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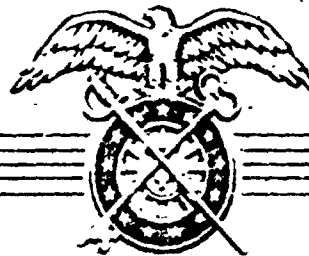
HEADQUARTERS
QUARTERMASTER RESEARCH & ENGINEERING COMMAND
U S ARMY

TECHNICAL REPORT
EP-83

FC

HAIL SIZE AND DISTRIBUTION

AD NO. **157400**
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QUARTERMASTER RESEARCH & ENGINEERING CENTER
ENVIRONMENTAL PROTECTION RESEARCH DIVISION

FEBRUARY 1958

NATICK, MASSACHUSETTS

FOR ERRATA

AD 157400

THE FOLLOWING PAGES ARE CHANGES

TO BASIC DOCUMENT

HEADQUARTERS QUARTERMASTER RESEARCH & ENGINEERING COMMAND, US ARMY
Quartermaster Research & Engineering Center
Natick, Massachusetts

31 March 1956

Technical Report EP-63, HAIL SIZE AND DISTRIBUTION, by Blanche B. Hall,
February 1956.

ERRATA

Page

- Title Change 1957 to 1958
- 111 Change last word to stations
- 27 Figure 12 caption, change Veligh to Meligh
- 29 In sixth paragraph, after first sentence, change to: The size of a hailstone is more important than its speed in determining possible damage to both stationary and moving objects. However, the speed of an aircraft in flight is an important additional factor in determining degree of damage to the aircraft. For this reason . . .
- 30 Figure 16 caption, change date to 26 July 1938
- 44 For Station No. 351, under Total, change 1 to 2
- 45 For Station No. 367, under Total, change 16 to 6
- 46 For Station No. 376, under Total, change 1 to 9
- 50 For Station No. 519, change line to read:
20 0 * 0 * * 1 0 0 0 0 0 0 1
- 52 For Station No. 559, under May, change k to 1
- 55 For Station No. 637, under Total, change 1 to *
- 61 For Abilene, 1945, under Annual, change 0 to 9
- 66 For Pocatello, 1947, under Jan, Jul, Aug, change to 1 2 0

HEADQUARTERS
QUARTERMASTER RESEARCH & ENGINEERING COMMAND, US ARMY
OFFICE OF THE COMMANDING GENERAL
NATICK, MASSACHUSETTS

Major General Andrew T. McNamara
The Quartermaster General
Washington 25, D. C.

Dear General McNamara:

This report, "Hail Size and Distribution," describes the world-wide distribution of hail, particularly of "true hail" that can damage military equipment and shelters. It discusses damage caused by large hailstones, and cites instances in which heavy showers of smaller hailstones have blocked roads and disrupted communications.

Size of hailstones determines their impact velocity, which may exceed 100 miles per hour. Studies of occurrence of hail show that land areas between 30° and 50° North latitude are most subject to frequent storms. Outside these areas storms are less frequent and seldom destructive.

Information in this report will enable planners to decide where hail constitutes a problem to military operations, and will assist design engineers to establish environmental criteria for the design and testing of equipment.

Sincerely yours,

1 Incl
EP-83

C. G. Calloway
C. G. CALLOWAY
Brigadier General, USA
Commanding

HEADQUARTERS QUARTERMASTER RESEARCH & ENGINEERING COMMAND, US ARMY
Quartermaster Research & Engineering Center
Natick, Massachusetts

ENVIRONMENTAL PROTECTION RESEARCH DIVISION

Technical Report

EP-83

HAIL SIZE AND DISTRIBUTION

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Meteorologist

ENVIRONMENTAL ANALYSIS BRANCH

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February 1957

Foreword

To insure that Army materiel and equipment are capable of satisfactory performance, it is necessary to evaluate the effects of weather on such materiel. Criteria have been established for guidance in the design of equipment that will encounter extreme temperatures, rainfall, wind, humidity, and such weather phenomena. Less frequent phenomena, such as hail and glaze, are more difficult to evaluate because of infrequent occurrence and inadequate observation data.

Tables of days of hail at 656 weather stations throughout the world show the areas of greatest frequency. The occurrence of various sizes of hailstones and review of experiments that show the approximate size that will damage military equipment are given, with theoretical maximum sizes and speeds of fall. Photographs are included of large hailstones that damaged vehicles, and accumulated masses of smaller stones that blocked roads.

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Approved:

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Abstract

Basic information is provided on frequency of occurrence and geographical distribution of hail throughout the world. Principal theories of hail growth and the factors which limit the maximum size of hailstones are discussed. Theoretically the maximum size of a single hailstone is 5.2 inches in diameter and maximum weight is 1.53 pounds. This size approaches very closely that of the largest hailstone officially recorded by the U.S. Weather Bureau: 5.4 inches in diameter and 1.5 pounds in weight.

Five tables summarize frequencies of hail at 656 stations throughout the world, and show that areas between 30° and 50° N. latitude are most affected. Eight maps covering most of the non-polar continental areas show station locations.

Maximum occurrence of true hail in the United States is in the plains of the Mississippi Valley, and the plateaus east of the Rocky Mountains. In this "hail belt," 25 weather stations recorded 125 or more days of hail during a 40-year period. Records of these stations from 1940 to 1949 show wide variation from year to year at individual stations, and between stations within a single year. Photographs and descriptions give examples of hail damage and accumulations of hailstones.

Hail is infrequent in Canada and Mexico, except in mountain stations in Mexico. Central Europe experiences moderate summer hail, while Great Britain and the Scandinavian countries receive most of their hail in the winter. In the Mediterranean area and Soviet Union, there is little hail.

Africa, South America and Australasia receive little hail except at high altitudes and more southerly latitudes, although there have been freak storms in those continents and other parts of the world with heavy resultant damage. India and northern Japan receive more hail than any other countries in Asia.

Information is presented on studies by the Weather Bureau and United Air Lines giving the ratio of thunderstorms to hailstones as around 10 to 1, or less, for about two-thirds of the United States. These and similar studies also show that a reporting network of 1 weather station for every 4 square miles would be required to produce representative figures of area hail frequency; an even closer network would be needed to study finer details of individual hailstorms. Such a network of weather stations is impracticable because of the high cost.

HAIL SIZE AND DISTRIBUTION

1. INTRODUCTION

The Environmental Protection Research Division of the Quartermaster Research and Engineering Command is interested in the effects of environment on men and materiel. The Environmental Analysis Branch evaluates the environmental factors relating to military needs and design. In this context, hail is considered a military problem.

Hail is an inadequately observed and reported weather phenomenon. There is no part of the world, except small areas where microclimatic studies have been made, where surface data on hail storms are sufficient to give an accurate picture of their frequency and distribution. Even where hail is reported, the type and size of hailstone that falls is not classified. The lack of universal requirement that observers report classification of hail (e.g., graupel, small hail, and true hail) thwarts any attempt to draw even annual average distribution lines on any world-wide scale. Weather observations from ocean weather stations with their coverage of only fragmentary portions of ocean areas tell little of hail hazards at sea, although it is known that hailstorms are less frequent over the oceans. Important effects of geographical differences upon hail size and distribution that are in need of investigation cannot be determined by analyzing the available frequency data.

However, useful information can be derived by the assembly and compilation of all the observations on surface hail that are available around the world.

Because the requirement exists that military equipment will have to operate in environments where hail is common, the problem of hail is one to be considered in establishing criteria for military design.

The information available, pertinent to an investigation of the effects of hail on military equipment on the ground, consists mainly of tables of days of hail for 656 weather stations throughout the world (Appendix A). There are also tables of days of hail and thunderstorms for 25 stations in the United States that had the greatest hail frequency during a 40-year period. Accounts of loss and illustrations of destructive hailstorms that have damaged stationary and mobile equipment are included in this report.

Although the study of hail is a microclimatic problem that cannot be adequately solved without closer networks of radar detection and surface reporting stations, this report should be an aid in answering general inquiries and in delineating areas of greatest hail frequency anywhere in the world.

2. Types

Hail is usually classified in three types: "graupel" or soft hail, small hail, and true hail. Soft hail and small hail often occur without thunder, and generally in winter months or in high latitudes. Soft hail is usually accompanied by snow and is crumbly; it ranges in size from coarse shot to small peas. Very little, if any, damage results from soft hail. Small hail is harder than soft hail, but because of its size, ranging from only about .08 to .2 inch in diameter, causes no appreciable amount of damage. The only type of hail to be considered from the standpoint of destruction is that larger than .21 inch in diameter — true hail.⁵⁰

True hail, the type with which this report is mainly concerned, falls almost exclusively in violent thunderstorms, but never when surface air temperature is below freezing.³

The type of hail to fall generally depends upon the altitude of the 0° C isotherm. If the isotherm is close to the ground, either small hail or graupel is formed. If it is higher, above approximately 4 km. (2.5 mi) with surface temperatures in the 80's (F) (26.7° to 31.7°C) and cumulonimbus clouds present, true hail is likely. When the isotherm is still higher as in tropical regions, and after midsummer in the temperate zones, hail seldom reaches the ground. This, some meteorologists claim, explains the relative scarcity of hail in the tropical regions and in low latitudes.²⁶ The excessive heat in the lower layers of the atmosphere melts the hailstones before they reach the surface. True hail is developed only when the cumulus cloud penetrates the 0° C isotherm and extends upward to about the -20° C level, thus insuring the formation of super-cooled droplets, ice crystals, and snowflakes. Hydrometeors in one or more of these forms are necessary for formation of all types of hail.

3. Occurrence

Hail occurs under two general conditions, either during instability showers in a single air mass or during frontal activity between two or more air masses. Frontal activity in the spring causes the annual maximum occurrence which diminishes gradually as convective-type summer storms take over.

Frontal activity of the cold-front type is most productive of hail; the most popular breeding grounds are the squall-line area of the active cold front. As the squall-line weather is caused by convergence rather than pure lifting by the front, it results in the possibility of the rapid vertical divergence necessary for the development of cumulonimbus clouds and hail.

Instability showers generally occur as two different types: afternoon convective or "heat" showers, and those resulting from orographic lift.

The convective storm is developed from heat given off by the earth's surface due to solar radiation, which causes an unstable condition with warm air under cold air. The orographic type of instability shower occurs when air moves up a slope to the cooling level of condensation.⁴⁶

A hailstorm is usually of the same duration as a heat shower, lasting up to approximately 30 minutes, with about 15 minutes as an average. The area covered by an intense hailstorm varies considerably, but the more severe storms often extend over 1 to 2 square miles. Damaging hailstorms may occur any time during the 24 hours, but most occur between 1500 and 2100 hours.²⁷

4. Formation

Hail may be considered in two classes according to hardness of centers: soft (graupel) and solid ice. It is generally accepted that a solid ice center results from the development of a water droplet, which is carried aloft by vertical currents into a region where temperatures well below freezing change it from a supercooled drop to a frozen pellet which becomes the nucleus of a hailstone. Soft-centered hail probably starts as a snow or ice crystal which collides with super-cooled droplets to form a graupel or soft-hail nucleus.

There are three principle theories on the actual growth of hailstones; the multiple-lift method, proposed by Humphreys,⁵ Brunt,⁷ and Grimminger;¹⁸ the long-fall method, favored by Byers,⁹ Schumann,³⁵ and Bilham and Relf;⁴ and a combination of the two.²²

The multiple-lift theory presupposes high vertical velocities which raise large drops high above the 0°C isotherm, to form small hailstones. The stones fall out of this upper region, hit another updraft, and are carried back to the upper freezing levels. The layer structure of the concentric spheres (Figs. 1 and 2) is explained by several repetitions of the process. This theory assumes there are air velocities capable of stopping the fall of hailstones as large as 2 or 4 inches (7.62 or 10.16 cm) in diameter and lifting them. During the growth of the hailstone, it drops from the ice-crystal level down through the super-cooled area, building up a translucent shell. A stronger current in the form of a gust blows the stone up again into the area of ice crystals and snowflakes, where it is coated with an opaque layer. Thus the number of layers found on a hailstone is a record of its history, as the concentric rings in the cross-section of a tree trunk are a record of its growth.

The long-fall theory presupposes the growth of the hailstone in one continuous fall, during which it captures super-cooled water droplets that lie in its path through the subfreezing areas. The vertical speeds of air need not be as great as those required by the multiple-lift theory to build large stones. Speed is still a main factor, however. The stone always continues downward; its fall may be slowed almost to a stop at times but



Figure 1. Hailstones with concentric rings, Richmond, England, 8 July 1891 (from Hann and Suring19).



Figure 2. Hailstone showing concentric ring formation, Iowa City, Iowa, 18 June 1940 (photo by C.A. Laird and R.E. Lynett).

a great lift back to upper levels is not necessary. The most important circumstance seems to be the concentration of the super-cooled droplets between the initial point and the 0°C isotherm. One explanation is that the types of layers are determined by the surface condition of the stone as it comes in contact with the super-cooled droplets.¹⁶

Humphreys' experiments in wind tunnels, pilots' flights into thunderstorms during the U.S. Weather Bureau thunderstorm project in Ohio,¹⁰ and the application of mathematical laws in the thermodynamic (multiple-lift) process of hailstone growth, yielded information on the complexities involved in producing hailstones of myriad shapes and structures (Fig. 3). Of considerable importance is the maximum size of hailstone that can be formed and its terminal velocity.

Table I, from Bilham and Relf,⁴ gives data on the aerodynamics of large hailstones. They set the theoretical maximum hailstone at about 1.5 pounds, with a diameter of approximately 5.2 inches.

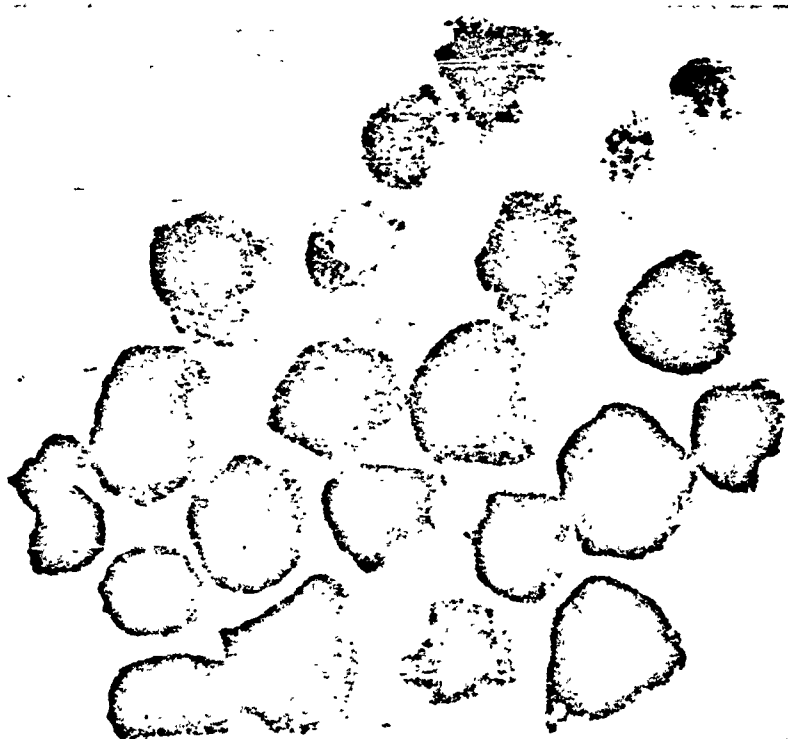


Figure 3. Irregularly-shaped hailstones (actual size). Washington, D.C., 24 April 1959.

TABLE 2. Terminal Velocity of Hailstones*
(Specific Gravity = 0.6)

Elevation (ft)	Air Density	Air-static Viscosity	Weight of Stone (lb)	Diameter of Stone (in)	Terminal Velocity (mph)
0	0.00237	0.000183	1	4.50	96
4,000	0.00221	0.000180	1.25	4.75	104
10,000	0.00203	0.000175	1.57	5.03	114
15,000	0.00189	0.000173	1.92	5.30	126
20,000	0.00176	0.000172	2.28	5.50	139

From Wilman and Felt

*Elevation above earth's surface

Bilham and Relf drew these conclusions from their calculations:

(1) There is a sudden and very large increase in the terminal velocity when the hailstone attains a diameter of about 4.5 inches.

(2) Hailstones will grow as long as they are in a region where ice can be deposited; under otherwise equal conditions, the time spent in the region will determine the size.

(3) The time spent in the region will be governed by the velocity of the hailstone in relation to the upward current.

Schumann³⁵ considers the theory of thermodynamic hailstone growth. He claims that in the growth of the hailstone by the capture of super-cooled water drops which lie in its path, the principal factors are average density, height at which the nucleus is formed, average upward velocity of the air, and concentration of condensed water in the region of the atmosphere where the temperature is below 0° C. He also asserts that the heat of fusion of the water which solidifies on the surface of the hailstone is effectively dissipated, partly by conduction to the surrounding atmosphere, but mainly by evaporation from the surface of the hailstone. However, as the stone reaches the 0° C isotherm, it can no longer rid itself of its surplus heat of fusion, and thus its growth and ultimate size are retarded. Schumann concludes that, with a vertical wind velocity of only 18 mph and a concentration of condensed water of 13 gm/m³ (.35 oz/yd³) a hailstone can be formed with a specific gravity of .6 and diameter of 3 inches.

Gerson¹⁷ states that while the nucleus remains in the below-freezing zone, it acquires a more or less concentric shell of rime ice by: 1) fusion of colliding super-cooled water drops, 2) congelation of impinging ice particles, and 3) sublimation of water vapor. This theory closely parallels that of Humphreys.

L. Harrison²² discusses the effects of differential liberation of latent heat of fusion and sublimation in the attending vertical fall of ice particles through a cloud of super-cooled water droplets. After discussing the development of a cumuliiform cloud into a cumulonimbus and the formation of water droplets, Harrison explains the growth of hailstones with emphasis on thermodynamic factors. He states that two concurrent related mechanisms exert a profound influence on thermodynamic conditions in the transformation to a cumulonimbus cloud: 1) liberation of latent heat of fusion and 2) liberation of latent heat of sublimation. Harrison combines factors of both the multiple-lift and long-fall theories. He believes the region between the -4°C and the 0° C isothermal layers and possibly extending downward to the 4°C layer is the region of maximum growth of hailstones. Harrison also explains in detail the action of liquid and frozen hydrometeors on the vertical currents of a cumulonimbus cloud.

Gaviola and Fuertes¹⁶ discount the necessity of strong ascending currents in clouds for hail formation. They calculate the time and speed of fall of growing hailstones in a standard atmosphere at rest. The time of fall through the first 4 km (2.5mi) is calculated to be about 5 minutes. They explain the alternate layers of opaque and clear ice as the result of the surface condition of the stone, i.e., a wet surface gives a transparent layer and a dry surface gives an opaque layer. They give a tentative description of the growth of large hailstones, explaining how ascending motion, turbulence, electrical phenomena, higher absolute humidity, and greater cloud heights permit growth of larger hailstones. They claim there is no evidence of vertical currents comparable in speed with that of falling hailstones.

Brers and Prasad,¹¹ in many observations of thunderstorms over Florida, found no vertical speeds greater than 100 ft/sec. However, it must be noted that very few hailstones reach the ground in Florida.

Gerson¹⁷ states that the degree of wetness of hail is determined by factors which control the heat transfer in the immediate vicinity of the hailstone during its life. He lists these factors: 1) initial temperature, mass, and physical properties of the stone, 2) integrated changes in the temperature, mass, and physical properties of the stone over the time considered, 3) relative velocities of the stone and surrounding air, 4) conditions of the surrounding air, including temperature, liquid water and water vapor content, and 5) pressure, number, size, mass, temperature, and impurity concentration of the drops of water.

One of the interesting subjects in the study of the formation of hail is the consideration of the irregular shapes, discussed by Arenberg.¹ He points out that Hann¹⁸ publishing a photograph of an odd-shaped hailstone, states that such stones appeared to be segments of a sphere, formed by explosions of balls of ice. Arenberg calculated the rate of heat loss from a sphere, assuming a steady state condition, and arrived at the nucleus size which could be frozen during a specified period of time. Coordinating his theory with Schumann's work, Arenberg assumes the nucleus to be a large rain drop which has begun to freeze. He also assumes proportions between solids and liquids that would maintain the spherical form. Since solid crystals prevent convection, the outer layer would freeze first. Collection of super-cooled droplets by the outer surface would maintain the stone's temperature at 0° C throughout. However, further growth would take place due to conduction, to freeze the liquid inside. Also, due to increased pressure, the freezing point would be slightly lower at the center than at the surface. If a hailstone that has reached 1½ to 2 inches in diameter is suddenly transformed upward to a point where the center begins to freeze, the change of state would develop tremendous internal pressure. Thus the stone would explode, forming polygonal pyramids with spherical bases (see Fig. 3). Arenberg supports his conclusions by using information on the tensile strength, modulus of elasticity, and compressibility of ice at low temperatures.

Johnson²⁴ states that examination of some broken pieces of hail shows plainly that they are fragments of a larger spherical stone of about 30 mm (1.1³ in) in diameter, in which the opaque and translucent layers alternated every 2 mm (.08 in). He concludes that the shattering took place at a high altitude and was caused by a pressure wave set up by a bolt of lightning that passed near the hailstone as it fell.

5. Frequency and Distribution

Accuracy in plotting distribution and frequency of hail throughout the world is limited by the scarcity of reports and the failure to identify the types of hail. However, data from 656 weather stations throughout the world have been tabulated in Appendix A.

Table III (Appendix A) shows total days with hail at 220 cities in the United States, with periods of observations ranging from 7 to 40 years (see Map 4 in Appendix B for weather station locations).

Average number of days with hail at 436 stations throughout the remainder of the world are shown in Tables IV through VII. Observation periods range from 2 to 36 years: at some stations the number of years of observation is unknown (see Maps 4 to 8 in Appendix B for station locations).

The 25 United States stations that have received more than 25 days of hail during a 40-year period were selected for a tabulation showing days of hail by years from 1940 through 1949 (Table VIII) and days of thunderstorms in the same years (Table IX).

Tabulations of hail from hourly observations at 20 airport stations have been made, but the number of occurrences reported were no greater, and in some locations fewer, than those received from 4-times-daily observations at U.S. Weather Bureau first-order stations. These tables, therefore, are not included in this report since they record hail only at the actual moment of observation, while reports from the regular Weather Bureau stations include accounts of hail at any time during the 24 hours.

The records of days of hail for North America were assembled at the U.S. Weather Bureau from published summaries, and where such summaries were unavailable, from original records.^{44, 48, 49} Various periods of records have been used because they represent the only data that could be found. Most records for foreign countries stopped during World War II when the distribution of climatic reports was discontinued. The sources of data in the tables for areas outside the United States are generally the same as those listed in the Weather Bureau's Index of Climatic and Weather Data.⁴⁷

Because of the inadequacies of hail reporting due to wide spacing of stations and the small area covered by a hailstorm, the tables are presented as an indication of the type of data available and a guide to the location of the stations where records have been kept.

Many studies containing detailed analyses and research have been made for individual countries. These studies, listed and abstracted in Meteorological Abstracts and Bibliography, April 1950,²⁹ and not listed in the references here, furnish information on the techniques employed by individual countries in meeting their particular problems of reporting and analyzing hail distribution. Examination of these publications for areas outside the United States, however, shows that the problems faced in this country exist all over the world, and that no practical method of hail reporting has yet been employed anywhere except in isolated microclimatic studies conducted in selected areas. The expense involved in installing a network of reporting stations that would provide detailed observations would be too great for practical return.

The distribution and frequency of hail as shown in the tables, therefore, must be interpreted without definition of type or size of hail that falls. Records are not published for many stations that experience hail. It becomes necessary therefore to substantiate the information given in the tables by statements from researchers who have had access to original, unpublished records. In many areas throughout the world where no tabulated observations of hail are available, written accounts describe hail occurrences. This is particularly true of desert areas in Africa, and equatorial islands in the Atlantic and Pacific Oceans where hail is extremely rare.^{33, 36, 51}

Summaries and interpretations of the tables, by country or area, are given below:

United States (Table IV and Map 4)

Hail frequency and distribution are covered in detail by Flora (1956)¹¹ who describes frequency in more detail than is required in this report, and analyzes hail conditions and damage to crops and property, state by state.

The tables of hail in this report provide a general coverage for the United States showing hail frequency by months for 220 stations. The greatest frequency for most of the country except the southern states and West Coast is in the spring; in some of the Plains states, Iowa, Minnesota, and Nebraska, and the plateau state of Wyoming, maximum frequency is in mid-summer. The Pacific coastal stations experience hail most often during the rainy season, November through March. (North Bend, Wash., had 224 hailstorms in a 10-year period, a record for the United States.) However, the hail that falls there is soft hail or graupel and therefore is not damaging. Inland stations with higher elevations do have destructive hailstorms that at times damage crops and property.

For the stations among the 220 in Table III that have had a total of 175 or more days of hail in the 40-year period 1910 to 1949, data have been tabulated from 1940 to 1949 in order to show the variation in frequency by years (Table VIII). At many of the stations, such as Omaha, Neb., and Rapid City, S.D., where the 10-year total frequency is low, some months during the hailstorm season are free of hail for one or more years. At

stations such as Cheyenne, Wyo., however, from 1 to 7 hailstorms are recorded for June and July every year during the 10-year period.

Damaging hailstorms are most frequent in the Mississippi Valley plains states and the High Plains east of the Rocky Mountains. This area is generally referred to as the "hail belt" of the United States.

Canada (Table IV, Map 4)

Hail is relatively infrequent in Canada. In the areas of greatest frequency, the Prairie Provinces and the region of the Great Lakes, an average of 2 hailstorms a year is experienced.

Mexico (Table IV, Map 4)

In Mexico, altitude greatly influences hail frequency. Low-lying coastal places such as Tampico, Salina Cruz, and Mazatlan report an annual average of one day or less. At mountain stations such as Mexico City and Saltillo, both above 6,000 feet elevation, the frequency greatly increases; Mexico City has an average of 6 days, and Saltillo 18 days, per year.

Alaska and Greenland (Table IV, Map 4)

In these high latitudes, hailstorms occur with varying frequency from October through June. The hail is soft hail or graupel, not damaging to property. At Nome, Alaska, hail has been recorded a total of only six times from 1931 to 1933, and then the falls were very light.²⁶

Scandinavia (Norway, Sweden, Denmark, Finland) (Table V, Map 5)

In these countries, which are above the latitudes where true hail of destructive size falls, hail occurrence is of minor importance. Trondheim, Norway, and Vestervig, Denmark, report 13 and 10 days a year, respectively, while other stations average 1 to 8 days. The occurrence is greatest in spring, fall, and winter at the North Atlantic coastal stations when cold-frontal storms from the Icelandic quasi-permanent low pressure area occur frequently. In Sweden, the occurrences noticeably diminish on the side of the mountains protected from the North Atlantic storms. Finland experiences hail infrequently but it occurs in every month of the year. Denmark has a monthly average of 3 to 5 days of hail in the spring and fall while in the summer it is practically non-existent.

British Isles (Table V, Map 5)

Throughout the British Isles hail occurs with varying frequency; a minimum of 4 days annual average is recorded at York in northern England and a maximum of 28 days at Malin Head on the northern coast of Ireland. From October through May the frequency varies from 1 to 5 days per month with December and January showing the highest average at all stations. This

frequency is related to seasonal storms blowing from the North Atlantic Ocean. In the summer when the cold frontal storms diminish, hail frequency is at a minimum: one day or less a month from June through September.

Central Europe (France, Belgium, Germany, Czechoslovakia, Austria, Hungary, Switzerland, Poland, Rumania) (Table V, Map 5)

The hail frequency pattern for France and Belgium resembles that of the British Isles, particularly at low elevations. There are fewer hail occurrences in these countries, but the influences producing winter maximum and summer minimum are the same. Progressing into the interior, the coastal hail pattern influenced by Atlantic storms changes to one under continental air mass and land-heating climatic controls. This gradually alters the seasonal pattern to spring or summer maximum and winter minimum. The summer increase in frequency is apparent in the middle European countries of Austria, Hungary, Rumania, Poland, and Czechoslovakia.

Mediterranean Countries (Spain, Portugal, Italy, Turkey, Greece, Yugoslavia, Albania, Cyprus, southern France, Dodecanese Islands, Israel, Morocco.) (Tables V, VI and VII, Maps 5 and 7)

The area between the mountain ranges of the Pyrenees, Alps, and Caucasus and the deserts of Sahara and Arabia in the south has mild, more or less rainy winters and long, hot, and dry summers - a climate usually characterized as the "Mediterranean type." Within this general type there are many variations depending largely on the topography. Hail occurs mostly in the winter and spring, the spring maximum being more pronounced in the European countries that border the sea on the west. The bordering European countries average about 1 to 5 hailstorms per year. Data for Israel and Morocco show an average of 2 to 3 days per year. In Egypt and elsewhere in North Africa, there are many accounts of severe hailstorms where large hailstones have done great damage to property and caused serious injury to animals and men.

The Azores (Table V, Map 5)

The Azores experience hailstorms in winter. At Ponta Delgada no hail occurs from May through September; at Horta there is occasional hail in the summer. The annual average of 3 days is the same as that along the coast of Spain.

U.S.S.R. (Table VI, Map 5 and 6)

The average of hail storms throughout Russia is 1 to 2 days per year. Continental climatic influences are apparent in the hail pattern which shows a summer maximum at all the stations. Since most of the area lies north of 50°N Lat. where destructive hailstorms seldom occur and the hail that falls is usually graupel, it is probable that destruction to property by hailstorms is not a disturbing problem.

Japan, Okinawa, Formosa (Table VI, Map 6)

These islands have a low frequency of hail; they average about 1 day a year except for Hakodate and Sapporo in Hokkaido (Northern Japan) which average 12 and 7 days respectively.

China, Manchuria, Korea (Table VI, Map 6)

Very little hail is reported in China. The average of 1 day a year may be too low because of incomplete records. It is reasonable to assume, however, that it is of minor importance in this area. Manchuria and Korea average about 2 days of hail a year, occurring mostly from spring through fall.

Chile (Table VII, Map 7)

Hail occurrence varies greatly in Chile, ranging from 1 day or less annually at many of the stations to 7 days at Valdivia and 11 days at Isla Guafo. From December through April the occurrence is very rare.

Argentina, Bolivia, Uruguay (Table VII, Map 7)

In Bolivia, hail occurrence ranges from an average of less than 1 day to 11 days per year, with maximum frequency in the winter. Deriego, Uruguay, only station in the country with hail records, shows an annual average of 4 days of hail; only April and October are free of hail. Argentina has an annual average of 3 days; hail occurs in almost all months of the year.

Brazil (Table VII, Map 7)

Brazil has little hail. An average of 1 or 2 days of hail a year occurs except at high elevations. At Itatiaya (approximately 9,000 feet elevation), a total of 8 days with hail in 6 years occurred from August through March. At Porto Alegre (at sea level), hail has been reported only in May, with an annual average of 3 days.

Africa (Table VII, Map 7)

Hailstones of great sizes have fallen in many parts of Africa, even in the Sahara Desert. Hail is remarkably frequent in the Cape of Good Hope and Transvaal (provinces in the Union of South Africa), and is at times most destructive.

According to Brooks,⁶ some of the hailstones may be as large as cricket balls and weigh 1.5 pounds each; they kill sheep and cows, and pierce corrugated iron roofs as if they were paper. Tables are not available for all sections of the continent. For countries that have published records, the data are possibly conservative since stations are so far apart.

Statistics for French West Africa showing almost no hail are not representative of the area as a whole; in regions of high altitude, the frequency is 8 or 10 storms a year.

Hail seldom occurs along the Ivory Coast. Bobo Dioulasso reports no occurrence in 6 years. In the northern part, hail is occasionally experienced.

No hail storms occurred along the Gold Coast during 15 years of observation. The data at Accra are representative of the area as a whole.

In Kenya, 4 days annual average is reported.

In Mozambique, less than 1 day of hail a year occurs.

In French Guinea, less than 1 day of hail a year occurs.

Australia and New Zealand (Table VII, Map 8)

According to Visser,³¹ about one hailstorm a year is experienced in the northern part of Australia. Hail has been observed on very rare occasions on the semi-tropical northern coast of Australia. There is on record a particularly severe hailstorm at Wyndham, December 1938, with heavy thunder, gales, and large hail.³² At some distance inland, hail occurs more often.

Hailstones are more frequent in Southern Australia than in the north. The annual average at Melbourne is 7 and at Adelaide 6. Hail along the coast is usually small and occurs in conjunction with cold front storms, usually in late winter and early spring. Severe storms with large hail usually occur farther inland in the summer when thermal thunderstorms are frequent.

New Zealand has an average of 2 hailstorms a year.³³ Hail is not a major problem in any of the tropical islands in the Pacific.

6. Hailstorm Observation

The study of hail storms, although inadequately supported in the past, is now being emphasized with great determination by various agencies. One method of studying hail is by use of radar and radarscope photographs. The great increase in commercial and military flying and the increased speeds of high-altitude aircraft have concentrated attention on the analyses of radarscope photographs for the detection of hail within storm clouds. The previous inability to observe hail within storm clouds now may be overcome; certain protuberances and shadings in the precipitation shadow on the radarscope or the point where shadows converge, have been found to be associated with hail formation. United Air Lines observers in a study of the Denver area (considered later in the report) found significant correlation between the "hail finger" protuberances and the occurrence of hail; researchers at Massachusetts Institute of Technology are not so firm in their conclusions

since 1) they have had little hail to study in the Boston area, and 2) every thunderstorm radarscope has irregularities of protuberances very difficult to analyze. Therefore, the only thing that a forecaster can say, even with the aid of a radar screen, is that there is a possibility of hail; he has less assurance of its occurrence than he does of the rain showers.

Observations made by the U.S. Weather Bureau thunderstorm project¹⁰ in Ohio with an AN/TPS-10 radar showed the most frequent appearance of the first radar echo at 1,000 feet above the freezing level (about, -2° C). Workman and Reynolds,⁵³ found in New Mexico that the first echo received by an AN/APQ-13 radar from the growing cumulus was centered at about -10° C. The discrepancy between these two is ascribed to the difference in detection capabilities of the two sets and to geographic differences.

Wexler,⁵² in computing the growth of precipitation particles in cumuli-form clouds and determining thereby the theoretical first appearance of radar echoes, found his theory in agreement with Workman and Reynolds' observations on the behavior of the first radar echo. Wexler's theory also explains the simultaneous ascent and descent of the echo after its first appearance as follows: "The echo ascent is caused by the detection of hail at successively higher levels in the cloud; the echo descent is caused by the descent of the first detectable hail through the updraft."

Numerous other investigators, among them Stout and Hiser,³⁸ and H.T. Harrison,⁴¹ have been studying the possibilities of hail detection through the interpretation of radar echoes in thunderstorms.

A great deal of study is still to be done in the interpretation of radar-scope shadows before the shape and section of the storm cloud where hailstones form can be identified in all regions where hailstorms occur. More complete thunderstorm-hail-upper-air observations are necessary before we can analyze other problems of hailstone development.

Records of radar detection of hail are becoming more numerous with the installation by the Department of Defense and other agencies of radar stations at airports, weather stations, and various research organizations. Eventually it may be possible to overcome the inadequacies of existing surface hail observations by providing more conclusive upper air meteorological observations on the characteristics of hailstones as they form, so that size as well as frequency may be forecast.

Statistical treatments of available data designed to arrive at areal frequency distributions are constantly being refined, tested, and published. The testing of such analyses must await the accumulation of accurate and more complete surface and radar observations.⁵⁹ Techniques for forecasting hailstone size have been developed by Fawbush and Miller¹³ and Foster and Bates.¹⁵ Empirical treatment of such a complex problem, however, is only one step toward a final solution, and the accuracy of forecasting hail occurrence and the size

of hailstones which may form must depend on additional radar observations from a closer network of weather stations.

Hail-thunderstorm Ratio

Another method of computing possible occurrence of hail for any area is by use of the hail-thunderstorm ratio.⁴² This ratio as developed by Shands³⁷ shows the percentage of days of hail in relation to days of thunderstorm. Map 1 shows that more than two-thirds of the United States has an annual hail-thunderstorm ratio up to 10% (that is, of every 100 thunderstorms, 10 are accompanied by hail). About one-third of the country has a ratio up to 5%. Records from 217 Weather Bureau first-order stations were used in arriving at these ratios. There are occurrences along the Pacific Coast, mentioned by Shands, and in the mountains of the Denver area² where the ratio of hail days to thunderstorm days exceeds 100%, and two stations in Washington state where it exceeds 400% (see Tables VIII and IX). This indicates that hailstorms occur in meteorological conditions other than those associated with thunderstorm cloud formation.⁴⁶

The hail-thunderstorm ratio is a good guide in determining ground exposure in the Central Plains. However, the ratio may be distorted in higher areas where the topography influences the vertical cloud structure.⁴⁷

United Air Lines Hailstorm Study

In 1949 United Air Lines began a microstudy of hailstorms in the Denver area by setting up at random 11 reporting stations; there was already a U.S. Weather Bureau station in the city.

Figure 4 shows the comparison between the Weather Bureau data for days with hail and thunderstorms, and the United Air Lines "unofficial network" data, in the Denver area 1949 through 1955, during the 8 months of the year when hail occurs.

During the first year of this study, with an 11-station network, the ratio of "area" reporting of hail to "point" reporting was 8:1; that is, there were 8 times as many hailstorms reported by the 11 stations as were recorded at the Weather Bureau station. In 1950 the United Air Lines network was expanded from 11 to 40 stations. However, contrary to expectations, during the period 1950-55, there was no increase in the ratio. The tabulation below shows the area frequency vs. point frequency of hail during the 7-year study.

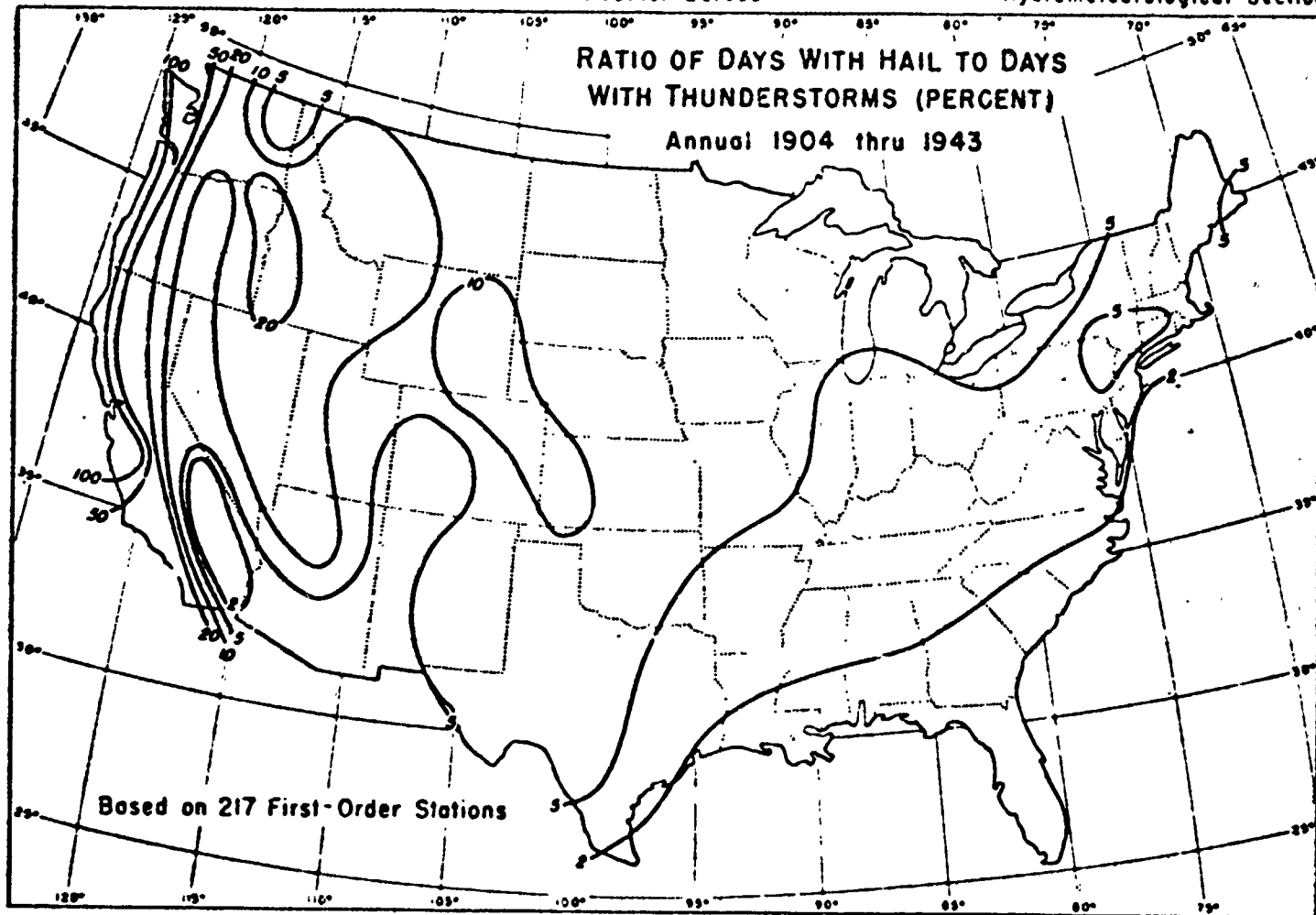
<u>YEAR</u>	<u>RATIO</u>
1949	8:1
1950	8:1
1951	4:1
1952	8:1
1953	3:1
1954	2:1
1955	3:1

U. S. Department of Commerce

Weather Bureau

Hydrometeorological Section

**RATIO OF DAYS WITH HAIL TO DAYS
WITH THUNDERSTORMS (PERCENT)**
Annual 1904 thru 1943



Based on 217 First-Order Stations

Map 1

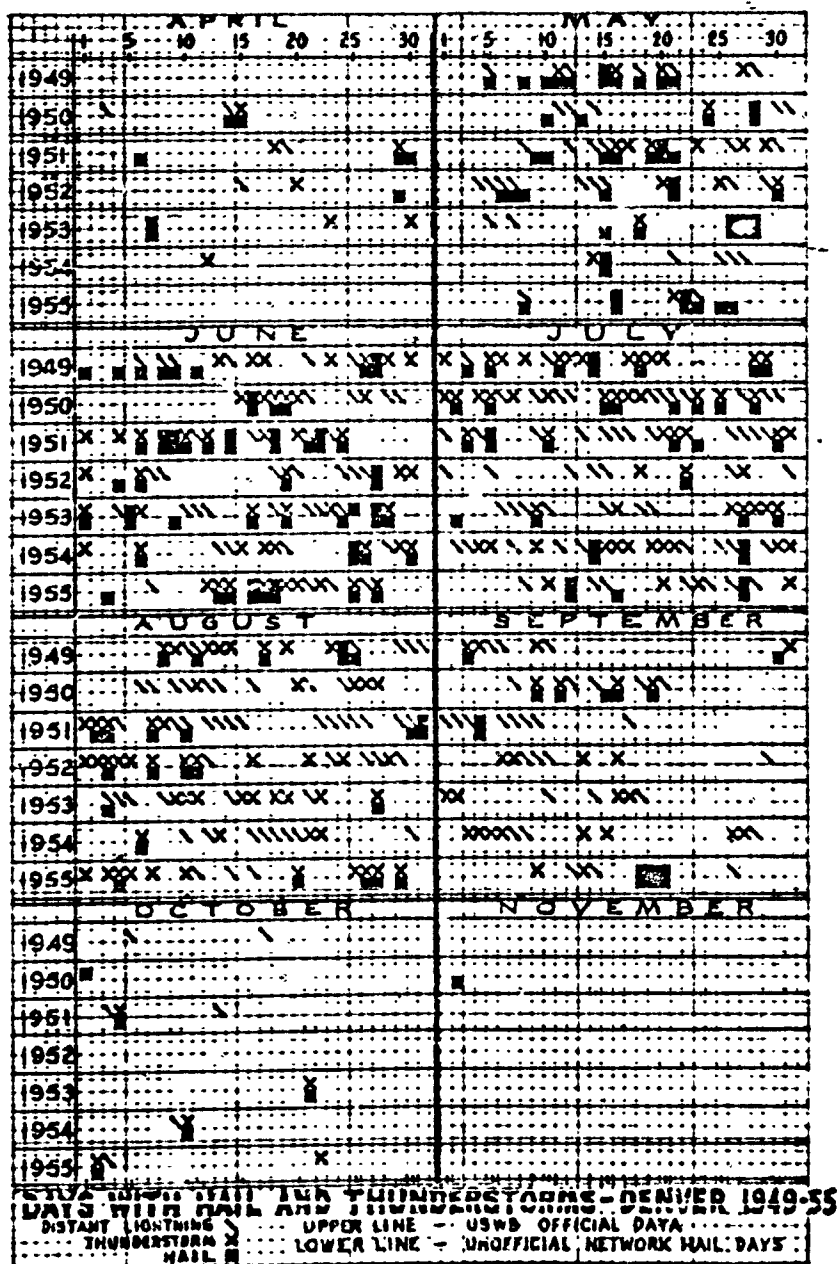
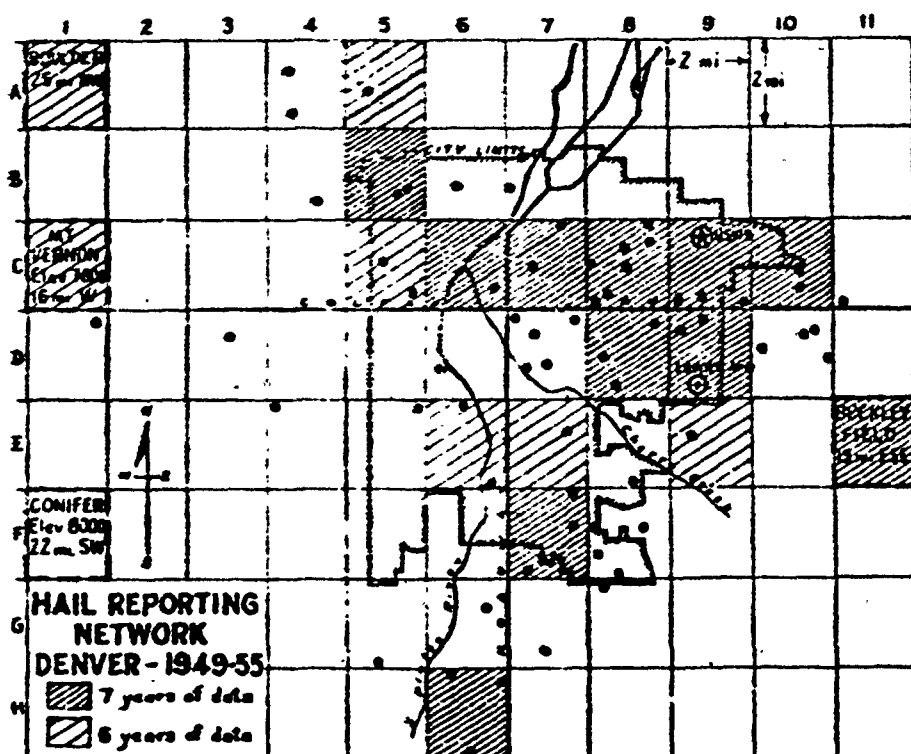


Fig. 4 Plot of days with hail and thunderstorms in the Denver area. Official and unofficial hail days are indicated. Thunderstorm and distant lightning occurrences are based on official records from the U.S. Weather Bureau—Stapleton Airfield Station.

According to Beckwith,² the low ratios of 1953 and 1954 were coincident with dry summers; the relatively low ratios of 1951 and 1955 were the result of a high incidence of hail at the Weather Bureau's station.

Point reporting at other stations in the network falls into a pattern consistent with the official frequencies as illustrated in the above table. For an identification of the grids representing 4-square-mile areas that were used in the unofficial hail reporting network for the Denver area, see Map 2. If individual stations other than the official Weather Bureau station are used as the base for an area-to-point ratio of hail, results are not significantly changed (Table II and Map 2)



Map 2 Unofficial hail reporting network for Denver area 1949-1955. Grids with 6 and 7 years of data are cross-hatched. Black circles are reporting points which have existed for one or more hail seasons. Grids representing Boulder, Mt. Vernon, Conifer, and Buckley Field are not shown to scale, but are indicated in relation to the intersection of Colfax Avenue and Broadway.

TABLE II: Comparison of Area with Point Reporting, Selected Stations.

Grid (Reporting Station)	Number of Hail Days							Average Area-to- Point Ratio
	1949	1950	1951	1952	1953	1954	1955	
C-9 (Weather Bureau)	4	3	9	2	7	4	9	4.3:1
E-11 (Navy, Buckley Field)	8	5	6	3	5	2	3	5.1:1
D-9	*	*	8	3	7	4	10	3.3:1
E-7	6	5	10	3	2	1	*	5.0:1
C-7	*	3	9	2	4	1	7	5.0:1

*No data

Estimates have been made by earlier investigators and United Air Lines that 1 installation for each 4 square miles would be necessary to produce reliable figures for area hail frequency. The cost of equipping and maintaining such a close network over a large area would be prohibitive. An even greater density of reporting stations would be required, however, for studying the finer details of individual hailstones such as size, distribution, and the dimensions of hailstone patterns. Accuracy of reporting at present appears to be achieved only under the controlled conditions of micrometeorological study.

Hailstone Size

Size of hailstones is of minor importance to farmers; hail of small size can be very damaging, depending on the stage of growth of plants and force of the driving wind. However, in design of military equipment, the size of the hailstone is the most important factor to consider.

Eliot¹² reports on the frequency of hailstone sizes in 597 storms in India:

	<u>Diameter (cm)*</u>	<u>Frequency (%)</u>
Not larger than pea	<0.6	27
Between pea and small lime	0.6 to 3.0	51
Larger than small lime	>3.0	22

*.6 cm = approx. .2 inch
3 cm = " 1.2 inch

He states: "It is probable that only a small proportion of the hailstorms in which the hailstones are of small size are reported. The number of these storms given in the preceding statement is almost certainly of no value for the purpose of comparison."

The frequency of 27% for occurrence of the smaller-size hailstones does seem too low in comparison with the frequencies of the larger sizes.

Hann and Suring¹⁹ summarize the distribution of hailstone sizes in Central Europe as follows:

<u>Size</u>	<u>Diameter(cm)*</u>	<u>Frequency</u>
Up to 2 or 3 cm diam	Up to 2 or 3	Most common
Pigeon eggs	4	Especially heavy storms
Hen eggs	5	Even heavier storms

It can be seen that it is impractical to plot distribution of masses or sizes from this type of information.

Gerson,¹⁷ grouping all the most common ranges of stone sizes measured by various investigators on the ground shortly after the fall of hail, produced the following comparison between selected regions:

<u>Region</u>	<u>Most Common Sizes (diam)</u> cm*
United States	1.0 to 1.8
Missouri	0.6 to 1.3
Central Europe	2.0 to 3.0
France	0.5 to 2.0
India	0.6 to 3.0

From this tabulation it appears that Central Europe experiences large hailstones more frequently than the areas with which it is compared, although the frequency of hailstorms is greater in the United States, as shown in Tables III and V.

However, according to the study conducted by the United Air Lines in Denver, the occurrence of large hailstones is more frequent than reported. In 1939, United Air Lines reported that hailstones the size of walnuts or larger were encountered in only 1 out of 800 thunderstorms that occurred along or near their route between Colorado and Illinois.⁴² The 1949-55 micrometeorological study of hail in the Denver area showed 39 occurrences of hail the size of walnuts were reported in a total of 2,639 storms.

*Approximate values in inches are:

.5 cm	= .2 inch
1 cm	= .4 "
2 cm	= .8 "
3 cm	= 1.2 "
4 cm	= 1.6 "
5 cm	= 2.0 "

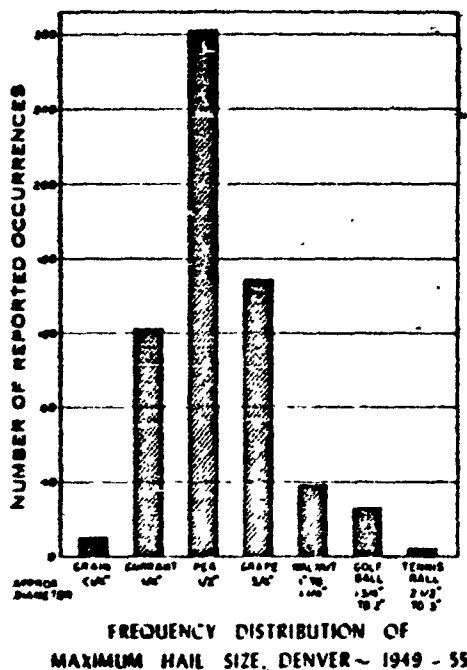


Fig. 5 Frequency distribution of maximum hail size reported in the unofficial network 1949-1955. This shows the number of cases reported of each hailstone size, the observer indicating only the largest stones observed in each report (courtesy of United Air Lines).

is extended to upper air levels, in damage to aircraft, occasioned largely by the difficulty confronting the forecaster in giving pre-flight advice to avoid hail.

In considering the advisability of establishing criteria for the design of military equipment, it is necessary to examine only the area around the world between 30° and 50° N. latitude. This is the belt of greatest frequency and within this belt lie the areas where occur the greatest damage to crops and equipment.

Figure 5 shows the frequency distribution of maximum hail size in the Denver area during the period of study, and Figure 6 shows the hail size by month for the same period.

With growing evidence that hail exists at some level in the majority of thunderstorms, the forecaster needs to estimate the size and type of hailstones. It is apparent that the frequency of destructive-size hailstones, i.e., the size of walnuts or larger, is much greater than has been heretofore considered.

To estimate in general the frequency of damaging-size hailstones is an impossibility at the present time. More exhaustive analysis of meteorological conditions that produce large hailstones is constantly being made, so that the forecaster or designer of military equipment may in time be aided by a surer knowledge of the areas where these conditions are apt to develop most frequently.^{40,41}

8. Damage

Hailstorm destructiveness in varying degrees of frequency and intensity is experienced in all latitudes of the earth, from the tropical to the Arctic, and in all heights from sea level to mountainous elevations. The destructiveness

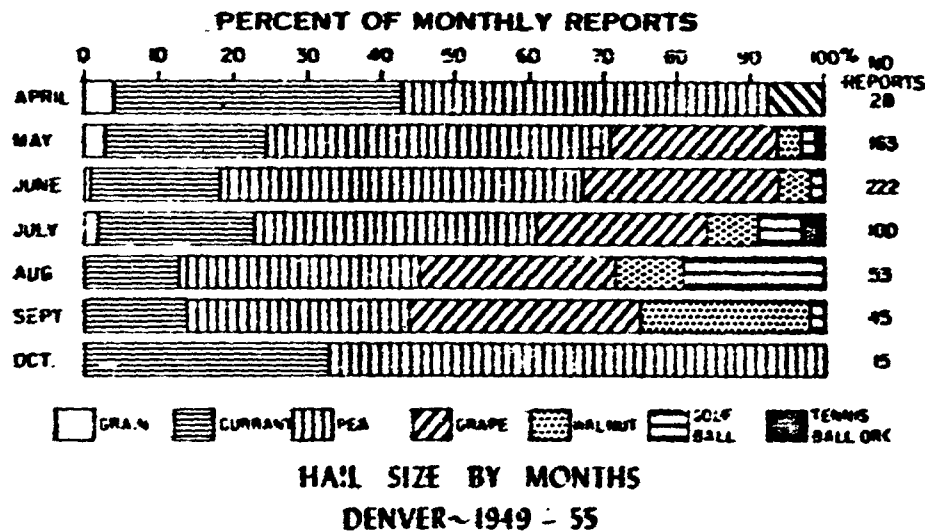


Fig. 6 Distribution of hail size by months, based on unofficial network data 1949-1955. As in Fig. 5, these graphs are on the basis of the largest stones observed in each incidence of hail reported. (Courtesy of United Air Lines)

In the Arctic, the hail that falls is infrequent and the hailstones is usually graupel, or soft hail, which can cause little or no damage to equipment.

In the tropics, destructive hailstorms do occur, but are so infrequent that there can be little justification for designing equipment to withstand the damage occasionally experienced.

The nature and degree of damage caused by a hailstorm depends on the season in which it occurs, and local characteristics of the damaged area. The most unfortunate circumstance connected with hailstorm incidence is that it occurs with greatest frequency, in the United States, during the season of growing and harvesting crops. The summer is also the time when livestock, machinery, and man's possessions in general are left unsheltered and exposed outdoors. Thus, the occurrence in this season results in increased damage to all kinds of property.

Data for 1940 through 1949 show an annual average property loss exceeding \$5,000,000 and annual average crop damage of more than \$30,000,000 in the United States.* Of all the states suffering damage due to hailstorms, Iowa consistently reported the highest losses.

Recorded losses from hailstorms in the United States are published by the Weather Bureau.^{45, 48, 49} These data on damage include information gathered by insurance companies and news-reporting media as well as that gathered by official Weather Bureau stations. It is reasonably certain that the majority of damaging storms observed have been tabulated by the Weather Bureau, and certainly none of widespread destructiveness has been omitted. The amounts of losses are largely estimates, since it is difficult to determine the proportion of total destruction that is caused by the rain and high winds that usually accompany a hailstorm.

Insurance companies have made careful climatic-statistical studies of the distribution patterns of hail in order to establish risk rates.³¹ In plotting hail frequencies for any year, or the total days for a number of years, there is a spottiness of pattern that indicates variables apparently more important than frequency in arriving at a rating percentage. The data indicate that one hailstorm may be more damaging than several others, depending on wind force, crop maturity, size and number of hailstones, nature of the exposed property, and many other factors

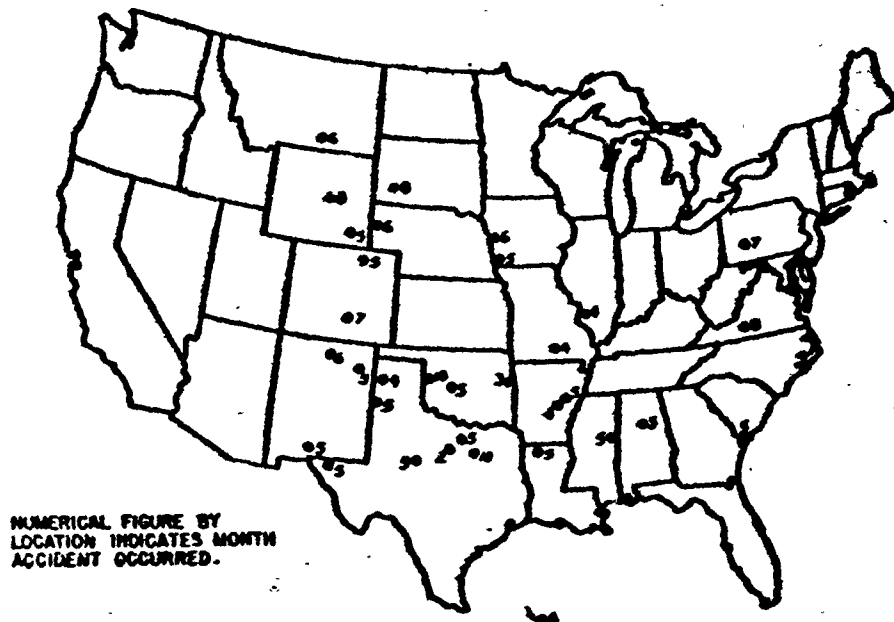
The U.S. Air Force makes studies of hailstorm damage sustained by USAF aircraft.⁴³ Map 3 shows the geographical location and month of damage to aircraft by hail from January 1946 through May 1950. Table X covers the period from January 1946 through May 1948, and Table XI covers the period from June 1948 through May 1950. The tables do not give losses in dollars, but describe weather conditions encountered, and in Table XI, the nature of the damage to the aircraft. In the first period, 62.5% of the aircraft flying through hailstorms received major damage. In the second period, the number was increased to 81%. No mention is made of the size of hailstones encountered.

United Air Lines reports that simulated tests by the Civil Aeronautics Authority in Indianapolis, Ind., resulted in evidence that a hailstone one inch in diameter is about the critical size between damage and no damage to the average modern propeller-driven transport airplane at cruising levels.⁴² Speed of the plane is an important factor, but the hailstone size has greater effect in determining the amount of damage. The CAA tests of simulated hailstones fired at a stationary target produced the following results:

Hailstone		Indentation (in.) on Simulated DC-6 Wing
Diameter (in.)	Speed (mph)	
3/4	260	None measurable
1 1/2	260	.04
2	160	.04

*More than 1,400 North Dakota farmers suffered total crop loss in 1957 because of hailstorms.

HAIL STORM DAMAGE TO AIRCRAFT
(LOCATION & MONTH)



Map 3.

Metal surfaces of DC-6 aircraft stationary on the ground would not ordinarily be damaged by hailstones of the above sizes, because hailstone speeds are far below 160 mph.

In the Weather Bureau thunderstorm project in 1949,¹⁰ hail was encountered on 51 of the 912 traverses through storms in Ohio, the maximum frequency occurring between the 10,000- and 15,000-foot levels.

9. Unusual Hail

Many accounts of unusual hail appear in early literature. Some are too startling to be accepted as authentic; others that do not tax the limits of known physical laws can be accepted as credible.

Evidence of prehistoric hailstones has been found by geologists²⁵ in fossil hailstone casts in coal measures (Fig. 7), where sand or loose soil had sifted over the prints made by hail in soft mud.

Hail in literature

In early (1295-96) literature, there appeared accounts of hailstones the size of a house²⁶ Such exaggerated reports are usually brought about



Fig. 7 Fossil hailstone casts from Natal, South Africa

by the discovery of huge blocks of ice on the ground after the hailstorm is over. These "huge hailstones" consist of a number of hailstones that have stuck together and merged after they have fallen in that state and thus, startling "discoveries" have been reported. There has never been any official confirmation of such large hailstones.

The largest stones that have been examined and officially confirmed are the size of baseballs, and in rare instances, grapefruit.

A reliable listing of more than 50 historical hailstorms that occurred in the late 1700's and through the 1800's in various parts of the world can be found in Russell's book.³⁴ These references are largely from physical science journals that have evaluated the

reliability of the data used.

Popular writing such as an item in Ripley's "Believe It or Not"³⁰ describing a hailstone the size of an elephant, is a source of inaccurate information.

An account of elephant-size hailstones can be found in a paper "Remarkable Hailstorms in India, March 1851 and May 1885," by Buist.³ Describing four occasions on which remarkable masses of ice "fell" in India in the early 1800's, Buist comments: "These masses of ice, like many of those that are considered hailstones of the largest size, have, in all probability, been formed by violent whirlwinds or eddies, and seem to have reached the monstrous dimensions in which we find them, either on their approach to, or their impingement on the ground: and the same thing will apply to those of much more moderate bulk, and which are commonly considered hailstones, though when examined they turn out to be a number of stones aggregated together."

Many of the masses doubtless owe their origin to being blown into hollows or cavities such as that reported by Russell³⁴ in Belgium in 1850; in this case the hailstones were swept into a dry well where they almost immediately congealed into a mass. It would seem from this account and others that early writers had credible explanations for large hailstone masses that were discovered after storms.

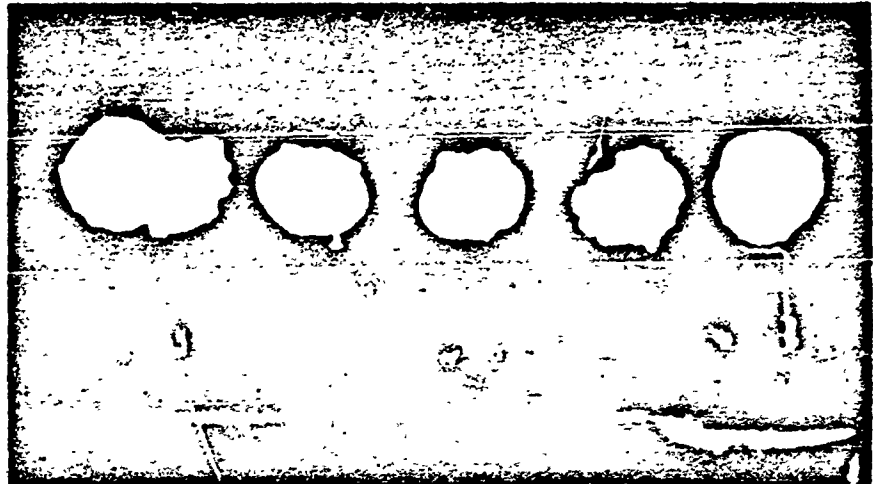


Fig. 8. Hailstones that fell at Potter, Neb., 7 July 1928.

Hail in contemporary times

One of the most remarkable hail falls on record in the United States occurred at Potter, Cheyenne County, Nebraska, on 7 July 1928. Here fell the largest officially-recorded hailstones in the country (Fig. 8). Larger stones have been reported at various places but none carried the authenticity of these. Most of the large hail ranged from 10 to 14 inches in circumference and weighed from $5/8$ to $1\frac{1}{2}$ pounds. The larger stones were approximately 10 to 15 feet apart. The largest stone recorded during the fall was 17 inches in circumference (5.41 inches in diameter) and weighed $1\frac{1}{2}$ pounds.

Figures 9 through 13 show the extreme size of hailstones that cause the most damage to equipment on the ground. Figure 14 illustrates the damage inflicted on an automobile by hailstones of extreme size (Fig. 13). However, the likelihood of equipment being struck by stones the size of baseballs (Figs. 9 and 12) is only about once in 5,000 hailstorms.

Hariharan²⁰ gives an account of hailstorms in Hyderabad State, India, that occurred on March 17 and 18, 1939. The largest hailstones that fell on the first day weighed $7\frac{1}{2}$ pounds, the largest on the second day weighed 5 pounds. The storm of March 17 affected 17 villages in an area of 30 square miles, causing considerable damage to property and injury to livestock.



Fig. 9 Hailstone that fell at
Suitland, Md., 26 May 1953



Fig. 10 Measurement of hailstone
shown in Figure 9



Fig. 11 Hailstone compared
with a tennis ball, Durban,
South Africa, 24 June 1929



Fig. 12 Hailstones the size of a baseball,
Veligh, Nebraska, 13-14 June 1950



Fig. 13 Hailstone that fell at
Weatherford, Okla., 1 July 1940



Fig. 14 Hail damage to automobiles at Weatherford, Okla., 1 July 1940

Hailstorms which are remarkable from the standpoint of destructiveness to crops and other surface property, need not always be characterized by large stones. There have been numerous instances of damage where large areas have been completely covered by heavy amounts of hailstones. Fig. 15 showing the deposit of stones over a wide area near Ada, Okla., on 29 May 1940, illustrates vividly the extent of destruction such a storm can bring to agriculture, particularly if it occurs during the season of growing crops.

The same type of storm occurring in a city (Fig. 16) or military installation may clog sewers, paralyze transportation, damage lights, windows, roofs, and equipment, and in general create temporary havoc. Destruction of equipment would be secondary to the more serious situation of vehicles blocking hail-covered roads and in ditches during and after hailstone showers.

Abstracts of 36 articles dealing with unusual hailstorms in many countries can be found in Meteorological Abstracts and Bibliography; 29 some of the articles report hailstones of startling size and destructiveness.

The Monthly Weather Review through 1949 reported hailstorm occurrences and gave brief descriptions. From time to time since then, the publication has had separate articles describing hailstorms.

10. Conclusions

Destructive-size true hail is most common in the zone between 30° and 50° North latitude, although unusual hailstorms may cause heavy damage anywhere in the world except the polar regions. Hail is most frequent during the winter in high latitudes and during the summer in lower latitudes.

Hailstones have been found as large as 5.4 inches in diameter and weighing 1.5 pounds, but most hail that reaches the ground is smaller than 1 inch in diameter. The speed of a hailstone rather than its size determines the amount of damage it will cause. For this reason, high-speed aircraft sustain greater damage than stationary or relatively slow-moving vehicles and equipment on the ground.

The U.S. Weather Bureau, the U.S. Air Force, airlines, insurance companies, and other agencies are actively engaged in hail research. It would be useful to the Army to have additional detailed information on the frequency and distribution of critical-size hailstones.

11. Acknowledgments

The cooperation of Mr. W.F. MacDonald of the U.S. Weather Bureau in making available the hail frequency material prepared by the author while in the Weather Bureau, and the Weather Bureau library for furnishing hail photographs, is greatly appreciated.



Fig. 15 Hailstone accumulation at Ada, Okla., on 29 May 1940



Fig. 16 Hailstone accumulation covering street and sidewalk in
Rapid City, S.D., 22 July 1929

Charts and tables of hail observations in the Denver area, furnished by Mr. W.B. Beckwith, Assistant Superintendent of Weather Service, United Air Lines, have added much to this report.

Tables of hailstone damage to aircraft in flight, obtained from the Inspector General's Office, Headquarters, U.S. Air Force, have been used to advantage in comparing damage aloft to that on the ground.

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Appendixes

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TABLE III: Total Days with Hail, United States

Station No. Name	Tra. Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
110 Abilene, Texas	40	2	4	16	38	60	11	6	1	4	6	6	2	156
111 Albany, N.Y.	40	1	0	3	4	14	9	11	5	3	1	1	0	52
112 Albuquerque, N.M.	12	1	1	7	8	8	2	3	4	3	4	1	3	43
113 Alpena, Mich.	40	0	0	5	4	13	8	8	6	8	4	4	1	61
114 Amarillo Tex.	40	1	3	9	16	28	22	6	6	2	7	5	0	105
115 Anniston, Ala.	25	1	5	3	7	5	5	6	1	3	1	1	0	38
116 Apalachicola, Fla.	18	0	1	0	1	0	2	1	0	1	0	0	0	6
117 Asheville, N.C.	40	0	2	3	7	11	11	10	5	0	0	0	0	49
118 Atlanta, Ga.	40	1	4	9	6	9	7	10	5	0	3	1	5	60
119 Atlantic City, N.J.	40	0	2	4	1	4	4	1	2	1	1	2	1	23
120 Augusta, Ga.	40	0	3	4	7	2	1	1	1	1	0	1	1	23
121 Austin, Texas	17	0	4	6	8	4	0	0	0	0	2	3	0	27
122 Baker City, Ore.	38	0	5	3	12	20	27	14	9	7	7	1	0	105
123 Baltimore, Md.	40	3	1	5	12	17	13	4	6	0	2	0	0	63
124 Bentonville, Ark.	14	3	10	5	5	8	4	1	1	0	3	3	5	48
125 Binghamton, N.Y.	40	2	0	3	4	9	15	17	11	5	5	3	0	74
126 Birmingham, Ala.	40	2	6	12	15	14	7	9	2	3	2	2	1	75
127 Bismark, N.D.	40	0	0	1	8	18	29	19	18	7	0	0	0	100
128 Block Island, R.I.	40	0	1	5	5	2	2	1	3	2	1	4	1	27
129 Boise, Idaho	40	2	10	29	26	27	15	2	2	4	7	12	7	143
130 Boston, Mass.	40	0	0	1	3	5	5	8	3	1	0	2	0	28
131 Broken Arrow, Okla.	12	1	3	8	16	12	9	1	1	1	2	0	0	54
132 Brownsville, Tex.	21	0	1	1	1	2	1	0	0	0	0	0	1	7
133 Buffalo, N.Y.	40	1	0	7	7	9	7	7	5	11	11	7	0	72
134 Burlington, Vt.	37	0	0	1	1	5	4	7	3	4	1	0	0	26
135 Cairo, Ill.	40	3	4	17	14	16	7	5	3	4	2	1	1	77
136 Canton, N.Y.	37	0	0	2	8	7	10	7	6	5	9	1	0	55
137 Cape Henry, Va.	35	0	0	5	7	6	5	1	3	0	4	1	0	32
138 Cape May, N.J.	18	6	1	5	1	0	1	1	1	0	0	2	3	21
139 Charles City Iowa	39	0	0	5	16	24	21	10	7	9	5	1	0	98
140 Charleston, S.C.	40	0	3	4	3	3	2	3	2	1	0	1	0	22
141 Charlotte, N.C.	40	3	5	10	4	12	2	4	6	0	2	2	2	52
142 Chattanooga, Tenn.	40	3	4	9	13	17	10	5	4	1	0	2	1	69
143 Cheyenne, Wyo.	40	0	0	1	23	82	117	62	51	31	13	0	0	380
144 Chicago, Ill.	40	0	2	5	13	12	15	9	8	1	1	4	1	71
145 Cincinnati, Ohio	40	2	1	14	17	13	10	7	3	3	6	0	1	77
146 Cleveland, Ohio	40	2	2	7	9	6	10	8	4	8	16	4	0	78
147 Columbia, Mo.	40	7	2	12	29	18	14	4	3	14	5	6	3	117
148 Columbia, S.C.	40	1	1	0	8	10	4	6	2	0	0	1	3	36
149 Columbus, Ohio	40	1	4	18	11	16	10	7	9	2	2	5	0	85
150 Concord, N.H.	35	1	0	2	3	9	3	4	2	1	2	1	1	29
151 Concordia, Kan.	39	0	2	12	14	41	32	7	12	8	5	3	3	139
152 Corpus Christi, Texas	46	0	4	6	10	11	0	0	0	1	1	2	2	37

TABLE III: (Cont'd)

Station No. Name	Yrs. Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	To- tal
153 Dallas, Tex.	35	6	20	27	27	31	7	2	3	5	2	3	3	136
154 Davenport, Iowa	40	1	1	14	23	23	19	8	3	5	3	5	1	106
155 Dayton, Ohio	29	4	3	8	12	10	11	7	5	2	1	1	0	64
156 Del Rio, Tex.	38	0	3	7	19	18	1	1	2	2	1	1	1	56
157 Denver, Colo.	40	0	0	2	17	45	33	11	13	9	6	1	0	137
158 Des Moines, Iowa	40	3	2	17	24	26	22	8	8	16	8	1	1	136
159 Detroit, Mich.	40	1	3	4	16	12	15	11	6	5	3	1	1	78
160 Devils Lake, N.D.	39	0	0	0	13	15	18	21	16	7	2	1	0	93
161 Dodge City, Kan.	40	0	3	13	29	41	44	16	10	9	7	5	0	179
162 Drexel, Neb.	10	0	0	2	10	8	11	1	0	5	2	2	0	41
163 Dubuque, Iowa	40	0	1	12	29	25	18	6	7	5	5	4	0	112
164 Due West, S.C.	11	1	3	0	3	3	0	3	1	1	1	0	1	17
165 Duluth, Minn.	40	0	0	1	11	23	16	13	10	5	5	1	0	84
166 Eastport, Me.	40	4	1	2	5	4	7	3	1	1	2	2	1	33
167 Elkins, W.Va.	40	2	6	8	14	20	13	8	1	2	4	2	1	81
168 Ellendale, N.D.	15	0	0	0	6	9	9	8	6	2	0	0	0	40
169 El Paso, Tex.	40	6	3	11	9	10	8	3	3	5	4	4	4	70
170 Erie, Penn.	40	2	5	9	8	5	12	3	4	12	20	4	1	85
171 Escanaba, Mich.	40	0	2	6	9	14	14	12	12	5	7	0	0	81
172 Eureka, Cal.	40	57	49	61	17	9	1	0	0	1	4	15	32	246
173 Evansville, Ind.	40	1	4	16	16	23	10	7	6	3	2	2	2	92
174 Flagstaff, Ariz.	9	0	0	0	1	3	5	17	15	13	3	0	0	57
175 Ft. Smith, Ark.	40	4	6	15	22	17	11	5	1	0	0	1	6	88
176 Ft. Wayne, Ind.	32	0	3	6	16	10	7	10	5	2	3	0	0	62
177 Ft. Worth, Tex.	40	2	9	20	30	18	11	4	1	1	0	1	2	99
178 Fresno, Cal.	40	8	11	16	9	4	0	0	0	1	1	2	4	56
179 Galveston, Tex.	40	0	3	5	8	6	0	1	0	1	1	4	0	29
180 Grand Haven, Mich.	27	0	1	3	5	10	2	2	2	6	8	2	0	41
181 Grand Junction, Colo.	40	1	1	6	18	20	11	4	3	7	3	1	0	75
182 Grand Rapids, Mich.	40	2	1	8	17	19	9	7	2	9	10	5	0	89
183 Green Bay, Wis.	40	0	0	5	9	12	14	7	3	6	3	3	0	62
184 Greensboro, N.C.	14	2	0	1	2	3	2	1	1	1	0	0	1	14
185 Greenville, S.C.	21	1	2	1	5	5	4	4	1	1	0	1	1	26
186 Groesbeck, Tex.	12	1	2	5	5	6	2	2	0	0	0	3	1	27
187 Hannibal, Mo.	29	2	4	14	20	20	16	3	5	0	3	3	0	90
188 Harrisburg, Pa.	40	0	1	1	11	10	17	8	4	2	3	0	0	57
189 Hartford, Conn.	39	0	0	2	5	11	12	15	7	1	1	2	1	57
190 Hatteras, N.C.	39	0	0	1	5	7	0	1	0	0	0	0	2	14
191 Havre, Mont.	40	0	0	3	10	26	22	13	8	8	3	0	0	93
192 Helena, Mont.	40	0	0	1	10	35	66	42	20	12	4	3	4	197
193 Houghton, Mich.	29	0	0	2	4	7	6	8	5	8	2	0	0	42
194 Houston, Texas	34	4	5	7	8	8	2	2	0	0	1	1	3	41

TABLE III: (Cont'd)

Station No. Name	Yrs. Obs	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	To- tal
195 Huron, S.D.	40	0	0	3	8	28	29	19	20	8	3	1	0	119
196 Independence, Cal	18	0	0	0	1	0	2	0	0	0	1	0	0	4
197 Indianapolis, Ind	40	2	4	12	18	21	11	14	4	4	2	1	1	94
198 Iola, Kan.	26	0	4	15	18	18	12	2	0	2	3	3	2	79
199 Ithaca, N.Y.	15	0	0	1	0	3	5	6	4	1	0	0	0	20
200 Jacksonville, Fla.	40	0	1	2	5	7	13	2	2	1	1	0	1	35
201 Jupiter, Fla.	7	0	0	0	2	1	0	0	0	0	0	0	0	3
202 Kalisnell, Mont.	40	0	0	3	4	19	25	19	11	8	3	0	0	92
203 Kansas City, Mo.	40	3	5	28	35	42	24	7	8	7	10	5	1	173
204 Keokuk, Iowa	38	0	4	15	18	26	10	7	8	8	6	7	2	111
205 Key West, Fla.	40	0	0	0	0	0	1	1	0	0	0	0	0	2
206 Knoxville, Tenn.	40	2	4	6	19	12	16	7	8	3	3	1	1	82
207 LaCrosse, Wis.	40	1	0	6	23	19	15	9	10	4	7	4	0	98
208 Lander, Wyo.	40	0	0	1	11	21	17	7	6	1	0	2	0	66
209 Lansing, Mich.	33	0	5	11	18	13	6	3	6	2	6	1	1	72
210 LaSalle, Ill.	8	0	1	1	4	4	1	1	0	3	1	1	0	17
211 Lewiston, Idaho	29	0	2	9	7	11	7	4	2	4	4	0	3	53
212 Lexington, Ky.	29	3	4	5	15	10	9	6	3	2	2	0	3	62
213 Lincoln, Neb.	40	0	1	15	29	28	30	13	8	10	4	3	1	142
214 Little Rock, Ark.	40	2	13	16	24	17	11	5	2	3	1	2	2	98
215 Los Angeles, Cal.	40	8	10	17	3	2	0	0	0	1	0	0	2	43
216 Louisville, Ky.	40	3	3	16	16	18	9	7	5	2	0	4	4	87
217 Ludington, Mich.	20	1	1	6	2	2	3	4	1	7	10	2	1	40
218 Lynchburg, Va.	36	1	1	1	6	5	10	4	1	1	0	1	0	31
219 Macon, Ga.	40	2	3	5	8	7	4	7	4	2	0	0	2	44
220 Madison, Wis.	39	0	1	7	17	23	10	16	11	4	4	5	0	98
221 Marquette, Mich.	40	0	0	1	3	11	14	13	7	15	5	0	0	69
222 Medford, Ore.	16	0	4	4	17	11	13	1	1	2	1	1	0	45
223 Memphis, Tenn.	40	3	10	11	23	10	10	1	0	3	3	3	4	81
224 Meridian, Miss.	40	2	6	7	16	5	3	3	2	0	1	0	0	45
225 Miami, Fla.	32	0	2	0	4	4	1	1	0	1	0	0	1	14
226 Miles City, Mont.	36	0	0	3	8	20	18	13	12	2	1	0	0	77
227 Milwaukee, Wis.	40	0	3	7	14	22	14	8	9	7	5	4	0	93
228 Minneapolis, Minn.	40	0	0	7	9	23	17	10	12	10	4	0	0	92
229 Missoula, Mont.	8	0	0	3	5	2	9	5	0	1	1	1	1	28
230 Mobile, Ala.	40	3	2	6	14	9	6	1	1	0	0	3	3	48
231 Modena, Utah	40	1	9	25	41	39	15	25	29	16	14	5	2	223
232 Montgomery, Ala.	40	3	6	12	12	5	8	3	0	1	0	1	0	51
233 Moorhead, Minn.	39	0	0	5	5	16	13	8	10	6	1	0	0	64
234 Mt. Tarapais, Cal.	17	15	6	17	2	2	0	0	0	0	1	6	8	57
235 Mt. Weather, Va.	9	1	1	1	2	2	7	5	2	1	3	0	0	25
236 Nantucket, Mass.	40	0	0	4	5	3	1	0	0	1	1	4	2	21

TABLE III: (Cont'd)

Station No. Name	Yrs. Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
237 Narragansett Pier, R.I.	14	5	6	6	7	0	1	1	0	1	0	1	6	34
238 Nashville, Tenn.	40	1	7	19	19	16	8	7	2	1	3	3	4	90
239 New Haven, Conn.	40	1	1	3	4	10	4	5	3	1	2	1	0	35
240 New Orleans, La.	40	2	5	7	14	7	1	5	1	1	1	1	2	47
241 New York, N.Y.	40	1	1	3	4	17	11	11	7	2	4	2	1	64
242 Norfolk, Va.	40	0	2	5	10	12	6	7	2	1	1	0	0	46
243 Northfield, Vt.	35	1	0	1	1	6	11	6	5	2	3	0	0	36
244 North Head, Wash.	40	42	50	65	32	18	2	0	0	4	19	40	40	312
245 North Platte, Neb.	40	0	2	4	22	32	28	22	15	6	3	0	0	134
246 Oklahoma City, Okla.	40	2	7	27	32	34	16	2	3	4	4	4	3	138
247 Omaha, Neb.	40	1	2	13	30	30	34	13	9	12	9	4	3	160
248 Oswego, N.Y.	39	1	0	2	3	3	5	6	5	11	25	18	0	79
249 Palestine, Tex.	40	3	3	10	19	13	3	0	2	2	1	1	2	59
250 Parkersburg, Va.	40	2	5	10	10	21	17	8	0	0	4	2	3	82
251 Pensacola, Fla.	40	1	6	7	10	5	2	3	0	0	0	1	3	38
252 Peoria, Ill.	38	0	2	13	15	21	9	7	4	4	3	3	0	81
253 Philadelphia, Pa.	40	0	2	3	2	7	3	3	6	0	0	1	0	27
254 Phoenix, Ariz.	40	3	12	7	7	4	0	2	3	1	3	1	4	47
255 Pierre, S.D.	26	0	0	1	5	13	13	9	6	1	1	0	0	49
256 Pittsburgh, Pa.	40	2	3	9	14	12	12	9	6	1	1	1	2	72
257 Pocatello, Idaho	40	0	6	20	36	42	25	25	18	15	7	2	4	200
258 Point Reyes Light, Calif.	23	18	13	12	2	0	0	0	0	1	0	0	8	54
259 Port Angeles, Wash.	14	1	0	8	5	1	0	0	1	0	0	0	1	17
260 Port Arthur, Tex.	26	1	3	3	9	5	1	0	0	0	0	0	1	23
261 Port Crescent, Wash.	12	0	1	1	1	1	0	0	0	0	1	2	1	8
262 Port Huron, Mich.	29	1	3	4	7	6	5	4	5	3	4	0	0	42
263 Portland, Maine	40	0	0	2	4	4	3	6	6	2	6	0	0	33
264 Portland, Ore.	40	7	15	40	32	23	7	0	0	3	12	10	4	153
265 Providence, R.I.	39	0	0	2	3	6	5	9	3	3	0	0	0	31
266 Pueblo, Col.	39	0	0	1	16	23	37	14	9	4	2	0	0	107
267 Raleigh, N.C.	40	0	4	3	7	13	1	6	4	0	0	2	3	43
268 Rapid City, S.D.	39	0	0	0	9	33	41	37	16	6	3	0	0	145
269 Reading, Pa.	31	0	2	1	7	13	5	14	10	1	3	0	1	57
270 Red Bluff, Cal.	32	6	7	19	7	10	4	0	0	1	1	0	5	60
271 Redding, Cal.	8	2	6	9	5	3	0	0	0	0	1	1	0	27
272 Reno, Nev.	38	1	0	2	5	14	9	6	8	4	2	1	0	52
273 Richmond, Va.	40	2	1	7	11	8	7	4	1	0	2	0	1	44
274 Rochester, N.Y.	40	0	0	2	3	9	7	4	5	9	4	0	1	44
275 Roseburg, Ore.	40	6	4	15	32	20	6	0	0	2	2	6	4	97
276 Roswell, N.M.	39	1	2	6	21	24	16	5	3	6	9	3	1	97
277 Royal Center, Ind.	13	1	1	7	11	7	1	9	0	0	1	0	0	38
278 Sacramento, Cal.	40	7	9	19	10	2	0	0	0	0	1	1	3	52

TABLE III: (Cont'd)

Station No. Name	Yrs. Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
279 Saginaw, Mich.	12	0	2	1	1	9	3	2	3	3	3	0	1	28
280 St. Joseph, Mo.	34	1	2	17	21	26	26	5	5	11	5	1	1	121
281 St. Louis, Mo.	40	4	4	19	23	24	9	8	8	4	2	3	0	108
282 St. Paul, Minn.	29	0	0	4	3	10	9	5	8	4	2	0	0	45
283 Salt Lake City, Utah	40	2	3	9	20	26	13	5	16	11	10	5	1	121
284 San Antonio, Tex.	40	3	6	23	30	23	6	3	1	1	1	2	1	100
285 San Diego, Cal.	40	10	9	12	8	1	0	0	0	0	1	3	7	51
286 Sands Key, Fla.	16	0	0	0	0	0	0	0	0	1	0	0	0	1
287 Sandusky, Ohio	40	0	3	8	14	15	13	13	9	2	4	0	0	81
288 Sandy Hook, N.J.	25	0	0	2	4	3	2	1	2	0	0	1	0	15
289 San Francisco, Cal.	40	30	24	29	5	1	0	1	0	2	9	6	13	120
290 San Jose, Cal.	27	5	5	7	2	0	0	0	0	0	1	0	3	23
291 San Luis Obispo, Cal.	23	6	5	10	0	0	0	0	0	1	0	2	2	26
292 Santa Fe, N.M.	38	2	1	13	19	46	27	36	23	13	27	3	1	211
293 Sault Ste. Marie, Mich.	40	0	0	4	3	6	7	5	7	7	13	4	0	56
294 Savannah, Ga.	40	1	3	1	4	13	5	3	3	1	1	0	0	35
295 Scranton, Pa.	40	3	0	6	6	12	21	8	5	3	12	1	1	78
296 Seattle, Wash.	40	4	9	23	17	8	5	1	1	3	7	10	9	97
297 Sheridan, Wyo.	36	0	0	2	14	30	42	14	11	10	0	0	0	123
298 Shreveport, La.	40	7	6	9	13	8	2	1	1	1	2	3	4	57
299 Sioux City, Iowa	40	0	2	4	18	27	28	9	10	13	3	1	0	115
300 Southeast Farallon, Cal.	9	10	5	5	0	1	0	0	0	0	0	0	0	21
301 Spokane, Wash.	40	1	2	26	25	42	14	4	7	6	9	2	2	140
302 Springfield, Ill.	40	0	5	30	24	21	15	4	4	4	0	4	3	114
303 Springfield, Mo.	40	6	8	24	26	25	14	9	4	0	2	7	3	128
304 Syracuse, N.Y.	40	0	1	1	0	7	12	11	3	3	5	1	0	44
305 Tacoma, Wash.	36	13	11	22	22	15	0	0	1	3	7	8	6	108
306 Tampa, Fla.	40	0	1	2	3	8	3	1	3	0	0	0	0	21
307 Tatoosh Is., Wash.	40	19	23	27	23	12	0	2	0	1	16	35	23	181
308 Taylor, Texas	29	2	4	5	16	14	3	1	2	2	0	1	1	51
309 Terre Haute, Ind.	31	0	2	18	16	14	10	8	4	1	1	2	2	78
310 Thomasville, Ga.	27	0	1	0	4	3	3	1	1	1	0	0	0	14
311 Toledo, Ohio	40	0	1	5	11	11	11	7	3	0	4	2	0	55
312 Tonopah, Nev.	17	0	1	1	1	7	0	2	2	2	0	0	0	16
313 Topeka, Kan.	40	2	1	17	26	21	23	12	9	13	9	3	0	136
314 Trenton, N.J.	30	0	1	5	5	9	11	8	6	1	3	0	0	49
315 Valentine, Neb.	40	2	2	3	9	25	34	24	23	7	4	1	0	134
316 Vicksburg, Miss.	40	3	10	13	20	5	6	2	2	3	0	3	1	68
317 Wagon Wheel Gap, Cal.	3	0	0	0	0	0	3	3	5	3	0	0	0	14
318 Walla Walla, Wash.	38	6	4	20	20	12	5	2	1	1	10	5	2	88
319 Washington, D.C.	40	0	2	4	10	12	10	7	3	1	2	1	0	52
320 Wausau, Wis.	17	0	1	0	3	9	10	4	2	3	0	1	0	33
321 Wichita, Kan.	40	2	6	17	31	43	26	8	5	6	7	4	3	158
322 Williston, N.D.	39	0	0	1	4	11	20	25	15	5	2	0	0	83

TABLE III: Cont'd)

<u>Station</u>	<u>Yrs</u>													<u>To-</u>
<u>No. Name</u>	<u>Obs</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>tal</u>
323 Wilmington, W.C.	40	0	1	3	5	8	4	2	2	0	0	0	0	25
324 Winnemucca, Nev.	40	3	8	12	12	16	12	5	2	3	6	3	0	82
325 Wytheville, Va.	37	1	1	6	10	11	5	4	3	2	0	0	0	43
326 Yakima, Wash.	15	0	1	1	2	4	2	0	0	0	0	0	0	10
327 Yankton, S.D.	29	0	0	6	11	20	12	11	11	3	2	1	0	77
328 Yellowstone Park Wyo.	35	0	0	1	6	27	52	39	35	18	3	0	0	181
329 Yuma, Ariz.	40	2	2	3	0	0	0	0	1	0	0	1	1	10

TABLE IV: Average Days with Hail, North America
(excluding United States)

Canada

Station No. Name	Yrs. Obs.	Yrs.												To- tal
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
100 Carcross, N.W.T.	23	0	*	0	0	0	*	0	0	0	0	0	0	*
101 Churchill, Man.	7	0	0	0	0	0	0	*	0	0	0	0	0	*
102 Cochrane, Ont.	29	0	*	*	*	*	*	*	0	*	*	*	*	1
103 Edmonton, Alta.	16	0	0	*	*	*	1	1	*	*	*	0	0	2
104 Fort Smith, N.W.T.	23	0	0	*	*	*	*	*	*	*	*	*	*	2
105 Hay River, N.W.T.	23	0	0	0	*	*	*	*	*	1	*	*	*	2
106 (The Pas, Man.	23	0	0	0	0	0	0	*	0	0	0	0	0	*
107 Victoria, B.C.	20	*	*	*	*	*	0	*	0	0	*	*	*	2
108 Watson Lake, Yukon	5	0	0	0	0	1	*	0	0	0	0	0	0	1
109 Winnipeg, Man.	36	*	0	*	*	*	*	*	*	*	*	0	0	2

(Stations No. 110 through 329 are in United States. See TABLE III)

Mexico

Station No. Name	Yrs. Obs.	Yrs.												To- tal
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
330 Guadalajara, Jalisco	5	0	0	*	0	*	1	1	1	*	*	0	0	3
331 Maymas, Sonora	5	0	0	0	0	0	0	0	0	0	0	*	0	*
332 Jalapa Enriquez, Vera Cruz	5	0	*	*	1	*	0	0	0	*	0	0	0	2
333 La Paz, Baja Cal.	3	0	0	0	0	0	0	0	*	*	0	0	0	*
334 Leon, Guanajuato	4	0	*	*	*	*	*	1	1	*	*	*	*	3
335 Mazatlan, Sinaloa	4	0	*	0	0	0	0	0	0	0	0	0	0	*
336 Mexico City, Mex.	4	0	*	*	1	*	1	2	1	1	*	*	*	6
337 Monterrey, Nuevo Leon	2	0	0	*	*	*	*	*	0	*	0	*	0	1
338 Morelia, Michoacan	5	*	*	*	*	1	1	1	1	*	*	*	0	4
339 Oaxaca, Oaxaca	4	0	*	*	1	1	*	0	*	*	*	0	0	2
340 Pachuca de Soto, Hidalgo	5	*	*	*	1	1	*	*	*	*	*	0	*	3
341 Queretaro, Queretaro	7	0	*	*	*	*	*	*	*	*	*	*	*	2

Note: Range from .1 to .4 is represented by *
Range from .5 to 1.4 is represented by 1
Range from 1.5 to 2.4 is represented by 2, etc.

TABLE IV: Average Days with Hail, North America
Mexico, (Cont'd)

Station No. Name	Yrs. Obs.	Yrs.												To- tal
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
342 Talina Cruz, Camaca	3	0	0	*	0	0	0	0	0	0	0	0	0	*
343 Saltillo, Coahuila	5	*	1	2	3	4	2	2	1	2	1	1	0	19
344 San Luis Potosi, San Luis Potosi	4	*	*	*	*	*	*	*	*	*	0	*	0	2
345 Tampico, Tamaulipas	5	0	0	1	0	0	0	0	0	0	0	0	0	1
346 Tuxtla Gutierrez, Chiapas	4	0	0	0	0	0	*	0	0	0	0	0	0	*
347 Victoria de Durango, Durango	5	0	0	0	0	0	0	1	0	*	*	0	0	1
348 Zacatecas, Zacatecas	6	*	1	*	*	*	*	*	*	*	*	*	*	3

Greenland

Station No. Name	Yrs. Obs.	Yrs.												To- tal
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
349 Julianehaab	25	*	*	*	*	0	0	0	0	0	*	*	*	1
350 Saqdlit	10	*	*	*	*	*	0	0	0	0	*	*	*	2
351 Sletten	5	0	*	0	0	0	0	0	0	0	1	1	0	1
352 Sydproven	5	1	1	1	1	1	1	0	0	0	1	2	1	10

TABLE V: Average Days with Mail, Europe

Norway

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
353 Alesund	35	1	*	*	*	*	*	0	0	*	1	1	1	6
354 Bergen	35	*	1	*	*	1	*	*	*	*	*	1	1	5
355 Bod	29	*	*	*	0	*	*	0	0	*	1	*	1	3
356 Karasjok	19	*	0	*	*	*	1	1	*	1	*	0	0	4
357 Mandal	35	*	*	0	0	*	0	0	0	*	*	*	*	2
358 Oslo	30	*	*	*	1	*	1	*	*	*	*	*	0	2
359 Troms	29	*	*	0	*	*	*	0	0	0	*	*	0	1
360 Trondheim	29	3	2	2	2	2	1	*	*	1	2	3	2	20
361 Vard	29	0	0	*	*	*	0	0	*	1	*	0	*	2

Sweden

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
362 Goteberg	8	0	0	*	*	*	1	0	*	*	*	0	*	2
363 Kalmar	8	0	0	1	*	*	*	*	0	*	0	*	0	2
364 Stockholm	8	0	*	0	1	*	1	*	*	*	1	0	0	3
365 Umea	8	0	0	0	0	1	*	1	0	0	0	0	0	2

Denmark

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
366 Copenhagen	40	*	1	1	2	1	*	*	*	*	1	1	1	8
367 Odense	53	*	1	1	2	1	*	*	*	*	1	*	*	16
368 Vestervig	40	1	1	1	1	1	*	*	*	*	1	2	2	10

Finland

<u>Station</u> <u>No.</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
369 Helsinki	31	1	*	1	1	*	1	*	*	1	*	1	1	7
370 Inari	25	*	0	0	*	*	*	*	*	*	0	0	0	*

Note: Range from .1 to .4 is represented by *
 Range from .5 to 1.4 is represented by 1
 Range from 1.5 to 2.4 is represented by 2, etc.

TABLE V: Average Days with Hail, Europe
Finland, (Cont'd)

Station No. Name	Yrs. Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	To- tal
371 Joensuu	5	*	0	0	0	1	0	0	0	1	1	0	0	3
372 Jyväskylä	31	*	*	*	1	1	1	*	*	1	*	*	*	5
373 Kuopio	14	*	0	*	*	*	*	*	*	*	0	0	*	2
374 Harichama	14	*	*	*	0	*	0	*	*	*	1	*	*	3
375 Marjaniemi	12	0	*	0	0	*	0	*	0	*	0	0	*	1
376 Pechenga	9	*	1	1	2	1	1	0	*	1	1	1	*	1
377 Sodankylä	25	0	*	*	1	*	*	*	*	*	*	1	*	4
378 Oulu	14	*	0	*	1	1	1	*	*	*	*	1	*	5
379 Vaasa	14	*	0	*	*	*	*	0	*	1	1	*	*	3

British Isles

Station No. Name	Yrs. Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	To- tal
380 Birmingham	8	1	1	3	4	2	1	*	*	*	1	1	1	16
381 Buxton	59	1	1	1	1	1	*	*	*	*	1	1	1	9
382 Colmonell	18	1	1	1	1	*	*	0	*	*	1	1	1	9
383 Cambridge	18	*	1	1	1	1	*	*	*	*	*	*	*	5
384 Cardiff	18	1	1	1	1	1	*	*	*	*	*	1	1	8
385 Douglas	59	3	3	3	2	1	*	*	*	*	2	3	3	20
386 Dungeness	43	1	1	1	1	*	*	*	*	*	*	1	1	7
387 Falmouth	59	3	3	2	1	1	*	*	*	*	1	2	3	17
388 Glasgow	18	3	2	2	3	2	*	*	*	*	1	1	2	17
389 Great Yarmouth	59	2	2	2	2	1	*	*	*	*	1	1	1	12
390 Liverpool	59	2	1	2	1	1	*	*	*	*	1	2	2	13
391 London	54	*	1	1	1	1	*	*	*	*	*	*	*	6
392 Manchester	8	*	1	1	1	2	*	*	0	*	*	2	*	8
393 Oxford	59	1	1	2	2	1	1	*	*	*	1	1	1	11
394 Portland Hill	18	1	1	1	*	*	0	*	*	0	*	1	1	6
395 St. Arm's Head	59	2	2	1	1	1	*	0	0	*	1	1	2	11
396 Scilly	59	2	2	2	1	*	*	0	*	*	1	1	2	11
397 Shoeburyness	4	1	1	1	1	1	*	*	*	0	*	1	1	7
398 Spurn Head	4	1	2	1	2	1	*	*	*	*	1	1	2	11
399 Tynemouth	59	1	1	2	2	1	*	*	*	*	1	1	1	10
400 York	18	*	*	1	1	1	*	*	*	*	*	*	0	5
401 Armagh	59	*	1	1	2	1	*	*	*	*	*	*	*	6
402 Bir Castle	59	1	1	3	3	2	*	*	*	*	1	1	1	13
403 Dublin	4	1	1	2	3	1	*	*	*	*	1	1	1	11
404 Malin Head	54	5	4	4	3	1	*	*	*	*	3	4	4	28
405 Markree Castle	4	4	4	3	4	2	*	*	*	*	2	3	4	26
406 Roche's Point	4	2	2	2	2	1	*	0	*	*	*	1	1	11
407 Valencia	59	5	4	4	2	1	*	0	*	*	2	3	5	26
408 Aberdeen	4	2	3	4	6	2	1	*	*	*	2	3	3	26
409 Inchkeith	4	1	*	2	2	1	*	*	*	0	*	1	1	8
410 Rothesay	8	5	3	2	3	1	*	*	*	*	2	3	4	23
411 Stornoway	4	3	3	4	2	1	*	0	*	1	1	3	3	21
412 Holyhead	4	3	2	3	2	1	0	*	*	1	2	3	3	20

TABLE V: Average Days with Hail, Europe (Cont'd)

BELGIUM

Station No. Name	Yrs													To- tal
	Obs	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
413 Arlon	15	*	1	1	1	2	1	1	*	*	1	*	1	9
414 Bastogne	15	*	1	*	*	1	1	*	*	1	*	*	1	6
415 Brussels	15	*	1	1	2	2	1	1	*	1	1	*	1	11
416 Furnes	19	1	1	1	1	1	*	*	*	*	1	1	1	9
417 Iseghem	18	1	1	2	2	1	*	*	*	*	1	1	1	10
418 Liege	19	*	1	1	1	1	1	*	*	*	1	1	1	8
419 Mons I	19	*	1	1	1	1	*	*	*	*	1	*	1	7
420 Namur	19	*	1	1	*	1	1	*	*	*	1	0	*	6
421 Neufchateau	6	1	*	2	2	1	*	1	1	1	1	*	*	10
422 Ostende	15	1	1	1	1	1	*	*	0	1	2	1	2	11
423 Spa	13	*	*	1	1	1	*	1	*	*	*	*	*	5
424 Turnhout	19	*	*	1	1	1	1	*	*	*	1	*	1	7

FRANCE

Station No. Name	Yrs													To- tal
	Obs	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
425 Aigoual	14	0	*	0	*	1	*	1	1	*	*	*	*	4
426 Aix-en-Provence	14	*	*	1	1	*	*	*	*	0	*	*	*	3
427 Angoulême	6	*	1	1	2	1	*	*	0	*	*	*	1	7
428 Antibes	6	*	*	*	*	*	*	0	0	*	*	*	*	2
429 Apt	4	0	*	*	*	*	*	0	0	*	*	*	0	1
430 Auch	4	*	*	0	1	*	*	0	0	*	0	0	*	2
431 Avignon	4	*	*	*	*	*	*	0	*	0	0	0	0	1
432 Beaucaire	10	*	*	*	*	*	*	*	0	0	*	*	*	2
433 Beaulieu	13	*	*	*	*	*	*	0	0	*	*	*	*	2
434 Biarritz	4	1	1	2	2	0	*	0	0	1	1	2	2	12
435 Brest	11	*	*	*	*	*	0	0	0	0	0	*	*	1
436 Cap Bear	14	0	*	*	*	*	0	0	0	*	*	0	0	1
437 Cap Croisette	14	*	*	*	*	*	0	*	0	*	0	*	0	1
438 Cape Ferrat	14	*	*	*	0	0	*	0	*	*	*	*	*	1
439 Cape Sicie	14	*	1	*	*	*	0	0	*	0	*	1	*	3
440 Cherbourg	15	2	2	2	2	1	*	0	*	*	*	2	3	14
441 Cuers	14	*	*	*	*	*	*	*	*	*	*	*	*	2
442 Dunkerque	14	1	1	1	1	1	*	*	*	*	*	1	1	7
443 Ile du Levant	5	*	*	1	2	0	0	0	0	0	*	*	1	2
444 La Roche Yon	14	*	*	*	1	*	0	0	0	*	*	*	*	3
445 Le Havre	15	1	1	1	1	1	*	*	*	*	1	1	1	8
446 Les Sables-Dolonne	14	1	1	1	2	*	*	0	0	*	*	1	1	8
447 Mont Louis	13	0	0	0	*	*	1	1	*	*	0	0	0	3

TABLE V: Average Days with Hail, Europe
France, (Cont'd)

Station No. Name	Yrs. Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	To- tal
444 Montpellier	14	*	*	*	*	1	*	*	*	*	0	1	*	3
449 Mt. Ventoux	29	0	*	*	1	1	1	*	1	*	*	1	*	6
450 Mulhouse	7	0	0	1	*	*	*	*	0	*	*	*	1	3
451 Nice	4	*	*	*	*	*	*	0	*	0	*	*	*	2
452 Orange	21	0	*	*	0	*	*	0	*	0	0	*	0	1
453 Perpignan	14	*	*	*	*	*	*	*	*	0	0	0	*	2
454 Pointe de Graves	14	1	1	1	1	1	*	0	0	0	*	*	*	5
455 Portiers	14	*	*	1	2	1	*	*	*	0	0	*	*	5
456 Rheims	7	*	*	*	*	*	*	*	*	*	*	*	0	2
457 Rochefort	15	1	1	1	2	1	*	*	*	0	*	1	1	8
458 St. Inglevert	15	1	1	1	1	*	0	*	*	*	*	1	1	6
459 Toulouse	14	*	1	2	1	*	*	*	*	1	1	1	1	9
460 Vichy	13	*	*	*	1	1	*	*	*	*	*	*	*	4

Spain

Station No. Name	Yrs. Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	To- tal
461 Bagur	12	*	*	*	*	*	0	0	*	0	*	*	0	1
462 Cadagua	6	0	*	0	*	0	0	0	0	0	0	*	*	1
463 Coruna	12	1	1	2	2	*	0	0	0	0	*	1	1	8
464 Darnius	12	0	*	1	*	0	0	*	*	*	*	0	0	2
465 El Pasteral	12	0	*	*	*	*	*	*	*	0	0	*	0	2
466 Gerona	12	0	0	*	*	1	*	0	0	0	*	0	0	2
467 Madrid	12	*	*	1	1	1	*	*	0	0	*	*	0	4
468 Puigcerda	12	0	0	*	*	1	1	1	1	*	*	*	0	5
469 Vilada	12	0	*	*	1	*	*	*	0	*	*	*	0	3

Portugal

Station No. Name	Yrs. Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	To- tal
470 Lisboa	30	*	1	1	1	*	*	0	0	0	0	*	*	3
471 Oporto	15	1	1	1	*	1	0	0	0	0	0	*	1	5

Azores

Station No. Name	Yrs. Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	To- tal
472 Horta	26	*	*	*	*	0	*	0	*	*	*	0	1	2
473 Ponta Delgada	30	1	1	1	*	0	0	0	0	0	*	1	*	4

TABLE V: Average Days with Mail, Europe (Cont'd)

Germany

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
474 Augsburg	10	0	0	0	*	*	*	*	0	0	0	0	0	1
475 (The) Brocken	41	0	*	*	*	1	1	1	*	*	0	0	0	4
476 Cologne	10	*	*	*	0	*	*	*	0	0	0	*	0	1
477 Danzig	7	2	2	1	1	1	*	*	*	1	2	2	2	14
478 Halle Ad Saale	10	0	0	*	*	*	*	*	*	*	0	0	0	1
479 Memel	13	1	*	*	*	*	*	0	*	*	1	1	1	5
480 Munich	16	*	0	*	*	1	1	*	*	*	*	*	0	2
481 Osnabruck	5	1	1	1	1	1	1	*	1	0	*	1	0	8
482 Wilhelmshaven	12	*	1	1	1	1	*	0	*	*	1	1	*	6

Czechoslovakia

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
483 Donnersberg	20	0	0	0	*	1	1	1	*	*	0	0	0	4
484 Kassa	7	0	0	0	0	1	*	0	0	0	0	0	0	1
485 Prague	Unknown.	0	0	0	*	1	*	*	*	*	0	0	0	2

Poland

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
486 Posen	29	*	*	1	1	1	*	*	*	*	*	*	*	4
487 Pinsk	Unknown.	0	0	0	0	1	*	*	*	0	0	0	0	2
488 Warsaw	Unknown.	0	0	0	*	1	*	1	0	*	0	*	*	3
489 Wilno	Unknown.	0	0	0	0	1	1	0	*	*	0	0	0	3

Austria

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
490 Innsbruck	Unknown.	0	0	0	0	*	*	1	*	0	0	0	0	1
491 Klagenfurt	Unknown.	0	0	0	0	1	1	1	*	*	0	0	0	3
492 Sonnblick	Unknown.	0	0	0	0	0	1	1	1	*	0	0	0	3

TABLE V: Average Days with Hail, Europe (Cont'd)

Hungary

Station No. Name	Yrs. Obs.													To- tal
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
493 Budapest	31	*	*	*	1	1	1	*	*	*	*	*	*	4
494 Debrecen	31	0	0	*	1	1	*	1	*	*	*	*	0	3
495 Hereny	31	0	0	*	*	1	1	*	*	*	0	*	0	3
496 Pecs	31	0	*	*	1	1	*	*	*	*	*	*	*	3
497 Szeged	31	*	*	*	*	1	*	*	*	*	0	0	0	2
498 Tatrafured	12	0	*	0	*	1	1	0	*	*	*	0	0	2
499 Turkeve	20	0	*	*	*	1	1	*	*	*	0	*	0	3

Yugoslavia

Station No. Name	Yrs. Obs.													To- tal
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
500 Arenzin Brijeg	20	*	*	*	*	1	*	*	*	*	*	*	*	2
501 Belgrade	5	1	1	1	*	1	1	*	*	*	0	*	1	7
502 Velika Kladusa	20	0	0	*	0	*	0	*	*	*	*	0	*	1
503 Kragujevac	6	0	*	0	*	*	1	1	*	*	*	*	0	3
504 Mliniste	17	0	0	0	0	0	*	*	0	*	0	0	0	*
505 Nis	6	0	0	0	0	*	*	*	0	0	0	0	0	1
506 Bosanski Novi	20	*	0	*	*	*	*	0	*	0	*	0	0	1
507 Bosanski Petrovac	20	0	0	0	0	*	0	0	0	*	0	0	0	*
508 Prolog	20	0	0	0	0	0	*	0	0	*	0	0	0	*
509 Sanski Most	20	0	*	0	*	*	*	*	*	*	0	0	0	1
510 Titovo Uzice	6	0	0	0	*	*	0	*	*	0	0	0	0	1
511 Vaganski Vrh	17	0	0	*	*	1	*	*	*	*	*	*	0	1
512 Zagreb	17	0	0	*	*	*	1	*	*	*	*	0	*	2

Romania

Station No. Name	Yrs. Obs.													To- tal
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
513 Braila	20	*	*	0	*	*	*	*	*	0	0	0	*	2
514 Bucharest	20	1	*	*	*	*	1	*	*	*	*	*	*	3
515 Chernovtsy	20	0	0	0	0	1	1	*	*	0	0	0	0	2
516 Kishinev	51	0	*	*	*	*	*	*	*	*	*	0	0	2
517 Cluj	20	0	0	*	*	1	1	1	*	*	0	0	0	3
518 Constanta	20	0	0	0	*	0	0	0	0	0	0	0	0	*
519 Craiova	20	0	*	*	*	1	*	*	*	0	0	*	0	1
520 Iasi	20	0	*	*	*	1	*	*	*	0	0	*	0	3
521 Sibiu	20	0	0	0	0	*	*	*	*	0	0	0	0	1
522 Sinaia	20	*	0	0	*	1	1	*	*	0	0	*	0	2
523 Timisoara	20	0	*	1	*	1	1	*	*	*	0	*	0	3

TABLE V: Average Days with Hail, Europe (Cont'd)

Switzerland

Station No. Name	Yrs. Obs.	Yrs.												To- tal
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
524 Basel	23	0	*	*	*	1	1	*	*	*	0	*	*	3
525 Luzern	23	0	0	*	*	*	*	1	*	*	0	0	0	2
526 Bern	23	0	0	0	*	1	*	*	*	*	0	*	*	2
527 Geneva	23	0	0	*	*	*	*	*	*	*	*	*	0	2
528 Lugano	23	0	0	*	*	*	*	1	*	*	*	0	0	2
529 Neuchatel	23	0	*	*	*	*	1	*	*	*	*	0	0	2
530 Zurich	23	0	0	*	*	*	1	*	*	*	*	0	0	2

Dodecanese (Aegean Sea)

Station No. Name	Yrs. Obs.	Yrs.												To- tal
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
531 Lemnos	4	1	1	1	0	1	0	0	0	0	0	*	1	5
532 Mytilene	4	1	*	0	0	*	0	0	0	0	1	*	1	3
533 Phiro	13	1	1	1	0	0	0	0	0	0	0	*	1	4
534 Samos	Unkwn.	2	3	1	*	*	0	0	0	0	0	1	1	8

Italy

Station No. Name	Yrs. Obs.	Yrs.												To- tal
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
535 Bologna	5	0	0	1	0	0	1	0	*	*	*	0	0	3
536 Catanzaro	4	0	*	*	1	0	0	0	0	0	0	1	0	2
537 Genoa	31	*	*	1	*	1	*	*	*	*	*	*	*	3
538 Iglesias	5	3	2	2	2	1	0	0	0	0	0	*	1	11
539 Messina	5	1	1	1	1	0	0	0	0	0	0	1	1	6
540 Milan	31	0	0	*	*	1	1	1	1	*	*	0	0	5
541 Naples	37	1	1	1	1	1	*	0	*	*	*	*	0	6
542 Palermo (Sicily)	31	2	1	1	1	*	0	*	*	*	*	1	1	8
543 Pola	Unkwn.	*	*	1	*	*	0	*	*	*	*	1	1	4
544 Rome	31	1	1	1	1	*	*	*	*	*	*	*	1	6
545 Syracuse	Unkwn.	1	*	1	*	*	0	*	*	*	*	*	1	4
546 Trieste	31	*	*	*	*	*	1	1	*	*	*	1	*	4
547 Trento	2	0	1	0	0	1	0	0	0	1	0	1	0	4
548 Sassari	Unkwn.	1	1	1	1	*	*	0	*	*	*	*	1	5

TABLE V: Average Days with Hail, Europe (Cont'd)

Bulgaria

Station	Yrs.													To-
No. Name	Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	tal
549 Bourgas	39	*	*	*	*	*	*	*	*	*	0	0	*	2
550 Gabrova	29	*	*	*	1	1	1	1	*	*	0	*	0	5
551 Kustendil	29	0	*	*	*	*	*	*	*	*	0	0	0	2
552 Pasardjik	29	0	0	*	*	*	*	*	*	0	*	0	0	1
553 Philippopolis	18	0	*	0	*	*	*	*	*	0	0	0	0	*
554 Fleven	29	*	0	0	*	*	1	*	*	*	*	*	*	2
555 Schowmen	29	*	*	*	1	1	1	*	*	*	0	0	0	3
556 Sliven	29	0	*	*	1	1	1	*	*	*	*	*	0	4
557 Sofia	34	*	*	*	1	2	1	1	*	*	*	0	*	6
558 Tschepelare	18	0	0	*	1	1	1	1	*	*	0	0	*	4
559 Varna	10	0	0	*	*	*	*	0	*	*	0	0	0	2
560 Vidin	12	*	*	0	0	*	1	*	*	0	0	0	*	2
561 Vrchetz	17	0	*	0	*	*	*	*	*	*	*	*	0	2

Greece

Station	Yrs.													To-
No. Name	Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	tal
562 Argosteli	26	1	1	1	1	*	*	*	0	*	*	*	1	5
563 Arta	26	1	1	1	1	*	*	*	*	*	*	*	1	5
564 Didymotichon	4	*	*	*	1	*	1	*	0	*	0	0	*	3
565 Egion	18	*	*	*	*	*	*	0	0	0	0	*	0	1
566 Gythion	11	*	*	*	*	*	0	0	0	0	0	*	0	1
567 Janina	15	*	*	1	1	1	1	*	*	*	*	*	*	4
568 Kavalla	4	1	1	1	*	1	*	0	0	0	*	0	*	4
569 Larissa	26	*	*	*	*	*	*	*	0	*	*	0	0	2
570 Missolonghi	26	1	1	1	1	*	*	0	0	*	*	*	1	5
571 Serrai	12	0	0	0	0	1	*	*	0	*	*	0	*	2
572 Trikkala	26	0	0	*	0	*	*	*	0	*	0	*	*	1
573 Volos	26	*	*	*	*	*	*	*	*	*	*	*	*	1

TABLE VI: Average Days with Hail, Asia
(including U.S.S.R. in Europe)

Turkey

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
574 Adana	18	*	*	1	*	1	*	1	*	*	*	*	*	4
575 Afyon Karahisar	18	0	0	*	*	*	*	0	0	0	0	0	0	1
576 Ankara	9	*	*	1	1	2	1	*	*	0	0	*	*	6
577 Bolu	6	0	*	*	*	1	2	1	*	*	*	*	0	6
578 Bursa	8	0	0	*	*	*	0	0	0	0	*	0	0	1
579 Corum	7	0	*	1	*	1	1	0	0	*	0	0	0	4
580 Diarbekir	6	0	0	*	1	1	*	*	0	*	1	0	0	4
581 Dortyol	8	1	1	3	1	1	*	0	0	*	*	*	*	8
582 Edirne	8	0	*	*	*	*	*	*	0	0	*	0	0	1
583 Eskisehir	6	*	0	*	*	2	1	*	0	*	0	0	0	4
584 Giresun	8	*	*	*	0	*	*	0	0	*	0	*	*	2
585 Goztepe	9	0	0	*	*	0	0	*	0	0	*	0	*	1
586 Kars	6	0	0	*	*	2	2	*	1	*	*	0	0	7
587 Kayseri	4	0	0	0	*	*	*	0	0	0	0	0	*	1
588 Kepsut	6	*	*	1	1	0	*	0	0	*	0	0	0	2
589 Konya	8	0	0	*	*	1	1	0	0	*	0	0	0	3
590 Kntahya	8	0	*	0	1	1	1	0	0	*	*	0	0	4
591 Malatya	6	0	0	0	*	1	1	0	0	0	0	0	0	2
592 Sivas	6	0	*	0	1	1	*	*	0	*	*	0	0	3
593 Tarsus	2	0	1	1	0	0	0	0	0	0	0	0	1	3
594 Urfa	5	*	*	1	*	*	*	0	*	*	0	*	0	3
595 Zonguldak	4	0	0	0	*	0	0	0	0	0	0	*	*	1
596 Seyrna	8	*	*	*	*	*	0	0	0	0	0	*	0	1
597 Teabzon	5	0	0	*	0	0	0	0	0	0	0	0	0	*

Jordan

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
598 Bethlehem	10	*	1	1	*	0	0	0	0	0	0	0	*	3

Israel

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
599 Jerusalem	10	*	1	1	*	*	0	0	0	0	0	*	1	4

NOTE: Range from .1 to .4 is represented by *
Range from .5 to 1.4 is represented by 1
Range from 1.5 to 2.4 is represented by 2, etc.

TABLE VI: Average Days with Hail, Asia (Cont'd)

U. S. S. R. (Europe)

Station No. Name	Yrs. Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
600 Astrakan	15	0	*	*	*	*	*	*	0	*	*	0	0	1
601 Kazan	12	0	0	0	*	*	0	1	*	*	0	0	0	2
602 Kiev	12	0	0	0	*	*	*	*	*	*	0	0	0	2
603 Leningrad	12	0	0	0	*	*	1	*	*	*	0	0	0	2
604 Moscow	12	0	0	0	*	1	1	*	*	*	0	0	0	3
605 Odessa	12	0	0	0	0	*	*	*	0	*	0	0	0	1
606 Sevastopol	14	0	0	0	*	*	0	*	0	*	0	0	0	1
607 Stavropol	12	*	0	*	1	1	1	*	*	*	0	0	0	4
608 Tiflis	17	0	0	0	*	1	1	*	*	*	0	0	0	3
609 Kirov	8	0	0	0	0	*	*	0	0	0	0	0	0	*

U. S. S. R. (Asia)

Station No. Name	Yrs. Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
610 Blagoveshchensk	6	0	0	0	0	*	*	*	*	0	0	0	0	1
611 Blagoveshchensk- Priisk	14	0	0	0	0	*	*	*	*	*	0	0	0	1
612 Borzla	19	0	*	1	1	1	*	*	*	0	*	*	0	4
613 Chita	14	0	0	0	0	*	1	*	1	*	0	0	0	3
614 Ekaterino- Nikolskoe	Unkn.	0	0	0	0	0	*	*	*	*	0	0	0	1
615 Irkutsk	Unkn.	0	0	0	*	1	3	*	1	1	*	0	0	7
616 Krasnoyarsk	26	0	0	0	0	*	*	*	*	*	0	0	0	1
617 Magdagachi	6	0	0	0	0	0	*	*	0	0	*	0	0	1
618 Nerchinsk	18	0	0	0	0	0	*	0	0	*	0	0	0	*
619 Nikolayevsk- na-Amure	Unkn.	0	0	0	0	0	*	*	*	*	0	0	0	*
620 Nikolsk Ous- souriiskii	Unkn.	0	0	0	*	*	*	*	*	*	*	0	0	1
621 Nizhneudinsk	9	0	0	0	0	0	1	*	0	0	0	0	0	1
622 Okhotsk	29	0	0	0	0	0	0	0	0	*	*	0	0	*
623 Ola	7	0	0	0	0	0	0	0	0	1	0	0	0	1
624 Oust-Kamtchatsk	5	0	0	0	0	0	0	0	0	*	0	0	0	*
625 Peschanain Bukhta	Unkn.	0	0	0	0	1	1	1	*	0	0	0	0	3
626 Petrovskii Zavod	Unkn.	0	0	0	0	*	*	*	*	*	0	0	0	1
627 Pokrauka	6	0	0	0	0	0	*	*	*	*	*	0	0	1
628 Rukhlova	5	0	0	0	0	0	1	1	0	0	0	0	0	2
629 Rykovakoe	29	0	0	0	*	*	*	*	*	*	0	0	0	1

TABLE VI: Average Days with Hail, Asia (Cont'd)

U. S. S. R. (Asia) (cont'd)

Station No. Name	Yrs. Obs.													To- tal
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
630 Troitskosavsk	17	*	0	0	0	0	*	*	*	*	0	0	0	1
631 Vladivostok	Unkn.	0	0	*	0	*	0	0	*	0	0	*	0	*

JAPAN, OKINAWA

Station No. Name	Yrs. Obs.													To- tal
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
632 Aburatsubo	18	0	0	0	0	*	*	*	0	*	*	*	0	1
633 Akita	17	*	0	*	0	*	0	0	0	0	*	1	*	1
634 Aomori	13	*	*	*	1	2	4	4	1	*	*	0	*	13
635 Itoya	13	0	*	0	*	0	0	0	0	*	*	*	*	*
636 Inomaki	13	0	0	*	*	*	*	0	0	0	0	*	0	1
637 Ishigaki	23	0	0	0	*	0	*	0	0	0	0	0	0	1
638 Kagoshima	23	*	0	*	0	0	0	1	0	0	0	*	0	1
639 Kohn	23	0	0	*	*	0	*	*	0	0	0	0	*	1
640 Kumamoto	23	*	0	*	*	0	0	0	0	0	0	0	0	*
641 Kure	23	0	0	*	0	0	0	0	0	0	*	*	*	*
642 Kyoto	23	0	*	*	*	*	*	0	0	0	*	*	*	1
643 Maoka	21	0	0	0	0	0	*	0	*	*	1	*	0	2
644 Miyazu	23	0	*	*	*	*	*	0	0	0	0	*	0	1
645 Nagano	23	0	0	0	*	*	0	*	*	0	*	0	0	1
646 Nagasaki	23	*	*	*	*	0	0	*	0	0	0	*	*	1
647 Nagoya	23	0	*	*	*	0	0	0	0	0	0	0	0	*
648 Naze	22	0	*	0	0	0	0	0	0	0	*	0	0	*
649 Nemuro	23	*	0	0	*	0	0	0	0	0	*	*	*	1
650 Niigata	23	*	*	*	*	*	0	*	0	0	*	*	*	1
651 Onahama	19	*	0	0	0	*	0	0	0	0	*	*	*	1
652 Osaka	23	*	*	*	*	0	0	0	*	0	0	*	*	1
653 Sakai	23	*	*	*	*	*	0	0	0	0	0	*	*	1
654 Sapporo	23	0	*	*	*	*	1	*	1	2	1	1	0	7
655 Shikoku	21	0	0	0	*	*	*	0	0	*	*	0	0	1
656 Suifu	5	0	0	0	0	0	0	0	0	0	*	*	0	*
657 Syang	5	0	0	0	0	0	0	0	0	0	*	*	0	*
658 Tokyo	23	0	*	*	*	*	*	0	0	0	0	0	0	1
659 Utsunomiya	6	0	0	1	1	0	0	0	0	0	0	0	1	3
660 Yokohama	23	0	0	*	*	*	*	*	0	*	*	*	*	1

FORMOSA

Station No. Name	Yrs. Obs.													To- tal
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
661 Arisai	4	0	1	*	0	*	0	1	2	*	*	0	*	5

TABLE VI: Average Days with Hail, Asia (Cont'd)

CHINA

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
662 Hankow	13	*	*	*	*	*	0	*	0	0	0	0	*	1
663 Tientsin	16	0	0	0	*	*	*	*	*	*	0	0	0	1
664 Tsingtao	11	0	*	0	*	*	*	0	0	*	0	0	0	1
665 Toanan	3	0	0	0	0	0	1	0	0	0	0	0	0	1

MANCHURIA

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
666 Anida	7	0	0	0	0	*	*	*	*	0	0	0	0	1
667 Changchun	10	0	0	0	*	1	1	*	0	1	1	0	0	4
668 Cjalanjtun	20	0	0	0	0	*	*	*	*	*	0	0	0	2
669 Dairen	10	0	0	0	0	*	0	0	*	1	0	0	0	1
670 Hailar	7	0	0	0	0	*	*	1	*	*	0	0	0	2
671 Imjanjpo	20	0	0	0	*	1	1	*	*	*	*	0	0	2
672 Manchouli	9	0	0	0	0	0	*	*	1	*	0	0	0	2
673 Mientuho	9	0	0	0	0	1	1	*	*	1	*	0	0	4
674 Pokotu	9	0	0	0	0	*	*	1	0	*	*	*	0	2
675 Taipingling	15	0	0	0	0	*	1	*	*	*	*	0	0	2
676 Yenki	7	0	0	0	0	1	*	0	0	*	0	0	0	1

KOREA

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
677 Gensan	15	0	0	0	*	*	*	0	0	0	*	0	0	1
678 Heizyo	20	0	0	*	*	*	*	0	0	*	1	*	*	3
679 Husan	15	0	0	*	*	*	0	*	0	0	*	*	0	1
680 Moppo	15	*	0	*	*	*	*	*	0	*	*	1	*	3
681 Saisyu	9	0	0	0	0	*	0	0	0	0	0	*	*	*
682 Sozan	5	0	0	0	*	0	*	0	0	*	1	0	0	2
683 Taikyū	15	0	0	*	*	*	*	0	0	*	0	0	0	1
684 Tyukan	20	0	0	0	*	1	1	*	*	*	*	*	0	3
685 Yuki	15	0	0	0	*	*	*	0	*	*	*	*	0	2
686 Zinsen	15	0	0	*	*	*	*	0	*	*	*	1	*	3
687 Zyosin	5	0	0	0	*	*	*	0	0	0	*	*	0	1

TABLE VII: Average Days with Hail, South America,
Africa, Australia

CHILE (South America)

Station No. Name	Yrs. Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	To- tal
688 Concepcion	11	0	0	0	0	0	*	*	0	*	0	0	0	*
689 Constitucion	10	*	0	0	0	0	*	*	*	*	*	*	0	1
690 Contulmo	12	*	0	0	0	0	*	1	1	*	1	*	0	3
691 Curico	12	*	0	0	0	0	0	*	*	0	*	*	0	1
692 De Cauquenes	9	0	0	0	0	0	0	0	0	*	0	0	0	*
693 El Teniente	12	*	0	0	0	*	0	0	*	*	*	*	*	1
694 Isla Guafio	12	*	*	*	*	1	1	1	2	2	1	2	1	11
695 Isla Juan Fernandez	12	0	0	0	0	0	*	*	*	0	0	0	0	1
696 Isla Mocha E.	12	0	0	0	0	0	*	*	*	0	0	0	0	1
697 Isla Santa Maria	8	0	0	0	0	0	*	*	0	0	*	0	0	*
698 Juncal	*	0	0	0	0	0	0	0	*	0	*	*	*	1
699 La Serena	12	0	0	0	0	0	0	0	*	0	*	0	*	*
700 Lebu	2	0	0	0	0	0	0	1	0	2	1	0	0	4
701 Linares	9	*	0	0	0	0	0	*	0	*	0	*	0	1
702 Potrerillos	12	0	*	*	1	0	1	*	*	1	*	*	0	4
703 Puerto Mont	12	*	0	*	*	*	1	*	1	1	1	1	*	6
704 Santiago	29	0	0	0	*	*	*	*	*	*	*	*	0	1
705 Talca	12	0	0	0	0	*	*	*	0	*	0	*	*	1
706 Valdivia	11	0	*	*	*	*	1	2	1	1	1	1	*	7

URUGUAY (South America)

Station No. Name	Yrs. Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	To- tal
707 Deriego	7	*	*	*	0	*	1	1	1	*	0	*	*	4

SOUTH ATLANTIC ISLANDS

Station No. Name	Yrs. Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	To- tal
708 Grytviken, South Georgia	10	2	3	2	3	4	2	1	1	2	1	2	2	25
709 Cape Pembroke, Falkland Isl.	10	2	2	2	4	3	2	2	2	2	3	4	3	31

NOTE: Range from .1 to .4 is represented by *
Range from .5 to 1.4 is represented by 1
Range from 1.5 to 2.4 is represented by 2, etc.

TABLE VII: Average Days with Mail, South America,
Africa, Australia (Cont'd)

ARGENTINA (South America)

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
710 Buenos Aires	19	*	0	1	0	1	*	*	*	*	1	1	*	4
711 Col De Chubut	20	*	*	1	*	*	1	1	1	*	*	0	0	4
712 Cordoba	29	*	*	*	*	*	1	1	1	*	*	*	*	4
713 Mendoza	27	1	*	*	*	*	*	0	*	*	*	*	*	3
714 Tucuman	21	*	*	*	*	*	0	0	*	0	*	*	*	1

BOLIVIA (South America)

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
715 LaPas	30	1	1	1	1	*	*	*	*	1	1	1	1	8
716 Potosi	5	2	1	1	0	*	0	0	0	0	*	0	*	4
717 Puerta Suarez	5	0	0	0	0	0	0	0	0	*	0	0	*	*
718 Sucre	30	1	*	1	1	*	*	*	*	1	1	1	1	7
719 Tupiza	5	1	1	*	0	0	0	0	0	0	0	*	1	3
720 Gruro	5	1	*	1	*	1	*	*	*	2	*	0	2	8
721 Corocoro	5	1	2	1	1	*	0	0	1	*	1	1	3	11
722 Patacamaya	5	1	1	1	1	*	*	1	*	1	1	1	1	9

BRAZIL (South America)

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
723 Itatiaya	6	1	1	1	0	0	0	0	1	1	1	1	1	8
724 Maristella	6	0	0	0	0	0	0	0	0	0	0	1	0	1
725 Nova Friburgo	9	*	*	0	0	0	0	0	0	0	0	0	0	*
726 Porto Alegre	9	0	0	0	0	3	0	0	0	0	0	0	0	3
727 Pyrenopolis	6	0	0	0	0	0	0	0	0	0	1	0	0	1
728 Uruguayana	8	0	0	0	0	0	1	0	0	1	0	0	0	2

MOROCCO (Africa)

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
729 Casablanca	6	*	1	*	0	*	0	0	0	0	0	0	*	2
730 Marrakech	6	0	*	1	0	*	*	*	0	0	0	0	0	1
731 Tangier	10	*	1	1	1	*	0	0	0	*	*	1	1	6

TABLE VII: Average Days with Hail, South America,
Africa, Australia (Cont'd)

FRENCH WEST AFRICA

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
732 Kayes	5	0	0	0	0	0	0	0	0	0	0	0	0	0
733 Port Etienne	6	0	0	0	0	0	0	0	0	0	*	0	0	*
734 Dakar	6	0	0	0	0	0	0	0	0	0	0	0	0	0
735 Zinder	6	0	0	0	0	0	2	1	0	0	0	0	0	3

IVORY COAST (Africa)

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
736 Bobo Dioulasso	6	0	0	0	0	0	0	0	0	0	0	0	0	0

GOLD COAST (Africa)

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
737 Accra	15	0	0	0	0	0	0	0	0	0	0	0	0	0

KENYA (Africa)

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
738 Eldama Ravine	4	0	0	0	*	0	*	1	1	2	*	0	0	4

MOZAMBIQUE (Portuguese East Africa)

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
739 Lourenco Marques	29	*	0	*	*	0	*	0	0	*	*	*	*	1

FRENCH GUINEA (Africa)

<u>Station</u> <u>No. Name</u>	<u>Yrs.</u> <u>Obs.</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>To-</u> <u>tal</u>
740 Conakry	6	0	0	0	0	0	0	0	0	0	0	0	0	0
741 Mali	6	*	0	0	0	*	0	0	0	0	0	0	0	*

TABLE VII: Average Days with Hail, South America
Africa and Australia (Cont'd)

NEW ZEALAND

Station No. Name	Yrs. Obs.													To- tal
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
742 Auckland	4	0	0	0	0	0	0	0	0	0	0	0	0	0
743 Christ Church	4	0	0	0	*	*	0	*	*	*	*	1	1	2
744 Dunedin	4	0	0	0	0	0	*	*	*	*	0	0	0	1
745 Hokitika	4	0	0	0	0	*	*	1	*	*	0	0	0	2
746 Invercargill	4	0	0	0	0	*	1	*	*	*	*	0	0	2
747 Milford Sound	4	1	1	0	0	0	*	1	2	1	1	1	*	7

AUSTRALIA

748 Sydney	} Unknown	} No monthly data	4
749 Wyndam			2
750 Melbourne			7
751 Adelaide			6
752 Hobart			3
753 Roebourne			1
754 Onslow			1
755 Ceduna			1

HEADQUARTERS QUARTERMASTER RESEARCH & ENGINEERING CENTER, US ARMY
Quartermaster Research & Engineering Center
Natick, Massachusetts

31 March 1958

Technical Report EP-63, NAIL SIZE AND DISTRIBUTION, by Blanche B. Hall,
February 1958.

ERRATA

Page

- Title Change 1-57 to 1-58
- iii Change last word to stations
- 27 Figure 12 caption, change Veligh to Veligh
- 29 In sixth paragraph, after first sentence, change to: The size of a nailstone is more important than its speed in determining possible damage to both stationary and moving objects. However, the speed of an aircraft in flight is an important additional factor in determining degree of damage to the aircraft. For this reason . . .
- 30 Figure 10 caption, change date to 26 July 1938
- 44 For Station No. 351, under Total, change 1 to 2
- 45 For Station No. 367, under Total, change 15 to 6
- 46 For Station No. 376, under Total, change 1 to 9
- 50 For Station No. 519, change line to read:
20 0 * 0 * * 1 0 0 0 0 0 1
- 52 For Station No. 559, under May, change 4 to 1
- 55 For Station No. 637, under Total, change 1 to *
- 61 For Abilene, 1945, under Annual, change 0 to 9
- 66 For Pocatello, 1947, under Jan, Jul, Aug, change to 1 2 0

TABLE VIII: Total Days with Hail at 25 United States Stations, 1940-49
(Stations with 125 Days of Hail in 40 Years)

ABILENE, TEXAS

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	1	1	1	0	0	0	0	0	0	0	3
1948	0	0	0	0	2	0	0	0	0	0	0	0	2
1947	0	0	0	1	1	1	0	0	0	1	0	2	6
1946	0	1	1	2	2	0	0	0	0	0	0	0	6
1945	0	0	3	1	2	2	0	0	0	0	1	0	0
1944	0	0	0	2	2	0	0	0	0	0	0	0	4
1943	0	0	1	1	0	0	0	0	0	0	0	0	2
1942	0	0	0	2	1	0	0	0	0	1	0	0	4
1941	0	0	0	1	0	1	1	1	0	0	1	0	5
1940	0	0	1	1	0	0	0	0	0	0	0	0	2
Sums	0	1	7	12	11	4	1	1	0	2	2	2	43

BOISE, IDAHO

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	0	0	0	0	0	0	0	1	1	0	2
1948	0	0	1	2	1	1	0	0	0	1	0	0	6
1947	0	1	1	0	0	0	0	0	0	0	0	1	3
1946	0	2	1	0	0	1	0	0	0	1	1	0	6
1945	0	0	0	0	3	0	0	0	0	0	1	0	4
1944	0	0	0	1	0	0	1	0	0	0	1	0	3
1943	0	0	0	0	0	1	0	0	0	1	0	0	2
1942	0	1	0	0	1	1	0	0	0	0	1	0	4
1941	0	0	0	0	0	0	0	0	0	0	0	0	0
1940	0	0	2	0	0	0	0	0	0	0	1	0	3
Sums	0	4	5	3	5	4	1	0	0	4	6	1	33

CHEYENNE, WYOMING

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	0	0	4	3	3	3	0	0	1	0	14
1948	0	0	0	0	4	5	5	1	0	1	0	0	16
1947	0	0	1	0	3	2	1	2	0	0	0	0	9
1946	0	0	0	0	2	1	2	2	0	0	0	0	8
1945	0	0	0	0	2	5	2	1	0	0	0	0	10
1944	0	0	0	0	2	5	2	0	1	0	0	0	10
1943	0	0	0	2	0	7	2	0	0	0	0	0	11
1942	0	0	0	1	0	7	3	2	1	1	0	0	15
1941	0	0	0	2	2	2	5	1	0	0	0	0	12
1940	0	0	0	2	1	2	1	1	0	0	0	0	7
Sums	0	0	2	7	20	39	26	13	2	2	1	0	112

TABLE VIII (cont'd)

CONCORDIA, KANSAS

<u>YEARS</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>ANNUAL</u>
1909	0	0	0	0	1	2	0	0	0	0	0	0	3
1908	0	0	0	0	0	0	1	0	1	0	0	0	2
1907	0	0	0	1	0	1	0	0	0	0	0	0	2
1906	0	0	0	0	1	0	0	0	0	1	0	0	2
1905	0	0	0	1	4	2	0	2	1	0	1	0	11
1904	0	0	1	2	1	1	2	0	0	0	1	0	8
1903	0	0	0	1	1	2	0	0	0	0	0	0	4
1902	0	0	1	0	4	2	0	0	0	0	0	1	8
1901	0	1	0	0	0	2	0	1	0	1	0	1	6
1900	0	0	2	0	0	0	0	0	0	1	0	0	3
<u>Sum</u>	<u>0</u>	<u>1</u>	<u>4</u>	<u>5</u>	<u>12</u>	<u>12</u>	<u>3</u>	<u>3</u>	<u>2</u>	<u>3</u>	<u>2</u>	<u>2</u>	<u>49</u>

DALLAS, TEXAS

<u>YEARS</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>ANNUAL</u>
1909	0	0	1	1	1	0	0	0	0	0	0	0	3
1908	0	0	1	0	3	0	0	0	0	0	0	0	4
1907	0	0	0	2	0	0	0	0	0	0	0	0	2
1906	0	1	1	2	3	0	0	0	0	0	0	0	7
1905	0	2	1	2	0	0	0	0	0	0	0	0	5
1904	0	0	1	0	0	0	0	0	0	0	0	0	1
1903	0	0	1	0	0	0	0	0	0	0	0	0	1
1902	0	0	0	0	1	1	0	0	0	0	0	0	2
1901	0	0	0	0	0	0	0	1	1	0	0	0	2
1900	0	0	2	0	0	0	0	1	0	0	0	0	3
<u>Sum</u>	<u>0</u>	<u>3</u>	<u>8</u>	<u>7</u>	<u>8</u>	<u>1</u>	<u>0</u>	<u>2</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>20</u>

DENVER, COLORADO

<u>YEARS</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>ANNUAL</u>
1909	0	0	0	0	1	1	1	1	0	0	0	0	4
1908	0	0	0	0	0	1	1	1	0	0	0	0	3
1907	0	0	0	2	1	0	2	0	0	0	0	0	5
1906	0	0	1	0	0	0	0	0	1	0	0	0	2
1905	0	0	0	1	3	4	0	0	0	0	0	0	8
1904	0	0	0	0	0	2	2	2	0	0	1	0	7
1903	0	0	0	1	2	1	0	1	0	0	0	0	5
1902	0	0	0	1	0	1	1	0	0	1	0	0	4
1901	0	0	0	1	1	0	1	1	0	0	0	0	4
1900	0	0	0	0	0	2	0	0	2	0	0	0	4
<u>Sum</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>6</u>	<u>8</u>	<u>12</u>	<u>8</u>	<u>6</u>	<u>3</u>	<u>1</u>	<u>1</u>	<u>0</u>	<u>46</u>

TABLE VIII (cont'd)

DES MOINES, IOWA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	1	0	0	1	0	1	0	0	1	0	4
1948	0	0	0	0	0	1	1	0	0	0	0	0	2
1947	0	0	0	2	1	2	0	0	0	0	0	0	5
1946	1	0	0	0	0	1	0	0	0	2	0	0	4
1945	0	0	2	0	1	1	1	1	0	0	1	0	7
1944	0	0	1	1	5	0	0	1	0	0	0	0	8
1943	0	0	2	1	0	0	0	0	0	0	0	0	3
1942	0	0	1	0	0	2	0	0	0	1	0	0	4
1941	0	0	0	0	0	2	1	1	1	0	0	0	5
1940	0	0	0	0	0	0	0	0	0	0	0	0	0
Sums	1	0	7	4	7	10	3	4	1	3	2	0	42

DODGE CITY, KANSAS

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	1	0	1	4	1	0	0	0	1	0	0	8
1948	0	0	0	1	2	0	0	0	0	0	0	0	3
1947	0	0	0	1	2	2	0	0	0	0	0	0	5
1946	0	0	1	1	0	1	0	0	0	0	0	0	3
1945	0	0	1	2	1	0	1	0	1	0	0	0	6
1944	1	0	1	2	2	1	1	1	0	0	0	0	9
1943	0	1	0	2	0	1	0	0	0	1	0	0	5
1942	0	0	1	2	1	2	0	0	0	0	1	0	7
1941	0	0	0	2	0	1	0	0	0	0	0	0	3
1940	0	0	1	2	0	2	2	0	0	0	0	0	7
Sums	1	2	5	16	12	11	4	1	1	2	1	0	56

EUREKA, CALIFORNIA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	1	0	0	0	0	0	0	0	0	0	0	1	2
1948	1	1	1	2	1	0	0	0	0	0	0	0	6
1947	2	0	0	1	0	0	0	0	0	0	0	1	4
1946	2	2	2	0	0	0	0	0	0	0	1	0	7
1945	0	1	2	1	0	0	0	0	0	0	0	1	5
1944	0	0	2	4	0	0	0	0	0	1	0	1	8
1943	1	2	1	0	0	0	0	0	0	1	0	0	5
1942	0	0	1	0	0	0	0	0	0	0	1	2	4
1941	0	0	1	0	1	0	0	0	0	0	1	1	4
1940	1	2	2	0	0	0	0	0	0	0	0	0	5
Sums	8	8	12	8	2	0	0	0	0	2	3	7	50

TABLE VIII (cont'd)

HELENA, MONTANA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	0	0	1	0	0	0	0	0	0	0	1
1948	0	0	0	0	0	1	3	1	0	0	0	0	5
1947	0	2	2	0	2	1	3	0	1	0	0	0	9
1946	0	0	0	0	1	2	2	0	0	0	0	0	5
1945	0	0	0	1	4	1	0	0	0	0	0	0	6
1944	0	0	0	1	0	0	2	2	0	0	0	0	5
1943	0	0	0	0	1	1	0	0	0	0	0	0	2
1942	0	0	0	0	0	2	1	1	0	1	0	0	5
1941	0	0	0	0	2	2	3	0	0	0	0	0	7
1940	0	0	0	1	2	0	2	0	0	0	0	0	5
Sums	0	0	2	3	13	10	16	4	1	1	0	0	50

KANSAS CITY, MISSOURI

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	1	0	0	2	2	0	0	0	0	0	1	0	6
1948	0	0	0	1	0	0	1	0	0	1	1	1	5
1947	1	0	0	0	0	0	0	0	0	0	0	0	1
1946	0	0	1	0	1	0	0	0	1	0	0	0	3
1945	0	0	1	1	1	2	0	0	0	0	1	0	6
1944	0	0	1	5	1	2	0	0	0	0	0	0	9
1943	0	0	1	2	1	0	0	0	0	0	0	0	4
1942	0	0	1	0	1	0	0	0	0	0	0	0	2
1941	1	1	0	1	0	0	0	0	0	1	0	0	4
1940	0	0	1	0	2	0	0	1	0	0	0	0	4
Sums	3	1	4	12	9	4	1	1	1	2	3	1	44

LINCOLN, NEBRASKA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	1	0	0	1	0	0	0	0	0	0	2
1948	0	0	0	0	0	0	0	0	1	0	1	0	2
1947	0	0	0	1	1	1	1	0	0	0	0	0	4
1946	0	1	1	0	0	0	0	0	0	1	0	0	3
1945	0	0	0	0	3	1	0	2	2	0	0	0	8
1944	0	0	2	2	0	1	0	0	0	0	0	0	6
1943	0	0	0	0	1	1	0	0	2	0	0	0	4
1942	0	0	1	0	2	0	1	0	0	0	1	0	5
1941	0	0	0	1	0	0	0	0	0	0	0	0	1
1940	0	0	0	0	0	1	0	0	0	0	0	0	1
Sums	0	1	5	4	7	6	2	3	5	1	2	0	36

TABLE VIII (cont'd)

NORTH HEAD, WASHINGTON

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	4	0	4	0	1	0	0	0	0	2	1	7	19
1948	7	6	6	8	2	0	0	0	1	1	10	9	51
1947	7	0	1	2	0	0	0	0	0	1	2	4	17
1946	6	4	5	3	0	0	0	0	0	1	1	3	23
1945	1	5	5	2	0	0	0	0	0	0	8	3	24
1944	2	2	6	3	0	0	0	0	1	0	2	1	17
1943	4	3	3	2	2	0	0	0	0	5	0	0	19
1942	0	2	7	2	0	0	0	0	0	1	4	6	22
1941	2	1	2	1	2	1	0	0	0	1	1	5	16
1940	3	3	2	2	0	0	0	0	0	2	2	2	16
Sums	36	26	42	25	7	1	0	0	2	14	31	40	224

NORTH PLATTE, NEBRASKA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	0	0	1	1	0	0	0	0	0	0	2
1948	0	0	0	0	1	0	2	1	0	0	0	0	4
1947	0	0	0	1	0	0	0	0	0	0	0	0	1
1946	0	0	1	0	1	0	0	0	0	1	2	1	6
1945	0	0	0	1	2	1	1	0	1	0	0	0	6
1944	0	0	0	0	0	1	0	0	0	0	0	0	1
1943	0	0	0	0	2	2	0	0	0	0	0	0	4
1942	0	0	0	1	2	1	0	2	0	0	0	0	6
1941	0	0	0	1	1	1	1	0	0	0	0	0	4
1940	0	0	0	0	0	0	0	1	0	1	0	0	2
Sums	0	0	1	4	10	7	4	4	1	2	2	1	36

OKLAHOMA CITY, OKLAHOMA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	1	1	2	0	0	0	0	0	0	0	4
1948	0	0	1	0	1	0	0	0	0	0	0	0	2
1947	0	0	0	3	1	0	0	0	0	0	0	0	4
1946	0	0	1	0	1	0	0	1	0	0	0	0	3
1945	0	2	1	2	1	4	0	0	0	0	0	0	10
1944	1	0	1	3	1	0	0	0	0	0	0	0	6
1943	0	0	0	0	4	1	0	0	1	0	0	0	6
1942	0	0	0	1	0	1	0	0	0	0	0	0	2
1941	0	0	0	1	0	0	0	0	0	0	0	0	1
1940	0	0	0	1	2	0	0	0	0	0	0	0	3
Sums	1	2	3	12	13	6	0	1	1	0	0	0	41

TABLE VIII (cont'd)

OMAHA, NEBRASKA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	1	0	1	0	0	2	0	0	0	0	0	0	4
1948	0	0	0	0	0	0	0	0	1	0	0	0	1
1947	0	2	0	1	0	1	1	0	0	0	1	0	4
1946	0	0	0	0	1	0	0	0	0	0	0	0	1
1945	0	0	0	1	3	0	2	0	0	0	0	0	6
1944	0	1	0	0	1	1	0	0	0	0	0	0	3
1943	0	0	0	0	2	0	1	0	0	0	0	0	3
1942	0	0	2	0	1	2	2	0	0	1	0	0	8
1941	0	0	0	0	0	1	1	0	0	0	0	0	2
1940	0	0	1	0	1	1	0	0	0	0	0	0	3
Sums	1	1	4	2	9	8	7	0	1	1	1	0	35

POCATELLO, IDAHO

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	1	0	4	1	0	0	0	0	0	0	6
1948	0	1	0	2	1	0	0	0	1	0	0	0	5
1947	0	0	0	0	0	0	1	2	0	0	0	0	3
1946	0	0	1	1	0	0	0	0	0	0	0	0	2
1945	0	0	0	0	2	0	0	0	0	0	0	0	2
1944	0	0	1	1	0	2	1	0	0	0	0	0	5
1943	0	0	1	1	1	3	0	1	0	0	0	0	7
1942	0	0	0	0	2	0	0	1	0	0	0	0	3
1941	0	0	0	0	1	0	2	0	0	0	0	0	3
1940	0	0	0	1	0	0	0	0	0	0	0	0	2
Sums	0	1	4	6	11	7	5	2	2	0	0	0	38

PORTLAND, OREGON

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	1	0	1	0	0	0	0	0	0	0	0	2
1948	1	0	2	2	0	0	0	0	0	0	0	0	5
1947	0	0	2	1	0	0	0	0	0	0	0	0	3
1946	0	0	0	0	0	0	0	0	0	0	0	0	0
1945	0	0	3	0	0	0	0	0	0	0	0	0	3
1944	0	0	2	2	0	0	0	0	0	0	0	0	4
1943	0	0	0	0	0	0	0	0	0	0	0	0	0
1942	0	2	3	1	0	0	0	0	0	0	0	0	7
1941	0	0	0	1	1	0	0	0	0	0	0	0	2
1940	0	0	1	0	2	0	0	0	0	0	0	0	3
Sums	1	3	13	4	3	0	0	0	0	0	1	0	29

TABLE VIII (cont'd)

RAPID CITY, SOUTH DAKOTA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	0	0	1	0	0	2	0	0	0	0	3
1948	0	0	0	0	2	0	1	4	1	0	0	0	8
1947	0	0	0	1	1	1	0	0	0	0	0	0	3
1946	0	0	0	1	0	1	2	0	1	0	0	0	5
1945	0	0	0	0	2	2	1	0	0	0	0	0	5
1944	0	0	0	1	0	3	3	1	0	0	0	0	8
1943	0	0	0	0	0	1	1	0	0	0	0	0	2
1942	0	0	0	0	0	1	1	0	0	0	0	0	2
1941	0	0	0	2	2	0	0	0	0	0	0	0	4
1940	0	0	0	0	0	0	0	0	0	0	0	0	0
Sums	0	0	0	5	8	9	9	7	2	0	0	0	40

SPOKANE, WASHINGTON

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	1	1	0	1	1	0	0	1	0	0	4
1948	0	0	3	3	1	0	0	0	1	1	1	0	10
1947	0	0	1	1	0	0	0	0	1	0	1	0	4
1946	0	0	1	0	0	0	0	0	0	0	1	0	2
1945	0	0	4	2	3	3	0	1	1	0	0	0	14
1944	0	0	0	1	0	0	0	1	0	0	0	0	2
1943	0	0	0	0	4	0	0	0	0	0	0	0	6
1942	0	0	0	0	2	0	0	0	0	0	0	0	2
1941	0	0	1	2	0	0	1	0	1	0	0	0	5
1940	0	0	0	2	0	0	0	0	0	0	0	0	2
Sums	0	0	12	12	10	4	1	3	4	2	3	0	51

SPRINGFIELD, MISSOURI

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	2	1	1	1	0	0	0	0	0	0	5
1948	0	0	0	3	2	1	0	0	0	0	0	0	6
1947	1	0	2	2	1	1	0	0	0	0	0	0	7
1946	0	0	0	1	1	0	0	3	0	0	0	0	5
1945	0	1	0	0	0	1	0	0	0	0	0	0	2
1944	0	0	1	4	0	0	1	0	0	0	1	0	7
1943	0	0	3	1	1	0	0	0	0	0	1	0	6
1942	0	1	0	0	1	1	0	0	0	0	0	0	3
1941	0	0	0	0	0	1	1	0	0	0	0	1	3
1940	0	0	1	1	0	0	0	1	0	0	0	0	3
Sums	1	2	9	13	7	6	2	4	0	0	2	1	47

TABLE VIII (cont'd)

TATOOSH ISLAND, WASHINGTON

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	1	9	1	2	0	0	0	0	0	0	4	2	19
1948	6	4	5	5	0	0	0	0	1	1	5	7	34
1947	7	0	0	1	0	0	0	0	0	0	1	1	10
1946	0	0	1	1	0	0	0	0	0	2	2	1	7
1945	2	2	5	6	0	0	0	0	0	0	0	1	10
1944	4	1	4	3	0	0	0	0	0	0	0	0	12
1943	3	4	4	3	0	0	0	0	0	0	0	0	14
1942	0	0	8	2	0	0	0	0	0	0	5	8	23
1941	0	0	3	1	1	0	0	0	0	0	2	5	12
1940	1	3	1	1	0	0	0	0	0	0	0	4	10
Sums	24	23	32	19	1	0	0	0	1	3	19	29	151

TIPEKA, KANSAS

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	1	0	0	0	1	0	0	1	0	0	1	0	4
1948	0	0	2	1	0	0	0	2	0	1	0	0	6
1947	1	0	0	1	1	0	0	0	0	0	0	0	3
1946	0	0	0	1	0	0	0	0	0	0	1	0	2
1945	0	0	0	0	3	1	1	0	0	0	0	0	5
1944	0	1	1	1	1	0	0	0	0	0	0	0	4
1943	0	0	0	0	1	1	1	0	0	0	0	0	3
1942	0	0	0	1	0	0	0	0	0	0	0	0	1
1941	0	0	0	1	0	0	0	0	0	1	0	0	2
1940	0	0	0	1	0	0	0	0	0	1	0	0	2
Sums	2	1	3	6	8	2	2	3	0	3	2	0	32

VALENTINE, NEBRASKA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	0	0	2	0	0	0	0	0	0	0	2
1948	0	0	0	0	0	1	0	1	0	0	0	0	2
1947	0	0	0	2	2	0	0	0	0	0	0	0	4
1946	0	0	0	1	1	2	1	0	0	1	0	0	6
1945	0	0	1	1	3	0	2	0	0	0	0	0	7
1944	0	0	0	0	2	0	1	2	0	0	0	0	5
1943	0	0	0	0	0	1	1	1	0	0	0	0	3
1942	0	0	0	1	1	4	1	1	0	0	0	0	8
1941	0	0	0	0	0	1	1	0	0	0	0	0	2
1940	0	0	1	1	0	2	1	1	0	1	0	0	7
Sums	0	0	2	6	11	11	8	6	0	2	0	0	46

TABLE VIII.-(cont'd)

WICHITA, KANSAS

<u>YEARS</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>ANNUAL</u>
1949	1	0	0	2	2	0	1	0	1	0	0	0	7
1948	0	1	0	0	0	2	1	0	0	1	0	0	5
1947	0	0	3	1	0	1	0	0	0	1	0	0	6
1946	0	0	1	0	1	0	0	0	0	0	0	0	2
1945	0	0	0	1	2	1	0	0	1	0	0	0	5
1944	0	0	1	6	1	1	0	0	0	0	0	0	9
1943	0	1	0	0	1	0	0	0	1	1	0	0	4
1942	0	0	0	1	2	1	0	0	0	0	0	0	4
1941	0	0	0	2	1	0	1	1	0	0	0	0	6
<u>1940</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>4</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>6</u>
<u>Sums</u>	<u>1</u>	<u>2</u>	<u>6</u>	<u>17</u>	<u>11</u>	<u>6</u>	<u>3</u>	<u>1</u>	<u>3</u>	<u>3</u>	<u>0</u>	<u>1</u>	<u>54</u>

TABLE IX: Total Days with Thunderstorms at 25 United States Stations
1940-49
(Stations with 125 Days of Hail in 40 Years)

ASILENE, TEXAS

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	2	2	7	10	9	5	5	3	3	0	2	48
1948	0	3	2	2	7	8	8	7	2	2	0	1	42
1947	0	1	1	4	13	7	6	5	3	6	0	4	50
1946	1	3	3	5	13	3	2	3	4	1	4	0	42
1945	0	3	8	6	8	10	7	3	2	0	1	0	48
1944	1	3	1	4	13	4	6	3	1	3	1	0	40
1943	0	0	2	5	9	6	2	2	4	1	0	0	31
1942	1	0	1	8	8	8	2	5	4	5	0	1	43
1941	1	2	2	6	7	10	6	11	4	6	1	0	56
1940	0	4	3	4	5	11	1	9	3	2	4	1	47
Sums	4	21	25	51	93	76	45	53	30	29	11	9	447

BOISE, IDAHO

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	0	0	6	5	2	6	2	0	1	0	22
1948	0	1	0	3	4	5	2	0	0	1	0	0	16
1947	0	0	0	1	3	4	0	0	3	0	0	0	11
1946	0	1	1	3	0	4	5	3	2	0	0	0	19
1945	0	0	1	1	6	3	2	1	1	3	0	0	18
1944	0	0	0	0	4	6	5	0	0	1	1	0	17
1943	0	0	1	0	2	5	2	2	0	1	0	0	13
1942	0	2	1	1	5	2	0	2	1	1	1	0	16
1941	0	0	0	1	5	4	6	2	0	0	0	0	18
1940	0	0	0	1	3	0	6	1	7	2	0	0	20
Sums	0	4	4	11	38	38	30	17	16	9	3	0	170

CHEYENNE, WYOMING

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	1	0	5	14	10	14	17	5	2	0	0	68
1948	0	0	0	4	4	12	17	10	6	1	0	0	58
1947	0	0	2	3	9	11	14	11	9	0	0	0	59
1946	0	0	2	4	4	7	15	13	5	2	0	0	52
1945	0	0	0	2	6	16	12	14	4	0	0	0	54
1944	0	0	0	1	10	12	13	9	4	2	0	0	51
1943	0	0	0	3	4	17	11	11	3	1	0	0	50
1942	0	0	0	2	6	12	17	11	2	3	0	0	53
1941	0	0	0	3	10	14	18	11	2	1	0	0	59
1940	0	0	0	4	5	9	19	9	13	1	0	0	60
Sums	0	1	4	31	76	120	150	116	53	13	0	0	564

TABLE IX: (cont'd)

CONCORDIA, KANSAS

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	1	0	2	4	8	15	7	7	8	5	0	0	57
1948	0	1	1	3	6	11	10	8	7	3	0	0	50
1947	0	0	2	6	6	13	5	2	3	4	0	0	41
1946	0	1	3	2	6	6	6	10	10	4	1	0	49
1945	0	0	2	5	14	13	9	5	6	0	2	1	57
1944	1	0	3	7	11	14	12	8	7	1	0	0	64
1943	0	0	0	6	6	12	8	14	5	4	0	0	55
1942	0	0	2	5	10	13	11	11	5	1	0	1	59
1941	0	1	0	2	9	9	7	10	8	9	2	1	54
1940	0	0	1	6	5	7	11	12	4	5	1	0	53
Sums	2	3	16	46	82	113	86	87	63	36	6	3	543

DALLAS, TEXAS

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	1	3	1	5	10	7	0	7	4	4	0	0	42
1948	0	4	3	3	8	7	6	2	1	2	0	1	37
1947	0	1	2	8	6	5	0	5	3	5	3	4	42
1946	2	4	2	4	14	4	3	1	4	3	4	1	46
1945	1	5	12	5	5	5	4	2	3	3	1	0	46
1944	0	7	4	8	10	1	5	4	1	1	1	1	43
1943	0	1	5	2	9	7	5	0	5	2	1	1	38
1942	1	2	0	13	6	7	1	6	2	4	1	1	44
1941	0	1	4	8	5	10	7	11	2	3	2	3	58
1940	0	1	7	7	6	9	5	7	0	2	3	2	49
Sums	5	29	40	63	79	62	36	45	25	31	16	14	445

DENVER, COLORADO

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	1	0	5	9	14	10	4	0	0	0	42
1948	0	0	1	0	7	15	11	9	2	1	0	0	46
1947	0	0	1	1	8	5	13	9	4	2	0	0	43
1946	0	0	2	2	7	7	16	5	5	0	0	0	44
1945	0	0	1	0	6	13	13	14	4	0	0	0	51
1944	0	0	0	1	10	7	14	5	0	1	1	0	39
1943	0	0	0	5	5	8	11	7	2	0	0	0	38
1942	0	0	1	4	2	10	13	6	1	2	0	0	39
1941	0	0	0	6	7	13	11	9	2	3	0	0	51
1940	0	1	0	1	4	7	17	7	13	1	0	0	51
Sums	0	1	7	20	61	93	133	91	37	10	1	0	444

TABLE IX: (cont'd)

DES MOINES, IOWA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	1	0	2	2	5	10	7	7	3	4	2	1	44
1948	0	0	2	5	1	6	10	9	5	2	1	2	43
1947	1	0	1	7	6	17	5	4	4	5	1	0	51
1946	1	0	6	4	5	12	7	9	8	3	1	0	56
1945	0	0	8	9	10	13	8	7	7	0	1	1	64
1944	2	1	2	3	19	10	9	7	8	1	2	0	64
1943	0	0	1	6	4	15	13	14	5	2	0	0	60
1942	0	0	3	3	9	13	13	5	6	1	0	0	53
1941	0	0	1	4	8	8	11	7	8	8	2	0	57
1940	0	0	2	1	4	7	12	10	1	5	0	0	42
Sums	5	1	28	44	71	111	95	79	55	31	10	4	534

DODGE CITY, KANSAS

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	1	2	4	13	12	12	10	6	2	0	0	62
1948	0	3	2	1	8	13	13	11	4	2	0	0	57
1947	0	0	2	3	12	10	6	7	4	2	0	0	46
1946	1	0	3	5	5	8	8	13	5	2	2	0	52
1945	0	0	2	9	8	11	14	6	8	1	0	0	59
1944	1	0	1	12	11	10	12	14	5	0	1	0	67
1943	0	1	0	4	11	10	13	8	4	5	0	0	56
1942	0	0	2	7	6	11	12	12	6	1	0	0	57
1941	0	0	0	6	9	10	4	9	1	7	1	0	47
1940	0	0	1	4	8	10	10	14	4	2	0	0	53
Sums	2	5	15	55	91	105	104	104	47	24	4	0	556

EUREKA, CALIFORNIA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	0	0	0	0	0	0	1	0	2	0	3
1948	0	0	0	0	0	3	0	0	0	0	0	0	3
1947	0	0	0	0	0	0	0	1	0	1	0	0	2
1946	2	0	0	0	0	1	1	0	1	0	2	0	7
1945	2	0	1	0	0	0	0	0	0	3	1	1	8
1944	0	0	1	1	0	1	1	0	1	2	0	1	8
1943	0	1	0	0	0	0	1	0	0	0	0	0	2
1942	1	2	0	0	0	0	0	0	0	0	1	0	4
1941	2	0	0	0	2	0	1	0	0	0	0	2	7
1940	2	0	1	0	0	0	0	0	0	1	0	1	5
Sums	9	3	3	1	2	5	4	1	3	7	6	5	49

TABLE IX: (cont'd)

HELENA, MONTANA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	0	1	6	9	10	13	3	1	0	0	43
1948	0	0	0	4	6	11	12	12	1	0	0	0	46
1947	1	0	1	0	2	12	16	17	2	2	0	0	53
1946	0	1	0	1	5	13	17	5	4	0	0	0	46
1945	0	0	0	0	8	5	10	7	3	0	0	0	33
1944	0	0	0	2	10	10	12	10	1	0	1	0	46
1943	1	0	0	0	7	8	9	7	0	1	0	0	33
1942	0	0	0	1	5	10	15	9	3	1	0	0	44
1941	0	0	0	3	9	9	13	10	1	0	0	0	45
1940	0	0	1	3	9	6	18	2	10	1	0	0	50
Sums	2	1	2	15	67	93	132	92	28	6	1	0	439

KANSAS CITY, MISSOURI

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	1	0	2	2	7	15	5	8	4	3	2	2	51
1948	0	1	8	1	5	1	11	5	6	3	2	1	44
1947	1	0	3	9	6	15	3	5	3	4	2	0	51
1946	1	0	2	3	6	5	5	6	5	4	1	0	38
1945	0	0	6	3	10	14	4	1	12	3	2	1	56
1944	1	1	6	10	12	6	8	12	3	2	2	0	63
1943	0	1	3	7	10	10	11	9	6	1	0	0	58
1942	0	3	5	4	8	14	8	7	4	1	4	1	59
1941	1	1	0	6	7	6	9	6	5	5	0	1	47
1940	0	0	3	2	7	6	5	11	2	3	1	1	41
Sums	5	7	38	47	78	92	69	70	50	29	16	7	508

LINCOLN, NEBRASKA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	1	0	1	2	12	14	9	6	7	7	0	0	59
1948	0	0	0	6	4	12	6	7	6	1	2	0	44
1947	1	0	0	9	9	11	7	2	5	7	0	0	51
1946	0	1	6	0	5	6	10	7	4	1	1	0	46
1945	0	0	5	4	11	12	10	8	8	0	1	1	58
1944	0	0	3	5	9	18	6	12	6	2	0	0	61
1943	0	0	1	6	5	8	14	10	4	2	0	0	50
1942	0	1	3	2	11	11	6	4	2	1	0	0	41
1941	0	0	0	7	9	7	8	5	9	4	2	1	52
1940	0	0	0	5	4	5	11	8	3	3	0	0	39
Sums	2	2	17	46	79	104	93	72	57	31	6	2	501

TABLE IX: (cont'd)

NORTH HEAD, WASHINGTON

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	0	0	0	0	0	0	2	1	1	0	4
1948	1	0	0	0	0	0	0	1	1	0	0	1	4
1947	0	0	1	0	0	0	1	0	0	0	0	0	2
1946	0	0	0	1	0	0	0	0	1	0	1	0	3
1945	0	0	0	0	0	0	0	1	0	0	4	0	5
1944	0	0	0	0	0	0	1	1	0	1	0	0	3
1943	0	0	0	0	0	0	0	0	0	3	0	0	3
1942	0	0	0	0	0	1	0	1	0	0	0	2	4
1941	0	1	0	0	1	1	1	1	1	1	1	2	10
1940	0	0	0	0	0	0	1	1	5	2	0	1	10
Sums	1	1	1	1	1	2	4	6	10	8	7	6	48

NORTH PLATTE, NEBRASKA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	2	4	10	10	13	5	5	4	0	0	53
1948	0	0	0	3	3	16	12	12	5	1	0	0	52
1947	0	0	1	6	7	15	13	7	5	3	0	0	57
1946	0	0	2	2	6	8	13	8	6	6	0	0	51
1945	0	1	1	5	14	13	12	11	9	0	0	1	67
1944	0	1	0	2	13	10	18	16	5	0	0	0	65
1943	0	0	0	3	6	12	15	12	7	0	0	0	55
1942	0	0	1	6	8	15	9	7	3	0	0	0	49
1941	0	0	0	5	11	10	14	2	4	2	0	0	48
1940	0	0	1	2	3	4	13	10	5	2	0	0	44
Sums	0	2	6	38	81	117	132	90	54	18	0	1	541

OKLAHOMA CITY, OKLAHOMA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	4	2	3	15	10	6	6	3	2	0	2	53
1948	1	3	4	1	6	7	10	5	2	2	1	0	42
1947	0	0	1	4	9	9	7	1	3	3	1	2	44
1946	1	3	3	2	8	5	4	4	4	2	2	0	38
1945	0	4	4	4	6	14	3	3	7	0	0	0	45
1944	1	3	2	7	8	7	8	4	2	4	3	0	49
1943	0	2	0	8	10	6	2	4	5	2	0	0	39
1942	1	2	2	6	2	9	5	9	5	3	1	1	46
1941	0	0	2	6	6	7	5	9	5	8	0	0	48
1940	0	0	0	6	7	9	6	11	4	5	1	0	49
Sums	4	21	20	51	77	83	56	56	40	31	9	5	453

TABLE IX: (cont'd)

OMAHA, NEBRASKA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	2	0	1	2	13	9	12	8	7	8	0	0	62
1948	0	0	1	8	3	9	9	8	6	1	2	0	47
1947	1	0	0	5	10	14	6	7	6	6	0	0	55
1946	0	1	4	2	7	10	4	7	7	5	1	0	48
1945	0	0	3	4	13	9	11	7	7	1	1	1	57
1944	1	1	2	3	12	15	9	9	5	1	1	0	59
1943	0	0	1	6	6	14	18	12	4	0	0	0	61
1942	0	0	4	3	10	10	12	4	7	1	0	0	51
1941	0	0	1	3	10	11	9	5	8	4	2	1	54
1940	0	0	2	4	3	6	9	12	2	5	0	0	43
Sums	4	2	19	40	87	107	99	79	59	32	7	2	537

POCATELLO, IDAHO

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	0	1	9	3	7	4	4	1	0	0	29
1948	0	0	0	2	5	9	3	7	3	1	0	0	30
1947	0	0	2	0	4	5	8	11	4	0	0	0	34
1946	0	1	2	3	5	1	9	9	1	0	1	0	32
1945	0	0	0	0	8	3	6	13	5	1	0	0	36
1944	0	0	1	2	5	8	8	1	0	1	0	0	26
1943	0	0	0	3	1	7	9	9	2	1	0	0	33
1942	0	0	0	0	2	3	7	3	2	3	0	0	20
1941	0	0	0	2	5	5	8	12	3	2	0	1	38
1940	0	0	0	3	4	0	7	6	11	1	0	0	32
Sums	0	1	5	16	48	44	72	75	36	11	1	1	310

PORTLAND, OREGON

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	1	0	1	0	0	0	0	1	0	0	3
1948	1	0	0	0	3	1	0	0	0	0	0	0	5
1947	0	0	3	0	0	3	1	2	1	0	0	0	10
1946	0	0	0	0	0	3	0	2	0	0	0	0	5
1945	0	0	0	0	1	0	1	0	0	0	0	0	2
1944	0	0	0	0	2	1	1	0	0	0	0	0	4
1943	0	0	0	0	2	5	0	0	0	1	0	0	8
1942	1	2	0	0	1	0	0	2	1	1	1	0	9
1941	0	1	0	2	5	1	1	1	2	0	1	0	14
1940	0	0	1	1	1	1	1	0	6	0	0	0	11
Sums	2	3	5	3	16	15	5	7	10	3	2	0	71

TABLE IX: (cont'd)

RAPID CITY, SOUTH DAKOTA

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	0	1	9	10	13	10	4	0	0	0	47
1948	0	0	0	5	2	17	12	11	2	0	0	0	49
1947	0	0	0	0	9	13	4	10	7	3	0	0	50
1946	0	0	0	2	5	10	15	11	7	1	0	0	51
1945	0	0	1	1	11	11	15	12	3	0	0	0	54
1944	0	0	0	0	12	13	17	8	3	1	1	0	55
1943	0	0	0	0	5	14	15	12	1	1	0	0	48
1942	0	0	0	3	5	12	14	13	2	0	1	0	50
1941	0	0	0	5	6	7	14	8	2	0	0	0	42
1940	0	0	0	2	3	7	15	6	2	1	0	0	36
Sums	0	0	1	19	67	114	138	101	33	7	2	0	482

SPOKANE, WASHINGTON

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	1	0	1	1	1	2	1	1	1	0	9
1948	0	0	0	2	2	9	2	1	0	0	0	0	16
1947	0	0	0	1	2	1	4	5	3	0	1	0	17
1946	0	0	1	0	3	2	0	1	3	1	0	0	11
1945	0	0	0	0	5	3	1	4	1	0	0	0	14
1944	0	0	0	0	5	6	1	4	1	0	0	0	17
1943	0	0	1	0	2	5	1	3	0	2	0	0	14
1942	0	0	0	0	2	3	5	1	0	1	0	0	12
1941	0	0	1	0	5	4	3	8	2	0	0	0	23
1940	0	0	0	0	3	3	5	0	3	0	0	0	14
Sums	0	0	4	3	30	37	23	29	14	5	2	0	147

SPRINGFIELD, MISSOURI

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	1	2	5	4	15	15	11	14	5	3	2	4	81
1948	0	0	6	6	9	16	15	7	5	5	3	2	74
1947	1	0	3	11	10	15	8	8	4	7	1	0	68
1946	1	2	5	4	12	7	9	9	4	4	2	1	60
1945	0	3	10	11	12	15	7	4	13	1	3	0	79
1944	1	3	3	10	8	8	9	16	2	4	5	0	69
1943	0	1	5	6	14	15	3	3	5	5	2	0	59
1942	1	3	2	7	12	7	2	8	3	2	5	1	53
1941	1	0	0	8	4	8	13	8	5	7	0	2	56
1940	0	0	6	6	8	5	6	13	1	3	0	0	49
Sums	6	14	45	74	104	111	83	90	47	41	23	10	648

TABLE IX: (cont'd)

TATOOSH ISLAND, WASHINGTON

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	0	0	0	0	0	0	1	0	3	0	4
1948	2	0	0	0	3	0	0	0	1	0	0	0	6
1947	0	0	0	0	0	0	0	0	0	1	0	0	1
1946	0	0	0	0	0	0	1	0	0	0	0	1	2
1945	0	0	0	0	0	0	0	0	0	0	0	1	1
1944	0	0	0	0	0	0	0	0	0	2	1	0	3
1943	0	0	0	0	0	0	0	0	0	1	0	0	1
1942	0	0	0	0	0	0	0	0	0	0	0	1	1
1941	0	0	1	0	1	0	2	0	0	0	2	3	9
1940	0	0	0	0	0	0	1	2	3	0	1	3	10
Sums	2	0	1	0	4	0	4	2	5	4	7	9	38

TOPEKA, KANSAS

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	2	3	2	3	12	18	7	6	9	4	1	2	69
1948	0	2	5	8	7	10	13	5	7	5	1	1	64
1947	1	0	2	8	6	12	4	5	2	6	2	0	43
1946	1	0	5	2	6	6	5	8	6	3	1	0	43
1945	0	0	5	7	11	12	8	2	8	3	1	0	57
1944	1	0	4	9	9	9	12	12	3	2	2	0	63
1943	0	1	0	5	7	11	9	10	10	1	0	0	54
1942	0	1	2	9	7	11	9	10	7	0	1	1	58
1941	1	0	0	6	8	6	9	7	4	6	1	1	49
1940	0	0	3	5	5	5	4	9	3	7	0	0	41
Sums	6	7	28	62	78	100	80	74	59	37	10	5	546

VALENTINE, KANSAS

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	0	0	1	1	8	9	9	9	8	5	0	0	50
1948	0	0	0	1	2	13	10	7	6	1	0	0	40
1947	0	0	0	4	6	12	8	5	4	3	0	0	42
1946	0	0	0	4	2	5	10	9	11	3	0	0	44
1945	0	0	1	1	6	8	10	9	2	0	0	0	37
1944	0	0	0	0	13	8	15	9	1	0	0	0	46
1943	0	0	0	3	6	13	16	10	2	1	0	0	51
1942	0	0	2	4	8	15	16	8	3	2	0	0	58
1941	0	0	0	6	8	6	10	10	6	3	0	0	49
1940	0	0	3	2	4	10	12	10	3	1	0	0	45
Sums	0	0	7	26	63	99	118	88	46	19	0	0	462

TABLE IX: (cont'd)

WICHITA, KANSAS

YEARS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1949	1	2	3	7	13	9	7	11	9	4	0	1	67
1948	0	2	3	5	6	11	11	6	6	5	1	0	56
1947	0	0	4	6	16	14	6	5	3	6	1	1	62
1946	1	0	5	5	8	6	7	6	4	3	2	1	48
1945	0	1	4	6	9	13	9	8	11	0	0	1	62
1944	1	1	5	12	9	8	10	12	4	2	3	0	67
1943	0	1	1	5	13	9	7	6	7	4	0	0	53
1942	0	2	5	8	5	18	6	7	7	2	0	1	61
1941	1	0	1	7	7	8	5	14	4	7	0	1	55
1940	0	0	6	9	6	8	9	8	5	8	1	0	60
Sums	4	9	37	70	92	104	77	83	60	41	8	6	591

TABLE 1: HAIL CAUSING DAMAGE* TO U.S.A.F. AIRCRAFT IN FLIGHT, Jan. 1946 thru May 1948

<u>Aircraft Type</u>	<u>Location</u>	<u>Date</u>	<u>Time</u>	<u>Flight Altitude (ft.)</u>	<u>Weather</u>
P-51	5 mi. SW Bellville, Ill.	4/7/46	1500C	2,000	10/10 altostratus bases at 12,000'; lower 5/10 cumulus, bases at 5,000'. Light rain showers.
C-47	Stuttgart, Ark.	5/12/47	2043C	25,000	Thunderstorm.
C-47A	15 mi. NE Greeley, Colo.	5/8/46	1655Z	8,500	Scattered thunderheads in area. Rain showers, ceiling 1000', visibility 3 to 5 mi.
TA-26B	Fonda, Iowa	6/26/46	1845C	5,500	Cumulus clouds and thunderstorms in area. Slow-moving cold front with cumulonimbus activity in front of storm.
B-25J	40 mi. NE Springfield, Mo.	4/6/48	2030E	—	Thunderstorms in vicinity.
A-26C	35 mi. NE Pine Bluff, Ark.	4/8/48	1600C	4,000	Scattered thunderstorms with 1200' ceiling, heavy rain storms, stratocumulus and swelling cumulus bases 3,000 to 4,000', tops 6,000 to 10,000'.
C-47D	Clovis, New Mexico	5/10/48	2015Z	6,000	Thunderstorm obscured by smoke and clouds at night.
B-29A	40 mi. E of Dallas, Texas.	10/30/47	0100C	12,000	2/10 altostratus clouds 17,000', lower 2/10 stratocumulus, bases 4,000', tops 6,000'. Scattered thunderstorms ahead of cold front.

*62.5% of aircraft sustained major damage.

Source - The Inspector General, Headquarters, U.S.A.F., Washington, D. C.

TABLE XI: HAIL CAUSING DAMAGE* TO U.S.A.F. AIRCRAFT IN FLIGHT, June 1948 thru May 1950*

Aircraft Type	Flight Altitude MSL (ft.)	Turbulence Encountered	Cloud Base MSL (ft.)	Cloud Top MSL (ft.)	Weather Conditions in Area of Hail	Resulting Damage to Aircraft
-46D	5000	Severe	3000	10,000	Broken cumulus clouds 3000' to 10,000'. Hail.	Astrodome dented. Red passing light and pilot's windshield broken. Leading edge of each wing dented.
-47D	8000	Unknown	9000	Unk.	Rain showers beneath clouds with hail.	R/L windshield broken. Leading edge of each wing and edges of vertical and horizontal stabilizers extensively dented.
F-80A	30,000	Violent	Unk.	Above 30,000	Lowering cumulus. Hail storm in front.	Damaged air ducts. Leading edge of each wing & edges of vertical & horizontal stabilizers extensively dented.
					Overcast, lightning in thunderstorm. Hail.	Nose cowl & wing tips dented & lights broken. Leading edge of each wing & edges of vertical & horizontal stabilizers extensively dented.
-80C	25,000	Moderate	Unk.	Unk.	Thunderstorm and hail.	Air ducts dented. Leading edge of each wing and edges of vertical and horizontal stabilizers extensively dented.
F-51	17,000	Unknown	5500	25,000	5500' overcast. Hail beneath base of clouds.	Cowl, ignition harness & windshield damaged. Leading edge of each wing & edges of vertical & horizontal stabilizers extensively dented.

*81% of aircraft sustained major damage.
*See notes at end of table

Source - The Inspector General,
Headquarters, U.S.A.F., Washington, D. C.

TABLE XI: HAIL CAUSING DAMAGE TO U.S.A.F. AIRCRAFT IN FLIGHT, June 1948 thru May 1950 (cont.)

Aircraft Type	Flight Altitude MSL (ft.)	Turbulence Encountered	Cloud Base MSL (ft.)	Cloud Top MSL (ft.)	Weather Conditions	Resulting Damage to Aircraft
AT-11	7000	Severe	Unk.	Unk.	Lowering cumulus clouds, rain and hail, broken clouds. Aircraft passed between two sections of vertical development.	Flexiglas nose and passing light broken. Leading edge of each wing and edges of vertical and horizontal stabilizers extensively dented.
B-29A	16,000	Severe	Unk.	25,000	Stratiform clouds, no evidence of thunderhead.	Eng. ring, cowling, distributor housing and tubing. Leading edge of each wing and edges of vertical and horizontal stabilizers extensively dented.
F-82E	25,000	Severe	Unk.	Unk.	Lightning, clouds lowering cumulus and cumulus nimbus.	Air scoops and prop. spinners damaged. Windshield broken. Leading edge of each wing and edges of vertical and horizontal stabilizers extensively dented.
B-29A	10,000	Severe	Unk.	Unk.	Thunderhead, rain, and hail. Aircraft flew into the roll edge of the thunderstorm.	Dents in turret cover. Dents in nose section and all engine cowlings. Dents in ignition manifold. Broken cooling fins #4 engine. Leading edge of each wing and horizontal stabilizers extensively dented.
B-29B	9000	None	Unk.	Unk.	Thunderstorm	Damage to 28 cylinder. Dents in propeller cuffs. Damage to all ignition harnesses. Leading edge of each wing and edges of vertical and horizontal stabilizers extensively dented.

TABLE II: HAIL CAUSING DAMAGE TO U.S.A.F. AIRCRAFT IN FLIGHT, June 1949 thru May 1950 (cont.)

Aircraft Type	Flight Altitude MSL (ft.)	Turbulence Encountered	Cloud Base MSL (ft.)	Cloud Top MSL (ft.)	Weather Conditions in Area of Hail	Resulting Damage to Aircraft
B-25J	6000	Severe	Unk.	Unk.	Cold front thunderstorm. Heavy rain. Hail size of golf balls.	Nose section cracked. Tail surfaces damaged. Windshield shattered. Leading edge of each wing and edges of vertical and horizontal stabilizers extensively dented.
B-26	5000	None	6000	10,000	Scattered clouds, light rain showers, hail encountered below rain.	Leading edge of each wing and edges of vertical and horizontal stabilizers extensively dented.
TB-17G	5000	Severe	Unk.	Unk.	Heavy rain, thunderstorm. Hail encountered entering cold front.	L/R de-icer boots torn, oil cooler failing, and 1, 2, 3, and 4 carburetor intake damaged, astro dome broken. Windshield broken. Leading edge of each wing and edges of vertical and horizontal stabilizers extensively dented.
B-29M	1000	Unk.	Unk.	Unk.	Light rain changing to hail.	Astro dome cracked. Leading edge of each wing and edges of vertical and horizontal stabilizers extensively dented.
B-50D	6500	Light	Unk.	Unk.	Thunderstorm. Heavy hail storm. In hail 3 min. climbing at 1000'/min.	4 prop spinners damaged. De-icer boots on props destroyed. Holes in radar dome. Leading edge of each wing and edges of vertical and horizontal stabilizers extensively dented.

TABLE XI: HAIL CAUSING DAMAGE TO U.S.A.F. AIRCRAFT IN FLIGHT, June 1948 thru May 1950 (cont.)

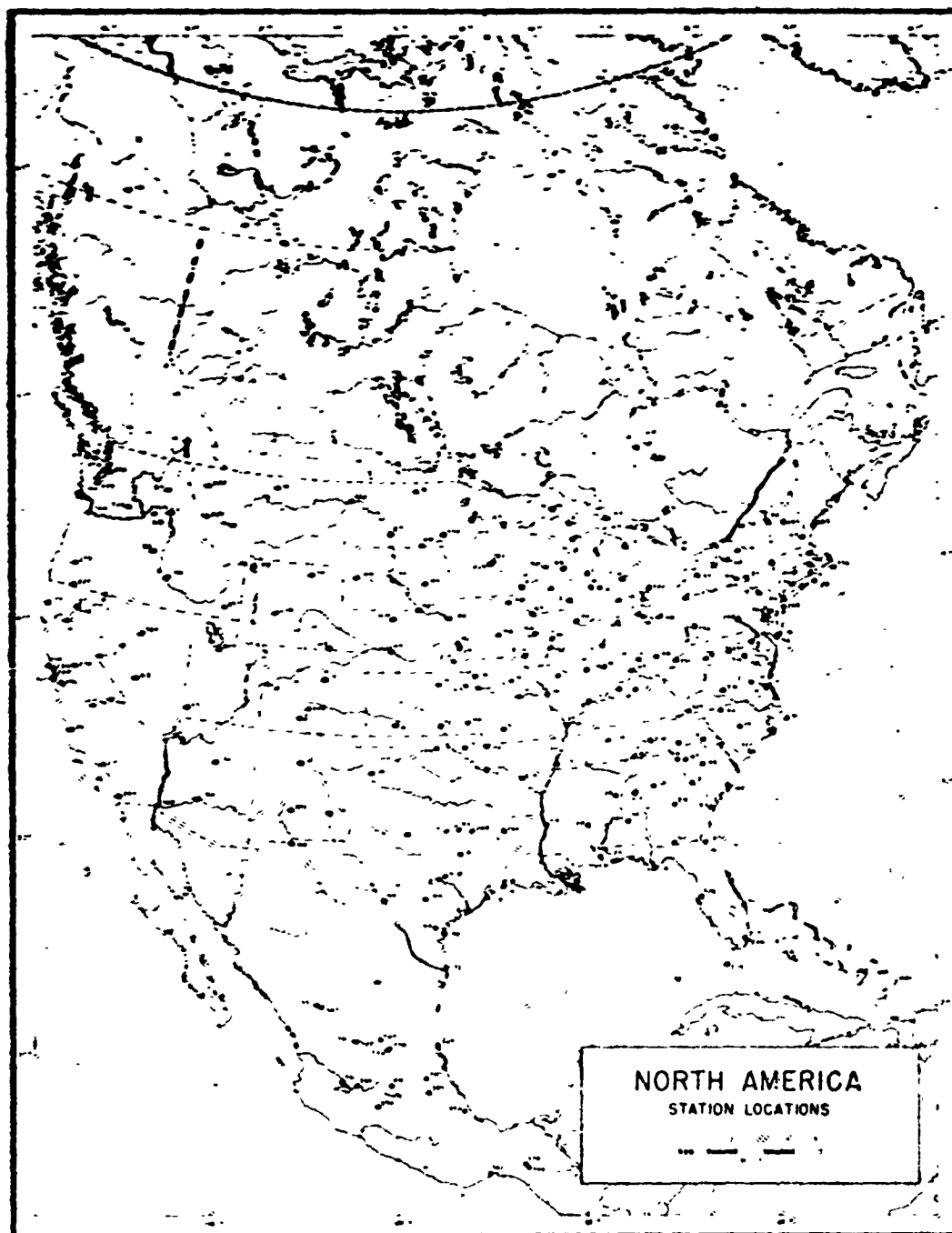
Aircraft Type	Flight Altitude MSL (ft.)	Turbulence Encountered	Cloud Base MSL (ft.)	Cloud Top MSL (ft.)	Weather Conditions in Area of Hail	Resulting Damage to Aircraft
TB-25J	9000	Light	5000	Unk.	Thunderstorms. Hail encountered 2 mi. in front and 4 mi. from center of thunderstorm.	Rt. & L. windshields cracked and broken. Leading edge of each wing and edges of vertical and horizontal stabilizers extensively dented. Landing lights broken.
TB-25J	12,000	Moderate to severe	Unk.	Unk.	Thunderstorms all quadrants. Sleet, snow, and hail.	Flexiglas nose broken and cracked. L. landing light broken. Leading edge of each wing and edges of vertical and horizontal stabilizers extensively dented.
TB-25J	7000	Light	Unk.	Unk.	Thunderstorms. Hail encountered below storm.	Air ducts damaged. Leading edge of each wing and edges of vertical and horizontal stabilizers extensively dented.
TB-25J	5000	Moderate	2000	10,000	Thunderstorms. Hail encountered near edge of storm.	Nose glass cracked and windshield cracked. Leading edge of each wing and edges of vertical and horizontal stabilizers extensively dented.
TB-25J	12,000	Moderate	Unk.	Unk.	Broken clouds. Thunderstorms. Hail encountered in area between 2 thunderstorms 1000' below.	R/L outer wing panels badly dented. R/L ignition harness cracked. R/L landing lights damaged. Leading edge of each wing and edges of vertical and horizontal stabilizers extensively dented.

TABLE XI: HAIL CAUSING DAMAGE TO U.S.A.F. AIRCRAFT IN FLIGHT, June 1948 thru May 1950 (cont.)

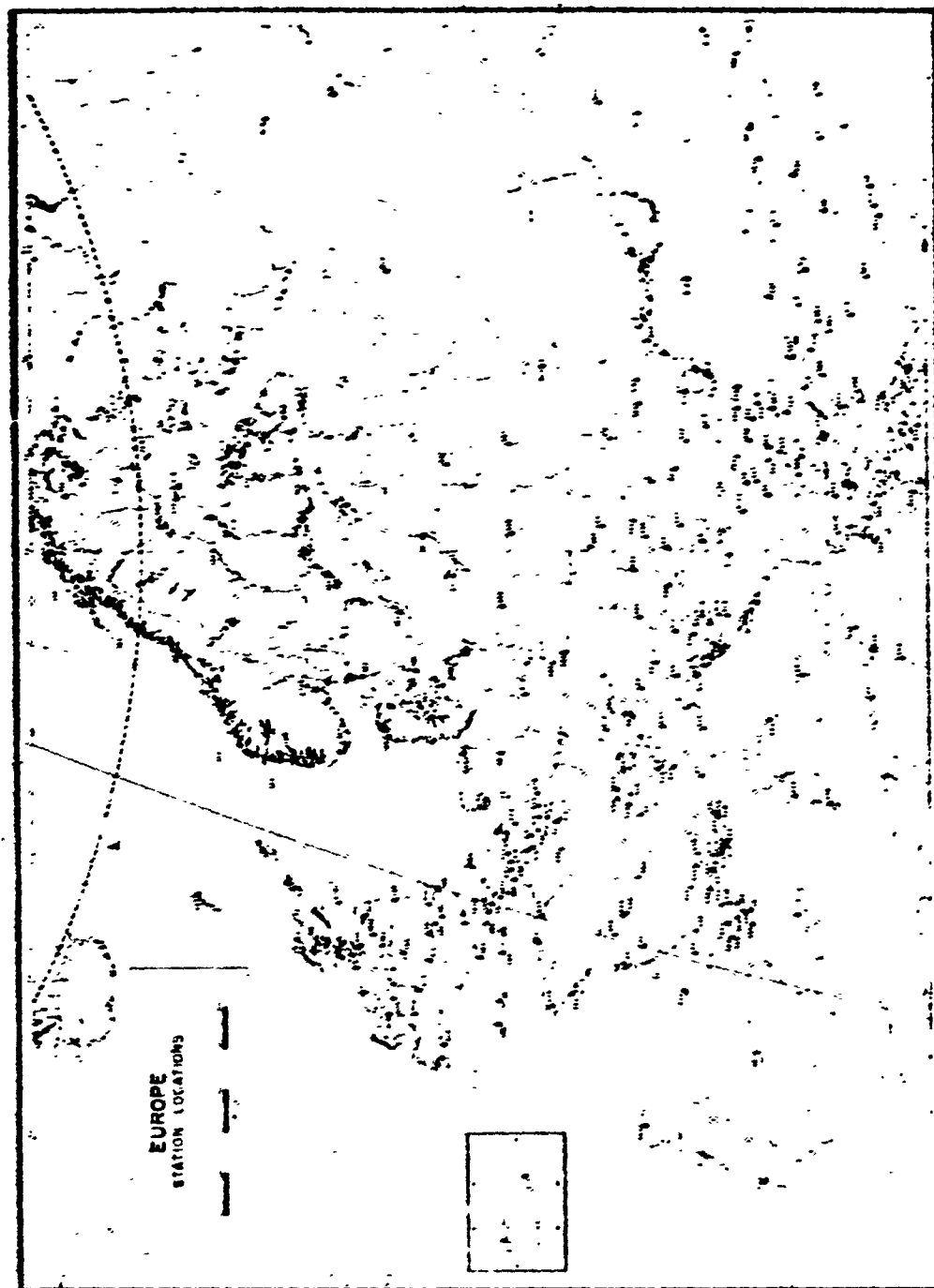
Aircraft Type	Flight Altitude MSL (ft.)	Turbulence Encountered	Minor Accidents		Weather Conditions in Area of Hail	Resulting Damage to Aircraft
			Cloud Base MSL (ft.)	Cloud Top MSL (ft.)		
C-47A	6500	Severe	Unk.	Unk.	Stratus clouds obscuring thunderheads.	Rt. elevator fabric ripped and punctured.
TB-25J	11,000	Severe	6000	14,000	Broken clouds cumulus. Thunderstorms in area.	Flexiglas nose broken and cracked. L/R landing light glass cracked. Cowl assembly slightly dented. Ignitor harness dented. Slight dents in leading edge of air foils.
C-47D	4500	None	5500	Unk.	Thunderstorms in area. Hail storms encountered in light rain.	Astrodome broken, holes torn in elevator fabric. Broke right landing light. A few dents in leading edge of air foil.
C-47D	8500	None	9500	Unk.	Rain showers. Hail encountered on fringe of rain.	Windshields shattered and astrodome broken. Nose section dented. Hole in fabric of elevator. Slight dents in leading edges of air foils.
B-25J	8000	None	Unk.	Unk.	Rain showers in area. Hail occurred in light rain shower.	Flexiglas nose cracked. R/L wing landing light glass broken. Glass in upper windshield broken out. Leading edges of air foils dented.

NOTES:

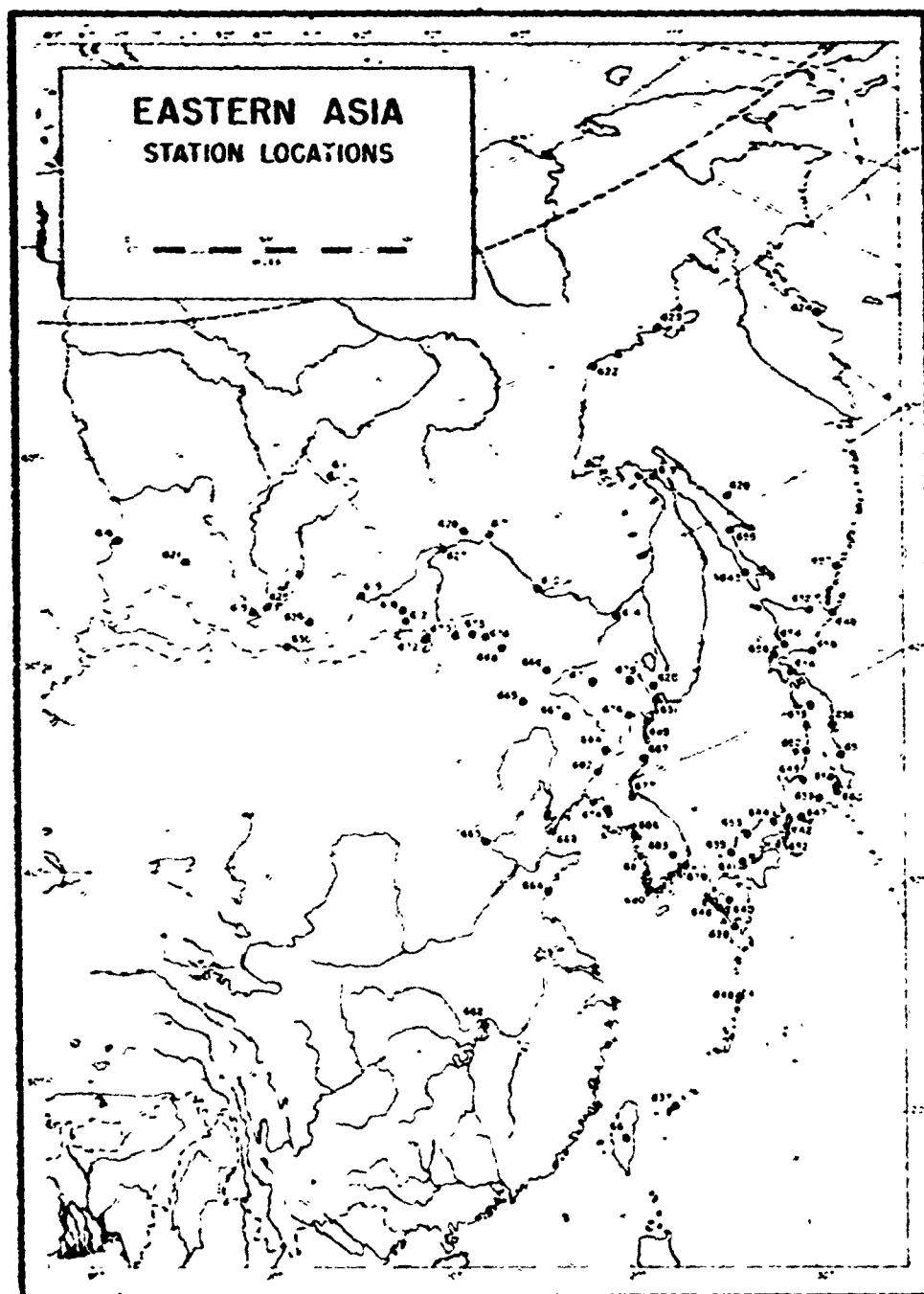
1. Duration of flights in hailstorms were estimated at between 25 seconds and 3 minutes.
2. Some degree of turbulence was observed each time that hail was encountered within a hailstorm. No turbulence was experienced when hail was encountered beneath cloud bases and in light rain.
3. In each instance, damage was inflicted on leading edges of both wings and leading edges of both horizontal and vertical stabilizers, with or without additional damage to other areas.



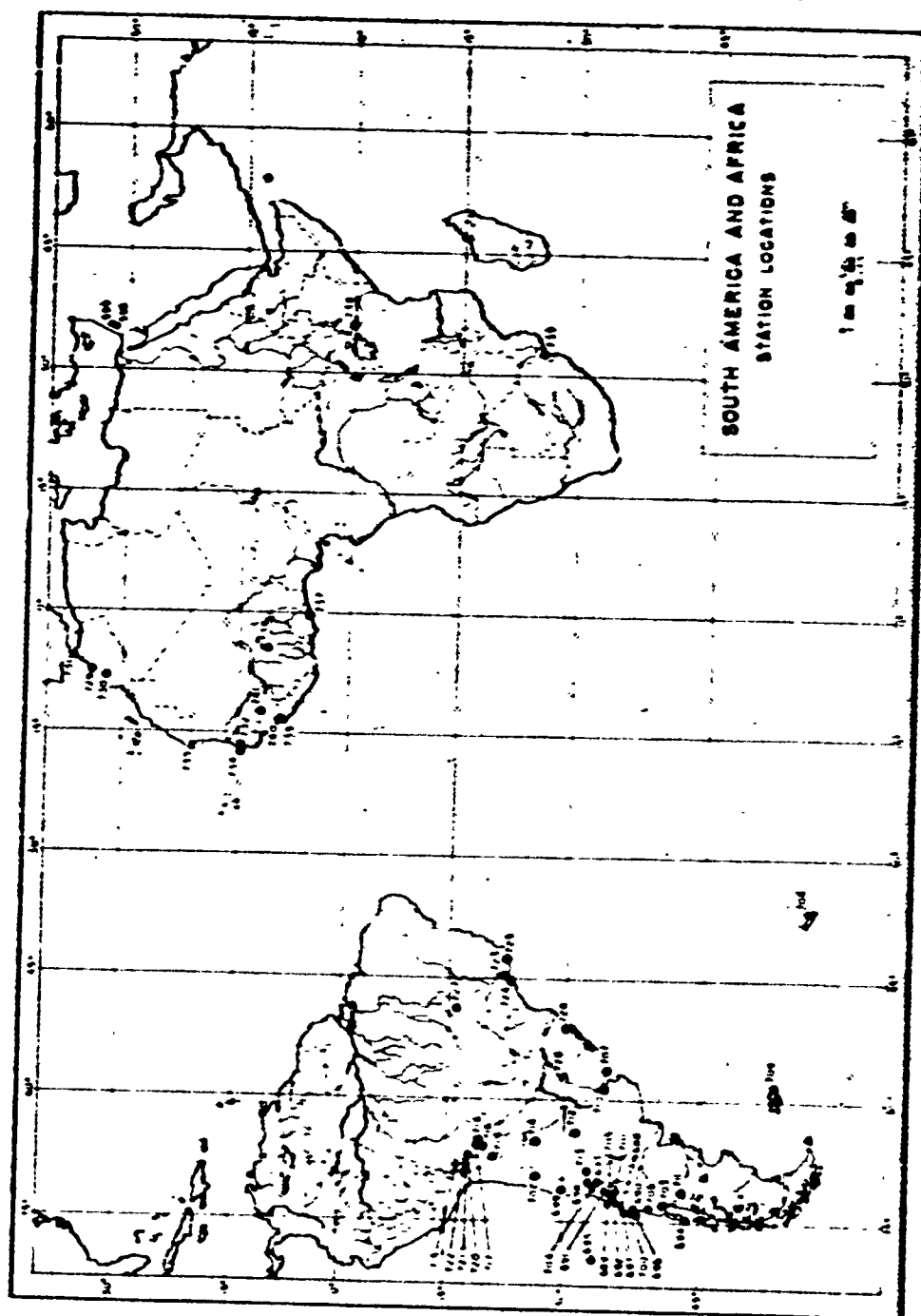
Map 4. North America — weather station locations



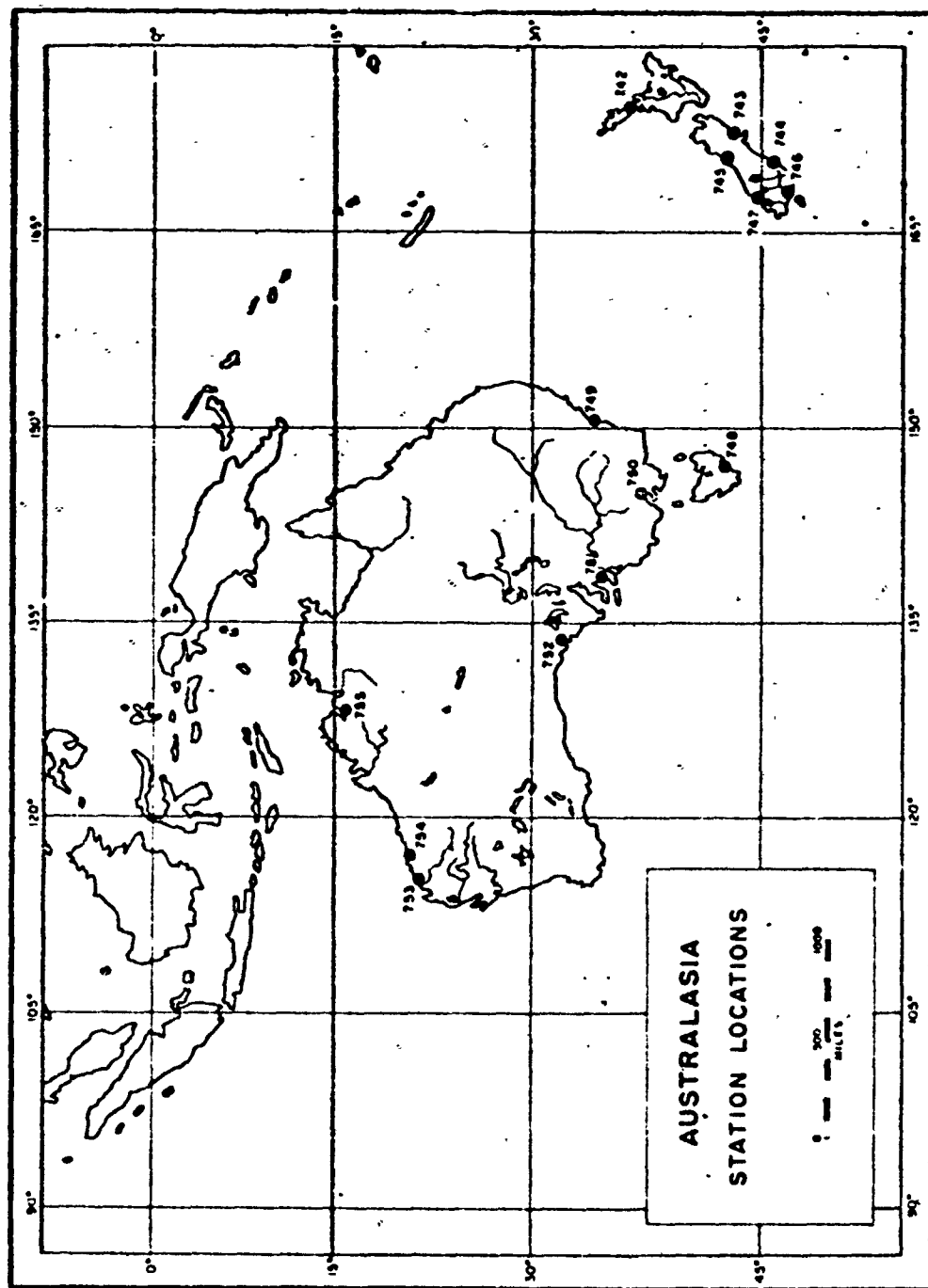
Map 5. Europe — weather station locations



Map 6. Eastern Asia — weather station locations



Map 9. South America and Africa - weather station locations



Map 8. Australasia — weather station locations