**its momentum and inertia, will rise through the belt of inverted gradient and form a temporary cloud of the cumulus or fracto-cumulus type at a level somewhat above the general level of the belt. In such cases the air in the cloud is colder than the air on either side of it, and it may be some 10° to 20° F. colder.**

## AN ANNOTATED BIBLIOGRAPHY OF EVAPORATION.

By MRS. GRACE J. LIVINGSTON. Dated Washington, D. C., January 8, 1908.

[*Continued from the Monthly Weather Review, April, 1909.*]

1897—*Continued.*

**Fortier, Samuel.**
Seepage water of northern Utah. Water sup. and irr. papers, 1897, No. 7: 17–24, 26, 43.

The apparatus consisted of a galvanized iron pan 36 by 36 by 10 inches floated in the reservoir. A diagonal bar scale permitted readings of the level to 1/100 inch. Tables of the evaporation at Fort Douglas, near Salt Lake City, Utah, for 1889–93, and at Fort Collins, Colo., 1887–91, are presented together with Russell's (1888) table of evaporation from the Piche atmometer at various localities in the United States. The total annual evaporation from water surfaces in Utah is estimated as from 3 to 6 feet, the evaporation during the dry season (May–August) of this region being equal to that of the other eight months. Gives a table of the relation between the crop harvested and the amount of evaporation. Under Logan river is discussed the relation between the rainfall and evaporation.

**Houdaille, F.**
Causes de vitesse maxima d'évaporation sous le climat de Montpellier. Ann. école nat. agr., Montpellier, 1897, **9**:286–95. Notice in Exp. sta. rec., 1897, **9**:1032–3.

The ratio of evaporation from the instrument previously described (Houdaille, 1890) to that from the Piche is given as 1.32. The mean daily evaporation (1875–84) varies between 2.28 millimeters in January and 9.35 millimeters in July. Gives the diurnal evaporation, temperature, humidity, and wind for January to September, 1896. Concludes that the wind is not an important factor in that locality, temperature and humidity being the main factors influencing evaporation there.

**Krebs, Wilhelm.**
Das Messen der Verdunstungsenergie mit dem Doppelthermometer. Met. Zeits., 1897, **14**:273–6.

Derives a formula for calculating evaporation directly from the readings of the psychrometer. Both Krebs and Ule (1897), claim priority in devising this method.

**Latham, B.**
Tables of evaporation from a 12-inch floating tank and a 5-inch exposed tank at Croydon, 1888–1897. Brit. rainf., 1897, (—):30–34.

Also gives illustration of Latham's evaporometer.

**Madrid, Observatorio de.**
Treinta años de observaciones meteorologicas, Madrid. 1860–94. Madrid. 1897.

Tables of the mean daily evaporation, 1860–94, from an exposed dish of water, accompanied by a table showing the lowering of temperature caused by evaporation. The average daily evaporation varies from 1.0 millimeter in January to 9.8 millimeters in July. The cooling effect varies from 1.3° C. to 9.1° C. for the same months. No yearly totals are given.

**Pallich, J. von.**
Ueber Verdunstung aus einer offen kreisförmigen Becken. Sitzber. k. Akad. Wiss. (Vienna), math. naturw. Kl., 1897, **107**(pt. 2a): 384–410.

Concludes that the ellipsoidal surfaces of equal vapor pressure above an evaporating surface, as mathematically derived by Stefan (1881), have too small an excentricity as compared with curves experimentally derived, and that this difference becomes more pronounced with higher temperatures. In the case studied this eccentricity should be 95 instead of 51 as given by Stefan's equation.

**Royal Meteorological Society.**
Exhibition of meteorological instruments in use in 1837 and 1897. Quart. jour. roy. met. soc., 1897, **23**:221–36.

On page 234 Pickering's (1898) atmometer is described; also a new Richard self-recording evaporometer. In this new pattern a sheet of blotting paper is kept moist by a wick which draws water from a closed reservoir. A float transmits to the pen the height of the liquid in the reservoir.

**Rafter, Geo. W.**
Stream flow in relation to forests. American Forestry Association, 1897, 12. Reprinted in Ann. rpt. Fisheries, Game, and Forest Commission for 1896. 1898.

An extensive discussion of the persistence at about the same rate, of the amount of evaporation from any given stream through long periods of time.

**Symons, G. J. and H. Sowerby Wallis.**
Records of evaporation. Brit. rainf., 1897, (—):28–34.

Gives the evaporation during 1897 at the usual stations, and also Latham's tables for 1888–97.

**Ule, Willi.**
Messung der Verdunstungsenergie mit dem Doppelthermometer. Met. Zeits., 1897, **14**:382–3.

Claims priority in the employment of the psychrometer to indicate the evaporating power of the air. (See Abbe, 1888, Krebs, 1895, 1897, and Ule, 1891.)

1898.

**Abbe, Cleveland.**
Evaporation and temperature. Mo. weather rev., 1898, **26**:213–4.

Summary of the work of Carpenter, 1898.

**Bedford, Duke of.**
See Pickering, S. U., and the Duke of Bedford.

**Carpenter, L. C.**
The loss of water from reservoirs by seepage and evaporation. Colorado Exp. sta. bul., 1898, No. 45. Abstract in Mo. weather rev., 1898, **26**:213. Abridged in Symons's met. mag., 1898, **33**:116–9.

Evaporation at Fort Collins, Colo., (alt. 4,990 ft.) from 1882–97, as measured by means of a hook-gage, gave an annual average of 40.94 inches. General discussion of the factors influencing evaporation. Unless the temperature of the water surface is warmer than the dew-point, evaporation can not proceed and condensation may occur. Evaporation from ice was 1.0 to 1.5 inches per month. The nocturnal evaporation, contrary to the general opinion, was almost the same as the diurnal, and these amounts approach equality as the body of water increases in size. Tabulates observations at many localities and altitudes in Colorado and California. He finds that the factors tending to decrease evaporation at high altitudes are lower temperatures, smaller differences between the vapor pressure at water surface temperature and that at the dew-point, and the decreased capacity for moisture of air at lower temperatures. Concludes that, although lessened air pressure and probable increased velocity of the wind at high altitudes favor evaporation, the annual rate is much less than at low altitudes.

**Carpenter, L. C.**
Losses of evaporation from canals. Records kept for two years on stretches of canals for irrigation purposes. Colo. Exp. sta. bul., 1898, No. 48. Summary in Exp. sta. rec., 1899, **10**:795–6.

Evaporation from canals is believed to be insignificant as compared with seepage, while in the case of reservoirs evaporation is the more important source of loss. The total depth of water lost from canals in the prevailing Colorado soils is estimated at from 1 to 2 feet per day over the whole surface of the canal, being less in clay soils than in sand or gravel.

**Carpenter, L. C., and others.**
Evaporation at the Colorado station. Colo. Exp. sta. bul., 1898, No. 49. Abstract in Exp. sta. rec., 1899, **10**:1019.

Results similar to those published in first title; repeats his formula published in 1888.

**Gravelius, H.**
Berichte über den Stand der Niederschlagsforschungen. Zeits. Gewässerk., 1898, **1**:341.

Reviews Heinz, 1898, who compared evaporation as observed at 15 stations in European Russia from 1871–95. A rapid increase in the annual evaporation is indicated in the direction from northwest to southeast: St. Petersburg, 331 millimeters; Vishni Volotshek, 352 millimeters; Moscow, 434 millimeters; Skopin, 572 millimeters; Nikolaiev (Saratof), 643 millimeters; Astrakhan, 750 millimeters. The yearly maximum occurred nearly everywhere in July and the minimum in January. Relations between the rainfall and evaporation are pointed out. Attention is drawn to the fact that experiments with evaporation from a grass surface have been conducted at Pavlovsk by means of Rykachev's (1900) atmometer since 1896.

**Grunsky, Carl Ewald.**
Irrigation near Fresno, Cal. Water sup. and irr. papers, 1898, No. 18:74–8.

Finds the loss of water from canals is less by evaporation than by seepage.

**Heinz, E. A.**
Ueber Niederschläge, Schneemenge, und Verdunstung in der Flussgebieten des Europäischen Russland. St. Petersburg. 1898. Review in Selsk. Khoz. i Lyesov., 1898, **109**:716–7. Notices in Met. Zeits., 1898, **15**:(77); Exp. sta. rec., 1898, **10**:327

Reviewed by Gravelius, 1898.

**Héjas, André.**
A zivatarok magyavországon az 1871 töl 1895—ig terjedö megfigyelések Alapján. (Die Gewitter in Ungarn nach den Beobachtungen von den Jahren 1871–95.—Kurzer Auszug des ungarischen Originales.) Budapest. 1898.

The original gives, on p. 50–1, the daily evaporation during March to October, for the years 1890–5, at Budapest. The average daily rate varied between 1.20 millimeters for March and 3.92 millimeters for July.

**Maxwell, W.**
Evaporation and plant transpiration. Jour. Amer. chem. soc., 1898, **20**:469–83. Reviewed in Exp. sta. rec., 1899, **10**:721–2.

Experiments were conducted at the experiment station at Honolulu, T. H., on the amount of moisture directly evaporated from the soil, and the relative proportion that escapes by transpiration from sugar cane during the different periods of growth. The transpiration from sugar cane growing in a tub was observed for 270 days, together with the outdoor and indoor evaporation of water in small galvanized evaporators, temperature, humidity, direction of wind, etc. The amount evaporated outdoors during this time was 33.480 cubic centimeters, with an average temperature of 75.9° F.; that indoors was only 14.175 cubic centimeters, with a temperature of 79.9° F. The humidity was the same in both cases. The inference is that the wind exerts a greater effect upon the rate of evaporation than the temperature.

**Mazelle, E.**
Verdunstung des Meerwassers und Süsswassers. Sitsber. k. Akad. Wiss. (Vienna), math.-naturw. Kl., 1898, **107**:(pt. 2). Also reprinted Vienna, 1898. 20p. 8vo. Abstracts in Ciel et terre, 1899, **20**:267–8; Anz. k. Akad. Wiss. (Vienna), math. naturw. Kl., 1898, no. 7, **35**:49–50.

Daily observations from June 1, 1896, to September 30, 1897, at Triest, with two Wild atmometers of similar construction and exposure, one containing fresh water, the other a 3.73 per cent salt solution, showed that the ratio between the results approached nearer unity as the rate of evaporation from the fresh water increased. An equation in which $x$ is the evaporation from the fresh water, and $y$ that from the salt water, shows the following relation: $y = -0.018 + 0.7303x + 0.0561x^2 - 0.0044x^3$. The total amount evaporated from the fresh water was 910.6 millimeters, that from the salt water 750.9 millimeters, the ratio being 100:82.46. Complete tables compare these rates of evaporation with other meteorological factors.

**Mohn, H[enryk].**
Grundzüge der Meteorologie. Berlin. 1898. (5th ed.)

See Mohn, 1875.

**Pickering, S. U., and The Duke of Bedford.**
A new form of evaporimeter. Woburn exp. fruit farm rpt. for 1897, p. 168–74. Also quoted in Exp. sta. rec., 1898, **9**:533.

The object of this instrument is to approach as nearly as possible to the conditions governing the leaves of a tree. It consists of a sheet of any absorbent material, held vertically by means of a movable copper frame in a vessel of water fitted with a graduated side tube. The evaporating sheet ends in a tongue which dips into the water and is thus kept moist.

**Symons, G. J., and H. Sowerby Wallis.**
Records of evaporation. Brit. rainf., 1898, (—):36–44.

Gives the evaporation at seven different stations; describes Miller's sand evaporator, and gives its records for 1879–98. See H. Sowerby Wallis for succeeding records.

**Wollny, E.**
Untersuchungen über die Verdunstung und das Produktionsvermögen der Kulturpflanzen bei verschiedenem Feuchtigkeitsgehalte der Luft. Forsch. Geb. Agr. Phys., 1898, **20**:528, Also Centbl. Agr. Chem. (Biedermann), 1900, **29**:289–90.

Experiments on the relation between transpiration and plant growth.

1899.

**Angot, Alfred.**
Traité élémentaire de météorologie. Paris. 1899.

A general discussion of the process and laws of evaporation and various methods of measuring it, occurs on p. 173–5.

**Galli, D. Ignazio.**
*Atmidometro a livello costanto.* Atti accad. pont. nuovi Lincei, 1899, **52**:157–8. Also Mem. accad. pont. nuovi Lincei, 1900, **17**: 165–82.

This evaporometer consists of two communicating cavities in a solid block of marble, one containing powdered marble, the other closed and filled with water which is drawn by capillarity to the surface of the powdered marble, where it is allowed to evaporate.

**Gravelius, H.**
Ueber Verdunstung. Zeits. Gewässerk., 1899, **2**:248–52.

The run-off of a region is regarded as a function of the rainfall, evaporation, seepage, and the amount of water used by the vegetation. Describes Rykachev's apparatus (1900) for measuring evaporation from soil.

**King, F. H.**
Irrigation and drainage. New York. 1899.

The transpiration of plants and the *slow rate of evaporation from a dry soil are dealt* with on p. 46–54 and 98.

**Minssen, Guilherme.**
Lyceu Rio Grandense de Agronomia de Pelotas. Contribuiçao para o estuda da Climatologia do Rio Grande do Sul. Observaçiónes meteorologica feitas durante o anno de 1899.

*Weekly observations at Pelotas, Brazil (lat. 31° 30′ S.), of evaporation from water, with* monthly and yearly totals for 1899; also weekly, monthly, and yearly averages from 1893–9. The results show an antipodal yearly march of evaporation comparable with that of the northern hemisphere. The monthly average during 1893–9 varied from 66.5 millimeters in June to 140.1 in December, the annual average being 1157.7 millimeters.

**Raulin, F. V.**
Résumé des observations atmidométriques (évaporation) faites dans la Peninsule Ibérique de 1857 à 1890. Ann. soc. mét., 1899. Reprinted Tours. 1899. 20 p. gr. 8vo.

**Wallis, H. Sowerby.**
Records of evaporation. Brit. rainf., 1899, (—):31–4.

Table of evaporation at Camden Square, London, 1885–99. Evaporation records for 1899 at eight stations, five of which use the standard tank, 6 by 6 by 2 feet, are published, together with a table of the observations at Croydon by Baldwin Latham.

1900.

**Brown, H. T., and F. Escombe.**
Static diffusion of gases and liquids in relation to the assimilation of carbon and translocation in plants. Phil. trans., 1900, **193**: 283–91. Abstract in Annals of Botany, London, 1900, **14**:537–42.

The rate of *diffusion of aqueous vapor through small apertures is controlled by the linear* dimensions of the aperture and not by the area; the velocity of flow varies inversely as the diameter of the opening. Critically reviews other work along this line, especially that of Stefan (1873).

**Davis, Walter G.**
Clima de Córdoba. Ann. ofic. met., 1900, **13**:492–505, 573–97.

This report contains very complete tables of temperatures of evaporation, and of comparative rates of evaporation from six dishes of different size, material, and *exposition.* The temperature of evaporation was shown to be lower than that of the air, the difference averaging 3.81° C. for the year. The greatest difference was 4.81° in September and the least 2.70° C. in June. The hourly means for 1889–98 are tabulated. The comparative observations were made with (1) two brass dishes 10 centimeters deep, exposing 314 square centimeters surface, one in the thermometer shelter, the other fully exposed to the weather; (2) two Wild balances, whose dishes have a surface of 250 square centimeters and a depth of 45 millimeters at the edge and 30 millimeters in the center, having the same exposure as the metal evaporators; (3) *a glass dish exposing 380 square centimeters evaporating* surface and 13 centimeters deep exposed near the other evaporators; (4) a square, zinc-lined tank of brick, 80 centimeters deep and exposing a surface of 1 square meter. This tank is buried in the ground so that its water level is at the level of the contiguous soil and about 10 centimeters below the edges of the tank. The water level is read by a micrometer screw. Readings were taken every two hours, night and day, with all the instruments, except the glass dish and the tank which were read only once in 24 hours. The results of all these instruments are compared in detail and a study is made of the influence of the direction and force of the wind upon evaporation. The amounts of evaporation in 2 hours corresponding to increments of 5 kilometers in wind velocity are tabulated separately.

**Escombe, F**

See Brown, H. T., and F. Escombe.

**Exner, Felix M.**
Messungen der täglichen Temperaturschwankungen in verschiedenen Tiefen der Wolfgangsees. Sitzber. k. Akad. Wiss. (Vienna), math. naturw. Kl., 1900, **109** (pt. 2a):905–22.

A table of the evaporation accompanies other meteorological data.

**Latham, B.**
The climatic conditions necessary for the propagation and spread of the plague. Quart. jour. roy. met. soc., 1900, **26**:37–94.

*The greatest amount of* evaporation or exhalation would take place with the maximum temperature of the ground and the minimum dew-point, and it is shown that the rise and fall of these differences agree in a remarkable manner with the rise and fall of the plague. Taking into consideration the wind and its influence on evaporation, the author used Dr. Pole's formula for calculating evaporation: $E=\frac{T^2-t^2}{A\,(100-w)}$, in which $T$ equals the temperature of the ground, $t$ the temperature of the dew-point, and $w$ the wind velocity in miles per hour. $A$ equals a coefficient, 80 for Bombay, and $E$ is the evaporation or exhalation *in depth per day in inches. Diagrams show curves of the tensional difference* agreeing with that of death from plague in Bombay.

**Lippincott, Joseph Barlow.**
Storage of water on the Gila River, Arizona. Water sup. and irr. papers, 1900, No. 33.

Quotes (p. 32–4) evaporation observations by the U. S. Geological Survey in Arizona and estimates the rate of evaporation from the reservoir at Buttes, Ariz.

**Maluschitski.**
On the value of evaporometric observations to agricultural practice. Izv. Moscov. selsk. khoz. inst. (Ann. inst. agron. Moscou), 1900, **6**:325–403. Abstract in Exp. sta. rec., 1901, **13**:427.

Studies the evaporation from a free water surface and from soils. For a free water surface Michelson and Wild atmometers were used, and Wild's was found the more reliable. Evaporation from soil was determined by means of large zinc lysimeters. From his own experiments and a survey of the literature the author concludes: "Since the structure of the soil and the state of its surface exert an immense and varied influence on the stored-up humidity, as well as on the evaporation, no correlation can be established between the evaporation from a water surface and that from a cultivated soil, and still less in the case of a soil covered with plants."

**Rykachev, M.**
New evaporometer for the study of the evaporation from grass and observations with it in 1896 at the Constantine Observatory. Zhur. opuitn. agron. (Russ. Jour. exp. Landw.), 1900, No. 1, **1**:115–7. Abstract in Exp. sta. rec., 1901, **13**:428.

This apparatus consists of three rectangular zinc boxes, the outer one sunk in the ground, the other two fitting tightly into it, one above the other, the upper one containing soil with sod. Excess of rain water percolates into the middle box and maintains a constant degree of humidity in the lower layer of the upper vessel. The amount lost by evaporation is determined by weighing the upper and middle boxes together. The temperatures of the soil and of the water in the lower box were recorded. The indications of this instrument were found to be two or three times greater than those of a Wild atmometer.

**Saussure, Horace Bénédicte de.**
Versuche über die Hygrometrie. Neuchâtel. 1783. Herausgegeben von A. J. Oettingen. 2 vol. (Ostwald's Klassiker der exakten Wissenschaften, Nos. 116, 119. Leipsic. 1900.)

See Saussure, 1783.

**Scott, R. H.**
Results of percolation experiments at Rothamsted, September, 1870, to August, 1899. Quart. jour. roy. met. soc., 1900, **26**:139–51.

Table I gives the annual amount of rain, and of percolation as measured at three depths, 20, 40, and 60 inches, in gages similar to those described by Lawes, Gilbert, and Warington (1881). Table II gives the monthly average for the entire period, and also the same grouped into half-yearly periods, September to February and March to August. Table III gives the actual monthly measurements for each year of the series. The evaporation may be obtained by subtracting the amount of percolation from the amount of rain.

**Wallis, H. Sowerby, and Hugh Robert Mill.**
Records of evaporation. *Brit. rainf.*, 1900, (—):46–9. Abstract Met. Zeits., 1902, **19**:281.

Comparative tables of evaporation at various stations. Summarizes results at Camden Square for 1885–1900 and Latham's results at Croydon.

**Warington, Robert.**
Lectures on some of the physical properties of the soil. Oxford. 1900.

Evaporation from a free water surface, from bare soil, and from soil covered with vegetation are discussed in some detail on. p. 107–26, quoting results of Ebermayer, King, Greaves, etc.

1901.

**Abbe, Cleveland.**
The rainfall and evaporation of Great Salt Lake. Mo. weather rev., 1901, **29**:68–91

Quotes A. J. Henry's table of the rainfall over the water-shed of Great Salt Lake, and estimates the rate of evaporation from salt water by applying Russell's (1888) observed rate from a fresh water surface.

**Alberti, Vittoria.**
Sul clima di Napoli, riassunto generale delle osservazioni meteorologiche fatte nella *R. Specula de Capodimonte 1888–1900. Atti. r.* ist. sci., Naples, **3**:(ser. 5), No. 4. Reprinted, Naples. 1901. 24 p.

Page 82 gives the monthly and annual evaporations at Naples from 1886–1900, with five-year means. The annual average is 730 millimeters, the maximum monthly rate, 100.1 millimeters (August), and the minimum, 34.4 millimeters (February).

**Balch, E[dwin] S[wift].**
Evaporation under ground. Mo. weather rev., 1901, **29**:545. Abstract in Exp. sta. rec., 1901, **13**:828.

Maintains that underground evaporation does not cause an appreciable lowering of temperature and that the cold within ice caves must be wholly due to the low temperatures of winter.

**Bok, O.**
Die Breusch. Zeits. Gewässerk., 1901, **4**:1–48.

A table on p. 45 gives the mean monthly depth of evaporation, together with results of observations of evaporation in meadow and forest, and the differences for the years 1891-5. Tables of rainfall, air temperature, relative humidity, and the water level of rivers are added.

**Carpenter, L. C., and R. E. Trimble.**
Meteorological observations for 1900. Colo. exp. sta. 13th Ann. rpt. Denver. 1901. 56 p.

Evaporation observations similar to those described in 1889. The monthly means during the years 1887-1900 vary from 1.24 inches in December to 5.63 inches in July. The mean annual evaporation was 41.16 inches and the average annual rainfall, 14.14 inches.

**Chandler, Albert E.**
Water storage on Cache Creek, California. Water sup. and irr. papers, 1901, No. 45:36-7.

Gives a table of the annual evaporation from Clear Lake, near San Francisco, for the years 1874-99, as observed by the State Engineering Department of California.

**Davis, Arthur Powell.**
Hydrography of the American Isthmus. Ann. rept. U. S. Geol. Survey, 1900-01, (—), Part iv, p. 507-630.

The evaporation from pans floating in Lake Nicaragua was observed at four stations. The monthly amounts for 1900 varied from 3.46 inches in August to 6.08 inches in May; the total amount for the year was about 52.4 inches.

**Galli, D. Ignazio.**
Esperienze coll' evaporimetro a livello costante. Atti accad. pont. nuovi Lincei, 1901, **54**:94.

In August, 1900, the author inaugurated comparative observations of evaporation of water in similar atmometers, one placed in the shade, but freely exposed to the wind; the other in the sun all day. No results are given. (See also Galli, 1899.)

**Grunsky, C. E.**
Water appropriations from King's River. In report of irrigation investigations in Cal., prepared by Elwood Mead. California exp. sta. bul., 1901, No. 100:259-325.

The experiments made by the California State Engineering Department under William Hammond Hall in 1881-5 at Kingsbury on King's River are described in the Appendix, p. 323-5. Two pans 36 by 36 by 15 inches with the water surface 5 inches below the rim were used, one floated in the river, the other placed on the bank. The average annual evaporation from the former was 3.851 feet, and from the latter 4.958 feet. The temperature of the water in the floated pan and of the river water were usually the same, while the water temperature in the pan on the ground varied considerably, being sometimes higher and sometimes lower than that of the river water.

**Hann, Julius.**
Lehrbuch der Meteorologie. 1st edition. Leipsic. 1901. 805 p.

A general survey of evaporation on p. 207-12. The phenomenon is defined as a function of temperature, humidity, wind velocity and air pressure. The formulas for calculating evaporation derived by Dalton, Weilenmann, Stelling, de Heen, Schierbeck, Trabert, Stefan, etc., are quoted.

**Ingham, W.**
Statistics dealing with evaporation, rainfall, and delivery of streams in Devonshire. Transactions of the Devonshire Association for the Advancement of Science, 1901, **33**:500. Abstract in Proc. inst. civ. engin., ——, **150**:506.

Measurements of evaporation from a free water surface in a tank at Kennick, Devonshire, for the years 1897-1900, show an annual average amount of 20.88 inches, or 50.81 per cent of the rainfa l. Records of rainfall on the Torquay watershed for 23 years are also given.

**König, Friedrich.**
Die Verteilung des Wassers über, auf und in der Erde, und die daraus sich ergebende Entstehung des Grundwassers und seiner Quellen mit einer Kritik der bisherigen Quellentheorien. Geschildert für Tiefbautechniker, technische Forst-, Montan- und Landwirtschaftslehranstalten, sowie zum Selbstudium. Jena. 1901. 7 vol.

A general discussion of the conditions favoring evaporation appears in vol. 4, p. 53-69. By modifying the Dalton formula he calculates the yearly rates of evaporation for different mean annual temperatures. The rates corresponding to 0°, 5°, 10°, 15°, 20°, and 25° C. would be 340, 720, 1,030, 1,650, 2,270, 3,500 millimeters. These agree with the amounts actually observed at Cumaná, Venezuela, 3,520 mm.; at Madeira, 2,030 mm.; at Sidney, 1,200 mm.; for Holland, 600-800 mm.; for the English coast, 900 mm.; for London, 650 mm.; and 800 mm. for East Scotland.

**Manson, Marsden.**
Features and water rights of Yuba River, Cal. In report of irrigation investigations in California prepared under the direction of Elwood Mead. Cal. exp. sta. bul., 1901, No. 100: 115-30.

A table of evaporation at Lake Fordyce (alt. 6,500 ft.) from Aug. 10-31, 1900, appears on p. 126. The daily average was 1/6 inch.

**Müller-Erzbach, W.**
Das Messen des Dampfdruckes durch Verdunstung. Sitzber. k. Akad. Wiss. (Vienna) math. naturw. Kl., 1901, **110** (pt. 2a):519-36.

The author concludes from his experiments that the vapor pressure of liquids may be determined with sufficient accuracy and more easily by evaporation than by manometric measurement.

**Olmsted, Frank H.**
Physical characteristics of Kern river, Cal. Water sup. and irr. papers, 1901, No. 46:25.

General statement of the losses due to evaporation and seepage.

**Oppokow, E.**
Das Verhalten des Grundwassers in der Stadt Neshin im Zusammenhange mit den meteorologischen Elementen. Zeits. Gewässerk., 1901, **4**:76-99.

Tables of rainfall, 1885-99, and evaporation, 1895-9, show an annual average for the former of 539 millimeters and for the latter of 379 millimeters.

**Schuyler, James D.**
Problems of water storage on torrential streams of southern California, as typified by Sweetwater and San Jacinto rivers. In report of irrigation investigations prepared under the direction of Elwood Mead. Calif. exp. sta. bul., 1901, No. 100:353-95.

The average annual rate of evaporation from Sweetwater Reservoir, from observations of several years, is 4.5 feet (p. 357).

**Smythe, William E.**
The irrigation problem of Honey Lake Basin, Cal. In report of irrigation investigations prepared unker the direction of Elwood Mead. Exp. sta. bul., 1901, No. 100:71-113.

The experiments of the California State Engineering Department, covering a period of five years, show the evaporation from Buena Vista, Kern, and Tulare lakes, which closely resemble Honey Lake, to be from 3.5 to 4.75 feet per year (p. 75).

**Taihoku Meteorological Observatory.**
Meteorological observations in Formosa, 1896-1901. Formosa. 1901.

The monthly evaporations at Taihoku, Taichu, Tainan, Taito, Koshun, Hokoto, and Keelung are given on p. 131-3. At Taihoku the monthly amount varies from 49.8 millimeters in February to 180.9 millimeters in July, and the annual average is 1266.2 millimeters. Tables of mean daily amounts and of daily maxima are also given.

**Trimble, R. E.**
See Carpenter, L. C., and R. E. Trimble.

**U. S. Geological Survey.**
Operations at river stations, 1900. Rpt. of the Division of Hydrography. Water sup. and irr. paper, 1901, No. 52:501.

**Wallis, H. Sowerby, and Hugh Robert Mill.**
Records of evaporation. Brit. rainf., 1901, (—):28-34.

Tables of evaporation for 1901 at nine stations, seven of which use standard tanks 6 feet square, with tables comparing evaporation throughout England, from 1888 to 1900. The average annual losses from the tank at Strathfield Turgiss, 18.03 inches for fourteen years (1870-83); from Miller's sand-protected evaporator at Lowestoft, 22.27 inches for twenty years (1878-97); from the tank at Camden Square, 15.19 inches for sixteen years (1885-1900); from Latham's floating atmometer at Croyden, 16.81 inches for fourteen years (1888-1901).

## 1902.

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Der Einfluss des Waldes auf die Verdunstung der Feuchtigkeit in seiner Umgegend. (Russian.) Lésoprom. věst., Moscow, 1902, (4), **49**:882-3.

**Abbassia Observatory.**
Report on meteorological observations, 1900. Public Works Department of Egypt, Survey Department. Cairo. 1902.

Tables of hourly evaporation (Wild evaporometer) and daily totals for the year 1900, show an annual evaporation of 1778.7 millimeters.

**Davis, Walter G.**
Climate of the Argentine Republic compiled from observations made to the end of the year 1900. Buenos Aires. 1902.

Observations described in Davis, 1900, are continued on p. 83-90, with tables including results from 1886-1900.

**Desenzano, Osservatorio Meteorologico.**
Osservazioni meteorologiche. Comment. Ateneo, Brescia, 1902, (—): 421-26.

The total evaporation at Desenzano, at the south end of Lake Garda, for the year from September, 1901, to August, 1902, inclusive, was 688.9 millimeters, the monthly amounts varying from 14.0 millimeters in February to 131.9 millimeters in July.

**Hungary.**
Königliche Ungarische Reichsanstalt für Meteorologie und Erdmagnetismus, Jahrbuch, 1902, **32**:97.

The daily evaporation at O-Gyalla during 1902 was 1.4 millimeters.

**Jaubert, Joseph.**
Annales de l'observatoire municipal (Observatoire de Montsouris), 1902, **3**:137-41, 222-6, 301-3.

The Piche evaporometer was employed at Montsouris and at the Tour St. Jacques in Paris. The water was usually frozen in the winter months. At Montsouris the monthly amount varied from 40.7 millimeters in October to 148.0 millimeters in July, and at the Tour St. Jacques from 69.3 millimeters in October to 177.8 millimeters in July.

**Lippincott, J. B.**
Storage of water on King's river, Cal. Water sup. and irr. papers, 1902, No. 58:22-4, 81-2, 99.

Tabulation of the observations of evaporation at Kingsbury, Cal., reported by Hall (1886) and quoted by Grunsky (1901). Summary of measurements made in King's river canals in August and September, 1901, to determine the loss by seepage and evaporation.

**Memmo, Osservatorio Meteorologico.**
Osservazioni meteorologiche. Comment. Ateneo, Brescia, 1902, (—): 428-32.

The maximum observed monthly evaporation for the year, September, 1901, to August, 1902, was 57.7 millimeters in July, 1902. Records were not obtained during the winter months owing to the freezing of the water in the instruments. The type of instrument is not indicated.

**Okada, T.**
Ueber die Evaporationskraft des Föhn. Met. Zeits., 1902, **19**:339-42.

In Japan the foehn is usually a northwest wind of considerable violence and greatly accelerates the rate of evaporation from water in a small copper dish freely exposed in an *open place. Observations are tabulated.*

**Ridgway, C. B.**
Experiments in evaporation. Wyoming exp. sta. bul., No. 52. Laramie. 1902.

For these experiments a tank was used having a perforated bottom and containing soil supplied with water from a larger reservoir directly below, the whole apparatus being sunk in the ground. Water was supplied to the reservoir through a tube leading from the surface of the ground. A float in the tube actuated a pointer moving over a graduated scale which reached above the ground, and showed the variations of the water level. The rate of evaporation from soil with the water level maintained 6 inches below the soil surface, was 95 per cent of that from a free water surface in the evaporation tank. With the water level 12, 18, and 22 inches below the soil surface, the evaporation was 70, 45, and 35 per cent respectively. Loosening the soil once a week to the depth of 2 inches diminished the evaporation 10 per cent; to the depth of 4 inches, 23 per cent; and to 6 inches, 45 per cent.

**Salo. Osservatorio Meteorologico.**
Osservazioni meteorologiche. Comment. Ateneo, Brescia, 1902, (—): 434–7.

The average daily evaporation at Salò, on Lake Garda, for the year September, 1901, to August, 1902, inclusive was 2 2 millimeters.

**Schwalbe, G.**
Ueber die Darstellung des jährliches Ganges der Verdunstung. Met. Zeits., 1902, **19**:49–59.

The following formula for calculating evaporation is presented: $v'=A'(t-t')$, where $v'$= calculated evaporation, $A'$=a constant embracing the wind factor and varying from 0.46 to 1.2 at different places, $(t-t')$ = the difference between the readings of the wet- and dry-bulb thermometers. This formula was tested at 19 stations in Russia. Curves comparing the observed and calculated values, $v$ and $v'$, at several places, lead to the conclusions: (1) $(t-t')$ is a relative measure of the evaporation. (2) The yearly march of $(t-t')$ and $v$ both depend on the sun's declination and in the same way.

There is a concise discussion of the formulas developed by Dalton, Stefan, Weilenmann, Stelling, de Heen, Ule, Krebs, Schierbeck, and Trabert, and a uniform notation is employed in writing them.

**Taylor. L. H.**
Water storage in the Truckee Basin, California-Nevada. Water sup. and irr. paper, 1902, No. 68: 34–6.

Monthly evaporation observed from a tank floated on the surface of Lake Tahoe, Cal., from May, 1900, to December, 1901, together with calculations of the inflow and outflow, served to determine the reduction of the lake level, which corresponded very closely with the reduction as observed by means of a fixed gage. The results of evaporation at Reno, Nev., during 1894, from a somewhat smaller tank sunk in the ground and surrounded with moist soil are tabulated.

**U. S. Department of Agriculture, Office of Experiment Stations.**
Report on irrigation investigations for 1901. Off. Exp. Sta., 1902, Bul. 119.

On p. 92, 294, 334–6, and 358 are records of evaporation secured by agents of the Office of Experiment Stations at various places in Arizona, Colorado, Montana, Nevada, New Mexico, New Jersey, Utah, Washington, and Wyoming.

**Wallis, H. Sowerby, and Hugh Robert Mill.**
Records of evaporation. Brit. Rainf., 1902, (—): 49–53.

Tables similar to those of the preceding years. For succeeding records see Mill, Hugh Robert.

1903.

**Barus, Carl.**
Absence of electrification in cases of sudden condensation and of sudden evaporation. Phys. rev., 1903, **16**:384.

Ordinary evaporation and condensation have long been known to be unaccompanied by electrification, but when a mass of water is suddenly shattered as in jets, there is a marked production of electricity. The question arose, therefore, as to whether the absence of an electric effect in ordinary evaporation and condensation cases was not due to the fact that the charges vanish too quickly to be noticeable. Further experiments, however, with sudden condensation and evaporation showed an absence of electrification.

**Batavia, Koninklijk magnetisch en meteorologisch Observatorium.**
Results of meteorological observations made at the experiment station "Oost-Java" at Pasoeroean, during the year 1902. Natkdg. Tijdsch. Ned. Ind., 1903, **62**: 267–72.

Includes observations on evaporation.

**Bok, Oscar.**
Verdunstungsmessungen nebst Untersuchungen über die Verdunstungshöhen an den forstlich-meteorologischen Stationen in Elsass-Lothringen. Beitr. Geophysik, Leipsic, 1903, **6**:1–16.

**Desenzano, Osservatorio Meteorologico.**
Meteorologia. Comment. Ateneo, Brescia, 1903, (—):139–43.

The monthly evaporation at Desenzano for the year from September, 1902, to August, 1903, inclusive, varied from 14.70 millimeters in January to 113.80 millimeters in August.

**Hall, A. D.**
The soil. An introduction to the scientific study of the growth of crops. New York. 1903.

Discusses (p. 120–2) the amount of heat required for evaporation, with tables and curves of soil temperatures showing the cooling effect of the evaporation of soil moisture. The advantage of cultivation of the surface soil in decreasing evaporation, owing to the breaking of the capillary channels, is pointed out (p. 92–101) and King's experiments with glass cylinders full of fine sand are described.

**Hann, J.**
*J. R. Sutton*—Experimente über Verdunstung. Met. Zeits., 1903, **20**:517–8.

Discusses the experiments of Sutton (1903) and Latham (1897–1904), on the influence of different methods of measuring evaporation, and considers: (1) the size of the evaporator, (2) the capillary attraction of the walls, (3) the enamelling of the outside surface, (4) the material of the instrument, (5) the influence of relative humidity and wind velocity, (6) the probability that the influence of the surface temperature of the water has been over estimated.

**Jaubert, Joseph.**
Notice sur l'évaporomètre de Montsouris. Ann. obs. Montsouris, 1903, **4**:30–2.

Describes an instrument for measuring evaporation from soil. It consists of a sheet iron box, 30 by 30 by 30 centimeters, filled with soil in which grass is allowed to grow. The variations in weight of the soil are registered automatically by a steel-yard balance on which the box rests. The whole is placed in the ground, so that its upper surface is on a level with that of the surrounding soil. The excess water in the box may be drawn off by means of a pipe soldered to the bottom of the box. The author believes the disadvantage of this method of determining soil moisture to lie in the fact that the soil in the box dries out more rapidly than natural soil, the latter being able to draw new supplies of moisture from lower layers.

**Jelinek, Carl.**
Jelinek's Psychrometer-Tafeln erweitert und vermehrt von J. Hann, neu herausgegeben und mit Hygrometer-Tafeln versehen von J. M. Pernter. Fünfte erweiterte Auflage. Leipsic. 1903.

**Lindgren, Waldemar.**
The water resources of Molokai, T. H. Water sup. and irr. paper, 1903, No. 79:48.

The probable amount of evaporation was calculated from the rainfall and runoff for separate areas.

**Memmo, Osservatorio Meteorologico.**
Meteorologia. Comment. Ateneo, Brescia, 1903, (—):144–7.

The average daily amount [of evaporation] for the year was 2.4 millimeters.

**Mill, Hugh Robert.**
Records of evaporation. Brit. rainf., 1903, (—):38–41.

The evaporation for the year (11 stations) was 17.7 inches. Latham's table of evaporation at Croydon appears as usual. The water in his 5-inch exposed vessel evaporated twice as much during the winter and spring, and in the summer only about 1.5 times as much as that in the 12-inch floating evaporator. A second table by Latham shows the amount of percolation at several stations.

**Müller-Erzbach, W.**
Der Dampfdruck des Wasserdampfes nach der Verdampfungsgeschwindigkeit. Sitzber. k. Akad. Wiss. (Vienna) math. naturw. Kl., 1903, **112**(pt. 2a):615–20.

The vapor pressures derived from the rate of evaporation from tubes are found to agree closely with those given by Regnault.

**Naples. R. Osservatorio di Capodimonte.**
Osservazioni meteoriche. Rend. soc. sci., 1903, **9**(3d ser.):16, 65, 98, 146, 168, 184, 219, 261–4, 307.

The monthly evaporation for 1903 varied from 38.1 millimeters in January to 112.8 millimeters in September, with the rainfall varying from zero in August to 196.4 millimeters in December.

**Okada, T.**
Vergleichende Messungen der Verdunstung des Meerwassers und des Süsswassers. Met. Zeits., 1903, **20**:380–4.

Under similar conditions, the ratio between the mean daily evaporation from salt and fresh water at Azino, Japan, was 0.950, and nearly constant for all seasons. Tables show the daily maxima and the monthly means from January, 1895, to December, 1901. The most important elements influencing evaporation are thought to be air temperature and insolation. Devises the formula

$$D = ax + by,$$

Where $D$ = fresh water minus sea water,
$x$ = temperature of the air,
$y$ = daily duration of sunshine,
$a, b,$ = constants, = 0.079 and 0.076, respectively, at Azino, in western Japan.

**Oppokow, E.**
Zur Frage der vieljährigen Abflusschwankungen in den Bassins grosser Flüsse, im Zusammenhang mit dem Gang der meteorologischen Elemente. Vergleichende Untersuchung des Abflusses im Gebiete des Dnjepr oberhalb der Stadt Kijew und der oberen Elbe in Böhmen. Zeits. Gewässerk., 1903, **5**:340–65.

Includes curves of rainfall, evaporation, and runoff from 1874–94, with a table of the yearly amounts from 1875–94 on the Elbe in Bohemia.

**Perman, D. E. P.**
The evaporation of water in a current of air. Communicated by Prof. E. H. Griffiths, F. R. S., to the Royal Society, February 19, 1903. Nature, 1903, (—):477.

**Rafter, George W.**
The relation of rainfall to runoff. Water sup. and irr. paper, 1903, No. 80:30–43.

Papers by Vermeule (1893 and 1900) are abstracted. Computes the evaporation from the Muskingum basin, N. Y. (O?). Definition and tables of so-called "negative evaporation" are added.

**Russell, H. C.**
Results of rain, river, and evaporation observations made in New South Wales during 1900. Sydney. 1903.

**Salo, Osservatorio Meteorologico.**
Meteorologia. Comment. Ateneo, Brescia, 1903, (—):148–55.

The average daily evaporation from September, 1902, to August, 1903, inclusive, was 2.4 millimeters.

**Sutton, J. R.**
Results of some experiments on the rate of evaporation. Trans. So. African phil. soc., 1903, **14**, pt. 1. Review in Met. Zeit., 1903, **20**: 517–8. Reprinted, 23 p., 8vo.

Compares the evaporation from various containers and from a Piche tube. Finds that the latter instrument is especially susceptible to the influence of the wind. The experiments of 1900 lead to the conclusions: (1) The humidity of the air exerts the most powerful influence on the rate of evaporation. (2) A wind factor is needed. (3) The great perturbing influence attributed to the temperature of the water has not been wholly confirmed.

Experiments with colored glass over the evaporating surface show that for each 1° excess of temperature due to such influence the depth of annual evaporation will increase by 1.5 inches.

**Ule, Willi.**
Niederschlag und Abfluss in Mitteleuropa. Forschungen zur Deutschen Landes- und Volkskunde, Stuttgart, 1903, **14**:435–516.

In the upper Saal valley the average rainfall for the 20 years, 1882–1901, was 615 millimeters, and the average run-off 170 millimeters. The run-off is 27.5 per cent, the evaporation is estimated at 51.5 per cent, and vegetation uses 21 per cent. This would make the average annual evaporation for this region about 316.7 millimeters.

**Vlasov, V. A.**
Observations météorologiques de la station du champ d'expérience de Poltava, 1886–1900. Vol. II: Dépôts atmosphèriques, évaporation, etc. (Russian and french.) Poltava. 1903. 633 p.

1904.

**Batavia, Koninklijk magnetisch en meteorologisch Observatorium.**
Results of meteorological observations made at the Experiment station "Oost-Java" at Pasuruan, during the year 1902. Natkdg. Tijdsch. Ned. Ind., 1904, **63**:220–5.

Includes observations on evaporation.

**Black, William Galt.**
Observations of rain, dust, and evaporation, Edinburgh, 1903. Symons's met. mag., 1904, **39**:29.

**Bologna, Osservatorio della R. Università.**
Osservazioni meteorologiche fatte durante l'anno, 1903. Mem. accad. sci., Bologna, 1904, 1, (6th ser.):325–53.

The total evaporation for 1903 was 1234.5 millimeters, the rainfall was 547.9 millimeters.

**Burgerstein.**
Die Transpiration der Pflanzen. Jena. 1904.

An exhaustive and critical bibliography of works dealing with transpiration from plants.

**Curtis, Richard R.**
Water-vapor. Quart. jour. roy. met. soc., 1904, **30**:193–209.

A general survey of the physics of evaporation with a statement of the relative amounts of rainfall and evaporation in the British Isles.

**Desenzano, Osservatorio Meteorologico.**
Osservazioni fatte nel 1903. Comment. Ateneo, Brescia, 1904, (—): 185–9.

The total evaporation for the year September, 1903, to August, 1904, inclusive, was 852.7 millimeters.

**Gibbs, L.**
Evaporation from the land. Quart. jour. roy. met. soc., 1904, **30**: 39–40.

Discusses literally and graphically the effect of the duration and character of the rainfall on the evaporation.

**Hungary.**
Königliche Ungarische Reichsanstalt für Meteorologie und Erdmagnetismus. Jahrbuch, 1904, **34**:218, 219.

At Nagytagyos the total evaporation for 1904 was 352.4 millimeters, and at Temesvár 494.4 millimeters.

**Jaubert, Joseph.**
Observatoire Municipal [de Paris], (Observatoire de Montsouris). Annales, 1904, **4**:19, 94–6, 220–4, 383–7.

At Montsouris the monthly totals varied between 92.6 millimeters in October to 173.5 millimeters in July; at the Tour St. Jacques they varied between 41.4 millimeters in October to 118.1 millimeters in July. No records are given for the winter months.

**Kimball, Herbert Harvey.**
Evaporation observations in the United States. Mo. weather rev., 1904, **32**:556–9. Reprinted U. S. Dept. Agric., Weather Bur., No. 327. Washington. 1905.

Quotes Rafter's (1903) computations of evaporation from the run-off and rainfall over a watershed for different localities during long periods. Two other methods of determining evaporation are considered as of more practical importance—by direct measurements from properly exposed water surfaces, and by computations based upon the temperature of the water surface and the values of certain meteorological elements. The formulas of T. Russell, Fitzgerald, Carpenter and Stelling are compared and discussed. An account of experiments made by the U. S. Geological Survey in 1888 in the arid regions is followed by a table of measured annual evaporations at various stations, for the purpose of checking Russell's computed values. Reproduces T. Russell's chart of evaporation over the United States.

**Krebs, Wilhelm.**
Ueber Verdunstungsmessungen mit dem Doppelthermometer für klimatologische und hydrographische Zwecke. Verhdl. Deut. phys. Gesellsch., 1904, **6**:278–9.

See Krebs, 1905.

**Luedecke, Carl.**
Ueber die Grösse der Bodenverdunstung bei verschiedenen Tiefe des Grundwasserspiegels. Kulturtechniker, Breslau, 1904, **7**:195–8.

**Memmo, Osservatorio Meteorologico.**
Osservazioni fatte nel 1903. Comment. Ateneo, Brescia, 1904, (—): 190–7.

The total evaporation for the year from September, 1903, to August, 1904, inclusive, was 890.1 centimeters.

**Mill, Hugh Robert.**
Records of evaporation. Brit. rainf., 1904, **44**:46–51.

27——4

Gives observations from the same stations as in 1903. The results obtained at the eleven stations average 17.32 inches, with a rainfall of 26.49 inches.

**Mitscherlich, Alfred.**
Ein Verdunstungsmesser. Landw. Vers. Stat., 1904, **60**:63–72, and 1904, **61**:320.

The author considers measurements of evaporation from open vessels of little value for agricultural purposes, since the instrument usually can not be placed in the open on account of rain, and because the edge of the vessel always protects the surface of the water from the full action of the wind. He devises an instrument essentially that described by Babinet, 1848, and Marié-Davy, 1869. The evaporation per square centimeter indicated by this instrument was to that from a free water surface as 1.94 to 1 for a large cylinder, and 1.39 to 1 for a smaller one. This apparatus exposed in the writer's experimental field at Kutschlau near Schwiebus, Brandenburg, from April 5 to July 20, 1903, indicated an evaporation of 190.14 millimeters, while the rainfall was 205.50 millimeters. At Kiel the evaporation was only about one-half to one-third that at Kutschlau and the rainfall was considerably greater. Recommends this evaporometer as a substitute for the registering hair hygrometer.

**Naples. R. Osservatorio di Capodimonte.**
Osservazioni meteoriche. Rend. accad. sci., fis. math. Sez., Naples, 1904, **10** (3d ser.): 38, 78, 180–1, 267–9, 323–6, 400.

The monthly amounts of evaporation in 1904 varied from 46.9 millimeters in January to 134.6 millimeters in July. The rainfall varied from 17.6 millimeters in July to 157.1 millimeters in October.

**Okada, T.**
Evaporation in Japan. Bul. cent. met. obs., Japan, 1904, No. 1:31.

Evaporation is observed at fifty stations in Japan. The evaporometer is a cylindrical, zinc-lined copper vessel, 20 centimeters in diameter and 10 centimeters deep. A table of comparative observations in sun and shade for 1891–1893 shows that the difference is greatest in summer and least in winter. Tables of the mean daily and the monthly evaporation for the fifty stations show minima in January and June and a maximum in August. Geographically the annual evaporation in Japan decreases from 1,910 millimeters at Koshun in the southwest, to 734 millimeters at Kushiro in the northeast. The annual rainfall usually exceeds the evaporation. The monthly evaporation at twelve stations is shown graphically and a chart presents the distribution of evaporation over Japan.

**Oppokow, E.**
Zur Frage der vieljährigen Abflussschwankungen in den Bassins grosser Flüsse, im Zusammenhang mit dem Gang der meteorologischen Elemente. Vergleichende Untersuchung der mittleren Abflusswerthe im Flussbecken des oberen Dnjepr und der oberen Elbe in Zusammenhang mit der Frage über Charakter und Grenzen des Einflussen der Lokalitäten eines Flussbeckens auf den Abfluss. Zeits. Gewässerk., 1904, **6**:1–23.

The percentage of the rainfall evaporating from a bare moor soil was found to be 29.3, and the run-off 59 per cent. For a mixture of moor soil and sand lying over moor soil the figures were 25.5 and 63 per cent. For moor soil covered with coarse sand, 11.6 and 87 per cent.

**Oppokow, E.**
Zur Frage der vieljährigen Abflussschwankungen in den Bassins grosser Flüsse, im Zusammenhang mit dem Gang der meteorologischen Elementen. Ueber Aufspeicherung und Consum der Feuchtigkeit im Bassin des oberen Dnjepr. Zeits. Gewässerk., 1904, **6**: 156–75.

The evaporation and seepage are calculated from the rainfall and run-off. Tables and curves are presented for the basin of the Dnieper, and tables from R. Scheck and Ule for the basin of the Saal, 1872–1901. (See Ule, 1903.)

**Oppokow, E.**
Einige Daten über die Schwankungen des Abflusses und der absoluten Verdunstung in den grossen Flussbassins im Zusammenhang mit den Klimaschwankungen und dem Einfluss der Boden- und Pflanzen-Bedeckung. (Russian.) Pédologie, St. Petersburg, 1904, **6**:182–9.

**Russell, H. C.**
Results of rain, river, and evaporation observations made in New South Wales during 1901–2. Sydney. 1904.

**Salo, Osservatorio Meteorologico.**
Osservazioni fatte nel 1903. Comment. Ateneo, Brescia, 1904, (—): 198–204.

The average daily amount for the year September, 1903, to August, 1904, inclusive, was 2.7 millimeters, ranging between 0.6 millimeters in December, and 6.4 millimeters in July.

**Sutton, J. R.**
On certain relationships between the diurnal curves of barometric pressure and vapor tension at Kenilworth (Kimberley), South Africa. Quart. jour. roy. met. soc., 1904, **30**:41–55.

A modern discussion of the physics of evaporation with consideration of the theories proposed by Dalton, Lamont, and Deluc. Concludes that changes in the barometer may be due to changes in the vapor pressure rather than to those of temperature.

**Sutton, J. R.**
Results of some further observations upon the rate of evaporation. Rpt. So. African assoc. adv. sci., Johannesburg. 1904.

Experiments from 1900–04 with a Piche atmometer and the evaporometer described in Sutton, 1903, shows the highest rate from the Piche in the daytime, but not at night. It is concluded that this may be due to the stronger winds of the day, and possibly to the greater range of the temperature of the water in the Piche. Quotes similar results by Shaw. In summer the ratios between the instruments are more nearly equal than in winter. A mathematical discussion seeks to determine the relation of the different factors which influence the evaporation rate.

1905.

**Abbe, Cleveland.**
The Piche evaporometer. Mo. weather rev., 1905, **33**:253–5.

Summarizes Russel's (1888) results. Describes the Piche atmometer, and gives a table showing the effect of wind upon the rate of evaporation. "The true method of treating evaporometers of all kinds within instrument shelters is to consider them as integrating hygrometers. For such exposures the total evaporation during an hour or a day is a simple result of the temperature, the wind, and the dryness. Knowing the two former and the measured evaporation, we may compute the average dryness. This average dryness is a much more important datum to the meteorologist than is the measured evaporation to the climatologist. Of course, hydraulic and irrigating engineers need to know the loss of water by evaporation, but in nature this is so mixed up with seepage, leakage, and consumption by animals and plants, that our meteorological data are of comparatively of little importance. For the agricultural engineer the lysimeter and Symons' evaporometer, 6 feet square, are essential apparatus, but for the meteorologist an integrating hygrometer, such as the Piche evaporometer really is, is the important instrument."

**Bacon, Arthur A.**
The equilibrium pressure of a vapor at a curved surface. Phys. rev., 1905, **20**:1-9.

Discussion of the laws regulating the equilibrium between evaporation and condensation at the surface of a liquid in capillary tubes, with a résumé of the history of the subject.

**Bentley, Richard.**
The growth of instrumental meteorology. Quart. jour. roy. met. soc., 1905, **31**:173-92.

Two paragraphs on evaporometers occur on p. 185 and 196. Richard's (1898) self-recording evaporation gage and Symons's evaporation tank are described.

**Boname, P.**
Meteorologie. Rap. ann. sta. agron. Mauritius, 1905, (—):1-10. Abstract in Exp. sta. rec., 1906, **18**:311.

The annual evaporation in Mauritius for 1905 was 376.2 millimeters, with a rainfall of 2,410.2 millimeters. This is said to have been an unusually wet year.

**Brückner, Eduard.**
Die Bilanz des Kreislaufs des Wassers auf der Erde. Geogr. Zeits., 1905, **11**:436-45. Abstract in Arch. sci. phys. et nat., 1905, **20**: 427-30.

General survey of the evaporation measurements made in different parts of the earth, and the part played by evaporation in the cycle of the waters of the earth.

**Day, W. H.**
Experiments on evaporation and transpiration. Ann. rpt. Ontario agr. coll. and expt. farm, 1905, **31**:40-2. Abstract, Exp. sta. rec., **17**:841.

Studies on the amount of water required by wheat, barley, oats, and peas show that barley requires the least water for growth and peas the most. An attempt to use the Piche evaporometer for purposes of comparison showed that several instruments "would not record the same amount under the same conditions nor even amounts bearing constant ratios to one another."

**Desenzano, Osservatorio Meteorologico.**
Osservazioni fatte nel 1904. Comment. Ateneo, Brescia, 1905, (—): 157-61.

The monthly evaporation for the year from September, 1904, to August, 1905, inclusive, varied from zero in December, and 1.2 millimeter in January to 104.2 millimeters in August.

**Fortier, Samuel.**
Loss of water by evaporation. Engin. rec., 1905, **51**:430.

Very comprehensive experiments in evaporation, undertaken by the Office of Exp. Stas. and the State of California, show that the amount of evaporation is largely dependant on the temperature of the water. The rate of evaporation from cultivated soil seems to depend on the amount of soil moisture, on the temperature and physical character of the soil, the condition of the atmosphere, the wind, etc. Experiments in irrigation indicate that surface flooding is most wasteful and that furrows 12 inches deep conserve much more moisture than do shallow furrows of 3 inches. The average evaporation under each method, during September and October, was 6428, 5581, and 4811 cubic feet per acre, respectively.

**Gessert, F.**
Die Grundwasserverdunstung in Steppen, speciell Südwest-afrika. Zeits. Kolonialpol., Berlin, 1905, **7**:301. Translated by L. Laloy in Bul. soc. géog., 1905, **12**:53-5.

The cause of the high evaporation rate from the steppe soils of Southwest Africa are given as: (1) circulation of air through the porous soils due to differences in temperature. (2) destruction of forests which formerly covered the soil, by erosion and periodic burning. (3) strong capillary action.

Evaporation is shown to produce an increase in the salt content of the upper layers of the soil. The amount of evaporation is estimated as probably more than the runoff of streams. The remedies for excessive evaporation are believed to lie in changing evaporation from the depths to the surface, either by pumps in some particular cases, or in a more general manner by reestablishing a plant cover such as dates and cactus.

**Hall, A. D.**
The Book of the Rothamsted Experiments. London. 1905. xl, 294 p.

Results of percolation experiments, averaged for each month for 34 years (1871-1904), appear on p. 22-3. The average annual rainfall was 28.98 inches, of which 15.8 inches was evaporated or retained by the soil in a 20-inch gage, 14.25 inches in a 40-inch gage, and 15.19 inches in a 60-inch gage.

**Hungary.**
Königliche Ungarische Reichsanstalt für Meteorologie und Erdmagnetismus. Jahrbuch, 1905, **35**:224, 225.

The monthly evaporation in 1905 at Temesvár varied from 8.2 millimeters in January to 81.3 millimeters in July, with a total for the year of 430.4 millimeters. At Nagytagyos the monthly amount varied from 6.7 millimeters in November to 72.9 millimeters in August, with a total of 331.3 millimeters.

**Krebs, Wilhelm.**
Ueber Verdunstungsmessungen mit dem Doppelthermometer für klimatologische und hydrographische Zwecke. Met. Zeits., 1905, **22**:211-21.

Measurements of evaporation from tanks placed in the waters of Mansfelder Lake in June, 1894, in Platten Lake, in October, 1894, and in White Lake in the High Vosges in July, 1903, are compared with the readings of the wet- and dry-bulb thermometers.

**Memmo, Osservatorio Meteorologico.**
Osservazioni fatte nel 1904. Comment. Ateneo, 1905, (—): 162-5.

The total evaporation for the year, from September, 1904, to August, 1905, inclusive, was 344.1 millimeters. The water in the instrument was frozen during the three winter months.

**Mill, Hugh Robert.**
Relation of evaporation from a water surface to other meteorological phenomena in 1905, at Camden Square. Brit. rainf., 1905, **43**:35-9.

Curves of the evaporation, temperature, etc., at Camden Square, are presented. When the curve of the rate of evaporation was below the average for the year it followed that of the mean temperature; when it was above the average it followed those of the duration of sunshine and the black-bulb temperature. The wind appeared to have little effect at any time.

**Mill, Hugh Robert.**
Records of evaporation. Brit. rainf., 1905, **45**:40-4.

Evaporation for the year, averaged from records at eleven stations in the British Isles, was 17.72 inches, with a rainfall of 25.35 inches.

**Mitscherlich, Alfred.**
Bodenkunde für Land- und Forstwirte. Berlin. 1905.

In section 35, p. 204-13, the author discusses evaporation from soil. He cites Eser, Ebermayer, Meister, Vogel, and Wollny on the influence of the size of the soil particles, the kind of soil, the vegetation, the inclination of the surface, the depth of the ground water and the capillary power of the soil, tillage of the soil, and mulches. Additional tables on p. 300-3 compare evaporation from free water surfaces with that from various kinds of soil and vegetation.

**Salo, Osservatorio Meteorologico.**
Osservazioni fatte nel 1904. Comment. Ateneo, Brescia, 1905, (—): 168-71.

The average daily evaporation varied from apparently zero in February and March and 0.7 millimeter in December to 4.3 millimeters in July.

**Shchusev, S. [V].**
La méthod de détermination de l'humidité des sols. (Russian.) Pédologie, St. Petersburg, 1905, **7**:63-6.

**Shipchinskii, V. V.**
Un cas d'évaporation. (Russian.) Met. Vest., 1905, **15**:87-95.

**Slovinskii, — —.**
[Meteorological observations for the year 1905 at the Ploti agricultural experiment station.]
Godichnuiĭ Otchet Ploty. Selsk. Khoz. Opuitn. Stantzii., 1905, **11**:1-24, 121-4. Abstract, Exp. sta. rec., 1906, **18**:311.

Observations on evaporation, in connection with other meteorological data.

**Strachan, Richard.**
On percolation gages. Horological journal, London, 1905, **47**:115-7.

Several well-known percolation gages and those used at Rothamsted are described; also a self-recording apparatus designed and constructed by Messrs. Richard Frères.

**Strachan, Richard.**
On evaporation gages. Horological journal, London, 1905, **47**:129-34, 157-61; 1905, **48**:19-24, 40-5, 50-4.

General discussion of various classes of evaporometers, with detailed historical and bibliographical survey of examples of all kinds, and some treatment of evaporation from a mathematical point of view.

**Strachan, Richard.**
Measurement of evaporation. Quart. jour. roy. met. soc, 1905, **31**: 277-84.

Evaporation (15.04 inches) as calculated from the meteorological data for 1898 obtained at the Royal Observatory, Greenwich, is compared with the observed evaporation at Camden Square (15.16 inches) and at Rothamsted (15.67 inches). Discusses Pole's formula (see Latham, 1900), and two proposed by R. J. Mann (1871), all of which are regarded as inapplicable. Abbe and Fitzgerald are quoted, and T. Russell's experiments on the influence of the wind on a Piche tube. "The necessity, however, is made apparent of improving the accuracy of evaporometers, and of the importance of achieving a standard instrument of this class." The formula used at the Royal Observatory for calculating evaporation is as follows: The depth of water evaporated in a month $= 13.59\ (V - v)\ ab$, where $V =$ vapor pressure at the temperature of the air, $v =$ vapor pressure at the dew-point, $a =$ mean daily temperature of the evaporating water, and $b =$ coefficient of expansion of water.

**Transeau, Edgar N.**
Forest centers of eastern America. Amer. nat., 1905, **39**:875-89. See also Ann. rpt. Mich. acad. sci., 1905.

Draws lines of equal ratios between rainfall and evaporation in eastern North America, Russell's (1888) chart being used as the basis for the evaporation data. Finds that these lines indicate "climatic centers" corresponding in general with the centers of plant distribution which latter are resultants of temperature, relative humidity, wind velocity, and rainfall.

**Wada, Y.**
Japanese meteorological service in Korea and Manchuria. (Translated by Dr. S. Tetsu Tamura.) Mo. weather rev., 1905, **33**:397-9.

At Chemulpo Observatory the total evaporation from an 8-inch evaporometer for the year June, 1904, to June, 1905, was 1254.8 millimeters. The monthly rates varied between 175.6 millimeters in June, 1905, and 59.0 millimeters in January, 1905. The total rainfall for the year was 707.6 millimeters.

1906.

**Alfaro, Anastasio.**
Costa Rican climatological data. Mo. weather rev., 1906, **34**:60, 305.

The total evaporation for January, 1906, was 62.5 inches, and for March, 67.9 inches.

**Boulatovitch, M.**
Meteorological observations for the year 1906 at the Ploti Agricultural Station. Godichnuiĭ Otchet Ploty. Selsk. Khoz. Opuitn. Stantzii, 1906, **12**:1-34, 229-34. Abstract, Exp. sta. rec., 1907, **19**: 616.

Evaporation for the year is given as 27.56 inches, the mean of 12 years being 32.78 inches.

**Day, W. H.**
Evaporation. Ann. rpt. Ontario agr. coll. and exp. farm, 1906, **32**: 31, 32. Abstract, Exp. sta. rec., 1907, **19**:11.

Observations of evaporation from a reservoir during the six months, June to November, showed a loss of 37.69 inches, or about 10 inches more than the mean annual rainfall for this place.

**Fritsche, Richard.**
Niederschlag, Abfluss und Verdunstung auf den Landflächen der Erde. Inaug. Diss. Halle-Wittenberg. Halle. 55 p. 8vo. Zeits. Gewässerk., 1906, **7**:321–70. Reviews, Naturw. Rundschau, 1907, **22**:111; Petermann's Mitteil., 1907, **53**:16 (Literaturbericht); Exp. sta. rec., 1908, **20**:114.

General estimates of annual rainfall, run-off, and evaporation on the land surfaces of the globe, revised from Murray (1887), and Brückner (Met. Zeits., 1887, **4**:[63]), and gives a table of evaporation according to latitude. (See also Brückner, 1908.)

**Ginestous, C.**
Meteorology of Tunis, winter of 1905–6. Bul. dir. agr. et com., Tunis, 1906, **10**:114–28. Abstract, Exp. sta. rec., 1906, **18**:10.

Sumarizes observations on pressure, temperature, humidity, rainfall, evaporation, etc., at a large number of stations in different parts of Tunis.

**Hann, Julius.**
Täglicher und jährlicher Gang der Verdunstung in Südindien. Met. Zeits., 1906, **23**:428–9.

Describes some experiments carried on at Trivandrum from 1857 to 1863 by John Allen Brown. Two evaporators, having exposed surfaces of 100 square inches, were filled with sea water, and placed, one in the shade, though exposed to wind, the other in the sun. The evaporation maxima fell in March and September, the minima in June, July, and November. The table of mean daily evaporation gives the annual amounts of 1032.36 millimeters in the shade, and 2523.94 millimeters in the sun.

**Henry, Alfred J.**
Salton Sea and the rainfall of the Southwest. Mo. weather rev., 1906, **34**:557–9.

Shows that the Salton Sea could not effect the rainfall of the Southwest.

[*To be continued.*]

## PHOTOGRAPHING THE LEONIDS OF NOVEMBER, 1909.

To encourage the photographing of the Leonids under favorable atmospheric conditions the Treptow Sternwarte near Berlin, announces the following prizes which it offers:

First prize.—A telescope for amateurs, constructed by G. and S. Merz, Munich, according to a design by Dr. F. S. Archenhold. Mounting is equatorial and various eyepieces are furnished with it. Value = M. 125.00.

Second prize.—Six bound volumes of the illustrated astronomical fortnightly, "Das Weltall." Value = M. 84.00.

Third prize. A complete set of the 21 extra numbers of the "Weltall" comprising the lectures and addresses published by the Treptow Observatory. Value = M. 30.50.

*Conditions of the competition.*

1. The photographs must be made from a balloon, during the time from November 13 to 16, 1909.
2. The competition is open to the citizens of all nations.
3. The papers and negatives offered in competition are to be signed by a Motto only, and are to be accompanied by a sealed envelope containing the correct address of the contestant, the appropriate motto only to be written on the outside of this envelope.
4. The original negatives, developed and fixed, must be submitted in competition, accompanied by the following data:
   *a*. Place, date, and hour of the exposure.
   *b*. Name of the balloon.
   *c*. Altitude of the balloon.
   *d*. Name of the constellation in which the meteors were observed [photographed].
   *e*. Description of the camera and the lens, giving also its focal length and the aperture employed.
   *f*. Length of the exposure.
5. The original negatives awarded prizes by the three judges, to be named later, together with all rights of publication, become the property of the illustrated periodical "Weltall," published by the Treptow Observatory, Treptow-Berlin, Germany.
6. The last date for receiving photographs in competition is January 1, 1910.

All papers and packages should be addressed,

Herrn Direktor Dr. F. S. Archenhold,
Treptow Sternwarte,
Treptow bei Berlin, Germany.

7. The results of the competition will be published in "Das Weltall."

Directions and hints for photographing meteor showers, etc, may be found in "Das Weltall," 1st Year, No. 3, and all further details or advice will be willingly given by the Director of the Treptow Observatory at the above address.

## HIGHEST BALLOON ASCENSION IN NORTH AMERICA[1].

By Prof. A. L. Rotch, Blue Hill Observatory, Mass.

Although a large number of *ballons-sondes* were dispatched from St. Louis in 1904–7 under the direction of the writer[2], none had been employed in the eastern States until last year. In May and July, 1908, four *ballons-sondes* were launched from Pittsfield, Mass., with special precautions to limit the time they remained in the air and so prevent them from drifting out to sea with the upper westerly wind. Three of the registering instruments have been returned to the Blue Hill Observatory with good records. The first instrument, sent up on May 7, was not found for 10 months and the record, forming the subject of the present article, is very interesting, because it gives complete temperature data from the ground up to 17,700 meters (11 miles). This is 650 meters higher than the highest ascension from St. Louis.

On May 7, 1908, a general storm prevailed, so that the balloon, traveling from the east, was soon lost in the clouds and its subsequent drift could not be followed; but the resultant course was 59 miles from the southwest, as determined by the place where the instrument fell 2 hours later. At the ground the temperature was 4.5° C., and this decreased as the balloon rose to the base of the clouds, which itself was considerably warmer than the underlying air. Above the clouds the temperature continued to fall with increasing rapidity up to a height of 12,500 meters (7.7 miles) where the minimum of —54.5° C. was registered. Here the great warm stratum was penetrated farther than ever before in this country, namely, to the height of 17,700 meters (11.0 miles) where the temperature was —46.5° C. An increase of 8.9° C. occurred, however, in the first 3,000 meters, for above 15,500 meters nearly isothermal conditions prevailed, confirming the belief of Teisserenc de Bort that what he calls the "stratosphere" is composed of a lower inverting layer with isothermal conditions above extending to an unknown height.

In an ascension last November in Belgium the relatively warm stratum was found to extend from 12,900 meters (8.0 miles) to the enormous height of 29,000 meters (18.0 miles), where there was still no indication of its diminution.

## TORNADOES IN OKLAHOMA.

On May 29, 1909, at about 4:30 p. m., two straight winds from about west and southwest respectively converged upon Key West, Lincoln County, and are reported to have there combined in a tornado of some intensity which traveled northeastward, crossing the Frisco railroad at Depew, Creek Nation. In the vicinity of Key West the straight winds are reported to have destroyed property to the value of $2,500 and injured six persons. The tornado here had a path a quarter of a mile wide. The storm reached Depew, fifteen miles northeast, about 5:30 p. m., and there destroyed thirty or forty houses and injured two men. Heavy rainfall accompanied this storm and caused great damage.

A second tornado, with a path two hundred yards wide, occurred almost simultaneously six or eight miles to the south, along a parallel path between Arlington and Newby. At the confluence of Pataqua Creek and Deep Fork of Canadian River this tornado killed four persons. Three others were injured and ten houses destroyed along its path. Heavy rain and hail fell after the tornado had passed.—*C. A., jr.*

[1] Reprinted from Science, 1909, **30**(n.s.):302–3.
[2] See Science, 1908, **27**(n.s.):315.