at its maximum brilliancy only the stars of brightest magnitude could be seen in that region of the sky, and the "milky way" was rendered entirely invisible. Over nine-tenths of the sky was cloudless throughout the evening, a trace of alto-stratus having been visible above the northern horizon, and an equal amount of cumulo-nimbus with distant lightning having been seen far off to the west. ANDREW H. PALMER.

Captain Niss in his description remarks that at 7:20 a. m. of May 16 his ship ran into a bank of fog and that coincidently his compass began to oscillate, swinging 15° to 22° to either side of an easterly deviation which was 1.5° greater than that normal for the year and place. This oscillation and increased deviation both ceased when he ran out of the fog, and his last sentence might give the impression that he ascribes the compass disturbance to the presence of the fog, but this is not at all likely.

One may, however, explain this sudden compass deviation in two ways. (1) It may have been the expression of the highly charged lower atmospheric strata which must have accompanied the well-marked thunderstorms to the west reported by both observers. In this case the needle disturbances would have been characteristically sharp jumps from the normal position, occurring at the times of the discharges. (2) It may have been due to the continued auroral phenomena, become invisible in the light of dawn. In this case the needle would have oscillated more or less strongly swinging to either side of the normal deviation, if there were such vibrations as produce the the "merry dancers"; or would have remained more steady, perhaps at an abnormal point if the aurora were in the nature of a glow. Captain Niss' report is not quite explicit enough to permit us to choose between these explanations.—*C. A., jr.*

AN ANNOTATED BIBLIOGRAPHY OF EVAPORATION.

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

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

1889—*Continued.*

Grossmann. [L.]
Beiträge zur Geschichte und Theorie des Psychrometers. Met. Zeits., 1889, **6**:121–30, 164–76.

Discusses the history and theory of the psychrometer.

Seyfert, T.
Der Einfluss des Bedeckens und des Mischens der Moorboden mit Sand auf seine Verdunstungs- und Temperaturverhältnisse. Mitt. z. Förderung der Moorkultur, 1889, Nos. 17, 18: 205–23; Centbl. Agr. Chem., 1889, (—):678–80. Abstract in Forsch. Geb. Agr. Phys., 1880, **13**:63–4.

Experiments in evaporation from natural moor soil, from the same with sand mixed into the surface layer, and from the same with sand on top but not mixed in, for the period June to October, gave amounts in the proportion, 100:38:20. The effect of a surface layer of sand in retarding evaporation is clearly shown.

Symon, G. J.
On the amount of evaporation. Brit. rainf., 1889, (—):18–43.

A complete résumé of all previous reports of evaporation published in "British Rainfall" from 1867 to 1887, together with descriptions and drawings of the various instruments used at Strathfield Turgiss. Tables of daily evaporation at Camden Square from July, 1889 to June, 1890, and the totals and maxima for each month and year from 1885–1890 are given.

Tacchini, P.
Temperatura ed evaporazione a Massaua. Atti r. accad. Lincei, 1889, **5** (4):329–30.

Investigations show that evaporation at Massaua is almost twice that at places whose mean temperatures are but half as high.

Place.	Mean annual temperature.	Mean daily evaporation.
	°C.	Mm.
Bari	15.7	3.1
Massaua	29.8	7.3
Reggio (Calabria)	17.6	3.6

Voeikov.
See Woeikof.

Waldo, Frank.
Distribution of wind velocities in the United States. Amer. met. jour., 1889, **6**:309–10.

Discusses the relation between the distribution of wind velocities and evaporation. Describes Russell's (1886, 1888) experiments in this line.

Woeikof, Alexander.
Der Einfluss einer Schneedecke auf Boden, Klima, und Wetter. Geog. Abh., 1889, **3** (Hft. 3):99.

Although the air above a large extent of snow is usually saturated owing to the continual evaporation from the snow, certain winds are so dry that the evaporation can not always maintain this saturated condition of the air. A greater dryness in the air above snow may also result in decreased evaporation due to the lower temperature of the snow compared that of the air.

1890.

Abbe, Cleveland.
Preparatory studies for deductive methods in storm and weather predictions. Ann. Rpt. Chief Signal Officer for 1889. Washington. 1890. App. 15, p. 117–21.

Discusses the various factors influencing the rate of evaporation. For meteorological purposes evaporation from a free water surface, or preferably from moistened cloth or paper, as in the ordinary psychrometer or in the Piche atmometer, is considered a sufficient indication of the evaporating power of the air. Presents the conclusions reached by Tate; the formulas derived by Wellenmann, Stelling, and Fitzgerald; and Russell's comparisons of evaporation with changes in wind velocity.

Battelli, Angelo.
Sull' evaporation dell' acqua e del terreno umido. Nuovo cimento, 1890, **28**(3):247–56. Abstract in Naturw. Runds., 1891, **6**:270; Ann. uffic. cent. met. Ital., **9**:—; Met. Zeits., 1891, **8**:394.

Comparative measurements of evaporation, both in sun and shade, from a free water surface and from soil saturated with water, at Chieri (Turin). Also observed a Piche atmometer, a psychrometer, and an anemometer. (See Battelli, 1892.)

Brückner, Eduard.
Verdunstung einer Schneedecke. Met. Zeits., 1890, **7**:150–2.

Review of Voeikov, 1889 and 1890. According to Brückner condensation ordinarily occurs on snow, rather than evaporation from it.

Colin, R. P. E.
Observations météorologiques faites à Tananarive. Obs. roy. de Madagascar. Tananarive. 1890. 2 vols. 8vo. Review in Symons's met. mag., 1892, **27**:38–40.

His evaporator consists of a zinc tank, 40×40×2.5 inches, inclosed in a wooden box. A table gives the evaporation for the first ten days in February, 1890.

Ekholm, Nils.
Zur Frage über die Verdunstung einer Schneelage. Met. Zeits., 1890, **7**:224–6. Notice in Forsch. Geb. Agr. Phys., 1890, **13**:475.

Discusses the question raised by Voeikov (1890), who declared that snow will evaporate when the temperature of the air is below zero.

Houdaille, F.
Mesure de l'évaporation diurne; description d'un évaporomètre enregistreur. Bul. mét. Hérault, 1890. See Houdaille, 1892.

Conclusions: (1) Daily evaporation as measured by the Piche atmometer is very irregular as compared with that from an evaporating surface more naturally exposed to the action of the wind and nearer the temperature of the air. (2) A continuous record of the rate of evaporation is important for meteorology and for various industries. (3) Describes a recording "evaporometer," which employs the registering mechanism of the Richard thermograph. (4) This rate is always much higher in the daytime than at night, generally at least three times higher. (5) The maxima are determined by the predominance of one of the three factors, temperature, relative humidity, and wind velocity.

Specifies objections to the Piche atmometer. Describes his own atmometer, which consists of an evaporating surface of blotting paper clamped on a brass plate connected with a graduated Mariotte's tube. An opening, 2 mm. in diameter, in the brass plate allows the liquid supplied from the tube to keep the paper constantly soaked.

Moulan, T.-C.
Quantités d'eau évaporées ou absorbées par la végétation dans la bassin de la Gileppe. Ciel et terre, 1890, **11**:328.

Approximate estimate of the water absorbed or evaporated by vegetation.

Russell, Thomas.
Evaporation. Mo. Weather Rev., 1890, **18**:290.

Table 1 shows the depth of monthly evaporation for 1888–9, as measured in a pan and by a Piche atmometer, at Sweetwater Dam, San Diego County, Cal. Table 2 shows the depths of evaporation observed at a number of stations in 1888–90 with Piche atmometers. Tables 3 and 4 show the depths evaporated from pans at stations other than those where the Piche had been used.

Symons, G. J.
On the amount of evaporation. Brit. rainf., 1890, (—):17–31.

Deals in detail with the work of Dines, 1870; Evans at Nash Mills, Hertfordshire (see Greaves, 1876); Greaves, 1876; Lawes at Rothamsted; S. H. Miller at Wisbech, 1878; Peek at Rousdon Observatory, near Lyme Regis, Devon; and Russell at Sydney, N. S. W. Symons assumes that at Sydney a facsimile of the Strathfield Turgiss tanks would lose about 30 inches a year.

van Bebber, W. J.
Lehrbuch der Meteorologie. Stuttgart. 1890. p. 103–9.

General discussion of the process of evaporation, with a description of the Piche atmometer. Results of Eser, Ebermayer, and Stelling are reviewed.

Woeikof, A.
Verdunstung einer Schneelage. Met. Zeits., 1890, **7**:38–9.

Points out that evaporation will take place from the surface of snow as long as the air temperature is below zero. (See Brückner, 1890.)

Wollny, E.
Forstlich-meteorologische Beobachtungen. (Zweite Mitteilung.) Forsch. Geb. Agr. Phys., 1890, **13**:134–84.

Continued from 1887. (See Wollny, 1895, for summary.)

1891.

Allen, H. N.
See Brace, de W. B., and H. N. Allen.

Brace, de W. B., and H. N. Allen.
Meteorological observations for 1890. Nebr. exp. sta. bul., 1891, 4 (no. 27):33–72; Exp. sta. rec., 1891, 3:29.

Gives the results of observations with 6 Piche evaporometers from June to October, suspended at elevations of 22, 40, 60, 80, and 100 feet.

[Bartet.]
Influence de la futaie de hêtre sur les pluies, l'évaporation et la température de l'air. Ciel et terre, 1891–2, 12:313–9.

Quotes observations near Nancy by Mathieu in 1867–77. In discussing the influence of a beech forest on rainfall, evaporation, and temperature at Bellefontaine from 1878–88 Bartet found the following data:

	In woods.	In open.
Annual evaporation (millimeters)	146.4	472.1
Annual rainfall (millimeters)	722.8	852.2
Evaporation as per cent of rain	20%	55%
Ratio of evaporation	1	3.22

The general results at Nancy and Bellefontaine are in mutual accord.

De Heen, P.
Recherches sur la vitesse d'évaporation des liquides pris au-dessous de la température d'ébullition. Bul. acad. sci. de Belgique, 1891, 21(3):11–25, 214–9, 798–810. Review in Ciel et terre, 1891, 12: 49–51. Abstract, Met. Zeits., 1891, 8:351.

Concludes (1) The rate of evaporation increases at first rapidly with the wind velocity, but with higher velocities the increase is more gradual. (2) For any wind velocity evaporation is directly proportional to the vapor pressure. (3) Evaporation is proportional to the molecular weight × vapor pressure.

Further experiments show that a current of saturated air is capable of raising molecules from the surface of the water. A formula is derived for expressing the rate of evaporation: $v = A\,F\,(100 - 0.88 + V^{\frac{1}{2}})$ where A = a constant, F = the vapor pressure at the temperature of the liquid, and V = wind velocity. Observes that all evaporometers acting by imbibition must furnish too small results since the soaked surface is cooled by the evaporation. *This influence is barely perceptible at the free surface of a liquid, as convection tends to counteract it.*

Greeley, A. W.
Irrigation and water storage in the arid regions. (A report on the climatology of the arid regions of the United States with reference to irrigation.) 51st Cong., 2d Sess., House of Rep., Ex. Doc. No. 287. Washington. 1891.

A compilation of data on rainfall and evaporation in the various arid regions of the world, with particular reference to the extensive arid regions of the United States. Appendices contain curves of precipitation, evaporation, amount of sunshine, and normal temperature and weight of aqueous vapor, also tables and charts for Colorado, New Mexico, Arizona, Utah, Nevada, and California. "These curves are composite ones, made up from selected stations, and therefore fairly represent evaporation conditions over the States or sections to which they pertain."

Hann, J.
Beobachtungen über Verdunstung zu Strathfield Turgiss, 1870–1883. Met. Zeits., 1891, 8:118–9.

Describes methods of observing evaporation at Strathfield Turgiss and Camden Square, London, England, and compares the results with the evaporation measured by Tacchini in southern France and by de Lesseps at the Suez Canal.

[Royal Meteorological Society.]
Exhibition of rain and evaporation gages. Amer. met. jour., 1891, 7:561–2.

The evaporation gages shown at the Royal Meteorological Society's 12th Annual Exhibition of Instruments included several instruments employed for measuring the evaporation from a free surface of water, and others for use with growing plants.

Symons, G. J., John W. Tripe, and William Marriott.
Twelfth Annual Exhibition of Instruments by the Royal Meteorological Society, held March 3–19, 1891. Quart. jour. roy. met. soc., 1891, 17:180–92.

Describes most of the instruments exhibited, notably the evaporometers designed by Babington, Lamont, Wild, de la Rue, Piche, Richard, and a collection of instruments exhibited by Symons. An evaporometer designed for use with growing plants is also described (p. 187, ¶ 59.)

Symons, G. J.
On the evaporation from a water surface at Camden Square, London. Brit. rainf., 1891, (—):24–5.

Gives tables of the daily evaporation from the standard tank from July, 1891, to June, 1892; also tables of the monthly and annual totals and maxima for 1885 to 1892.

Ule, Willi.
Zur Beurtheilung der Evaporationskraft eines Klimas. Met. Zeits., 1891, 8:91–6.

Investigations with a Wild evaporometer lead to a formula employing the psychrometer differences and the wind velocity, viz: $v = A\,\Sigma(t - t')\,w$, where v = the rate of evaporation, A = a constant, t and t' = the psychrometer temperatures. The value of A varies considerably with the season.

1892.

Battelli, Angelo.
Comparison de l'évaporation d'une surface d'eau et d'une surface de terre humide. Abstract in L'atmosphère, Octobre, 1892, (—):145–148; Ciel et terre, 1892–3, 13:436.

From the experiments detailed in Batelli, 1890, he concludes: When the temperature of the air is rising, evaporation from saturated soil is in general, greater than from a surface of still water; when the temperature is decreasing, evaporation from the soil diminishes more rapidly than that from water. The evaporation from a free water surface increases more rapidly with the velocity of the wind than that from moist soil. The higher the relative humidity the greater is the proportion of water evaporated from saturated soil in comparison to that evaporated from still water. Evaporation from water in the sun is greater than that in the shade, not only during the day but also during the following night.

Brace, de W. B.
Mean relative evaporation at six different elevations. Nebraska exp. sta. bul., 1892, No. 20: 215–51. Abstract in Exp. sta. rec., 1892, 3:799.

Increase in evaporation is shown with increase in altitude. Continuation of his experiments of 1891.

Carpenter, L. G.
Irrigation engineering. Colorado exp. sta., ann. rpt., 1891:45–57. 1892. Abstract in Exp. sta. rec., 1892, 4:368–9.

A table shows comparative rates of evaporation from water in tanks placed in the ground at Fort Collins, Divide, and Rockyford, Colo., and from tanks floating in a canal and a lake

King, F. H.
Investigations relating to soil moisture. Wisconsin exp. sta., ann. rpt., 1891:100–34. Abstract in Exp. sta. rec., 1892, 4:122–9.

Experiments show that spring plowing checks the evaporation of soil water. The mean daily rate of evaporation from cultivated soil was 0.685 lbs., and from uncultivated soil 0.808 lbs. per sq. foot.

Houdaille, F.
Marche diurne de l'évaporation à Montpellier, 1891–2. Bul. mét. Hérault, 1892, (—):59–78. Review in Met. Zeits., 1893, 10:431–2.

The curve of a self-recording evaporometer running for 409 days, during the years 1891–2, shows three distinct periods, from midnight to sunrise, from sunrise to sunset, and from sunset to midnight. These periods correspond to equally distinct periods in the rate of evaporation from soil and from plants. The maxima and minima for these periods show interesting variations. The average ratio between daily and nocturnal evaporation is 3.82, varying from 6.90 in August to 1.63 in December. Gives a résumé of the experiments by Hépites, 1887. Diagrams compare evaporation with relative humidity, temperature, and wind velocity.

Houdaille, F.
Recherches expérimentales sur l'influence de la vitesse du vent, de la radiation solaire, et de l'état électrique de l'air dans le phénomène de l'évaporation. Ann. école nat. agr., Montpellier, 1892, 6:197–247.

An investigation of the influence of the velocity of the wind upon evaporation disclosed the following facts: (1) The increase in the rate of evaporation with air movement is very rapid for low velocities, but at 4 meters per second and higher it becomes almost proportional to the wind velocity. (2) The increase of the rate of evaporation is proportional to the increase in wind velocity independently of the difference $(F - f)$, the difference between the vapor tension at the surface of the liquid and that of the air. (3) The relation of the evaporation from a surface of 18 sq. cm. to the air current and to $(F - f)$ is given by the formula,

$$P = 1.475\,(F - f) + 0.725\,[(F - f)^2 + 10\,(F - f)]^{\frac{1}{2}}.\,[V^2 + 17\,V]^{\frac{1}{2}}.$$

(4) When, under the action of the wind, the evaporating surface cools considerably, the rate of evaporation should rather be compared to the factor $(F' - f)$, in which F' is the vapor pressure at the temperature t' of the wet-bulb. (5) The ratio between the rates of evaporation from different surfaces remains almost constant and independent of the wind velocity.

A study of the influence of solar radiation showed (1) that the increase of evaporation due to solar radiation is almost proportional to the intensity of the latter whatever may be the initial value of the evaporation, as measured in shade and in quiet air. (2) The coefficient of the utilization of solar heat in vaporization varies between very wide limits according to the temperature, humidity of the air, and the intensity of insolation. (3) A high electric tension causes a rather rapid increase in the rate of evaporation.

Houdaille, F.
Recherches expérimentales sur le phénomène de l'évaporation. L'atmosphère, August, 1892, (—):101–5.

Latham, Baldwin.
Presidential Address to the Royal Meteorological Society. Quart. jour. roy. met. soc., 1892, 18:53–67. Abstract in Symons's met. mag., 1892, 29:10–11.

Discusses the laws and conditions governing evaporation. Describes experiments showing the influence of capillary action in increasing the evaporating surface, and thus the amount of evaporation. A diagram compares evaporation, differences in vapor pressure, temperatures of air, water, and dew-point. Latham's evaporometer forms the frontispiece to Brit. rainf., 1897.

Müller, P. A.
Ueber die Frage der Verdunstung der Schneedecke. St. Petersburg. 1892. 47p. 4to. From Repert. f. Met., 14: No. 4. Abstract in Ciel et terre, 1893, 14:192; Met. Zeits., 1892, 9:(80).

In 27 per cent of the hourly observations condensation took place at the surface of the snow, while evaporation occurred in the remaining 73 per cent.

Paris, Observatoire de la Tour Saint Jacques.
Monthly meteorological tables for 1892. L'atmosphère, 1892.

These tables include daily observations of a Piche evaporometer and of a self-recording instrument.

Schubert, J.
Das Klima von Eberswalde nach 15-jährigen Beobachtungen, 1876–1890. Met. Zeits., 1892, 9:233–5.

The average monthly evaporation varies from 7.5 mm. in December to 62.4 mm. in June The annual average is 405.5 mm.

Symons, G. J.
Evaporation. Brit. rainf., 1902, (—):15–23.

Evaporation results are quoted from the Massachusetts State Board of Health Report on Water Supply and Sewage *for 1890. Compares the evaporation at Lawrence, Mass.,* with that at Philadelphia, Pa., at Otterbourne, Hants, at Strathfield Turgiss, and Camden Square, London, Eng.

1893.

Hann, J.
Houdaille's Untersuchungen über den täglichen Gang der Verdunstung zu Montpellier. Met. Zeits., 1893, 10:431–2.

Review of Houdaille, 1892, 1st title.

Hubbard, Gardiner G.
Relations of air and water to temperature and life. Nat. geog. mag., 1893, **5**:112-4.

Scattered facts concerning evaporation are cited.

Kerner, Fritz von.
Korrespondirende Berggipfel and Thalbeobachtungen der Temperatur, Feuchtigkeit und Verdunstung. Met. Zeits., 1898, **10**:269.

An increase in the amount of evaporation from 0.6 millimeter at 1,215 meters altitude, to 0.9 millimeters at 3,274 meters, is attributed to the decrease in the air pressure since there was no wind.

Piche, A.
Le déperditomètre. Paris. 1893. 4 p. 8vo. From Compt. rend. assoc. franç., Congrès de Pau, 1892.

Diagram and description of an instrument to indicate "sensible temperatures."

Symons, G. J.
Experiments on evaporation at Southampton Waterworks, and at Camden Square. Brit. rainf., 1893, (—):23-6.

Presents the usual records for the large tanks.

van Bebber, W. J.
Meteorologie. Leipsic. 1893.

A general survey on p. 133-5 of the existing knowledge regarding evaporation from water and soil surfaces, and from plants.

Waldo, Frank.
Modern Meteorology. London. 1893. 8vo. p. 149-53, 205-7, 438-40.

Discusses the best methods for investigating evaporation; describes the Piche and Wild evaporometers, and gives numerous statistics of evaporation from water, soils, plants, etc. Discusses the influences of light and temperature and summarizes Wollny's experiments in soil moisture and evaporation.

1894.

Abbe, Cleveland.
Humidity. Mo. weather rev., 1894, **22**:407, 453, 496.

Fitzgerald's (1886) formula for determining average vapor pressure is presented. The evaporometer is spoken of as an "integrating hygrometer."

Britzke, O.
Ueber den jährlichen Gang der Verdunstung in Russland. St. Petersburg. 1894. 54 p. 4to. Repert. f. Met., **17**, No. 10. Review Met. Zeits., 1895, **12**:(76)-(77).

Tables of temperatures, relative humidity, wind velocity, evaporation and the relation between the rainfall and evaporation. The observations have considerable value, according to Kassner, owing to the fact that they were made at so many different stations with similar apparatus, the Wild weighing evaporometer similarly exposed in a Wild thermometer shelter, and for long periods of time.

King, F. H.
Studies relating to ground water and soil moisture. Wisconsin exp. sta. rpt. for 1893, p. 167-200. 1894. Abstract in Exp. sta. rec., 1896, **7**:565-7.

It is stated that annual evaporation from manured soil exceeded that from unmanured by 108.5 tons per acre. In two experiments with tubes of sand, one wet with distilled water, the other with a solution of potassium nitrate, capillary ascent and evaporation from the surface was shown to be 22.84 per cent greater in the presence of the potassium nitrate.

Moore, John William.
Meteorology. London. 1894. p. 181-5.

Various methods of observing evaporation are described.

Ruvarac.
Ergebnisse der ombrometrischen Beobachtungen in Böhmen für 1893. Technisches Bureau des Landesculturrathes. Prag. 1894.

See Ruvarac, 1895, and Richter, 1895, for results.

Symons, G. J., and H. Sowerby Wallis.
Experiments on evaporation at Southampton Waterworks, (Otterbourne, Hants), and at Camden Square. Brit. rainf., 1894, (—): 21-4.

The two similar tanks show an annual rate of 19.5 inches at Otterbourne, and 14.5 inches at Camden Square, London.

Todd, Charles.
Meteorological work in Australia, a review. n. p. 1894. 25 p. 8vo. (Reprinted from Rpt. Australasian assoc. adv. sci., 1893.) Summary in Symons's met. mag., 1895, **30**:44-5; Met. Zeits., 1895, **12**:36-7.

Gives table of mean evaporation at Adelaide for 23 years, and at Alice Springs for 1890-2. The annual average at Adelaide is 55.53 inches; at Alice Springs, 98.55 inches in 1891, and 100.35 inches in 1892. The average rainfall at Adelaide for 54 years is 21.08 inches; at Alice Springs for 19 years, 11.25 inches. (See Todd, Chas., 1879.)

Tomlinson, S.
Rainfall and evaporation observations at the Bombay Waterworks. Quart. jour. roy. met. soc., 1894, **20**:63-70.

Gives temperature, relative humidity, rainfall, etc., at Coloba Observatory, the evaporation at the Bhandarwada Filters and elsewhere. Also the approximate average evaporation that may be expected monthly from a water surface in the neighborhood of Bombay, showing the highest rates in March, April, and May, and the lowest in July, August, and September. The annual total from a surface of 1 square foot is 85.5 inches, from a reservoir of 10,000 square feet, 76.0 inches, and from a lake of 300 to 3,000 acres, 62.3 inches.

Vermeule, C[ornelius] C[larkson].
Report on the water supply, water power, the flow of streams, and attendant phenomena. Final Rept., State Geologist of New Jersey, Vol. III. Trenton. 1894.

Formulas for evaporation are developed from the values of the annual rainfall and the mean annual temperature, but in most cases the computed values fail to agree with those obtained by observation. Abstracted by Rafter, 1903.

Wollny, E.
Forstlich-meteorologische Beobachtungen. Dritte Mitteilungen. Forsch. Geb. Agr. Phys., 1894, **17**:153-202. Abstract Exp. sta. rec., 1894, (—):—; Met. Zeit., 1896, **13**:76-7.

Describes experiments comparing the evaporation from pine trees, birch trees, grass and fallow land with the rainfall. The results of this and previous papers in 1887 and 1890, are summarized in Wollny, 1895. See also Abbe, 1895.

1895.

Abbe, Cleveland.
The meteorological work of the U. S. Signal Service, 1870 to 1891. Rpt. Internat. Meteorol. Cong., Chicago, August, 1893. U. S. Weather Bureau, Bul. 11, pt. II (Apr., 1895), p. 232-285.

Regular observations of evaporation were inaugurated by the Signal Service in 1885, and T. Russell's "investigation of the influence of the wind on the indications of Piche's apparatus and his estimates (Russell, 1888) of the general depth of evaporation throughout the United States, mark out the path that must be pursued by future investigators in this line."

Abbe, Cleveland.
Note by the Editor. Mo. weather rev., 1895, **23**:421-2. Notice in Exp. sta. rec., 1897, **8**:111. Reprinted, Nature, 1896, **54**:283.

Translation of summary of Wollny's (1895) investigations on evaporation.

Bebber, W. J. van.
Hygienische Meteorologie. Stuttgart. 1895.

General discussion on p. 150-2 of the process of evaporation, the factors influencing it, and the Piche evaporometer as a suitable instrument for measuring its amount.

Harrington, Mark W.
Sensible temperatures. Paper read before the American Climatological Association in Washington, 1894. Review in Amer. met. jour., 1895, **12**:93-4.

Points out that the sensible temperature is lowered by the absorption of heat due to evaporation.

Houdaille, F.
Météorologie agricole. Paris. 1895. p. 36-9, 103-4, 124-5.

This publication recounts the results of much of the author's previous work on evaporation, adding nothing new to the conclusions reached in preceding papers.

Krebs, Wilhelm.
Verdunstungsbeobachtungen mit dem Doppelthermometer. Met. Zeits., 1895, **12**:38-9.

The discussion started in this paper regarding the psychrometer as a measure of evaporation, is dealt with at greater length in 1904.

Pague, B. S.
Sensible temperatures, or the effect of heat on the body in California. San Francisco. 1895. Reprinted, Amer. met. jour., 1895, **12**:196-8.

Treats of the well-known fact that the body is cooled by the evaporation of perspiration from the skin.

Penck, Albrecht.
Evaporation in central Europe. Reviewed in Geog. jour., 1895, **5**:583.

Direct measurements of evaporation in Austria and Bavaria since 1821 and in Prussia since 1876 indicate an average yearly evaporation in north Germany of 15.7 inches, decreasing southward to about 11.8 inches. A marked increase is shown in the Hungarian plain, 25.6 inches at Budapest and still more in the southeastern districts. An almost uniform decrease of 60 per cent is observed in forest stations, compared with the open country, while a remarkable increase is noticed in towns. In Vienna the evaporation exceeded that in the immediate neighborhood by 5.9 inches. Classifies the monthly curves of evaporation according to districts. The total aqueous vapor passing into the air over a large area is estimated from the total rainfall and the total calculated discharge by rivers, the difference being taken as the amount of evaporation. From these results he concludes that evaporation is influenced to some extent by the rainfall itself.

Russell, Thomas.
Meteorology, weather, and methods of forecasting. Descriptions of meteorological instruments and river flood predictions in the United States. New York. 1895. 8vo.

On p. 47 describes the Piche atmometer and an experiment showing the effect of various wind velocities on evaporation. On p. 70-1 compares the depth of water evaporated at various stations.

Symons, G. J., and H. Sowerby Wallis.
Percolation experiments at Apsley Mills, Hemel Hempstead. Brit. rainf., 1895, (—):26-35.

The results of percolation experiments at Apsley Mills, conducted by Sir John Evans, are tabulated, according to seasons, for the 12 years, 1883-94, as follows:

Rainfall, percolation, and evaporation at Apsley Mills, 1883-94.

	Rain.	Sand, 3 feet.		Sand, 5 feet 2 inches.	
		Percolation.	Evaporation.	Percolation.	Evaporation.
Summer	12.55	3.91	8.64	3.94	8.61
Winter	13.51	12.55	0.96	12.57	0.94
Year	26.06	16.46	9.60	16.51	9.55
		Chalk, 3 feet 3 inches.		Chalk, 5 feet 2 inches.	
Summer		1.83	10.72	1.97	10.58
Winter		10.42	3.09	15.25	3.26
Year		12.75	13.81	12.22	13.84

Rainfall, percolation, and evaporation at Apsley Mills, 1883–94—Cont'd.

	Ordinary soil, 3 feet 3 inches.		Ordinary soil, 5 feet 2 inches.	
	Percolation.	Evaporation.	Percolation.	Evaporation.
Summer	1.54	10.01	1.59	10.96
Winter	11.21	3.30	10.97	2.54
Year	12.75	13.31	12.56	13.50

Symons, G. J., and H. Sowerby Wallis.
Experiments at Southampton Waterworks and at Camden Square. Brit. rainf., 1895, (—):36–9.

Evaporation observations at Camden Square from 1885 to 1895 and at Otterbourne from 1892 to 1895 show an annual average for the former place of 14.66 inches, and 20.46 inches for the latter.

Wallis, H. Sowerby.
See Symons and Wallis.

Wollny, E.
Untersuchungen über die Verdunstung. Forsch. Geb. Agr. Phys., 1895, **18**:486–516. Review in Met. Zeits., 1896, **13**:362–4; by Abbe, 1895; Ciel et terre, 1896, **17**:570–1; Centbl. Agr. Chem. (Biedermann), 1897, **26**:74–7.

"Lysimeters" (zinc boxes 400 square centimeters in cross section and 30 centimeters deep), standing in the open with a 15-centimeter layer of soil in them, and weighed every five to nine days, furnished the following results: (1) Soil evaporates less than a free water surface. (2) Sand evaporates least, loam most, while bare turf and humus or vegetable mold are intermediate. (3) Evaporation from soil is increased by a cover of vegetation. (4) Evaporation depends on meteorological conditions and on the quantity of moisture in the soil. (5 and 6) Temperature is the most important factor affecting evaporation, modified by other factors, mainly by the amount of water supplied by the substratum. (7) For evaporation from a free water surface, from saturated soil and from ordinary moist soil whether covered with living plants or not, the important elements to be considered are temperature, relative humidity, cloudiness, direction and velocity of the wind, and the amount of rain. (8) Sometimes a soil covered with plants evaporates more than a free water surface. (9) The amount of water evaporated from a soil covered with plants and not irrigated can not be greater than the quantity received by the soil before or during the period of growth. But swamp lands, lands well irrigated, and free water surfaces evaporate, under favorable conditions, a greater quantity of water than corresponds to the precipitation during the same time. (10) the evaporating power of a soil depends on its physical properties. With less permeability, larger capacity for water and greater capillary power, evaporation is more active. (11) Soil with plants evaporates more as the plants are better developed, stand closer together, or have longer period of growth, and vice versa.

1896.

Boggs, Edward M.
Arizona weather. Arizona exp. sta. bul., 1896, No. 20.

Evaporation at Tucson, Ariz., was observed by means of a galvanized-iron tank, 6 by 4 by 4 feet, sunk in the ground. The water always stood within *a few inches* of the top, and its level was read by means of a Boyden hook gage reading directly to 0.001 foot, placed in a still well about 10 inches from the tank and connected therewith by a pipe of small diameter. The tank was in a fenced inclosure, fully exposed to the wind. The observations from December, 1891, to June, 1895, showed an annual evaporation of 77.7 inches, somewhat less than is commonly attributed to this region. The evaporation from a second tank containing growing waterlilies was only 1 per cent less than from the first.

Bühler, A.
Untersuchungen über die Verdunstung des Wassers aus dem Boden. Mitt. Schweiz. Centralanst. forstl. Versuchsw., 1895(?), **4**:315. Reviewed in Met. Zeits., 1896, **13**:(22); Mo. weather rev., 1896, **24**:374; Ciel et terre, 1896, **17**:21–2.

Experiments were made at Adlisburg from June 27 to September 1, 1894, with evaporation from loamy clay in five metal boxes, 20 centimeters square and 10 centimeters high, one placed level and four on an incline of 30° and facing the four cardinal points of the compass. The following rates were obtained: Horizontal, 100; north exposure, 91; east exposure 87.5; south exposure, 100.5; west exposure, 100.5. The ratios for differently shaded plots were: for unprotected soil, 100; one-fourth covered, 88; one-half covered, 71; three-fourths covered, 62. Evaporation was found to be the most rapid from noon to 3 p. m.

Crosby, D. J.
Temperatures and evaporation in different soils. Michigan exp. sta. bul., No. 125, p. 30–2. Quoted in Exp. sta. rec., 1896, **7**:373–5.

In experiments on evaporation from sand, clay, loam, and muck, it was found that the sand lost water most rapidly; loam, clay, and muck following in the order named. The surface temperature, however, was highest in muck and lowest in sand, but at depths of 3 and 6 inches the sand was the warmer. When the light-colored sand was covered with lamp black and the dark-colored muck with white lime, this order of temperatures was reversed, showing that the color of the surface largely controlled the temperatures below.

Milne, John.
Movements of the earth's crust. Geog. jour., 1896, **7**:229–55.

On p. 242–3 the author discusses the influence of evaporation on the movements of the earth's crust. Applying the figures obtained by Miller, 1878, he shows that "the greatest displacement of a horizontal pendulum ought to be expected when such an instrument was placed on the boundaries of two areas respectively covered with soil and grass. On a fine day the differential evaporation effect on the two sides of the instrument would be equivalent to moving a load of about 2.5 tons per 29 yards square from the ground covered with grass, which is quite sufficient to produce many of the observed effects."

Müller, P. A.
Ueber die Temperatur und Verdunstung der Schneeoberfläche und der Feuchtigkeit in ihre Nähe. Mem. acad. imp. sci., St. Pétersbourg, Phys. Math. Cl., 1896, **5** (8), No. 1. Also St. Petersburg. 1896. 38 p. 4to. Review in Met. Zeits., 1897, **14**: (12).

Discusses observations on the surface temperature of snow, the temperature and relative humidity of the air in its neighborhood, and its evaporation. The author emphasizes the *point that condensation occurs when the difference between the dew-point of the air and* the temperature of the surface of the snow is positive, evaporation occuring when this difference is negative.

Penck, A[lbrecht].
Untersuchungen über Verdunstung und Abfluss von grösseren Landflächen. Geog. Abh., 1896, **5**:461–508. Review in Met. Zeits., 1897, **14**: (55). Abstract in Geog. jour., 1897, **9**:563–4.

Studies of the monthly variations in the relation between the rainfall, drainage, and evaporation of the river Elbe in Bohemia. The average rainfall for 1888–1890 was 696 millimeters, runoff, 214 millimeters, and evaporation, 482 millimeters, the evaporation factor being 69.2 per cent of the total loss. The average evaporation factor for 1893–4 was 76 per cent. Richter's (1895) similar factor for the latter period is quoted. Evaporation is further arranged according to temperature, rainfall, seasons, etc., and formulas for determining the same are devised.

Phillips, W. F. R.
Sunstroke in California and Arizona. Mo. weather rev., 1896, **24**:454–6.

Quotes Fitzgerald's (1886) formula for calculating evaporation, in connection with an investigation of the evaporation from the human body to prove that, in accordance with statistics, sunstrokes occur as often in localities where the relative humidity is low as where it is high.

Schierbeck, N. P.
Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlingar, 1896, No. 1. Copenhagen.

A mathematical treatment of the subject of evaporation. (See Schwalbe, 1902, for his formula.)

Symons, G. J., and H. Sowerby Wallis.
Evaporation. Brit. rainf., 1896, (—):27–31.

Tables give daily evaporation at Camden Square, Middlesex, Isfield Place, Sussex, Otterbourne, Hampshire, and Kennick Reservoir, Devon, from July, 1896, to June, 1897.

Trabert, Wilhelm.
Neue Beobachtungen über die Verdampfungsgeschwindigkeit. Met. Zeits., 1896, **13**:261–3.

The formulas of Dalton, Stefan, and Schierbeck are presented. The author's own formula, a modification Schierbeck's (1896), is $V=k(1+at)w^{\frac{1}{2}}(e_0-e)$. Where V=the rate of evaporation, k=a constant, a=1/273, w=the wind velocity, t=the air temperature, e_0=the maximum vapor pressure at the temperature of the water, and e that at the temperature of the air. But $(e_0-e)=(e_0-e_0')(e_0'-e)$, where e_0' is the maximum vapor pressure at the temperature of the wet-bulb. The readings of the wet- and dry-bulb thermometers are believed to offer a better and more practical method of determining evaporation than the direct observation of the loss in weight due to evaporation.

Twigg, R. H.
Evaporation at Kimberley, South Africa. Quart. jour. roy. met. soc., 1896, **22**:166. Review in Met. Zeits., 1896, **13**:279.

The evaporation gage of the Kimberley Waterworks Co. is a wrought-iron tank 4 by 4 by 4 feet, sunk in the ground to within an inch of the top and kept nearly full of water. Daily readings were made with a hook-gage designed by the author which allows readings to 1/1000 inch. A table shows the monthly evaporation from January, 1891, to January, 1895.

1897.

Abbe, Cleveland.
Evaporation at Fort Collins, Colo. Mo. weather rev., 1897, **25**:211.

Summarizes Carpenter's (1889) experiments with evaporation, and quotes his formula.

Alston, Garwood.
Comparison of evaporation results in New South Wales and South Africa. Trans. So. African phil. soc., 1897, **9**:8–19.

A comparison of the results obtained in New South Wales by Russell (1888–1904), and those obtained by the author from a reservoir at Van Wyks Vley shows 41 inches at Lake George, N. S. W., and 66 inches at Van Wyks Vley. At other Australian stations the evaporation varies from 28 to 60.5 inches.

Barnes, Nathan H.
Arizona weather climate. Arizona exp. sta. bul., 1897, No. 27.

This is, with a few changes and additions, the paper by Boggs, 1896.

Bruyn, H. E., de.
Mededeeling over de betrekking tusschen regenvall, verdamping en waterafooer. The Hague. 1897. 14 p. 4to. Review in Met. Zeits., 1897, **14**:(66).

Canestrini, Eugenio.
Sull' evaporazione del' acqua da superficie acquea, terrosa, ed erbosa. Atti soc. veneto-trentina sci. nat., 1897, **3**(2d. ser.):295–305.

In connection with experiments with evaporation from soils with and without vegetation, references are made to Schübler, 1831, Masure, 1860, Haberlandt, 1877, Risler, 1869–70–71, Hellriegel, 1883, and Wollny, 1895. From the author's own experiments he concludes *in general that: (1) a soil constantly saturated evaporates more water in a year than a free* water surface; (2) a soil with growing grain evaporates much more than a bare soil.

Davis, Arthur Powell.
Irrigation near Phoenix, Ariz. Water sup. and irr. papers, 1897, No. 2.

On p. 83–5 discusses methods for reducing evaporation from reservoirs in Arizona, and proposes to cover the surface of the water with a film of crude petroleum.

[*To be continued.*]