10 Pilot Weather Reports

Pilot weather reports (PIREPs) have been around since the beginning days of aviation. Over the last century reporting, transmission, and distribution procedures and technologies have increased exponentially. As well as pilots, reports can originate from airport personnel, air traffic controllers, and even the public.

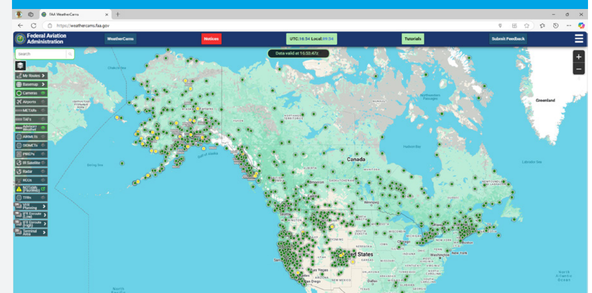
By the late 2000s PIREPs began to be supplemented by the FAA's Aviation Weather Camera Network. Since then, the network has grown to almost 1000 locations (callout). Like all aviation products, weather camera images have their own unique application and limitations.

The introduction to NASA's January 2011 Aviation Safety Reporting System (ASRS) newsletter, Callback, states:

> "At the beginning of their flying careers, most pilots quickly learn the value of PIREPS – "pilot reports" of actual inflight weather conditions that are provided by pilots, for other pilots. These near real-time weather reports help pilots anticipate inflight conditions, verify forecasts, and fill in the weather picture while enroute. PIREPS provide information on cloud tops and layers, precipitation, turbulence, icing, visibility, temperature, wind speed and direction, and other weather-related conditions. They are generally given to FSS...or ATC for quick dissemination, but may also be transmitted through dispatchers and other aircraft."

Unfortunately, for several reasons, pilots just don't seem to get around to providing much needed information. They may fail to realize that reports confirming conditions are just as important as those refuting the forecast. Some may conclude that with today's technology reports just aren't that important. After tangling with nature, we're

With the introduction of stand-alone AWOS installations in the 1990s and prior to observations becoming available for long-line distribution, FSS specialists would routinely transmit AWOS reports in the form of PIREPs.



often so happy to get on the ground that we fail to consider our fellow aviators still up in the muck; those that would much appreciate knowing what we encountered to assist with their own flight decisions. Take for example the following. A CRJ200 sustained damage during a landing rollout in high winds and "blowing dust" because of insufficient ATIS information and lack of a PIREP from a preceding flight crew.

Case Study

> *(ASRS) On landing rollout the Captain's (left windscreen) shattered at approximately 100 knots. We had been advised of dust blowing along the runway. The dust appeared to be coming from the end and sides of the runway. We had been given no indication that the dust was actually sand and small pebbles used for road and runway sanding operations. When the windscreen cracked, we were approximately 2500 ft from the threshold and visually in the clear with the visible dust 2000-3000 ft further down the runway. At the time the windscreen cracked, we were rapidly slowing to make sure we were firmly on the runway and at a slow pace before we neared the dust. Upon entering the dust area we had severely reduced visibility down to less than 1/4 mile. We slowly moved clear of the runway. After clearing, we heard that another aircraft on Runway 28R had aborted a takeoff for a cracked windscreen.*
>
> *We later learned that a total of four aircraft had cracked windscreens. Of particular concern was the fact that nothing was on the ATIS regarding the dust. No indication was given that the dust was actually sand and small pebbles. We asked for a PIREP from a previous aircraft and received no warning regarding this issue.... Winds reported on the ATIS were 280 degrees at 26 knots gusting to 41 knots. Later heard from ATC Tower person that they had winds gusting between 39 and 55 knots during the time this happened. We didn't get that information during our flight.*

Satellites, along with upper air observations and radar reports, supplement surface observations. Satellites, however, only observe cloud tops; upper air observations are relatively infrequent and widely spaced. Radar typically only "sees" precipitation. An urgent need continues for information on cloud tops, weather conditions at flight altitudes, along routes between weather reporting stations—especially in mountainous

upper air observations—Upper air observations consist of the twice daily balloon observations, supplemented by PIREPS, and air carrier data link wind and temperature information; additionally, UPS and Southwest provide moisture data.

areas—and at airports without weather reporting service. In many cases the pilot is the best and only source of actual weather conditions. Phenomena include:

- cloud layers,
- cloud tops,
- haze, smoke, dust, and sand tops,
- inflight visibility,
- slant range visibility,
- winds and temperatures aloft,
- turbulence,
- icing, and
- low-level wind shear.

Recognizing the importance of PIREPs, the FAA has directed air traffic controllers to actively solicit PIREPs, especially during marginal or IFR conditions, and during periods of hazardous weather. Pilots operating IFR are required to "...report ...any unforecast weather conditions encountered...." These reports are not only of value to other pilots, but to controllers, weather provides, and forecasters alike. PIREPs can be reported to any air traffic facility (center, tower, FSS). Some Data Link vendors allow direct submission of PIREPs.

Unfortunately, the FAA's overemphasis on requesting PIREPs during FSS briefings has brought on predictable consequences. Like the "V-F-R Not Recommended" statement it goes in one ear and out the other!

Most domestic PIREPs are manually entered by FSS specialists, Center Weather Service Unit (CWSU) meteorologists, Air Route Traffic Control Center (ARTCC) weather coordinators, and military base operations personnel. It's all but impossible to clarify a miscoded report. In such cases our only option is to ignore the report, then provide accurate information as soon as possible.

PIREPs are transmitted using the location identifier (LOCID) for the surface report (METAR) nearest the occurrence using the file type UA (SAC UA; Sacramento, California pilot report).

Note

> PIREPs are coded to ensure the report is stored and distributed with the surface observation location nearest the condition being reported. If more than

Undoubtedly, for the infamous $100 hamburger!

one location is appropriate, the location that provides the greatest distribution and/or prominence, such as a major hub airport is used.

A Piper Arrow pilot and his wife learned the importance of checking PIREPS, even for an 18-minute flight after a lunch stop.

Case Study

(ASRS) My wife and I departed for our destination after a lunch stop. Arrival from the west had been uneventful with a descent through clouds and ceilings about 3,500-4,000 MSL.... On departure, we entered clouds at 3,000 MSL, a little lower than expected. We flew out of that layer at 5,000 MSL having picked up about 1/8 inch of clear ice. I was surprised to find another cloud layer almost on top of the first and was back in IMC by 6,000 MSL. The plane continued to slowly accumulate ice but I (foolishly) hoped that the second layer would be very thin and I would quickly climb out the top of it. At 8,000 MSL we were still IMC and still accumulating ice. I received clearance for descent and lowered the landing gear and pulled the power back to get a 2,000 FPM descent to what I assumed would be clear, warm air at 3,000 MSL. I was dismayed to still be in IMC at 3,000 MSL with ATC telling me that we could not descend further. ATC offered the GPS 16 approach to ZZZ as the closest option and I took it. We flew in IMC until descending below 2,900 MSL on the final approach. By that time, we had over 1/2 inch of clear ice. Air temperature on the ground was just +1°C....

I made several mistakes on this 18-minute flight. Among them: taking off without rechecking METARS and PIREPS; assuming that the weather east of our lunch stop would be essentially the same as the weather to the west; continuing the climb into the second cloud layer; and not immediately returning when I climbed out of 5,000 and saw clouds where I did not expect them.

PIREP Format

Like surface observations, PIREPs have evolved over the years. At one time FSS specialist were instructed to enter just what the pilot said. This resulted in predictable consequences (smooth as a baby's bottom, rougher than a cob); subjective terms with little operational value. During the same period with the FAA's haphazard approach to PIREP format, automated data processing was difficult, if not impossible. With the lack of direction—from both the FAA and NWS—PIREPs appeared in confusing, misleading, and non-standard formats. This led to considerable misunderstandings and, in fact, impacted the safety of our ATC system. Correctly formatted PIREPs eliminate confusion and increase the usefulness of this valuable product. Since Lockheed-Martin (now Leidos) began providing FSS service, PIREP coding has improved significantly. (It will be interesting to see how "pilot input" Data Link reports will look.)

PIREPs are entered using standard ICAO weather contractions and format. FAA/NWS personnel encode PIREPs using a standard format. An understanding of the format (callout) illustrates needed information and will assist in decoding and interpreting reports.

Report Type: UUA or UA

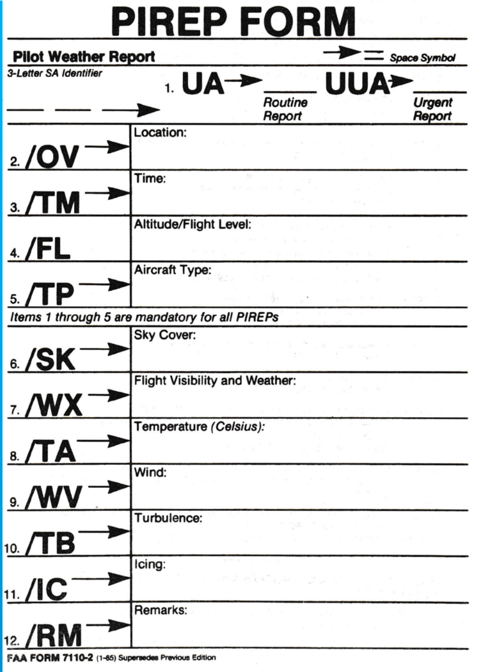
An urgent pilot report (UUA) represents a hazard, or potential hazard, to flight operations. The message type UUA receives special handling and distribution. Urgent PIREPs include:

- tornadoes, waterspouts, or funnel clouds,
- hail,
- severe or extreme turbulence,
- severe icing,
- low-level wind shear when reported with an airspeed change of 10 knots or more,
- volcanic ash (including the detection of sulfur gases in the cabin), and
- any other phenomena considered hazardous.

Other PIREPs, designated UA, receive routine distribution.

Location: /OV

The location where the phenomena was observed is reported in relation to a three or four-letter airport or radio navigational aid (NAVAID) identifier. Normally, if a PIREP


PIREP FORM

Pilot Weather Report → = Space Symbol

3-Letter SA Identifier

1. UA → Routine Report UUA → Urgent Report

2. /OV → Location:

3. /TM → Time:

4. /FL Altitude/Flight Level:

5. /TP → Aircraft Type:

Items 1 through 5 are mandatory for all PIREPs

6. /SK → Sky Cover:

7. /WX → Flight Visibility and Weather:

8. /TA → Temperature *(Celsius)*:

9. /WV → Wind:

10. /TB → Turbulence:

11. /IC → Icing:

12. /RM → Remarks:

FAA FORM 7110-2 (1-85) Supersedes Previous Edition contains conditions at an airport or specific geographical location such as a mountain pass, the code for that airport or location appears in remarks.

> DEN UUA /OV DEN301021 .../RM OG 1V5 WND 50-80G100+ BLOWING 3/4 GRAVEL

This urgent (UUA) report contains conditions observed on the Denver 301 radial at 21 nm. The remarks (/RM) indicate the report refers to conditions on the ground (OG) at Boulder Municipal Airport (1V5). It seems the wind is gusting to more than 100 knots and blowing 3/4 inch gravel around. This illustrates the importance of such reports.

Decoding reports without a “plain language” application can be difficult without a copy of FAA Handbook 7350.5 Location Identifiers. However, most computer systems provide a decode function; aeronautical charts contain NAVAID identifiers; and Sectional charts depict airport identifiers in the airport data block. If necessary, a pilot can always call the FSS for clarification.

Locations may be encodes as: an airport (/OV HAF, Half Moon Bay airport), a fix (/OV LAX or /OV LAX060010, Los Angeles VOR or the Los Angeles 060 radial at 10 nautical miles (nm), or between fixes (SEA-BTG, Seattle VOR and the Battleground VOR; SLC245080-JNC210040, Salt Lake City 245 radial at 80 nm and the Grand Junction 210 radial at 40 nm).

Time: /TM

Time when the phenomena was reported, referenced to Coordinated Universal Time (UTC) or Zulu (Z).

> CMI UA /OV CMI /TM 1307...

This is a Champaign/Urbana, Illinois PIREP. Phenomena was observed at 1307Z.

Altitude/Flight Level: /FL

The altitude, in hundreds of feet MSL, that the phenomena was encountered. DURC (during climb) and DURD (during descent) may appear in remarks.

CMI UA /OV CMI /TM 1307 /FL030...

Phenomena was encountered at 3000 ft MSL.

Type Aircraft: /TP

Type of aircraft uses standard international (ICAO) aircraft type designators. From time to time, this element will contain /TP PUP (pickup truck), /TP CAR, /TP FBO (airport Fixed Base Operator), or as reported on the Denver PIREP /TP MAN.

CMI UA /OV CMI /TM 1307 /FL030 /TP E145...

The type aircraft is an Embraer. Type aircraft is significant, especially with reports of turbulence and icing. (More about this in the PIREP Objectivity section, and chapter 21, Turbulence and chapter 22, Icing.)

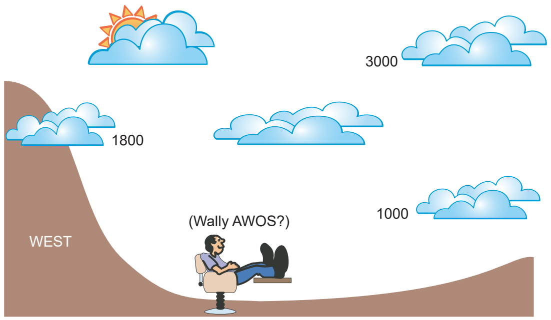
Sky Cover: /SK

Standard sky cover contractions (SKC, FEW, SCT, BKN, OVC) are used followed by cloud bases in hundreds of feet. It's important to remember that PIREP bases and tops are always mean sea level (MSL). Cloud tops are indicated by the word "TOP" followed by the height. Additional layers are separated by a solidus (/) and clear above indicated by SKC.

.../SK FEW-SCTUNKN-TOP030/BKN060-TOP100/SKC....

The example reports a few to scattered (1/8 to 4/8 coverage) clouds with tops at 3000 ft MSL; a broken layer (5/8 to 7/8 coverage) bases 6000 ft MSL, tops 10,000 ft MSL; clear above.

Recall the conditions reported by the observer in Fig. 9-2 (callout): ...FEW010 BKN018 OVC030.... If field elevation were 2000 ft, a PIREP describing these layers might read:



METAR: FEW010 BKN018 OVC030
...RMK MTNS OBSCD W

...FEW030-TOP035/SCT038-TOP043/SCT050-TOP055...

Bases of a few clouds 3000, tops 3500; scattered bases 3800 tops 4300 and bases 5000 tops 5500 ft respectively. Keep in mind, pilot's reference cloud bases to a pressure altimeter set to MSL, surface observations (METAR) report clouds heights AGL. Given the summation principle and different cloud height references the observation and PIREP are perfectly consistent.

A pilot report can be one of the most accurate means of determining cloud height, assuming the pilot actually penetrates the clouds, or climbs or descends through an opening in the layer. Otherwise, it's just a pilot's estimate. As pilots we should always report cloud bases and tops to the tower or FSS, especially when different from reported.

Case Study

> Departing the Livermore, California, a controller requested a report on cloud bases. I replied and the controller asked if they were AGL or MSL. Hum?

Weather: /WX

Weather encountered and flight visibility are reported in this element.

Weather consists of phenomena described in the Present Weather section—using the same contractions—described in chapter 9, Surface Observations. When hail is reported, size should be included in remarks in 1/4 in increments (GR1/2; hail 1/2 in).

Flight visibility is reported to the nearest whole statute mile and encoded with the suffix SM (FV01SM, FV05SM, etc.). A report of unrestricted visibility appears as FV99SM. FV99SM has potential ambiguity. Does it mean visibility 99 miles or greater or seven miles or greater? Pilots should report specific values to 98 miles to eliminate any misunderstanding.

> DTL UA /OV DTL /TM 1322 /FL000 /TP BE99 /WX FV10SM /RM OG DTL

This report at Detroit Lakes, Michigan by a Beech 99 Airliner reports conditions on the ground (OG).

Case Study

> A pilot approaching Lovelock, Nevada (elevation 3900 ft), skeptical of the report surface visibility of two miles in blowing sand, reported flight visibility 20 miles. Upon landing, however, the pilot concurred, stating the tops of the blowing sand were at 200 ft AGL—recall the discussion of blowing sand from chapter 9. This report would appear:
>
> ...FL075.../WX FV20SM BLSA TOP041....

Air Temperature: /TA

Air temperature is reported in degrees Celsius, with negative values prefixed with the letter M—like METAR.

> YIP UA /OV SVM /TM 1332 /FL040 /TP CRJ2 /TA 12 /WV 30830KT

A Canadair Regional Jet reports conditions over Salem, Michigan (SVM).

Wind: /WV

Wind direction and speed is encoded using three digits to indicate direction, and two or three digits to indicate speed (/WV 36020KT, observed wind 360° at 20 knots). Speed is in knots (KT).

Note

> According to the FAA, wind direction should be in relation to "magnetic north," which is consistent with most area navigation systems, but inconsistent with other reports and forecasts.
>
> YIP UA /OV SVM /TM 1332 /FL040 /TP CRJ2 /TA 12 /WV 30830KT

Anyone know how to calculate winds with an E6B flight computer? Besides Mr. Spock.

CHOP—Slight, rapid, and somewhat rhythmic bumpiness without appreciable changes in altitude or attitude.

Turbulence: /TB

Turbulence intensity (NEG, LGT, MOD, SEV, EXTRM) and altitude—when different from /FL—appears in this element. Clear Air Turbulence (CAT) and CHOP should be added when appropriate. When turbulence has been forecast, but reports indicate smooth /TB NEG is entered. Therefore, /TB NEG is interpreted as smooth—rather than turbulence that bounces the aircraft down!

HEF UA /OV AML235012/TM 1237/FLUNKN/TP B752/TB MOD 050-060

In this Manassas, Virgina (HEF) PIREP a Boeing 752 reports moderate turbulence between 5000 and 6000 ft 12 miles southwest of the Aremel, Virgina (AML) VOR. Type aircraft should always be included with a turbulence PIREP.

SNA UA /OV SNA-GMN/TM 2218/FL125/TP PA28/TA 00/WV 33020KT /TB MOD/RM LIKE AN E TICKET AT DISNEYLAND

OK I'm dating myself. An "E" ticket used to be for the BIG rides!

DEN UA /OV DEN240060/TM 1715/FL350/TP DC8/TB MOD CAT/RM MOD CAT AT 373 NEG BLO 367 (ZDV)

This report was filed by Denver Center's Weather Service Unit (ZDV). It amplifies the turbulence portion indicating that moderate CAT was encountered at 37,300 ft and it was smooth below 36,700 ft.

A strong Santa Ana wind in southern California was responsible for the conditions described in the following PIREPs at Ontario, California (ONT), surface wind was gusting to 45 knots.

ONT UUA /OV ONT/TM 1445/FL050/TP B727/TB MOD OCNL SEV 050-SFC /RM CRCLG FAP LNDG ONT

ONT UUA /OV ONT/TM 1450/FL020/TP B727/RM UNABLE TO LAND DUE TO X-WINDS

Icing: /IC

The intensity of icing (NEG, TRACE, LGT, MOD, SEV), type (CLR, RIME, MX) and altitude—when different from /FL—is entered in this element. Like turbulence, when icing is forecast but not encountered, NEG is entered; a NEG encounter is as important and useful as one reporting the phenomena!

IPT UA /OV IPT/TM 1155/FL060/TP C208/TA M05/IC LGT-MOD MX

A Cessna Caravan reports light to moderate mixed icing at 6000 ft over Williamsport, Pennsylvania (IPT). With icing reports temperature and type aircraft are important elements and should always be included.

No one has any business flying in these conditions:

FAT UUA /OV CZQ090030.../FL160-240 /TP F18/IC SEV CLR

BFL UUA /OV PMD330040.../FL100 /TP C402/IC SEV RIME/RM PUP 1 INCH CANT SEE THRU WINDSHIELD

Remarks: /RM

Remarks amplify information or describe conditions not already reported. Remarks report phenomena such as low-level wind shear (LLWS), convective activity, surface conditions at airports, or other information to expand or clarify the report—similar to remarks on METAR.

Because of its significance, low-level wind shear is extremely important. Wind shear PIREPs should include location, altitude, and airspeed and vertical speed changes.

RNO UA/ OV RNO.../TP DC9/RM LLWS 001-SFC +30 TO 40 KTS

The pilot experienced a 30- to 40-knot increase in airspeed between 100 feet and the surface.

STS UUA/.../FL030/TP C500/RM DURGD RY02 LLWS RESULTING IN 80 KTS CHG AIRSPEED

Like METAR, convective (thunderstorm) activity appears in remarks. Direction, distance, and movement should be included.

SAC UUA /OV SAC/TM 1753/FL030/TP C172/TB MOD-SEV/RM OCNL LTG-CG DSNT NE

The pilot observed cloud to ground lightning to the distance northeast. (Pilots should use the same frequency and type descriptions for lightning as described in chapter 9, Surface Observations.)

PIREP discipline was certainly lacking prior to Lockheed-Martin assuming the Flight Service function. We're going to miss out on some of the more colorful reports. That's too bad. As we'll see in some of the examples below—most prior to the Lockheed-Martin era (2005)—these could be most illuminating, helpful, and fun!

Some interesting PIREP remarks have read:

BFL UA /OV WJF-BFL/TM 1845/FL045/TP UH60/SK OVC050/TB LGT OCNL MOD/RM THRU TSP PASS UNDER CLDS. OK FOR HELIO NOT SO HOT FOR FIXED WING

/RM SMOKE OVER NWS BUILDING DRIFTING EAST-SOMEONE THINKING

/RM VFR NOT RECOMMENDED-THREE AIRCRAFT COULD NOT MAINTAIN VFR DUE TO ICING IN CLOUDS.

Odd; oh well, I guess it is difficult to maintain VFR in the clouds when you're icing up.

/RM HAD TO CLIMB TO FL200 TO REMAIN VFR-NOW LEAVING FREQ TO CONTACT ZOA.

Because this pilot is already 2000 ft into Class A airspace, leaving the frequency to contact ZOA (Oakland Center) seems like a "right good" idea.

/RM STRONGEST TURBC I HAVE EXPERIENCE IN 15 YEARS...; reported by a King Air.

/RM 2 PASSENGERS INJURED...HAD TO TURN BACK...; reported by a Navy P3.

/RM IFR NOT RECOMMENDED DUE TO STRONG HEAD WINDS AND 2000 FT PER MIN UP AND DOWN DRAFTS WILL NEVER DO IT AGAIN...; reported by a Cessna 182.

/RM SOME REAL GOOD JOLTS PUT KNOT ON HEAD..., aircraft type missing.

/RM ONE LARGE JOLT, STEW FELL DOWN (SHE IS OK) LOTS OF DRINKS SPILLED...; reported by a Fairchild 27.

/RM UNA TO CONTROL HELICOPTER. RETURNED. NURSES KISSED THE GROUND.

/RM WIND O/G at FCH (Fresno, California Chandler Airport) IS 300-330 DEGREES AT 40 KTS AND ALL THE C150'S AND C152'S ARE INTMTLY FLYING ON THEIR CHAINS.

/RM SEV LLWS AFTER 3 APCHS UNABLE TO LAND...; reported by a Lear Jet.

/RM LOTS OF BAD TURBC. THIS ISN'T THE SMARTEST THING I'VE EVER DONE. HUGHES COPTER.

/RM ROUGHER THAN A COBB...; a good old standby, but not very useful!

/OV AVX .../TP FBO/SK SKC/WX SKC/TB NEG/RM LET'S GO FLY

AVX is Catalina Island's Airport in the Sky, 20 miles off the coast of Los Angeles, California. If you're in the area, try to get out there; you may want to sample a Buffalo Burger at the restaurant.

FSS and NWS personnel, have on occasion, editorialized on PIREPs, usually around the time of championship sporting events. Although, unauthorized and unprofessional, pilots used to see these, usually humorous, reports from time to time. Others contain comments of a personal, social, or political nature. For example:

> HWD UA /OV OAK110007/TM 1600/FL060/TP BE33/SK SKC/WX FV99SM/ TB NEG/RM DURC HWD NBND SEVL H LYRS AT FL015/FL042/FL060. SLANT VSBY 15-30SM. PTCHY ST OFSHR-THRU GOLDEN GATE OVR CITY OF OAKLAND. REPORTED BY A DERANGED BONANZA PILOT

OK, I was the deranged Bonanza pilot!

Another read:

> BFL UA/ OV EHF/TM 1900/FL100/TP UNKN/SK SKC/IC MOD

Case Study

> Could this be an example of "clear air icing?" No. A strong weather system was forecast to move rapidly into central California. As it happened, the system stalled off the coast, with weather advisories for mountain obscuration and icing continuing in effect. When it became apparent the system had stalled, I called the Aviation Weather Center and asked the forecaster to amend the advisory for mountain obscuration. I didn't mention icing; I assumed it would be amended as well. (We all know what happens when we ass/u/me!) Silly me. Sure enough the forecaster amended the mountain obscuration, but left the icing advisory. I stopped issuing the icing advisory but one of my co-workers vented some frustration in the form of the preceding PIREP.

> LAX UA /OV SXC213186/TM 1911/FL070/TP VYGR/SK BKNUNKN-TOP040/ TB LGT /RM VOYAGER 1....

Voyager 1

Yes, this was an actual report filed by the Voyager crew on their record-setting around-the-world flight in December 1986.

PIREP Objectivity

PIREPs from air carrier, military, and corporate pilots tend to be more accurate because of their training and experience. New and low-time pilots (inexperienced) tend to be less precise. Cloud bases and tops, temperatures, and even winds can be measured. Flight visibility and weather are direct observations. The intensities of turbulence and icing, on the other hand, are some of the most subjective and misunderstood quantities in aviation. That's because they're usually based on a pilot's training and experience and, to some extent, the type of aircraft.

Evaluate PIREPs within the context of surface reports, forecasts, and other PIREPs. A single report of severe turbulence from a Beech Sundowner under clear skies and light winds should be viewed with skepticism. On the other hand, a report of severe turbulence from a Cessna 172 with conditions favorable for a strong mountain wave, with advisories in effect, must be seriously considered.

Case Study

> The rather shaky voice (learner) called flight service (me) to report moderate to severe turbulence through the Gorman Pass south of Bakersfield, California. I asked the novice, "Did you actually lose control of the airplane?" The pilot replied, "Well, no." I asked, "Would it be okay if we called it light to moderate turbulence?" The pilot agreed.

Pilots who overestimate intensities of turbulence and icing may think they've experienced severe conditions and fail to heed reports or forecasts. This is not to say PIREPs from pilots of Cessna 152s or Piper Warriors are never accurate and should be ignored. But PIREPs that are not objective are worse than useless! Not only do they give a false impression to other pilots, but forecasters must take them as fact and issue advisories. Inaccurate reports can skew forecast weather models. All of which undermine forecast credibility.

Turbulence

The intensity of turbulence is, to some degree, affected by aircraft type and flight configuration. United States Air Force studies have shown the following to generally increase the effects of turbulence.

- decreased weight
- decreased air density
- decreased wing sweep angle
- increased wing area
- increased airspeed

Turbulence imposes gust loads that appear to be almost instantaneous. Gust loads increase with the speed of the aircraft and gust velocity.

Turbulence intensity and duration have been classified for reporting purposes in the *Aeronautical Information Manual* (AIM). (I have also included my own—colorful (?) descriptions of turbulence intensity.)

Light (LGT)

Turbulence that momentarily causes slight, erratic changes in altitude and/or attitude.

A turbulent condition during which your coffee is sloshed around, but doesn't spill, unless the cup's too full. Unsecured objects remain at rest; passengers in the back seat are rocked to sleep.

Moderate (MOD)

Turbulence that causes changes in indicated airspeed, altitude, and/or attitude, but where the aircraft remains in positive control.

A turbulent condition during which even half-filled cups of coffee spill. Unsecured objects move about; passengers in the back seat are awakened by a definite strain against their seat belts.

Severe (SEV)

Turbulence that causes large, abrupt variations in indicated airspeed, and large changes in altitude and/or attitude. The aircraft might be momentarily out of control.

A turbulent condition during which the coffee cup you left on the instrument panel whizzes by the passengers in the back seat. The aircraft might be momentarily out of control, but you don't let on. Anyone not using their seat belt is peeling themselves off the cabin ceiling.

Extreme (EXTRM)

Turbulence in which the aircraft is violently tossed about and is practically impossible to control. It may cause structural damage. (It must have been quite exciting for the B-52 crew in the callout.)

Usually associated with rotor clouds in a strong mountain wave or a severe thunderstorm, extreme turbulence is a rarely encountered condition where the aircraft might be impossible to control. The turbulence can cause structural damage. Your passengers are becoming concerned by the beads of sweat on your brow, your white knuckles, and new frequency and new transponder code you have just selected—121.5 and 7700.

Turbulence encountered in clear air, not associated with cumuliform clouds, usually above 15,000 ft and associated with wind shear should be reported as clear air turbulence (CAT). Slight, rapid, and somewhat rhythmic bumpiness without appreciable changes in altitude or attitude defines CHOP. Since CHOP does not cause appreciable changes in either altitude or attitude, it would not be classified as severe.

In addition to intensity, the duration of turbulence should be reported.

- Briefly—Turbulence encountered for an extremely short period, usually only one or two jolts.
- Occasional—Less than 1/3 of the time.
- Intermittent—Between 1/3 and 2/3 of the time.
- Continuous—More than 2/3 of the time.

maneuvering speed—The maximum speed at which full, abrupt control movements can be made without exceeding the structural limits of the airplane. Vertical gusts and wind shear put additional loads on the aircraft. Turbulent air penetration speed prevents structural damage as a result of gust loads. In turbulent flight maintain an airspeed well above indicated stall speed and below maneuvering speed.

In 1964 this B52 encountered extreme turbulence in a mountain wave over Colorado.

The following reports illustrate mountain wave activity.

> RNO UUA /OV FMG330025/TM 2345/FL105/TP BE35/TB SEV/RM TMPRY LOST CONTROL...PILOT CUT ARM IN TURBC...RTNG TO RNO.

A SIGMET was in effect for severe turbulence, Reno surface winds were out of the west gusting to 27 knots, and winds across the Sierra Nevada mountains were gusting to near 50 knots. The pilot had the clues, but elected to go. From the PIREP it would appear the pilot regretted the decision.

Another pilot caught in a mountain wave reported:

> RNO UUA /OV FMG270012.../TP C404 /TB EXTREME 130-110 MOD SEV 110-090 /RM EXPERIENCING STRUCTURAL DAMAGE.

Airlines are not immune to mountain wave turbulence:

> DEN UUA /OV DEN313047/TM 0158/FL350/TP L101/TB SEV/RM SEV MTN WAVE PLUS AND MINUS 6000 FPM.

This Lockheed Tristar (L101) at 35,000 ft over the Rockies experienced severe turbulence and 6000 ft per minute updrafts and downdrafts. This illustrates the severity of mountain waves and the fact that they can extend to the stratosphere.

Low-Level Wind Shear

Studies show that many non-convective LLWS reports have in fact been triggered by low-level turbulence. Many pilots lump any turbulence below 2000 ft AGL into the category of wind shear; probably because of FAA and media emphasis. Both can be severe.

Note

> So, what's the difference between low-level turbulence and low-level wind shear? Turbulence causes airspeed fluctuations (both, PLUS AND MINUS) with no appreciable, or only a momentary, change in vertical speed (both,

PLUS AND MINUS). A strong wind shear boundary produces airspeed changes in one direction (plus or minus, BUT NOT BOTH) accompanied by a rapid change in vertical speed (plus or minus, BUT NOT BOTH).

Low-level wind shear results from density boundaries (inversions, sea breezes, thunderstorms); or, a significant changes in wind direction and/or speed over a relatively short distance (low-level jet streams, strong pressure systems, fronts). The depth and strength of the shear zone depends on temperature, and wind direction and speed differences.

Density boundaries typically result in a relatively shallow shear zone, but tend to produce the most significant turbulence—at times moderate of greater. Expect a momentary sharp jolt, accompanied by a pronounced change in vertical speed, indicated airspeed, and wind direction.

Wind direction/speed differences usually produce a less well defined shear zone, but tend to extend through a relatively deep vertical layer. Expect vertical speed and indicated airspeed excursions, along with a more gradual change in wind direction than occurs with density boundary shear.

Recent and accurate PIREPs can verify or refute the presence of turbulence and low-level wind shear. If reports or forecasts indicate turbulence or LLWS, a pilot can minimize the hazards; techniques and strategies are presented in chapter 21, Turbulence.

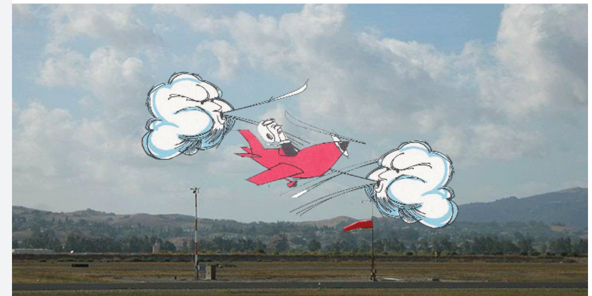
Icing

Like turbulence, there is a tendency, especially with new or low-time pilots, to overestimate icing intensity. Reported intensities are to some degree affected by type aircraft and the availability of ice protection equipment.

Case Study

A recently rated instrument pilot, after experiencing his second encounter with icing in a Cessna 172, reported the encounter as severe. Certainly any

LLTB vs LLWS



"Click" *LLTB vs LLWS* to view animation.

icing in a low-performance airplane without ice protection equipment creates a severe hazard. The encounter lasted about 30 minutes, the pilot was unable to maintain altitude and forced to descend. This description, however, is at best only of moderate intensity.

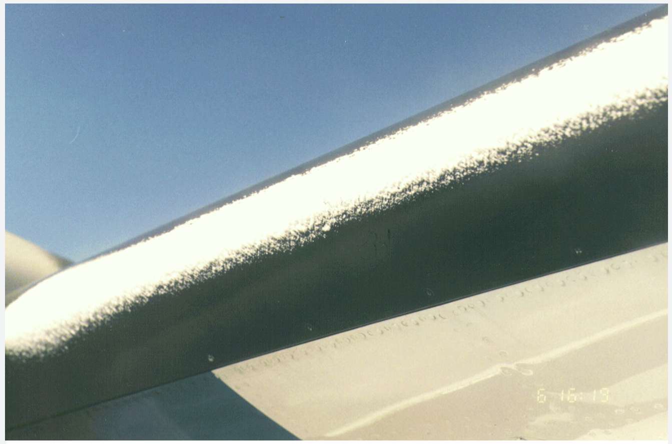


Fig. 10-1. *Rime ice forms when small supercooled water droplets freeze instantaneously.*

Like turbulence, icing types and intensities have been classified for reporting purposes in the *Aeronautical Information Manual* (AIM). Perhaps the following definitions are more descriptive.

Rime Ice

Rime ice is milky, opaque, and granular, normally formed when small supercooled water droplets instantaneously freeze upon impact with the aircraft. Rime icing is illustrated in Fig. 10-1. It is most frequently encountered in stratiform clouds at temperatures between 0°C and -20C.

Clear Ice

Clear ice (sometimes called glaze ice) is glossy and formed when large supercooled water droplets flow over the aircraft's surface after impact, and freeze into a smooth sheet of solid ice or grow as "horns" as shown in Fig. 10-2. It is most frequently encountered in cumuliform clouds or freezing precipitation. Brief, but severe accumulations occur at temperatures between 0°C and -10°C, with reduced intensities at lower temperatures, and in cumulonimbus clouds

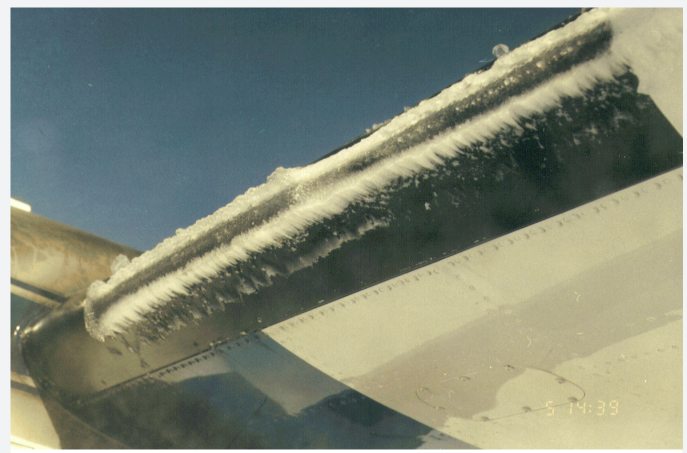


Fig. 10-2. *Clear ice is formed when large supercooled water droplets flow over the aircraft's surface after impact and freeze.*

down to as low as -25°C.

Rime and Clear Ice (Mixed icing)

Mixed ice is a hard, rough, irregular, whitish conglomerate formed when supercooled water droplets vary in size or are mixed with snow, ice pellets, or small hail. Deposits become blunt with rough bulges building out against the airflow.

Trace

Ice becomes perceptible and the rate of accumulation is slightly greater than the rate of sublimation. It is not hazardous even though ice protection equipment is not utilized, unless encountered for more than one hour. A representative accretion rate for reference purposes is less than 1/4 inch per hour on the outer wing. Be aware that any ice, even in trace amounts, is potentially hazardous.

Your spouse admires how pretty it looks on the wing; ATC has just instructed you to climb. You advise them icing is probable and request a descent. The controller calmly replies that in that case "you can declare an emergency or land." Shortly, you're handed off to the next controller. You inquire about a lower altitude and the controller responds, "Is that Terry up there?" (A friend at Los Angeles Center.) A lower altitude was approved in about 15 minutes.

Light (LGT)

The rate of accumulation can create a problem if the flight continues for more than one hour. Occasional use of ice protection equipment removes or prevents accumulation. Ice should not present a problem if the protection equipment is used. A representative accretion rate for reference purposes is 1/4 to one inch per hour on the outer wing. Consider exiting the condition.

Your student hasn't noticed the ice yet; your pilot friend in the back seat is hoping he has enough life insurance; you're negotiating with ATC for a lower altitude, which they can approve in 15 miles. This will only take about eight minutes, but each minute seems like 10!

Since the clarity, color, and shape of a mixture of rime and clear ice has the characteristics of both, accurate identification may be difficult.

Moderate (MOD)

The rate of accumulation, even for short periods, becomes potentially hazardous and the use of ice protection equipment or flight course diversion becomes necessary. A representative accretion rate for reference purposes is one to three inch per hour on the outer wing. Exit the condition as soon as possible.

On his second encounter with ice, a friend and his passengers, in an aircraft without ice protection equipment, survived moderate icing only because the terrain was lower than the freezing level.

Severe (SEV)

The rate of accumulation is such that ice protection equipment fails to reduce or control the hazard. Immediate diversion is necessary. A representative accretion rate for reference purposes is more than three inch per hour on the outer wing. (Fact: It seems that the maximum intensity reported for icing was "heavy" until 1968. Certain pilots still insist on using this term. However, it is a misnomer—all ice is heavy! It's time to move on.)

This is a situation where the person in the left seat very rapidly ceases being the pilot and becomes a passenger; the wing is an ice cube.

Like turbulence, recent and accurate PIREPs can verify or refute the presence of icing. To paraphrase: An accurate report is worth a thousand forecasts. If reports or forecasts indicate icing potential, a pilot can minimize the hazards; techniques and strategies are presented in chapter 22, Icing.

Some Final Thoughts

PIREPs are an essential part of the observational program. This can be especially true at ASOS stand-alone sites. Take for example the following METAR and PIREP.

METAR KGUC 201436Z AUTO 00000KT 10SM CLR M23/M28 A3018 RMK A01

GUC UA /OV GUC/TM1520/FLUNKN/TP C310/RM PILOT REPORTS AWOS WRONG-THERE IS A LOW CIG-NEED IFR TO DEPART

The fog layer drifted over the laser CHI the next hour and a broken layer was reported.

Case Study

We delayed our departure from Dalhart, Texas because of morning radiation fog (callout). The fog dissipated prior to the AWOS "catching up with conditions" and we departed. (Recall from chapter 9 that the AWOS algorithm may take between 10 and 30 minute to report changing conditions.) Upon departure I provided flight service with a PIREP of actual conditions.

Every time we fly we become observers, but reports must be timely. Pilots have a tendency to wait until the latter portion or end of a flight to provide a report. A pilot on a flight from Seattle to Los Angeles contacted Oakland Flight Watch and reported conditions departing Seattle two and a half hours earlier.

A somewhat overzealous briefer instructed a learner to make a pilot report at the conclusion of the flight. The learner calling the FSS the following day meekly apologized for failing to provide the report, then proceeded to recount in detail the conditions encountered. (I'll bet this pilot doesn't forget on the next flight.) Get into the habit of routinely providing timely reports. Keep in mind that reports confirming the forecast are as important as those for unforecast weather. To be of the most value reports of turbulence and icing must accurately contain location, time, altitude, type aircraft, sky cover, and temperature, as well as the intensity and duration of turbulence and icing. Here again, negative reports are as valuable as those reporting significant conditions.

The next time someone complains about the lack of weather information or forecast accuracy, ask if they routinely provide objective pilot reports. If you fly and just don't get around to making a report consider this:

BFL UA/OV BFL/TM 1450/FLUNK/TP ALL/RM WISH I HAD A TOP REPORT FROM BFL TO ONT.

Don't think this can't happen at manual or augmented sites; it does, especially at night.

Recall the section on "ASOS Bashing" in chapter 9, Surface Observations. Like turbulence and icing, at "stand-alone" ASOS sites a PIREP can supplement, confirm, or refute the observation.

Many years ago I provide a PIREP to Los Angeles Flight Watch. It seems the Flight Watch specialist commented, “That pilot really knows how to give a PIREP!” Another responded, “He should, he works here.”

Weather Cameras

The FAA’s Aviation Weather Camera Network images are available at https://weathercams.faa.gov. The Network consists of camera facilities in remote or mountainous locations with up to four cameras. Figure 10-3 graphically depicts locations. The direction of each camera is provided with reference to a Sectional Chart. A “clear day” image provides reference and comparison.

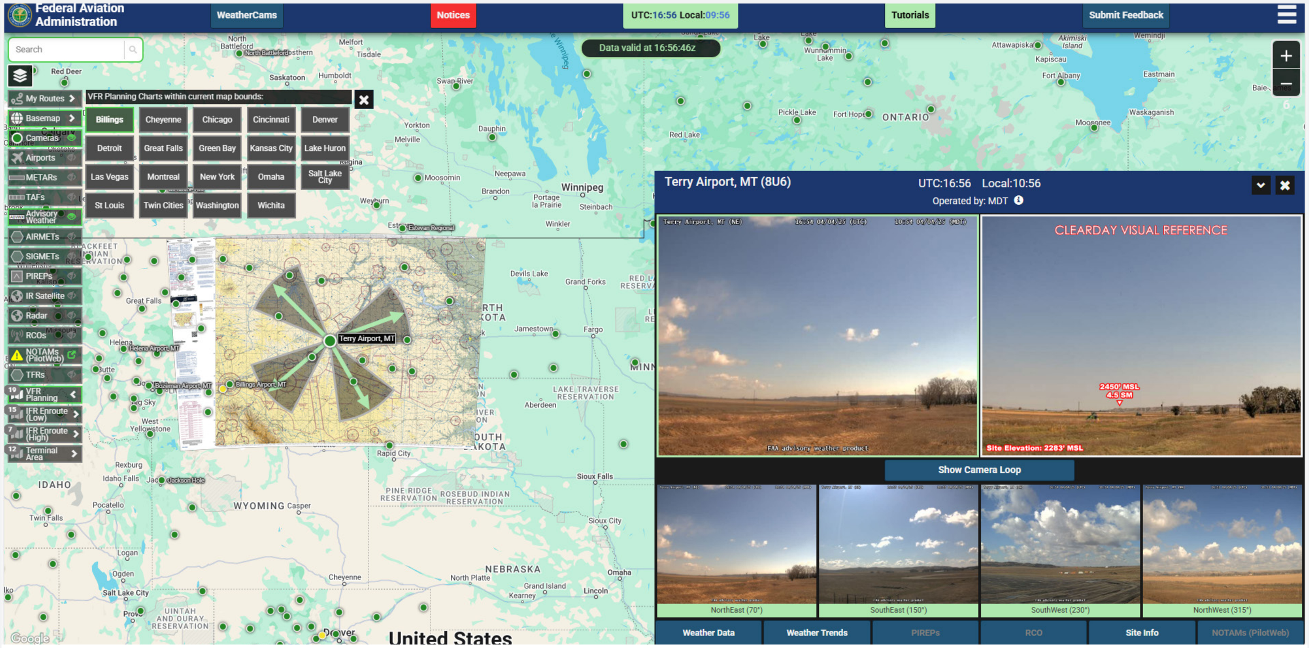


Fig. 10-3. *Aviation Weather Camera images may differ from actual conditions.*

Camera images improve situational awareness. They are not intended to determine weather minimums (VFR or IFR), except when authorized by the Administrator. In addition to the camera images, the website provides a variety of safety information, including adverse conditions (weather advisories), current conditions (METARs, PIREPs, radar, satellite imagery), and weather trends (TAFs).

Images are generally updated every 10 minutes. The time of the last update appears on each image. Actual site conditions may differ from displayed due to rapidly changing weather conditions, image update frequency, or optical distortion.

Warning

> The FAA's Aviation Weather Camera Network images are NOT as substitute for a compliant weather briefing as presented in chapter 18, Pilot Briefing Services.

Visibility Estimation through Image Analytics (VEIA), available on the FAA's Aviation Weather Camera Network, is an algorithm used to produce visibility estimates (statute miles) by analyzing the views in the camera imagery. VEIA uses all cameras at a single site to produce one prevailing visibility estimate for that location by identifying and measuring the strength of the edges of permanent features in the landscape/scene and comparing them to a clear day reference. VEIA estimates allow users to quickly access visibility estimates between sunrise and sunset (not during twilight hours or at night). VEIA estimates are supplemental information, for use with other meteorological information, displayed in conjunction with the specific site's camera images.

Visual Weather Observation System (VWOS), available on the FAA's Aviation Weather Camera Network, is an advanced camera system that is comprised of a suite of weather sensors and 360-degree camera images that collectively observe and report several data fields, including winds, cloud height, visibility, present weather, temperature, dewpoint, and pressure. VWOS uses automated processes to self-check and validate its operations and data outputs. It provides users with visual and textual weather observations as guidance, for use with other weather information, to make flight decisions into airports without AWOS or METAR.