	.05	72.8	.0587
10000	20.63	20.5	.03	70.6	.0570
11000	19.87	17.4	.....	68.4	0.0552
12000	19.10	14.4	.....	66.2	.0534
13000	18.35	11.1	.....	64.1	.0517
14000	17.67	7.7	.....	62.2	.0502
15000	17.06	4.1	.....	60.5	.0488
16000	16.54	0.9	.....	59.0	0.0476
17000	.....	−2.4	.....	.....	.....

April.

0	29.96	57.0	0.31	94.9	0.0766
1000	28.94	53.2	.28	92.4	.0746
2000	27.94	49.6	.25	89.9	.0725
3000	26.94	46.2	.22	87.2	.0704
4000	25.95	43.2	.20	84.5	.0682
5000	24.99	39.9	.18	82.0	.0662
6000	24.07	36.7	0.15	79.5	0.0642
7000	23.18	33.6	.14	77.1	.0622
8000	22.33	30.7	.12	74.7	.0603
9000	21.50	27.9	.10	72.3	.0584
10000	20.71	25.0	.08	70.2	.0567
11000	19.92	21.6	.....	67.9	0.0548
12000	19.17	18.3	.....	65.8	.0532
13000	18.38	14.9	.....	63.6	.0513
14000	17.65	11.5	.....	61.5	.0496
15000	16.94	7.9	.....	59.5	.0480
16000	16.26	4.5	.....	57.6	0.0465
17000	15.58	1.0	.....	55.6	.0449
18000	14.95	−2.6	.....	53.8	.0434
19000	*14.56	−6.3	.....	*52.8	*.0426
20000	.....	−10.1	.....	.....	.....
21000	.....	−13.9	.....	.....	.....
22000	.....	−17.7	.....	.....	.....
23000	.....	−20.9	.....	.....	.....

*Based on few observations; figures not regarded as reliable.

TABLE 2.—*Mean free-air pressures, temperatures, vapor pressures, and densities, as observed at Mount Weather, Va. (English measures)*—Con.

May.

Altitudes above M. S. L.	Pressures.	Temperatures.	Vapor pressures.	Densities.	
Feet.	*Inches.*	°*F.*	*Inches.*	%	*Lbs./cu. ft.*
0	29.93	69.6	0.45	92.4	0.0746
1000	28.94	65.5	.40	90.1	.0727
2000	27.95	61.3	.38	87.7	.0708
3000	26.96	57.2	.31	85.3	.0689
4000	26.00	53.2	.26	83.0	.0670
5000	25.07	49.5	.22	80.6	.0651
6000	24.17	45.9	0.18	78.3	0.0632
7000	23.30	42.4	.15	76.1	.0614
8000	22.44	39.0	.12	73.8	.0596
9000	21.61	35.6	.10	71.6	.0578
10000	20.83	32.4	.09	69.5	.0561
11000	20.05	28.9	.....	67.3	0.0544
12000	19.29	25.7	.....	65.2	.0527
13000	18.54	22.3	.....	63.1	.0510
14000	17.80	18.7	.....	61.1	.0493
15000	17.08	14.5	.....	59.2	.0478
16000	16.35	10.2	.....	57.1	0.0461
17000	15.57	5.9	.....	55.0	.0444
18000	14.91	2.3	.....	53.0	.0428
19000	14.29	− 0.9	.....	51.2	.0413
20000	.....	− 4.0	.....	.....	.....
21000	.....	− 7.2	.....	.....	.....
22000	.....	−10.5	.....	.....	.....
23000	.....	−13.2	.....	.....	.....

June.

0	29.88	73.8	0.56	91.4	0.0738
1000	28.90	70.2	.51	89.0	.0719
2000	27.92	66.6	.45	86.6	.0699
3000	26.94	63.0	.40	84.2	.0680
4000	26.01	59.5	.34	81.9	.0661
5000	25.09	56.5	.29	79.6	.0642
6000	24.20	53.2	0.24	77.3	0.0624
7000	23.31	50.0	.20	75.0	.0605
8000	22.49	47.1	.17	72.8	.0587
9000	21.66	43.9	.14	70.5	.0569
10000	20.88	40.6	.12	68.5	.0553
11000	20.12	37.2	.....	66.4	0.0536
12000	19.39	33.6	.....	64.5	.0521
13000	18.65	29.8	.....	62.5	.0505
14000	17.97	26.1	.....	60.7	.0490
15000	17.32	22.5	.....	59.0	.0476
16000	16.67	19.4	.....	57.1	0.0461
17000	16.06	16.3	.....	55.4	.0448
18000	15.48	13.1	.....	53.8	.0434

July.

0	29.88	80.0	0.67	90.2	0.0728
1000	28.90	75.9	.59	88.0	.0710
2000	27.90	72.0	.52	85.6	.0691
3000	26.96	67.8	.45	83.5	.0674
4000	26.05	64.0	.39	81.3	.0656
5000	25.15	60.4	.33	79.1	.0638
6000	24.26	56.8	0.28	76.8	0.0620
7000	23.39	53.4	.23	74.6	.0602
8000	22.56	50.2	.19	72.4	.0585
9000	21.73	46.9	.15	70.3	.0567
10000	20.95	43.7	.12	68.2	.0551
11000	20.20	40.1	.....	66.3	0.0535
12000	19.47	36.3	.....	64.4	.0520
13000	18.74	32.5	.....	62.5	.0504
14000	18.03	28.9	.....	60.6	.0489
15000	17.34	25.3	.....	58.7	.0474
16000	16.71	22.1	.....	57.0	0.0460
17000	16.14	18.9	.....	55.4	.0447
18000	15.67	15.6	.....	54.2	.0437
19000	* 15.08	12.6	.....	* 52.5	* .0424
20000	.....	9.3	.....	.....	.....
21000	.....	6.1	.....	.....	.....
22000	.....	2.8	.....	.....	.....
23000	.....	−0.2	.....	.....	.....

* Based on few observations; figures not regarded as reliable.

TABLE 2.—*Mean free-air pressures, temperatures, vapor pressures, and densities, as observed at Mount Weather, Va. (English measures)*—Con.

August.

Altitudes above M. S. L.	Pressures.	Temperatures.	Vapor pressures.	Densities.	
Feet.	*Inches.*	°*F.*	*Inches.*	%	*Lbs./cu. ft.*
0	30.01	77.4	0.81	90.9	0.0734
1000	29.02	73.6	.69	88.6	.0715
2000	27.99	69.6	.58	86.2	.0696
3000	27.01	66.0	.48	83.9	.0677
4000	26.07	62.6	.40	81.5	.0658
5000	25.16	59.4	.34	79.2	.0640
6000	24.28	56.3	0.29	77.0	0.0621
7000	23.42	53.2	.24	74.7	.0603
8000	22.59	50.4	.20	72.5	.0585
9000	21.77	47.1	.16	70.4	.0568
10000	20.98	43.7	.13	68.3	.0552
11000	20.22	40.3	.....	66.3	0.0535
12000	19.48	37.0	.....	64.3	.0519
13000	18.78	33.8	.....	62.4	.0504
14000	18.11	30.0	.....	60.7	.0490
15000	.....	26.1	.....	.....	.....
16000	.....	21.6	.....	.....	.....
17000	.....	16.9	.....	.....	.....
18000	.....	12.0	.....	.....	.....
19000	.....	6.8	.....	.....	.....

September.

0	30.02	72.5	0.60	92.0	0.0742
1000	29.04	68.7	.54	89.7	.0724
2000	28.03	65.1	.48	87.2	.0704
3000	27.07	61.9	.42	84.8	.0684
4000	26.12	59.0	.35	82.3	.0665
5000	25.20	56.3	.30	79.9	.0645
6000	24.30	54.0	0.25	77.4	0.0625
7000	23.41	51.4	.19	75.0	.0606
8000	22.56	48.9	.17	72.7	.0587
9000	21.75	45.9	.15	70.5	.0569
10000	20.97	42.6	.14	68.4	.0552
11000	20.21	39.2	.....	66.4	0.0536
12000	19.50	35.8	.....	64.5	.0521
13000	18.78	32.2	.....	62.6	.0505
14000	18.06	28.4	.....	60.7	.0490
15000	17.37	24.3	.....	58.9	.0475
16000	16.70	20.8	.....	57.0	0.0460
17000	.....	19.2	.....	.....	.....
18000	.....	17.4	.....	.....	.....
19000	.....	15.6	.....	.....	.....
20000	.....	10.4	.....	.....	.....
21000	.....	4.3	.....	.....	.....
22000	.....	−3.3	.....	.....	.....

October.

0	29.97	58.6	0.38	94.6	0.0763
1000	29.00	55.4	.35	92.1	.0744
2000	28.00	52.2	.31	89.5	.0722
3000	27.01	49.1	.28	86.9	.0701
4000	26.06	46.6	.26	84.3	.0680
5000	25.15	44.6	.22	81.7	.0660
6000	24.23	42.8	0.20	79.0	0.0638
7000	23.31	41.0	.17	76.3	.0616
8000	22.44	38.8	.16	73.8	.0596
9000	21.59	36.3	.14	71.4	.0576
10000	20.79	33.4	.13	69.1	.0558
11000	20.01	30.2	.....	67.0	0.0541
12000	19.26	27.0	.....	64.9	.0524
13000	18.55	23.9	.....	62.8	.0507
14000	17.85	21.0	.....	60.8	.0491
15000	17.15	17.8	.....	58.9	.0475
16000	16.45	14.0	.....	56.9	0.0459
17000	15.83	10.0	.....	55.2	.0446
18000	15.24	6.6	.....	53.6	.0432
19000	* 14.80	3.4	.....	* 52.4	* .0423
20000	.....	−0.2	.....	.....	.....
21000	.....	−4.2	.....	.....	.....
22000	.....	−8.9	.....	.....	.....
23000	.....	−14.8	.....	.....	.....

* Based on few observations; figures not regarded as reliable.

TABLE 2.—*Mean free-air pressures, temperatures, vapor pressures, and densities, as observed at Mount Weather, Va. (English measures)*—Con.

November.

Altitudes above M. S. L.	Pressures.	Temperatures.	Vapor pressures.	Densities.	
Feet.	*Inches.*	*°F.*	*Inches.*	*%*	*Lbs./cu. ft.*
0	30.00	46.2	0.17	97.3	0.0785
1000	28.98	43.2	.15	94.5	.0763
2000	27.94	40.3	.13	91.7	.0740
3000	26.90	37.8	.12	88.7	.0716
4000	25.92	35.2	.11	85.9	.0694
5000	24.96	33.1	.09	83.1	.0671
6000	24.04	31.3	0.08	80.4	0.0649
7000	23.11	29.5	.07	77.5	.0626
8000	22.24	27.3	.07	74.9	.0605
9000	21.38	24.6	.06	72.5	.0585
10000	20.59	21.7	.06	70.2	.0567
11000	19.82	18.5	.....	68.0	0.0549
12000	19.09	15.4	.....	66.0	.0532
13000	18.38	12.0	.....	64.0	.0517
14000	17.68	8.6	.....	62.0	.0501
15000	17.00	5.2	.....	60.1	.0485
16000	16.33	1.9	.....	58.1	0.0469
17000	15.70	−1.1	.....	56.3	.0454
18000	15.09	−4.0	.....	54.4	.0439
19000	.....	−7.2	.....	.....	.....

December.

0	30.01	35.6	0.16	99.4	0.0802
1000	28.96	33.3	.16	96.3	.0778
2000	27.90	30.9	.16	93.3	.0753
3000	26.85	28.9	.16	90.1	.0728
4000	25.85	27.9	.15	86.9	.0702
5000	24.87	27.1	.14	83.8	.0676
6000	23.93	26.1	0.13	80.8	0.0652
7000	23.00	24.6	.11	77.9	.0629
8000	22.13	22.5	.10	75.3	.0608
9000	21.29	19.8	.08	72.9	.0588
10000	20.49	16.9	.07	70.6	.0570
11000	19.72	13.8	.....	68.4	0.0552
12000	18.98	10.9	.....	66.2	.0534
13000	18.24	7.9	.....	64.0	.0517
14000	17.53	4.6	.....	62.0	.0500
15000	16.81	1.2	.....	59.9	.0483
16000	* 16.01	−1.8	.....	* 57.4	* 0.0463

Spring.

0	29.92	57.2	0.31	94.7	0.0765
1000	28.93	53.8	.28	92.2	.0744
2000	27.92	50.4	.25	89.7	.0724
3000	26.93	46.9	.22	87.1	.0703
4000	25.96	43.9	.19	84.5	.0682
5000	25.00	41.0	.17	81.9	.0661
6000	24.09	38.3	0.14	79.3	0.0640
7000	23.19	35.4	.12	76.8	.0620
8000	22.33	32.5	.10	74.4	.0601
9000	21.51	29.5	.08	72.2	.0582
10000	20.72	26.4	.06	70.0	.0565
11000	19.95	23.0	.....	67.9	0.0548
12000	19.20	19.8	.....	65.7	.0531
13000	18.46	16.5	.....	63.7	.0514
14000	17.76	13.1	.....	61.7	.0498
15000	17.04	9.3	.....	59.7	.0482
16000	16.34	5.5	.....	57.7	0.0466
17000	15.65	1.8	.....	55.7	.0450
18000	15.02	− 1.8	.....	53.9	.0435
19000	* 14.40	− 5.4	.....	* 52.1	* .0420
20000	.....	− 8.9	.....	.....	.....
21000	.....	−12.5	.....	.....	.....
22000	.....	−15.9	.....	.....	.....
23000	.....	−19.1	.....	.....	.....

* Based on few observations; figures not regarded as reliable.

TABLE 2.—*Mean free-air pressures, temperatures, vapor pressures, and densities, as observed at Mount Weather, Va. (English measures)*—Con.

Summer.

Altitudes above M. S. L.	Pressures.	Temperatures.	Vapor pressures.	Densities.	
Feet.	*Inches.*	*°F.*	*Inches.*	*%*	*Lbs./cu. ft.*
0	29.88	77.0	0.68	90.7	0.0732
1000	28.90	73.2	.59	88.4	.0714
2000	27.92	69.4	.51	86.1	.0695
3000	26.98	65.7	.44	83.8	.0677
4000	26.06	62.2	.38	81.6	.0659
5000	25.15	58.8	.32	79.3	.0640
6000	24.25	55.6	0.27	77.0	0.0622
7000	23.37	52.3	.22	74.7	.0603
8000	22.55	49.3	.18	72.6	.0586
9000	21.73	46.2	.15	70.4	.0568
10000	20.94	42.8	.12	68.3	.0552
11000	20.19	39.4	.....	66.3	0.0536
12000	19.45	35.8	.....	64.4	.0520
13000	18.73	32.2	.....	62.5	.0504
14000	18.03	28.6	.....	60.6	.0489
15000	17.32	25.0	.....	58.7	.0474
16000	16.69	21.9	.....	56.9	0.0459
17000	16.09	18.3	.....	55.3	.0446
18000	15.55	14.5	.....	53.9	.0435
19000	* 14.99	10.6	.....	* 52.4	* .0423
20000	.....	6.6	.....	.....	.....
21000	.....	3.2	.....	.....	.....
22000	.....	0.0	.....	.....	.....
23000	.....	− 2.9	.....	.....	.....

Fall.

0	30.00	59.2	0.36	94.6	0.0763
1000	29.01	55.9	.32	92.1	.0743
2000	27.99	52.7	.29	89.4	.0722
3000	27.02	49.6	.26	86.9	.0701
4000	26.06	47.1	.23	84.2	.0680
5000	25.10	45.0	.20	81.5	.0658
6000	24.17	43.2	0.17	78.8	0.0636
7000	23.27	41.0	.15	76.2	.0615
8000	22.41	38.8	.14	73.7	.0595
9000	21.58	36.1	.13	71.4	.0576
10000	20.79	33.1	.12	69.2	.0558
11000	20.04	29.8	.....	67.1	0.0542
12000	19.31	26.6	.....	65.2	.0526
13000	18.59	23.4	.....	63.1	.0510
14000	17.87	19.9	.....	61.2	.0494
15000	17.16	16.5	.....	59.2	.0478
16000	16.52	13.1	.....	57.4	0.0463
17000	15.90	9.9	.....	55.6	.0449
18000	15.37	6.6	.....	54.1	.0437
19000	* 14.87	3.4	.....	* 52.8	* .0426

Winter.

0	30.12	33.3	0.13	100.2	0.0809
1000	29.05	31.6	.12	97.0	.0783
2000	27.94	30.2	.11	93.6	.0756
3000	26.86	28.6	.10	90.3	.0729
4000	25.85	27.5	.09	87.1	.0703
5000	24.87	26.6	.09	83.9	.0678
6000	23.93	25.3	0.08	81.0	0.0654
7000	23.02	23.7	.07	78.2	.0631
8000	22.16	21.6	.06	75.6	.0610
9000	21.31	19.2	.06	73.1	.0590
10000	20.51	16.3	.05	70.7	.0571
11000	19.72	13.3	.....	68.4	0.0552
12000	18.99	10.2	.....	66.3	.0536
13000	18.31	7.3	.....	64.4	.0520
14000	17.65	4.3	.....	62.5	.0504
15000	16.93	1.0	.....	60.4	.0487
16000	* 16.02	−2.2	.....	* 57.5	* 0.0464
17000	.....	−5.6	.....	.....	.....
18000	.....	−9.0	.....	.....	.....

*Based on few observations; figures not regarded as reliable.

TABLE 2.—*Mean free-air pressures, temperatures, vapor pressures, and densities, as observed at Mount Weather, Va. (English measures)*—Con.

Year.

Altitudes above M. S. L.	Pressures.	Temperatures.	Vapor pressures.	Densities.	
Feet.	*Inches.*	*°F.*	*Inches.*	*%*	*Lbs./cu.ft.*
0	29.92	56.7	0.34	94.8	0.0765
1000	28.93	53.8	.31	92.2	.0744
2000	27.94	50.9	.27	89.6	.0723
3000	26.94	47.8	.24	86.9	.0702
4000	25.95	45.3	.21	84.2	.0680
5000	25.00	43.0	.18	81.5	.0658
6000	24.09	40.6	0.15	78.9	0.0637
7000	23.21	38.1	.13	76.5	.0617
8000	22.36	35.6	.11	74.1	.0598
9000	21.54	32.7	.10	71.8	.0579
10000	20.75	29.7	.08	69.6	.0562
11000	19.97	26.4	.....	67.4	0.0544
12000	19.25	23.0	.....	65.5	.0528
13000	18.51	19.8	.....	63.4	.0512
14000	17.82	16.3	.....	61.5	.0496
15000	17.11	12.7	.....	59.5	.0480
16000	16.40	9.3	.....	57.4	0.0464
17000	15.77	5.9	.....	55.7	.0449
18000	15.24	2.5	.....	54.2	.0438
19000	* 14.76	− 1.1	.....	* 52.9	* .0427
20000	.....	− 4.9	.....	.....	.....
21000	.....	− 8.9	.....	.....	.....
22000	.....	−12.8	.....	.....	.....
23000	.....	−17.0	.....	.....	.....

* Based on few observations; figures not regarded as reliable.

TABLE 3.—*Mean values of atmospheric pressures, temperatures, vapor pressures, and densities, based on sounding balloon observations at Fort Omaha, Nebr.; Indianapolis, Ind.; Huron, S. Dak.; and Avalon, Cal.*

Spring.

Altitude above M. S. L.	Pressures.		Temperatures.		Vapor pressures.		Densities.	
m.	*mm.*	*mb.*	*°C.*	*°A.*	*mm.*	*mb.*	*%*	*kg./cu.m.*
0	757	1009	16.9	289.9	9.45	12.60	93.4	1.207
500	716	955	13.9	286.9	7.71	10.28	89.3	1.154
1000	674	899	9.7	282.7	5.93	7.91	85.5	1.105
2000	597	796	5.0	278.0	3.93	5.25	77.0	0.995
3000	527	703	0.9	273.9	2.70	3.60	69.0	.892
4000	465	620	− 5.1	267.9	1.68	2.25	62.3	.805
5000	409	545	−12.4	260.6	0.75	1.01	56.6	.732
6000	357	476	−17.2	255.8	0.42	0.56	50.1	0.648
7000	311	415	−24.5	248.5	.18	.24	44.9	.581
8000	270	360	−35.2	237.8	.10	.133	40.8	.527
9000	233	311	−43.4	229.6	.026	.035	36.4	.471
10000	201	268	−50.4	222.6	.010	.013	32.4	.419
11000	172	229	−53.8	219.2	0.006	0.008	28.2	0.364
12000	148	197	−54.8	218.2	.004	.005	24.4	.315
13000	127	169	−55.2	217.8	.004	.005	21.0	.271
14000	109	145	−55.4	217.6	.004	.005	18.0	.233
15000	95	127	−55.2	217.8	.005	.007	15.7	.203
16000	81	108	−56.3	216.7	0.004	0.005	13.4	0.174
17000	69	92	−57.8	215.2	.003	.004	11.5	.149
18000	59	79	.....	.....	.....	.....	.....	.....
19000	50	67	.....	.....	.....	.....	.....	.....
20000	43	57	.....	.....	.....	.....	.....	.....
21000	37	49	.....	.....	.....	.....	.....	.....
22000	32	43	.....	.....	.....	.....	.....	.....
23000	27	36	.....	.....	.....	.....	.....	.....
24000	23	31	.....	.....	.....	.....	.....	.....
25000	19	25	.....	.....	.....	.....	.....	.....

TABLE 3.—*Mean values of atmospheric pressures, temperatures, vapor pressures, and densities, based on sounding balloon observations at Fort Omaha, Nebr.; Indianapolis, Ind.; Huron, S. Dak.; and Avalon, Cal.*—Continued.

Summer.

Altitude above M. S. L.	Pressures.		Temperatures.		Vapor pressures.		Densities.	
m.	*mm.*	*mb.*	*°C.*	*°A.*	*mm.*	*mb.*	*%*	*kg./cu.m.*
0	761	1015	24.9	297.9	14.94	19.92	91.1	1.177
500	719	959	23.2	296.2	11.90	15.87	86.6	1.120
1000	679	905	21.6	294.6	9.35	12.47	82.4	1.065
2000	604	805	16.6	289.6	5.78	7.70	74.6	0.965
3000	536	715	10.3	283.3	3.58	4.77	67.8	.876
4000	475	633	3.9	276.9	2.22	2.96	61.5	.795
5000	419	559	− 2.5	270.5	1.30	1.74	55.6	.718
6000	369	492	− 8.5	264.5	0.73	0.97	50.1	0.647
7000	324	432	−14.3	258.7	.45	.60	45.0	.581
8000	284	379	−20.9	252.1	.260	.346	40.4	.523
9000	248	331	−27.2	245.8	.142	.190	36.2	.468
10000	215	287	−33.9	239.1	.073	.097	32.3	.418
11000	187	249	−40.5	232.5	0.032	0.042	28.9	0.374
12000	161	215	−46.8	226.2	.014	.019	25.6	.331
13000	139	185	−50.0	223.0	.008	.011	22.4	.290
14000	119	159	−53.6	219.4	.005	.007	19.5	.252
15000	102	136	−56.1	216.9	.003	.004	16.9	.218
16000	88	117	−58.0	215.0	0.002	0.003	14.7	0.190
17000	75	100	−57.3	215.7	.003	.004	12.5	.162
18000	64	85	−55.5	217.5	.004	.005	10.6	.137
19000	55	73	−53.2	219.8	.006	.008	9.0	.116
20000	47	63	−51.1	221.9	.008	.011	7.6	.098
21000	41	55	−49.4	223.6	0.009	0.012	6.6	0.085
22000	35	47	−48.3	224.7	.011	.015	5.6	.072
23000	30	40	−45.7	227.3	.015	.020	4.7	.061
24000	27	36	−41.9	231.1	.022	.029	4.2	.054
25000	23	31	−39.7	233.3	.027	.036	3.5	.048
26000	19	25	−38.5	234.5	0.026	0.034	2.9	0.038
27000	16	21	−40.4	232.6	.022	.029	2.5	.032
28000	15	20	−37.0	236.0	.038	.050	2.3	.030
29000	14	19	−35.4	237.6	.041	.055	2.1	.027
30000	12	16	−34.8	238.2	.046	.061	1.8	.023
31000	11	15	−34.0	239.0	0.051	0.068	1.6	0.021
32000	10	13	−41.9	231.1	.004	.005	1.5	.020

Fall.

0	759	1012	23.8	296.8	11.00	14.67	91.4	1.182
500	719	959	19.5	292.5	9.00	12.00	87.9	1.136
1000	678	904	14.9	287.9	7.28	9.71	84.2	1.089
2000	603	804	10.2	283.2	5.00	6.66	76.2	0.986
3000	532	709	3.8	276.8	2.99	3.99	69.0	.893
4000	468	624	− 3.1	269.9	1.69	2.25	62.2	.804
5000	413	551	− 9.9	263.1	0.97	1.29	56.4	.729
6000	362	483	−17.1	255.9	0.52	0.70	50.8	0.657
7000	317	423	−23.4	249.6	.29	.39	45.6	.590
8000	276	368	−30.6	242.4	.142	.189	40.9	.529
9000	240	320	−37.3	235.7	.066	.088	36.6	.473
10000	207	276	−43.7	229.3	.029	.039	32.4	.419
11000	178	237	−50.3	222.7	0.015	0.020	28.4	0.367
12000	153	204	−52.2	220.8	.010	.013	24.9	.322
13000	131	175	−53.9	219.1	.008	.010	21.5	.278
14000	113	151	−54.3	218.7	.007	.009	18.6	.240
15000	95	127	−55.5	217.5	.006	.008	15.7	.203
16000	82	109	−55.4	217.6	0.006	0.008	13.5	0.175
17000	70	93	−55.0	218.0	.005	.007	11.5	.149
18000	60	80	−53.5	219.5	.006	.008	9.8	.127
19000	52	69	−51.0	222.0	.008	.011	8.4	.109
20000	45	60	−47.2	225.8	.014	.018	7.2	.093
21000	39	52	−44.6	228.4	0.019	0.025	6.1	0.079
22000	34	45	−42.5	230.5	.026	.034	5.3	.068
23000	29	39	−39.9	233.1	.042	.056	4.5	.058
24000	25	33	−37.2	235.8	.075	.100	3.8	.049
25000	22	29	−42.2	230.8	.002	.003	3.4	.044
26000	19	25	−40.2	232.8	0.002	0.003	2.9	0.038
27000	17	23	−39.7	233.3	.002	.003	2.6	.034
28000	14	19	−40.1	232.9	.002	.003	2.2	.028
29000	12	16	−40.5	232.5	.002	.003	1.8	.024
30000	10	13	−40.8	232.2	.002	.003	1.6	.020

TABLE 3.—*Mean values of atmospheric pressures, temperatures, vapor pressures, and densities, based on sounding balloon observations at Fort Omaha, Nebr.; Indianapolis, Ind.; Huron, S. Dak.; and Avalon, Cal.*—Continued.

Winter.

Altitude above M. S. L.	Pressures.		Temperatures.		Vapor pressures.		Densities.	
m.	*mm.*	*mb.*	°*C.*	°*A.*	*mm.*	*mb.*	%	*kg./cu.m.*
0	764	1019	6.0	279.0	3.40	4.53	98.2	1.270
500	720	960	2.1	275.1	2.96	3.95	93.9	1.214
1000	677	903	− 1.5	271.5	2.48	3.30	89.4	1.157
2000	597	796	− 3.3	269.7	1.82	2.43	79.4	1.027
3000	526	701	− 7.8	265.2	1.01	1.35	71.2	0.920
4000	462	616	−12.9	260.1	0.57	0.76	63.8	.825
5000	404	539	−19.4	253.6	.26	.35	57.2	.740
6000	352	469	−26.1	246.9	0.14	0.19	51.2	0.662
7000	306	408	−33.0	240.0	.05	.07	45.8	.592
8000	265	353	−39.0	234.0	.028	.037	40.7	.526
9000	229	305	−45.1	227.9	.015	.020	36.1	.467
10000	197	263	−48.6	224.4	.009	.012	31.5	.408
11000	170	227	−50.6	222.4	0.007	0.009	27.5	0.355
12000	146	195	−51.9	221.1	.006	.008	23.7	.307
13000	125	167	−52.6	220.4	.005	.007	20.4	.263
14000	107	143	−54.3	218.7	.005	.007	17.6	.227
15000	91	121	−54.8	218.2	.004	.005	15.0	.194
16000	78	104	−55.4	217.6	0.004	0.005	12.9	0.166
17000	67	89	−55.2	217.8	.004	.005	11.0	.143
18000	57	76	−54.6	218.4	.004	.005	9.4	.121
19000	49	65	−55.2	217.8	.004	.005	8.1	.104
20000	42	56	−54.3	218.7	.003	.004	6.9	.089
21000	36	48	−54.0	219.0	0.004	0.005	5.9	0.076
22000	31	41	−46.1	226.9	.003	.004	4.9	.064
23000	26	35	−46.0	227.0	.004	.005	4.1	.053
24000	22	29	−45.9	227.1	.004	.005	3.5	.045

Year.

0	760	1013	19.1	292.1	10.54	14.05	93.0	1.202
500	719	959	16.2	289.2	8.47	11.29	88.9	1.150
1000	677	903	13.3	286.3	6.73	8.97	84.6	1.094
2000	601	801	8.4	281.4	4.41	5.88	76.1	0.984
3000	531	708	2.6	275.6	2.72	3.63	69.0	.892
4000	469	625	− 3.5	269.5	1.64	2.19	62.4	.807
5000	412	549	−10.0	263.0	0.90	1.20	55.9	.723
6000	362	483	−16.5	256.5	0.50	0.67	50.7	0.655
7000	316	421	−22.9	250.1	.28	.37	45.4	.586
8000	275	367	−29.6	243.4	.153	.204	40.6	.524
9000	239	319	−36.2	236.8	.080	.107	36.2	.468
10000	207	276	−41.9	231.1	.040	.053	32.2	.416
11000	179	239	−46.8	226.2	0.019	0.025	28.4	0.367
12000	154	205	−50.4	222.6	.010	.013	24.8	.321
13000	132	176	−52.3	220.7	.007	.009	21.5	.278
14000	113	151	−54.1	218.9	.006	.008	18.5	.240
15000	97	129	−55.6	217.4	.004	.005	16.0	.207
16000	83	111	−56.5	216.5	0.004	0.005	13.8	0.178
17000	71	95	−56.0	217.0	.004	.005	11.8	.151
18000	61	81	−54.7	218.3	.004	.005	10.0	.130
19000	53	71	−53.1	219.9	.006	.008	8.6	.112
20000	46	61	−50.9	222.1	.007	.009	7.4	.096
21000	39	52	−49.3	223.7	0.010	0.013	6.3	0.081
22000	34	45	−46.6	226.4	.014	.019	5.3	.068
23000	29	39	−44.0	229.0	.022	.029	4.4	.057
24000	25	33	−40.3	232.7	.038	.051	3.9	.050
25000	22	29	−40.3	232.7	.023	.031	3.4	.044
26000	19	25	−39.0	234.0	0.020	0.027	2.9	0.038
27000	16	21	−38.2	234.8	.015	.020	2.5	.032
28000	15	20	−38.0	235.0	.026	.035	2.3	.030
29000	14	19	−37.1	235.9	.028	.037	2.1	.028
30000	12	16	−36.8	236.2	.030	.040	1.8	.024
31000	11	15	−34.0	239.0	0.051	0.068	1.7	0.021
32000	10	13	−41.9	231.1	.004	.005	1.6	.020

TABLE 4.—*Mean values of atmospheric pressures, temperatures, vapor pressures, and densities, based on sounding balloon observations at Fort Omaha, Nebr.; Indianapolis, Ind.; Huron, S. Dak.; and Avalon, Cal. (English measures).*

Spring.

Altitude above M. S. L.	Pressures.	Temperatures.	Vapor pressures.	Densities.	
Feet.	*Inches.*	°*F.*	*Inches.*	%	*Lbs./cu.ft.*
0	29.80	62.4	0.372	93.4	0.0754
1000	28.82	59.2	.330	90.9	.0734
2000	27.84	56.1	.287	88.3	.0713
3000	26.85	52.7	.245	85.8	.0693
4000	25.87	49.5	.211	83.2	.0672
5000	24.92	46.4	.187	80.7	.0651
6000	24.02	43.3	0.166	78.3	0.0632
7000	23.15	40.3	.149	75.9	.0612
8000	22.28	37.4	.133	73.5	.0593
9000	21.46	34.5	.118	71.2	.0575
10000	20.63	31.6	.105	68.9	.0556
11000	19.80	28.8	0.091	66.5	0.0537
12000	19.06	26.1	.079	64.4	.0520
13000	18.35	22.6	.067	62.5	.0504
14000	17.64	19.6	.056	60.4	.0488
15000	16.97	16.5	.045	58.5	.0472
16000	16.34	13.3	0.034	56.7	0.0457
17000	15.71	10.2	.027	54.9	.0443
18000	15.12	6.8	.022	53.2	.0430
19000	14.53	3.6	.019	51.6	.0416
20000	13.94	0.3	.016	49.8	.0402
21000	13.39	− 3.3	0.013	48.2	0.0389
22000	12.83	− 7.1	.010	46.6	.0376
23000	12.28	−11.4	.007	45.0	.0364
24000	11.77	−15.9	.006	43.6	.0352
25000	11.26	−20.7	.005	42.2	.0340
26000	10.79	−26.0	0.004	40.9	0.0330
27000	10.31	−31.5	.003	39.6	.0320
28000	9.84	−37.3	.002	38.3	.0309
29000	9.41	−43.1	.002	37.1	.0300
30000	9.02	−47.9	.002	36.0	.0291
Miles.					
6	8.34	−54.9	0.001	33.9	0.0273
7	6.46	−65.2	.0002	26.9	.0217
8	5.12	−67.2	.0002	21.4	.0173
9	4.02	−67.4	.0002	16.8	.0136
10	3.15	−69.5	.0002	13.3	.0107
11	2.44	.....	.....	.....	.....
12	1.89	.....	.....	.....	.....
13	1.49	.....	.....	.....	.....
14	1.14	.....	.....	.....	.....
15	0.87	.....	.....	.....	.....

Summer.

0	29.96	76.8	0.588	91.1	0.0735
1000	28.98	75.0	.509	88.5	.0714
2000	27.99	73.2	.441	85.8	.0692
3000	27.01	71.2	.384	83.1	.0671
4000	26.06	68.7	.326	80.7	.0651
5000	25.16	66.2	.281	78.3	.0632
6000	24.25	63.3	0.246	75.9	0.0613
7000	23.43	60.4	.215	73.8	.0596
8000	22.60	57.2	.189	71.6	.0578
9000	21.77	53.8	.163	69.5	.0561
10000	20.94	50.0	.139	67.4	.0544
11000	20.20	46.4	0.119	65.5	0.0528
12000	19.49	42.8	.103	63.6	.0514
13000	18.78	39.4	.089	61.7	.0498
14000	18.07	35.8	.076	59.8	.0483
15000	17.40	32.4	.065	58.0	.0468
16000	16.77	28.9	0.056	56.3	0.0455
17000	16.14	25.7	.047	54.6	.0441
18000	15.55	22.3	.040	53.0	.0428
19000	14.96	18.9	.033	51.3	.0414
20000	14.37	15.4	.028	49.7	.0401

TABLE 4.—*Mean values of atmospheric pressures, temperatures, vapor pressures, and densities, based on sounding balloon observations at Fort Omaha, Nebr.; Indianapolis, Ind.; Huron, S. Dak.; and Avalon, Cal. (English measures)*—Continued.

Summer—Continued.

Altitude above M. S. L.	Pressures.	Temperatures.	Vapor pressures.	Densities.	
Feet.	*Inches.*	*° F.*	*Inches.*	*%*	*Lbs./cu. ft.*
21000	13.82	12.0	0.024	48.1	0.0388
22000	13.31	8.6	.020	46.7	.0377
23000	12.80	5.4	.017	45.2	.0365
24000	12.28	1.9	.014	43.7	.0353
25000	11.77	− 1.5	.012	42.2	.0341
26000	11.33	− 4.9	0.010	40.9	0.0330
27000	10.87	− 8.3	.009	39.6	.0320
28000	10.43	−11.7	.007	38.3	.0309
29000	10.00	−15.2	.006	37.0	.0298
30000	9.57	−18.6	.005	35.7	.0288
Miles.					
6	8.90	−24.7	0.010	33.6	0.0271
7	7.08	−44.5	.004	28.0	.0226
8	5.59	−57.5	.001	22.8	.0184
9	4.37	−66.6	.0002	18.3	.0148
10	3.39	−72.4	.0001	14.4	.0116
11	2.64	−68.8	0.0002	11.1	0.0090
12	2.05	−62.7	.0002	8.5	.0069
13	1.61	−56.9	.0004	6.6	.0053
14	1.26	−52.4	.0006	5.1	.0041
15	1.02	−43.1	.0009	4.0	.0033
16	0.81	−37.5	0.0010	3.2	0.0025
17	0.65	−35.9	.0009	2.5	.0020
18	0.54	−31.9	.0016	2.1	.0017
19	0.46	−29.6	.0020	1.8	.0014
20	0.39	−43.4	.0016	1.5	.0012

Fall.

0	29.87	74.8	0.433	91.3	0.0737
1000	28.91	70.0	.382	89.2	.0720
2000	27.96	65.1	.337	87.1	.0703
3000	27.02	60.1	.298	85.0	.0686
4000	26.10	57.0	.265	82.7	.0668
5000	25.20	54.5	.237	80.2	.0648
6000	24.32	52.0	0.212	77.8	0.0628
7000	23.44	48.7	.185	75.5	.0610
8000	22.58	45.1	.158	73.3	.0592
9000	21.73	41.7	.135	71.1	.0574
10000	20.90	38.1	.115	68.9	.0556
11000	20.11	34.5	0.097	66.7	0.0539
12000	19.36	30.6	.081	64.8	.0523
13000	18.60	27.0	.068	62.7	.0506
14000	17.89	23.2	.058	60.8	.0491
15000	17.23	19.4	.049	59.0	.0476
16000	16.58	15.4	0.041	57.3	0.0462
17000	15.96	11.5	.035	55.6	.0449
18000	15.35	7.7	.030	53.9	.0435
19000	14.74	3.7	.025	52.2	.0422
20000	14.17	0.1	.020	50.6	.0408
21000	13.61	−3.8	0.017	49.0	0.0396
22000	13.05	−7.4	.014	47.4	.0383
23000	12.51	−11.2	.012	45.8	.0370
24000	11.97	−14.8	.010	44.2	.0357
25000	11.50	−18.4	.008	42.8	.0346
26000	11.00	−22.0	0.007	41.3	0.0333
27000	10.55	−25.8	.006	40.0	.0323
28000	10.08	−29.6	.004	38.5	.0311
29000	9.65	−33.0	.004	37.2	.0300
30000	9.25	−36.6	.003	35.9	.0290
Miles.					
6	8.58	−42.9	0.002	33.8	0.0273
7	6.73	−60.0	.0006	27.7	.0223
8	5.28	−64.7	.0003	22.0	.0177
9	4.09	−67.0	.0003	17.1	.0138
10	3.15	−68.1	.0002	13.2	.0107
11	2.48	−65.2	0.0002	10.3	0.0083
12	1.93	−57.5	.0003	7.9	.0064
13	1.54	−49.0	.0007	6.2	.0050
14	1.22	−41.3	0013	4.8	.0039
15	0.96	−40.9	.0029	3.8	.0030
16	0.79	−39.8	0.0001	3.1	0.0025
17	0.63	−39.8	.0001	2.5	.0020
18	0.47	−41.1	.0001	1.8	.0015

TABLE 4.—*Mean values of atmospheric pressures, temperatures, vapor pressures, and densities, based on sounding balloon observations at Fort Omaha, Nebr.; Indianapolis, Ind.; Huron, S. Dak.; and Avalon, Cal. (English measures)*—Continued.

Winter.

Altitude above M. S. L.	Pressures.	Temperatures.	Vapor pressures.	Densities.	
Feet.	*Inches.*	*° F.*	*Inches.*	*%*	*Lbs./cu. ft.*
0	30.09	42.8	0.134	98.2	0.0793
1000	29.03	38.8	.124	95.4	.0770
2000	27.96	34.5	.113	92.8	.0750
3000	26.96	30.6	.102	90.2	.0728
4000	25.96	28.6	.091	87.3	.0704
5000	24.96	27.5	.080	84.1	.0679
6000	24.02	26.6	0.071	81.1	0.0655
7000	23.13	25.2	.062	78.3	.0632
8000	22.25	22.6	.054	75.8	.0612
9000	21.36	20.1	.046	73.1	0590
10000	20.56	17.2	.039	70.8	.0572
11000	19.76	14.4	0.033	68.5	0.0553
12000	18.98	11.7	.028	66.1	.0534
13000	18.27	8.6	.023	64.1	.0517
14000	17.56	5.4	.019	62.0	.0501
15000	16.88	2.3	.015	60.0	.0484
16000	16.20	−1.5	0.012	58.1	0.0469
17000	15.55	−4.9	.009	56.2	.0454
18000	14.95	−8.7	.008	54.6	.0440
19000	14.32	−12.5	.006	52.6	.0425
20000	13.70	−16.2	.005	50.8	.0410
21000	13.13	−20.2	0.004	49.1	0.0396
22000	12.58	−23.8	.003	47.4	.0383
23000	12.03	−27.4	.002	45.7	.0369
24000	11.50	−30.8	.002	44.1	.0356
25000	11.02	−34.2	.002	42.6	.0344
26000	10.55	−37.7	0.001	41.1	0.0332
27000	10.08	−41.1	.001	39.6	.0320
28000	9.65	−44.3	.001	38.2	.0308
29000	9.21	−47.2	.001	36.7	.0296
30000	8.82	−50.1	.001	35.4	.0286
Miles.					
6	8.18	−54.0	0.0004	33.2	0.0268
7	6.38	−59.6	.0003	26.2	.0212
8	5.03	−63.0	.0002	20.8	.0168
9	3.93	−66.1	.0002	16.4	.0132
10	3.03	−67.7	.0002	12.7	.0102
11	2.36	−66.6	0.0002	9.9	0.0080
12	1.81	−66.1	.0002	7.6	.0061
13	1.42	−65.2	.0002	5.9	.0048
14	1.10	−51.1	.0002	4.4	.0035
15	0.87	−50.4	.0002	3.4	.0028

Year.

0	29.92	66.4	0.415	93.0	0.0750
1000	28.99	62.8	.365	90.7	.0732
2000	27.96	59.2	.317	88.2	.0712
3000	26.97	55.6	.276	85.7	.0692
4000	25.98	53.1	.242	83.0	.0670
5000	25.08	50.7	.213	80.5	.0650
6000	24.18	48.7	0.188	77.9	0.0629
7000	23.31	45.5	.164	75.6	.0610
8000	22.46	42.3	.141	73.4	.0592
9000	21.63.	39.0	.121	71.1	.0574
10000	20.80	35.8	.104	68.9	.0556
11000	19.99	32.4	0.089	66.7	0.0538
12000	19.24	29.3	.076	64.6	.0521
13000	18.50	25.9	.065	62.5	.0505
14000	17.80	22.3	.055	60.6	.0489
15000	17.13	19.0	.046	58.7	.0474
16000	16.49	15.8	0.039	57.0	0.0460
17000	15.84	12.2	.032	55.1	.0445
18000	15.24	8.6	.027	53.4	.0431
19000	14.63	5.0	.022	51.7	.0417
20000	14.02	1.4	.019	49.9	.0403
21000	13.46	−2.2	0.016	48.3	0.0390
22000	12.91	−6.0	.013	46.8	.0378
23000	12.36	−9.8	.011	45.2	.0364
24000	11.87	−13.4	.009	43.7	.0353
25000	11.39	−17.0	.008	42.3	.0341

TABLE 4.—*Mean values of atmospheric pressures, temperatures, vapor pressures, and densities, based on sounding balloon observations at Fort Omaha, Nebr.; Indianapolis, Ind.; Huron, S. Dak.; and Avalon, Cal. (English measures)*—Continued.

Year.

Altitude above M. S. L.	Pressures.	Temperatures.	Vapor pressures.	Densities.	
Feet.	*Inches.*	°*F.*	*Inches.*	%	*Lbs./cu. ft.*
26000	10.92	−20.6	0.007	40.9	0.0330
27000	10.46	−24.2	.006	39.5	.0319
28000	10.01	−27.6	.005	38.1	.0307
29000	9.59	−31.0	.004	36.8	.0297
30000	9.20	−34.2	.003	35.5	.0287
Miles.					
6	8.54	−39.6	0.002	33.4	0.0270
7	6.77	−54.2	.001	27.4	.0222
8	5.31	−61.8	.0003	21.9	.0177
9	4.13	−67.0	.0002	17.3	.0140
10	3.20	−69.7	.0002	13.5	.0109
11	2.52	−67.2	0.0002	10.6	0.0085
12	1.98	−62.3	.0002	8.0	.0065
13	1.57	−56.4	.0003	6.4	.0052
14	1.22	−50.1	.0007	4.9	.0040
15	0.95	−41.6	.0014	3.7	.0030
16	0.75	−38.6	0.0008	3.0	0.0025
17	0.63	−36.4	.0007	2.5	.0020
18	0.55	−35.1	.0010	2.1	.0017
19	0.47	−36.8	.0017	1.8	.0015
20	0.40	−44.0	.0002	1.6	.0013

TABLE 5.—*Mean annual atmospheric pressures, temperatures, and densities at various heights above sealevel in England.*

Altitude above M. S. L.	Pressure.	Temperature.	Density.
m.	*mb.*	°*A.*	*kg./cu.m.*
0	1014	282	1.253
1000	900	278	1.128
2000	795	273	1.014
3000	699	268	0.909
4000	615	262	0.818
5000	568	255	0.735
6000	469	248	0.658
7000	407	241	0.589

TABLE 6.—*Mean annual densities, as observed at Mount Weather, Va., in the central and western United States and in England.*

Altitude above M. S. L.	Mount Weather, Va.	Central and western United States.	England.
m.	*kg./cu.m.*	*kg./cu.m.*	*kg./cu.m.*
0	1.226	1.202	1.253
1000	1.113	1.094	1.128
2000	1.002	0.984	1.014
3000	0.903	0.892	0.909
4000	0.816	0.807	0.818
5000	0.731	0.723	0.735
6000	*0.672	0.655	0.658
7000	.....	0.586	0.589

* Based on few observations; figures not regarded as reliable.

THE TURNING OF WINDS WITH ALTITUDE.

By WILLIS RAY GREGG, Meteorologist in Charge.

[Dated: Division of Aerological Investigations, Weather Bureau, Feb. 16, 1918.]

Free-air wind conditions, as observed at Mount Weather, Va., have been summarized in the Bulletin of the Mount Weather Observatory (v. 6, pt. 4) and somewhat more briefly in "Meteorology and Aeronautics" by Maj. Wm. R. Blair, recently published by the National Advisory Committee for Aeronautics as Report No. 13. The purpose of the present paper is to present some additional conclusions which may be considered as supplementary to those given in the summaries mentioned; and which are believed to be of considerable interest and value to aviators.

In this summary no free-air observations at altitudes less than 1,500 meters have been used. Those from 1,500 to 2,000 meters have been considered as having reached a height of 2,000 meters. A large number of captive balloon records also have been ignored, as they were made when both surface and upper winds were variable, owing to "flat map" conditions (i. e., no well-developed HIGH or LOW), and no regular or consistent turning of the winds was apparent. Finally, on days when more than one observation was made, only one has been considered, except when the records were obtained under radically different conditions (e. g., before and after the passage of a LOW). With these exceptions, all free-air observations ever made at Mount Weather have been considered, including those in the diurnal series work and in the "International" records in 1913–14. These exceptions should be borne in mind in connection with Table 1, which gives the percentage frequency of winds at the surface from 16 directions.

TABLE 1.—*Percentage frequency of surface winds from 16 directions.*

Direction.	Frequency.
	Per cent.
N.....	1.0
NNE....	0.3
NE.....	0.4
ENE.....	0.6
E.....	0.8
ESE.....	2.8
SE.....	12.6
SSE.....	7.8
S.....	7.8
SSW.....	3.3
SW.....	2.9
WSW....	3.3
W.....	7.9
WNW...	21.6
NW.....	24.1
NNW....	2.5

The values in this table are slightly different from those in Table 22, v. 6, part 4, Bulletin of the Mount Weather Observatory (repeated in Table 2, p. 44, of Report No. 13, Meteorology and Aeronautics). The latter table is, however, based on observations during 1911–12 only and includes those in which an altitude of less than 1,500 meters was reached. Of the observations in the summer months to a height of less than 1,500 meters, a large proportion were made with a surface wind from north-northeast to east. This wind was in nearly all cases very shallow, and above it there was a layer about 1 kilometer in depth with little, if any, wind. At higher levels clouds, if present, usually indicated a westerly wind. Those observations in winter to less than 1,500 meters in height were usually made in a surface westerly wind which rapidly increased in velocity with altitude, thus beating the kites down. It is probable that these winds would show about the same turning tendencies as those indicated later for the westerly winds.

TABLE 2.—*Mean turning of winds with altitude, when surface winds are of moderate velocity.*

Direction at earth's surface.	Number of observations.	Percentage turning—		
		Clockwise.	Counterclockwise.	Not turning.
		%	%	%
N. to ENE.	31	45	35	20
E. to ESE.	50	76	12	12
SE. to SW.	474	94	2	4
WSW.....	46	76	7	17
W.....	109	51	12	37
WNW.....	298	41	29	30
NW.....	337	29	40	31
NNW.....	34	35	38	27