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Having assumed my new duties as Chief of the Weather Division, Hq. AAF, in Washington, D. C., I wish to take this opportunity of sending my greetings to the personnel of the Weather Service in all parts of the world.

I believe that the officers and men in the Weather Service agree with me that the "Weather Service Bulletin" is proving a most effective media for the dissemination of pertinent information. My tour of duty in the European Theater of Operations convinced me that interest in the "Bulletin" is widespread and I anticipate that it will continue to enjoy its well-deserved favor.

I am happy to have this opportunity of using the pages of the "Bulletin" to extend this greeting and I intend, from time to time, to use its columns to address Weather Service personnel on matters which are of mutal interest.

D. N. YATES,
Colonel, Air Corps,
Chief, Weather Division,
Office, Asst. Chief of Air Staff,
Operations, Commitments &
Requirements

Colonel Yates is receiving the Legion of Merit from Lt. General Carl Spaatz on the front cover of this issue for, the citation says, "his part in deciding the choice of D-day in Europe. Colonel Yates showed good judgment, skill, and sound leadership in the reconciliation of differences among weather forecasts for 6 June 1944...he picked what was probably the only day in June on which the great operation could have been launched." Colonel Yates also holds the Distinguished Service Medal, awarded for his management of meteorological exchanges between the U.S. and the Soviet Union. In 1943 he was Deputy Chief of the Weather Division, and during the past year, USSTAF's Director of Weather Services under the command of General Spaatz.

ANALOGUE FORECASTING

Forecasters from all domestic Regions submitted questions about analogues and their use, in response to a Weather Wing letter. "Analogue Forecasting," which received very careful preparation in Washington and in Asheville, is the answer to these inquiries.

For almost three years the Weather Division of Headquarters AAF has prepared long range weather forecasts for the highest echelons of command: the White House, the Secretary of War, the General Staff, the Air Staff, the XX Air Force, the Troop Carrier Command, the Corps of Engineers, and Regional Weather Centrals. These units have frequently required precise forecasts at long range in time and distance on very short notice. The technique found to be best suited to these needs is the use of "analogues" (past synoptic situations, chosen from the Historical Series for their relationship to the current weather maps and consequent forecasting value).

Close contact has been kept by the Weather Division with all known methods of forecasting, and procedures developed by other agencies have been used when advisable. But temporal emergencies have prevented the construction of many principal and auxiliary charts, and even prohibited the concentration of many minds on the problem---essentials to almost every long range technique. Only analogue forecasts have been achieved with the necessary economy of time and personnel.

Most important of all, analogue forecasts are unsurpassed in accuracy at long range. Statistical verification (page 4) shows that they are quite superior to climatology and at least equal to the best methods of long range forecasting now known. Nonetheless, field forecasters are probably more concerned about the selection and use of analogues which are transmitted daily on the teletype. A pertinent discussion follows.

ANALOGUE SELECTION

In order that similar situations of the past can be obtained quickly from the 40-year file of daily Northern Hemisphere Historical Maps, mechanical procedures and equipment have been set up. Each Historical Map was classified according to the location and intensity of its important low and high pressure centers. This information was then encoded and transferred to punch cards. Each day the current map is similarly classified, and then the punched card files are searched for references to a full set of like characteristics on some Historical Maps. International Business Machines make it possible to run through 3,600 cards every day in about 20 minutes.

Pressure-center positions and season of the year are the selected properties. It is primarily the major systems that are considered in machine searching for similar maps, but if there be fewer major systems than usual, the machine can handle some of the minor ones too. The possible analogues are restricted to the current season by machining only cards for that portion of each year which is within 30 days of the current month and day. Weather changes rapidly in the spring and fall, and then it is frequently necessary to restrict choice of analogues to those which differ from the current month and day by less than two weeks.

After the I.B.M. machines have sorted out several potential analogues, which agree more or less with the current map in season and location of pressure centers, then a Weather Division forecaster undertakes further elimination. He compares the 24, 48, and 72 hour-old synoptic maps with their contemporaries in potential analogue series, discarding those Historical Map sequences which are unlike the current situation in development. He also considers frontal patterns, upper-air influences, and perhaps other resemblances---present and past---in reducing the preliminary field of Historical Maps. Sometimes it is necessary to sacrifice some resemblance on the first day in order to introduce agreement in history. And there is still another consideration in picking analogues for Zones 0, 1, and 6: choice may be made of that analogous sequence which most closely fits the selector's prognosis of the current situation. In summary, the final analogues which are transmitted over the teletype are results of a multi-phased compromise.

Although mechanical aids expedite the selection of analogues, the theory behind their use in forecasting is quite complicated. Analogues are expected to picture the dynamic processes which are taking place, and thus to permit the forecaster to see what happened in the past when similar

Classification	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan
Excellent	3	2	0	0	0	0	0	0	0	0
Very Good	11	15	8	0	0	12	19	7	18	6
Good	56	34	28	13	24	24	19	30	43	31
Fair	30	49	59	61	56	48	57	59	39	60
Poor	0	0	5	26	20	16	5	4	0	3
Total	100	100	100	100	100	100	100	100	100	100

TABLE I: Percentage Distribution of Analogue Classifications by Months

dynamic processes were operating.

Here is how Weather Division forecasters pick the final analogue sequence for their own predictions. They vary the relative importance of current resemblance and history as against future development. The criterion is the extent of their confidence about being able to anticipate the development. If they find that the situation under study is within their prognostic ability, they choose the analogue that follows their expectation. On the other hand, if the situation is a particularly strange one and they do not have confidence in their expectation of its development, they then pick that analogue which has the best current resemblance and history (measured by the transmitted classification). There is an added point in favor of the latter course: it has been found that there is a positive correlation between the current resemblance of the analogue and its length of forecastability. The higher the classification on the analogue, the longer it will hold up.

Each analogue date teletyped to the field is accompanied by one of five possible classifications: Excellent, Very Good, Good, Fair, or Poor. The two main criteria for determining the classification of the analogue are resemblance to the present map and a daily agreement in the near past. Every effort is made to pick analogues which will have the highest possible classification. It must be understood that the classification scale is completely arbitrary, and the classifications based upon it are likewise so. Weather Division could, by revising its requirements downward, raise the level of the classifications. Therefore, it is not correct to say that analogues in the lower brackets are of negative value, for the practice is not to transmit any analogue without some forecasting value. The indications provided by an analogue should be kept in mind, but in proportion to the classification.

When several analogues are transmitted for a single zone with the same classification, it is expected that the field forecaster will select the one which agrees best with his prognostic maps. However, the analogues are placed on the teletype in order of recommended value for each zone, even when the classifications are alike.

The analogue sequences are changed each day so that the most accurate analogue will be available. Even for the longer range forecasts, the accuracy of the newest analogue will probably be greater than that of an older one. It has been noticed that differences in forecast accuracy which are introduced by changing the analogues daily decrease with increased forecasting period. Thus, the sixth map in yesterday's analogue sequence will usually differ less in accuracy from the fifth map of today's analogue sequence than the second map in yesterday's sequence differs from the first map in today's sequence.

ACTUAL FORECASTING

No attempt is made to prescribe a forecasting technique in this article, but the practice of Weather Division meteorologists is presented. Conventional methods have proven to be more accurate than straight analogue forecasts for periods under three days. At about three days, however, the analogue overtakes the short range forecaster in precision and becomes demonstrably better. Furthermore, analogues are useful *aids* in short range work. Seventy-two hours is the approximate point at which forecasts from prognostic maps are overtaken in precision by forecasts read off the analogue. For shorter periods, the development of the analogue is used only as a guide--- a single consideration in the application of many meteorological principles to the preparation of one, two, and three day prognostic maps. The analogue which is placed on the teletype is selected with this short range use in mind. There is good reason why it is not advisable to read the weather elements off a "straight analogue" as a forecast for the shorter periods: analogues are not usually chosen for their similarity to the specific weather elements, but rather for their depiction of the general situation, expressed by the frontal systems and the positions of highs and lows. As the length of the forecast period is increased beyond 72 hours, however, short range tools are not applicable, and more reliance must be placed on the "straight analogues." Long period forecasts are read from weather reports plotted on the chosen Historical Maps.

UPPER AIR

One of the recent trends in meteorology has been increased emphasis upon study of the upper air as a forecasting tool. Weather Division is using upper air data in the selection of analogues whenever they are available: the upper air situation on the date of the surface analogue should be similar to the current pattern aloft.

A project has just been completed which makes available an historical file of upper air maps for the Northern Hemisphere for the years 1929-1944. Copies of this file are currently being printed for mass distribution to the field as a companion series to the surface Historical Maps. It is possible that upper air analogues eventually will be transmitted to the field along with surface analogues, and research on this idea is now in progress. The file will also be used for intensive study of the value of upper air data to analogue forecasting.

OTHER USES OF ANALOGUES

The existing map analysis can be extended into areas of no synoptic data by the use of analogues. The analogue transmitted for the area in which the field forecaster has absolutely no reports can be used to provide the missing pressure and frontal pattern approximately. For example, U. S. West Coast forecasters can extend their continental analysis into the Pacific Ocean by using the current analogues for Zone 2 or Zone 3. Naturally, the higher the classification of an analogue, the better it is for this purpose. However, even "Excellent" analogues are not copies of the current map, so

Observed Duration (hours)	Forecast Duration (hours)		
	24	48	72
0	18	15	0
24	44	35	36
48	16	35	18
72	16	15	18
96	2	0	10
120 and over	4	0	18
	100%	100%	100%

TABLE II: Percentage Distribution of *Observed* Analogue Duration for Given *Forecast* Duration.

that a solution prepared from meagre synoptic data is usually more precise than an analogous situation.

When the forecaster is provided with a set of analogue dates, he is enabled to see what happened years ago when a similar synoptic pattern existed. His forecasting "experience" is extended to the limit of the Historical Series, and his "memory" does not skip over any of the past maps. He possesses fully, then, the tool of synoptic climatology in terms of probable development of pressure systems.

VERIFICATION

It is essential to analogue forecasting that the meteorologist be able to evaluate the valid period of analogues in advance of their use. This ability to estimate the duration of analogues has been verified for the North Atlantic zone between July and October 1944. An analogue sequence was considered to end when the next map in the sequence fell below an arbitrary grade, "60 percent," based on current resemblance.

The results indicate that forecasters can anticipate the length of time over which the analogues will "hold up." That is, the proportion of analogues that actually hold up as long as they are forecast to do so significantly exceeds the proportion of analogues that normally last that long in any random sample of analogue dates. Thus only 35% of all analogues are normally expected to last 48 hours or longer, while 50% of those *forecast* to hold up for 48 hours last that long at least. Similarly, 15% of all analogues are expected to last 72 hours or longer but 46% of those forecast to hold up did so.

Number of maps on which each was superior				
Zone	Analogue Superior	X Superior	Analogue Superior	Y Superior
Pacific	98	105	96	63
North America	111	92	93	59
Atlantic	110	89	110	49
Total	319	286	299	171

TABLE III: Comparison of Three-Day Prognostic Maps Prepared with the Aid of Analogues against Those Done with Other Methods, "X" and "Y".

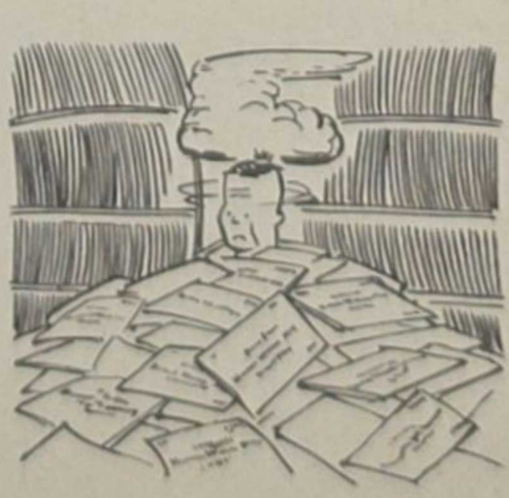
Number of sequences on which each was superior		
Zone	Analogue Superior	Random Climatology Superior
Pacific	13	3
North America	12	4
Atlantic	11	5
Total	36	12

TABLE IV: Comparison of Fourteen-Day Prognostic Maps prepared with the Aid of Analogues against Maps Selected by "Randam Climatology."

In recent impartial comparisons, the analogue forecasts prepared at Weather Division have shown an accuracy at least equal to that of the best of other long range methods. The comparisons with other long range forecasters have been restricted to forecasts prepared up to five days in advance, for the forecasts of the latter extend no further. Beyond five days the comparisons have been with climatology.

The most recent summary covers three-day forecasts between May and February 1945 for three geographical zones: the Pacific Ocean, North America, and the Atlantic Ocean. The analogue forecast compared here consists of prognostic maps prepared with the aid of analogue sequences. The other methods, "X" and "Y", have ranked among the highest in long range forecasting for several years. It is notable that they both represent an approach requiring quite involved and lengthy techniques in the preparation of forecasts.

The method of verification consisted in having a board of six meteorologists judge the maps for accuracy and then assign a grade to each of them. The identification of the maps was completely hidden from the judges. The average of the six grades was then used for deciding which map was superior. Analogues were superior to "X" on 53% of the maps compared, and superior to "Y" on 69%. Considering 50% to be the expected value if there is no significant difference in accuracy between the two forecasters, aside from random factors, it is clear that analogues are at least equal to "X" and definitely superior to "Y".



The latest verification for fourteen day analogue forecasts covered the period of January to May 1944. Comparisons were made with "random climatological maps," chosen from the Historical Series as having the same day and month as the corresponding analogue, but with a year picked at random. This check is believed to determine whether analogue forecasters show an element of skill in their selection of analogue situations at the fourteen day range.

In forecasts of weather elements, similar findings result. A special program of weather element forecasts was held over the period November 1943 - May 1944. Using the Short Range Verification form and scoring, a number of long range forecast units both in and out of the Army participated, and prepared forecasts ranging by twelve hour intervals up to five days in advance. The analogue forecasters of the Forecast Branch took part in the program, and used analogues as their basic forecasting tool.

The results indicate that there are no significant differences between Analogue and "X" on either of the two groups of forecast lengths. Forecaster "Y" shows evidence of being superior to Analogue on the short range lengths, particularly 24 hours, but on the long range forecasts the two are equally accurate, allowing for random differences. Thus, on the basis of weather element (pressure, temperature, ceiling height, visibility, and precipitation) forecasts, the analogue forecasters demonstrate a level of accuracy comparable to that of the others, particularly at the longer forecast lengths.

For forecasts of weather elements beyond five days in advance, it is necessary to compare the forecasts made by the use of analogues with a climatological forecast, because none of the other forecasters prepare regular forecasts beyond that range. The "Ten Day Forecast" booklet, containing forecasts

Forecast Length (Hours)	Analogue	X	Analogue	Y
	Number of forecasts on which each was superior			
12	13	8	7	9
24	10	15	3	13
36	16	8	9	8
48	12	8	9	9
60	10	15	7	10
72	12	15	7	9
84	8	6	7	5
96	8	8	5	6
108	6	8	5	8
120	9	8	5	6
Total for Short Range Fcsts (12-72 Hrs)	73	69	42	58
Total for Long Range Fcsts (84-120 Hrs)	31	30	22	25
Grand Total	104	99	64	83

TABLE V: *Weather Element* Forecasts of Various Lengths Prepared with the Aid of Analogues Are Compared with the Forecasts of Other Methods.

of precipitation and general weather (A, B, C, D and E weather classes) for stations in the Northern Hemisphere, provides the data used in this analysis. At one time, experimental forecasts for extreme temperatures and winds were tried, but the accuracy achieved was not sufficient to warrant their continuance. The climatological forecast is made by distributing the climatological frequency of occurrence throughout the forecast period at random by the use of random numbers. The days of rain are randomly distributed, except that overcast skies are arbitrarily assigned to those days for which rain is forecast in order that the two forecasts be consistent.

Analogue forecasts of general weather were superior to climatology on 90% of the North American forecasts and 80% of the North Atlantic forecasts.

The utility of the "Ten Day Forecasts" was tested by questionnaire to all recipients of that booklet. Responses indicated that 86% make use of the general weather forecasts, half of them finding this particular section most useful of all; 75% use the kinematic charts (principally weather personnel); 43% use the sunlight, twilight, and darkness charts; and 18% use the chemical warfare charts.

The ease with which analogue dates are selected, the comparable accuracy of analogues to more involved and lengthy methods, and the greater range of analogue forecasts definitely justify the use of this technique.

ANALOGUE TRANSMISSION

Analogues are transmitted to domestic regions and to combat theaters. Those overseas are transmitted by cable. Those transmitted within North America are sent daily, in cipher, as a scheduled transmission over Schedule C from 1529-1530 Greenwich Mean Time. The originating point of the message is Washington, which transmits it to the two relay stations of Denver and Louisville. Washington transmits the message over circuits 30 and 31 of schedule C, Denver over circuits 32 and 33, and Louisville over circuits 34 and 35. It is permissible, if the message is not received or garbled for the weather station concerned to call the proper relay point for the information, using the approved CAA procedure.

ANALOGUE ZONES

The analogue zones were originally chosen to conform essentially to climatological divisions, such as the North Pacific Ocean Zone, the North Atlantic Ocean Zone, and the North American Continent Zone. With increased use of analogues and accumulation of experience, revisions in the old zone boundaries have been introduced and new zones have been added. At the present time, analogues are being chosen for seven zones covering virtually the entire Northern Hemisphere.

In general, the analogues chosen for continental areas are better than those selected for ocean areas because more data are available for analysis in continental areas, both on the current and historical

Zone	Analogue	Climatology	Tied
	Number of forecast periods in which each was superior		
Pacific	10	5	0
North America	65	7	3
Atlantic	37	10	2

TABLE VI: Comparison of *General Weather* Forecasts at a Ten-Day Range between Random Climatology and Analogues during Five Months.

Zone	Analogue	Climatology	Tied
	Number of forecast periods in which each was superior		
Pacific	46	24	3
North America	42	25	8
Atlantic	41	32	2

TABLE VII: Comparison of *Precipitation* Forecasts at a Ten-Day Range between Random Climatology and Analogues during Five Months.

maps. An offsetting factor to this, however, is the disturbing effect of terrain features upon the straightforward development of frontal systems. The marginal areas of analogues are usually less reliable than the middle of the map, because the zones are selected so that strategic areas will be centered. The western edges of the continental zones are usually more reliable than the eastern, because systems coming off the ocean are more regular in their behavior than systems which have travelled the full breadth of a continent.

The zones for which analogues are being selected follow:

Zone 0 (0° - 75°W) - The analogue for this zone covers the North Atlantic Ocean, and is of particular interest to those forecasting for the ferry routes and for the United Kingdom.

Zone 1 (60°W - 130°W) - The analogue for this area covers the entire United States and Canada. It is of particular interest to forecasters located in the eastern half of the United States.

Zone 2 (100°W - 170°E) - The analogue for this zone covers the western half of North America and the eastern Pacific Ocean. It is particularly selected to provide an indication of the pressure systems that are moving onto the continent from the Pacific Ocean.

Zone 3 (120°W - 140°E) - The analogue for this area covers the entire Pacific Ocean. It is selected to provide information for forecasters in the eastern Pacific area, such as those on the Hawaiian Islands and on the Aleutian Chain.

Zone 4 (150°E - 85°E) -The analogue for this zone covers eastern Asia and extends into the Pacific Ocean to include Japan. It is chosen to aid in forecasting for eastern China, the Philippines, and Japan.

Zone 5 (100°E - 35°E) - The analogue for this area covers western Asia and the Middle East. It is particularly chosen to provide assistance in forecasting for the Middle East.

Zone 6 (30°E - 45°W) The analogue for this zone includes Western and Central Europe, extending eastward beyond the Azores. It is particularly intended to aid in forecasting for the British Isles and Western Europe.

FANATIC JAP WOUNDS 12 WEATHERMEN IN POA

The end of the battle for the Palau's was in sight, and the Japs were forming for a suicidal, banzai charge. Some had already filtered through the lines; nine were killed in the camp area after nightfall.

In a pre-dawn hour, a phone call warned Captain Charles Griffith that more enemy soldiers were slipping through in the direction of Weather's camp. He ran out to give alarm---only to collide with a six foot Nip, who fired his Luger pointblank. But Griffith was not hit! One of the bullets struck Sgt. Clifford Johnson as he lay sleeping.

Griffith ran back into his tent to get a rifle. The enemy followed close after him, clutching a Teller mine to his chest. As the Nip entered, Lieutenant Robert Shaw jumped from bed and grabbed him. They wrestled for several moments while Griffith stooped to pick up his gun---an action which saved his life. For, while Shaw was attempting to twist the mine out of the Jap's hands, it went off, killing Shaw and the Jap instantly.

Some fragments struck Griffith and Lieutenant Gordon Baker, who also was sleeping in the officers' tent. Other fragments peppered a large tarpaulin nearby, wounding eight enlisted men.

POSTWAR AIR TRANSPORT

Commercial airlines of the United States are flying their own aircraft to remote corners of the world, on regular schedules, at demi-sonic speeds, for low cost, and with B-29 cargo space. This statement is not a "possibility of the postwar Utopia," it is a current fact. The North Atlantic, the Near East, the North and South Americas, the Pacific Ocean Areas, and the Far East are all being spanned by civilian equivalents of the most advanced military air transports, flown by airline pilots. While much of this activity is devoted to government service under contract, its changeover to public use may not even have to wait until six months after the war's duration.

Nations of the world are willing to grant (or unable to deny) the U.S. such a predominant, even unrivalled, position in commercial air transport during wartime, but there is ample evidence that peace will bring a severe competition for lucrative routes, schedules, and cargoes. One must admit that this eventuality portends the same war-breeding rivalries in money making that have torn the world since the Punic Wars.

The International Civil Aviation Conference, held by 52 nations in Chicago recently, was a step toward the elimination of cutthroat competition by super-national regulation: in that sense it was akin to Dumbarton Oaks, Bretton Woods, and White Sulphur Springs in the political, economic, and subsistence fields. Drawing the analogy still farther, the International Civil Aviation Conference was only partly successful. Rates, quotas, and routes were left generally unfixed, but specific operational techniques were drawn up. For example, there was an agreement to establish a global weather network for service to the airlines of every country without discrimination under the jurisdiction of an international organization.

Many of the 52 delegations to the International Civil Aviation Conference in Chicago included meteorologists, who planned for a world-wide weather service after the war. Their proposals were combined and compromised by sub-committee action into an agreement which was submitted to the Conference. The assembled delegations then voted approval of its scope and arrangement. Of course, no scheme of technical operation can be established as final until a permanent civil aviation organization is set up. However, the Chicago agreement reveals the current official thought of the United Nations, an interesting omen.

When (if) the Chicago plan becomes a

binding reality, each contracting state will have committed itself to provide a meteorological establishment within its borders comparable to that now maintained within the United States. Effective interchange of weather data, service for international airlines without discrimination, and delegation of regulating authority to a supernational committee will then become realities as well.

QUOTATIONS FROM THE AGREEMENT:

"The provisions shall be international in application. They shall require the participation of a contracting State even when the air route does not cross the State. They are also applicable to the oceans, the interior seas, and the uninhabited areas of continents.

"The observations shall be taken by meteorological observers with the aid of equipment whose quality and dependability are such that they would be endorsed by the International Meteorological Organization. The observations shall be taken at hours fixed by international agreement, and shall be collected at regional or national centers. The reports shall be drawn up in forms and according to the code tables specified by the International Meteorological Organization.

"Observations shall be provided in the following... frequency: (a) four complete surface synoptic observations per station daily at the internationally agreed synoptic times; this number shall be increased to eight as required...(b) A sufficient number of supplemental surface observations (will be taken) to provide complete and continuous information on the progress and development of meteorological conditions...(c) four upper wind soundings (will be) made at starting times as close as possible to the principal synoptic hours." In addition, Raobs, Apobs, Sferics, and aircraft reconnaissance have been provided for.

Minimum standards for communications facilities were set in detail. The relationship between meteorologist and operations officer at air traffic control centers was fixed. And finally, special procedures for protection from weather in each phase and type of flight were established.

ECONOMICS

One might question that the less affluent United Nations can set up or sustain the sort of weather service outlined in the Chicago agreement, an organization comparable to the network within the United States. But there are three good reasons for expecting that each of the participating nations were realistic in accepting the scope of the proposed weather network.

In the first place, unofficial thinkers maintain that the AAF will find it convenient to offer much of its meteorological equipment overseas to the countries in which it will be operating at the war's close. The current policy toward AAF installations in Canada may be a precedent: that government has made overtures for the postwar purchase of AAF equipment and bases within its boundaries which have been accepted by the United States.

Secondly, the United States is assisting Western Hemisphere nations to train enough of their citizens to staff the postwar aviation organization in those countries. The State Department now holds classes in airway traffic problems for fifty young men from seven Latin American states, and other classes will follow. Meteorology and Communications receive important attention in the curriculum. Furthermore, certain AAF Weather Squadrons are giving in-station training to the civilians within their regions.

In the third place, the Chicago conference specificially agreed that a nation could appoint a private agency to provide its official meteorological service. A state of limited resources might designate the weather unit of a foreign or domestic airline. No discrimination would have to be feared in this case, because the meteorological service rendered anywhere would be subject to regulation of the international meteorological organization.

Every detail of this agreement presupposes that some sort of international body will be set up for its administration and assessment of costs involved. But although the world-wide network is not yet a fact, the support which this concept has received from 52 United Nations warrants its examination and review.

The International Committee on Air Navigation was meeting in Paris, France, as this issue of the Weather Service Bulletin went to press. The meteorological subcommittee of ICAN was scheduled to confer for three days about the meteorological sections of the Chicago agreement. Weather Bureau and AAF Weather Service representatives were to uphold the interest of the United States at this meeting.

SYNOPTIC CLIMATOLOGY

by DR. WOODROW C. JACOBS
Weather Division, Hq., AAF

The strategic weather problem in Very Heavy Bombardment is that of terminal selection in an area where reports are few or nonexistant, the Japanese Empire. The data at hand are historical: individual weather observations from the past, plus climatic averages for the various elements. The latter have little or no tactical significance---means hide the possibilities for particular day, say the day of attack. The amorphous mass of raw data overwhelmed comprehension until mechanical techniques were found to reduce it to useful and simple patterns.

The system of 'synoptic climatology', arrived at by applying International Business Machine sorting methods to climatological data, has proven to be a solution. With mechanical patience, mechanical accuracy, and mechanical speed, weather information of value for any chosen day and hour is sifted from huge files. In short, that weather which has happened most often in the past under conditions similar to the present is discovered, even if the present situation is poorly defined. Both strategical and tactical service is rendered by this approach.

The method of forecasting by synoptic climatology must be carefully distinguished from the method of forecasting by analogues, though the two methods are closely inter-related. Synoptic climatology provides a method of constructing and interpreting the current situation when data is sparse: the emphasis is on weather in the present and immediate future. The selection of an analogue requires reference to the current map, and the emphasis there is on long range forecasting. However, so broad a statement of the distinction is misleading unless the numerous refinements of both methods are taken into account.

Climatic data have little use in strategical planning when they are merely average values or the independent frequencies of various weather elements. A knowledge of weather conditions as they occur simultaneously over large areas is required: not necessarily the answer to "Will Tokyo be shut in on D-day?" but rather to "If Tokyo should be closed, what are the chances that Kobe will be open at that time?"

Early in the war, Weather Division undertook research for the development of a synoptic climatology; that is, to break down the purely fictitious mean climatic picture into the actually-occuring weather patterns of which climate is composed. The procedure which was finally adopted for summarizing climatic data in a synoptic manner is shown by the box diagram of Figure 1. The various steps in the application of this method to a given region are as follows:

1. Divide, if necessary, the large geographic region into smaller sub-areas of such size that each can be described by a single direction of gradient air flow. The maximum possible size for the areas will vary somewhat, depending upon the portion of the globe being considered; ordinarily, it will lie between 100,000 and 200,000 square miles (the area of Oregon is 97,000 square miles).

2. Examine the series of Historical (weather) Maps and classify them for each area according to:

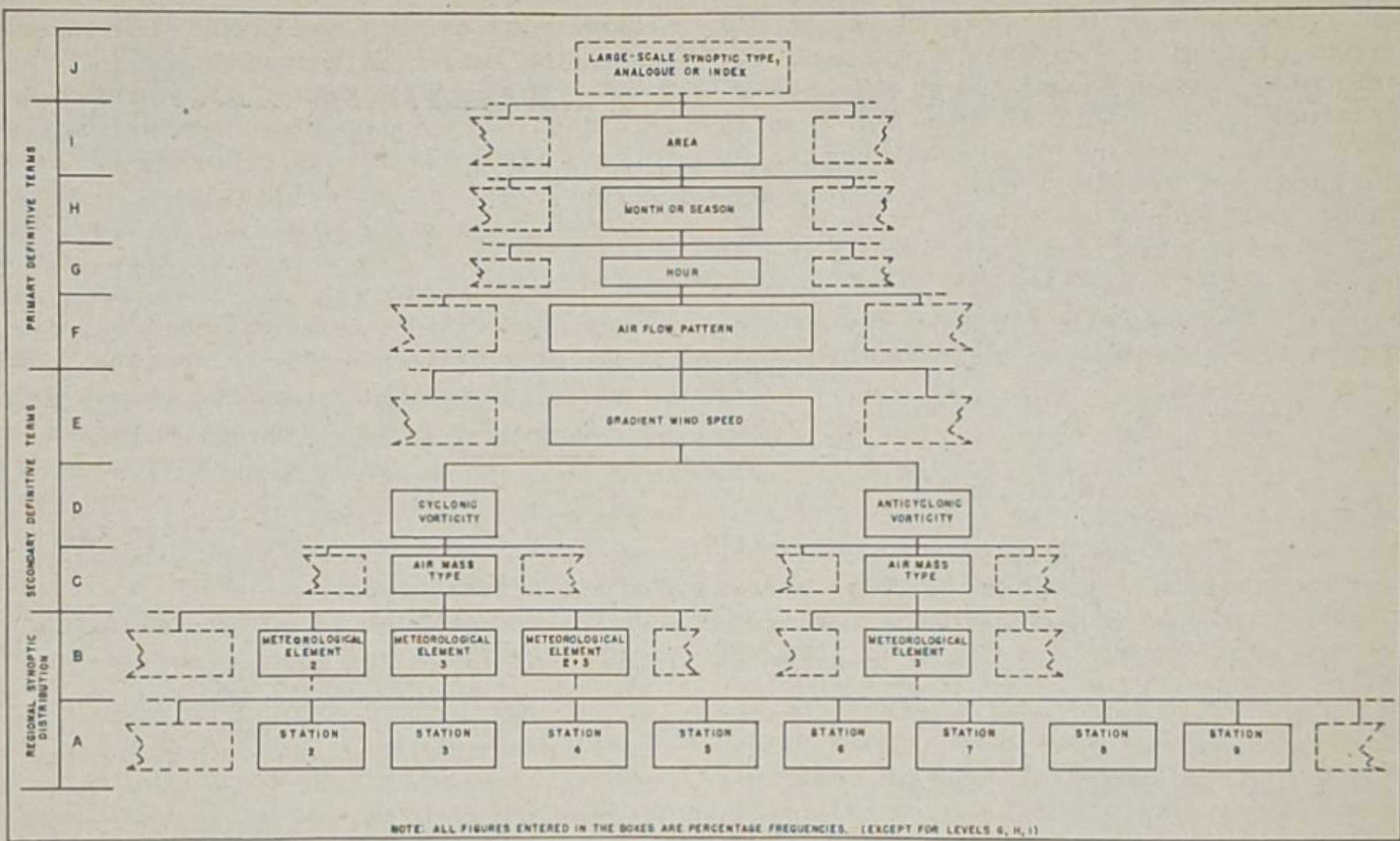
a. Direction of gradient air flow over the area (level F on box diagram),

b. The gradient wind speed by three or more velocity groups (level E on box diagram),

c. The curvature of the isobars over the area, i.e., whether cyclonic or anticyclonic (level D on box diagram),

d. The air mass type prevalent over the area (level C on box diagram).

3. Assemble all available weather obs which were taken at the date and hour of each Historical Map.



PLAN FOR A SYNOPTIC CLIMATOLOGY

4. Code, and then punch these data on International Business Machine cards.

5. Summarize these data (by I.B.M*), both singly and combined, for each station with respect to flow type, velocity of flow, character of flow, and air mass type. The results are presented in the form of frequency distributions. Because of the short records for most enemy-held areas and the time element in summarization, it has been customary for the Weather Division to summarize the data with respect to the primary definitive terms only (levels A, B, F, G, H, I).

Let us assume that we are interested in the simultaneous occurrence of certain ceiling and visibility conditions over a rather large area. An example of the results of a summary according to the first five steps might be as follows: The SE flow type occurs on 30 percent of the days at 0600 during January; and on 50 percent of these days, the gradient wind speed is between 10 and 20 m.p.h. In 75 percent of these latter cases, the curvature of the isobars is cyclonic, with a 50-percent frequency of mT/mPw air (maritime polar air with maritime tropical air aloft). Furthermore, when the above conditions hold, at stations 1, 2, and 3 an average of 85 percent of the days show ceilings greater than 600 feet together with visibility greater than one mile. Meanwhile, for stations 4, 5 and 6 the same figure is five percent. If weather conditions between stations are independent, and we have assumed a large unit area, the product of the frequencies of elements at individual stations is used in determining the probability of simultaneous occurrence.

The chances, then, that a situation will occur where stations 1, 2, and 3 will be open while stations 4, 5 and 6 are closed at 0600 during January is:

$.30 \times .50 \times .75 \times .50 \times .85 \times (1 - .05) = 0.045$

or on an average of between one and two days a month. If it is justifiable to assume a large measure of dependence between stations, the individual frequencies can simply be averaged for the purpose of determining the probability of occurence of certain patterns of weather.

A further examination of the data may show that other groups give the same distribution. In that case, the final probability is merely the sum of all probabilities showing the same (or similar) distribution.

It is customary for the Weather Division to summarize the data with respect to eight directions of gradient flow plus three additional flow patterns represent-

*For a brief description of some of the I.B.M. summary techniques, see the article "Weather by the Numbers" in the June 1944 issue of the *Weather Service Bulletin*.

ing: (1) ridge or high over the area; (2) trough or low center over area; and (3) weak col or variable conditions. The illustrations on pages 12, 13 show the results of an actual summary for Hokkaido made on the basis of gradient airflow breakdown alone. Only four flow types are shown, but in this particular case they account for 75 percent of all cases during the winter season; the remaining 25 percent are distributed among the other seven flow classifications.

It may be noted that the mean chart (which is the "classical" presentation) shows a distribution of weather elements roughly similar to that for the NW flow. This resemblance is to be expected, because NW flow prevails during 41 percent of the season. However, since the mean chart represents the average of conditions with all flows, much of the detail has been smoothed out. In regions where the various air flows occur with more nearly equal frequency, the mean chart may illustrate no features whatever of the real distribution.

The completeness of the classification scheme in any area is of course determined by the degree to which the frequencies of elements approach either 0 percent or 100 percent when added together. Total frequencies between these limits are indicative of the fact that additional definitive parameters are needed. The inclusion of levels E, D and C in the summaries (the latter of which can be broadened to include frontal features) may be expected to accomplish this in part, if not completely.

A sixth step in the analysis may be taken, intercorrelation of areas and flow types. In order to accomplish this, the following additional summaries are made:

1. *The frequency with which various air flows occur simultaneously in two or more areas* (a coupling of areas);

2. *The order of resolution of flows in each area* (a coupling of flow patterns);

3. *The persistency of flow patterns.*

These three summaries furnish information concerning:

1. *The length of period during which a given weather pattern may persist;*

2. *The type of weather pattern likely to follow the first;*

3. *The weather pattern likely to occur over a region larger than any one of the gradient flows.*

In the Japanese area, for example, it has been necessary to divide the island group (including Formosa) and Korea into nine sub-areas; but, by relating the flows in these areas, it is possible to reconstruct in some degree a picture of weather conditions as they may occur simultaneously over the entire island group.

The application of the synoptic climatology to date has been primarily in strategic planning. However, it has equally valuable applications in weather forecasting, among which may be mentioned:

(1) The interpretation of local and small-scale weather features. In a region where the current weather information in a large area is limited to one or two stations on the synoptic chart, interpretive data may be available for as many as 50 or 100 additional stations. For example, on Saipan, an island less than 15 miles in length, data of certain types are available for about 25 stations (nearly one station per square mile);

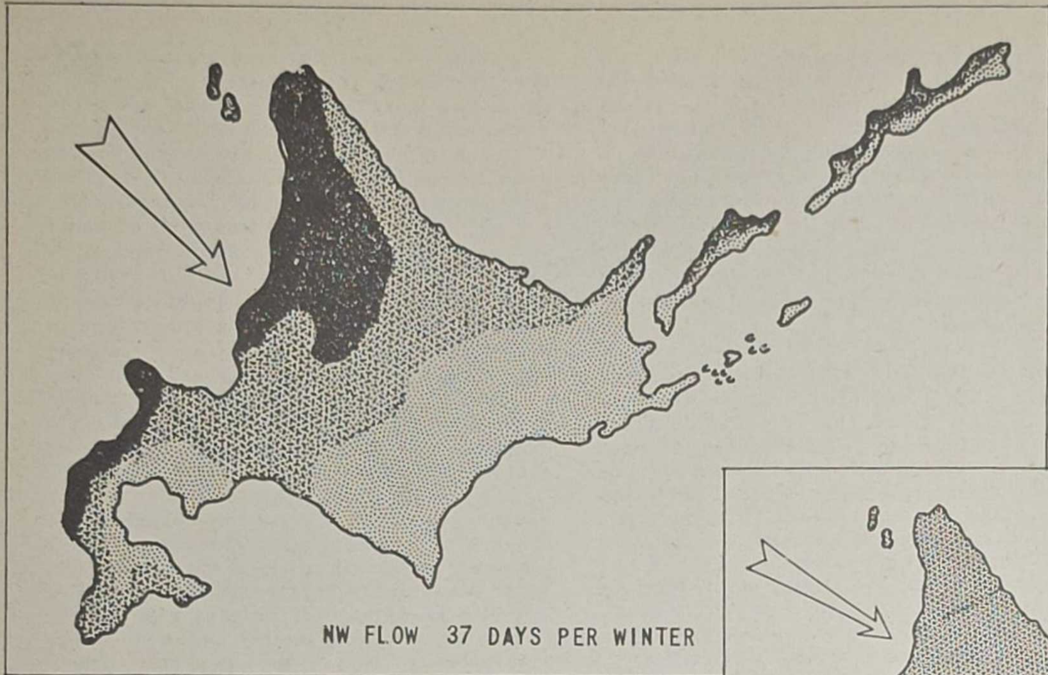
(2) As an aid in interpreting weather conditions over remote areas for which specific weather information is not available. This is true to the extent that it is possible to define (or forecast) the pressure gradient over an area with a fair degree of accuracy on the basis of a few widely-separated pressure reports. Forecast analysis has shown that field forecasters are more adept in forecasting the pressure field than they are in interpreting the pressure field in terms of actual weather.

Much of the recent work of the Weather Division along this line has applied to the Asia theater. Today it is quite possible that we have a better knowledge of weather processes over the Japanese Islands than do the Japanese themselves. It is probably also true that our knowledge of the climate of Japan is, in many respects, more complete than our knowledge of the climate of North America.

At present, our knowledge of the physical processes in the atmosphere and the effects of surface features upon them is far too incomplete to enable us to interpret and evaluate local and small scale weather features on the basis of theoretical considerations alone. Empirical methods must be a major part of the solution for some time to come. It is to be hoped that the technique presented here will serve as a valuable tool in the fields of both applied and theoretical meteorology, and that its development and use may lead to a greater coordination of activities between the theoretical meteorologist, the forecaster, the statistician, and the geographer-climatologist. Certainly it has already allowed the meteorologist to serve the military in a way and to a degree that would have been thought impossible several years ago.

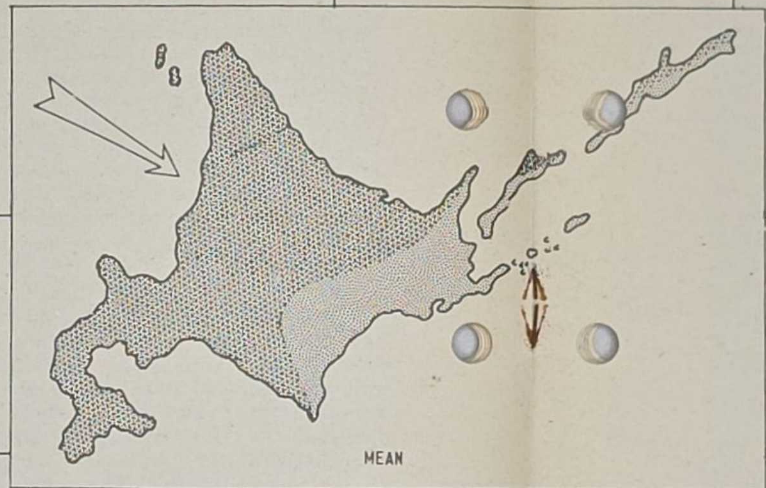
HOKKAIDO, JAPAN

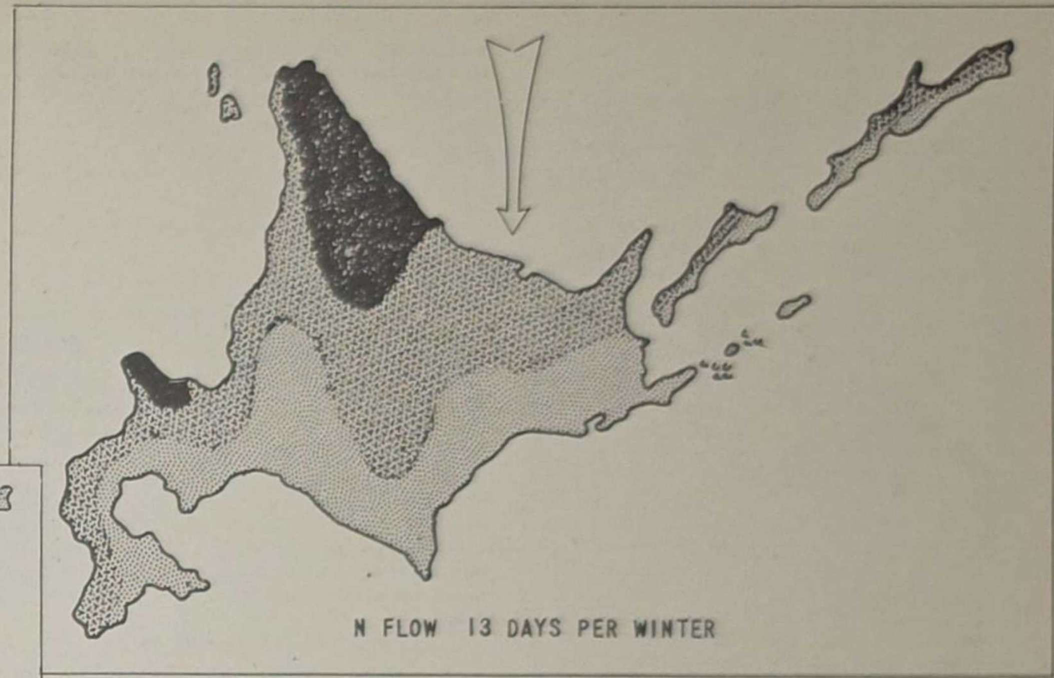
SYNOPTIC CLIMATOLOGY consists of analyzing the mean climatic picture (a fictitious average) into its components of actual weather patterns.



The map above contributes 40% to the mean chart

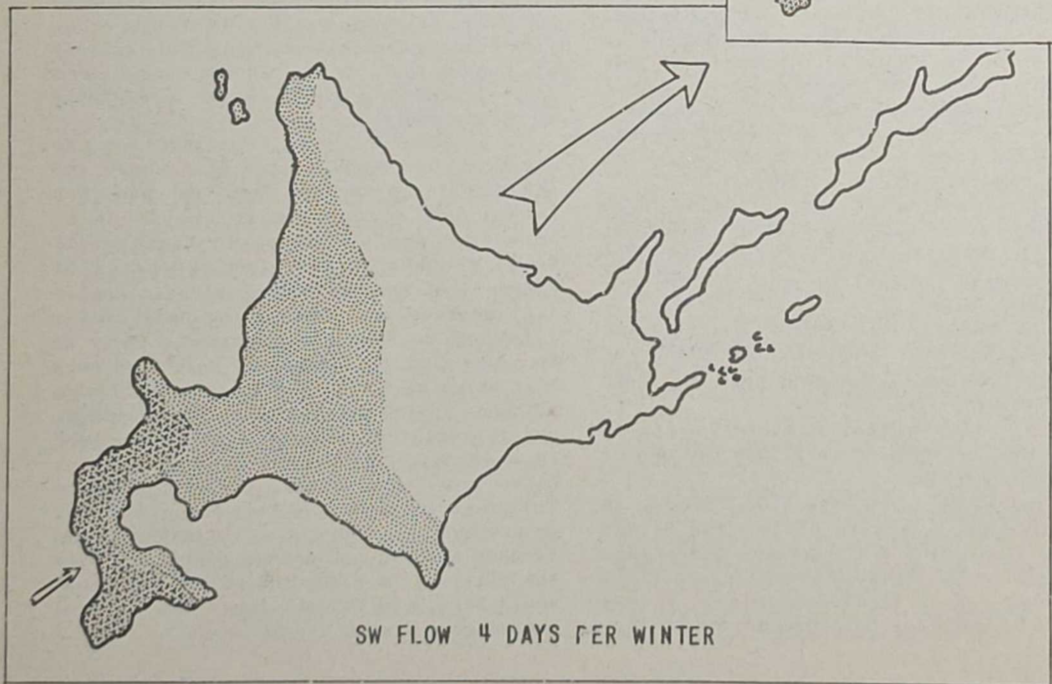
The map below contributes 5% to the mean chart





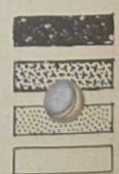
The map above contributes 16% to the mean chart

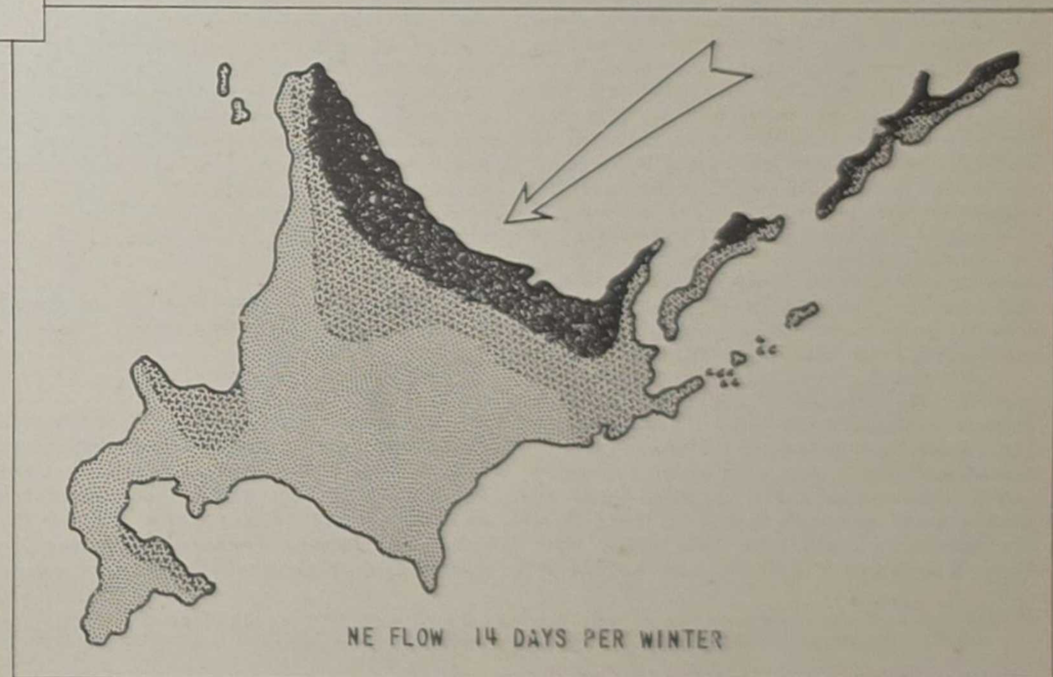
The map below contributes 14% to the mean chart



LEGEND

Percentage frequency of Days having Overcast Skies and Precipitation at 0600 during Winter.





This article is a sequel to "Daytime Visibility" by Major Wallace Howell in the *Weather Service Bulletin* for November 1944, Vol. 2, No. 5.

VISIBILITY: Air to Ground

by CAPT. LAWRENCE BARKER
SWO., 379th Bombardment Group, Heavy

It is well-known to weather forecasters that the air-to-ground visibility from low altitudes is considerably lower than the visibility observed along the earth's surface.* Yet flying personnel seem unaware of this fact. Flying Control Officers expect the weather station to lower a 500 yard visibility report when they hear from an aircraft flying at 300 feet that the pilot can see no more than 200 yards. Pilots who are diverted to a field with a visibility reported at 1,000 yards complain because they cannot see the field at a slant range of 500 yards. Similar experiences are common, especially to weather personnel in England where fog and industrial haze are the most frequent restrictions to flying. Such misunderstandings are likely to bring discredit to the weather station involved: while an unsuccessful forecast might have been inevitable, a "mistaken observation" always seems to be a careless and dangerous fumble.

In the argument which generally follows such an experience, the forecaster is careful to explain the difference between visibility measured at the ground and that measured from an aircraft in flight. According to Circular "N", the visibility to be recorded in Weather Service obs is the maximum distance to which prominent suitable objects like trees and houses are visible when viewed *against the horizon sky.* The pilot, in attempting to land his plane, looks at landmarks of indeterminate prominence---the runway in particular---as viewed *against the ground.* The weather observer will naturally be able to discern reference points at a much greater distance than the pilot can do so.

If the forecaster gets this point across, his client will generally counter with an argument like this: "Why doesn't the Weather Service provide a visibility measurement which will tell how far a pilot can see from the air, rather than an academic and unusable report?" This is a good question and a just criticism. The rest of this paper will attempt to answer the question, and to provide an approximate solution for the problem of air-to-ground visibility in day time.

The visibility from aloft depends on the direction of the sun, the cloud cover, the variation of atmospheric pollution with altitude, and many other factors which cannot be easily evaluated. This discussion will be restricted to a consideration of the visibility from aircraft which are attempting to land; limited though this may seem, it is after all the most important consideration when the visibility is low.

According to Circular "N", and as Major Howell emphasizes, the visibility to be recorded by weathermen is "the greatest distance at which an object can be discerned at all." Such a definition is necessary for accuracy and for standard use. And full account of this has been taken in setting the visibility minimums for instrument and contact flight.

The taking and reporting of regular air-to-ground observations by flyers from landing aircraft would be a solution, but certainly an impractical one. Or, an empirical relation between the air-to-ground and the ground visibility could be found for each runway at each airport---but determination of this relationship would take too much time and effort. There is available, however, a simple association between the two definitions of visibility which can be derived theoretically, and which gives generally good practical results.

According to Major Howell, the formula for ground visibility may be written as:

$$(1) \quad d_1 = \frac{1}{a} \ln \frac{1}{c}.$$

if "d_1" is the visibility, "a" the coefficient of extinction (scattering coefficient), and "c" the contrast threshold. This formula is correct for a black visibility marker viewed in daylight against the horizon. There are other assumptions underlying this equation, but they are

*In cases of shallow ground fog or haze which does not reach to the flight altitude of aircraft, it has been found that the air-to-ground visibility exceeds the ground visibility.

either fulfilled or at least their non-fulfillment does not generally involve a large error.

For a "gray" visibility marker of albedo "R" (when the sky is clouded), the formula becomes:

$$(2)\quad d_2 = \frac{1}{a}\ \ln \frac{1}{c}\left[1 - \frac{R}{2}\right]$$

On the other hand, consider an expression which may be used for air-to-ground visibility. Middleton** derives it as a formula for the visibility of objects with albedo "R" viewed against a background of albedo "R' ", not against the horizon:

$$(3)\quad d_3 = \frac{1}{a}\ \ln \frac{1}{c}\left[\frac{(R' - R)}{2} + c - \frac{cR'}{2}\right]$$

If the difference in albedo between the object and its background is 0.1 or greater, then the last two terms within the parenthesis can be omitted. The formula to be used in that case is:

$$(4)\quad d_3 = \frac{1}{a}\ \ln \frac{1}{c}\left[\frac{(R' - R)}{2}\right]$$

These expressions are applicable when four familiar conditions exist concurrently. That is to say, "d_3" is not the air-to-ground visibility under all circumstances, but only when it is *daytime*, when there is a *haze or light fog*, when the *sun is shaded* (or in such a position as not to cause a glare near the line of sight), and when "a" (the extinction coefficient) *varies but slightly* up to the altitude of the aircraft. The latter condition is satisfied if the ground fog or haze does reach up to the altitude of the aircraft. Though the number of these assumptions may seem imposing, all of them are frequently justified.

(R' - R)	d_3/d_1	d_3/d_2
0.1	0.23	0.26
0.2	0.41	0.46
0.3	0.52	0.57
0.4	0.54	0.66
0.5	0.65	0.73
0.6	0.69	0.78
0.7	0.73	0.82
0.8	0.76	0.86
0.9	0.79	0.89
1.0	0.82	0.92

TABLE 1

Table 1 is computed by the use of formulas 1, 2, and 4; using "R" = 0.7 and "c" = 0.02. It gives the air-to-ground visibility "d_3" as a fraction of the standard ground visibility, "d_1" or "d_2", for various values of the albedo difference, (R' - R).

From this table it is a simple matter to find the air-to-ground visibility from the observed ground visibility, if you know the albedo difference between the objects and their backgrounds which the pilot looks at while landing. This difference (for the runways and the surrounding terrain) is usually between 0.2 and 0.3, but may be as high as 0.5 or 0.6 if there is snow on the ground and the dark runway is swept clean. When the ground is muddy, with mud on the runways as well, this albedo difference may fall to 0.1 or below. It has been observed that rain will wash the runways clear of mud, but persistent damp and foggy conditions usually bring a thin film of mud to all roads and runways in spite of careful "mud discipline."

One can see from column 2 of the table that the air-to-ground visibility is theoretically about 40-50% of the measured ground visibility on the average; sometimes it may be as low as 20%, especially when the weather has been damp and foggy; and it may be as high as 70%. Most visibility markers are not black, but gray. Column 3 relates the air-to-ground visibility given by the observation of a gray visibility marker of albedo 0.7. The result shows about the same relationship as in column 2, but because "d_2" is slightly less than "d_1", the air-to-ground visibility will be a slightly larger percentage of the ground visibility than before.

Knowing the ground visibility and the albedo difference (estimated), it is possible to use column 3 and give a pilot useful information as to how far he can see the runway on his landing approach. Operational flying is often carried on in below-instrument weather; and such knowledge in the hands of the pilot or control officer will help determine whether an aircraft can land safely, or whether it should be diverted.

Most important, this solution gives weather and flying personnel a common understanding in the matter of visibility; it emphasizes the difference between ground and air-to-ground visibility in daylight, and gives for most occasions of haze and fog an approximate relationship which is of aid to landing aircraft.

**Middleton, W.E.K., "Visibility in Meteorology", Second Edition, Univ. of Toronto Press, 1941.

One Year of SRV

Short Range Verification has completed its first year of forecasting analysis. A million and a half terminal forecasts have been received and graded, establishing the first objective and quantitative evaluation of terminal forecasting accuracy in domestic Weather Service operations. Four thousand AAF meteorologists have been ranked according to SRV scores that are strictly comparable in regard to stations, elements, times, and range. The SRV program has also assisted research on forecast methods and verification techniques.

No reliable information existed before 1943 about the accuracy of spot forecasting on a broad basis. Rumors and tales passed from person to person, stimulating the growth of "fish stories" until there were some real "whoppers," both complimentary and derogatory of the Weather Service. But forecast verifications throughout the domestic Regions by SRV have at last provided an objective yard stick.

Every field forecaster was superior to climatology in his 12-hour predictions, and 92% proved to be better than historical means in the 48-hour period. The average weatherman surpassed climatology in the shortest period by 50%, and those in SRV's top tenth showed 70% greater skill.(Fig. 1)

Forecasts of ceiling height, precipitation, and visibility---critical flying weather factors---were made by the 4,000 participating meteorologists with differences in accuracy that were very small. Pressure and temperature predictions proved to be the criteria on which forecasters were given relative rankings, because only these forecasts varied significantly. The difference between the best and worst forecasters of pressure and temperature was as great as the discrepancy between a perfect spot forecast and the average climatological value.

Seasons	Trentile	"Practical Unit"
	Expressed as Percentage of Winter's Score	
Fall	107.6	85.1
Winter	100.0	100.0
Spring	109.3	86.4
Summer	109.8	64.0

TABLE I: Seasonal Variation in SRV Scores is Shown by Comparison of "Trentile" and "Practical Unit" Scores (Low Total Is Best).

SRV (trentile) scores, the lower the better, vary with the change of seasons, hitting their lowest average in winter and their highest in summer. Pressure and frontal patterns are more sharply defined in the coldest season, and most forecasting techniques then take on a more reliable nature. On the other hand, weather is more variable in winter than in summer, and the absolute accuracy of forecasts in practical units (millibars, feet, and degrees) is 30% greater in summer. This paradox is explained by the fact that value of the SRV scoring unit (trentile) is much greater in winter than in summer: in terms of probability, such variability is necessary so that forecasting in one season be comparable to that in another.

An interesting study has been made of difference between the best and worst spot forecasters in each range. Data aren't available to compare ceiling height, visibility, and precipitation forecasts, but analyses of samples show that differences among predictions of these elements are very small. Accordingly, the total score for the three elements has been divided among them.

Table III indicates that on any given 24-hour spot forecast, one out of two field forecasters will be within 4.6 mb. of the observed pressure value at a given station and within 4.6°F of the observed temperature. In-station verification of prognostic maps can well be based on this information. The difference in pressure between observed and forecast values at a pattern of check points on the prognostic map would be determined, to discover if any area of

	Period in hours			
	12	24	36	48
	(Difference in Trentiles)			
Pressure	5.6	7.5	7.3	4.8
Temperature	4.0	7.5	7.0	3.6
Ceiling Height	1.1	1.9	1.5	0.7
Visibility	1.1	1.9	1.5	0.7
Precipitation	1.1	1.9	1.5	0.7
Total	12.9	20.7	18.8	10.5
Average Trentile Score	33.2	36.7	42.1	42.9

TABLE II: Differences in Accuracy Shown by Best and Worst Forecasters, on the Average, for Each Spot Forecast Length on SRV Forms.

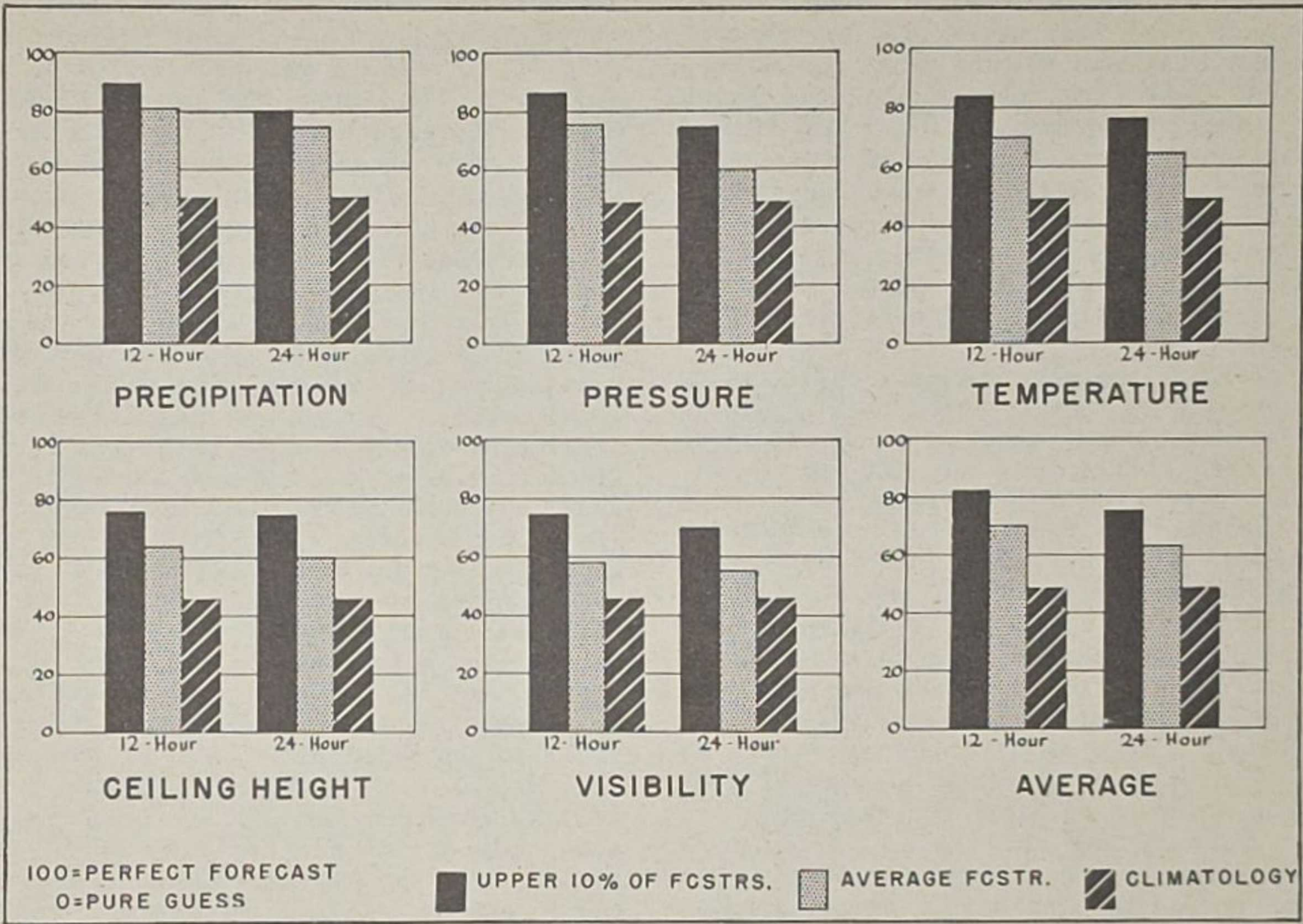


Figure 1

SPOT FORECAST ACCURACY BY WEATHER ELEMENT

the pressure field falls outside the limits listed in Table III. The Verification Section, Weather Division, Headquarters AAF, is prepared to offer suggestions on maintaining field verifications. Forecasters who are interested may write to it through channels for information, giving full particulars of their problem and purpose.

Reliability of SRV

The SRV grade assigned to a participating forecaster represents his ability to make spot forecasts. This is true to a degree equal to that of the most advanced testing procedures used in educational aptitude examinations. The procedure of scoring and grading has been developed from specially-devised statistical methods, and it is accomplished expeditiously and accurately by means of punch-card computing machines.

SRV forecasts are not scored on a "right or wrong" basis, but on the distance in probability units (trentiles) between the forecast and observed values. The interpretation to be placed on the highest ranking forecaster's achievement is not that his forecasts were perfect, but that his predictions have been closer to the observed values, on the average, than those of any other forecaster. SRV scores are generalized evaluations of a forecaster's relative accuracy on comparable forecast problems. On the other hand, his "reputation" for field forecasts is affected by a miscellany of factors, all tending to destroy comparability: for example, it is harder to forecast in some localities than in others, and the pilots at one field may be more able or experienced than at others.

SRV ensures, insofar as possible, that competition is held under equal conditions for all. It avoids favoring any Region by establishing standard stations for which

Forecast Length	Pressure (mbs)	Temperature (°F)
12-Hours	2.2	4.0
24-Hours	4.6	4.6
36-Hours	5.6	5.4
48-Hours	7.0	7.0

TABLE III: Interval About the Observed Value Which Contains 50 Per Cent of the Forecasters.

the forecasting is done, by changing the stations every four weeks, and by scattering the stations widely over the United States. SRV gives no advantage to those who choose to forecast only in "easy" situations. It is true that the forecasts are for "spots" at fixed times, and are not route or airway operational forecasts. But "spot" forecasts are probably more difficult than any other type to produce, and they are more adaptable to accurate verification.

Perhaps the most frequent objection to SRV results in the statement that forecasters at the busier stations are handicapped by having little time for SRV participation. A pertinent questionnaire was sent to the station weather officers of all domestic stations participating in the program. More than 90% of the 310 responses stated that no difficulty is encountered in finding enough time to prepare the three forecasts per week per man which are required. In addition, two thirds of SWO's reported that each of the forecasters at their respective stations have equal time within which to complete the forecasts.

Forecasting ability is certainly a slowly-changing trait, and for that reason there should be a stability to SRV grades. In other words, the changes in relative position of forecasters should be slight between successive grading periods if SRV is reliable. Table IV shows that SRV grades do possess the essential quality of stability.

Thus, it appears that 83% of the forecasters who had been graded A in weeks 1-42 received either an A or B in weeks 43-52, which is a very significant proportion. Only 3% of these A men received a D, and none an X. Similarly, 89% of the X men in weeks 1-42 received a C, D, or X in weeks 43-52. 95% of the men graded X in the 43-52 week grading period were C, D, or X in weeks 1-42. The overall impression given is that there is a definite inclination of the grades toward stability.

A study has been made relating the SRV standing of forecasters to their experience, background, knowledge, and interest in meteorology. The A men hold a greater proportion of the ranking positions in the field (Sta WO's, ass't Sta WO's or NCOIC's), the X men hold proportionately fewest of these positions. Men in such offices generally possess high ability and/or great experience, so the relationship is an affirmation of the grades assigned them. More of the A forecasters and fewer of the X forecasters are assigned to stations which require forecasts for long flights. Their duties require the kind of forecasts that are most representative of the forecasting required for SRV, a visualization and study of the weather over broad sections of the United States rather than for local areas. More A men have detailed knowledge of the basic forecasting techniques, and proportionately more A men are acquainted with the recent long range techniques than are the C men, who in turn demonstrate a similar superiority over the X men. These statements are based upon a questionnaire survey made of A, C, and X forecasters, and strongly support the reliable nature of SRV grading.

Analysis of the year's scores shows that there is no "trick system" known which can beat the SRV scoring procedure. If the best "system" known to the Weather Division had been used to forecast throughout the year, the standing achieved would have been 3,176th among 3,180 participants. The potential use of such devices is one reason why the 12-and 24-hour forecasts are weighted more than the 36-and 48-hour predictions, because the superiority of valid forecasting methods over "systems" is most pronounced at the shorter ranges.

		Grade Received on Weeks 1-42				
		A	B	C	D	X
Proportion Received the Following Grades on Weeks 43-52	A	41	14	6	2	1
	B	42	43	26	17	10
	C	14	36	47	44	26
	D	3	6	18	28	31
	X	0	1	3	9	32
Total Percent		100	100	100	100	100

TABLE IV: Relation Between Grades Received by Forecasters on Weeks 1-42 and Weeks 43-52

The Weather Division is maintaining research which seeks to determine the validity and usefulness of the several techniques which form a basic part of current forecasting equipment. Organized testing, the essence of verification, is the most efficient procedure for achieving this goal.

STANDING OF FORECASTERS

NATIONAL RANKING	NAME	RANK	REGION	STATION	"R" VALUE	"S" SCORE	REGIONAL RANKING
1	Jordan, H. J.	MSg	4	Smyrna AF	94	405	1
2	Melhorn, W. N.	2Lt	4	Bluethenthal	94	447	2
3	Auslander, H.	SSg	23	Sedalia AF	91	554	1
4	Whiteley Jr., G.	Cpt	2	Rochester	67	624	1
5	Clarke, R. F.	TSg	23	Kansas City	93	632	2
6	Hoffman, R. E.	1Lt	4	Jacksonvl AF	91	637	3
7	Katz, Y.H.	MSg	1	Stockton FD	92	644	1
8	Hirschfeld, W. P.	TSg	25	Ft. Dix AB	93	649	1
9	Harris, E. W.	SGt	4	Florence AF	86	681	4
10	Law, Jr., E. A.	2Lt	2	Patterson FD	83	694	2
11	Kautz, E. D.	MSg	1	Salinas AB	92	701	2
12	Brumbach, J. J.	2Lt	25	Phillips FD	82	715	2
13	Brouns, R. C.	2Lt	2	Fargo AP	78	718	3
14	Lutz, G. H.	2Lt	4	Brookley FD	85	723	5
15	Taft, H. E.	2Lt	3	Tulsa	90	725	1
16	Koss, H. D.	TSg	2	George FD	90	732	4
17	Peterson, B. J.	TSg	24	Ellensburg AF	91	734	1
18	Goldman, J. G.	TSg	4	Birmingham AF	94	747	6
19	Moir, J. F.	2Lt	4	Avon Park AF	81	749	7
20	Gans, W. L.	SSg	25	Olmsted FD	90	752	3
21	Lenon, D. R.	2Lt	23	Lincoln	85	755	3
22	Ace, E. R.	2Lt	1	Coolidge AF	89	760	3
23	Criscillis, P. A.	2Lt	4	Asheville WXWG	93	761	8
23	Musa, R. C.	2Lt	4	Brookley FD	86	761	9
25	Johnson, P. A.	1Lt	1	Mines FD	92	767	4
26	Pipp, W. B.	2Lt	23	Peterson FD	79	771	4
27	Tomchek, E. J.	MSg	4	Maxwell FD	95	774	10
28	Hoffman, C. E.	1Lt	2	Chanute FD	93	775	5
29	Coleman, R. H.	2Lt	25	Ft Dix AB	87	778	4
29	Wetzel, W. E.	2Lt	25	Bolling FD	91	778	5
31	Holladay, C. E.	2Lt	3	De Ridder AB	89	780	2
32	Kleyensteuber, C. J.	TSg	1	Glendale	93	781	5
33	Reed, C. K.	1Lt	23	Rosecrans FD	93	782	5
34	Worthman, P. E.	Cpt	4	Asheville	93	783	11
35	Heggie, G. D.	1Lt	23	Peterson FD	93	784	6
35	Lee, G. M.	MSg	24	McChord FD	92	784	3
35	Onsager, G. F.	TSg	24	Redmond AF	92	784	2
38	Gaugh, F. G.	SGt	4	Boca Raton AF	75	788	12
39	Jones, M. V.	MSg	4	Maxwell FD	92	790	13
39	Koller, C. R.	2Lt	4	Sarasota AF	89	790	14
41	Olsen, J. W.	1Lt	4	MacDill FD	74	791	15
42	Bluhm, W. C.	SSg	25	Pittsburgh AP	90	792	6
43	Anderson, E. E.	2Lt	4	Asheville WXWG	88	795	16
43	Davison, W. R.	SSg	23	Malden AF	93	795	7
45	Gleason, J. M.	2Lt	4	Chatham AF	84	797	17
46	Moraski, J. J.	MSg	25	Pittsburgh AP	90	799	7
47	Heinrichs, G. A.	TSg	2	Rochester	77	800	6
47	Grasso, C. H.	2Lt	4	Asheville	89	800	18
49	Jess, E. O.	Cpt	4	Seymr Johnson	94	802	19
49	Lawless, K. R.	2Lt	4	Morris FD	93	802	19
49	Welch Jr., A. E.	MSg	4	Memphis AP	95	802	19
49	Berger, R.	SSg	23	Buckley FD	90	802	8
53	Strum, A.	TSg	1	Mather FD	88	805	6
53	Dorsch, R. G.	2Lt	2	Patterson FD	74	805	7
53	Webb, F. E.	1Lt	4	Chatham AF	93	805	22
56	Parker, R. L.	CWO	4	Maxwell FD	93	806	23
57	Henry, A. J.	TSg	25	Pittsburgh AP	89	808	8
58	Morris, J. C.	2Lt	4	Asheville WXWG	87	809	24
58	Sheperd, K. R.	2Lt	4	Venice AF	87	809	24
60	Williamson, G. A.	1Lt	4	Maxwell FD	94	810	26

NATIONAL RANKING	NAME	RANK	REGION	STATION	"R" VALUE	"S" SCORE	REGIONAL RANKING
61	Cable, D. A.	TSg	4	Sarasota AF	91	811	27
62	Smith, H. F.	2Lt	4	Venice AF	84	813	28
62	Wagner, I.	TSg	4	W M Northern FD	90	813	29
64	Jackson, J. E.	2Lt	4	Winston Salem	88	814	30
64	Simpson, D. L.	2Lt	4	Asheville	91	814	31
66	Begg, E. L.	SSg	23	Lowry FD	89	815	9
67	Josephson, E.	SSg	23	Peterson FD	88	818	10
68	Harms, R. W.	1Lt	4	Courtland AF	93	820	32
68	Herman, P. B.	2Lt	4	Buckingham AF	83	820	33
68	Trainer, J. R.	2Lt	4	Sarasota AF	73	820	34
71	Garrison Jr., J. B.	2Lt	4	Memphis AP	86	821	36
71	Luck, E. C.	Cpt	4	Sarasota AF	89	821	35
73	Branche, J. B.	1Lt	4	Tuskegee AF	94	822	37
74	Vanderzee, C. E.	1Lt	23	Lincoln	92	823	11
75	Murphy, E. E.	SSg	3	Muskogee AF	92	824	3
75	Kaminski, H. S.	TSg	4	Daniel FD	94	824	38
75	Werner, W. L.	2Lt	23	Lincoln	79	824	12
75	Aichele, W. J.	2Lt	25	Pittsburgh AP	91	824	9
79	Zink, W. R.	2Lt	4	Hattiesbrg AF	86	825	39
80	Solomon, M. L.	SSg	24	Portland AB	91	826	4
81	Culbertson, H. M.	2Lt	1	March FD	93	827	7
82	Heinmiller, C. S.	2Lt	3	Hondo AF	86	828	4
82	Kimmel, M. M.	1Lt	4	Hattiesbrg AF	94	828	40
82	Martinson, G. W.	2Lt	4	Greenwood AF	88	828	41
82	Ruzicka, R. R.	SSg	25	Boston AP	88	828	10
86	Coughlin, H. J.	2Lt	1	Marysville AF	84	829	9
86	Coulter, G. G.	MSg	1	Los Angeles	94	829	8
88	Elder, K. C.	CWO	2	Scott FD	73	830	8
88	Mazer, J. L.	2Lt	4	Courtland AF	83	830	42
90	Gillespie, L. V.	Maj	1	Long Beach	93	831	10
90	Norton, O. A.	TSg	4	Hendricks FD	92	831	43
90	Rosing, B.	TSg	23	Bruning AF	93	831	13
93	Smania, L. P.	TSg	4	Boca Raton AF	90	832	44
93	Toyli, M.	MSg	4	Jacksonvl AF	90	832	45
95	McCrabb, H. S.	1Lt	3	Perrin FD	93	833	5
95	Dale, A. C.	2Lt	4	Nashville AP	91	833	46
97	Sherman, W. G.	2Lt	4	Courtland AF	88	834	47
98	McCroden, T. J.	2Lt	3	Kirtland FD	89	835	6
98	Blair, W. A.	2Lt	25	Cambridge	75	835	11
100	Banken, E. L.	2Lt	4	Birmingham AF	93	836	48
100	Wimbish, C. A.	TSg	4	Grensbo HI PT	91	836	49
100	Purcell, M. A.	2Lt	23	Casper AB	85	836	14
100	King, T. L.	2Lt	25	Pittsburgh AP	87	836	12

SUMMARY OF RESULTS BY REGIONS

Regions	Forecasters Participating	Distribution of Grades (%)				
		A	B	C	D	X
Fourth	600	16	35	37	8	4
Twenty-fifth	247	14	31	36	15	4
Second	256	8	36	37	14	5
First	375	7	33	43	14	3
Average		10	30	40	15	5
Twenty-third	348	11	26	42	16	5
Twenty-four	154	8	25	43	17	7
Third	576	5	24	43	21	7

A.M.S. Convention

When hundreds of the most influential men in a profession gather en masse, and when a thousand of their fellow specialists participate in achieving a common purpose by correspondence from all over the world, one feels that a great movement is in progress. Such was the scope of the American Meteorological Society convention in Kansas City last month, at which an overwhelming approval was given to a program for expanding the Society. Its new status is that of a professional organization which develops, regulates, and standardizes the application of meteorology to, industrial, commercial, and agricultural pursuits.

The commercial airlines, the AAF Weather Service, the U. S. Weather Bureau, the U. S. Navy's Aerology Section, and the universities which maintain meteorological departments sent representatives of wide fame: Buell, Minser, and Little; Gillenwaters, Jones, Heinlein, Arakelian, and Kolb; Namias, Young, Fulks, and Bice; Orville, True, and Smith; Neiburger, Byers, Brooks, McElwayne, Ference, and Lemmon. The Canadian Department of Transport's chief meteorologist, a Soviet Navy weatherman, and the Civil Aeroanutics Authority's meteorological specialist were there as well.

More than a thousand AMS members made known by mail their approval of the Reorganization Plan and their choice of Byers, Fletcher, Hewson, Kaster, and Little as Councillors. This heavy response certified Secretary Brooks' announcement of a swelling expansion in Society memberships at the professional level. Two reasons were advanced for this interest. First, many military weathermen wished to support and benefit from the Executive Secretary's function as an intermediary in the establishment and filling of professional positions. Second, many comprehend the prestige of attaining a recognized standing in a professional society, even if the specialty of that society is not the field of their postwar ambitions.

A major interest at the Kansas City meeting was the presentation and discussion of several scientific papers. Although much of the material discussed there is familiar to readers of the "Weather Service Bulletin" and other classified military publications, or is of local nature, there were several subjects of importance that received an edifying examination by the many able minds at the convention.

For example, Colonel W. W. Jones of the AAF led a symposium on "Use of Upper Air Data." The Colonel went to the heart of a moot problem when he questioned the value of isentropic analysis, saying that he had never heard of anyone who could forecast a theta chart.

Mr. Namias, an originator of isentropic analysis, answered to the effect that there was more to forecasting than pressure analysis. Some of his forecasters were given the actual pressure field at 10,000 feet and at the surface, then asked to state what weather elements existed at that time for certain stations. The result showed a significant departure from observed values. The pressure pattern cannot be forecast exactly anyway; and so, other factors---the thermodynamic modification of air masses and the distribution of moisture ---must be given important consideration before a successful forecast can be achieved. The best way known to investigate the just-mentioned variables in a synoptic situation is through isentropic analysis, Mr. Namias declared. Furthermore, he said, flood rains in the U. S. come from moisture distributions below 3 km. in the atmosphere, which often do not affect the 10,000 foot map. In reference to the problem of forecasting an isentropic map, the best device is continuity. The motion of a contour line relative to a corresponding moisture line from one map to another indicates a good expectation of up or down slope motion.

Mr. Neiburger pointed out the value of being able to diagnose the current situation by isentropic analysis: it is often forgotten that one cannot forecast unless he grasps the full significance of the present weather.

These snapshots of the AMS convention will be supplemented in succeeding issues of the AMS and *Weather Service Bulletins*.

Metro Musings

AVIATION AWARDS

The Institute of Aeronautical Sciences presents valued awards every year to scientists who have contributed to the progress of aviation. Research in meteorology is recognized among other advances, of course. The Robert M. Losey award in this field was given last month to John C. Bellamy, who is Director of the Institute of Tropical Meteorology, special consultant to the AAF Weather Service, and a staff member at the University of Chicago.

In the past year Mr. Bellamy has been identified with several outstanding projects in meteorology. With Lt. Plumley of the AAF he set up the method of "Detailed Analysis" for extrapolating pressure field solutions from low, data-full maps to high, unplotted charts. Dynamic analysis of convergenesis and divergenesis in the atmosphere is a product of Bellamy's thinking, soon to be published as a University of Chicago Miscellaneous Report. As head of the Institute of Tropical Meteorology at San Juan, Porto Rico, Bellamy has directed study in the phase of meteorology most critical for the current war effort. And finally, Bellamy was unable to accept the award personally because he was serving in the Pacific Ocean Areas at the time.

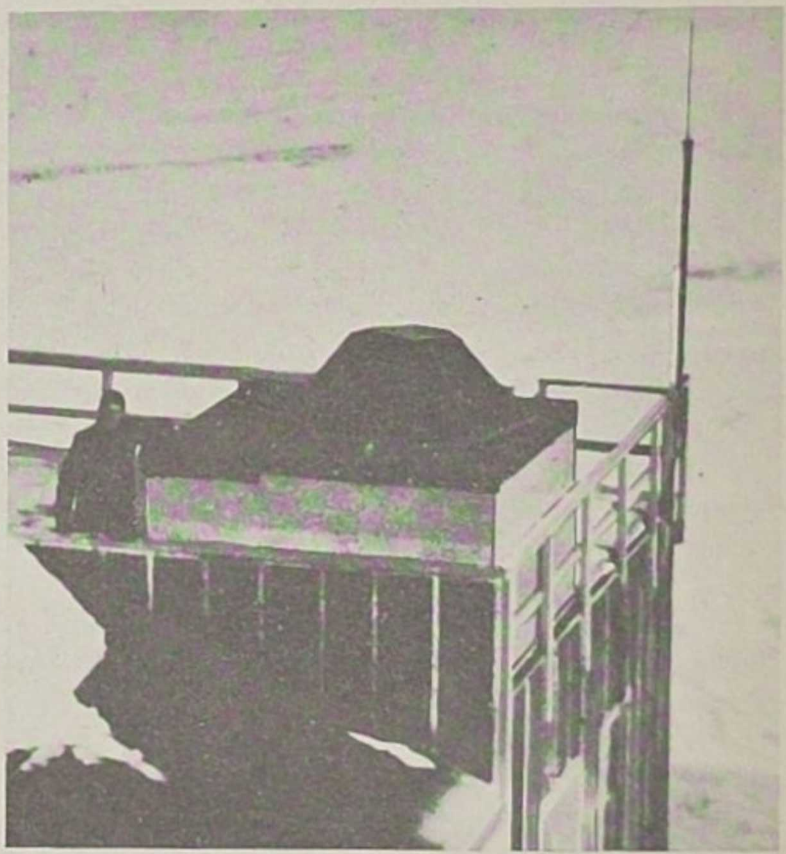
The Robert M. Losey Award was established in honor of the first chief of the AAF Weather Service, who was killed during a Nazi dive bomber attack in the Norway of 1939 while he was serving as a military observer there.

Dr. C. G. Rossby, President of the American Meteorological Society among other titles, received an honorary membership in the Institute of Aeronautical Sciences.

The Octave Chanute Award was presented to Colonel Benjamin Kelsey of the AAF for his work in testing high speed aircraft and in analyzing the effects of compressibility (*Air Force* magazine, July 1944).

The John Jeffries Award for contributions to aeronautical medicine went to Air Marshal Sir Harold E. Whittingham, director general of medical services of the Royal Air Force. In accepting this award he credited cooperation in aerial medicine between the British and American air forces for the solution of such problems as oxygen supply at high altitudes, protection against frostbite, prevention of blackout in combat acrobatics, prevention of "bends" in explosive decompression of cabins at high altitude, and the prevention of air sickness among paratroopers.

OBSERVERS' SHELTER



Pibal observers at Coral Harbor (located on a small island in Hudson Strait) are no longer exposed to Arctic winds while making their runs. A shelter has been improvised which enables the observer to follow his balloon through a rectangular opening in a rotary turret while being completely shielded on all sides. If the elevation angle is high, he can follow the balloon by adjusting a hinged top cover fitted to the roof.

The shelter, constructed by Sgts. Glenn Stonex and Lee Merriman, is located on top of the radiosonde shack, and receives its heat from there. The turret is mounted on rollers, which are protected from blowing snow and sleet by heavy canvas skirts.

CORRECTION

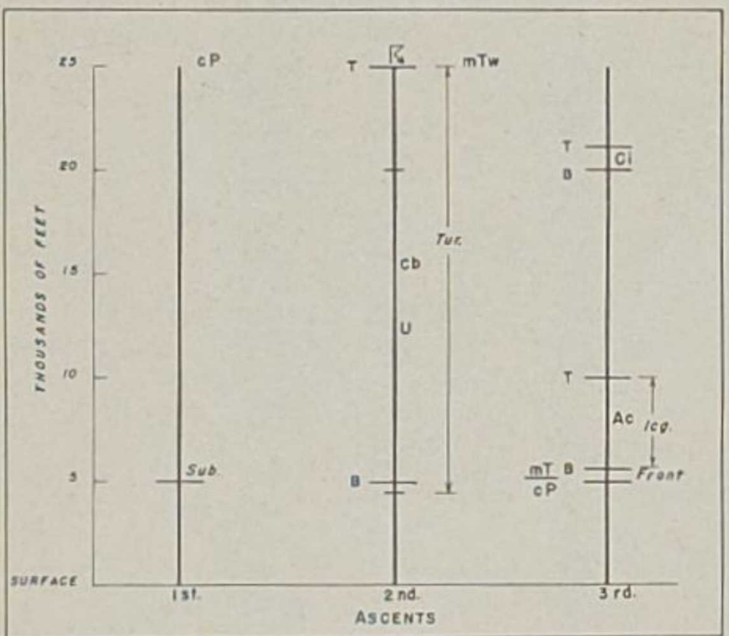
The example given in "Barometer Corrections," January 1945 issue of the *Bulletin*, was in error as to the algebraic sign of the temperature correction. Although the absolute value of the correction was correct as given, Form 80 shows that it must be subtracted instead of added to the reading.

RAOB ANALYSIS

New methods of analyzing radiosonde soundings in order to make maximum use of upper air data have been devised by two Regions, the 23rd and the 8th.

In the 23rd such significant features of an ascent as air mass type and change, stability, inversions, icing, turbulence, and thunderstorms are recorded on a station log.

The 8th has adopted a diagrammatic method: a line parallel to the temperature ordinate is broken into segments to show:



Instability: Convectively unstable layers are indicated by dashes, a "U" being entered midway between them. Ascent 2 shows convective instability from 4000 to 20,000 feet. Neutral stability is indicated similarly, except that "N" is entered.

Inversions: Inversions and isothermal layers are indicated by a short horizontal line at the level corresponding to their top, the cause being entered. Ascent 1 shows a subsidence inversion, and ascent 3 a frontal inversion, at 5,000 feet.

Cloud Decks: Short lines, labelled "T" and "B", are used to indicate the top and bottom of cloud and fog decks. Cloud types are written in. Cumulonimbus from 5,000 to 25,000 feet is represented in ascent 2, while the third has altocumulus from 6,000 to 10,000 and cirrus from 20,000 to 22,000 feet.

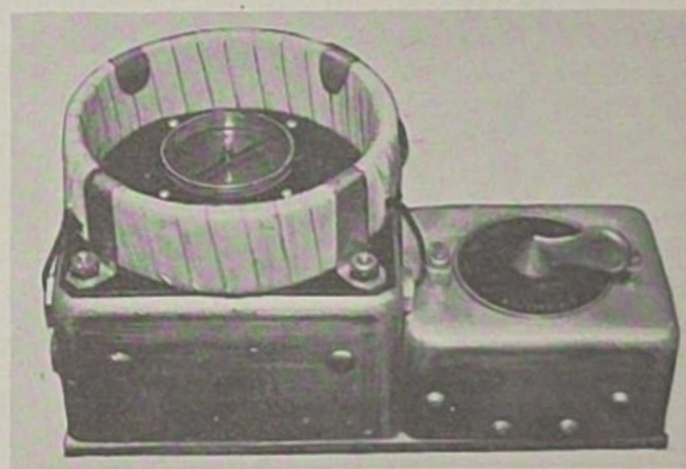
Icing and Turbulence: Broken arrows to the right of the "ascent" line represent these layers. Icing between 6,000 and 10,000 feet is shown in ascent 3, and turbulence between 4,000 and the top of the sounding in ascent 2.

Thunderstorms: The usual symbol placed at the top of the column is entered for forecast thunderstorms. One is expected in ascent 2.

Air Mass Classification: Air mass symbols are placed at the top of the ascent line, unless overrunning is occurring, and then the symbols are placed at the proper level. This situation is illustrated by the third ascent.

'WINDICATOR'

When the weather station at Big Spring Army Air Field, Texas, was reduced from an "A" to a "B" type, it was stripped of much of its equipment, including its wind indicator. However, by raiding the Post salvage yard and spending a total of 18 cents, Observer Ramon Z. Burnsworth was able to produce a new version of an automatic wind direction indicator---the "Windicator."



The recipe used in cooking up this instrument reads like a bone-yard inventory: assorted scraps of aluminum sheet and tubing; discarded lengths of chrome-plated tubing; remnants of two old radio rheostats; a radio generator; a cracked aircraft magneto; rust-encrusted oil pipe casing; nondescript sections of taped wire; a broken compass; a cupful of gasket shellac and a few teaspoonsful of kerosene (donated by Sub-Depot's paint shop); and eight flashlight batteries (supplied by the Signal Property Office). The outlay of 18 cents went to buy a spool of No. 28 magnet wire.

The "Windicator" is working smoothly, giving the station instantaneous knowledge of surface wind variations.

FORECASTERS' SCHOOL, POA

An advanced school for AAF forecasters has been established at Weather Headquarters, Pacific Ocean Areas. Forecasters from both rear and forward areas are being given four weeks of training in the latest techniques, with emphasis on tropical and Eastern Asiatic weather. Drs. Jacob Bjerknes and John C. Bellamy aided in giving instruction to the early classes.

RAWIN REPORTING STATIONS

STATION	ASCENTS Per Day	IDENTIFICATION Letters	IDENTIFICATION No.	CIRCUIT HEADING Skj C	CIRCUIT HEADING Skj O
Reports Available on Domestic Teletype Circuits					
Chanute Field, Ill.	4	DNU	531	PB 2	
Coraopolis, Pa.	4	DWP	520	PB 2	
Dyersburg, Tenn.	1*	DZB		PB 5	
El Paso, Texas	4	EO	270	PB 8	
Fairfield, Calif.	4	DFA		PB 35	
Fort Sill, Okla.	2	DFG		PB 8	
Galveston, Texas	4	GS	252	PB 8	
Gowen Fld., Boise, Idaho	1*	BE	681	PB 11	
Grenier Fld., N. H.	4	DUR		PB 1	
Hunter Fld., Savannah, Ga.	2	DCH	207	PB 3	
Los Angeles, Calif.	4	LA (BU)	295	PB 9	
Maxwell Fld., Ala.	4	DXW		PB 4	
Medford, Oregon	1*	MF	597	PB 11	
Orlando, Fla.	4	DOA	205	PB 31	PB 9881
Patterson Fld., Ohio	4	DPK		PB 2	
Pope Fld., Fort Bragg, N. C.	2	DOP	303	PB 3	
Portland, Me.	2	PW	606	PB 1	
Presque Isle, Me.	1*	DZQ	713	PB 1	PB DZQ
Richmond, Va.	4	RW	401	PB 3	
San Diego, Calif.	4	SQ	290	PB 9	
Seattle, Wash.	4	SA	793	PB 10	
Smoky Hill AAF, Salina, Kansas	1*	DSN		PB 7	
Spring Lake, N. J.	4	DSL		PB 30	
Watson Lake, Yukon Territory	2	QH	953	PB DGW	
Scheduled Reports					
Adak, Aleutians	3	NCI	992		PB 3MW 7-8
Amchitka, Aleutians	1	CH	005		PB 3MW 7-8
Annette Is., Ketchikan, Alaska	2	UKG	048		PB 302
Fort Morrow, Port Heiden, Alaska	2	ZG	017		PB 3MW 7-8
Nome, Alaska	2	HYO	532		PB 303
Shemya, Aleutians	4	PF	549		PB 3MW 7-8
Yakutat, Alaska	2	UVY	963		PB 302
Unscheduled Reports					
Albrook Fld., Fort Clayton, C. Z.	1	UAF	923		PB WZA
Ascension Island, S. A.	2	UCD	717	PB NO	PB WYRO
Belem, Brazil	2	ULW	513	PB NO	PB WYRO
Cayenne, Fr. Guiana	2	URD	874		PB WYI
France Fld., Fort Davis, C. Z.	1	UFA	922		PB WZA
Gander Lake, N'fld.	2	UQX	803		PB DZQ
Goose Bay, Labrador	3	YR	816		PB DZQ
Hickam Fld., Oahu, Territory of Hawaii	4	WZJ	998		ML NPM
Ikateq, Greenland	2	WYQO	555		PB DZQ
Kindley Fld., Bermuda	2	KF	925		PB WZT
Lagens, Azores	2	GP	343		PB WYQY
Meeks Fld., Keflavik, Iceland	4	VT	581		PB DZQ
Narsarssuak, Greenland	2	WYXE	589		PB DZQ
Roberts Fld., Liberia	2	WYUD	432		MX WYUC
San Juan, Puerto Rico	2	UIG	015		PB WYI

**One flight per day pending arrival of supplies.*

COELUM AD PROELIUM ELIGE

CONTENTS

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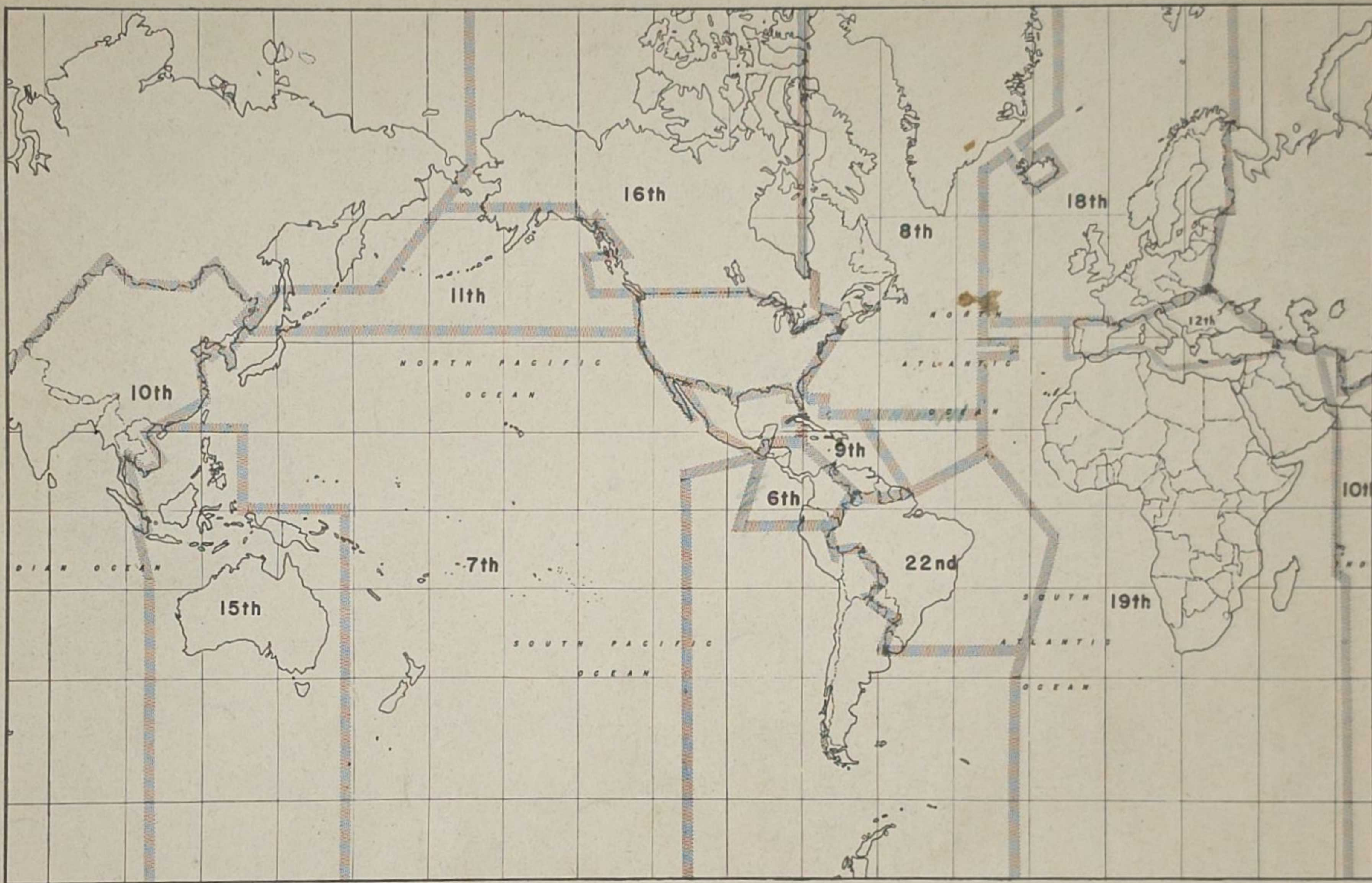
(R) means Restricted

BOUNDARIES OF FOREIGN WEATHER REGIONS



RESTRICTED