

Figure 17-11. 200 MB Constant Pressure Chart

The forecast positions of jet streams, trough lines, and isotachs may also be indicated on the upper level constant pressure prognostic charts. Figure 17-15 shows a 300-mb prognostic chart made from the 300-mb chart which comprises Figure 17-10. Since the wind flows parallel to the contour lines, and the wind speed is inversely proportional to the distance between contours, forecast values of wind speed and direction can be ascertained from prognostic constant pressure charts.

Aircrews must remember that prognostic charts represent weather conditions *expected* at a *specific* time — not *average* weather conditions over a *period* of time.

WINDS ALOFT CHARTS

Winds aloft charts are prepared four times each day. The wind data from *rawin*, *rawinsonde*, and *pilot balloon* (PIBAL) observations, which are made at 0000Z, 0600Z, 1200Z and 1800Z, are collected at NMC and plotted on charts. The same barb and pennant sys-

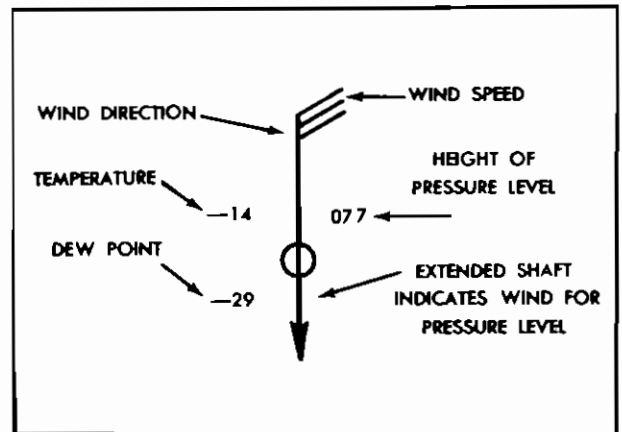


Figure 17-12. Data Plotting Model Used on Constant Pressure Charts

tem used on the surface and constant pressure charts is used on the winds aloft charts. (Refer to Figure 17-15.)

NMC transmits winds aloft charts four times daily. The charts contain winds for selected levels in the troposphere and stratosphere. At the present time some of these

Figure 17-13. 700-MB Prognostic Chart

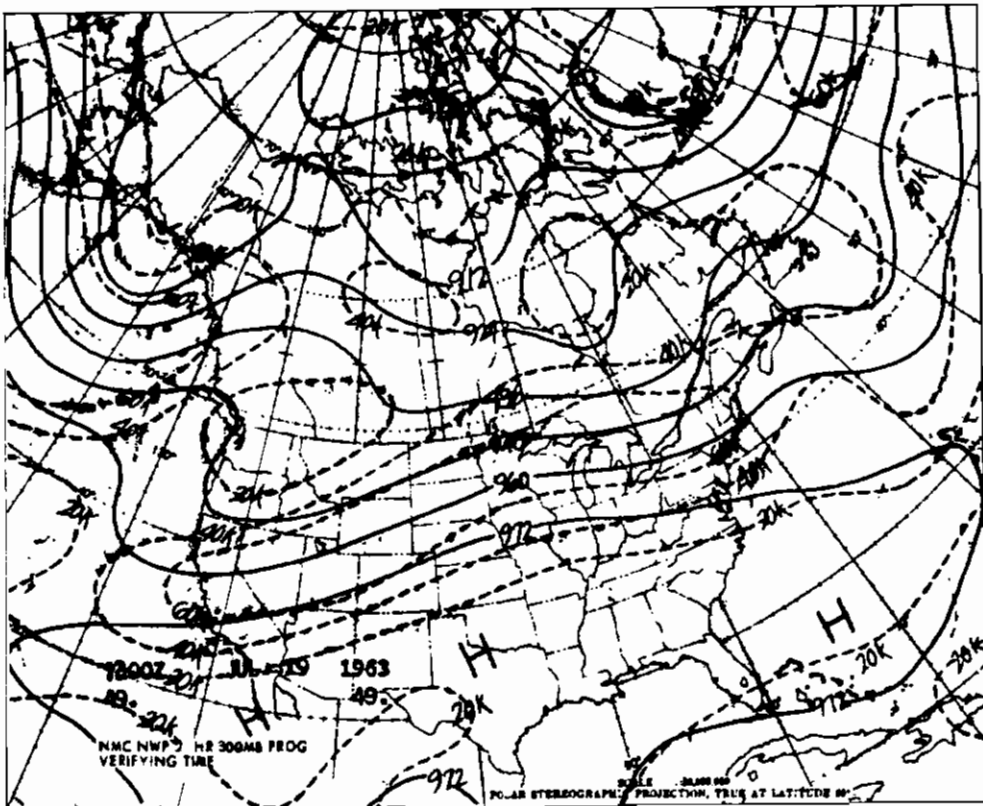
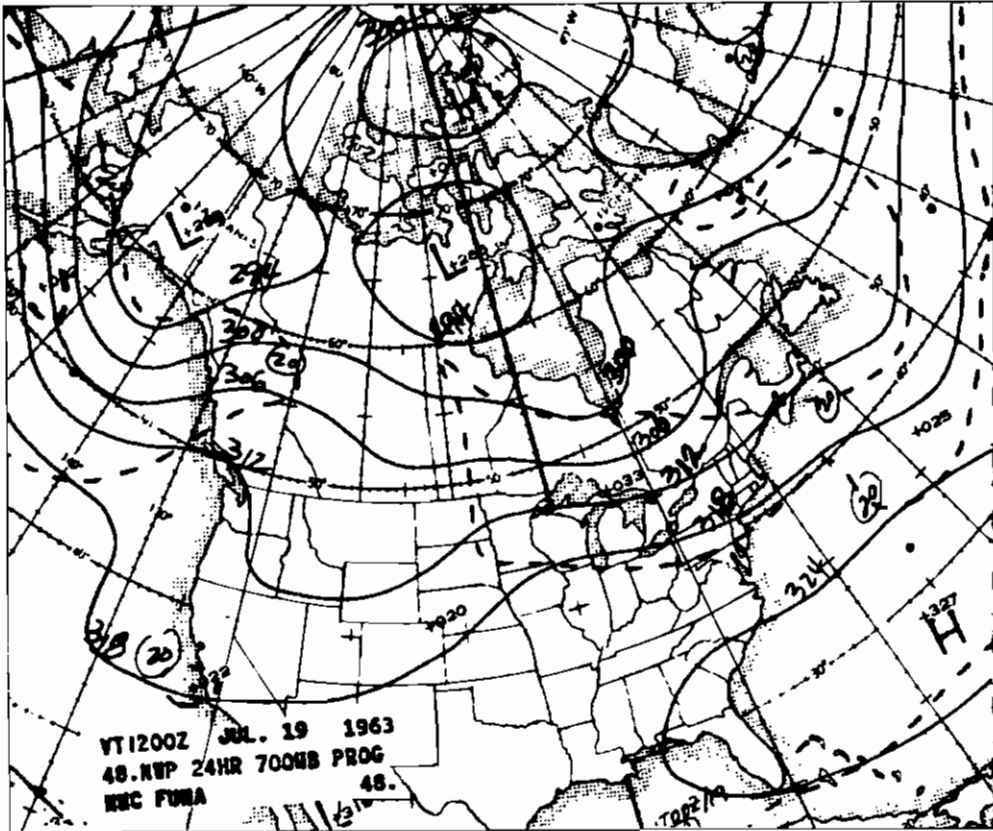


Figure 17-14. 300 MB Prognostic Chart

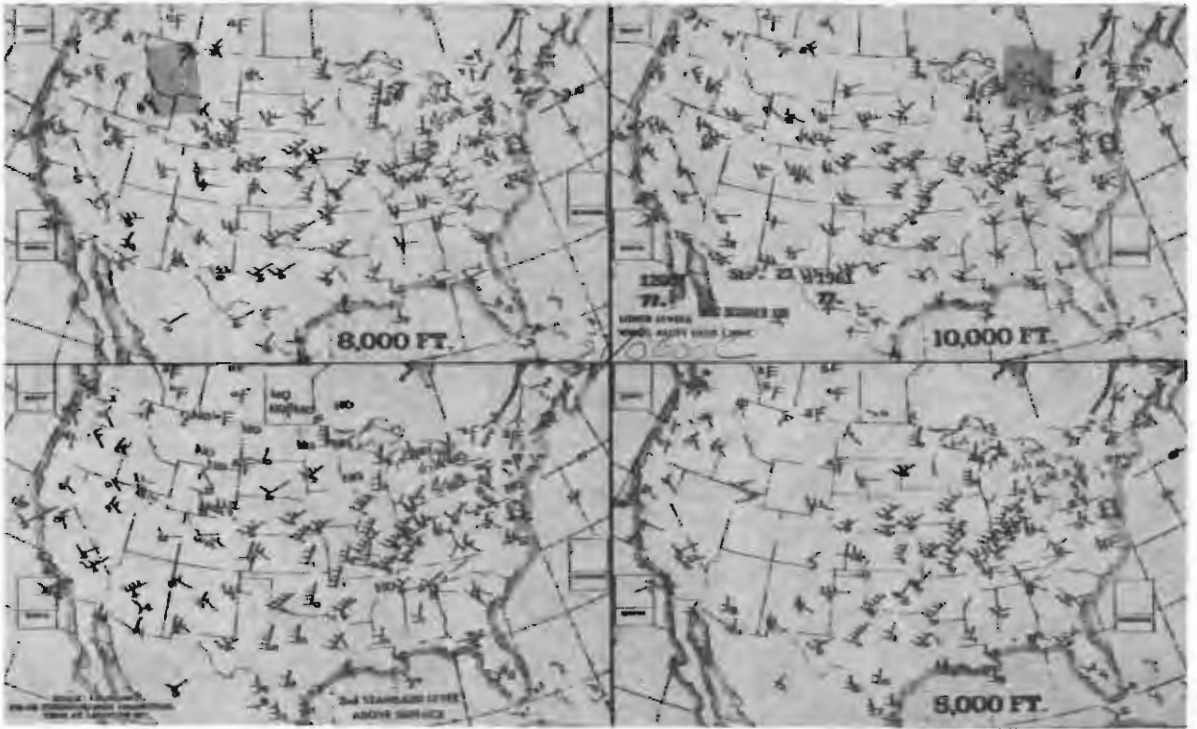
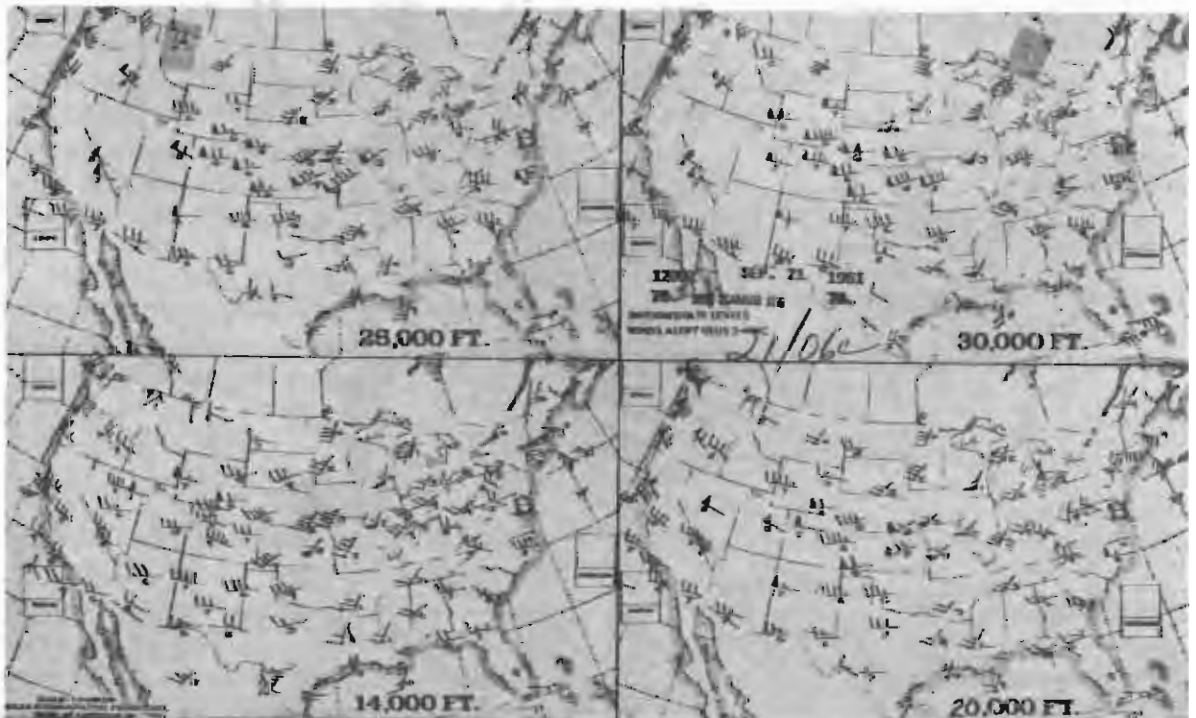


Figure 17-15. Winds Aloft Charts

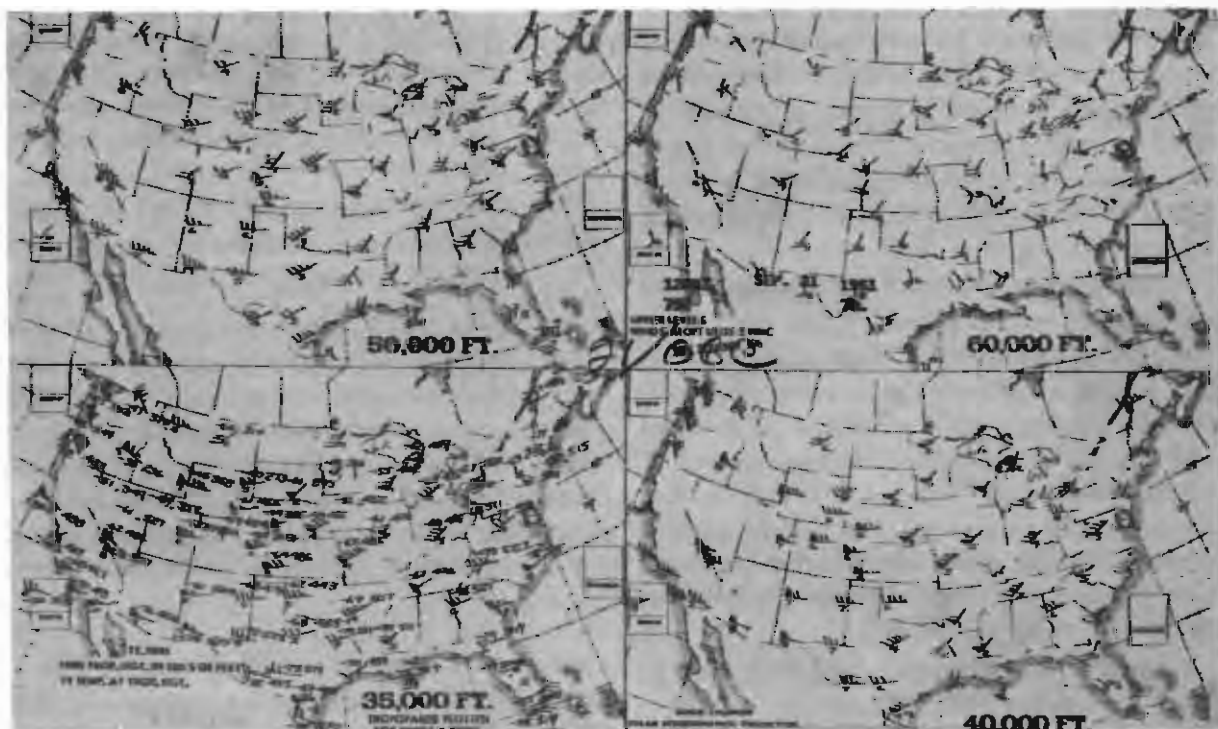


levels are near, or coincide with, the constant pressure charts, while the others are for levels between constant pressure levels. Thus, the winds aloft charts supplement the constant pressure charts. It must be noted that these are not forecast, but are actual winds and can be up to 9 hours old. These winds aloft charts are of considerable importance to aircrews in safe flight planning, since the winds aloft must be considered in computing correct headings, best flight altitudes, ranges, ground speed, and estimated time en route. Winds aloft

Weather charts specially prepared for briefing large groups are often *skeletonized* to show only the features significant to the mission at hand. However, the symbols and colors used, and the general scheme of depicting weather information remain the same.

AVIATION WEATHER OBSERVATIONS AND REPORTS

Surface weather observations are taken at each USAF air base from what is now called



charts are shown in the illustrations of Figure 17-15.

NOTE

The foregoing discussion on charts is an introduction to the charts you will find displayed in most base weather stations. It does not cover the subject completely; for example, you will find facsimile prognostic charts for other levels, and for different time periods. In addition there are other types of charts, primarily of interest to forecasters, which may or may not be displayed.

the *Representative Observation Site*. These sites are located where the weather observer has an unrestricted view of the approaches and runway complex. The weather measuring instruments are now being located where they will measure the ceiling, visibility, and wind that the landing pilot will encounter on his approach and landing.

The *rotating beam ceilometer* (RBC) is being put in the approach zone of the primary instrument runway approximately one-half mile from touchdown point. The *transmis-*

someter (measures visibility), and *wind measuring equipment* are being located adjacent to the touchdown point of the primary instrument runway. At those air bases having two precision instrument approach runways, dual instruments are being installed. This will allow the observer to switch from one to the other as the active runway changes.

The observer takes a complete observation hourly, and a special observation any time a weather element makes a significant change. These observations are called *Aviation Weather Reports*, and are transmitted over teletype circuits in one of two code forms. Aircrew personnel need be concerned with only one of them — that used for Aviation Weather Reports. The other code, which is designed to provide the detailed information needed in plotting surface synoptic charts and is therefore called the *synoptic code*, is of use primarily to forecasters and is not discussed in this manual.

The following discussion concerns the *aviation weather reporting code*. These reports are transmitted on an hourly basis, with each station having a specified place in sequence with the other stations on that circuit. The aviation weather reports are sometimes referred to as *hourly teletype sequences*, *hourly collections*, *weather sequences*, and *hourly surface reports*. Special observations taken between hourly reports are transmitted on the teletype circuit as available.

RAN 5 Ⓞ M15 ● 40 ⊕ 11/2S- 183/28/27
2212G21/003/REMARKS

Station Indicator (call letters): RAN — Three letter symbols are used to identify the reporting station which in this case is Chanute AFB, Illinois.

Sky Condition and Ceiling: 5 Ⓞ M15 Ⓞ 40 ⊕ — The height (in hundreds of feet) of the base of each layer of clouds is followed by a symbol which indicates the amount of sky cover. The ceiling layer is preceded by a letter which indicates the method used to obtain the ceiling.

In this example, there are three decks of clouds. The lowest deck is scattered at 500 feet. The second deck, which is the ceiling, is broken with an average height of 1500 feet.

The "M" indicates that the ceiling was measured (by an instrument such as the ceilometer). The third deck is an overcast at 4000 feet.

SKY CONDITION SYMBOLS:

- Clear (less than $\frac{1}{10}$ of the sky covered by clouds) — CLR
- Ⓞ Scattered clouds ($\frac{1}{10}$ to $\frac{5}{10}$, inclusive, of the sky covered by clouds) — SCTD
- Broken clouds ($\frac{6}{10}$ to $\frac{9}{10}$, inclusive, of the sky covered by clouds) — BKN
- ⊕ Overcast clouds (complete sky coverage) — OVC
- X Obscured (sky is completely hidden by precipitation or surface-based phenomena such as fog, haze, smoke, and the like)
- X Partial obscuration ($\frac{1}{10}$ to $\frac{9}{10}$, inclusive, of the sky hidden by precipitation or surface-based phenomena)

A minus sign (—) preceding a cloud symbol (not the obscuration symbol) indicates a *thin* layer of clouds, (the sun, moon, stars, or other clouds are visible through the clouds). A plus sign (+) preceding a sky condition cloud cover symbol indicates a dark layer of clouds. Partial obscuration (—X) and thin cloud decks (—● or —⊕) do not in themselves constitute a ceiling.

CEILING CLASSIFICATION SYMBOLS:

A ceiling classification symbol always precedes the height of the lowest layer of clouds which constitute a ceiling. The following symbols are used:

- M Measured ceiling (measured by ceiling light, ceilometer, and the like)
- A Aircraft ceiling (ceiling reported by a pilot while in flight over or within $1\frac{1}{2}$ nautical miles of any runway of the air base; can refer to either definite cloud bases or vertical visibility if an obscuration exists)
- B Balloon ceiling (ceiling measured by timing the ascent of a balloon which rises at a known rate until it is observed to enter the base of the clouds)
- W Indefinite ceiling (vertical visibility)

into an obscuration produced by surface-based phenomena such as fog, haze, smoke and the like, or precipitation which hides the sky — indefinite ceilings are always estimations)

- E Estimated ceiling (height of base of cloud estimated by a weather observer)

In addition to the foregoing, the height of a broken or overcast layer of cirrus clouds is also indicated, when possible. (Not shown in the sample report.) If the height of the cirrus ceiling is unknown, the letter U precedes the sky condition symbol. If reported by an aircraft within the preceding hour, and within 50 miles of the reporting point, the letter A precedes the height value. Under certain conditions, an approximate height can be computed from radiosonde data. When this is done, the letter R is assigned. (The letter R is also assigned to a ceiling which was measured by CPS-9 radar.) The letter D is used when the height has been determined by A or R during the past six hours (but not during the past hour) and no appreciable change has taken place. In all other cases, a cirrus layer symbol is preceded by a slant (/) to indicate *high cloud, height unknown*. (Heights of cirrus are not estimated as in the case with lower clouds, and will only have a height figure when reported by an aircraft or figured from a radiosonde observation.)

Visibility: 1½ — Visibility is indicated in statute miles and fractions of statute miles. In the example, the visibility is 1½ miles. When the visibility is less than three miles, and variable, a V is inserted after the prevailing visibility which is contained in this portion of the code. A notation is added in the *remarks* section which indicates the limits of variability.

Weather and Obstructions to Vision: S—. Types of precipitation and obscuring phenomena are included in this portion of the code. Letter symbols are used to indicate the phenomena. A minus sign (—) after precipitation indicates light intensity; a plus sign (+) indicates heavy intensity; a double sign (— —) indicates very light intensity. In the example, light snow is falling from the clouds.

The following precipitation weather symbols are used:

R Rain	EW Sleet Showers
S Snow	AP Small Hail
L Drizzle	SP Snow Pellets
E Sleet	SG Snow Grains
A Hail	ZL Freezing Drizzle
T Thunderstorm	ZR Freezing Rain
RW Rain Showers	IC Ice Crystals
SW Snow Showers	

Tornado and *Waterspout* are written in full and not coded.

Obstruction-to-vision symbols are as follows:

F Fog	D Dust
GF Ground Fog	BD Blowing Dust
IF Ice Fog	BN Blowing Sand
H Haze	BS Blowing Snow
K Smoke	BY Blowing Spray

Plus (+) and minus (—) signs are not used with obstructions to vision.

Sea Level Pressure: 183. Sea level pressure is reported in tens, units, and tenths of millibars. The hundreds digits (usually a 9 or 10) are omitted, as is the decimal point. In the example, 183 indicates a sea level pressure of 1018.3 millibars.

Temperature: 28. Temperature is indicated to the nearest whole degree Fahrenheit. A minus sign is placed in front of the temperature to indicate negative (subzero) values. In the example, the temperature is 28°F.

Dew Point Temperature: 27. The dew point temperature is indicated in the same manner as the temperature. In the example, the dew point is 27°F.

Wind Directions: 22. Wind directions are indicated to the nearest 10° true. In the example, 22 means the wind is blowing from 220°.

Wind Speed: 12G21. Surface wind speed is reported to the nearest knot. When the wind speed is estimated instead of measured, the letter **E** follows the speed. A calm condition is indicated by 0000. Gusts are indicated by inserting a **G** after the average wind speed followed by the value of the peak gust. Squalls are indicated in a similar manner by using the letter **Q**. In the example, the wind speed is 12 knots with gusts to 21 knots.

Altimeter Setting: 003. The altimeter setting is reported in units, tenths, and hundredths of inches of mercury. The tens digit and decimal point are omitted. The tens digit is a "2" or "3". In the example, the altimeter setting is 30.03 inches of mercury.

Remarks: At stations using visibility measuring equipment (transmissometers), Runway Visibility (RV) or Runway Visual Range (RVR) will be entered in "Remarks" as specified below.

● At Air Force bases RV will be determined, in almost all cases, by use of a transmissometer located in the touchdown area of the active runway. It can also be determined visually by an observer at the approach end of the active runway when the transmissometer is inoperative.

RV is reported when prevailing or runway visibility is 1 mile or less. Reportable values of RV are 1/4-, 1/4, 5/16, 3/8, 1/2, 5/8, 3/4, 7/8, 1, and 1+ statute miles.

RV is disseminated locally and on tactical weather loops to operation control agencies but is not disseminated on longline meteorological nets.

Examples: RV1/4- indicates RV is less than 1/4 mile; RV1/2 indicates RV is 1/2 mile; RV1+ indicates RV is more than 1 mile. RVNO indicates RV is not available because of inoperative transmissometer or unavailability of data from another source.

● The 10-minute mean value of Runway Visual Range (RVR), when available at civil airports, is reported in "Remarks" when the prevailing visibility is less than 2 miles, and/or RVR is 6,000 feet or less.

The format used when the 10-minute mean value is representative of all RVR equipped runways is VRV_rV_r(V_r). **Example:** VR10- indicates visual range for all systems is less than 1,000 feet.

When the 10-minute mean value for a specific runway varies significantly from the 10-minute mean value for the RVR equipped active runway, the format is R_{nn}(d)VRV_rV_r(V_r). **Example:** VR48 R10LVR20 indicates the mean RVR for all systems is 4,800 feet; the mean RVR on runway 10L is 2,000 feet. **Example:** VR42 R12LVRNO indicates the mean RVR for all systems is 4,200 feet; the system on runway 12L is inoperative. Some civil airports still use the R_{nn}(d)VV_{nn} format. **Example:** R13LVV1/2 means the runway visibility on runway 13L is 1/2 statute mile.

This part of the report is used to indicate all pertinent weather information which cannot be given properly in the main body of the report. The symbols, contractions, and plain language used in the remarks section are too numerous to be listed here. Weather station personnel should be consulted.

Listed here are a few examples of contractions and symbols used in the remarks section:

BINOVC — breaks in overcast

VSBY 1V2 — visibility variable one to two miles

VSBY N1 — visibility to the north one mile

F DSIPTG — fog dissipating

CB N — cumulonimbus to the north

TWRG CU SW — NW — towering cumulus clouds from southwest through northwest (always clockwise)

CIG 10V20 — ceiling variable 1,000 to 2,000 feet

⊕ 34 — top of overcast 3,400 feet MSL (reported from an aircraft)

⊕ 34/60 ⊕ 68 — an aircraft has reported a layer of broken clouds (not visible from the ground) with bases 6,000 feet and tops 6,800 feet MSL

Pilot Reports

Pilot reports (PIREPS) of weather phenomena encountered in flight are a valuable

source of information which frequently is not available otherwise. Those reports are coded, in the form of contractions, by weather station personnel and distributed to other weather stations via teletype.

Pilot reports usually contain the following information:

- Location of weather phenomena with respect to air bases or other nationally known points. (These are more desirable references than airways fanmarkers and intersection points.)
- Type, intensity, altitude, and time of occurrence of weather phenomena.
- Type of aircraft when the report contains information on turbulence, icing or contrails.

DISPLAY OF WEATHER CHARTS AND DATA AT WEATHER STATIONS

Weather data and charts are usually displayed in a manner making them easily accessible to forecasters and aircrews. Forecasters frequently use aviation weather reports and weather charts as visual aids for briefings.

Current and *forecast* surface and upper air charts and winds aloft chart are generally displayed on the walls or panels in the weather station, each chart being conspicuously identified. The manner of display varies from station to station. In most stations, you will find a special section which is designed for the pilot to use to get weather information for flight planning without aid from the forecaster.

Aviation weather reports are attached to clip boards and usually displayed on a sloping desk. A separate clip board is used for each circuit (sequence collection). A map of the area for which the reports are received is usually mounted near the clip boards. Station call letters are placed over each station on the map. Different colors are used for each circuit to aid in identification.

Pilot reports are numbered consecutively as received, and placed on a clip board. These may be plotted on a special map. Areas of icing, turbulence, hail, and other hazards are plotted in *red*.

Advisories received from the severe weather and hurricane warning centers are plotted on

maps and displayed in the weather stations. The areas where thunderstorms, tornadoes, hail, turbulence, and strong winds are expected are conspicuously outlined and labeled. The latest position and expected track of hurricanes are plotted on a map and displayed in the station.

RADAR STORM DETECTION UNITS

About one-half of the Air Force weather stations in the United States, and a number of overseas stations are equipped with weather radar sets. Forecasters are able to detect and track thunderstorms and heavy precipitation areas within a radius of 50 to 200 miles of the station, depending on the type of radar.

Radar reports (RAREPS) giving the location, shape, intensity, direction, and speed of movement of storms detected by radar units are transmitted in plain language over weather teletype circuits.

TELEVISION

There are several bases today that utilize closed circuit television to brief pilots in base operations and outlying alert areas. This allows aircrews and other interested personnel to receive visual weather briefings without going to the weather station.

Most bases that have television in base operations also have a small self-briefing display which allows you to flight plan before getting the final weather briefing. You are not required to write down the weather in Section D of the DD Form 175; you merely write *Briefed by Television* and enter the briefing void time and forecaster's initials. The briefing is recorded and any questions you ask are also recorded.

PILOT-TO-FORECASTER SERVICE (PFSV)

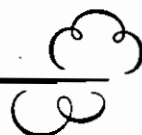
Air Weather Service operates a pilot-to-forecaster facility at many bases. This allows the pilot to call directly to the forecaster from the air. These are located geographically to give good coverage over the continental United States. The terminal equipment is conveniently located in the forecast section of the

weather station and within the United States is tuned to UHF channel 344.6 mc. Other frequencies may be used in overseas areas. The word METRO is used in calling the forecaster, for example "Kelly Metro". This is the best and fastest method of obtaining weather information while in flight. You can receive a forecast for your destination at alti-

tude before starting your descent. This is also a good opportunity to pass a pilot report, especially if you have encountered any weather or winds that had not been forecast for the flight.

A map showing the location of pilot-to-forecaster facilities is published in the USAF En Route Supplement.

The Role of Weather in Flight Planning



Getting all the facts and applying them correctly is a necessity in flight planning. Before going into the weather station, know exactly what information you need. You will want to know what type of weather to expect en route, at your destination, and any alternates, as well as the local weather at the time of take-off and during your climb to altitude.

The more information you give the forecaster, the better he can serve you. Tell him the type of aircraft you are flying, your estimated time of departure (ETD), your proposed route and flight altitude, cruising air-speed, and any other additional information that will assist him in visualizing your particular flight.

When the briefing is over, you should have received the following information:

WEATHER FOR TAKEOFF AND CLIMB

- Surface temperature and pressure altitude (or density altitude)
- Surface winds
- Bases and tops of cloud layers
- Visibility
- Precipitation (type and intensity)
- Freezing level
- Climb winds

FORECAST WEATHER EN ROUTE

- Bases, tops, type, and amount of each layer of clouds
- Visibility at flight level (or flight altitude)
- Type, location, intensity, and direction and speed of movement of fronts

- Freezing level
- Temperatures and winds at flight level (or flight altitude)
- Areas of severe weather (thunderstorms, hail, icing, and turbulence)
- Areas of good weather (for use in event of an emergency landing en route)

FORECAST WEATHER FOR DESTINATION AND ALTERNATES

- Bases, tops, type, and amount of cloud layers
- Visibility
- Weather and obstructions to vision
- Freezing level
- Surface wind speed and direction
- Forecast altimeter setting (for jet and turbine-engine aircraft)

Be sure that all essential weather elements are included in your briefing. Request clarification or additional information concerning any weather information about which you have a doubt. The forecaster is there to help you — use him. Once you have the information you want and apply it to your flight, you're all set. You know what to expect at the point of takeoff, en route, and at the destination and the alternates. You are prepared to take appropriate action when necessary. Remember, if your departure is delayed longer than 1½ hours, it is your responsibility to recheck the weather.

The forecast weather at the point of take-off is often neglected in flight planning. Knowl-



**AWS FLIGHT FORECAST
CROSS SECTION**

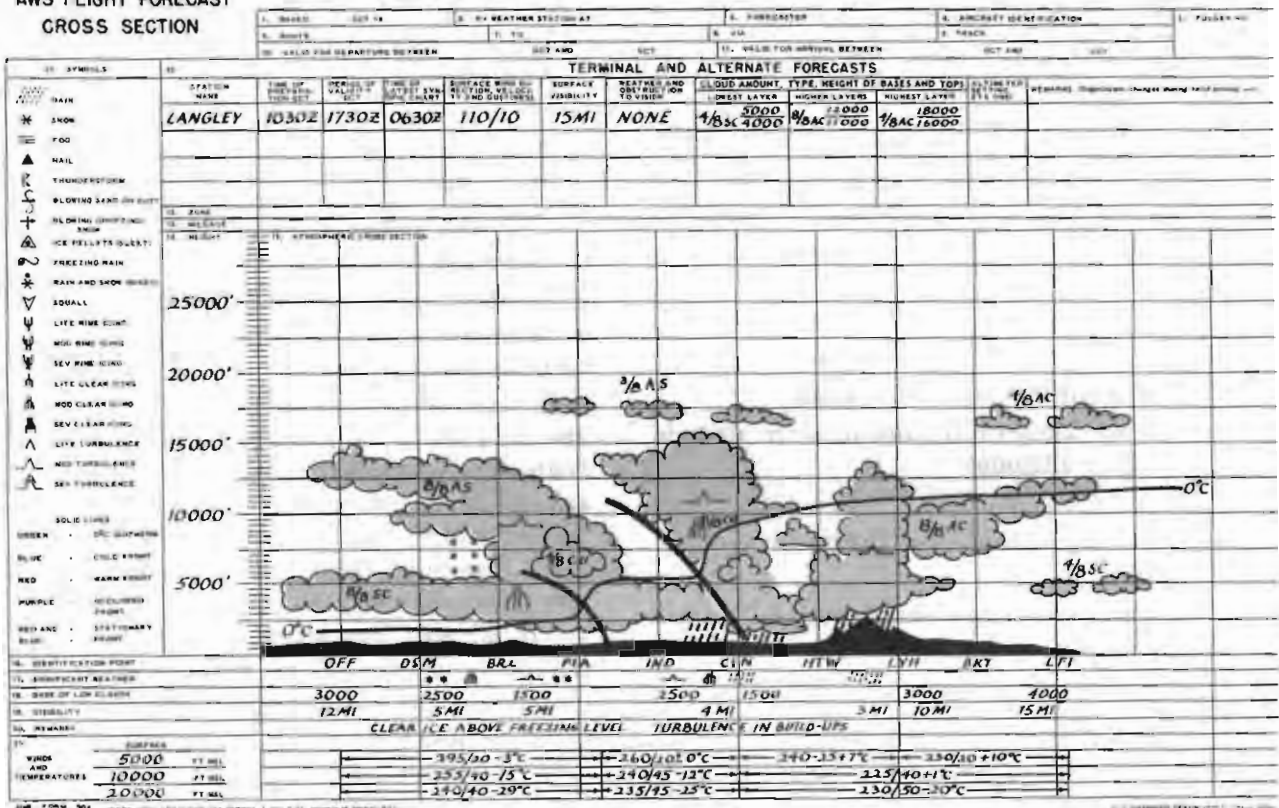


Figure 18-1. Flight Cross Section and Related Portion of Surface Chart

edge of this weather will be the deciding factor when an immediate decision must be made in the event of an emergency soon after takeoff. In some cases, the weather may deteriorate rapidly shortly after takeoff.

Winds up to flight altitudes must be known in order to compute the distance which will be covered, and the fuel which will be consumed during the climb to altitude.

A knowledge of the types of clouds at flight altitudes gives the aircrews an idea of the areas of possible precipitation, icing, turbulence, and other hazards to flight. If you have this knowledge, you may be able to make the proper operational decision in the event of an en route emergency.

CROSS SECTIONS

During the weather briefing, the forecaster will probably use the latest surface synoptic chart to delineate pressure systems, frontal systems, and areas of *good* and *bad* weather. In other words, the charts serve as a visual aid. A *flight forecast cross section* may also be used to aid pilots to visualize the weather expected en route. The related illustration, Figure 18-1, shows a flight forecast cross section and ac-

companying surface weather chart.

The cross section is self-explanatory. Among the items included are:

- Fronts — surface, upper air position, and slope
- Clouds — types, altitudes of bases and tops
- Freezing level — solid green line
- Turbulence — appropriate symbol
- Icing — appropriate symbol
- Winds and temperatures for various altitudes
- Surface visibility — significant weather.

HORIZONTAL WEATHER DEPICTION CHARTS

Horizontal Weather Depiction (HWD) charts are commonly used for weather briefings and flight folders for long flights, particularly over water. The weather, cloud, precipitation patterns, and forecast position of the fronts are portrayed in symbolic form with a legend to enable understanding of the symbols employed, as is shown in Figure 18-2.

BY ORDER OF THE SECRETARY OF THE AIR FORCE

OFFICIAL:

R. J. PUGH
Colonel, USAF
Director of Administrative Services

CURTIS E. LEMAY
Chief of Staff

Glossary

- Adiabat** — A curve on a thermodynamic diagram along which a thermodynamic change takes place without the gain or loss of heat. (Sometimes dry adiabat.)
- Adiabatic Process** — A thermodynamic process in which no heat or mass crosses the boundaries of a system.
- Adiabatic Cooling** — The cooling of air as it rises and expands due to a decrease in pressure, without heat or mass passing through the boundaries of the system undergoing the adiabatic process.
- Adiabatic Heating** — The descent of air with increasing pressure causing an increase in temperature. (See Adiabatic Cooling above.)
- Advection** — Transfer of atmospheric properties by horizontal movement of air.
- Air Mass** — A vast body of air (often covering hundreds of thousands of square miles) in which the conditions of temperature and moisture are much the same at all points in a horizontal direction.
- Altimeter (Pressure Type)** — An aneroid barometer calibrated to indicate altitude instead of pressure.
- Altimeter Setting** — Pressure of the reporting station converted to make the altimeter read zero elevation at an altitude of 10 feet above mean sea level (or to read field elevation 10 feet above the runway).
- Anemometer** — An instrument for measuring the speed of the wind.
- Aneroid Barometer** — An instrument which measures atmospheric pressure by using a partially evacuated metal chamber. The chamber is of thin metal that can expand or contract the chamber volume as the atmospheric pressure changes.
- Anticyclone** — An area of high pressure that has clockwise circulation about it in the Northern Hemisphere and counterclockwise circulation about it in the Southern Hemisphere.
- Atmosphere** — The gaseous envelope (air) that surrounds the earth.
- Atmospheric Pressure** — The force per unit area exerted by the weight of the atmosphere from the level of measurement to its outer limits.
- Barograph** — A self-recording aneroid barometer arranged so that changes in pressure are recorded, often on a paper-covered rotating drum.
- Buys-Ballot's Law** — If an observer in the Northern Hemisphere stands with his back to the wind, lower pressure will be on his left.
- Ceiling** — The height ascribed to the lowest layer of clouds or obscuring phenomena when it is reported as broken, overcast, or total obscuration and not classified *thin* (clouds) or *partial* (obscuration).
- Ceilometer** — An automatic, recording, cloud height indicator.
- Celsius** (Same as Centigrade by recent convention.) — A temperature scale with 100 degrees between the freezing and boiling points of water, the freezing point being zero degrees, and the boiling point being 100 degrees; to convert Celsius to Fahrenheit use the formula: $Fahrenheit = 9/5C + 32$. To convert Fahrenheit to Celsius use the formula: $Celsius = 5/9 (F^{\circ} - 32)$.
- Clear-Air Turbulence** — Turbulence encountered by aircraft while flying in air space that is devoid of clouds, regardless of the atmospheric phenomenon that is causing the turbulence. The jet stream, however, seems to be the most-often reported cause.
- Clouds** — A hydrometeor consisting of a visible aggregate of minute water or ice particles in the atmosphere above the earth's surface.
- Cold Front** — The line of discontinuity at the earth's surface along which a mass of cold air is displacing a warmer air mass.
- Condensation** — The physical process by which a vapor (gas) becomes a liquid. The opposite of evaporation.

- Condensation Level** — The level where clouds will form. (Visible water droplets or ice crystals form.)
- Condensation Nuclei** — Small particles such as dust, smoke, or sea salt spray upon which water vapor condenses.
- Conditional Instability** — A vertical distribution of temperature such that the layer is stable for dry air, but unstable for saturated air, i.e., the lapse rate is between 3°C/1000 ft. and 1.5°C/1000 ft.
- Conduction** — Transfer of heat by molecular action.
- Contrail** — A cloud-like streamer frequently observed to form behind aircraft flying in clear, cold, humid air.
- Convection** — The transport of an atmospheric property by vertical air movements.
- Convergence** — The contraction of a vector field (coming together).
- Crevasse** — A deep rift in a glacier or any other form of land ice.
- Cyclone** — An area of low pressure that has counterclockwise closed circulation about it in the Northern Hemisphere, and clockwise in the Southern Hemisphere.
- Density** — The mass of a substance per unit of its volume.
- Dew** — Water vapor which condenses on solid surfaces that have cooled below the condensation point of the air in contact with them.
- Dew Point** — The temperature to which the air must be cooled, at constant pressure and constant water vapor content, in order for saturation to occur.
- Diurnal** — Daily, especially pertaining to actions which are completed within 24 hours, and which recur every 24 hours.
- Doldrums** — A nautical term for the equatorial area of low pressure (trough) with special reference to the light surface winds found in this region.
- Drizzle** — Precipitation from stratiform clouds consisting of numerous and very small water droplets, also frequently associated with fog.
- D-Value** — The difference between actual geometric altitude of a point in space and the pressure altitude of that same point. Thus, $D = Z - Z_p$, where Z is the actual altitude of a point in space, and Z_p is the pressure altitude of that same point.
- Easterly Wave** — A migratory wave-like disturbance of the tropical easterlies. It is a wave within the broad easterly current and moves from east to west, generally more slowly than the current in which it is imbedded. Easterly waves occasionally intensify into tropical cyclones.
- Eddy** — A whirl or circling current of air or water, different and differentiated from the general flow.
- Effective Pilot Ceiling** — The level at which the pilot first sees the ground ahead of him when making an approach. The effective pilot ceiling is generally less than the reported ceiling when the sky is obscured.
- Evaporation** — The transformation of water into water vapor, but can also be applied to most liquids. Evaporation is a cooling process.
- Fahrenheit** — A temperature scale in which the freezing point of water is 32 degrees and the boiling point is 212 degrees under standard conditions of pressure (760 MM of Hg). (See *Celsius (centigrade)* for conversions.)
- Foehn Wind** — A warm, dry wind blowing down the leeward slopes of mountains. It is called a Chinook Wind in the Rocky Mountains.
- Fog** — A suspension of minute water droplets near the earth's surface with no apparent downward motion. Fog differs from clouds only in that the base of the fog is at the earth's surface while clouds are above the surface. When composed of ice crystals, it is termed ice fog.
- Front** — A line or zone of discontinuity between two adjacent air masses of different temperature and moisture content.
- Frontogenesis** — The beginning or creation of a front or frontal zone.
- Frontolysis** — The dissipation of a front or frontal zone.
- Frost** — Crystals of ice formed like dew, but at temperatures below freezing.
- Glaze** — A deposit of clear ice (synonymous with clear ice), but usually contains some air pockets, and formed on exposed objects by the freezing of a film of super-cooled water deposited by rain, drizzle, and the like.
- Gradient** — The horizontal rate of change per unit distance. Pressure gradient is the change in pressure per unit distance in the direc-

tion of the most rapid rate of decrease of pressure.

Gradient Wind — The wind that blows along curved isobars or contours with a velocity corresponding to the spacing of the isobars or contours. The wind 2,000 feet above the surface is often referred to as the gradient wind.

Gust — A sudden, brief increase in the speed of the wind.

Hail — Precipitation in the form of balls or irregular lumps of ice, invariably produced by convective clouds, nearly always cumulonimbus. The largest hailstone observed in the United States was 17" in circumference and weighed about 1.5 pounds.

Haze — Fine dust or salt particles (often with water molecules) dispersed through a portion of the atmosphere, often dense enough to restrict visibilities.

Humidity — The measure of water vapor content in the air.

Hurricane — A tropical cyclone with wind speeds of 64 knots or greater.

Hygrometer — An instrument for measuring the humidity of the air.

Instability — The state of a system such that a small motion within it brings about unbalance, resulting in motions which upset the original state of the system. Usually, also, refers to the state of vertical stability or instability as used in meteorology.

Inversion — Layer in which the temperature increases with altitude, instead of decreasing with increasing altitude.

Isobar — A line joining points of equal pressure.

Isodrosotherm — A line joining points of equal dew point.

Isotach — A line joining points of equal wind speed. (Sometimes called Isovel.)

Isotherm — A line joining points of equal temperature.

Jet Stream — A meandering river of high velocity winds, 50 knots or greater, imbedded in the normal wind flow aloft, often 1,000 to 3,000 miles long, 100 to 400 miles wide. The core of the jet stream is generally found at altitudes of 20,000 to 40,000 ft. Several individual jet streams have been isolated, so caution must be exercised as different

people sometimes define the jet stream differently.

Lapse Rate — The rate of decrease of an atmospheric variable with height, the variable being temperature unless otherwise specified.

Lightning — A sudden flash of light caused by electrical discharges produced by thunderstorms.

Meteorology — The study dealing with the phenomena of the atmosphere.

Monsoon — Winds that consistently blow onshore during the summer and offshore during the winter due to the temperature differential, and consequent pressure differential between land and water areas.

Nuclei — (See condensation nuclei.)

Obscuration (Partial) — The situation of sky cover when a surface-based phenomenon obscures a portion of the sky from the point of observation.

Obscuration (Total) — The situation of sky cover when a surface-based phenomenon obscures all of the sky from the point of observation. The number preceding the X symbol indicates vertical visibility into the obscuring phenomenon, in hundreds of feet. Example: W3X $\frac{1}{4}$ F, the vertical visibility is 300 feet. (The horizontal visibility is $\frac{1}{4}$ statute mile.)

Occluded Front or Occlusion — The front formed when and where a cold front overtakes a warm front or stationary front.

Ozone — A nearly colorless (but faintly blue) gaseous form of oxygen with a characteristic odor like that of weak chlorine. Its formula is O₃, and it is found in trace quantities in the earth's atmosphere.

Pilot Balloon — A small balloon filled with hydrogen or helium that is released by an observer who, with the use of an instrument called a *theodolite*, is able to determine wind speed and directions aloft from the movement of the balloon as it ascends.

Polar Air — Cold, dry air having its source in the polar regions.

Polar Front — The frontal zone between air masses of polar and those of tropical origin.

Precipitation — Any or all of the forms of water or ice particles large enough to fall from the atmosphere and reach the ground.

Pressure — (See atmospheric pressure.)

Prevailing Visibility — The greatest horizon-

- tal visibility which is equalled or surpassed throughout half of the horizon circle; it need not be a continuous half.
- Psychrometer** — An instrument consisting of two thermometers, a wet bulb thermometer (muslin wick over its bulb) and a dry bulb thermometer and is used in the calculation of dew point and relative humidity.
- Radiation** — The process by which electromagnetic radiation is propagated through free space.
- Radiosonde** — An instrument equipped with a set of measuring instruments which automatically converts data of temperature, pressure, and humidity into electrical impulses, and transmits the information to a receiving and recording set on the ground. The radiosonde is often carried aloft by a balloon. A similar instrument, called a dropsonde, is dropped by parachute from an airplane and transmits its information back to the mother plane.
- Rain** — Precipitation which reaches the earth's surface as water droplets.
- Relative Humidity** — The ratio of the amount of moisture in the air to the amount which the air could hold if it were saturated, usually expressed as a per cent.
- Ridge** — An elongated area of relatively high pressure extending from the center of a high pressure region.
- Saturated Air** — Air that contains the maximum amount of water vapor it can hold at a given pressure and temperature. (Relative humidity of 100%.)
- Shower** — Precipitation falling from cumuli-form clouds; starting and stopping suddenly, and changing rapidly in intensity.
- Slant Range Visibility** — (Approach visibility.) The distance from which a pilot on the instrument approach glide path can see landing aids at the runway threshold.
- Sleet** — Generally transparent, globular, solid grains of ice which have formed from the freezing of raindrops, or the refreezing of largely melted snowflakes when falling through a below-freezing layer of air near the earth's surface.
- Snow** — Precipitation in the form of white or translucent ice crystals, chiefly in complex branched hexagonal form and often agglomerated into snowflakes.
- Solar Constant** — The rate at which solar radiation is received outside the earth's atmosphere on a surface normal to the incident radiation, and at the earth's mean distance from the sun.
- Source Region** — An extensive area of the earth's surface characterized by uniform surface conditions where masses of air remain long enough to take on fairly definite properties.
- Squall Line** — A nonfrontal line of thunderstorms that generally precedes fast moving cold fronts; a mature instability line.
- Stability** — State of equilibrium of the atmosphere (see Instability).
- Stratosphere** — A layer of the atmosphere above the troposphere in which the air is often stable. The temperature in the stratosphere ranges from about -45°C to -75°C and the lapse rate often tends to be stable (in the mean approximately isothermal). The top of the stratosphere is often said to extend to the base of the mesosphere. (See Chapter 1.)
- Sublimation** — Process by which a gas is changed to a solid or a solid to a gas without going through the liquid state. (Chemists often refer only to the change from solid to gas as sublimation.)
- Subsidence** — An extensive sinking motion of air most frequently observed in polar anticyclones (high pressure regions). The subsiding air is dynamically warmed and becomes more stable.
- Synoptic Chart** — A weather map showing the weather conditions over a large area at a given time.
- Temperature** — A measure of the degree of hotness or coldness of a substance.
- Theodolite** — An optical instrument used to observe a pilot balloon for the purpose of determining wind speed and wind direction, and includes a sighting telescope and necessary scales.
- Tornado** — A violently rotating column of air, pendant from a cumulonimbus cloud, and nearly always observable as a *funnel cloud* or tube.
- Tropical Air** — Warm air having its source in the low latitudes, chiefly in the regions of the subtropical anticyclones.
- Tropical Cyclones** — A cyclone of great inten-

sity, originating in the tropics. Tropical cyclones have been classified according to their intensity, and include tropical depressions, hurricanes, and typhoons. (See Chapter 13.)

Tropopause — The boundary between the troposphere and stratosphere, usually characterized by an abrupt change of lapse rate.

Troposphere — The lower layer of the atmosphere in which there is normally a temperature decrease with height of about 2°C per 1,000 feet. The portion of the atmosphere where the majority of vertical currents, appreciable water vapor content, and weather exist.

Trough — An elongated area of relatively low pressure usually extending from the center of a low pressure system. The opposite of ridge.

Turbulence — The bumpiness, up and down motion or eddies in the normal air current, often of random distribution. Flying in turbulent air areas can result in hazardous

conditions. (See discussion in Chapter 10.)

Unstable — (See Instability.)

Vapor Pressure — The partial pressure due to (exerted by) water vapor in the atmosphere.

Virga — Precipitation falling from clouds, but evaporating before hitting the earth's surface.

Visibility — The maximum horizontal distance at which ordinary objects may be seen and identified.

Warm Front — The boundary between two air masses which moves so that warm air replaces cold air. The warm air is advancing and the cold air retreating.

Waterspout — A tornado over water. Rarely, a whirlwind over water similar to a dust devil (small-scale whirlwind) over land.

Weather — The short-term variations of the atmosphere in terms of temperature, pressure, wind, moisture, cloudiness, precipitation, and visibility.

Wind — Air in motion relative to the surface of the earth.

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