The Front

NOAA's National Weather Service

December 2009

Why NWS Needs Your Pilot Reports

By Chris Smallcomb, Science & Operations Officer, NWS Reno

Below are a couple of actual pilot reports (PIREPS) as they are seen on NWS computers.

While most PIREPS are not as humorous or serious as these two examples, they are extremely valuable not only to fellow pilots but also to forecasters. PIREPS help other pilots anticipate atmospheric conditions, most notably icing and turbulence. For commercial aviation, these reports can help air traffic staff guide aircraft through areas of less turbulence or icing.

How do your PIREPS help NWS forecasters?

- **Wind Speed and Direction:** Wind observations in the lowest few thousand feet above ground help detect low-level wind shear, which can greatly impact arrivals and departures. This information can be incorporated into updated Terminal Aerodrome Forecasts (TAF). Winds aloft reports from 15,000 to 35,000 ft mean sea level (MSL) help forecasters assess the strength and position of the jet stream, one of the primary drivers of weather and precipitation.

- **Temperatures:** Observations of temperatures aloft help determine atmospheric stability. This is often critical for thunderstorm forecasting. During the winter, temperatures aloft help determine snow levels across the West, especially in sparsely populated areas.

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When's the Next *Front?*

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The Front

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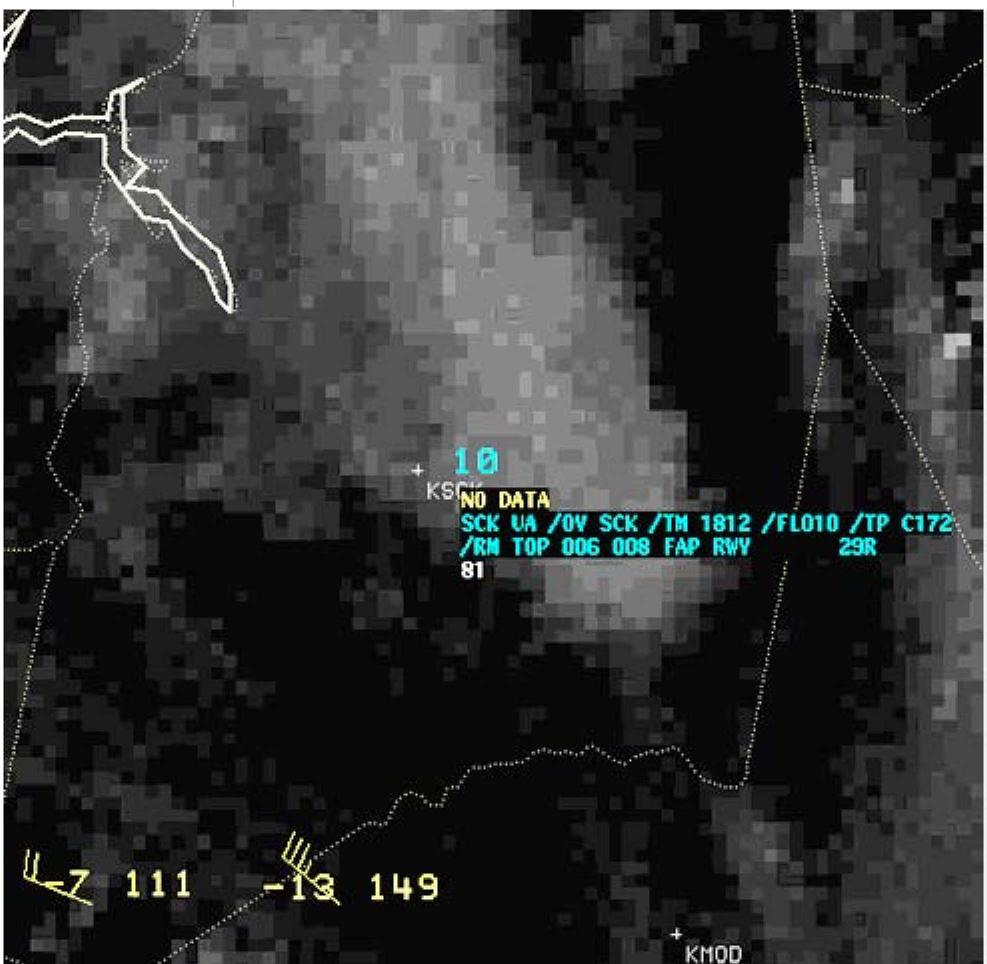
Mission Statement

To enhance aviation safety by increasing the pilot's knowledge of weather systems and processes and National Weather Service products and services.

- **Icing and Turbulence:** Reports of these aviation hazards go to the NWS Aviation Weather Center. The AWC issues the Significant Meteorological advisory (SIGMETS) and Airman's Meteorological Information (AIRMETS) related to icing and turbulence. Therefore it's critical for them to have real-time observations. The more severe reports may also be referenced in local NWS office [aviation forecast discussions](), which are issued several times a day. Severe turbulence often accompanies downslope wind storms in the lee of the Sierra Nevada, often mentioned in the NWS Reno forecast discussions.

- **Cloud Bases and Tops:** Even with sophisticated radar, satellite and other observation systems, determining the exact base and top of clouds can be challenging, especially for low clouds, stratus and fog. PIREPS of cloud bases and tops are valuable in determining cloud thickness, which helps forecasters determine the likelihood of clouds thinning or burning off. This data is especially critical in areas prone to low clouds and fog, such as the busy San Francisco-Oakland-San Jose air corridor.



This visible satellite image centered over Stockton, CA, shows an area of low clouds and fog depicted in light grey. The image was recorded during the morning of December 14, 2009. In light blue, a PIREP at 1,000 ft above ground level (AGL), nearby, indicates cloud tops between 600 and 800 ft AGL on final approach to runway 29R.

Automated Meteorological Data Collection and Reporting System (MDCRS) data from commercial aircraft are shown in yellow. These observations display:

- *Wind speed/direction: barb*
- *Temperature: upper left*
- *Altitude: upper right, in hundreds of feet*

For example, the furthest west observation indicates west-northwest winds at 20 knots and a temperature of -7 C at an altitude of 11,100 ft MSL.

Better reports and observations, not only from PIREPS but also storm spotters, Webcams and road weather networks help improve the picture of what's going on in the atmosphere. Automated temperature, wind and humidity reports from MDCRS and the Aircraft Communications Addressing and Reporting System in commercial aircraft also get incorporated into computer models. All of these observations lead to improved forecasts and warnings.

Your safety is paramount! Help us keep you safe by sending PIREPs.✈

VFR Flight into IMC Weather: How to Stay Safe Out There

By [Dustin Harbage](), Meteorologist, NWS Jackson, KY

What can happen if you are flying Visual Flight Rules (VFR) and enter Instrument Meteorological Conditions (IMC) weather? Other than a violation by the Federal Aviation Administration (FAA), which could cause you to lose your hard earned license, there are several other consequences—none good.

- Vertigo, probably one of the major causes of aircraft accidents for VFR pilots. Your senses tell you one thing while your airplane is doing something else. The results can be catastrophic:
- Flight into terrain
- Collision with another aircraft that may rightfully be where they are supposed to be

Why do we allow this situation to happen? There are several reasons:

- *We have got to get there.* Is it really worth your life or the lives of your passengers?
- *We believe it will get better.* Do you know something more than the professional weather forecasters who have the experience and computer power to make accurate forecasts?
- *We believe we can remain VFR and squeak through.* It is never worth the risk to bet your life in marginal and/or deteriorating conditions.
- *We can still see the ground as we follow the highway with a hand-held global positioning system (GPS).* This is not a guarantee that the weather will not get worse and it does not give you clearance from other aircraft that are legally flying Instrument Flight Rules (IFR). Also vertical visibility is not the same as horizontal visibility. Consider two aircraft on a collision course. If both aircraft are doing just 100 mph, that is a closure rate of more than 200 mph. That means if you were able to see the other aircraft 3 miles away, questionable in less than Marginal VFR weather (MVFR), you would have less than 1 minute to recognize the hazard and avoid the collision.
- *Is it really IFR?* If you can see through the cloud, is it IFR? The regulations do not address differences in clouds. Simply said, if it is a cloud, the regulations say you *cannot* fly through it.
- *If we can climb or descend through the "sucker hole" is it OK?* That sucker hole could take you through an altitude that another aircraft is occupying, or what happens if the hole closes while you are in it or closes behind you and leaves you with no way to get back down under VFR conditions? Remember, VFR regulations state that you must avoid all clouds by 1000 ft above, 500 ft below, and 2000 ft horizontal.

Is inflight visibility less than 3 miles?

So how can you tell if inflight visibility is less than 3 miles? This skill is usually not taught in pilot training. In fact, many advanced pilots do not know how to accurately judge distances in flight. How do we measure 2,000 ft horizontal cloud clearance, or 500 ft below cloud clearance?

Cloud Base is particularly important in areas where terrain rises fast.

We probably guess, but we can make more accurate or educated guesses by listening to local automated weather reports. Another way to determine distances is to check your GPS for landmarks that are a certain distance from you and then locate those landmarks.

How long does it take to make a 180 degree turn if you are about to go IMC? Forever? 1 minute?—that seems like forever! Do you practice 180 standard rate turns under the hood? Can you do it without climbing or descending? Is a 180 turn done at 130 knots any quicker than one at 70 knots?

Actually, the turn takes the same amount of time regardless of speed; however, the faster you go, the wider the turn and the more terrain you cover before clearing the IMC conditions.

There are many reasons you may be unable to fly IFR. Perhaps you are not instrument rated or maybe you are just not instrument current. Many VFR pilots just don't like to talk to Air Traffic Control (ATC), or are unable to get ATC clearance because the frequency is too congested. Maybe the minimum enroute altitudes (MEA) are too high. In the western mountains, many MEAs are 13,000 to 17,000 ft and small, unpressurized aircraft are limited to 10,000 ft, even if the airplane can go higher.

So what are some of the weather indicators to avoid VFR into IMC? Three crucial ones are as follows:

- **Cloud Base:** If cloud base lowers and you are forced to descend, think about turning around. The cloud base may stay the same, but watch out if you're flying into an area where terrain rises fast (TRF).
- **Cloud Coloring:** Sun shining through clouds is usually good. Lack of sunlight through clouds and darkening skies can indicate deteriorating conditions ahead.
- **Cloud Type:** Various types of clouds can indicate deteriorating weather conditions.
  - **Cirrus:** Can be a fore-runner of worsening weather, 12-24 hours in the future
  - **Cumulonimbus:** Tells you its convectively unstable now
  - **Cumulo-Granite:** Obvious

Cirrus

Cumulonimbus

Cumulo-Granite

Rapidly changing cloud conditions alert you to the need to turn back or land short of your destination.

- **Visibility:** A reduction in visibility is one of the most important indicators of deteriorating weather conditions. You should think about going back to that airport you just passed.
- **Cloud Height:** Height is important, especially in the mountains. Remember, METAR and TAF report the height of clouds AGL, not MSL. OVC040 = Overcast at 4,000 ft above the airport. If the airport is 1,000 ft, cloud bases are then at 5,000 ft MSL. If the airport is in a valley, it may be VFR but surrounding mountains may be obscured by clouds.
- **Wind Direction:** A change in wind direction may indicate a change in the weather. If you note a change in crab angle or a change in ground speed, and the clouds are increasing in density, coverage or height, think about turning around or landing short of your destination.

Weather Tools for VFR Flight Decision

Cloud base and surface visibility can and should be obtained before you become airborne. Check all of the following before taking off:

- Area Forecast (FA) and AIRMET
- Local Aviation Forecast Discussions
- TAF
- METAR
- Weather Depiction Chart
- 12-hour Low Level Significant Weather Prognostic charts
- PIREPS with cloud tops, layers, and inflight visibility for your route of flight. Don't forget to submit PIREPS when you are flying, to help the next pilot.

How do you get a weather update in flight? Ask! That's what the radio is for. Try Flight Watch on the frequency 122.0. Local Flight Service (AFSS) frequencies are also listed on Sectional Charts. Listen to the local Automated Weather Observation System (AWOS) and Automated Surface Observing System (ASOS) frequencies from nearby airports. Talk to the ARTCC or local tower controllers enroute and see what kind of reports they might have. Finally, in this modern age, your GPS may offer weather to the cockpit via satellite on an XM radio connection.

If you do become IFR, have a Sectional Chart handy. It lists Mountain MEAs. If you get into trouble, and have to go below MEA, you should know what's below you! It's better to drop down into a valley than onto a mountain. Don't get trapped flying into rising terrain and lowering ceilings with no room to turn around. A benign valley could turn into a box canyon with no way out. The best course of action is to stop short of the IFR weather or call ATC and get an IFR clearance to a safe landing.

Many of the new GPS used for navigation also have weather radar displays; however, this radar has limitations. Some weather radars are located on mountain tops, so they miss low level weather. The weather radar beam does not follow the curvature of Earth, thus the beam will overshoot some distant weather.

Thunderstorms are always dangerous and usually contain severe turbulence in and near them. Lightning can strike as much as 20 miles away from a storm. Hail can be thrown several miles ahead of a storm. Thunderstorms like to form in and around mountains.

Thunderstorm at airport, courtesy of National Center for Atmospheric Research, 1984.

Probably the worst hazard for VFR flights near thunderstorms is microbursts. Look for Virga, rain that evaporates before reaching the ground, under clouds. Rain evaporates and cools the air. Cool air is more dense and sinks. Dense air races towards the ground, then spreads outwards in all directions. What are possible hazards? Winds of 50 to 100 knots, dangerous wind shear, unexpected severe cross winds, blowing dust (expanding ring), and severe downdrafts under the showers or Virga. You will feel helpless as you watch your vertical speed indicator go past 2,000 fpm in an uncontrolled decent. Don't let that happen to you!

- 8000+ hours
- 2000+ hr USAF H/C-141
- 2500+ hr and type rating B-727
- 1000+ hr MD-80 and DC-9
- 2000+ hr light twin piston
- 200+ hr light single piston

Dustin is a pilot, ATP. ✈

Aircraft Icing: Ways to Avoid the Big Chill

By [Sally Pavlow](), Senior Meteorologist, NWS Topeka, KS

There's no doubt that aircraft icing is a problem for aviators. Whether it's in flight or on the ground, ice is a hazard that can sometimes be avoided if a pilot is aware of when conditions are favorable for aircraft icing.

Aircraft Icing Factors

In order for ice to form, there are a few things that must be present in the atmosphere:

- **Liquid Water Content:** LWC is the most important factor in aircraft ice formation. More specifically, the density of the liquid water droplets is the controlling factor in *severity* of aircraft icing. Although LWC is not routinely sampled, a study by the University of Wisconsin found that LWC can be somewhat inferred through temperature. The study found that not only was a *low* LWC responsible for a majority of their aircraft icing, but it occurred from roughly -4˚C to -8˚C. It is important to note this is only for layered clouds, not thunderstorms that have their own unique set of conditions for icing.

- **Temperature:** In order for ice to form, there must be supercooled water droplets in the atmosphere where the temperature is below 0˚C. Super cooled water droplets begin with temperatures just above 0˚C. The water is cooled rapidly, usually by a "lifting" mechanism. The lift is usually provided by mechanical (coldfront/warmfront/elevation) or by convection to form stratiform and cumulus clouds. In addition the formation of these these droplets can be from condensation. Because there is no ice nuclei present (some type of particle in the atmosphere that helps ice grow), the drop stays as a liquid even in subfreezing temperatures. Studies have found that most icing occurs between 0˚C and -20˚C, which means that an aircraft can fly through a supercooled water droplet layer and begin to accumulate ice as it ascends or descends. This, of course, depends on whether the other ingredients for icing are present as well.

- **Droplet Size:** The last factor to consider in the formation of aircraft icing is droplet size. While the size of the supercooled water droplets affects icing severity and type, it does so to a lesser extent than LWC and temperature. Smaller droplet sizes have less mass and are quickly swept across the airfoil, allowing less time to accumulate. Larger drop sizes can strike the leading edge of the airfoil and freeze instantly, allowing for rapid accumulation. There is some relationship between cloud type and droplet size. Cumulus clouds tend to have larger droplet sizes, while stratus have smaller. High cirrus

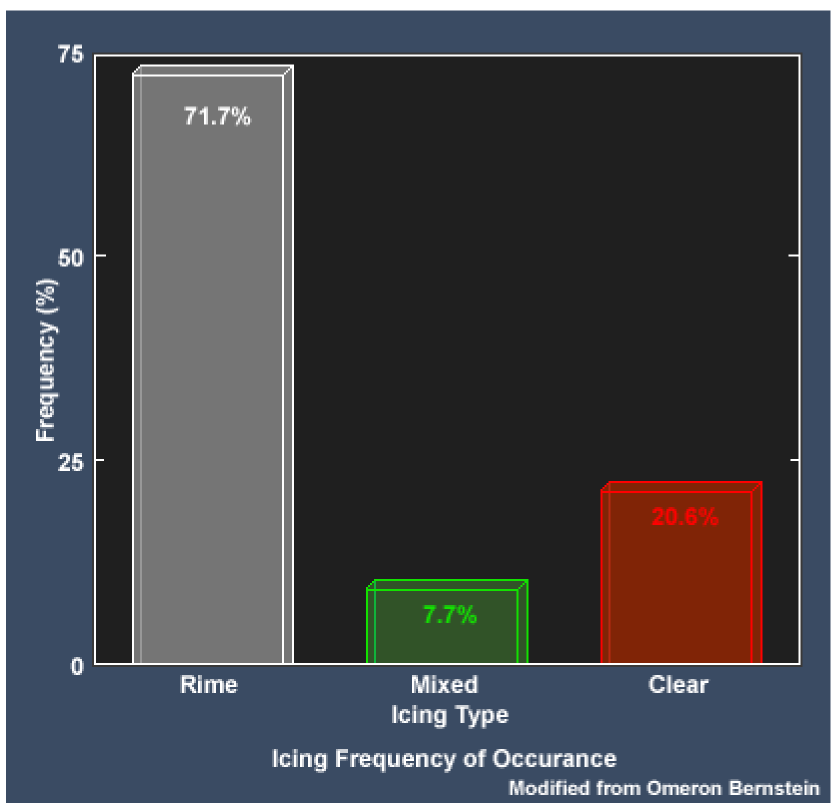


__Figure 1:__ Frequency of icing occurring. Data taken from the COMET module on aircraft icing.

clouds tend to be composed completely of ice crystals since they are present in temperatures below -20˚C.

Types of Icing

There are three types of icing that affect aircraft: rime, clear and mixed. Of the three types, rime icing occurs most frequently.

- **Rime Icing:** This type of icing occurs when small, supercooled liquid droplets strike the leading edge of an airfoil and freeze instantly. This rapid freezing traps tiny bubbles of air, giving rime icing a milky white color that you can see building up on an aircraft. **Figure 2** illustrates moderate rime icing. Even though rime icing is the most prevalent type, it isn't considered the most dangerous, since it forms typically where de-icing equipment can remove it. If an aircraft is not equipped with de-icing equipment, rime ice can be hazardous as it disturbs air flow over the airfoil.

- **Clear Icing:** Clear ice forms when only a portion of the drop freezes on impact while the rest of the drop flows down the remainder of the airfoil and slowly freezes (see **Figure 3**). Also, because of the slow freezing that occurs as part of the drop flows down the airfoil, bumps, ridges and horn-like curls can form, which are more disruptive to air flow over the airfoil. Clear ice can be more dangerous to the aircraft because some of the bumps, ridges and horns form out of the reach of de-icing equipment. Clear icing conditions tend to be found more often in a higher LWC with larger drop sizes.

- **Mixed Icing:** In some instances, an aircraft can encounter a mix of both rime and clear icing. This poses the same danger as clear icing since some of the ice can exist out of the reach of de-icing equipment (see **Figure 4**).

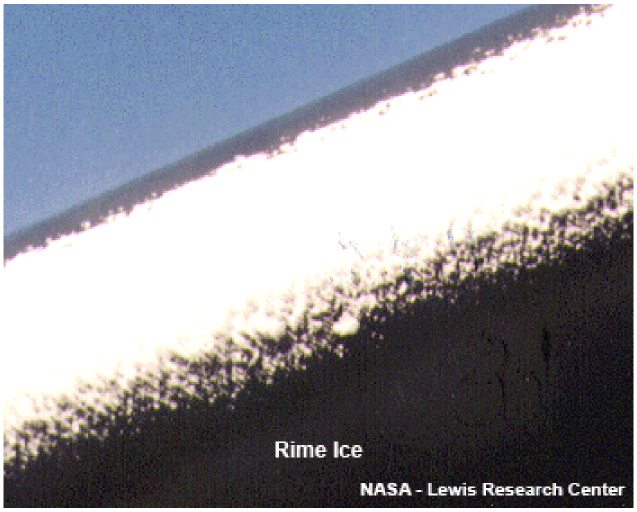


Figure 2: *Rime ice*

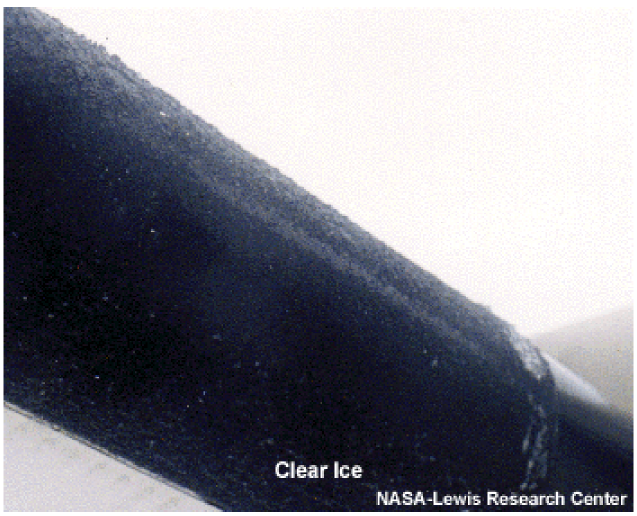


Figure 3: *Clear ice*

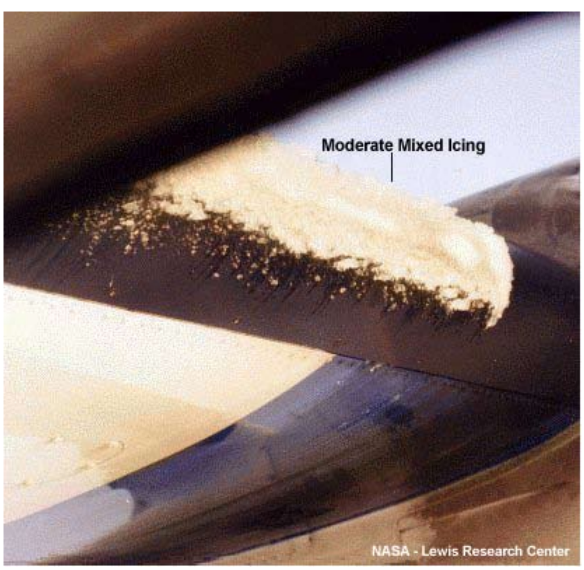


Figure 4: *Moderate mixed icing*

So what is a pilot to do when trying to assess icing potential either before takeoff or in-flight? Before takeoff, a visit to the Aviation Weather Center Website is a good place to start (See **Figure 5**). Once there, click on Icing on the left side. You will find information on current icing advisories, PIREPS, freezing level graphics and more.

Another way to make a quick determination of the potential for icing are the following very general guidelines for icing vs. cloud type.

Stratiform

Small Cloud Droplets:

- Rime/mixed most common
- Usually confined to layer 3,000 ft.-4,000 ft. thick

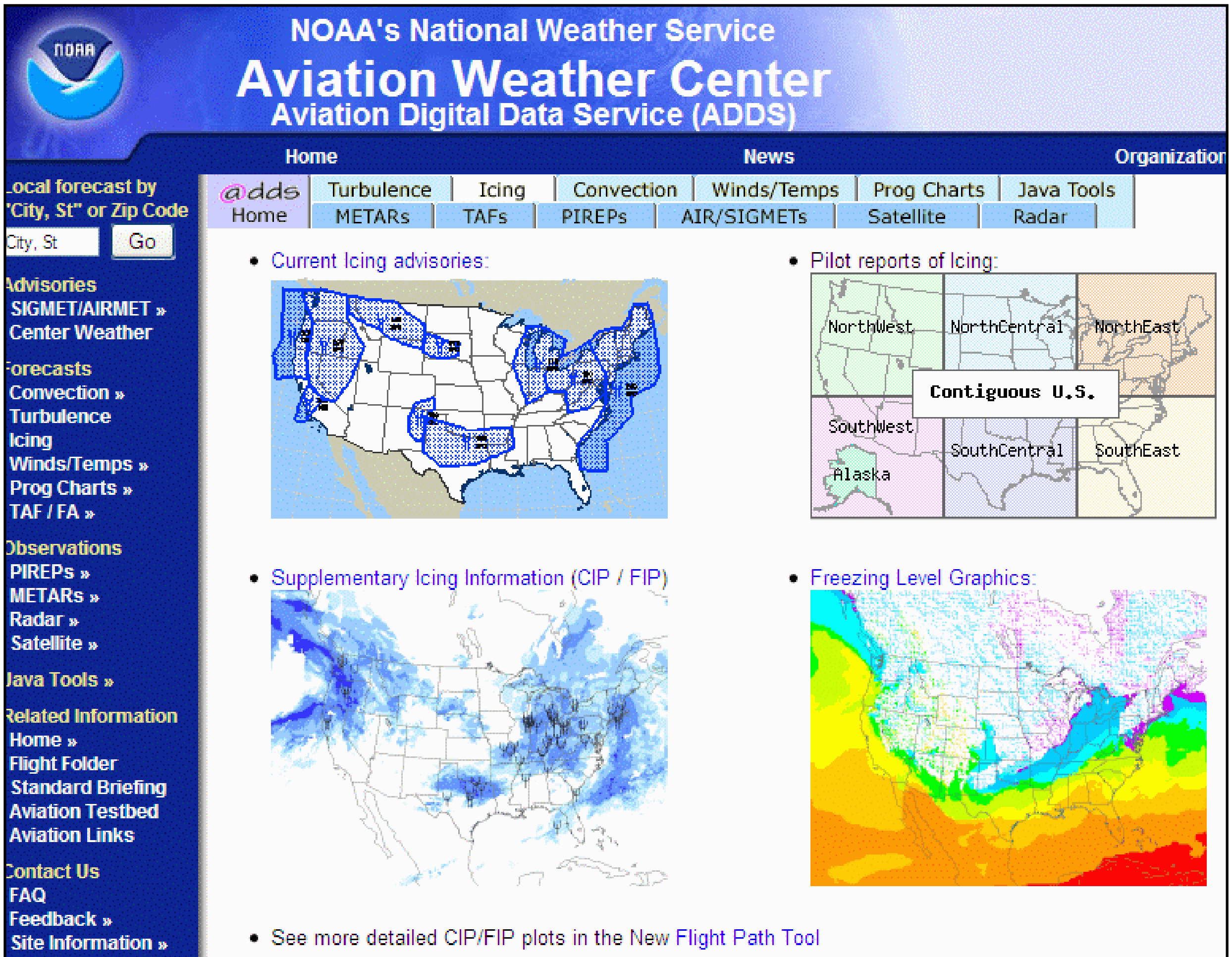


Figure 5: *The [Aviation Weather Center] is the place to assess icing information.*

- Max values occur in upper part of cloud
- Large horizontal extent

Cumuliform

Large Cloud Droplets:

- Icing found in updraft portion of cloud
- Heavy rime most frequently in cloud tops
- Clear icing most likely in building Cu
- Rime often found in fully developed TS
- Relatively small horizontal extent

While these guidelines are *generally* true, don't rule out the possibility that supercooled droplets may exist in ALL cloud types.

Freezing Rain and Sleet

The last type of icing that can occur is freezing rain and sleet. Both rain and sleet have the potential to accumulate a lot of ice in a short amount of time. Freezing rain and sleet occur when a layer of warm air overruns colder air at the surface. **Figure 6** illustrates a vertical snapshot of the atmosphere, showing how the depth of the warm layer, as well as the depth of cold air at the surface, determines the difference between freezing rain and sleet.

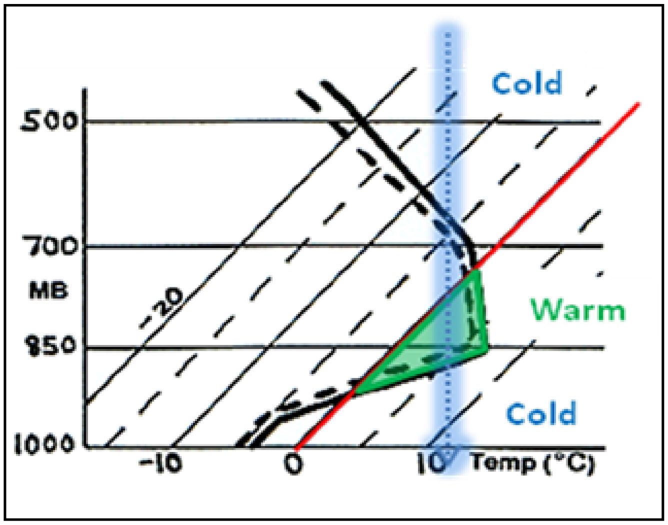
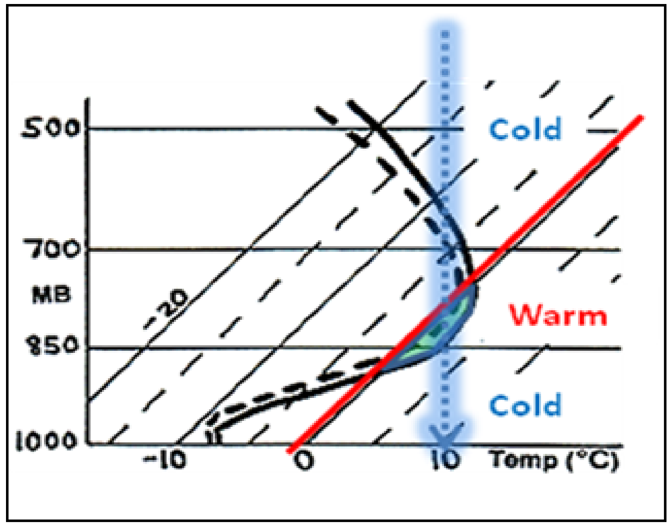


Figure 6: *Freezing rain*



Sleet

See the February 2004 edition of *The Front* for more on this subject of the vertical profile.

Pilots should be extra vigilant when freezing rain (FZRA) and/or sleet (IP) is forecast to occur. Your pilot weather briefer should make you aware of any potential for freezing rain or sleet anywhere along your route. The Aviation Weather Center Website also contains a TAF Java tool, **Figure 7**, with which pilots can mouse over all TAF sites in the country and see what is forecast.

Even though winter is associated more with icing, it can occur any time of year, even in the summer when cumulus clouds and thunderstorms are present. ✈

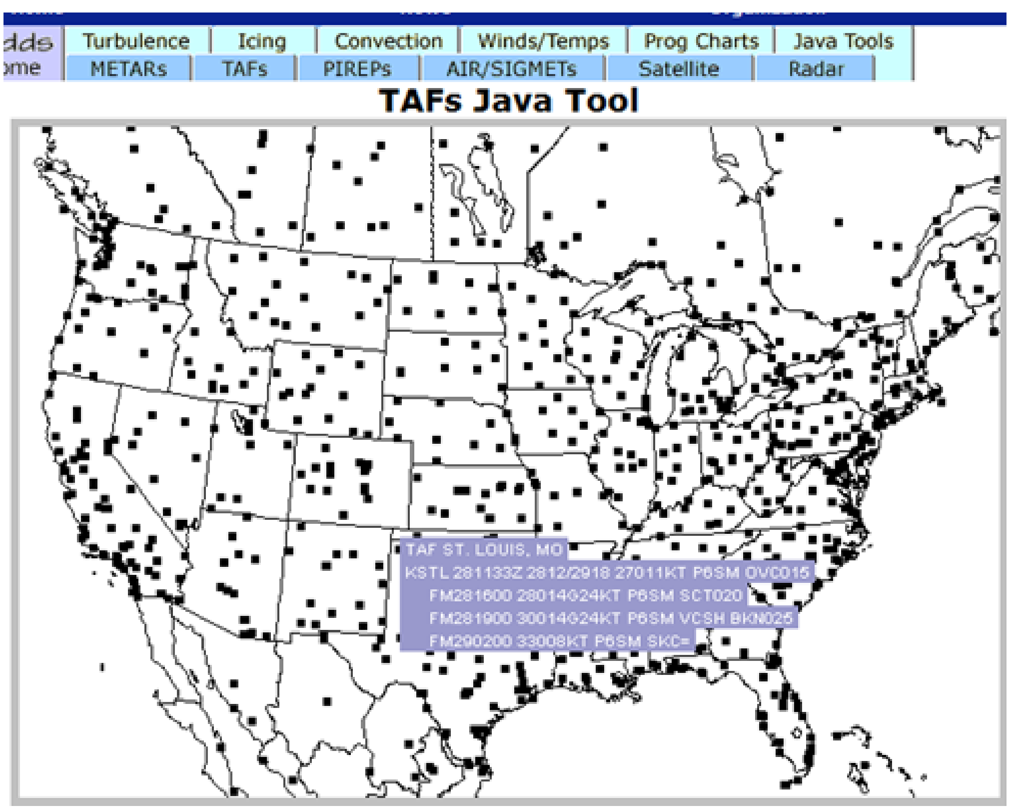


Figure 7: *TAF Java tools*