# AVIATION WEATHER SERVICES

AC 00-45F

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Photo courtesy of Aaron A. Gilstad

October 2007

## FOREWORD

Aviation Weather Services, Advisory Circular 00-45F**,** is published jointly by the National Weather Service (NWS) and the Federal Aviation Administration (FAA). This publication supplements its companion manual Aviation Weather, Advisory Circular 00-6A, which documents weather theory and its application to the aviation community.

This advisory circular, AC 00-45F**,** explains U.S. aviation weather products and services. It details the interpretation and application of advisories, coded weather reports, forecasts, observed and prognostic weather charts, and radar and satellite imagery. Product examples and explanations are taken primarily from the Aviation Weather Center's Aviation Digital Data Service website (http://adds.aviationweather.noaa.gov/).

The AC 00-45F was written primarily by Robert A. Prentice and Douglas D. Streu, and edited by Cynthia Abelman. Additional contributors include Raymond Tanabe, Larry Burch, Duane Carpenter, Kathleen Schlachter, Lisa Glikbarg, Celia Miner, Jon Osterberg, Ronald Olson and Richard Akers.

An on-line version of this document, which includes links to additional information, can be found at:

http://www.srh.noaa.gov/faa/

Comments and suggestions for improving this publication are encouraged and should be directed to:

National Weather Service Coordinator, W/SR64
Federal Aviation Administration, AMA-514
Mike Monroney Aeronautical Center
P.O. Box 25082
Oklahoma City, OK 73125-0082

Or via e-mail at:

m9-amc-ama-pwb@faa.gov

Advisory Circular, AC 00-45F**,** supersedes AC 00-45E**,** Aviation Weather Services, revised 1999.

**NOTE: CLICK ON ANY SELECTION IN THE OF THE TABLE OF CONTENTS TO GO DIRECTLY TO THAT ENTRY IN THE DOCUMENT**

**NOTE: CLICK ON ANY SELECTION IN THE OF THE TABLE OF CONTENTS TO GO DIRECTLY TO THAT ENTRY IN THE DOCUMENT.**

# 1 AVIATION WEATHER SERVICE PROGRAM

The aviation weather service program is a joint effort of the National Weather Service (NWS), the Federal Aviation Administration (FAA), the Department of Defense (DOD), and other aviation-oriented groups and individuals. This section discusses the civilian agencies of the U.S. Government and their observation, communication and forecast services to the aviation community.

## 1.1 National Oceanic and Atmospheric Administration (NOAA)

The National Oceanic and Atmospheric Administration (NOAA) is an agency of the Department of Commerce (DOC). NOAA conducts research and gathers data about the global oceans, atmosphere, space, and sun, and applies this knowledge to science and service which touches the lives of all Americans. Among its six major divisions are the National Environmental Satellite Data and Information Service (NESDIS) and the NWS.

### 1.1.1 National Environmental Satellite Data and Information Service (NESDIS)

The National Environmental Satellite Data and Information Service (NESDIS) manages the U.S. civil operational remote-sensing satellite systems, as well as other global information for meteorology, oceanography, solid-earth geophysics, and solar-terrestrial sciences. NESDIS provides this data to NWS meteorologists and a wide range of other users for operational weather forecasting.

#### 1.1.1.1 Satellite Analysis Branch (SAB)

NESDIS' Satellite Analysis Branch (SAB) serves as the operational focal point for real-time imagery products and multi-disciplinary environmental analyses. The SAB's primary mission is to support disaster mitigation and warning services for U.S. Federal agencies and the international community. Routine environmental analyses are provided to forecasters and other environmental users and used in the numerical models of the NWS. The SAB schedules and distributes real-time satellite imagery products from global geostationary and polar-orbiting satellites to environmental users. The SAB coordinates the satellite and other information for the NOAA Volcanic Hazards Alert program under an agreement with the FAA and works with the NWS as part of the Washington, D.C. Volcanic Ash Advisory Center (VAAC).

### 1.1.2 National Weather Service (NWS)

The National Weather Service (NWS) provides weather data, forecasts and warnings for the United States, its territories, adjacent waters and ocean areas for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure that can be used by other government agencies, the private sector, the public and the global community. The following is a description of NWS offices associated with aviation weather.

#### 1.1.2.1 National Centers for Environmental Prediction (NCEP)

The National Centers for Environmental Prediction (NCEP) is where virtually all global meteorological data is collected and analyzed. NCEP then provides a wide variety of national and international weather guidance products to NWS field offices, government agencies, emergency managers, private sector meteorologists, and meteorological organizations and societies throughout the world. NCEP is a critical resource in national and global weather prediction and is the starting point for nearly all weather forecasts in the U. S.

NCEP is comprised of nine distinct centers and the Office of the Director. Each center has its own specific mission. The following NCEP centers provide aviation weather products and services:

#### 1.1.2.1.1 NCEP Central Operations (NCO)

NCEP's Central Operations (NCO) in Camp Springs, Maryland, sustains and executes the operational suite of the numerical analysis and forecast models and prepares NCEP products for dissemination. It also links all nine of the national centers together via computer and communications-related services.

#### 1.1.2.1.2 Aviation Weather Center (AWC)

The Aviation Weather Center (AWC), a Meteorological Watch Office (MWO) for the International Civil Aviation Organization (ICAO), is located in Kansas City, Missouri. The AWC issues the following products in support of FAA air traffic controllers and the National Airspace System (NAS): Airman's Meteorological Information (AIRMETs), Significant Meteorological Information (SIGMETs), Convective SIGMETs, Area Forecasts (FAs), Significant Weather Prognostic Charts (low, middle, and high), Collaborative Convective Forecast Product (CCFP), National Convective Weather Forecast (NCWF), Current Icing Product (CIP), and Forecast Icing Potential (FIP).

#### 1.1.2.1.3 Hydrometeorological Prediction Center (HPC)

The Hydrometeorological Prediction Center (HPC) in Camp Springs, Maryland, provides analysis and forecast products specializing in quantitative precipitation forecasts to five days, weather forecast guidance to seven days, real-time weather model diagnostics discussions and surface pressure and frontal analyses.

#### 1.1.2.1.4 Storm Prediction Center (SPC)

The Storm Prediction Center (SPC) in Norman, Oklahoma, provides tornado and severe weather watches for the contiguous U. S. along with a suite of hazardous weather forecasts including the Alert Severe Weather Watch Bulletins and mesoscale guidance products

#### 1.1.2.1.5 Tropical Prediction Center (TPC)

The Tropical Prediction Center (TPC) in Miami, Florida, provides official NWS forecasts of the movement and strength of tropical weather systems and issues the appropriate watches and warnings for the contiguous U.S. and surrounding areas. It also issues a suite of marine products covering the tropical Atlantic, Caribbean, Gulf of Mexico, and tropical eastern Pacific.

### 1.1.2.2 Alaskan Aviation Weather Unit (AAWU)

The Alaskan Aviation Weather Unit (AAWU), located in Anchorage, Alaska, is a MWO for the ICAO. The AAWU is responsible for the entire Anchorage Flight Information Region (FIR). They issue the following products for the airspace over Alaska and adjacent coastal waters: AIRMETs, SIGMETs, FAs, Graphic Area Forecasts, and Significant Weather Prognostic Charts (Low- and Mid-level – below flight level (FL) 250).

The AAWU is also designated as the Anchorage Volcanic Ash Advisory Center (VAAC). The VAAC area of responsibility includes the Anchorage FIR and Far Eastern Russia and is responsible for the issuance of Volcanic Ash Advisories (FVs).

#### 1.1.2.3 Center Weather Service Unit (CWSU)
Center Weather Service Units (CWSUs) are units of NWS meteorologists under contract with the FAA that are stationed at and support the FAA's Air Route Traffic Control Centers (ARTCC).

CWSUs provide timely weather consultation, forecasts, and advice to managers within ARTCCs and to other supported FAA facilities. This information is based on monitoring, analysis, and interpretation of real-time weather data at the ARTCC through the use of all available data sources including radar, satellite, Pilot Weather Reports (PIREPs), and various NWS products such as Terminal Aerodrome Forecasts (TAFs), FAs, and inflight advisories.

Special emphasis is given to those weather conditions hazardous to aviation or which would impede the flow of air traffic within the NAS. Rerouting of aircraft around hazardous weather is based largely on forecasts provided by the CWSU meteorologist. They issue the following products in support of their respective ARTCC: Center Weather Advisories (CWA) and Meteorological Impact Statements (MIS).

#### 1.1.2.4 Weather Forecast Office (WFO)
A NWS Weather Forecast Office (WFO) is a multi-purpose, local weather forecast center that produces, among its suite of services, aviation-related products. In support of aviation, WFOs issue Terminal Aerodrome Forecasts (TAFs), Transcribed Weather En Route Broadcasts (TWEBs) forecasts, with some offices issuing Airport Weather Warnings, and Soaring Forecasts.

WFO Honolulu is also designated as a Meteorological Watch Office (MWO) for ICAO. As a result of this unique designation, WFO Honolulu is the only WFO to issue the following text products: AIRMETs, SIGMETs, FAs, and Route Forecasts (ROFOR). WFO Honolulu serves as the Central Pacific Hurricane Center (CPHC). CPHC provides official NWS forecast of the movement and strength of tropical weather systems and issues the appropriate watches and warnings for the central Pacific including the State of Hawaii. WFO Honolulu also issues a suite of marine products covering a large portion of the Pacific Ocean.

#### 1.1.2.5 NWS Office at the FAA Academy
The mission of the National Weather Service (NWS) Office at the FAA Academy is to provide weather training for Federal Aviation Administration (FAA) Air Traffic Controllers, write reference materials, and administer NWS certification examinations for FAA Pilot Weather Briefers and Tower Visibility Observers.

## 1.2 Federal Aviation Administration (FAA)

The FAA, a part of the Department of Transportation (DOT), provides a safe, secure, and efficient aerospace system that contributes to national security and the promotion of U.S. aerospace safety. As the leading authority in the international aerospace community, the FAA is responsive to the dynamic nature of user needs, economic conditions, and environmental concerns.

The FAA provides a wide range of services to the aviation community. The following is a description of those FAA facilities which are involved with aviation weather and pilot services.

### 1.2.1 Air Traffic Control System Command Center (ATCSCC)

The Air Traffic Control System Command Center (ATCSCC) is located in Herndon, Virginia. ATCSCC has the mission of balancing air traffic demand with system capacity. This ensures maximum safety and efficiency for the NAS while minimizing delays. The ATCSCC utilizes the Traffic Management System, aircraft situation display, monitor alert, the follow-on functions, and direct contact with ARTCC and terminal radar approach control facility (TRACON) traffic management units to manage flow on a national level.

Because weather is the most common reason for air traffic delays and re-routings, the ATCSCC is supported by Air Traffic Control System Command Center Weather Unit Specialists (ATCSCCWUS). These flight service specialists are responsible for the dissemination of meteorological information as it pertains to national air traffic flow management.

### 1.2.2 Air Route Traffic Control Center (ARTCC)

An ARTCC is a facility established to provide air traffic control service to aircraft operating on Instrument Flight Rules (IFR) flight plans within controlled airspace and principally during the en route phase of flight. When equipment capabilities and controller workload permit, certain advisory/assistance services may be provided to Visual Flight Rules (VFR) aircraft.

En route controllers become familiar with pertinent weather information and stay aware of current weather information needed to perform air traffic control duties. En route controllers advise pilots of hazardous weather that may impact operations within 150 NM of the controller's assigned sector(s).

### 1.2.3 Air Traffic Control Tower (ATCT) and Terminal Radar Approach Control (TRACON)

An ATCT is a terminal facility that uses air/ground communications, visual signaling, and other devices to provide ATC services to aircraft operating in the vicinity of an airport or on the movement area. It authorizes aircraft to land or take off at the airport controlled by the tower or to transit the Class D airspace area regardless of flight plan or weather conditions (IFR or VFR). A tower may also provide approach control services.

TRACONs manage the airspace from 10 to 40 miles outside of selected airports and below 13,000 feet. They also coordinate aircraft spacing as they approach and depart these airports.

Terminal controllers become familiar with pertinent weather information and stay aware of current weather information needed to perform air traffic control duties. Terminal controllers advise pilots of hazardous weather that may impact operations within 150 NM of the controller's assigned sector or area of jurisdiction. ATCTs and TRACONs may opt to broadcast hazardous weather information alerts only when any part of the area described is within 50 NM of the airspace under the ATCT's jurisdiction.

The tower controllers are also properly certified and act as official weather observers as required.

An Automatic Terminal Information Service (ATIS) is a continuous broadcast of recorded information in selected terminal areas. Its purpose is to improve controller effectiveness and to relieve frequency congestion by automating the repetitive transmission of non-controlled airport/terminal area and meteorological information.

### 1.2.4 Flight Service Station (FSS) / Automated Flight Service Station (AFSS)

Flight Service Stations (FSSs) and Automated Flight Service Stations (AFSSs) provide pilot weather briefings, en route weather, receive and process IFR and VFR flight plans, relay ATC clearances, and issue Notices to Airmen (NOTAMs). They also provide assistance to lost aircraft and aircraft in emergency situations, and conduct VFR search and rescue services.

## 1.3 Dissemination of Aviation Weather Products

The ultimate users of aviation weather services are pilots and aircraft dispatchers. Maintenance personnel may use the service to keep informed of weather that could cause possible damage to unprotected aircraft.

Pilots contribute to aviation weather services as well as use them. PIREPs help other pilots, dispatchers, briefers and forecasters as an observation of current conditions.

In the interest of safety and in compliance with Title 14, Code of Federal Regulations, all pilots should get a complete weather briefing before each flight. The pilot is responsible for ensuring he/she has all the information needed to make a safe flight.

### 1.3.1 Weather Briefings

Prior to every flight, pilots should gather all information vital to the nature of the flight. This includes an appropriate weather briefing obtained from a specialist at an FSS, AFSS, or via Direct User Access Terminal Service (DUATS).

To provide an appropriate weather briefing, specialists need to know which of the three types of briefings is needed - a standard, abbreviated or outlook. Other helpful information is whether the flight will be conducted VFR or IFR, aircraft identification and type, departure point, estimated time of departure (ETD), flight altitude, route of flight, destination, and estimated time en route (ETE).

This information is recorded in the flight plan system and a note is made regarding the type of weather briefing provided. If necessary, it can be referenced later to file or amend a flight plan. It is also used when an aircraft is overdue or is reported missing.

#### 1.3.1.1 Standard Briefing

A standard briefing provides a complete weather picture and is the most detailed of all briefings. This type of briefing should be obtained prior to the departure of any flight and should be used during flight planning. A standard briefing provides the following information in sequential order if it is applicable to the route of flight.

1. Adverse Conditions - This includes information about adverse conditions that may influence a decision to cancel or alter the route of flight. Adverse conditions include significant weather such as thunderstorms, aircraft icing, turbulence, wind shear, reduced visibilities and other important items such as airport closings.

2. VFR Flight NOT RECOMMENDED (VNR) - If the weather for the route of flight is below VFR minimums, or if it is doubtful the flight could be made under VFR conditions due to the forecast weather, the briefer may state that VFR is not recommended. The pilot can then decide whether or not to continue the flight under VFR, but this advisory should be weighed carefully.

3. Synopsis - The synopsis is an overview of the larger weather picture. Fronts and major weather systems along or near the route of flight and weather which may affect the flight are provided.

4. Current Conditions - This portion of the briefing contains the current surface weather observations, pilot weather reports (PIREPs), satellite and radar data along the route of flight. If the departure time is more than 2 hours away, current conditions will not be included in the briefing.

5. En Route Forecast - The en route forecast is a summary of the weather forecast for the proposed route of flight.

6. Destination Forecast - The destination forecast is a summary of the expected weather for the destination airport at the estimated time of arrival (ETA).

7. Winds and Temperatures Aloft - Winds and temperatures aloft is a forecast of the winds at specific altitudes along the route of flight. However, the temperature information is provided only on request.

8. NOTAMs - This portion supplies Notice to Airmen (NOTAM) information pertinent to the route of flight which has not been published in the Notice to Airmen publication. Published NOTAM information is provided during the briefing only when requested.

9. ATC Delays - This is an advisory of any known air traffic control (ATC) delays that may affect the flight.

10. Other Information - At the end of the standard briefing, the specialist will provide the radio frequencies needed to open a flight plan and to contact En Route Flight Advisory Service (EFAS). Any additional information requested is also provided at this time.

#### 1.3.1.2 Abbreviated Briefing

An abbreviated briefing is a shortened version of the standard briefing. It should be requested when a departure has been delayed or when specific weather information is needed to update a previous standard briefing. When this is the case, the weather specialist needs to know the time and source of the previous briefing so the necessary weather information will not be omitted inadvertently.

#### 1.3.1.3 Outlook Briefing

An outlook briefing should be requested when a planned departure is 6 or more hours away. It provides initial forecast information that is limited in scope due to the timeframe of the planned flight. This type of briefing is a good source of flight planning information that can influence decisions regarding route of flight, altitude, and ultimately the "go, no-go" decision. A follow-up standard briefing prior to departure is advisable since an outlook briefing generally only contains information based on weather trends and existing weather in geographical areas at or near the departure airport.

The FSS/AFSS's purpose is to serve the aviation community. Pilots should not hesitate to ask questions and discuss factors they do not fully understand. The briefing should be considered complete only when the pilot has a clear picture of what weather to expect. Pilots should also make a final weather check immediately before departure if at all possible.

### 1.3.2 Direct Use Access Terminal Service (DUATS/DUAT)

The Direct User Access Terminal Service, which is funded by the FAA, allows any pilot with a current medical certificate to access weather information and file a flight plan via computer. Two methods of access are available to connect with DUATS. The first is on the Internet through Computer Sciences Corporation (CSC) at http://www.duats.com or Data Transformation Corporation at http://www.duat.com. The second method requires a modem and a communications program supplied by a DUATS provider. To access the weather information and file a flight plan by this method, pilots use a toll free telephone number to connect the user's computer directly to the DUATS computer. The current vendors of DUATS service and the associated phone numbers are listed in Chapter 7 of the *Aeronautical Information Manual (AIM).*

### 1.3.3 Aviation Digital Data Service (ADDS)

The Aviation Digital Data Service (ADDS) provides the aviation community with text, digital and graphical forecasts, analyses, and observations of aviation-related weather variables. ADDS is a joint effort of NOAA Forecast Systems Laboratory (FSL), NCAR Research Applications Laboratory (RAL), and the AWC.

### 1.3.4 Telephone Information Briefing Service (TIBS)

The Telephone Information Briefing Service (TIBS) is a service prepared and disseminated by selected Automated Flight Service Stations. It provides continuous telephone recordings of meteorological and aeronautical information. Specifically, TIBS provides area and route briefings, as well as airspace procedures and special announcements, if applicable. It is designed to be a preliminary briefing tool and is not intended to replace a standard briefing from a flight service specialist. The TIBS service is available 24 hours a day and is updated when conditions change, but it can only be accessed by a TOUCH-TONE phone. The phone numbers for the TIBS service are listed in the Airport/Facility Directory (A/FD).

TIBS should also contain, but is not limited to: surface observations, TAFs, and winds/ temperatures aloft forecasts.

Each AFSS provides at least four route and/or area briefings. As a minimum, area briefings encompass a 50 NM radius. Pilots have access to NOTAM data through: Area or route briefings, on separate channels that are designated specifically for NOTAMs, or by access to a briefer.

Separate channels are designated for each route, area, local meteorological/aeronautical information, special event, airspace procedures, etc.

The order and content of the TIBS recording is as follows:

1. Introduction. Includes the preparation time and the route and/or the area of coverage. The service area may be configured to meet the individual facility's needs.

2. Adverse Conditions. A summary of Convective SIGMETs, SIGMETs, AIRMETs, Center Weather Advisories, Alert Severe Weather Watch Bulletins, and any other available information that may adversely affect flight in the route/area.

3. VNR Statement. Included when current or forecast conditions, surface or aloft, would make the flight under visual flight rules doubtful.

4. Synopsis. A brief statement describing the type, location, and movement of weather systems and/or air masses that might affect the route or the area. This element may be combined with adverse conditions and/or the VNR element, in any order, when it will help to more clearly describe conditions.

5. Current Conditions. A summary of current weather conditions over the route/area. PIREPs are included on conditions reported aloft and a summary of observed radar echoes. Specific departure/destination observation may also be included.

6. Density Altitude. The statement "check density altitude" will be included for any weather reporting point with a field elevation of 2,000 feet MSL or above that meets certain temperature criteria.

7. En Route Forecast. A summary of appropriate forecast data provided in logical order, i.e., climb out, en route, and descent.

8. Winds Aloft. A summary of winds aloft forecast for the route/area as interpolated from forecast data for the local and/or the adjacent reporting locations for levels through 12,000 feet. The broadcast should include the levels from 3,000 to 12,000 feet, but usually includes at least two forecast levels above the surface.

9. Request for PIREPs. When weather conditions within the area or along the route meet requirements for soliciting PIREPs, a request will be included in the recording.

10. NOTAM information that affects the route/area may be included as part of the briefing, on a separate channel, or obtained by direct contact with a pilot weather briefer.

11. Military Training Activity. A statement is included in the closing announcement to contact a briefer for information on military training activity.

12. Closing Announcement.

TIBS services may be reduced during the hours of 1800-0600 local time only. Resumption of full broadcast service is adjusted seasonally to coincide with daylight hours. During the period of reduced broadcast, a recorded statement may indicate when the broadcast will be resumed and to contact Flight Service for weather briefing and other services.

For those pilots already in flight and needing weather information and assistance, the following services are provided by flight service stations. They can be accessed over the proper radio frequencies printed in flight information publications.

### 1.3.5 Hazardous Inflight Weather Advisory Service (HIWAS)

HIWAS is a national program for broadcasting hazardous weather information continuously over selected navigational aids (NAVAIDs). The broadcasts include advisories such as AIRMETs, SIGMETS, convective SIGMETs, and urgent PIREPs. These broadcasts are only a summary of the information, and pilots should contact an FSS/AFSS or En Route Flight Advisory Service (EFAS) for detailed information.

The HIWAS broadcast area is defined as the area within 150 NM of HIWAS outlets.

HIWAS broadcasts are not interrupted or delayed except for emergency situations, when an aircraft requires immediate attention, or for reasonable use of the voice override capability on specific HIWAS outlets in order to use the limited Remote Communications Outlet (RCO) to maintain en route communications. The service is provided 24-hours a day. An announcement is made for no hazardous weather advisories.

Hazardous weather information is recorded if it is occurring within the HIWAS broadcast area. The broadcast includes the following elements:

1. A statement of introduction including the appropriate area(s) and a recording time.

2. A summary of Convective SIGMETs, SIGMETs, AIRMETs, Urgent PIREPs, Aviation Watch Notification Messages, Center Weather Advisories, and any other weather such as isolated thunderstorms that are rapidly developing and increasing in intensity, or low ceilings and visibilities that are becoming widespread which are considered significant and are not included in a current hazardous weather advisory.

3. A request for PIREPs, if applicable.

4. A recommendation to contact AFSS/FSS/FLIGHT WATCH for additional details concerning hazardous weather.

Once the HIWAS broadcast is updated, an announcement will be made once on all communications/NAVAID frequencies except emergency, EFAS, and navigational frequencies already dedicated to continuous broadcast services. In the event a HIWAS broadcast area is out of service, an announcement is made on all communications/NAVAID frequencies except on emergency, EFAS, and navigational frequencies already dedicated to continuous broadcast services.

### 1.3.6 En Route Flight Advisory Service (EFAS)

The purpose of EFAS, radio call "FLIGHT WATCH" (FW), is to provide en route aircraft with timely and pertinent weather data tailored to a specific altitude and route using the most current available sources of aviation meteorological information.

EFAS specialists tailor en route flight advisories to the phase of flight that begins after climb out and ends with descent to land. Current weather and terminal forecast at the airport of first intended landing and/or the alternate airport is provided on request. When conditions dictate, EFAS specialists provide information on weather for alternate routes and/or altitudes to assist the pilot in the avoidance of hazardous flight conditions. The pilot is advised to contact the adjacent flight watch facility when adverse weather conditions along the intended route extend beyond the Flight Watch Area (FWA).

EFAS is NOT used for routine in-flight services; e.g., flight plan filing, position reporting, or full route (pre-flight) briefings. If a request for information is received that is not within the scope of EFAS, the pilot is advised of the appropriate AFSS/FSS to contact.

EFAS specialists suggest route or destination changes to avoid areas of weather that in the judgment of the specialists constitutes a threat to safe flight.

EFAS is provided on 122.0 MHz to aircraft below FL180. An assigned discrete frequency is used to provide EFAS to aircraft at FL180 and above. This frequency can also be used for communications with aircraft below FL180 when communication coverage permits. Aircraft operating at FL 180 or above that contact FW on frequency 122.0 MHz are advised to change to the discrete frequency for EFAS.

# 2 AVIATION WEATHER PRODUCT CLASSIFICATION AND POLICY

The demand for new and improved aviation weather products continues to grow and, with new products introduced to meet the demand, some confusion has resulted in the aviation community regarding the relationship between regulatory requirements and the new weather products.

This section will clarify that relationship by providing:

- classification of the weather products and policy guidance in their use,
- descriptions of the types of aviation weather information, and
- categorization of the sources of aviation weather information.

## 2.1 Classification of Aviation Weather Products

The FAA has developed two classifications of aviation weather products: *primary* weather products, and *supplementary* weather products. The classifications are meant to eliminate confusion by differentiating between weather products that may be used to meet regulatory requirements and other weather products that may only be used to improve situational awareness.

All flight-related, aviation weather decisions must be based on the primary weather products. Supplementary weather products augment the primary products by providing additional weather information, but may not be used as stand-alone products to meet aviation weather regulatory requirements or without the relevant primary products. When discrepancies exist between primary and supplementary products pertaining to the same weather phenomena, pilots must base flight-related decisions on the primary weather product. Furthermore, multiple primary products may be necessary to meet all aviation weather regulatory requirements.

Aviation weather products produced by the federal government (NWS) are primary products unless designated as a supplementary product by the FAA. In addition, the FAA may choose to restrict certain weather products to specific types of usage or classes of user. Any limitations imposed by the FAA on the use of a product will appear in the product label.

### 2.1.1 Primary Weather Product Classification

A primary weather product is an aviation weather product that meets all of the regulatory requirements and safety needs for use in making weather-related flight decisions.

**Note: Sections 3 through 8 of this Advisory Circular are considered Primary Weather Products.**

### 2.1.2 Supplementary Weather Product Classification

A supplementary weather product is an aviation weather product that may be used for enhanced situational awareness. A supplementary weather product must only be used in conjunction with one or more primary weather products. In addition, the FAA may further restrict the use of the supplementary weather products through limitations described in the product label.

**Note: Section 9 of this Advisory Circular contains information on Supplementary Weather Products.**

## 2.2 Types of Aviation Weather Information

The FAA has identified the following three distinct types of weather information that may be needed to conduct aircraft operations: observations, analyses, and forecasts.

### 2.2.1 Observations

Observations are raw weather data collected by some type of sensor(s). The observations can either be in situ (e.g. surface or airborne) or remote (e.g. weather radar, satellite, profiler, and lightning).

### 2.2.2 Analysis

Analyses of weather information are an enhanced depiction and/or interpretation of observed weather data.

### 2.2.3 Forecasts

Forecasts are the predictions of the development and/or movement of weather phenomena based on meteorological observations and various mathematical models.

In-flight weather advisories, including Significant Meteorological Information (SIGMET), Convective SIGMETs, Airman's Meteorological Information (AIRMET), Center Weather Advisories (CWA), and Meteorological Impact Statements (MIS), are considered forecast weather information products.

## 2.3 Categorizing Aviation Weather Sources

The regulations pertaining to aviation weather reflect that, historically, the federal government was the only source of aviation weather information. That is, the FAA and NWS, or its predecessor organizations, were solely responsible for the collection and dissemination of weather data, including forecasts. Thus, the term "approved source(s)" referred exclusively to the federal government. The federal government is no longer the only source of weather information, due to the growing sophistication of aviation operations and scientific and technological advances.

Since all three types of weather information defined in paragraph 2.3 are not available from all sources of aviation weather information, the FAA has categorized the sources as follows: federal government, Enhanced Weather Information System (EWINS), and commercial weather information providers.

### 2.3.1 Federal Government

The FAA and NWS collect weather observations. The NWS analyzes the observations, and produces forecasts, including in-flight aviation weather advisories (e.g., SIGMETs). The FAA and NWS disseminate meteorological observations, analyses, and forecast products through a variety of systems. The federal government is the only approval authority for sources of weather observations (e.g., contract towers and airport operators).

Commercial weather information providers contracted by the FAA to provide weather observations (e.g., contract towers) are included in the federal government category of approved sources by virtue of maintaining required technical and quality assurance standards under FAA and NWS oversight.

### 2.3.2 Enhanced Weather Information System (EWINS)

EWINS is an FAA-approved proprietary system for tracking, evaluating, reporting, and forecasting the presence or absence of adverse weather phenomena. EWINS is authorized to produce flight movement forecasts, adverse weather phenomena forecasts, and other meteorological advisories.

To receive FAA approval, EWINS-approved source must have sufficient procedures, personnel, and communications and data processing equipment to effectively obtain, analyze, and disseminate aeronautical weather data. For a full explanation of the requirements for EWINS approval, see the *Air Transportation Operations Inspector's Handbook*, Order 8400.10, volume 3, chapter 7, section 5. An EWINS-approved source may produce weather analyses and forecasts based on meteorological observations provided by the federal government. Approval to use EWINS weather products is issued on a case by case basis and is currently only applicable to FAR part 121 and 135 certificate holders, who may either act as their own EWINS or contract those services from a separate entity. For these approved users, the weather analyses and forecasts produced by their approved EWINS are considered primary weather products as defined in paragraph 2.2.1, Primary Weather Products.

### 2.3.3 Commercial Weather Information Providers

Commercial weather providers are a major source of weather products for the aviation community. In general, they produce proprietary weather products based on NWS products with formatting and layout modifications but no material changes to the weather information itself. This is also referred to as "repackaging."

Commercial providers may also produce forecasts, analyses, and other proprietary weather products and substantially alter the information contained in NWS-produced products. Hence, operators and pilots contemplating using such services should request and/or review an appropriate description of services and provider disclosure. This should include, but is not limited to,

- the type of weather product (e.g., current weather or forecast weather),
- the currency of the product (i.e., product issue and valid times), and
- the relevance of the product.

Pilots and operators should be cautious when using unfamiliar products, or products not supported by FAA/NWS technical specifications. Commercially-available proprietary weather products that substantially alter NWS-produced weather products, or information, may only be approved for use by part 121 or part 135 operators or fractional ownership programs if the commercial provider is EWINS-qualified (see paragraph 2.4.2, above). Government products that are only repackaged and not altered, or products produced by EWINS-approved source, are considered primary weather products as defined in paragraph 2.2.1, Primary Weather Products.

# 3 OBSERVED TEXT PRODUCTS

## 3.1 Aviation Routine Weather Reports (METAR) and Selected Special Weather Reports (SPECI)

Surface weather observations are fundamental to all meteorological services. Observations are the basic information upon which forecasts and warnings are made in support of a wide range of weather sensitive activities within the public and private sectors, including aviation.

Although the METAR/SPECI code is used worldwide, each country is allowed to make modifications or exceptions to the code for use in their particular country. This section will focus on the U.S. modifications and exceptions. METAR/SPECIs are available online at: http://adds.aviationweather.gov/metars/

### 3.1.1 Aviation Routine Weather Report (METAR)

Aviation Routine Weather Report (METAR) is the primary observation code used in the U. S. to satisfy World Meteorological Organization (WMO) and International Civil Aviation Organization (ICAO) requirements for reporting surface meteorological data. A METAR report includes the airport identifier, time of observation, wind, visibility, runway visual range, present weather phenomena, sky conditions, temperature, dew point, and altimeter setting. Excluding the airport identifier and the time of observation, this information is collectively referred to as "the body of the report." As an addition, coded and/or plain language information elaborating on data in "the body of the report" may be appended to the end of the METAR in a section coded as "Remarks." The contents of the "Remarks" section vary with the type of reporting station. The METAR may be abridged at some designated stations only including a few of the mentioned elements.

### 3.1.2 Selected Special Weather Report (SPECI)

A Selected Special Weather Report (SPECI) is an unscheduled report taken when any of the criteria given in Table 3-1 are observed during the interim period between the hourly reports. SPECI contains all data elements found in a METAR plus additional plain language information which elaborates on data in the body of the report. All SPECIs are made as soon as possible after the relevant criteria are observed.

Whenever SPECI criteria are met at the time of the routine METAR, a METAR is issued.

**Table 3-1. SPECI Criteria**

| | | |
|---|---|---|
| **1** | **Wind Shift** | Wind direction changes by 45 degrees or more in less than 15 minutes and the wind speed is 10 knots or more throughout the wind shift. |
| **2** | **Visibility** | Surface visibility as reported in the body of the report decreases to less than, or if below, increases to equal or exceed:<br><br>a. 3 miles<br>b. 2 miles<br>c. 1 mile<br>d. The lowest standard instrument approach procedure minimum as published in the National Ocean Service (NOS) *U.S Instrument Procedures*. If none published use ½ mile. |
| **3** | **Runway Visual Range (RVR)** | The highest value from the designated RVR runway decreases to less than, or if below, increases to equal or exceed 2,400 feet during the preceding 10 minutes. U.S. military stations may not report a SPECI based on RVR. |
| **4** | **Tornado, Funnel Cloud, or Waterspout** | a. is observed.<br>b. disappears from sight, or ends. |
| **5** | **Thunderstorm** | a. begins (a SPECI is not required to report the beginning of a new thunderstorm if one is currently reported).<br>b. ends. |
| **6** | **Precipitation** | a. hail begins or ends.<br>b. freezing precipitation begins, ends, or changes intensity.<br>c. ice pellets begin, end, or change intensity |
| **7** | **Squalls** | When they occur |
| **8** | **Ceiling** | The ceiling (rounded off to reportable values) forms or dissipates below, decreases to less than, or if below, increases to equal or exceed:<br><br>a. 3,000 feet.<br>b. 1,500 feet<br>c. 1,000 feet<br>d. 500 feet<br>e. The lowest standard instrument approach procedure minimum as published in the National Ocean Service (NOS) *U.S Instrument Procedures.* If none published, use 200 feet. |
| **9** | **Sky Condition** | A layer of clouds or obscurations aloft is present below 1,000 feet and no layer aloft was reported below 1,000 feet in the preceding METAR or SPECI. |
| **10** | **Volcanic Eruption** | When an eruption is first noted |
| **11** | **Aircraft Mishap** | Upon notification of an aircraft mishap, unless there has been an intervening observation |
| **12** | **Miscellaneous** | Any other meteorological situation designated by the responsible agency of which , in the opinion of the observer, is critical. |

### 3.1.3 Format

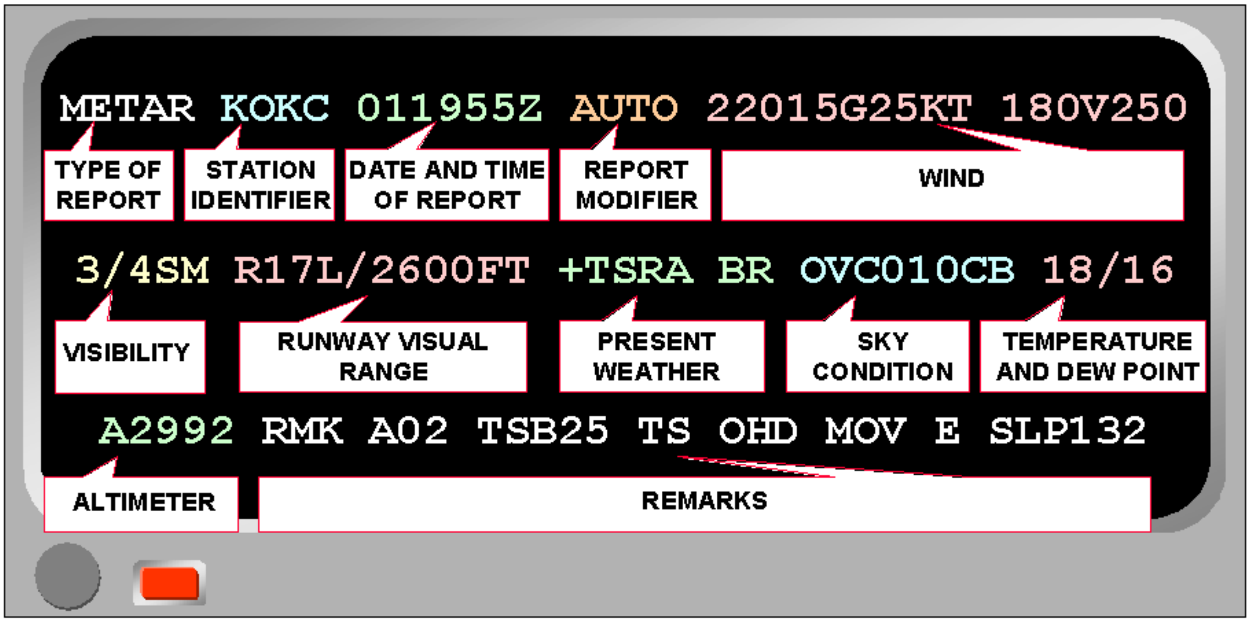


**Figure 3-1. METAR/SPECI Coding Format**

A METAR/SPECI (Figure 3-1) has two major sections: the Body (consisting of a maximum of 11 groups) and the Remarks (consisting of 2 categories). Together, the body and remarks make up the complete METAR/SPECI. When an element does not occur, or cannot be observed, the corresponding group is omitted from that particular report.

#### 3.1.3.1 Type of Report

**METAR** KOKC 011955Z AUTO 22015G25KT 180V250 3/4SM R17L/2600FT +TSRA BR OVC010CB 18/16 A2992 RMK AO2 TSB25 TS OHD MOV E SLP132

The type of report, **METAR** or **SPECI** precedes the body of all reports.

#### 3.1.3.2 Station Identifier

METAR **KOKC** 011955Z AUTO 22015G25KT 180V250 3/4SM R17L/2600FT +TSRA BR OVC010CB 18/16 A2992 RMK AO2 TSB25 TS OHD MOV E SLP132

The station identifier, in ICAO format, is included in all reports to identify the station to which the coded report applies.

The ICAO airport code is a four-letter alphanumeric code designating each airport around the world. The ICAO codes are used for flight planning by air traffic controllers and airline operation departments. These codes are not the same as the International Air Transport Association (IATA) codes encountered by the general public used for reservations, baggage handling and in airline timetables. ICAO codes are also used to identify weather stations located on- or off-airport.

Unlike the IATA codes, the ICAO codes have a regional structure. For example, the first letter is allocated by continent (Figure 3-2), the second is a country within the continent; the remaining two are used to identify each airport.

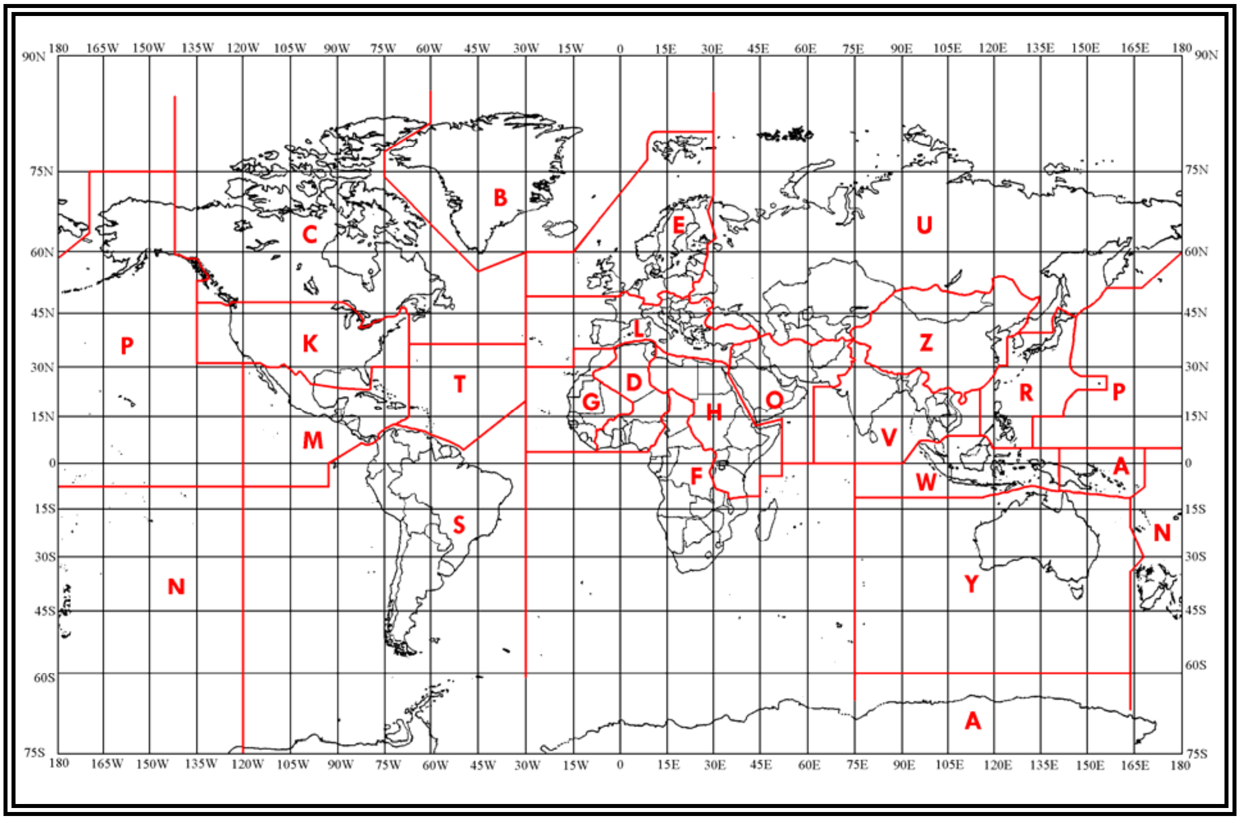


**Figure 3-2. ICAO Continent codes**

In the contiguous U. S., ICAO station identifiers are coded **K** followed by the three-letter IATA identifier. For example, the Seattle, Washington (IATA identifier SEA) becomes the ICAO identifier KSEA.

ICAO station identifiers in Alaska, Hawaii, and Guam begin with the continent code P, followed by the proper country code (A, H, and G respectively), and the two-letter airport identifier.

Examples:

| | |
|---|---|
| PANC | Anchorage, AK |
| PAOM | Nome, AK |
| PHNL | Honolulu, HI |
| PHKO | Keahole Point, HI |
| PGUM | Agana, Guam |
| PGUA | Anderson AFB, Guam |

Canadian station identifiers begin with C, followed by the country code, and the two-letter airport identifier.

Examples:

| | |
|---|---|
| CYYZ | Toronto, Canada |
| CYYC | Calgary Canada |
| CYQB | Quebec, Canada |
| CYXU | London, Canada |
| CZUM | Churchill Falls, Canada |

Mexican and western Caribbean station identifiers begin with M, followed by the proper country code and two-letter airport identifier.

Examples:

| | |
|---|---|
| MMMX | Mexico City, Mexico |
| MUGM | Guantanamo Bay, Cuba |
| MDSD | Santo Domingo, Dominican Republic |
| MYNN | Nassau, Bahamas |

Eastern Caribbean station identifiers begin with T, followed by the proper country code, and airport identifier.

Examples:

| | |
|---|---|
| TJSJ | San Juan, Puerto Rico |
| TIST | Saint Thomas, Virgin Islands |

For a list of Alaskan, Hawaiian, Canadian, Mexican, Pacific, and Caribbean ICAO identifiers see FAA Order 7350.7. For a complete worldwide listing, see ICAO Document 7910, "Location Indicators." Both are available on-line.

### 3.1.3.3 Date and Time of Report

METAR KOKC **011955Z** AUTO 22015G25KT 180V250 3/4SM R17L/2600FT +TSRA BR OVC010CB 18/16 A2992 RMK AO2 TSB25 TS OHD MOV E SLP132

The date and time is coded in all reports as follows: the day of the month is the first two digits (**01**) followed by the hour (**19**), and the minutes (**55**). The coded time of observations is the actual time of the report or when the criteria for a SPECI is met or noted. If the report is a correction to a previously disseminated report, the time of the corrected report is the same time used in the report being corrected. The date and time group always ends with a **Z** indicating Zulu time (or UTC). For example, METAR KOKC 011955Z would be disseminated as the 2000 hour scheduled report for station KOKC taken on the 1st of the month at 1955 UTC.

### 3.1.3.4 Report Modifier (As Required)

METAR KOKC 011955Z **AUTO** 22015G25KT 180V250 3/4SM R17L/2600FT +TSRA BR OVC010CB 18/16 A2992 RMK AO2 TSB25 TS OHD MOV E SLP132

The report modifier, **AUTO**, identifies the METAR/SPECI as a fully automated report with no human intervention or oversight. In the event of a corrected METAR or SPECI, the report modifier, **COR**, is substituted for AUTO.

#### 3.1.3.5 Wind Group

METAR KOKC 011955Z AUTO **22015G25KT 180V250** 3/4SM R17L/2600FT +TSRA BR OVC010CB 18/16 A2992 RMK AO2 TSB25 TS OHD MOV E SLP132

Wind is the horizontal motion of air past a given point. It is measured in terms of velocity, which is a vector that includes direction and speed. It indicates the direction the wind is coming FROM.

In the wind group, the wind direction is coded as the first three digits (**220**) and is determined by averaging the recorded wind direction over a 2-minute period. It is coded in tens of degrees relative to true north using three figures. Directions less than 100 degrees are preceded with a **0**. For example, a wind direction of $90^0$ is coded as **090**.

Immediately following the wind direction is the wind speed coded in two or three digits (**15**). Wind speed is determined by averaging the speed over a 2-minute period and is coded in whole knots using the units, tens digits and, when required, the hundreds digit. When wind speeds are less than 10 knots, a leading zero is used to maintain at least a two digit wind code. For example, a wind speed of 8 knots will be coded **08KT**. The wind group is always coded with a **KT** to indicate wind speeds are reported in knots. Other countries may use kilometers per hour (KPH) or meters per second (MPS) instead of knots.

Examples:

**05008KT** ········► Wind 50 degrees at 8 knots
**15014KT** ········► Wind 150 degrees at 14 knots
**340112KT** ········► Wind 340 degrees at 112 knots

##### 3.1.3.5.1 Wind Gust

Wind speed data for the most recent 10 minutes is examined to evaluate the occurrence of gusts. Gusts are defined as rapid fluctuations in wind speed with a variation of 10 knots or more between peaks and lulls. The coded speed of the gust is the maximum instantaneous wind speed.

Wind gusts are coded in two or three digits immediately following the wind speed. Wind gusts are coded in whole knots using the units, tens, and, if required, the hundreds digit. For example, a wind out of the west at 20 knots with gusts to 35 knots would be coded **27020G35KT**.

##### 3.1.3.5.2 Variable Wind Direction (speed 6 knots or less)

Wind direction may be considered variable when, during the previous 2-minute evaluation period, the wind speed was 6 knots or less. In this case, the wind may be coded as **VRB** in place of the 3-digit wind direction. For example, if the wind speed was recorded as 3 knots, it would be coded **VRB03KT**.

##### 3.1.3.5.3 Variable Wind Direction (speed greater than 6 knots)

Wind direction may also be considered variable when, during the 2-minute evaluation period, it varies by 60 degrees or more and the speed is greater than 6 knots. In this case a variable wind direction group immediately follows the wind group. The directional variability is coded in a clockwise direction and consists of the extremes of the wind directions separated by a **V**. For example, if the wind is variable from 180° to 240° at 10 knots, it would be coded **21010KT 180V240**.

#### 3.1.3.5.4 Calm Wind

When no motion of air is detected, the wind is reported as calm. A calm wind is coded as **00000KT**.

### 3.1.3.6 Visibility Group

```
METAR KOKC 011955Z AUTO 22015G25KT 180V250 3/4SM R17L/2600FT +TSRA BR
OVC010CB 18/16 A2992 RMK AO2 TSB25 TS OHD MOV E SLP132
```

Visibility is a measure of the opacity of the atmosphere.

Prevailing visibility is the reported visibility considered representative of recorded visibility conditions at the station during the time of observation. It is the greatest distance that can be seen throughout at least half of the horizon circle, not necessarily continuous.

Surface visibility is the prevailing visibility from the surface at manual stations or the visibility derived from sensors at automated stations.

The visibility group is coded as the surface visibility in statute miles. A space is coded between whole numbers and fractions of reportable visibility values. The visibility group ends with **SM** to indicate that the visibility is in statute miles. For example, a visibility of one and a half statute miles is coded **1 1/2SM**. Other countries may use meters (no code).

Automated stations use an **M** to indicate "less than." For example, **M1/4SM** means a visibility of less than one-quarter statute mile.

### 3.1.3.7 Runway Visual Range (RVR) Group

```
METAR KOKC 011955Z AUTO 22015G25KT 180V250 3/4SM R17L/2600FT +TSRA BR
OVC010CB 18/16 A2992 RMK AO2 TSB25 TS OHD MOV E SLP132
```

The runway visual range (RVR) is an instrument-derived value representing the horizontal distance a pilot may see down the runway.

RVR is reported whenever the station has RVR equipment and prevailing visibility is 1 statute mile or less and/or the RVR for the designated instrument runway is 6,000 feet or less. Otherwise the RVR group is omitted.

Runway visual range is coded in the following format: the initial **R** is code for runway and is followed by the runway number. When more than one runway is defined with the same runway number a directional letter is coded on the end of the runway number. Next is a solidus **/**; followed by the visual range in feet and then **FT** completes the RVR report. For example, an RVR value for Runway 01L of 800 feet would be coded **R01L/0800FT**. Other countries may use meters.

RVR values are coded in increments of 100 feet up to 1,000 feet, increments of 200 feet from 1,000 feet to 3,000 feet, and increments of 500 feet from 3,000 feet to 6,000 feet. Manual RVR is not reported below 600 feet. At automated stations, RVR may be reported for up to four designated runways.

When the RVR varies by more than one reportable value, the lowest and highest values will be shown with **V** between them indicating variable conditions. For example, the 10-minute RVR for runway 01L varying between 600 and 1,000 feet would be coded **R01L/0600V1000FT**.

If RVR is less than its lowest reportable value, the visual range group is preceded by **M**. For example, an RVR for runway 01L of less than 600 feet is coded **R01L/M0600FT**.

If RVR is greater than its highest reportable value, the visual range group is preceded by a **P**. For example, an RVR for runway 27 of greater than 6,000 feet will be coded **R27/P6000FT**.

### 3.1.3.8 Present Weather Group

```
METAR KOKC 011955Z AUTO 22015G25KT 180V250 3/4SM R17L/2600FT +TSRA BR
OVC010CB 18/16 A2992 RMK AO2 TSB25 TS OHD MOV E SLP132
```

Present weather includes precipitation, obscurations, and other weather phenomena. The appropriate notations found in Table 3-2 are used to code present weather.

**Table 3-2. METAR/SPECI Notations for Reporting Present Weather[1]**

| QUALIFIER | | WEATHER PHENOMENA | | |
|---|---|---|---|---|
| INTENSITY OR PROXIMITY<br>1 | DESCRIPTOR<br>2 | PRECIPITATION<br>3 | OBSCURATION<br>4 | OTHER<br>5 |
| **-** Light | **MI** Shallow | **DZ** Drizzle | **BR** Mist | **PO** Dust/Sand whirls |
| Moderate[2] | **PR** Partial | **RA** Rain | **FG** Fog | **SQ** Squalls |
| **+** Heavy | **BC** Patches | **SN** Snow | **FU** Smoke | **FC** Funnel Cloud, Tornado, or Waterspout[4] |
| **VC** In the Vicinity[3] | **DR** Low Drifting | **SG** Snow Grains | **VA** Volcanic Ash | **SS** Sandstorm |
| | **BL** Blowing | **IC** Ice Crystals (Diamond Dust) | **DU** Widespread Dust | **DS** Duststorm |
| | **SH** Shower(s) | **PL** Ice Pellets | **SA** Sand | |
| | **TS** Thunderstorms | **GR** Hail | **HZ** Haze | |
| | **FZ** Freezing | **GS** Small Hail and/or Snow Pellets | **PY** Spray | |
| | | **UP** Unknown Precipitation | | |

1. The weather groups are constructed by considering columns 1 to 5 in the table above in sequence, i.e., intensity followed by description, followed by weather phenomena, e.g., heavy rain shower(s) is coded as +SHRA.
2. To denote moderate intensity no entry or symbol is used.
3. See text for vicinity definitions.
4. Tornadoes and waterspouts are coded as +FC.

Separate groups are used for each type of present weather. Each group is separated from the other by a space. METAR/SPECI reports contain no more than three present weather groups.

When more than one type of present weather is reported at the same time, present weather is reported in the following order:

- Tornadic activity – Tornado, Funnel Cloud, or Waterspout.
- Thunderstorm(s) with and without associated precipitation.
- Present weather in order of decreasing dominance, i.e., the most dominant type is reported first.
- Left-to-right in Table 3-2 (Columns 1 through 5).

Qualifiers may be used in various combinations to describe weather phenomena. Present weather qualifiers fall into two categories: intensity (Section 3.1.3.8.1) or proximity (Section 3.1.3.8.2) and descriptors (Section 3.1.3.8.3).

#### 3.1.3.8.1 Intensity Qualifier

The intensity qualifiers are light, moderate, and heavy. They are coded with precipitation types except ice crystals (**IC**) and hail (**GR** or **GS**) including those associated with a thunderstorm (**TS**) and those of a showery nature (**SH**). Tornadoes and waterspouts are coded as heavy (**+FC**). No intensity is ascribed to the obscurations of blowing dust (**BLDU**), blowing sand (**BLSA**), and blowing snow (**BLSN**). Only moderate or heavy intensity is ascribed to sandstorm (**SS**) and duststorm (**DS**).

When more than one form of precipitation is occurring at a time or precipitation is occurring with an obscuration, the reported intensities are not cumulative. The reported intensity will not be greater than the intensity for each form of precipitation.

#### 3.1.3.8.2 Proximity Qualifier

Weather phenomena occurring beyond the point of observation (between 5 and 10 statute miles) are coded as in the vicinity (**VC**). VC can be coded in combination with thunderstorm (**TS**), fog (**FG**), shower(s) (**SH**), well-developed dust/sand whirls (**PO**), blowing dust (**BLDU**), blowing sand (**BLSA**), blowing snow (**BLSN**), sandstorm (**SS**), and duststorm (**DS**). Intensity qualifiers are not coded in conjunction with **VC**.

For example, **VCFG** can be decoded as meaning some form of fog is between 5 and 10 statute miles of the point of observation. If **VCSH** is coded, showers are occurring between 5 and 10 statute miles of the point of observation.

Weather phenomena occurring at the point of observation (at the station) or in the vicinity of the point of observation are coded in the body of the report. Weather phenomena observed beyond 10SM from the point of observation (at the station) is not coded in the body but may be coded in the remarks section (Section 3.1.3.12).

#### 3.1.3.8.3 Descriptor Qualifier

Descriptors are qualifiers which further amplify weather phenomena and are used in conjunction with some types of precipitation and obscurations. The descriptor qualifiers are: shallow (**MI**), partial (**PR**), patches (**BC**), low drifting (**DR**), blowing (**BL**), shower(s) (**SH**), thunderstorm (**TS**), and freezing (**FZ**).

Only one descriptor is coded for each weather phenomena group, e.g., **FZDZ**.

The descriptors shallow (**MI**), partial (**PR**), and patches (**BC**) are only coded with **FG**, e.g., **MIFG**. Mist (**BR**) is not coded with any descriptor.

The descriptors low drifting (**DR**) and blowing (**BL**) will only be coded with dust (**DU**), sand (**SA**), and snow (**SN**), e.g., **BLSN** or **DRSN**. **DR** is coded with **DU**, **SA**, or **SN** for raised particles drifting less than six feet above the ground.

When blowing snow is observed with snow falling from clouds, both phenomena are reported, e.g., **SN BLSN**. If blowing snow is occurring and the observer cannot determine whether or not snow is also falling, then **BLSN** is reported. Spray (**PY**) is coded only with blowing (**BL**).

The descriptor for showery-type precipitation (**SH**) is coded only with one or more of the precipitation qualifiers for rain (**RA**), snow (**SN**), ice pellets (**PL**), small hail (**GS**), or large hail (**GR**). The **SH** descriptor indicates showery-type precipitation. When any type of precipitation is coded with **VC**, the intensity and type of precipitation is not coded.

The descriptor for thunderstorm (**TS**) may be coded by itself when the thunderstorm is without associated precipitation. A thunderstorm may also be coded with the precipitation types of rain (**RA**), snow (**SN**), ice pellets (**PL**), small hail and/or snow pellets (**GS**), or hail (**GR**). For example, a thunderstorm with snow and small hail and/or snow pellets would be coded as **TSSNGS**. **TS** are not coded with **SH**.

The descriptor freezing (**FZ**) is only coded in combination with fog (**FG**), drizzle (**DZ**), or rain (**RA**), e.g., **FZRA**. **FZ** is not coded with **SH**.

#### 3.1.3.8.4 Precipitation

Precipitation is any of the forms of water particles, whether liquid or solid, that falls from the atmosphere and reaches the ground. The precipitation types are: drizzle (**DZ**), rain (**RA**), snow (**SN**), snow grains (**SG**), ice crystals (**IC**), ice pellets (**IP**), hail (**GR**), small hail and/or snow pellets (**GS**), and unknown precipitation (**UP**). **UP** is reported if an automated station detects the occurrence of precipitation but the precipitation sensor cannot recognize the type.

Up to three types of precipitation may be coded in a single present weather group. They are coded in order of decreasing dominance based on intensity.

#### 3.1.3.8.5 Obscuration

Obscurations are any phenomenon in the atmosphere, other than precipitation, reducing the horizontal visibility. The obscuration types are: mist (**BR**), fog (**FG**), smoke (**FU**), volcanic ash (**VC**), widespread dust (**DU**), sand (**SA**), haze (**HZ**), and spray (**PY**). Spray (**PY**) is coded only as **BLPY**.

With the exception of volcanic ash, low drifting dust, low drifting sand, low drifting snow, shallow fog, partial fog, and patches (of) fog, an obscuration is coded in the body of the report if the surface visibility is less than 7 miles or considered operationally significant. Volcanic ash is always reported when observed.

#### 3.1.3.8.6 Other Weather Phenomena

Other weather phenomena types include: well-developed dust/sand whirls (**PO**), sand storms (**SS**), dust storms (**DS**), squalls (**SQ**), funnel clouds (**FC**), and tornados and waterspouts (**+FC**).

Examples:

| | |
|---|---|
| **-DZ** → | Light drizzle |
| **-RASN** → | Light rain and snow |
| **SN BR** → | (Moderate) snow, mist |
| **-FZRA FG** → | Light freezing rain, fog |
| **SHRA** → | (Moderate) rain shower |
| **VCBLSA** → | Blowing sand in the vicinity |
| **-RASN FG HZ** → | Light rain and snow, fog, haze |
| **TS** → | Thunderstorm (without precipitation) |

**+TSRA** ····················► Thunderstorm, heavy rain
**+FC TSRAGR BR** ··········► Tornado, thunderstorm, (moderate) rain, hail, mist

### 3.1.3.9 Sky Condition Group

```
METAR KOKC 011955Z AUTO 22015G25KT 180V250 3/4SM R17L/2600FT +TSRA BR
OVC010CB 18/16 A2992 RMK AO2 TSB25 TS OHD MOV E SLP132
```

Sky condition is a description of the appearance of the sky. It is coded as: sky condition, vertical visibility, or clear skies.

The sky condition group is based on the amount of sky cover (the first three letters) followed by the height of the base of the sky cover (final three digits). No space is between the amount of sky cover and the height of the layer. The height of the layer is recorded in feet Above Ground Level (AGL).

Sky condition is coded in ascending order and ends at the first overcast layer. At mountain stations, if the layer is below station level, the height of the layer will be coded as ***///***.

Vertical visibility is coded as **VV** followed by the vertical visibility into the indefinite ceiling. No space is between the group identifier and the vertical visibility. Figure 3-3 illustrates the effect of an obscuration on the vision from a descending aircraft.

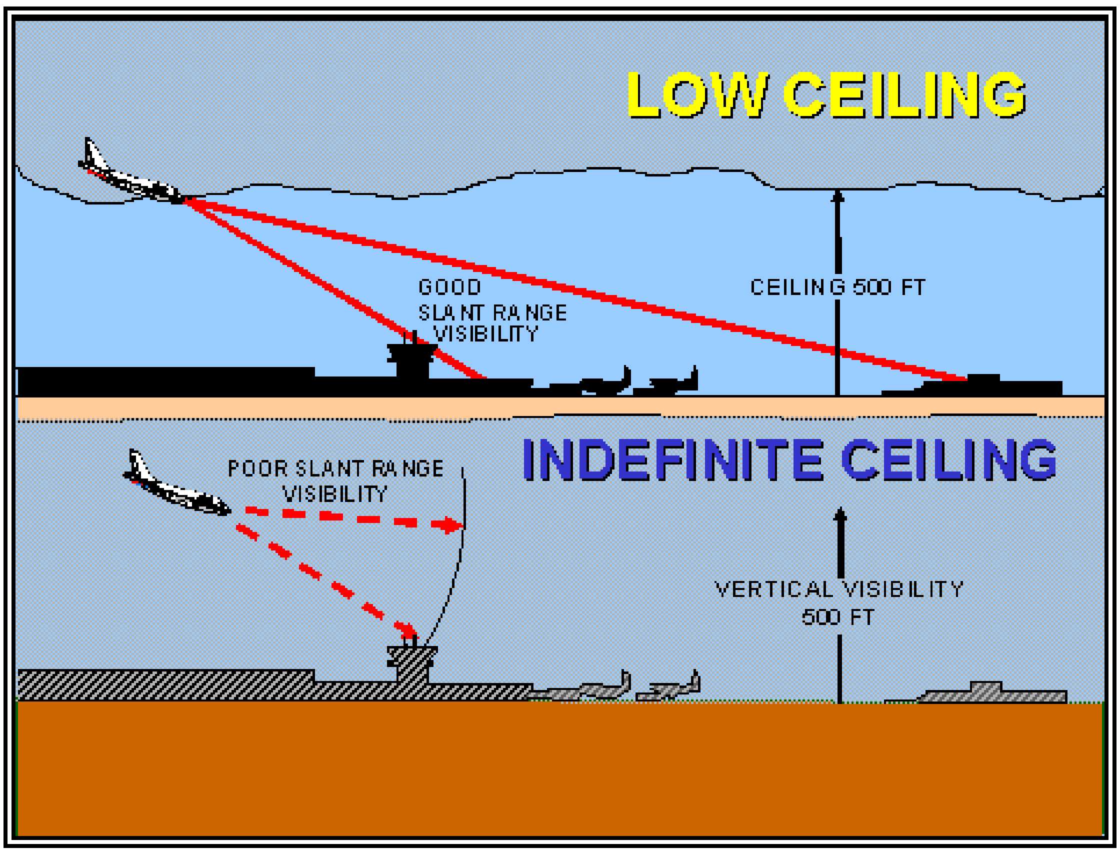


**Figure 3-3. Obscuration Effects on Slant Range Visibility**
**The ceiling is 500 feet in both examples, but the indefinite ceiling example (bottom) produces a more adverse impact to landing aircraft. This is because an obscuration (e.g., fog, blowing dust, snow, etc.) limits runway**

**acquisition due to reduced slant range visibility. This pilot would be able to see the ground but not the runway. If the pilot was at approach minimums, the approach could not be continued and a missed approach must be executed.**

Clear skies are coded in the format, **SKC** or **CLR**. When **SKC** is used, an observer indicates no layers are present; and **CLR** is used by automated stations to indicate no layers are detected at or below 12,000 feet.

Each coded layer is separated from the others by a space. Each layer reported is coded by using the appropriate reportable contraction seen in Table 3-3. A report of clear skies (**SKC** or **CLR**) is a complete layer report within itself. The abbreviations **FEW**, **SCT**, **BKN**, and **OVC** will be followed, without a space, by the height of the layer.

**Table 3-3. METAR/SPECI Contractions for Sky Cover**

| Reportable Contraction | Meaning | Summation Amount of Layer |
|---|---|---|
| **VV** | Vertical Visibility | 8/8 |
| **SKC or CLR**[1] | Clear | 0 |
| **FEW**[2] | Few | 1/8 – 2/8 |
| **SCT** | Scattered | 3/8 – 4/8 |
| **BKN** | Broken | 5/8 – 7/8 |
| **OVC** | Overcast | 8/8 |

1. The abbreviation **CLR** will be used at automated stations when no layers at or below 12,000 feet are reported; the abbreviation **SKC** will be used at manual stations when no layers are reported.
2. Any layer amount less than 1/8 is reported as FEW.

The height is coded in hundreds of feet above the surface using three digits in accordance with Table 3-4.

**Table 3-4. METAR/SPECI Increments of Reportable Values of Sky Cover Height**

| Range of Height Values (feet) | Reportable Increment (feet) |
|---|---|
| Less than or equal to 5,000 | To nearest 100 |
| 5,001 to 10,000 | To nearest 500 |
| Greater than 10,000 | To nearest 1,000 |

The ceiling is the lowest layer aloft reported as broken or overcast. If the sky is totally obscured with ground based clouds, the vertical visibility is the ceiling.

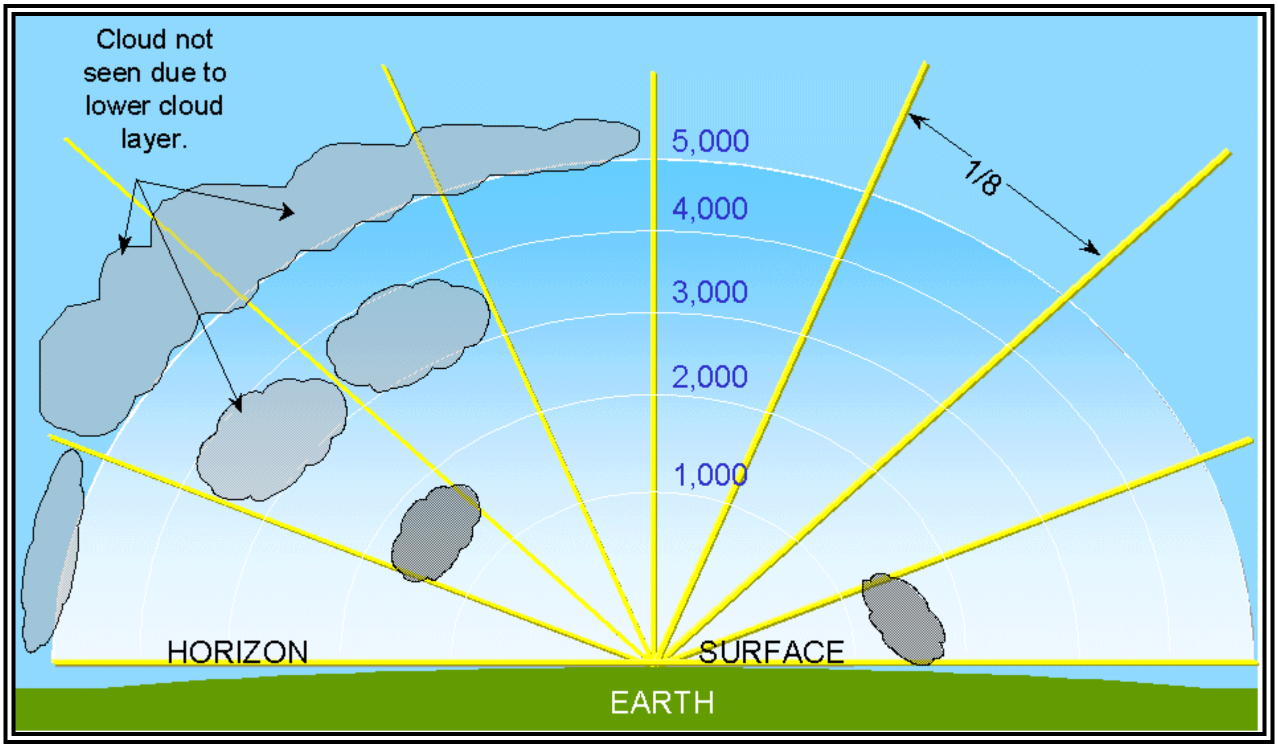


**Figure 3-4. METAR/SPECI Sky Condition Coding**

**Clouds at 1,200 feet obscure 2/8ths of the sky (FEW). Higher clouds at 3,000 feet obscure an additional 1/8th of the sky, and because the observer cannot see above the 1,200-foot layer, he is to assume that the higher 3,000-foot layer also exists above the lower layer (SCT). The highest clouds at 5,000 feet obscure 2/8ths of the sky, and again since the observer cannot see past the 1,200 and 3,000-foot layers, he is to assume the higher 5,000-foot layer also exists above the lower layers (BKN). The sky condition group would be coded as: FEW012 SCT030 BKN050.**

At manual stations, cumulonimbus (**CB**) or towering cumulus (**TCU**) is appended to the associated layer. For example, a scattered layer of towering cumulus at 1,500 feet would be coded **SCT015TCU** and would be followed by a space if there were additional higher layers to code.

Examples:

| | |
|---|---|
| **SKC** | No layers are present |
| **CLR** | No layers are detected at or below 12,000 feet AGL |
| **FEW004** | Few at 400 feet AGL |
| **SCT023TCU** | Scattered layer of towering cumulus at 2,300 feet |
| **BKN105** | Broken layer (ceiling) at 10,500 feet |
| **OVC250** | Overcast layer (ceiling) at 25,000 feet |
| **VV001** | Indefinite ceiling with a vertical visibility of 100 feet |
| **FEW012 SCT046** | Few clouds at 1,200 feet, scattered layer at 4,600 feet |
| **SCT033 BKN085** | Scattered layer at 3,300 feet, broken layer (ceiling) at 8,500 feet |
| **SCT018 OVC032CB** | Scattered layer at 1,800 feet, overcast layer (ceiling) of cumulonimbus at 7,500 feet |
| **SCT009 SCT024 BKN048** | Scattered layer at 900 feet, scattered layer at 2,400 feet, broken layer (ceiling) at 4,800 feet |

### 3.1.3.10 Temperature/Dew Point Group

METAR KOKC 011955Z AUTO 22015G25KT 180V250 3/4SM R17L/2600FT +TSRA BR OVC010CB **18/16** A2992 RMK AO2 TSB25 TS OHD MOV E SLP132

Temperature is the degree of hotness or coldness of the ambient air seems as measured by a suitable instrument. Dew point is the temperature to which a given parcel of air must be cooled at constant pressure and constant water vapor content for the air to become fully saturated.

Temperature and dew point are coded as two digits rounded to the nearest whole degree Celsius. For example, a temperature of 0.3°C would be coded at **00**. Sub-zero temperatures and dew points are prefixed with an **M**. For example, a temperature of 4°C with a dew point of –2°C would be coded as **04/M02**; a temperature of –2°C would be coded as **M02**.

If temperature is not available, the entire temperature/dew point group is not coded. If dew point is not available, temperature is coded followed by a solidus, ***/*,** and no entry made for dew point. For example, a temperature of 1.5°C and a missing dew point would be coded as **02/.**

### 3.1.3.11 Altimeter

METAR KOKC 011955Z AUTO 22015G25KT 180V250 3/4SM R17L/2600FT +TSRA BR OVC010CB 18/16 **A2992** RMK AO2 TSB25 TS OHD MOV E SLP132

The altimeter setting group codes the current pressure at elevation. This setting is then used by aircraft altimeters to determine the true altitude above a fixed plane of mean sea level.

The altimeter group always starts with an **A** (the international indicator for altimeter in inches of mercury) and is followed by the four digit group representing the pressure in tens, units, tenths, and hundredths of inches of mercury. The decimal point is not coded. For example, an altimeter setting of 29.92 inches of Mercury would be coded as **A2992**.

### 3.1.3.12 Remarks (RMK)

METAR KOKC 011955Z AUTO 22015G25KT 180V250 3/4SM R17L/2600FT +TSRA BR OVC010CB 18/16 A2992 **RMK AO2 TSB25 TS OHD MOV E SLP132**

Remarks are included in all METAR and SPECI, when appropriate.

Remarks are separated from the body of the report by the contraction **RMK**. When no remarks are necessary, the contraction **RMK** is not required.

METAR/SPECI remarks fall into two categories: (1) Automated, Manual, and Plain Language, and (2) Additive Maintenance Data.

**Table 3-5. METAR/SPECI Order of Remarks**

| Automated, Manual, and Plain Language | | | | Additive and Automated Maintenance Data | |
|---|---|---|---|---|---|
| 1. | Volcanic Eruptions | 14. | Hailstone Size | 27. | Precipitation* |
| 2. | Funnel Cloud | 15. | Virga | 28. | Cloud Types* |
| 3. | Type of Automated Station | 16. | Variable Ceiling Height | 29. | Duration of Sunshine* |
| 4. | Peak Wind | 17. | Obscurations | 30. | Hourly Temperature and Dew Point |
| 5. | Wind Shift | 18. | Variable Sky Condition | 31. | 6-Hourly Maximum Temperature* |
| 6. | Tower or Surface Visibility | 19. | Significant Cloud Types | 32. | 6-Hourly Minimum Temperature* |
| 7. | Variable Prevailing Visibility | 20. | Ceiling Height at Second Location | 33. | 24-Hour Maximum and Minimum Temperature* |
| 8. | Sector Visibility | 21. | Pressure Rising or Falling Rapidly | 34. | 3-Hourly Pressure Tendency* |
| 9. | Visibility at Second Location | 22. | Sea-Level Pressure | 35. | Sensor Status Indicators |
| 10. | Lightning | 23. | Aircraft Mishap | 36. | Maintenance Indicator |
| 11. | Beginning and Ending of Precipitation | 24. | No SPECI Reports Taken | Note: Additive data is primarily used by the National Weather Service for climatological purposes.<br><br>* These groups should have no direct impact on the aviation community and will not be discussed in this document. | |
| 12. | Beginning and Ending of Thunderstorms | 25. | Snow Increasing Rapidly | | |
| 13. | Thunderstorm Location | 26. | Other Significant Information | | |

Remarks are made in accordance with the following:

- Time entries are made in minutes past the hour if the time reported occurs during the same hour the observation is taken. Hours and minutes are used if the hour is different;
- Present weather coded in the body of the report as **VC** may be further described, i.e., direction from the station, if known. Weather phenomena beyond 10 statute miles of the point(s) of observation are coded as distant (**DSNT**) followed by the direction from the station. For example, precipitation of unknown intensity within 10 statute miles east of the station would be coded as **VCSH E**; lightning 25 statute miles west of the station would be coded as **LTG DSNT W**;
- Distance remarks are in statute miles except for automated lightning remarks which are in nautical miles;

- Movement of clouds or weather, when known, is coded with respect to the direction toward which the phenomena are moving. For example, a thunderstorm moving toward the northeast would be coded as **TS MOV NE**;

- Directions use the eight points of the compass coded in a clockwise order; and

- Insofar as possible, remarks are entered in the order they are presented in the following paragraphs (and Table 3-5).

**3.1.3.13 Automated, Manual, and Plain Language Remarks**
These remarks generally elaborate on parameters reported in the body of the report. Automated and manual remarks may be generated either by an automated station or observer. Plain language remarks are only provided from an observer.

**3.1.3.13.1 Volcanic Eruptions (Plain Language)**
Volcanic eruptions are coded in plain language and contain the following, when known:

- **Name** of volcano
- **Latitude and longitude** or the direction and approximate distance from the station
- **Date/Time** (UTC) of the eruption
- Size **description**, approximate height, and direction of movement **of the ash cloud**
- Any **other pertinent data** about the eruption

For example, a remark on a volcanic eruption would look like the following:

```
MT. AUGUSTINE VOLCANO 70 MILES SW ERUPTED AT 231505 LARGE ASH CLOUD
EXTENDING TO APRX 30000 FEET MOVING NE.
```

Pre-eruption volcanic activity is not coded. Pre-eruption refers to unusual and/or increasing volcanic activity which could presage a volcanic eruption.

**3.1.3.13.2 Funnel Cloud**
At manual stations, tornadoes, funnel clouds, and waterspouts are coded in the following format: Tornadic activity, **TORNADO**, **FUNNEL CLOUD**, or **WATERSPOUT,** followed by the beginning and/or ending time, followed by the location and/or direction of the phenomena from the station, and/or movement, when known. For example, **TORNADO B13 6 NE** would indicate that a tornado began at 13 minutes past the hour and was 6 statute miles northeast of the station.

**3.1.3.13.3 Type of Automated Station**
**AO1** or **AO2** are coded in all METAR/SPECI from automated stations. Automated stations without a precipitation discriminator are identified as **AO1**; automated stations with a precipitation discriminator are identified as **AO2**.

**3.1.3.13.4 Peak Wind**
Peak wind is coded in the following format: the remark identifier **PK WND**, followed by the direction of the wind (first three digits), peak wind speed (next two or three digits) since the last METAR, and the time of occurrence. A space is between the two elements of the remark identifier and the wind direction/speed group; a solidus, ***/***, (without spaces) separates the wind

direction/speed group and the time. For example, a peak wind of 45 knots from 280 degrees which occurred at 15 minutes past the hour is coded **PK WND 28045/15**.

#### 3.1.3.13.5 Wind Shift

Wind shift is coded in the format: the remark identifier **WSHFT**, followed by the time the wind shift began. The contraction **FROPA** is entered following the time if there is reasonable data to consider the wind shift was the result of a frontal passage. A space is between the remark identifier and the time and, if applicable, between the time and the frontal passage contraction. For example, a remark reporting a wind shift accompanied by a frontal passage that began at 30 minutes after the hour would be coded as **WSHFT 30 FROPA**.

#### 3.1.3.13.6 Tower or Surface Visibility

Tower or surface visibility is coded in the following format: tower **TWR VIS** or surface **SFC**, followed by the observed tower/surface visibility value. A space is coded between each of the remark elements. For example, the control tower visibility of 1 ½ statute miles would be coded **TWR VIS 1 1/2**.

#### 3.1.3.13.7 Variable Prevailing Visibility

Variable prevailing visibility is coded in the following format: the remark identifier **VIS**, followed the lowest and highest visibilities evaluated separated by the letter **V**. A space follows the remark identifier and no spaces are between the letter **V** and the lowest/highest values. For example, a visibility that was varying between 1/2 and 2 statute miles would be coded **VIS 1/2V2**.

#### 3.1.3.13.8 Sector Visibility (Plain Language)

Sector visibility is coded in the following format: the remark identifier **VIS**, followed by the sector referenced to 8 points of the compass, and the sector visibility in statute miles. For example, a visibility of 2 1/2 statute miles in the northeastern octant is coded **VIS NE 2 1/2**.

#### 3.1.3.13.9 Visibility at Second Location

At designated automated stations, the visibility at a second location is coded in the following format: the remark identifier **VIS**, followed by the measured visibility value and the specific location of the visibility sensor(s) at the station. This remark will only be generated when the condition is lower than that contained in the body of the report. For example, a visibility of 2 1/2 statute miles measured by a second sensor located at runway 11 is coded **VIS 2 1/2 RWY11**.

#### 3.1.3.13.10 Lightning

When lightning is observed at a manual station, the frequency, type of lightning and location is reported. The contractions for the type and frequency of lightning are based on Table 3-6, for example, **OCNL LTGICCG NW**, **FRQ LTG VC**, or **LTG DSNT W**.

When lightning is detected by an automated system:

- Within 5 nautical miles of the Airport Location Point (ALP), it is reported as **TS** in the body of the report with no remark;
- Between 5 and 10 nautical miles of the ALP, it is reported as **VCTS** in the body of the report with no remark; and
- Beyond 10 but less than 30 nautical miles of the ALP, it is reported in remarks only as **LTG DSNT** followed by the direction from the ALP.

**Table 3-6. METAR/SPECI Type and Frequency of Lightning**

| Type of Lightning | | |
|---|---|---|
| **Type** | **Contraction** | **Definition** |
| Cloud-ground | CG | Lightning occurring between cloud and ground. |
| In-cloud | IC | Lightning which takes place within the cloud. |
| Cloud-cloud | CC | Streaks of lightning reaching from one cloud to another. |
| Cloud-air | CA | Streaks of lightning which pass from a cloud to the air, but do not strike the ground. |
| **Frequency of Lightning** | | |
| **Frequency** | **Contraction** | **Definition** |
| Occasional | OCNL | Less than 1 flash/minute. |
| Frequent | FRQ | About 1 to 6 flashes/minute. |
| Continuous | CONS | More than 6 flashes/minute. |

#### 3.1.3.13.11 Beginning and Ending of Precipitation

At designated stations, the beginning and ending time of precipitation is coded in the following format: the type of precipitation, followed by either a **B** for beginning or an **E** for ending, and the time of occurrence. No spaces are coded between the elements. The coded times of the precipitation start and stop times are found in the remarks section of the next METAR. The times are not required to be in the SPECI. The intensity qualifiers are coded. For example, if rain began at 0005 and ended at 0030 and then snow began at 0020 and ended at 0055, the remarks would be coded as **RAB05E30SNB20E55**. If the precipitation were showery, the remark is coded **SHRAB05E30SHSNB20E55**. If rain ended and snow began at 0042, the remark would be coded as **RAESNB42**.

#### 3.1.3.13.12 Beginning and Ending of Thunderstorms

The beginning and ending of thunderstorms are coded in the following format: **TS** for thunderstorms, followed by either a **B** for beginning or an **E** for ending and the time of occurrence. No spaces are between the elements. For example, if a thunderstorm began at 0159 and ended at 0230, the remark is coded **TSB0159E30**.

#### 3.1.3.13.13 Thunderstorm Location (Plain Language)

Thunderstorm locations are coded in the following format: the thunderstorm identifier, **TS**, followed by location of the thunderstorm(s) from the station and the direction of movement when known. For example, a thunderstorm southeast of the station and moving toward the northeast is coded **TS SE MOV NE**.

#### 3.1.3.13.14 Hailstone Size (Plain Language)

At designated stations the hailstone size is coded in the following format: the hail identifier **GR**, followed by the size of the largest hailstone. The hailstone size is coded in ¼ inch increments. For example, **GR 1 3/4** would indicate that the largest hailstone were 1 ¾ inches in diameter. If small hail or snow pellets, **GS,** is coded in the body of the report, no hailstone size remark is required.

#### 3.1.3.13.15 Virga (Plain Language)

Virga is coded in the following format: the identifier **VIRGA**, followed by the direction from the station. The direction of the phenomena from the station is optional, e.g., **VIRGA** or **VIRGA SW**.

#### 3.1.3.13.16 Variable Ceiling Height

The variable ceiling height is coded in the following format: the identifier **CIG**, followed by the lowest ceiling height recorded, **V** denoting variability between two values, and ending with the highest ceiling height. A single space follows the identifier with no other spaces between the letter **V** and the lowest/highest ceiling values. For example, **CIG 005V010** would indicate a ceiling is variable between 500 and 1,000 feet.

#### 3.1.3.13.17 Obscurations (Plain Language)

Obscurations, surface-based or aloft, are coded in the following format: the weather identifier causing the obscuration at the surface or aloft followed by the sky cover of the obscuration aloft (FEW, SCT, BKN, OVC) or at the surface (FEW, SCT, BKN), and the height. Surface-based obscurations have a height of **000**. A space separates the weather causing the obscuration and the sky cover; no space is between the sky cover and the height. For example, fog hiding 3/8 to 4/8 of the sky is coded **FG SCT000**; a broken layer at 2,000 feet composed of smoke is coded **FU BKN020**.

#### 3.1.3.13.18 Variable Sky Condition (Plain Language)

Variable sky condition remarks are coded in the following format: the two operationally significant sky conditions (FEW, SCT, BKN, OVC) separated by spaces and **V** denoting the variability between the two ranges. If several layers have the same condition amount, the layer height of the variable layer is coded. For example, a cloud layer at 1,400 feet varying between broken and overcast is coded **BKN014 V OVC**.

#### 3.1.3.13.19 Significant Cloud Types (Plain Language)

Significant cloud type remarks are coded in all reports.

#### 3.1.3.13.19.1 Cumulonimbus or Cumulonimbus Mammatus

Cumulonimbus or Cumulonimbus Mammatus not associated with thunderstorms are coded in the following format: the cloud type (**CB** or **CBMAM**) followed by the direction from the station and the direction of movement when known. The cloud type, location, direction, and direction of movement entries are separated from each other by a space. For example, a CB up to 10 statute miles west of the station moving toward the east would be coded **CB W MOV E**. If the CB was more than 10 statute miles to the west, the remark is coded **CB DSNT W**.

Cumulonimbus (CB) always evolves from the further development of towering cumulus (TCU). The unusual occurrence of lightning and thunder within or from a CB leads to its popular titl, thunderstorm. A thunderstorm usually contains severe or greater turbulence, severe icing, low level wind shear (LLWS), and instrument flight rules (IFR) conditions.

**Figure 3-5. Cumulonimbus (CB) Example**
**CB always evolves from the further development of towering cumulus (TCU). The usual occurrence of lightning and thunder within or from a CB leads to its popular title, thunderstorm. A thunderstorm usually contains severe or greater turbulence, severe icing, low level wind shear (LLWS), and instrument flight rules (IFR) conditions. (Copyright Robert A. Prentice, 1990)**

**Figure 3-6. Cumulonimbus Mammatus (CBMAM) Example**
**Cumulonimbus Mammatus (CBMAM) (also called mammatus) appears as hanging protuberances, like pouches, on the undersurface of a cloud. (Copyright Robert A. Prentice, 1993)**

### 3.1.3.13.19.2 Towering Cumulus

Towering cumulus clouds are coded in the following format: the identifier **TCU** followed by the direction from the station. The cloud type and direction entries are separated by a space. For example, a towering cumulus cloud up to 10 statute miles west of the station is coded as **TCU W**.

**Figure 3-7. Towering Cumulus (TCU) Example**

**Towering Cumulus (TCU). TCU is produced by strong convective updrafts and, thus, indicates turbulence. Icing is typically found above the freezing level. TCU often transforms into cumulonimbus (CB). (Copyright Charles A. Doswell, III, 1977)**

### 3.1.3.13.19.3 Altocumulus Castellanus

Altocumulus Castellanus is coded in the following format: the identifier **ACC** followed by direction from the station. The cloud type and direction entries are separated by a space. For example, an altocumulus cloud 5 to 10 statute miles northwest of the station is coded **ACC NW**.

**Figure 3-8. Altocumulus Castellanus (ACC) Example**
**Altocumulus Castellanus (ACC). ACC indicates convective turbulence aloft from the top of the cloud to its base and usually an undetermined height below cloud base as well. (Photo courtesy of National Severe Storms Laboratory/University of Oklahoma)**

### 3.1.3.13.19.4 Standing Lenticular or Rotor Clouds

Stratocumulus (**SCSL**), altocumulus (**ACSL**), or cirrocumulus (**CCSL**), or rotor clouds are coded in the following format: the cloud type followed by the direction from the station. The cloud type and direction entries are separated by a space. For example, altocumulus standing lenticular clouds observed southwest through west of the station are coded **ACSL SW-W**; an apparent rotor cloud 5 to 10 statute miles northeast of the station is coded **APRNT ROTOR CLD NE**; and cirrocumulus clouds south of the station are coded **CCSL S**.

**Figure 3-9. Standing Lenticular and Rotor Clouds Example**
**From top to bottom: Cirrocumulus standing lenticular (CCSL), altocumulus standing lenticular (ACSL), and rotor cloud. These clouds are characteristic of mountain waves. Mountain waves can occasionally produce violent downslope windstorms. Intense mountain waves can present a significant hazard to aviation by producing severe or even extreme turbulence that extends upward into the lower stratosphere.**

### 3.1.3.13.20 Ceiling Height at Second Location

At designated stations, the ceiling height at a second location is coded in the following format: the identifier **CIG** followed by the measured height of the ceiling and the specific location of the ceilometer(s) at the station. This remark is only generated when the ceiling is lower than that contained in the body of the report. For example, if the ceiling measured by a second sensor located at runway 11 is broken at 200 feet, the remark would be **CIG 002 RWY11**.

#### 3.1.3.13.21 Pressure Rising or Falling Rapidly

At designated stations, the reported pressure is evaluated to determine if a pressure change is occurring. If the pressure is rising or falling at a rate of at least 0.06 inch per hour and the pressure change totals 0.02 inch or more at the time of the observation, a pressure change remark is reported. When the pressure is rising or falling rapidly at the time of observation, the remark **PRESRR** (pressure rising rapidly) or **PRESFR** (pressure falling rapidly) is included in the remarks.

#### 3.1.3.13.22 Sea-Level Pressure

At designated stations, the sea-level pressure is coded in the following format: the identifier **SLP** immediately followed by the sea level pressure in hectopascals. The hundreds and thousands units are not coded and must be inferred. For example, a sea-level pressure of 998.2 hectopascals is coded as **SLP982**. A sea-level pressure of 1013.2 hectopascals would be coded as **SLP132**. For a METAR, if sea-level pressure is not available, it is coded as **SLPNO**.

#### 3.1.3.13.23 Aircraft Mishap (Plain Language)

If a SPECI report is taken to document weather conditions when notified of an aircraft mishap, the remark **ACFT MSHP** is coded in the report but the SPECI not transmitted.

#### 3.1.3.13.24 No SPECI Reports Taken (Plain Language)

At manual stations where SPECIs are not taken, the remark **NOSPECI** is coded to indicate no changes in weather conditions will be reported until the next METAR.

#### 3.1.3.13.25 Snow Increasing Rapidly

At designated stations, the snow increasing rapidly remark is reported, in the NEXT METAR, whenever the snow depth increases by 1 inch or more in the past hour. The remark is coded in the following format: the remark indicator **SNINCR**, the depth increase in the past hour, and the total depth of snow on the ground at the time of the report. The depth of snow increase in the past hour and the total depth on the ground are separated from each other by a solidus, **/**. For example, a snow depth increase of 2 inches in the past hour with a total depth on the ground of 10 inches is coded **SNINCR 2/10**.

#### 3.1.3.13.26 Other Significant Information (Plain Language)

Agencies may add to a report other information significant to their operations, such as information on fog dispersal operations, runway conditions, **FIRST** or **LAST** reports from station, etc.

### 3.1.3.14 Additive and Automated Maintenance Data

Additive data groups (Table 3-5) are only reported at designated stations and are primarily used by the NWS for climatological purposes. Most have no direct impact on the aviation community but a few are discussed below.

#### 3.1.3.14.1 Hourly Temperature and Dew Point

At designated stations, the hourly temperature and dew point group are further coded to the tenth of a degree Celsius. For example, a recorded temperature of +2.6°C and dew point of -1.5°C would be coded as **T00261015**.

The format for the coding is as follows:

**T** Group indicator
**0** Indicates the following number is positive; a **1** would be used if the temperature was reported as negative at the time of observation
**026** Temperature disseminated to the nearest $10^{th}$ and read as 02.6
**1** Indicates the following number is negative; a **0** would be used if the number was reported as positive at the time of observation
**015** Dew Point disseminated to the nearest $10^{th}$ and read as 01.5

No spaces are between the entries. For example, a temperature of 2.6°C and dew point of –1.5°C is reported in the body of the report as **03/M01** and the hourly temperature and dew point group as **T00261015**. If the dew point is missing only the temperature is reported; if the temperature is missing the hourly temperature and dew point group is not reported.

#### 3.1.3.14.2 Maintenance Data Groups

The following maintenance data groups, Sensor Status Indicators and the Maintenance Indicator, are only reported from automated stations.

##### 3.1.3.14.2.1 Sensor Status Indicators

Sensor status indicators are reported as indicated below:

- If the Runway Visual Range is missing and would normally be reported, **RVRNO** is coded
- When automated stations are equipped with a present weather identifier and the sensor is not operating, the remark **PWINO** is coded
- When automated stations are equipped with a tipping bucket rain gauge and the sensor is not operating, **PNO** is coded
- When automated stations are equipped with a freezing rain sensor and the sensor is not operating, the remark **FZRANO** is coded
- When automated stations are equipped with a lightning detection system and the sensor is not operating, the remark **TSNO** is coded
- When automated stations are equipped with a secondary visibility sensor and the sensor is not operating, the remark **VISNO LOC** is coded
- When automated stations are equipped with a secondary ceiling height indicator and the sensor is not operating, the remark **CHINO LOC** is coded

##### 3.1.3.14.2.2 Maintenance Indicator

A maintenance indicator, **$**, is coded when an automated system detects maintenance is needed on the system.

### 3.1.4 Examples of METAR Reports, Explanations, and Phraseology

**METAR KMKL 021250Z 33018KT 290V360 1/2SM R31/2600FT SN BLSN FG VV008 00/M03 A2991 RMK AO2 RAESNB42 SLPNO T00111032**

**METAR** → Aviation Routine Weather Report
**KMKL** → United States Jackson McKellar-Sipes Regional Airport, Tennessee
**021250Z** → The 2nd day of the month, 1300 hour scheduled report taken at 1250 UTC
**33018KT** → Wind 330 degrees at 18 knots
**290V360** → Wind direction variable between 290 and 360 degrees
**1/2SM** → Visibility one-half statute mile
**R31/2600FT** → Runway 31, runway visual range on runway 2,600 feet
**SN** → Moderate snow
**BLSN FG** → Blowing snow and fog
**VV008** → Indefinite ceiling, vertical visibility 800 feet AGL
**00/M03** → Temperature 0°C, dew point -3°C
**A2991** → Altimeter, 29.91 inches of mercury
**RMK** → Remarks
**AO2** → Automated station with a precipitation discriminator
**RAESNB42** → Rain ended at four two, snow began at four two past the hour
**SLPNO** → Sea-level pressure not available
**T00111032** → Temperature 1.1°C, dew point -3.2°C

Jackson McKellar-Sipes Regional Airport, wind three three zero at one eight, wind variable between two niner zero and three six zero, visibility one-half, runway three one R-V-R, two thousand six hundred, snow, blowing snow, fog, indefinite ceiling eight hundred, temperature zero, dew point minus three, altimeter two niner niner one, remarks rain ended and snow began at four two past the hour.

**METAR KIPT 191254Z 00000KT 1 1/2SM -RA BR SCT034 BKN100 19/18 A2993 RMK AO2 RAB24 SLP133 P0001 T01890178**

**METAR** → Aviation Routine Weather Report
**KIPT** → United States Williamsport Regional Airport, Pennsylvania
**191254Z** → 19th day of the month, the 1300 hour scheduled report taken 1254 UTC
**00000KT** → Wind calm
**1 1/2SM** → Visibility one and one-half statute mile
**-RA BR** → Light rain, mist
**SCT034 BKN100** → Scattered 3,400 feet AGL, ceiling broken 10,000 feet AGL
**19/18** → Temperature 19 degrees Celsius, Dew Point 18 degrees Celsius
**A2993** → Altimeter, 29.93 inches of mercury
**RMK** → Remarks
**AO2** → Automated station with a precipitation discriminator
**RAB24** → Rain began at 1224 UTC
**SLP133** → Sea level pressure 1013.3 hectopascals
**P0001** → Precipitation over the past hour 00.01 inch
**T01890178** → Temperature 18.9 degrees Celsius, dew point 17.8 degrees Celsius

Williamsport Regional Airport, wind calm, visibility one and one half, light rain, mist, three thousand four hundred scattered, ceiling one zero thousand broken, temperature one niner, dew point one eight, altimeter two niner niner three, remarks rain began at two four past the hour.

**SPECI KCVG 312228Z 28024G36KT 3/4SM +TSRA SQ BKN008 OVC020CB 28/23 A3000 RMK TSB24 TS OHD MOV E**

**SPECI** → Aviation Selected Special Weather Report
**KCVG** → United States Covington Cincinnati/Northern Kentucky International Airport, Kentucky
**312228Z** → The 31st of the month Special report taken at 2228 UTC
**28024G36KT** → Wind 280 degrees at 24 knots, gusts 36 knots
**3/4SM** → Visibility three-quarters statute mile
**+TSRA SQ** → Thunderstorm with heavy rain and squalls
**BKN008 OVC020CB** → Ceiling broken 800 feet AGL, overcast 2,000 feet AGL cumulonimbus
**28/23** → Temperature 28°C, dew point 23°C
**A3000** → Altimeter 30.00 inches of mercury
**RMK** → Remarks
**TSB24** → Thunderstorm began at two four minutes past the hour
**TS OHD MOV E** → Thunderstorm overhead moving east

Covington Cincinnati/Northern Kentucky International Airport, special report, two eight observation, wind two eight zero at two four, gusts three six, visibility three-quarters, thunderstorm, heavy rain, squall, ceiling eight hundred broken, two thousand overcast cumulonimbus, temperature two eight, dew point two three, altimeter three zero zero zero, thunderstorm began two four, thunderstorm overhead, moving east."

METAR KLAX 191350Z 08004KT 4SM HZ OVC009 18/16 A2997 RMK AO2 SLP147 T01830156

**METAR** → Aviation Routine Weather Report
**KLAX** → United States Los Angeles International Airport, California
**191350Z** → The 19th day of the month, the 1400 hour scheduled report at 1350 UTC
**08004KT** → Wind 80 degrees at 4 knots
**4SM** → Visibility 4 statute miles
**HZ** → Haze
**OVC009** → Ceiling overcast 900 feet AGL
**18/16** → Temperature 18°C, dew point 16°C
**A2997** → Altimeter 29.97 inches of mercury
**RMK** → Remarks
**AO2** → Automated observation with precipitation discriminator
**SLP147** → Sea level pressure 1014.7 hectopascals
**T01830156** → Temperature 18.3°C, dew point 15.6°C

Los Angeles International Airport, wind zero eight zero at four, visibility four, haze, ceiling niner hundred overcast, temperature one eight, dew point one six, altimeter two niner niner seven.

**SPECI KDEN 241310Z 09014G35KT 1/4SM +SN FG VV002 01/01 A2975 RMK AO2 TWR VIS 1/2 RAESNB08**

**SPECI** → Aviation Selected Special Weather Report
**KDEN** → United States Denver International Airport, Colorado

**241310Z** → The 24th of the month, Special report taken at 1310 UTC
**09014G35KT** → Wind 90 degrees at 14 knots, gusts to 35 knots
**1/4SM** → Visibility one-quarter statute mile
**+SN FG** → Heavy snow, fog
**VV002** → Indefinite ceiling, vertical visibility 200 feet AGL
**01/01** → Temperature 1°C, dew point 1°C
**A2975** → Altimeter 29.75 inches of mercury
**RMK** → Remarks
**AO2** → Automated observation with precipitation discriminator
**TWR VIS 1/2** → Tower visibility one-half statute mile
**RAE08SNB08** → Rain ended at 08 past the hour and snow began at 08 minutes past the hour

Denver International Airport, wind zero niner zero at one four, gusts three five, visibility one-quarter, heavy snow, fog, indefinite ceiling two hundred, temperature one, dew point one, altimeter two niner seven five, remarks tower visibility one half, ran ended and snow began at zero eight.

**METAR KSPS 301656Z 06014KT 020V090 3SM -TSRA FEW040 BKN060CB 12/ A2982 RMK OCNL LTGICCG NE TSB17 TS E MOV NE PRESRR SLP093**

**METAR** → Aviation Routine Weather Report
**KSPS** → United States Sheppard Air Force Base/Wichita Falls Municipal Airport, Texas
**301656Z** → The 30th day of the month, the 1700 scheduled report taken at 1656 UTC
**06014KT 020V090** → Wind 60 degrees at 14 knots, wind variable between 020 and 090 degrees
**3SM** → Visibility 3 statute miles
**-TSRA** → Thunderstorm, light rain
**FEW040 BKN060CB** → Few 4,000 feet AGL, ceiling broken 6,000 feet AGL cumulonimbus
**12/** → Temperature 12°C, dew point missing
**A2982** → Altimeter 29.82 inches of mercury
**RMK** → Remarks
**OCNL LTGICCG NE** → Occasional lightning in cloud, cloud-to-ground northeast
**TSB17** → Thunderstorm began at 17 minutes past the hour
**TS E MOV NE** → Thunderstorm east moving northeast
**PRESRR** → Pressure rising rapidly
**SLP093** → Sea-level pressure 1009.3 hectopascals

Sheppard Air Force Base/Wichita Falls Municipal Airport, automated, wind zero six zero at one four, wind variable between zero two zero and zero niner zero, visibility three, thunderstorm, light rain, few clouds at four thousand, ceiling six thousand broken cumulonimbus, temperature one two, dew point missing, remarks occasional lightning in-cloud, cloud-to-ground northeast, thunderstorm began at one seven, thunderstorm east moving northeast, pressure rising rapidly.

**SPECI KBOS 051237Z VRB02KT 3/4SM R15R/4000FT BR OVC004 05/05 A2998 RMK AO2 CIG 002V006 T00520048**

**SPECI** → Aviation Selected Special Weather Report

**KBOS** → United States Boston, Massachusetts
**051237Z** → The 5th of the month, Special report taken at 1237 UTC
**VRB02KT** → Wind variable at 2 knots
**3/4SM** → Visibility three-quarters statute mile
**R15R/4000FT** → Runway 15R, visual range on runway 4,000 feet
**BR** → Mist
**OVC004** → Ceiling overcast 400 feet AGL
**05/05** → Temperature 5°C, dew point 5°C
**A2998** → Altimeter 29.98 inches of mercury
**RMK** → Remarks
**AO2** → Automated observation with precipitation discriminator
**CIG 002V006** → Ceiling variable between 200 to 600 feet
**T00520048** → Temperature 5.2°C, dew point 4.8°C

Boston General Edward Lawrence Logan International Airport, special report, three seven observation, wind variable at two, visibility three-quarters, runway one five right R-V-R four thousand, mist, ceiling four hundred overcast, temperature five, dew point five, altimeter two niner niner eight, remarks, ceiling variable between two hundred and six hundred.

## 3.2 Pilot Weather Reports (PIREP)

No report is timelier than the one made from the flight deck of aircraft in flight. In fact, aircraft in flight are the only means of observing actual icing and turbulence conditions. Pilots welcome pilot weather reports (PIREPs) as well as pilot weather briefers and forecasters. Pilots should report any observation, good or bad, to assist other pilots with flight planning and preparation. If conditions were forecasted to occur but not encountered, a pilot should also report this inaccuracy. This will help the NWS verify forecast products and create more accurate products for the aviation community. Pilots should help themselves, the aviation public, and the aviation weather forecasters by providing PIREPs.

Pipe Up with a PIREP and help the aviation community operate more safely and effectively.

PIREPs are available in the internet at the Aviation Digital Data Service (ADDS) web page at: http://adds.aviationweather.gov/pireps/

### 3.2.1 Format

A PIREP is transmitted in a prescribed format (Figure 3-7). Required elements for all PIREPs are: message type, location, time, altitude/flight level, type aircraft, and at least one other element to describe the reported phenomena. The other elements will be omitted when no data is reported with them. All altitude references are mean sea level (MSL) unless otherwise noted. Distance for visibility is in statute miles and all other distances are in nautical miles. Time is reported in Universal Time Coordinated (UTC).

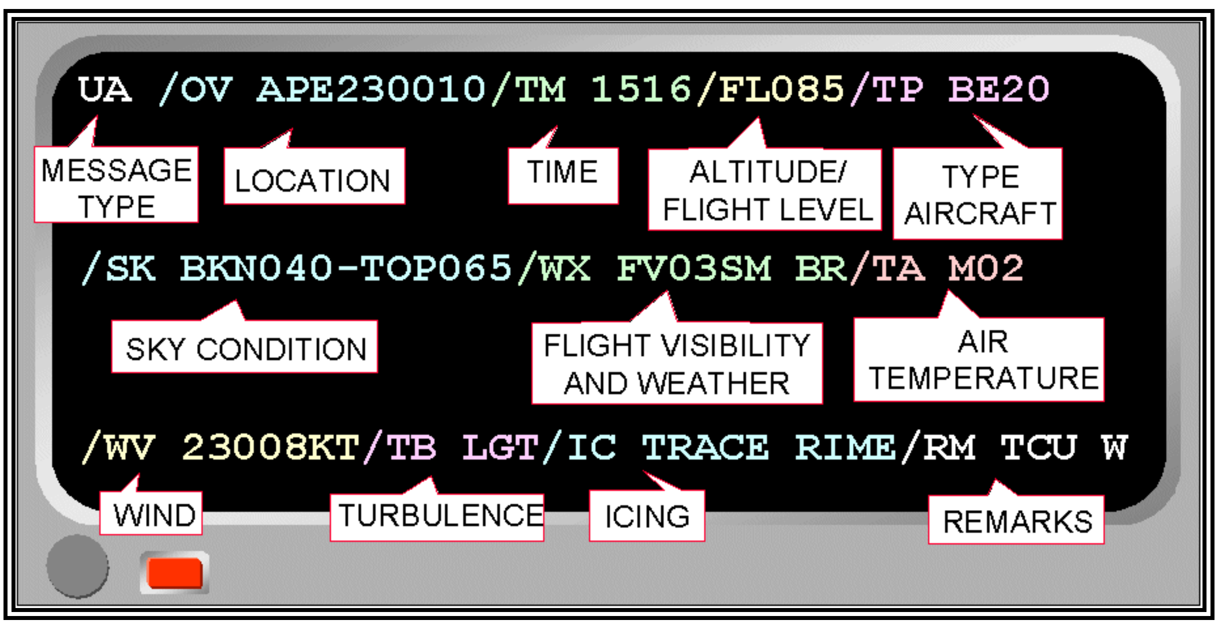


**Figure 3-10. Pilot Weather Report (PIREP) Coding Format**

#### 3.2.1.1 Message Type (UUA/UA)

The two types of PIREPs are Urgent (**UUA**) and Routine (**UA**).

##### 3.2.1.1.1 Urgent PIREPs

Urgent (**UUA**) PIREPs contain information about:

- Tornadoes, funnel clouds, or waterspouts
- Severe or extreme turbulence (including Clear Air Turbulence)
- Severe icing
- Hail
- Low Level Wind Shear (**LLWS**) within 2,000 feet of the surface. LLWS PIREPS are classified as **UUA** if the pilot reports air speed fluctuations of 10 knots or more or if air speed fluctuations are not reported but LLWS is reported, the PIREP is classified as **UUA**.
- Volcanic ash clouds
- Any other weather phenomena reported which are considered by the briefer as being hazardous, or potentially hazardous, to flight operations.

#### 3.2.1.1.2 Routine PIREPs

Routine PIREPs are issued after receiving a report from a pilot that does not contain any urgent information as listed in Section 3.2.1.1.1.

### 3.2.1.2 Location (/OV)

The Location (**/OV**) can be referenced either by geographical position or by route segment.

#### 3.2.1.2.1 Location

Location can be referenced to a VHF NAVAID or an airport, using either the three-letter International Air Transport Association (IATA) or four letter International Civil Aviation Organization (ICAO) identifier. If appropriate, the PIREP is encoded using the identifier, then three digits to define a radial and three digits to define the distance in nautical miles.

Examples:

| | |
|---|---|
| **/OV APE** → | Over Appleton VOR |
| **/OV KJFK** → | Over John F. Kennedy International Airport, New York City, NY |
| **/OV APE230010** → | 230 degrees at 10 nautical miles from the Appleton VOR |
| **/OV KJFK107080** → | 107 degrees at 80 nautical miles from John F. Kennedy International Airport, New York City, New York |

##### 3.2.1.2.1.1 3.2.1.3.1.1 Route Segment

A PIREP can also be referenced using two or more fixes to describe a route.

Examples:

| | |
|---|---|
| **/OV KSTL-KMKC** → | From Lambert-Saint Louis International Airport, Missouri to Charles B. Wheeler Downtown Airport, Kansas City, Missouri |
| **/OV KSTL090030-KMKC045015** → | From 90 degrees at 30 nautical miles from Lambert-Saint Louis International Airport, Missouri to 45 degrees at 15 nautical miles from Charles B. Wheeler Downtown Airport, Kansas City, Missouri |

### 3.2.1.3 Time (/TM)

Time (**/TM**) is the time that the reported phenomenon occurred or was encountered. It is coded in four digits UTC.

Example:

**/TM 1315** → 1315 UTC

### 3.2.1.4 Altitude/Flight Level (/FL)

The Altitude/Flight Level (**/FL**) is the altitude in hundreds of feet MSL where the phenomenon was first encountered. If not known, **UNKN** is entered. If the aircraft was climbing or descending, the appropriate contraction (**DURC** or **DURD**) is entered in the remarks (**/RM**). If the condition was encountered within a layer, the altitude range is entered within the appropriate element that describes the condition.

Examples:

**/FL085** → 8,500 feet MSL
**/FL310** → Flight Level 310
**/FLUNKN /RM DURC** → Flight Level unknown, remarks, during climb

### 3.2.1.5 Aircraft Type (/TP)

Aircraft Type (**/TP**) is entered. If not known, **UNKN** is entered. Icing and turbulence reports always include aircraft type.

Examples:

**/TP BE20** → Super King Air 200
**/TP SR22** → Cirrus 22
**/TP P28R** → Piper Arrow
**/TP UNKN** → Type unknown

### 3.2.1.6 Sky Condition (/SK)

Sky Condition (**/SK**) group is used to report height of cloud bases, tops, and cloud cover. The height of the base of a layer of clouds is coded in hundreds of feet MSL. The top of a layer is entered in hundreds of feet MSL preceded by the word **-TOP**. If reported as clear above the highest cloud layer, **SKC** is coded following the reported level.

Examples:
**/BKN040-TOP065** → Base of broken layer 4,000 feet MSL, top 6,500 feet MSL
**/SK OVC100-TOP110/ SKC** → Base of an overcast layer 10,000 feet MSL, top 11,000 feet MSL, clear above
**/SK OVC015-TOP035/OVC230** → Base of an overcast layer 1,500 feet MSL, top 3,500 feet MSL, base of an overcast layer 23,000 feet MSL
**/SK OVC-TOP085** → Overcast layer, top 8,500 feet MSL

Cloud cover amount ranges are entered with a hyphen separating the amounts; i.e., **BKN-OVC**.

Examples:

**`/SK SCT-BKN050-TOP100`** → Base of a scattered to broken layer 5,000 feet MSL, top 10,000 feet MSL

**`/SK BKN-OVCUNKN-TOP060/BKN120-TOP150/ SKC`** → Base of a broken to overcast layer unknown, top 6,000 feet MSL, base of a broken layer 12,000 feet MSL, top 15,000 feet MSL, clear above

Unknown heights are indicated by the contraction **UNKN**.

Example:

**`/SK OVC065-TOPUNKN`** → Base of an overcast layer 6,500 feet MSL, top unknown

If a pilot indicates he/she is in the clouds, **IMC** is entered.

Example:

**`/SK OVC065-TOPUNKN /RM IMC`** → Base of an overcast layer 6,500 feet MSL, top unknown, remark, in the clouds

When more than one layer is reported, layers are separated by a solidus (**/**).

#### 3.2.1.7 Flight Visibility and Weather (/WX)

Weather conditions encountered by the pilot are reported as follows:

Flight visibility, when reported, is entered first in the **/WX** field. It is coded as **FV** followed by a two-digit visibility value rounded down, if necessary, to the nearest whole statute mile and appended with **SM** (**FV03SM**). If visibility is reported as unrestricted, **FV99SM** is entered.

Flight weather types are entered using one or more of the standard surface weather reporting symbols contained in Table 3-7.

**Table 3-7. PIREP Weather Type and Symbols**

| Type | METAR Code |
|---|---|
| Drifting / Blowing Snow | DRSN/BLSN |
| Drifting Dust | DRDU |
| Drifting Sand | DRSA |
| Drizzle/Freezing Drizzle | DZ/FZDZ |
| Dust / Blowing Dust | DU/BLDU |
| Duststorm | DS |
| Fog (visibility less than 5/8SM) | FG |
| Freezing Fog | FZFG |
| Freezing Rain | FZRA |
| Funnel Cloud | FC |
| Hail (Approximately ¼-inch diameter or more) | GR |
| Hail Shower | SHGR |
| Haze | HZ |
| Ice Crystals | IC |
| Ice Pellets/Showers | PL/SHPL |
| Mist (visibility great than or equal to 5/8SM) | BR |
| Patchy Fog | BCFG |
| Patchy Fog on part of airport | PRFG |
| Rain/Showers | RA/SHRA |
| Sand/Blowing Sand | SA/BLSA |
| Sandstorms | SS |
| Shallow Fog | MIFG |
| Small Hail/Snow Pellet Showers | SHGS |
| Small Hail/Snow Pellets | GS |
| Smoke | FU |
| Snow Grains | SG |
| Snow / Showers | SN/SHSN |
| Spray | PY |
| Squalls | SQ |
| Thunderstorm | TS |
| Tornado/Waterspout | +FC |
| Unknown Precipitation | UP |
| Volcanic Ash | VA |
| Well developed Dust/Sand Whirls | PO |

Intensity modifiers for precipitation (**-** for light, no qualifier for moderate, and **+** for heavy) indicates precipitation type, except ice crystals and hail, including those associated with a thunderstorm and those of a showery nature.

Intensity modifiers for obscurations are ascribed as moderate or heavy (**+**) for dust and sandstorms only. No intensity modifiers are used for blowing dust, blowing sand, or blowing snow.

Example:

**/WV FV01SM +DS000-TOP083/SKC /RM DURC** → Flight visibility 1 statute mile, base heavy duststorm layer at the surface, top 8,300 feet MSL, clear above, remarks, during climb

When more than one form of precipitation is combined in the report, the dominant type is reported first.

Examples:

**/WX FV00SM +TSRAGR** → Flight visibility zero statute miles, thunderstorm, heavy rain, hail
**/WX FV02SM BRHZ000-TOP083** → Flight visibility 2 statute miles, base of a haze and mist layer at the surface, top 8,300 feet MSL

If a funnel cloud is reported, it is coded as **FC** following **/WX** group and is spelled out as **Funnel Cloud** after **/RM** group. If a tornado or waterspout is reported, it is coded **+FC** following **/WX** group and **TORNADO** or **WATERSPOUT** is spelled out after the **/RM** group.

Examples:

**/WX FC /RM FUNNEL CLOUD** → Funnel cloud, remarks, funnel cloud
**/WX +FC /RM TORNADO** → Tornado, remark, tornado

When the size of hail is stated, it is coded in 1/4-inch increments in remarks (**/RM**) group.

The proximity qualifier **VC** (vicinity) is only used with **TS**, **FG**, **FC**, **+FC**, **SH**, **PO**, **BLDU**, **BLSA**, and **BLSN**.

Example:

**/WX FV02SM BLDU000-TOP083 VC W** → Flight visibility 2 statute miles, base of a blowing dust layer at the surface, top 8,300 feet MSL in the vicinity, west

When more than one type of weather is reported, they are reported in the following order:

- **TORNADO**, **WATERSPOUT**, or **FUNNEL CLOUD**
- Thunderstorm with or without associated precipitation
- Weather phenomena in order of decreasing predominance.

No more than three groups are used in a single PIREP.

Weather layers are entered with the base and/or top of the layer when reported. The same format as in the sky condition (**/SK**) group is used.

Example:

**/WX FU002-TOP030** → Base of a smoke layer, 200 feet MSL, top 3,000 feet MSL

### 3.2.1.8 Air Temperature (/TA)

Outside air temperature (**/TA**) is reported using two digits in degrees Celsius. Negative temperatures is prefixed with an **M**; e.g., **/TA 08** or **/TA M08**.

### 3.2.1.9 Wind Direction and Speed (/WV)

Wind direction and speed is encoded using three digits to indicate wind direction (magnetic) and two or three digits to indicate reported wind speed. When the reported speed is less than 10 knots, a leading zero is used. The wind group will always have **KT** appended to represent the units in knots.

Examples:

**/WV 02009KT** → Wind 20 degrees (magnetic) at 9 knots
**/WV 28057KT** → Wind 280 degrees (magnetic) at 57 knots
**/WV 350102KT** → Wind 350 degrees (magnetic) at 102 knots

### 3.2.1.10 Turbulence (/TB)

Turbulence intensity, type, and altitude are reported after wind direction and speed.

Intensity is coded first. Duration is coded next if reported by the pilot (intermittent, occasional, continuous) followed by the intensity using contractions **LGT**, **MOD**, **SEV**, or **EXTRM**. Range or variation of intensity is separated with a hyphen; e.g., MOD-SEV. If turbulence was forecasted, but not encountered, **NEG** is entered.

Type is coded second. **CAT** (Clear Air Turbulence) or **CHOP** is entered if reported by the pilot. High-level turbulence (normally above 15,000 feet AGL) not associated with clouds (including thunderstorms) is reported as CAT.

Altitude is reported (last) only if it differs from value reported in the Altitude/Flight Level (**/FL**) group. When a layer of turbulence is reported, height values are separated with a hyphen. If lower or upper limits are not defined, **BLO** or **ABV** is used.

Examples:

**/TB LGT** → Light turbulence
**/TB LGT 040** → Light turbulence at 4,000 feet MSL
**/TB OCNL MOD-SEV BLO 080** → Occasional moderate to severe turbulence below 8,000 feet MSL
**/TB MOD-SEV CAT 350** → Moderate to severe clear air turbulence at 35,000 feet MSL
**/TB NEG 120-180** → Negative turbulence between 12,000 to 18,000 feet MSL
**/TB CONS MOD CHOP 220/NEG 230-280** → Continuous moderate chop at 22,000 feet MSL, negative turbulence between 23,000 to 28,000 feet MSL
**/TB MOD CAT ABV 290** → Moderate clear air turbulence above 29,000 feet MSL

Turbulence reports should include location, altitude, or range of altitudes, and aircraft type, and, when reported, whether in clouds or clear air. The pilot determines the degree of turbulence, intensity, and duration (occasional, intermittent, and continuous). The report should be obtained and disseminated, when possible, in conformance with the U.S. Standard Turbulence Criteria Table 3-8.

**Table 3-8. PIREP 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;**[1]<br>or<br>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 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 1/3 of the time.<br><br>Intermittent-1/3 to 2/3<br><br>Continuous-More than 2/3 |
| 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;**[1]<br>or<br>Turbulence that is similar to Light Chop but of greater intensity. It causes rapid bumps or jolts without appreciable changes in aircraft or attitude. Report as **Moderate Chop.**[1] | Occupants feel definite strains against seat belts or shoulder straps. Unsecured objects are dislodged. Food service and walking are difficult. | NOTE<br>1. Pilots should report location(s), time (UTC), intensity, weather in or near clouds, altitude, type of aircraft and, when applicable, duration of turbulence.<br><br>2. Duration may be based on time between two locations or over a single location. All locations should be readily identifiable.<br><br>**EXAMPLES:**<br>Over Omaha. 1232Z, Moderate Turbulence, in cloud, flight Level 310, B737.<br><br>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.**[1] | 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.**[1] | | |

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

### 3.2.1.11 Icing (/IC)

Icing intensity, type and altitude is reported after turbulence.

Intensity is coded first using contractions **TRACE**, **LGT** (light), **MOD** (moderate), or **SEV** severe). Reports of a range or variation of intensity is separated with a hyphen. If icing was forecast but not encountered, **NEG** (negative) is coded.

The following table classifies icing intensity according to its operational effects on aircraft.

**Table 3-9. Icing Intensities, Contractions, and Airframe Ice Accumulation**

| Intensity | Contraction | Airframe Ice Accumulation |
|---|---|---|
| Trace | TRACE | Ice becomes perceptible. Rate of accumulation slightly greater than rate of sublimation. It is not hazardous even without the use of deicing/anti-icing equipment unless encountered for an extended period of time (over 1 hour). |
| Light | LGT | The rate of accumulation may create a problem if flight is prolonged in this environment (over 1 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 | MOD | 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 | SEV | The rate of accumulation is such that deicing/anti-icing equipment fails to reduce or control the hazard. Immediate diversion is necessary. |

Icing type is reported second. Reportable types are **RIME**, **CLR** (clear), or **MX** (mixed).

The following table classifies icing type according to it description.

**Table 3-10. Icing Types, Contractions, and Descriptions**

| Icing Type | Contraction | Description |
|---|---|---|
| Rime | RM | Rough, milky, opaque ice formed by the instantaneous freezing of small super-cooled water droplets. |
| Clear | CLR | A glossy, clear or translucent ice formed by the relatively slow freezing of large super-cooled water droplets. |
| Mixed | MX | A combination of both rime and clear. |

The reported icing/altitude is coded (last) only if different from the value reported in the altitude/flight level (**/FL**) group. A hyphen is used to separate reported layers of icing. **ABV** (above) or **BLO** (below) is coded when a layer is not defined.

Pilot reports of icing should also include location (**/OV**), type aircraft (**/TP**), and air temperature (**/TA**).

Examples:

**`/IC LGT-MOD MX 085`** → Light to moderate mixed icing, 8,500 feet MSL
**`/IC LGT RIME`** → Light rime icing
**`/IC MOD RIME BLO 095`** → Moderate rime icing below 9,500 feet MSL
**`/IC SEV CLR 035-062`** → Severe clear icing 3,500 to 6,200 feet MSL

**3.2.1.12 Remarks (/RM)**
The remarks (**/RM**) group is used to report a phenomenon which is considered important but does not fit in any of the other groups. This includes, but is not limited to, low-level wind shear

(**LLWS**) reports, thunderstorm lines, coverage and movement, size of hail (1/4-inch increments), lightning, clouds observed but not encountered, geographical or local description of where the phenomenon occurred, and contrails. Hazardous weather is reported first. LLWS is described to the extent possible.

#### 3.2.1.12.1 Wind Shear

Ten knots or more fluctuations in wind speed (+/- 10KTS), within 2,000 feet of the surface, require an Urgent (**UUA**) pilot report. When Low Level Wind Shear is entered in a pilot report, **LLWS** is entered as the first remark in the remarks (**/RM**) group.

Example:

**/RM LLWS +/-15 KT SFC-008 DURC RY22 JFK** → Remarks, Low Level Wind Shear, air speed fluctuations of plus or minus 15 knots, surface to 800 feet during climb, runway 22, John F. Kennedy International Airport, New York.

#### 3.2.1.12.2 FUNNEL CLOUD, TORNADO, and WATERSPOUT

Funnel cloud, tornado, and waterspout are entered with the direction of movement when reported.

Example:

**/RM TORNADO W MOV E** → Remarks, tornado west moving east

#### 3.2.1.12.3 Thunderstorm

Thunderstorm coverage is coded as **ISOL** (isolated), **FEW** (few**)**, **SCT** (scattered), **NMRS** (numerous) followed by description as **LN** (line), **BKN LN** (broken line), **SLD LN** (solid line) when reported. This is followed with **TS**, the location and movement, and the type of lightning when reported.

Example:

**/RM NMRS TS S MOV E GR1/2** → Remarks, numerous thunderstorms south moving east, hail 1/2–inch in diameter

#### 3.2.1.12.4 Lightning

Lightning frequency is coded as **OCNL** (occasional) or **FRQ** (frequent), followed by type as **LTGIC** (lightning in cloud), **LTGCC** (lightning cloud to cloud), **LTGCG** (lightning cloud to ground), **LTGCA** (lightning cloud to air), or combinations, when reported.

Example:

**/RM OCNL LTGICCG** → Remarks, occasional lighting in cloud, cloud to ground

#### 3.2.1.12.5 Electrical Discharge

For an electrical discharge, **DISCHARGE** is coded followed by the altitude.

Example:

**/RM DISCHARGE 120** → Remarks, discharge, 12,000 feet MSL

#### 3.2.1.12.6 Clouds

Remarks are used when clouds can be seen but were not encountered and reported in the sky condition group (**/SK**)

Examples:

**/RM CB E MOV N** → Remarks, cumulonimbus east moving north
**/RM OVC BLO** → Remarks, overcast below

#### 3.2.1.12.7 Plain Language

If specific phraseology is not adequate, plain language is used to describe the phenomena or local geographic locations. Remarks that do not fit in other groups like **DURC** (during climb), **DURD** (during descent), **RCA** (reach cruising altitude), **TOP**, **TOC** (top of climb), or **CONTRAILS** are included.

Examples:

**/RM BUMPY VERY ROUGH RIDE**
**/RM CONTRAILS**
**/UA/OV BIS270030/TM 1445/FL060/TP CVLT/TB LGT /RM DONNER SUMMIT PASS**

#### 3.2.1.12.8 Volcanic Eruptions

Volcanic ash alone is an Urgent PIREP. A report of volcanic activity includes as much information as possible including the name of the mountain, ash cloud and movement, height of the top and bottom of the ash, etc., is included. If the report is received from a source other than a pilot, Aircraft **UNKN**, Flight Level **UNKN**, and **/RM UNOFFICIAL** is entered.

Example:

**/UUA/OV ANC240075/TM 2110/FL370/TP DC10/WX VA/RM VOLCANIC ERUPTION 2008Z MT AUGUSTINE ASH 40S MOV SSE**

Urgent Pilot Weather Report, 240 degrees at 75 nautical miles from Anchorage International Airport, Alaska, 2110 UTC, flight level 310, a DC10 reported volcanic ash, remarks, volcanic eruption occurred at 2008 UTC Mount Augustine, ash 40 nautical miles south moving south-southeast.

#### 3.2.1.12.9 SKYSPOTTER

The **SKYSPOTTER** program is a result of a recommendation from the Safer Skies FAA/INDUSTRY Joint Safety Analysis and Implementation Teams. The term **SKYSPOTTER** indicates a pilot has received specialized training in observing and reporting in-flight weather phenomenon, pilot weather reports, or PIREPs.

When a PIREP is received from a pilot identifying themselves as a **SKYSPOTTER** aircraft, the additional comment "**/AWC**" is added at the end of the remarks section of the PIREP.

Example:

**PIREP TEXT/RM REMARKS/AWC**

### 3.2.2 PIREP Examples

**UUA /OV ORD/TM 1235/FLUNKN/TP B727/TB MOD/RM LLWS +/- 20KT BLW 003 DURD RWY27L**

Urgent Pilot Weather Report, over Chicago O'Hare Airport, Illinois, 1235 UTC, flight level unknown, from a Boeing 727, moderate turbulence, remarks, Low Level Wind Shear, airspeed fluctuations of plus or minus 20 knots below 300 feet AGL during descent, runway 27 left.

**UUA /OV BAM260045/TM 2225/FL180/TP BE20/TB SEV/RM BROKE ALL THE BOTTLES IN THE BAR**

Urgent Pilot Weather Report, 260 degrees at 45 nautical miles from Hazen VOR, Nevada, 2225 UTC, 18,000 feet MSL, Beech Super King Air 200, severe turbulence, remarks, broke all the bottles in the bar.

**UA /OV KMRB-KPIT/TM 1600/FL100/TP BE55/SK BKN024-TOP032/BKN-OVC043-TOPUNKN /TA M12/IC LGT-MOD RIME 055-080**

Pilot Weather Report, Martinsburg, West Virginia to Pittsburgh International Airport, Pennsylvania, 1600 UTC, 10,000 feet MSL, Beechcraft Baron, base of a broken layer 2,400 feet MSL, top 3,200 feet MSL, base of a broken to overcast layer 4,300 feet MSL, top unknown, temperature minus 12, light to moderate rime ice between 5,500 to 8,000 feet MSL.

**UA /OV IRW090064/TM 1522/FL080/TP C172/SK SCT090-TOPUNKN/WX FV05SM HZ/TA M04/WV 24040KT/TB LGT/RM IN CLR**

Pilot Weather Report, 90 degrees and 64 nautical miles from Will Rogers VORTAC, Oklahoma City, Oklahoma, 1522 UTC, 8,000 feet MSL, Cessna 172, base of a scattered layer 9,000 feet MSL, top unknown, flight visibility 5 statute miles, haze, temperature minus 4, wind 240 degrees at 40 knots, light turbulence, remarks, in clear.

**UA /OV KLIT-KFSM/TM 0310/FL100/TP BE36/SK SCT070-TOP110/TA M03/WV 25015KT**

Pilot Weather Report, between Little Rock and Fort Smith, Arkansas, 0310 UTC at 10,000 feet MSL. Beech 36, base of a scattered layer at 7,000 feet MSL, top 11,000 feet MSL, temperature minus 3, wind 250 degrees at 15 knots.

**UA /OV KAEG/TM 1845/FL UNKN/TP UNKN /RM TIJERAS PASS CLSD DUE TO FG AND LOW CLDS UNA VFR RTN KAEG.**

Pilot Weather Report, over Double Eagle II Airport, Albuquerque, New Mexico, 1845 UTC, remarks, Tijeras Pass closed due to fog and low clouds, unable to fly VFR, returned to Double Eagle II Airport.

**UA /OV ENA14520/TM 2200/FL310/TP B737/TB MOD CAT 350-390.**

Pilot Weather Report, 145 degrees at 20 nautical miles from Kenai, Alaska, at 2200 UTC, at flight level 310, Boeing 737, moderate clear air turbulence between 35,000 and 39,000 feet MSL.

## 3.3 Radar Weather Report (SD/ROB)

A Radar Weather Report (SD/ROB) contains information about precipitation observed by weather radar. This is a textual product derived from the WSR-88D NEXRAD radar without human intervention. *The resolution of this textual product is very coarse, up to 80 minutes old, and should only be used if no other radar information is unavailable.*

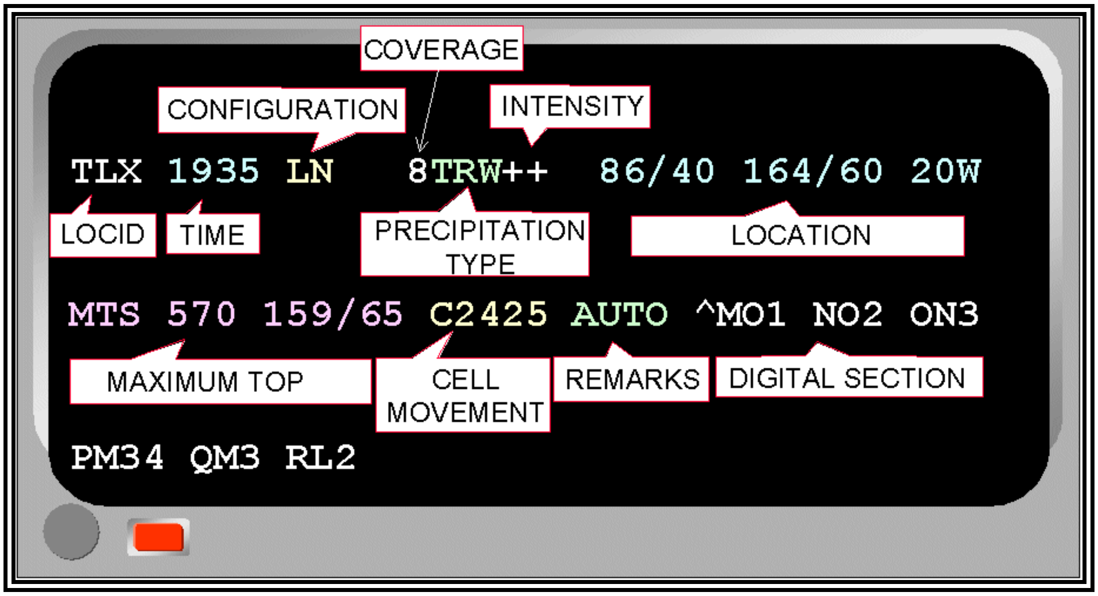


**Figure 3-11. Radar Weather Report (SD/ROB) Coding Format**

### 3.3.1 Format

Reports are transmitted hourly from WSR-88D Weather Radar sites (see figure 3-12). The SD/ROB format is presented in Figure 3-8.

#### 3.3.1.1 Location Identifier

The location identifier is reported as the three-letter International Air Transport Association (IATA) code.

Example:

**TLX** ⟶ Oklahoma City Twin Lakes, Oklahoma

#### 3.3.1.2 Time

The time of the observation is reported in four-digits Universal Time Coordinated (UTC).

Example:

**1935** ⟶ 1935 UTC

#### 3.3.1.3 Configuration

Three types of configurations can be reported: **CELL**, **LN** (line), and **AREA**. Multiple configurations can be reported within one Weather Radar Report.

A **CELL** is a single, isolated convective echo.

A **LN** (line) is a convective echo that meets the following criteria:

- Contains heavy or greater intensity precipitation
- Is at least 30 miles long
- Length is at least four times greater than width
- Contains at least 25 percent coverage

An **AREA** is a group of echoes of similar type, not classified as a line.

Figure 3-9 illustrates the three configurations that can be reported in a Weather Radar Report.

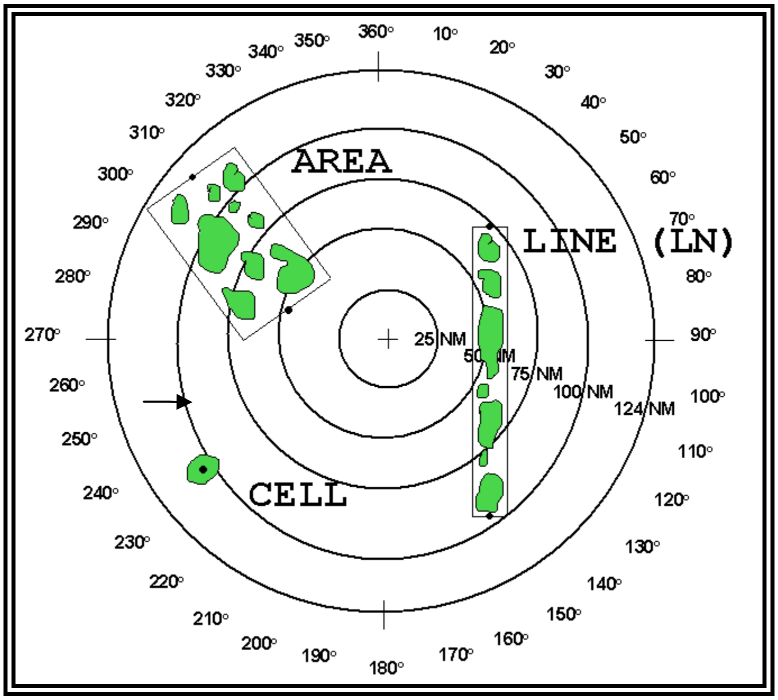


**Figure 3-12. Radar Weather Report (SD/ROB) Configurations**

### 3.3.1.4 Coverage

Coverage of precipitation is coded in single digits representing tenths of coverage.

For echo configurations containing multiple precipitation types, coverage is coded for each type. Total coverage is obtained by adding the individual values.

Examples:

**2TRW+4R** → 2/10 coverage TRW+, 4/10 coverage R, 6/10 total coverage
**3R6S-** → 3/10 coverage R, 6/10 coverage S-, 9/10 total coverage

### 3.3.1.5 Precipitation Type

Precipitation type is determined by computer model.

Reportable types are:

- Rain (**R**)
- Rain shower (**RW**)
- Snow (**S**)
- Snow shower (**SW**)
- Thunderstorm (**T**)

Multiple precipitation types can be reported within a configuration.

### 3.3.1.6 Precipitation Intensity

Four precipitation intensities can be reported as shown in table 3-11.

**Table 3-11. SD/ROB Reportable Intensities**

| Symbol | Intensity | dBZ |
|---|---|---|
| **-** | Light | 0-29 |
| (no entry) | Moderate | 30-40 |
| **+** | Heavy | 41-45 |
| **++** | Heavy | 46-49 |
| **X** | Extreme | 50-56 |
| **XX** | Extreme | 57 or more |

Examples:

**7R-** → 7/10 coverage of light rain
**3R-6S** → 3/10 coverage light rain, 6/10 coverage moderate snow, 9/10 total coverage
**2TRWX4R-** → 2/10 coverage thunderstorms, extreme rain showers, 4/10 coverage light rain, 6/10 total coverage

### 3.3.1.7 Location

An area is coded with two end points and a width that defines a rectangle. Each end point is defined by an azimuth and range (AZRAN).

A line is also coded with two end points and a width that defines a rectangle. Each end point is defined by an AZRAN.

A cell is coded as a single point with a diameter (**D**). This point is defined by an AZRAN.

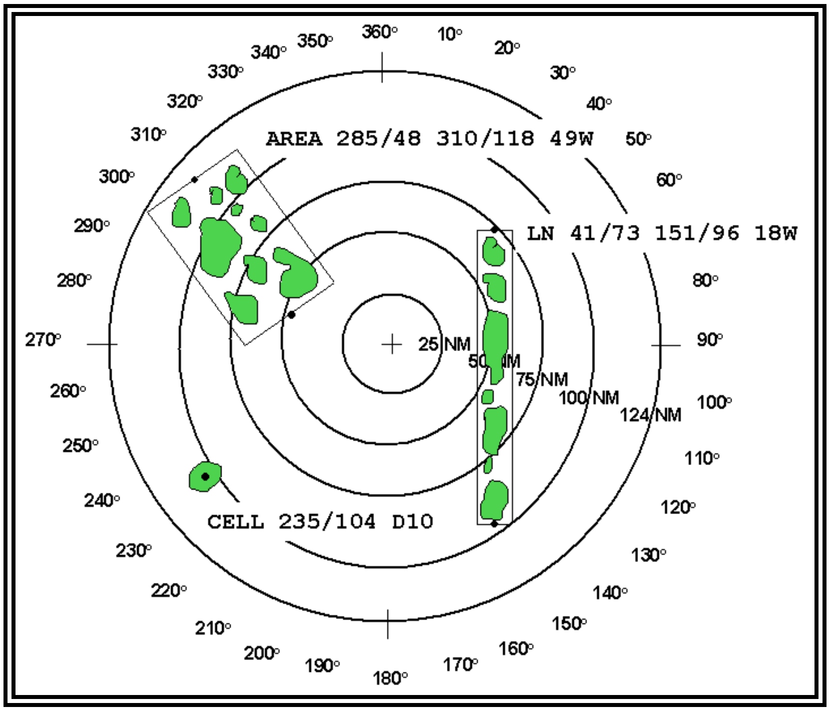


**Figure 3-13. SD/ROB AREA, Line (LN), and CELL Location Examples**
**The "+" denotes the radar location.**

### 3.3.1.8 Maximum Top

Maximum top (**MT** or **MTS**) denotes the altitude and location of the top of the highest precipitation echo.

All radar heights are estimates and assume standard atmosphere conditions and, thus, standard radar wave propagation. **MT** denotes radar data alone was used to determine the maximum top. **MTS** denotes both satellite and radar data were used to estimate the maximum top.

The maximum top is coded as a three-digit number in hundreds of feet MSL. Location is coded as an azimuth and range (AZRAN) relative to the radar site. If echo tops are uniform in altitude, the letter "U" precedes the altitude with no AZRAN provided.

Examples:

**MT 150 19/32** → Maximum top 15,000 feet MSL at 19 degrees, 32 nautical miles
**MT 340 182/98** → Maximum top 34,000 feet MSL at 182 degrees, 98 nautical miles
**MTS 520 5/121** → Maximum top with satellite data 52,000 feet MSL at 5 degrees, 121 nautical miles

### 3.3.1.9 Cell Movement

Cell movement is the average motion of all the cells within a configuration. It is coded in the following format: the cell movement group is indicated by the letter **C** followed by four digits. The first two digits represent the direction the cell(s) is (are) moving from in tens of degrees referenced to true north. The last two digits represent the speed of the configuration in knots.

Movement of areas and lines is not coded.

Examples:

**C0209** → Cell movement from 20 degrees at 9 knots
**C2043** → Cell movement from 200 degrees at 43 knots
**C3616** → Cell movement from 360 degrees at 16 knots

**3.3.1.10 Remarks**
Remarks contain information about the radar's status and type of report. Currently, all weather radar reports are automated.

**Table 3-12. Weather Radar Report Remarks and Meaning**

| REMARK | MEANING |
|---|---|
| PPINE | Equipment normal and operating, but no echoes observed |
| PPINA | Observation not available |
| PPIOM | Radar out for maintenance |
| AUTO | Report derived from an automated weather radar |

**3.3.1.11 Digital Section**
The information contained in the digital section is used primarily to create the Radar Summary Chart. However, with the proper grid overlay chart for the corresponding radar site, the digital section code can also be used to determine precipitation location and intensity. (See Figure 3-11 for an example of a digital code plotted from the Oklahoma City, Oklahoma, Weather Radar Report.)

Each digit represents the maximum precipitation intensity found within a grid box as determined by the weather radar. Light intensity is denoted by a **1**, **2** is for moderate, **3** and **4** is for heavy, **5** and **6** is used for extreme precipitation. These digits were once commonly referred to as VIP levels because precipitation intensity, and therefore the digit, was derived using a video integrator processor (VIP). Whereas the old WSR-57 and WSR-74 weather radar video integrator processors displayed six data levels, the WSR-88D weather radar displays sixteen data levels. The data levels are still converted back to six levels for use in the Radar Weather Report. To avoid confusion, the term VIP should no longer be used to describe precipitation intensity. For example, if a grid box is coded with the number 2, it would be described as "moderate" precipitation," not "VIP 2" or "level 2" precipitation.

A grid box is identified by two letters. The first represents the row in which the box is found and the second letter represents the column. For example **MO1** identifies the box located in row M and column O as containing light precipitation. A code of **MO1234** indicates precipitation in four consecutive boxes in the same row. Working from left to right: box MO = 1, box MP = 2, MQ = 3, and box MR = 4.

A Weather Radar Report contains data about precipitation echoes only. It does not contain information about important non-precipitation echoes such as clouds, fronts, dust, etc., which can be detected by weather radar under certain circumstances.

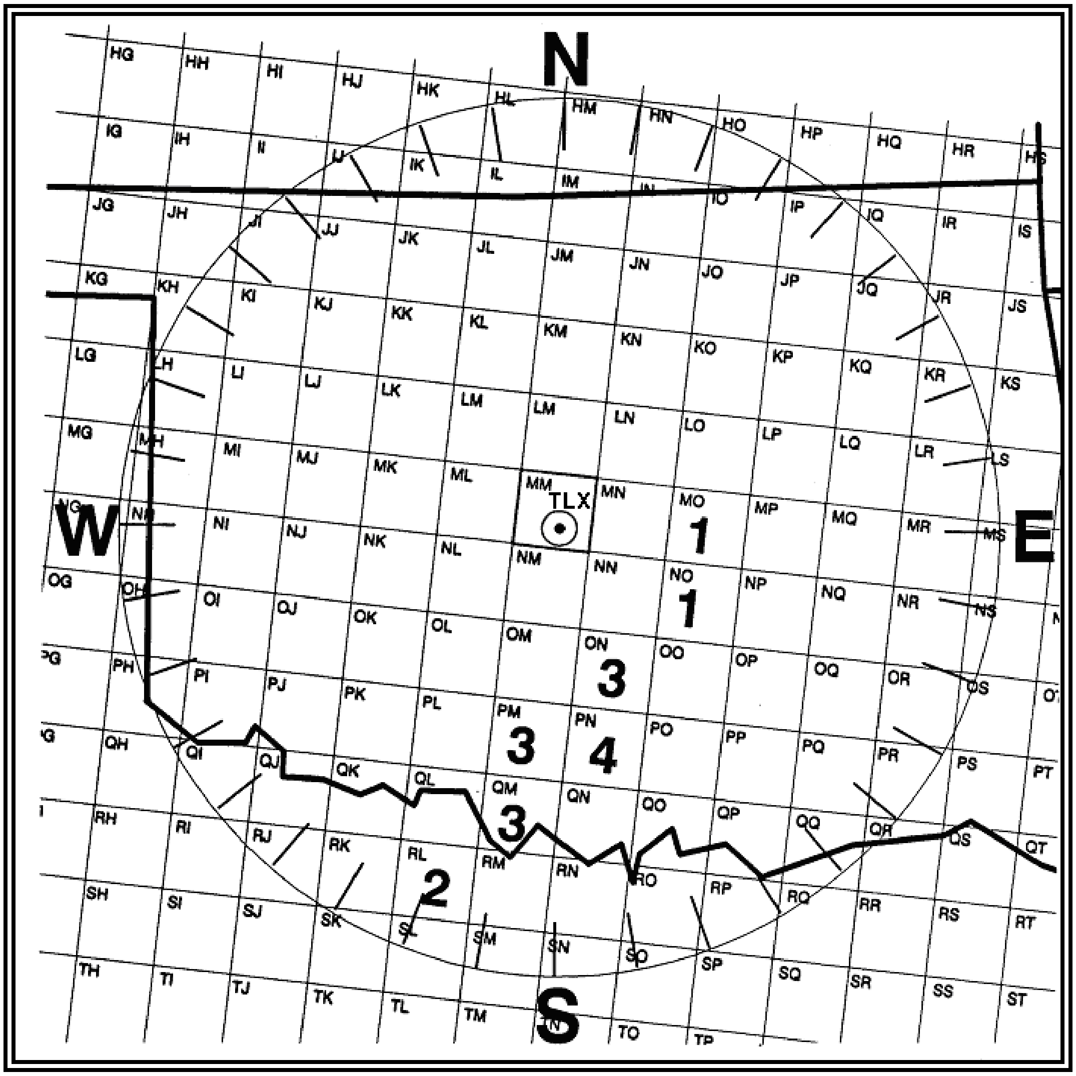


**Figure 3-14. SD/ROB Digital Section Information Plotted on a PPI Grid Overlay Example (See Table 3-11 for Intensity Level Codes 1 through 6.)**

### 3.3.2 Examples

```
GRB 1135 AREA 4TRW+ 9/101 133/76 54W MT 310 45/47 C2428 AUTO
```

Green Bay, Wisconsin, automated Radar Weather Report at 1135 UTC. An area of echoes, 4/10 coverage, contained thunderstorms and heavy rain showers. Area is defined by points (referenced from GRB radar site) at 9 degrees, 101 nautical miles and 133 degrees, 76 nautical miles. These points, plotted on a map and connected with a straight line, define the center line of the echo pattern. The width of the area was 54 nautical miles; i.e., 27 nautical miles either side of the center line. Maximum top was 31,000 feet MSL located at 45 degrees and 47 nautical miles from Green Bay. Cell movement was from 240 degrees at 28 knots.

```
ICT 1935 LN 9TRWX 274/84 216/93 22W MTS 440 260/48 C2131 AUTO
```

Wichita, Kansas, automated Radar Weather Report at 1935 UTC. A line of echoes, 9/10 coverage, contained thunderstorm with intense rain showers. The center of the line extended from 274 degrees, 84 nautical miles to 216 degrees, 93 nautical miles. The line was 22 nautical miles wide.

To display graphically, plot the center points on a map and connect the points with a straight line; then plot the width. Since the thunderstorm line was 22 nautical miles wide, it extended 11 nautical miles either side of your plotted line.

The maximum top is 44,000 feet MSL at 260 degrees, 48 nautical miles from Wichita. Cell movement was from 210 degrees at 31 knots.

```
GGW 1135 AREA 3S- 95/129 154/81 34W MT 100 130/49 0805 AUTO
```

Glasgow, Montana, automated Radar Weather Report at 1135 UTC. An area, 3/10 coverage, of light snow. The area's centerline extended from points at 95 degrees, 129 nautical miles to 154 degrees, 81 nautical miles from Glasgow. The area was 34 nautical miles wide. The maximum top was 10,000 feet MSL, at 130 degrees, 49 nautical miles from Glasgow. Cell movement was from 80 degrees at 5 knots.

```
JGX 2235 AREA 2TRW++6R- 67/130 308/45 106W MT 380 66/54 C2038 AUTO
```

Atlanta, Georgia, automated Radar Weather Report at 2235 UTC. An area of echoes, total coverage 8/10, with 2/10 of thunderstorms with very heavy rain showers and 6/10 coverage of light rain (This suggests that the thunderstorms were embedded in an area of light rain). The area was 53 nautical miles either side of the line defined by the two points, 67 degrees, 130 nautical miles and 308 degrees, 45 nautical miles from Atlanta. Maximum top was at 38,000 feet and was located on the 66 degree radial of JGX at 54 nautical miles. Cell movement was from 200 degrees at 38 knots.

```
HKM 0235 CELL TRW+ 19/22 D5 MT 270 18/23 C0414 AUTO
```

Kohala, Hawaii, automated Radar Weather Report at 0235 UTC. A cell, containing thunderstorms with very heavy rain showers, 5 miles in diameter, was located 19 degrees, 22 nautical miles from Kohala. Maximum top was 27,000 feet located at 18 degrees, 23 nautical miles from Kohala. Movement was from 40 degrees at 14 knots.

```
TLX 0435 PPINE AUTO
```

Oklahoma City, Oklahoma, automated Radar Weather Report at 0435 UTC, detected no echoes.

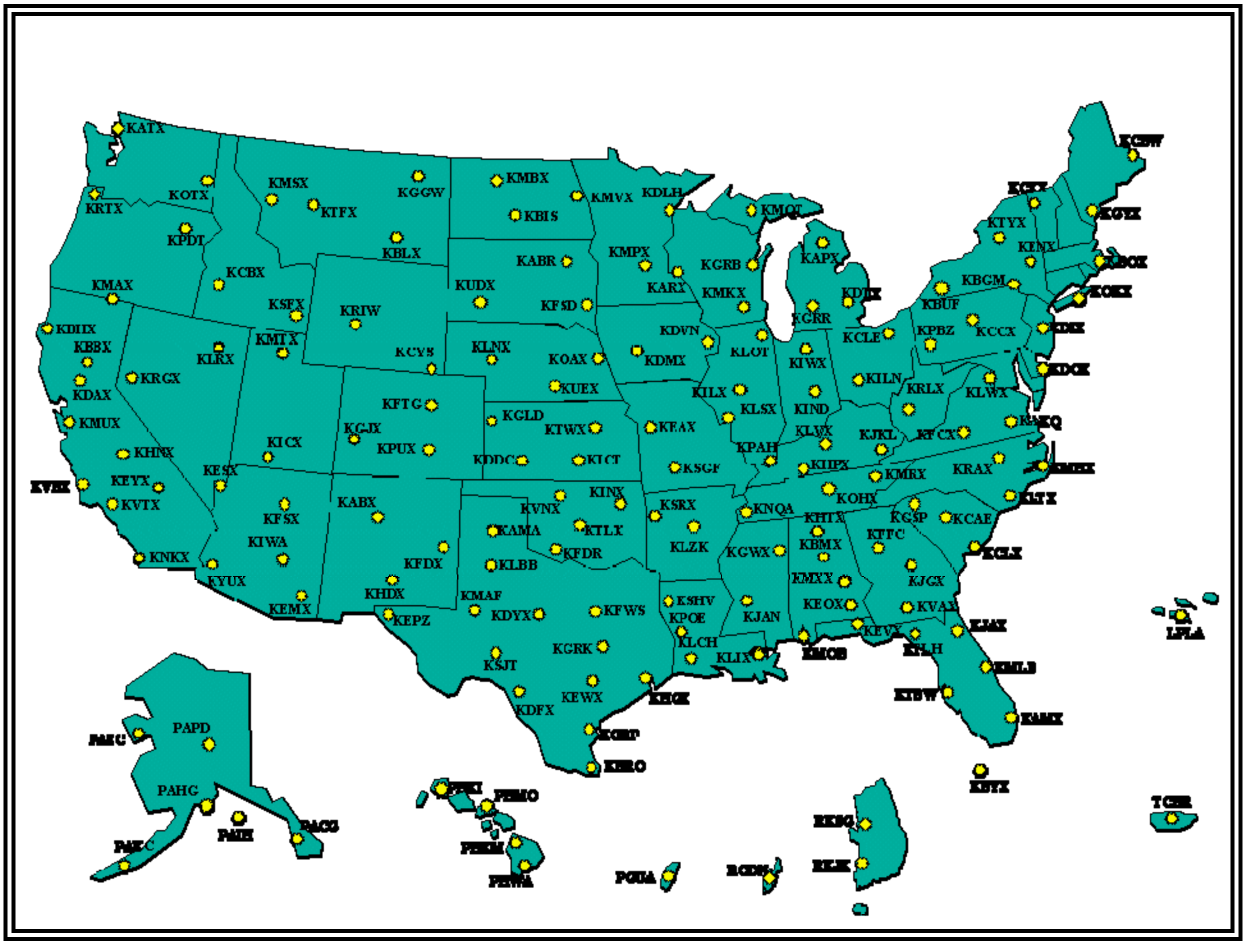


Figure 3-15.  WSR-88D Weather Radar Network Sites

# 4 RADAR AND SATELLITE IMAGERY

## 4.1 Radar

### 4.1.1 Description

Radar images are graphical displays of precipitation and non-precipitation targets detected by weather radar. WSR-88D Doppler radar displays these targets on a variety of products which can be found on the internet on the National Weather Service (NWS) Doppler Radar Images web site at: http://radar.weather.gov/ridge/

### 4.1.2 Modes of Operation

The WSR-88D Doppler radar has **two** operational modes, **Clear Air** and **Precipitation**.

#### 4.1.2.1 Clear Air Mode

In Clear Air Mode, the radar is in its most sensitive operation. This mode has the slowest antenna rotation rate which permits the radar to sample the atmosphere longer. This slower sampling increases the radar's sensitivity and ability to detect smaller objects in the atmosphere. The term "clear air" does not imply "no-precipitation" mode. Even in Clear Air Mode, the WSR-88D can detect light, stratiform precipitation (e.g., snow) due to the increased sensitivity.

Many of the radar returns in Clear Air Mode are airborne dust and particulate matter. The WSR-88D images are updated every 10 minutes when operating in this mode.

#### 4.1.2.2 Precipitation Mode

Precipitation targets typically provide stronger return signals to the radar than non-precipitation targets. Therefore, the WSR-88D is operated in Precipitation Mode when precipitation is present although some non-precipitation echoes can still be detected in this operating mode.

The faster rotation of the WSR-88D in Precipitation Mode allows images to update at a faster rate approximately every 4 to 6 minutes.

### 4.1.3 Echo Intensities

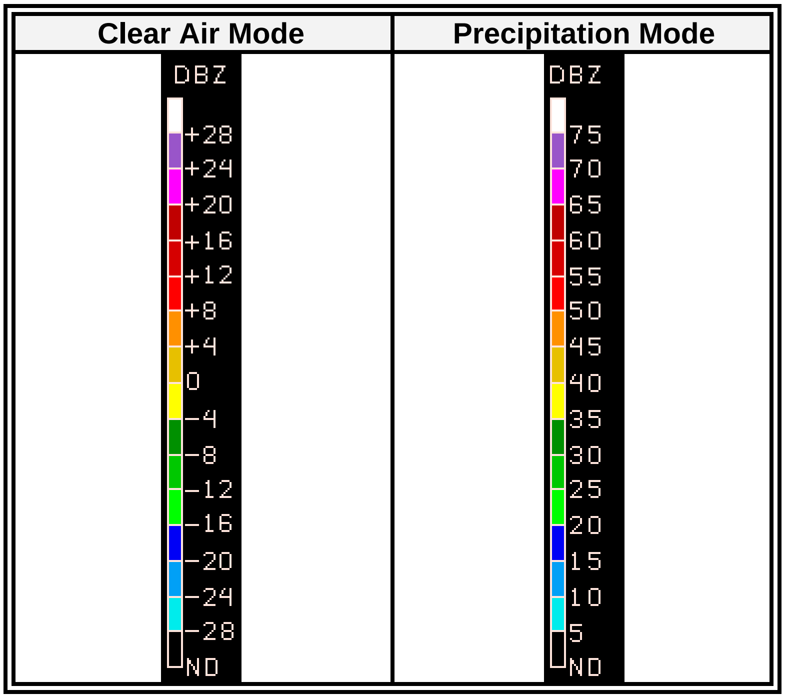


**Figure 4-1. WSR-88D Weather Radar Echo Intensity Legend**

The colors on radar images represent different echo reflectivities (intensities) measured in dBZ (decibels of Z). The dBZ values increase based on the strength of the return signal from targets in the atmosphere. Each reflectivity image includes a color scale that represents a correlation between reflectivity value and color on the radar image. Figure 4-1 depicts these correlations for both Clear Air and Precipitation Mode. For Clear Air Mode the scale ranges from -28 to +28 dBZ, for Precipitation Mode the scale ranges from 5 to 75 dBZ. *The color on each scale remains the same in both operational modes, only the dBZ values change.* The scales also include **ND** correlated to black which indicates no data was measured.

Reflectivity is correlated to intensity of precipitation. For example, in Precipitation Mode, when the dBZ value reaches 15, light precipitation is present. The higher the indicated reflectivity value, the higher the rainfall rate. The interpretation of reflectivity values is the same for both Clear Air and Precipitation Modes.

Reflectivity is also correlated with intensity terminology (phraseology) for air traffic control purposes. Table 4-1 defines this correlation.

**Table 4-1. WSR-88D Weather Radar Precipitation Intensity Terminology**

| Reflectivity (dBZ) Ranges | Weather Radar Echo Intensity Terminology |
|---|---|
| <30 dBZ | Light |
| 30-40 dBZ | Moderate |
| >40-50 dBZ | Heavy |
| 50+ dBZ | Extreme |

Values below 15 dBZ are typically associated with clouds. However, they may also be caused by atmospheric particulate matter such as dust, insects, pollen, or other phenomena. The scale **cannot** be used to determine the intensity of snowfall. However, snowfall rates generally increase with increasing reflectivity.

### 4.1.4 Products

The NWS produces numerous radar products of interest to the aviation community. The next section will discuss Base Reflectivity and Composite Reflectivity both available through National Weather Service (NWS) Doppler Radar Images web site at: http://radar.weather.gov/ridge/

#### 4.1.4.1 Base Reflectivity

Base Reflectivity is a display of both the location and intensity of reflectivity data. Base Reflectivity images encompass several different elevation angles (tilts) of the antenna. The Base Reflectivity image currently available on the ADDS website begins at the lowest tilt angle (0.5°), more specifically 0.5° above the horizon.

Both a short range (Figure 4-2) and long range (Figure 4-3) image is available from the 0.5º Base Reflectivity product. The maximum range of the short range Base Reflectivity product is 124 NM from the radar location. This view will not display echoes farther than 124 NM from the radar site, although precipitation may be occurring at these greater distances. Other options to view precipitation beyond 124 NM from the radar site include selecting the long-range view which increases coverage out to 248 NM, selecting adjacent radars, or viewing a radar mosaic.

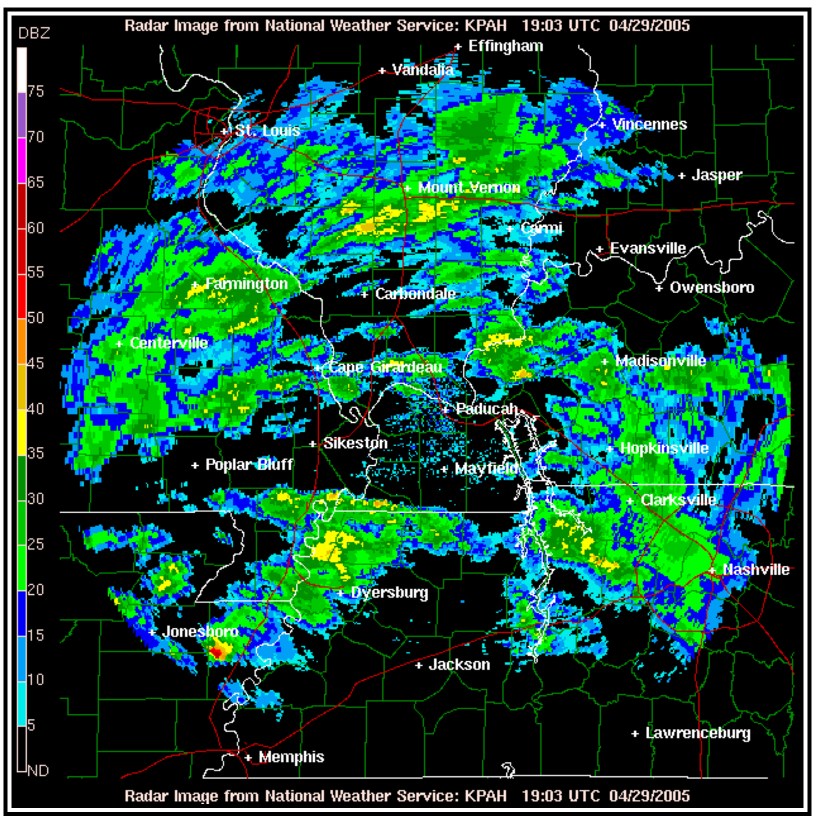


**Figure 4-2. WSR-88D Weather Radar Short Range (124 NM) Base Reflectivity Product Example**

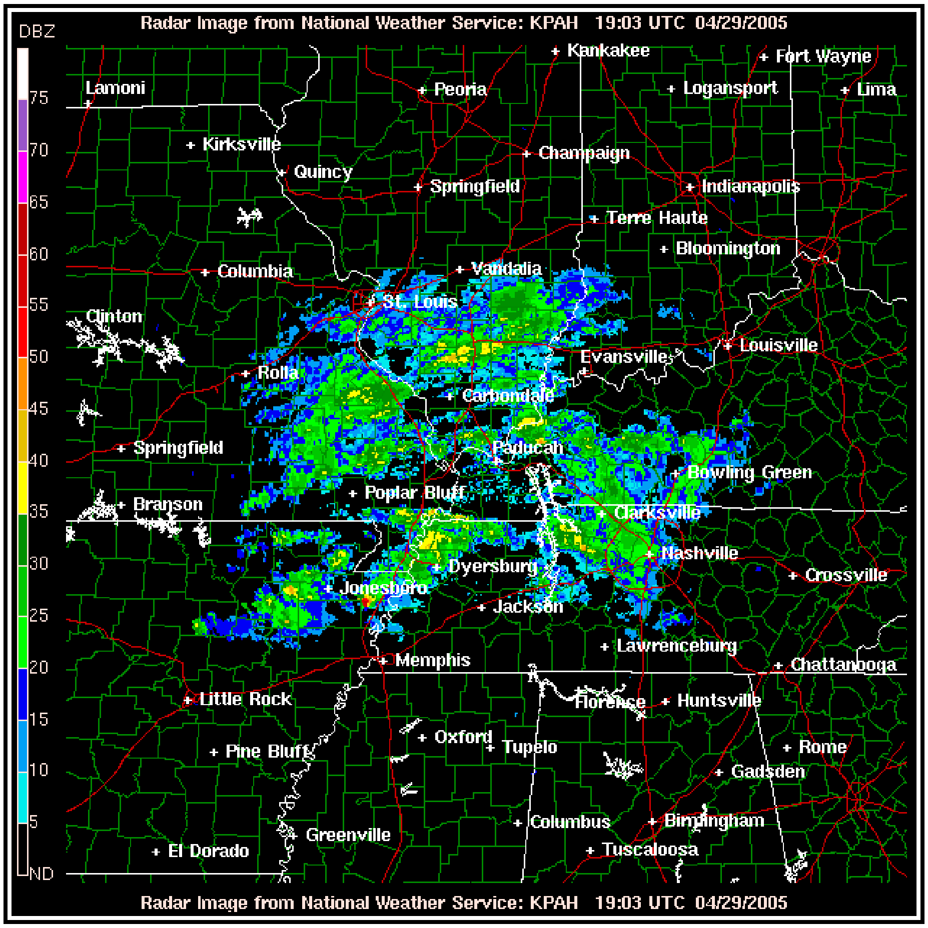


**Figure 4-3. WSR-88D Weather Radar Long Range (248 NM) Base Reflectivity Product Example**

### 4.1.4.1.1 Base Reflectivity Use

The Base Reflectivity product can be used to determine the location of precipitation and non-precipitation echoes, the intensity of liquid precipitation, and the general movement of precipitation when animating the image.

If the echo is precipitation, the product can be used to determine if it is convective or stratiform in nature. Stratiform precipitation (Figure 4-4) has the following characteristics:

- Widespread in areal coverage,
- Weak reflectivity gradients,
- Precipitation intensities are generally light or moderate (39 dBZ or less),
    - o Occasionally, precipitation intensities can be stronger
- Echo patterns change slowly when animating the image.

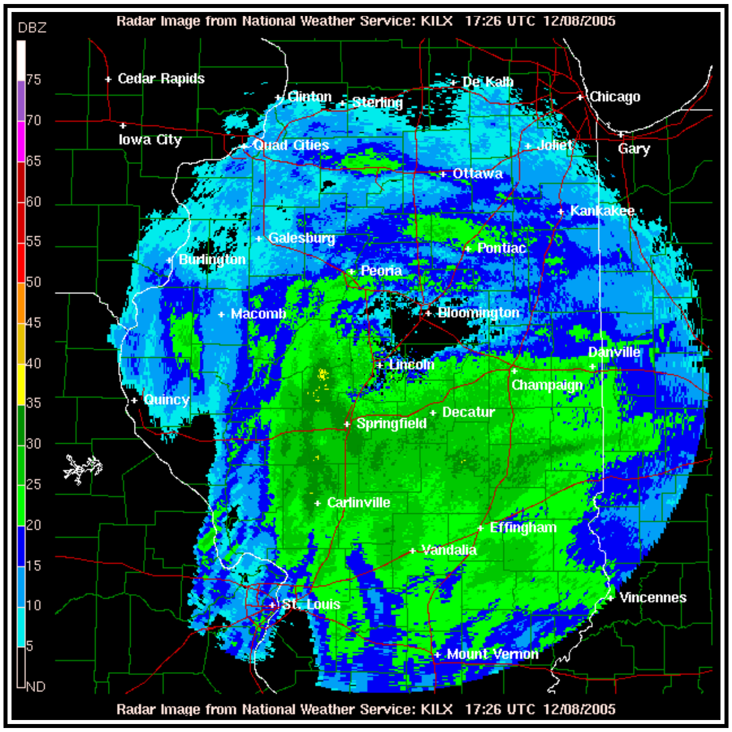


**Figure 4-4. WSR-88D Weather Radar Stratiform Precipitation on the 0.5ºBase Reflectivity Product Example**

Hazards associated with stratiform precipitation include possible widespread icing above the freezing level, low ceilings and reduced visibilities.

Convective precipitation (Figure 4-5) can be described using the following characteristics:

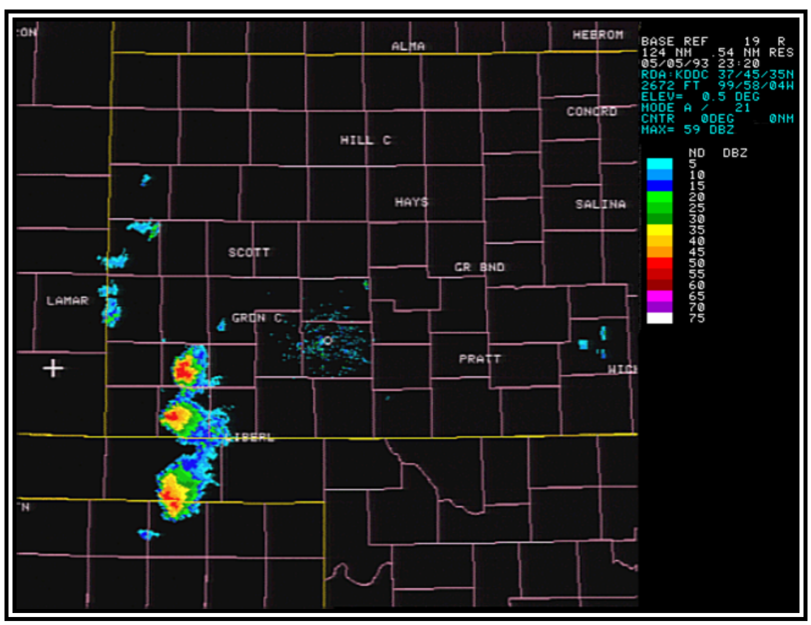


**Figure 4-5. WSR-88D Weather Radar Convective Precipitation on the 0.5ºBase Reflectivity Product Example**

- Echoes tend to form as lines or cells,
- Reflectivity gradients are strong,

- Precipitation intensities generally vary from moderate to extreme,
  - Occasionally precipitation intensities can be light
- Echo patterns change rapidly when animating the image

Numerous hazards are associated with convective precipitation. They include: turbulence, low-level wind shear, strong and gusty surface winds, icing above the freezing level, hail, lightning, tornadoes and localized IFR conditions with heavy precipitation.

#### 4.1.4.1.2 Strengths of Base Reflectivity

The strengths of the Base Reflectivity product include:

- The location of precipitation and non-precipitation echoes is depicted, and
- The intensity and movement of precipitation is relatively easy and straight forward to determine.

#### 4.1.4.1.3 Limitations of Base Reflectivity

Limitations associated with the Base Reflectivity product include:

- The radar beam may overshoot targets, and
- The image may be contaminated by:
  - Beam blockage
  - Ground clutter
  - Anomalous Propagation (AP) and
  - Ghosts.

##### 4.1.4.1.3.1 Radar Beam Overshooting

Radar beam overshooting may occur because the radar beam (typically the 0.5 degree slice) can be higher than the top of precipitation. This will most likely occur with stratiform precipitation and low-topped convection. For example, at a distance of 124 NM from the radar, the 0.5º Base Reflectivity radar beam is at an altitude of approximately 18,000 feet; at 248 NM the beam height is approximately 54,000 feet. Any precipitation with tops below these altitudes and distances will **not** be displayed on the image. Therefore, it is quite possible that precipitation may be occurring where none appears on the radar image.

##### 4.1.4.1.3.2 Beam Blockage

Beam blockage (Figure 4-6) occurs when the radar beam is blocked by terrain and is particularly predominant in mountainous terrain. This impacts both the Composite Reflectivity and Base Reflectivity images.

Beam blockage is most easily seen on the 0.5º Base Reflectivity images where it appears as a pie-shaped area (or areas) perpetually void of echoes. When animating the imagery, the beam blockage area will remain clear of echoes even as precipitation and other targets pass through.

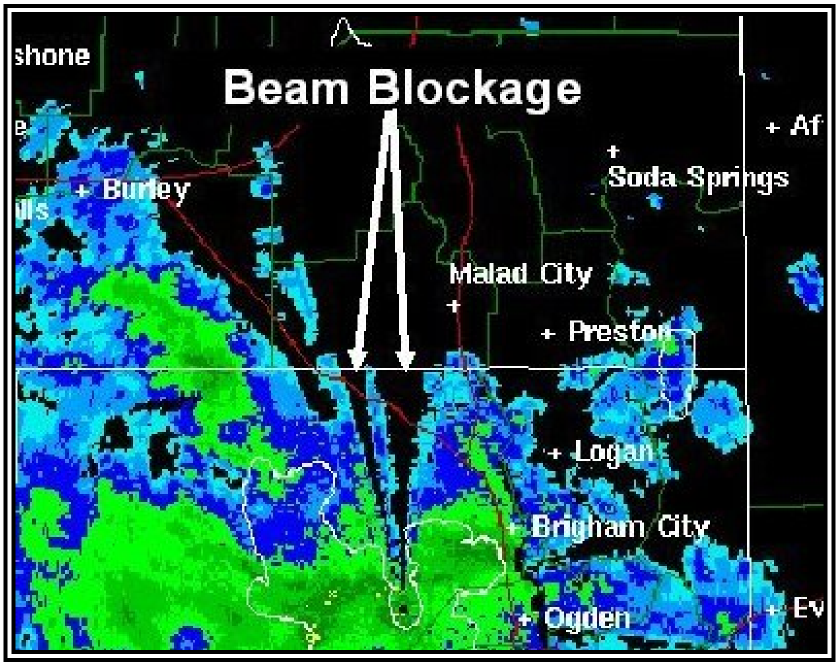


**Figure 4-6. WSR-88D Weather Radar Beam Blockage on Base Reflectivity Product Example**

### 4.1.4.1.3.3 Ground Clutter

Ground clutter (Figure 4-8) is radar echoes returns from trees, buildings, or other objects on the ground. It appears as a roughly circular region of high reflectivities at ranges close to the radar. Ground clutter appears stationary when animating images and can mask precipitation located near the radar. Most ground clutter is automatically removed from WSR-88D imagery, so typically it is does not interfere with image interpretation.

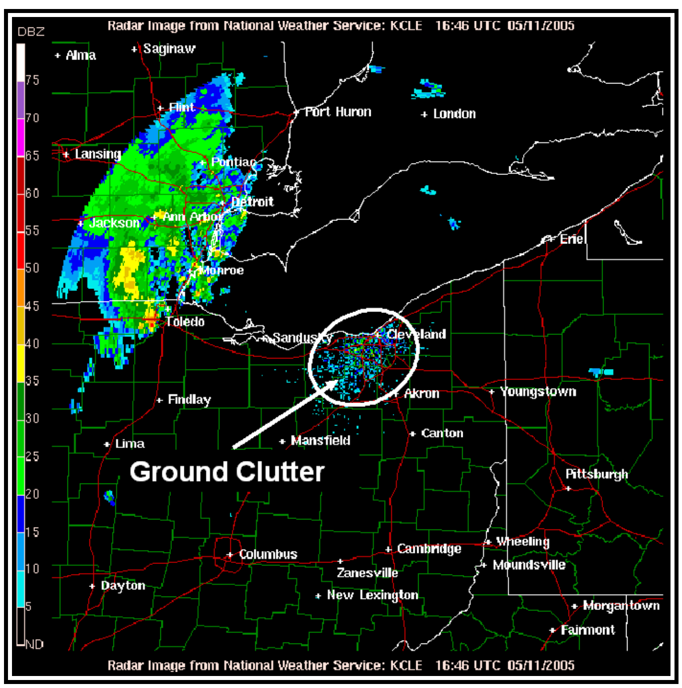


**Figure 4-8. WSR-88D Weather Radar Ground Clutter Example**

### 4.1.4.1.3.4 Ghost

A Ghost (Figure 4-9) is a diffused echo in apparently clear air caused by a “cloud” of point targets such as insects or by refraction returns of the radar beam in truly clear air.

The latter case commonly develops at sunset due to superrefraction during the warm season. The ghost develops as an area of low reflectivity echoes (typically less than 15dBZ) near the radar site and quickly expands. When animating the imagery, the ghost echo shows little movement.

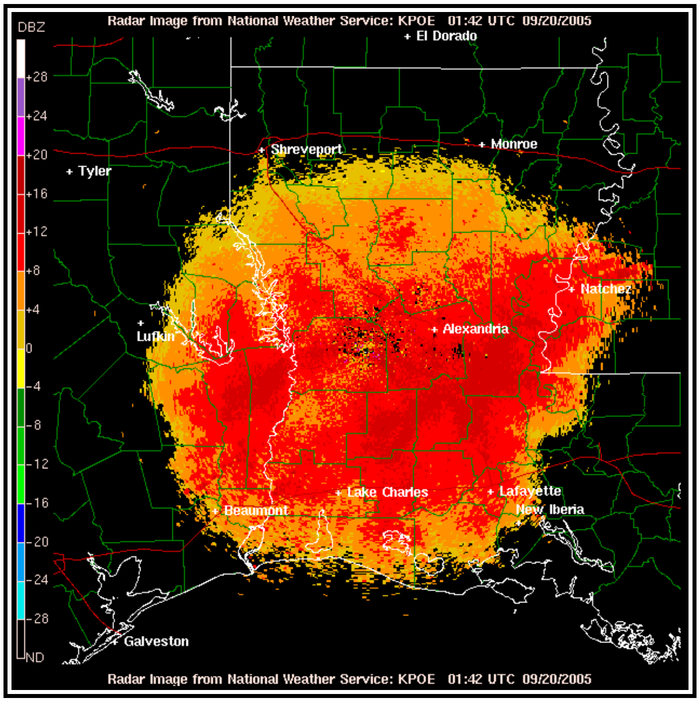


**Figure 4-9. WSR-88D Weather Radar Ghost Example**

### 4.1.4.1.3.5 Angels

Angels are echoes caused by a physical phenomenon not discernible by the eye at the radar site. They are usually causes by bats, birds or insects. Angels typically appear as a donut-shaped echo with low reflectivity values (Figure 4-10). When animated, the echo expands and becomes more diffuse with time.

Angels typically only appear only when the radar is in Clear Air Mode because of their weak reflectivity. Echoes caused by birds are typically detected in the morning when they take flight for the day. Echoes caused by bats are typically detected in the evening, when they are departing from caves.

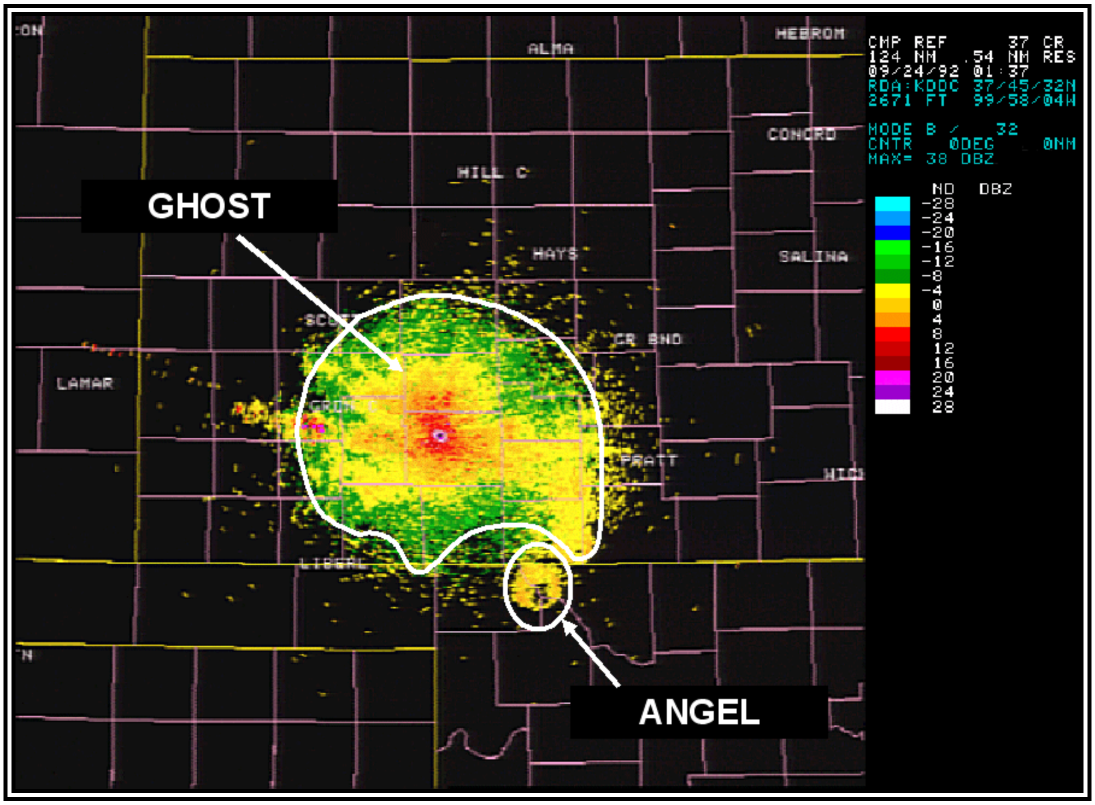


**Figure 4-10. WSR-88D Weather Radar Angle Example**
**This angel was caused by bats departing Selman Bat Cave at Alabaster Caverns State Park, Oklahoma around sunset**

### 4.1.4.1.3.6 Anomalous Propagation (AP)

Anomalous propagation (AP) (Figure 4-11) is an en extended pattern of ground echoes caused by superrefraction of the radar beam. Superrefraction causes the radar beam to bend downward and strike the ground. It differs from ground clutter because it can occur anywhere within the radar's range, not just at ranges close to the radar.

AP typically appears as speckled or blotchy, high reflectivity echoes. When animating images, AP tends to "bloom up" and dissipate and has no continuity of motion. AP can sometimes be misinterpreted as thunderstorms; differentiating between to two is determined by animating images. Thunderstorms move with a smooth, continuous motion while AP appears to "bloom up" and dissipate randomly.

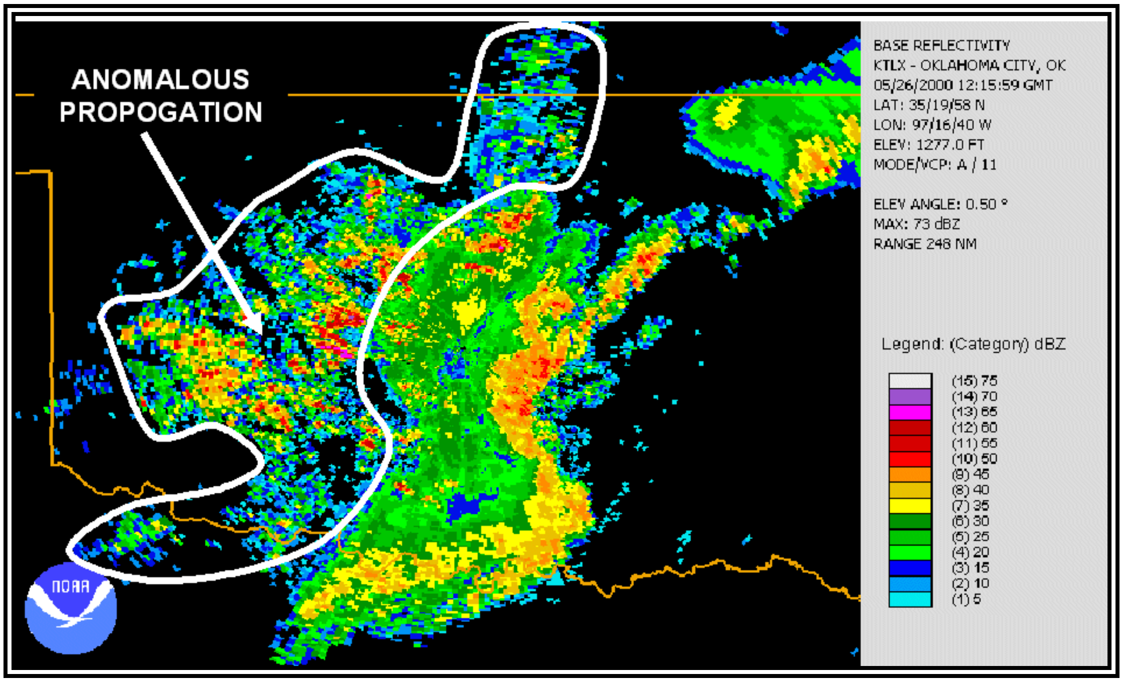


**Figure 4-11. WSR-88D Weather Radar Anomalous Propagation (AP) Example**

### 4.1.4.2 Composite Reflectivity

Composite reflectivity is the maximum echo intensity (reflectivity) detected within a column of the atmosphere above a location. The radar scans through all of the elevation slices to determine the highest dBZ value in the vertical column (Figure 4-12) then displays that value on the product. When compared with Base Reflectivity, the Composite Reflectivity can reveal important storm structure features and intensity trends of storms.

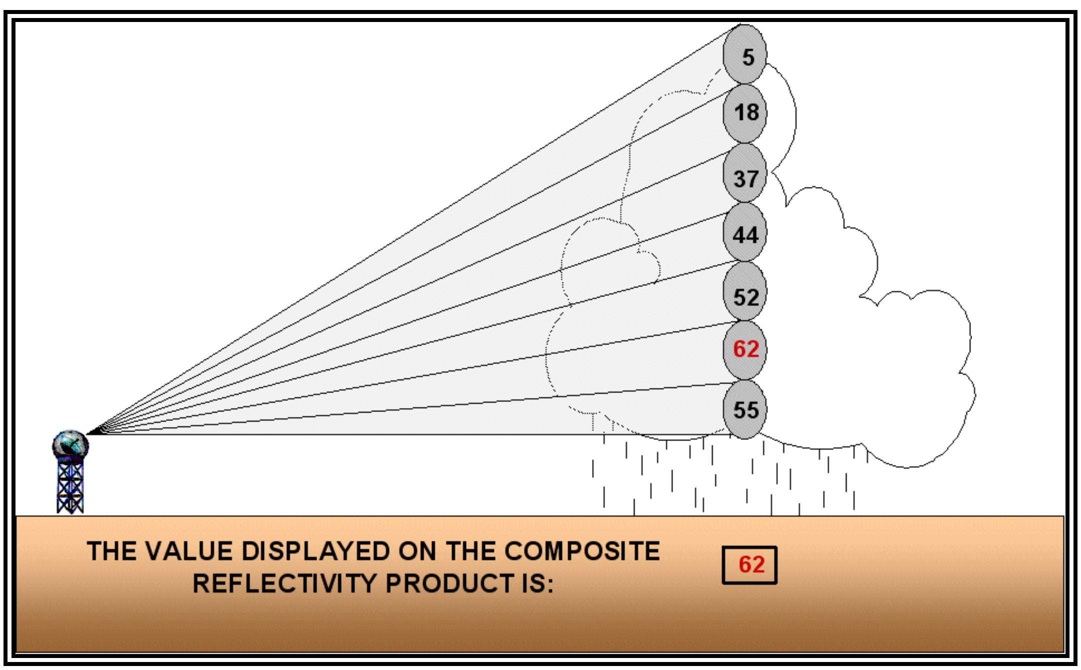


**Figure 4-12. Creation of a Composite Reflectivity product**

The maximum range of the long range Composite Reflectivity product (Figure 4-13) is 248 NM from the radar. The "blocky" appearance of this product is due to its lower spatial resolution as it has one-fourth the resolution of the Base Reflectivity product.

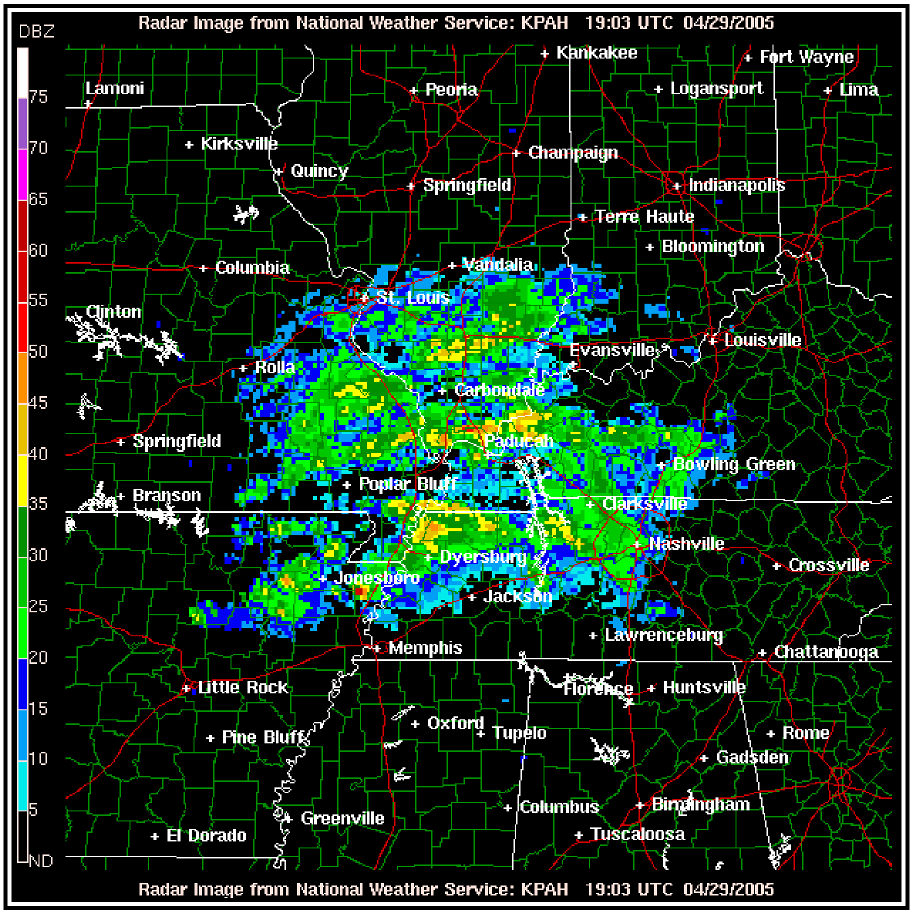

**Figure 4-13. WSR-88D Weather Radar Long Range (248 NM) Composite Reflectivity Product Example**

For a higher resolution (1.1 x 1.1 NM grid) Composite Reflectivity image, users must select the short range view (Figure 4-14). The image is less "blocky" as compared to the long range image. However, the maximum range is reduced to 124 NM from the radar location.

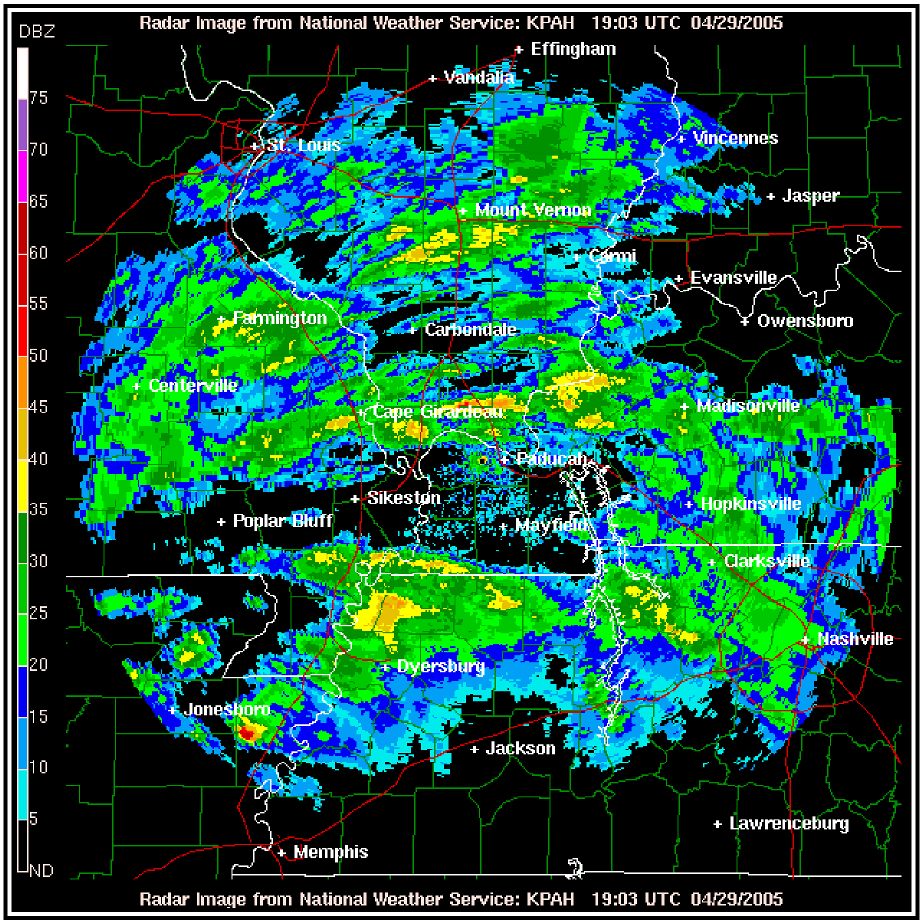


**Figure 4-14. WSR-88D Weather Radar Short Range (124 NM) Composite Reflectivity Product Example**

### 4.1.4.2.1 Composite Reflectivity Use

The primary use of the Composite Reflectivity product, which offers the highest reflectivity value in a vertical column, is to determine the vertical structure of the precipitation. The image must be compared with the Base Reflectivity image to determine the vertical structure of the precipitation. Figure 4-15 includes the 0.5º Base Reflectivity and Composite Reflectivity images for the same location and period of time.

In Figure 4-15, within location A, the intensity of the echoes is higher on the Composite Reflectivity image. Also, within area B, many more echoes present on the Composite Reflectivity. Since the Composite Reflectivity product displays the highest reflectivity of **all** elevation scans, it is detecting these higher reflectivities at some higher altitude/elevation than the Base Reflectivity product, which is sampling closer to the ground. This often occurs when precipitation and especially thunderstorms are developing.

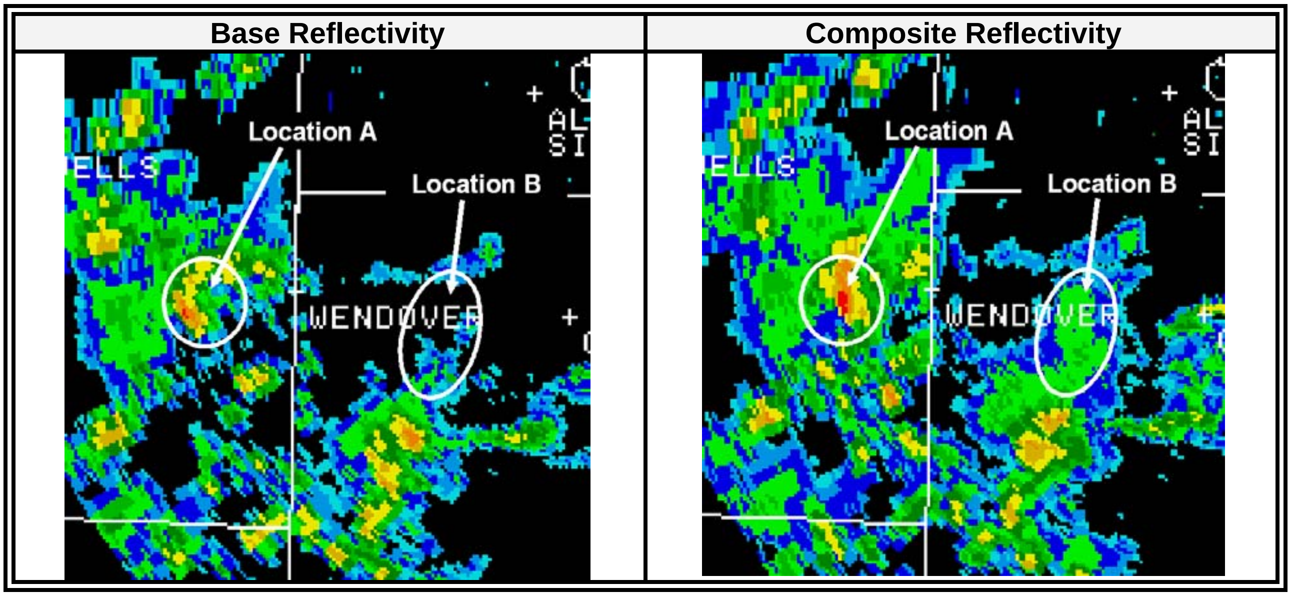


**Figure 4-15. WSR-88D Weather Radar 0.5º Base Reflectivity Versus Composite Reflectivity Comparison**

#### 4.1.4.2.2 Strengths of Composite Reflectivity

The primary strength of the Composite Reflectivity product is its three-dimensional view of reflectivity. The method used to determine this three-dimensional view is described in section 4.1.4.2.1.

#### 4.1.4.2.3 Limitations of Composite Reflectivity

Limitations associated with the Composite Reflectivity product include:

- The radar beam may overshoot targets, and
- The image may be contaminated by:
    - Beam blockage
    - Ground clutter
    - Anomalous Propagation (AP) and
    - Ghosts.

##### 4.1.4.2.3.1 Radar Beam Overshooting

Radar beam overshooting may occur because the lowest base reflectivity tilt (0.5) can be higher than the top of precipitation. This will most likely occur with stratiform precipitation and low-topped convection. For example, at a distance of 124 NM from the radar, the radar beam is at an altitude of approximately 18,000 feet above the radar; at 248 NM the beam height is approximately 54,000 feet. Any precipitation with tops below these altitudes and distances will **not** be displayed on the image. Therefore, it is quite possible that precipitation may be occurring where none appears on the radar image.

##### 4.1.4.2.3.2 Beam Blockage

Beam blockage (Figure 4-6) occurs when the radar beam is blocked by terrain and is particularly predominant in mountainous terrain. This impacts both the Composite Reflectivity and Base Reflectivity images.

Beam blockage is most easily seen on the 0.5º Base Reflectivity images where it appears as a pie-shaped area (or areas) perpetually void of echoes. When animating the imagery, the beam blockage area will remain clear of echoes even as precipitation and other targets pass through.

#### 4.1.4.2.3.3 Ground Clutter
Ground clutter (Figure 4-8) is radar echoes returns from trees, buildings, or other objects on the ground. It appears as a roughly circular region of high reflectivities at ranges close to the radar. Ground clutter appears stationary when animating images and can mask precipitation located near the radar. Most ground clutter is automatically removed from WSR-88D imagery, so typically it is does not interfere with image interpretation.

#### 4.1.4.2.3.4 Ghost
A Ghost (Figure 4-9) is a diffused echo in apparently clear air that is caused by a “cloud” of point targets such as insects or by refraction returns of the radar beam in truly clear air.

The latter case commonly develops at sunset due to superrefraction during the warm season. The ghost develops as an area of low reflectivity echoes (typically less than 15 dBZ) near the radar site and quickly expands. When animating the imagery, the ghost echo shows little movement.

#### 4.1.4.2.3.5 Angels
Angels are echoes caused by a physical phenomenon not discernible by the eye at the radar site. They are usually causes by bats, birds or insects. Angels typically appear as a donut-shaped echo with low reflectivity values (Figure 4-10). When animating, the echo expends and becomes more diffuse with time.

Angels typically only appear only when the radar is in clear air mode because of their weak reflectivity. Echoes caused by birds are typically detected in the morning when they take flight for the day. Echoes caused by bats are typically detected in the evening when they take flight from caves.

#### 4.1.4.2.3.6 Anomalous Propagation (AP)
Anomalous propagation (AP) (Figure 4-11) is an en extended pattern of ground echoes caused by superrefraction of the radar beam. Superrefraction causes the radar beam to bend downward and strike the ground. It differs from ground clutter because it can occur anywhere within the radar’s range, not just at ranges close to the radar.

AP typically appears as speckled or blotchy, high reflectivity echoes. When animating images, AP tends to “bloom up” and dissipate and has no continuity of motion. AP can sometimes be misinterpreted as thunderstorms; differentiating between to two is determined by animating images. Thunderstorms move with a smooth, continuous motion while AP appears to “bloom up” and dissipate randomly.

### 4.1.5 Radar Mosaics
A radar mosaic consists of multiple single site radar images combined to produce a radar image on a regional or national scale. Regional and national mosaics can be found at the National Weather Service (NWS) Doppler Radar Images web site: http://radar.weather.gov/ridge/

The mosaics are located toward the bottom of the page.

### 4.1.5.1 0.5º Mosaics - Contiguous U.S. and Hawaii

The NWS produces a set of regional and national mosaics (Table 4-2) in the contiguous U.S. using the 124 NM 0.5º Base Reflectivity product (Figure 4-16).

**Table 4-2. NWS Radar Mosaic Products**

| | |
|---|---|
| Pacific Northwest | Pacific Southwest |
| Upper Mississippi Valley | Southern Mississippi Valley |
| Northeast | Southeast |
| Southern Rockies | Northern Rockies |
| Southern Plains | Great Lakes |
| Low Resolution National | High Resolution National |

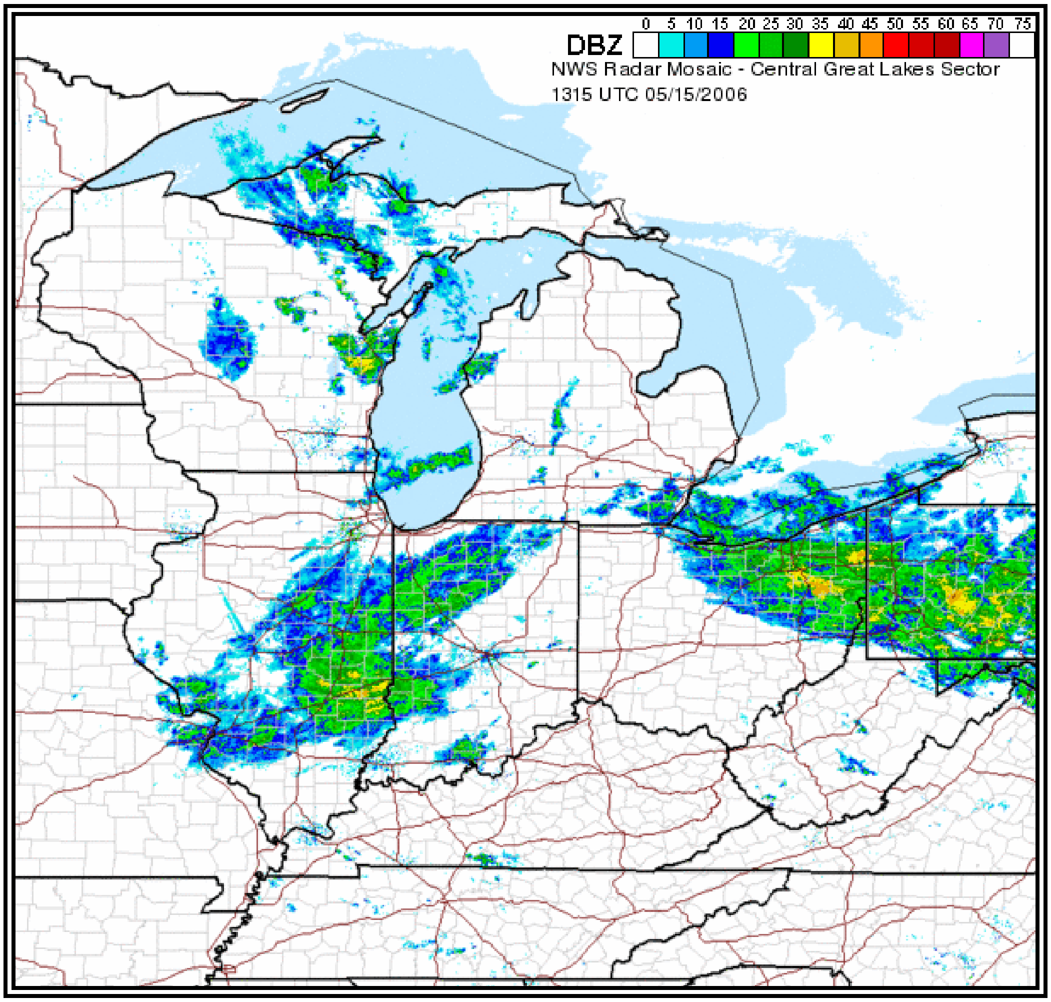


**Figure 4-16. Great Lakes Regional Radar Mosaic Example**

The most recent image from single site radars is used to create the product. Single site data older than 15 minutes from the current time of the product are excluded from the image. Therefore, data on the mosaics will be no greater than 15 minutes old. Where radar coverage overlaps, the highest dBZ value will be plotted on the image.

#### 4.1.5.2 0.5º Mosaics - Alaska

The Alaskan mosaic (Figure 4-17) differs from the contiguous product in only one way: it is created using the 248 NM 0.5º Base Reflectivity single site product.

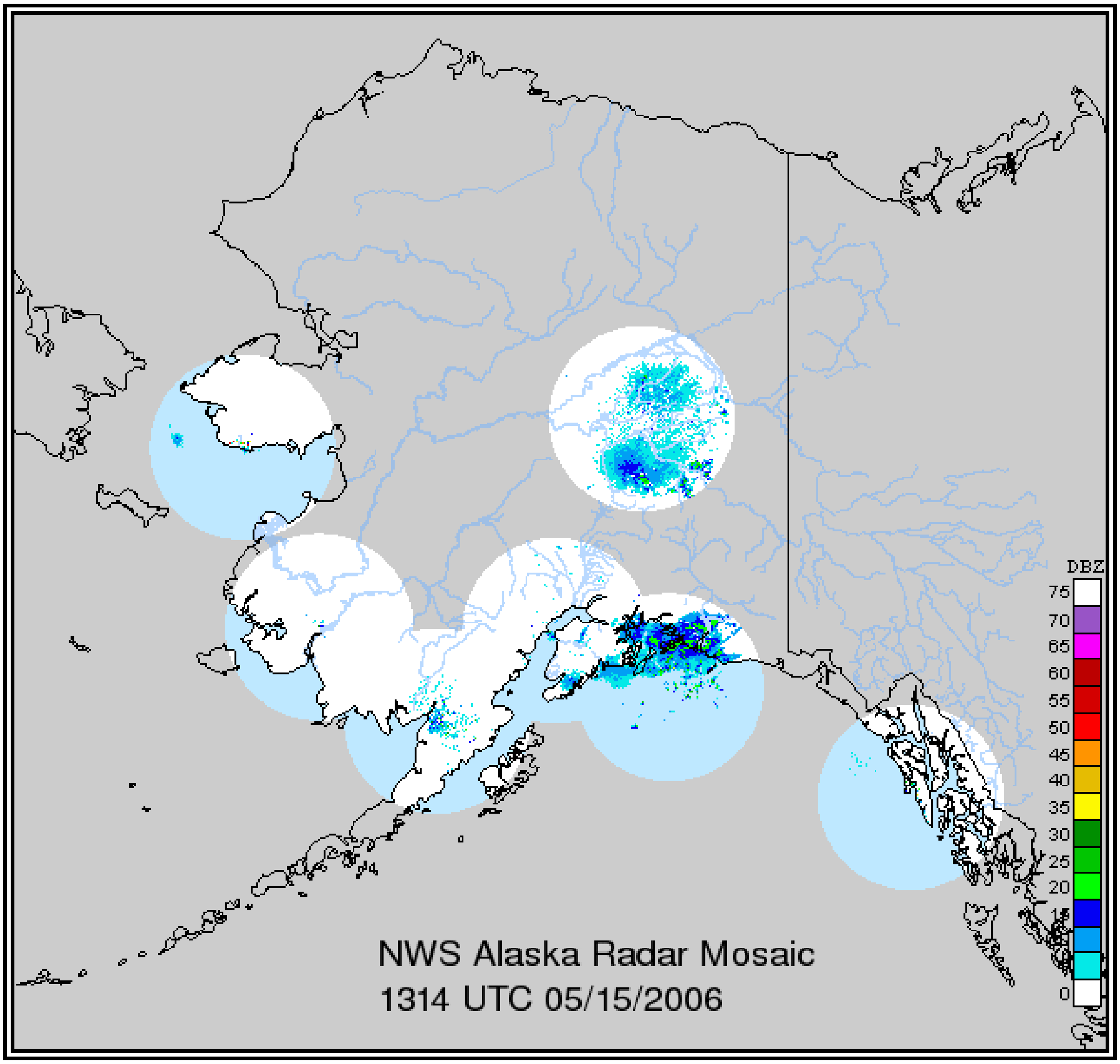


**Figure 4-17. Alaskan Regional Radar Mosaic Example**

The long range Base Reflectivity product is used because the radar sites are located at greater distances from each other. Even with the use of the long range product, many areas of Alaskan do not have radar coverage. These areas are shaded gray on Figure 4-17.