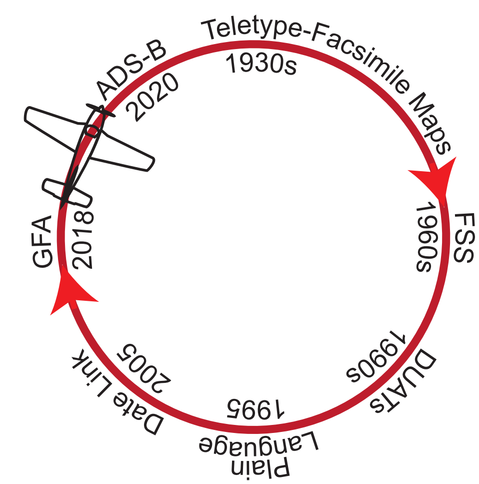
9 Surface Observations

Since their inception in the early 1930s pilots have objected to coded weather information. The FAA took over most pilot weather briefing responsibilities in the 1960s. When asked about coded reports many reply, “Why do I have to read the weather? When I call flight service, they read and explain the reports.” This was, for the most part, true prior to the introduction of personal computers in the 1990s. During initial implementation, Direct User Access Terminal (DUAT) reports were distributed in coded format. Subsequently, these systems were modified to provide “plain language” translations. For almost all the existence of aviation weather reports and forecasts the only place pilots could expect to see “coded” weather was on FAA written tests! Over the last decade, as part of the digital and communications revolution, weather data has become available through flight deck weather displays—Data Link, including Automatic Dependent Surveillance-Broadcast (ADS-B). We’ve come “full circle” and you guessed it! We’re back to reading coded reports.



Whether coded or translated, data is useless unless we can correctly interpret and apply the information. To do this we must understand observation, reporting, and coding standards.

Beginning with a description of surface weather reports, we’ll include the methods and criteria used for observations—manual and automated. Failure to understand the methods, requirements, and limitations of observations leads to misunderstanding, misinterpretation, and unwarranted criticism of these products.

In less than one hundred years aviation surface observations have gone through numerous changes. Evolutions took place in the 1960s when “wind arrows” were superseded by wind direction in degrees. In the 1970s sky condition symbols were replaced with contractions. A revolution occurred in the 1980s when the “electronic” distribution

"Get used to it"

"I am an active general aviation pilot and FSS specialist. I have learned that in aviation the only thing that doesn't change is change itself. Anyone that has a problem with change doesn't belong in Air Traffic Control or Aviation. I am tired of pilots and controllers whining about the new METAR/TAF codes. They're here, and here to stay. We have some serious problems to resolve in our industry, but METAR/TAF codes are not one of them."

"Terry T. Lankford"

"Thanks, Terry, Do you know the difference between a jet engine and a pilot? The engine finally stops whining.—Ed."

Flying (Magazine) April 1997

Operational Flight Categories

Category	Ceiling (FT)		Visibility (SM)
VFR	> 3000	and	> 5
MVFR	1000 to 3000	and/or	3 to 5
IFR	≥600 to < 1000	and/or	≥ 2 to < 3
LIFR[1]	≥ 200 to < 600	and/or	≥ 1/2 to < 2
VLIFR[2]	< 200	and/or	< 1/2

[1]Low Instrument Flight Rules
[2]Very Low Instrument Flight Rules

and display of weather reports succeeded teletype transmission—which began in the 1930s and '40s. Further revolutions followed with the introduction of automated observations and DUAT distribution in the early 1990s, and the transition to the international METAR code in 1996.

Aviation Routine Weather Reports

Aviation Routine Weather Reports (METAR) contain the following data and appear in the following sequence:

- type of report,
- station identifier,
- date and time of report,
- report modifier, if required,
- wind,
- visibility,
- weather and obstructions to visibility,
- sky condition,
- temperature and dewpoint,
- altimeter setting, and
- remarks.

Missing or unreported elements are omitted. The letter "M" means minus or less than, "P" plus or more than.

METARs are routinely transmitted each hour. When a significant change occurs an Aviation Special Weather Report (SPECI) is generated. A complex criterion determines the requirement for SPECIs. Generally, they're required when the weather improves to, or deteriorates below, Flight Category (callout) limits, or approach and landing, or alternate Instrument Flight Rules (IFR) minimums. Specials are also required for:

- Beginning, ending, or change in intensity of hail, freezing precipitation, or ice pellets.
- Beginning or ending of thunderstorm activity.
- Tornados, funnel clouds, or waterspouts.

- Wind shift or squalls.
- Volcanic eruption.

Weather can change without the requirement for a SPECI. SPECIs are not available at all locations; these reports will normally carry the remark "NOSPECI." In such cases significant changes can occur without expeditious notification.

In addition to long-line transmission of routine hourly METAR, and SPECI reports, many automated facilities provide one-minute observations (OMO), usually through discrete low-power radio frequencies and by telephone. They may differ from long-line transmissions and are not "instant weather." Sky condition and visibility employ time averaging algorithms to be more representative and buffer rapidly changing conditions. They're designed to report deteriorating weather faster than improving conditions. Specific visibility and sky condition algorithms are discussed in appropriate sections. Pilots must understand and apply these limitations to properly evaluate and apply OMO observations.

METARs use standard four-letter International Civil Aviation Organization (ICAO) location identifiers (LOCID). The official time of observation follows the report location transmitted as a six digit date/time group appended with a "Z" to denote Coordinated Universal Time (UTC).

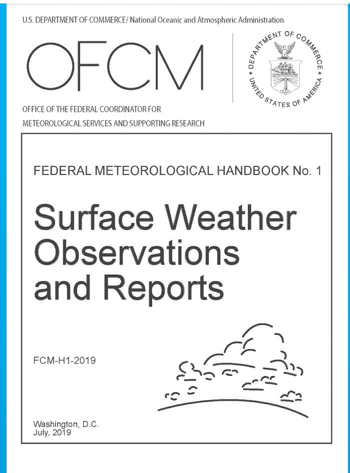
Fact

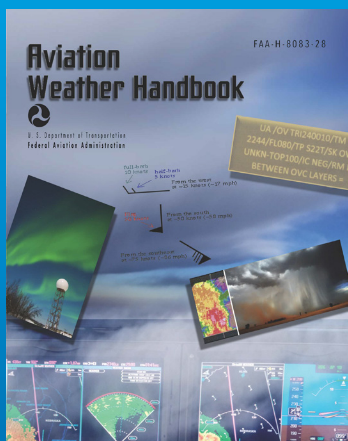
> The time standard used on aviation weather products is Coordinated Universal Time (UTC), at times—pardon the pun—referred to as ZULU or "Z." It seems that an advisory committee of the International Telecommunications Union in 1970 was tasked with replacing the international time standard of Greenwich Mean Time (GMT). The question became whether to use English or French word order for Coordinated Universal Time. So, not "CUT" or "TUC," but "UTC" was adopted.

Since METARs contain parameters applicable to other disciplines within the meteorological community, we'll restrict our discussion to those elements that affect aviation operations. For details on other aspects of reports refer to Federal Meteorological

long-line transmission—When applied to weather reports and forecasts (METARs, SPECIs, and TAFs), indicates data is available on national and international data bases—Leidos Flight Service, National Weather Service (AWC), Flight Information Service-Broadcast (FIS-B), and commercial vendors.

On November 5, 1870 the first official weather reports were issued by the U.S. Army. These reports were based on twenty-four observations from around the nation using the still relatively newfangled telegraph.





Handbook No. 1 *Surface Weather Observations and Reports* and FAA-H-8083-28 *Aviation Weather Handbook*.

Report Modifier

Following the date/time group the report modifier identifies the type of facility—*automated* or *manual*.

"AUTO" refers to an observation without human intervention or oversight. (These locations may be referred to as "stand-alone.") When "AUTO" appears, sensor type appears in remarks: "AO1" the station does not have a precipitation discriminator; "AO2" a station equipped with a precipitation discriminator. (A precipitation discriminator consists of a sensor, or sensor array, that differentiates between types of precipitation—liquid, freezing, frozen.)

The absence of "AUTO" indicates that all or part of the report has observer review or oversight. Augmented indicates someone is physically at the site. Augmentation requires an observer manually add data which the automated equipment is not capable of reporting and the ability to correct non-representative, erroneous, or missing data. With the implementation of automated observing equipment most elements are initially derived from automated sensors.

Correction "COR" indicates a METAR/SPECI was originally transmitted with an error. With a corrected report, the only way to identify the error or change is to compare it with the original report.

Wind

Wind direction is reported in relation to true north, given as the direction from which the wind is blowing to the nearest 10 degrees.

Magnetic Wind Direction

> The only time pilots can expect to receive "official" wind direction in relation to magnetic north is from a control tower, an FSS providing Local Airport

Advisory (LAA)—Alaska only, Automatic Terminal Information Service (ATIS) recording, or automated observing system (AWOS/ASOS) One Minute Observation (OMO) telephone or radio broadcast.

Reported as a two-minute prevailing direction and speed, wind uses a five digit group—six if speed exceeds 99 knots. The first three digits indicate wind direction ...34017KT, the next two or three digits speed ...34017KT, wind 340° at 17 knots. With either direction or speed sensors inoperative or unreliable the wind group is omitted.

Gusts (G) refer to rapid fluctuations in speed that vary by 10 knots or more. A report ...18G24KT... describes an average speed of 18 knots with fluctuations between 14 and 24 knots. (Gustiness is a measure of turbulence.) The greater the difference between sustained speed and gusts, the greater the mechanical turbulence. Typically, pilots can expect light to moderate turbulence with sustained winds or gusts in the 25 to 30 knot range, and moderate or greater turbulence above 30 knots. Terrain and obstructions—such as buildings or hangers—increase turbulence. More in chapter 21, Turbulence.

A calm wind is reported as 00000KT. If wind direction varies by 60 degrees or more with a speed greater than six knots, a variable wind group separated by the letter "V" follows the prevailing group ...34017KT 310V010; wind variable between 310º and 010º. A variable wind, especially when speed exceeds 10 knots, may indicate a rapidly changing crosswind. Pilots need to exercise additional caution during takeoff and landing with "variable" winds reported. If the wind is six knots or less, and varying in direction, it may be reported as variable "VRB" without an assigned direction. For example, ...VRB04KT; wind variable at four knots.

Peak wind appears in remarks when speed exceeds 25 knots. The direction, speed, and time of occurrence is reported ...PK WND 35060/40: peak wind 350° at 60 knots occurred at 40 minutes past the hour. Peak wind might substantially exceed the value reported in the body of the report.

Wind shift appears in remarks and describes a change in direction of 45° or more that takes place in less than 15 minutes, with sustained speeds of 10 knots or more ...WSHFT 55: wind shift occurred at 55 minutes past the hour. A wind shift of relative light winds might only indicate a local change; in coastal areas the shift often signals

Ever wonder who takes all those AWOS observations and makes the broadcasts? It's "Wally AWOS" and his cousins.

the advance or retreat of stratus or fog. In the Midwest the shift might precede the formation or dissipation of upslope fog. Wind shift is usually a good indicator of frontal passage. To indicate frontal passage (FROPA) may be included in remarks of a manual or augmented report. In southern California a wind shift may indicate the advance or retreat of a Santa Ana condition or a Chinook along the east slopes of the Rockies—a dry, often strong, foehn type wind over and through mountains and passes.

Visibility

Surface visibility represents horizontal visibility occurring at the surface—prevailing visibility or its automated equivalent—reported in statute miles (SM). Visibility measures the transparency of the atmosphere. During the day it's the distance at which predominant objects can be seen; at night it's the distance unfocused lights of moderate intensity are visible.

Case Study

> One National Weather Service observer was quite perplexed when the tower reported increased visibility after sunset. The reason was the change in criteria. Pilots should note that daytime values do not necessarily represent the distance that other aircraft can be seen. At night, especially under an overcast, unlighted objects might not be seen at all, and there may be no natural horizon.

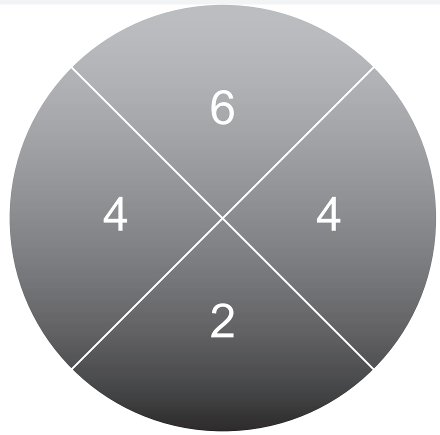


Fig. 9-1. *Prevailing visibility need not be continuous*

Prevailing visibility is the greatest visibility equaled or exceeded throughout at least half the horizon circle, which need not be continuous. Figure 9-1 illustrates a reported prevailing visibility of four miles. Because one sector has a visibility of only two, which is operationally significant, remarks contain ...VIS S 2... visibility south two. Sectors might exist with visibility greater than prevailing. These values may or may not appear in remarks.

Case Study

> At one southern California airport, it seems local pilots estimate prevailing visibility as: "1/4 mile to the north, 1/4 mile to the east, 1/4 mile to the south, and 1/4 mile to the west—great! Prevailing visibility is one mile, it's VFR." This is not only incorrect but extremely dangerous.

Automated systems determine visibility from a scatter device. (The visibility sensor is shown in the lower right portion of the callout.) Automated visibility sensors indirectly derive a value of visibility corresponding to what the human eye would see. The visibility sensor projects light in a cone-shaped beam, sampling only a small segment of the atmosphere—an area about the size of a basketball. The receiver measures only the light scattered forward, every 30 seconds. A computer algorithm—mathematical formula—evaluates readings for the past 10 minutes to provide a representative value. Reported visibility is the average one minute value for the past 10 minutes.

Automated equipment does not extrapolate prevailing visibility. Automated visibility may not be representative of surrounding conditions. The existence of fog banks and visibility in different sectors will not, normally, be reported. Regulations specifically take these variables into consideration for IFR, where a suitable alternate may be required. VFR pilots should use the same caution and, although not required by regulations, plan for an acceptable VFR alternate during reduced visibility or when conditions are forecast to change.

During rapidly decreasing conditions it takes between three and nine minutes for the algorithm to generate a SPECI. During rapidly increasing conditions the algorithm takes between six and 10 minutes to catch up with actual conditions. This feature adds a margin of safety and buffers rapid fluctuations in visibility. (Failure to understand and consider these parameters has led to misunderstanding and unwarranted criticism of observations.)

Sensor site is critical. If the sensor is in areas favorable for the development of fog, blowing dust, or near water, reported conditions may not be representative. Airports covering large areas or near lakes or rivers may require multiple sensors to provide a representative observation. To this end, some airports are equipped with more than

Manual observations also suffer from "latency"—a lag between actual and report conditions and site location limitations.

Overheard from "Norcal Approach:" "Visibility minus one-quarter." *Can visibility be less than zero?* I don't think so. The controller meant to say: "Visibility *less* than one-quarter."

point of observation—The location where observations are normal taken. Certain elements may be made at other sites (i.e. Tower visibility from the tower cab; sky condition elements from a location at the instrument runway.) At automated sites from the ASOS/ AWOS installation—which may or may not be adjacent to the instrument runway.

one visibility sensor. Specific site visibility lower than that in the body of the report appears in remarks ...VIS 2 RY11; visibility two, at runway one one.

Automated visibility values are reported from less than one-quarter (M1/4SM) to a maximum of 10 statute miles. Proponents of automated systems point out they are more consistent, objective, standardized, continuous, and representative. This is certainly true for IFR operations, since the sensors are normally located at the approach end of the instrument runway and typically more reliable in less than VFR conditions.

Manual and automated visibility observations may be considerably different, especially during daylight hours. With automated systems the existence of fog banks and visibility in different sectors may not be reported. Reports from surrounding locations, pilot weather reports (PIREPs), and satellite images can help fill in the gaps. The bottom line: With reports close to minimums (VFR or IFR) pilots must exercise additional caution, carry extra fuel reserves, and have a solid alternate or two.

Variable visibility appears in remarks when rapidly increasing or decreasing visibility occurs during the time of observation, with average visibility less than three miles ...VIS 1 1/2V2, visibility variable between one and one-half and two. Variable visibility implies rapidly changing conditions at the airport.

At certain tower controlled airports weather observers report and augment observations. The point of observation is, typically, not collocated with the tower. Tower controllers report tower-level visibility when less than four miles. Because visibility can differ substantially over short distances, a complicated formula determines whether tower (TWR) or surface (SFC) visibility is reported in the body of the observation. The remarks portion contains the other value ...1SM...RMK TWR VIS 0, ...1 1/2SM...RMK SFC VIS 2. These remarks alert pilots to variable visibility over the airport. (It is not unheard-of for the tower to report visibility less than three or even less than one mile, thus precluding VFR or special VFR operations.)

Case Study

> *(ASRS) The ASOS in Kalispell, Montana was reporting visibility one-quarter mile. I was given a clearance to descent to 8000 ft and hold at the Smith Lake*

NDB. I cancelled IFR and informed ATC that I was going to the airport to see if the ASOS was correct. I proceeded VFR. I have seen this system report inaccurately in the past. I flew to the runways and ascertained that runway 20 was clear for approximately one-half to three-quarters of its length. There was fog over the approach end of runway 2 (runway 2 is the ILS runway and the location of the ASOS). I remained VFR and landed on runway 20.

The reporter states that the ASOS was not accurate. That's not true. The ASOS was perfectly correct. Had a human observer been in the same location—point of observation—as the ASOS, a manual observation would have reported the same conditions.

The reporter went on to say, "My contention is that the weather system is inadequate and unsafe...." ASOS bashing? The ASOS was accurate within the scope and limitations of the equipment. Certainly, the weather report required this flight to have a suitable alternate airport and fuel reserves. Had the whole airport been covered with fog the pilot would have had to simply proceed to the alternate.

Ironically, the reporter continued: "At no time was safety compromised. My landing was a judgment call. I was never out of VFR conditions."

Let's not forget VFR operations. The ASOS report would "clue us in" to have adequate alternates and fuel reserves, which, more than likely, would be greater than that required by regulations. Did the reporter provide a PIREP of existing conditions? It certainly would have been very helpful to ATC, forecasters, and other pilots alike.

Runway Visual Range (RVR) in feet applies to IFR operations. Where available, RVR appears in reports when prevailing visibility is one mile or less or RVR 6000 ft or less. RVR measures the horizontal distance a pilot can see high intensity runway lights while looking down the runway—not slant range. A transmissometer projects a beam of light toward the receiver. A photoelectric cell measures the amount of light reaching the receiver. This value is electronically converted into visibility and displayed at appropriate locations (tower, weather office, approach facility, or a combination of locations).

Runway Visual Range appears after visibility using the following format. The letter "R" followed by the runway number, a solidus "/," and the value in feet. The following will be added as required:

- V—Variable ...R32R/1600V2400FT; runway 32 right visual range variable between 1600 and 2400 ft.
- M—Less than ...R22L/M1600FT; runway 22 left visual range less than 1600 ft.
- P—Greater than ...R36/P6000FT; runway 36 visual range greater than 6000 ft.

If RVR varies by one or more reportable value, the lowest and highest values appear, separated by the letter "V." When RVR is below the minimum reported by the system, the letter "M" will prefix the value; above the maximum reported by the system the letter "P" will prefix the value. Automated stations may report up to four RVR values. When missing, "RVRNO" appears in remarks.

A report indicating landing minimums does not necessarily mean that reported visibility exists at the decision altitude (DA) or minimum descent altitude (MDA). RVR reflects the fact that visibility can vary substantially between the normal point of observation and the runway touchdown zone.

Present Weather

Following the visibility group, Present Weather is reported when occurring at, or in the vicinity of, the station's point of observation. Present weather consists of qualifiers and weather phenomena. Table 9-1 lists reportable phenomena. Qualifiers are divided into *Intensity/Proximity* and *Descriptors*; weather phenomena consist of *Precipitation*, *Obscurations*, and *Other*. Intensity of precipitation, proximity to the airport, and descriptors modify and expand on phenomena. Present weather groups are constructed in the order shown in Table 9-1 (left to right). Up to three precipitation types may be reported.

Note

> Several contractions don't make sense in English. That's because they were derived from French words—shown in italics.

Table 9-1. *Present Weather*

Qualifier				Weather Phenomena					
Intensity/ Proximity		Descriptor		Precipitation		Obscuration		Other	
–	Light	MI	Shallow	DZ	Drizzle	BR	Mist	SQ	Squalls
Moderate		PR	Partial	RA	Rain	FG	Fog	FC	Funnel Cloud
+	Heavy	BC	Patches	SN	Snow	HZ	Haze	+FC	Tornado Waterspout
VC	Vicinity	DR	Low Drifting	SG	Snow Grains	FU	Smoke		
		BL	Blowing	IC	Ice Crystals	DU	Dust	DS	Duststorm
		SH	Showers	PL	Ice Pellets	SA	Sand	SS	Sandstrom
		TS	Thunder-storm	GS	Snow Pellets	VA	Volcanic Ash	PO	Dust/Sand Whirls
		FZ	Freezing	GR	Hail	PY	Spray		
				UP	Unknown				

The inclusion of specific Qualifiers and Weather Phenomena depends on the sensors available and the type of observation—manual, automated, automated with augmentation—along with the training and experience of personnel providing manual or augmented reports.

Intensity/Proximity

Intensity describes the rate of precipitation. Intensity is reported for precipitation types, except ice crystals and hail, using three levels.

- (-) light
- (no symbol) moderate
- (+) heavy

Intensity refers to precipitation NOT the descriptor and NOT greater than the intensity for each form of precipitation. That is, "-FZRAPL" describes light freezing rain and light ice pellets—not light freezing rain and moderate ice pellets. Since only one descriptor may be used, TS and SH will not appear in the same group. (Since thunderstorms imply showery precipitation "TSRA" may be translated as "thunderstorm with moderate rain showers.)

Warning

> The weather phenomena -TSRA, sometimes erroneously translated as "light thundershower," or worse "light thunderstorm and rain," is neither. The correct translation: "thunderstorm with light rain" or "light rain showers." There is no such thing as a light thunderstorm!

Proximity modifies the location of weather phenomena. Vicinity (VC) describes precipitation not occurring at the point of observation; or an obscuration between five and 10 SM from the point of observation. For example, "VCFG" any type of fog in the vicinity of the airport. Automated stations may generate "VCTS" when lightning is detected between five and 10 SM from the point of observation. Weather phenomena occurring beyond 10 SM, not reported in the body of the observation, may appear in remarks.

Descriptor

Descriptors expand on, or modify, weather phenomena when used with specific types of precipitation and obscurations.

Shallow (MI)—*mince*—refers to radiation fog (MIFG) that extends to less than six feet above the surface.

Partial (PR) describes fog (PRFG) that covers part of the airport.

Patches (BC)—*banc*—indicates fog (BCFG) that randomly covers parts of the airport. The fog has little vertical extent—greater than or equal to six feet, but less than 20 feet; primarily reducing horizontal visibility. Stars may be seen at night and the sun during the day.

Shallow, partial, and patches describe "ground fog;" radiation fog that reduces horizontal visibility at the surface, with little vertical extent. With the coverage of fog around the airport going from random (BC)—subjectively "scattered," to limited (MI), to substantial (PR)—subjectively greater than “scattered.”

Low Drifting (DR) refers to phenomena raised by the wind to less than six feet and, typically, does not significantly reduce visibility. Low drifting snow (DRSN) may produce a hazard during taxi, takeoff, and landing as snow piles up on airport movement areas. Snow drifts, which can be inferred by reports of drifting snow, also present an airport surface condition hazard; which typically is advertised in a Notice to Air Missions (NOTAM).

Blowing (BL) describes phenomena raised by the wind to a height of six feet or more. When applied to sand, dust, or spray, blowing implies horizontal visibility is reduced to less than seven miles. When applied to snow, blowing identifies snow lifted by the wind in such quantities that visibility is restricted at and above the surface. Blowing snow (BLSN) reduces visibility creating a different type of hazard than low drifting snow (DRSN), especially to the VFR pilot. Blowing snow occurs when strong winds blow over freshly fallen snow. Visibility can be reduced to near zero but is typically restricted to within a few hundred feet of the surface. Visibility improves rapidly when the wind subsides.

Showers (SH) describe precipitation characterized by the suddenness with which it starts and stops, rapid changes of intensity, and usually by a rapid change in the appearance of the sky. When appropriate, the descriptor showers (SH) are applied to Rain (RA), Snow (SN), Ice Pellets (PL), Snow Pellets (GS), and Hail (GR).

Showers may or may not result from convection. A report of showers does not in itself indicate the development of thunderstorms.

A Thunderstorm (TS) is produced by a cumulonimbus cloud, accompanied by lightning and/or thunder. TS is reported when thunder is heard, or overhead lightning is observed. A thunderstorm (TS) may be coded by itself when precipitation is not occurring at the station (point of observation).

Case Study

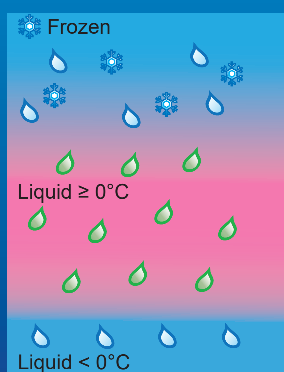
> In the mid-1970s at the Ontario, California airport the FSS was responsible for weather observations. However, because of the FSS’s poor point of observation, the tower was responsible for visibility. One night while working mid shift I thought I heard thunder. I asked the tower if they heard thunder or

saw lightning. "Oh yeah," the controller replied, "I've been watching it for the last couple of hours." Well, so much for the system. The FAA has taken steps, however, to ensure tower controllers immediately report this type of activity.

Automated stations may use lightning detection sensors or obtain lightning information from the National Lighting Detection Network. Whether an automated station uses an on-site sensor or the National Network, thunderstorms are reported based on lightning data. The station algorithm reports a thunderstorm when two lightning strikes occur within 15 minutes of each other—to reduce false alarms. The station reports a thunderstorm in the present weather element when lightning occurs within five miles of the station. Should the thunderstorm detection system be inoperative the site will contain the remark "...RMK TSNO." Some automated sites may not be equipped to report thunderstorms.

Severe Thunderstorm

When surface winds of 50 knots or more, or hail 3/4 inches or greater accompany a thunderstorm, for aviation purposes the storm is classified as severe. The three-quarter inch hail criteria were established in 1954, wind criteria were lowered to 50 knots in 1970. Since 1996 there is no longer an ICAO weather code to alert pilots to a severe thunderstorm, but the criteria appear in METAR wind and present weather elements and remarks. Public forecasts for severe thunderstorm hail criteria were raised to one inch in 2010.



Freezing precipitation (FZ) in the form of freezing rain (FZRA) or freezing drizzle (FZDZ) results when liquid precipitation falls from warmer air into air that is at or below freezing. Droplets freeze upon impact producing significant structural icing. Freezing precipitation occurs when rain and/or snow falls into a deep layer of above freezing temperatures, becomes all rain, then enters a shallow layer of below freezing air (callout). The rain does not have time to freeze into ice pellets; drops freeze on contact with the ground or exposed objects. Additional discussions and explanations are presented in chapter 22, Icing.

The descriptor freezing also applies to fog. Traditional "ice fog" reduces horizontal visibility to less than five-eighths of a mile and forms at very low temperatures (-30°C or less) in calm conditions at high latitudes. On METARs freezing fog (FZFG) is reported when fog occurs at temperatures below 0° Celsius, whether the fog deposits rime ice.

Precipitation

Precipitation is any form of water (liquid or solid) that falls from the sky and reaches the ground. Precipitation does not include clouds, fog, dew, frost, or VIRGA—rain that evaporates before reaching the surface. Precipitation is reported when occurring at the point of observation. Precipitation within 10 statute miles of the point of observation is reported as in the vicinity.

Drizzle (DZ) consists of very small, but numerous and fairly uniformly dispersed liquid drops. Drizzle restricts visibility to a greater degree than rain because drizzle drops are smaller and fall in stable air, often accompanied by fog, haze, and smoke. Drizzle appears to float while following air currents, although unlike fog droplets fall to the ground.

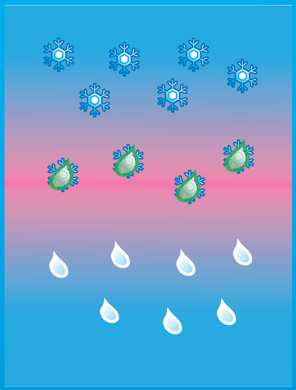
Rain (RA) is liquid precipitation. For automated stations, rain remains in liquid form upon impact with the ground or other exposed objects.

Snow (SN) is composed of white or translucent ice crystals, chiefly in complex branched hexagonal form and often integrated into snowflakes. For automated stations snow is any form of frozen precipitation other than hail. Wet snow—snow that contains a great deal of liquid water—produces structural icing. "WET SN" may appear in remarks of manual or augmented reports.

Snow can fall about 1000 ft below the freezing level before melting. Snow often begins at temperatures of 2 degrees C; it's even possible to see snowflakes at temperatures around 10 degrees C. This only occurs when the air is very dry. As snow falls into above-freezing air, it begins to melt. The water evaporates and cools the air. Evaporation cools the snow, which retards melting. Water vapor is added to the air, which increases the dewpoint. Finally, the air cools and becomes saturated at 0 degrees C. This is one reason why the snow level is typically lower than the freezing level.

Snow Grains (SG) are very small, white, and opaque grains of ice, the solid equivalent

"It never gets too cold to snow." However, since warmer air holds more moisture than cold, the heaviest snowfalls usually occur when the temperature is not far below freezing.



Ice pellets occur when snow falls into a shallow layer of above freezing temperatures; the snowflakes partially melt. As the precipitation falls into a deep layer of below freezing air, it refreezes into ice pellets.

of drizzle.

Ice Crystals (IC) might appear suspended and fall from a cloud or clear air—sublimated from water vapor directly into a solid. (Ice crystals are sometime known as *diamond dust*.)

Ice Pellets (PL), formally sleet, are grains of ice consisting of frozen raindrops, or largely melted and refrozen snowflakes. Ice pellets are transparent or translucent pellets of ice, which are round or irregular, rarely conical. There are two main types: Hard grains of ice consisting of frozen raindrops or largely melted and refrozen snowflakes; or pellets of snow encased in a thin layer of ice. They fall as continuous or intermittent precipitation.

Note

> On November 5, 1998 the international abbreviation for ice pellets was changed to "PL." It seems this was required because in certain combinations with other weather contractions it resulted in offensive language. It's nice to know our METAR and TAF codes are "politically correct."

Snow Pellets (GS)—*grésil*—are also known as graupel or soft hail consisting of white, opaque, round or sometimes conical grains of ice that grow by supercooled water accreting on ice crystals or snowflakes. Distinguished from snow grains, snow pellets are softer and larger.

Hail (GR)—*gréle*—is precipitation in the form of small balls or pieces of ice falling separately or frozen together in irregular lumps. Hail appears in the body of the METAR, hailstone size in remarks.

Unknown Precipitation (UP) is reported when an automated station's precipitation discriminator cannot identify the type of precipitation—liquid, freezing, or frozen. For example, this SPECI from Rock Hill, South Caroline.

> SPECI KUZA 191942Z AUTO 36007KT 3SM UP BR BKN004 OVC009 02/01 A2976 RMK AO2

Obscurations

Obscurations are any phenomena in the atmosphere, other than precipitation, that reduce horizontal visibility. They typically result from fog, haze, dust, and smoke. Obscurations are normally only reported in the body of the report with visibilities less than seven miles or when considered operationally significant. Volcanic ash is always reported in the body of the report. When phenomena exist with visibilities seven miles or greater, a remark typically describes the condition ...RMK HZ ALQDS... haze all quadrants.

Mist (BR)—*brume*—results from minute water droplets or ice crystals suspended in the air. Mist is reported with visibility five-eighths of a mile or greater. (In METAR mist refers to an obstruction to visibility, not precipitation—its generic definition.)

Fog (FG) consists of minute water droplets based at the surface which reduce visibility to less than five-eighths of a mile.

Smoke (FU)—*fumée*—consists of small particles produced by combustion suspended in the air.

Haze (HZ) describes the suspension of extremely small, dry particles invisible to the eye, but sufficiently numerous to reduce visibility.

Haze, combined with smoke, often describes conditions in metropolitan areas. Large anticyclones—high pressure cells—can dominate the southeast United States trapping haze and pollutants, especially in industrial areas. Above the haze layer, visibilities are unrestricted and temperatures cool, resulting in a much more comfortable flight.

Dust (DU) consists of a combination of fine dust or sand particles suspended in the air. Dust can be raised to above 16,000 ft by the wind. Visibilities, surface and aloft, can be at or near zero. Because of its fine particles, once the wind subsides dust can remain suspended for days and drift thousands of miles.

Sand (SA), made up of particles larger than dust, usually remains within a few hundred feet of the surface. Like dust, it can reduce visibility to near zero. Once the wind

So what's the difference between fog and mist?

Fog is reported when the visibility is less than five-eights of a mile. With visibility five-eights or greater, mist designates the phenomena. Allegedly the distinction between fog and mist came about because the British didn't consider it fog unless you could "cut it with a knife." Source FAA. Why five-eights of a mile, that's equivalent to 1000 meters.

The 2010 Islandic volcano eruption resulted in major disruptions to northern European air travel.

...RMK TORNADO B13 DSNT NE
Tornado began at 13 minutes past the hour to the distant northeast.

subsides particles fall back to the surface and visibility improves rapidly.

Volcanic Ash (VA) consists of fine particles of rock powder, blown out from a volcano. The particles remain suspended for long periods, extend well into the Flight Levels, and may drift thousands of miles. Volcanic eruptions when first observed appear in the remarks of METARs ...MT. ST. HELENS VOLCANO 70 MILES NE ERUPTED 181505 LARGE ASH CLOUD EXTERNDING TO APPROX 30000 FEET MOVING SE....

Spray (PY) consists of water droplets blown by the wind from the wave crests of large bodies of water and carried up a short distance in the air.

Other

Other Weather Phenomena describes conditions potentially hazardous to aviation operations. These include strong, variable winds, tornadic activity, significant, well-developed dust and sand events, including dust/sand whirls (dust devils).

A Squall (SQ), reported in the body of a METAR, is a sudden increase in wind of at least 16 knots, sustained at 22 knots or more, for at least one minute. Usually associated with convective activity, squall implies severe low-level wind shear as well as severe turbulence. (Squall "SQ" is reported in the body of a METAR. It may or may not be associated with convective phenomena such as a thunderstorm or squall line.)

Funnel Cloud (FC), Tornado and Waterspout (+FC), describe tornadic activity—a small, violently spinning column of air, potentially the most destructive of all-weather events. A funnel cloud describes a tornado that has not touched the ground. Tornado indicates the funnel cloud has "touched down." A waterspout is a tornado over water in contact with the surface.) Remarks provide details, including the status of the phenomena (beginning, progress, or end), location, and movement.

Fair Weather Waterspouts

> Fair weather waterspouts form over warm, shallow coastal waters, common over south Florida from the late cool through the warm season, often occurring during early to mid-morning and sometimes during late afternoon. The

term fair weather comes from the fact that they form during fair and relatively calm weather in light wind. They're fueled by the energy release of latent heat from ocean moisture. They are usually less dangerous than their tornadic "big brother;" but tend to be stronger than their dust devil "cousins." Never-the-less they should be avoided!

Duststorm (DS) reports severe conditions characterized by strong winds (25 knots or greater), covering extensive areas, and reducing visibility to less than five-eighths of a mile.

Sandstorm (SS), unlike a duststorm, causes grains of sand to be blown into the air. Sand particles are generally restricted to within 10 feet of the surface and rarely rise more than 50 feet of the surface.

Dust/Sand Whirls (PO)—*poussiere*—(commonly known as *dust devils*—callout) are whirlwinds that form on clear days with light winds in dry, hot regions. They have diameters of 10 to 50 ft, extending from the surface to several thousand feet. Wind speeds within the rotation vary from 25 to more than 75 knots. Although the majority are small, dust devils are capable of substantial damage. The NTSB has investigated 170 accidents since 1982.

Case Study

> We flew into a dust devil doing pattern work at Lancaster's Fox Field in California's Mojave Desert. The encounter was equivalent to light to moderate turbulence, it shook the Cessna 150, and the low pressure in the vortex caused both windows to pop open!

Sky Condition

Sky condition consists of sky cover—amount of cloud cover, height in feet, and convective cloud types. Heights range from the surface upward, to a maximum of 12,000 ft for automated stations. (Next generation Cloud Height Indicators (CHI) will report clouds to 25,000 ft.) Cloud heights are reported as three digits, in hundreds of feet above ground level (AGL). The amount of sky cover is reported in eighths—sometimes

Fair weather waterspouts tend to form from convergence in unstable air beneath developing cumulus. Fair weather waterspouts are not generally associated with thunderstorms. Unlike tornadic waterspouts, they develop on the surface and work their way upward. By the time the funnel is visible, they're near maturity. Typically, fair weather waterspouts dissipate rapidly when they make landfall and rarely penetrate inland.

In 2001 a plane took off from Decatur, Texas loaded with sky divers. Just after takeoff the pilot encountered a strong dust devil, lost control, and crashed. Seven people were injured.

referred to as *octas*. Sky cover consists of:

- CLR—clear automated stations, no clouds
- SKC—clear manual stations, no clouds
- FEW—few less than 1/8 to 2/8 coverage
- SCT—scattered 3/8 to 4/8 coverage
- BKN—broken 5/8 to 7/8 coverage
- OVC—overcast 8/8 coverage
- VV—indefinite ceiling (vertical visibility) 8/8 coverage

At manual stations, cumulonimbus (CB) or towering cumulus (TCU) is appended to the associated layer.

Ceiling is designated as the lowest broken (BKN) or overcast (OVC) layer, or vertical visibility (VV) into a total, surface based obscuration. For manual observations, sky cover refers to clouds or obscuring phenomena as seen by an observer on the ground from horizon to horizon. Sky cover is the summation of layers based on specific criteria. Conditions aloft, as seen by a pilot, can differ substantially. The summation principle with terms like obscuring phenomena and obscuration can be complex and misunderstood.

In Fig. 9-2 the observer sees 2/8 cloud cover at 1000 ft AGL and reports a few clouds at 1000 (FEW010). Another 3/8 cloud cover is observed at 1800 ft AGL. According to the summation principle a total of 5/8 (2/8 + 3/8 = 5/8) sky cover exists; a ceiling 1800 broken (BKN018) is reported. The observer sees the remaining sky covered by clouds at 3000 ft

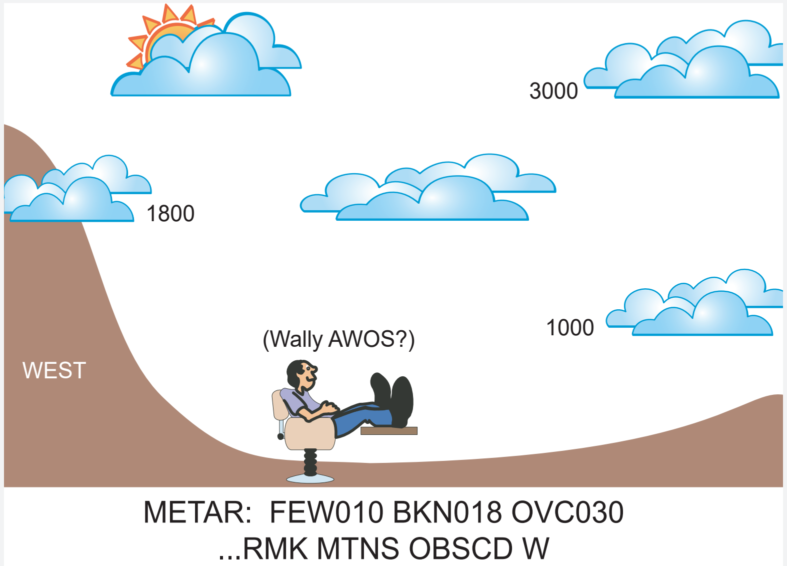


Fig. 9-2. *The summation principle has led many a pilot to mistakenly question the accuracy of observations.*

Like many specialties, aviation weather has its own language. For communication and understanding to take place, each party must understand and use the same definitions. Take the pilot that called UNICOM and asked, "What's the ceiling?" After a pregnant pause the operator replied, "I think it's oak."

AGL and reports 3000 overcast (OVC030). The observer, unable to determine the extent of higher layers, reports them as continuous.

Automated stations determine sky cover and height from a laser CHI. Cloud elements reflect the laser. A computer algorithm processes the last 30 minutes of data; then generates values of sky cover and cloud height. To be more responsive, the algorithm "double-weighs" the last 10 minutes of data.

At the transition between scattered and broken human observers often "over report" cloud cover. This is known as the "packing effect," a condition where an observer does not detect the opening in the cloud deck toward the horizon. Pilots also tend to overestimate the amount of cloud cover. Automated observations are not biased by these perceptions.

In rapidly changing conditions the automated system algorithm tends to lag slightly behind actual conditions. If a sudden overcast layer develops, automated observations will take two minutes to report scattered; within 10 minutes the system will report a broken layer.

On rare occasions, automated systems may report a dense moisture layer as clouds before the layer becomes visible. This may occur with an approaching front when the sensitive laser detects the large scale lifting of prefrontal moisture. There have been cases when automated stations reported a layer 20 minutes before an observer.

Automated stations will only report conditions that pass directly over the sensor. During light wind conditions, observers have reported up to three-eighths sky cover when automated sensor reported CLR. Ironically, manual observations suffer from similar limitations. Sky cover might not be representative of surrounding conditions, especially at night or during low visibility, when the observer cannot see or evaluate the whole sky. Recall Fig. 9-2, if the observer was unable to see the scattered layer at 1000 ft, a ceiling of 1800 ft would be reported. If the CHI or other device went through a hole in the 1800-foot layer, the observer might report a ceiling of 3000 overcast. Such errors can, and do, occur because of limitations on the observer and equipment.

Notwithstanding the previous case, exercised caution climbing or descending VFR

As an FSS briefer for some 25 years, I have on occasion briefed doom and gloom only to find a bright, beautiful day. It would seem that certain tower controllers use the following criteria: They consider the roof of the tower cab as opaque; therefore, one cloud is scattered, two is broken, and three is overcast with breaks!

through a broken deck. Although it might be possible to safely negotiate the layer, several factors must be considered. Can appropriate distance from clouds as specified in regulations be maintained? Is the weather improving or deteriorating? We don't want to get caught on top or between layers. Is the area congested with other VFR traffic or aircraft operating IFR? Criteria in the regulations are minimums; they do not necessarily mean "safe." What alternates are available? Positive answers are required before any attempt. (Recall the discussion in chapter 7, Personal Minimums.)

For manual observations sky cover and cloud height may only be an estimate, an educated guess by the observer, based on the observer's training and experience. Like visibility, cloud cover and heights should always be viewed with caution, especially at night or close to minimums.

At certain automated locations additional sensors are used to obtain more representative reports. In such cases, remarks will identify site specific sky conditions which are lower than in the body of the observation. For example, ...RMK CIG 020 RY11..., ceiling two thousand at runway one one.

Variable describes a situation where the amount of sky cover or height changes during the time of observation. For example, ...SCT015...RMK SCT V BKN... scattered layer variable to broken. If more than one cloud layer is being reported, the variable layer height appears in remarks (...SCT015 SCT025...RMK SCT015 V BKN). Cloud height variability is shown as follows: ...BKN010...RMK CIG 008V012, ceiling 1000 broken... ceiling variable between 800 and 1200. A variable ceiling below 3000 ft must be reported, above 3000 only if considered operationally significant. Variability alerts pilots, briefers, and forecasters to rapidly changing conditions over the airport.

A partial obscuration indicates that between one-eight and seven-eighths of the sky is hidden by a surface-based obscuring phenomenon. Precipitation—including snow, haze, smoke, and fog may cause this condition. Automated systems do not report a partial obscuration.

Refer to Fig. 9-3. In the example half (four-eighths) of the sky is hidden by fog. The observer sees another one-eighth cloud cover at 3000 ft. In METAR a partial obscuration is indicated as FEW, SCT, or BKN on the surface (FEW000, between one-eighth

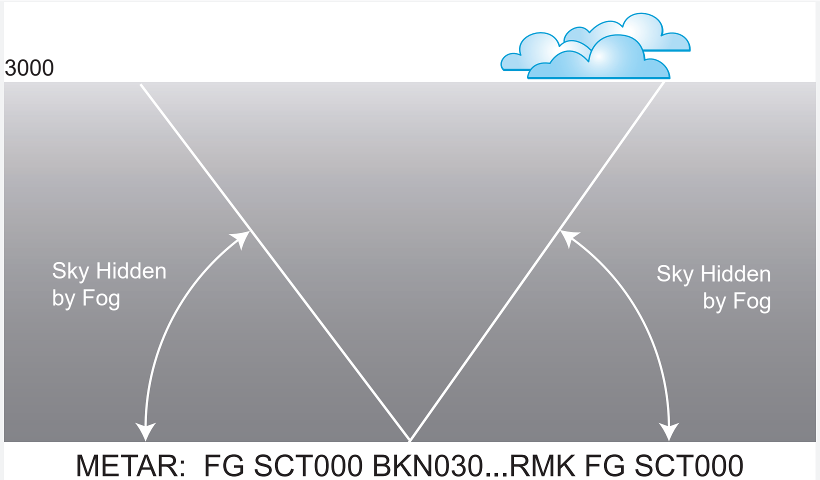


Fig. 9-3. *A partial obscuration indicates that between one-eight and seven-eighths of the sky is hidden by a surface-based obscuring phenomena.*

and two-eighths of the sky obscured). In Fig. 9-3 the observer reports visibility reduced by fog (FG), four-eighths of the sky obscured, with a ceiling of 3000 broken. (The observer uses the summation principle of cloud cover (4/8 + 1/8 = 5/8). Five-eighths is reported as a broken layer. The remark reveals that it is an obscuration ...RMK FG SCT000—not a cloud layer. What else could it be? Technically a layer with a base less than 50 ft would be reported as "000." This is unlikely. If the observer did not intend to report a layer with a base less than 50 ft the remark ...FG SCT000... would not appear.

A partial obscuration may be reported without cloud layers; for example ...3SM HZ FU SCT000...RMK SCT000. Remarks indicate that between three- and four-eighths of the sky is hidden by haze and smoke. A partial obscuration must not be confused with a ceiling. Although, with a large amount of sky hidden, cloud coverage amounts might not be representative and slant range visibility can be less than reported surface visibility.

Semper fi!

> Why such a complicated procedure? The international METAR code has no previsions to report a partial obscuration. The FAA and NWS concurred—probably for the first time—and proposed that a partial obscuration be eliminated from U.S. reporting procedures. But there are other players, in this case the Department of Defense (DOD). Within DOD is the Department of the Navy and the Marine Corps. Well, the Marines just couldn't get along without a partial obscuration.

U. S. military METARs may report a partial obscuration.

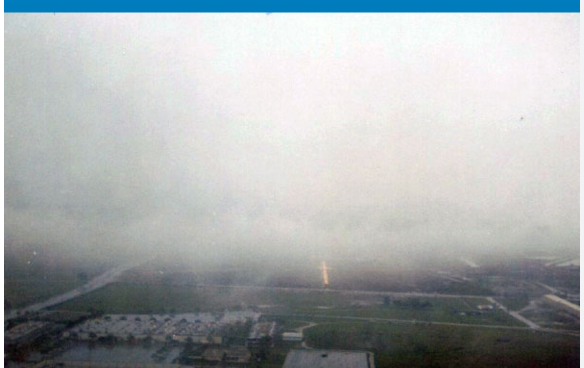
Normally, a pilot can expect ground contact while flying in areas with a partial obscuration. This is why they are not considered a ceiling. Penetrating a partial obscuration VFR requires the appropriate horizontal visibility for the class of airspace. A partial obscuration with visibilities less than basic VFR can often be safely negotiated under the provisions of Special VFR.

Case Study

> After being briefed that his destination was reporting visibility two in mist and haze, clear, mist and haze obscuring between six- and seven-eighths of the sky (2SM BR HZ BKN000...RMK BKN000 BR HZ), the Beechcraft Baron pilot emphatically demanded to know the ceiling. The pilot stated this information was required to determine IFR minimums. There was no ceiling. IFR minimums, in this case, would be based on visibility alone. The pilot could expect to maintain ground contact throughout the approach, sighting the airport within about two miles.

When the sky is completely hidden by a surface based obscuring phenomena an indefinite ceiling (VV) is reported. An indefinite ceiling is the vertical visibility upward into a surface-based obscuration that completely conceals the sky; the distance at which a pilot can expect ground contact when looking straight down on descent or the point at which the ground disappears on climb out. This condition is most often caused by fog, but snow, smoke, or even heavy rain can cause this condition ...+RA VV000... heavy rain, indefinite ceiling zero.

The accuracy of an indefinite ceiling depends on the observer and available



Aircraft on approach, with Approach Lighting System visible.

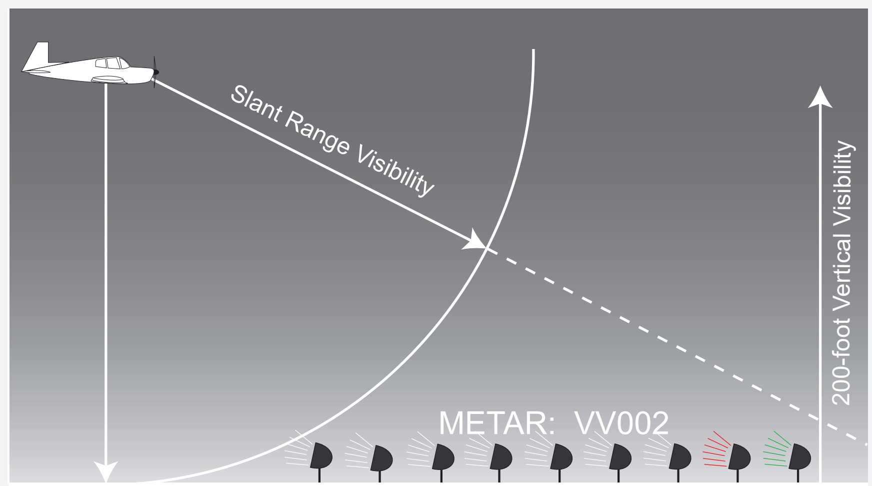


Fig. 9-4. *An indefinite ceiling is the vertical visibility into a surface-based obscuring phenomena.*

equipment. Whether the value is determined by a CHI or just a guess by the observer it is reported as indefinite. In Fig. 9-4 the observer has either measured or estimated the vertical visibility as 200 ft. The sky is completely obscured. The observer, unable to determine cloud layers above, reports an indefinite ceiling 200 ...VV002....

Indefinite ceilings are most often associated with IFR conditions. Presume that a destination is reporting an indefinite ceiling 200 and that 200 ft is the decision altitude (DA) for the Instrument Landing System (ILS) approach. Assuming the observation is accurate, at DA a pilot should be able to look straight down and see the Approach Lighting System (ALS). However, the pilot would not necessarily be able to see the runway due to the increased slant range distance. This is illustrated in Fig. 9-4. In fact, slant range visibility could be less than vertical visibility! That's why approach lights are considered part of the ILS and minimums increase when they're out of service.

Would the conditions in the previous example preclude a legal landing? Not necessarily, if landing requirements are met. The aircraft must remain in a position from which a normal descent to landing can be made, the flight visibility must not be less than that prescribed for the approach, and the runway environment remains distinctly visible. Any requirement not met or lost after DA requires an immediate missed approach.

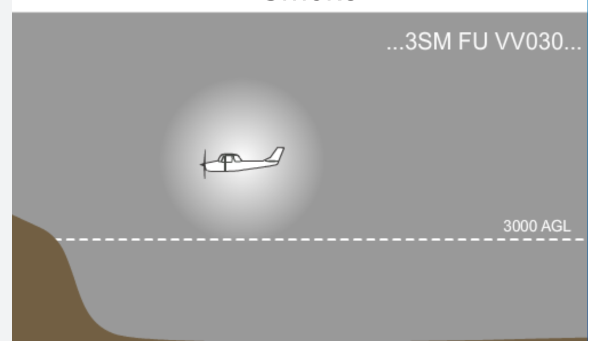
How about VFR with an indefinite ceiling of 1000 ft? Even though ceiling and surface visibility might technically meet legal minimums, flight visibility might be substantially less. Now consider the possibility that the observer might not have ceiling height-finding equipment, the reported ceiling might only be a "guesstimate."

At Redding, California the NWS observer made the following report:

SPECI KRDD 051650Z ...3SM FU HZ VV030....

The reported vertical visibility is 3000 ft, sky completely hidden by smoke and haze. A pilot flying in this area can only expect to maintain ground contact within about 3000 ft of the surface. This situation could be extremely dangerous for the VFR pilot. Should the pilot climb above 3000, the pilot may technically be in VFR conditions, but without ground contact and most probably without a natural horizon. Pilots attempting to operate in similar conditions have lost aircraft control with fatal results.

Smoke



"Click" *Smoke* to view animation.

How about the following report?

METAR KMWS 131758Z 18005KT 1SM BR OVC///...

When a cloud layer develops below the point of observation, such as Mt. Wilson, 6000 ft above the Los Angles Basin, the layer is encoded “OVC///” (an overcast layer with tops below the point of observation).

Another situation occurs with snow. Consider the following: ...3SM -SN VV015.... The visibility is three miles in light snow, indefinite ceiling 1500 ft. Is it VFR? Technically, yes. A pilot could expect ground contact within 1500 ft of the surface, but slant range visibility will be considerably less. Additionally, should the pilot climb above 1500 ft AGL, the pilot may not be in clouds, but will have no visible contact with the ground and no natural horizon! This is a good example of a situation that may be legal, but not safe.

At times stations may report weather phenomena aloft. Most often this will be a smoke layer. The body of the report will contain the layer (...SCT050...) and the remarks identify the phenomena (...RMK FU SCT050).

Case Study

> *(ASRS) The pilot tuned in the AWOS and received a report of 100 scattered. Over the final approach fix the pilot experienced a solid undercast with tops at 1300 ft. There were no suitable VFR airports in the area. The pilot, unable to land, was forced to return to the departure airport.*

The reporter commented: “This AWOS error could have caused a serious fuel problem for a long range flight arriving with minimum required fuel remaining.” For IFR operations, regulations most often take this into consideration. Minimum fuel reserves for VFR flights are just that—minimum. As soon as an undercast is encountered a VFR pilot must check to determine its extent. It makes no sense to fly over an undercast betting your life that an airport will be clear with only a 30 minute fuel reserve and beyond the range of a suitable alternate. (If nothing else, this could be construed as “Careless and Reckless.”)

Case Study

> *(ASRS) The AWOS was reporting clear. On approach an air carrier stated: “Unable to make a visual approach because of clouds. The airport is the only clear spot in the area.”*

These case studies illustrate the need to obtain all available information. If all other airports in a general location are overcast, the pilot should view a report of 100 scattered or clear with some skepticism. On the other hand, the airport being the only clear spot in the area is not uncommon. If you have the capability of flying IFR, stay on the IFR flight plan until landing VFR is assured.

Case Study

> Returning from Oshkosh we planned an intermediate stop at Grand Island, Nebraska. We were on top of a low undercast for most of the leg with Grand Island reporting visibility 10 ml, clear. About 15 ml east of the field we still could not see beyond the clouds. We elected to pick-up a clearance for an ILS approach. This added about 10 minutes to the flight. It turned out the clouds ended about a mile east of the airport. This was a tactical decision based on our observations and an understanding of the limitations of weather observations.

Automated Sky Condition Anomalies

Wally and his cousins report sky cover and height based on a CHI algorithm that divides data into no hit (clear), cloud hit (cloud layer), and unknown hit (lack of a sharp return). Total obscurations require a surface visibility of one mile or less and a high percentage of “unknown hits” at or below 2000 ft AGL. Unknown hits are processed as vertical visibility—an indefinite ceiling (VV).

At manual and augmented locations smoke layers most often result in a partial obscuration. A portion of the sky is visible through the smoke. Dense smoke layers confuse Wally. In areas of extensive smoke (callout), expect unreliable sky cover and cloud base reports from automated stations. Satellite imagery is often helpful in resolving these issues.

Case Study

> I was repositioning the airplane from Livermore, California to Calaveras in the Sierra foothills. Calaveras was reporting a surface visibility of four miles, with several scattered layers reported above 3000 ft. Approaching the

> foothills at 5000 ft I was engulfed in a brownish smoke layer, with not ground contact, natural horizon, or sky visible above. On approach I acquired ground contact at about 3000 ft MSL (1800 ft AGL) and the airport at about two miles slant range visibility.

Use extra caution when flying in these areas. VFR Have appropriate alternates and retreat at the first signs of unsuitable conditions. IFR—Be prepared for and do not delay executing a missed approach when conditions warrant.

Case Study

> The pilot and three passengers encountered deteriorating visibility in smoke due to a wildfire. A passenger—also a pilot—stated that the forward visibility was not very good; the ground could only be seen looking straight down. A witness reported the visibility was only one-quarter mile. The occupants discussed diverting. Two minutes before the accident the airplane made a 180 degree turn, began a descent, another turn and climb resulted in a ground speed of 37 knots, the airplane continued to turn and slow. Impact damage indicated a nose-down, near-vertical attitude, consistent with an aerodynamic stall.

Temperature, Dewpoint, and Altimeter Setting

"It's not the heat, it's the moisture." Some benchmark dewpoints:

5°C—desert dry
10°C—pleasant
15°C—a bit sticky
20°C—uncomfortable
25°C—miserable

Temperature and dewpoint are reported using two digits in whole degrees Celsius, separated by a solidus (/) ...20/15... temperature 20°C, dewpoint 15°C. Temperature below zero is prefixed with the letter "M" ...08/M03; temperature 8°C, dewpoint -3°C. Dewpoint can never be higher than temperature. A reported dewpoint greater than temperature results from equipment malfunction or during transmission. When the dewpoint is missing, temperature alone is reported ...M05/... temperature minus 5ºC, dewpoint missing. When temperature is missing both elements are omitted. (Temperature and dewpoint to the nearest tenth of a degree Celsius appear in remarks.)

Case Study

> At one time an FAA written test question asks, "What is the approximate

base of the cumulus clouds if the surface air temperature at 1000 ft MSL is 70°F and the dewpoint is 48°F?"

A. 4000 ft MSL.
B. 6000 ft MSL.
C. 5000 ft MSL.

From AC 00-6A Aviation Weather (1975): "You can estimate height of cumuliform cloud bases using surface temperature-dewpoint spread. Unsaturated air in convective currents cools at about 5.4°F per 1000 ft; dewpoint decreases at about 1°F. Thus, in a convective current, temperature and dewpoint converge at about 4.4°F per 1000 ft."

(Temperature) – (Dewpoint) ÷ 4.4 X 1000 = Cloud Base AGL

70 - 48 ÷ 4.4 X 1000 ~ 5000 AGL

Notice the FAA's answers are MSL. Another little "gotcha" from the folks in Oklahoma City!

This procedure is based on the surface heating of a parcel of air that rises and cools at the dry adiabatic lapse rate. When temperature reaches the dewpoint, saturation occurs and clouds form at the Lifted Condensation Level (LCL). (Recall the discussion of stability in chapter 2.) Cloud bases using Celsius temperatures can be approximated using the formula:

(Temperature) – (Dewpoint) ÷ 2.5 X 1000 = Cloud Bases AGL

For example, use this observation from Denver, Colorado:

METAR KDEN 182350Z ...SCT090 SCT150 BKN250 33/08...

Applying the formula to the Denver METAR:

(33°C – 08°C) ÷ 2.5 X 1000 ~ 10,000 AGL

Estimated cloud base would be at approximately 10,000 ft AGL consistent with the observer's report of 9000 scattered. It's important to remember the procedure only applies to convective clouds produced by surface heating, during the warmer part of the day, with a standard lapse rate. An article in a popular aviation magazine once touted this procedure for any cloud layer. That's not true.

Today this procedure is not much of any practical operational value. Ironically, it still appears (hidden) in FAA-H-8083-28 Aviation Weather Handbook Appendix D, Ceiling Estimation by the Pilot.

The altimeter setting, in inches of mercury, follows temperature/dewpoint in a four-digit group prefixed with the letter "A" ...A2992, altimeter two nine nine two."

In countries that report altimeter setting in hectopascals (millibars), the group starts with the letter "Q" rounded down to the nearest whole unit. For example, 1016.6 is reported as ...Q1016, altimeter one zero one six millibars."

Remarks

Remarks amplify information already reported, describe conditions observed but not occurring at the point of observation, or contain operationally significant or supplemental information. Supplemental data consist of climatological information—in numerical code groups, and automated maintenance data and maintenance requirements. The introduction of automated systems has certainly eliminated many useful and, at times, colorful remarks:

TORNADO W MOV E SPECIALIST HDG S

CREPUSCULAR RAYS SW

Some operationally significant remarks have already been mentioned. Plain language programs typically decode remarks. Exceptions occur when the observation has been manually augmented, and the decoder cannot interpret the data. Hum? Some things never change.

The *Glossary of Meteorology* defines crepuscular rays as, "Literally, 'twilight rays'; alternating lighter and darker bands (rays and shadows) that appear to diverge in fan-like array from the sun's position at about twilight." Towering cumulus produce this effect, especially with haze in the lower atmosphere. This would seem a rather complicated way of saying: HAZY TCU SW (hazy with towering cumulus southwest).

This observation came from an NWS observer at Denver, Colorado:

> METAR KDEN...RMK DSIPTG GUSTNADO N (dissipating gustnado north—a glorified dust devil.)

When lightning (LTG) is seen, it appears in remarks. The frequency of occurrence, type, and location are included.

- OCNL occasional (less than 1 flash/minute)
- FRQ frequent (between 1 and 6 flashes/minute)
- CONS continuous (more than 6 flashes/minute)
- CG cloud-to-ground
- IC in-cloud
- CC cloud-to-cloud
- CA cloud-to-air

When precipitation or a thunderstorm begins or ends, remarks indicate the type along with time of occurrence. These remarks are climatological, but they do alert pilots, briefers, and forecasters to weather, often significant, occurring at or in the vicinity of the station.

Convective and mountain wave cloud types are reported, along with direction from the station and movement—when known. Other cloud types include:

- CBMAM (Cumulonimbus Mammatus)
- ACC (Altocumulus Castellanus)
- SCSL (Standing Lenticular Stratocumulus)
- ACSL (Standing Lenticular Altocumulus)
- CCSL (Standing Lenticular Cirrocumulus)
- Rotor clouds

Designated stations report sea level pressure in remarks. This three-digit code follows the contraction “SLP.” The code contains the last three digits of the sea level pressure to the nearest tenth of a hectopascal (hPa). Because average pressure is 1013.2 hPa, prefix the code with a 9 or 10, whichever brings it closes to 1000.0 hPa. For example,

...RMK SLP102..., sea level pressure 1010.2 hPa.

Caution

> Sea level pressure is not the altimeter setting in hectopascals (millibars). ATC will convert "inches" to "millibars" upon request.

Like SLP, designated stations report snow depth increases by one inch or more in the past hour. The remark contains the contractions ...SNINCR... in the past hour, a solidus (/), and the total snow depth on the ground at the time of observation. For example, ...RMK SNINCR 2/10..., snow increased two inches during the past hour, total depth on the ground 10 inches.

Sensor status indicators advise users that specific equipment is not available. These consist of:

- RVRNO—Runway visual range information not available.
- PWINO—Present weather identifier not available.
- PNO—Precipitation amounts not available.
- FZRANO—Freezing rain information indicator not available.
- TSNO—Lightning information not available.
- VISNO—Visibility sensor information not available.
- CHINO—Cloud height indicator information not available.

Observations, especially automated reports, can and should be supplemented with radar and satellite products. Radar can determine the existence of rain, snow, and thunderstorms. Along with satellite imagery, radar is better at determining the areal extent of phenomena than either a manual or automated observation alone.

International METAR/SPECI

Many codes are common to both METAR and TAF. Those common codes are presented in chapter 17, Terminal Aerodrome Forecasts, in the section on Military and International TAFs.

Like the U.S., individual member states have exceptions; basic international METAR/TAF codes are contained in World Meteorological Organization (WMO) publication: WMO-No. 782 Aerodrome Reports and Forecasts A Users' Handbook to the Codes. This document is available at:

World Meteorological Organization
Communications and Public Affair Office
7 bis, avenue de la Paix
P.O. Box 2300
CH 1211 Geneva 2
Switzerland
www.wmo.int

The following are unique to International METAR/SPECIs:

- NIL – Report not filed or missing.
- Wind speed of 100KT or more indicated by the letter "P," P99KT (P49MPS or P199KMH).
- NDV – No Directional Variations. Used with automated visibility sensors to indicate sector visibility is not available.
- R24/1800 – RVR in meters.
- REUP – Unknown precipitation
- NCD – No Clouds Detected. Used with automated sensors.

METARs may include recent weather (RE), wind shear (WS RWY24), sea surface temperature and state of the sea, and state of the runway—contamination and friction measurement; and trend forecasts.

ASOS Bashing (?)

We've presented observing, reporting, and coding standards for surface observations—both manual and automated. To effectively use this product it's incumbent to understand observation criteria and limitations. Whether coded or translated, data is useless unless we can correctly interpret and apply the information—along with all other available reports and forecasts. The following Case Study illustrates this point.

Case Study

> *(ASRS) An EXTREME intensity thunderstorm was 10 ml west of the airport moving east, toward the airport. Clouds associated with the cell created an overcast layer above the airport. ASOS reported the weather as visibility 10 ml, clear. This was not very representative of the weather at the time.*

Should this come as a surprise? Let's see. The visibility appears perfectly correct. The pilot could see the thunderstorm 10 ml west of the airport—visibility had to be at least 10 ml. The automated station was clear. We know that (at the time of this report) CLR meant "clear below 12,000 ft." The overcast layer was above this level. Some ASOS sites are not equipped to report thunderstorms; shown in remarks as "...RMK TSNO." In such cases there would be no report of convective activity either in the body or remarks of the observation. There is no inconsistency between the actual and observed weather. (Do you suppose the pilot provided a PIREP on the observed conditions?)

Warning

> If you base a flight decision on a single report, you can be in for trouble. As required by regulations, Preflight Action must include "all available information...."

The following METAR would seem to report unrestricted visibility, thunderstorm with no precipitation, and clear skies! Could this be possible?

> KNKX 121453Z AUTO 19005KT 10SM TS CLR 10/08 A3001 RMK A02

A thunderstorm (TS) is reported when thunder is heard or overhead lightning is observed. Automated stations report thunderstorms based on lightning data. The station algorithm assigns thunderstorm (TS) in the present weather element when two lightning strikes within five miles of the station occur within 15 minutes. Precipitation is only reported when occurring at the point of observation. Based on reporting criteria a thunderstorm may be reported without precipitation. As in the preceding example, if clouds are above 12,000 ft, the ASOS reports "...CLR...."

Pilots, dispatchers, controllers, and briefers need to understand the limitations of all weather reports and forecasts; weather observations are no exception. Both manual and automated reports can and should be supplemented with adjacent reports and forecasts, and radar and satellite products. With the weather our goal is no surprises.


Failure to understand the methods, requirements, and limitations of observations leads to misunderstanding, misinterpretation, and unwarranted criticism; and potential can lead down the primrose path to disaster!