up into the atmosphere. φ gives the mass of water in the form of vapor rising across one horizontal square centimeter per second *on the average of a large horizontal area*, and this must then be equal to the average rate of rainfall at that level. We extend the area to cover the entire globe; then taking the layer of the atmosphere in the kilometer next above the ground, and inserting in the equations the mean values of the vertical gradient of mass of water per mass of air, and the mean values of the density and rate of precipitation, we find ξ at 500 meters to be 140,000 cm.$^{-2}$ grm.^{2} sec.$^{-5}$; similarly, taking the layer in which the upper clouds occur, at which height the precipitation consists only of the slow descent of the clouds themselves, and estimating the amount and size of the cloud-particles (*cf.* L. F. Richardson, *Proc. Roy. Soc.*, A96, 19–31, 1919), it is possible to get ξ at 8.5 kilometers to be from 3 to 180 C. G. S. For the layer in the meter next above the ground, some psychrometric observations indicate that ξ for 0.5 meter is 1,000 or less.

The value at 500 meters is in fair agreement with the value deduced from certain experimental investigations.

In the stratosphere, ξ must, of course, be so small that the equality of temperatures will not be disturbed.

The mean values being taken over the whole globe, the effects of the largest circulatory motions between the poles and the equator are combined with those of rising currents in cyclones, anticyclones, cumulus eddies, etc., in deducing the value of the coefficient of eddy-diffusivity, the latter thus becoming a statistical measure of the effects of circulatory motions which we can not or do not wish to consider in detail.

The quantity x may also be entropy, potential temperature, or velocity in a fixed azimuth, all per unit mass, and hence the equations have applications to the mechanics of eddy motion in the atmosphere.

These equations are an improvement on similar ones derived by Taylor, the effect of altitude being considered (*Phil. Trans.*, A215, p. 3, 1915).—*E. W. W[oolard]*.

A FORMULA FOR THE RELATION OF MEAN WIND VELOCITY TO ALTITUDE WITH RESPECT TO HELLMANN'S INVESTIGATIONS.[1]

By DR. F. BRADTKE.

[Abstracted from *Meteorologische Zeitschrift*, Nov.-Dec., 1918, vol. 35, pp. 313-315.]

In Hellmann's work on "The Motion of Air in the Lower Layers of the Atmosphere," he deduces two formulae to be applied in obtaining the mean wind speed at various elevations, the one for extremely low elevations, the other for the higher. These are:

$$(1)\quad v = a + b \log (h + c), \text{ and,}$$

$$(2)\quad v/v_0 = \sqrt[5]{h/h_0},$$

the first to apply above 123 meters, the second below 16 meters. He implies that there can be no simple expression for use at all altitudes.

The following equation has been determined, which, as will be shown, gives, with great accuracy, the speed at any elevation:

$$v = 1.2 + 1.79\ h^{0.246}$$

[1] Meteorol. Zeitschr., 1917, vol. 34, p. 273.

To show the accuracy with which this formula can be used the following table gives the mean wind velocity as determined at various heights by Hellmann at Nauen; and below them are presented the values as computed by this formula:

h=	2	16	32	123	258 meters
v= observed	3.33	4.69	5.40	7.02	8.26 m. p. s.
v= computed	3.32	4.74	5.40	7.05	8.22 m. p. s.

Carrying the test farther, the computed value for 305 meters is 8.51 meters per second, and the observed value on the Eiffel Tower is 8.71 meters per second; the computed speed is 9.32 meters per second for 500 meters and the observed value from Lindenberg kite flights for this elevation is 9.3 meters per second. Hellmann's formula gives ..48 and 9.25 meters per second, respectively.—*C. L. M.*

ON THE DEPENDENCE OF WIND SPEED UPON ALTITUDE.

By V. LASKA.

[Abstracted from *Meteorologische Zeitschrift*, Nov.-Dec., 1918, vol. 35, pp. 315-316.]

The calculations are based upon an interpolation formula in which h is altitude above the ground in meters, and ν the wind speed in meters per second, as follows:

$$\log \nu_x = \log \nu_1 \, [1 + (x-1)/10] \qquad (1)$$

in which

$$h = 2^x,\ h < 500 \text{ meters.}$$

The comparison of calculated to observed values in the vicinity of the ground is given in the following table:

TABLE 1.

h	2	4	8	16	32	64	128	256	512
ν Calculated	3.4	3.9	4.4	4.9	5.6	6.3	7.1	8.0	9.1
ν Observed	3.3	—	—	4.7	5.4	—	7.0 (h= 123)	8.3 (h= 258)	9.1

When $h=0$, Hellmann has given a value of wind speed of 2.8, but the author takes the stand that the formula gives the correct value of 0.0; in other words, in order to account for the wave-forming tendency of the air, there must be a quiet layer—perhaps only a few millimeters in thickness, next to the ground. It follows that there is a very sudden increase in the immediate vicinity of the ground. The original formula is simplified to—

$$\log \nu / \log h = c \qquad (2)$$

Where there are several elevations we have

$$\log \nu_1 \nu_2 \ . \ . \ . \ . \ \nu_n / \log h_1 h_2 \ . \ . \ . \ h_n = c \qquad (3)$$

The demonstration of this is shown in Table 2.

TABLE 2.

	Jersey.	Zikawei.		Nauen.		Strassburg.			Chicago.		
h	55	12	41	16	32	18	52	144	32	47	83
ν	7.4	3.6	5.9	4.7	5.4	2.8	4.2	6.0	4.2	4.6	7.8
c	.050	0.52	0.48	0.56	0.49	0.36	0.36	0.36	0.41	0.40	0.46
c (formula 3)	.050		0.49	0.52			0.36			0.43	

It appears that the relation $\nu = \sqrt{h}$ and also the formula of Hellmann, $\nu/\nu_1 = \sqrt[5]{h/h_1}$ yield similar results. We can write this last equation as

$$\frac{\log \nu - \log \nu_1}{\log h - \log h_1} = c$$

which can be rewritten as

$$\log \nu - c \log h = \log \nu_1 - c \log h_1 = C.$$

If C approaches zero we obtain formula 2. These formulae can only be used as interpolation formulae and are limited to the reduction of observations of wind.—*C. L. M.*

DAILY MARCH OF WIND VELOCITY AT 30 M. ABOVE OSTEND AND 90 M. ABOVE BRUGGE.

By ALBERT PEPPLER.

[Abstracted from *Meteorologische Zeitschrift*, March–April, 1919, vol. 36, pp. 90–93.]

During the war measurements of wind velocity were made both at Ostend and at Brugge. The Ostend curve is a relatively simple one, showing a minimum at 3 a. m., a steady increase in speed to 3 p. m., and a quite steady fall again to the minimum. This period is especially marked on hot summer days. The Brugge curve is more complex. The principal minimum occurs at about 8 a. m., after which there is a steady increase to 1 p. m., followed by a fall to a secondary minimum at 8 p. m., and then a rise to the secondary maximum at 1 a. m. Thus, there are two 12-hour periods which combine to give wide variations in the daytime and secondary variations at night. It should also be noted that the higher anemometer gives speeds of smaller magnitude during the day and of greater magnitude during the night than the lower one.—*C. L. M.*

THE DIURNAL VARIATION OF WIND VELOCITY IN THE FREE AIR.

By J. ROUCH.

[Abstracted from Comptes Rendus, Paris Acad. Aug. 11, 1919, pp. 293–295.]

In the upper layers of the atmosphere, different diurnal variations of wind velocity are observed from those in the lower layers. The speed is a maximum during the night and a minimum during the day. This has been observed by Angot on the Eiffel Tower and is substantiated by numerous mountain stations.

Certain pilot balloon observations made during the summer of 1918 have been grouped by time of day and the mean differences between the two times taken for a given level. These were grouped for morning and afternoon. In Table 1 the plus sign (+) denotes an afternoon wind greater than a morning wind; the minus sign (−) indicates an afternoon wind less than the morning wind.

This table shows that the wind speed in the morning is greater than the afternoon wind at 200 meters at Bayonne, Cette, and Rochefort; between 200 and 400 meters at Havre; between 400 and 600 meters at Oran; and, as has been mentioned, at Paris, at an altitude of 300 meters, it is a maximum during the night and a minimum during the day. This difference is noted to an altitude of 2,000 meters, although it is a maximum at about 1,000 meters. Above 2,000 meters it appears that the time of day does not make much difference, although there is a slight indication that the winds of afternoon above that level are greater than those of the morning. Above the 3,000-meter level observations are insufficient for drawing conclusions; below, it is believed that the above-stated relations are valid.—*C. L. M.*

TABLE I.

Stations.	Times.	Altitudes (meters).											
		0	200	400	600	800	1,000	1,500	2,000	2,500	3,000	3,500	4,000
Oran (58)[1]	7 a. m.–4 p. m.	+4.7	+2.7	+0.4	−0.9	−1.7	−1.4	−0.4	−0.2	+0.4	+1.8	....	....
Bayonne (44)	7 a. m.–1 p. m.	+3.7	−0.4	−2.3	−2.1	−0.9	−0.4	−0.3	−1.1	−0.9	−0.1	....	....
Cette (69)	7 a. m.–1 p. m.	+1.2	−0.8	−2.2	−1.6	−1.5	−1.7	−1.3	....	....	....	....	....
LeHavre (21)	7 a. m.–1 p. m.	+2.5	+0.5	−1.8	−2.0	−1.5	−1.0	−1.2	....	....	....	....	....
Rochefort (36)	7 a. m.–12 m.	+1.5	−4.6	−3.6	−3.2	−2.1	−0.8	−0.7	−0.8	−0.2	0.0	....	....
Saint-Cyr (40)	7 a. m.–2 p. m.	+1.7	....	....	....	....	−0.8	....	+0.6	....	+0.5	....	+0.3

[1] Numbers in parentheses indicate number of observations.

THE INFLUENCE OF THE VELOCITY OF THE WIND ON THE VERTICAL DISTRIBUTION AND THE VARIATIONS OF THE METEOROLOGICAL ELEMENTS IN THE LOWER LAYERS OF THE ATMOSPHERE.

By C. E. BRAZIER.

[Comptes Rendus, Paris Acad. Sci. January 20, 1919, pp. 179–182.]

The barometric pressure at the ground level, calculated from observations made on the Eiffel Tower, is lower than the observed pressure. When the mean wind for 24 hours is 0.9 meters per second on the ground, and 4.4 meters per second at the top of the tower, and the surface pressure was 761.4 mm. and the tower pressure was 736.5 mm., the computed ground pressure was 761.3 mm., thus showing a difference of 0.1 mm. In the case of a moderate wind (mean velocity, base 2.1, top 8.1 m/s) this difference is 0.2 mm., and in the case of a strong wind (mean velocity, base 3.7, top 11.5 m/s) it increases to 0.3 mm., showing clearly that the difference increases with the speed of the wind.

The discussion is closed with the following three conclusions relative to other meteorological relations: "1st. For a given diurnal variation of the amount of heat received by the earth from the sun, the amount of the diurnal variation of air temperature in the immediate neighborhood of the ground, is greater for a gentle wind than for a strong one.

"2d. Except at a certain level, the altitude of which may vary with the season and the place of observation and which, in April and above Paris, is lower than 200