

August 1933

Daily Synoptic Series

Historical Weather Maps

Northern Hemisphere Sea Level

August 1933

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 usual 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.

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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 errors³, as distinguished from chance errors, and emphasizes stations in areas sparsely covered by reports. In addition, entries are verified which, upon a careful overall 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

¹The 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 University of Chicago, and the University of California at Los Angeles under cooperative agreements with the Weather Bureau.

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

³E. 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.