PREFACE

The maps reproduced in this volume are from the series of Historical Weather Maps prepared through a cooperative project of the Army Air Forces and the Weather Bureau, with the assistance of university meteorological staffs in the work of map analysis.

The financial support for the Historical Maps Project has been furnished by the Army Air Forces. Staffing, organization, and management have been by the Statistics Division of the Weather Bureau with the assistance of Army Air Forces personnel for analysis. Maps have been analyzed under the supervision of the meteorological staffs of New York University and of the California Institute of Technology.

INTRODUCTION

SOURCES AND PREPARATION OF OBSERVATIONS

SOURCES OF OBSERVATIONS

The sources of the observational data for this Northern Hemisphere Map series may be classified as follows: (1) Yearbooks published by national meteorological services or observatories, containing synoptic data for one or several stations; (2) daily bulletins issued by meteorological offices of various governments, containing reports of observations from a national or international network of stations; and (3) manuscript reports such as ship weather observation logs and original station observation records.

With a few important exceptions, the chief problem in using the various meteorological publications giving daily synoptic data was the selection of the reports which would result in the most complete, reliable, and uniform maps. Since in most areas not all the stations reporting could be used, the following criteria were adopted in making the station selection: completeness of report, position, reliability, altitude, length of record, and ease of coding. Where a choice of sources was possible, preference was given, in general, to the yearbook type of publication since these reports are usually more complete, more reliable, and are in such form as to permit more efficient and accurate coding. Daily synoptic observations generally report pressures reduced to sea level by a method not defined in the data source. Monthly and yearly publications by observatories generally report station pressures only. These have been reduced to sea level and corrected for standard gravity where necessary by the methods described in the paragraph below on "Pressure Reductions." A total of 175 sources was used in preparing the maps for the period 1899–1928, with an average of 45 of these being used for any one year. The sources are listed below and the years for which each source was used are indicated.

Mention should be made of the scarcity of reports in some regions for certain periods. The most serious lack is that for Russia and Siberia for the period 1915–23. Due to the war the publications of most observatories in European Russia were suspended between 1914 and 1917. After 1917 throughout most of Russia and Siberia observations were either not taken, or if taken, were not sent to this country in any synoptic form. Not until August 1923 when the *Leningrad Daily Bulletin* becomes available, does the number of Russian observations approach that of the pre-war period. The war had a decided effect on the continuity of the European yearbooks. The number of stations reporting in each were usually reduced, e. g., in the *Annales du Bureau Central Météorologique*, while others ceased publication altogether, e. g. *Preussen Meteorologisches Jahrbuch.* Several choices were possible in dealing with this problem. In France reports for a non-synoptic hour were used. To compensate for the lack of synoptic reports in Prussia, observations from other sources for stations as close to the Prussian border as possible were selected, thus reducing the blank area of the map to a minimum. No satisfactory substitute was found for the main source for western Russia, and, since the only alternative was to use the occasional publications of the smaller observatories giving only a few stations, the coverage for this area is rather meager.

Mexican reports are extremely irregular for certain periods. Yearbooks for individual observatories were used whenever available but the chief dependence was on the daily bulletin, the *Carta del Tiempo*. The number of stations reporting in this source varied widely, and from 1910 through 1916 the inclusion of tabulated reports in this bulletin ceased entirely.

Every effort possible within the limits of the time available was made to secure all reports of daily observations in existence. Where published reports were not available, original records were in some cases secured and used.* It is certain, however, that observations have been made at some stations for which records are not available or for which daily observations were never published. In some cases it is not at present possible to obtain original records.

An attempt was made to get the meteorological data of expeditions, especially of those in the Arctic and Central Asiatic regions. While it is not expected that all such material was obtained, it is believed that the majority of this type of data has been procured.

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. were not available, reports at the hour nearest 13 G. M. T. were used, and the region is designated on the 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 one hour are identified by inclusion of the Greenwich hour in the station model.

CODE AND STATION MODEL

The International Weather code was used in the coding and plotting of these maps. The limitations of the code in which observational data are tabulated circumscribe the precision and completeness with which observed phenomena are presented. 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 occasional errors of interpretation. The number of elements reported varied greatly in different sources, and certain of the elements rarely appeared. Comments concerning translations into International Code are included in the table of symbols.

STATION NUMBERS

The numbers identifying the stations on these maps are the international index numbers for all stations to which such numbers have been assigned. For other stations, numbers which do not duplicate regular international numbers were arbitrarily assigned. No attempt was made to include on the maps the numbers for all stations which were plotted, since this would result in crowding of numbers in many areas.

PRESSURE REDUCTIONS

Pressure values reported as station pressure, or reduced to a standard elevation other than sea level, were reduced to sea level. For each station and each altitude tables or charts were prepared from which corrections were obtained to effect this reduction. In some cases reported pressures were not corrected to standard gravity, or temperature and instrument error corrections had not been applied. These corrections were included in the altitude reduction tables and graphs or were applied as separate corrections.

For stations at elevations not greater than 50 meters, a constant average correction was determined and applied to the reported pressure values. For stations at elevations from 50 meters to 300 meters, pressure reduction tables were prepared giving the correction to be applied for pressure and temperature intervals so chosen that: (1) the tabular difference from entry to entry in either direction did not exceed 0.8 mb., and (2) the maximum error of the correction to be added to the reported pressure was not over 0.4 mb. For the majority of stations above 300 meters, charts were made showing the correction to be applied at 5-degree centigrade intervals, with values between scale lines interpolated. Because of the greater difficulty encountered in using charts, tables were prepared for many stations higher than 300 meters.

Diagrams applicable to station pressures up to 800 meters were prepared for use when it was not convenient to prepare a table or chart for a specific station. The complete set of diagrams consisted of 9 charts, 8 of which were used in determining a first approximation to the correction for various altitudes, the ninth for the additional correction to be applied for various pressures. These diagrams are somewhat more accurate than the tables but are less convenient to use.

Computations were made from adaptations of the formula:

$$P_o - P = P(G_c \text{ antilog } H_b N - 1)$$

Where:

P_o = sea-level pressure.
P = station pressure.
G_c = factor for reduction to standard gravity or $(1 - 0.00259 \cos 2\phi)(1 - 0.000000196\ H_b)$.
ϕ = latitude.
H_b = station elevation computed in terms of 0.98 gdm.
gdm = geodynamic meters.

$$N = \frac{1}{67.572(272.5 + t_{mv}\,°C.)}$$

In the computation of N, the mean virtual temperature, t_{mv}, was obtained on the assumption of a uniform lapse rate of one-half the dry adiabatic and corrected for humidity on the basis of mean dew point data collected for various station temperatures at five weather stations in continental United States. Altogether more than 60 charts and more than 1600 pages of tables were compiled.

PREPARATION OF HISTORICAL MAPS

The preparation of this series of maps was organized on a functional basis, the functions including: preparation of data, coding reports in international code form, entry on punched cards, machine listing, map plotting, and analysis. A data preparation unit procured and selected sources of data, selected the stations to be used, and prepared instructions for coding. Three coding units entered the data in international code form, making conversions, pressure corrections, etc., where necessary. The coded reports were entered on punched cards from which listings were prepared. The maps were then plotted from these listings and transmitted to two analysis units.

Technical supervision of each function was vested in unit supervisors who were professional and advanced subprofessional meteorologists. Over-all control was maintained by a technical staff of persons experienced in the various functions.

VERIFICATION

All coding and card punching of data were subjected to 100 percent verification within the coding and punching units. The listings from the punched cards were checked for error and where necessary reference was made to the coded data for verification. A 100-percent check was made on map plotting until the reliability of the plotter was established, after which a 25-percent check was continuously applied. In addition, for certain periods a check was made from the plotted maps to the original data to establish the over-all accuracy of the maps. Listings of plotted data were available for reference by analysts.

ANALYSIS PROCEDURE

FRONTAL ANALYSIS

GENERAL PURPOSE

In the analysis of the Northern Hemisphere Sea-Level Synoptic Charts, it was 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 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 rendered impossible any attempt to carry weak frontal systems of short life on more than one chart; (c) the most important reason lay in the purpose of the analysis, which was 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 were 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 were consequently 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. Continuity was established between this series and the previously prepared ten-and-one-half-year series.

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 were disregarded until it is realized that the observations were taken at different times.

AIDS TO CONTINUITY

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

(*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. If on the preceding map, conditions were not favorable for frontogenesis and a front developed in the latter part of the 24-hour period, frontogenesis was indicated even though the front showed well-developed characteristics.

(*b*) *Prolonging frontolysis.*—This practice consisted 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 resulting front being the same as the predominating front on the preceding map. Consolidation of this sort on the maps will be found occurring between: Two cold fronts, two occluded fronts, one cold front and one (cold type) 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 was 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. Although the symbol of an occluded front does not distinguish the type, in winter along the West Coast of North America the character of the occlusion may change from a cold front type to a warm front type with an upper cold front indicated on the map. In this case frontolysis and frontogenesis were not indicated, as the transformation is assumed to occur as the system approaches the colder air of the continent and the surface cold type occlusion begins to move aloft as an upper cold front or an upper occluded front.

(*c*) *Transition of cold fronts to occlusions.*—A number of cases will be found on these maps where a cold front had apparently been transformed into an occluded front for a part of its extent. In most of these cases it was believed that a true occlusion process had taken place, and a warm front was shown to become associated with the cold front system.

(*d*) In a few cases an upper front is shown to change to a surface front without frontolysis or frontogenesis being indicated. It is assumed that the pressure trough associated with the upper front creates sufficient convergence near the ground to produce a well-developed surface front in less than 24 hours. In other cases the upper front may actually reach the ground when it approaches higher terrain.

ISOBARIC ANALYSIS

USE OF SHIP PRESSURE DATA

The isobaric analysis over the oceans had 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 values. In the course of the analysis certain ships became 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

*Dr. J. Patterson, Controller, Canadian Meteorological Service, made a great contribution to this project by lending original manuscript records for the years 1899–1905.

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 was 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.

DOT AND DASH ISOBARS

In some regions of weak isobaric gradient such as in the Tropics, supplementary isobars were drawn for the 2½-millibar interval where these might be helpful in determining the pressure field. These supplementary isobars were 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 was not always possible to draw isobars in tropical cyclones down to the lowest pressure; furthermore these minimum pressures were frequently unknown. On some maps the lowest pressure was indicated even though all the isobars were not drawn.

AREAS WITH LITTLE OR NO DATA

In the polar region, and over Siberia and certain sections of the oceans insufficient data were found from which to draw a completely reliable pressure pattern. Although no differentiation was made in the isobars over these areas, it should be understood that the pressure field was drawn by extrapolation in order to provide a continuous and logical pressure field.

EXPLANATION OF PLOTTING SYMBOLS

SYMBOL a—BAROMETRIC TENDENCY

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

International symbols are used. Where the specific characteristic was not available in the source, symbol number 3 is used to indicate rising pressure; symbol number 8 is used to indicate falling pressure

SYMBOL C_L—FORM OF LOW CLOUD

SYMBOL C_M—FORM OF MIDDLE CLOUD

SYMBOL C_H—FORM OF HIGH CLOUD

International symbols are used for plotting cloud forms. The cloud forms as reported in the data source are translated, in so far as is possible, into international states of the sky. The following table gives the code numbers used for the principal types of cloud forms encountered in the data sources for this series of maps. In some cases more definite descriptions were given for which additional code numbers were usable.

Low Cloud Forms

Name	Code No.
Cumulus	1
Fracto-cumulus	1
Cumulo-nimbus	3
Stratus	5
Strato-cumulus	5
Fracto-stratus	5
Stratus-cumuliform	5
Nimbus or nimbo-stratus	6
Fracto-nimbus	6
Nimbus-cumuliform	6
Cumulus and strato-cumulus	7
Cumulus and stratus	7
Cumulo-nimbus and strato-cumulus	8
Cumulo-nimbus and stratus	8
Cumulo-nimbus and nimbus	9
Mammato-cumulus	9

Middle Cloud Forms

Name	Code No.
Alto-stratus	1
Strato-cirrus	1
Alto-cumulus	3
Cumulo-cirrus	3
Stratus- cumulus-, or cirrus-lenticularis	4
Cumulo-stratus	6
Alto-stratus and strato-cumulus	7

High Cloud Forms

Name	Code No.
Cirrus	1
Cirro-stratus	8
Cirro-cumulus	9

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 is blowing.

SYMBOL d_s—DIRECTION OF SHIP'S MOVEMENT

A small arrow indicates the direction in which the ship is moving at the time of observation. This element was very rarely reported in the data available for this series.

SYMBOL F—WIND FORCE, BEAUFORT SCALE

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.

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

The international code figure is entered.

SYMBOL N—TOTAL AMOUNT, ALL CLOUDS

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

The international code symbol for N is entered in the station circle. The code figure for N_h is entered where such data are given or where it is possible to determine the value of this element from the data as given.

Symbol 2 is plotted when N equals 1 or 2; symbol 6 is plotted when N equals 6 or 7. A missing value for N is indicated by an "M" in the station circle, unless an indication of the coverage 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 entered in millibars to tenths, with the initial 9 or 10 omitted. All pressures are reduced to sea level, standard gravity, and corrected for temperature. Pressures for ship stations are entered to the nearest whole millibar.

SYMBOL pp—AMOUNT OF BAROMETRIC CHANGE

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

SYMBOL RR—PRECIPITATION

The amount of precipitation is given in inches to hundredths for a 24-hour period ending at the time of observation, or at a time within 8 hours of the time of observation.

SYMBOL TT—AIR TEMPERATURE

SYMBOL tt—WATER TEMPERATURE

Temperatures are entered in whole degrees of the Fahrenheit scale.

SYMBOL U—RELATIVE HUMIDITY

International code figures for humidity are entered.

SYMBOL V—HORIZONTAL VISIBILITY

International code figures are entered.

SYMBOL v_s—SHIP'S SPEED

International code figures for ship's speed are entered with the symbol for d_s.

SYMBOL W—PAST WEATHER

SYMBOL ww—PRESENT WEATHER

International code symbols are used to indicate past and present weather. The following table gives the code numbers used for various types of weather as reported in the data sources.

WEATHER TABLE

Type of weather	Intensity of phenomenon	At time of observation	In previous hour but not at time of observation	In past weather period
		ww	ww	W
Thunderstorm		90	28	9
Thunderstorm with hail	Light	94	28	9
Thunderstorm with hail	Moderate or unidentified.	96	28	9
Thunderstorm with hail	Heavy	99	28	9
Thunderstorm with snow.	Light	[1] 93	[2] 28	9
Thunderstorm with snow.	Moderate or unidentified.	[1] 95	[2] 28	9
Thunderstorm with snow.	Heavy	[1] 97	[2] 29	9
Thunderstorm with rain	Light	[1] 93	[3] 28	9
Thunderstorm with rain	Moderate or unidentified.	[1] 95	[3] 28	9
Thunderstorm with rain	Heavy	[1] 97	[3] 29	9
Hail	Light, moderate, or unidentified.	88	27	8
Hail	Heavy	89	27	8

[1] If the precipitation has ceased in the past hour, but thunderstorm continues, it is coded as weather in the past hour (ww=28 or 29).

[2] If the thunderstorm has stopped but the snow continues ww is coded 92.

[3] If the thunderstorm has stopped but the rain continues ww is coded 91.

WEATHER TABLE—Continued

Type of weather	Intensity of phenomenon	At time of observation	In previous hour but not at time of observation	In past weather period
		ww	ww	W
Snow pellets		87	26	8
Ice crystals		79	23	7
Snow	Unidentified	70	23	7
Snow	Light	72	23	7
Snow	Moderate	74	23	7
Snow	Heavy	76	23	7
Snow with rain	Light, moderate, or unidentified	68	24	7
Snow with rain	Heavy	69	24	7
Snow with fog	Moderate or unidentified fog	77	41	7
Snow with fog	Heavy fog	77	42	7
Rain	Unidentified	60	22	6
Rain	Light	62	22	6
Rain	Moderate	64	22	6
Rain	Heavy	66	22	6
Rain and fog	Moderate or unidentified fog	67	41	6
Rain and fog	Heavy fog	67	42	6
Fog	Light	08		
Fog	Moderate or unidentified	40	41	4
Fog	Heavy	40	42	4
Drifting snow		35		3
Thunder		11	(W=9)	9
Lightning		07		
Haze		05		
Ground fog		04		

LIST OF SOURCES

Country	Source	Period
Algeria	Bulletin de l'Algerie	1915–1928
Austria	Jahrbücher der K. K. Anstalt für Meteorologie und Geodynamik	1899–1928
	Ergebnisse der Meteorologischen Beobachtungen an den Landesstationen in Bosnien-Hercegovina	1900–1910
	Jahrbuch der Meteorologischen, Erdmagnetischen, und Seismischen Beobachtungen	1910–1915
	Magnetische und Meteorologische Beobachtungen in Prag	1914
Belgium	Duc d'Orléans—Compagne Artic de 1907	1907
British Guiana	Meteorological Observations	1912–1914 1916–1920
British West Africa	Meteorological Observations, Gambia Colony	1912–1919
British West Indies	Meteorological Returns—Trinidad	1909–1919
	Meteorological Observations at Prospect, Bermuda	1910–1920
	Meteorological Register—St. John's	1910–1918
	Meteorological Report—Richmond Hill, Grenada	1910–1919
	Meteorological Observations—Barbados	1912–1918
	Meteorological Observations—Jamaica	1912–1919
Bulgaria	Annuaire de l'Institute Météorologique de Bulgarie	1899–1927
	Bulletin Mensual de l'Institut Météorologique Central de Bulgarie	1928
Canada	Weekly Reports (manuscript)	1899–1905
	Cruise of the "Neptune"	1903–1904
	Meteorological Service—Parts III, V	1906–1915
	Daily Weather Maps	1907–1914 1921–1928
	Monthly Record of Meteorological Observations	1916–1928
China	Bulletin Mensuel Observatoire Magnétique et Météorologique de Zikawei	1899–1904
	Daily Weather Charts, Zi-ka-wei Observatory	1906–1910 1915–1928
Cuba	Estación Central Meteorológica Boletín	1903–1905
	Observatorio Meteorológico y Séismico Colegio de Belen, Habana	1908–1925
	Anales del Observatorio del Colegio de Monserrat	1911–1920
Denmark	Meteorologiske Aarbog det Danske Meteorologisk Institut	1899–1928
	Denmark Ekspeditionen til Grønlands	1906–1908
	Meddelelser om Grønland	1909–1910
	Vejrberetning—Danske Meteorologisk Institut	1921–1928
Dutch Guiana	Met. Waarnemingen in Suriname und Curacao	1905–1918
Egypt	Report on the Meteorological Observations made at Abassia Obs., Cairo	1899
	Meteorological Observations	1900–1904
	Meteorological Report	1900–1920
	Daily Weather Report	1915–1928
Esthonia	Meteorologisches Jahrbuch für Esti	1921–1928
Finland	Meteorologisches Jahrbuch für Finnland	1899–1928
France	Annales du Bureau Central Météorologique	1899–1920
	Bulletin Annuel des Bouches du Rhône	1915–1928
	Bulletin International de France	1915–1925

LIST OF SOURCES—Continued

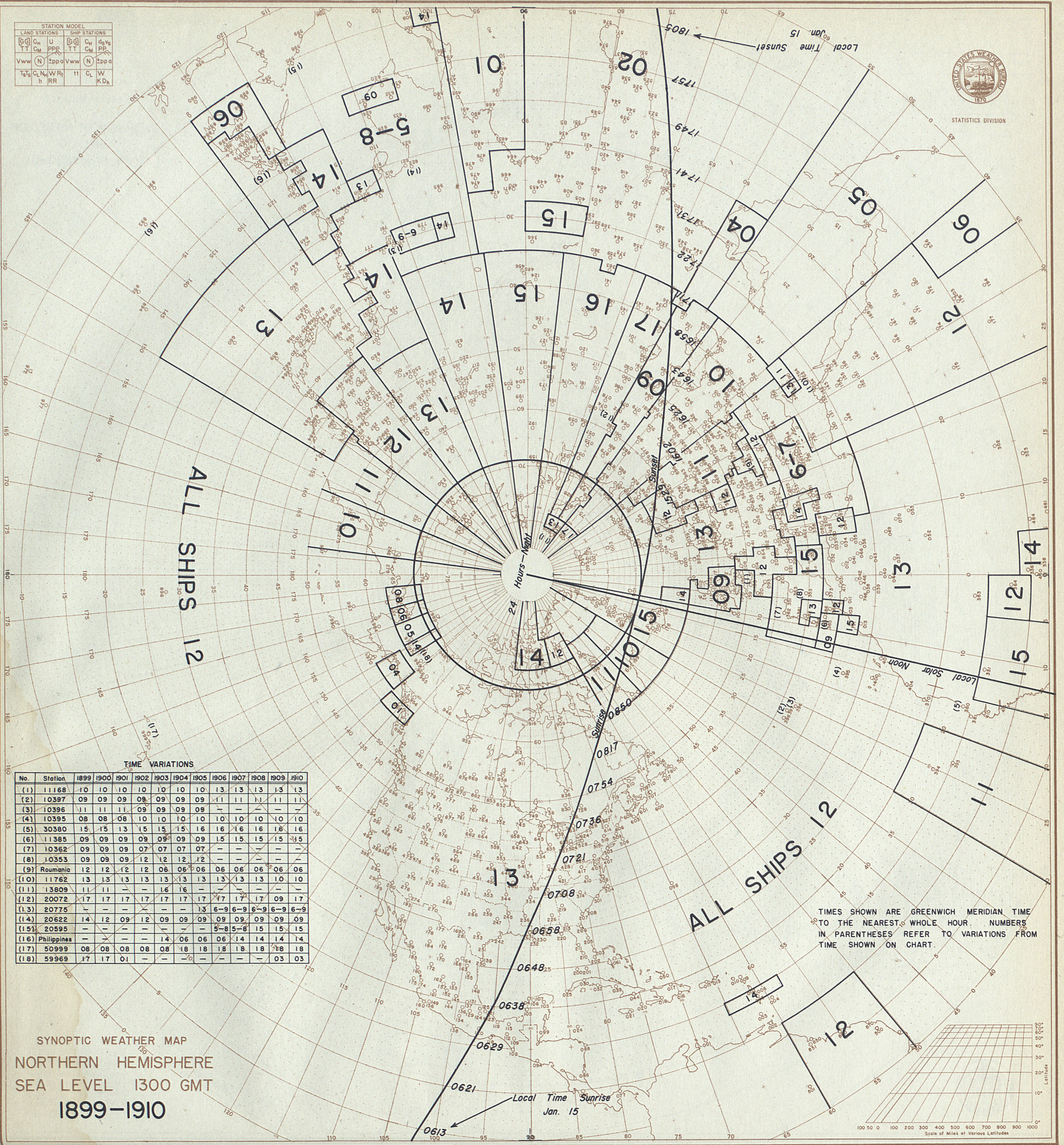
Country	Source	Period
Germany	Deutsches Meteorologisches Jahrbuch—Bayern	1899–1928
	Deutsches Meteorologisches Jahrbuch—Bremen	1899–1920
	Deutsches Meteorologisches Jahrbuch—Preussen	1899–1913
	Deutsche Seewarte Jahrbuch	1899–1928
	Deutsche Ueberseeische Meteorologische Beobachtungen	1899–1901, 1910–1913
	Deutsches Meteorologisches Jahrbuch—Sachsen	1911–1914
	Ergebnisse der Meteorologischen Beobachtungen in Potsdam	1915–1920
	Deutsches Meteorologisches Jahrbuch—Hessen	1919–1928
	Deutsche Seewarte Wetterbericht	1921–1927
Great Britain	Bulletin des Observations Météorologiques (Jersey)	1899–1913
	Hourly Readings, Meteorological Council, London	1899–1907
	Meteorological Observations at Stations of the Second Order—Meteorological Council	1899–1907
	British Meteorological Yearbook	1908–1920
	Daily Weather Report—British Meteorological Office	1921–1928
Haiti	Bulletin Sém. de l'Observatoire Mét. du Séminaire Collège St. Martial	1910–1920
Hong Kong	China Coast Meteorological Register, Hong Kong	1899–1920
	Monthly Meteorological Bulletin—Hong Kong Observatory	1913–1928
Hungary	K. Ungarn Reichsanstalt für Meteor. u. Erdmag: Jahrbücher	1899–1910, 1915–1920
	Evkonyvei Hivatalos Kiadvany, I Resz. (Hungarian Yearbook, Part I)	1911–1914
	Jahrbücher der Zentralanstalt für Meteorologie und Geodynamik	1915–1920
Iceland	Annuaire Météorologique	1920–1923
India	India Daily Weather Report	1899–1928
Italy	Bollettino Meteorico del R. Ufficio Centrale de Meteorologia—Roma	1899–1927
	Osservatorio Meteorologico del R. Instituto Nautico di Riposto (Etna)	1899–1903, 1910–1914, 1919–1920
	Osservazioni Meteorologiche—Torino	1899–1906, 1909–1910
	Osservazioni Scientifiche la Spedizione Polore di S. A. R. Luigi—Amedeo di Savoia	1899–1900
	Pubblicazioni Specola Vaticana	1899–1901
	Accad. d'Agric. Artie Com.—Atti e Memorie Verona	1900–1910
	Osservazioni Meteoriche—Capodimonte	1900–1918
	Annuario Messina Osservatorio	1904–1909
	Marittimo Telegramma Meteorologico—Trieste—I. R. Osservatorio	1905–1914
	Bollettino Meteorico—Geodynamico di Pompeii—(Naples)	1908–1910
	Bollettino Meteorico e Riepilogo—Genova	1911–1914
	Bollettino dell'Osservatorio Collegio Pennisi Acireale	1915–1928
	Bollettino Meteorologico e Geodinamico	1915
	Foglio Meteorico Mensile—Instituto Idrografico della R. Marina—Genova	1918–1919, 1923–1927
	Osservatorio Geofisico del Seminario Patriarcale Bollettino Mensile, Venice	1920–1928
	Bollettino Aerologico dell Servizio Aerologico Roma	1921–1927
	Osservazioni Meteorologiche R. Osservatorio Astronomico di Brera in Milano	1921–1922, 1928
	Bollettino Meteorologico e Aerologico	1927
Japan	Monthly Report of the Central Meteorological Observatory of Japan	1899–1928
	Japanese Weather Charts—Central Meteorological Observatory	1901
	Meteorological Observations at Japanese Observation Stations	1904–1905
	Results of the Meteorological Observations (Korea)	1904
	Annual Report of the Met. Observatory of Government General of Chosen—Jinsen Observatory	1915–1920
Latvia	Daily Weather Maps	1925–1928

LIST OF SOURCES—Continued

Country	Source	Period
Libya	Bollettino Meteorologico della Cirenaica-Benghazi	1928
Malaya and Straits Settlements	Straits Settlements Meteorological Returns	1902, 1908–1916
Mexico	Boletín del Observatorio del Colegio de San Juan Nepomuceno	1899–1905
	Boletín Mensual del Observatorio Meteorológico del Estado de Chiapas	1899–1901
	Boletín Mensual del Observatorio Meteorológico del Estado de Oaxaca	1899–1900, 1903–1904
	Carta del Tiempo	1899–1909, 1917–1928
	Zacatecas Registro de Observaciones Meteorológicas	1899–1901
	Boletín Mensual del Observatorio Meteorológico del Colegio de Estado de Puebla	1900–1911
	Boletín del Observatorio Meteorológico de León	1901–1911
	Boletín Mensual Observatorio Meteorológico Central de México	1902–1919
	Boletín Mensual de la Sección Meteorológica del Estado de Yucatan	1905–1916
	Boletín Mensual de la Sección Meteorológica del Estado de Michoacan	1908–1912
	Boletín Mensual de la Sección Meteorológica de Estado de Sinaloa	1908–1910
	Boletín del Observatorio Meteorológico del Instituto Juarez	1909–1911
	Boletín Meteorológico de Colombres	1911–1912
Morocco	Bulletin Scientifique du Maroc	1922–1928
Netherlands	Jahrboek-Koninklijk Nederlandsch Meteorologische Institut	1899–1928
Nigeria	Meteorological Observations, Northern Nigeria	1912–1913
Norway	Jahrbuch des Norwegischen Instituts	1899–1920
	Report of the Second Norwegian Arctic Expedition in the "Fram"	1899–1902
	The Scientific Results of the Norwegian Expedition in the "Gjøa"	1903–1906
	The Norwegian North Polar Expedition with the "Maud", 1918–1925	1918–1920
	Vaerkart Norske Meteorologiske Institute	1923–1928
Philippine Is.	Boletín Mensual, Observatorio de Manila	1899–1902
	Annual Report of the Philippine Weather Bureau	1902–1928
Poland	Meteorologische Beobachtungen in Lemberg (Lwow)	1911–1928
	Annuaire de l'Institut Météorologique de Pologne	1920, 1925–1926
	Panstowy Institut Meteorologiczny	1926–1927
Portugal	Annals Observatorio de Luiz en Lisboa	1899–1905
	Boletino Meteorológico Observatorio do Infante D. Luiz	1899–1905
	Observacões Meteorológicas e. Magneticas de Coimbra	1899–1905, 1925–1928
	Anais do Observatório Central Meteorológicas Infante D. Luiz	1906–1926
	Anais Meteorológicas das Colónais	1919–1928
Rumania	Annales—Institut Météorologique de Romaniei	1899–1902
	Buletinul Meteorologic Zilnic Institutul Meteorologic Central Al Romaniei	1903–1914, 1922–1928
Russia	Annales de l'Observatoire Physique Central (Nicolas)	1899–1908, 1910–1911, 1914
	Annales do l'Observatoire Physique Central (Nicolas) I Partie	1899–1908, 1910–1911, 1914
	Annales de l'Observatoire Physique Central (Nicolas) Supplement	1899–1913
	Annuaire de l'Observatoire Météorologique et Magnétique a l'Univ. Impériale à Odessa	1899–1912
	Beobachtungen des Tiflisser Physikalischen Obs.	1899–1905
	Bulletin de l'Observatoire Météorologique de l'Univ. Imp. de Kazan	1899–1913
	Meteorological Observations at Jurjew	1899–1920
	Observations Météorologiques en Manchourie	1899–1906
	Beitrage zur Klimatologie der Nordküste Asiens	1900–1903

LIST OF SOURCES—Continued

Country	Source	Period
Russia—Con.	Beobachtungen Meteorologische Observatorium Moskau	1902–1911
	Amur Met. Bureau and Eastern Railroad Meteorological Obs.	1903–1915
	Zapiski Po Gidrografii	1906–1907
	Hydro-meteorological Observations of the Hydrological Expedition	1907–1908, 1915
	Morcoff Observatione Météorologique	1909–1915
	Observations faites à l'Observatoire Météorologique de l'Université de Kiev	1909
	Yearbook of the Meteorological Bureau of the Amur Government	1909–1912
	Bulletin Météorologique Quotidien de l'Observatoire Physique Central à St. Petersburg	1911–1914
	Station Goch, Province de l'Amour	1911–1912
	Meteorological Observations of the G. Y. Sedov Polar Exp. Vol I, Obs. at Foka Bay	1912–1913
	Observations de l'Observatoire Météorologique et Magnétique à Ekaterinburg	1912–1916
	Recueil des Observations Hydro-Météorologique, Fascicule XIII (Sevastopol)	1912–1913
	Meteorological Observations of the G. Y. Sedov Polar Exp. (Calm Bay), (Franz Joseph Land)	1913–1914
	Annales de l'Observatione Physique Central—Obs. à Irkoutsk	1914–1915, 1917
	Observations des Stations Météorologiques du Réseau de l'Observatoire Mét. de Vladivostok	1914–1915
	Travaux de la Section de la Météorologie Agricole-Observations Mét. Faites à Sinelnikowo Ekaterinoslow	1915
	Bulletin de la Société Ouralienne d'Amis des Sciences Naturelles	1917
	Hydro-Meteorological Bulletin—Central Station Arkhangelsk—Ministry of Trade and Industry	1918–1919
	Daily Weather Maps, Vladivostok Naval Observatory	1921–1923, 1927–1928
	Daily Meteorological Bulletin—Leningrad	1923–1928
San Salvador	Anales del Observatorio Nacional Meteorológico de San Salvador	1919–1928
Spain	Anales del Instituto y Observatorio de Marinha—San Fernando	1899–1928
	Observaciones Meteorológicas, Colegio en Ona	1899–1905, 1915–1919
	Anuario del Observatorio de Madrid	1902–1905, 1911–1914
	Boletín Mensuel del Observatorio de Granada	1903–1915, 1923–1928
	Boletín Mensuel del Observatorio del Ebro	1911–1914, 1920–1928
	Anuario del Observatorio Central Meteorológico (Suplemento), Canary Islands	1912–1916
	Resumen de las Observaciones—Observatorio Central Meteorológico	1915–1920
Sweden	Meteorologiska Iaktagelser I Sverige	1899–1920
	Scientific Results of a Journey in Central Asia	1899–1902
	Southern Tibet Expedition by Sven Hedin	1906–1908
	Statens Meteorologisk Hydrografiska Anstalt Årsbok	1920–1928
Switzerland	Annalen Schweitzerischen Meteorologischen Zentral Anstalt	1915–1928
Syria	Monthly Bulletin American University, Beirut	1921–1928
United States	Form 1001—United States Weather Bureau	1899–1928
	Report of the Chief of the Weather Bureau—Expedition to Franz Joseph Land	1899
	Report of the U. S. R. S. "Nunivak" on the Yukon River	1899–1900
	U. S. W. B. Forms 1201 and 1210—Ship Reports	1899–1928
	Weather Records for Honolulu and Hawaiian Islands	1899–1903
	The Ziegler Polar Expedition	1903–1905
	U. S. W. B. Forms 1201 and 1210—Land Reports	1908–1920
Yugoslavia	Bulletin Météorologique de Béograd	1920–1928



TIMES SHOWN ARE GREENWICH MERIDIAN TIME TO THE NEAREST WHOLE HOUR. NUMBERS IN PARENTHESES REFER TO VARIATIONS FROM TIME SHOWN ON CHART.

TIME VARIATIONS

No.	Station	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910
(1)	11168	10	10	10	10	10	10	10	13	13	13	13	13
(2)	10397	09	09	09	09	09	09	09	11	11	11	11	11
(3)	10396	11	11	11	09	09	09	09	—	—	—	—	—
(4)	10395	08	08	08	10	10	10	10	10	10	10	10	10
(5)	30380	15	15	13	15	15	15	16	16	16	16	16	16
(6)	11385	09	09	09	09	09	09	09	15	15	15	15	15
(7)	10362	09	09	09	07	07	07	07	—	—	—	—	—
(8)	10353	09	09	09	12	12	12	12	—	—	—	—	—
(9)	Roumania	12	12	12	12	06	06	06	06	06	06	06	06
(10)	11762	13	13	13	13	13	13	13	13	13	13	10	10
(11)	13809	11	11	—	—	16	16	—	—	—	—	—	—
(12)	20072	17	17	17	17	17	17	17	17	17	17	09	17
(13)	20775	—	—	—	—	—	—	13	6–9	6–9	6–9	6–9	6–9
(14)	20622	14	12	09	12	09	09	09	09	09	09	09	09
(15)	20595	—	—	—	—	—	—	—	5–8	5–8	15	15	15
(16)	Philippines	—	—	—	—	14	06	06	06	14	14	14	14
(17)	50999	08	08	08	08	08	18	18	18	18	18	18	18
(18)	59969	17	17	01	—	—	—	—	—	—	—	03	03

SYNOPTIC WEATHER MAP

NORTHERN HEMISPHERE

SEA LEVEL 1300 GMT

1899–1910