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CLASSIFICATION OF THE HYDROMETEORS. II.

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[Continued from this REVIEW, July, 1916, 44:385-392.]

Rain without clouds (Regen ohne Wolken).

The writer has never seen this rare phenomenon. It is certified to by a few earlier observations but, strange to say, there are no detailed accounts of it in more recent times.

I find the phenomenon first mentioned by Richard in his "Histoire naturelle de l'air" (Paris, 1770, v. 5, p. 439); then Le Gentil in his "Voyage dans les mers de l'Inde" (Paris, 1781, v. 2, p. 635) states that a fine rain often falls, particularly at evening (!), on the island of Mauritius during the season of the Southeast Trades. This question could readily be settled since there has been a meteorological observatory on Mauritius for a number of decades. Kämtz (Vorlesungen über Meteorologie, p. 164) states that the phenomenon is not so rare, for he has observed it at least as often as once a year. Ch. Martins, translating Kämtz' lectures, added observations by three physicists, and Flammarion (L'Atmosphère, Paris, 1888, p. 637) cites four additional observations. Loomis (Meteorology, New York, 1882, p. 121) cites an old case from America (1800) and finally Hann (Lehrbuch der Meteorologie, 3d ed., Leipzig, 1915, p. 303) states that on one occasion he observed a fine rain (Sprühregen) in the Alps during a fresh north wind and from a clear sky (heiterem Himmel). No single case seems to have been investigated more closely.

To explain this phenomenon it is necessary to assume that under special circumstances, which are not yet understood and perhaps include a condition of supersaturation, raindrops can develop without the formation of true clouds. Such a fall of rain could be of but brief duration and in small amount, which is in agreement with most of the reports at hand.

I doubt the reliability, however, of some of the older observations which report these rainfalls as occurring just at evening (see below), and believe with Loomis that many so-called cases are falls from clouds that had passed out of sight, i. e. clouds that had meanwhile moved so close to the horizon that they were no longer seen. The drops must have had a very oblique descending path by reason of a strong upper wind. (6)

Some modern works (Hann's "Lehrbuch"; Marriott's "Hints," etc.) state that in France there is even a special term describing the rain falling from a clear sky, viz, "serein." According to what has been stated above (p. 387), however, this word means the evening dew or evening moisture. Therefore, a false significance has crept in here.

In the first place, there seems but slight probability that so rare a phenomenon should have a special name. In the older French technical literature the word "serein" is always found in conjunction with "rosée" ("du serein et de la rosée"), and the old view was that the evening humidity was unhealthy for man; because "les vapeurs qui tombent lorsque le soleil s'abaisse à l'horizon * * * sont mêlée avec les exhalaisons qui sortent des plantes, de la terre * * *. L'air chargé de ces corpuscules se nomme serein, parceque c'est le soir * * * que les vapeurs chargées de ces exhalaisons se répandent dans la région inférieure de l'atmosphère." In these words my authority (Richard, op. cit., v. 5, p. 235) also indicates the etymology of the word "serein," it is derived from the Latin "serus" (late) as is also the Italian word "sera" (evening).[32] At that time, and for long afterward, it was the prevailing opinion that dew fell from (clear) sky, and the same must also have held for the evening moisture (Abendtau). Thus it is probable that someone—whom I can not identify—toward the end of the eighteenth century converted the evening moisture into an evening rain falling from a clear sky. In Garnier's "Traité de météorologie" (Paris, about 1837), page 236, the section on hydrometeors begins with the chapter "Du serein" and is followed by the chapter "De la rosée." But "serein" then no longer meant the evening moisture (Abendtau) but rather "une petite pluie qui tombe quelquefois sans que l'on aperçoive aucun nuage * * *" a light rain that sometimes falls when one cannot perceive any cloud), while the rest of the explanation is appropriate to dew! The same author also endeavors to explain rain from a clear sky, but with no more success than is attained by the two physicists Becquerel (father and son) who devote a whole section to the subject in their "Éléments de physique terrestre et de météorologie" (Paris, 1847, p. 375).

Today the concept "serein" as a hydrometeor has wholly disappeared from French meteorological literature.

Snow without clouds (Schnee ohne Wolken).

A phenomenon much more frequent and much better known than rain from a clear sky is the formation and slow fall of snow in the lowest layers of the air under a cloudless sky. This phenomenon occurs only during severe cold and in calm air. The snow crystals and ice particles, sparkling in the sunlight, are particularly small and sparsely distributed, so that they do not darken the air. There are large numbers of ice needles among the forms, and therefore the phenomenon has been called simply *ice needles* (Eisnadeln) and even has been given an independent symbol; but there also occur beautifully formed stellar and tabular snow crystals, together with structureless ice granules.

The phenomenon is most frequent in the polar regions, where it early attracted the attention of explorers and more particularly because it is often associated with halo phenomena. It has received the name "diamond dust" (Diamantstaub), a name known to the whaling master Martens (1671) mentioned on page 388 and footnote 20. In Germany many a winter passes without developing the phenomenon, but Bodman observed it 28 times within 18 months on the Swedish Antarctic Expedition, and Heim saw it even 26 times in 9 months while on the second German Antarctic Expedition. It appears from the photomicrographs of the "diamond dust," made on the latter expedition and also by Dobrowolski, of the Belgian Antarctic Expedition, that besides needles and tablets prisms are abundantly present, but the latter only at very low temperatures.

(2) DIRECT CONDENSATION OF WATER VAPOR IN THE FREE AIR.

[The clouds, forming a chapter by themselves, are not considered.]

(3) INDIRECT CONDENSATION OF WATER VAPOR IN THE FREE AIR.

Rain (Regen).

Rain is the name given to water falling to the earth from the clouds in drops that are not undercooled. Rain is the most widespread, most frequent, and most copious form in which the aqueous vapor of the atmosphere condenses. The area of its distribution embraces the whole surface of the earth, with the exception of the interior of Antarctica and probably of northern Greenland.[33] As to its frequency, there are arid regions within which the average annual number of rain days is less than 1, while this number probably rises to 280 in some tropical districts.[34] The copiousness of rainfall is best indicated by the fact that in a downpour (Platzregen) a quantity of rain amounting to depths of 10 to 12 millimeters may fall within 1 minute, a rate of precipitation not equaled by any other hydrometeor.

[32] See *Diez:* Etymologisches Wörterbuch d. romanischen Sprachen. 5th ed. p. 292, Article "Sera."

[33] The English and the Norwegian expeditions found no rain even at the edge of Antarctica (lat. 77° to 78° S.). As the land rises inland to an altitude of about 2,800 meters about the South Pole, it may safely be assumed that only snow and no rain falls in the heart of Antarctica.

At the North Pole, which lies in the midst of the sea, it probably rains at times; while on the high plateau of northern Greenland probably snow alone falls.

[34] With the exception of the polar regions already mentioned, there are probably no regions where it never rains. Reports to this effect by travelers in deserts, as well as the statements by the natives, must be accepted with caution. For example, Upper Egypt above Assuan was formerly held to be rainless; but since meteorological stations with regular observations have been established there several rainfalls (usually insignificant, to be sure) are recorded there every year.

Rain receives special names according to its areal extent, its duration, and its intensity (Stärke).

Extent.—In this respect general rains (Landregen) and local rains (Strichregen) are opposites.

Duration.—A rainfall of brief duration is called a shower (Regenschauer, Regenhusche); a long-continued rain is a prolonged rain (Dauerregen).

Intensity.—With reference to intensity there are distinguished the extremes of cloudburst (Wolkenbruch), downpour (Platzregen, Gussregen, Schlagregen), and the drizzle (Sprühregen, Staubregen) [or misting rain or mist]. Many nations have a special name with a corresponding verb for this latter kind. Thus in German "Nieseln," verb "es nieselt;" in English "drizzle," verb "it drizzles" [and "mist," "it is misting"]; in French "bruine," verb "il bruine." There is need of such a word, for there are districts—particularly along the coast—where this kind of gentle rain is so frequent during the colder half year that it practically determines the character of the precipitation. Naturally there are transitional stages to a wetting fog (nässende Nebel). The resulting quantity of water, a layer of less than 0.1 mm. depth, is not measurable with the ordinary raingage.

Snow (Schnee).

Snow is the name given to those ice crystals (belonging to the hexagonal crystal system) that originate directly by sublimation from the water vapor of the free atmosphere.

The great variety of forms which snow crystals may assume permit of classifying them in a system based upon the degree of development of the principal plane of symmetry with reference to that of the principal axis perpendicular thereto. The system proposed by the writer in 1893, in the article "Schneekristalle," which subdivides the tabular and the columnar forms each into three subgroups, has found acceptance among my colleagues and has not been modified by the subsequent additions of photomicrographs by Bentley (very numerous, but some unfortunately much retouched),[35] Dobrowolski, Sigson, Szlavik, and Westman.

The forms of the snow crystals are rarely noticed during such a snowfall as one observes at the earth's surface. It is only when it is just beginning to snow in calm air and when the crystals fall on dark objects, that one distinctly recognizes their shapes, sometimes without the aid of a magnifying glass. This stage is the most favorable one for photomicrographic work, but it does not last long. The crystals become more numerous and often reach the earth's surface in a damaged state, since they have collided with one another on their downward passage. As the fall of snow becomes denser a number of crystals combine into a conglomerate of crystal fragments forming what is called a "snowflake" when it reaches the ground. This latter is by far the most frequent form in our snow falls, while in the polar regions the individual crystals have somewhat more importance.[36] In the snowflake the horizontal axis, which may attain 10 cm. or more, is longer than the vertical axis and the margins of the flake are turned upward slightly by reason of the resistance to its fall which the air offers.

The character of the snowfall also depends on its water content, which usually increases rapidly with the temperature. The large-flaked "wet" snow that falls at positive temperatures [temperatures above freezing] and usually melts rapidly, is in contrast to the "dry," "powdery" snow, that does not pack ("backt" nicht), but creaks (knirscht) under the foot and the wagon wheel, indicating that the uniting of the snow particles is difficult by reason of deficient regelation. (7) It is therefore, also, not suitable for snowballing and the modeling of snow men. When there is "watery" snow, nature herself sometimes causes such "packing," looping snow garlands (Schneegirlanden) from branch to branch.

It happens, not rarely, that rain and snow fall simultaneously; in some parts of Germany this is called "Schlackenwetter." In England this phenomenon is called "sleet," a name, however, that is used in the United States of North America [and Canada] for graupel or soft hail, according to Loomis ("Meteorology," New York, 1883, p. 129). Compare what is said below under "Sleet; ice particles (Eiskörner)."

The delicate light snow crystals, the individuals weighing but a few tenths of a milligram, fall very slowly to the earth by reason of the great resistance offered by the air, and they are very subject to the influence of the wind as they fall. There are, therefore, some terms expressing this relation to the wind: Driving snow (Schneegestöber), Schneesturm, Schneetreiben, Schneetrift, Schneewehe. In fact, we have introduced an international symbol, ⊰, for Schneegestöber or a falling snow in connection with a wind storm, a symbol that is easily misapplied, for during a high or stormy wind it is often difficult to decide whether fresh snow is falling or old snow is being whirled into the air. Westman, in his observations in Spitsbergen (1899–1900), devised four new symbols for these and similar studies. [The German usage is not uniform; different writers use Schneetreiben and Schneegestöber with just opposite meanings.—*Transl.*]

Graupel; snow pellets; soft hail; winter hail; (Graupeln).[37]

We have at present no reliable genetic definition of the concept graupel (grésil, soft hail), and the same is true of hail (Hagel). These two products are so divergent in external appearances, however, that an attentive observer can scarcely confuse them.

Graupel consists of opaque, usually roundish grains of the size of grits up to that of peas, or from about 2 to 5mm. in diameter, which have the appearance of small snow pellets and are readily *pulverized.*[38] The pellet often has a conical form with a convex base (i. e., is a sector of a sphere). The grains are also often covered with a very thin film of ice, which, in my opinion, indicates a transition stage to hail (Hagel).

Alfred Wegener (Thermodynamik der Atmosphäre, p. 288) distinguishes between Reifgraupel and Frostgraupel, basing this distinction on O. Lehmann's investigations in crystallization. The first form is that of fully developed spherocrystals, i. e., spherical shapes developed by the branching of a single crystal. "The compact forms of the Frostgraupel," on the other hand, were the result of "contact with undercooled water drops, which cemented the delicate texture of the Reifgraupel as they froze." Wegener properly adds that this subject is not yet finally disposed of. Certainly we have far too few exact observations on the structure of graupel grains, while the striking and often remarkable forms of hailstones have received a great deal more consideration.

Graupel usually falls during showers in disturbed, squally weather. Rarely is it alone, usually snow accompanies it, yet more frequently it is followed by snow, sleet (Eiskörner), and other forms. The fact that graupel seems to prefer the daytime for its occurrence is a sign

[35] This remark probably does not apply to Bentley's photographs as published in the MONTHLY WEATHER REVIEW May 1901; Annual Summary, 1902; Annual Summary, 1907. So far as the Weather Bureau knows, there was no retouching and certainly there was none done on the prints from which our engravings were made.—C. A., jr.

[36] The forms of the snow crystals falling at St. Petersburg were closely studied during two winters, but successfully only on 56 per cent of the days with snow.

(*Shukevich.* The forms of snow crystals and of other solid hydrometeors that fall in St. Petersburg. Bull. Ac. sci., St. Pétersbourg, 1910, 6.sér., No. 4. [Russian.])

[37] In meteorological works the German word is written both "Graupeln" and "Graupel." In both cases it is a plural noun. The German dictionaries state that it is derived from "Graupen" and is first met with in the 15th century in the combination "isgrûpe."—*Author.* [Graupen=barley grits in everyday life.—*Translator.*]

Graupel has, I think, been uniformly used as a singular (collective) noun in English, though there is perhaps no German authority for such use. It fits into our vocabulary much better as a singular than as a plural.—*C. F. Talman.*

[38] The writer would emphasize the quality of ready pulverization, because the Dictionnaire de l'Académie Française gives the wrong definition of "grésil" [the French word for graupel], viz, "petite grêle fort menue et *fort dure*" (very fine and *very hard* small hail).

that convective currents play a part in its formation. It is of frequent occurrence at the higher mountain levels (summer time) where it practically determines the character of the precipitation, in the polar regions (winter, spring), and over the lowlands of our latitudes within the districts traversed by LOWS. This explains why the number of days with graupel in northwestern Germany (10 to 20 days per annum) is much larger than it is for southern Germany where the monthly maximum is attained in March or April. On the summit of the Schneekoppe in the Riesengebirge there are, on the other hand, 35 days per annum having graupel falls.

Hail (Hagel).

The International Meteorological Congress, meeting at Vienna in 1873, came to the following agreement:

Working definition of hail.[38a]

Hail may be defined as a precipitation of frozen water, in which the stones attain such a magnitude that they may be expected to do damage to agricultural products.

This remarkable decision, which does not contain any real definition of hail and emphasizes the very elastic concept of damage, of course rendered very little aid in accomplishing the ultimate object of the decision of the congress, viz, to secure comparable numbers for the frequency of the phenomenon; for damage by hail depends altogether on the character of the vegetation and the developmental stage in which it stands. Small hailstones falling during the cold season or in the early Spring should not be recorded, according to that decision.

Fortunately this definition has been but little regarded in the meteorological instructions issued by the different observational réseaux, and a definition corresponding to the external appearance of hail has been given; for example, the one given in the Prussian Instructions:

Hail consists of pieces of dully transparent ice of various shapes, ranging from the size of a pea to that of a hen's egg or often even greater; and usually inclosing an opaque white nucleus (a grain of graupel). There is often an alternation of concentric hard transparent layers with soft opaque layers. (Edition of 1904, p. 36.)

The surface of the hailstone may bear irregularly formed or perfect crystalline growths.

In central and southern Germany large hailstones are called "Schlossen;" in some localities small stones are called "Riesel." The formerly common name of "Kieselstein (Hagelstein)" and the verb "kieseln (hageln)" have vanished from meteorological literature of to-day.[39]

Hail is of almost universal occurrence and, thanks to the impressive manner of its fall and to the damage it causes, it is one of the best-known hydrometeors. In contradiction to the statement of some textbooks, I would point out that hail is not wanting even in the polar regions. On Sverdrup's arctic expedition (lat. 76° to 79° N.) hail was twice observed; on the Swedish antarctic expedition (lat. 64° to 65° S.) it was observed the same number of times, and graupel was also observed on 15 days; the two French expeditions to Graham Land (lat. 65° S.) record, respectively, 2 and 5 days with hail in addition to 7 and 26 days with graupel.

[38a] *Great Britain. Meteorological Committee.* Codex of resolutions adopted at International meteorological meetings, 1872-1907. * * * English edition, London, 1909. 8°. (M. O. No. 200.) p. 24.

[39] The popular German word "der Kiesel," meaning a pebble of flint or quartz, seems to contain the root of the meteorological term "Kieselstein" given above; perhaps there is some connection between "Kiesel" and "Kieselstein" or hail.—C. A., Jr.

Sleet (Eiskörner).[40]

Sleet (Eiskörner) consists of glass-hard, transparent spherules of ice that fall during the cold half of the year. The spherules strike the ground hard like bird shot, rebound elastically, and when they strike the dry Fall foliage make a rather loud noise [rattling] that at once attracts the attention. Often the ice pellets are not round but rather angular or pointed.

Sleet (Eiskörner) consists of raindrops which have formed as such in an upper warm, moist air layer and have solidified into icy spherules in a lower colder layer. In a case discussed by me elsewhere [41] I have shown that it is probable that the falling ice splinters came from rapidly, and therefore but partially, melted snow crystals and that the resulting drops froze in the cold lower layer. Shukevich (see footnote 36) was also able to demonstrate by means of the kite observations at Pavlovsk, the presence of upper warm layers during some sleet falls at St. Petersburg (Petrograd).

Sleet (United States definition) has received but little notice heretofore; it is not mentioned in most textbooks and observers usually confuse it with graupel.[42] The two hydrometeors are very similar in size and in shape, but as graupel grains are opaque while sleet grains are hard and transparent the two may be readily distinguished. Sleet probably falls more frequently than is supposed; in Germany it occurs as often as hail, or oftener. At Potsdam Meteorological Observatory during the 21 years, 1893–1913, sleet falls were observed on 22 occasions. The falls were distributed among the months as follows:

	1893–1913. *Sleet falls.*
January	6
February	3
April	1
May	1
November	5
December	6

so that 91 per cent of all occurrences came during the four months November to February. Thus it appears that there the annual period differs from that of graupel. An earlier observer, Dr. Fricke at Dirschau near Danzig, found that sleet there fell 6 to 8 times during the year. Shukevich reports (see footnote 36) that it was observed at St. Petersburg 11 times between February, 1907, and May, 1909.

Sleet (Eiskörner) falls in brief showers, often several times a day and rarely alone, for it is usually accompanied by or succeeded by snow or rain or graupel. It therefore shares these peculiarities with graupel. The observations at Potsdam and at St. Petersburg further show that the cold air layer wherein the raindrops freeze is not always the lowermost one resting on the ground. In about one-third of all cases the temperature at the ground is above freezing. In conclusion, it may be remarked that the occurrence of sleet falls usually indicates a change in the weather.

[40] The translator employs here and elsewhere the Weather Bureau terminology recently published in this REVIEW, May, 1916, 44:285-286.

[41] Sitzungsbericht d. Berliner Akad. d. Wissensch., 1912, p. 1048.

[42] The new American textbook by W. I. Milham ("Meteorology," New York, 1912. 8°) describes Eiskörner correctly on p. 241, but they are called "winter hail." Elsewhere in the same work (p. 242), on the other hand, it is stated that according to the instructions of the United States Weather Bureau ice grains (eiskörner) are to be called "sleet."—*Author.*

Before this memoir was received the Weather Bureau had taken steps to sharpen its own usage, and the results of the study then undertaken have been prestened, as remarked above, in the issue of the REVIEW for May, 1916, 44:281-286.—*Translator.*

Glaze (U. S.), glazed frost (Engl.), (Glatteis).

Glaze (glazed frost, Glatteis) is the name given to the smooth coat of ice that forms on the ground and sometimes also on trees and other objects. It may form in three different ways: (1) When the rain consists of undercooled water drops which freeze as soon as they touch the ground; (2) when a sudden change in the weather after a long period of severe cold causes ordinary rain to fall upon the still frozen ground where it turns to ice; (3) when under similar conditions a wet fog (nässender Nebel) or fog rain (Nebelregen) deposits its droplets. (8)

A heavy deposit of the glaze or ice coating is produced only by the first of the three processes, and particularly on those occasions when the temperature of the ground and of projecting objects is below 0°C. It must be expressly pointed out, however, that this latter is not a necessary condition for the formation of glaze by undercooled rain. The fundamental principles of the theory of formation of glaze were probably first recognized by Nouel,[43] who assumed this condition. Since his day this condition is repeatedly stated (e. g. Hann: Lehrbuch der Meteorologie, 3d ed., p. 255; Angot: Traité de météorologie, p. 255, etc.). The records of the Potsdam observatory from 1893 to 1913 show, however, that in 28 per cent of the cases where glaze was observed to form the temperature of the ground was above 0° C.

On the other hand, ways (2) and (3) of forming glaze (Glatteis) require a previously frozen ground and in both cases the incrustation of ice attains but slight thickness and does not last long. The rain soon thaws out the soil and the fog yields but a small amount of water. A further difference between the first and the second manner of formation of glaze is that under (1) trees, bushes, transmission wires, etc., become incrusted, while under (2) the crust forms on the ground almost exclusively.[44]

Since latent heat of melting is released when undercooled raindrops solidify the water can freeze completely only when the undercooling is considerable. Direct observations show that the latter is not of rare occurrence. Recently, however, an indirect proof of the same is found in the fact that when winter kite flights bring the kites and wire into a cloud, both kites and wire are often heavily coated with this glaze when they are landed.

Pernter was inclined to recognize only the first kind of ice coating, strange to say, and doubted the occurrence of the other two kinds. Observations in northern Germany leave no doubt of the fact, however, that ordinary rain can also produce an ice coating (Glatteis) or glaze on a frozen soil. According to W. M. Davis ("Elementary Meteorology," Boston, 1894, p. 294), in North America, where Glatteis, or glaze, is also called "ice storm,"[45] the ice coating forms chiefly in the latter manner; but this is doubtful because the heavy destructive coating can only result from undercooled rain, as is shown by some descriptions of American ice storms (Eisstürme).[46] (8)

It is desirable that in future more attention be paid to the origin of the ice coating, or glaze, and that a note thereon be entered in the observer's journal. If the temperature is higher than 0°C., then there can be no doubt as to the source of the coating. It is only when the ground is colder than 0° C. that the second manner of formation has to be considered. Then, if the falling raindrops freeze when they touch the ground, but remain liquid on the clothing or umbrella of the observer just after he comes outdoors, one undoubtedly has to do with glaze formed in the second way.

We know very little about the distribution of ice storms and their ice coating or glaze, because the published monthly and annual summaries of meteorological stations do not include this or many another hydrometeor (dew, frost, rime, or sleet); even the great observatories do not give a summary of such observations.[47] The scheme of publication agreed on at the Meteorological Congress at Vienna in 1873, while it performed a great service in furthering the comparability of the observational results from different countries, undeniably brought in its train the disadvantage that all the central offices confine themselves to filling out and publishing the data called for by the international outline and do not give additional data. We have lost sight of the fact that this outline merely indicated the *minimum* amount of material needed, and that we may properly offer more than is specified therein.

The Potsdam observations give some clue to the frequency of ice storms or the formation of glaze (Glatteis) in the district about Berlin. During the 21 years 1893 to 1913, inclusive, glaze (Glatteis) was observed 61 times, or an average of 3 times a year; in 1896 it formed 9 times, and during three years it failed to develop at all. The distribution by months is shown in Table 2.

TABLE 2.—*Monthly totals, formation of glaze (Glatteis) at Potsdam near Berlin, 1893 to 1913, inclusive.*

Months.	Days.	Months.	Days.
October	2	April	0
November	9	May	0
December	24	June	0
January	18	July	0
February	6	August	0
March	2	September	0

It is not such a rare condition that glaze should form on two or three days in succession; indeed, in 1896 it formed on five days in succession, viz, December 20 to 24, inclusive. On these days the temperature of the ground was below 0° C., fog was uninterruptedly present, and a very gentle rain fell to a total amount of only 3.2 mm. This was therefore a case of glaze of the third class. A comparison of the simultaneous records made at Potsdam and elsewhere shows that in this case the glaze was chiefly restricted to one station, and was therefore local in character. There are, however, several other cases where it is known that the phenomenon was of widespread occurrence, and the thorough studies of these cases have given the latter a certain degree of fame. In these cases the German publications have often employed the term "ice rain" (Eisregen) in place of glaze (Glatteis). From the discussion on preceding pages it would seem more correct to apply the name "ice rain" (Eisregen) to falls of sleet (Eiskörner); for when glaze (Glatteis) forms it is not ice that rains down but liquid water that does not freeze to ice until it has reached the ground.

[43] *Nouel, E.* Mémoire sur la théorie du givre et du verglas. Annuaire, Soc. météorol. de France, 1863, pp. 27-45.

[44] Some French writers distinguish between "verglas de pluie" (rain-formed glaze) and "verglas de neige" (snow-formed glaze). The latter form indicates a transformation, however, and no condensation, for it develops when frost suddenly occurs after the snow cover of the ground is partially melted or thawed.

[45] See, however, the report on "Sleet," where the preferred usage of the Weather Bureau is set forth, MONTHLY WEATHER REVIEW, May, 1916, 44: 285.— *Transl.*

[46] Pike, F. V. Three "ice storms" [Jan. 19, 27-30, Feb. 11, 1886]. Amer. meteorol. jour., Ann Arbor, Mich., May, 1886, 3: 32-39.
See also "Eissturm in Philadelphia [21 Feb., 1902]." Meteorol. Ztschr., 1905, 22: 373; *or* Contrib., Botan. lab., Univ. Penn., 1904.

[47] The observational réseau of the Kingdom of Saxony has been a praiseworthy exception in this respect.—*Author.*
It is proper to state here that the United States Weather Bureau has in the past furnished a considerable amount of data as to glaze and ice storms to wire-using companies and other engineers; and that it has in hand a project for the systematic study of the meteorological side of the problems bearing on damage by snow and ice storms.—C. A., Jr.