WEATHER SERVICE Bulletin

ARMY AIR FORCES HEADQUARTERS WEATHER WING
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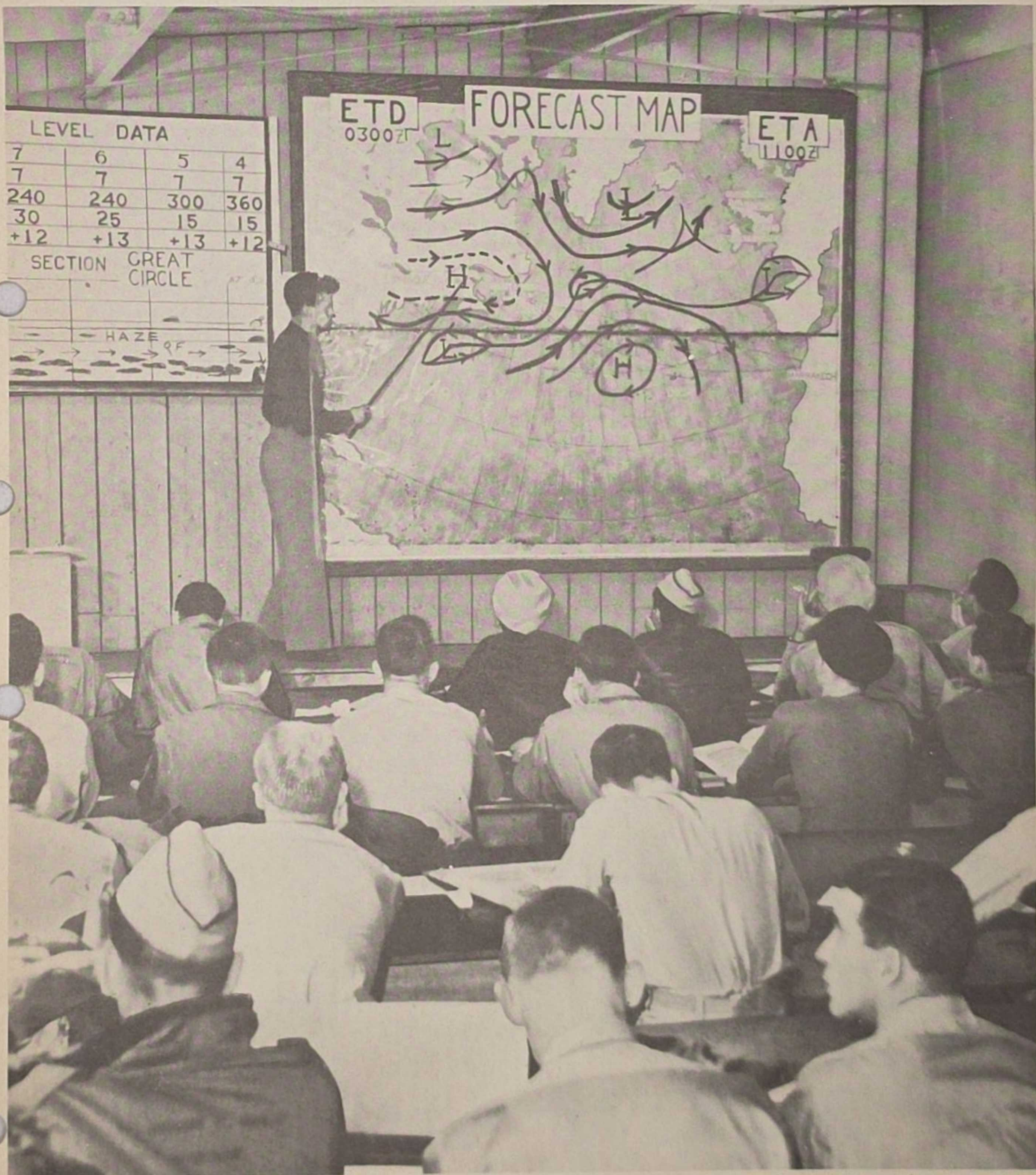


REVIEWING THE FORECASTERS' EXAMINATION

A proficiency examination for forecasters was given throughout the domestic regions in the first week of October. Weathermen in twelve regions, Headquarters Weather Wing, and Headquarters Army Air Forces pondered over questions about practical and theoretical meteorology for three consecutive hours on three consecutive days. Rated forecasters currently assigned to administrative duty were not exempted.

Although 220 (85%) of the questions were standard for all participants, the final 40 were devoted to a map analysis of spotted charts covering the particular area concerning the examinee. There were four such sets of sectional questions: "Northwest Arctic" given in the 16th Region, "Northeast Arctic" for the 8th Region, "Temperate North America" taken by forecasters in the U.S., and "Tropical America" given in the 6th, 9th, and 22nd Regions.

Each question was carefully reviewed by the Technical Board of this headquarters to eliminate controversial issues and to obtain a just balance between the new and the old in meteorology. And to answer repeated queries, the analysis of spotted maps and diagrams required by the final 40 questions will not be graded.

The Regional Control Officers concerned submitted sample questions which were considered in composing the test. These contributions proved particularly helpful in determining desirable proficiency standards, and in establishing a fair basis for inclusion of regional forecasting problems. It is interesting to note that the "difficulty level" finally adopted was below that of the questions received from R.C.O.'s.

There is no intention to rate or disrate forecasters solely on the basis of marks received on this test. One cannot expect to be awarded an MOS 8219 or 787 for a "passing" grade; nor will a "failing" mark mean disqualification.

On the other hand, the answers given will be subjected to detailed statistical analysis for information about individual and collective weaknesses. The results will determine the design of training programs and guide the selection of students for the refresher course at Chanute Field. And probably most important, this headquarters expects that each forecaster will undertake study to correct his personal weaknesses pointed out by the examination report.

Subject	Weight	Questions	Time
Synoptics	27%	70	1:45
Dynamics	8%	20	:30
Climatology	8%	20	:30
Surface Chart Analysis	15%	40	1:00
Auxiliary Chart Analysis	15%	40	1:00
Operational and General	12%	30	:45
Analysis of spotted charts and diagrams			2:00
Associated forecasting questions	15%	40	1:00

DEADLY Burlesque!

by Capt. WILLIAM L. ROBERTS

It's almost worth your life at an airbase on a Greenland fijord when a Foehn windstorm roars down from towering expanses of the icecap. This violence once wrenched a B-25 from its shackles and sent the plane hell-bent down the runway, toward the open water. In the excitement that ensued, an Army weatherman rushed outdoors and was blown head over heels, fifty feet downwind. With perfect impartiality, the Foehn then picked up a Navy aerologist and flattened him out against the side of a hangar, shattering his limbs.

These storms don't stop at lethal threats, they invade your privacy too. Once an observer on duty during a particularly violent blow felt the "call" and hurried on hands and knees through a tunnel to the nearby outhouse. No sooner was he comfortably settled inside than the roof blew off overhead. He beat a hasty and disorganized retreat at once, muttering imprecations all the while. Frustration proved better than valor nonetheless, because the rest of the outhouse disappeared from sight in the next gust!

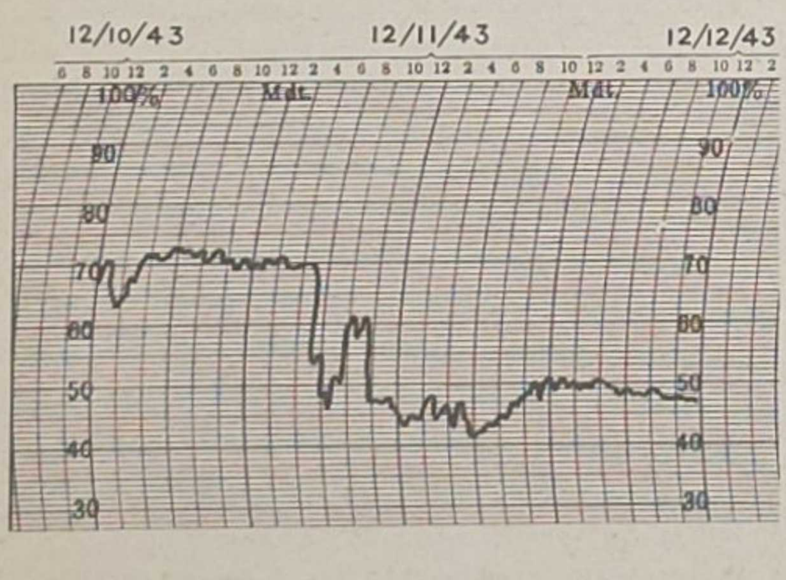
Greenland's icecap is a great flat dome, crevassed at the edges; one point close to the southwest coast is 7,100 feet high. Storms must pass to the south of this barrier or decay against its western wall. However, the average path of winter cyclones is close to the southern tip of Greenland, and passage of a deep low there means that terrifying Foehn effects will be felt along Greenland's southwest coast.

Conditionally unstable air is forced up the eastern side of the 10,000 foot icecap by frequent Atlantic cyclones, cooling at the moist adiabatic rate while widespread precipitation is being released. When this air reaches the western cliffs, it takes a precipitous descent at the dry adiabatic rate; warming and drying so that amazing temperature anomalies are produced. Furthermore, funneling effects of the long, deep, narrow fijords produce local winds that are far in excess of even the steep gradients that can be expected.

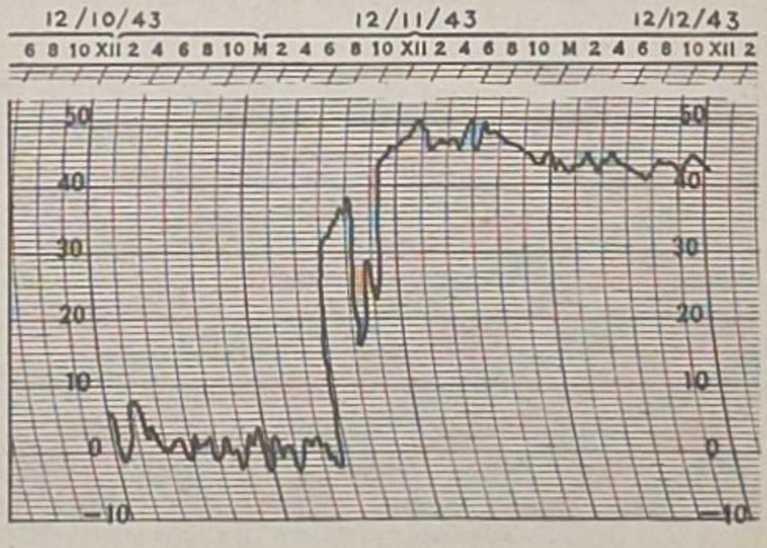
It's not at all rare for Foehn windstorms to blow for days at terrific velocities, raising havoc with everything in their path. Fortunately, both the time and the intensity of these storms can be forecast with considerable accuracy, well in advance.

Large-scale disasters are thereby avoided, but no warning prevents occasional, freakish incidents like the case of the "whirling latrine." Although aircraft are anchored to steel mats with double shackles on all three wheels, they are far from immune to the quirks of Foehn winds. In one instance, a parked C-46 was bravely bucking the storm when two jeeps and a three-ton truck were thrown into it, cracking a propeller, crushing a tail surface, and caving in the fuselage.

Even the warnings that the Foehn gives before its arrival are bizarre in the extreme. It was dead calm and well below freezing (8°F.) one morning at our base in southwest Greenland, when an RAF C-47



HYGROGRAPH trace



THERMOGRAPH TRACE

These are the actual records taken during the sporadic foehn activity of 11 December 1943.

departing for Iceland suddenly startled the control tower observer by reporting a temperature of 41°F. and severe turbulence over the field at only 1,500 feet.

The forecaster on duty understood that Foehn winds were blowing at that level and would soon work their way down to the surface. He coerced a pilot into making a local hop to check the rate at which the inversion was being destroyed. In the fifteen minutes while he was aloft, the pilot followed the lower edge of the katabatic winds down from 1,000 feet to 700 feet.

The pilot hurried in for a landing when the clearance became that small. However, the forecaster still was able to get a reliable height estimation by watching flocks of ravens which took off in the clear, cold air and circled lazily upward ---until suddenly they were whipped downstream at a dizzy pace by the lowering Foehn current.

Somewhat later, a weather officer who had just walked to his barracks from duty phoned in that he had passed a "warm front" en route. It was still calm and cold at the weather station, but the wind was already blowing in a fresh current at the B.O.Q. that was 30° warmer. Yet the quarters were only a half-mile away and a few hundred feet above the station

It wasn't long before the windstorm shot anemometers up to 100 mph in gusts and to 70 mph for prevailing wind. The tail shackles on a C-47 were snapped, making a gigantic wind vane of the aircraft by swinging it back and forth with each peculiarity of the windstorm. A momentary lull later gave intrepid crewmen a chance to rechain the plane. And just when a deep breath of relief seemed to be in order, the Foehn took new life and zest, playfully lifting a PBY and the steel mat to which it was anchored a full two feet off the ground.

Foehn-ish, grim humor is almost inexhaustible. Waterfalls "fall" horizontally, pebbles are blown through windows, and the constant grinding of blowing sand makes windshields opaque. A foot of snow may disappear in an hour by blowing away, melting, and evaporating directly into the exceedingly dry Foehn air. It is almost impossible to open doors inward when these storm winds are blowing parallel to them, and aneroid barometers have shown as much as a millibar difference in pressure between the inside and the outside of the door. One memorable day, a Coast ship reported blowing sand from fully 300 miles off shore---a good story, even though it may have been only an error introduced by coding or radio transmission.

The storm of 11 December 1943 is particularly well documented, and a glance at the record will give the weatherman a good example of what can be expected in a Greenland-coast winter:

Shortly before 0600, the Foehn set in as forecast, and within 15 minutes the wind was blowing at 35 mph with gusts to 53 mph. The temperature climbed from -3°F. to 32°F, an almost vertical trace on the thermograph. During the next two hours, a moderate wind prevailed (highest gust was 58 mph) and the temperature climbed slowly to 38°F.

A decided trough forms over southwest Greenland during these easterly Foehns, produced by decreased densities from compressional warming. Another factor may be that airflow passing from rough terrain to smooth water creates a field of divergence. Such a trough had formed on this occasion.

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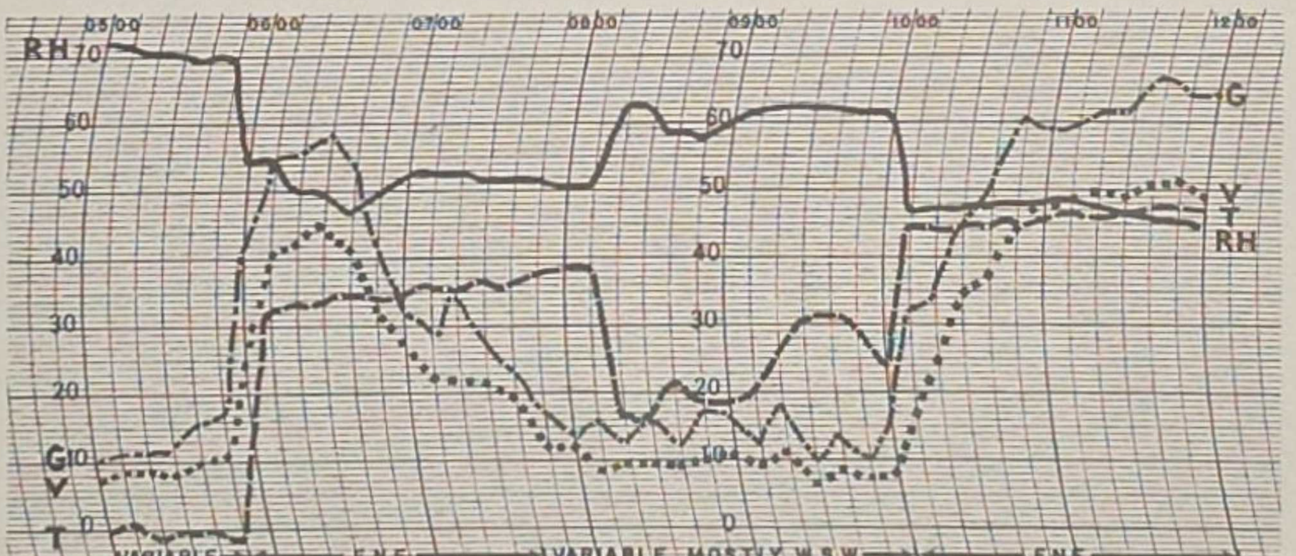


The onset of foehn weather at 0600 and again at 1015 was far from subtle on 11 December 1943 as is apparent from this summary of weather data: *RH*(relative humidity), *G*(wind speed in gusts), *V*(prevailing wind speed, and *T*(Fahrenheit temperature).

Simple Navigation of Aircraft: Part I

"Would you like to swing on a star?" If you are that imaginative and impractical, there's no point in reading this series on how to get from one place to another in an airplane: your sense of the romantic will be pleased by a helter-skelter of final landing places, picked out by a fanciful and naive disregard of navigation.

But can you afford to be so blithe, even if you don't ever expect to chart a flight? Most pilots with whom we do business are stuffily practical: they are always concerned with getting from say Big Spring to Houston if their orders call for that. And the weatherman's advice is sought by the flyer largely for use in navigational procedures, so it's at least interesting to investigate this application of your forecast.

Furthermore, errors in navigation will be pointed out that are made because aircrewmen don't have the same familiarity with meteorological theory and conditions that you have. Quite useful too, is a knowledge of how the winds aloft may be determined in flight: some PIREPS winds have forecasting value and others don't, depending on the method used. In particular, if you should come upon a weather condition of special interest while taking a familiarization flight, a determination of the wind at flight level might be necessary for a full interpretation of the situation.

It is obvious that winds aloft information is important to navigation because air currents tend to throw aircraft off course: if the destination lies due east and a northwest wind comes up, the pilot ought to head somewhat north of east.

Balancing of the wind force by an opposite heading can be made exact by a simple vector diagram, the "Triangle of Velocities:"

1) Connect the present base with the terminal by a line on the map. Measure an angle known as the *True Course* clockwise from the mid-meridian to this line of flight.

2) Plot a vector for the wind velocity (mph) at the present base, *downwind*.

3) From the end of the wind vector, swing an arc of radius equal to the *True Air Speed* (the *Indicated Air Speed* plus corrections for the density at flight altitude) to intersect the True Course. The length so cut off on the True Course represents the *Ground Speed*, the actual progress of the plane toward the destination. Naturally, the number of Ground Speed vectors on the True Course line is the duration of flight in hours.

4) Draw a line from the end of the wind vector to the arc's intersection with the True Course. This line is directed along the *True Heading*, that attitude of the plane which will permit maintenance of the True Course despite the cross-wind (figure 1).

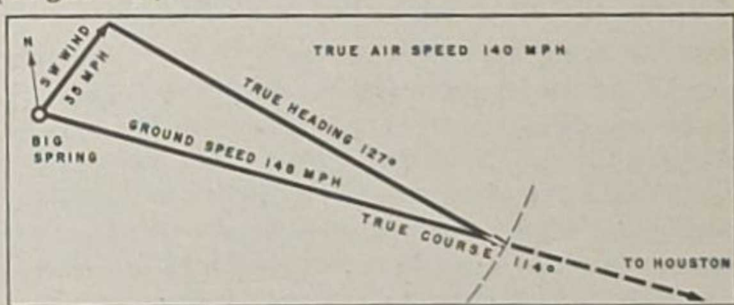


Figure 1: "*Triangle of Velocities*" Is used to compute simple drift produced by crosswinds.

Choice of the map to be used for charting U.S. flights is almost automatic, because the Regional and Sectional Aeronautical Charts are standard for domestic operations. These charts, like their counterparts in Weather, are Lambert Conformal projections.

Of course the earth's spherical surface can't be represented exactly on a flat surface, so it is a characteristic of all maps that *some* representation is warped. In the case of the Conformal projection, if a True Course is flown from New York to San Francisco that has been measured at the eastern city, the destination will be missed by 29°. This may be understood

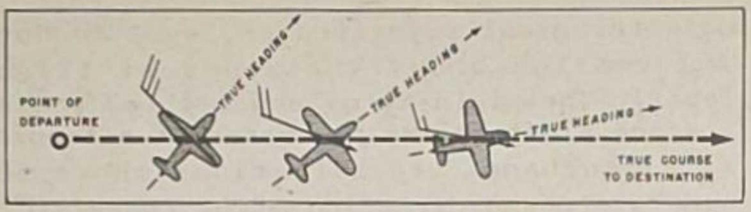


Figure 2: Reheading of the aircraft to counter windshifts is necessary to maintain True Course.

intuitively from the fact that meridians of longitude on the Conformal Chart are not parallel. Practically, airmen get over this shortcoming by measuring each True Course angle at its mid-point as advised in 1).

There are many navigational procedures in use because each one is appropriate for a certain condition of route weather or length of flight. Convective disturbances interfere with radio aids to navigation, overcasts blot out the chance to use stars as guide-posts, and undercasts (or poor visibility, inaccurate maps, and monotonous terrain) prevent travel according to the recognition of familiar or mapped landmarks underneath. In addition, the longer and more complex the flight, the greater the need for an accuracy obtained by comparing the independent results of several methods.

However, consider first a simple flight, made under CFR in the daytime for only a few hundred miles. In this situation the widely-used (and very easy) combination of Pilotage and Dead Reckoning is appropriate.

Suppose the pilot takes off and starts to fly the True Heading worked out in figure 1. He knows that the forecast winds won't hold perfectly and that the plane can't be held exactly on the True Heading: very shortly he will be on a faulty course. After flying for say 60 miles, though, he may recognize a certain railroad station below. A glance at the map would reveal that he was say five miles off course to

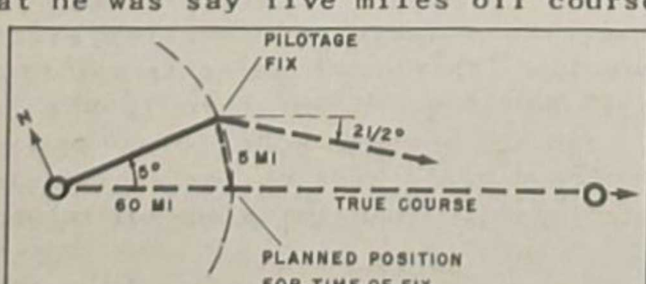


Figure 3: There are six radians in 360°, so flight for 60 miles out on the radius of a circle places the plane where it is the same number of degrees or miles away from other, nearby points along the circumference. This approximation is satisfactory.

the left. Figure 3 shows that an error of *five miles* for 60 miles of flight is five *degrees* of error. Now then, if his destination is 120 miles further on, simple arithmetic calls for a 2.5° change of heading to the right so as to hit the terminal on the head. Such correction of heading must be made frequently because wind changes or pilot error in holding to course are to be expected.

This method of navigation is called Pilotage, the directing of a plane from place to place by reference to visible cultural, relief, and water features; most conveniently, those pictured in detail on Sectional Charts. But only flights over the most familiar, well-mapped, and identifiable terrain can rely solely on this rather hit-or-miss method. It is well known that pilots sometimes become lost, even on CAVU flights over well-marked terrain, because some distraction has caused them to lose that approximate orientation needed to identify landmarks. Villages all look alike when you don't know which one to expect.

Pilotage can be made much easier and safer by combination with *Dead Reckoning*, which is a way to determine position by keeping an account of the distance and direction traveled from a known point of departure. The True Airspeed, time elapsed, and True Heading are recorded when ever a change is made in heading or speed. By successively computing a "Triangle of Velocities" for each leg, an approximate position and future heading can be obtained even when the pilot temporarily loses his touch with the map by Pilotage.

The forecast winds are useful for Dead Reckoning when the computed headings and positions can be corrected occasionally by reference to a Pilotage fix. Furthermore, a comparison of the expected position with that which is observed gives a measurement of the real wind acting on the flight. In fact, such a checking of Dead Reckoning against Pilotage (called an *Air Plot*) is the only way to make a wind observation when the more complex devices for instrument flight are not available.

The Air Plot is the easiest and most accurate method whenever there are frequent changes in heading, airspeed, and altitude. Here's how the technique goes (figure 4):

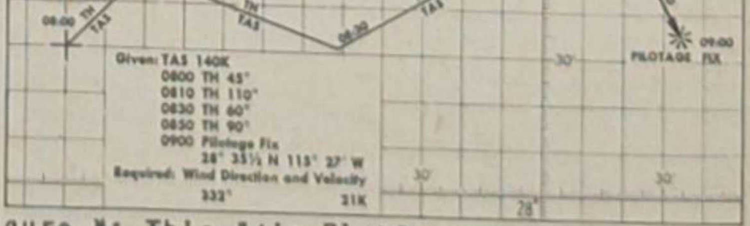


Figure 4: This "Air Plot" wind determination is simple but useful, though not precise.

Plot a "no-wind" track on the aeronautical chart, using the True Airspeed, the True Heading, and the time elapsed between changes of direction or speed to get the length of each leg. At any time that a fix can be obtained, the vector difference between the actual and the "no-wind" locations represents the total wind force acting since the beginning of the Air Plot. The length of this vector must be divided by the number of wind-hours it measures to get the wind speed in mph.

The Air Plot wind is of little weather forecasting value because it masks, and is in turn distorted by, shifts that may have occurred on a constant level. Furthermore, if flight is made at several altitudes, the forecasting significance becomes altogether scrambled by the effects of vertical shear.

Nonetheless, Air Plot winds can be used quite successfully for navigation on flights where the interval between Pilotage orientations is expected to be fairly small. Cumulative errors are apt to become grave, however, unless the Air Plot is started anew each time a fix is obtained.

There are other techniques for determining the winds aloft from an aircraft in flight: "Wind by Bearings," "Absolute Altimetry," and "Double Drift." Each one of these methods produces an *instantaneous* wind vector that is particularly useful from both a meteorological and navigational viewpoint: its accuracy is superior to the single-theodolite observation, and it can be expected to persist during the next Dead Reckoning leg better than the Air Plot wind. Unfortunately, only the larger military and air line planes are equipped to carry out these observations, and the necessity for making them is ordinarily limited to protracted, instrument flights.

A weatherman making a familiarization flight may, in instances of particular meteorological significance, want to have information about the winds at flight level. The vicinity of a possible frontal surface aloft or the perimeter of a tropical disturbance are situations where the wind speed and direction might conceivably be necessary to achieve a full interpretation.

With instruments and procedures now in use, it is possible to measure only the "drift" (normal component of the wind) from a plane pursuing a single heading. If the *full* wind vector is desired, the drift must be measured along each of two headings that are mutually perpendicular. Navigation tables and computers (E-6 B) have been prepared to convert drifts into wind speed and direction.

When the planned course is abandoned temporarily for a wind determination on equal perpendicular legs, it is customary to follow a flying procedure that may be accounted for by a simple alteration of the Dead Reckoning. For example, if a pilot uses the True Heading as the hypotenuse of an isosceles right triangle (fig 5), completion of the wind determination will bring the aircraft back on course and considerably farther along the route than before. Then a subtraction of minutes from the time elapsed on the original course will be enough to account for all three changes in heading.

DOUBLE DRIFT

For wind obs from aircraft equipped with a Driftmeter when fixed objects can be discerned on the ground below, the Double Drift method is ideal.

Standard Flying Procedure

At a carefully-observed time, the pilot makes a 45°, "Standard Rate" turn to the right from the True Heading he has been following. The turn is made precise by use of the gyro compass and requires exactly 15 seconds. This new heading is maintained for two minutes. A 90° turn to the left (in just 30 seconds) follows, and the second heading is kept up for another two-minute period. Then the plane is returned

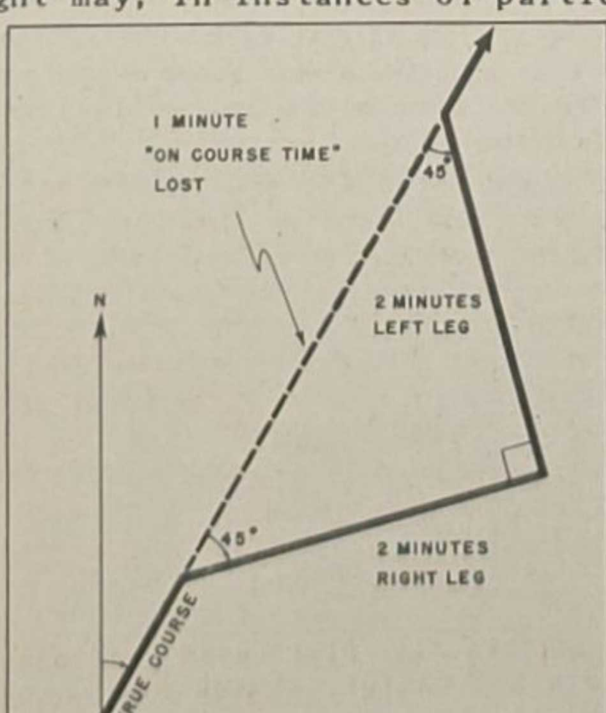


Figure 5: This *DOUBLE DRIFT* flying procedure involves the least loss of "on route time" and the least confusion of Dead Reckoning logs.

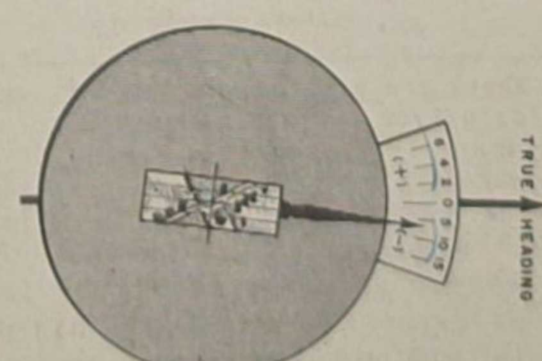


Figure 6: A *DRIFTMETER* compares the actual course being flown with the plane's heading.

to the original course by a 45° turn to the right. Some jiggling with algebra will show that if one minute is subtracted from the time elapsed on the original heading, the Dead Reckoning will have been kept correctly.

The Driftmeter is read on each leg while the Double Drift is in progress. In the case of the B-3 Driftmeter (figure 6), parallel lines on the instrument's grid are lined up with the apparent path of some landmark passing below the plane. This adjustment of the revolving grid actuates a pointer which indicates the drift on that course. The zero point of the drift dial obviously is along the longitudinal axis (True Heading) of the plane.

Navigation tables or the E-6B Computer will convert these drift readings into wind direction and speed.

ABSOLUTE ALTIMETRY

("D System of Weather Navigation")

This technique is not dependent on vision of a landmark, and can be carried out during flight sandwiched in between cloud decks even when radio reception is impossible. Because the radio altimeter is needed as special equipment, however, such wind determination is limited to flights over water surfaces where the radio altimeter gives accurate readings. In addition to being ineffective over land, the method does not apply to tropical latitudes (30° or less).

It is widely understood that the gradient of contour lines on an isobaric surface is a function of the geostrophic wind at that level. Now it is possible to fly the plane along a surface of constant pressure by maintaining a constant reading on the pressure altimeter. Then the change in absolute altimeter readings over a certain period of time (the gradient of contours) can be used to compute the normal component of the wind on the heading being flown. Flight along a course similar to figure 5 will permit measurement of the full wind vector, except that each leg must be extended to about 20 minutes because the slope of isobaric surfaces is small.

Weather Division Report Number 708, "Determination of Absolute Height and Wind for Aircraft Operations," gives an extraordinarily clear discussion of Altimetry, beginning with simple concepts of hydrostatics and pressure altitude and continuing through the practical use of the "D System of Weather Navigation."

WIND BY BEARING

A compromise between Double Drift (which ordinarily requires sight of the earth's surface) and Absolute Altimetry (appropriate for use over a solid undercast) is *Wind By Bearing*. This technique should be adopted when a mountain peak (recognized or not) is seen to poke up through the clouds on flight over an undercast. An instrument which can be used to measure a "bearing" or angle of a fixed object from the longitudinal axis of the plane is required: an astro-compass, a gun turret, or a pelorus.

The technique follows:

Fly the aircraft over and beyond the landmark for a definite length of time, holding the airspeed and heading constant. Take a bearing on the object at an observed time. Then take up a new heading at 90° to the original and get a second bearing at a noted time.

Establish the true air position for each angle-determination along its own heading for *the time of the second observation*. Do this by moving the line representing the first, or earlier, bearing along the original heading up to the time of the second by use of True Airspeed. (See figure 7).

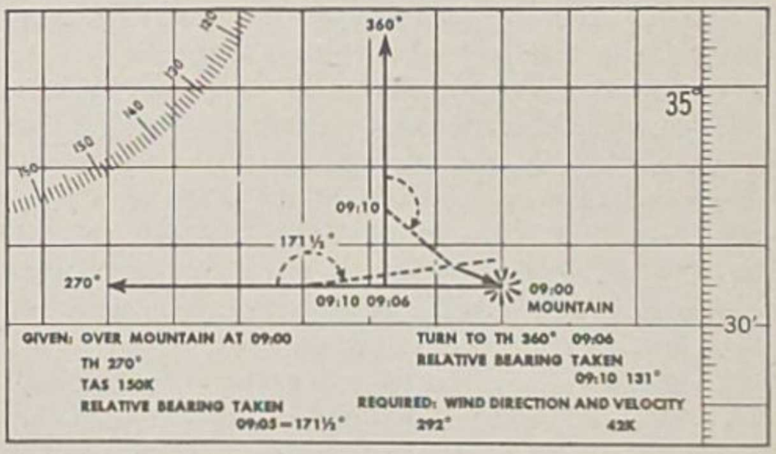
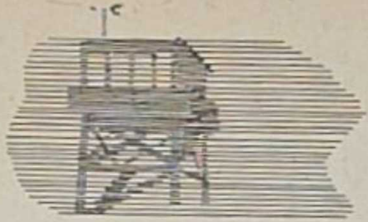


Figure 7: *WIND BY BEARING* technique navigates flight over undercasts when peaks may be seen.

Plot a line along the angle found on each heading at the "synchronized" position of the bearing. From the intersection of these two lines, draw a wind vector *toward* the object on which the bearings were taken. This vector represents the wind direction and speed for the period of time that elapsed between passing over the object (0900 in figure 7) and the time of the second bearing (0910).

Remember to convert the wind speed to a full hour before using it in Dead Reckoning.

The Wind By Bearing method can be applied even when no landmark protrudes through the undercast if a radio compass and stations within range (transmitting a clear signal) are available. This phase of the procedure will be discussed under *Radio Aids to Navigation* in a later article of this series.



CRACKUP WEATHER

Weather was a factor in less than three percent of all Army aircraft accidents which occurred within the United States during the year ending 1 July 1944. But a man's chance of surviving a crash in bad weather was no more than one in three, and fifteen percent of all fatalities happened in this way. It is evident that such a high death rate gives an extremely grave nature to responsibility for a weather accident.

Three individuals are answerable for the loss of a flight in adverse weather: the pilot, the forecaster, and the clearing authority. One or more of these men is fixed with the responsibility by an Accident Investigation Board, except that the decisions which indicate that weather contributed to the accident are evaluated by Headquarters Weather Wing. In the year under consideration, 55% of the bad-weather crashes were attributed to pilot error, 23% to forecasting mistakes, and 22% to clearance or supervisory discrepancies.

Restricting this discussion to forecasting mistakes for the moment, these were the individual circumstances:

Forecast incorrect; analysis adequate	35%
Poor or incorrect analysis	35%
Forecast too optimistic	23%
Failure to consider terrain	7%
Forecaster permitted pilot to influence meteorological judgment	6%
Failure to use all available data	4%
Forecast vague	4%
Form 23 improperly completed	2%
Failure to remain on duty	1%
Failure to notify proper authority of impending storm	1%
(Some accidents were due to a combination of deficiencies)	118%

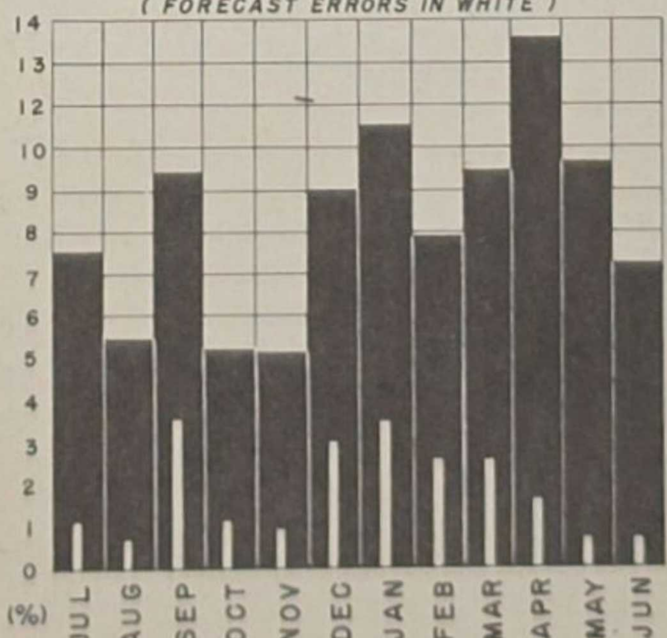
Some incorrect forecasts that resulted in accidents were based on sound meteorological reasoning. No punitive action was even contemplated in these cases, but their numbers have increased the first large category.

The classification which offers the most immediate possibilities for improvement of the weather accident rate is "Failure to Consider Terrain." Often while every hourly sequence along a proposed route shows "contact" weather, peaks or ridges between reporting stations rise to the level of cloud bases and reduce the route weather to below contact or instrument minimums. This is a simple and vital consideration, but it is often neglected.

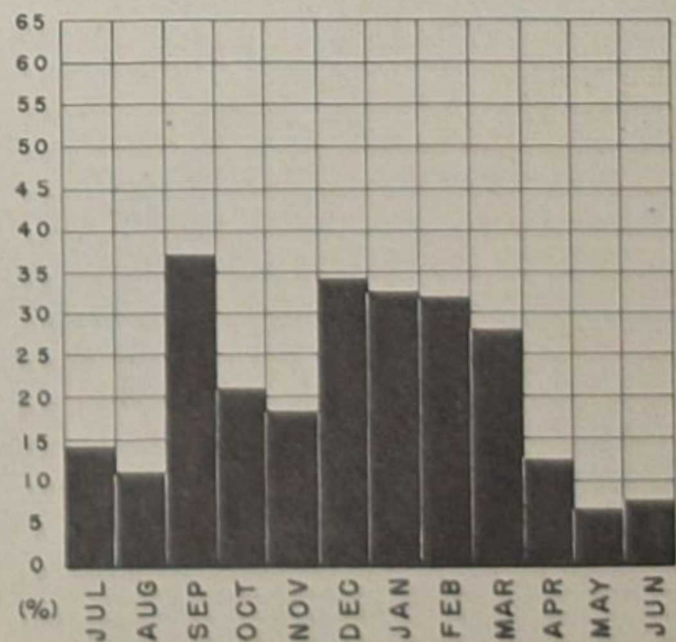
For example, a flight was cleared CFR direct from Bowman Field to Charleston over the highest ranges of the Smoky Mountains. The forecast gave ceilings of 1,500 feet based on sequence reports of a 1,500 foot ceiling at Asheville. But this station is at an elevation of only 2,400 feet and mountains nearby are over 4,000 feet higher. The meteorologist was oblivious of the obvious fact that only ceilings higher than 5,000 feet at Asheville are associated with contact weather over the mountain range.

Nor is this case an isolated one: nine aircraft collided with mountains in the very limited area of eastern Tennessee and western North Carolina, and five of them were attributable to forecasting error. No elaborate training program is needed to eliminate blunders of this sort; familiarization with features of physical relief that have meteorological or operational significance is only a matter of studying a pertinent topographic map.

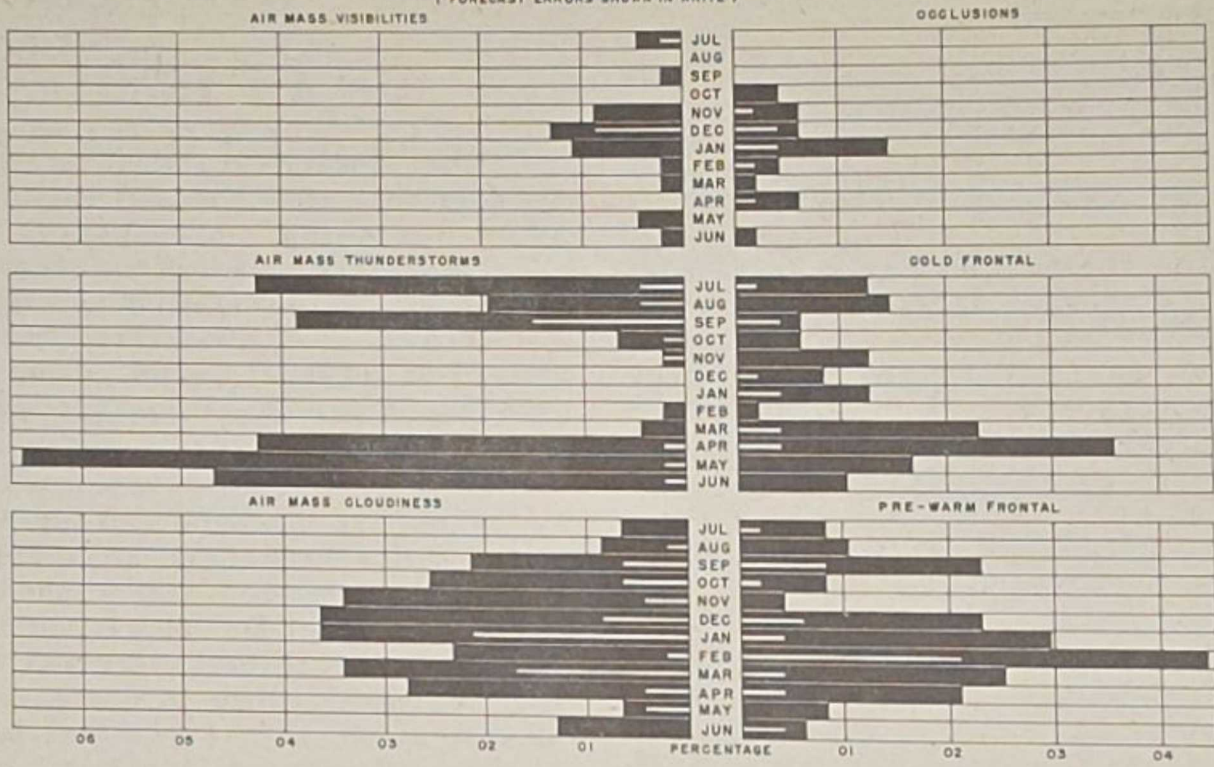
YEARLY DISTRIBUTION OF WEATHER ACCIDENTS
(FORECAST ERRORS IN WHITE)



RELATION OF FORECAST ERRORS TO WEATHER ACCIDENTS IN EACH MONTH



DISTRIBUTION OF ACCIDENTS BY MONTH FOR EACH WEATHER TYPE
(FORECAST ERRORS SHOWN IN WHITE)



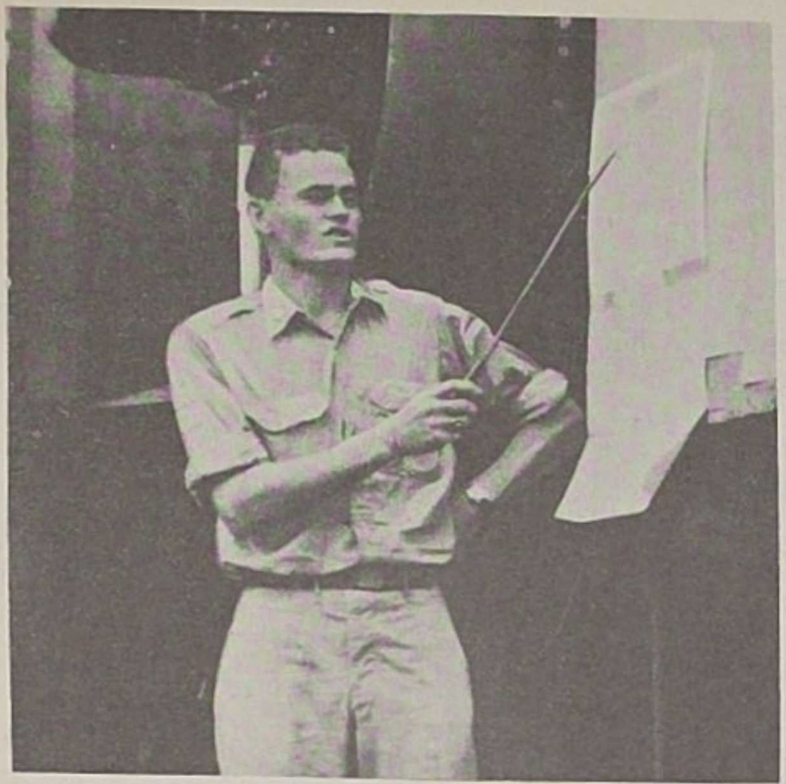
"Forecast Incomplete" and "Forecast Vague" resulted in large part from a limited understanding by the weatherman of just what the pilot needs to know. This was manifest from an inspection of weather entries on the Form 23's given in the case of these accidents. It is obvious then, that a forecaster must acquaint himself with the weather problems involved in flying and navigation. This can be done effectively by discussion with a clearance officer and by flying as much as possible. Full and precise information about weather factors that are hazardous to aircraft operation is necessary background to the writing of a complete and explicit forecast.

The "Poor" fraction of the accidents ascribed to "Poor or Incorrect Analyses" can be reduced considerably, perhaps through the educational program underway in the Weather Service but otherwise by the evaluation and subsequent transfer of incompetent forecasters. Emphasis can be placed here upon the value of a careful analysis, including all forecasting devices, in the preparation of reliable forecasts.

The accidents in which bad weather was a factor have been classified according to the synoptic situation dominant at the time. The six weather patterns which are considered and the distribution of weather accidents among them follow:

Air Mass Thunderstorms	27%
Air Mass Cloudiness	25%
Pre-warm Frontal Conditions	22%
Cold Fronts	16%
Air Mass Restricted Visibility	5%
Occlusions	5%

During the twelve-month period under consideration, more than twice the number of planes involved in all the types of weather accidents considered above were damaged on the ground by hail and high winds. For the most part this damage was confined to light aircraft caught by winds and hail during cold frontal passages and thunderstorms, although several reports mentioned tornadoes. On the average, eleven planes were involved in each case of damage on the ground.



Major Charles R. Dole, CO of the Tenth Weather Central in China which secured its own "analogues when isolated," is shown briefing aircrews before a heavy bomber strike against the Japanese.

You don't have to be much of a meteorologist to appreciate the difficulties of weather forecasting for the B-29 raids on Japan from bases in China. Time and distance ranges are very great and data is severely limited. Although the complete story about techniques used is quite secret, "Analogues" are an essential consideration.

How is the best analogue to the synoptic situation of each Oriental day chosen, far from the complex sorting machines available to the Weather Division for its choice of domestic "weather types?" No one will want to suggest that a statistical unit was flown over the Hump or that the meagre manufacturing facilities of China are called upon for complicated equipment. But the only obvious alternative, comparison of each current weather map with every Northern Hemisphere chart of the historical series, is terrifying in its implications of detail, effort, and delay.

An ingenious procedure was developed in a Weather Central of the Tenth Region that solves the problem. While the initial expense of time and effort was considerable, the selection of an analogue is accomplished currently by a brief mechanical technique. The procedure might be adaptable for use by other Weather Centrals beyond effective communication with Washington. The details given below are proving effective in C.B.I., but some modifications for use elsewhere probably will be needed.

ANALOGUES when ISOLATED

The first step in determining analogues is to classify the daily map in a number code that summarizes concisely the position of all highs, lows, ridges, troughs, and tropical disturbances. When the analogue system was introduced here, the Northern Hemisphere charts of the historical series were identified individually in a similar manner. Then a simple but effective way of finding an historical chart which has the same code number tag as the present situation gives the answer without loss of blood, sweat, or tears.

PREPARING THE SYSTEM

The map area pertinent to the forecasting problem was divided into an arbitrary number of units, most conveniently by outlining these boundaries on a Plexiglas overlay of the regular base map. Each unit was numbered consecutively for easy identification. For operations served by Tenth Weather, the area between 60°E and 180° was divided into sixty zones as shown in figure 1.

The location of Highs and Lows is represented by the number of that zone which incloses the greatest part of the area delineated by the pressure center's inner isobar. The synoptic situation in figure 1, for example, is identifiable this way:

HIGHS	24-6
LOWS	17-19-8

Troughs and ridges are indicated by the number of that zone at the end of such pressure lines which has more than half its area interior to the outer isobar. In figure 1:

Ridges	28-43-5-15-21-46
Troughs	40-30-26-14

After some use of this code, it was discovered that any one map might be classified rather differently by each of two men, or even by one man on two occasions. Therefore certain conventions were adopted to restrict the codification of any map to a unique solution:

I. The code numbers of pressure centers and lines are recorded in order of their future effect on the forecast area. In figure 1, High #24 is revealed by later maps to affect Japan more than High #6 and therefore comes first in the code. Forecast positions have to be used in classifying current maps.

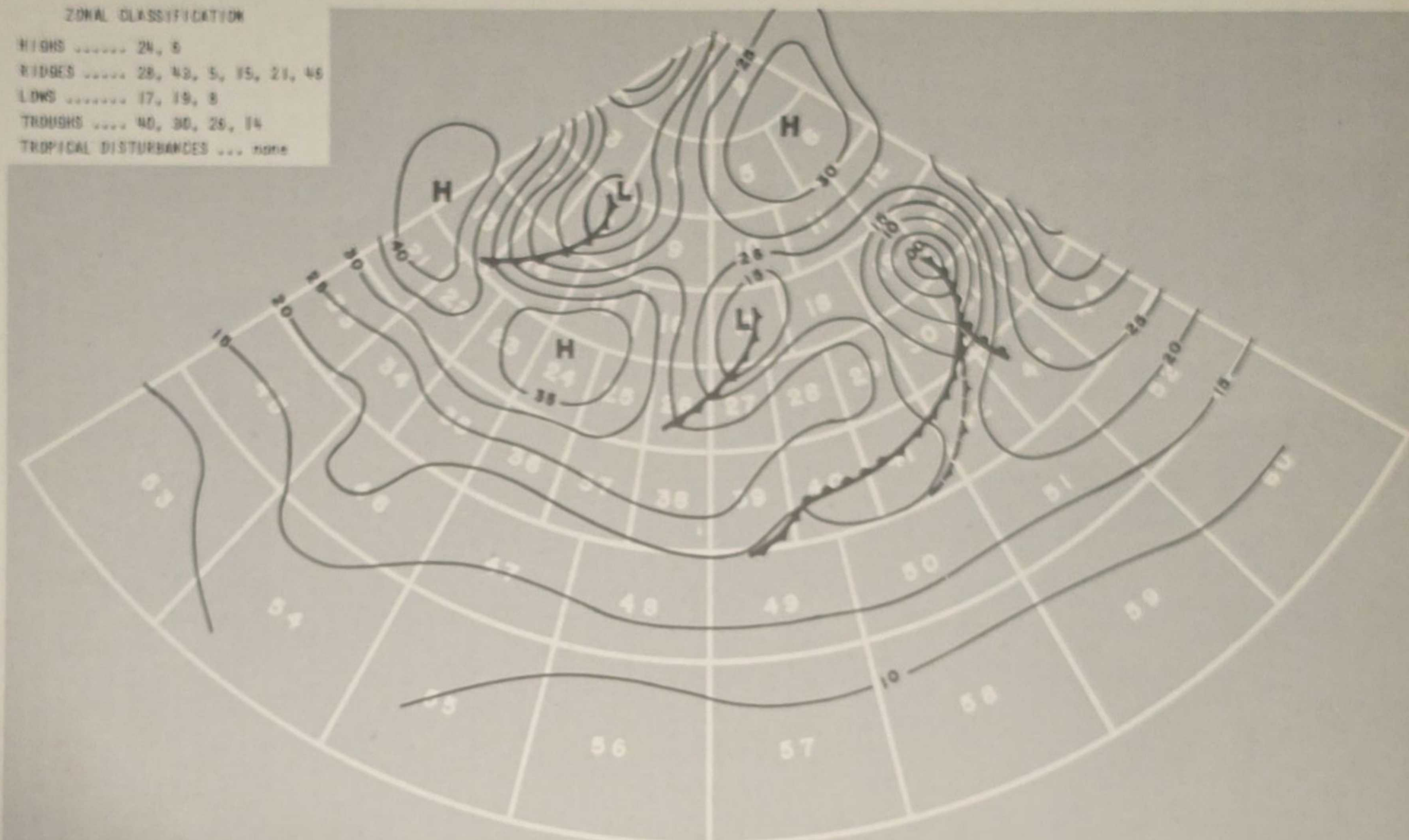

ZONAL CLASSIFICATION
HIGHS 24, 6
RIDGES 28, 43, 5, 15, 21, 46
LOWS 17, 19, 8
TROUGHS 40, 30, 26, 14
TROPICAL DISTURBANCES ... none

Figure 1

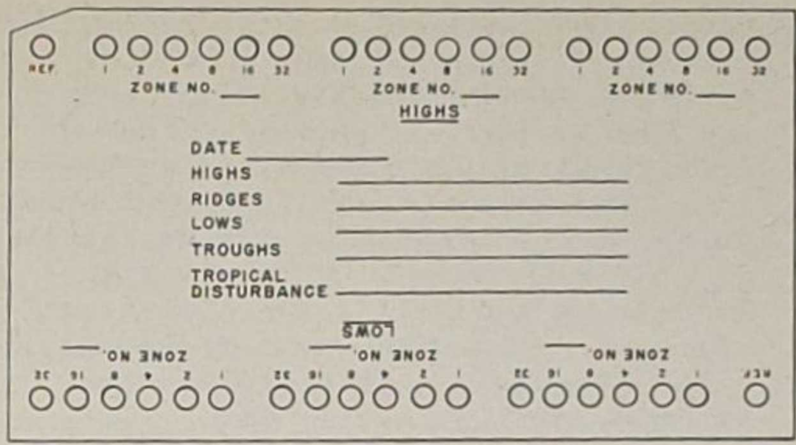
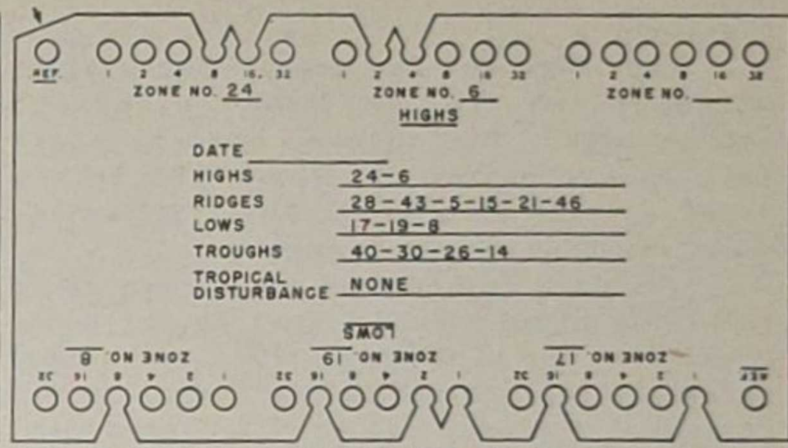


Fig. 2



UPPER LEFT CORNER OF CARD CUT OFF TO INSURE CORRECT POSITION (SEE ARROW)
Fig. 3

II. In cases where the central isobar of a pressure center incloses equal area in two or more zones (thus confusing the choice of code number), the zone to the northeast is selected.

III. Low pressure situations where closed isobars exist over a water surface south of 25° are classified arbitrarily as tropical disturbances, provided that no frontal structure is associated with the system.

After the historical series had been completely "typed" by this number code, a punch-card filing system was established. One blank card (figure 2) was prepared for each historical map. The six holes around the perimeter assigned to each pressure center suffice to indicate any zone number between one and sixty by various combinations. Indentations are placed over holes which add up to the zone number: the map of figure 1 is represented by indenting the blank form of figure 2 in the manner shown by figure 3.

There is a unique combination for every zone between one and sixty because the holes represent powers of two. For example, figure 3 shows how the primary High (#24 in figure 1) was identified by indenting the punch-holes labelled 8 and 16 (sum 24) which are the third and fourth powers of two respectively. Similarly, the secondary Low (#19 in figure 1) was referred to by indenting holes 16, 2, and 1 (sum 19) which are the fourth, first, and zero powers of two respectively. For the purposes of simplifying the punch-card filing, reference to the position of ridges, troughs, and tropical disturbances is made only in typewritten numbers and not in punches.

Once a punch card has been prepared for each map in the historical series, and after each card is individualized by indentions of the holes which represent pressure center positions on the subject map, analogues can be selected with ease. The value of the indentations is made clear by the routine of operating the system described below.

PRACTICAL PROCEDURE

After a frontal and isobaric analysis of the current synoptic map has been completed, it is "typed" according to the number code used in classifying the historical series. Suppose for the sake of demonstration that figure 1 is the current situation. Then one must pick out a reference card indented like figure 3. Of course this filing card of the analogue is buried among thousands, all just like it except for positions of the indentations.

The card file is arranged so that each card is oriented the same way (made easy by the dog-ear in the upper left hand corner). The first selection is made by inserting rods through the whole file's top row in those holes which describe the current map. Then only those cards which have indentations in all of the required holes will fall out of the file when it is shaken over a basket.

Of course, certain zone numbers larger than the required figure will be released at the same time: those composed of several powers of two, some of which add up to the zone number sought. For example, a card which represents a primary High in zone #31 (holes 16, 8, 3, 2, 1) would be released with the cards indented only at the required 16 and 8. However, the Highs of secondary and tertiary importance restrict the number of such ambiguous selections by requiring a similar coincidence in their indented holes.

Refinement of this first distillation lying in the basket, so as to eliminate these ambiguities, is the next step. Realign the cards taken from the basket. Then push a rod through each hole in the top row in succession, except 16 and 8 in the first group and except 4 and 2 in the second group, shaking free extraneous cards after each insertion. The cards which remain on the last rod represent accurate analogues insofar as High positions are concerned (#24 and #6 in our example).

Turn them over and repeat the sorting procedure on the Low groups along the bottom edge. Preliminary choices again fall in the basket and then are given a final sifting by shaking out the "ambiguous" cards in the Low groups.

The maps represented by the few cards remaining after the last sorting are withdrawn from the historical file and checked carefully against the current map. Application of analogue criteria by inspection determines the ultimate choice of analogue.

An historical chart having an appropriate pressure center located in a zone *next* to the zonal position of a High or Low on the current map often may be a satisfactory analogue. A sorting for pressure center positions in adjoining zones may be profitable if an analogue is not revealed by using the actual position.

A three-man team classified the whole historical series at the rate of one month of historical maps per hour. The code numbers for pressure phenomena were typed on each card and the appropriate indentations made within this time limit. Two other copies of their findings were prepared. One was filed so as to be safe from threat of enemy action. The other was arranged chronologically, first by months and then by ten-year periods, to permit an occasional visual search for analogues.

Instructions in AR 615-25 and AR 615-26 were very helpful in the development of this map-sorting and filing system. Experience emphasized the importance of having corresponding punch-holes aligned with precision: certainly a carefully-prepared template must be used.

A further possibility of this system would be to sketch on the back of each card a rough replica of the historical chart it represents, giving fronts and centers. Then reference to the back of those cards remaining after the last selection by rods would permit the rough elimination of several more cards. Obvious dissimilarities caught in this way reduce even further the number of actual historical maps that must be compared laboriously to the present situation. This suggestion requires considerable additional preparation, and it is questionable whether the work involved is justified.

continued from page 2

At about 0800, an eddy low of similar nature (but shallow and local) developed in the vicinity. It was strong enough to destroy the surface circulation near our station and bring the cold air back over the base. Ten minutes later, the thermometer dropped back from 38° to 15° and the eddy low washed itself out.

An hour later, a similar variation took place: the temperature rose to 30° during a light easterly flow and fell again to 23° a short time later as another, though less intense, eddy formed.

Not to be boring, but when this eddy had destroyed itself by glutting with cold air, the easterly Foehn picked up once more and in 10 minutes the temperature had risen again from 23° to 44°. The wind picked up to 50 mph with gusts over 65, and within an hour the temperature rose slowly to 50°; bringing to a close what is probably the most erratic period in the history of temperature and wind recordings.

Within a period of two hours, and with most of the changes occurring in a few minutes, a gross change of 107° F. and a net increase of 47° F. was recorded. The total temperature increase that day was 53°, compared with the average diurnal variation of 17° for that time of year.

Winter temperatures in southwest Greenland average between 20 and 25°F., somewhat higher than at many stations in the United States. It is readily seen that Foehn winds not only modify the climate of large areas, but also they destroy the meaning of climatic averages by creating tremendous variations from minute to minute. Military operations in Greenland's region of Foehns, equipped on an assumption that the average temperature and windspeed would hold, could only be forced to endure unexpected extremes.

REGIONAL HEADACHES

by Major R. L. Sorey & Lt. R. W. Beart

The Twenty-third Region, one of several activated in the United States only a year ago, began its existence beset with grave responsibilities. The highest official attention was focussed on the Very Heavy Bombardment training concentrated at bases served by the new squadron. Even more trying, B-29 operation makes demands upon its weather service for forecasts at extraordinarily high levels and over long routes.

Furthermore, several conditions which existed as well in other regions struck the new-born Twenty-third with particular force. Forecasters were inexperienced The boundary between the duties of Staff and Station Weather Officer was not clear. Briefing procedures were limited, non-standard, and often poorly-designed. Authorized promotions for enlisted men had been almost exhausted, and opportunities for advancement were limited further by paring of the whole training program in weather.

This is the approach that was taken to these problems under the direction of Lt. Col. Diran Arakelian, the Regional Control Officer:

LOW EXPERIENCE LEVEL

Combat theaters made heavy demands for weathermen in the summer of 1943. These orders were filled according to General Arnold's directive that the best-qualified men be sent overseas. Obviously, very few experienced weathermen were available for duty in the domestic regions by the close of 1943.

Certainly no action could be taken that would simply create experience and ability. However, a secondary step was taken to sift out carefully the best men on hand for appointment as Station Weather Officer or Station Chief. Then technical and administrative responsibility was concentrated upon these superior abilities. The weather service rendered thereafter showed this greater influence given to the most able forecasters.

Secondly, an in-flight training program was established. Forecasters fly the routes with which they are principally concerned, obtaining direct evidence about the meteorological effects which are hazardous to flight.

Finally, careful inspection of map files at various weather stations showed that the maintenance of continuity was poor. A heterogeneous group of men, trained by six different forecasting schools, was presenting information based on widely variant pictures for the same weather situation. Not only did this increase the difficulties of forecasters at individual stations, but pilots going from one station to another within the region were confused by differing analyses of the same weather situation. Such inconsistency threatened to jeopardize the faith of flyers in the forecasting service supplied to them.

Two methods are used to improve continuity. First, Station Weather Officers are directed to make the 1230Z map analysis themselves, and to see that the other forecasters at their stations analyze later maps by maintaining a continuous movement of systems from the 1230Z positions. This plan enables new and inexperienced forecasters to obtain valuable assistance, because their analyses are made with the help and supervision of more experienced weathermen.

Secondly, an official analysis for the 0630Z map is transmitted by teletype and telegraph to all stations in the region, along with a general forecast for the day by areas. Every forecaster is authorized to change this analysis, but only if he reports both the changes and the reasons for them in a letter to the Regional Control Office.

STATION AND STAFF FUNCTIONS

The division of duties between forecasters assigned to stations and forecasters assigned to staff duties made by regulation was fuzzy. No one could tell where the functions of one began and the other's ended. Combat Crew Training Schools in particular showed the undesirable results of this confusion.

A workable solution adapted in the Twenty-third Region was to have the Station Weather Officer at C.C.T.S. bases assume both Staff and Station duties. The SWO was directed to study operations at his base, and then to design a complete and unified program for individualized weather service, adapted to the requirements of each type of using personnel. As an example of the results the Commanding Officer at C.C.T.S. bases, the Director of Flying, the Director of Training, the Operations Officer, and the men of each training mission now receive a style of daily weather briefing suited to their specific responsibilities.

STANDARDS FOR BRIEFING TECHNIQUES

After a few months of experimentation with the many procedures developed in this way, the R.C.O. decided that Kearney AAB, Nebraska, had the most satisfactory technique in weather presentations for high-altitude, long-distance flights. The methods used at Kearney were made standard throughout the region for such weather briefings, and RCO representatives were sent to the various C.C.T.S. bases to explain the new procedure.

It was discovered that there are probably important differences in briefing ability among the several forecasters that might be assigned to a station. All forecasters were required, therefore, to present an operational briefing at each visit of the R.C.O. or the Technical Inspector. The men best qualified for briefing service were singled out on this basis.

NEW TECHNIQUES

The Twenty-third Region established a "Master Station" at Kansas City to develop original forecasting tools, particularly to meet the problems of B-29 operation.

One of the first products of this research was the "Equivalent Potential Temperature Chart," devised for thunderstorm forecasting. This chart was considered to be so useful that each forecasting station in the region was required to prepare one daily. Other problems considered by the Master Station have been: forecasting of winds at high levels, forecasting of upslope stratus, simplification of upper-air charts, local forecasting problems submitted from individual stations, and development of suitable prognostic charts.

The Very Heavy Bombardment training program makes repeated demands on its weather service for wind forecasts well above 20,000 feet. The paucity of wind reports at such heights is well known, but Bellamy and Plumley developed a method for drawing "altimeter correction" charts to represent wind flow on constant pressure charts. This method gives information about high altitudes which is derived in part from the more plentiful wind and pressure reports at lower levels. The originators of the technique then visited the larger stations to explain this procedure. These constant pressure charts subsequently have been adopted as the standard upper-air charts in the Twenty-third Region.

Additional instruction in new techniques was given at a recent conference of Station Weather Officers as another phase of a continuous training program. Forecasting seminars of the type held in all domestic regions are the latest development.

MORALE PROBLEMS

By the close of 1943 the Weather Service had reached its limit of expansion and all organizations were at or near authorized strength. It was evident then that weathermen could not continue to expect the rapid promotions that had been the rule. In particular, enlisted men had not been bound by the seniority regulations which had restricted the promotion of officers, and therefore their promotions had been exhausted more completely. At about the same time opportunities were limited further by the diminished quotas available for Forecasting School and Radiosonde Technician School.

A decline in efficiency was feared as a result of this situation, and so a two-fold program was introduced; partly a stimulation of pride in weather duty and in part a recognition and correction of incidental morale problems.

Station Weather Officers were informed of the necessity for operating an excellent station so that pride in weather duty would balance the scarcity of promotions. Station Chiefs were given responsibility for the enlisted man's welfare; and in cooperation with the weather officer of recognizing and solving morale problems when they first appeared. In addition, the RCO and the Technical Inspector carried out extensive inspections of barracks, mess, and recreational facilities. Enlisted men were encouraged to make use of confidential conferences with these officers so that every effort could be made to adjust complaints and remove the causes of poor morale.

Station Weather Officers and Station Chiefs were instructed to estimate the abilities of enlisted personnel with care, so that ratings could be given to the most deserving. In some cases, a promotion for one required a reduction in grade for another. This situation made clear the necessity for maintaining a high rating to keep the grade held at present.

WINDS ABOVE PIBALS

Trends in the design of military aircraft, particularly within the Very Heavy Bombardment Program, foretell new demands on the meteorologist for forecasts of winds at very high levels. But raob and pibal reports consistently become sparse above 10,000 feet. However, this article will show that certain reasonably-valid assumptions permit an isobaric analysis of constant-level maps at higher altitudes that draws upon the far-more-plentiful observations at 5,000 and 10,000 feet.

Experience shows that isolines of pressure-difference between two mandatory levels retain an almost constant pattern up to the tropopause. That is to say, if isolines of $\Delta p_{5,10}$ (5,000 foot pressure *minus* 10,000 foot pressure) are drawn, then the configuration of lines resulting is the same as if the variable were $\Delta p_{10,20}$ (10,000 foot pressure minus 20,000 foot pressure). (Linear spacings and absolute values of pressure difference do *not* hold from one interval to another, however).

Here is a quick outline of how to capitalize on this relationship:

First, use the heavily-spotted 5,000 and 10,000 foot charts to determine the unique pattern of Δp; the great number of signals permits an excellent accuracy. Then analyze the raobs reaching to 20,000 feet to get actual values of $\Delta p_{10,20}$. Now draw isolines $\Delta p_{10,20}$ exactly for these values and as closely as possible according to the configuration of the $\Delta p_{5,10}$ field. Once the map of $\Delta p_{10,20}$ has been completed, the desired pattern of isobars at 20,000 feet is found by subtraction:

$$P_{20} = P_{10} - \Delta P_{10,20}$$

Don't run away for fear of all this arithmetic: there is an easy way out called "graphical subtraction." If the isobars at one level are superimposed on the isobars at a second level (using the same interval of say 2 mb. in both sets), then lines drawn through successive isobar intersections *going from high pressure to low pressure for both levels (in steps of say 2 mb.)* are the answer wanted: lines of equal pressure difference. (See figure 1.) "Graphical subtraction" must be replaced by arithmetic only in those areas where the isobars cross each other at small angles and the pressure difference line is the short diagonal of the quadrilateral.

(Forecasters will be quick to see that this technique is very much like the graphical method for finding mean isotherms, except that the isobar interval on one level is not equal to that of the second in a mean isotherm determination).

A practical routine for working out the analysis of high level maps by drawing on the more plentiful data at lower levels is given below. It requires: 1) that observers plot an additional figure in the station circle on upper-air charts, the difference in pressure between that level and the one above; 2) that the kinematic analysis of upper-air charts (e.g., entry of isotherms) be delayed until the pressure field has been completed on each of the maps to be drawn; and 3) that one extra variable be delineated by isolines on each of the upper-air maps except the highest below the tropopause.

THE PROCEDURE

Upper-air work for the period is begun by drawing isobars on the 5,000 and 10,000 foot charts, giving particular weight to obtaining a parallelism with the winds. It is important to make the isobars heavy by firm use of a soft black pencil or a thick pen, in view of the tracing that is called for later.

When the isobars have been finished, place these maps on a light table with the 5,000 foot chart on top. Draw isolines of $\Delta p_{5,10}$ on the 5,000 foot chart by the method of graphical subtraction. The plotted values of $\Delta p_{5,10}$ are not needed in this operation, but they are useful as a check. Heavy, orange lines are suggested.

Next, shuffle the maps by placing the 10,000 foot chart on top. The isolines of $\Delta p_{10,20}$ are drawn on the 10,000 foot chart for values divisible by the isobar interval

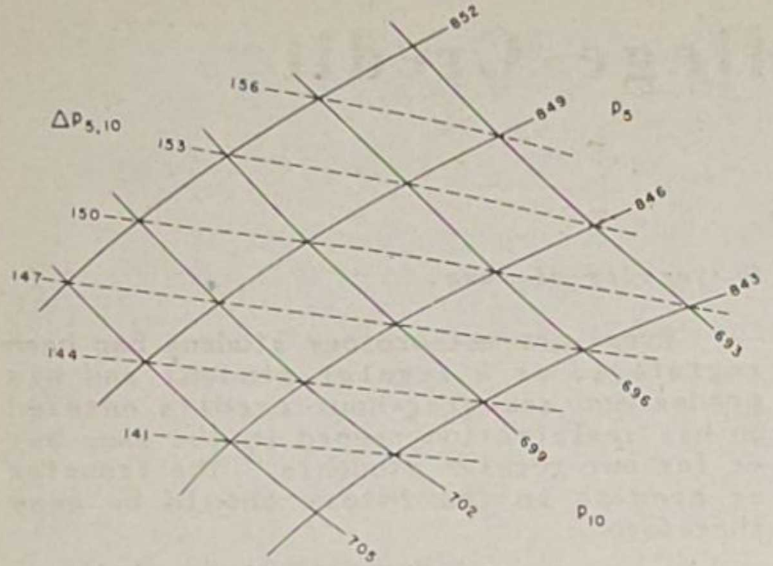


Figure 1, *Graphical Subtraction* here has given isolines of pressure difference separated by units of 3mb because the isobar interval chosen is 3mb.

chosen. They are drawn exactly for plotted values $\Delta p_{10,20}$, but the pattern of $\Delta p_{5,10}$ is followed as closely as possible.

Then the 10,000 foot chart is slipped under the 20,000 foot chart (spotted but unanalyzed) on the light table. One is now ready to achieve the final object of this whole procedure, analysis of the pressure field at 20,000 feet. This can be done by graphical subtraction of the orange $\Delta p_{10,20}$ lines from the black 10,000 foot isobars, both of which appear on the underlying map: $P_{20} = P_{10} - \Delta p_{10,20}$. The resulting analysis should be checked against the plotted values of P_{20} to make sure that the subtraction has been performed properly. An adjustment of the 20,000 foot isobars is then made to obtain agreement with the plotted winds at that level.

If maps are to be drawn for levels above 20,000 feet, the analysis of $\Delta p_{10,20}$ must be changed to account for adjustment of the 20,000 foot isobars according to the wind reports. The amount of change in $\Delta p_{10,20}$ is a measure of how the basic assumptions of this method represent actual conditions.

The isobars at 10 km. can be analyzed by exactly the same procedure as given above, utilizing the adjusted pattern of $\Delta p_{10,20}$.

Some obvious limitations to this method exist. First the method cannot be used in regions close to the Equator, where the gradient wind relations do not hold. Secondly, the method cannot be used to fill out the pressure analysis above the tropopause because the basic assumption is not valid there. In the third place, in regions where there are very few wind observations at low levels, the best the method can do is to provide for consistent isobar patterns. When there are extremely few observations at high levels, there is no way to check the analysis. And finally, the forecasting interpretation of each upper-air chart is made more difficult by the addition of an extraneous isoline.

"Detailed Upper Air Analysis," which was written by John Bellamy and Lt. William Plumley, presents an analogous method for filling out the analysis at upper levels for *constant pressure* charts.

Weather Division Report Number 795, "A Rational Method of Constructing High Altitude Weather Maps" contains a detailed study of the techniques discussed in this article. Report 795 uses an example of 3mb isobars, but any interval can be used as long as it is the same for each level concerned in graphical subtraction. In addition, 15,000 feet has recently become a mandatory level in the raob code, and can receive the same treatment indicated for the other charts. Reported winds and pressures at 15,000 feet can thereby be used to obtain more accurate analyses at higher levels.

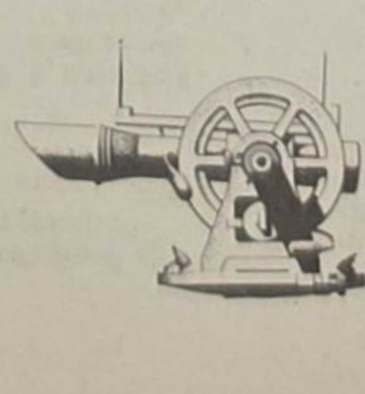
The editors of Weather Division Report #795 wish to call attention to two typographical errors which appear therein:

On page one, the formula which gives the change in pressure from height z_1 to height z_2 should read,

$$\Delta p_{z_1, z_2} = -g \int_{z_1}^{z_2} \rho(z)dz$$

On page five, third paragraph, the second sentence should read,

"The field of p_{20} ($= p_{10} - \Delta p_{10,20}$) is drawn on the 20,000 foot chart by graphical subtraction of the red $\Delta p_{10,20}$ lines..."



A B C's of College Credit

At present, the policy is general among the "A" schools that none of these five universities will vary the credit allowed for meteorological cadet training on such a basis as the school at which the cadet program was taken. The University Meteorological Committee has agreed already that full credit should be granted for courses at the AAFCTC weather school (Grand Rapids and Chanute Field).

Just how many points will be given by each university for "A" training depends on the individual's record, the policy of the university chosen, and the degree which is sought (ex-cadets may wish to apply their military experience to additional meteorological training or toward a degree in the Liberal Arts for example).

Some schools (M.I.T. for one) call for at least one grade above the lowest passing grade before "transfer credit" for a subject can be admitted. Others (Chicago and M.I.T. as examples) require that the course for which credit is sought have an equivalent in the curriculum of the accrediting institution. New York University "permits the granting of a maximum of 36 hours of credit (for 'A' training)... provided that the average grade of C or better is attained. To make use of the maximum number of credits it will be necessary to apply them toward the degree of Bachelor of Science in Meteorology."

The conference of Science Representatives from "B" colleges, held on 8,9 August 1943 at Chicago resolved that the "B" program is of a type which deserves undergraduate credit toward a degree and where given it should not exceed 30 hours.

Correspondence with several institutions of higher learning has revealed their stand about accrediting "B" training. A uniform decision is to withold "double credit" for military courses duplicating a college course already claimed by a student. The remarks which follow are taken from official letters:

Brown University

Credit equivalent to seven semester courses (28 semester hours) will be granted for satisfactory completion of the "B" program.

University of Iowa

Every pre-meteorology student has been registered as a regular student and his grades and semester-hour credits entered on his registration record in the same way as for our regular students. The transfer of credits in the future should be easy therefore.

Subject	Semester hours credit Per term	Semester hours credit Per course
Mathematics I	4	8
Mathematics II	3	6
Physics	4	8
Geography	2	4
English	.5	1
Speech	.5	1
		28

Massachusetts Institute of Technology

The individual subjects which we are giving in the "B" program will be given credit as subjects of college grade, except that they will not count towards our Bachelor of Science degree. After the war is over and students who took meteorology "B" return to our institution to continue their studies, we will then decide on the basis of individual quality of work whether or not each subject will be accepted towards our Bachelor of Science degree in the particular field in which the man is specializing.

Subject	Units	Semester Hours
Physics	23	11
Geography	10	5
Communications	5	5
Mathematics	24	10
Mechanics	17	6
		37

University of Michigan

Following is a tentative report on the maximum number of semester hours credit which the University of Michigan will grant for successful completion of the "B" course:

Subject	Semester hours
Calculus	8
Mechanics	6
Physics	8
Geography	4
English & Speech	2
	28

University of New Mexico

Credit for courses in the Premeteorology program:

Course	Semester hours
I	8
II	6
III	8
IV	3
V	2
	27

University of Minnesota

Credit is to be given quarter by quarter. In order to obtain the number of semester hours from these units, multiply each by two-thirds:

Subject	Quarter hour credits Qr. I	Qr. II
Mathematics	6	6
Vectorial Mechanics	4	4
Physics	6	6
Geography	3	3
English	1½	1½
Speech	½	½
Physical Training	1	1
	22	22

New York University

Transcripts of records which have been furnished all students who have completed the "B" course here state these credits:

Mathematics	10
Physics	9
Mechanics	6
Geography	4
Communications	1
	30

We will allow students applying to this college for credit toward a Bachelor of Science degree:

Mathematics	10
Physics	10
Mechanics	9
Electives	4

If an applicant for credit here had completed one year in an engineering college, we would probably allow full credit covering the following sophomore courses: mathematics (7 semester hours), physics (10 semester hours), dynamics (3 semester hours), and 5 semester hours of credit toward cultural electives.

In the case of engineering students who had previously one and one half years of engineering, this university would consider giving blanket credit for the second half of its sophomore year. Engineering degrees are awarded on completion of required courses, and hence it is not feasible to allow the maximum of 30 credits suggested by the Science representatives.

University of North Carolina

Subject	Quarter hours
Mathematics	12
Mechanics	9
Physics	12
English	3
Geography	6

This is equivalent to 28 semester hours of credit.

Washington University, St. Louis

Subject	Semester Basis "B" Units
Mathematics	10
Mechanics	5
Physics	8
English	3 composition or 2 speech
Geography	3
	28 or 29

(tentative)

University of Washington, Seattle

We have agreed, subject to approval of the general faculty, that the courses in the "B" program at the University of Washington shall be given credit here according to the following table:

Course	Quarter credits	Semester credits
I	21	14
II	8	5 1/3
III	15	10
IV	7	4 2/3
V	3	2
	54	36

University of Wisconsin

Following is a report on the number of semester hours credit in each of the courses which is being granted to Premeteorology "B" students:

Course		Semester Credits
I	. . . .	9
II	. . . .	7
III	. . . .	8
IV	(Geography)	4
V	(English 1) (Speech 1)	2
		30

Similar information regarding the pre-meteorological military program on the lowest level is given below, subject to modifications for unsatisfactory grades or duplications with previous college courses:

Amherst College

Academic records of the students in the "C" Pre-Meteorology Program are kept in the regular college offices and the following maximum semester-hour credits is given for courses which have been successfully completed in this program:

Subject	Semester hours
Mathematics	15
Physics	12
Vector Analysis	4
Geography	6
English	4
Speech	2
History	6
	49

The amount of credit to be given to each individual will depend upon his previous scholastic record, including both his entrance credits and his credits for college courses.

Bowdoin College

Here at Bowdoin, credits toward a degree are arranged on a *semester course* basis thirty-four semester courses plus Freshman courses in hygiene and public speaking being required. There is a certain amount of confusion in interpreting semester course values into semester hour credits, but the usual ratio is three hours for one course.

These recommendations will be followed exactly in the case of men who may wish to qualify for a Bowdoin degree and will be transmitted, at the request of members of the "C" unit, to any other college at which they may wish academic credit.

Subject	Semester courses	
Mathematics	4	
Vector Analysis & Mechanics	2	
General Physics	3	
Geography	2	
English and History	3	plus credit for required work in public speaking

Brown University

On July 6, 1943 the faculty voted that the satisfactory completion of the academic work of the "C" meteorological program at Brown University be regarded as equivalent to the satisfactory completion of three semesters of academic work in the regular course of Brown University and that on request it will be so certified.

The exact distribution of credit among the various academic fields was left for subsequent determination.

University of California

The Board of Admissions will allow 48 semester units of academic credit for the "C" program now under way on the Berkeley Campus. This is exclusive of any credit that might eventually be allowed for military science and physical education. This action has been approved by both Northern and Southern Divisions of our Board of Admissions; in other words, it applies both at Berkeley and Los Angeles.

The committee did not undertake to allocate this total number of units among the several courses in the C program, but a fair distribution of units of credit would be as follows:

Subject	Semester units credit
Mathematics	15
Mechanics	6
Physics	12
Geography	6
History	6
Public Speaking	3
	48

When the "C" course is completed, we plan to give each student who completes the program satisfactorily an official certificate of completion that will establish the 48 units of credit on our records. Presumably they may then be transferred on an official transcript of record to any other university where the student may wish to continue his work, or they may be counted for degree-granting purposes in any department of the University of California.

Carelton College

Subject	Semester hours
Mathematics	16
Mechanics	6
Physics	10
Geography	6
History	4
English & Speech	4
	46

University of Chicago

On the understanding that the University is limited to academic credit for transfer purposes of 45 semester hours in the pre-meteorological program, the Academic Committee has decided that the credit should apportioned in the following manner:

Subject	Semester hours
Mathematics	18
Vector Analysis	6
Physics	9
Geography	6
History, Political Thought, and Communication	6
	45

It was the concensus in the Academic Committee that it would be fairer to grant 50 rather than 45 semester hours of academic credit for the complete program. If credit of 50 semester hours were possible the committee would suggest that 8 rather than 6 semester hours credit be given for Geography and 9 rather than 6 for Course V.

University of Iowa

Every pre-metorology student has been

registered as a regular student in the university and his grades and semester hour credits entered upon his registration record in the same manner as on our regular civilian students , so that the transfer of credit should be easy.

Subject	Semester hours credit Per term	Per course
Math. I	3.5	14
Math. II	1.5	6
Physics	3	12
Geography	1.5	6
English		3
Speech	.5	2
History	1	4
		47

Denison University

Subject	Semester hours credit
Mathematics	20
Physics	10
Geography	6
History	4
English	3
Speech	2
	45

Hamilton College

Academic Subject	Semester hours credit at end of term 1st	2nd	3rd	4th
Mathematics	4	7	10	13
Mathematics	2	4	6	8
Physics	3	6	9	12
Geography	1	2	3	5
History	None	1½	2	3
English	None	1½	2	3
Speech	None	None	None	1
	10	22	32	45

No credit will be granted for work in Course V completed with a grade lower than 70, or with a grade of "inferior."

Haverford College

Subject	Maximum Semester hours
Mathematics	16
Vector Mech.	6
Physics	10
Geography	5
History & English	8
	45

It is our purpose to allot credit to each man for work satisfactorily completed according to his record, whether or not a man remains the full 48 weeks, or whether or not he passes each of his five courses.

Kenyon College

Subject	Semester hours credit
Mathematics I	15 (4,4,4,3)
Mathematics II	5 (1,1,1,2)
Physics	11 (2,3,3,3)
Geography	6 (3,3)
History	3 (whole course)
English	2 (1,1)
Speech	2 (1,1)
	44

University of Minnesota

Attention is invited to the fact that the credits granted are quarter credits. In order to obtain the number of semester credits, multiply each number by two thirds.

Subject	Quarter hour credits Qr. I	Qr. II	Qr. III	Qr. IV
Mathematics	8	6	6	6
Vectorial Mech.	0	2	2	2
Physics	4	4	4	4
Geography	3	3	3	3
History	2	1	1	1
English	1.5	1.5	1.5	1.5
Speech	.5	.5	.5	.5
P. T.	1	1	1	1
	20	19	19	19

University of Oregon

Subject	Quarter hour credits Qr. 1	Qr. 2	Qr. 3	Qr. 4
Mathematics	10	7	8	4
Physics	2	5	5	9
Geography	2	2	1	1
History	1	1	1	1
Rhetoric	1	1	1	1
Speech and Dramatic Arts	1	1	1	1
Physical Education	1	1	1	1
Military (no credit)				

(tentative)

Pomona College

Subject	Semester hours
Mathematics	16
Physics	11
Vectorial Mech.	6
Geography	6
Course V	9 (English 4, Speech 1, History 4)
	48

University of Wisconsin

Course		Semester Credits
I		14
II		11
III		10
IV	(Geography)	6
V	(English . . . . 2) (Speech . . . . 2) (History & Govt 4)	8
		49

Washington University, St. Louis

Subject	Semester Basis "C" Units

next page →

Bomber Classes by Lt. John Guissinger Jr.

The weathermen at our Flying Fortress base in England have found it profitable to give brief and informal instruction in weather to combat crews. Many navigators and pilots have been prevented from making much use of weather service by an ignorance of even simple meteorological facts and laws. And from the weatherman's point of view, the flyers are much more willing and effective observers of in-flight weather when they have learned the uses to which their obs are put.

The instruction does not follow a formal pattern because new crews are always arriving as replacements. Anyway, the schoolish atmosphere implied in a regular schedule would probably produce the same inattention that apparently nullifies much ground school metro training.

Instead, the weather officer who happens to be on duty when new crews are introduced to various field offices siezes that opportunity to orient newcomers to the meteorological services that are available. Then the weatherman fits into some navigation classes to give another little spiel, this time on the most practical aspects of using, modifying, and obtaining weather information while on a continental mission. Of course, such pedantic language as "horizontal convergence produces instability showers" never enters the discussion, and only such simple terms as *High*, *front*, and *isobar* are used.

Later navigation sessions permit a short review of air mass theory, followed by a description of typical situations like: "North Sea stratus," occlusions, and high pressure weather. The transition of frontal clouds and precipitation that are typical for the United Kingdom into different patterns over the continent excites particular interest.

Other remarks tell how the forecast is made for operational missions. This is a good introduction for the announcement of just what the crews (navigators particularly) are expected to observe about weather during the missions. Stress is placed on the use of their reports in planning subsequent operations the same night or in forecasting for the next day. It's an easy conclusion that the mutual safety of airmen depends on the accuracy and completeness of such reports. The flyers are then ready to listen to the weatherman's list of hints about estimating cloud amounts and types, reading instruments, flying through fronts, and so on.

The increased interest in weather that airmen show after these sessions with a meteorologist, and especially the greater amounts of information that they report, has more than repaid for the little extra work that these informal talks mean for the weather staff.

Mathematics	20
Mechanics	5
Physics	10
English	6
History	4 or more
Geography	6
	51 or more

(tentative)

Reed College

Subject	Semester hours credit
Mathematics	16
Vector Mech.	6
Physics	10
Geography	5
History & English	8
(tentative)	45

University of Virginia

Subject	Semester hours credit
Mathematics	15
Physics	15
Geography	6
History	3
English	3
Political Science	3
	45

Vanderbilt University

Subject	Credit Hours for each Quarter
Mathematics	5
Mechanics	2
Physics	4
Geography	2
English	1
History	1
	15 x 4 = 60

THE COVER

A weather briefing for trans-Atlantic flight to Africa from Newfoundland is in progress. Navigators and pilots are referring occasionally to their flight folders to correlate the specific data given there with the general synoptic picture being described by the forecaster.

The chart behind the weather officer contains "Recommended Flight Level Data." The route has been broken up into zones in this table (top row of numbers) to make the wind forecast more detailed. The second row shows the flight level for each zone; the third and fourth rows the wind direction and speed; and the last row the temperature.

Meteorological data for the cross-section presented was not taken from points along a straight line on the base map between the terminals. On the map projection used, the shortest flying route between two points appears as an arc (of a Great Circle), and the actual trajectory of flight chosen will therefore be along this arc. The great distances involved in transoceanic flight give the difference a meteorological importance.

The route weather for each flight is crayoned on a Plexiglas overlay of the base map, to be erased and changed in time for the next briefing session. The chart beneath, however, does not vary its presentation of land and sea areas, the rhumb-line and Great Circle routes, and names of important bases. Airflow is described on the overlay by use of streamlines, which are believed to have a more obvious significance than isobars.

RAWIN ROUNDUP

At the present time, each of thirty RAWIN stations in North America are transmitting regularly two to four winds aloft reports each day over teletype schedules "C" and "O". A steady improvement in the number of stations reporting, maximum height of the data, and percentage of obligated runs transmitted can be observed.

This headquarters studied the RAWIN reports appearing on teletype sequences between 15 July and 15 September, and discovered that 85% of the obligated runs had been reported. The distribution of maximum altitudes of RAWIN reports was as follows:

60,000 feet or more	5%
50,000 to 60,000 feet	19%
40,000 to 50,000 feet	26%
30,000 to 40,000 feet	33%
20,000 to 30,000 feet	14%
10,000 to 20,000 feet	2%
10,000 feet or less	0

PIGEON PROBLEMS

by M/Sgt. MILTON WERBIN

by M/Sgt. Milton Werbin

Humans are not the only flyers on military duty; the Army makes extensive use of the homing pigeon as a courier. Although weather conditions affect their flight seriously, don't expect G.I. fowls to flutter into your station with a Form 23 clutched in claw. They're not that wise in Army ways yet, but the bird handlers of the Signal Corps regularly ask for a daily forecast. Considerable experience with pigeon staff duties has made Forecaster Werbin ecstatic about his clients, and in CAVU (the 26th Region's magazine), the sergeant says:

The pigeon is a boon to forecasters. He's one guy to whom you don't have to assign a fast-talking weatherman in order to sell him on weather service. Never will a feathered avian give you the business of "This is only local stuff," or "I sure don't want to spend the night in this burg," or even "That stuff will burn off by noon, won't it?" Not the least of a bird's attractiveness is that he will never pull a green card on you, and always prefers CFR.

Pilot Pigeon generally flies at low altitudes, 500 to 1,000 feet. He avoids clouds religiously and remains well below the bases. Hedge-hopping is a dangerous game, but much less so than wandering into a strong updraft. A carrier pigeon, you know, weighs only a few pounds. However, a few birds were taken up to "35,000 feet" in the high-altitude test chambers at AAFTAC and successfully endured the lack of oxygen without masks, and the temperatures of 60 below zero without flying suits.

Visibility unlimited to a member of the family Columbidae (that means pigeon too) is 100 miles, so any kind of obstruction to VV is a pain in the eye to Columbo. Cruising speed averages 30 to 40 mph, and ten hours is about the limit of operations. It is evident that a strong head wind will greatly reduce fowl speed and range. Unfortunately there is no way of telling the bird to fly at say 8,000 feet where winds will be most favorable.

No tower instruction need be given a pigeon about the proper runway to use when coming in for a landing. A surface wind from the south always brings him in from the north. That wisdom puts the bird one up on humans, but both aviators are subject to instrument trouble in thunderstorms. The pigeon may have his homing instinct disconcerted and confused, similar to the pilot who becomes bewildered by the erratic nature of radio ranges in extraordinary electrical activity.

The homing instinct of a pigeon is a curious phenomenon that has not been explained completely. The accepted theory is that the bird heads for home to appease his hunger, and especially to carry out his social obligation to reproduce the species. A well-trained homing pigeon, you see, will not eat or mate anywhere but in the coop in which he was raised. In other words, pigeons do not "fly the coop."

Quite recently, a training program for pigeons produced night flyers. The birds previously were daytime operators only, and even now are specialists in one or the other. Night-flyers do exercise in the daytime, however.

There is a story told about an heroic pigeon of World War I. This bird flew home to U.K. across the North Sea from Norway through an active cold front. He delivered a vital message and then, very dramatically, keeled over dead.

It's interesting to read what TM 11-40 "The Homing Pigeon" has to say about physical distinctions between the male and female of the species:

"The cock's coo is coarse...while the hen's is sharp. The cock's eyes are bright and fiery, but the hen's are rather mild. In fact, an experienced pigeoneer can usually distinguish between the sexes by the expression in the pigeon's eye."

Ain't boids just like humans?

BEATING A BLOW

by WO (JG) MATT L. MLEZIVA

The Army Hurricane Warning Service reported a tropical storm near Jamaica in the early hours of 1 August. Just a quick look at the broad southeasterly flow onto the Carolina coast existing at 10,000 feet told those of us on duty at Camp Davis AAB, N. C., that our weather station was on the spot.

A hasty conference among the forecasting talents available produced a consensus after a fair amount of haggling. It was agreed that the trough aloft would steer the storm onshore from the reported positions, and in particular that Oak Island (301) would be about the first place to feel the tropical storm.

Once the collective mind was made up, forecasters kept close to the teletypes, watching every report in the area for increasing wind speeds and falling pressures. The morning brought these preliminary signs as expected. Pibal data was meagre because ceilings were low, but these windspeeds rose at a rate similar to the surface winds. Surface pressures were falling steadily:

TIME	SEA LEVEL PRESSURE	SURFACE WIND
0730	1017.1	EAST 18
0830	1017.0	EAST 16
0930	1016.7	EAST 29
1030	1016.4	EAST 23
1130	1015.8	EAST 22
1230	1015.4	EAST 26
1330	1013.8	EAST 29
1430	1010.9	ENE 51

After a careful check on the accuracy of these reports, the station staff decided that an evacuation warning was imminent. Every military component in the vicinity of Camp Davis was notified that evacuation would be necessary in a short while. Preparation was made to dispatch a large force of government vehicles beachward to transport civilians to safety.

When the evacuation order did arrive two hours later, the rolling stock was ready to set about the removal of 10,000 civilians from the beaches to safety in Camp Davis and Wilimington. Just at the time when the evacuation was being completed, the storm crossed the coastline. It is believed that the preliminary notification given by the Camp Davis weather station before the official storm warning may have represented the difference between the successful protective measures that were accomplished and a possible disaster.

The storm entered North Carolina from the ocean between Wilimington and Oak Island, moving northward through the eastern edge of the state. Wilimington reported a peak velocity of 52 mph from the south, placing that station to the east of the storm center.

Greatest damage was caused by the east wind which preceded the storm because the flow from that direction was extremely gusty. Various sources placed the total loss at several figures between one and two million dollars, without consideration of the extensive damage to crops. Teriffic breakers caused considerably more trouble than even the wind along the beaches, but communications everywhere suffered heavily from falling trees. The south wind which prevailed after passage of the storm center was stronger, but its steadiness lessened the destructive effect.

Most stations in southeastern North Carolina received as much as four inchesof rainfall from influence of the tropical disturbance, but reports indicate that no rain fell in the very center of the storm. In fact, a red glow of the setting sun could be viewed, although dimly, through the very low cloud deck observed at the estimated time of the storm-center passage.

Headquarters Notes

A.M.S. DEVELOPMENTS

The president of the American Meteorological Society, Dr. C.G. Rossby, recently clarified and added to the information contained in the leaflets distributed to Weather Service forecasters by the Society. Dr. Rossby's statements follow:

The reorganization plan for the Society will be submitted to all members, presumably in the latter part of November. There is every reason to believe that it will be adopted at the annual A.M.S. meeting to be held in Kansas City about the middle of January.

The new structure calls for two classes of members: "professional" at ten dollars per calendar year and "regular" with the customary dues and privileges. The professional membership will be open to weather forecasters who have had at least one year of professional experience subsequent to graduation from weather school. An important point is that the A.M.S. is a professional society, with the intention that all membership grading will be based on professional training and experience and not on distinctions between officers and enlisted men.

A balanced budget at a sufficiently high level to permit additional operations as a professional society should call for an income of more than $30,000 as shown below. Our present annual budget is about $10,000 (used mainly for the *A.M.S. Bulletin* and derived principally from membership dues).

Proposed Budget

Income		
1,000 professional members	*($10)*	*$ 10,000*
1,500 regular members	*($3.50)*	*5,250*
75 corporate members (airlines, etc.)	*($100)*	*7,500*
Subscriptions		*4,000*
Outside support		*5,000*
		$ 31,750
Expenditures		
Journal		*$ 8,000*
Bulletin		*7,000*
Editorial salaries		*3,000*
Rent		*2,000*
Executive office		*10,000*
		$ 30,000

The present recruiting drive is based on soliciting members for the eighteen month period from 1 July 1944 to 31 December 1945. The A.M.S. hopes that all meteorologists who will have reached the experience level required for professional membership by 1 July 1945 will join now so that they can vote this fall on the new plan. If some weathermen approached happen to be members for 1944 under the old plan ($3.50), they will be given credit on dues paid for the latter half of the year. In such case a professional membership for the eighteen-month period will require $13.25.

The A.M.S. is campaigning to make potential employers aware of the existence of the Society's personnel file, and an extreme interest has been excited in important organizations. There appears to be a growing sentiment for utilization of the A.M.S. as a certifying agency for airline meteorological positions. This will be discussed further at the Air Transport Association meeting in a few days, where the A.M.S. will be represented by Dr. Horace R. Byers.

The Society expects to arouse the interest of the Air Transport Association and the Civil Aeronautics Administration in utilizing ex-military weathermen fitted for air or ground crew positions outside the field of meteorology itself. Some Weather Service personnel have received various types of specialized training which should make them particularly useful in certain positions.

The Society is now working with the Weather Bureau on an agreement to define the legitimate spheres of private and government enterprise in meteorology. This should eventually produce a "Magna Charta" of the Meteorological Engineering profession.

NEW MEMO SERIES

As a result of modern concepts and procedures introduced to the domestic regions by teams of technical consultants, many stations have adopted new techniques of surface and upper air analysis. Additional upper air charts are being drawn, and superior methods of analyzing and forecasting from them are being applied.

In order to consolidate these gains, Headquarters Weather Wing has begun preparation of a 95- and 105- series of Weather Wing Memorandums. The 95- series is intended to achieve uniformity in the details of surface and upper air analysis by prescribing colors and values of isopleths and other analytical symbols. It is based upon an examination of the current practices in the domestic regions. The 105- series is wholly advisory and informative rather than directive. It will serve to keep officers in the field informed about important developments in general, theoretical, and applied meteorology, and in the analysis and use of surface and upper air charts. It is an outgrowth of the knowledge and experience of the technical consultant teams and many of the memorandums have been prepared with their assistance.

AA SEARCHLIGHTS AS CEILING LIGHTS

From Operational Instruction, 15th Weather Region

Searchlight units of an AA Command in New Guinea have been instructed by their headquarters to provide the assistance required by weather stations for the determination of cloud heights at night (vertical beams flashed at requested times).

In conjunction with this order, the following procedure has been required of weather stations in the 15th Region:

Obtain a large scale Standard Air Defense grid map (500 yards per inch) and tion and searchlight postions nearby. Grid postions of searchlights can be obtained from the AA S-3 officer to three-figure accuracy.

Measure the base line from the weather station to each searchlight position, using the map scale. Compute for each searchlight a table of ceilings up to 30,000 feet using the equation:

$$H = B \tan A$$

where H = height of cloud base above station

B = horizontal distance from observation point to the searchlight

A = elevation angle (see page 161 in Circular N for tangent functions)

Post the table for each searchlight, identified by the azimuth angle to the AA position, for use by the weather observers. The station theodolite should be used to determine the elevation angle when the elevation angle is low or when a clinometer is not available. The searchlight beams can be used to check the orientation of the theodolite against the plotted azimuth to the AA positions.

Take observations of cloud heights at two-hour intervals when clouds are above 2,000 feet; hourly when the cloud height is between 1,000 and 2,000 feet; and half hourly when clouds are below 1,000 feet.

EMERGENCY REPAIRS OF METRO BALLOONS

by T/Sgt. Patrick J. Harney

Observers and radiosonde technicians will remember with chagrin when they used a tankful of hydrogen on a balloon which suddenly showed a minor leak. Particularly if isolated at a station where balloons or gas were critically low, an emergency measure would have been valuable.

Sometimes an emergency patch of Scotch tape pressed on the balloon over the escaping gas will make the balloon usable immediately. The tape should be wide enough to extend about an inch beyond the tear in every direction, because expansion of the balloon at high levels will strain the patch. The ends can be left hanging loose. A note on the bottom of page 6 in the September Weather Service Bulletin suggests sources of suitable tape.

Sometimes a dab of rubber cement will plug a pinhole in the rubber surface. If a small leak or tear can be discovered before inflation, it can be repaired more satisfactorily by "tying-off" this rupture or by patching the tear with a piece of rubber from a burst balloon and rubber cement.

These measures should be considered in emergencies only: it is obviously "pound foolish" to risk a raob, RAWIN, or pibal ascent when circumstances permit the safer procedure of replacing a defective balloon.

SHORT RANGE VERIFICATION

An "r" value is now assigned to each participating forecaster which indicates the reliability of his achievements for indicating relative ability---a function of the number of forecasts which he has submitted. Thus an "r" value of 71 would show that there is a 29% chance factor which might change the given score and ranking. However, in the cases of "r" values of 50 or more it is expected that the chance factor would not change the present grade of the forecaster by more than one grade in either direction.

The latest S.R.V. ranking of U.S. forecasters was delayed two weeks to permit the inclusion of many ex-students recently assigned to the field (during week 39). Very soon enough forecasts will have been submitted to permit an S.R.V. comparison of older forecasters with recent graduates, as well as an evaluation of the latters' S.R.V. results by schools.

SUMMARY OF RESULTS BY REGIONS

Regions	Forecasters Participating	Distribution of grades(%) A	B	C	D	X
Fourth	745	15	33	36	13	3
Second	182	8	40	34	14	4
First	436	10	28	45	14	3
Twenty-third	448	8	31	41	14	6
Average		10	30	40	15	5
Twenty-fifth	285	10	26	42	18	4
Third	675	7	27	43	16	7
Twenty-fourth	153	12	28	34	17	9

LEADING FIELD FORECASTERS according to the SHORT RANGE VERIFICATION PROGRAM (grading report weeks 1-42, 4 Oct 1943 thru 23 July 1944

RANKING	NAME	RANK	REGION	STATION	"R" VALUE	"S" SCORE
1	Jordan, H.J.	M/S	4	Smyrna AF	93	372
2	Hirschfeld, W.P.	T/S	25	Ft Dix AB	87	622
3	Clarke, R.F.	T/S	23	Bruning AF	90	627
4	Auslander, H.	S/S	23	Sedalia AF	88	637
5	Oliveri, A.S.	2Lt	2	Chicago	83	644
6	Koller, C.R.	2Lt	4	Sarasota AF	80	681
7	Kautz, E.D.	M/S	1	Salinas AB	91	700
8	Jones, M.V.	M/S	4	Sarasota AF	88	716
9	Melhorn, W.N.	2Lt	4	Blumenthal	89	724
10	Katz, Y.H.	M/S	1	Stockton FD	88	728
11	Johnson, P.A.	2Lt	1	Fairfld Suisn	88	746
11	Bossenmaier, W.S.	2Lt	4	Boca Raton AF	51	746
13	Hoffman, R.E.	2Lt	4	Jacksonvl AF	87	749
14	Cable, D.A.	T/S	4	Sarasota AF	86	759
15	Stousland, B.R.	2Lt	23	Malden AF	70	761
16	Nickles, P.M.	2Lt	4	Boca Ratlon AF	48	765
17	Reed, C.K.	1Lt	23	Rosecrans FD	89	766
18	Shannon Jr., J.G.	1Lt	3	Pyote AF	90	771
18	Smania, L.P.	T/S	4	Boca Raton AF	86	771
18	Lee, G.M.	M/S	24	McChord FD	88	771

21	Kleyensteuber, C.J.	T/S	1	U.C.L.A.	91	772
22	Vanderzee, C.E.	1Lt	23	Lincoln	87	776
22	Riegel, M.R.	2Lt	25	Richmond AB	45	776
24	Holladay, C.B.	2Lt	4	Dyersburg AF	59	783
24	Lawless, K.R.	2Lt	4	Morris FD	90	783
26	Jackson, J.E.	2Lt	4	Winston Salem	81	784
27	Tomchek, E.J.	M/S	4	Maxwell Fd	93	787
28	Hoffman, C.E.	1Lt	2	Chanute FD	89	789
28	Wetzel, W.E.	2Lt	25	Bolling FD	88	789
30	Pipp, W.B.	2Lt	23	Peterson FD	52	792
31	Gillespie, L.V.	CPT	1	Long Beach	91	795
32	Criscillis, P.A.	2Lt	4	Asheville WXWG	86	796
32	Moler, W.F.	T/S	23	Smoky Hill AF	88	796
34	Murphy, E.E.	S/S	3	Muskogee AF	87	800
35	Carey, J.R.	2Lt	4	Key FD	81	803
35	Welch Jr., A.E.	M/S	4	Memphis AP	93	803
35	Lees, W.H.	M/S	23	Buckley FD	91	803
38	Goldman, J.G.	T/S	4	Birmingham AF	90	804
39	Getty, R.J.	2Lt	23	Sedalia AF	87	805
40	Harms, R.W.	2Lt	4	Courtland AF	89	809
40	Hyler, W.S.	2Lt	4	Myrtle Bch AF	52	809
40	Toyli, M.	M/S	4	Jacksonvl AF	86	809
43	Bernbaum, H.H.	2Lt	1	Ontario AF	58	810
43	Shreve, E.W.	2Lt	3	Dalhart AF	56	810
43	Onsager, G.G.	T/S	24	Redmond AF	89	810
46	Leight, W.G.	2Lt	3	Bergstrom FD	89	811
46	Wuebben, R.L.	S/S	3	Hondo AF	81	811
46	Rossi, M.E.	S/S	23	Buckley FD	87	811
49	Goodman, I.	2Lt	25	Lynbrook LI	79	812
50	Arbanas, A.A.	M/S	1	Salinas AB	86	815
50	Strum, A.	T/S	1	Mather FD	82	815
52	Davis, M.K.	2Lt	3	Blytheville AF	57	816
52	Taft, H.E.	2Lt	3	Tulsa	82	816
52	Luck, E.C.	Cpt	4	Sarasota AF	87	816
52	Parrish, R.H	M/S	4	Winston Salem	91	816
56	Altschul, G.I.	1Lt	2	Chicago	70	819
57	Williamson, G.A.	1Lt	4	Maxwell FD	92	820
58	Cooper, W.W.	1Lt	4	Hillsboro AF	79	821
58	Proctor, D.	S/S	4	Grensbo HI PT	82	821
58	Heggie, G.D.	1Lt	23	Peterson FD	90	821
61	Byrn, J.S.	2Lt	23	Coffeyville AF	73	823
62	Draper, A.L.	2Lt	1	Collidge AF	81	825
62	Plummer, G.C.	2Lt	4	Sarasota AF	33	825
64	Tschirgi, J.M.	2Lt	4	Avon Park AF	44	826
64	Neff, R.E.	T/S	23	McCook AF	86	826
66	Wright, W.A.	T/S	2	Stout FD	87	827
67	Branche, J.B.	1Lt	4	Tuskegee AF	90	828
67	Werner, W.L	2Lt	23	Lincoln	46	828
69	McCroden, T.J.	2Lt	3	Kirtland FD	85	830
70	Schepman, R.O.	S/S	3	Pyote AF	79	831
71	Leavitt, H.D.	T/S	4	Boca Raton AF	88	832
71	Power, J.R.	2Lt	4	Waycross AF	56	832
71	Davison, W.R.	S/S	23	Malden AF	89	832
74	Graves, W.D.	T/S	3	Abilene	92	833
74	Findlay, W.W.	T/S	4	Courtland AF	91	833
74	Simpson, D.L.	2Lt	4	Asheville	81	833
74	Babson, S.S.	M/S	24	Wala Wala AF	73	833
78	Coulter, G.G.	M/S	1	Mines FD	89	834
78	Kaminski, H.S.	T/S	4	Daniel FD	89	834
78	Solomon, M.L.	S/S	24	Portland AB	87	834
81	Oliver, J.P.	2Lt	3	El Paso AP	80	836
81	Feldman, S.	T/S	4	Winston Salem	91	836
81	McGovern, F.J	2Lt	24	McChord FD	82	836
84	Stark, R.J.	T/S	1	Gardner FD	87	837
84	Wagner, I.	T/S	4	WM Northern FD	83	837

84	Wimbish, C.A.	T/S	4	Grensbo HI PT	87	837
87	Oslin, E.A.	T/S	4	Eglin FD	77	838
87	Petersen, V.L.	2Lt	4	Hendricks FD	86	838
87	Foreman, D.	2Lt	25	Dover AF	33	838
90	Schuman, M.P.	S/S	1	Palmdale AF	88	839
90	Farris, G.F.	2Lt	4	Gunter FD	51	839
92	McCullough, W.J.	2Lt	1	Kingman AF	78	840
92	Palluck, A.J.	T/S	4	Buckingham AF	89	840
92	Yorra, A.	1Lt	4	Boca Raton AF	87	840
92	Gans, W.L.	S/S	25	Olmsted FD	83	840
96	Dale, A.C.	2Lt	4	Nashville AP	84	841
96	Posa, J.L.	2Lt	4	Blumenthal	72	841
96	Brumbach, J.J.	2Lt	25	Baltimore AF	67	841
99	Minor, C.E.	2Lt	1	Gardner FD	81	842
99	Alexander, H.	2Lt	3	Ardmore AF	52	842
99	Parker, R.L.	CWO	4	Maxwell FD	90	842
102	Benjamin, L.W.	T/S	4	Memphis AP	87	843
102	Worthman, P.E.	CPT	4	Asheville WXWG	88	843
102	Lenon, D.R.	2Lt	23	Lincoln	53	843
102	Busching, D.L.	2Lt	24	Portland AB	33	843

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