AVIATION WEATHER SERVICES

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CONTENTS

	Page
INTRODUCTION	VII
Section 1—THE AVIATION WEATHER SERVICE PROGRAM	
Data Flow	1
Observations	1
Meteorological Centers and Forecast Offices	2
Service Outlets	2
Users	3
Section 2—SURFACE AVIATION WEATHER REPORTS	
Station Designator	15
Type and Time of Report	16
Sky Condition and Ceiling	17
Visibility	19
Weather and Obstructions to Vision	20
Sea Level Pressure	21
Temperature and Dew Point	21
Wind	22
Altimeter Setting	22
Remarks	22
Report Identifiers	29
Reading the Surface Aviation Weather Report	30
Section 3—PILOT AND RADAR REPORTS	
Pilot Weather Reports (PIREPS)	31
Radar Weather Reports (RAREPS)	32
Section 4—AVIATION WEATHER FORECASTS	
Terminal Forecasts	35
Area Forecast (FA)	42
TWEB Route Forecasts and Synopsis	44
Inflight Advisories (WS, WA, WAC)	45
Winds and Temperatures Aloft Forecast (FD)	46
Special Flight Forecast	47
Hurricane Advisory (WH)	48
Convective Outlook (AC)	48
Severe Weather Watch Bulletin (WW)	48
Section 5—SURFACE ANALYSIS	
Valid Time	51
Isobars	51
Pressure Systems	51
Fronts	51
Other Information	53
Using the Chart	53

Section 6—WEATHER DEPICTION CHART

	Page
Plotted Data	55
Analysis	57
Using the Chart	57

Section 7—RADAR SUMMARY CHART

Echo Pattern and Coverage	59
Weather Associated with Echoes	59
Intensity and Trend of Precipitation	59
Heights of Echo Bases and Tops	60
Movement of Echoes	60
Additional Information	60
Using the Chart	60

Section 8—SIGNIFICANT WEATHER PROGNOSTICS

Domestic Flights	63
International Flights	65
Using Significant Weather Progs	67

Section 9—WINDS AND TEMPERATURES ALOFT

Forecast Winds and Temperatures Aloft (FD)	71
Observed Winds Aloft	71
Using the Charts	71

Section 10—FREEZING LEVEL CHART

Plotted Data	75
Analysis	75
Using the Chart	75

Section 11—STABILITY CHART

Lifted Index	77
K Index	77
Stability Analysis	77
Using the Chart	79

Section 12—SEVERE WEATHER OUTLOOK CHART

General Thunderstorms	81
Severe Thunderstorms	81
Tornadoes	81
Using the Chart	81

Section 13—CONSTANT PRESSURE CHARTS

Plotted Data	83
Analysis	84
Three Dimensional Aspects	85
Using the Charts	85

Section 14—CONSTANT PRESSURE PROGNOSTICS

Height Contours/Streamlines	93
Temperature	93
Windspeed	93
Formats	93
Using the Charts	95

Section 15—TROPOPAUSE, MAX WIND, AND WIND SHEAR CHARTS

	Page
Observed Tropopause Chart	99
Domestic Tropopause Wind and Wind Shear Progs	99
International Tropopause and Wind Shear Progs	103

Section 16—TABLES AND CONVERSION GRAPHS

Icing Intensities	109
Turbulence Intensities	110
Locations of Probable Turbulence by Intensities versus Weather and Terrain Features	111
Standard Conversions	112
Density Altitude Computation	113
Selected Contractions	115
Acronyms	117

INTRODUCTION

The rapid expansion of air transportation makes necessary a move toward mass briefing to meet aviation demands. As a result, you, the pilot, must become increasingly self-reliant in getting your weather information. On occasion, you may need to rely entirely on self-briefing.

AVIATION WEATHER,* AC 00-6A, tells about weather, what to look for, and weather impact on flying. This advisory circular supplements AVIATION WEATHER explaining weather service in general and the details of interpreting and using reports, forecasts, weather maps, and prognostic charts. Many charts and tables apply directly to flight planning and inflight decisions. You may wish to remove certain pages and carry them in your flight kit wherever you go. It also incorporates in sections 2, 3, and 4 the changeover from cloud cover symbols to contractions for all reports, observations, and forecasts transmitted by teletypewriter effective August 1, 1975.

This advisory circular is an excellent source of study for pilot certification examinations. Its 16 sections run the gamut from the student pilot to the airline transport pilot.

AVIATION WEATHER SERVICES, AC 00-45, is updated periodically to reflect changes brought about by the latest service demands, techniques, and capabilities. The purchase of an updated copy is a wise investment for any active pilot.

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* Price and availability to be announced in the FAA Advisory Circular Checklist.

Section 1

THE AVIATION WEATHER SERVICE PROGRAM

Weather service to aviation is a joint effort of the National Weather Service (NWS), the Federal Aviation Administration (FAA), the military weather services, and other aviation oriented groups and individuals. Because of international flights and a need of world-wide weather, foreign weather services also have a vital input into our service. The NWS coordinates weather services, and many NWS products at all echelons are specifically for aviation.

Figure 1–1 is a flow diagram of weather data. This section follows the development and flow of observations, reports, and forecasts through the service to the users.

DATA FLOW

Longline communications providing the flow of data through the system are mostly teletypewriter and facsimile. Teletypewriter circuits collect and distribute weather reports, forecasts, and warnings. Facsimile transmits weather charts.

Each service outlet has a drop on an area teletypewriter circuit which provides complete data within a few hundred miles of the outlet but only sparse data for more remote areas. Reports and forecasts not routinely available on the local area circuit are available on a request/reply circuit.

National Weather Service facsimile distributes graphic weather analyses and prognostic charts. Most service outlets have facsimile.

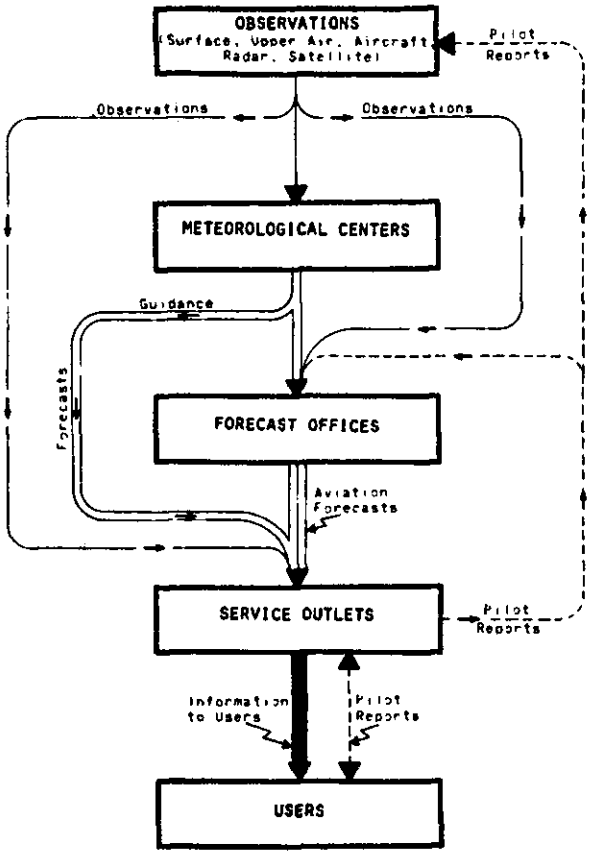


FIGURE 1–1. Data flow in the aviation weather service. All data is available through service outlets. Note the important feedback of pilot reports.

OBSERVATIONS

Weather observations are measurements and estimates of existing weather. Observations are made at the surface and aloft. When recorded and transmitted, an observation becomes a report. These reports are the basis of all weather analyses and forecasts. Note in figure 1–1 that weather reports flow to all echelons in the aviation weather service.

Surface Observations

Surface aviation observations include weather elements pertinent to flying. A network of airport stations provides routine up-to-date aviation weather reports. Most stations are either NWS or FAA; however, military services and contracted civilians complete the network. All official civilian weather observers must be certified by the National Weather Service.

Radar Observations

Precipitation reflects radar signals, and the reflected signals are displayed as echoes on the radar scope. NWS radar covers nearly all the U.S. east of the Rocky Mountains. Radar coverage over the remainder of the U.S. is largely by Air Route Traffic Control radars. Thus, except for some western mountainous terrain, radar coverage is nearly complete over the contiguous 48 States. Figure 1–2 maps the radar observing network.

Other Observations

Many other observations have a significant input to the aviation weather service. Upper air observations taken twice daily at specified stations furnish temperature, humidity, pressure, and wind, often to heights above 100,000 feet. Weather satellites scan the Earth providing cloud pictures. These pictures are especially useful in remote areas. Pilots themselves are a vital source of weather observations. In fact, aircraft in flight are the only means of directly observing turbulence, icing, and height of cloud tops.

METEOROLOGICAL CENTERS AND FORECAST OFFICES

Meteorological centers collect and analyze data and prepare forecasts on a national, hemispheric, or global basis. NWS forecast offices prepare forecasts which are generally more detailed.

National Meteorological Center (NMC)

The National Meteorological Center (NMC) of the NWS is the hub of all weather processing. From worldwide weather reports it prepares forecasts and charts of observed and forecast weather. Many of the charts are computer prepared. Others are computer outputs adjusted and annotated by meteorologists. A few are manually prepared by forecasters.

Some NMC products are specifically for aviation. For example, NMC prepares the winds and temperatures aloft forecast. Figure 1-3 is the network of forecast winds and temperatures for the contiguous 48 States.

National Hurricane Center (NHC)

The NWS National Hurricane Center (NHC) develops hurricane forecasting techniques and issues hurricane forecasts for the Atlantic, the Caribbean, the Gulf of Mexico, and adjacent land areas. It is located at Miami, Florida. Hurricane warning centers at San Francisco and Honolulu issue warnings for the eastern and central Pacific.

National Severe Storms Forecast Center (NSSFC)

The NWS National Severe Storms Forecast Center (NSSFC) prepares forecasts of severe convective storms over the contiguous 48 States. It is located at Kansas City, Missouri near the heart of the area most frequented by severe thunderstorms and tornadoes.

National Environmental Satellite Service (NESS)

The National Environmental Satellite Service (NESS) directs the weather satellite program. Through newly developed radiation measuring techniques, it contributes directly to NMC processing. Satellite cloud photographs are available at field facilities by facsimile and at some stations by direct picture reception.

Weather Service Forecast Office (WSFO)

A Weather Service Forecast Office (WSFO) issues forecasts, advisories and warnings for its area. Figure 1-4 (Alaska, fig. 1-10) shows locations of WSFOs, their areas of responsibility, and the airports for which each office prepares terminal forecasts. Selected WSFOs issue area forecasts. Figure 1-5 (Alaska, fig. 1-10) shows locations of these offices and their forecast areas.

Weather Service Office (WSO)

A Weather Service Office (WSO) prepares local forecasts and warnings and provides general weather service. It shoulders part of the terminal forecast responsibility. A WSO can adjust the local terminal forecast for a period of two hours or less.

SERVICE OUTLETS

A weather service outlet as used here is any facility, either government or non-government, that provides aviation weather service. This section discusses only FAA and NWS outlets.

Flight Service Stations (FSS)

The FAA Flight Service Station (FSS) provides more aviation weather briefing service than any other government service outlet. It provides preflight and inflight briefings, makes scheduled and unscheduled weather broadcasts, and furnishes weather advisories to known flights in the FSS area.

Selected FSSs also provide transcribed weather dissemination to aid inflight and preflight briefing. By listening to the transcriptions, you can assess any further need for more detailed briefing. There are two types of transcriptions—(1) Transcribed Weather Broadcast (TWEB) and (2) Pilot's Automatic Telephone Weather Answering Service (PATWAS).

The TWEB is a continuous broadcast on low/medium frequencies (200 to 415 kHz) and selected VORs (108.0 to 117.95 mHz). PATWAS is a recorded telephone briefing service. TWEB and PATWAS transcriptions are on a route concept. A few selected stations also prepare transcriptions for a local area—usually within a 50 nautical mile radius of the station.

Order and content of the transcription are as follows:

1. Synopsis
2. Flight Precautions
3. Route Forecasts
4. Outlook (Optional)
5. Winds Aloft Forecast
6. Radar Reports
7. Surface Weather Reports
8. Pilot Reports
9. Notice to Airmen (NOTAMs)

The first five items are forecasts prepared by the NWS and are discussed in detail in section 4. The synopsis and route forecasts are prepared especially for TWEB and PATWAS. Flight precautions, outlook, and winds aloft are adapted respectively from inflight advisories, area forecasts, and the NMC winds aloft forecast. Radar reports and pilot reports are discussed in section 3. Surface reports are the subject of section 2.

Figure 1–6 maps locations of TWEB outlets; and figure 1–7, PATWAS locations. Figure 1–8 shows routes for which forecasts are prepared. The AIRMAN'S INFORMATION MANUAL, Part 3, shows the availability of TWEB at a facility and lists the frequency. Part 2 shows PATWAS telephone numbers in the directory of FSS and Weather Service telephone numbers.

The enroute flight advisory service (Flight Watch) is a weather service on a common frequency of 122.0 mHz from selected FSSs. The Flight Watch specialist maintains a continuous weather watch, provides time-critical assistance to enroute pilots facing hazardous or unknown weather, and may recommend alternate or diversionary routes. Additionally, Flight Watch is a focal point for rapid receipt and dissemination of pilot weather reports. Flight Watch is operational on the West Coast as shown in figure 1–11 and will be expanded throughout the U.S. during the next few years. To avail yourself of this service, call "FLIGHT WATCH" on 122.0 mHz.

Air Route Traffic Control Center (ARTCC)

FAA Air Route Traffic Control Centers (ARTCC) advise air traffic under their control of significant weather. The controller may also advise aircraft of forecast terminal conditions that may cause a change in flight plan.

Terminal Control Facility

The FAA terminal controller becomes familiar with and remains aware of current weather information needed to perform air traffic control duties. He informs arriving and departing aircraft of pertinent local weather conditions. He shares responsibility with the NWS for reporting visibility observations at many facilities. At other facilities he has the full responsibility for observing, reporting, and classifying aviation weather elements.

Weather Service Office

NWS Weather Service Offices provide weather briefings in areas not served by Flight Service Stations and provide local warnings to aviation. They furnish backup assistance to FAA service outlets.

Weather Service Forecast Office

NWS Weather Service Forecast Offices provide some selective pilot briefings and supply backup service to FAA outlets. When getting a briefing from an FSS, you may, if necessary, request a telephone "patch in" to the WSFO forecaster. A few WSFOs make and record PATWAS.

USERS

The ultimate users of the aviation weather service are pilots and dispatchers. Maintenance personnel also may use the service in protecting idle aircraft against storm damage. As a user of the service, you also contribute to it. Send pilot weather reports (PIREPs) to help your fellow pilots, briefers and forecasters. The service can be no better or more complete than the information that goes into it.

In the interest of safety, you should get a complete briefing before each flight. If you have L/MF radio, you can get a preliminary briefing by listening to the TWEB at your home or place of business. If you have no radio and PATWAS is available, dial PATWAS for a briefing. If, after listening to the TWEB or PATWAS, you desire additional information, contact an FSS or WSO for a more complete briefing. The AIRMAN'S INFORMATION MANUAL, and often the local telephone directory, lists numbers to call for aviation weather.

How to Get a Good Weather Briefing

When requesting a briefing, make known you are a pilot. Give clear and concise facts about your flight:

1. Aircraft number or your name
2. Destination, route, and planned altitude
3. Whether flying VFR or IFR
4. Departure time
5. Time enroute or time of arrival
6. Intermediate stops if any

With this background, the briefer can proceed directly with the briefing and concentrate on weather relevant to your flight.

The weather briefing you receive should include:

1. Hazardous weather if any (you may elect to cancel at this point)
2. Weather synopsis (positions of lows, fronts, etc.)
3. Forecast (enroute and destination)
4. Alternate routes (if any)
5. Forecast winds aloft

The FSSs and WSOs are to serve you. You should not hesitate to discuss factors that need elaboration or to ask questions. You have a complete briefing only when you have a clear picture of the weather to expect. It is to your advantage to make a final weather check immediately before departure if at all possible.

Request/Reply Service

The request/reply service mentioned earlier is available at all FSSs, WSOs, and WSFOs. You may request through the service any reports or forecasts not routinely available at your service outlet. Included in the request/reply are route forecasts used in TWEB and PATWAS recorded briefings. You can request a forecast for any numbered route shown in figure 1–8 or any of the longer cross–country routes shown in figure 1–9.

Have an Alternate Plan of Action

When weather is questionable, get a picture of expected weather over a broader area. Preplan a route to take you rapidly away from the weather if it goes sour. When you fly into weather through which you cannot safely continue, you must act quickly. Without preplanning, you may not know the best direction to turn; a wrong turn could lead to disaster. A preplanned diversion beats panic. Better be safe than sorry.

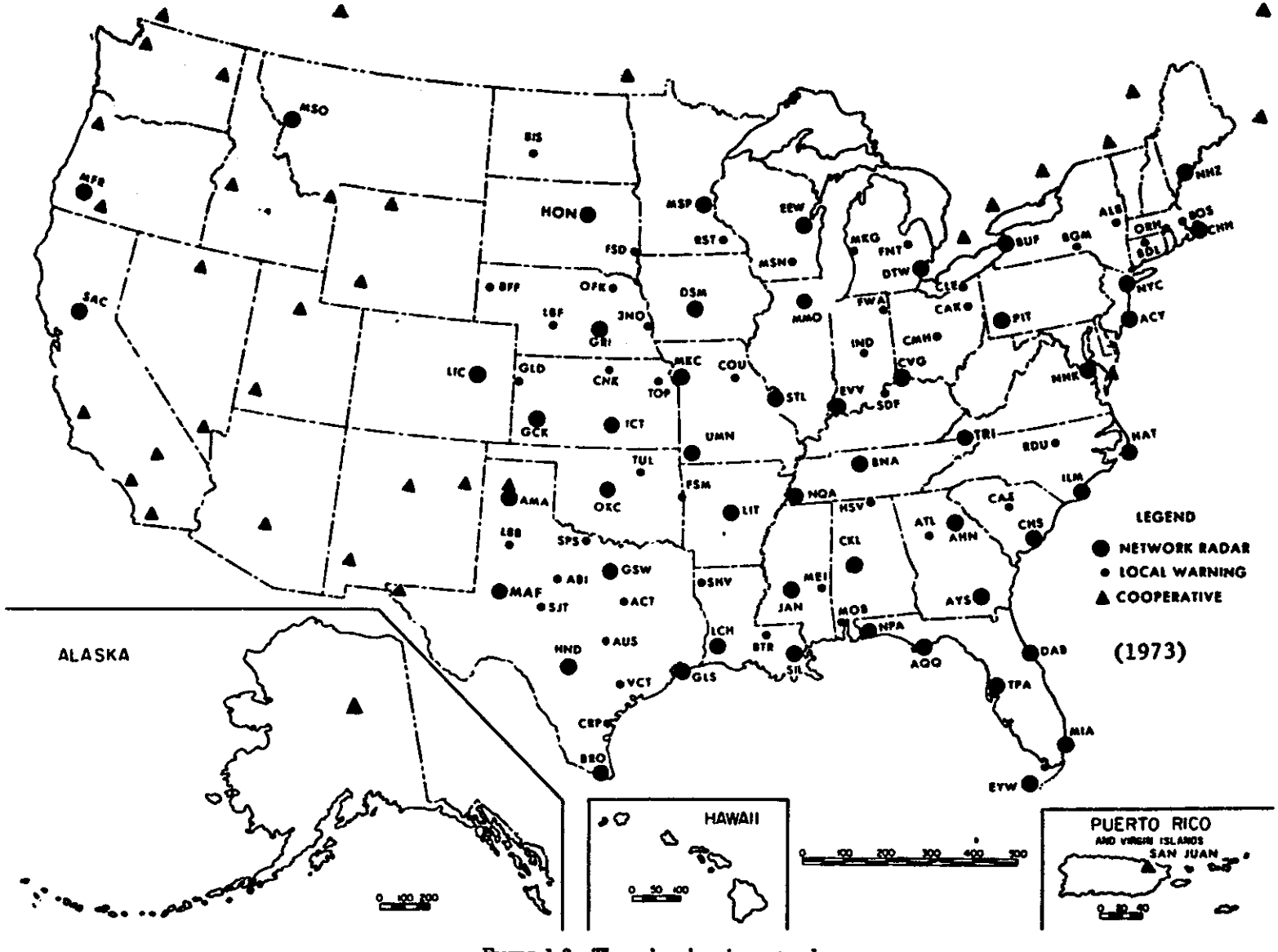


FIGURE 1-2. The radar observing network.

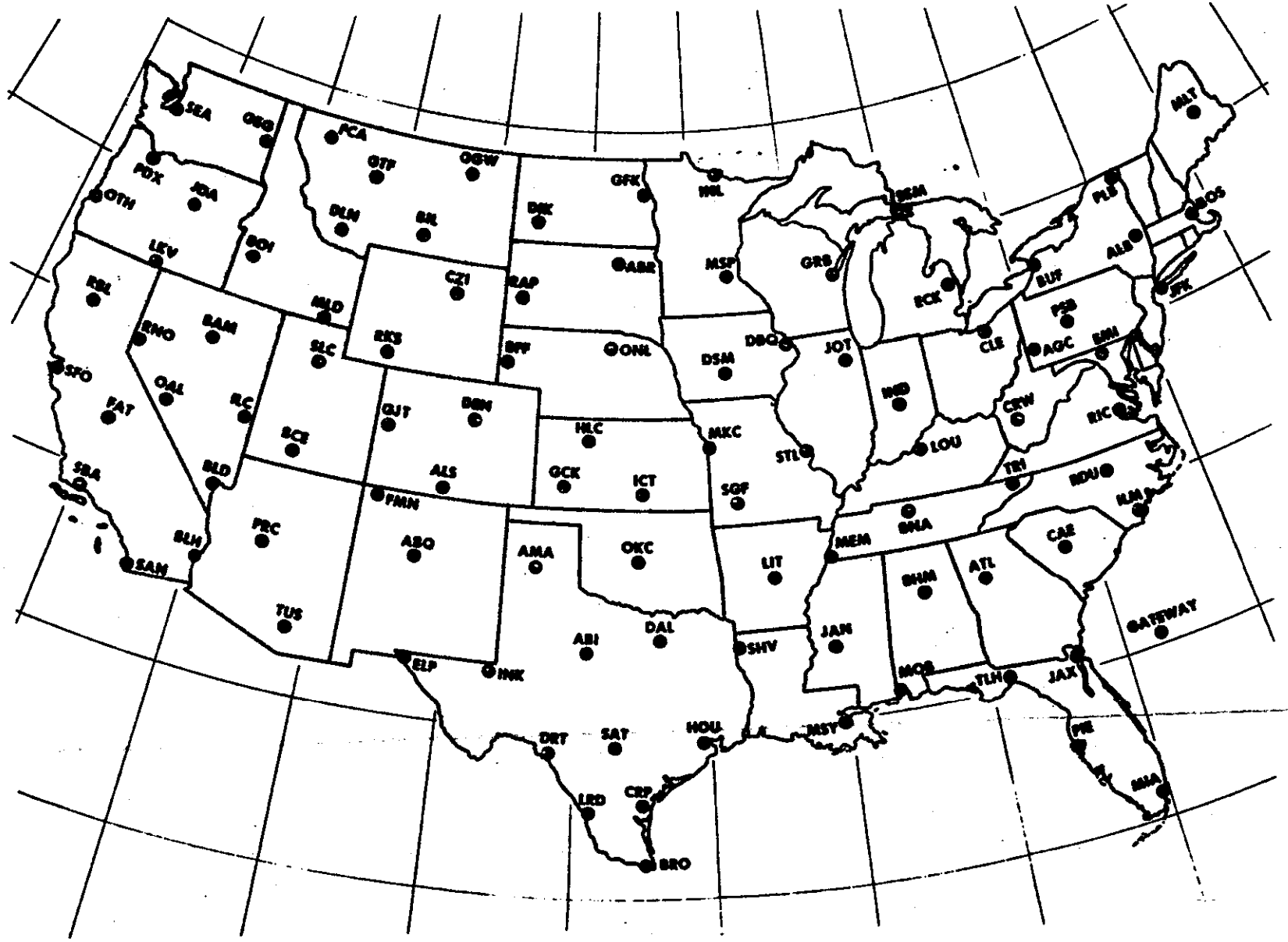


FIGURE 1-3. The forecast winds and temperatures aloft network.

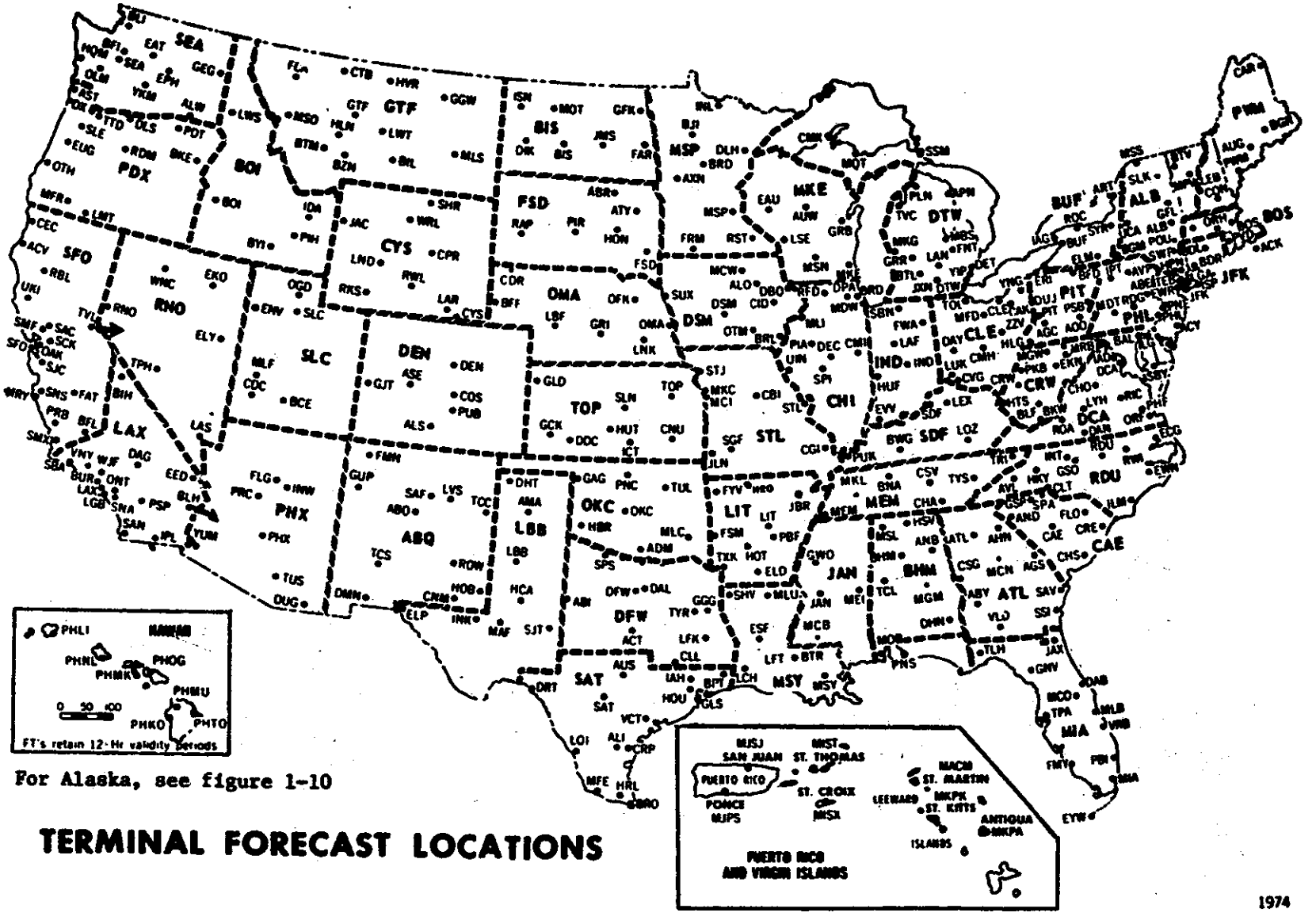


FIGURE 1-4. Locations of WSFOs, their areas of responsibility, and airports for which each prepares terminal forecasts.

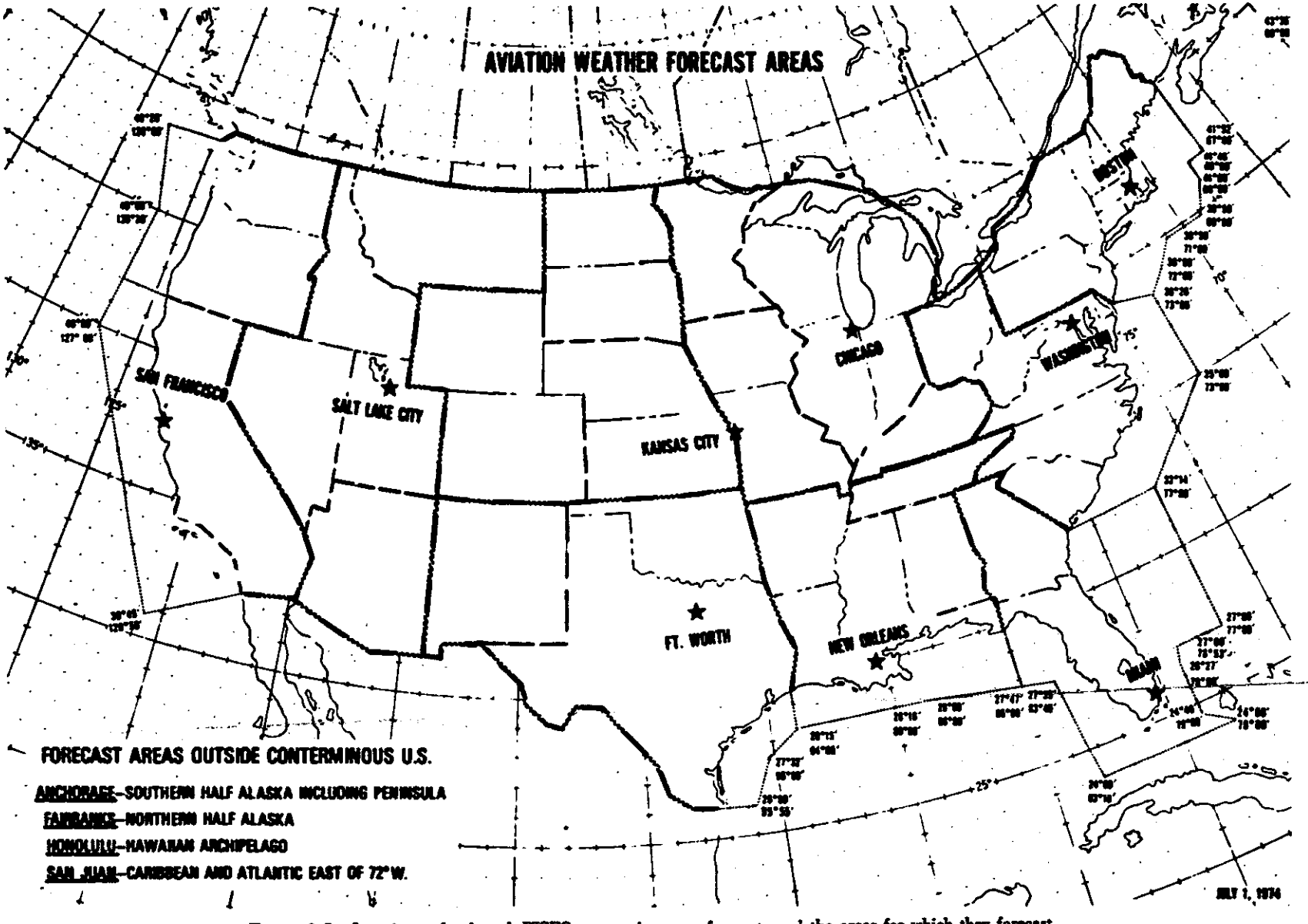


FIGURE 1–5. Locations of selected WSFOs preparing area forecasts and the areas for which they forecast.

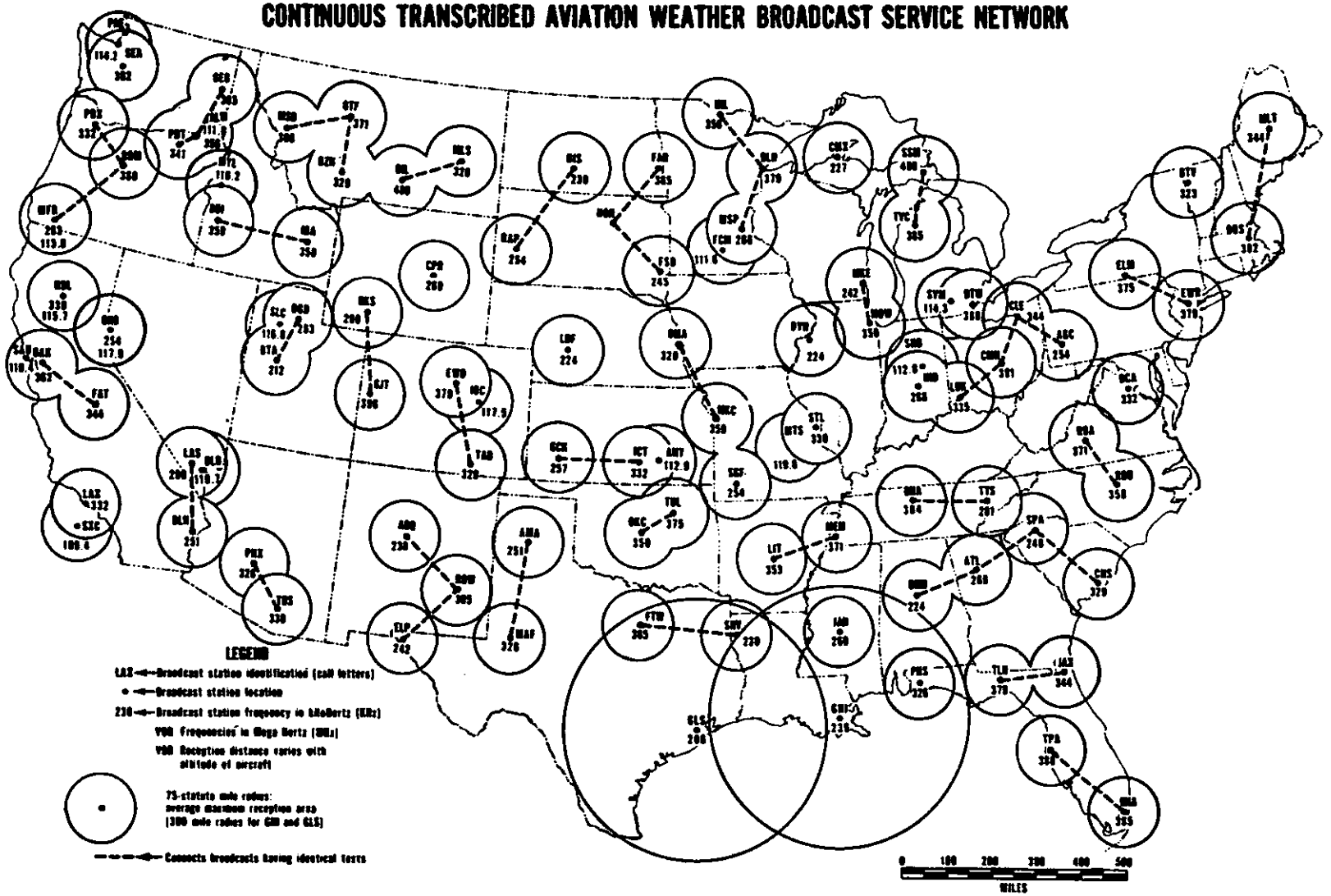


FIGURE 1-6. Locations of selected FSSs providing Transcribed Weather Broadcasts (TWEBs).

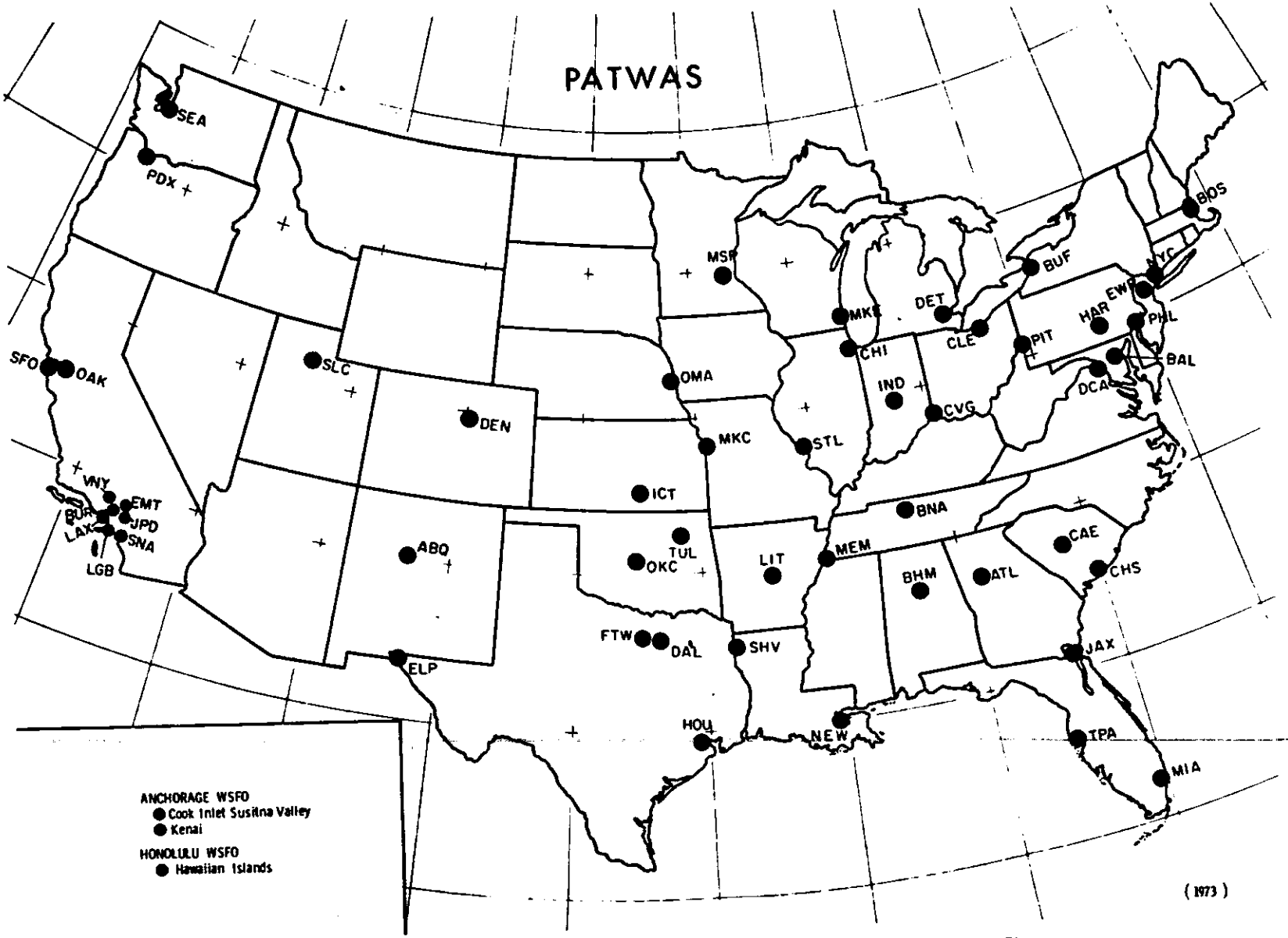


FIGURE 1-7. Locations of Pilot's Automatic Telephone Weather Answering Service (PATWAS).

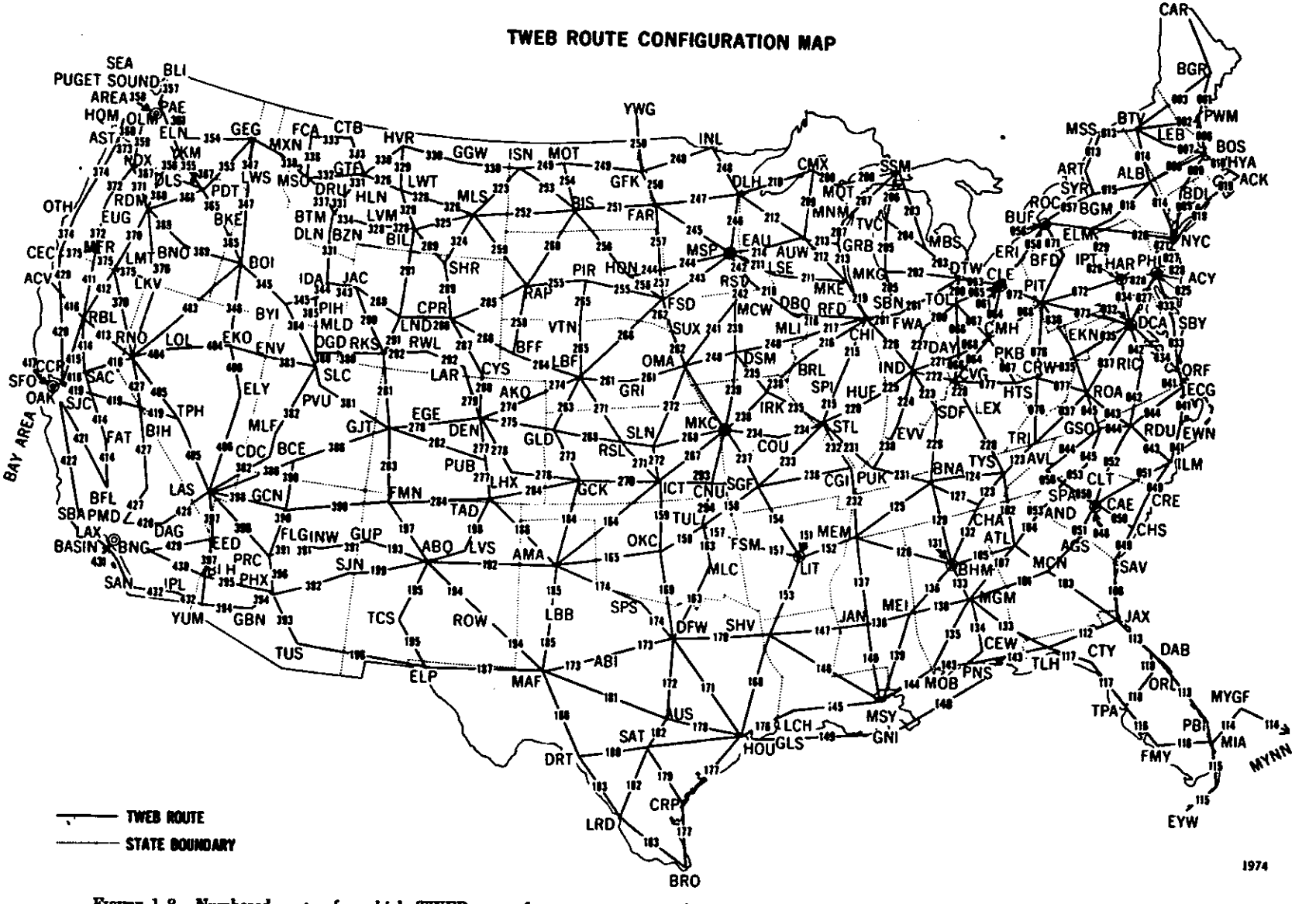
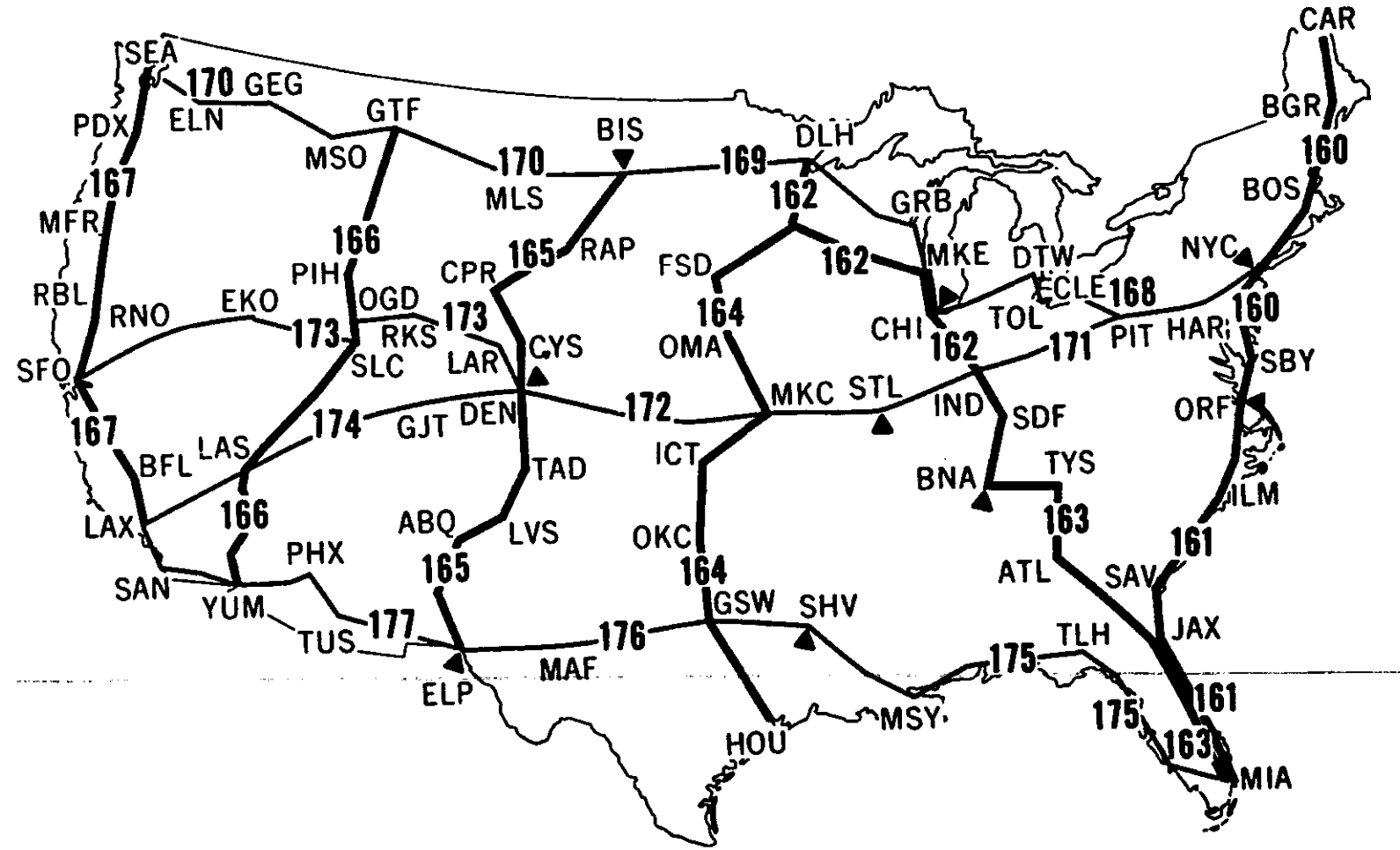


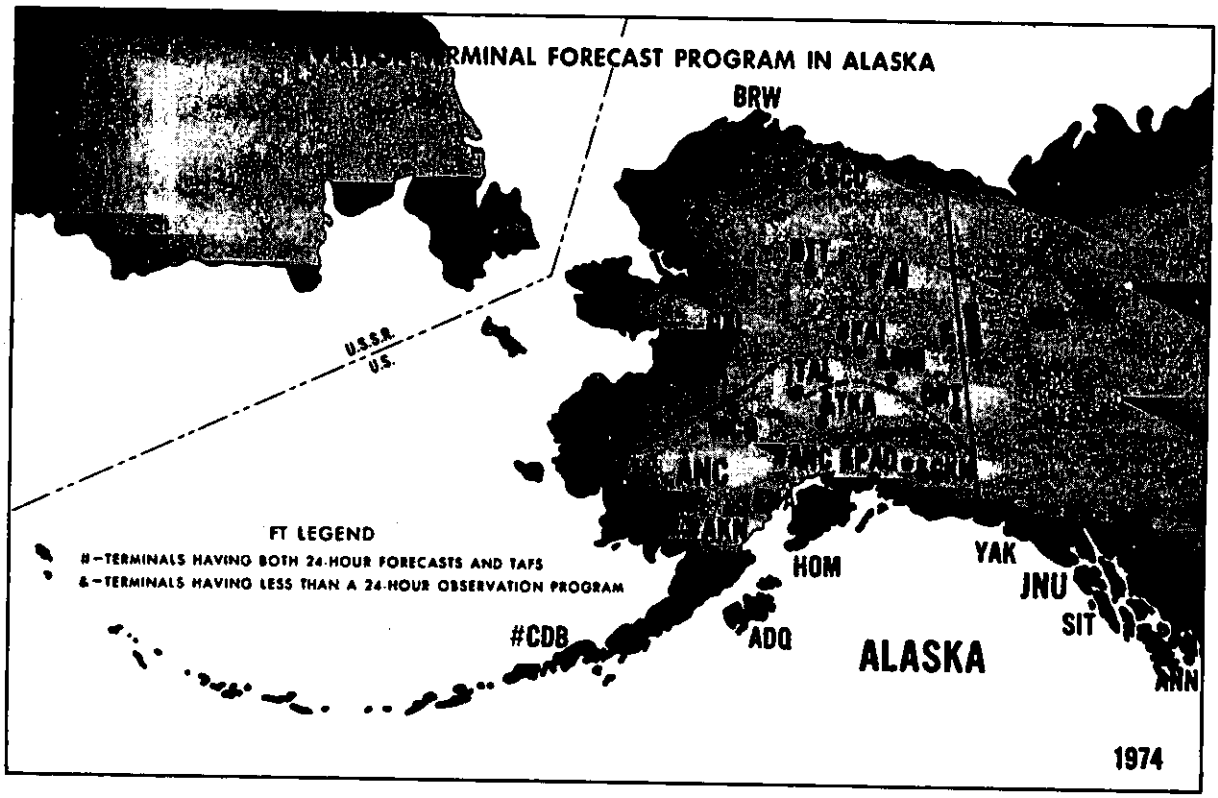
FIGURE 1–8. Numbered routes for which TWEB route forecasts are prepared. Route forecasts may be requested through request/reply service.

CROSS COUNTRY TWEB ROUTES AND RL REQUEST REPLY NUMBERS



▲ SEPARATES SEGMENTS OF CROSS COUNTRY ROUTES

FIGURE 1–9. Cross country numbered routes for which route forecasts are available through request/reply service.



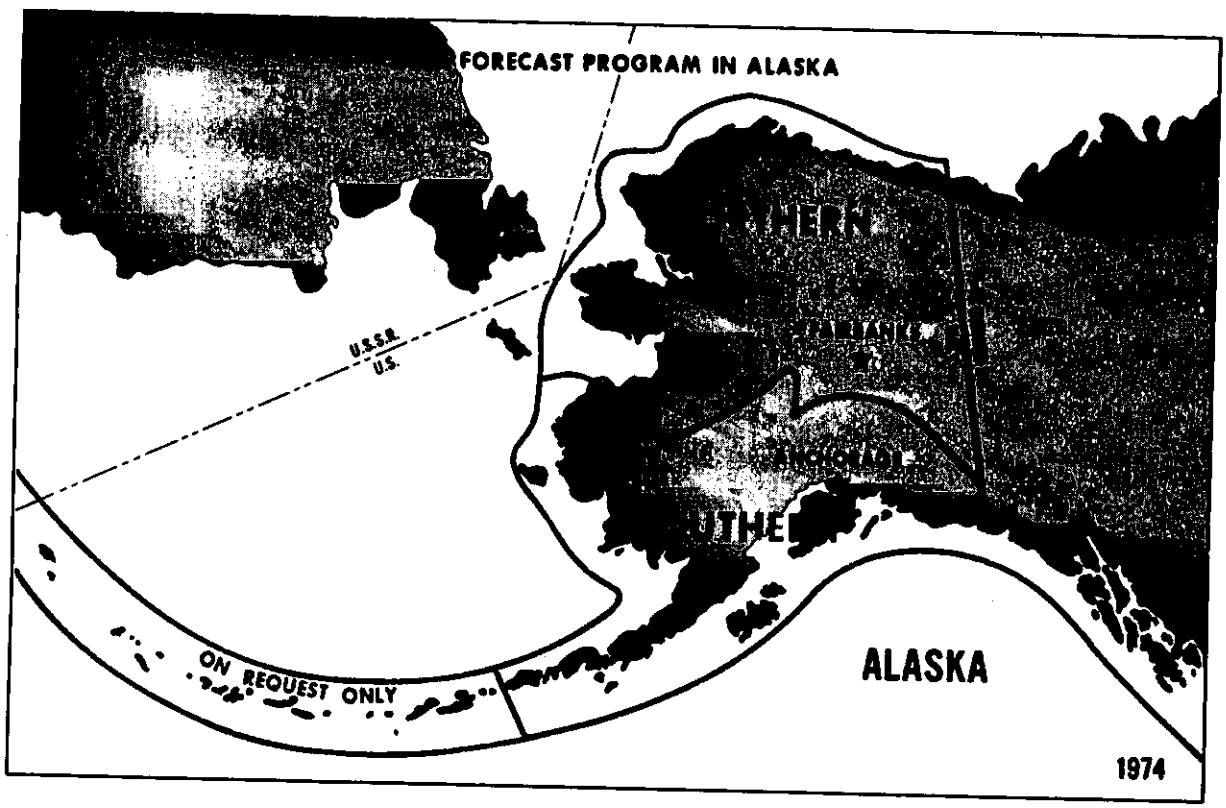


FIGURE 1–10. Alaska WSFOs, locations for which terminal forecasts are prepared (top) and forecast areas (bottom).

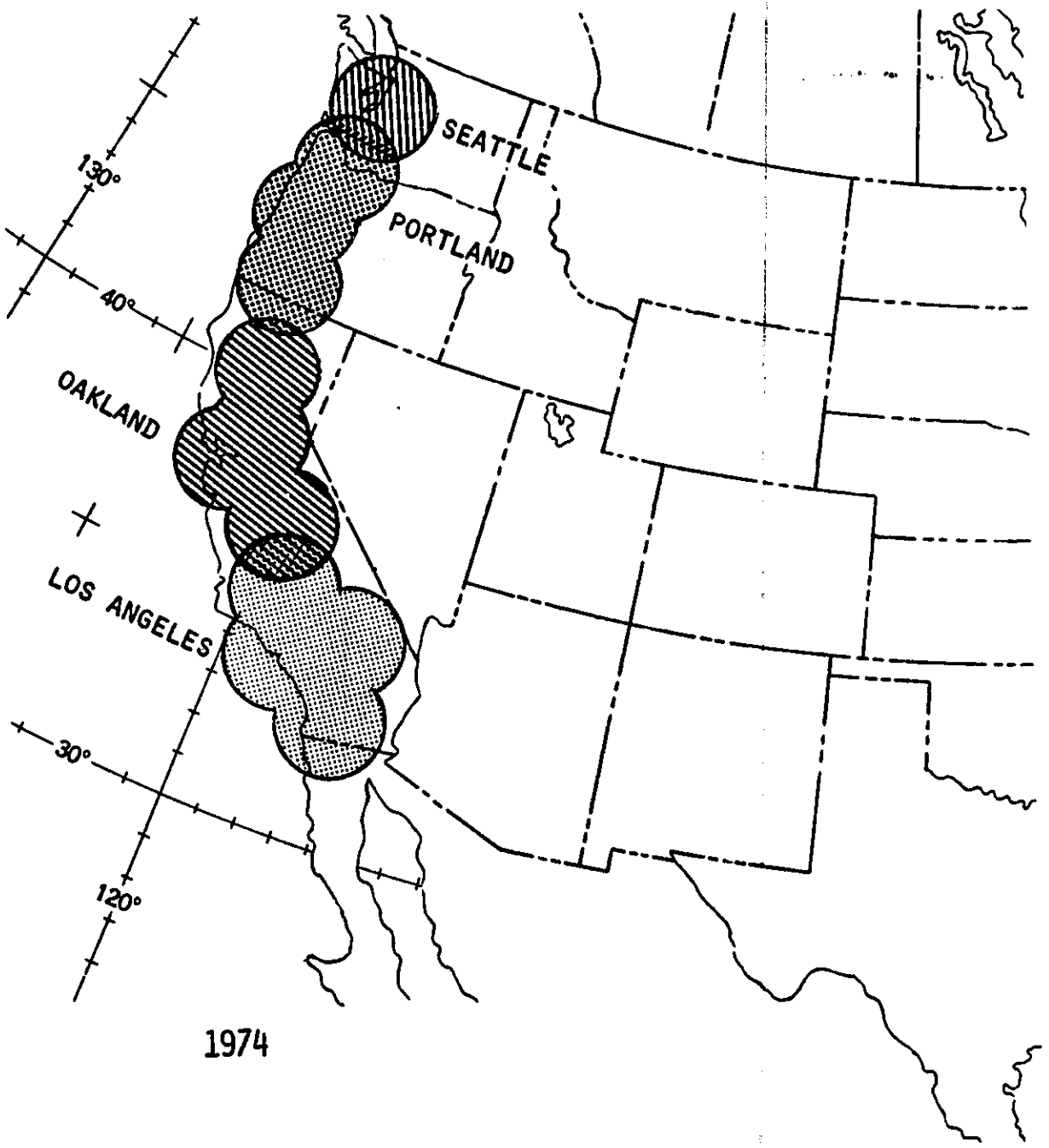


FIGURE 1-11. Four operational Enroute Flight Advisory Service (Flight Watch) facilities and approximate reception areas. All facilities except Seattle have remote transmitter sites. An aircraft at 5,000 feet can receive a transmission to a distance of about 80 miles from any central or remote site.

Section 2

SURFACE AVIATION WEATHER REPORTS

When an observation is recorded and transmitted, it is a weather *report*. A surface aviation weather report contains some or all of the following elements:

1. Station Designator
2. Type and Time of Report
3. Sky Condition and Ceiling
4. Visibility
5. Weather and Obstructions to Vision
6. Sea Level Pressure
7. Temperature and Dew Point
8. Wind Direction, Speed, and Character
9. Altimeter Setting
10. Remarks

Those elements not occurring at observation time or not pertinent to the observation are omitted from the report. When an element should be included but is unavailable, the letter "M" is transmitted in lieu of the missing element. Those elements that are included are transmitted in the above sequence.

Following are five reports as transmitted on teletypewriter. These reports are used in discussing the above 10 elements. If you have this reference in a loose leaf binder, you will find it helpful to remove this page and keep it before you as you proceed through the discussion.

INK CLR 15 106/77/63/1112G18/000
BOI 150SCT 30 181/62/42/1304/015
LAX 7SCT 250SCT 6KH 129/60/59/2504/991→LAX↘6/38
MDW SP −X M7OVC 11/2R+F 990/63/61/3205/980/RF2 RB12
JFK SP W5X 1/2F 180/68/64/1804/006/R04RVR22V30 TWR VSBY1/4

STATION DESIGNATOR

The station designator is the three-letter location identifier for the reporting station. These five reports are from Wink, Texas (INK); Boise, Idaho (BOI); Los Angeles, California (LAX); Chicago Midway Airport, Illinois (MDW); and John F. Kennedy Airport, New York City (JFK).

TABLE 2-1. Summary of sky cover designators

Designator	Meaning	Spoken
CLR	CLEAR. (Less than 0.1 sky cover.)	CLEAR
SCT	SCATTERED LAYER ALOFT. (0.1 through 0.5 sky cover.)	SCATTERED
BKN*	BROKEN LAYER ALOFT. (0.6 through 0.9 sky cover.)	BROKEN
OVC*	OVERCAST LAYER ALOFT. (More than 0.9, or 1.0 sky cover.)	OVERCAST
−SCT	THIN SCATTERED. At least ½ of the sky cover aloft is transparent at and below the level of the layer aloft.	THIN SCATTERED
−BKN	THIN BROKEN.	THIN BROKEN
−OVC	THIN OVERCAST.	THIN OVERCAST
X*	SURFACE BASED OBSTRUCTION. (All of sky is hidden by surface based phenomena.)	SKY OBSCURED
−X	SURFACE BASED PARTIAL OBSCURATION. (0.1 or more, but not all, of sky is hidden by surface based phenomena.)	SKY PARTIALLY OBSCURED

* Sky condition represented by this designator may constitute a ceiling layer.

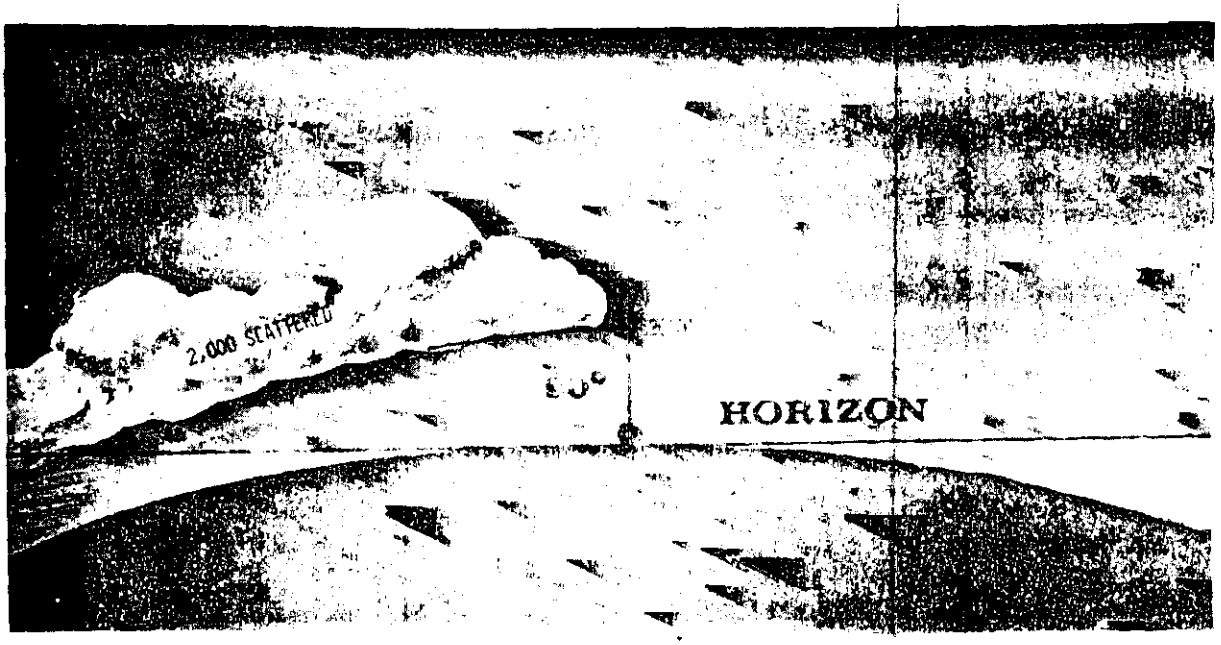


FIGURE 2–1. Scattered sky cover by a single advancing layer. Scattered is 5/10 or less sky cover (5/10 in this example).

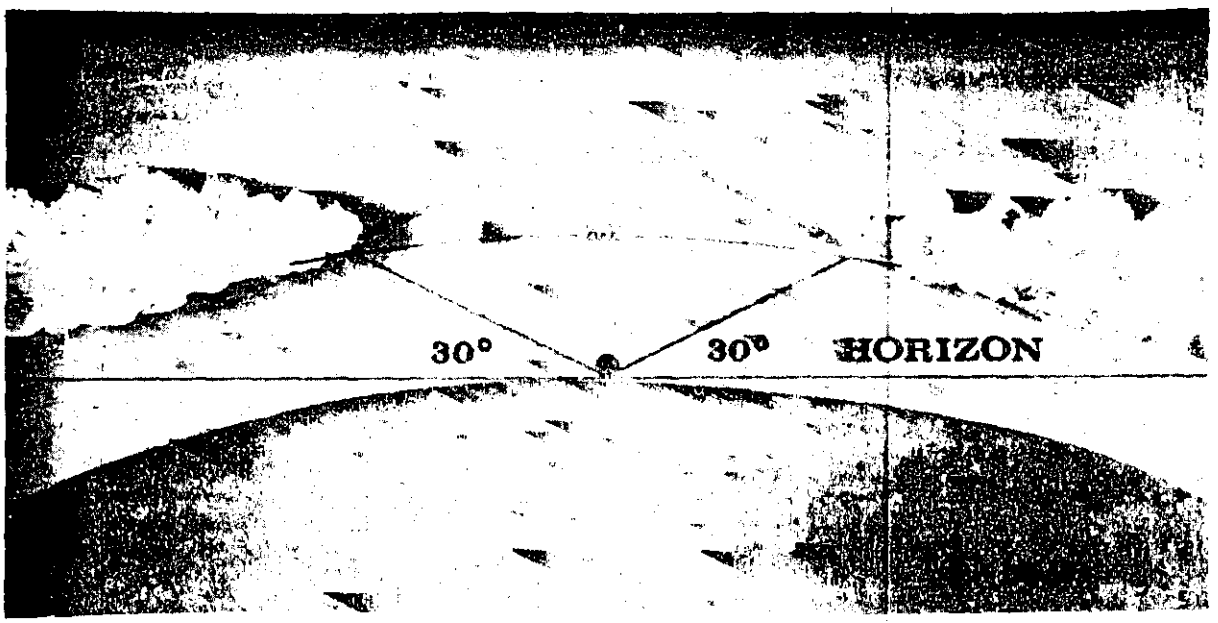


FIGURE 2–2. Scattered sky cover by a single layer surrounding the station (5/10 covered in this example).

TYPE AND TIME OF REPORT

The two basic types of reports are:

1. Record hourly reports of observations taken on the hour and

2. Special reports of observations taken when needed to report significant changes in weather.

Record *hourly* reports are transmitted in sequenced collectives and are identified by sequence headings. The first three reports are of this type (INK, BOI, and LAX). A record *special* is a record hourly that reports a significant change in weather. It is identified by the letters "SP" as shown in the reports from MDW and JFK. The special identifier is the only type-of-report entry that ever appears in an hourly collective. A report transmitted out of sequence must convey the time and type of the observation. These out-of-sequence reports are discussed later.

FIGURE 2-3. Summation of cloud cover in multiple layers.

SKY CONDITION AND CEILING

A clear sky or a layer of clouds or obscuring phenomena *aloft* is reported by one of the first seven *sky cover designators* in table 2-1. A layer is defined as clouds or obscuring phenomena with the base at pproximately the same level. Height of the base of a layer precedes the sky cover designator. Height is in hundreds of feet *above ground level.*

Note that INK is reporting sky clear. No height precedes the designator since no sky cover is reported. BOI reports a scattered layer at 15,000 feet above the station. Figures 2-1 and 2-2 illustrate single layers of scattered clouds.

When more than one layer is reported, layers are in ascending order of height. For each layer above a lower layer or layers, the sky cover designator for that layer represents the *total sky* covered by that layer and all lower layers. LAX reports two layers—a scattered layer at 700 feet and a higher layer at 25,000 feet. Total coverage of the two layers does not exceed 5/10 coverage, so the upper layer also is reported as scattered. Figures 2-3 and 2-4 illustrate cloud cover of multiple layers.

"Transparent" sky cover is clouds or obscuring phenomena aloft through which blue sky or higher sky cover is visible. As explained in table 2-1, a scattered, broken, or overcast layer may be reported as "thin". To be classified as thin, a layer must be half or more transparent, and remember that sky cover of a layer includes all sky cover below the layer. For example, if at LAX the sky had been visible through half or more of the total sky cover reported by the higher layer, the report would have been

LAX 7SCT 250—SCT etc.

Any phenomena *based at the surface* and hiding all or part of the sky is reported as SKY OBSCURED* or SKY PARTIALLY OBSCURED* as explained in table 2-1. An obscuration or partial obscuration may be precipitation, fog, dust, blowing snow, etc. No height value precedes the designator for partial obscuration since vertical visibility is not restricted overhead. A height value precedes the designator for an obscuration and denotes vertical visibility into the phenomena.

Ceiling is defined as:

1. Height of the lowest layer of clouds or obscuring phenomena aloft that is reported as broken or overcast and not classified as thin, or
2. Vertical visibility into a surface-based obscuring phenomena that hides all the sky.

Now look at the reports from MDW and JFK. MDW reports a partial obscuration and an overcast at 700 feet. The overcast constitutes a ceiling at 700 feet. Note also that the height of this ceiling layer is preceded by the letter "M". JFK reports a total obscuration, and the height value preceding the sky cover designator represents 500 feet vertical visibility into the obscuring phenomenon. Height of the ceiling value is preceded by the letter "W". The "M" and "W" are "ceiling designators".

* Descriptions in capital letters are the usual phraseology in which these reports are broadcast.

TABLE 2-2. Ceiling designators

Coded	Meaning	Spoken
M	MEASURED. Heights determined by ceilometer, ceiling light, cloud detection radar, or by the unobscured portion of a landmark protruding into ceiling layer. (Figure 2-5 illustrates the principle of the ceilometer.)	MEASURED CEILING
E	ESTIMATED. Heights determined from pilot reports, balloons, or other measurements not meeting criteria for measured ceiling.	ESTIMATED CEILING
W	INDEFINITE. Vertical visibility into a surface based obstruction. Regardless of method of determination, vertical visibility is classified as an indefinite ceiling.	INDEFINITE CEILING

A *ceiling designator* always precedes the height of the ceiling layer. Table 2-2 lists and explains ceiling designators. At MDW the ceiling height was measured. JFK had an indefinite ceiling which was vertical visibility into a surface based obscuration.

The sky cover and ceiling as determined from the ground represent as nearly as possible what the pilot should experience in flight. In other words, a pilot flying at or above the reported ceiling layer aloft should see less than half the surface below him. The pilot descending through a surface

FIGURE 2-4. Summation of cloud cover in multiple layers. Note that at the height of the upper layer, sky cover is reported as overcast even though the upper layer itself covers less than ½ of the sky.

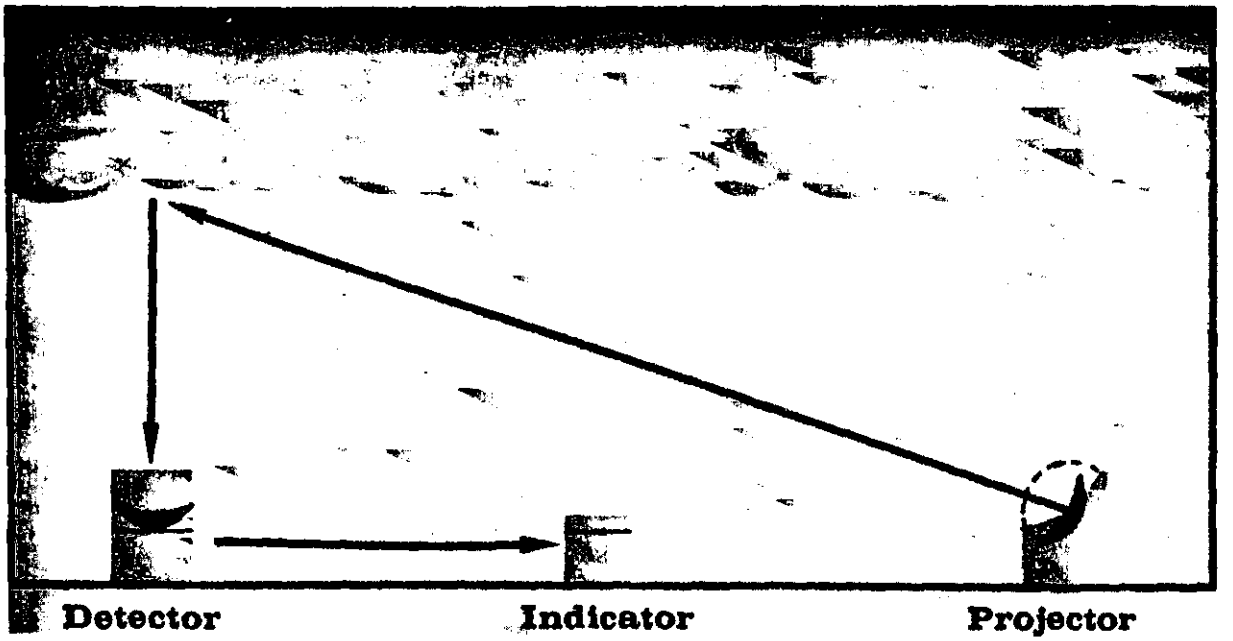


FIGURE 2-5. The rotating beam ceilometer. The projector beams a spot of modulated light on the cloud. The modulated light can be detected day or night. As the projector rotates, the spot moves along the cloud base. When the spot is directly over the detector, it excites a photoelectric cell measuring the angle of the light beam. Height of the cloud is then determined automatically by triangulation. This instrument scans much more rapidly than the older fixed beam ceilometer which is being phased out.

based total obscuration should first see the ground directly below him from the height reported as vertical visibility into the obscuration. However, because of the differing viewing points of the pilot and the observer, these surface reported values do not always exactly agree with what the pilot sees. Figure 2-6 illustrates the effect of an obscured sky on the vision from a descending aircraft.

The letter "V" appended to the ceiling height indicates variable ceiling; the range of variability is shown in remarks. Variable ceiling is reported only when it is critical to terminal operations. As an example,

M12VOVC and in remarks CIG10V13

means MEASURED CEILING ONE THOUSAND TWO HUNDRED VARIABLE OVERCAST, CEILING VARIABLE BETWEEN ONE THOUSAND AND ONE THOUSAND THREE HUNDRED.

Now, let's go back to our five reports and read them through sky and ceiling:

INK CLR	WINK, CLEAR
BOI 150SCT	BOISE, ONE FIVE THOUSAND SCATTERED
LAX 7SCT 250SCT	LOS ANGELES, SEVEN HUNDRED SCATTERED, TWO FIVE THOUSAND SCATTERED
MDW SP -X M7OVC	CHICAGO MIDWAY, SPECIAL, SKY PARTIALLY OBSCURED, MEASURED CEILING SEVEN HUNDRED OVERCAST
JFK SP W5X	NEW YORK KENNEDY, SPECIAL, INDEFINITE CEILING FIVE HUNDRED SKY OBSCURED

VISIBILITY

Prevailing visibility at the observation site immediately follows sky and ceiling in the report. Prevailing visibility is the greatest distance objects can be seen and identified through at least 180° of the horizon. It is reported in statute miles and fractions.

Prevailing visibilities in the five reports are:

INK	VISIBILITY ONE FIVE
BOI	VISIBILITY THREE ZERO
LAX	VISIBILITY SIX
MDW	VISIBILITY ONE AND ONE-HALF
JFK	VISIBILITY ONE-HALF

When visibility is critical at an airport with a weather observing station and a control tower, both take visibility observations. Of the two observa-

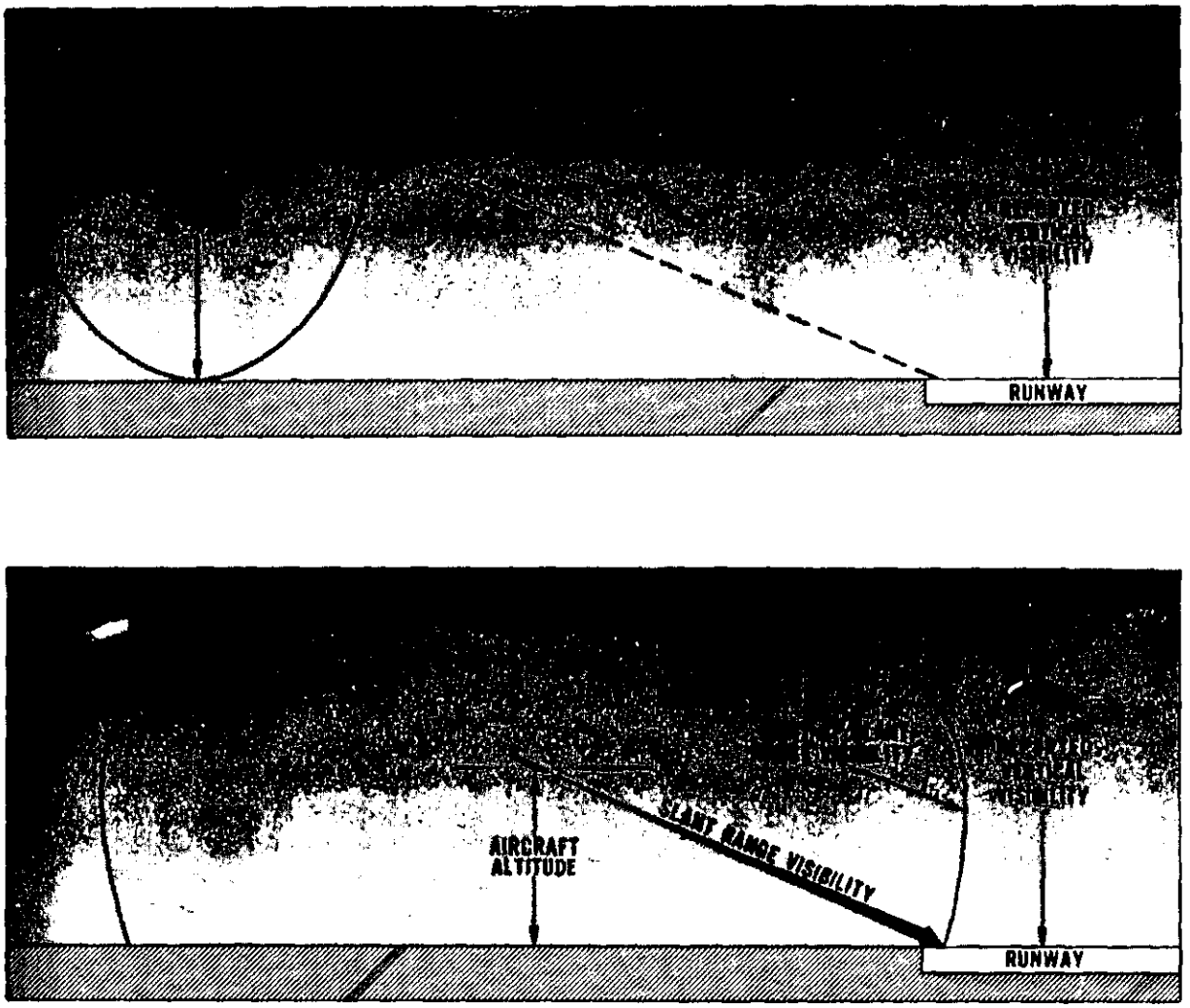


FIGURE 2-6. Vertical visibility is the altitude above the ground from which a pilot should first see the ground directly below him (top). His real concern is slant range visibility which most often is less than vertical visibility. He usually must descend to a lower altitude (bottom) before he sees a representative surface and can fly by visual reference to the ground.

tions, the one most representative is usually reported as prevailing visibility. If the other is operationally significant, it is reported in remarks. Note that the report from JFK has a remark,

TWR VSBY1/4

meaning TOWER VISIBILITY ONE-QUARTER.

The letter "V" suffixed to prevailing visibility denotes variable visibility; the range of visibility is shown in remarks. Variable visibility is reported only when critical to aircraft operations. As an example,

3/4 and in remarks VSBY1/2V1

means VISIBILITY THREE QUARTERS VARIABLE . . . VISIBILITY VARIABLE BETWEEN ONE-HALF AND ONE.

Visibility in some directions may differ significantly from prevailing visibility. These significant differences are reported in remarks. For example, prevailing visibility is reported as 1½ miles with a remark,

VSBY NE2 1/2SW3/4

which means visibility to the northeast is 2½ miles; and to the southwest, it is ¾ of a mile.

WEATHER AND OBSTRUCTIONS TO VISION

Weather and obstructions to vision when occurring at the station at observation time are reported immediately following visibility. If observed at a distance from the station, they are reported in remarks.

The term *weather* as used for this element refers only to those items listed in table 2–3 rather than to the more general meaning of all atmospheric phenomena. Weather includes all forms of precipitation plus thunderstorm, tornado, funnel cloud, and waterspout.

Precipitation is reported in one of four intensities. The intensity symbol follows the weather symbol with meanings as follows:

Very light	– –
Light	–
Moderate	(no sign)
Heavy	+

No intensity is reported for hail (A) or ice crystals (IC).

A thunderstorm is reported as "T" and a severe thunderstorm, as "T+". A *severe thunderstorm* is one in which surface wind is 50 knots or greater and/or hail is ¾ inch or more in diameter.

Obstructions to vision include the phenomena listed in table 2–4. No intensities are reported for obstructions to vision.

Now referring back to our initial five reports, INK and BOI report no weather or obstructions to vision, and no entries appear in the reports. LAX reports two obstructions to vision, smoke and haze. MDW reports heavy rain as weather and fog as an obstruction to vision. JFK reports fog; is this weather or obstruction to vision?

Two types of remarks concern obscuring phenomena surface and aloft. These remarks we study here.

When obscuring phenomena is surface based and partially obscures the sky, a remark reports tenths of sky hidden. For example,

K6

means 6/10 of the sky is hidden by smoke. Now look at the report from MDW; how much of the sky is hidden and by what obscuring phenomena? Note the remark

RF2

which means 2/10 of the sky is hidden by rain and fog.

A layer of obscuring phenomena aloft is reported in the sky and ceiling portion the same as a layer of cloud cover. A remark identifies the layer as obscuring phenomena. For example,

20–BKN and a remark K20–BKN

means a broken layer of smoke based on 2,000 feet above the surface and not concealing the sky (thin).

SEA LEVEL PRESSURE

Sea level pressure is separated from the preceding elements by a space. It is transmitted in

TABLE 2–3. Weather symbols and meanings

Coded	Spoken
Tornado	TORNADO
Funnel Cloud	FUNNEL CLOUD
Waterspout	WATERSPOUT
T	THUNDERSTORM
T+	SEVERE THUNDERSTORM
R	RAIN
RW	RAIN SHOWER
L	DRIZZLE
ZR	FREEZING RAIN
ZL	FREEZING DRIZZLE
A	HAIL
IP	ICE PELLETS
IPW	ICE PELLET SHOWERS
S	SNOW
SW	SNOW SHOWERS
SP	SNOW PELLETS
SG	SNOW GRAINS
IC	ICE CRYSTALS

TABLE 2–4. Obstructions to vision—symbols and meanings

Coded	Spoken
BD	BLOWING DUST
BN	BLOWING SAND
BS	BLOWING SNOW
BY	BLOWING SPRAY
D	DUST
F	FOG
GF	GROUND FOG
H	HAZE
IF	ICE FOG
K	SMOKE

record hourly reports only. It is in three digits to the nearest tenth millibar with the decimal point omitted. Sea level pressure usually is greater than 960.0 millibars and less than 1050.0 millibars. The first 9 or 10 is omitted. To decode, prefix a 9 or 10 whichever brings it closer to 1000.0 millibars. Again going back to our five reports, sea level pressures are:

INK	1010.6 millibars
BOI	1018.1
LAX	1012.9
MDW	999.0
JFK	1018.0

TEMPERATURE AND DEW POINT

Temperature and dew point are in whole degrees Fahrenheit. They are separated from sea level

pressure by a slash (/). If sea level pressure is not transmitted, temperature is separated from preceding elements by a space. Temperature and dew point are separated also by a slash. A minus sign precedes a temperature or dew point when below 0°F. From our five reports, we have:

INK . . . 77/63	WINK . . . TEMPERATURE SEVEN SEVEN, DEW POINT SIX THREE
BOI . . . 62/42	BOISE . . . TEMPERATURE SIX TWO, DEW POINT FOUR TWO
LAX . . . 60/59	LOS ANGELES . . . TEMPERATURE SIX ZERO, DEW POINT FIVE NINER
MDW . . . 63/61	CHICAGO MIDWAY . . . TEMPERATURE SIX THREE, DEW POINT SIX ONE
JFK . . . 68/64	NEW YORK KENNEDY . . . TEMPERATURE SIX EIGHT DEW POINT SIX FOUR

WIND

Wind follows dew point and is separated from it by a slash. Average one minute direction and speed are in four digits. The first two digits are direction *from* which the wind is blowing. It is in tens of degrees referenced to true North*, i.e., 01 is 10°; 21 is 210°; 36 is 360° or North. The second two digits are speed in knots. A calm wind is reported as 0000.

If windspeed is 100 knots or greater, 50 is added to the direction code and the hundreds digit of speed is omitted. Example,

5908

means

090° (09+50=59) at 108 knots.

A *gust* is a variation in windspeed of at least 10 knots between peaks and lulls. A *squall* is a sudden increase in speed of at least 15 knots to a sustained speed of 20 knots or more lasting for at least one minute. Gusts or squalls are reported by the letter "G" or "Q" respectively following the average one-minute speed and followed by the peak speed in knots. For example,

1522Q37

means

wind 150° at 22 knots with peak speed in squalls to 37 knots.

Winds decoded from our five reports are

INK	WIND ONE ONE ZERO DEGREES AT ONE TWO PEAK GUSTS ONE EIGHT
BOI	WIND ONE THREE ZERO DEGREES AT FOUR
LAX	WIND TWO FIVE ZERO DEGREES AT FOUR
MDW	WIND THREE TWO ZERO DEGREES AT FIVE
JFK	WIND ONE EIGHT ZERO DEGREES AT FOUR

When any part of the wind report is *estimated* (direction, speed, peak speed in gusts or squalls), the letter "E" precedes the wind group. Example,

E1522G28

is decoded WIND ONE FIVE ZERO DEGREES ESTIMATED TWO TWO PEAK GUSTS ESTIMATED TWO EIGHT.

A few stations do not transmit sea level pressure, temperature, and dew point; and these elements usually are not included in a special. When the elements are not transmitted, the wind group is separated from the preceding element by a space; i.e.,

CSM SP W5X 2F 1705/990

is a record special from Clinton-Sherman Oklahoma (CSM) *not* transmitting sea level pressure, temperature, or dew point.

ALTIMETER SETTING

Altimeter setting follows the wind group and is separated from it by a slash. Normal range of altimeter settings is from 28.00 inches to 31.00 inches of mercury. The last three digits are transmitted with the decimal point omitted. To decode, prefix to the coded value either a 2 or a 3 whichever brings it closer to 30.00 inches. Examples,

996 means ALTIMETER TWO NINER NINER SIX, (29.96 inches)

013 means ALTIMETER THREE ZERO ONE THREE (30.13 inches)

An estimated altimeter is read from an instrument not compared to a standard instrument as recently as required (see AVIATION WEATHER, Chapter 3). It is reported by prefixing an "E" to the coded value. Example,

E035 means ALTIMETER ESTIMATED THREE ZERO THREE FIVE

REMARKS

Remarks, if any, follow altimeter setting separated from it by a slash. Certain remarks should be reported routinely; others the observer may include when considered significant to aviation. Often, some of the most important information in an observation may be the remarks portion discussed in succeeding paragraphs.

* Wind direction for the local station is *broadcast* in degrees magnetic.

Runway Visibility and Runwc · Visual Range

The first remark, when transmitted, should be runway visibility or runway visual range. Figure 2–7 illustrates the difference. The terms are defined as follows:

Runway visibility—the visibility from a particular location along an identified runway, usually determined by transmissometer instrument. It is in miles and fractions. Figure 2–8 diagrams the principle of the transmissometer.

Runway visual range—the maximum horizontal distance down a specified instrument runway at which a pilot can see and identify standard high intensity runway lights. It is always determined using a transmissometer and is reported in hundreds of feet.

The report consists of a runway designator and the contraction "VV" or "VR" followed by the appropriate visibility or visual range. Both the VV and the VR report are for a 10-minute period preceding observation time. The remark usually reports the 10-minute extremes separated by the letter "V". However, if the visual range or visibility has not changed significantly during the 10 minutes, a single value is sent indicating that the value has remained constant.

The following examples show several reports and their decoding:

R36VV11/2	RUNWAY THREE SIX, VISIBILITY ONE AND ONE-HALF. (Visibility remained constant during the 10-minute period.)
R05LVV1V2	RUNWAY FIVE LEFT, VISIBILITY VARIABLE BETWEEN ONE AND TWO.
R18VR20V30	RUNWAY ONE EIGHT, VISUAL RANGE VARIABLE BETWEEN TWO THOUSAND FEET AND THREE THOUSAND FEET.
R26RVR24	RUNWAY TWO SIX RIGHT, VISUAL RANGE TWO THOUSAND FOUR HUNDRED FEET. (Visual range remained constant during the 10-minute period.)

Runway visual range in excess of 6,000 feet is written 60+. VR less than the minimum value that can be observed by the instrument is encoded

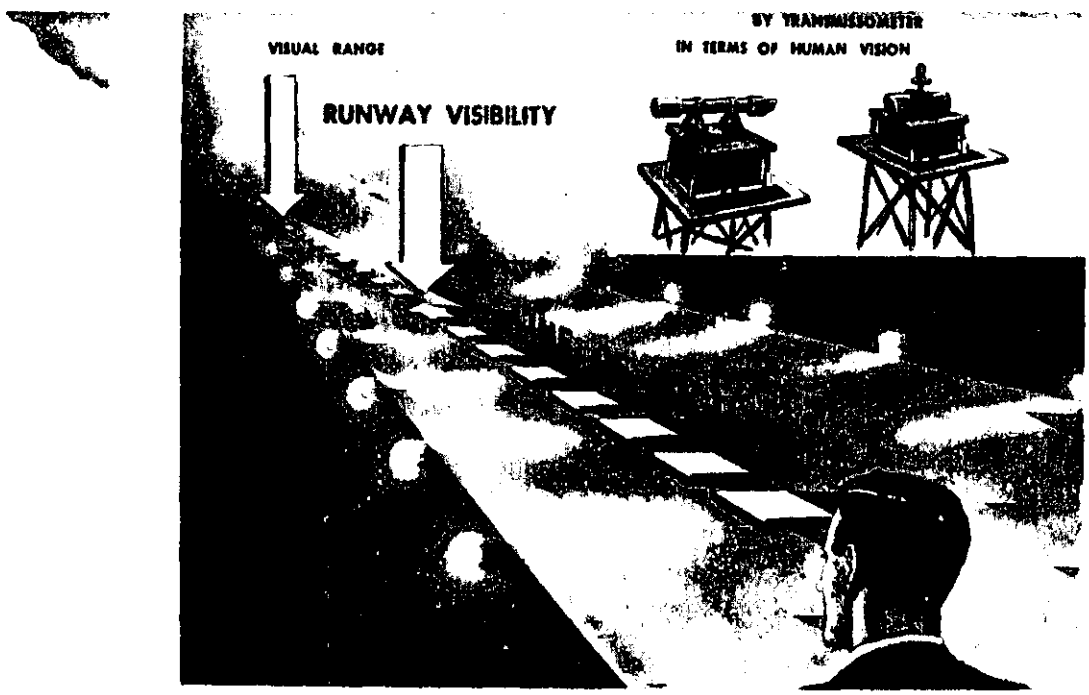


FIGURE 2–7. Difference between *runway visibility* and *runway visual range*. Runway visibility is the distance down the runway the pilot can see unlighted objects or unfocused lights of moderate intensity. Runway visual range is the distance he can see high intensity runway lights. Visual range usually is greater than visibility because the high intensity lights penetrate farther into the obscuring phenomena.

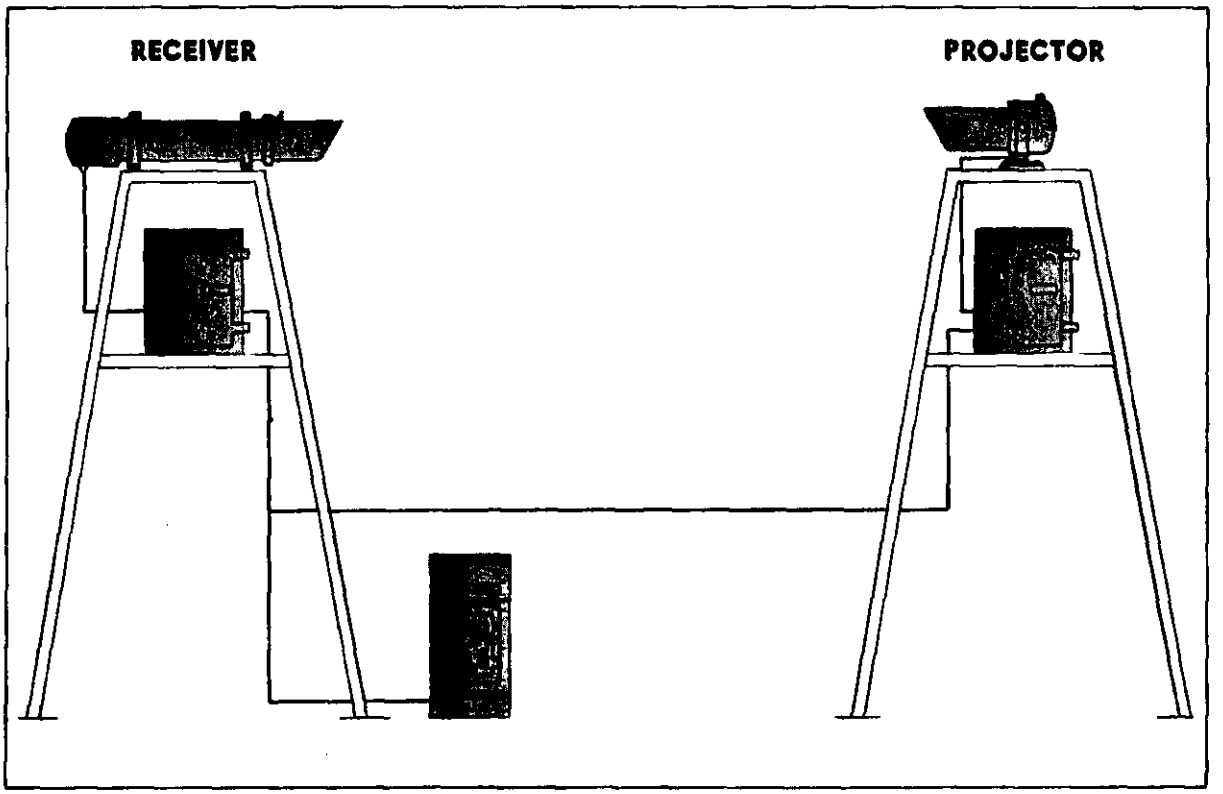


FIGURE 2-8. The transmissometer. The projector beams light toward the receiver. Obscuring phenomena in the path of the beam absorbs some of the light. A photoelectric cell in the receiver measures the amount of light penetrating through the obscuring phenomena. The amount received is converted into visibility.

as the minimum suffixed by a minus sign. For example:

R36LVR10—V25

is decoded RUNWAY THREE SIX LEFT, VISUAL RANGE VARIABLE FROM LESS THAN ONE THOUSAND FEET TO TWO THOUSAND FIVE HUNDRED FEET.

Heights of Bases and Tops of Sky Cover Layers

Bases and tops of clouds or obscuring phenomena may be reported. These remarks originate from pilots. Heights are above MSL.

/UA BKN 50	Top broken layer 5,000 feet (MSL)
/UA OVC 30/60 OVC	Top lower overcast 3,000 feet, base of higher overcast 6,000 feet.

Clarification of Coded Data

Following, by category, are coded remarks clarifying or expanding on coded elements:

SKY AND CEILING

Coded Elements	*Coded Remarks*	*Coded Elements*	*Coded Remarks*
FEW CU	Few cumulus clouds	30SCT V BKN	Scattered layer at 3000 feet variable to broken
HIR CLDS VSB	Higher clouds visible	SC BANK NW	Stratocumulus cloud bank northwest
BRKHIC	Breaks in higher overcast	TCU W*	Towering cumulus clouds west
BINOVC	Breaks in overcast	CB N MOVG E*	Cumulonimbus north moving east
BRKS N	Breaks north		
BKN V OVC	Broken layer variable to overcast		
CIG 14V19	Ceiling variable between 1400 feet and 1900 feet	CBMAM OVHD-W*	Cumulonimbus mamma overhead to west

Sky and Ceiling—Continued

Coded Elements	*Coded Remarks*	*Coded Elements*	*Coded Remarks*
ACCAS ALQDS*	Altocumulus castellanus all quadrants	CONTRAILS N 420 MSL	Condensation trails north at 42,000 feet MSL
ACSL SW-NW*	Standing lenticular altocumulus southwest to northwest	CLDS TPG MTNS SW	Clouds topping mountains southwest
ROTOR CLDS NW*	Rotor clouds northwest	RDGS OBSCD W-N	Ridges obscured west through north
VIRGA E-SE*	Virga (precipitation not reaching the ground) east through southeast	CUFRA W APCHG STN	Cumulus fractus clouds west approaching station
		LWR CLDS NE	Lower clouds northeast

Obscuring Phenomena

D5	Dust obscuring 5/10 of the sky	K20SCT	Scattered layer of smoke aloft based at 2000 feet above the surface
S7	Snow obscuring 7/10 of the sky		
BS3	Blowing snow obscuring 3/10 of the sky	THIN FOG NW	Thin fog northwest (from reporting station)
FK4	Fog and smoke obscuring 4/10 of the sky		

Visibility (Statute Miles)

VSBY S1W1/4	Visibility south 1, west ¼	TWR VSBY3/4	Tower visibility ¾
VSBY1V3	Visibility variable between 1 and 3	SFC VSBY1/2	Surface visibility ½

Weather and Obstructions To Vision

T W FQT LTGCG	Thunderstorm west, frequent lightning cloud to ground	OCNL RW	Occasional moderate rain shower
RB30	Rain began 30 minutes after the hour	WET SNW	Wet snow
SB15E40	Snow began 15, ended 40 minutes after the hour	SNOINCR 5	Snow increase 5 inches during past hour
UNCONFIRMED TORNADO 15W OKC MOVG NE 2000	Unconfirmed tornado 15 (nautical miles) west of Oklahoma City, moving northeast, sighted at 2000Z	R− OCNLY R+	Light rain occasionally heavy rain
		RWU	Rain showers of unknown intensity
T OVHD MOVG E	Thunderstorm overhead, moving east	F DSIPTG	Fog dissipating
OCNL DSNT LTG NW	Occasional distant lightning northwest	K DRFTG OVR FLD	Smoke drifting over field
HLSTO 2	Hailstones 2 inches in diameter	KOCTY	Smoke over city
INTMT R-	Intermittent light rain	SHLW GFDEP 4	Shallow ground fog 4 feet deep
		DUST DEVILS NW	Dust devils northwest
		PATCH GF S	Patch ground fog south

Wind

WSHFT30	Wind shifted at 30 minutes past the hour	PK WND 3348/22	Peak wind within the past hour from 330° at 48 knots occurred 22 minutes past the hour
WND 27V33	Wind variable between 270° and 330°		

Pressure

PRESRR	Pressure rising rapidly	PRJMP 8/1012/18	Pressure jump (sudden increase) .08 inches began 1012 GMT, ended 1018 GMT
PRESFR	Pressure falling rapidly		
LOWEST PRES 631 1745	Lowest pressure (sea level) 963.1 millibars at 1745 GMT		

* These cloud types are highly significant, and the observer should always report them. Figures 2-9 through 2-14 are photographs of these clouds and explain their significance. A pilot in flight should also report them when observed.

FIGURE 2-9. Towering Cumulus (TCU). The most direct significance of this cloud is that atmosphere in the lower altitudes is unstable and conducive to turbulence.

FIGURE 2-10. Cumulonimbus (CB). The anvil portion of a CB is composed of ice crystals. The CB or thunderstorm cloud contains most types of aviation weather hazards; particularly turbulence, icing, and hail.

FIGURE 2-11. Cumulonimbus Mamma (CBMAM). This characteristic cloud results from violent up and down currents and is often associated with severe weather. It indicates probable severe or greater turbulence.

FIGURE 2-12. Altocumulus Castellanus (ACCAS). ACCAS indicates unstable conditions aloft, but not necessarily below the base of the cloud. Compare with towering cumulus, a cloud representing unstable air and turbulence from the surface upward.

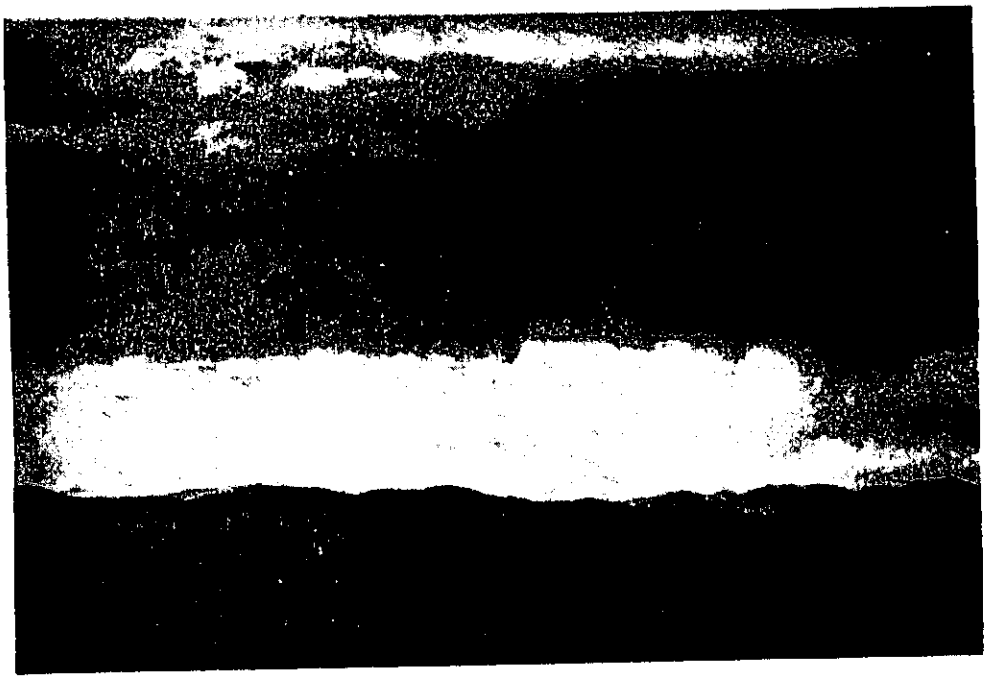


FIGURE 2–13. Virga. Virga is precipitation falling from a cloud but evaporating before reaching the ground. Virga results when air below the cloud is very dry—most common in the western part of the country.

FIGURE 2–14. Standing Lenticular Altocumulus (ACSL). These clouds are characteristic of the standing or mountain wave. A similar cloud is the Standing Lenticular Cirrocumulus (CCSL). CCSL are whiter and at higher altitude. Both are indicative of possible severe or greater turbulence.

Freezing Level Data

Upper air (rawinsonde) observation stations append in remarks *freezing level data.* The coded remark is appended to the first record report transmitted after the information becomes available. Code for the remark is as follows:

RADAT UU (D) ($h_ph_ph_p$) ($h_ph_ph_p$) (/n)

(a) RADAT—a contraction identifying the remark as "freezing level data".

(b) UU—relative humidity at the freezing level in percent. When more than one level is sent, "UU" is highest relative humidity observed at any of the levels transmitted.

(c) (D)—a coded letter "L", "M", or "H" to indicate that relative humidity is for the "lowest", "middle", or "highest" level coded. This letter is omitted when only one level is sent.

(d) ($h_ph_ph_p$)—a height in hundreds of feet above MSL at which the upper air sounding crossed the 0° C isotherm. No more than three levels are coded. If the sounding crosses the 0° C isotherm more than three times, the levels coded are the lowest and the top two levels.

(e) (/n)—indicator to show the number of crossings of the 0° C isotherm, other than those coded. The indicator is omitted when all levels are coded.

Examples:

RADAT 87045	Relative humidity 87%, only crossing of 0° C isotherm was 4,500 feet MSL.
RADAT 87L024105	Relative humidity 87% at the lowest (L) crossing. Two crossings occurred at 2,400 and 10,500 feet MSL.
RADAT 84M019045051/1	Relative humidity 84% at the middle (M) crossing of the three coded crossings. Coded crossings were at 1,900, 4,500, and 5,100 feet. The 84% humidity was at 4,500 feet MSL. "/1" indicates one additional crossing and it was between 1,900 and 4,500 feet.
RADAT MISC	The sounding terminated below the first crossing of the 0° C isotherm—temperatures were all above freezing.
RADAT ZERO	The entire sounding was below 0° C.

Icing Data

When the rawinsonde observer determines definitely that icing was occurring on his instruments, he enters the data in the following code:

RAICG HHMSL (SNW)

(a) RAICG—indicates icing data follows.

(b) HH—height in hundreds of feet at which icing occurred. "MSL" is always appended to the height.

(c) (SNW)—used to indicate that snow is causing a reduced balloon ascension rate. (Omitted otherwise.)

Examples:

RAICG 12MSL—Icing at 1,200 feet MSL.

RAICG 24MSL SNW—Icing at 2,400 feet MSL in snow.

Other Information

A group or groups of numerically coded data may appear in remarks. These data are primarily of concern to the meteorologist and are not discussed here.

A printed arrow marks the end of weather information and signifies that the rest of the report is notice(s) to airmen (NOTAM). The NOTAM code is explained in the AIRMAN'S INFORMATION MANUAL.

REPORT IDENTIFIERS

A heading begins the record hourly collective on the local circuit identifying the type of message, the circuit number, and the date and time of observations making up the collective reports. For example,

SA21 271900

means surface aviation reports (SA); 21 is the circuit number; 27 is the day of the month; and the observations were made at 1900 GMT.

A slightly different heading begins each relay. It identifies the location of reporting stations either (1) by States or (2) in relation to the local circuit It indicates the time the relay began. Example,

SA NEAR EAST201904

means surface aviation reports; area covered by the relay is just east of the local circuit area; day of the month is the 20th (20); time of observations is 1900 GMT (19); and the relay began 4 minutes past the hour (04).

Relay designators other than States are INTERMEDIATE EAST, FAR EAST, NEAR NORTH, etc. The relay collectives are assembled by a centralized computer and are unique to each circuit.

Individual reports must each convey the time and type of report. These reports include specials, corrected reports, and supplemental reports. Following are examples:

Example 1

INK 1100.....

indicates a relayed report from Wink, Texas for 1100 GMT (all times transmitted in teletypewriter reports are GMT). Since the time is on the hour, it signifies a record hourly so that further identification is unnecessary.

Example 2

INK COR 1100.....

signifies a correction to the 1100 GMT record hourly report as originally transmitted. The correction may transmit the complete corrected report, or it may contain only the corrected element or elements.

Example 3

INK SP 2315.....

indicates a special report of an observation taken at 2315 GMT to report a significant change in weather.

Example 4

INK COR SP 2315.....

indicates a correction to the special report in example 3.

Example 5

BVO SW 1130.....

indicates a Supplemental Aviation Weather Reporting Station (SAWRS) report by the contraction "SW". SAWRS reports are unscheduled and are made by non-Government observers at airports not served by a regularly reporting weather station. Observations are taken during commercial aircraft operations. Type and time are transmitted. This report was from Bartlesville, Oklahoma at 1130 GMT.

READING THE SURFACE AVIATION WEATHER REPORT

Now that we have studied the individual elements and their decoding, let's read completely each of the five reports. Capitalized phrases are those elements which *normally* are broadcast by the station at or near the airport where the observation was made:

INK CLR 15 106/77/63/1112G18/000

WINK, WINK, CLEAR, VISIBILITY ONE FIVE, pressure 1010.6 millibars, TEMPERATURE SEVEN SEVEN, dew point six three, WIND ONE ONE ZERO DEGREES AT ONE TWO PEAK GUSTS ONE EIGHT, ALTIMETER THREE ZERO ZERO ZERO.

BOI 150SCT 30 181/62/42/1304/015

BOISE, BOISE, ONE FIVE THOUSAND SCATTERED, VISIBILITY THREE ZERO, pressure 1018.1 millibars, TEMPERATURE SIX TWO, dew point four two, WIND ONE THREE ZERO DEGREES AT FOUR, ALTIMETER THREE ZERO ONE FIVE.

LAX 7SCT 250SCT 6HK 129/60/59/2504/991→LAX↘6/38

LOS ANGELES, LOS ANGELES, SEVEN HUNDRED SCATTERED TWO FIVE THOUSAND SCATTERED, VISIBILITY SIX, HAZE, SMOKE, pressure 1012.9 millibars, TEMPERATURE SIX ZERO, DEW POINT FIVE NINER, WIND TWO FIVE ZERO DEGREES AT FOUR, ALTIMETER TWO NINER NINER ONE.

Note that nothing past the arrow was read. The arrow indicates that NOTAM information follows and is not part of the *weather* report.

MDW SP −X M7OVC 11/2R+F 990/63/61/3205/950/RF2 RB12

CHICAGO, CHICAGO MIDWAY, SPECIAL, SKY PARTIALLY OBSCURED, MEASURED CEILING SEVEN HUNDRED OVERCAST, VISIBILITY ONE AND ONE-HALF, HEAVY RAIN, FOG, pressure 999.0 millibars, TEMPERATURE SIX THREE, DEW POINT SIX ONE, WIND THREE TWO ZERO DEGREES AT FIVE, ALTIMETER TWO NINER FIVE ZERO, TWO TENTHS SKY OBSCURED BY RAIN AND FOG, rain began 12 minutes past the hour.

JFK SP W5X 1/2F 180/68/64/1804/006/R04RVR22V30 TWR VSBY1/4

NEW YORK, NEW YORK KENNEDY, SPECIAL, INDEFINITE CEILING FIVE HUNDRED SKY OBSCURED, VISIBILITY ONE-HALF, FOG, pressure 1018.0 millibars, TEMPERATURE SIX EIGHT, DEW POINT SIX FOUR, WIND ONE EIGHT ZERO DEGREES AT FOUR, ALTIMETER THREE ZERO ZERO SIX, RUNWAY FOUR RIGHT VISUAL RANGE VARIABLE BETWEEN TWO THOUSAND TWO HUNDRED FEET AND THREE THOUSAND FEET, TOWER VISIBILITY ONE QUARTER.

Section 3

PILOT AND RADAR REPORTS

The preceding section explained the decoding of surface aviation weather reports. However, these spot reports only sample the total weather picture. Pilot and radar reports help fill the gaps between stations.

PILOT WEATHER REPORTS (PIREPS)

No observation is more timely than the one you make from your cockpit. In fact, aircraft in flight are the only means of directly observing cloud tops, icing, and turbulence. Your fellow pilots welcome your PIREP as well as do the briefer and forecaster. Help yourself and the aviation weather service by sending pilot reports!

A PIREP usually is transmitted by teletypewriter in a prescribed format. The letters "UA" identify the message as a pilot report. Next in order are location; time; phenomena encountered; altitude; and, if the report is turbulence or icing, the type of aircraft. All altitude references are MSL unless noted, distances are in nautical miles, and time is in GMT.

A PIREP is transmitted over teletypewriter as a single message, in a group of PIREPs collated by States (UBUS 1 bulletins), or as a remark appended to a surface aviation weather report. Description of the phenomena may be sent as received or coded in contractions and symbols.

Let's read a PIREP message transmitted by Washington, D.C. (DCA):

DCA UA 20 S DCA 1620 MDT RIME ICE 50 BE18

"A pilot 20 nautical miles south of Washington at 1620 GMT encountered moderate rime icing at 5,000 feet MSL. The aircraft was a BE–18."

Most contractions in PIREP messages are self-explanatory. Icing and turbulence reports state intensities using standard terminology when possible. Intensity tables for turbulence and icing are in section 16. If a pilot's description of an icing or turbulence encounter cannot readily be translated into standard terminology, the pilot's description is transmitted verbatim.

The following excerpts may assist you in reading transmitted pilot weather reports:

UA RDU . . . . DURGD OAOI 150 OI 80 . . . .

means ". . . during descent on and off instruments at 15,000 feet; on instruments at 8,000 feet . . . ."

UA MGW . . . . 10–2515/−2 . . . .

is decoded ". . . . wind at 10,000 feet, 250° at 15; temperature −2° C. . . ."

UA MRB . . . INTMTLY BL MDT TURBC R 60 TURBC INCRS WWD . . .

states ". . . . intermittently between layers (contraction BL); moderate turbulence, moderate rain at 6,000 feet; turbulence increases westward . . ."

UA ABQ 1845 TIJERAS PASS CLOSED DUE TO FOG AND LOW CLDS. UNABLE VFR RTNG ABQ.

is self-explanatory. Information of this type is helpful to others planning VFR flight in the area.

UA CLE OVR TOL 2200 MDT CAT 350–390 B707

means " . . . over Toledo at 2200 GMT a pilot reports moderate clear air turbulence from flight level 35,000 to 39,000; aircraft is a Boeing 707." The report was transmitted by Cleveland.

To lessen the chance of misinterpretation by others, you are urged to report icing and turbulence in standard terminology (intensity tables for turbulence and icing, section 16). If your report cannot be translated into standard terminology, it is transmitted verbatim. This PIREP stated,

. . . . PRETTY ROUGH AT 6,500, SMOOTH AT 8,500 PA24

Would a report of "light", "moderate", or "severe" turbulence at 6,500 have meant more to you?

Pilot reports of cloud bases and tops are usually in symbols and are often appended to surface avia-

tion weather reports. Height of cloud base precedes the sky cover symbol, and top follows the symbol. For example,

38 BKN 70

means base of a broken layer at 3,800 feet and top 7,000 feet (all MSL).

The following example appended to an aviation weather report,

DSM M8OVC 3R–F 132/45/44/3213/992/UA 1735 12NW DSM OVC 65/80 OVC 140

is decoded " . . . . pilot reports at 1735 GMT 12 (nautical miles) northwest of Des Moines, top of the lower overcast 6,500 MSL; base of a second layer (overcast) at 8,000 and top, 14,000 feet MSL."

Pilot reports of a non-meteorological nature sometimes help air traffic controllers. This "plain language" report stated:

. . . 3N PNS LRG FLOCK OF GOOSEY LOOKING BIRDS HDG GNLY NORTH MAY BE SEAGULLS FORMATION LOUSY COURSE ERRATIC . . . .

While in humorous vein, this PIREP alerted pilots and controllers to a bird hazard.

Your PIREP always helps someone else and becomes a part of the aviation weather service. Please report anything you observe that may be of concern to other pilots.

RADAR WEATHER REPORTS (RAREPS)

Thunderstorms and general areas of precipitation can be observed by radar. Radar weather reports are routinely transmitted by teletypewriter and some are included in scheduled weather broadcasts by Flight Service Stations.

Most radar stations report each hour with intervening special reports as required. They report location of precipitation along with type, intensity and trend. Table 3–1 explains symbols denoting intensity and trend. Table 3–2 summarizes the order and content of a radar weather report.

To assist you in interpreting RAREPs, five examples are decoded into plain language:

LIT 1133 AREA 4TRW+/+ 22/100 88/170 196/180 220/115 CELLS 2425 MT 310 AT 162/110

Little Rock, Arkansas radar weather observation at 1133 GMT

An area of echoes, four-tenths coverage, containing thunderstorms and heavy rainshowers, increasing in intensity

Area is defined by points (referenced LIT radar) at 22°, 100 NM (nautical miles); 88°, 170 NM; 196°, 180 NM; and 220°, 115 NM. (These points plotted on a map and connected with a line outline the area of echoes.)

Individual cells are moving from 240° at 25 knots

Maximum tops (MT) are 31,000 feet located at 162° and 110 NM from LIT

JAN 1935 SPL LN 10TRWX/NC 86/40 164/60 199/115 12W CELLS 2430 MT 440 AT 159/65 D10

Jackson, Mississippi, a 1935 special radar report

Line of echoes, ten-tenths coverage, thunderstorm, intense rainshowers, no change in intensity

Center of the line extends from 86°, 40 NM; 164°, 60 NM; and 199°, 115 NM. The line is 12 NM wide (12W). (To display graphically, plot the center points on a map and connect the points with a line; since the thunderstorm line is 12 miles wide, it extends 6 miles either side of your plotted line.)

Thunderstorm cells are moving from 240° at 30 knots

Maximum tops are 44,000 feet, centered at 159°, 65 NM from Jackson. Diameter of this cell is 10 NM (D10)

MAF 1130 AREA 2S 27/80 90/125 196/50 268/100 2410 MT 100 UNIFORM

Midland, Texas radar weather report at 1130 GMT

An area, two-tenths coverage, of snow

Area is bounded by points 27°, 80 NM; 90°, 125 NM; 196°, 50 NM; and 268°, 100 NM

Movement is from 240° at 10 knots

Maximum tops are 10,000 feet; tops are uniform (smooth)

HDO 1132 AREA 2TRW++ 6R−/NC 67/130 308/45 105W CELLS 2240 MT 380 at 66/54

Hondo, Texas radar weather report at 1132 GMT

An area of echoes containing two-tenths coverage of thunderstorms, very heavy rainshowers, and six-tenths coverage light rain. No intensity change. (This report suggests thunderstorms embedded in a general area of light rain.)

Although the pattern is an "area", only two points are given followed by "105W". This means the area lies 52½ miles either side of the line defined by the two points—67°, 130 NM and 308°, 45 NM

Thunderstorm cells are moving from 220° at 40 knots

Maximum tops are 38,000 feet at 66°, 54 NM

TABLE 3-1. Precipitation intensity and intensity trend

Intensity		Intensity Trend	
Symbol	Intensity	Symbol	Trend
−	Light	+	Increasing
(none)	Moderate		
+	Heavy	−	Decreasing
++	Very heavy		
X	Intense	NC	No change
XX	Extreme		
U	Unknown	NEW	New echo

TABLE 3-2. Order and content of a radar weather report

OKC 1934 LN 8TRW++/+ 86/40 164/60/ 199/115 15W 2425
MT 570 AT 159/65 2 INCH HAIL RPRTD THIS ECHO

OKC 1934	LN	8	TRW++/+	86/40 164/60 199/115	15W	2425
a.	b.	c.	d.	e.	f.	g.

MT 570 AT 159/65	2 INCH HAIL RPRTD THIS ECHO
h.	i.

a. Location identifier and time of radar observation (GMT)
b. Echo pattern[1] (line in this example)
c. Coverage in tenths (8/10 of this example)
d. Type, intensity, and trend of weather[2] (thunderstorm (T), very heavy rainshowers (RW++), increasing in intensity (/+))
e. Azimuth (reference true N) and range in nautical miles (NM) of points defining the echo pattern
f. Dimension of echo pattern[3] (15 NM wide)
g. Pattern movement (line moving from 240° at 25 knots); may also show movement of individual storms or "cells"
h. Maximum tops and location (57,000 feet)
i. Remarks; self-explanatory in plain language contractions.

[1] Echo pattern may be a line (LN), fine line (FINE LN), area (AREA), spiral band area (SPIRAL BAND), or single cell (CELL).

[2] Teletypewriter weather symbols are used. See Table 3-1 for intensity and intensity trend symbols.

[3] Dimension of an echo pattern is given when azimuth and range define only the center or center line of the pattern.

When a radar report is transmitted but contains no encoded weather observation, a contraction is sent which indicates operational status of the radar. Table 3–3 explains the contractions.

OKC 1135 PPINE

Oklahoma City, Oklahoma radar at 1135 GMT detects no echoes

Radar weather reports also contain groups of digits, i.e., 00220 00221, etc., which are entered on a line following the RAREP. This manually digitized radar information is omitted from the foregoing examples since it is used primarily by meteorologists and hydrologists for estimating amount of rainfall.

A radar weather report may contain remarks in addition to the coded observation. Certain types of severe storms produce distinctive patterns on the radar scope. For example, a hook-shaped echo may be associated with a tornado; and a spiral band with a hurricane. If hail, strong winds, tornado activity, or other adverse weather is known to be associated with identified echoes on the radar scope, the location and type of phenomena are included as a remark. Examples of remarks are: "HAIL REPORTED THIS ECHO"; "TORNADO ON GROUND AT 338/15"; and "HOOK ECHO 243/18".

When using hourly and special radar weather reports in preflight planning, note the location and coverage of echoes, the type of weather reported, the intensity trend, and especially the direction of movement. A word of caution—remember that radar detects only thunderstorms and general areas of precipitation; it is *not* designed to detect enroute ceiling and visibility. An area may be blanketed with fog or low stratus, but unless precipitation is also present, the radar scope will be clear of echoes. Use radar reports along with PIREPs and aviation weather reports and forecasts.

RAREPs help you to plan ahead to avoid thunderstorm areas. Once airborne, however, you must depend on visual sighting or airborne radar to evade individual storms.

TABLE 3–3. Contractions reporting operational status of radar

Contraction	Operational status
PPINE	Equipment normal and operating in PPI (Plan Position Indicator) mode; no echoes observed.
PPIOM	Radar inoperative or out of service for preventative maintenance.
PPINA	Observations omitted or not available for reasons other than PPINE or PPIOM.
ROBEPS	Radar operating below performance standards.
ARNO	"A" scope or azimuth/range indicator inoperative.
RHINO	Radar cannot be operated in RHI (Range-height indicator) mode. Height data not available.

Section 4

AVIATION WEATHER FORECASTS

Good flight planning considers forecast weather. This section explains the following aviation forecasts:

1. Terminal Forecasts
   (a) Domestic (FT)
   (b) International (ICAO TAF)
2. Area Forecast (FA)
3. TWEB Route Forecast and Synopsis
4. SIGMET and AIRMET (WS, WA, and WAC)
5. Winds and Temperatures Aloft Forecast (FD)
6. Special Flight Forecast

Also discussed are the following general forecasts which may aid in flight planning:

1. Hurricane Advisory (WH)
2. Convective Outlook (AC)
3. Severe Weather Watch Bulletin (WW)

U.S. terminal and area forecasts group ceiling and visibility into the following categories:

LIFR (Low IFR)	—Ceiling less than 500 feet and/or visibility less than 1 mile.
IFR	—Ceiling 500 to less than 1,000 feet and/or visibility 1 to less than 3 miles.
MVFR (Marginal VFR)	—Ceiling 1,000 to 3,000 feet and/or visibility 3 to 5 miles inclusive.
VFR	—Ceiling greater than 3,000 feet and visibility greater than 5 miles; includes sky clear.

These categorical groupings are used for the outlook portions of the forecasts extending beyond 18 hours. They enable the forecaster to more realistically describe conditions in the outlook period intended primarily for advanced operational planning.

The cause of LIFR, IFR, or MVFR is also given by either ceiling or visibility restrictions or both. The contraction "CIG" and/or weather and obstruction to vision symbols are used. If winds or gusts of 25 knots or greater are forecast for the outlook period, the word "WIND" is also included for all categories including VFR. Examples:

LIFR CIG	—Low IFR due to low ceiling.
IFR F	—IFR due to visibility restricted by fog.
MVFR CIG H K	—Marginal VFR due both to ceiling and to visibility restricted by haze and smoke.
IFR CIG R WIND	—IFR due both to low ceiling and to visibility restricted by rain; wind expected to be 25 knots or greater.

You should memorize the categories and their defining ceiling and visibility limits. Knowing them is mandatory to readily interpreting an outlook into operational planning.

Forecasts are regularly scheduled in collectives; but occasionally an unscheduled forecast must be transmitted out of collective. A forecast transmitted out of a collective must be identified by one of the following contractions with meaning as noted:

RTD—Routine delayed weather bulletin
COR—Correction bulletin
AMD—Amendment bulletin

TERMINAL FORECASTS

A terminal forecast is for a specific airdrome. In the U.S., it is for an area within a 5-mile radius of the center of the runway complex. Terminal forecasts are in both the domestic U.S. code (FT)

and the ICAO (TAF) code. Scheduled terminal forecasts are valid for 24 hours.

U.S. Terminal Forecast Code (FT)

Terminal forecasts in the U.S. code (FT) are issued three times daily by WSFOs. Figure 1–4, section 1, shows the FT network. Issue and valid times are according to time zones of the issuing WSFO (see table in the next column).

WSFO Location (time zone)	*Issue time*	*Valid period*
Eastern/Central	0940Z	10Z–10Z
	1440Z	15Z–15Z
	2140Z	22Z–22Z
Mountain/Pacific	0940Z	10Z–10Z
	1540Z	16Z–16Z
	2240Z	23Z–23Z

Format of the FT is essentially the same as that of the SA report. Following is an FT:

STL 251010 C5X 1/2S–BS 3325G35 OCNL C0X 0S+BS. 16Z C30BKN 3BS BRF SW−. 22Z 30SCT 3315. 00Z CLR. 04Z VFR WIND . .

To aid in the discussion, we have divided the forecast into the following elements lettered "a" through "i"

STL (a.) 251010 (b.) C5X (c.) 1/2 (d.) S−BS (e.) 3325G35 (f.) OCNL C0X 0S+BS. (g.)

16Z C30BKN 3BS BRF SW−. 22Z 30SCT 3315. 00Z CLR. (h.)

04Z VFR WIND . . (i.)

a. *Station identifier.* "STL" identifies St. Louis, Missouri. The forecast is for St. Louis.

b. *Date-time group.* "251010" is date and valid times. The forecast is valid beginning on the 25th day of the month at 1000Z valid until 1000Z the following day.

c. *Sky and ceiling.* "C5X" means ceiling 500 feet, sky obscured. The letter "C" always identifies a *forecast* ceiling layer.

d. *Visibility.* "1/2" means visibility ½ mile. Visibility is in statute miles and fractions. Absence of a visibility entry specifically implies visibility more than 6 miles.

e. *Weather and obstructions to vision.* "S–BS" means light snow and blowing snow. These elements are in symbols identical to those used in SA reports and entered only when expected.

f. *Wind.* "3325G35" means wind from 330° at 25 knots gusting to 35 knots—the same as in SAs. Omission of a wind entry specifically implies wind less than 10 knots.

g. *Remarks.* "OCNL C0X 0S+BS" means occasional ceiling zero, sky obscured, visibility zero, heavy snow and blowing snow. Remarks may be added to more completely describe expected weather.

h. *Expected changes.* When changes are expected, preceding conditions are followed by a period and the time and conditions of the expected change. "16Z C30BKN 3BS 3320 BRF SW−. 22Z 30SCT 3315. 00Z CLR." means by 1600Z, ceiling 3,000 broken, visibility 3, blowing snow, wind 330° at 20 knots, brief light snow showers. By 2200Z, 3,000 scattered, visibility more than 6 (implied), wind 330° at 15 knots. By 0000Z sky clear, visibility more than 6, wind less than 10 knots (implied).

i. *6-hour categorical outlook.* The last 6 hours of the forecast is a categorical outlook as explained on page 35. "04Z VFR WIND . ." means that from 0400Z until 1000Z—the end of the forecast period—weather will be ceiling more than 3,000 and visibility greater than 5 (VFR); wind will be 25 knots or stronger. The double period (. .) signifies the end of the forecast for the specific terminal.

Scheduled FT Collectives and Relays. Scheduled FTs are collected on area teletypewriter circuits. Selected FTs are then relayed to the area circuit from surrounding areas. The coverage of FTs becomes more sparse as the relays become more remote from the circuit area.

The heading of an FT collective identifies the message as an FT with a 6-digit date-time group giving the transmission time. For example, "FT130940" means a collective transmitted on the 13th at 0940Z.

Relay headings on some circuits are by States. On other circuits a relay heading identifies location relative to the area circuit. For example, "FT NEAR WEST 130941" means the terminals are just west of the circuit area; the relay was transmitted on the 13th at 0941Z. Other relay areas

are NEAR EAST, NEAR NORTH, INTERMEDIATE SOUTH, FAR WEST, etc. These FT relay areas are the same as covered by SA relays whether by State or by areas relative to the local circuit. For example, if the SA report for station XYZ is in the FAR EAST relay, the FT for XYZ also will be found in the FAR EAST relay of FTs. The relays are assembled by computer and are unique to each circuit; they do not coincide with adjacent circuit collectives and relays.

Out of Sequence FTs. A delayed, corrected, or amended FT is identified in the message rather than in the heading. Following are a delayed FT for Binghamton, New York, a corrected FT for Memphis, Tennessee, and an amended FT for Lufkin, Texas:

BGM FT RTD 131615 1620Z 100SCT 250SCT 1810. 18Z 50SCT 100SCT 1913 CHC C30BKN 3TRW AFT 20Z. 03Z 100SCT C250BKN. 09Z VFR . .

MEM FT COR 132222 2230Z 40SCT 300SCT CHC TRW. 02Z CLR. 16Z VFR . .

LFK FT AMD 1 131410 1425Z C8OVC 4F OVC V BKN. 15Z 20SCT 250−BKN. 19Z 40SCT 120SCT CHC C30BKN 3TRW. 04Z MVFR CIG F . .

Note in each forecast a time group following the valid period; this is the issue time. Note also that the amended forecast for LFK has the entry "AMD 1". Amended FTs for each terminal are numbered sequentially starting after each scheduled forecast.

ICAO Terminal Forecast (TAF)

Terminal forecasts for international flights (TAF) are in an alphanumeric code. They are scheduled four times daily at 0000Z, 0600Z, 1200Z and 1800Z.

Format. The TAF is a series of groups made up of digits and letters. An individual group is identified by its position in the sequence, by its alphanumeric coding, by its length, or by a numerical indicator. Listed below are a few contractions used in the TAF. Some of the contractions are followed by time entries indicated by "tt" or "tttt" or by probability, "pp":

GRADU tttt—A gradual change occurring during a period in excess of one-half hour. "tttt" are the beginning and ending times of the expected change to the nearest hour; i.e., "GRADU 1213" means the transition will occur between 1200Z and 1300Z.

RAPID tt —A rapid change occurring in one-half hour or less. "tt" is the time to the nearest hour of the change; i.e., "RAPID 23" means the change will occur about 2300Z.

TEMPO tttt—Temporary changes from prevailing conditions lasting less than one hour. "tttt" are the earliest and latest times during which the temporary changes are expected; i.e., "TEMPO 0107" means the temporary changes may occur between 0100Z and 0700Z.

INTER tttt —Changes from prevailing conditions are expected to occur frequently and briefly. "tttt" are the earliest and latest times the brief changes are expected; i.e., "INTER 1518" means that the brief changes may occur between 1500Z and 1800Z.

PROBpp —Probability of conditions occurring. "pp" is the probability in percent; i.e., "PROB20" means a 20% probability of the conditions occurring.

FRONT tttt—Frontal passage. "tttt" is the time in hours and minutes of expected frontal passage; i.e., "FRONT 1645" means an expected frontal passage at 1645Z.

CAVOK —No clouds below 5,000 feet and visibility 6 miles or greater. No precipitation or thunderstorms.

WX NIL —No significant weather or obstructions to vision.

SKC —Sky clear.

Following is a St. Louis forecast in TAF code. It is the same as the preceding FT example except that it begins 2 hours later.

KSTL 1212 33025/35 0800 71SN 9//005 INTER 1215 0000 39BLSN 9//000 GRADU 1516 33020 4800 38BLSN 7SC030 TEMPO 1620 85SNSH GRADU 2122 33015 9999 WX NIL 3SC030 RAPID 00 VRB05 9999 SKC

The forecast is broken down into the elements lettered "a" to "k" to aid in the discussion. Not included in the example but explained at the end are three optional forecast groups for "l" icing, "m" turbulence, and "n" temperature.

KSTL	1212	33025/35	0800	71SN	9//005
a.	b.	c.	d.	e.	f.

INTER 1215 0000 39BLSN 9//000 (g.)

GRADU 1516 33020 4800 38BLSN 7SC030 (h.)

TEMPO 1620 85SNSH (i.)

GRADU 2122 33015 9999 WX NIL 3SC030 (j.)

RAPID 00 VRB05 9999 SKC (k.)

a. *Station identifier.* The TAF code uses ICAO 4-letter station identifiers. In the contiguous 48 States the 3-letter identifier is prefixed with a "K"; i.e., the 3-letter identifier for Seattle is SEA while the ICAO identifier is KSEA. Elsewhere, the first two letters of the ICAO identifier tell what region the station is in. "MB" means Panama/Canal Zone (MBHO is Howard AFB); "MI" means Virgin Islands (MISX is St. Croix); "MJ" is Puerto Rico (MJSJ is San Juan); "PA" is Alaska (PACD is Cold Bay); "PH" is Hawaii (PHTO is Hilo).

b. *Valid time.* Valid time of the forecast follows station identifier. "1212" means a 24-hour forecast valid from 1200Z until 1200Z the following day.

c. *Wind.* Wind is forecast usually by a 5-digit group giving degrees in 3 digits and speed in 2 digits. When wind is expected to be 100 knots or more, the group is 6 digits with speed given in 3 digits. When speed is gusty or variable, peak speed is separated from average speed with a slash. For example, in the KSTL TAF, "33025/35" means wind 330°, average speed 25 knots, peak speed 35 knots. A group "160115/130" means wind 160°, 115 knots, peak speed 130 knots. "00000" means calm; "VRB" followed by speed indicates direction variable; i.e., "VRB10" means wind direction variable at 10 knots.

d. *Visibility.* Visibility is in meters. Table 4–2 is a table for converting meters to miles and fractions. "0800" means 800 meters converted from the table to ½ mile.

e. *Significant weather.* Significant weather is decoded using table 4–1. Groups in the table are numbered sequentially. Each number is followed by an acronym suggestive of the weather; you can soon learn to read most of the acronyms without reference to the table. Examples: "17TS", thunderstorm; "18SQ", squall; "31SA", sandstorm; "60RA", rain; "85SNSH", snow shower. "XX" between the number and acronym means "heavy". Examples: "33XXSA", heavy sandstorm; "67XXF. ZRA", heavy freezing rain. In the KSTL forecast, "71SN" means light snow. The TAF encodes only the single most significant type of weather; the U.S. domestic FT permits encoding of multiple weather types.

f. *Clouds.* A cloud group is a 6-character group. The first digit is coverage in octas (eighths) as shown in the top of table 4–3. The two letters identify cloud type as shown in the bottom of the table. The last three digits are cloud height in hundreds of feet. In the KSTL TAF, "9//005" means sky obscured (9), clouds not observed (//), vertical visibility 500 feet (005). The TAF may include as many cloud groups as necessary to describe expected sky condition.

g. and i. *Variation from prevailing conditions.* Variations from prevailing conditions are identified by the contractions INTER and TEMPO as defined earlier. In the KSTL TAF, "INTER 1215 0000 39BLSN 9//000" means intermittently from 1200Z to 1500Z (1215) visibility zero meters (0000) or zero miles, blowing snow (39BLSN), sky obscured, clouds not observed, vertical visibility zero (9// 000). "TEMPO 1620 85SNSH" means between 1600Z and 2000Z, temporary, or brief, snow showers. Omission of other groups imply no significant change in wind, visibility, or cloud cover.

h, j, and k. *An expected change in prevailing conditions.* An expected change in prevailing conditions is indicated by the contraction GRADU, RAPID, or FRONT as defined earlier. In the KSTL TAF, "GRADU 1516 33020 4800 38BLSN 7SC030" means a gradual change between 1500Z and 1600Z to wind 330° at 20 knots, visibility 4,800 meters or 3 miles (table 4–2), blowing snow, ⅞ stratocumulus (table 4–3) at 3,000 feet. "GRADU 2122 33015 9999 WX NIL 3SC030" means a gradual change between 2100Z and 2200Z to wind 330° at 15 knots, visibility 10 kilometers

or more (more than 6 miles), no significant weather, 3/8 stratocumulus at 3,000 feet. "RAPID 00 VRB05 9999 SKC" means a rapid change about 0000Z to wind direction variable at 5 knots, visibility more than 6 miles, sky clear.

l. *Icing.* An icing group may be included. It is a 6-digit group. The first digit is 6 identifying it as an icing group. The second digit is the type of ice accretion from table 4–4, top. The next three digits are height of the base of the icing layer in hundreds of feet. The last digit is the thickness of the layer in *thousands* of feet. For example, let's decode the group "680304". "6" indicates an icing forecast; "8" indicates severe icing in cloud (table 4–4); "030" says the base of the icing is at 3,000 feet; and "4" specifies a layer 4,000 feet thick.

m. *Turbulence.* A turbulence group also may be included. It also is a 6-digit group coded the same as the icing group except a "5" identifies the group as a turbulence forecast, and type of turbulence is from table 4–4, bottom. Decode the group "590359". "5" identifies a turbulence forecast; "9" specifies frequent severe turbulence in cloud; (table 4–4) "035" says the base of the turbulent layer is 3,500 feet; "9" specifies that the turbulence layer is 9,000 feet thick.

When either an icing layer or a turbulent layer is expected to be more than 9,000 feet thick, multiple groups are used; the top specified in one group is coincident with the base in the following group. Let's assume a cloud base at 5,000 feet and the forecaster expects frequent turbulence in thunderstorms from the surface to 45,000 feet; the most hazardous turbulence is at mid-levels. This could be encoded 530005 550509 591409 592309 553209 554104. While you most likely will never see such a complex coding with this many groups, the flexible TAF code permits it.

n. *Temperature.* A temperature code is seldom included in a terminal forecast. However, it may be included if critical to aviation. It may be used to alert the pilot to high density altitude or possible frost when on the ground. The temperature group is identified by the digit "0". The next two digits are time to the nearest hour GMT at which the temperature will occur. The last two digits are temperature in degrees Celsius. A minus temperature is preceded by the letter "M". Examples: "02137" means temperature at 2100Z is expected to be 37° C, about 99° F; "012M02" means temperature at 1200Z is expected to be minus 2° C. A forecast may include more than one temperature group.

TABLE 4–1. TAF weather codes

Code	*Decode*	*Code*	*Decode*
04FU	Smoke. Visibility reduced by smoke, e.g., veldt or forest fires, industrial smoke or volcanic ashes	17TS	Thunderstorms. Thunderstorm, but no precipitation at the time of observation
06HZ	Dust haze. Widespread dust in suspension in the air, not raised by wind at or near the station at the time of observation	18SQ	Squall. Squalls at or within sight of the station during the preceding hour or at the time of observation
08PO	Dust devils. Well-developed dust whirl(s) or sand whirl(s) seen at or near the station during the preceding hour or at the time of observation, but no duststorm or sandstorm	19FC	Funnel cloud. Funnel cloud(s) (tornado cloud or waterspout) at or within sight of the station during the preceding hour or at the time of observation
11MIFG	Shallow fog. Patches of shallow fog or ice fog at the station, whether on land or sea, not deeper than about 2 metres on land or 10 metres at sea	30SA	Duststorm or sandstorm. Slight or moderate duststorm or sandstorm—has decreased during the preceding hour
12MIFG	Shallow fog. More or less continuous shallow fog or ice fog at the station, whether on land or sea, not deeper than about 2 metres on land or 10 metres at sea	31SA	Duststorm or sandstorm. Slight or moderate duststorm or sandstorm—no appreciable change during the preceding hour

TABLE 4-1. TAF weather codes—Continued

Code	*Decode*
32SA	Duststorm or sandstorm. Slight or moderate duststorm or sandstorm—has begun or has increased during the preceding hour
33XXSA	Heavy duststorm or sandstorm. Severe duststorm or sandstorm—has decreased during the preceding hour
34XXSA	Heavy duststorm or sandstorm. Severe duststorm or sandstorm—no appreciable change during the preceding hour
35XXSA	Heavy duststorm or sandstorm. Severe duststorm or sandstorm—has begun or has increased during the preceding hour
36DRSN	Low drifting snow. Slight or moderate drifting snow—generally low (below eye level)
37DRSN	Low drifting snow. Heavy drifting snow generally low (below eye level)
38BLSN	Blowing snow. Slight or moderate blowing snow—generally high (above eye level)
39BLSN	Blowing snow. Heavy blowing snow —generally high (above eye level)
40BCFG	Fog patches. Fog or ice fog at a distance at the time of observation, but not at the station during the preceding hour, the fog or ice fog extending to a level above that of the observer
41BCFG	Fog patches. Fog or ice fog in patches
42FG	Fog. Fog or ice fog, sky visible—has become thinner during the preceding hour
43FG	Fog. Fog or ice fog, sky invisible—has become thinner during the preceding hour
44FG	Fog. Fog or ice fog, sky visible—no appreciable change during the preceding hour
45FG	Fog. Fog or ice fog, sky invisible—no appreciable change during the preceding hour
46FG	Fog. Fog or ice fog. sky visible—has begun or has become thicker during the preceding hour
47FG	Fog. Fog or ice fog, sky invisible—has begun or has become thicker during the preceding hour
48FZFG	Freezing fog. Fog, depositing rime, sky visible
49FZFG	Freezing fog. Fog, depositing rime, sky invisible
50DZ	Drizzle. Drizzle, not freezing, intermittent—slight at time of observation
51DZ	Drizzle. Drizzle, not freezing, continuous—slight at time of observation
52DZ	Drizzle. Drizzle, not freezing, intermittent—moderate at time of observation
53DZ	Drizzle. Drizzle, not freezing, continuous—moderate at time of observation
54XXDZ	Heavy drizzle. Drizzle, not freezing, intermittent—heavy (dense) at time of observation
55XXDZ	Heavy drizzle. Drizzle, not freezing, continuous—heavy (dense) at time of observation
56FZDZ	Freezing drizzle. Drizzle, freezing, slight
57XXFZDZ	Heavy freezing drizzle. Drizzle, freezing, moderate or heavy (dense)
58RA	Rain. Drizzle and rain, slight
59RA	Rain. Drizzle and rain, moderate or heavy
60RA	Rain. Rain, not freezing, intermittent—slight at time of observation
61RA	Rain. Rain, not freezing, continuous—slight at time of observation
62RA	Rain. Rain, not freezing, intermittent—moderate at time of observation
63RA	Rain. Rain, not freezing, continuous—moderate at time of observation
64XXRA	Heavy rain. Rain, not freezing, intermittent—heavy at time of observation
65XXRA	Heavy rain. Rain, not freezing, continuous—heavy at time of observation
66FZRA	Freezing rain. Rain, freezing, slight

TABLE 4-1. TAF weather codes—Continued

Code	*Decode*
67XXFZRA	Heavy freezing rain. Rain, freezing, moderate or heavy
68RASN	Rain and snow. Rain or drizzle and snow, slight
69XXRASN	Heavy rain and snow. Rain or drizzle and snow, moderate or heavy
70SN	Snow. Intermittent fall of snowflakes—slight at time of observation
71SN	Snow. Continuous fall of snowflakes—slight at time of observation
72SN	Snow. Intermittent fall of snowflakes—moderate at time of observation
73SN	Snow. Continuous fall of snowflakes—moderate at time of observation
74XXSN	Heavy snow. Intermittent fall of snowflakes—heavy at time of observation
75XXSN	Heavy snow. Continuous fall of snowflakes—heavy at time of observation
77SN	Snow. Snow grains (with or without fog)
79PE	Ice pellets. Ice pellets, type (a)
80RASH	Showers. Rain shower(s), slight
81XXSH	Heavy showers. Rain shower(s), moderate or heavy
82XXSH	Heavy showers. Rain shower(s), violent
83RASN	Shower(s) of rain and snow mixed, slight
84XXRASN	Heavy showers of rain and snow. Shower(s) of rain and snow mixed, moderate or heavy
85SNSH	Snow showers. Snow shower(s), slight
86XXSN	Heavy snow showers. Snow shower(s), moderate or heavy
87GR	Soft hail. Shower(s) of snow pellets or ice pellets, type (b), with or without rain or rain and snow mixed—slight
88GR	Soft hail. Shower(s) of snow pellets or ice pellets, type (b), with or without rain or rain and snow mixed—moderate or heavy
89GR	Hail. Shower(s) of hail (hail, ice pellets, type (b), snow pellets), with or without rain and snow mixed, not associated with thunder—slight
90XXGR	Heavy hail. Shower(s) of hail (hail, ice pellets, type (b), snow pellets), with or without rain or rain and snow mixed, not associated with thunder—moderate or heavy
91RA	Rain. Slight rain at time of observation—thunderstorm during the preceding hour but not at time of observation
92XXRA	Heavy rain. Moderate or heavy rain at time of observation—thunderstorm during the preceding hour but not at time of observation
93GR	Hail. Slight snow, or rain and snow mixed or hail (hail, ice pellets, type (b), snow pellets) at time of observation—thunderstorm during the preceding hour but not at time of observation
94XXGR	Heavy hail. Moderate or heavy snow, or rain and snow mixed or hail (hail, ice pellets, type (b), snow pellets) at time of observation—thunderstorm during the preceding hour but not at time of observation
95TS	Thunderstorm. Thunderstorm, slight or moderate, without hail (hail, ice pellets, type (b), snow pellets) but with rain and/or snow at time of observation
96TSGR	Thunderstorm with hail. Thunderstorm slight or moderate with hail (hail, ice pellets, type (b), snow pellets) at time of observation
97XXTS	Heavy thunderstorm. Thunderstorm, heavy, without hail (hail, ice pellets, type (b), snow pellets) but with rain and/or snow at time of observation
98TSSA	Thunderstorm with duststorm or sandstorm. Thunderstorm combined with duststorm or sandstorm at time of observation
99XXTSGR	Heavy thunderstorm with hail. Thunderstorm, heavy, with hail (hail, ice pellets, type (b), snow pellets) at time of observation

TABLE 4-2. Visibility conversion—TAF code to miles

Meters	*Miles*
0000	0
0100	1/16
0200	1/8
0300	3/16
0400	1/4
0500	5/16
0600	3/8
0800	1/2
1000	5/8
1200	3/4
1400	7/8
1600	1
1800	1 1/8
2000	1 1/4
2200	1 3/8
2400	1 1/2
2600	1 5/8
2800	1 3/4
3000	1 7/8
3200	2
3600	2 1/4
4000	2 1/2
4800	3
6000	4
8000	5
9000	6
9999	more than 6

TABLE 4-3. TAF cloud code

Cloud amount		*Cloud type*	
0	0 (Clear)	CI	Cirrus
1	1 octa or less but not zero	CC	Cirrocumulus
		CS	Cirrostratus
2	2 octas	AC	Altocumulus
3	3 octas	AS	Altostratus
4	4 octas	NS	Nimbostratus
5	5 octas	SC	Stratocumulus
6	6 octas	ST	Stratus
7	7 octas or more but not 8 octas	CU	Cumulus
		CB	Cumulonimbus
8	8 octas (Overcast)	//	Cloud not visible due to darkness or obscuring phenomena
9	Sky obscured, or cloud amount not estimated		

TABLE 4-4. TAF icing and turbulence

Figure Code	*Amount of ice accretion (TAF group 6)*
0	No icing
1	Light icing
2	Light icing in cloud
3	Light icing in precipitation
4	Moderate icing
5	Moderate icing in cloud
6	Moderate icing in precipitation
7	Severe icing
8	Severe icing in cloud
9	Severe icing in precipitation

Figure Code	*Turbulence (TAF group 5)*
0	None
1	Light turbulence
2	Moderate turbulence in clear air, infrequent
3	Moderate turbulence in clear air, frequent
4	Moderate turbulence in cloud, infrequent
5	Moderate turbulence in cloud, frequent
6	Severe turbulence in clear air, infrequent
7	Severe turbulence in clear air, frequent
8	Severe turbulence in cloud, infrequent
9	Severe turbulence in cloud, frequent

AREA FORECAST (FA)

An area forecast (FA) is a forecast of general weather conditions over an area the size of several States. It is used to determine forecast enroute weather and to interpolate conditions at an airport for which no FT is issued. Figure 1-5, section 1, maps FA areas.

Example of an FA:

MIA FA 200040.
01Z FRI—19Z FRI.
OTLK 19Z FRI—07Z SAT.

FLA E OF 85 DEGS GA AND CSTL WTRS . . .

HGTS ASL UNLESS NOTED . . .

SYNOPSIS . . . STNRY HI PRES RDG NCAR CST EWD OVR ATLC. E TO SE FLO CONTG OVR FLA AND GA . . .

SIGCLDS AND WX . . .

NRN AND CNTRL GA . . .
40 SCT VRBL BKN LYRD TO 140. AFT 07Z OCNL CIGS BLO 10 VSBYS BLO 5HK. CONDS IMPVG BY 15Z TO CIGS ABV 15 VSBY 5HK. OTLK. VFR . . .

E CST SECS CNTRL SRN FLA AND ADJ CSTL WTRS . . .
GENLY 25 SCT VRBL BKN TOPS 100–120. SCT SHWRS OVR WTRS DRFTG WWD OCNLY MOVG ONSHR CSTL AREAS WITH CONDS LCLY CIG 25 BKN 2RW TOPS 180. OTLK. VFR . . .

SRN GA AND RMNDR FLA AND ADJ WTRS . . .
NO SIGCLD AND WX. OTLK. VFR . . .

ICG . . . LCL MDT IN TCU/RW. FRZG LVL 110 N GA TO 140 S FLA.

FAs are scheduled every 12 hours. They cover an 18-hour period with an additional 12-hour outlook. All times are GMT in whole hours (two digits), i.e., 13Z. Wind speed is in knots; and wind direction, in degrees true. All distances except visibility are in nautical miles; visibility is in statute miles.

Each FA has the sections:

1. Heading
2. Forecast Area
3. Height Statement
4. Synopsis
5. Significant Clouds and Weather Plus Outlook
6. Icing and Freezing Level

Heading

The heading identifies an area forecast, the originating WSFO, the date and time of issue, and the valid periods of the forecast and outlook. For example,

FA MKC 131240
13Z THU–07Z FRI
OTLK 07Z FRI–19Z FRI

states that the FA was issued by Kansas City (MKC) on the 13th day of the month at 1240Z. The forecast is valid from 1300Z Thursday until 0700Z Friday with a categorical outlook from 0700Z Friday until 1900Z Friday.

Forecast Area

The area is in contractions identifying States; portions of States; and, where applicable, adjacent waters. For example,

TENN ARK LA MISS ALA FLA W OF 85 DEGS CSTL WTRS

means Tennessee, Arkansas, Louisiana, Mississippi, Alabama, Florida west of 85° Longitude and coastal waters adjacent to the area.

Height Statement

Each FA contains the statement,

HGTS ASL UNLESS NOTED

to alert the user that heights for the most part are above sea level. For example, "3 THSD BKN TOPS 100 HIR TRRN OBSCD" means broken clouds 3,000 feet tops 10,000 feet—all heights ASL; terrain above 3,000 feet will be obscured. Tops of clouds and bases and tops of icing are always ASL.

Heights *above ground level* may be denoted in either of two ways. (1) Ceiling by definition is above ground. Therefore, the contraction "CIG" indicates above ground. For example "CIGS GENLY BLO 1 THSD" means that ceilings are expected to be generally below 1,000 feet. (2) The contraction "AGL" means above ground level. "SCT 2 THSD AGL" means scattered clouds, bases 2,000 feet above ground level.

Synopsis

The synopsis briefly summarizes locations and movements of fronts, pressure systems, and circulation patterns. It also may give moisture and stability conditions.

Significant Clouds And Weather

The significant clouds and weather section, identified by the contraction,

SIGCLD AND WX

forecasts, in broad terms, cloudiness and weather significant to flight operations. Table 4–5 defines the contractions and compares them to the designators used in the FT.

Obstructions to vision are included when forecast visibility is 6 miles or less. Expected precipitation and thunderstorms are always included. Table 4–6 gives expected coverage indicated by the terms "isolated," "few," "scattered," and "numerous."

The SIGCLD and WX section usually is several paragraphs. The breakdown may be by States, by well known geographical areas, or in reference to location and movement of a pressure system or front. Figure 4–1 is a map to assist in identifying geographical areas.

A categorical outlook, identified by "OTLK", is included for each area breakdown. Examples "OTLK. VFR BCMG MVFR CIG F AFT 09Z" means that weather is expected to be VFR becoming marginal VFR due to low ceiling and to visibility restricted by fog after 0900Z.

TABLE 4–5. Contractions in FA

Contraction	*FT Designator*	*Definition*
CLR	CLR	Sky clear
SCT	SCT	Scattered
BKN	BKN	Broken
OVC	OVC	Overcast
OBSC	X	Obscured, obscure, or obscuring
PTLY OBSC	−X	Partly obscured
THN	−	Thin
VRBL	V	Variable
CIG	C	Ceiling
INDEF	W	Indefinite

TABLE 4–6. Areal coverage of showers and thunderstorms

Adjective	*Coverage*
Isolated	Extremely small number
Few	15% or less of area or line
Scattered	16% to 45% of area or line
Numerous	More than 45% of area of line

Icing

The contraction,

ICG

identifies the icing section which gives location, type, and extent of expected icing. It always includes the freezing level in hundreds of feet ASL. It may contain qualifying terms such as "ICG LKLY", icing likely; "MDT MXD ICGIC ABV FRZLVL", moderate mixed icing in clouds above the freezing level.

Amended Area Forecasts

Amendments to the FA are issued as needed. Only that portion of the FA being revised is transmitted as an amendment. Area forecasts are also amended and updated by inflight advisories.

TWEB ROUTE FORECASTS AND SYNOPSIS

The TWEB Route Forecast is similar to the Area Forecast (FA) except more specific information is contained in a route format. Forecast sky cover (height and amount of cloud bases), cloud tops, visibility (including vertical visibility), weather and obstructions to vision are described for a corridor 25 miles either side of the route. Cloud bases and tops are always ASL unless noted. Ceilings are always above ground.

The Synopsis is a brief statement of frontal and pressure systems affecting the route during the forecast validity period.

The TWEB Route Forecasts are prepared by the WSFOs for more than 300 selected short-leg and cross-country routes over the contiguous U.S., figure 1–8, section 1. WSFOs prepare synopses for the routes in their areas. These forecasts go into the Transcribed Weather Broadcasts (TWEB) and the Pilot's Automatic Telephone Weather Answering Service (PATWAS) transcriptions described in section 1. Individual route forecasts and synopses are also available by request/reply teletypewriter through any FSS or WSO.

The TWEB Route Forecasts and Synopses are issued by the WSFOs three times per day according to time zone. The early morning and midday forecasts are valid for 12 hours; the evening forecast, for 18 hours:

WSFO Location (time zone)	*Issue time*	*Valid period*
Eastern/Central	1040Z	11Z–23Z
	1740Z	18Z–06Z
	2240Z	23Z–17Z
Mountain/Pacific	1140Z	12Z–00Z
	1840Z	19Z–07Z
	2340Z	00Z–18Z

This schedule provides 24-hour coverage with most frequent updating during the hours of greatest general aviation activity.

Example of a TWEB Synopsis:

BIS SYNS 252317. LO PRESS TROF MVG ACRS NDAK TDA AND TNGT. HI PRESS MVG SEWD FM CANADA INTO NWRN NDAK BY TNGT AND OVR MST OF NDAK BY WED MRNG.

BIS—Bismarck, N.D. WSFO issuing Synopsis and Route Forecasts

SYNS—Synopsis for the area covered by the Route Forecasts

25—25th day of the month

2317—Valid 23Z on the 25th to 17Z on the 26th (18 hours)

(Rest of Message)—LOW PRESSURE TROUGH MOVING ACROSS N. DAKOTA TODAY AND TONIGHT. HIGH PRESSURE MOVING SOUTHEASTWARD FROM CANADA INTO NORTHWESTERN N. DAKOTA BY TONIGHT AND MOST OF N. DAKOTA BY WEDNESDAY MORNING.

Example of a TWEB Route Forecast:

249 TWEB 252317 GFK MOT ISN. GFK VCNTY CIGS AOA 5 THSD TILL 12Z OTRW OVR RTE CIGS 1 TO 3 THSD VSBY 3 TO 5 MI IN LGT SNW WITH CONDS BRFLY LWR IN HVYR SNW SHWRS

249—Route number

TWEB—TWEB Route Forecast

25—25th day of month

2317—Valid 23Z on the 15th to 17Z on the 16th (18 hours)

GFK MOT ISN—Route: Grand Forks to Minot to Williston, N.D.

(Rest of Message)—GRAND FORKS VICINITY CEILINGS AT OR ABOVE 5000 FEET UNTIL 1200Z OTHERWISE OVER ROUTE CEILINGS 1 TO 3 THOUSAND FEET VISIBILITY 3 TO 5 MILES IN LIGHT SNOW WITH CONDITIONS BRIEFLY LOWER IN HEAVIER SNOW SHOWERS.

When visibility is not stated it is implied to be 7 miles or greater.

Because of their varied accessibility and route format, these forecasts perhaps are the most important and useful weather information available to the pilot today for flight operations and planning. You should become familiar with them and use them regularly.

INFLIGHT ADVISORIES (WS, WA, WAC)

Inflight advisories are unscheduled forecasts to advise enroute aircraft of development of potentially hazardous weather. They are also excellent for preflight planning and briefing. All heights are ASL unless noted; i.e., ceiling heights are always AGL. The advisories are of three types—SIGMET (WS), AIRMET (WA), and CONTINUOUS AIRMET (WAC).

SIGMET (WS)

A SIGMET advises of weather potentially hazardous to all categories of aircraft, specifically:

1. Tornadoes
2. Lines of thunderstorms (squall lines)
3. Embedded thunderstorms
4. Hail of ¾" or greater in diameter
5. Severe or extreme turbulence
6. Severe icing
7. Widespread sandstorms/duststorms lowering visibilities to below 3 miles

AIRMET (WA)

An AIRMET is for weather that may be hazardous to single engine and light aircraft and in some cases to other aircraft as well, specifically:

1. Moderate icing
2. Moderate turbulence
3. Sustained winds of 30 knots or greater at or within 2,000 feet of the surface
4. Onset of extensive areas of visibility below 3 miles and/or ceilings less than 1,000 feet, including mountain ridges and passes

AIRMET Continued (WAC)

AIRMET Continued is issued for:

1. Continued moderate turbulence over mountainous terrain
2. Continued ceilings below 1,000 feet and/or visibility less than 3 miles over an extensive area.

Valid Period

A WAC remains valid until cancelled. Valid period of a WS or WA is specifically stated.

Format

Format of an advisory consists of a heading and text.

Heading. The heading identifies the (1) issuing WFSO, (2) type of advisory, and (3) valid period. Examples:

BOS WS 202210
202210–210300Z

A SIGMET issued by Boston WSFO on the 20th at 2210Z valid from 2210Z on the 20th until 0300Z on the 21st.

MKC WA 052055
052100–060100Z

An AIRMET issued by Kansas City WSFO on the 5th at 2055Z valid from 2100Z on the 5th until 0100Z on the 6th.

SLC WAC 060800
060800–UFN

An AIRMET Continued issued by Salt Lake City WSFO on the 6th at 0800Z valid from 0800Z on the 6th until further notice (UFN).

Text. The text of the advisory contains (1) a message identifier, (2) a flight precautions statement, and (3) further details if necessary.

Message identifier. A WSFO identifies each hazardous area by a phonetic identifier (ALFA, BRAVO, CHARLIE, etc.). Advisories for each hazardous area are numbered sequentially (ALFA 1, ALFA 2, ALFA 3, etc.; or BRAVO 1, BRAVO 2, BRAVO 3, etc.). A new advisory of the same alphabetic series by the same WSFO automatically cancels preceding advisories of the same series; i.e., ALFA 2 cancels ALFA 1, BRAVO 3 cancels BRAVO 2, etc. A new issuance by one WSFO does not cancel an advisory by another WSFO unless specifically stated; i.e., ALFA 2 by Kansas City *does not* cancel ALFA 1 by Fort Worth.

Flight precautions statement (FLT PRCTN). A flight precautions statement in each advisory states location and kind of hazard, and it also gives the onset time if the hazard is not already occurring. This flight precaution is used in the flight precaution statement of the TWEB and PATWAS.

Further details. Further details describe the hazard when necessary. If the hazard is expected to continue beyond the valid period shown in the heading of a WS or WA, the fact is stated. For example, "CONDS CONTG BYD 02Z".

Following are examples of each of the three types of inflight advisories:

BOS WS 202210
202210–210300Z

SIGMET ALFA 1. FLT PRCTN. SVR ICG NH WRN ME BLO 160. OVRNG CONDS RESULTING IN SVR ICGICIP SFC–160. CONDS CONTG BYD 03Z.

MKC WA 052055
052100–060100Z

AIRMET FOXTROT 6. FLT PRCTN. SE COLO SRN AND WRN KAN CIG GENLY BLO 10 VSBY BLO 3 IN FOG AND SNW. LCL FRZG PCPN SRN KAN. MDT MXD ICGICIP. CONDS CONTG BYD 01Z.

SLC WAC 060800
060800–UFN

AIRMET ECHO 1 FLT PRCTN. FQT MDT TURB LCLY STG UDDF OVR AND NR MTNS CNTRL AND SRN UTAH WILL CONT UFN. CONT AIRMET UNTIL CNCL NOTICE IS RCVD

WINDS AND TEMPERATURES ALOFT FORECAST (FD)

Winds and temperatures aloft are forecast for specific locations in the contiguous U.S. as shown in figure 1–3, section 1. FD forecasts are also prepared for a network of locations in Alaska.

Below is a sample FD message containing a heading and six FD locations. The heading always includes time during which the FD may be used (1800–0300Z in the example) and a notation "TEMPS NEG ABV 2400". Since temperatures above 24,000 are always negative, the minus sign is omitted.

FD WBC 151745
BASED ON 151200Z DATA
VALID 1600Z FOR USE 1800–0300Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
ALS			2420	2635−08	2535−18	2444−30	245945	246755	246862
AMA		2714	2725+00	2625−04	2531−15	2542−27	265842	256352	256762
DEN			2321−04	2532−08	2434−19	2441−31	235347	236056	236262
HLC		1707−01	2113−03	2219−07	2330−17	2435−30	244145	244854	245561
MKC	0507	2006+03	2215−01	2322−06	2338−17	2348−29	236143	237252	238160
STL	2113	2325+07	2332+02	2339−04	2356−16	2373−27	239440	730649	731960

Forecast Levels

The line labelled "FT" shows the 9 standard FD levels. Through 12,000 feet the levels are true altitude; 18,000 feet and above are pressure altitude. The FD locations are transmitted in alphabetical order.

Note that some lower level groups are omitted. No winds are forecast within 1,500 feet of station elevation. No temperatures are forecast for the 3,000-foot level or for a level within 2,500 feet of station elevation.

Decoding

A 4-digit group shows wind direction (reference true North) and windspeed. Look at the St. Louis (STL) forecast for 3,000 feet. The group 2113 means wind from 210° at 13 knots. The first two digits give direction in tens of degrees; the second two, speed in knots.

A 6-digit group includes forecast temperature. In the STL forecast, the coded group for 9,000 feet is 2332+02; wind is 230° at 32 knots temperature +2° C.

Encoded windspeed 100 to 199 knots have 50 added to the direction code and 100 subtracted from the speed. The STL forecast for 39,000 feet is "731960". Wind is 230° at 119 knots, temperature −60.

How do you recognize when coded direction has been increased by 50? Coded direction (in tens of degrees) ranges from 01 (010°) to 36 (360°). Thus, a coded direction of more than "36" indicates winds 100 knots or more; the coded direction will range from 51 through 86.

If windspeed is forecast at 200 knots or greater, the wind group is coded as 199 knots; i.e., "7799" is decoded 270° at 199 knots or greater. When forecast speed is less than 5 knots, the coded group is "9900" and read, "LIGHT AND VARIABLE."

Examples of decoding FD winds and temperatures:

Coded	*Decoded*
9900+00	Wind light and variable, temperature 0° C
2707	270° at 7 knots
850552	350° (85−50=35) at 105 knots (05+100=105), temperature −52° C.

SPECIAL FLIGHT FORECAST

When planning a *special category* flight and scheduled forecasts are insufficient to meet your needs, you may request a special flight forecast through any FSS or WSO. The contact forwards the request to a WSFO and receives the printed forecast via teletypewriter. Special category flights are hospital or rescue flights; experimental, photographic, or test flight; record attempts; and mass flights such as air tours, air races, and fly-aways from special events.

Make your request far enough in advance to allow ample time for preparing and transmitting the forecast. Advance notice of 6 hours is desirable. In making a request, give the:

1. Aircraft mission
2. Number and type of aircraft
3. Point of departure
4. Route of flight (including intermediate stops, destination, alternates)
5. Estimated time of departure
6. Time enroute
7. Flight restrictions (such as VFR, below certain altitudes, etc.)
8. Time forecast is needed

The forecast is written in plain language contractions as in the examples:

SPL FLT FCST ABQ-PHOTO MISSION-ABQ 121500Z. THIN CI CLDS AVGG LESS THAN TWO TENTHS CVR. VSBY MORE THAN 30. WNDS AND TEMPS ALF 10–2320+03. ABQ WSFO 121300Z.

SPL FLT OTLK MKC-RST 062100Z–062400Z. CIG 2 THSD OVC OR BTR. WNDS ALF 3–2320. MKC WSFO 052300Z.

HURRICANE ADVISORY (WH)

When a hurricane threatens, an abbreviated hurricane advisory (WH) is issued to alert aviation interests. The advisory gives location of the storm center, its expected movement and maximum winds in and near the storm center. It does not contain details of associated weather; specific ceilings, visibilities, weather, and hazards are in area and terminal forecasts and inflight advisories.

An example of an abbreviated aviation hurricane advisory:

WH MIA 181010
HURCN IONE AT 1105Z CNTRD 29.4N 75.2W OR 400 NMI E OF JACKSONVILLE FLA EXPCTD TO MOV N ABT 12 KT. MAX WNDS 110 KT OVR SML AREA NEAR CNTR AND HURCN WNDS WITHIN 55–75 MIS.

CONVECTIVE OUTLOOK (AC)

A convective outlook (AC) describes prospects of both severe and general thunderstorms during the following 24 hours. Use the outlook primarily for planning flights later in the day. Outlooks are transmitted by the National Severe Storms Forecast Center (NSSFC) about 0900Z and 1500Z.

A notation, "ABV SELS LIMITS", means activity probably will meet the criteria for a severe weather watch. Expected conditions requiring a severe weather watch are:

1. Severe thunderstorms—one or both of the following:
   (a) Damaging surface wind with gusts of 50 knots or more
   (b) Hail ¾ inch or more in diameter
2. Tornado activity

Following is a convective outlook:

AC MKC 020840

MKC AC 020840
VALID 021200–031200Z

SQLN CRNTLY IN ECNTRL TEX PNHDL EXTNDS NWD INTO NRN TEX PNHDL AND SW KANS AS LN OF OVRRNG TSTMS. THIS LN MOVG EWD 30 KT WILL GRDLY INTSFY DURG THE FRNN WITH SVR TSTM ACTVTY WELL ABV SELS LIMITS EXPCD BGN BY .LATE FRNN CNTRL OKLA TO N CNTRL TEX MOVG EWD DURG AFTN THRU ERN OKLA SE KANS AND NE TEX INTO MOST OF ARK SW AND SRN MO DURG AFTN AND EVE BFR DMNSHG. INTSFY LATE EVE NE ARK SE MO W KY AND W TENN.

TSTMS DURG PRD EXPCD TO RT OF LN DRT INK HOB GCK STJ BRL DAY HTS LOZ BNA LFK SAT DRT. FEW TSHWRS CRNTLY IN NEW ENG WILL DMNSH DURG FRNN HWVR ISOLD TSHWRS ALSO EXPCD DURG THE PRD TO RT OF LN DOV IPT MSS.

FORECASTER (NAME)

SEVERE WEATHER WATCH BULLETIN (WW)

A severe weather watch bulletin (WW) defines areas of possible severe thunderstorms or tornado activity. The bulletins are issued by the National Severe Storms Forecast Center at Kansas City, Mo. WWs are unscheduled and are issued as required. On the next page is a severe weather watch bulletin.

A severe thunderstorm watch describes expected areal coverage of thunderstorms using the density adjectives listed in table 4–6. A tornado watch simply states that the threat of tornadoes exists in the designated watch area. Forecasters do not attempt to indicate areal coverage of these extremely localized storms.

Status reports are issued as needed to show progress of storms and to delineate areas no longer under the threat of severe storm activity. Cancellation bulletins are issued when it becomes evident that no severe weather will develop or that storms have subsided and are no longer severe. The bulletins are self-explanatory.

When tornadoes or severe thunderstorms have developed, local WSOs and WSFOs issue local warnings.

BULLETIN
TORNADO WATCH NUMBER 451
ISSUED 455 PM CDT SEPT 29 1972

A . . . THE NATIONAL WEATHER SERVICE HAS ISSUED A TORNADO WATCH FOR . . .

NORTHERN MISSISSIPPI

SOUTHEASTERN ARKANSAS

NORTHEAST LOUISIANA
THE THREAT OF TORNADOES AND SEVERE THUNDERSTORMS WITH LARGE HAIL AND DAMAGING WINDS WILL EXIST IN THESE AREAS FROM 5 PM CDT UNTIL 9 PM CDT THIS FRIDAY EVENING. THE GREATEST THREAT OF TORNADOES AND SEVERE THUNDERSTORMS IS IN AN AREA ALONG AND 70 MILES . . . 60 NAUTICAL . . . EITHER SIDE OF A LINE FROM 30 MILES . . . 25 NAUTICAL . . . NORTH OF COLUMBUS MISSISSIPPI TO EL DORADO ARKANSAS

PERSONS IN OR CLOSE TO THE TORNADO WATCH AREA ARE ADVISED TO BE ON THE WATCH FOR LOCAL WEATHER DEVELOPMENTS AND FOR LATER STATEMENTS AND WARNINGS.

B . . . OTHER WATCH INFORMATION . . .

THIS TORNADO WATCH REPLACES TORNADO WATCH NUMBER 449 ISSUED AT 130 PM CDT . . . WATCH NUMBER 449 WILL NOT BE EFFECTIVE AFTER 5 PM CDT.

C . . . TORNADOES AND A FEW SVR TSTMS WITH HAIL SFC AND ALF TO 1 IN. EXTRM TURBC AND SFC WND GUSTS TO 65 K. SCTD CBS WITH MAX TOPS TO 550. MEAN WIND VECTOR 24535.

D . . . INSTBLTY LN NOW FM WRN TENN ACRS CNTRL ARK INTO NE TEX MOVG SEWD ABT 25 K.

E . . . OTHER TSTMS. CONTD RMNDR AC.

F . . . FORECASTER (NAME)

FIGURE 4–1. Geographical areas and terrain features. Forecasts often best locate weather by reference to terrain.

Section 5

SURFACE ANALYSIS

A surface analysis is commonly referred to as a surface weather map. In the contiguous 48 States a map covering these States and adjacent areas is transmitted every three hours. Other areas with facsimile receive-surface weather maps appropriate to their areas at regularly scheduled intervals. Figure 5–1 is a section of a surface weather map and figure 5–2 illustrates symbols depicting fronts and pressure centers. The following explains contents of the chart.

VALID TIME

Valid time of the map corresponds to the time of the plotted observations. A date-time group in Greenwich Mean Time tells the user when conditions portrayed on the map were occurring.

ISOBARS

Isobars are solid lines depicting the pressure pattern. They are usually spaced at 4 millibar intervals. When pressure gradient is weak, dashed isobars are sometimes inserted at 2 millibar intervals to more clearly define the pressure pattern. Each isobar is labelled by a two-digit number. For example, 32 signifies 1032.0 mb; 00 is 1000.0 mb; and 92 is 992.0 mb.

PRESSURE SYSTEMS

The letter "L" denotes a low pressure center and an "H" marks a high pressure center. The pressure at each center is indicated by a two-digit underlined number which is interpreted the same as isobar labels.

FRONTS

The analysis shows frontal positions by the symbols in figure 5–2. The "pips" on the frontal symbols indicate the type of front and point the direction of movement. Pips on either side of the symbol of a stationary front suggest little or no movement. Briefing offices sometimes color the symbols to facilitate use of the map.

A three-digit number entered along a frontal symbol classifies the front as to type, table 5–1; intensity, table 5–2; and character, table 5–3. For example, the front at the lower left of figure 5–1 is labelled "463" meaning a cold front at the surface ("4" in table 5–1); moderate, increasing ("6" in table 5–2); and frontal activity increasing ("3" in table 5–3). Two short lines across a front indicate change in classification. Note in figure 5–1 the two lines crossing the cold front where its classification changes from "463" to "452".

TABLE 5–1. Type of front

Code Figure	*Description*
0	Quasi-stationary at surface
1	Quasi-stationary above surface
2	Warm front at surface
3	Warm front above surface
4	Cold front at surface
5	Cold front above surface
6	Occlusion
7	Instability line
8	Intertropical front
9	Convergence line

TABLE 5–2. Intensity of front

Code Figure	*Description*
0	No specification
1	Weak, decreasing
2	Weak, little or no change
3	Weak, increasing
4	Moderate, decreasing
5	Moderate, little or no change
6	Moderate, increasing
7	Strong, decreasing
8	Strong, little or no change
9	Strong, increasing

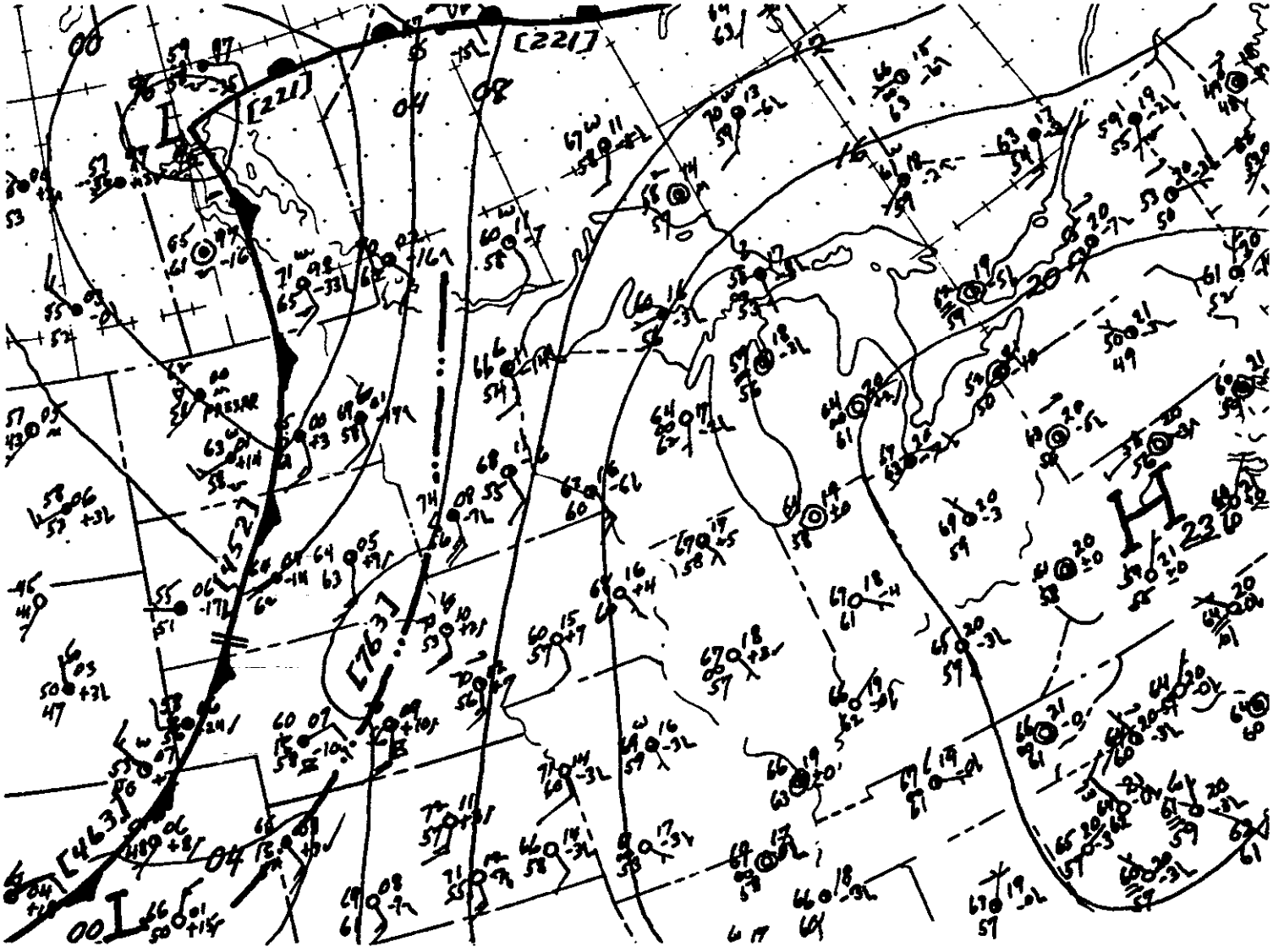


FIGURE 5–1. Section of a Surface Weather Analysis.

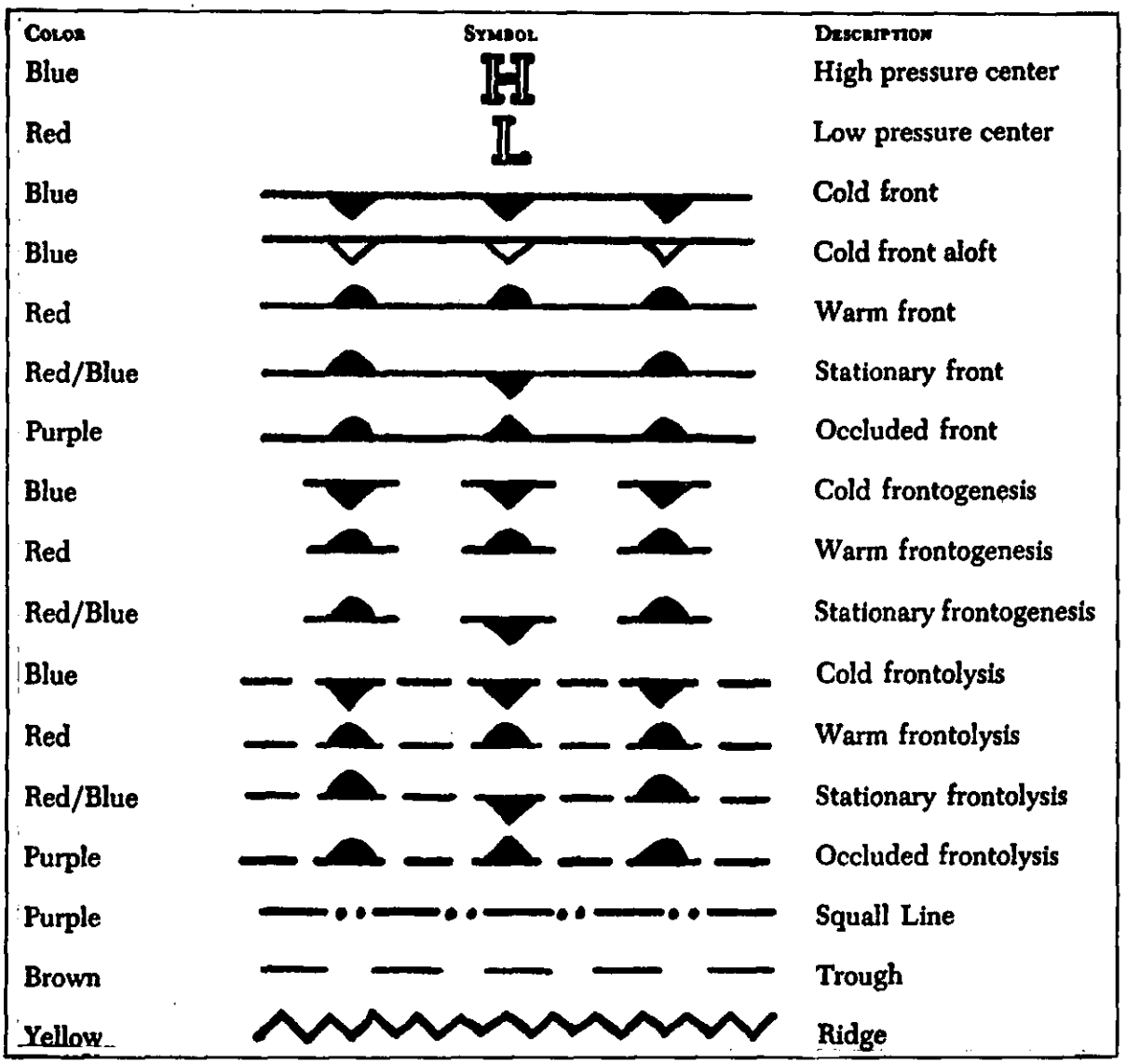


FIGURE 5–2. List of symbols on surface analyses. Colors are those suggested for on-station use. NOTE: A trough line usually is further identified by the coded group "830XX". Do not attempt to decode this group using the tables showing frontal classification. A trough line is not a front.

TABLE 5–3. Character of front

Code Figure	*Description*
0	No specification
1	Frontal area activity decreasing
2	Frontal area activity, little change
3	Frontal area activity increasing
4	Intertropical
5	Forming or existence expected
6	Quasi-stationary
7	With waves
8	Diffuse
9	Position doubtful

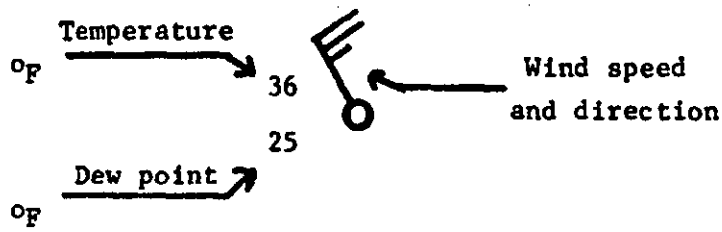
OTHER INFORMATION

Figure 5–3 shows an abbreviated station model which explains how to read temperature, dew point, and wind from the surface map. A complete station model plot contains detailed weather information more conveniently available from other facsimile charts and from teletypewriter data.

USING THE CHART

The surface analysis provides you a ready means of locating pressure systems and fronts and also gives you an overview of winds, temperatures, and

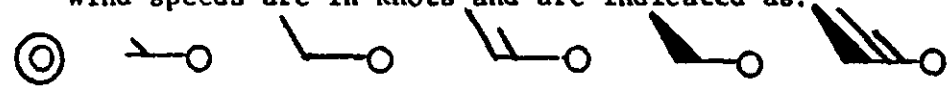
dew points *as of map time*. When using the map, keep in mind that weather moves and conditions change. For example, a front located over northern Kansas may be nearing Oklahoma by the time you see the map. Using the surface map in conjunction with other charts such as weather depiction, radar summary, upper air, and prognostics (forecast charts) gives a more complete weather picture.



Decoded: Temperature 36 °F
Dew point 25 °F
Wind from northwest at 25 knots

Explanation: Temperature and dew point always in °F.
A minus sign (-) indicates below 0°F.

Wind speeds are in knots and are indicated as:



Calm 5 kts 10 kts 15 kts 50 kts 65 kts

Circle around the station means calm. A half-flag has a value of 5 kts, full flag 10 kts and pennant, 50 kts. These are used in an appropriate combination to represent wind speed; e.g., two pennants indicate wind speed of 100 knots. Wind direction in the above illustration is west, except for calm where direction is indeterminate.

FIGURE 5-3. Abbreviated station model and explanation.

Section 6

WEATHER DEPICTION CHART

The weather depiction chart is prepared from surface aviation (SA) reports to give a quick picture of conditions as of valid time of the chart. Figure 6–1 is a weather depiction chart.

PLOTTED DATA

Shown for each plotted station as appropriate are:

1. Total sky cover
2. Height of cloud or ceiling
3. Weather and obstructions to vision, and
4. Visibility.

Total Sky Cover

Total sky cover is shown by the station circle shaded as in table 6–1.

TABLE 6–1. Total sky cover

Symbol	*Total sky cover*
○	Sky clear
◔	Less than 1/10 (Few)
◔	1/10 to 5/10 inclusive (Scattered)
◕	6/10 to 9/10 inclusive (Broken)
●	10/10 with breaks (BINOVC)
●	10/10 (Overcast)
⊗	Sky obscured or partially obscured

Cloud Height or Ceiling

Cloud height is entered under the station circle in hundreds of feet—the same as coded in an SA report. If total sky cover is few or scattered, the height is the base of the lowest layer. If total sky cover is broken or greater, the height is the ceiling. Broken or greater sky cover without a height entry indicates *thin* sky cover. Partially or totally obscured sky is shown by the same sky cover symbol. Partial obscuration is denoted by absence of a height entry; total obscuration has a height entry denoting the ceiling (vertical visibility into the obscuration).

Weather and Obstructions to Vision

Weather and obstructions to vision are entered just to the left of the station circle using the same letter designators as used in SA reports. Precipitation intensity is not entered. When several types of weather and/or obstructions are reported at a station, only the most significant one or two types are entered. When an SA reports clouds topping ridges, a symbol unique to the weather depiction chart is entered to the left of the station circle:

▲ denotes clouds topping ridges.

Visibility

When visibility is less than 7 miles, it is entered to the left of weather and obstructions to vision. It is in miles and fractions.

Table 6–2 shows examples of plotted data.

TABLE 6–2. Examples of plotting on the Weather Depiction Chart

Plotted	*Interpreted*
◔ 8	Few clouds, base 800 feet, visibility more than 6
RW● 12	Broken sky cover, ceiling 1,200 feet, rain shower
5H◑	Thin overcast with breaks, visibility 5 in haze
▲◔ 30	Scattered at 3,000 feet, clouds topping ridges
2F○	Sky clear, visibility 2, ground fog or fog
½BS⊗	Sky partially obscured, visibility ½, blowing snow
¼S⊗ 5	Sky obscured, ceiling 500, visibility ¼, snow
1TR● 12	Overcast, ceiling 1,200 feet, thunderstorm, rain, visibility 1

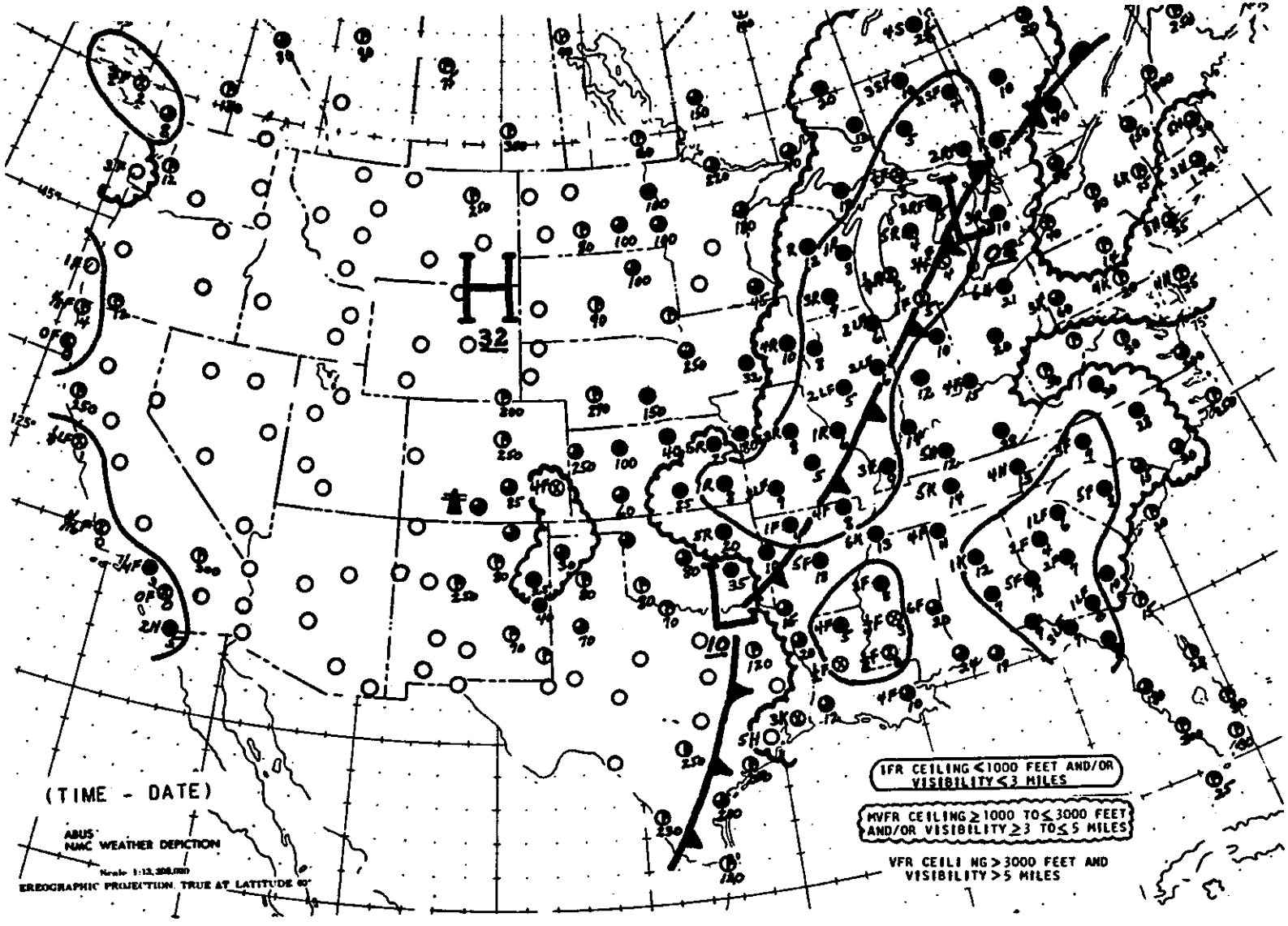


FIGURE 6-1. A Weather Depiction Chart.

ANALYSIS

The chart shows observed ceiling and visibility by categories as follows:

1. IFR—Ceiling less than 1,000 feet and/or visibility less than 3 miles, outlined by a *smooth* line.
2. MVFR (Marginal VFR)—Ceiling 1,000 feet to 3,000 feet inclusive and/or visibility 3 to 5 miles inclusive, outlined by a *scalloped* line.
3. VFR—Ceiling greater than 3,000 feet or unlimited and visibility greater than 5 miles, *not* outlined.

In addition, the chart shows major fronts and high and low pressure centers from the surface analysis for the preceding hour. These features are depicted the same as on the surface chart.

USING THE CHART

The weather depiction chart is a choice place to begin your weather briefing and flight planning. From it, you can determine general weather conditions more readily than from any other source. It gives you a "bird's eye" view at map time of areas of favorable and adverse weather and pictures frontal and pressure systems associated with the weather.

The chart may not completely represent enroute conditions because of variations in terrain and weather between stations. Furthermore, weather changes; by the time the chart is available, plotted data around the stations have been superseded by SA reports. After you initially size up the general picture, your final flight planning must consider forecasts, progs, and the latest pilot, radar, and surface weather reports.

Section 7

RADAR SUMMARY CHART

A radar summary chart graphically displays a collection of radar reports. Valid time is time of the radar observations. Figure 7–1 is a radar summary chart. It shows precipitation echoes indicating their location, coverage, movement, and tops along with other pertinent weather information associated with the echoes. This section explains chart annotations, symbols, and use.

ECHO PATTERN AND COVERAGE

The *echo pattern* is the arrangement of echoes. A pattern may be (1) a line of echoes, (2) an area of echoes, or (3) an isolated cell. A cell is a solid convective mass normally 20 nautical miles or less in diameter. *Echo coverage* is the areal coverage of echoes or cells within an area or line. Table 7–1 shows depiction and symbols used to denote echo pattern and coverage.

TABLE 7–1. Echo coverage symbols on the Radar Summary Chart

Symbol	*Meaning*	*Called*
	A line of echoes	Line
	An area of echoes	Area
⊕	Over 9/10 coverage	Solid
◍	5/10 to 9/10 coverage	Broken
◐	1/10 to 5/10 coverage	Scattered
⊙	Less than 1/10 coverage	Widely scattered
O	Isolated cell	Cell
✸	Strong cell detected by two or more radars	Cell

WEATHER ASSOCIATED WITH ECHOES

Weather radar primarily detects particles of precipitation size within a cloud or falling from a cloud. The echo from an aggregate of particles does not specifically identify the type of precipitation. However, the radar observer usually can determine precipitation type from other sources. Table 7–2 lists symbols identifying type of precipitation associated with echoes.

TABLE 7–2. Weather symbols

Symbol	*Meaning*
R	Rain
RW	Rain showers
A	Hail
S	Snow
IP	Ice Pellets
SW	Snow showers
L	Drizzle
T	Thunderstorm
ZR, ZL	Freezing precipitation

INTENSITY AND TREND OF PRECIPITATION

Type of precipitation is further annotated to show *intensity* and *intensity trend*. Intensity follows the precipitation symbol, and a solidus (/) separates intensity from intensity trend. Table 7–3 lists symbols for intensity; table 7–4, for intensity trend.

TABLE 7–3. Echo intensity

Symbol	*Echo intensity*	*Estimated precipitation*
–	Weak	Light
(none)	Moderate	Moderate
+	Strong	Heavy
++	Very strong	Very heavy
X	Intense	Intense
XX	Extreme	Extreme
U	Unknown	Unknown

TABLE 7-4. Intensity trend

Symbol	*Meaning*
+	Increasing
−	Decreasing
NC	No change
NEW	New

Examples of precipitation type, intensity, and trend are:

R−/+	Light rain, increasing in intensity.
TRW+/−	Thunderstorm, heavy rain shower, decreasing in intensity.
RW/NC	Moderate rain shower, no change in intensity.
TRW−/NEW	Thunderstorm, light rain shower, newly developed.
TRWXX/NC	Thunderstorm, rain shower extreme intensity, no change.
S	Snow. (No intensity or characteristic is shown for frozen precipitation.)

HEIGHTS OF ECHO BASES AND TOPS

Heights in hundreds of feet MSL are entered above and/or below a line to denote echo tops and bases respectively. Examples are:

450	Average tops 45,000 feet
220/80	Bases 8,000 feet; tops 22,000 feet
330	Top of an individual cell, 33,000 feet
(650)	Maximum tops, 65,000 feet
A350	Tops 35,000 feet reported by aircraft

Absence of a figure below the line indicates that the echo base was not reported. Radar detects tops more readily than bases since precipitation usually reaches the ground. Also, curvature of the earth prohibits the detection of bases of distant precipitation.

Vertical extent of echoes is measured by a range-height indicator. Primary weather radar has this feature, but Air Traffic Control (ATC) radar does not. Information from ATC radar shows tops only when reported by aircraft. Most radar weather reports across the intermountain regions of the western United States are from ATC radar.

MOVEMENT OF ECHOES

Movement of echoes is also shown. Movement of individual storms within a line or area often differs from the movement of the overall storm pattern. Movement of individual echoes is shown by a direction arrow and a number representing speed in knots. Movement of a line or area is shown by an arrow with flags, a full flag for 10 knots and a half flag for 5 knots.

Individual echo movement to the northeast at 35 knots.

Line or area movement to the east at 20 knots.

ADDITIONAL INFORMATION

"Boxes" enclosed by a dashed line indicate a severe weather watch in effect. Refer to the latest severe weather watch (WW) for specifics.

When reports from a particular radar station do not appear on the chart, notations plotted at the radar site give the reason. Table 7-5 lists the notations and their meanings.

TABLE 7-5. Symbols indicating no echoes

Symbol	*Meaning*
NE	No echo (equipment operating but no echoes observed)
NA	Observation not available
OM	Equipment out for maintenance

USING THE CHART

The radar summary chart aids in preflight planning by identifying general areas and movement of precipitation and/or thunderstorms. Radar detects only drops or ice particles of precipitation size; it does not detect clouds and fog. Therefore, the absence of echoes does not guarantee clear weather. Furthermore, cloud tops may be higher than precipitation tops detected by radar. The chart must be used in conjunction with other charts, reports and forecasts.

Examine chart annotations carefully. Always determine location and movement of echoes. If echoes are anticipated near your planned route, take special note of echo intensity and trend. Echoes of light or moderate intensity may contain turbulence. Echoes of strong or greater intensity or echoes increasing in intensity may contain hazardous turbulence and hail. Echo tops also are often a clue to severity of thunderstorms. A good rule is to avoid echoes with tops of 35,000 feet or higher.

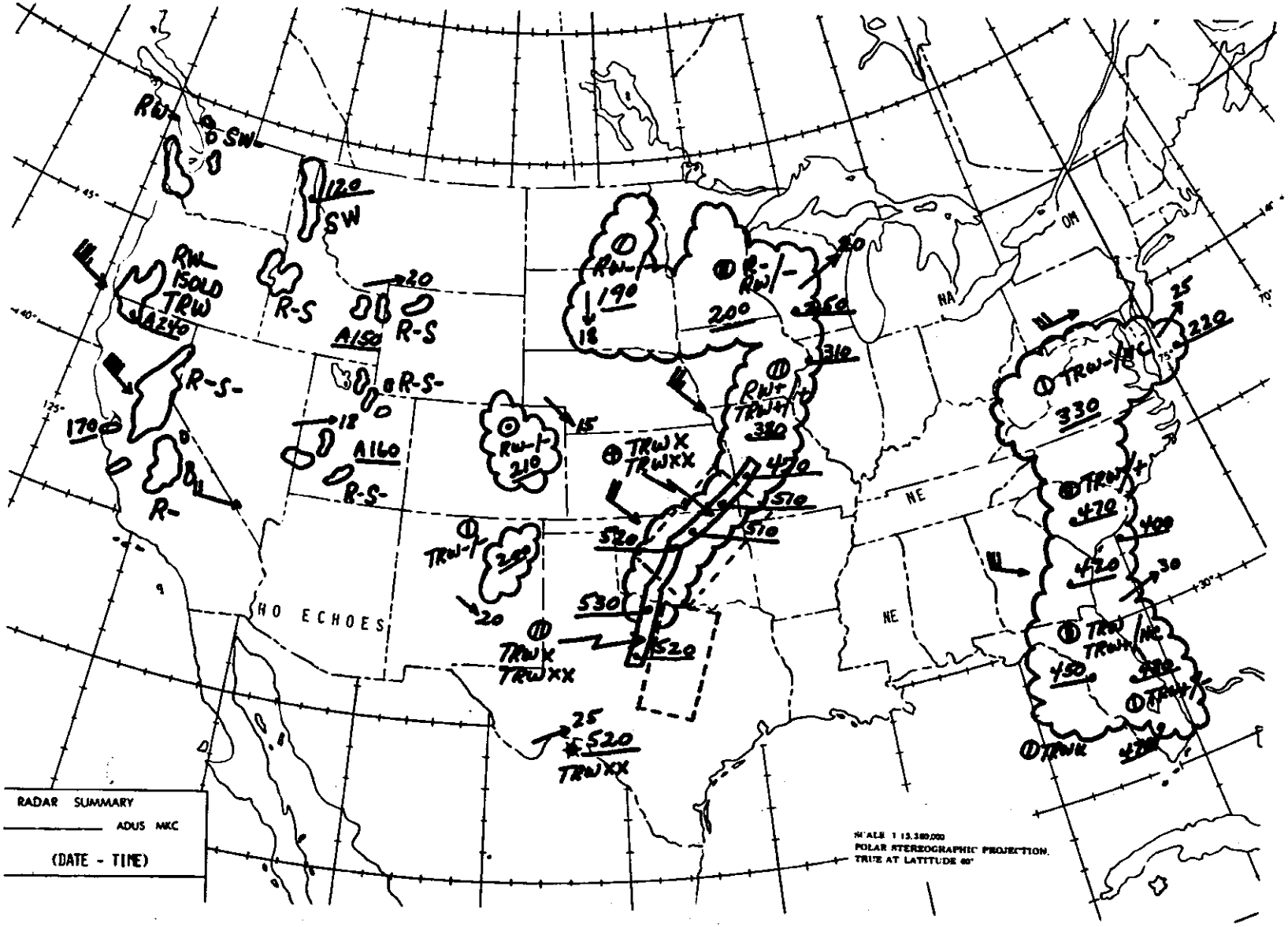


FIGURE 7–1. A Radar Summary Chart.

Suppose your proposed route will take you through an area of widely scattered thunderstorms with no increase anticipated. When these storms are separated by good VFR weather, you most likely can pick your way among them, visually sighting and circumnavigating the storms. However, widespread cloudiness may conceal the thundertorms. To avoid these embedded thunderstorms, you must either use airborne radar or detour the area. Echoes reported as broken or solid are difficult to circumnavigate either visually or by airborne radar. More details on avoiding hazards of thunderstorms are given in chapter 11, Aviation Weather.

Keep in mind that the chart is for preflight planning only. Once airborne, you must evade individual storms from inflight observations either by visual sighting or by airborne radar.

Section 8

SIGNIFICANT WEATHER PROGNOSTICS

Significant weather prognostic charts, called "progs" for brevity, portray forecast weather which may influence flight planning. Table 8–1 explains some symbols used on these charts. Significant weather progs are issued both for domestic and international flights.

TABLE 8–1. Some standard weather symbols

Symbol	*Meaning*
	Moderate turbulence
	Severe turbulence
	Moderate icing
	Severe icing
	Rain
	Snow
	Drizzle
	Rain shower
	Snow shower
	Thunderstorm
	Freezing rain
	Tropical storm
	Hurricane (typhoon)

NOTE: Character of precipitation is the manner in which it occurs. It may be intermittent or continuous. A single symbol denotes intermittent, a pair of symbols indicates continuous.

●●	Continuous rain
*	Intermittent snow
••	Continuous drizzle

DOMESTIC FLIGHTS

Significant weather progs are prepared for the conterminous U.S. and adjacent areas. The U.S. low level significant weather prog is designed for domestic flight planning to 24,000 feet and a U.S. high level prog is for domestic flights above 24,000 feet to 45,000 feet. Chart legends include valid time in GMT.

U.S. Low Level Significant Weather Prog

The low level prog is a four-panel chart as shown in figure 8–1. The two lower panels are 12- and 24-hour surface progs. The two upper panels are 12- and 24-hour progs of significant weather from the surface to 400 millibars (24,000 feet). The charts show conditions as they are forecast to be *at* the valid time of the chart.

Surface Prog. The two surface prog panels use standard symbols for fronts and pressure centers explained in section 5. Movement of each pressure center is indicated by an arrow showing direction and a number indicating speed in knots. Isobars depicting forecast pressure pattern are included on some 24-hour surface progs.

The surface prog outlines areas of forecast precipitation and/or thunderstorms as shown in the lower panels of figure 8–1. Smooth lines enclose areas of expected continuous or intermittent precipitation; dash-dot lines enclose areas of showers or thunderstorms. Note that symbols indicate precipitation type and character. If precipitation will affect half or more of an area, that area is shaded; absence of shading denotes more sparse precipitation, specifically less than half areal coverage. Look at the lower left panel of figure 8–1. At 1200Z the forecast is for continuous snow affecting half or more of an area in portions of the northern Rocky Mountain States. Showers and thunderstorms affecting less than half the area are forecast on the same prog for the central Gulf Coast. Rain or drizzle over less than half the area is indicated for the Carolinas.

Significant Weather. The upper panels of figure 8–1 depict ceiling, visibility, turbulence, and freezing level. Note the legend near the center of the chart which explains methods of depiction.

Smooth lines enclose areas of forecast IFR weather; scalloped lines enclose areas of marginal

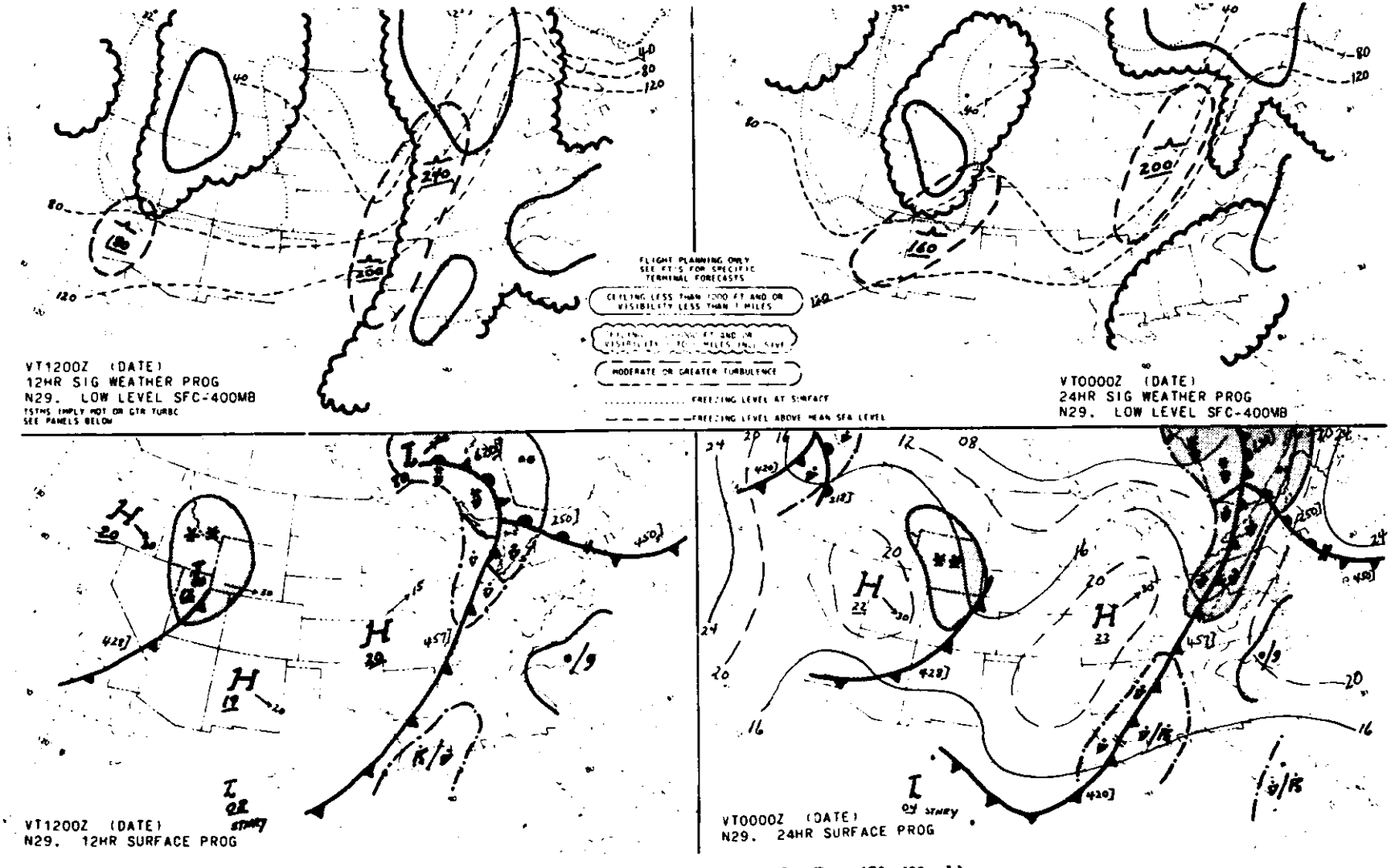


FIGURE 8-1. U.S. Low Level Significant Weather Prog (Sfc-400 mb).

weather (MVFR); VFR areas are not outlined. Recall that this is the same manner of depiction used on the weather depiction chart to portray ceiling and visibility.

Long-dashed lines enclose general areas of forecast moderate or greater turbulence. However, thunderstorms forecast on a surface prog always imply moderate or greater turbulence in the storms even though a general area of turbulence may not be outlined on the associated significant weather panel. (See legend, 12-hr sig weather prog, figure 8-1).

A symbol entered within a general area of forecast turbulence denotes intensity. Figures below and above a short line show expected base and top of the turbulent layer in hundreds of feet. Absence of a figure below the line indicates turbulence from the surface upward. No figure above the line indicates turbulence extending above the upper limit of the chart. Turbulence forecast from the surface to above 24,000 feet is indicated by the notation "SFC" below the line. In the upper left panel of figure 8-1, the annotation appearing in extreme southern California denotes moderate turbulence, surface to 18,000 feet.

Freezing level height contours for the uppermost freezing level are drawn at 4,000-foot intervals. The 4,000-foot contour terminates at the 4,000-foot terrain level along the Rocky Mountains. Contours are labelled in hundreds of feet MSL. Freezing level line at the surface is labelled "32°". An upper freezing level contour crossing the surface 32° line indicates multiple freezing levels due to layers of warmer air aloft.

The low level significant weather prog does not specifically outline areas of icing. However, icing is always implied in clouds and precipitation above the freezing level.

U.S. High Level Significant Weather Prog

The U.S. high level significant weather prog, figure 8-2, encompasses airspace from 400 to 150 millibars (24,000 feet to 45,000 feet pressure altitude). The prog outlines areas of forecast turbulence, continuous dense cirriform clouds, and cumulonimbus clouds. Table 8-2 interprets some examples of chart annotation.

Turbulence. Long-dashed lines enclose areas of probable moderate or greater turbulence. Symbols denote intensity, base, and top. Cumulonimbus clouds *imply* moderate or greater turbulence and icing.

Cirriform Clouds. Large-scalloped lines enclose areas of dense, continuous cirriform clouds of broken or overcast coverage. Expected base and top are given with the notation "LYR" meaning either single or multiple layers. A single digit preceding the notation "LYR" is coverage in "octas" or eighths, eight-eighths being overcast.

Cumulonimbus Clouds. Small-scalloped lines enclose areas of expected cumulonimbus development. The contraction "CB" denotes cumulonimbus; a digit preceding the contraction denotes coverage in octas. The notation "FEW CB" denotes less than one-eighth coverage.

Cumulonimbus coverage and heights represent an overall average for the forecast area. When a wide variation is expected within an area, separate CB amounts and heights may be indicated.

INTERNATIONAL FLIGHTS

Significant weather progs for international aviation cover large geographical areas. The areas covered extend from eastern Asiatic coastal areas across the Pacific; the Atlantic into Europe; northwestern Africa; and part of the Southern Hemisphere including northern South America and the South Pacific. These progs appear on both Mercator and polar stereographic projections, but methods of depiction are the same.

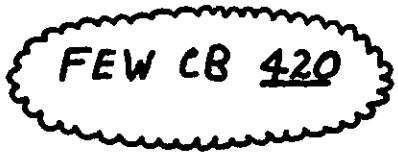
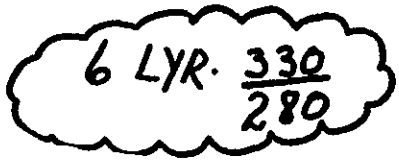
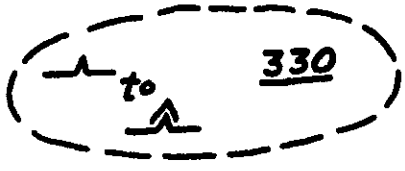
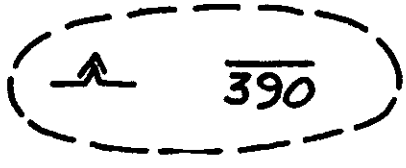
The only low level (surface to 400 millibars) international significant weather prog is for the North Atlantic area. All other international significant weather progs are high level progs from 400 millibars to 150 millibars.

North Atlantic Significant Weather Prog

Figure 8-3 is a North Atlantic low level significant weather prog. Note that it shows forecast positions of surface pressure centers and fronts using standard symbols. Scalloped lines depict areas of only broken or overcast layered clouds but any amount of cumulonimbus. Cloud cover is in octas, or eighths. Bases and tops are shown as on the U.S. significant weather progs. No figure above the line indicates tops above 24,000 feet. For example, note the lower left portion of figure 8-3. The annotations labelled "FEW CB" indicate less than one-eighth cumulonimbus with bases at 1,500 feet and tops above 24,000 feet. The area near the upper center of the chart labelled "8 LYR" denotes eight-eighths, or overcast, layered clouds with bases 1,500 feet and tops 18,000 feet.

Forecast cumulonimbus always implies turbulence and icing. Standard symbols and annotations indicate other areas of expected turbulence and icing. For example, on figure 8-3, the annotation at about 45°N and 50°W indicates icing from 11,000

TABLE 8-2. Depiction of clouds and turbulence on a High Level Significant Weather Prog

Depiction	Meaning
1. 	Few (less than one-eighth coverage) cumulonimbus, tops 42,000 feet. Bases are below 24,000 ft.—the lower limit of the prog.
2. 	Three-eighths cumulonimbus, tops above 45,000 feet.
3. 	Six-eighths coverage (broken), layered cirriform clouds, base 28,000 and tops 33,000 feet.
4. 	Moderate to severe turbulence from below lower limit of the prog (24,000 feet) to 33,000 feet. (Consult low-level prog for turbulence forecasts below 24,000 feet.)
5. 	Severe turbulence from 39,000 feet to above upper limit of the prog (45,000 feet).

NOTES:

Base and top shown by figures below and above a short line respectively.

Cumulonimbus Clouds, Examples 1 and 2. Bases always below 400 millibars and are not shown. Tops above 150 millibars shown as "ABV 450".

Cirriform Clouds and Turbulence. Figure below the line omitted when base is below 400 millibars. Figure above omitted when top above 150 millibars.

feet to 16,000 feet within the "7 LYR" of clouds. Referring to the upper center of the chart, an area of moderate turbulence is forecast from the surface to 18,000 feet.

Freezing level on this prog is indicated only by a 10,000-foot MSL contour. Note on figure 8-3 the dashed line labelled "100". Freezing level north of this line is below 10,000 feet; south of the contour, freezing level is above 10,000 feet.

International High Level Significant Weather Progs

Figure 8-4 is an international high level significant weather prog. The legend "SIG WX (400-150MB)" in the upper right identifies the chart. This example on a Mercator projection covers the Pacific ocean from about Honolulu westward to the Asiatic coast.

Annotations on international high level significant weather progs are the same as on U.S. high level significant weather progs. In addition, the international prog shows surface positions of pressure centers, fronts, tropical storms, and hurricanes (typhoons in the western Pacific). Note on figure 8–4 near 28° N. and 138° E. the typhoon, "ELLEN". Also shown are tropical storm "DOT" near 31° N. and 127° E. and tropical depression "BILLIE", marked as a low pressure center at 37° N. and 121° E.

USING SIGNIFICANT WEATHER PROGS

Use the significant weather progs in planning your flight to avoid areas and/or altitudes of most probable significant icing and turbulence. You may also plan your flight to remain clear of extensive cloudiness. By comparing progs with analyses, you can determine expected movement and changes in weather patterns.

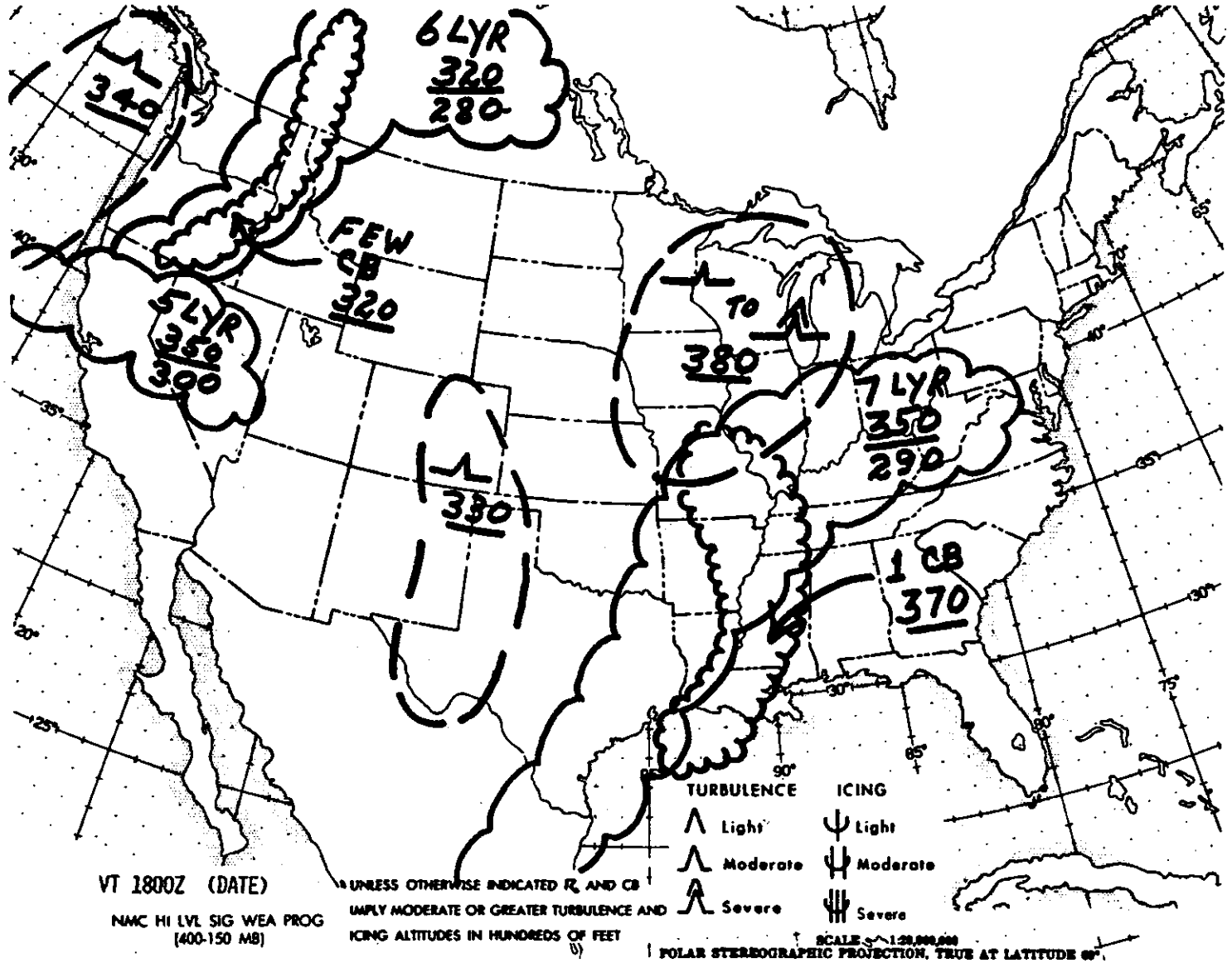


FIGURE 8-2. U.S. High Level Significant Weather Prog (400–150 mb).

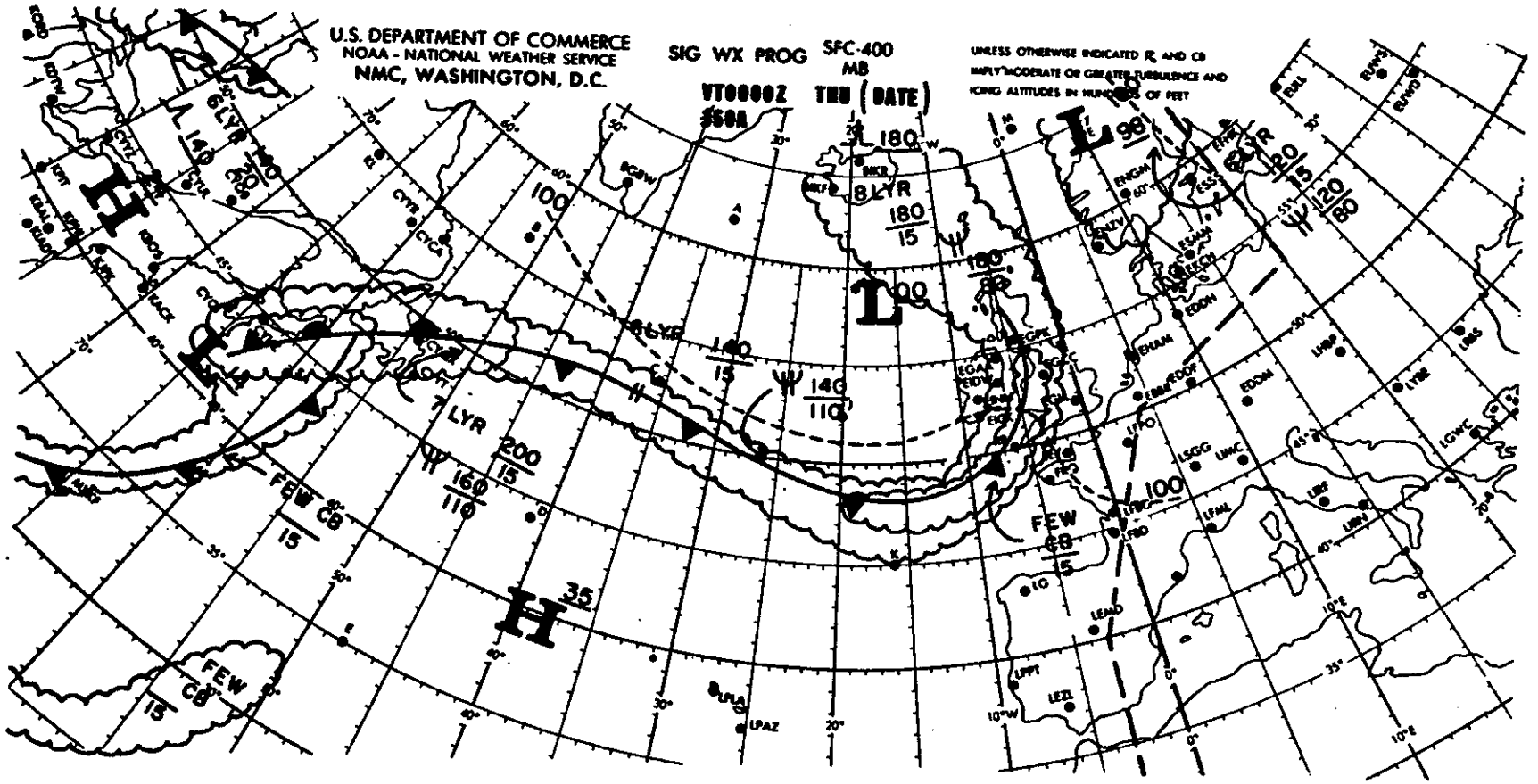


FIGURE 8-3. North Atlantic Low Level Significant Weather Prog (Sfc-400 mb).

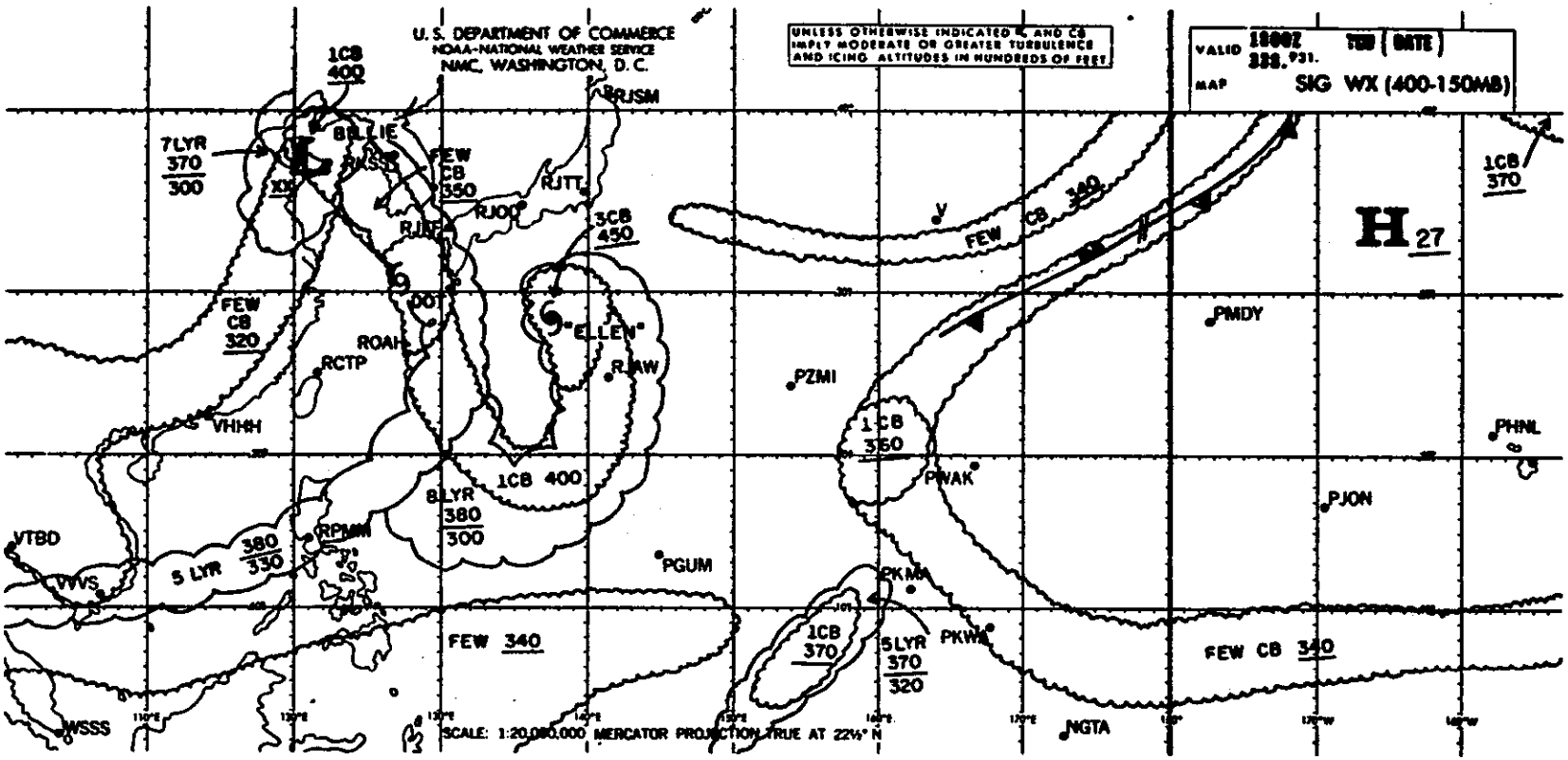


FIGURE 8-4. Pacific High Level Significant Weather Prog (400–150 mb). This Mercator projection extends from about Honolulu to eastern Asia.

Section 9

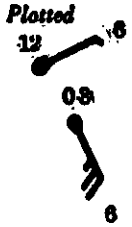
WINDS AND TEMPERATURES ALOFT

Winds aloft charts, both forecast and observed, are transmitted routinely by facsimile. The *forecast* winds aloft charts also contain forecast temperatures aloft. Forecast charts are computer prepared and observed charts are hand plotted.

FORECAST WINDS AND TEMPERATURES ALOFT (FD)

Forecast winds and temperatures aloft charts are prepared for eight levels on eight separate panels. A legend on each panel shows the valid time and the level of the chart. Levels below 18,000 feet are true altitudes; levels 18,000 and above are pressure altitudes or flight levels. Figure 9–1 is one panel of a winds and temperatures aloft forecast.

Temperature in °C for each forecast point is entered in two digits above the station circle. Arrows with pennants and barbs similar to those used on the surface map show wind direction and speed. Wind direction is drawn to the nearest 10 degrees, and the second digit of the coded direction is entered at the outer end of the arrow. First you determine the general direction and then use the digit to determine direction to the nearest 10°. For example, a wind in the northwest quadrant with a digit 3 indicates 330°. A calm or light variable wind is shown by "99" entered to the lower left of the station circle. Following are examples of plotted temepratures and winds with their interpretations:

Plotted	*Interpretation*
	12° C, wind 060° at 5 knots 3° C, wind 160° at 25 knots
	−9° C, wind 260° at 50 knots −47° C, wind 360° at 115 knots −11° C, wind calm (light variable)

OBSERVED WINDS ALOFT

Charts of observed winds are sent at 6-hour intervals for selected levels, each level on a separate panel. Wind direction and speed at each observing station is shown by arrows the same as on the forecast charts. The only difference is that a calm wind is shown by encircling the station. Figure 9–2 is a panel of the observed winds aloft chart.

USING THE CHARTS

The use of winds aloft charts seems obvious—to determine winds at a proposed flight altitude or to select the best altitude for a proposed flight. Temperatures also can be determined from the *forecast* charts. To determine winds and temperatures at a level between charted levels, interpolate between the charted levels.

Forecast winds are generally preferable to observed winds since they are more relevant to flight time. Observed winds are more than 2 hours old when received by facsimile, and their reliability diminishes with time.

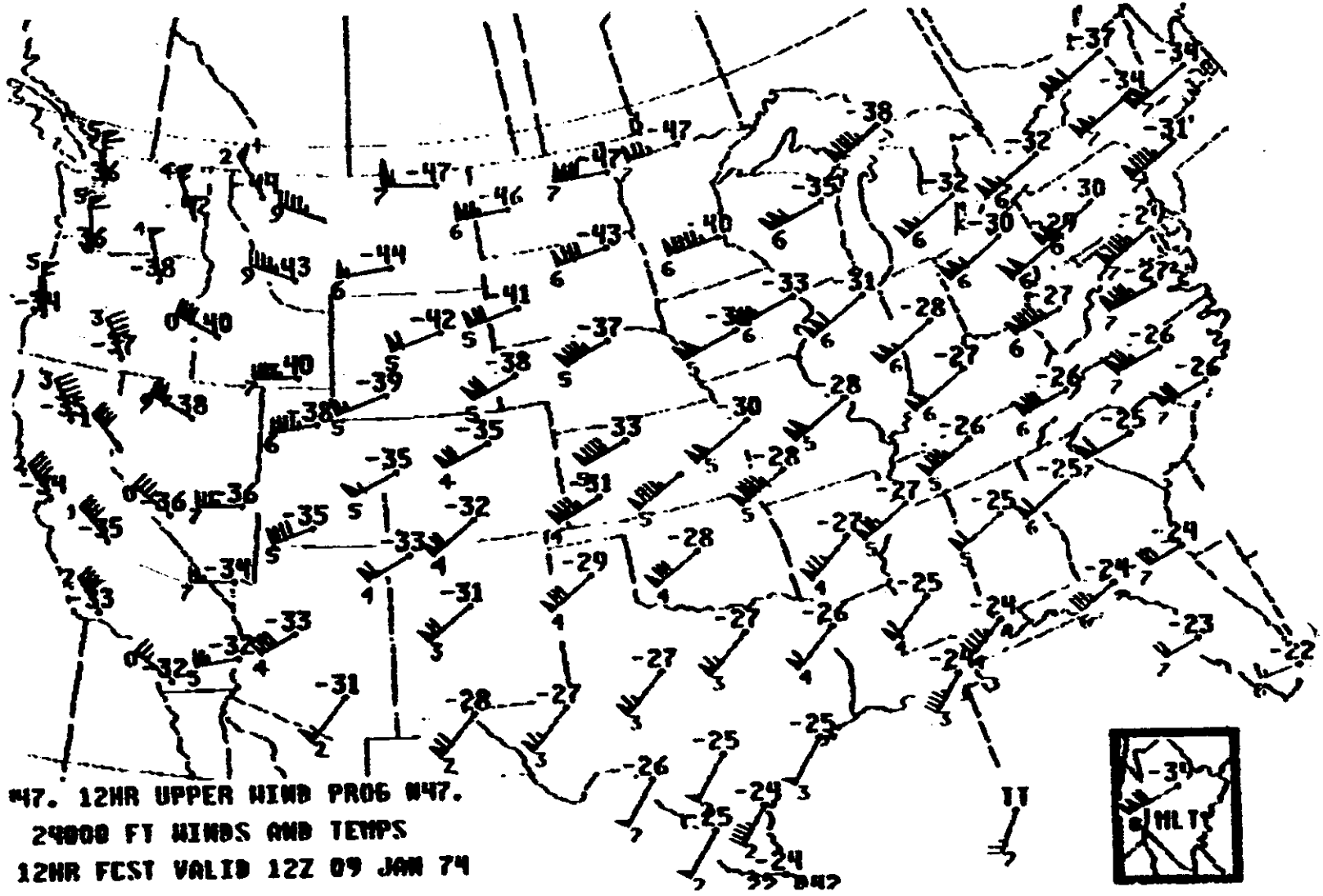


FIGURE 9-1. A panel of winds and temperatures aloft forecast for 24,000 feet pressure altitude.

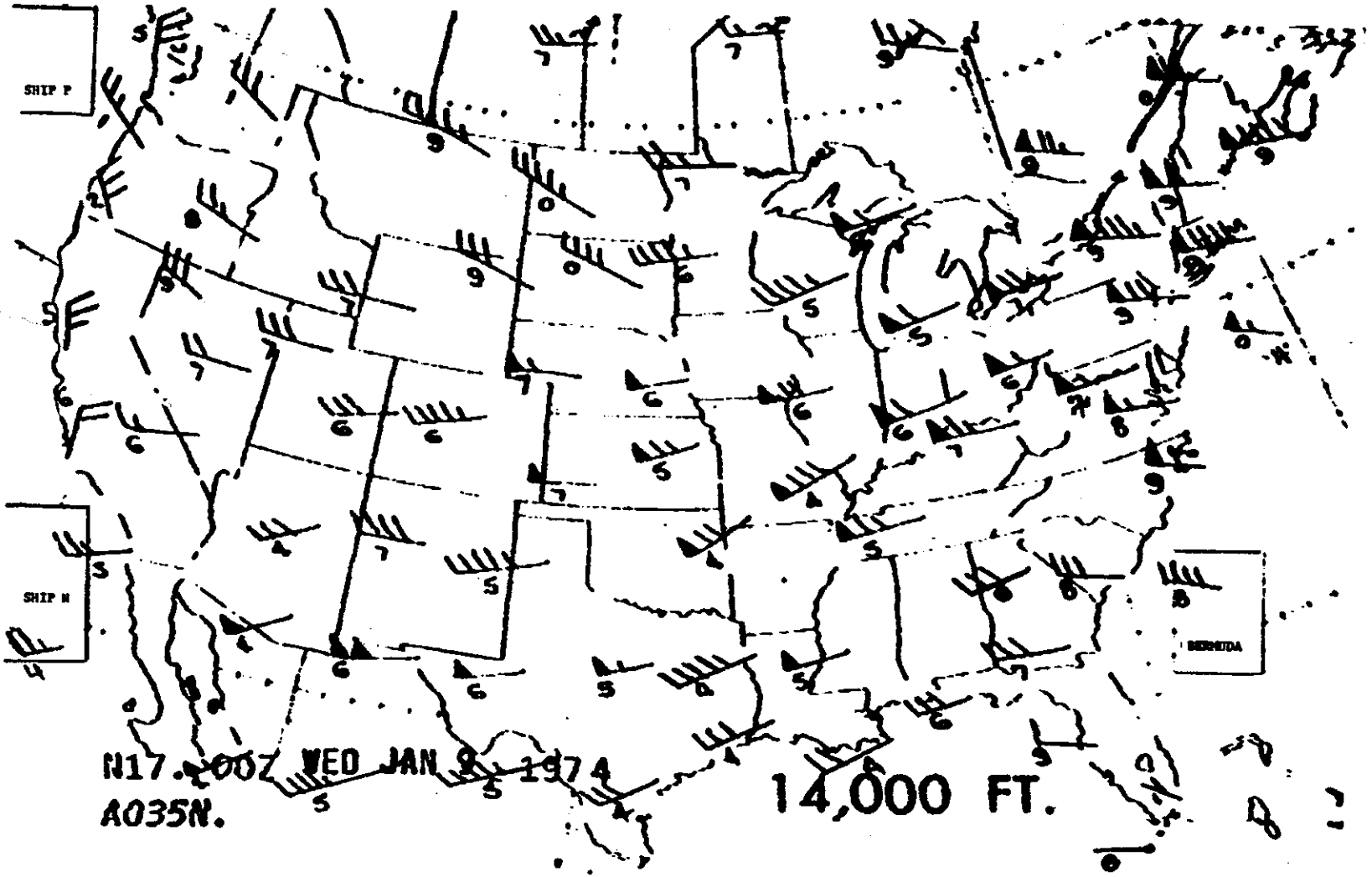


FIGURE 9-2. A panel of observed winds aloft for 14,000 feet.

Section 10

FREEZING LEVEL CHART

A freezing level chart, figure 10–1, is an analysis of observed freezing level data from upper air observations.

PLOTTED DATA

Table 10–1 explains plotting of freezing level data. Note that more than one entry denotes multiple crossings of the 0° C isotherm.

ANALYSIS

Solid lines are contours of the freezing level drawn for 4,000-foot intervals and labelled in hundreds of feet MSL. When a station reports more than one crossing of the 0° C isotherm, the lowest crossing is used in the analysis. This is in contrast to the low level significant weather prog on which the depicted forecast freezing level aloft is the highest freezing level. A dashed line shows the intersection of the freezing level with the surface.

USING THE CHART

The contour analysis shows an overall view of the lowest observed freezing level. Always plan for possible icing in clouds or precipitation above the freezing level—especially between temperatures of 0° C and −10° C.

Plotted multiple crossings of the 0° C isotherm at a station always show an inversion with warm air above subfreezing temperatures. This situation can produce very hazardous icing when precipitation is occurring.

Area forecasts show more specifically the areas of expected icing. Low level significant weather progs show anticipated changes in the freezing level.

TABLE 10-1. Plotting of freezing levels

Plotted	*Interpreted as—*
BF	Entire observation below freezing (0° C)
000	Surface temperature 0° C. Freezing level at surface
Three digits other than 000	Height of a freezing level aloft in hundreds of feet MSL, i.e.; 002, 200 feet MSL; 120, 12,000 feet MSL
110 051 BF	Below frezing from surface to 5,100 feet; above freezing from 5,100 feet to 11,000 feet; and below freezing above 11,000 feet
090 034 003	Lowest freezing level, 300 feet; below freezing from 300 feet to 3,400 feet; above freezing 3,400 to 9,000 feet; below freezing above 9,000 feet.

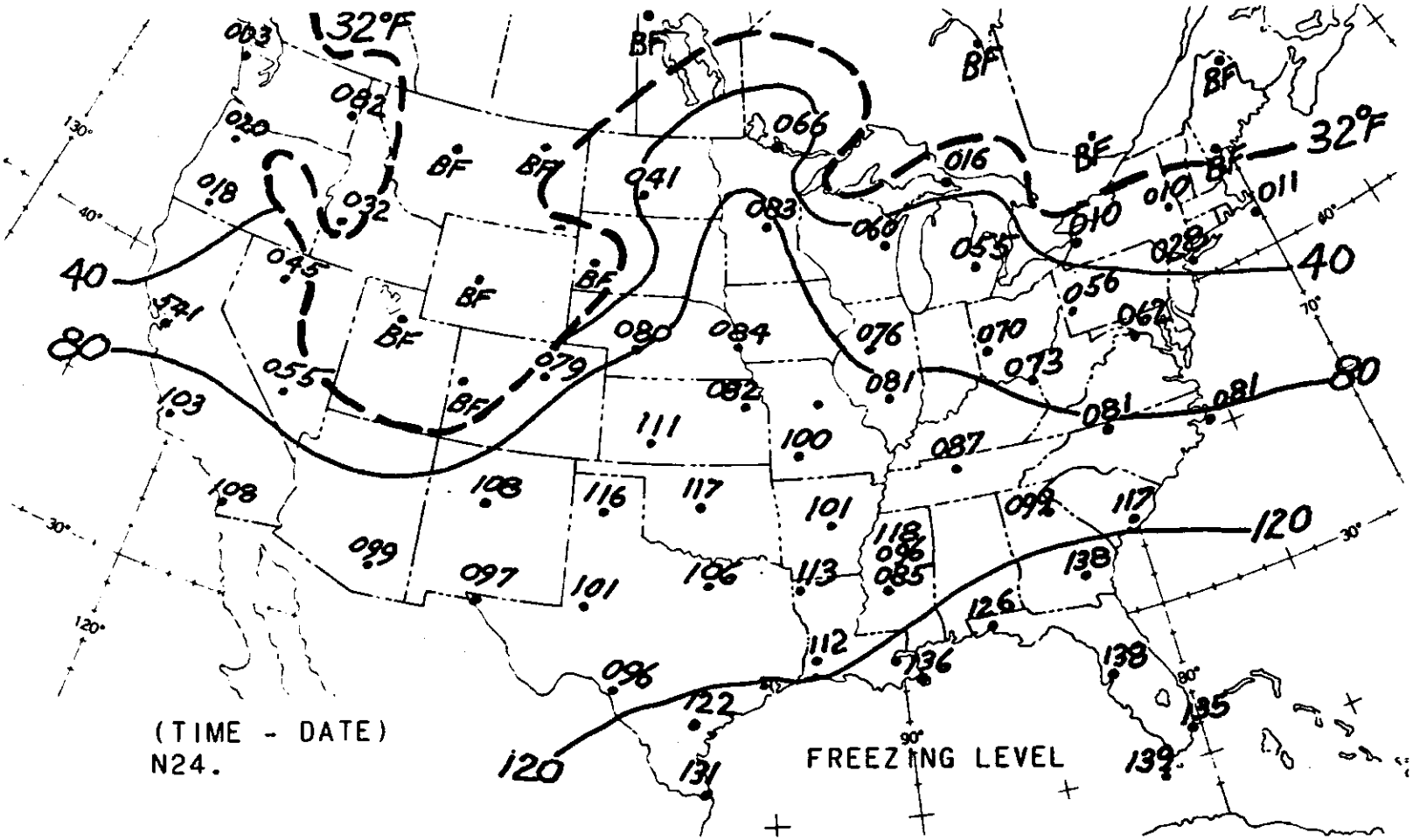


FIGURE 10–1. A freezing level chart.

Section 11
STABILITY CHART

The stability chart, figure 11–1, outlines areas of stable and unstable air. Two stability indices are computed for each upper air station; one is the *lifted index* and the other, the *K index*. At each station, lifted index is plotted above a short line, and the K index, below the line.

This section explains computation of the indices and the analysis and use of the chart. If you run into trouble with the discussion, you should review AVIATION WEATHER, chapter 6, "Stable and Unstable Air."

LIFTED INDEX

The lifted index is computed as if a parcel of air near the surface were lifted to 500 millibars. As the air is "lifted", it cools by expansion. The temperature the parcel would have at 500 millibars is then subtracted from the existing 500-millibar temperature. The difference is the lifted index—it may be positive, zero, or negative.

Positive Index

A positive index means that a parcel of air *if lifted* would be colder than existing air at 500 millibars. The air is stable. *Large positive (high) values indicate very stable air.*

Zero Index

A zero index denotes that air lifted to 500 millibars would attain the same temperature as the existing 500-millibar temperature. The air is neither stable nor unstable (neutrally stable).

Negative Index

A negative index means that the low-level air *if lifted* to 500 millibars would be warmer than existing air at 500 millibars. The air is unstable. *Large negative (low) values indicate very unstable air.*

K INDEX

The K index is primarily for the meteorologist; but a discussion is included for those who are interested. It combines moisture does not depend on lifting. It i three terms as follows:

K = (850 mb temp − 500 mb temp) + (8
(700 mb temp-dew point

The first term (850 mb temp is proportional to the mean lap temperature difference shows a lapse rate. The greater the diff unstable the air and the higher t

The second term (850 mb measure of low-level moisture. Si is added, high moisture content increases the K value.

The third term (700 mb temp-d is a measure of saturation at 70(greater the spread, the drier is th term is subtracted, it lowers the ever, moist air (small spread) less than does dry air (large spr greater the degree of saturation the larger is the K value.

Putting the three together, we the following contributes to a h index:

1. An unstable lapse rate
2. High moisture content at 85
3. A high degree of saturation at

Thus, a large K index supports clo cipitation.

STABILITY ANALYSIS

The analysis is based on the lift Solid lines are drawn for indices −4. A "U" identifies an area of an "S", an area of stability. In g a lifted index between 0 and + stable. It may become unstable heating, upslope flow, frontal liftin or inflow of cold air aloft.

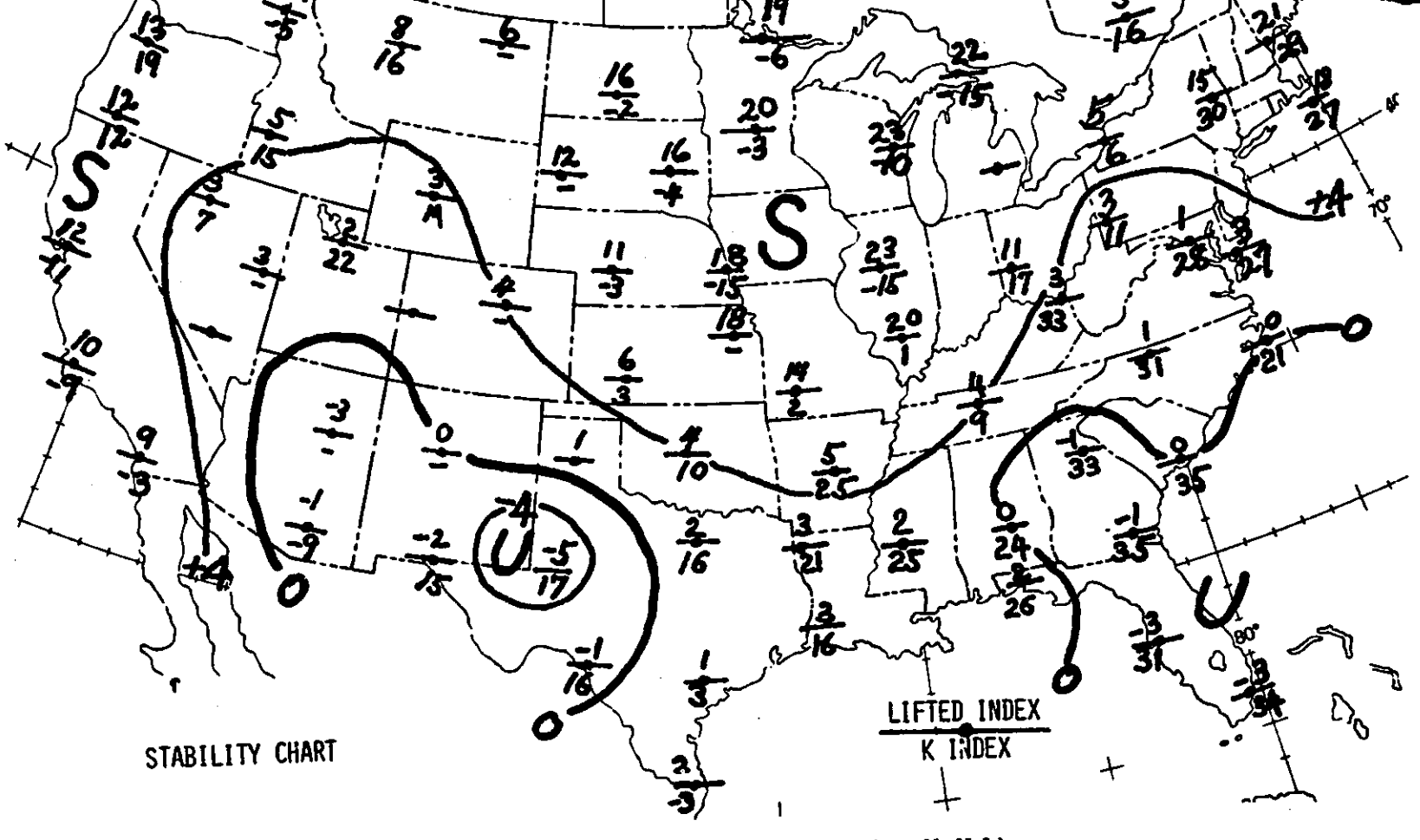


FIGURE 11–1. A stability chart. (This chart is keyed to table 11–1.)

USING THE CHART

From the chart you can make a quick estimate of areas of probable convective turbulence. Those of you making use of the K index also can estimate most likely areas of clouds and precipitation. The K index should be compared with the lifted index. Table 11–1 shows the comparisons along with probable weather and operational impact. The table is keyed to the chart in figure 11–1.

Correlations between the ii weather vary with seasons anc of the country. Also, exten develops depends on the degr or on forced lifting such as l a front. First estimates mad only preliminary to detailed f

TABLE 11–1. Using the K and lifted indices

Lifted Index	K Index	*Area in figure 11–1*	*Probable weather*	(
Zero or Negative (unstable)	High (wet)	Georgia Florida	Instability showers or thunderstorms	Turbul ous; sc
Zero or Negative (unstable)	Low (dry)	Southwest TX Southern NM Eastern AZ	Limited cumulus activity; little if any precipitation	Bumpy good f
Positive (stable)	High (wet)	New England	Stratified cloudiness; steady precipitation	Smooth restrict
Positive (stable)	Low (dry)	Northern Plains, Calif. coast	Predominantly fair	Smooth VFR;

Section 12

SEVERE WEATHER OUTLOOK CHART

The severe weather outlook is a preliminary 24-hour outlook presented in two 12-hour panels. Figure 12–1 is one panel of the outlook. The chart graphically delineates areas of general and severe thunderstorms and may show areas of possible tornadoes.

GENERAL THUNDERSTORMS

A line with an arrowhead delineates an area of probable thunderstorm activity. When you face in the direction of the arrow, activity is expected to the right of the line. An area labelled APCHG indicates probable thunderstorm activity *approaching* severe intensity.

SEVERE THUNDERSTORMS

A hatched area indicates severe thunderstorms; and the following notations show expected areal coverage:

Notation	*Expected coverage*
ISOLD	Extremely small number
FEW	Up to 15% coverage
SCTD	16% to 45% coverage
NMRS	More than 45% coverage

If an instability line is forecast, the chart may include a squall line symbol and expected time of development.

TORNADOES

Tornadoes are indicated only if a tornado watch is in effect at chart time. The watch area is cross-hatched. No areal coverage is specified.

USING THE CHART

The severe weather outlook is strictly for *advance* planning. It alerts all interests to the possibility of future storm development. As the time of severe weather approaches, the forecaster can more specifically delineate the time, extent, and nature of the weather and issue a severe weather watch (WW).

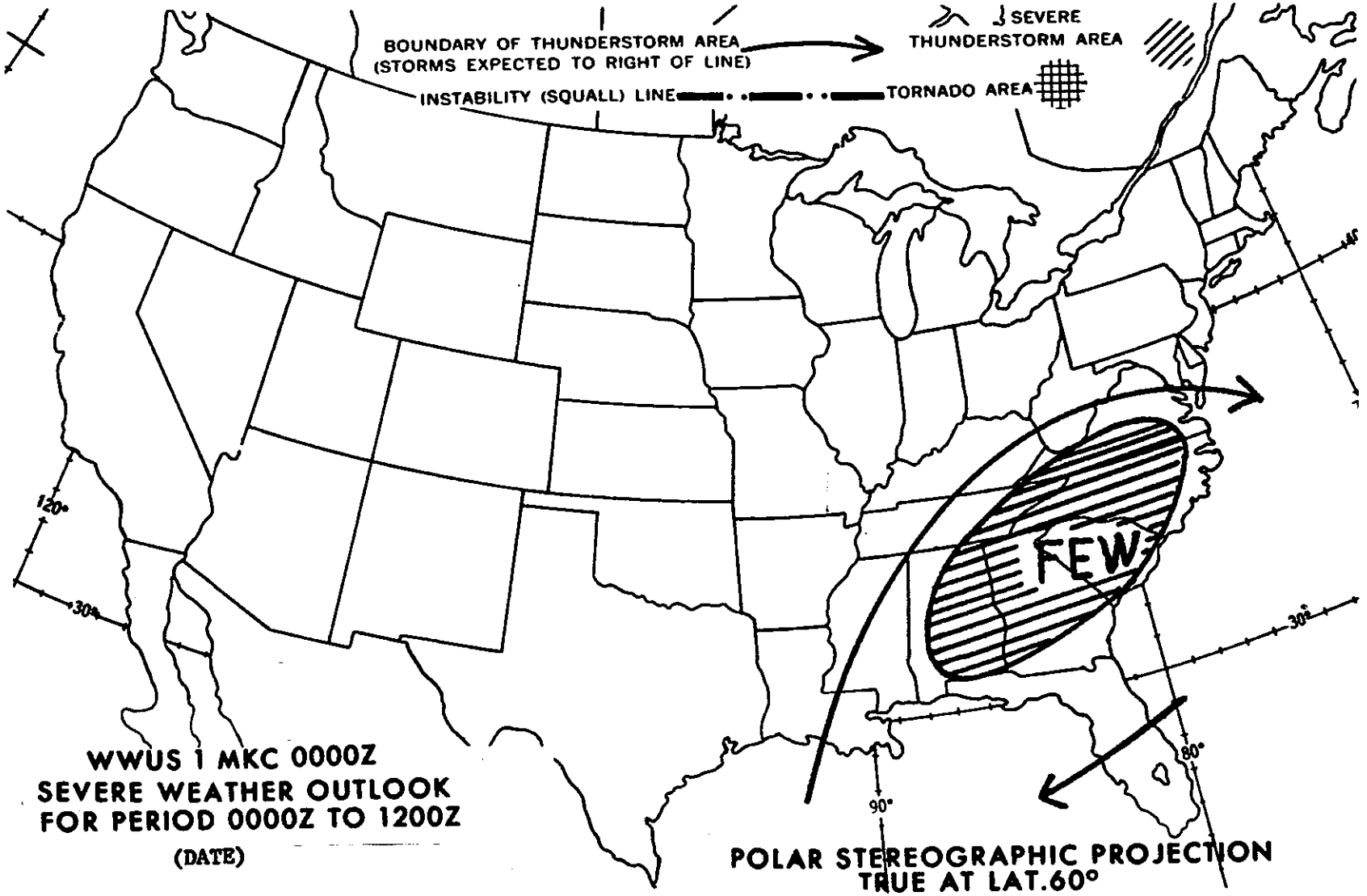


FIGURE 12-1. A panel of a severe weather outlook chart. If a severe weather watch is in effect when the chart is issued, the WW area is outlined on the chart and appropriately shaded as severe thunderstorms or tornadoes.

Section 13

CONSTANT PRESSURE CHARTS

A constant pressure chart is an upper air weather map at a specified pressure surface or flight level.* *Any surface of equal pressure in the atmosphere is a constant pressure surface, pressure altitude, and flight level.* Every 12 hours, computer prepared constant pressure charts are transmitted by facsimile for five pressure levels.

To the meteorologist, pressure is relevant to forecasting, so he labels the charts in millibars. To the pilot, pressure altitude or flight level of the chart is more relevant. Table 13–1 lists the approximate pressure altitude and height in meters of each chart along with other information pertinent to the analysis. Figures 13–2 through 13–6 are sections of each chart.

A constant pressure chart depicts highs, lows, troughs, and ridges aloft by the height contour patterns resembling isobars on a surface map. For a direct use of a constant pressure chart, assume you are planning a flight at 10,000 feet. The 700-millibar chart is approximately 10,000 feet MSL. It is a source of observed temperature, temperature-dew point spread, and winds aloft for your flight.

* *Flight level* is used here for all pressure altitudes, although in routine operations lower level flights are at indicated altitude called *cruising altitude.*

PLOTTED DATA

Figure 13–1 illustrates and decodes the standard data plot. The format varies slightly depending on the pressure level and available data. For example, when air is too dry to measure the dew point, an "X" is plotted for the temperature-dew point spread on lower levels, but the entry is omitted on upper levels. A light variable wind or missing wind data are represented by "LV" and "M", respectively plotted to the lower right. Aircraft reports are used in analyses over areas of sparse data. A square in lieu of a station circle signifies an aircraft report. The flight level of the aircraft is plotted in feet; temperature and wind are at flight level of the aircraft (see figs. 13–5 and 13–6).

TABLE 13–1. Features of constant pressure charts—U.S.

Pressure (millibars)	Pressure altitude in feet (flight level)	Approximate height in meters	Temperature—dew point spread	Isotachs	Contour interval (meters)	Prefix to plotted value	Suffix to plotted value	Examples of height plotting and contour labelling	
								Plotted/ labelled	Height
850	5,000	1,500	Yes	No	60	1	---	581	1,581
700	10,000	3,000	Yes	No	60	2 or 3*	---	882	2,882
500	18,000	5,500	Yes	No	60	----	0	578	5,780
300	30,000	9,000	Yes**	Yes	120	----	0	943	9,430
200	39,000	12,000	Yes**	Yes	120	1	0	217	12,170

* Prefix a "2" or "3" whichever brings the height closer to 3,000 meters.

** Omitted when air is too dry to measure de w point.

Flight level of an aircraft is plotted in lieu of height of constant pressure surface.

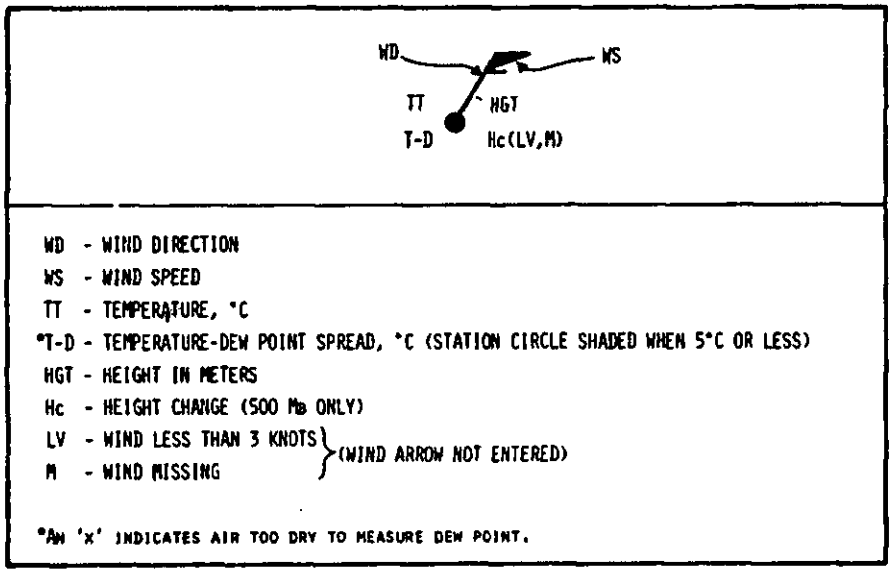


FIGURE 13-1. Standard station plotting model on constant pressure analyses. Entries vary slightly with levels and with data available. Note that when air is too dry to measure the dew point, an "X" is entered for temperature-dew point spread. The entry is usually omitted on the 200- and 300-millibar levels since air at these levels normally is too dry to measure dew point. Height change appears only on the 500-millibar chart.

The following examples show some station plots and how they are decoded. Meanings of the legend below each plot are: W, wind; T, temperature; T–DP, temperature-dew point spread; H, height of pressure surface in meters; Hc, 12-hour height change (500 millibars only):

(850 mb)	(700 mb)	(500 mb)	(200 mb)
W: less than 3	W: 010° 20 kt	W: 210° 60 kt	W: Missing
T: 22° C	T: 9° C	T: −19° C	T: −60° C
T–DP: 4° C	T–DP: 17° C	T–DP: Dry	T–DP: Dry
H: 1,479 m.	H: 3,129 m.	H: 5,580 m.	H: 11,910 m.
		Hc: +30 m.	

ANALYSIS

All charts contain *contours* and *isotherms*; some contain *isotachs*. Contours are lines of equal height; isotherms, lines of equal temperature; and isotachs, lines of equal windspeed.

Height Contours

A pattern of height contours resembles isobars on a surface weather map and we may compare a height analysis to a pressure analysis. A contour high, low, ridge, or trough is analogous to a pressure high, low, ridge, or trough. Since an upper air chart is above the surface friction layer, winds at these levels for practical purposes parallel the contours.

Refer to figures 13–2 through 13–4 and note the low aloft near northern California extending upward through 500 millibars. Figures 13–5 and 13–6 show the low opening into a trough at 300 and 200 millibars.

Isotherms

Isotherms drawn at 5° C intervals show horizontal temperature variations at chart altitude. Let's refer to the 850 millibar chart (5,000 feet pressure altitude), figure 13–2 and locate an isotherm. Note the dashed line extending from west to east through Utah and Colorado and labelled "00" at the eastern edge of Colorado. This is the 0° C isotherm. North of this isotherm, temperatures at 5,000 feet are below freezing. The −15° C isotherm extends across South Dakota. By inspecting isotherms, you can determine if your flight will be toward colder or warmer air. Subfreezing temperatures and a temperature-dew point spread of 5° C or less suggest possible icing.

Isotachs

Isotachs appear on only the 300- and 200-millibar charts. To aid in identifying areas of strong winds, hatching denotes windspeeds of 70 to 110 knots; a clear area within a hatched area indicates winds 110 to 150 knots, etc. Note the clear area in figures 13–5 and 13–6 extending eastward from northern New Mexico. On the 200-millibar chart, figure 13–6, the 130-knot isotach is over northern New Mexico and across the Texas Panhandle. Winds at 39,000 feet over Amarillo, Texas are from the west at 135 knots. Winds over northern California at this flight level are only 30 knots—note the dashed line labelled "30K".

THREE DIMENSIONAL ASPECTS

As established earlier, we may treat a height contour analysis as a pressure analysis. Closely spaced contours mean strong wind as do closely spaced isobars. Wind blows clockwise around a contour high and counterclockwise around a low.

Features on synoptic surface and upper air charts are related. However, a weak surface system often loses its identity in a large scale upper air pattern; while another system may be more evident on an upper air chart than on the surface chart. Many times weather is more closely associated with an upper air pattern than with features on the surface map.

We have learned as a general rule to regard a surface low as a producer of bad weather and a high as a producer of good weather. However, *widespread cloudiness and precipitation often develop in advance of an upper air low or trough which is not evident at the surface.* In contrast, an upper air high usually means good weather. An exception is an upper air high or ridge that has a stabilizing effect at low levels. Smoke, haze, dust, or even low stratus and fog may persist for extended periods; yet the surface map may show no cause for the restriction.

Highs and lows generally slope westward or northwestward into the upper atmosphere. Due to this slope, wind aloft with an upper system often blows across the associated surface system. Surface fronts, lows, and highs tend to move with the upper winds. For example, strong winds aloft across a surface front will cause the front to move rapidly; but if upper winds parallel a front, it moves slowly if at all.

An intense, cold low leans less than does a warm or weaker system. The low becomes almost vertical and is clearly evident on both surface and upper air maps. Upper winds encircle the surface low rather than blow across it. Thus, the storm moves very slowly and usually causes extensive and persistent cloudiness, precipitation, strong winds, and generally adverse flying weather. The term "cold low" describes such a system.

In contrast to the cold low is the "thermal low". A dry, sunny region becomes quite warm from intense surface heating resulting in a surface low pressure area. The warm air is carried to high levels by convection, but cloudiness is scant because of lack of moisture. Pressure decreases slowly with altitude in warm air; thus, the warm surface low often is "capped" by a high aloft. Unlike the cold low, the thermal low is relatively shallow with weak pressure gradients and no well defined cyclonic circulation. However, you must be alert for high density altitude, light to moderate convective turbulence, and isolated showers and thunderstorms which have high bases and generally produce light precipitation. The thermal low is a semipermanent feature of the desert regions in the southwestern United States and northern Mexico during warm weather.

These are only a few examples of associating weather with upper air features. They point out the need to view weather in three dimensions.

USING THE CHARTS

From the charts you can approximate the observed temperature, wind, and temperature-dew point spread along your proposed route. Usually you can select a constant pressure chart close to your planned altitude. For altitudes about midway between two charted surfaces, interpolate between the two charts.

Determine temperature from plotted data or the pattern of isotherms. To readily delineate areas of high moisture content, station circles are shaded

indicating temperature-dew point spreads of 5° C or less. You can get the actual spread from plotted data. A small spread alerts you to cloudiness, precipitation, and icing. Determine windspeed for lower levels from plotted data; for the 300- and 200-millibar surfaces, determine speed from the isotach pattern. Wind direction parallels the contours.

As stated earlier, constant pressure charts often show the cause of weather and its movement more clearly than does the surface map. For example, the large scale wind flow around a low aloft may spread cloudiness, low ceilings, and precipitation far more extensively than indicated by the surface map alone.

Keep in mind that constant pressure charts are observed weather. Upper air prognostic charts (next section) show expected changes and may be more relevant at your flight time.

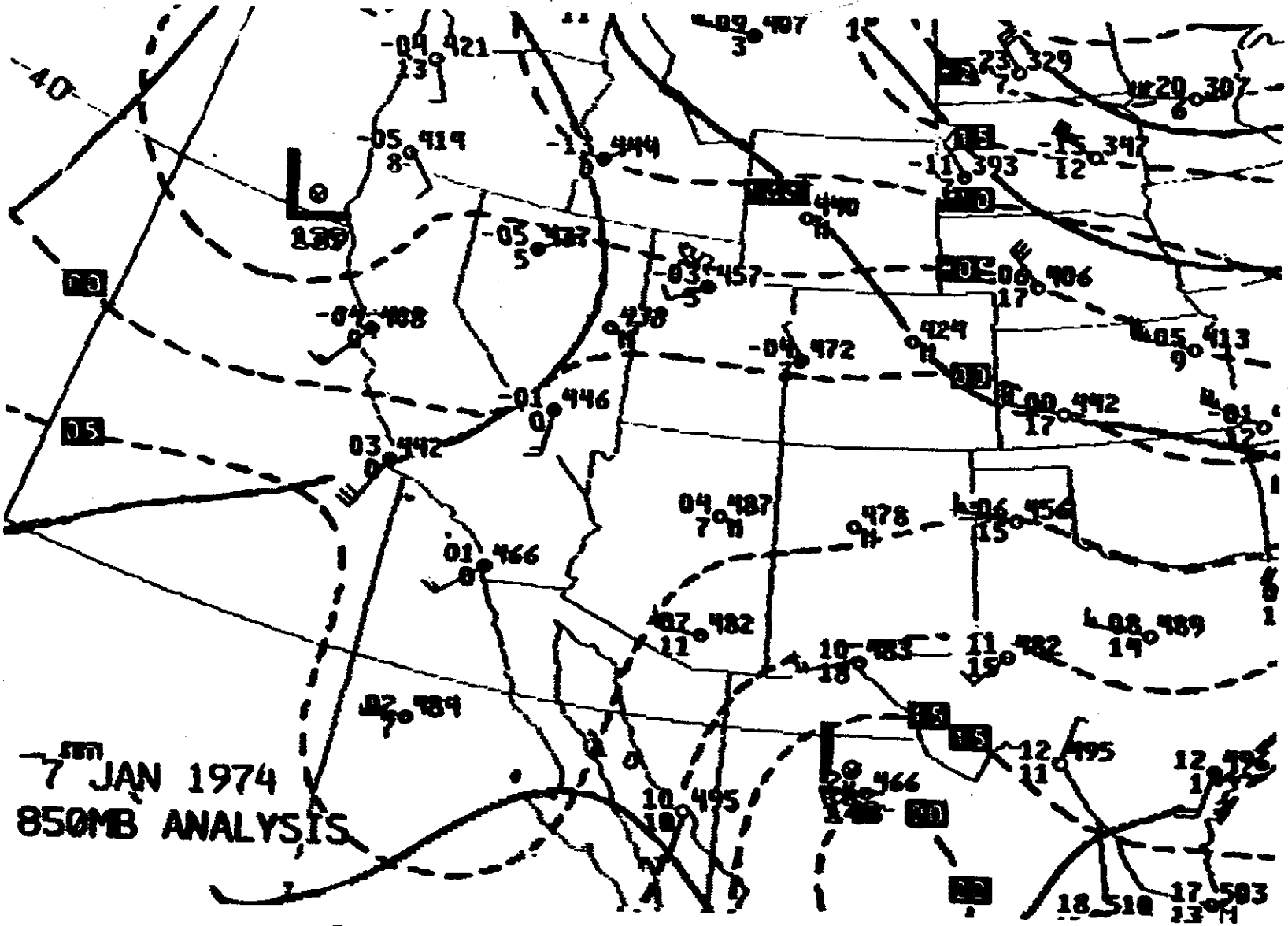


FIGURE 13-2. A section of an 850-millibar analysis, pressure altitude 5,000 feet.

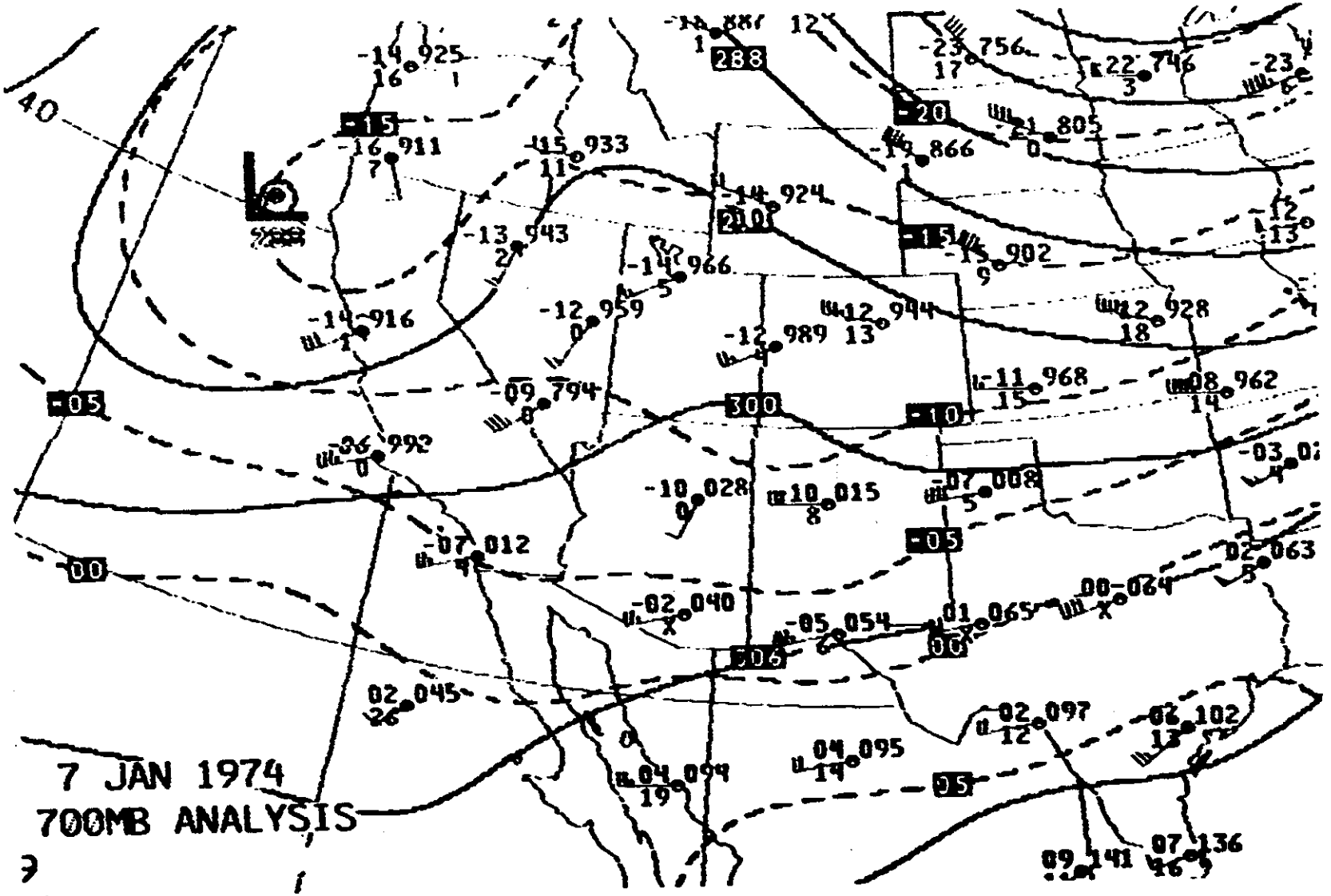


FIGURE 13-3. A section of a 700-millibar analysis, pressure altitude 10,000 feet.

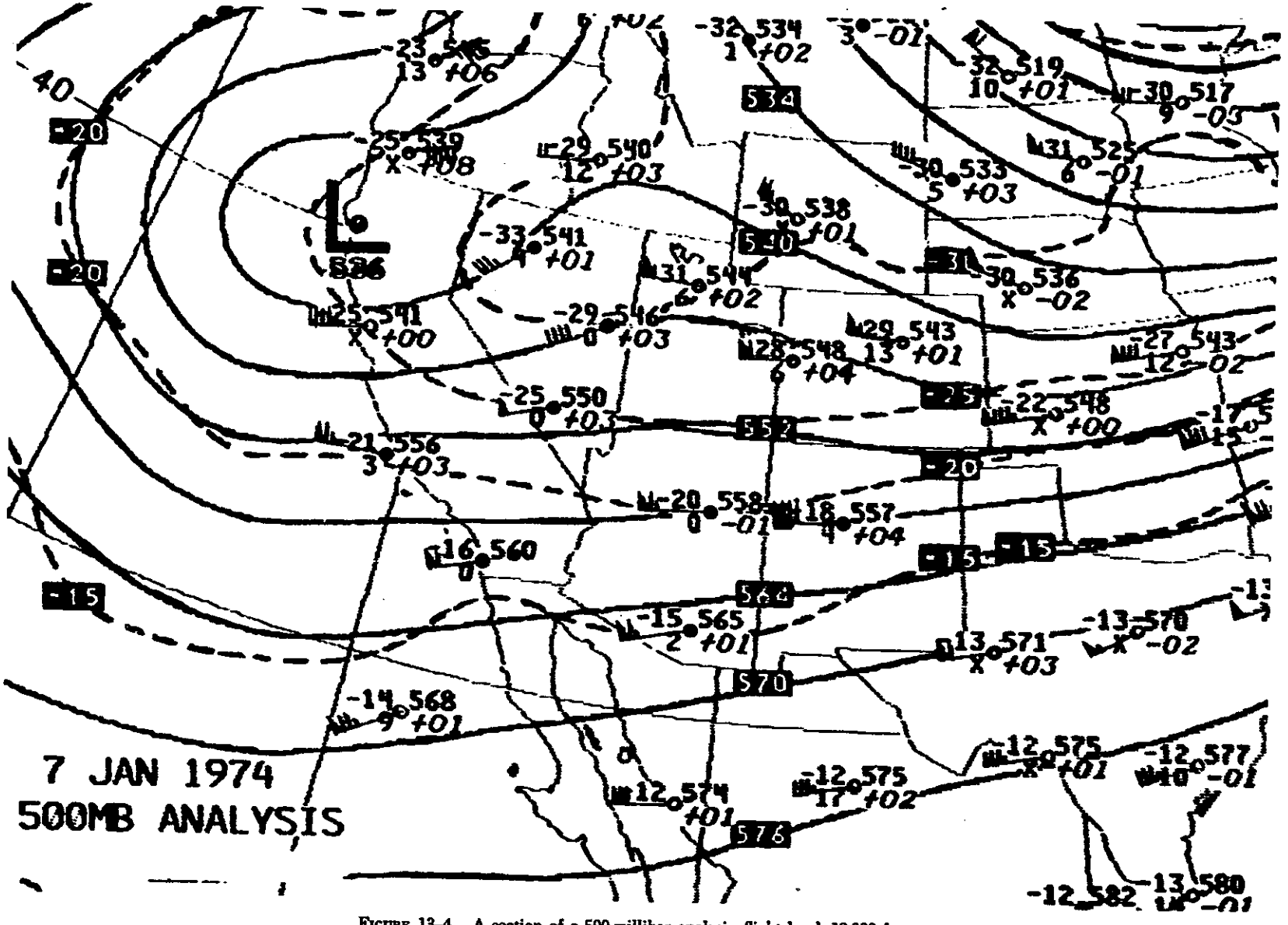


FIGURE 13–4. A section of a 500-millibar analysis, flight level, 18,000 feet.

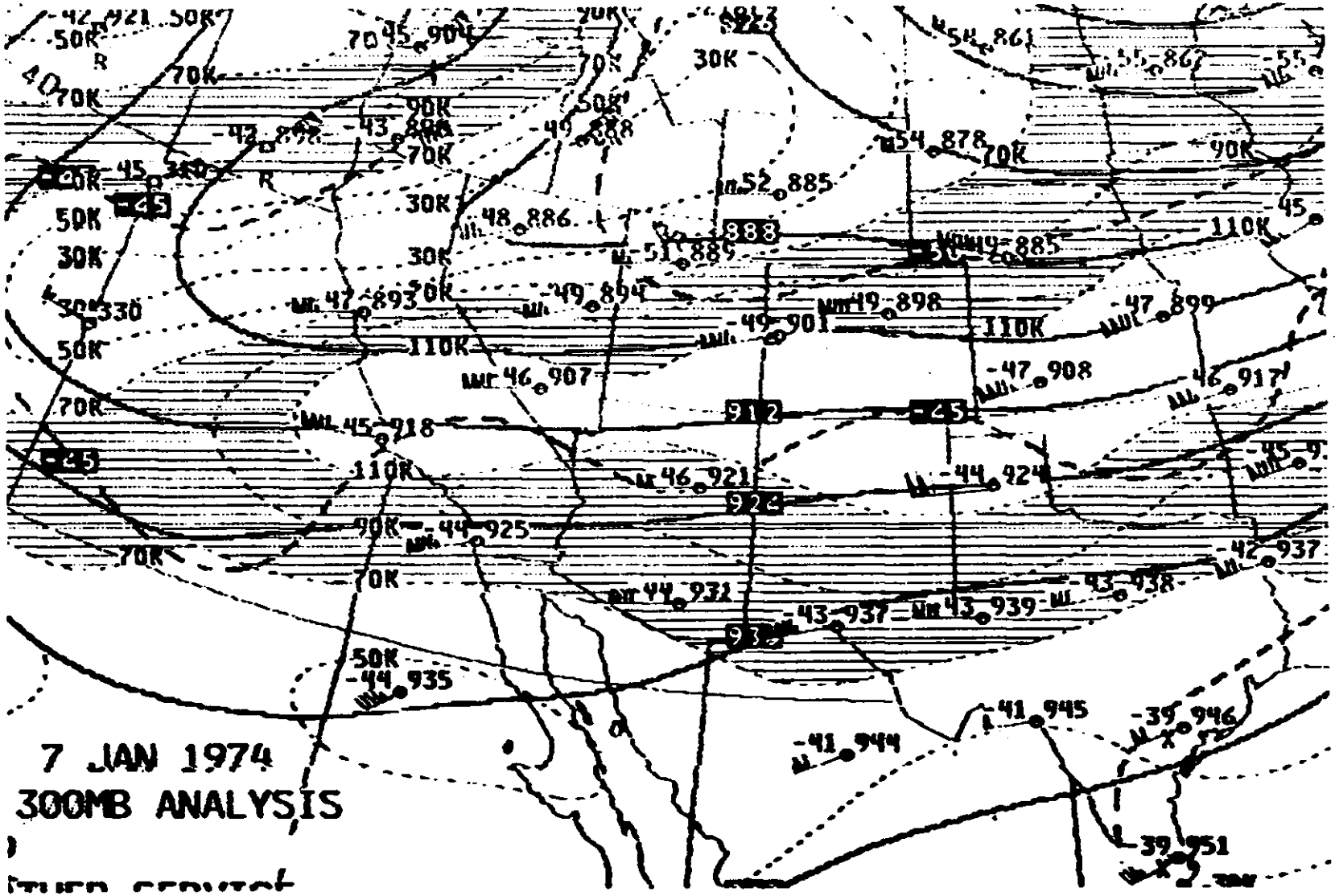


FIGURE 13-5. A section of a 300-millibar analysis, flight level, 30,000 feet.

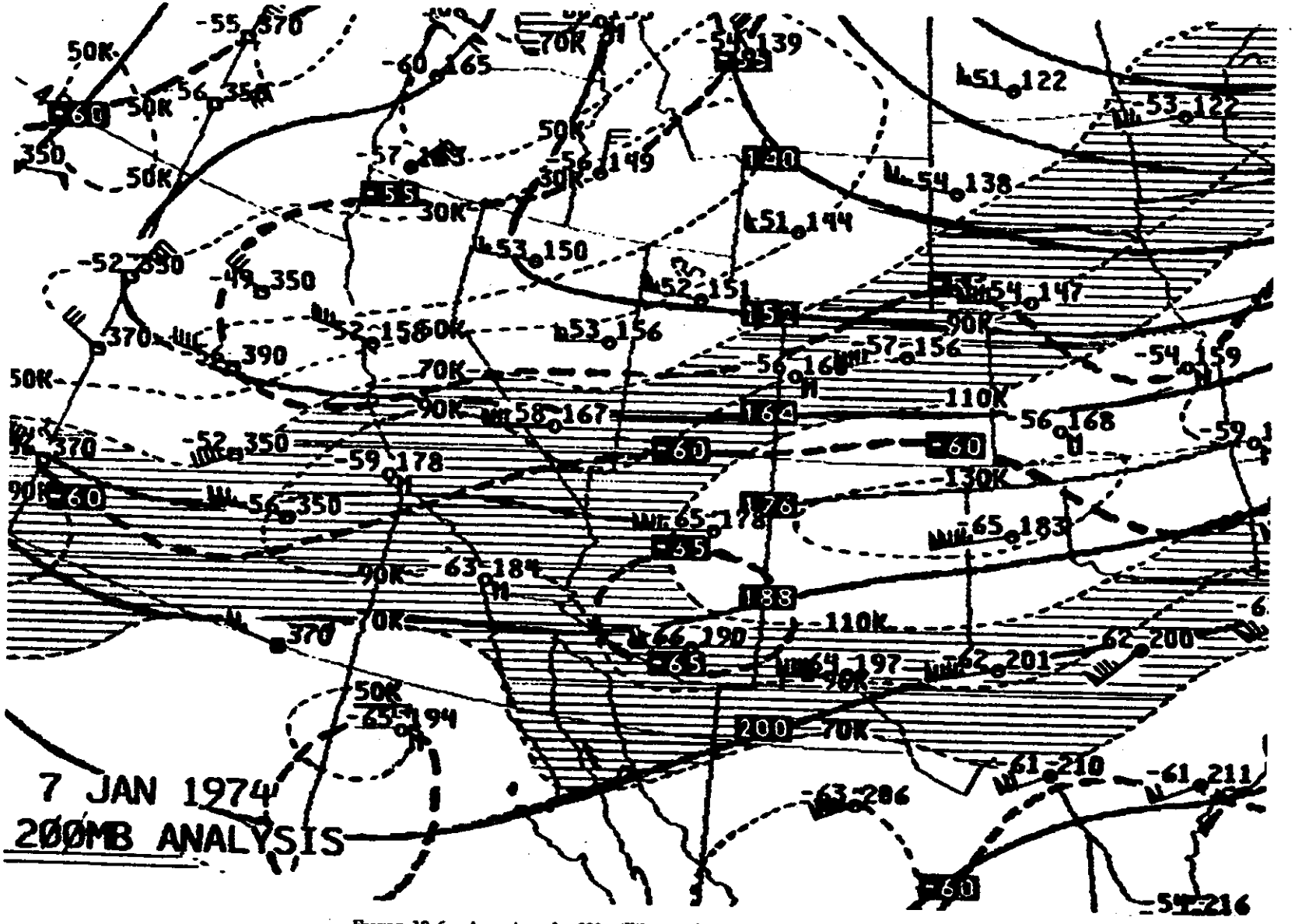


FIGURE 13–6. A section of a 200-millibar analysis, flight level, 39,000 feet.

Section 14

CONSTANT PRESSURE PROGNOSTICS

Constant pressure prognostic charts are computer prepared for the same standard levels as the analyses discussed in section 13. Progs are issued for large geographical areas. Some are primarily for the meteorologist while others are specifically for international flight documentation. Format varies slightly with different computer techniques. 850- and 700-millibar progs normally are not prepared for flight documentation, but a briefer may use them on occasion during preflight briefing. A legend on each prog identifies pressure surface and valid time; and on some charts, a legend along the side shows a few of the parameters depicted on the chart.

HEIGHT CONTOURS/STREAMLINES

Each chart has either height contours or streamlines. These solid lines show forecast positions of upper highs, lows, troughs, and ridges. Charts on polar stereographic projections have contours with heights labelled in meters. Charts on Mercator projections have streamlines (lines parallel to wind direction); streamlines are not labelled.

TEMPERATURE

The forecast temperature field is indicated either by isotherms at 5° C intervals or by encircled "spot" temperatures in sufficient density to delineate the thermal field. Some hemispheric progs do not show the temperature field.

WINDSPEED

Windspeed is shown by isotachs drawn for 20-knot intervals for speeds from 10 knots to 130 knots and at 40-knot intervals for speeds stronger than 130 knots. On hemispheric progs, areas of windspeed from 70 knots to 110 knots are hatched to aid in identifying strong winds. A clear area inside an area of hatching indicates speeds stronger than 110 knots. No hatching is used on larger scale charts prepared for flight documentation.

In addition to isotach windspeed at the constant pressure surface, some 500- and 300-millibar progs also show "spot" winds at levels other than the chart level:

Chart Level	*Winds at*
500 mb	400 mb
300 mb	250 mb

Thus, forecast winds are also presented for FL240 and FL340. These winds are depicted by arrows and flags as on winds aloft charts.

FORMATS

A brief look at some different formats will help you use the charts. When given a constant pressure prog, you should be able to interpret the chart using this discussion and the legend on the chart.

Figure 14–1 is a section of a 500-millibar hemispherical prog. This format is used on some hemispherical 300- and 200-millibar progs also. Note that the chart has only contours and isotachs. Contours and high and low centers are labelled in meters as shown in table 14–1. Isotachs are labelled in knots. Note also that areas of wind greater than 70 knots are shaded.

Figure 14–2 illustrates the format of a constant pressure prog on a polar stereographic projection. This format is used on 500- and 300-millibar progs prepared for international flight documentation. Open figures are used to label contours and high and low centers in meters as shown in table 14–1. Isotachs are labelled in knots using dark squares with white figures. Spot temperatures at the pressure surface are circled. Figure 14–3 is a section of a 300-millibar prog in this format. This particular chart has no spot winds for 250 millibars, but some 300-millibar progs do.

Figure 14–4 illustrates the format of a 200-millibar prog on a Mercator projection. Light solid lines are streamlines and are unlabelled. Heavy solid lines are height contours of the tropopause and are labelled in flight levels. Note the heavy line labelled "FL450" meaning the tropopause along this line is at flight level 45,000 feet (150 millibars). Temperatures at the 200-millibar surface are circled and temperatures of the tropopause are in rectangles. Spot winds on the 200-millibar prog are also for 200 millibars and conform to the streamline and isotach patterns. Figure

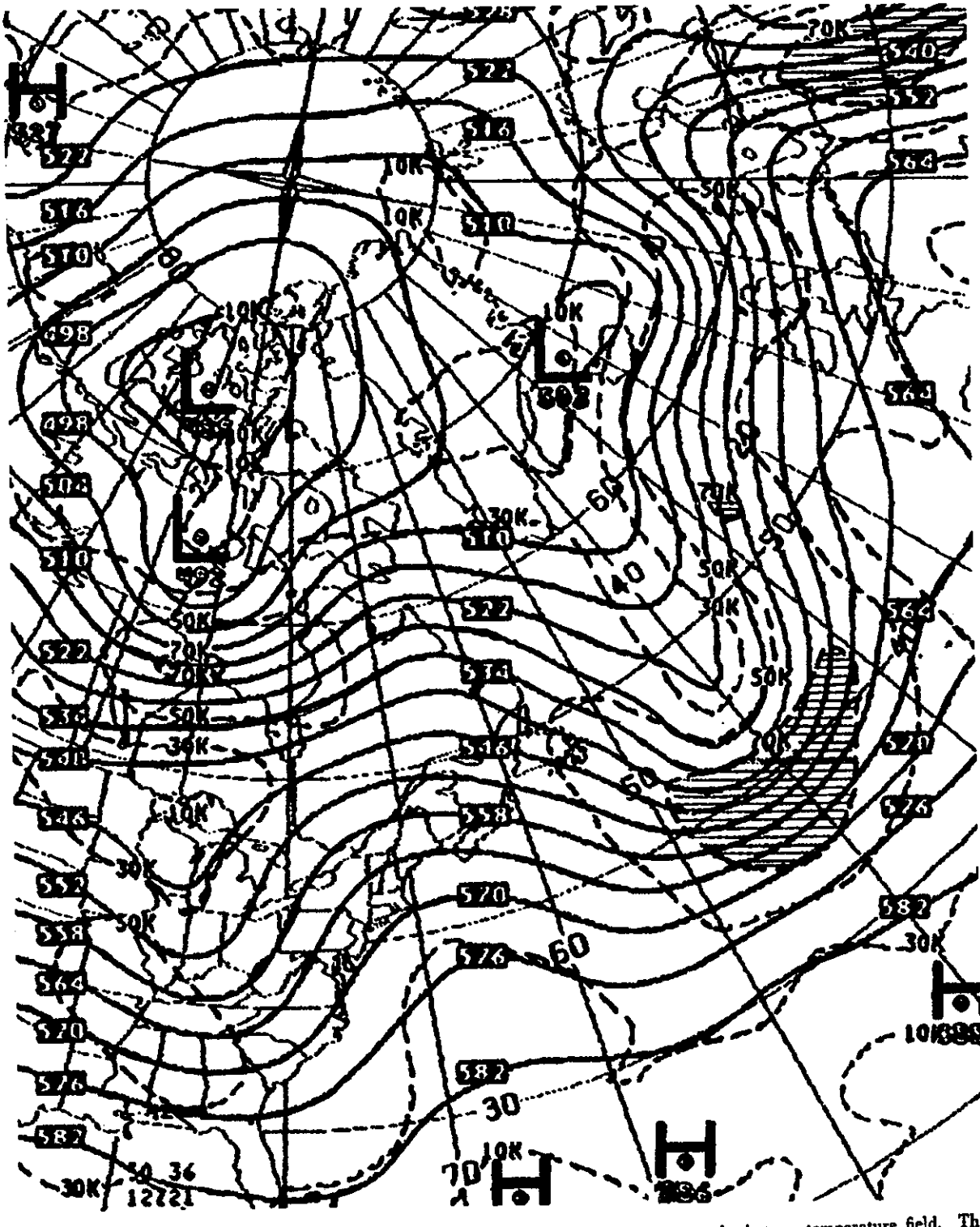


FIGURE 14–1. A section of a hemispheric 500-millibar prog with contours and isotachs but no temperature field. This format is used on hemispheric 300- and 200-millibar charts also. Hatching shows wind between 70 and 110 knots.

TABLE 14-1. Height labelling of contours and of high and low centers

Pressure in millibars	Flight level in feet	Approx. height in meters	Prefix to labelled value	Suffix to labelled value	Examples	
					Labelled	Height in meters
850	5,000	1,500	1	---	444	1,444
700	10,000	3,000	2 or 3*	---	288	3,288
500	18,000	5,500	---	0	582	5,820
300	30,000	9,000	---	0	948	9,480
200	39,000	12,000	1	0	205	12,050

* Prefix a "2" or "3" whichever brings the height closer to 3,000 meters.

14-5 is a section illustrating a 200-millibar prog prepared for international flight documentation.

A combination prog is prepared for the North Pacific between the Western U.S. coast and eastern Asia. It includes a 300-millibar prog and a tropopause wind shear prog (explained in section 15). The progs are in the same formats, but are sent as a single transmission in two panels.

USING THE CHARTS

Use a constant pressure prog primarily to extract forecast wind and temperature for flights within plus or minus 6 hours of the valid time of the chart. A constant pressure prog shows expected movements of weather systems; and you may compare it with any type of prog having the same valid time to get a three dimensional picture of expected weather.

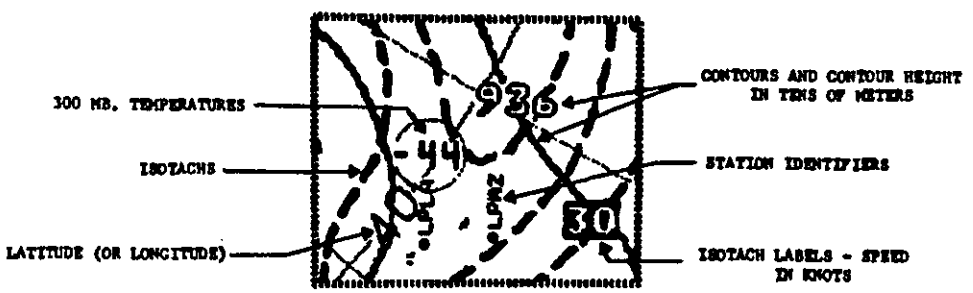


FIGURE 14-2. Format of a 300-millibar prog prepared on a polar stereograph projection. Contours are labelled in meters (open figures). Isotachs are labelled in knots. Temperatures are circled. The same format is used on some 500-millibar progs.

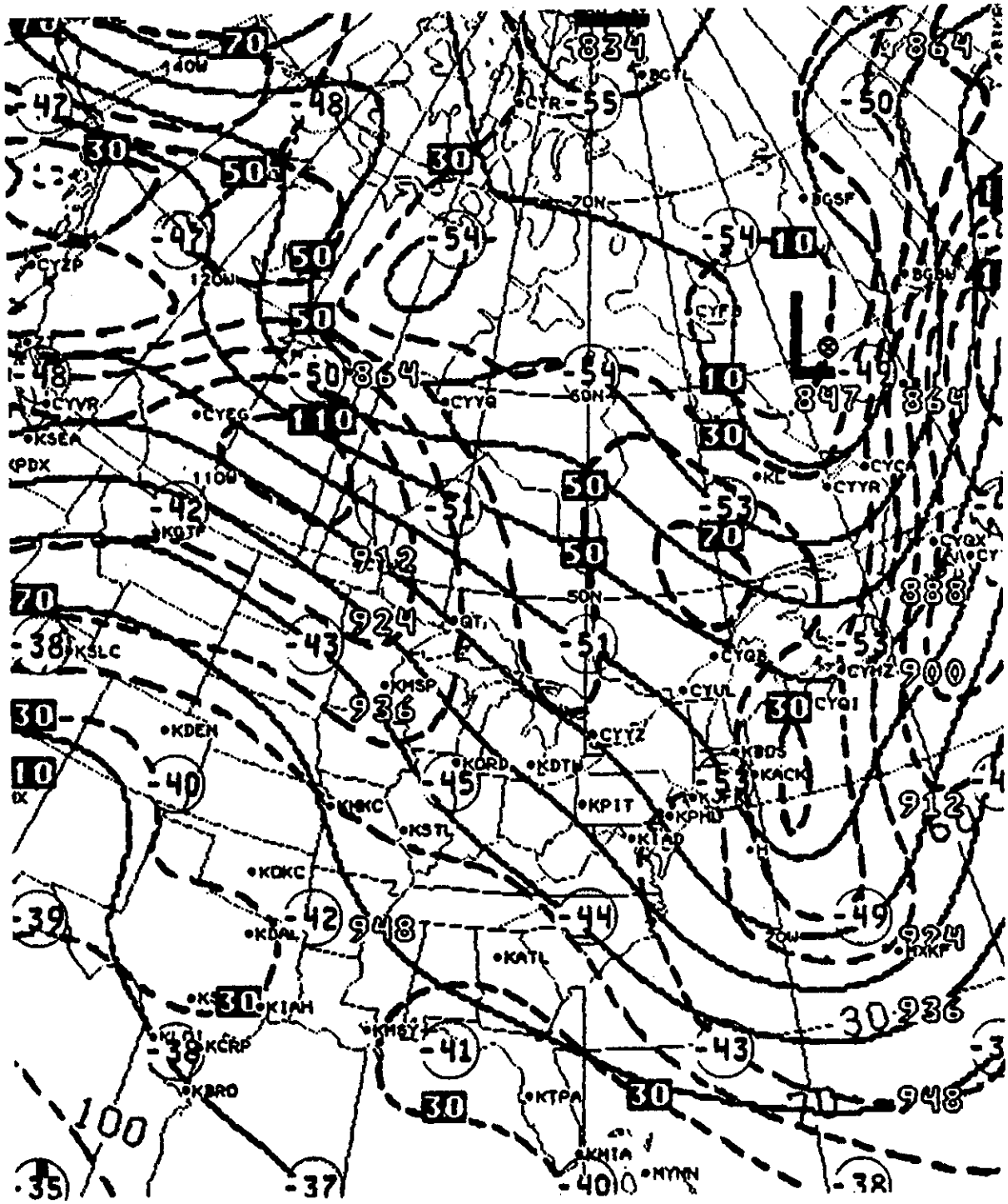


FIGURE 14-3. A section of a 300-millibar prog for international flight documentation. See figure 14-2 for explanation. Some 300-millibar progs show spot winds for 250 millibars.

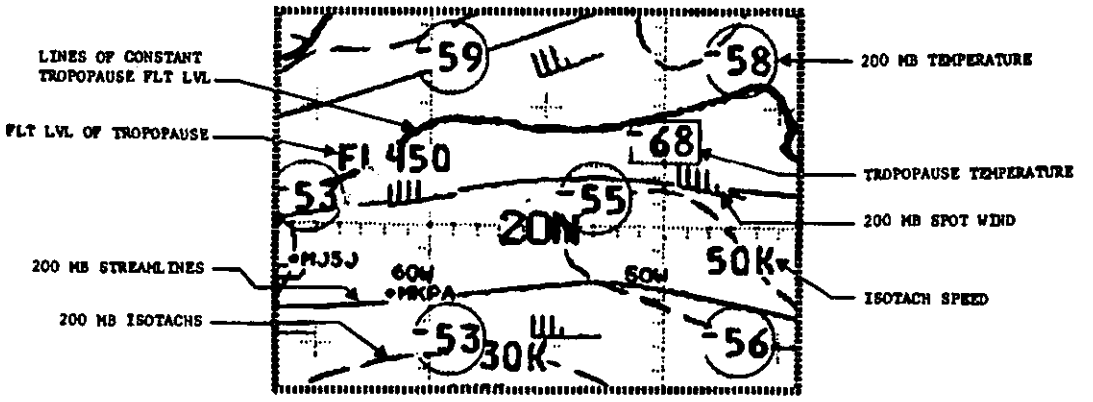


FIGURE 14–4. Format of a 200-millibar prog prepared on a Mercator projection. Heavy lines are lines of constant flight level of the tropopause. Light solid lines are streamlines and are unlabelled. 200-millibar temperatures are circled. Tropopause temperatures are in rectangles. Spot winds are also for the 200-millibar surface.

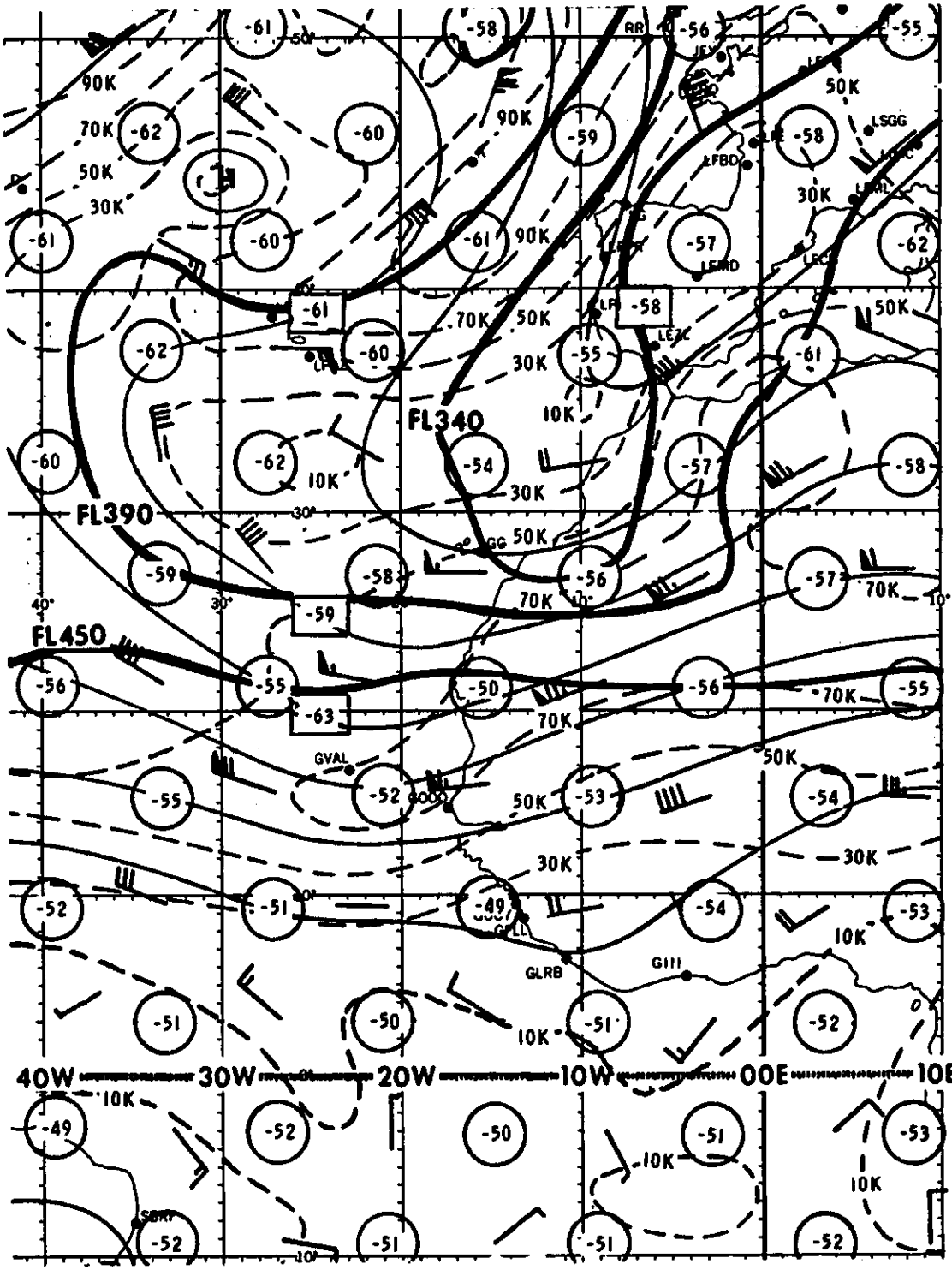


FIGURE 14–5. A section of a 200-millibar prog for international flight documentation.

Section 15

TROPOPAUSE, MAX WIND, AND WIND SHEAR CHARTS

A chart of the observed tropopause is prepared for the contiguous 48 States. A maximum wind prog and vertical wind shear prog, both associated with the tropopause, are prepared also for the 48 States. Tropopause/vertical wind shear progs are prepared for international flights.

OBSERVED TROPOPAUSE CHART

The observed tropopause chart shows for each upper air observing station the pressure, temperature, and wind at the tropopause. Figure 15–1 shows the chart with Albuquerque, New Mexico (ABQ) identified to aid in explaining the station model. Decode the plotted data at Albuquerque as follows: tropopause wind, 240° at 115 knots; tropopause temperature, −61° C; tropopause pressure, 200 millibars.

Using the Chart

Maximum wind occurs near the tropopause, so this chart is essentially a chart of observed maximum winds. A close inspection of the chart reveals a jet stream from central New Mexico across southeastern Kansas, central Missouri, and southern Illinois to West Virginia. The reason wind data are missing over Oklahoma, eastern Kansas, and Illinois is that strong winds carried the radiosonde instruments too far from observing stations to obtain reliable wind data. This area of missing wind data is actually the area of strongest winds in the jet stream.

From the chart you can determine wind and temperature at the tropopause. You can then use constant pressure progs or the FD winds and temperatures aloft forecast to interpolate for a flight level between a constant pressure level and the tropopause.

DOMESTIC TROPOPAUSE WIND AND WIND SHEAR PROGS

Forecast parameters at the tropopause over the contiguous 48 States and some adjoining oceanic and North American areas are shown on two charts—the *tropopause winds* and the *tropopause height/vertical wind shear progs.*

Tropopause Winds

The tropopause winds prog, figure 15–2, depicts wind direction by streamlines—solid lines. Streamlines have no dimensions and are unlabelled; they are in sufficient density to show the direction field. Direction of the streamline basically is from west to east in mid latitudes. A high or low may be encircled by a closed streamline; you can readily determine whether it is a high or low, and you know the circulation around these systems.

Windspeed is shown by isotachs at 20-knot intervals—dashed lines in figure 15–2. They are labelled in knots. Areas of windspeeds between 70 and 110 knots are hatched as are windspeeds between 150 and 190 knots. The shading criteria are the same as used on selected constant pressure analyses and progs.

Tropopause Height/Vertical Wind Shear

The tropopause height/vertical wind shear prog, figure 15–3, depicts height of the tropopause in millibars and vertical wind shear in knots per 1,000 feet. Solid lines trace intersections of the tropopause with standard constant pressure surfaces. The intercepts are labelled in millibars by white letters in dark rectangles. Since a line on a constant pressure surface is also a line of constant pressure altitude, the isopleths are also lines of constant flight level (see chapter 3, AVIATION WEATHER, discussion of Pressure Altitude). Following is a listing of pressures and corresponding flight levels:

Millibars	*Flight Level*
500	18,000
450	21,000
400	24,000
350	27,000
300	30,000
250	34,000
200	39,000
150	45,000

Vertical wind shear is in knots per 1,000 feet depicted by dashed lines at 2-knot intervals. Wind shear is averaged through a layer from about 8,000 feet below to 4,000 feet above the tropopause.

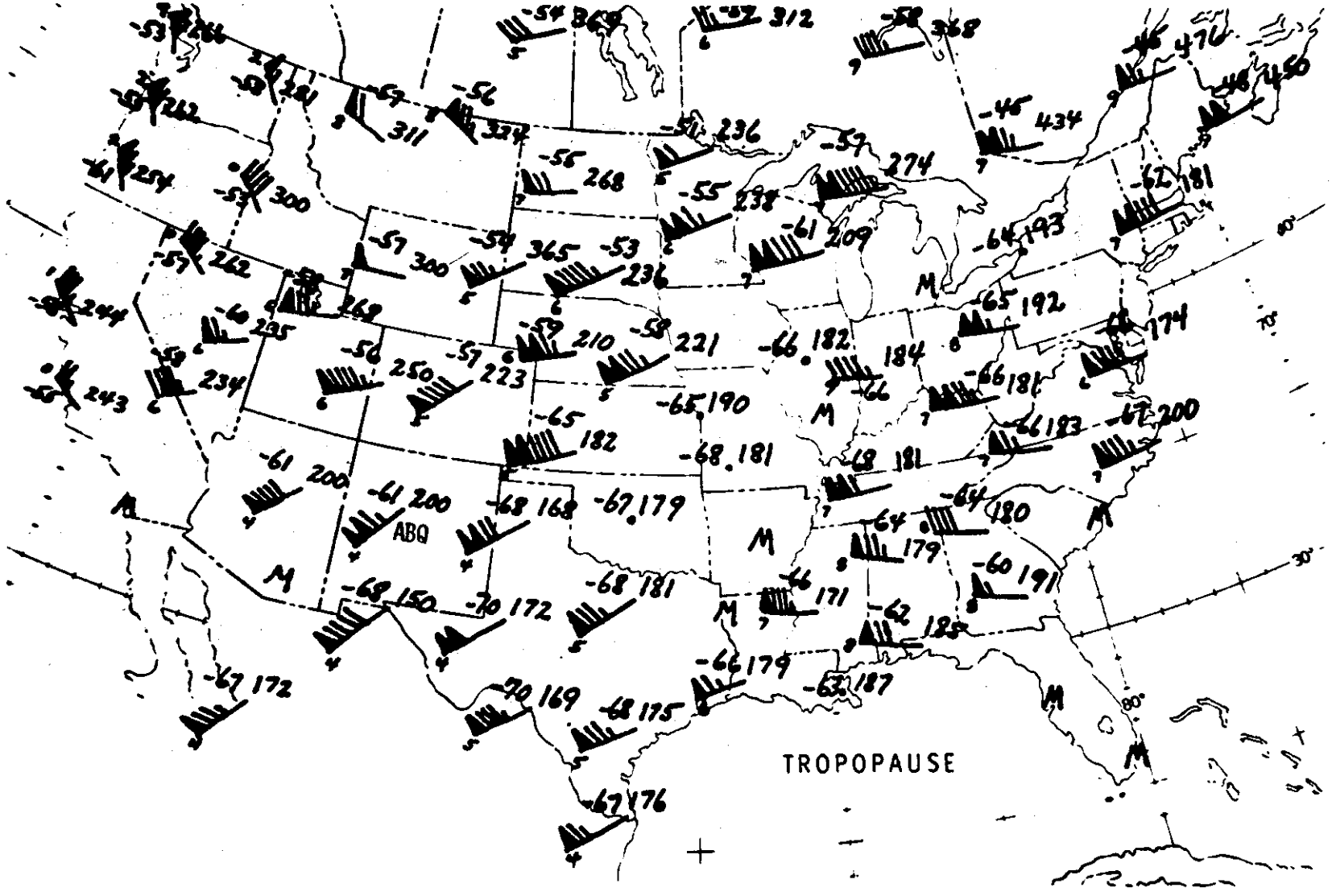


FIGURE 15–1. An observed tropopause chart.

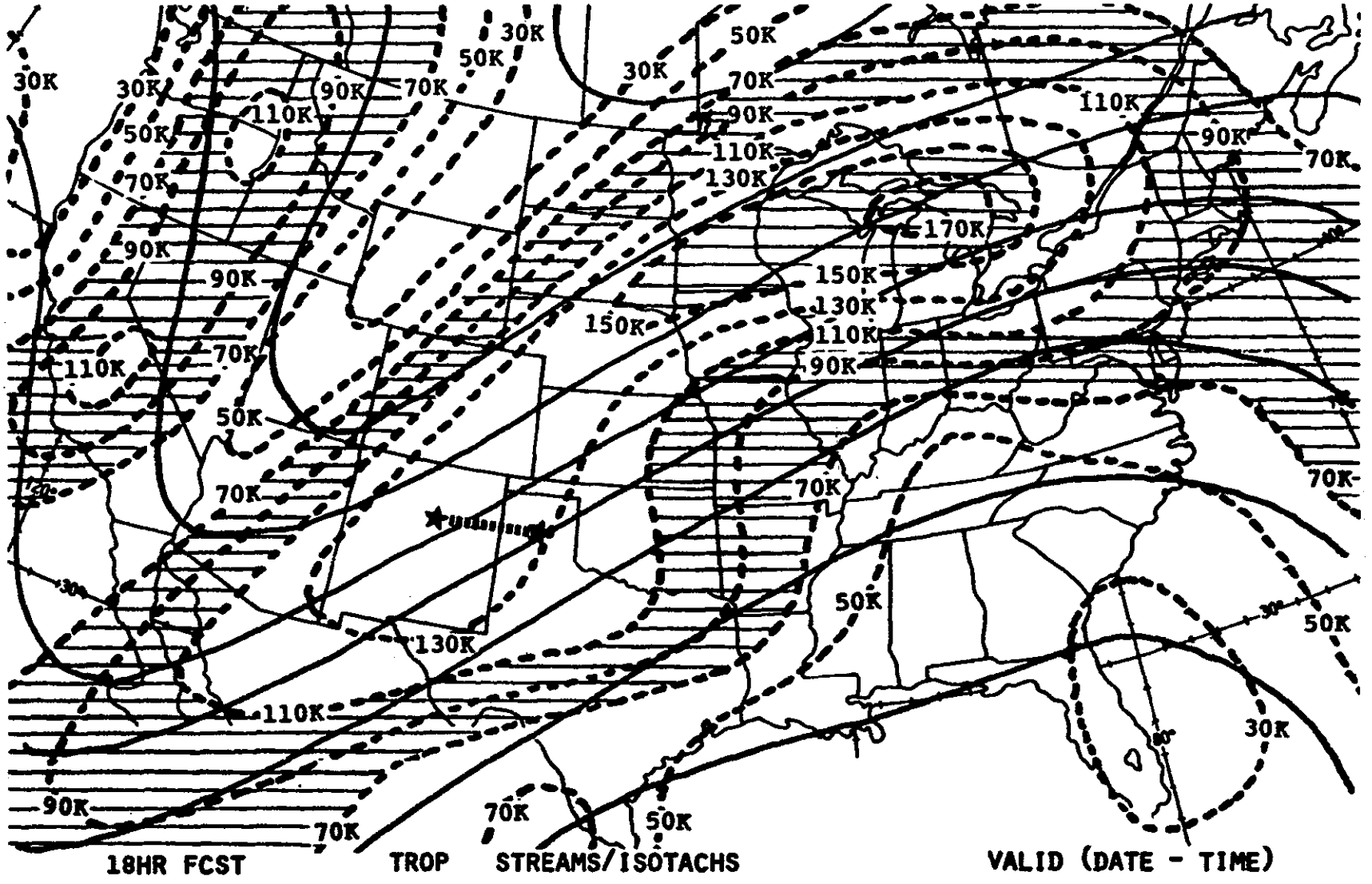


FIGURE 15-2. Section of a tropopause wind prog.

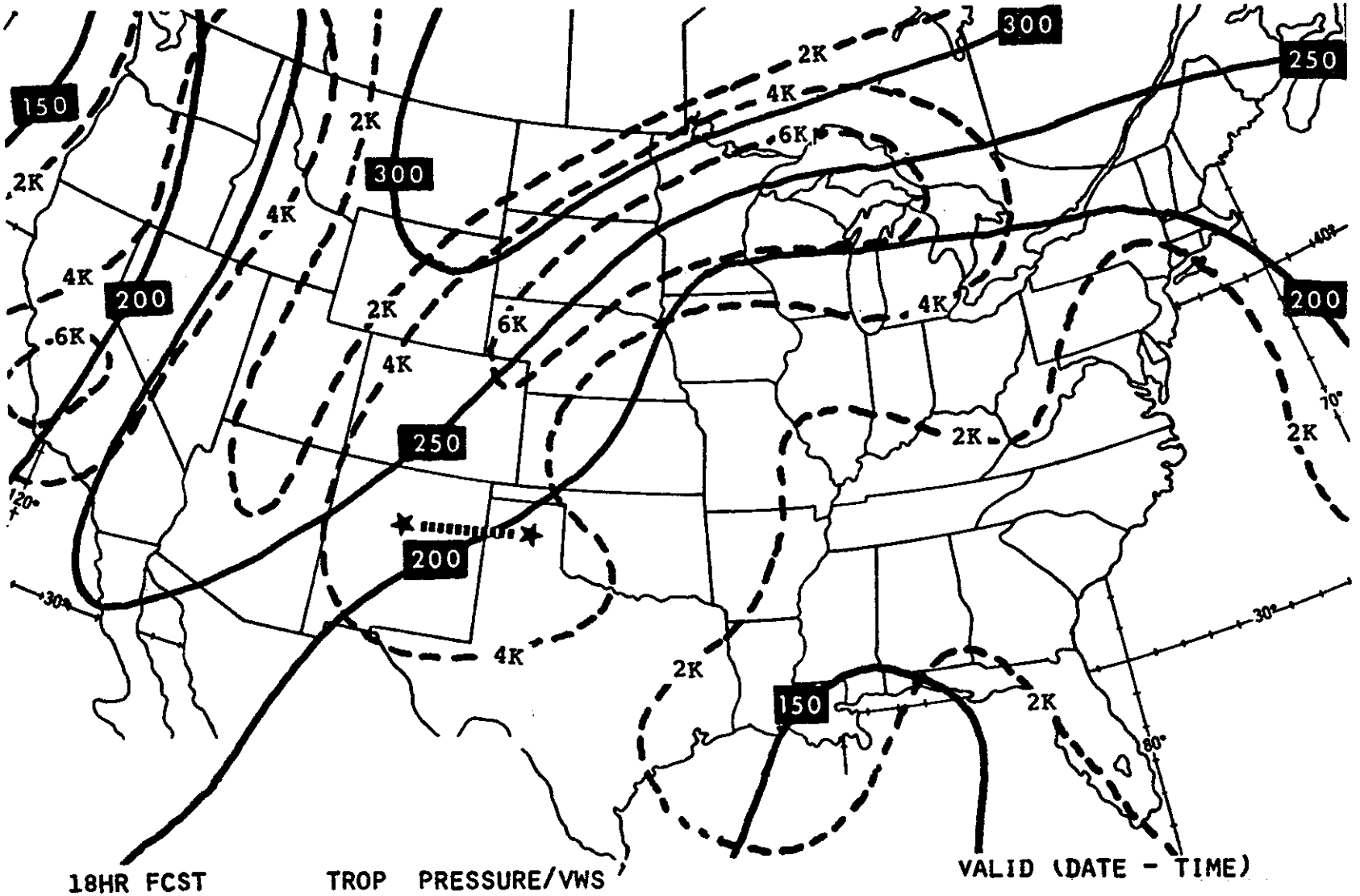


FIGURE 15-3. Section of a tropopause height/vertical wind shear prog.

Using the Charts

The progs are issued twice daily and may be used for a period up to plus or minus 6 hours from the valid time. The charts may be used to determine vertical and horizontal wind shears as clues to probable wind shear turbulence. They also may be used to determine winds for high level flight planning.

Although neither chart depicts the jet stream, locating the jet is not difficult. It passes through isotach and vertical shear maxima. It is well to examine both charts to get better accuracy than is likely if you use either chart alone. Examine figures 15–2 and 15–3; note a jet maximum from eastern Washington and Oregon extending southward and slightly westward through central California. It reappears near the southwest corner of the charts, enters the U.S. near the Arizona-New Mexico border, extends northeastward across central Nebraska, and then swings more easterly through the central Great Lakes and southern New England.

Horizontal wind shear can be determined from the spacing of isotachs. The horizontal wind shear critical for turbulence is 40 knots per 150 miles (see chapter 13, AVIATION WEATHER, discussion on clear air turbulence). 150 nautical miles is 2½° latitude.

Refer to figure 15–2 and measure 2½° latitude by laying a pencil along a meridian in the Atlantic. Move the pencil perpendicular to the isotachs across north central Montana, and you can see that the horizontal shear—the difference in windspeed—is about 40 knots along this distance. This spacing represents the wind shear critical for probable wind shear turbulence. The strong wind shear from southwestern Arizona to northwestern Minnesota suggests a probability of turbulence due to horizontal wind shear.

Vertical wind shear can be determined directly from the dashed lines in figure 15–3. The vertical shear critical for probable turbulence is 6 kt/1,000 ft. You find this critical value in central California and from western Nebraska to the Great Lakes. An area of extremely high probability of moderate or even hazardous turbulence is the three-State junction of the Dakotas and Minnesota where horizontal shear is about 80 kt/150 mi., and vertical shear is in excess of 6 kt/1,000 ft.

Wind direction and speed at the tropopause flight level may be read directly from the streamlines and isotachs. To determine wind at a flight level below or above the tropopause, first determine direction and speed at the tropopause. Wind direction changes very little within several thousand feet of the tropopause, so this direction may be used throughout the layer for which vertical wind shear is computed. Next determine wind shear and the number of thousands of feet the desired flight level differs from flight level of the tropopause. Multiply the shear by the thousands of feet and subtract this value from the speed at the tropopause.

As an example, let's assume a westbound flight wants the probability of turbulence and the wind for a leg from Amarillo to Albuquerque. Note from the charts in figures 15–2 and 15–3 that horizontal wind shear is negligible. Vertical wind shear is interpolated between the 4- and 6-knot shear lines and is about 5 kt/1,000 ft. Widespread significant turbulence is unlikely. (You should also refer to the high-level significant weather prog and pilot reports for further clues to turbulence.)

Wind direction along the route determined from the streamlines is about 230°—a quartering headwind. Speed is strongest at the tropopause; so for a westbound flight, choose a flight level as far as practical above or below the tropopause. Height of the tropopause determined from figure 15–3 is flight level 39,000 feet (200 millibars). Let's further assume that the high-level significant weather prog shows cirrus prevalent below the tropopause and you wish to stay clear of clouds. You would like to check the wind at 43,000 feet. From figure 15–2, you determine tropopause windspeed to be on the high side of the 130-knot isotach but quite a distance from the 150-knot isotach. Let's interpolate the speed as 135 knots. The flight level, 43,000 feet, is 4,000 feet above the tropopause. Multiply the 5-knot shear by 4, and you get a difference of 20 knots. Subtract 20 knots from 135, the speed at the tropopause, and you get a speed of 115 knots. Wind at FL430 is 230° at 115 knots.

INTERNATIONAL TROPOPAUSE AND WIND SHEAR PROGS

Tropopause and wind shear progs prepared for international flight documentation cover several areas to serve flights across the North Atlantic, the North and South Pacific, and the Caribbean. These progs are computer prepared for direct transmission by facsimile. They show flight level of the tropopause, mean vertical wind shear, and temperatures. Figure 15–4 shows a section of and figure 15–5 the format of a tropopause wind shear prog.

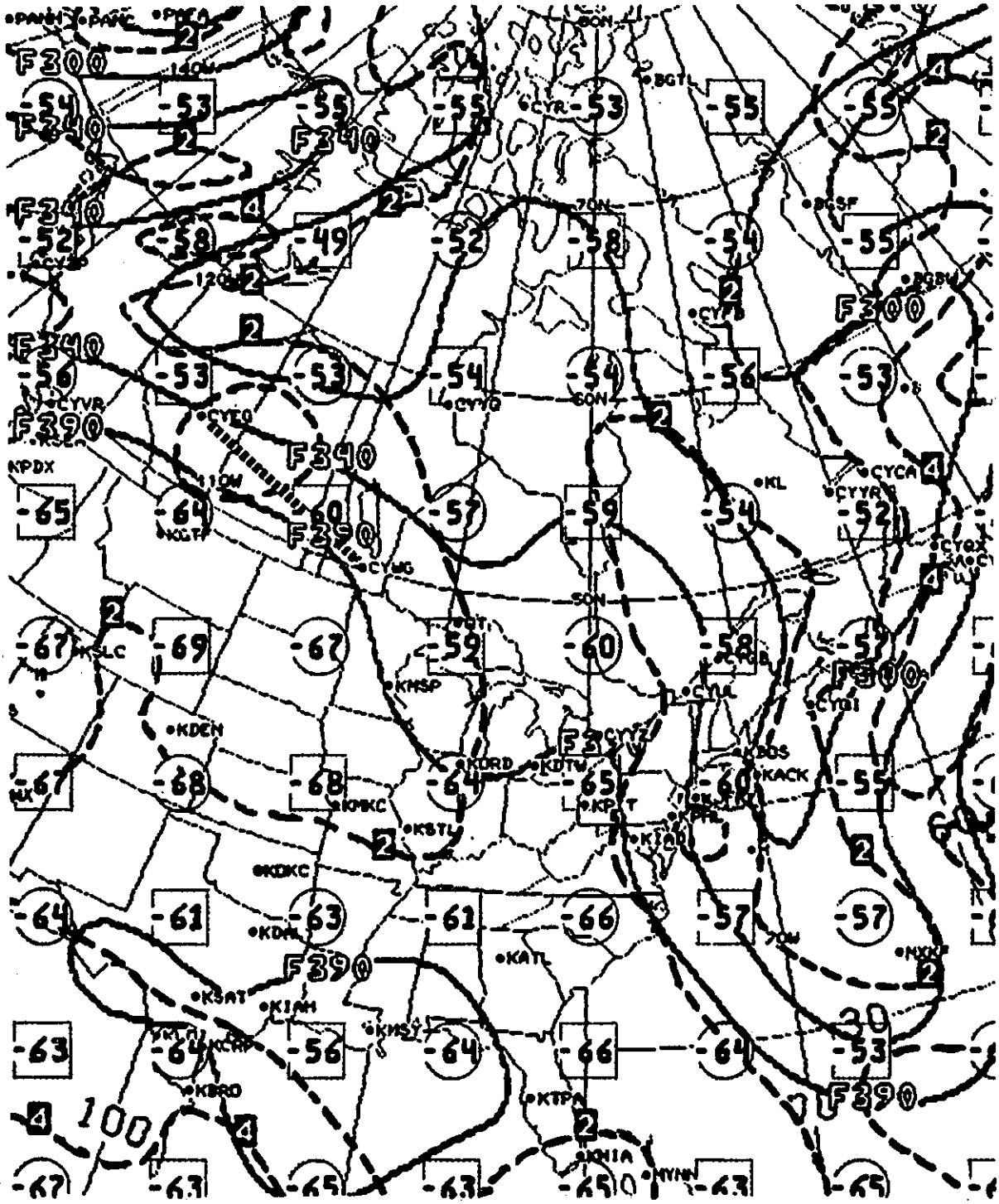


FIGURE 15-4. Western section of an international tropopause wind shear prog for the Atlantic. This section was chosen to show a geographical area with which the reader is most likely familiar.

Tropopause Flight Levels

Tropopause heights are in flight levels. Solid lines trace intersections of the tropopause with constant pressure surfaces. They are labelled as flight levels in hundreds of feet preceded by the letter "F". The figures are "open" to distinguish them from other labels. Note the line in figure 15–5 labelled "F390" and the several flight level labels along the upper left edge of figure 15–4.

Mean Vertical Wind Shear

Vertical wind shear is shown by dashed lines. Shear is in knots per 1,000 feet with dashed lines drawn at 2-knot intervals. Labels are dark squares with white numbers. Note in figure 15–5 the dashed shear line labelled "2" meaning a shear of 2 knots/1,000 feet. Wind shear is averaged through a layer from about 8,000 feet below to 4,000 feet above the tropopause.

Temperatures

Spot temperatures are entered for both the tropopause and for 150 millibars—flight level 45,000 feet (FL450). Tropopause temperatures are enclosed in squares; temperatures at FL450 are circled. Note how these are indicated in figure 15–5.

Using the Chart

When you are planning to fly at a level in the vicinity of the tropopause, you can often use the tropopause and wind shear prog together with constant pressure progs to compute winds and temperatures for your planned flight level. You can also use the chart when planning a flight above FL390, the highest constant pressure or flight level prog.

Both the rate of change of windspeed with height and the temperature lapse rate change abruptly at the tropopause. Therefore, you cannot interpolate *through* it; you must restrict each interpolation to airspace either *above* or *below* it. When both your flight level and the tropopause fall between two constant pressure prog levels, you must use the wind shear prog for interpolation.

When using the domestic wind shear prog, you worked upward or downward from the tropopause maximum wind. Since for this prog you have no maximum wind, you must work downward or upward from a constant flight level prog. To illustrate, let's assume you are returning from Alaska to Chicago O'Hare airport via Edmonton (CYEG) and Winnipeg (CYWG), Canada at FL370. Let's compute wind and temperature for the leg from CYEG to CYWG. This segment is shown by the heavy dotted line on figure 15–4.

The tropopause over CYEG is at FL340 and over CYWG, near FL390. Obviously at FL370, you will fly through the tropopause during this leg of your flight. Figure 15–6 is a cross section of the route to assist you in following the computation.

The constant pressure prog nearest your flight level is 200 millibars (FL390), 2,000 feet above your flight level. We begin in our computation by extracting wind direction and speed from the FL390 prog at CYEG, at CYWG, and at a point about midway between where you will fly through the tropopause. Assume we determined the 39,000-foot (200 millibar) winds to be:

CYEG	280° at 75 knots,
Midpoint	290° at 95 knots,
CYWG	300° at 100 knots.

Next we get wind shear for the three points from figure 15–4. Note a line of constant wind shear near CYEG and encircling the first half of the route. The line is unlabelled. However, the steeply sloping tropopause through the area suggests a maximum wind shear. Also, to the north of CYEG, we see a 4-knot shear on the same side of the 2-knot line. This unlabelled line, therefore, has to be 4 knots/1,000 ft. and is the shear at both CYEG and midpoint. CYWG lies about half way between the 4- and 2-knot shear lines, so we interpolate shear over CYWG at 3 knots/1,000 ft.

Now let's compute wind at FL370 for each point starting with CYEG. Look at figure 15–6 and note that your flight level is between the tropopause and FL390. Therefore, expect stronger wind at FL370 than at FL390. Multiplying the shear (4 knots) by the altitude difference in thousands of feet (2), we get a speed difference of 8 knots. *Adding* this to wind at FL390, we get a wind over CYEG at FL370 of 93 knots from 280°. In the same manner we get a wind at midpoint of 290°, 103 knots. From figure 15–4, we see that the tropopause over CYWG for all practical purposes is at FL390, and this is also shown on the cross section of figure 15–6. Therefore, wind is at a maximum at FL390 and becomes less at FL370 as we get farther from the tropopause. Multiplying the shear (3 knots) by the altitude difference, we get a windspeed difference of 6 knots. *Subtracting* this difference from the 39,000 foot windspeed, we get a wind over CYWG at FL370 of 94 knots from 300°.

Now let's interpolate temperatures at FL370 for the same three points. Look again at figure 15–4 and note tropopause temperatures enclosed in

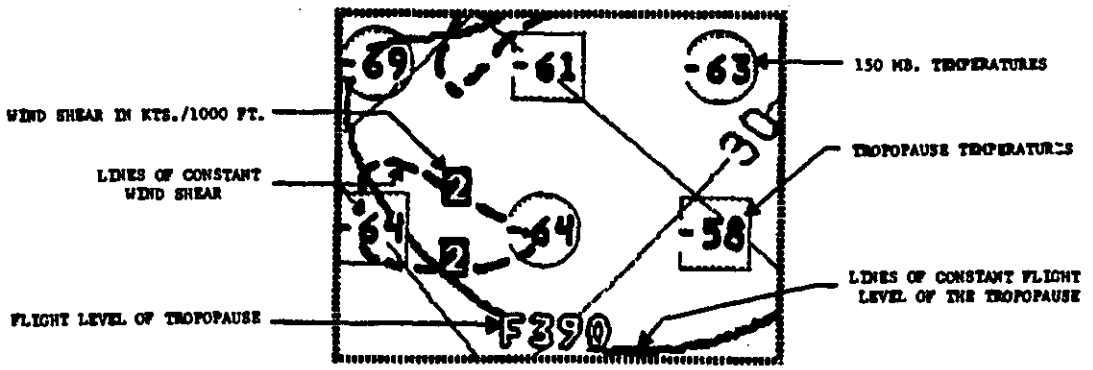


FIGURE 15-5. Format of the international tropopause wind shear prog.

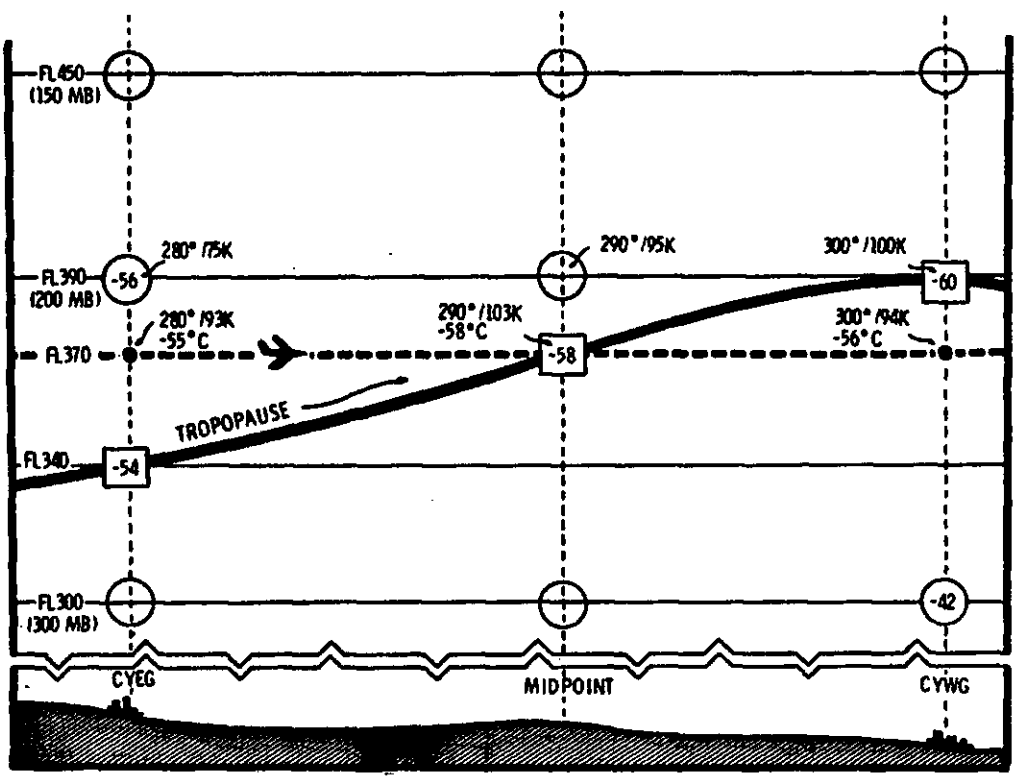


FIGURE 15-6. Cross section of a route from Edmonton, Canada to Winnipeg, Canada based on the prog in figure 15-4. It is used in figuring wind and temperature at flight level 37,000. Forecast temperatures are available at flight levels 30,000 and 39,000 from constant pressure progs and at 45,000 from the tropopause wind shear prog. Only the temperatures used in this computation are entered.

squares. Just northwest of CYEG, temperature is −53° C; and just northwest of CYWG, −60° C. From these values, we estimate tropopause temperatures as shown below and as entered in squares on the cross section in figure 15–6:

CYEG −54° C,
Midpoint −58° C,
CYWG −60° C.

Remember that lapse rate changes at the tropopause, so we cannot interpolate *through* it. Note in figure 15–6 how it is necessary to choose temperature at FL390 over CYEG and at FL300 over CYWG. These temperatures would come from the 200- and 300-millibar progs. At midpoint, you will be at the tropopause, so temperature at your flight level is the tropopause temperature, −58° C. Interpolating for FL370 at the other two points we get −55° C over CYEG and −56° C over CYWG.

Winds and temperatures for FL370 at:

CYEG 280° at 93 knots, −55° C,
Midpoint 290° at 103 knots, −58° C,
CYWG 300° at 94 knots, −56° C.

This example is complex since the flight is through the tropopause. In most cases, you can compute an average wind and temperature for a relatively long segment of a route.

Section 16
TABLES AND CONVERSION GRAPHS

This section provides graphs and tables you can use operationally in decoding weather messages during preflight and inflight planning and in transmitting pilot reports. Information included covers:

1. Icing intensities and reporting.
2. Turbulence intensities and reporting.
3. Locations of probable turbulence by intensity versus weather and terrain features.
4. Standard temperature, speed, and pressure conversions.
5. Density altitude computations.
6. Selected contractions and acronyms.

The table of *Icing Intensities* classifies each intensity according to its operational effects on aircraft.

The table of *Turbulence Intensities* classifies each intensity according to its effects on aircraft control and structural integrity and on articles and occupants within the aircraft.

The table of *Locations of Probable Turbulence* lists each turbulence intensity along with terrain and weather features conducive to turbulence of that intensity.

The graph for *Density Altitude Computations* provides a means of computing density altitude, either on the ground or aloft, using the aircraft altimeter and outside air temperature.

Contractions are used extensively in surface, radar, and pilot reports and in forecasts. Most of them are known from common usage or can be deciphered phonetically. The list of *Selected Contractions* contains only those most likely to give you difficulty. Acronyms used in this manual are defined in the list of *Acronyms*.

TABLE 16–1. Icing intensities, airframe ice accumulation, and pilot report

Intensity	*Airframe ice accumulation*	*Pilot report*
Trace	Ice becomes perceptible. Rate of accumulation slightly greater than rate of sublimation. It is not hazardous even though deicing/anti-icing equipment is not used unless encountered for an extended period of time—over one hour.	Aircraft identification, location, time (GMT), intensity and type of icing,* altitude/FL, aircraft type, IAS *Example of pilot's transmission:* Holding at Westminister VOR 1232. Light Rime Icing. Altitude six thousand, Jetstar IAS 200 kt
Light	The rate of accumulation may create a problem if flight is prolonged in this environment (over one hour). Occasional use of deicing/anti-icing equipment removes/prevents accumulation. It does not present a problem if the deicing/anti-icing equipment is used.	
Moderate	The rate of accumulation is such that even short encounters become potentially hazardous and use of deicing/anti-icing equipment or diversion is necessary.	
Severe	The rate of accumulation is such that deicing/anti-icing equipment fails to reduce or control the hazard. Immediate diversion is necessary.	

* Icing may be rime, clear, or mixed.

Rime ice: Rough milky opaque ice formed by the instantaneous freezing of small supercooled water droplets.

Clear ice: A glossy, clear or translucent ice formed by the relatively slow freezing of large supercooled water droplets.

Mixed ice: A combination of rime and clear ice.

TABLE 16-2. Turbulence reporting criteria

Intensity	*Aircraft reaction*	*Reaction inside aircraft*	*Reporting term-definition*
Light	Turbulence that momentarily causes slight, erratic changes in altitude and/or attitude (pitch, roll, yaw). Report as **Light Turbulence;*** or Turbulence that causes slight, rapid and somewhat rhythmic bumpiness without appreciable changes in altitude or attitude. Report as **Light Chop.**	Occupants may feel a slight strain against seat belts or shoulder straps. Unsecured objects may be displaced slightly. Food service may be conducted and little or no difficulty is encountered in walking.	Occasional — Less than ⅓ of the time. Intermittent — ⅓ to ⅔. Continuous — More than ⅔.
Moderate	Turbulence that is similar to Light Turbulence but of greater intensity. Changes in altitude and/or attitude occur but the aircraft remains in positive control at all times. It usually causes variations in indicated airspeed. Report as **Moderate Turbulence;*** or Turbulence that is similar to Light Chop but of greater intensity. It causes rapid bumps or jolts without appreciable changes in aircraft altitude or attitude. Report as **Moderate Chop.**	Occupants feel definite strains against seat belts or shoulder straps. Unsecured objects are dislodged. Food service and walking are difficult.	**NOTE** 1. Pilots should report location(s), time (GMT), intensity, whether in or near clouds, altitude, type of aircraft and, when applicable, duration of turbulence. 2. Duration may be based on time between two locations or over a single location. All locations should be readily identifiable. EXAMPLES: a. Over Omaha, 1232Z, Moderate Turbulence, in cloud, Flight Level 310, B707. b. From 50 miles south of Albuquerque to 30 miles north of Phoenix, 1210Z to 1250Z, occasional Moderate Chop, Flight Level 330, DC8.
Severe	Turbulence that causes large, abrupt changes in altitude and/or attitude. It usually causes large variations in indicated airspeed. Aircraft may be momentarily out of control. Report as **Severe Turbulence.***	Occupants are forced violently against seat belts or shoulder straps. Unsecured objects are tossed about. Food service and walking are impossible.	
Extreme	Turbulence in which the aircraft is violently tossed about and is practically impossible to control. It may cause structural damage. Report as **Extreme Turbulence.***		

* High level turbulence (normally above 15,000 feet ASL) not associated with cumuliform cloudiness, including thunderstorms, should be reported as CAT (clear air turbulence) preceded by the appropriate intensity, or light or moderate chop.

SC/AMS Meeting 7/67

Locations of Probable Turbulence by Intensities Versus Weather and Terrain Features

LIGHT TURBULENCE

1. In hilly and mountainous areas even with light winds.

2. In and near small cumulus clouds.

3. In clear-air convective currents over heated surfaces.

4. With weak wind shears in the vicinity of:

a. Troughs aloft.

b. Lows aloft.

c. Jet streams.

d. The tropopause.

5. In the lower 5,000 feet of the atmosphere:

a. When winds are near 15 knots.

b. Where the air is colder than the underlying surfaces.

MODERATE TURBULENCE

1. In mountainous areas with a wind component of 25 to 50 knots perpendicular to and near the level of the ridge:

a. At all levels from the surface to 5,000 feet above the tropopause with preference for altitudes:

(1) Within 5,000 feet of the ridge level.

(2) At the base of relatively stable layers below the base of the tropopause.

(3) Within the tropopause layer.

b. Extending outward on the lee of the ridge for 150 to 300 miles.

2. In and near thunderstorms in the dissipating stage.

3. In and near other towering cumuliform clouds.

4. In the lower 5,000 feet of the troposphere:

a. When surface winds exceed 25 knots.

b. Where heating of the underlying surface is unusually strong.

c. Where there is an invasion of very cold air.

5. In fronts aloft.

6. Where:

a. Vertical wind shears exceed 6 knots per 1,000 feet, and/or

b. Horizontal wind shears exceed 18 knots per 150 miles.

SEVERE TURBULENCE

1. In mountainous areas with a wind component exceeding 50 knots perpendicular to and near the level of the ridge:

a. In 5,000-foot layers:

(1) At and below the ridge level in rotor clouds or rotor action.

(2) At the tropopause.

(3) Sometimes at the base of other stable layers below the tropopause.

b. Extending outward on the lee of the ridge for 50 to 150 miles.

2. In and near growing and mature thunderstorms.

3. Occasionally in other towering cumuliform clouds.

4. 50 to 100 miles on the cold side of the center of the jet stream, in troughs aloft, and in lows aloft where:

a. Vertical wind shears exceed 6 knots per 1,000 feet, and

b. Horizontal wind shears exceed 40 knots per 150 miles.

EXTREME TURBULENCE

1. In mountain wave situations, in and below the level of well-developed rotor clouds. Sometimes it extends to the ground.

2. In growing severe thunderstorms (most frequently in organized squall lines) indicated by:

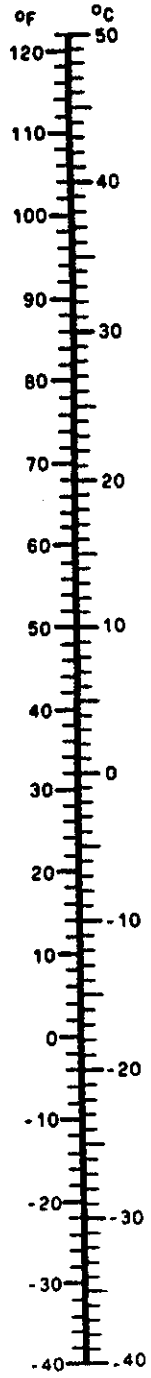
a. Large hailstones (¾ inch or more in diameter).

b. Strong radar echoes, or

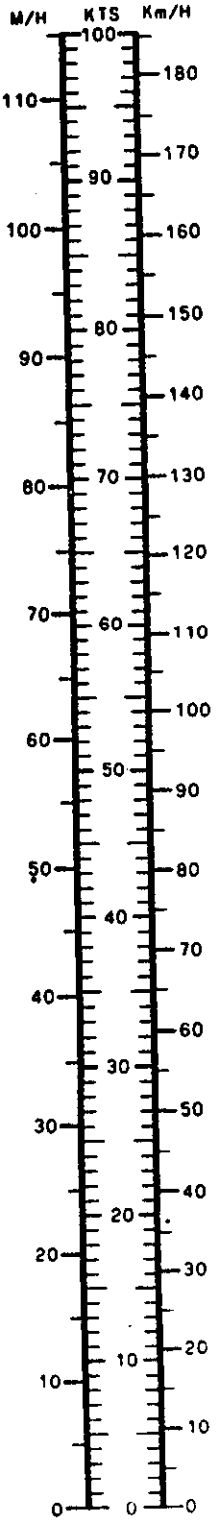
c. Almost continuous lightning.

STANDARD CONVERSIONS

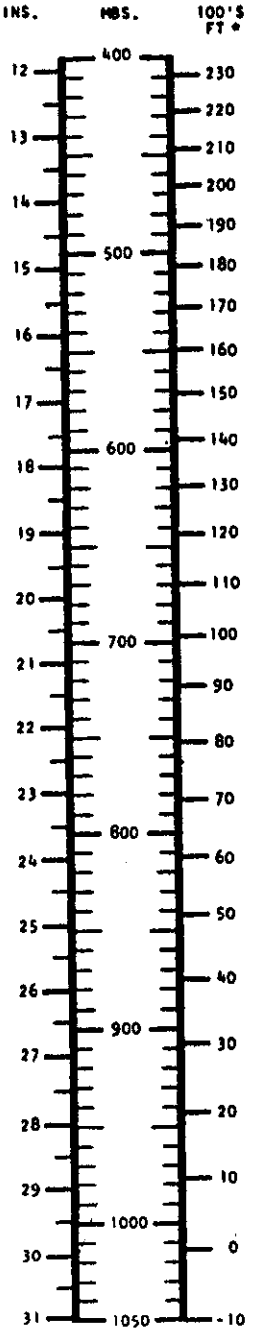
Tempera-ture



Speed-Distance

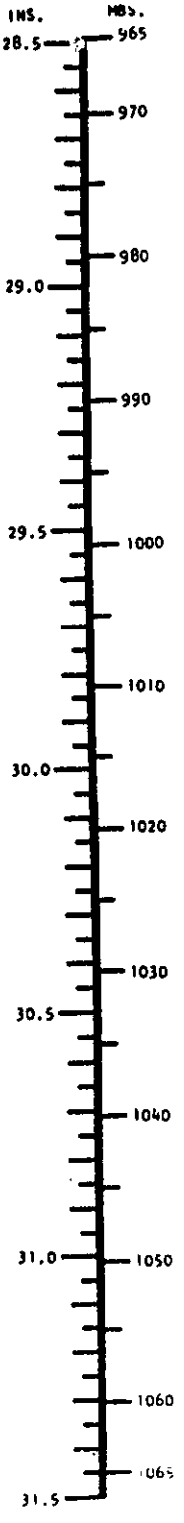


Pressure - Altitude

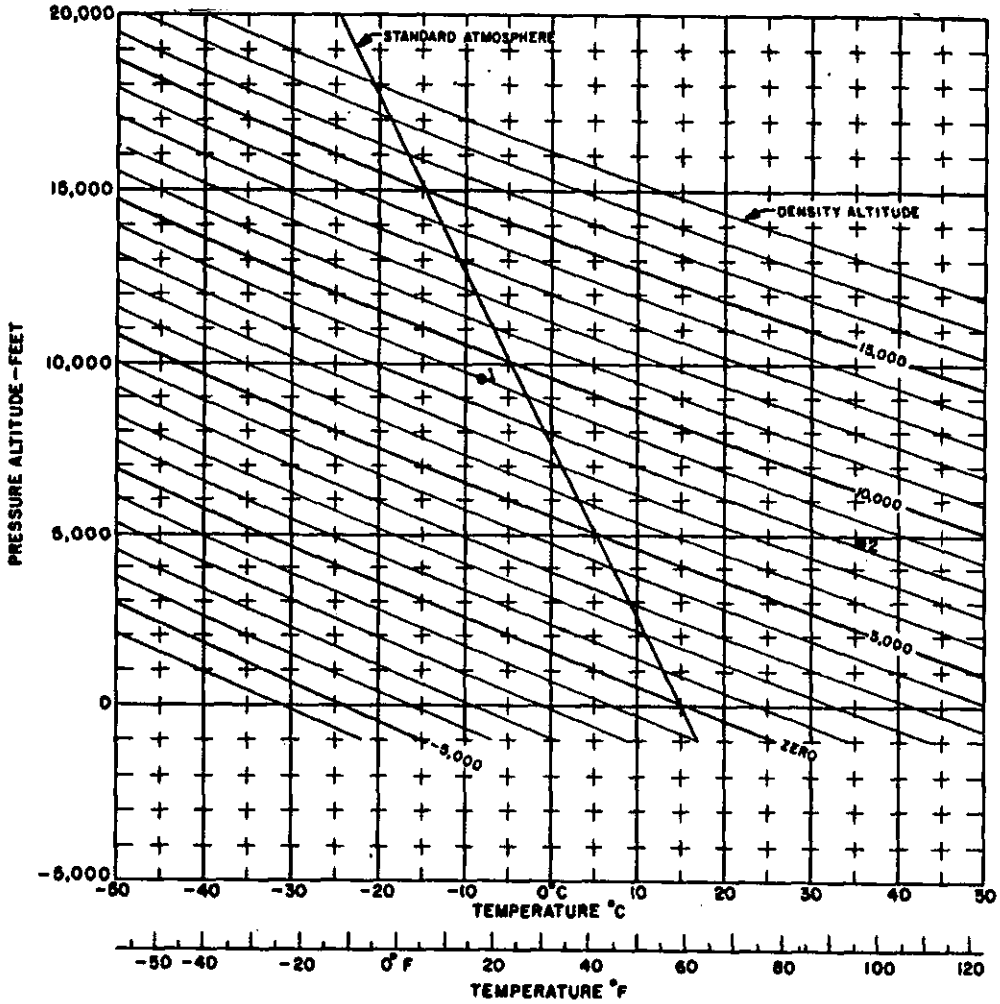


*Standard Atmosphere

Altimeter Setting



Density Altitude Computation



Use this graph to find density altitude either on the ground or aloft. Set your altimeter at 29.92 inches; it now indicates pressure altitude. Read outside air temperature. Enter the graph at your pressure altitude and move horizontally to the temperature. Read density altitude from the sloping lines.

Example 1. Find density altitude in flight. Pressure altitude is 9,500 feet; and temperature, −8° C. Find 9,500 feet on the left of the graph and move across to −8° C. Density altitude is 9,000 feet (marked "1" on the graph).

Example 2. Find density altitude for take-off. Pressure altitude is 4,950 feet; and temperature, 97° F. Enter the graph at 4,950 feet and move across to 97° F. Density altitude is 8,200 feet (marked "2" on graph). Note that in the warm air, density altitude is considerably higher than pressure altitude.

Selected Contractions

A

ACLD	above clouds
ACSL	standing lenticular altocumulus
ACYC	anticyclonic
AFDK	after dark
ALQDS	all quadrants
AC	altocumulus
ACCAS	altocumulus castellanus
AS	altostratus
AOA	at or above
AOB	at or below

B

BCKG	backing
BFDK	before dark
BINOVC	breaks in overcast
BL	between layers
BLZD	blizzard
BOVC	base of overcast
BRKHIC	breaks in higher overcast

C

CBMAM	cumulonimbus mamma
CC	cirrocumulus
CCSL	standing lenticular cirrocumulus
CFP	cold frontal passage
CI	cirrus
CLRS	clear and smooth
CRLCN	circulation
CS	cirrostratus
CU	cumulus
CUFRA	cumulus fractus
CYC	cyclonic

D

DFUS	diffuse
DNSLP	downslope
DP	deep
DTRT	deteriorate
DURGC	during climb
DURGD	during descent
DWNDFTS	downdrafts

E

EMBDD	embedded

F

FNTGNS	frontogenesis (front forming)
FNTLYS	frontolysis (front decaying)
FROPA	frontal passage

G

GFDEP	ground fog estimated _____ feet deep

H

HDEP	haze layer estimated _____ feet deep
HLSTO	hailstones
HLYR	haze layer aloft

I

ICG	icing
ICGIC	icing in clouds
ICGICIP	icing in clouds and precipitation
ICGIP	icing in precipitation
INTMT	intermittent
INVRN	inversion
IPV	improve
ISOLD	isolated

K

KDEP	smoke layer estimated _____ feet deep
KLYR	smoke layer aloft
KOCTY	smoke over city

L

LTG, LTNG	lightning
LTGCC	lightning cloud-to-cloud
LTGCCCG	lightning cloud-to-cloud, cloud-to-ground
LTGCW	lightning cloud-to-water
LTGIC	lightning in cloud
LTNG, LTG	lightning

M

MEGG	merging
MLTLVL	melting level
MNLD	mainland
MOGR	moderate or greater
MRGL	marginal
MSTR	moisture

N

NCWX	no change in weather
NPRS	non persistent
NRW	narrow
NS	nimbostratus

O

OAOI	on and off instruments
OAT	outside air temperature
OCFNT	occluded front
OCLD	occlude
OFP	occluded frontal passage
OFSHR	off shore
OI	on instruments
OMTNS	over mountains
ONSHR	on shore
OTAS	on top and smooth
OVRNG	overrunning

P

PDW	priority delayed weather
PRESFR	pressure falling rapidly
PRESRR	pressure rising rapidly
PRIND	present indications are
PRST	persist

Q

QSTNRY	quasistationary
QUAD	quadrant

R

RGD	ragged
RTD	routine delayed weather

S

SC	stratocumulus
CLR, SKC	sky clear
SNOINCR	snow depth increase in past hour
SNRS, SR	sunrise
SNST, SS	sunset
SNWFL	snowfall
SQAL	squall
SQLN	squall line
SR, SNRS	sunrise
SS, SNST	sunset
ST	stratus
STFRA	stratus fractus
STFRM	stratoform
STM	storm

T

TCU	towering cumulus
TOVC	top of overcast
TROP	tropopause
TWRG	towering

U

UDDF	up and down drafts
UPDFTS	updrafts
UPSLP	upslope

V

VLNT	violent
VR	veer

W

WDSPRD	widespread
WFP	warm frontal passage
WK	weak
WRMFNT	warm front
WSHFT	wind shift
WV	wave

Acronyms

AC—Convective Outlook Bulletin; identifies a forecast of probable convective storms.

AIRMET—Airman's Meteorological Information; an inflight advisory forecast of conditions possibly hazardous to light aircraft or inexperienced pilots.

ARTCC—Air Route Traffic Control Center, FAA.

FA—Area Forecast; identifies a forecast of general aviation weather over a relatively large area.

FAA—Federal Aviation Administration, Department of Transportation.

FD—Winds and Temperatures Aloft Forecast; a forecast identifier.

FSS—Flight Service Station, FAA.

FT—Terminal Forecast; identifies a forecast in the U.S. forecast code.

ICAO—International Civil Aviation Organization.

IFSS—International Flight Service Station, FAA.

LAWRS—Limited Aviation Weather Reporting Station; usually a control tower; reports fewer weather elements than a complete SA.

NESS—National Environmental Satellite Service, National Oceanic and Atmospheric Administration, Department of Commerce; serves NWS with satellite weather observations.

NHC—National Hurricane Center, NWS.

NMC—National Meteorological Center, NWS.

NOAA—National Oceanic and Atmospheric Administration, Department of Commerce.

NSSFC—National Severe Storms Forecast Center, NWS.

NWS—National Weather Service, National Oceanic and Atmospheric Administration, Department of Commerce.

PATWAS—Pilot's Automatic Telephone Weather Answering Service; a self-briefing service.

PIREP—Pilot Weather Report.

RAREP—Radar Weather Report.

SA—Surface Aviation Weather Report; a message identifier.

SAWRS—Supplemental Aviation Weather Reporting Station; usually an airline office at a terminal not having NWS or FAA facilities.

SIGMET—Significant Meteorological Information; an inflight advisory forecast of weather hazardous to aircraft.

TAF—Terminal Aviation Forecast; identifies a terminal forecast in the ICAO code.

TWEB—Transcribed Weather Broadcast; a self-briefing radio broadcast service.

UA—Teletypewriter identifier of a pilot weather report (PIREP).

WA—Teletypewriter identifier of an AIRMET valid for a specified period.

WAC—Teletypewriter identifier of an AIRMET continuing in effect until cancelled.

WH—Hurricane Weather Advisory; identifies a hurricane advisory forecast specifically for aviation.

WS—Teletypewriter identifier of a SIGMET.

WSFO—Weather Service Forecast Office, NWS.

WSO—Weather Service Office, NWS.

WW—Severe Weather Watch; identifies a forecast of probable severe thunderstorms or tornadoes.

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