# PREFACE

The maps reproduced in this volume are from the series of Historical Weather Maps in process of preparation through a cooperative project of the Army, Navy, and Weather Bureau, with the assistance of University meteorological staffs in the work of map analysis.[1]

The Historical Maps Series will include:

**Northern Hemisphere Sea-Level Series,** for as long a period as practicable, to be published by months. By April 1, 1943, 83 months of daily maps had been analyzed for the years from 1931 through 1938.

**Northern Hemisphere 3-Kilometer Series,** from about August 1932, to be published by months. By April 1, 1943, 32 months of daily maps had been analyzed.

**North American High-Level Series** (10, 13, and 16 kilometers), from about July 1939, to be published by months.[2] By April 1, 1943, 8 months of maps for these three levels had been analyzed.

**Northern Hemisphere Monthly Mean Series,** for sea level and 3-kilometers, several years of which will be combined for publication.

The program for the production of a long series of carefully analyzed weather maps covering as much of the Northern Hemisphere as available data permit, and utilizing present day techniques of weather analysis, was initiated in October 1941 in response to urgent requests based on wartime needs. Meteorologists have long needed such series of weather maps in the development of more accurate methods for forecasting than have been possible heretofore, and in extending the period for which reliable weather forecasts can be made. The maps constitute a record of weather behavior in the Northern Hemisphere, presented in a readily usable form both for the forecaster who is interested in improving the accuracy of his forecasts and for the research meteorologist who wants to test physical hypotheses as well as empirical forecasting techniques.

### USES OF HISTORICAL MAPS

Many practical uses for the historical maps will suggest themselves to the forecaster and the research meteorologist. The maps should be very useful to the forecaster in refreshing his memory of the changes in weather from season to season and helping him to avoid "seasonal lag." They will aid him in becoming familiar with the synoptic meteorology of new regions in which he has had no previous practical experience. Students studying these maps in connection with the series of upper level charts will obtain a much clearer view of the atmospheric circulation over the hemisphere, a view of value, particularly to the young military meteorologists who must take over the responsibility for forecasting in new regions. For the research meteorologist the maps will be an invaluable aid in the study of air mass source regions, in basic investigations dealing with general circulation and specific concepts such as the zonal index, in the typing of maps, and in other activities designed to improve the scope of forecasts. The high level maps especially will assist the meteorologist in acquiring a far better understanding of the three-dimensional behavior of the atmosphere and the manner in which the upper air processes are related to surface weather.

### PREPARATION OF HISTORICAL MAPS

The plotting of these various maps, including the assembling and preparation of synoptic data and the checking of the plotted maps, is done in a plotting unit organized in Washington, D. C. The plotted maps are reproduced by the ozalid process for analysis and for special studies. The original plotted master tracings are retained for addition of basic data which may later become available. Additional copies of the observational data without analysis can be made available for special research studies.

# CONTENTS



# SOURCES AND PREPARATION OF OBSERVATIONS

### SOURCES OF OBSERVATIONS

Observational data for the Northern Hemisphere synoptic sea-level charts are obtained mainly from three general sources: Reports published periodically by national meteorological services in the Northern Hemisphere, unpublished reports (such as ships' logs), and manuscript maps. In general, preference in the choice of data sources has been given to the most original sources—that is, to reports rather than to manuscript maps—or to the tabulated reports of the local meteorological service for each area in preference to others, provided observations at or near 13 G. M. T. are listed. In the case of European data, the Deutsche Seewarte Wetterbericht has been chosen as a reliable source for a large area over a long period, even though more original sources exist for some of the countries of Europe for periods of various lengths.

In the case of colonies, second preference has usually been given to publications of the nation governing the particular area. For areas not adequately covered by the primary source it has frequently been necessary to use more than one source of data in order to secure minimum acceptable coverage. In such instances, reports in a specific area may be mixed, with true comparability prevented by differences in time, and by certain other factors inherent in the schemes of presentation of the data adopted by the several meteorological services. For example, reports from a given area from one source may include pressure values reduced to sea-level by a method not defined in the data source, while a second source of data may report station pressures which are reduced to sea-level in the plotting unit as described in the paragraph below on "Pressure Reductions." The major data sources are tabulated on page 4 with the geographic area for which they are used, the period, and pertinent information regarding the form of presentation of observational data in the original.

While every effort has been made to secure all available synoptic reports of meteorological observations, it is probable that sources exist which were not tapped in the search for weather data for the Northern Hemisphere, and which might make possible definite improvements in the charts yet to be published as well as in all original charts as they continue to be used for special research studies.

### TIME OF OBSERVATION

The choice of the synoptic time, 13 Greenwich Mean Time, was dictated by the much greater volume of data available at that hour as compared with other possible time choices such as 07, 19, or 01 G. M. T. Especially is the contrast marked in ocean areas. Ships' observations until recent years were made once daily at Greenwich Mean Noon so that the inclusion of the Pacific and the Atlantic areas requires the choice of a synoptic time such as to include within a reasonable tolerance the 12 G. M. T. ocean observations. In the case of areas for which observations at or within one hour of 13 G. M. T. are not available, reports at the hour nearest 13 G. M. T. are used, and the region is designated on the monthly time chart by the synoptic time for that group of reports. Reports included in any area which differ in time from the areal synoptic time by more than 1 hour are identified by inclusion of the Greenwich hour in the station model. (See below, "Table of Symbols.")

### CODE AND STATION MODEL

The International Plotting Code was chosen for use on the Historical Weather Maps with but few supplemental symbols and with ocean swells reported in the Bergeron symbols. (See below, "Table of Symbols.")

The limitations of the code in which observational data are tabulated circumscribe the precision and completeness with which observed phenomena are represented. Moreover, the necessity for presenting on one map, in one standard code, data originally presented in various forms or codes, gives rise to additional loss of precision and perhaps to occasional errors of interpretation. Comments concerning the translations into the International Plotting Code of certain items appearing in earlier codes of the various meteorological services are included in the outline of data sources.

### ORGANIZATION OF THE PLOTTING UNIT

The entry of observational data on the Historical Weather Maps is organized on a project basis, with a fairly stable personnel distribution. Certain facilitating functions, such as library, physical preparation of maps for plotting, and over-all technical control and administration, are performed on a section basis and serve each of the projects. The work of plotting sea-level charts consists of four functions, performed in sequence; (1) the plotting of land data, (2) the verification of land data, (3) the plotting and verification of ocean data, and (4) the entry of special data and post-analysis corrections of plotted reports.

Work assignments consisting of the execution of one of these functions for a month of maps are made to squads of from six to ten persons who are clerical and subprofessional employees of the Weather Bureau. Thus each squad performs one of the above-named functions exclusively, and the advantages of specialization accrue. Individuals, however, work in various squads (and in different projects) from time to time, so that the personnel become rather versatile and there is considerable flexibility in the unit organization.

The technical supervision of the plotting work, in accordance with established procedures and conventions, is vested in a squad leader, who is an advanced subprofessional in Meteorology. As plotting personnel are provided with code tables, tables for conversion of units, key maps and other plotting aids, the necessity for independent judgment is reduced to a minimum. Questions involving technical judgments, procedural decisions, and determination of methods, are handled by the staff officers of the plotting unit, who are professional meteorologists. "Interpretations" of data are not made except in accordance with recognized procedures. Adopted methods which do involve some interpretation of data have been evolved by the technical staff of the plotting unit, frequently in consultation with authorities who have served as advisers to the project.

### PRESSURE REDUCTIONS

For stations reporting only station pressure, or pressure reduced to some standard elevation other than sea-level, the reported pressures were reduced to sea-level in the map plotting unit. For stations reporting pressure values at elevations not greater than 100 meters, a constant correction for each station was determined, and applied to station pressure values. Computation of such corrections for altitude were based on the "Smithsonian Meteorological Tables." For stations reporting pressures at altitudes in excess of 100 meters, a table has been prepared giving sea-level pressure as a function of both reported pressure and reported surface temperature. These tables were computed on the assumption of a uniform lapse rate of five-tenths the dry adiabatic in obtaining the mean temperature of the air column.

In some instances different altitudes were reported at various times by the data source, or from other evidence it appeared that the reported altitudes were inaccurate. For these stations, mean station pressures for a period as extended as possible were obtained; mean sea-level values obtained from Shaw's "Manual of Meteorology" were then compared with the station means, and an "effective altitude" for the station determined. Corrections are applied in accordance with this "effective altitude" only in cases in which other evidence indicates that the "effective altitude" is in fact the physical elevation of the reporting station—for example, when one of the reported altitude values is the same as the computed "effective altitude." Values obtained by application of such corrections are compared with nearby sea-level reports before they are accepted for use.

### VERIFICATION

The map preparation procedure includes verification of plotted data, with emphasis upon the detection and elimination of systematic errors. In recognition of the greater relative importance in analysis and research of those reports which are isolated, special emphasis is placed upon the verification of all isolated reports such as those from Siberia, Alaska, and Northern Canada.

Land data entered on Northern Hemisphere sea-level charts are verified by a spot-check of about 12 percent of reports entered. The spot-check is designed to locate and correct systematic errors[3], as distinguished from chance errors, and emphasizes stations in areas sparsely covered by reports. In addition, entries are verified which, upon a careful over-all survey of the map by experienced checkers, appear to be inconsistent.

Very nearly all ocean reports are verified for position. An average of about 30 percent of elements plotted from ships' reports are verified either as a result of questions raised on the over-all survey, or as a part of the complete check of isolated ship reports.

Analysts observe elements which appear to be incorrectly plotted or incorrectly reported, and such apparently questionable entries are reported to the plotting unit and corrections are made after reference to source data. Since the plotting unit has adopted the principle of plotting the data as reported, it may result that no corrections are made in some cases in which the data as reported appear to be in error.

The residual error, determined from the regular sample checks of plotted data, is estimated to be about 1 percent. Variations occur from month to month, from 0.5 percent to 1.8 percent; and the maximum error tolerance is regarded as being 2 percent.

# ANALYSIS PROCEDURE

## FRONTAL ANALYSIS

### GENERAL PURPOSE

In the analysis of the Northern Hemisphere Sea-Level Synoptic Charts, it has been the aim to present only the major frontal systems in addition to the isobaric analysis. Adherence to this principle was deemed necessary for several reasons: (a) the scale of the base map utilized has prohibited analysis in as great a detail as could be done on a larger scale map, since on the smaller scale chart only a limited network of reports can be entered in certain regions; (b) the time interval of 24 hours between successive maps frequently renders impossible any attempt to carry weak frontal systems of short life on more than one chart; (c) the most important reason lies in the purpose of the analysis, which is to give a concise and clear-cut representation of the circulation systems over the hemisphere; the inclusion of minor frontal systems of short duration would have rendered this picture less clear without contributing materially to the understanding or solution of the larger scale circulation problems.

### MAINTENANCE OF CONTINUITY

In the conduct of the analyses, inter-map continuity and intra-map consistency have been continually stressed. Before each analysis was given final approval by one of the supervising analysts, a reasonable standard of continuity was required. Abrupt breaks in the continuity have consequently been avoided as much as possible in order to render the historical sequence of frontal systems apparent without close study of the data. As an aid in obtaining the best continuity, extensive use was made of supplementary 12-hour Northern Hemisphere isobaric charts which were made available to the analysts from the files of the United States Weather Bureau in Washington, together with the North American charts prepared by the Air-Mass Analysis Section of the Weather Bureau. Use was also made of the Deutsche Seewarte Polar Year Northern Hemisphere Maps available for the Polar Year 1932–1933.

Some difficulty in maintaining continuity was encountered in certain regions where during some years a lack of simultaneity existed in the time of observation between adjacent areas. Occasionally this time difference was as great as 9 hours. In such regions, the nonsynchronous data were roughly extrapolated in time as the analysis was made. Consequently in areas where the elements were undergoing rapid change at the time of observation it will at first appear that some data have been disregarded until it is realized that the observations were taken at different times. The greatest disparity of this type has been observed between Japan and the ships in the western Pacific, especially during 1938, and between Russia and Europe for longer periods.

### AIDS TO CONTINUITY

In order to maintain the highest degree of continuity between the maps, certain practices were employed in the analysis as follows:

(*a*) Anticipating frontogenesis. On a map on which frontogenesis was not apparent, but was probable, it has been indicated whenever the succeeding map showed a fully developed front already in existence. In these cases it was assumed that the frontogenesis took place sometime during the 24-hour interval between the two maps and for this reason it was "anticipated" on the earlier map.

(*b*) Prolonging frontolysis. This practice consists of indicating a front undergoing frontolysis on a map where there were few if any indications of the presence of a front. It was used principally in the case of well-defined fronts which underwent sudden frontolysis and could be traced only with great difficulty on the succeeding map.

(*c*) Anticipating wave formation on a front. Occasionally there arose instances, especially over the oceans, where a fully developed wave cyclone seemed to have appeared in the field of observation without being preceded by any substantial evidence of wave genesis. In such cases a wave was sometimes indicated on the map 24 hours previous to the appearance of the advanced wave cyclone. However, this practice was limited to cases where the pressure and temperature fields were such that wave genesis was likely.

### TRANSFORMATION OF FRONTS

The following practices, used in the analysis of the Northern Hemisphere Maps, may appear at times to violate some commonly accepted principles of continuity. For this reason an explanation of the use of these practices is given here together with the reasoning involved in using them:

(*a*) Consolidation of two fronts. When two fronts of similar type were found to be in close proximity on one map, and when the succeeding map no longer contained sufficient evidence to show that the two had remained separate, they were consolidated into one front, the type being that of the predominating front on the preceding map. Consolidations of

[1] The financial support for the Historical Maps Project has been furnished primarily by the United States Army Air Forces (approximately 70 percent) with the remainder furnished by the Navy and the Weather Bureau. The project was initiated originally by Navy request on the Weather Bureau; and the staffing, organization, and management have been by the Weather Bureau except for an initial period when the Army and Navy supplied personnel. Maps have been analyzed under the supervision of the meteorological staffs of New York University, the University of Chicago, and the University of California at Los Angeles under cooperative agreements with the Weather Bureau.

[2] Daily charts for period July 1939 to March 1941 inclusive; twice daily from April 1941.

[3] E. g., the Monthly Report of the Central Meteorological Observatory of Japan, one of the sources used, contains all the monthly observations for two stations on each page The three daily observations and the elements reported are printed vertically. Reading the wrong column would result in either the wrong element or the wrong time of observation being plotted for the month.

this sort on the maps will be found occurring between: Two cold fronts, two occluded fronts, one cold and one occluded front, or two warm fronts.

(*b*) Transformation of occluded fronts. In numerous instances, an occluded front on one map was changed to a cold front or to a warm front on the subsequent map. In performing this transformation it has been assumed that one or the other of the frontal surfaces of the occlusion was destroyed and the remaining surface was intensified by renewed frontogenetical processes.

(c) Transition of cold fronts to occlusions. A number of cases will be found on these maps where a cold front has apparently been transformed into an occluded front for a part of its extent. In most of these cases it is believed that a true occlusion process has taken place, but the warm front or possibly two or more warm frontal surfaces were not distinguishable on the map as surface discontinuities and could have been indicated only in an arbitrary manner. Accordingly, although it was necessary to indicate the occlusion process to satisfy the existing weather phenomena, it was deemed best in such cases to omit the doubtful warm fronts entirely from the analyses.

## ISOBARIC ANALYSIS

### GENERAL REMARKS

Special care has been given to the drawing of the isobars on the Northern Hemisphere maps, particularly in regions where the data were scarce or unreliable. In doubtful or uncertain cases the analysis was based on continuity from the preceding pressure pattern. Frequent reference was made to the topography of the land areas to secure the correct interpretation of orographical effects on the isobaric patterns.

### USE OF SHIP PRESSURE DATA

The isobaric analysis over the oceans has presented a constant source of difficulty because of the lack of reliable and consistent pressure observations from ships. This is particularly noticeable in the earlier years when it is not uncommon to find ships' barometer readings deviating 5 to 10 millibars from their correct value. In the course of the analysis certain ships have become identified as being more consistently accurate than others, and where present these were given a greater weight than the less reliable reports. However in the larger number of cases it was not possible to decide directly between the correct and the incorrect ship pressures. The other elements in the ships' observations are not subject to the same degree of error as the pressure.

Generally speaking, winds above force two Beaufort are representative of the pressure field at sea. Consequently the technique was adopted of drawing the isobars in conformity with the wind pattern and velocity field, using the pressure values given in the observations as a rough guide to the pressure value of the isobars. In the case of isolated ship reports, pressure values which may at first have appeared to be out of line with the development expected from the preceding map were not disregarded without making a serious attempt to fit them into a logical analysis. Moreover no ship observation has been completely disregarded unless it was found to have been plotted erroneously. In this case the observation was crossed out and reported to the map plotting unit for correction.

### USE OF DASHED ISOBARS

Dashed isobars were used in regions where there were insufficient data from which to draw a completely reliable pressure pattern, although a reasonable extrapolation of the pressure field was still possible.

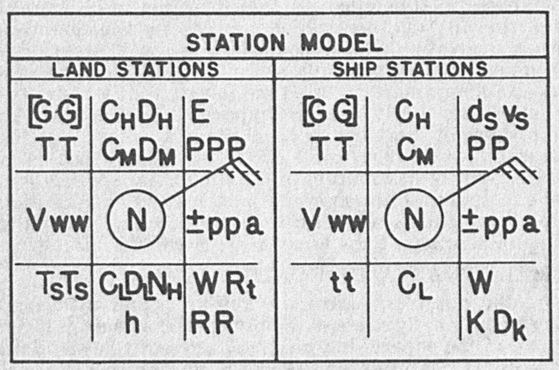
### DOT AND DASH ISOBARS

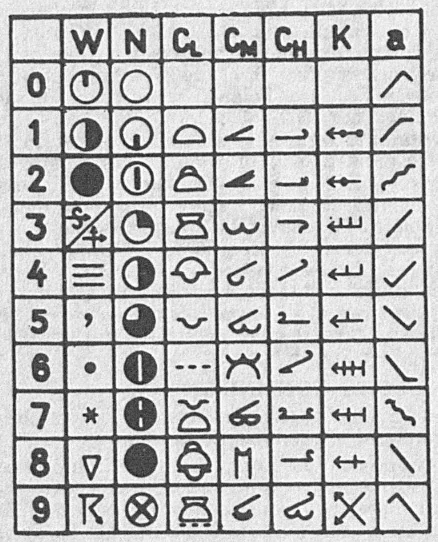
In some regions of weak isobaric gradient such as in the Tropics, supplementary isobars have been drawn for the 2½-millibar interval where these might be helpful in determining the pressure field. These supplementary isobars have been drawn with a line consisting of alternate dots and dashes. (See "Table of Symbols.")

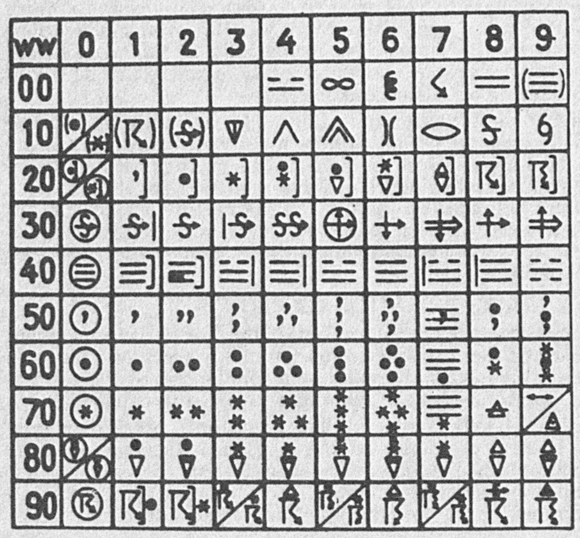
### ISOBARS IN TROPICAL CYCLONES

Due to the small scale of the map it has not always been possible to draw isobars in tropical cyclones down to the lowest pressure; furthermore these minimum pressures are frequently unknown. On some maps the lowest pressure has been indicated even though all the isobars have not been drawn.

## TABLE OF SYMBOLS





### SYMBOL a—BAROMETRIC TENDENCY

(Characteristic of tendency during 3-hour period ending at observation.)

| Code figure | Description | |
|---|---|---|
| 0 | Rising, then falling | Barometer now higher than, or the same as, 3 hours ago. |
| 1 | Rising, then steady; or rising, then rising more slowly. | |
| 2 | Rising unsteadily, or unsteady | |
| 3 | Rising steadily, or steady. | |
| 4 | Falling or steady, then rising; or rising, then rising more quickly. | |
| 5 | Falling, then rising. | Barometer now lower than 3 hours ago. |
| 6 | Falling, then steady; or falling, then falling more slowly. | |
| 7 | Falling unsteadily, or unsteady. | |
| 8 | Falling steadily. | |
| 9 | Steady or rising, then falling; or falling, then falling more quickly. | |

### SYMBOL $C_L$—FORM OF LOW CLOUD

| Code figure | Form of cloud |
|---|---|
| 0* | No low clouds. |
| 1 | Cumulus of fine weather. |
| 2 | Cumulus heavy and swelling, without anvil top. |
| 3 | Cumulonimbus. |
| 4 | Stratocumulus formed by the flattening of cumulus. |
| 5 | Layer of stratus or stratocumulus. |
| 6 | Low broken up clouds of bad weather. |
| 7 | Cumulus of fine weather and stratocumulus. |
| 8 | Heavy or swelling cumulus, or cumulonimbus, and stratocumulus. |
| 9 | Heavy or swelling cumulus (or cumulonimbus) and low ragged clouds of bad weather. |

*Also indicates an obscured sky when "9" is reported for $N_h$ or N.

### SYMBOL $C_M$—FORM OF MIDDLE CLOUD

| Code figure | Form of cloud |
|---|---|
| 0* | No middle clouds. |
| 1 | Typical altostratus, thin. |
| 2 | Typical altostratus, thick (or nimbostratus). |
| 3 | Altocumulus, or high stratocumulus, sheet at one level only. |
| 4 | Altocumulus in small isolated patches; individual clouds often show signs of evaporation and are more or less lenticular in shape. |
| 5 | Altocumulus arranged in more or less parallel bands, or an ordered layer advancing over sky. |
| 6 | Altocumulus formed by a spreading out of the tops of cumulus. |
| 7 | Altocumulus associated with altostratus or altostratus with a partially altocumulus character. |
| 8 | Altocumulus castellatus, or scattered cumiform tufts. |
| 9 | Altocumulus in several sheets at different levels, generally associated with thick fibrous veils of cloud and chaotic appearance of the sky. |

*Also indicates an obscured sky when "9" is reported for $N_h$ or N.

### SYMBOL $C_H$—FORM OF HIGH CLOUD

| Code figure | Form of cloud |
|---|---|
| 0* | No high clouds (no cirrus). |
| 1 | Cirrus, delicate, not increasing, scattered and isolated masses. |
| 2 | Cirrus, delicate, not increasing, abundant, but not forming a continuous layer. |
| 3 | Cirrus of anvil clouds, usually dense. |
| 4 | Cirrus, increasing, generally in the form of hooks ending in a point or in a small tuft. |
| 5 | Cirrus (often in polar bands) or cirrostratus advancing over the sky, but not more than 45° above the horizon. |
| 6 | Cirrus (often in polar bands) or cirrostratus advancing over the sky and more than 45° above the horizon. |
| 7 | Veil of cirrostratus covering the whole sky. |
| 8 | Cirrostratus, not increasing and not covering the whole sky. |
| 9 | Cirrocumulus predominating, associated with a small quantity of cirrus. |

*Also indicates an obscured sky when "9" is reported for $N_h$ or N.

### SYMBOL $D_L$, $D_M$, $D_H$—DIRECTION OF CLOUD MOVEMENT

Direction of movement of low, middle and high cloud, respectively, is indicated by a small arrow in the direction of movement.

### SYMBOL DD—DIRECTION OF WIND

Wind direction is represented by the shaft of an arrow which has the station circle as its head. This shaft extends away from the circle in the direction from which the wind the wind is blowing.

### SYMBOL Dk—DIRECTION OF SWELL

In the open sea, the direction in which swell is moving is given by the arrow in the symbol "K."

### SYMBOL ds—DIRECTION OF SHIP'S MOVEMENT

A small arrow indicates the direction in which the ship is moving at the time of observation.

### SYMBOL F—WIND FORCE, BEAUFORT SCALE

| Code figure | Explanatory title | Miles per hour (statute) | Beau. No. |
|---|---|---|---|
| 0 | Calm | Less than 1 | 0 |
| 1 | Light air | 1–3 | 1 |
| 2 | Slight breeze | 4–7 | 2 |
| 3 | Gentle breeze | 8–12 | 3 |
| 4 | Moderate breeze | 13–18 | 4 |
| 5 | Fresh breeze | 19–24 | 5 |
| 6 | Strong breeze | 25–31 | 6 |
| 7 | High wind | 32–38 | 7 |
| 8 | Gale | 39–46 | 8 |
| 9 | Strong gale | 47–54 | 9 |
| 9 | Whole gale | 55–63 | 10 |
| 9 | Storm | 64–75 | 11 |
| 9 | Hurricane | Above 75 | 12 |

Wind force is represented by the number of feathers on the wind arrow, each short feather having a value of one, and each long feather having a value of two.

Calm is indicated by a concentric circle around the station circle: ◎

Wind force zero with direction given is shown as an arrow without feathers:

Variable winds are indicated by feathers placed directly on the station circle:

Wind force missing is indicated by an "x" placed at the end of the arrow. When both force and direction are missing, the wind arrow is omitted entirely.

### SYMBOL (GG)—GREENWICH MEAN TIME

When the time of the report differs from the synoptic time of the area by more than one hour, it is recorded to the nearest hour.

### SYMBOL h—HEIGHT OF LOWEST CLOUDS

| Code figure | Height in meters | Height in feet |
|---|---|---|
| 0 | 0 to 49 | 0 to 163 |
| 1 | 50 to 99 | 164 to 327 |
| 2 | 100 to 199 | 328 to 655 |
| 3 | 200 to 299 | 656 to 983 |
| 4 | 300 to 599 | 984 to 1,967 |
| 5 | 600 to 989 | 1,968 to 3,280 |
| 6 | 1,000 to 1,499 | 3,281 to 4,920 |
| 7 | 1,500 to 1,999 | 4,921 to 6,561 |
| 8 | 2,000 to 2,499 | 6,562 to 8,201 |
| 9 | Above 2,500* | Above 8,202* |

*Or no low clouds.

### SYMBOL K—STATE OF SWELL IN OPEN SEA

| Code figure | State of swell | Code figure | State of swell |
|---|---|---|---|
| 0 | No swell. | 5 | Long, moderate swell. |
| 1 | Short, low swell. | 6 | Short, heavy swell. |
| 2 | Long, low swell. | 7 | Average, heavy swell. |
| 3 | Short, moderate swell. | 8 | Long, heavy swell. |
| 4 | Average, moderate swell. | 9 | Confused swell. |

### SYMBOL N—TOTAL AMOUNT, ALL CLOUDS

### SYMBOL $N_h$—AMOUNT OF CLOUDS WHOSE HEIGHT IS GIVEN BY "h"

| Code figure | Proportion of sky covered by clouds | Code figure | Proportion of sky covered by clouds |
|---|---|---|---|
| 0 | Absolutely no clouds. | 6 | Nine-tenths. |
| 1 | Less than one-tenth. | 7 | More than nine-tenths, but with openings. |
| 2 | One-tenth. | | |
| 3 | Two or three-tenths. | 8 | Sky fully covered. |
| 4 | Four, five, six-tenths. | 9 | Sky obscured by fog, dustorm, etc. |
| 5 | Seven or eight-tenths. | | |

Symbol 2 is used when 1 or 2 is reported; symbol 6 is used when 6 or 7 is reported.

A missing value for N is indicated by an "M" in the station circle, unless an indication for N is obtainable from the present weather. In general, when N is not reported, sky cover is taken as overcast when precipitation is reported, three quarters' covered when showers or thunderstorms are reported, and missing in all other cases.

### SYMBOL PPP (PP)—ATMOSPHERIC PRESSURE

Pressures are plotted in tens, units, and tenths of millibars, with the initial 9 or 10 omitted. All pressures are reduced to sea level, standard gravity, and corrected for temperature. Pressure for ship stations are plotted to the nearest whole millibar.

### SYMBOL pp—AMOUNT OF BAROMETRIC CHANGE

The net change during the three hour period ending at time of observation is entered in tenths of millibars, decimal point omitted.

### SYMBOL TT—AIR TEMPERATURE

### SYMBOL $T_dT_d$—DEWPOINT TEMPERATURE

All temperatures are entered in whole degrees of the Fahrenheit scale. Missing air temperatures are indicated by "M" only if $T_dT_d$ is also reported; otherwise no indication is made.

### SYMBOL tt—WATER TEMPERATURE

Water temperatures are entered in whole degrees of the Fahrenheit scale and are obtained directly from $T_d$, the coded difference between air and water temperature. The following values are used for $T_d$:

| Code No. $T_d$ | Difference, °F | Code No. $T_d$ | Difference, °F |
|---|---|---|---|
| 0 | −10 | 5 | +1 |
| 1 | −8 | 6 | +2 |
| 2 | −5 | 7 | +5 |
| 3 | −2 | 8 | +8 |
| 4 | −1 | 9 | +10 |

The difference is applied to air temperature to obtain water temperature.

### SYMBOL V—HORIZONTAL VISIBILITY

| Code figure | Visibility in meters | | Visibility in miles |
|---|---|---|---|
| | Objects are visible at | Objects not visible at | Objects not visible at |
| 0 | ------- | 50 | $\frac{1}{32}$ (55 yds.) |
| 1 | 50 | 200 | $\frac{1}{8}$ (220 yds.) |
| 2 | 200 | 500 | $\frac{5}{16}$ (550 yds.) |
| 3 | 500 | 1,000 | $\frac{5}{8}$ (1,100 yds.) |
| 4 | 1,000 | 2,000 | $1\frac{1}{4}$ (2,200 yds.) |
| 5 | 2,000 | 4,000 | $2\frac{1}{2}$ miles |
| 6 | 4,000 | 10,000 | 6 miles |
| 7 | 10,000 | 20,000 | 12 miles |
| 8 | 20,000 | 50,000 | 30 miles |
| 9 | 50,000 | ------- | ------- |

### SYMBOL $V_s$—SHIP'S SPEED

The speed of ship's movement is entered in knots near the arrow indicating ship's direction (ds). The symbol $\phi$ indicates no movement, or "hove to."

### SYMBOL W—PAST WEATHER

| Code figure | Weather | Code figure | Weather |
|---|---|---|---|
| 0 | Clear or scattered clouds. } not entered | 4 | Fog, or thick dust-haze (visibility less than 1,000 meters, 1,100 yards.) |
| 1 | Broken clouds or variable sky, } not entered | 5 | Drizzle. |
| 2 | Overcast. } not entered | 6 | Rain. |
| 3 | Sandstorm or duststorm, or storm of drifting snow. | 7 | Snow or sleet. |
| | | 8 | Showers. |
| | | 9 | Thunderstorm. |

### SYMBOL ww—PRESENT WEATHER

Note.—In coding present weather the highest code figure in complete table applicable to weather at time of observation is used.

**Figures 00 to 19: Abbreviated description of sky and special phenomena**

00 Cloudless (from no clouds up to but not including 1/10).
01 Partly cloudy (from exactly 1/10 to exactly 5/10).
02 Cloudy (over 5/10 up to and including exactly 9/10).
03 Overcast (over 9/10).
04 Low fog, whether on ground or at sea.
05 Haze (but visibility 1,000 meters, 1,100 yards or more).
06 Dust devils seen.
07 Distant lightning.
08 Light fog (visibility 1,000 meters, 1,100 yards or more).
09 Fog at a distance, but not at station (or ship).
10 Precipitation within sight.
11 Thunder, without precipitation at station (or ship).
12 Duststorm within sight, but not at station (or ship).
13 Ugly, threatening sky.
14 Squally weather.
15 Heavy squalls in last 3 hours.
16 Waterspouts seen in last 3 hours.
17 Visibility reduced by smoke.
18 Blowing dust (visibility 1,000 meters, 1,100 yards or more).
19 Signs of tropical storm or hurricane.

**Figures 20 to 29: Precipitation in last hour (But not at time of observation)**

20 Precipitation in any form.
21 Drizzle.
22 Continuous or intermittent rain.
23 Continuous or intermittent snow.
24 Continuous or intermittent rain and snow, mixed.
25 Rain showers.
26 Snow showers.
27 Hail, or rain and hail, showers.
28 Light or moderate thunderstorm.
29 Heavy thunderstorm.

**Figures 30 to 39: Duststorms and storms of drifting snow (Visibility less than 1000 meters, 1100 yards)**

30 Duststorm or sandstorm.
31 Duststorm or sandstorm has decreased.
32 Duststorm or sandstorm, no appreciable change.
33 Duststorm or sandstorm has increased.
34 Line of duststorms.
35 Storm of drifting snow.
36 Light or moderate storm of drifting snow } generally low.
37 Heavy storm of drifting snow } generally low.
38 Light or moderate storm of drifting snow } generally high.
39 Heavy storm of drifting snow } generally high.

**Figures 40 to 49: Fog (Visibility less than 1,000 meters, 1,100 yards)**

40 Fog.
41 Moderate fog in last hour } but not at time of observation.
42 Thick or dense fog in last hour } but not at time of observation.
43 Fog, sky discernible } has become thinner during last hour.
44 Fog, sky not discernible } has become thinner during last hour.
45 Fog, sky discernible } no appreciable change during last hour.
46 Fog, sky not discernible } no appreciable change during last hour.
47 Fog, sky discernible } has begun or become thicker during last hour.
48 Fog, sky not discernible } has begun or become thicker during last hour.
49 Fog in patches.

**Figures 50 to 59: Drizzle**

50 Drizzle.
51 Intermittent } light drizzle.
52 Continuous } light drizzle.
53 Intermittent } moderate drizzle.
54 Continuous } moderate drizzle.
55 Intermittent } heavy drizzle.
56 Continuous } heavy drizzle.
57 Drizzle and Fog.
58 Light or moderate drizzle and rain.
59 Heavy drizzle and light rain.

**Figures 60 to 69: Rain**

60 Rain.
61 Intermittent } light rain.
62 Continuous } light rain.
63 Intermittent } moderate rain.
64 Continuous } moderate rain.
65 Intermittent } heavy rain.
66 Continuous } heavy rain.
67 Rain and fog.
68 Light or moderate } rain and snow, mixed.
69 Heavy } rain and snow, mixed.

**Figures 70 to 79: Snow**

70 Snow.
71 Intermittent } light snow in flakes.
72 Continuous } light snow in flakes.
73 Intermittent } moderate snow in flakes.
74 Continuous } moderate snow in flakes.
75 Intermittent } heavy snow in flakes.
76 Continuous } heavy snow in flakes.
77 Snow and fog.
78 Snow grains.
79 Ice crystals; or sleet.

**Figures 80 to 89: Showers**

80 Showers.
81 Showers of light or moderate } rain.
82 Showers of heavy } rain.
83 Showers of light or moderate } snow.
84 Showers of heavy } snow.
85 Showers of light or moderate } rain and snow.
86 Showers of heavy } rain and snow.
87 Showers of snow pellets.
88 Showers of light or moderate } hail, or rain and hail.
89 Showers of light or moderate } hail, or rain and hail.

**Figures 90 to 99: Thunderstorm**

90 Thunderstorm, with precipitation falling.
91 Rain and thunder in last hour, with rain.
92 Precipitation and thunder during last hour, with snow, or rain and snow mixed.
93 Light thunderstorm, without hail, but with rain or snow.
94 Light thunderstorm, with small hail.
95 Moderate thunderstorm, without hail, but with rain or snow.
96 Moderate thunderstorm, with small hail.
97 Heavy thunderstorm, without hail, but with rain or snow.
98 Thunderstorm, combined with duststorm.
99 Heavy thunderstorm with hail.

Not all sources report present weather. When regularly reported, a missing value is indicated by "M" in the ww position.

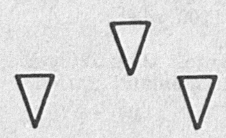
### SYMBOL RR—PRECIPITATION

The amount of precipitation is given in inches, to hundredths, for the 11 to 13-hour period ending at time of observation. Some sources report for other periods, as indicated in the description of specific sources.

### ADDITIONAL SYMBOLS

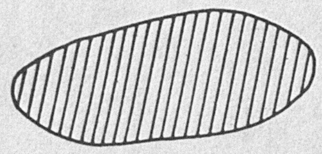
1. Parentheses enclose pressures or temperatures obtained by interpolation from isopleths drawn on previously prepared maps.
2. Brackets enclose pressure values for stations above 100 meters for which reduction to sea-level was made in the plotting unit.
3. The symbol (Ra) indentifies reports from Cavite messages or similar wireless reports.
4. On ship reports the abbreviated name of the ship is entered below the report.

## PRECIPITATION SYMBOLS



SHOWERS

DRIZZLE

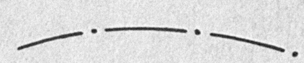


HATCHING DENOTES AREA OF PRECIPITATION (other than drizzle) OR GENERAL AREA OF MIXED PRECIPITATION TYPES.

## ISOBARS

SOLID ISOBARS FOR EACH 5 MILLIBAR INTERVAL WHERE PRESSURE VALUES ARE REASONABLY CERTAIN.

DASHED ISOBARS FOR EACH 5 MILLIBAR INTERVAL WHERE PRESSURE FIELD IS UNCERTAIN.

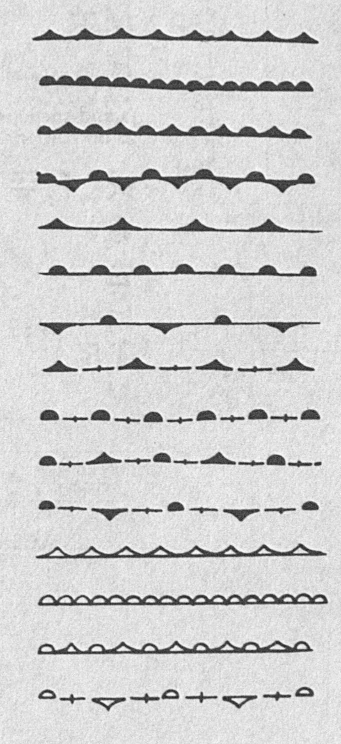


ALTERNATE DASH AND DOT FOR INTERMEDIATE VALUES OF 2.5 MILLIBARS IN REGIONS OF EXTREMELY FLAT PRESSURE FIELDS.

## AIR MASS DESIGNATORS

| | |
|---|---|
| mP | POLAR MARITIME |
| cP | POLAR CONTINENTAL |
| mT | TROPICAL MARITIME |
| cT | TROPICAL CONTINENTAL |
| cA | ARCTIC CONTINENTAL |

## SYMBOLS USED FOR DESIGNATING FRONTS:



COLD FRONT
WARM FRONT
OCCLUDED FRONT
STATIONARY FRONT
COLD FRONTOGENESIS
WARM FRONTOGENESIS
STATIONARY FRONTOGENESIS
COLD FRONTOLYSIS
WARM FRONTOLYSIS
OCCLUDED FRONTOLYSIS
STATIONARY FRONTOLYSIS
COLD FRONT ALOFT
WARM FRONT ALOFT
OCCLUDED FRONT ALOFT
OCCLUDED FRONTOLYSIS ALOFT

# OUTLINE OF DATA SOURCES, MAY 1936

## LAND AREAS

| Area | Source No. | Special Code | Period of precipitation |
|---|---|---|---|
| Africa: | | | |
| French North Africa | 1 | A, C | No report |
| Libya | 9 | † | No report |
| Egypt | 2, 9[a] | B, D | 24 hours |
| Asia: | | | |
| China | 20 | C | 24 hours[b] |
| India and Burma | 4 | C, G | 24 hours |
| Indo China | 5 | B, D | No report |
| Japan and Korea, Pelew, Saipan, Ponapi and Truk | 6 | B, C, F[c] | 24 hours |
| Philippines and Yap | 7 | B | No report |
| Siberia | 8 | A | 12 hours[d] |
| Asia Minor: | | | |
| Turkey and Jerusalem, Palestine | 9 | † | No report |
| Europe: | | | |
| England | 10*, 12 | A, C, H | No report |
| France | 11*, 12 | A | No report |
| Greece | 9 | A | No report |
| Rhodes | 9 | † | No report |
| Russia | 8 | A | 12 hours |
| Other European Countries and Iceland | 12 | A | No report |
| Atlantic Islands[e] | 12, 17* | A, B, C | No report |
| The Americas: | | | |
| North America | 13 | E | No report |
| South America | 13 | E | No report |
| Central America, Caribbean Area and Bermuda | 13 | E | No report |
| U. S. Island Possessions | 13 | E | No report |
| Greenland | 14 | B, C | 24 hours |
| Mygbukta | 12 | A | No report |

## OCEAN AREAS

| Ocean | Source No. | Special Code |
|---|---|---|
| Atlantic and Mediterranean | 12, 13, 15 | A, C, E, F, H |
| Pacific | 13, 15 | C, E, F, H |
| Indian | 15 | C, F, H |

## SINGLE STATION SOURCES

| Station | Source No. | Special Code | Period of precipitation |
|---|---|---|---|
| Beirut, Syria | 16 | C, F | No report |
| Bolama, Port. Guinea | 17 | C | No report |
| Bucharest, Rumania | 21 | # | 24 hours |
| Georgetown, British Guiana | 18 | B, C | No report |
| Istanbul, Turkey | 3 | # | 24 hours |
| Ponta Delgada, Horta, Funchal | 12, 19* | A, B, C | No report |

*Used only when reports are missing from regular source.
†Reports are entered from previously prepared weather maps. Pressures are interpolated from the isobaric analysis.
#Reports only direction and force of wind and precipitation.
[a] Reports are entered from previously prepared weather maps for several stations in northern Egypt.
[b] Nanking only reports precipitation for 24 hours.
[c] A few stations only report cloud types.
[d] Reports at 19 hours local time only.
[e] Tenerife, Sao Vicente.

## SOURCES OF DATA

1 Bulletin de l'Afrique du Nord, *Office National Meteorologique de France.*
2 Daily Weather Report, *Egypt.*
3 Bulletin Meteorologique et Sismologique, *Istanbul.*
4 Indian Daily Weather Report.
5 Daily Weather Charts, *Zi-ka-wei Observatory, Shanghai.*
6 Weather Chart, *Central Meteorological Observatory of Japan, Tokyo.*
7 Annual Report of the Weather Bureau, *Department of Agriculture and Commerce, Commonwealth of the Philippines.*
8 Moscow Daily Meteorological Bulletin.
9 Bulletin Quotidien du Temps, *Service Meteorologique National, Greece.*
10 Daily Weather Report, British Section, *Meteorological Office, London.*
11 Bulletin Quotidien d' Etudes de l'Office National Meteorologique de France.
12 Deutsche Seewarte Wetterbericht, *Hamburg.*
13 Forecasters' Manuscript Maps, *United States Weather Bureau.*
14 Meteorologiske Aarbog, Part II, *Meteorologiske Institut, Denmark.*
15 Ship Weather Observations, *United States Weather Bureau Forms 1201 and 1210.*
16 Monthly Bulletin of the Observatory, *American University of Beirut.*
17 Anias Meteorologicas das Colonias, *Ministerio das Colonias, Portugal.*
18 Report on Meteorology, *British Guiana.*
19 Anias do Observatorio Central Meteorologico, *Lisbon.*
20 Monthly Meteorological Bulletin, *Nanking Institute of Meteorology, National Research Institute.*
21 Buletinul Lunar Observatiunilor Meteorologici, *Bucharest.*

# SPECIAL CODES

### *Code A*

REGULAR INTERNATIONAL CODE REPORTS

The following coverages are used when N is not specifically given, but when present weather is reported:

| ww given | N used | ww given | N used |
|---|---|---|---|
| 00 | 0 | 04—49 | Missing |
| 01 | 4 | 50—79 | 8 |
| 02 | 5 | 80—99 | 5 |
| 03 | 8 | | |

### *Code B*

Plain language description translated to International Code symbols:

PRESENT WEATHER

| Description | ww |
|---|---|
| Ground fog | 04 |
| Haze or sand haze | 05 |
| Lightning | 07 |
| Mist | 08 |
| Fog over sea | 09 |
| Thunder | 11 |
| Yellow dust | 18 |
| Thunderstorm within the last hr. | 28 |
| Rain and drizzle | 58 |
| Rain and snow | 68 |
| Sleet | 79 |
| Hail | 88 |

Other descriptions which fit exactly International Code descriptions are used with the proper symbols.

### *Code C*

SKY COVERAGE

| Tenths of sky covered with clouds | N or $N_h$ | Tenths of sky covered with clouds | N or $N_h$ |
|---|---|---|---|
| 0 | 0 | 4, 5, or 6 | 4 |
| 0, but cloud types given | 1 | 7 or 8 | 5 |
| 1 | 2 | 9 | 6 |
| 2 or 3 | 3 | 10 | 8 |

### *Code D*

SKY COVERAGE

| Description | N |
|---|---|
| Clear | 0 |
| 1/4 or partly cloudy | 3 |
| 1/2 or cloudy | 4 |
| 3/4 or very cloudy | 5 |
| 4/4 or overcast | 8 |

### *Code E*

Forecasters' Manuscript Maps

PRESENT WEATHER

| Base map description | ww used | N used when coverage missing |
|---|---|---|
| = | 08 | Missing. |
| q, ∧ | 14 | Missing. |
| F, ≡ | 40 | Missing. |
| M, ≠ | 50 | 8 |
| R, •, ••, ∴ | 60 | 8 |
| :∇, ∇:, ∇· (Land stations) | 60 | 8 |
| (Ship stations) | 80 | 5 |
| R& F, ≡̣ | 67 | 8 |
| S, * | 70 | 8 |
| △̇ | 79 | 8 |
| P, *∇ | 80 | 5 |
| T, ⏉ | 90 | 5 |
| V | (Visibility=9) | |

SKY COVERAGE

| Symbol given | N used | Symbol given | N used | Symbol given | N used |
|---|---|---|---|---|---|
| ○ | 0 | ⦶ | 4 | ⊕ | 8 |

### *Code F*

CLOUD TYPES

| Description | Cloud form used |
|---|---|
| Cu or K | L 1 |
| Cu Nb or KN | L 3 |
| St or S<br>St Cu or Sk | L 5 |
| Nb or N | L 6 |
| Cu and St Cu or K and SK<br>Cu and St or K and S | L 7 |
| Cu Nb and St Cu or Kn and SK<br>Cu Nb and St or KN and S | L 8 |
| Cu Nb and Nb or KN and N | L 9 |
| A St or SC | M 1 |
| Nb St or NS | M 2 |
| A Cu or KC | M 3 |
| A St and ACu or SC and KC | M 7 |
| Ci or C | H 1 |
| Ci St or CS | H 8 |
| Ci Cu or CK | H 9 |

### *Code G*

INDIAN PRESENT AND PAST WEATHER

| Description | ww used | W used |
|---|---|---|
| Low ground fog. | 04 | 4 |
| Haze.<br>Dust haze.<br>Dust fog. | 05 | |
| Lightning. | 07 | |
| Fog at sea.<br>Fog at a distance. | 09 | |
| Thunder. | 11 | |
| Squally. | 14 | |
| Duststorm. | 30 | 3 |
| Fog.<br>Foggy. | 40 | 4 |
| Moderate fog in last hour. | 41 | |
| Drizzle.<br>Drizzling. | 50 | 5 |
| Rain.<br>Raining. | 60 | 6 |
| Snow.<br>Snowing. | 70 | 7 |
| Thunderstorm.<br>Thunderstorm and drizzling.<br>Thunderstorm with hail. | 90 | 9 |

### *Code H*

PRESENT WEATHER; BEAUFORT WEATHER NOTATION

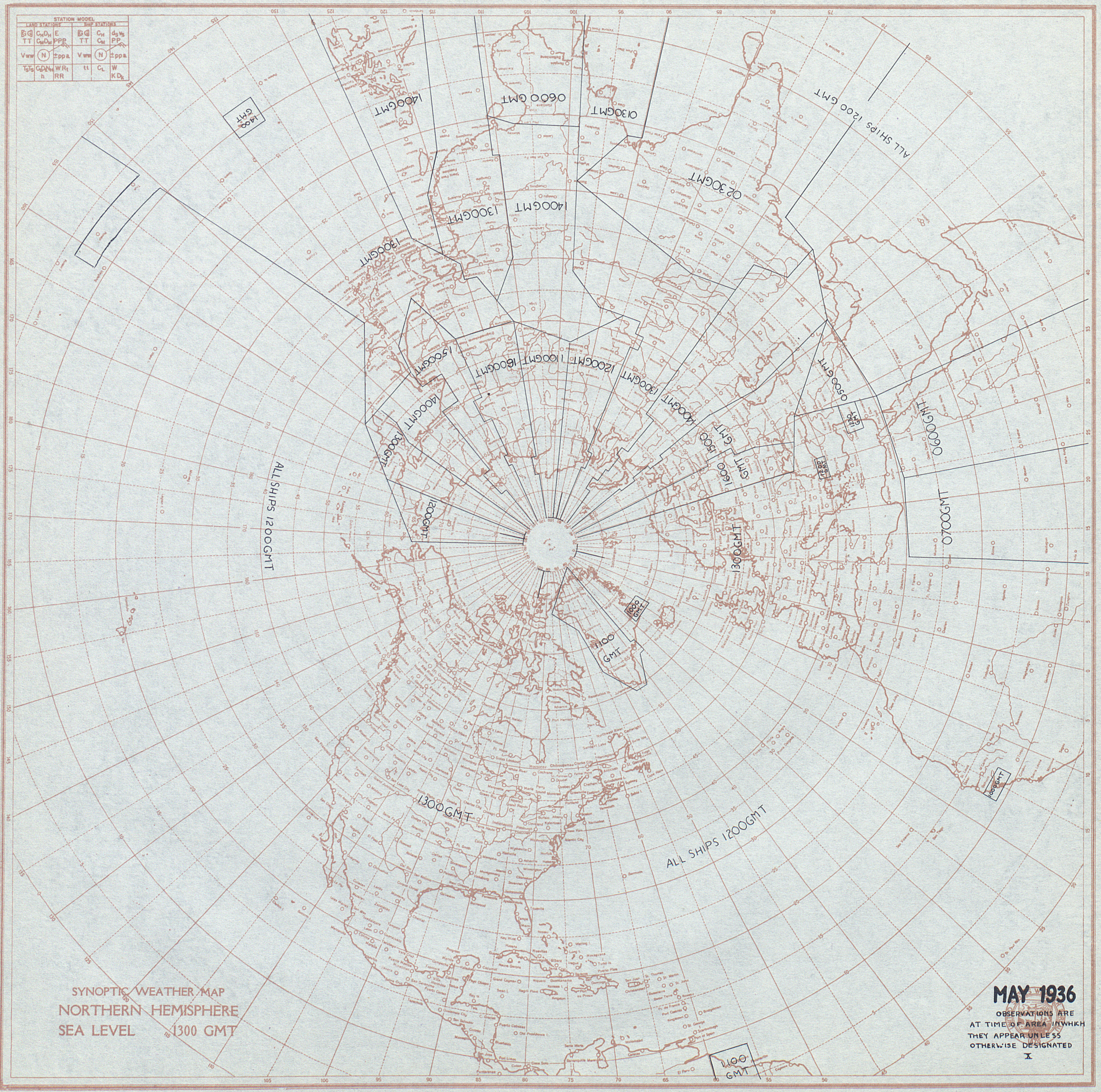
| Description | WW Used |
|---|---|
| b–blue sky (not more than a quarter of the sky covered.) | (N–3) |
| bc–sky partly cloudy (one-half covered.) | (N–4) |
| c–generally cloudy (three-quarters covered.) | (N–5) |
| o–overcast sky. | (N–8) |
| v–unusual visibility. | visibility=9 |
| z–dust haze; the turbid atmosphere of dry weather. | 05 |
| l–lightning. | 07 |
| m–mist, visibility 1000–2200 yds. | 08 |
| fs–fog over sea (coast station.) | 09 |
| jp–precipitation within sight of station. | 10 |
| t–thunder. | 11 |
| u–ugly threatening sky. | 13 |
| q–squalls. | 14 |
| kq–line squall. | 15 |
| ks–storm of drifting snow. | 35 |
| f–fog, visibility 220–1100 yds. | 40 |
| fe–thick, damp fog. | 40 |
| F–thick fog, visibility less than 220 yds. | 40 |
| fg–fog on lower ground (inland station). | 49 |
| d–drizzle or fine rain. | 50 |
| r–rain. | 60 |
| s–snow. | 70 |
| rs–sleet. | 79 |
| p–passing showers. | 80 |
| h–hail. | 88 |
| h(r)–hail, or rain and hail. | 88 |

Capital letters indicate intense, suffix "o" indicates slight, and repetition of letters indicates continuity. More specific present weather symbols are applied when sufficiently descriptive combinations are applicable.

A "solidus" divides actual existing weather from preceding conditions thus:

bc/r=fair weather after rain.

Symbols given with a solidus are plotted as past weather (W).



STATION MODEL
ALL SHIPS 1200 GMT
ALL SHIPS 1200GMT
ALL SHIPS 1200GMT
1400GMT
0900 GMT
0130GMT
0230GMT
1400GMT
1300GMT
1300GMT
1500GMT
1200GMT
1100GMT
1600GMT
1300GMT
1400GMT
1500GMT
0500GMT
0600GMT
0700GMT
1300GMT
1100 GMT
1300GMT
1100 GMT
SYNOPTIC WEATHER MAP
NORTHERN HEMISPHERE
SEA LEVEL 1300 GMT
MAY 1936
OBSERVATIONS ARE
AT TIME OF AREA IN WHICH
THEY APPEAR UNLESS
OTHERWISE DESIGNATED
X