Types 1 and 2 give very little rainfall, and Type 3 only light rainfall in northern China and no effect at all in central or southern China. Type 4 gives quite heavy rainfall at lower Yangtze stations, but only light rainfall over the upper Yangtze region, the southern, and the northern coast. Type 5 is the heaviest rain bringer to southern China, but it has little effect in central China and the LOW seldom goes up to Shantung. No. 6 has but little influence on the precipitation of China, and usually comes in winter.

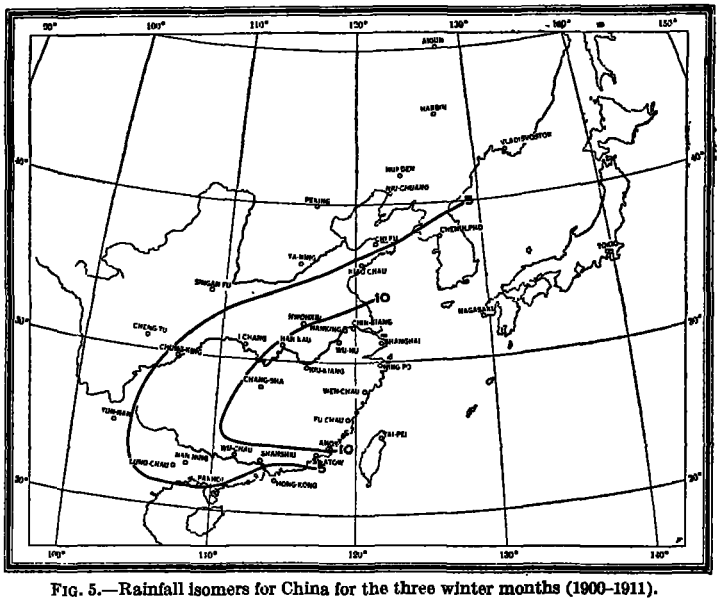

FIG. 5.—Rainfall isomers for China for the three winter months (1900–1911).

The stations Foochow, Amoy, and Swatow are so unfavorably situated that they receive only light rainfall during the storms of Types 4 and 5 when there is heavy rain to the north and south of them. This causes a deficiency of precipitation at those stations and they receive less than their position would seem to entitle them to.

Tornadoes.—There was only one tornado throughout the whole period, and that was in 1902 in Shantung.

ABSOLUTE DAILY AND MONTHLY MAXIMA, AND SNOWFALLS.

Pakhoi, the southernmost station, has the distinction of having the highest extreme annual, monthly, and daily maxima. These occurred in three different years. The extreme annual maximum is 2,691.3 millimeters, or about 100 inches. Such amount is of common occurrence in the United States, specially on the high mountains of the Northwest. The extreme monthly maximum at Pakhoi occurred in July, 1900, and the amount is 952.9 millimeters; and the daily maximum occurred June 27, 1903, the amount being 319.5 millimeters, or about 13 inches. The maximum daily rainfall in the United States is about 20 to 25 inches and the maximum monthly rainfall about 71 inches,[9] considerably more than those recorded in China. This no doubt is due to the longer record which is to be obtained in the United States.

Along the southern coast in Hongkong and Pakhoi and their neighborhood more than half of the mean annual fall comes in the three summer months, June, July, and August. In central China, south of the Yangtze, the percentage for the same three months is smaller, about 40, while in the region north of Yellow River more than 60 per cent of the mean annual comes in these three months. This is of much importance to north China, since the rainfall in this part of the country is light—about 750 millimeters, or 30 inches—and as winter in north China is very cold. If a large portion of the precipitation should come in winter it would be in the form of snow, and hence be of little use to the farmers.

The percentages in the three winter months—December, January, and February—vary from 15 per cent in central China along the coast to about 1.5 per cent in Mukden. In northern China the precipitation in these three months all comes in the form of snow, while in central China the precipitation partly consists of rain. In the month of January, Pekin is a little colder than Boston. It has a monthly mean of 24°F., or 268.3°A., while in central China, Shanghai has a monthly mean of 37.2°F., or 276.1°A., in January. At Ningpo or even a little south we have snow every year, probably five or six times annually, while at Canton or Hongkong snow is rare.

[9] For some maximum daily and monthly rainfalls in the United States see McAdie's "Climatology of California," Washington, 1903. (Weather Bureau bulletin L), pp. 171–172.

AMERICAN DEFINITION OF "SLEET."

By CLEVELAND ABBE, Jr.

[Dated: Weather Bureau, June 30, 1916.]

In undertaking to collect and discuss American statistics of the occurrence and the amount of ice coating or "glaze" (a term just adopted for the coating) deposited on electric transmission and other lines, the Weather Bureau had forced on its attention the prevailing diversity in the use of the terms "sleet," "ice storm," "glazed frost," "silver thaw," "glare ice," etc. As the phenomena bearing these names are all more or less of public interest, it is very necessary that our names for them shall be clearly defined and as specific as possible in application. The chief difficulty met with seems to be the prevailing uses of the word "sleet"; accordingly, on January 6, 1916, the Chief of the Weather Bureau appointed a "committee to formulate suggestions of an appropriate nomenclature of sleet * * *."[1]

The committee thus appointed considered the subject from the five points of view: (1) Etymology of the word "sleet"; (2) early definitions; (3) modern definitions; (4) meteorological usage; (5) Weather Bureau usage. It will be convenient to discuss the committee's report in this manner.

1. ETYMOLOGY.

The word "sleet" is of uncertain derivation. Murray in the New English Dictionary, finds that it probably represents the Old English (Anglian) *slét* (which was phonetically derived from *sléatj*) and is related to the Middle Low German word *slôte* (LG. slôte, slate), Middle High German *slôze*, *slôz* and German *schlosse*, which mean "hail." Murray goes on to say that the Norwegian dialectal *sletta*, the Danish *slud*, and the Icelandic *slydda* have the sense of "sleet," but that it is difficult to associate any of these phonetically with the English word. (These Scandinavian words seem to mean "splash" or "slap"; and thus suggest the action which is repeatedly associated with *slét* in the early English authorities quoted by Murray. This significance will be recalled later in connection with usage.)

The committee sent out a large number of requests for information on this subject, but nothing in addition to the above derivations was received in reply.

[1] The members of the committee were Prof. H. C. Frankenfield (chairman), Prof. C. Fitzhugh Talman, Mr. P. C. Day, and Cleveland Abbe, jr.

2. EARLY DEFINITIONS.

A definition quoted by Murray's New English Dictionary and dating back to 1635 (Swan) says: "We have sometimes sleet; which is snow and rain together." This is the only explicit definition among the illustrations quoted by Murray under the noun.

The verb *to sleet* was defined as early as 1325 (?) as "now snow, now rain" (see Murray, 1, under the verb).

A similar meaning for the word *sleet* is implied under *sleetiness* in Bailey's Dictionary, v. 2, of 1727 and in Webster's of 1847.

We may, then, properly class Murray's definition under the present head and give it here, viz,

Sleet.—Snow which has been thawed by falling through an atmosphere of a temperature of a little above freezing point, usually accompanied by rain or snow.

However, there are some early American dictionaries which give different definitions. Thus the Royal Standard English Dictionary, fourth Brookfield edition, published at Brookfield, Mass., in 1809 defines "sleet" as "small snow or hail, rain and snow mixed together." In a dictionary [2] published at Burlington, N. J., in 1813 we find:

sleet (perhaps from the Danish "*slet*"). A kind of smooth or small hail or snow, not falling in flakes but in single particles.

In using the past participle as an adjective we find a popular transition to another interesting phenomenon. In 1849 Whittier wrote of winter "roaring through the sleeted pines" (quoted in Murray's New English Dictionary), and elsewhere is found the similar use "sleeted spars and frozen sails." Evidently "sleeted" means also covered with "sleet," which here stands for a coating of ice. American experience, at least, indicates that the icy coating of trees, spars, etc., rarely if ever results from a storm of "rain and snow mixed together." The present divergent usages were thus early foreshadowed.

3. MODERN DEFINITIONS.

In order to learn the present popular uses of the word *sleet* in the United States, the following letter was addressed to about 40 representative literary students, engineering organizations, electrical workers, and meteorologists:

UNITED STATES DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU,
OFFICE OF THE CHIEF,
Washington, D. C., March 11, 1916.

DEAR SIR: There has been some discussion in this Bureau as to the way in which the term "sleet" should be used for official purposes. A search of dictionaries and of a large amount of technical and non-technical literature appears to establish the following facts:

(1) In England "sleet" means usually, though not invariably, a mixture of raindrops and snowflakes.

(2) In this country the term "sleet" has nearly always been applied in meteorological literature to some form of water which is in a frozen state before reaching the ground, viz, either small particles of clear ice (often mingled with rain or snow) or little snowlike pellets, differing in structure from true hailstones, but often called "winter hail," or "soft hail." (In German the latter form of precipitation is commonly called Graupel, and this name is sometimes used in English texts. The French equivalent is grésil.)

(3) Non-meteorological usage in this country varies; comprising the uses noted above under (1) and (2), and also another, in accordance with which the term "sleet" is applied to a coating of ice on terrestrial objects formed by rain which freezes after contact with such objects. When this coating is heavy, and especially when it results in the breaking of branches, wires, etc., the phenomenon as a whole is often called an "ice storm." This use of the term "sleet" is common in the newspapers, and also in engineering literature, particularly in reference to accumulations of ice, due to rain, on wires and rails. In England the specific name of this form of ice is usually "glazed frost," and this term is used officially by the British Meteorological Office. The name "silver thaw" has also been applied to it in both Great Britain and the United States, but this expression is so inappropriate and misleading that it is avoided by most scientific writers.

The Bureau will feel indebted to you for any information you may be able to supply as to the use or uses of the term "sleet" current in your vicinity, and also as to the meaning which, in your experience, most commonly attaches to the term in contemporary speech and literature. Information would also be appreciated concerning the etymology and history of the word "sleet" in case you are able to add anything to what is found in the latest editions of the New English, Century, New International, and Standard Dictionaries.

A franked and addressed envelope is inclosed for your reply.

Very respectfully,

C. F. MARVIN,
Chief of Bureau.

The replies to this letter may be arranged into two general groups: (1) Technical wire-using industries, (2) literary and academic circles. The general tenor of the replies is fairly represented by the following selections (Nos. 1 to 12 and 24):

Wire-using industries.—Representatives of telephone, telegraph, and electric-power companies submitted replies represented by the following:

(1) DULUTH STREET RAILWAY CO.,
Duluth, Minn., April 14, 1916.

* * * The writer has always understood *sleet* to be water falling from the clouds and striking the earth in solidly frozen and compact drops, and has understood the difference between snow and sleet to be that the former is frozen in the form of flakes, while the latter is solidly frozen drops.

While I understand the above to be the general idea of *sleet*, it is true that the ice coating which forms on street railway trolley wires, when the wire is cold enough to freeze rain or mist coming into contact with it, is quite generally referred to as "sleet" on the wire. * * *

H. WARREN,
Vice President and General Manager.

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(2) "ELECTRICAL WORLD,"
New York, N. Y., March 15, 1916.

Answering your inquiry of March 11 concerning the definition of "sleet" as applied in this country, the expression is used throughout the electrical industry by operators of both electric-lighting plants and street-railway properties as referring to the condition of frozen rain or ice which *coats* line wires, trees, and other overhead objects. By a common opinion "sleet" refers to rain or snow which has fallen on cold objects and there congealed, forming an adherent coating.

O. H. CALDWELL,
Assistant Managing Editor.

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(3) "ELECTRIC RAILWAY JOURNAL,"
New York, N. Y., March 16, 1916.

* * * A very definite use of the term [sleet] has developed in the electric-railway industry. In this case it is applied to all coatings of ice on wires or rails which may be formed by rain that freezes as it falls or by small hailstones that adhere to cold objects; * * * and a number of devices have been introduced to remove the accumulations of ice from the overhead contacts or the third rails. These devices are invariably called "*sleet cutters.*"

My understanding of the term as used in the electric-railway industry is that it is applied to the accumulation of ice, rather than to the form of a precipitation that causes the ice. * * *

F. KINGSLEY,
Associate Editor.

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(4) WESTERN UNION TELEGRAPH CO.,
Washington, D. C., March 8, 1916.

The term "sleet" is used by this company and other wire-using companies in a sense somewhat different from the meaning generally given it by others. The term is applied by us to a cold rain that freezes on striking the ground, poles, and wires, forming a transparent icy coating.

So far as we know, there is no term that applies to this particular form of precipitation, which, on account of the great damage to pole lines and wires that so frequently results from the ice loads, is of tremendous importance to the public, not only because of interrupted telegraph and

[2] New critical pronouncing dictionary of the English language, by an American Gentleman. Burlington, N. J. 1813.

telephone service, but also because of the effect on railroad service when dispatching circuits and automatic signal systems fail.

For the consideration of the Weather Bureau, it might be suggested that it would be of great practical benefit to distinguish between this form of precipitation—or condition of the weather—and ordinary rain or snow. This distinction would be more beneficial than that now made between snow and the peculiar icy pellets which others now call sleet. It would be of great value, it seems to us, to have weather reports take this peculiar weather condition into account, and a convenient name might be devised for it in order to avoid present conflicting usage of the term "sleet."

GENERAL SUPERINTENDENT OF PLANT
(Through H. F. TAFF, *Manager*).

It appears from these selections that the industries represented by them habitually call the ice coating formed by cold rain, or snow, or rain and snow combined, or even "small hailstones," by the name of "sleet." It is evident, however, that some, if not all, recognize another meaning for "sleet," viz, precipitation in the form of "solidly frozen drops" (Nos. 1 and 4). One letter (No. 4) specifically points out the need for "a convenient name * * * to avoid present conflicting usage."

A recent personal canvas among some prominent electrical engineers by one member of the committee, also elicited the above definition of "sleet." When asked to give a name for the ice pellets falling as such and not clinging to the wires or other objects, none was able to do so. After discussion, however, all readily admitted that their use of "sleet" (as reflected in letters 2, 3, and 4) was not technically correct, and the majority expressed entire willingness to accept in place of "sleet storm" the term "ice storm" for use by the Weather Bureau, as they would understand exactly what was meant.

Literary and academic usages.—The following selections from replies submitted by writers, instructors, and others show diverse usages in other than technical circles.

(5) HARVARD UNIVERSITY,
Cambridge, Mass., March 15, 1916.

It is my impression that the popular usage of the term "sleet" in this vicinity is with reference to a mixture of snow and rain, or wet snow. I have also heard it used, though less frequently, for what I call an ice storm, i. e., a coating of ice on terrestrial objects. I myself prefer the English use of "sleet" for snow and rain; "soft hail" for the snow pellets; "frozen rain" for what popular usage designates as hail, but which, occurring in winter, is really frozen rain drops without the concentric structure or origin of hail. * * *

ROBERT DEC. WARD,
Professor of Climatology.

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(6) WEATHER BUREAU,
Boston, Mass., March 22, 1916.

* * * The term "ice storm" seems to be generally understood by the public and press in this vicinity as meaning an accumulation of ice on objects by the freezing of rain on them and not a fall of *frozen* rain. * * *

J. W. SMITH,
District Forecaster.

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(7) WEATHER BUREAU,
Ithaca, N. Y., March 17, 1916.

* * * It would seem that the term "sleet" might well be defined as in paragraph 2 of your letter [above, p. 282]. I think it very desirable to add to our meteorological vocabulary an expression to indicate the conditions when accumulations of ice occur on wires and other objects. It would seem that "ice storm" is an appropriate expression and has the advantage of being already in use. It is a better expression than "sleet storm," because a heavy fall of sleet may occur without any such accumulation, or ice may form on wires and the like when the precipitation is wholly in the form of rain.

WILFORD M. WILSON,
Professor of Meteorology.

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(8) HARVARD UNIVERSITY,
Cambridge, Mass., March 16, 1916.

To me the word "sleet" has the meaning which you put under No. 2 [above, p. 282], i. e., "either small particles of clear ice (often mingled with rain or snow), or little snow-like pellets, etc." This meaning I recognize as the most familiar to me if an exact definition is to be given, though the sense No. 1 ("a mixture of raindrops and snowflakes") would not surprise me, and I might use, on occasion, the word in that sense myself. * * * I am not familiar with the terms "winter hail," "soft hail," "ice storm," "glazed frost," "silver thaw."

EDWARD STEVENS SHELDON,
Professor of Romance Philology.

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(9) WEATHER BUREAU,
Portland, Oreg., March 27, 1916.

Conversation with newspaper men and others on the subject [of sleet] brought out the fact that there is little difference of opinion in this section of the country as to the meaning of the word [sleet]. * * *

To sum the matter up, sleet consists of small pellets of ice which fall in winter; rain which falls along with sleet is not included in the term, but is separately mentioned; raindrops unfrozen until they reach the ground, but which freeze immediately after coming in contact with terrestrial objects, are, nevertheless, raindrops, but the whole phenomenon is called a "silver thaw." * * * [Mentioned in paragraph 3 of the circular letter, p. 282.]

FLOYD D. YOUNG.
Assistant Observer,

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(10) METEOROLOGICAL OFFICE,
Toronto, Canada, April 6, 1916.

Your statements regarding the use of the term [sleet] in the United States cover most perfectly its use by the public and press in Canada, and I do not think I can add anything useful. Our newspapers frequently speak of rain freezing as it falls as a "sleet storm," and the terms "silver thaw" and "glazed frost" are practically unknown outside meteorological reports. * * * [Compare No. 24.]

R. F. STUPART,
Director.

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(11) *New York, N. Y., March 18, 1916.*

I regret to say that I can not supply you with anything of value in regard to the use of the word "sleet."

All I can do is to say that I myself have been in the habit of using the word to indicate wind-driven drops of semifrozen rain.

BRANDER MATTHEWS.

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(12) UNIVERSITY OF VIRGINIA,
University, Va., March 14, 1916.

I can add nothing to the etymology or history of the word "sleet" beyond what is found in the dictionaries mentioned. Let me suggest, however, as to meaning, that *nothing is sleet that does not rattle on a tin roof or against the window pane.* It seems to me that the element of sound is what differentiates "sleet" from its winter congeners. If you will investigate the occurrence of the word in modern literature (see concordances to Bible, Shakespeare, Tennyson, Wordsworth, etc.), my impression is that you will find its chief differential lies in its noise-making property. This is my instinctive feeling about the word and corresponds, I think, to the current acceptation.

C. ALPHONSO SMITH,
E. A. Poe School of English.

These selections (5) to (12) show that among those most accustomed to use words carefully, viz, writers and students of language, the term "sleet" is primarily applied to some form of precipitation while it is still in the air rather than to any deposit on the ground or other objects (Cf. nos. 5, 7, 8, 11, 12). This stands out at once in marked contrast to the usage, more or less popular but by no means universal (Nos. 4, 6, 9), that applies the term to the coating of ice sometimes formed during cold rains.

These replies strongly suggest the reflection that the name "sleet" is being transferred from its original meaning of a form of falling precipitation, to an ice coating. This tendency is perhaps developing because it is carelessly concluded that the coating is the result of the falling of the icy or snowy pellets which are the original "sleet." It is an easy transition in the popular, non-meteorological mind, from "sleeted spars" through "sleety" spars to spars covered with "sleet."

The popular conclusion is wrong. Though associated there is no genetic relation between what is more properly called "sleet" and the ice coating of the glazed, icy spars.

The committee find it specially significant that several of the weightier communications emphasize the characteristic of "sleet" being wind-driven, semifrozen drops such as would rattle on a roof or against a window pane (Nos. 11, 12). Evidently some of our people still hear in the word "sleet" the suggestion of the slapping, splashing, or rattling sounds and sensations which Murray and others find to be related to the old English word *slēt*.

4. METEOROLOGICAL USAGES.

The following quotations will serve to show how meteorologists and those professedly writing on meteorological subjects, have defined *sleet*.

Unofficial publications.—

(13) I have little to say of [rain, snow, and hail], three modes of the resolution of the nimbus, which has not been already treated of by meteorologists, nor of their compound, commonly called sleet.—*Thos. Forster* "Researches about atmospheric phenomena." 2d ed., London, 1815. p. 83.

(14) In this case, precipitated moisture descending in the frozen form of flakes of snow, begins to melt so soon as it reaches those atmospheric strata, the temperature of which is above the freezing point. In such circumstances the snow, by the time it reaches the surface of the earth, is partially melted; and has received the name of sleet.—*Graham Hutchison* "A treatise on the causes and principles of meteorological phenomena." Glasgow, 1835. p. 215.

(14A) *Hail.*—* * * Three species of hail, founded on the different sizes of the hailstones, are generally distinguished.

* * * Very small hailstones are termed *sleet* [Graupeln. Riesel, grésil in French]. Generally spherical, or almost spherical, they rarely attain a diameter of 2 millimeters; though they may reach 3 or even 4. Isolated hailstones [Die einzelnen Körner] are opaque, frequently soft, and of a whiteness approaching that of snow. The largest are sometimes surrounded with a slight film of ice; they fall in winter and in spring during gusty weather; they rarely accompany storms [selten von Gewittern begleitet]. pp. 375, 376.

* * * *Formation of sleet* [*Entstehung der Graupeln.*].—This is more easily explained because it is more commonly observed in the cold season. * * * p. 387.—*C. V. Walker*, translation (1845) of *Ch. Martins* annotated French version (1843) of *Ludwig Friedrich Kämtz*, "Vorlesungen über Meteorologie." Halle, 1840.

(NOTE.—Words in [ ] are from the original German version; note that the English translation employs *sleet* for the French *grésil* which Martins used as the equivalent of the German *Graupeln*. In another passage (Walker, p. 379; Kämtz, p. 450) we find the English *sleet* used for the French *giboulées* and the German *Graupeln* when referring to these Graupeln-like falls in France during the spring.—C. A. jr.)

(15) [Hail] is different from sleet, which is nothing more than frozen rain and occurs only in cold weather.—*John Brocklesby* "Elements of meteorology." 3d ed., New York, 1849. p. 122.

(16) Sleet is the mixture of rain and snow or small hail occurring during variable and gusty weather.—*David Purdie Thomson* "Introduction to meteorology." Edinburgh, 1849. p. 199.

(17) Sleet appears to be formed from snowflakes falling through a stratum of moist air at a temperature of 32°F. or higher. The size of the flakes is caused by the snow coming against each other and uniting by regelation, and they are no doubt further increased by the condensation of vapour on their surfaces as they float down through the moist air. Sleet falls chiefly in winter and spring and is very rarely an accompaniment of storms.—*Alex. Buchan* "Handy book of meteorology." Edinburgh, 1867. pp. 123, 124.

(18) The fine, soft hail seen in autumn and winter particularly, the surface of which looks as though powdered with flour, is usually called *sleet*. It is, properly speaking, a kind of middle formation between hail and snow.—*Wm. Lackland* "Meteors, aërolites, storms, and atmospheric phenomena. Tr. from the French of Zürcher & Margollé." New York, 1871. p. 83.

(19) Sleet is a mixture of snow and rain.—*R. H. Scott* "Elementary meteorology." 3d ed., London, 1887. p. 143.

These selections show that from 1815 on there have been various conceptions of "sleet" among meteorologists. We find it defined as—

(*a*) A mixture of rain, snow, and hail (see 13, 16).

(*b*) A mixture of rain and snow (see 19).

(*c*) Partially melted snow (see 14, 17).

(*d*) Frozen rain, differing from hail (see 15).

(*e*) Fine, soft hail, which seems to be powdered with flour (see 14A and 18).

The definition by R. H. Scott (No. 19), while given in an unofficial publication, probably carries the most authority among the above quotations. The author was in charge of the British Meteorological Office when he wrote this definition. It is not fundamentally divergent from Nos. 16 or 17, and agrees with the old English definition given by Murray (see p. 282).

It is notable that the American author quoted (No. 15) has a divergent definition, see (*d*), above, which reappears in letters 1, 8, 9, 11, 12, quoted on pages 282–3. Lackland's translation of Zürcher and Margollé (No. 18) offers a definition (*e*) which may rest upon the shoulders of his dictionary maker (compare, however, 14A and its note). At any rate it furnishes occasion to quote (20) an official American author writing privately but under strong official influences (italics ours):

(20) There is a kind of soft hail, rounded pellets, and of very soft grain, which falls in winter or spring. This seems to be rather frozen *sleet*, which *itself is* a mixture of snow and rain, rather than true hail. A distinction is made between this soft hail, as it is called, and true hard hail, by meteorologists abroad; in the United States this distinction is not always made.—*A. W. Greely* "American weather." New York, 1888. p. 78.

This passage from Greely shows that also American usage confused the English word "sleet" with the phenomenon of what is sometimes called "soft hail" (*Fr.* grésil; *Ger.* Graupel). Greely, however, adheres to the English definition of sleet as a mixture of snow and rain; this is all the more interesting in view of the following official definitions.

Official publications.—Among the early official instructions to meteorological observers in America, stands the work prepared in 1850 by Prof. Arnold H. Guyot at Cambridge, Mass., and issued by the Smithsonian Institution.[3] It contains the following definitions and instructions:

(21) *Sleet*, which consists in small balls of snow, white and opaque, commonly without a crust of ice, like the opaque nucleus found within hailstones, falling more frequently in spring and in autumn.

Frozen rain drops should be distinguished from the preceding forms; they make little balls of transparent ice.—*Directions* for meteorological observations. * * * Smithsonian Institution, Washington, 1870. p. 31.

The Smithsonian Instructions, from which (21) is quoted, had been in use since 1850, and became the prescribed reference work for the observer sergeants of the Signal Service, U. S. A., when that service began meteorological work in 1870.[4] It is not at present ascertainable how long this definition of sleet prevailed in the Signal Service. The following quotation shows that it was still prescribed, at least for voluntary observers, as late as 1882.

(22) There will also be noted:

Sleet, which consists in small balls of snow, white and opaque, commonly without a crust of ice, like the opaque nucleus found within hailstones, falling more frequently in spring and in autumn.

Frozen rain drops should be distinguished from the preceding forms; they make little balls of transparent ice.—*Instructions* for voluntary observers of the Signal Service, U. S. A. Washington, 1882. p. 87.

[3] *Smithsonian* miscellaneous collections. (19). Directions for meteorological observations and the registry of periodical phenomena. Washington, Smithsonian Institution 1870. p. l., 70 p. 8°. (Reprinted with additions, from the original edition, Washington, May 1, 1850. 40 p.)

Arnold Henry Guyot, author of the above instructions, was born in Switzerland in 1807, educated at Neuchâtel and German universities; he came to the United States in 1848, in 1849 delivered lectures in French on Physical Geography, and in 1850 prepared these instructions (probably in English) for Joseph Henry, Secretary of the Smithsonian Institution. Selection 14A above, shows that his use of sleet conformed to good contemporary English usage.

[4] *See* Annual Report of the Chief Signal Officer for 1870. Washington, 1870. p. 22, Paper 2, paragraph II; *and also* Same, for the fiscal year ended June 30, 1871. Washington, 1871. p. 79, Paper 4, paragraph 37.

The present definition of sleet has been in force in the Weather Bureau since about 1897. The Bureau's "Instructions for preparing meteorological forms" states it as follows, in paragraph 119:

(23) Care should be taken in determining the character or precipitation when in the form of sleet or hail. Only the precipitation that occurs in the form of frozen or partly frozen rain should be called *sleet*. * * * It frequently happens that snow falls in the form of small round pellets, which are opaque, having the same appearance as snow when packed. This should never be recorded as sleet.—*Weather Bureau* "Instructions for preparing meteorological forms." Washington, 1913. Paragraph 119.

The director of the Canadian Meteorological Office advises this Bureau, under date of April 6, 1916, as follows:

(24) In the Book of Instructions issued to Canadian observers, occur the following definitions of certain terms which have a bearing on the subject (sleet):

Graupel, denoted by △. The stones are small, like snow pellets, without crystalline structure. When mixed with rain it often bears the name of "sleet."

Silver thaw is the phenomenon of frozen moisture on trees or other objects when the weather suddenly becomes warm after great cold.

Glazed frost. This term is applied to the glazed surface formed on the ground, trees, and other objects by rain falling and immediately freezing thereon. It differs from the "silver thaw" in this respect, that the latter is formed by the condensation of vapor, and consequently has not the same smooth surface.

The British Meteorological Office, however, publishes the following:

(25) * * * No separate letter is given for sleet; the combination rs [i. e. rain and snow] is generally used.—*Meteorological Office* "The Observer's Handbook." Annual edition 1913. London, 1913. p. 52.

This definition adheres to the earliest English meanings quoted by Murray; but we see the Canadian definition (24) departing from it and tending toward the early American concepts given on p. 284 and in quotation (21).

Among the Weather Bureau publications the usage has been officially controlled by the "instructions" quoted under (21), (22), and (23). Nevertheless many lapses into the popular confusion of names have occurred. The following will serve to illustrate variations in Weather Bureau usage:

(26) The sleet storm of the 24th (at Vevay, Ind.) covered all exposed objects with a heavy coat of ice and many trees were broken.—*Monthly Weather Review*, March, 1888, p. 671.

(27) At Kansas City, Mo., a severe sleet storm occurred on the 26th, wires became thickly coated with ice; [and in Iowa] telegraph lines were covered with sleet.—*Monthly Weather Review*, December, 1888, p. 309.

(28) Sleet is a winter phenomenon; it is made up of small transparent drops of ice, apparently formed by the freezing of raindrops as they fall through the lower cold air.—*J. Warren Smith* quoted in Monthly Weather Review, October, 1898, p. 470.

(29) The heavy storm of snow, sleet, hail, and wind [did much damage] March 11 and 12 * * * the sleet was of bird-shot size, which melted as it fell and then crusted between the rails.—*Monthly Weather Review*, April, 1901, p. 175.

(30) The sleet storm in northern New York * * * [was due to] rain which froze upon contact with solid objects.—*Bennett* in Monthly Weather Review, March, 1913, p. 372–3.

However, some semiofficial publications by Weather Bureau men carefully maintain the distinction between "sleet," "snow and rain," "ice storm," and the glaze or ice coating (Glatteis). The following passage from a recent work by Weather Bureau officials is one of these instances where the best Weather Bureau usage is clearly presented:

(31) *Heavy and damaging storms of snow, sleet, and ice.*—It is desired in this connection to make some reference to the most damaging storms of snow, sleet, and ice. Sleet invariably falls in connection with snow or rain, or both, and ice storms are commonly confused with sleet storms. Sleet is frozen rain; ice storms are occasioned by rain freezing upon objects with which it comes in contact. In the former the freezing occurs before the drops strike the earth; in the [ice storms] the cold surfaces upon which the rain falls freeze the water into a coating of ice.—*Cox & Armington* "Weather and climate of Chicago." Chicago, 1914. p. 224.

CONCLUSION.

1. The fundamental confusion of usage in the United States seems to arise from applying the same name, "sleet," to two forms of frozen precipitation, one of which is frozen in the free air and the other after contact with terrestrial objects. It is interesting to note that the official terms of all other countries distinguish between and apply distinctive names to these two conditions of the hydrometeor.

The U. S. Weather Bureau, following the earlier Signal Service and Smithsonian practices, also has distinguished between these two conditions. It is evident from the preceding that a considerable portion of the public also feel the need for making such a distinction; and the Weather Bureau is of the opinion that science is better served by maintaining such a distinction rather than by broadening the scope of the term. It is therefore recommended that the term "sleet" be restricted to *one* form of precipitation.

2. As has been sufficiently pointed out, the present British definition of "sleet" as mingled snow and rain, now used in official British literature, does not appear to have been adopted by any other nation; and it is not in accord with definitions by some English writers. Strange to say, it is also out of accord with the French definition of the French word "grésil," which dictionaries published in England give as the French equivalent of the English word "sleet."

In view of the above the Weather Bureau finds that it is not justified in changing the present Weather Bureau definition of "sleet." The Weather Bureau therefore adheres to its definition which has been in force since about 1897, viz:

Only the precipitation that occurs in the form of frozen or partly frozen rain should be called sleet. (See selection No. 23.)

The present official Weather Bureau definition of *sleet*, here reaffirmed, is understood to apply to the same phenomenon which German meteorologists call "Eiskörner" (ice grains) and to exclude those forms of precipitation which the English call "soft hail" (*Ger.* Graupel, *Fr.* grésil) and "glazed frost" (*Ger.* Glatteis, *Fr.* verglas).

3. The Weather Bureau recognizes the need for a convenient name for the coat of ice that forms chiefly by the freezing of cold rain when it strikes cold objects or the earth's surface. As pointed out on p. 283, it seems clear that the name "sleet" is not properly to be applied to this ice coating; and the wire-using industries, who are the chief users of "sleet" in this manner, have expressed their willingness to adopt another and more logical term.

Certain publications have employed the name "ice storm" in such a manner that this term seems to be used as the name for the ice coating. This usage is not approved. The Weather Bureau holds that a term including the word "storm" should be applied to the general weather conditions producing certain effects, and not to the actual effects (ice coating, flooding, etc.) due to the stormy weather.

The English name for this ice coating, "glazed frost," has indeed the sanction of the British Meteorological Office, and also of the International Meteorological Organization,[5] as the English name for the phenomenon

[5] Codex of Resolutions adopted at International Meteorological Meetings, 1872–1907. * * * English edition. London, 1909. (M. O. No. 200.) p. 25.

called *Glatteis* in German and *verglas* in French; but it appears to be unfamiliar to the America npublic, including Canada. (See Nos. 10 and 24.) Furthermore, to the American the word "frost"—either alone or in composition—is more closely associated with the phenomenon of hoarfrost or sublimated water vapor than it is with ice or with temperatures below the freezing point of water. The Weather Bureau therefore rejects this name for the ice coating resulting from an ice storm and proposes to adopt the name "glaze" for the ice coating which forms when cold rain comes in contact with strongly chilled terrestrial objects.

This use of "glaze" has already been recognized as occurring in the United States; it is, in fact, the fourth meaning under that word as given in Murray's New English Dictionary, and we there find the following illustration:

(32) 1796. *Morse*, American Geography, v. 1, p. 215: Whenever the winter * * * sets in with rain, so as to cover the branches and leaves of trees with a glaze of ice.

The term "glaze" is accordingly adopted as the official Weather Bureau equivalent of the English term "glazed frost," the French "verglas," and the German "Glatteis."[6] The Bureau would not exclude from the pages of its publications, however, these other equivalent expressions when used by other than Weather Bureau writers.

RIME (RAUHFROST, DUFT, GIVRE).

In the course of the above discussion regarding American terminology, resulting in the adoption of "glaze," an old American name, for the English "glazed frost" (Glatteis, verglas), the Weather Bureau has also had to consider the phenomenon called "rime" (Rauhreif, givre). It is here desired to call the attention of the American student to the following statement taken from the Observer's Handbook published by the Meteorological Office, London:[7]

Rime. V. The international symbol V is intended to represent the phenomenon denoted by the German words *Rauhreif*, *Rauhfrost*, *Anreim*, *Duft*, and the French *givre*. Silver Thaw has been used as the English equivalent of these terms by some writers; others, however, use this expression to translate the German "Glatteis," French "verglas." It is here proposed to use the word rime to translate the German "Duft," French "givre."

Rime, as thus defined, is an accumulation of frozen moisture on trees, etc., which presents a silvery white and **rough** surface, bearing some resemblance to hoarfrost; it is, however, **only formed during fog,** whereas hoarfrost is a result of nocturnal radiation from the earth to a clear sky.

In our [i. e., England's] climate rime is of comparatively rare occurrence, for the white deposit on grass, etc., observed on foggy mornings consists in most cases of hoarfrost which had formed before fog developed. On Ben Nevis the depositions, however, were frequently so thick that they greatly interfered with the work of observing by clogging up the louvers of the thermometer shelter, etc. The phenomenon was noted in the record under the name "fog crystals."

The particles in a fog, even at temperatures far below the freezing point, consist of droplets of undercooled water, and when these come in contact with bodies they solidify immediately and form rime. Hoarfrost and rime may be distinguished, to a certain extent, by the fact that the former is not readily formed on good conductors of heat in thermal contact with relatively warm bodies on which they can draw for a supply of heat to replace that lost by radiation, whereas rime is deposited on all with equal facility.

The Weather Bureau at present feels that no addition is necessary to this statement, and wishes to record its official adoption of *rime*, as defined above, into the Weather Bureau vocabulary.

The phenomenon of rime is not uncommon in the United States, although rare at lower altitudes in our temperate districts. For example, at the Weather Bureau station on the Blue Ridge near Bluemont, Va., Mount Weather standing at an altitude of about 1,725 feet above M. S. L., rime was observed and photographed several times during the period 1903–1913. Pennants of "fog crystals," as we used to call the rime, would form to a length of many inches during driving cloud (fog) in cold weather (March). A very modest example of this Mount Weather rime is published in Fassig's "Climate and Weather of Baltimore" (Maryland Weather Service, v. 2), as Plate XXI, and its formation described on page 413 of that work. Plate XXII of the same work also illustrates the development of *glaze* (Glatteis) at the same locality. The rime is there called "frost figures." The frost-like deposit reported from Buffalo, N. Y., by Mr. Cuthbertson in the MONTHLY WEATHER REVIEW, March, 1902, **30**:125–6, seems to have been a most interesting case of the formation of rime in quiet, fog-filled air (it was there called "hoarfrost," the name by which it was then known in the Weather Bureau).

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TWO ABNORMAL PRESSURE DISTRIBUTIONS IN ITALY.

Prof. Filippo Eredia, of the Ufficio Centrale di Meteorologia e di Geodinamica at Rome, submits the two isobaric charts presented in figures 1 and 3, with the statement that they are of interest not only because of the regularity in the pressure distribution but also because they represent, respectively, the highest and the lowest barometric pressures over Italy as shown by the Italian daily weather maps (Bollettino dell' Ufficio Centrale). The accompanying weather and sea conditions are presented in figures 2 and 4, which also repeat the isobars for 5-millimeter intervals.

Prof. Eredia writes that every day before drawing the isobars on the daily charts he subjects the individual reports to a minute examination and to comparisons between neighboring stations, giving particular attention to the barometric observations. In this scrutiny he finds his direct knowledge of the various stations, as well as the employment of special reports, of great value in determining the reliability of the individual daily reports; furthermore, he carefully checks the latter against the 24-hour changes at neighboring stations. It thus occurs that the barometric observations, as published for some cities in the Bollettino, do not always agree with the positions of the more carefully adjusted isobars of the corresponding map. Thus the pressures reported by Nice (Nizza) are often out of accord with the values at neighboring stations. In such cases the Nice pressure is rejected, as was done in drawing the isobars for January 24, 1907 (fig. 1).

The localities forming the Italian reporting réseau for the daily map, and therefore used for forecasting, are all at medium altitudes, so that the sea-level reductions of the barometers are perfectly comparable among themselves. For some years the Italian service has been making use of daily pilot-balloon observations at various stations. It is hoped to present an account of this pilot-balloon service in a later issue.—C. A. jr.

[6] *See* the English edition of the Codex, cited in footnote 5. *Also* Internationaler Meteorologischer Kodex * * * bearbeitet von G. Hellmann & H. H. Hildebrandsson. Deutsche Originalausgabe, 2te vermehrte Aufl., Berlin, 1911. (Veröffentl. d. k. preuss. meteorol. Instituts. Nr. 242.) p. 19.

[7] *Great Britain. Meteorological Office.* The Observer's Handbook. * * * Annual edition, 1913. London, 1913. (M. O. 191. For official use.) p. 55.