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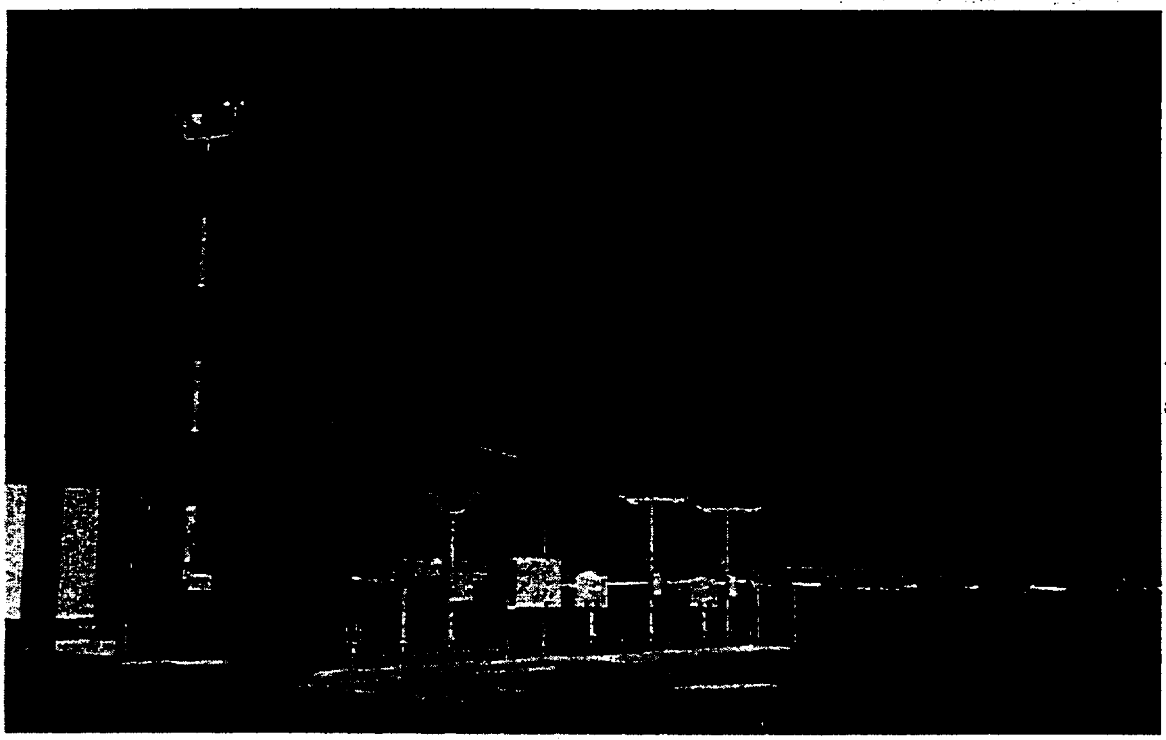

A Typical ASOS Installation

ASOS is the primary weather observation system in the United States

INSIDE

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THE WAY YOU DO THE THING YOU DO

ASOS Ceiling and Visibility

/*TF/ This article is an MBI for ATC personnel who are certified weather observers, including LAWRS observers.

The two most controversial elements of an automated surface observing system (ASOS) are visibility and sky condition. ASOS critics cite these elements as the least accurate, and it certainly can be argued that they are the least understood. As air traffic controllers, we must thoroughly understand the ASOS, for it is the primary weather observation system in the United States, and we are responsible for augmentation, backup, and interpretation of its output to the aviation community. How does ASOS determine visibility and sky condition? How do humans? Knowing the answer to these questions will help to clarify the variations between human and automated observation of those two elements.

Understanding Human Visibility

Visual contrast is a key factor in determining how far and clearly you can see. Ground observers have the benefit of seeing dark objects against the lighter background of the sky. A pilot's view is generally toward the ground, providing a darker, more limited contrast background. This lack of contrast makes it much more difficult to identify objects. Even on days with reports of good surface visibility, pilots have missed "seeing" other aircraft or finding airports. Surface visibility may not always match well with flight visibility.

The human observer on or near the ground often has more restricted visibility than pilots. The ground observer may not see the true horizon when determining visibility, but rather looks slightly upward over trees, ridges, and buildings. This upward view can cause the observed horizon to merge with low stratus and force an artificially low visibility. If an observer's view is blocked within 8 degrees of the horizon, a cloud layer at 500 feet would preclude the observer from seeing targets more than .75 mile from the observation. A cloud layer at 3,000 feet would create a 4-mile limit.

Light scattering, sun angle, altitude, and individual visual acuity all affect the ability to "see" in the atmosphere. When haze, smoke, light precipitation, fog, or snow is in the atmosphere, pilots in flight may encounter visibility distinctly different from the ground observer's.

At night, observers must be able to adapt their eyes to darkness to determine accurate visibility. Often at major airports, nearby lights are too bright to allow eyes to completely adapt to darkness.

Visibility Sensor Operation

The visibility sensor does not directly measure how far one can "see," instead it measures the clarity of the air. ASOS converts a sensor-derived value of clarity to a visibility corresponding to what the human eye would see. ASOS employs a forward scatter visibility meter to measure the clarity of the air. The system cants the transmitter and receiver at a small angle, preventing direct light from striking the receiver. ASOS projects light in a cone-shaped beam. The receiver measures only the light scattered forward.

The sensor samples only a small segment of the atmosphere, an area about the size of a basketball. To "broaden" the evaluation, an algorithm (mathematical logic) processes the air passing through the sensor for the past 10 minutes to provide a representative visibility. The more moisture, dust, snow, rain, or particles in the light beam, the more light is scattered. The sensor measures the return every 30 seconds. The visibility value transmitted is the average 1-minute value from the past 10 minutes.

A question often asked is, "How quickly can ASOS respond to rapidly changing conditions?" ASOS employs a special processing algorithm, called the "harmonic" mean, to provide better system responsiveness in rapidly changing conditions.

Each minute ASOS processes the most recent 10 minutes of sensor data to obtain representative visibility. When the visibility drops suddenly (in 1 minute) from 7 miles to 1 mile, it takes about 3 minutes for the 10-minute mean values to register 3 miles and transmit a special observation. A total of 9 minutes will pass before the algorithm lowers the visibility to 1 mile. When the visibility rapidly improves from 1 mile to 7 miles, ASOS generates a special observation after 6 minutes, when the harmonic mean reaches the 2-mile threshold. After 10 minutes, ASOS will report 7 miles. Why longer to improve? By using the harmonic mean, where lower values have a greater impact than higher values, the visibility is more slowly improved and more quickly lowered. This feature adds a margin of safety and buffers rapid changes

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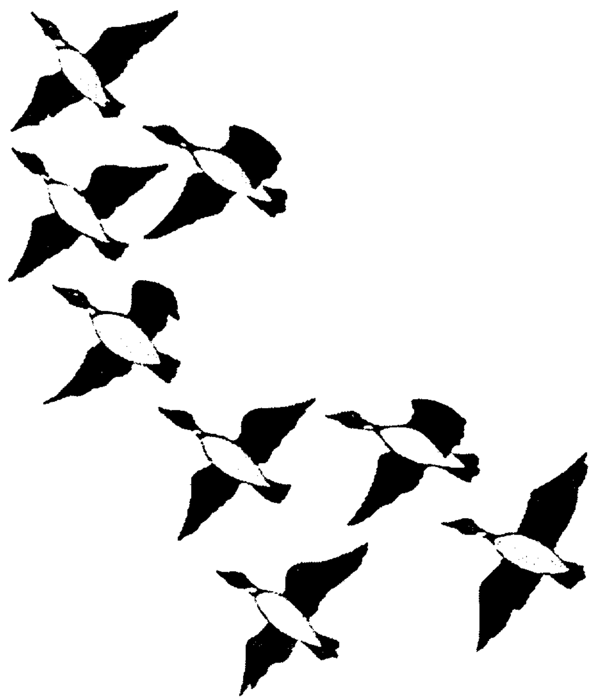

IT'S BIRD MIGRATION SEASON!

See "Bird Activities: Cautions for the Planes" on Page 2

INSIDE

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ASOS is not biased by the "packing effect" because it measures only the sky conditions passing over the sensor. ASOS does not view the sky at an angle. Thus, human observers and pilots may feel that ASOS does not report enough cloud coverage.

Sensor Lag

Every minute the ASOS algorithm evaluates 30 minutes of data to create ceiling and cloud cover values. The last 10 minutes of data are double-weighted to reflect more accurately the most current conditions. Yet in rapidly changing conditions, the automated observations will lag slightly behind the actual weather. If skies are clear and a sudden overcast appears on the sensors, ASOS will take 2 minutes to report a scattered deck of clouds. Within 10 minutes, the system will show a broken layer. Only during the most rapidly changing conditions does the system present a noticeable lag. This lag is no greater than when human observers see a change in conditions, create the observation, and transmit it onto the various data networks.

Summary

At any one airport, at any one time, a manual observation, an automated observation, and a pilot report may be startlingly different. Some of the difference is the nature of weather itself, which resists standardization. As ATC personnel, we must weigh operational impact. Overall, the ASOS remains timely and accurate.

The benefits of a larger network of observation sites - more data, lower minima, fewer missed approaches - cannot be overlooked. Reviewing the procedures of, and variations between, human and ASOS weather observations is the first step toward understanding. (ARW-200)

WEATHER OBSERVATION SERVICE STANDARDS

ARW-200

During 1995, a government/industry team worked to comprehensively reassess the requirements for surface observations at the nation's airports. That work resulted in agreement on a set of service standards, and the FAA and NWS ASOS sites to which the standards would apply. The term "service standards" refers to the level of detail in the weather observation. The service standards consist of four different levels of service (A, B, C, and D), as described below. Specific observational elements included in each service level are listed in the table that follows.

1. **Service Level D** defines the minimum acceptable level of service. It is a completely automated service in which the ASOS observation will constitute the entire observation, i.e., no additional weather information is added by a human observer. This service is referred to as a stand-alone D site.

2. **Service Level C** is a service in which the human observer, usually an air traffic controller, augments or adds information to the automated observation. Service Level C also includes backup of ASOS elements in the event of an ASOS malfunction or an unrepresentative ASOS report. In backup, the human observer inserts the correct or missing value for the automated ASOS elements. This service is provided by air traffic controllers under the Limited Aviation Weather Reporting Station (LAWRS) process, FSS and NWS observers, and, at selected sites, Non-Federal Observation Program observers.

Two categories of airports require detail beyond Service Level C in order to enhance air traffic control efficiency and increase system capacity. Services at these airports are typically provided by contract weather observers, NWS observers, and, at some locations, FSS observers.

3. **Service Level B** is a service in which weather observations consist of all elements provided under Service Level C, plus augmentation of additional data beyond the capability of the ASOS. This category of airports includes smaller hubs or special airports in other ways that have worse than average bad weather operations for thunderstorms and/or freezing/frozen precipitation, and/or that are remote airports.

4. **Service Level A**, the highest and most demanding category, includes all the data reported in Service Level B, plus additional requirements as specified. Service Level A covers major aviation hubs and/or high volume traffic airports with average or worse weather. (ARW-200)

processing 30 minutes of data, the observation becomes more representative of an area 3-5 miles around the sensor site. To be more responsive to the latest changes in the weather, the last 10 minutes of the data are double-weighted in the algorithm calculations. ASOS identifies the recorded "hits" by height and processes them into layers. It may create up to three layers. The system assigns a coverage value of FEW (few), SCT (scattered), BKN (broken), or OVC (overcast). The system reports cloud layers up to an altitude of 12,000 feet. If no clouds are detected, ASOS transmits CLR BLO (Clear Below) 120 in the observation.

The computer algorithm also tests the sensor return for obscurations and variable ceilings. An obscuration occurs when fog and/or precipitation masks the ability of a surface observer to clearly see the base of the lowest clouds. Fog and/or precipitation can also mask the ceilometer from determining clear cloud "hits" in the signal return. The observation will carry a totally obscured sky condition (VV001, VV002, etc.) if there is a sufficient number of fog and/or precipitation "hits", the visibility is 1 mile or less, and there is a cloud layer at 2,000 feet or less. ASOS also will determine variable ceilings when a ceiling is below 3,000 feet. If the variability tests are met, the observation will contain a remark such as "CIG 008V016."

Sensor Performance

ASOS reports all cloud layers as opaque. Thus when ASOS detects high moisture layers or very thin layers of clouds, the algorithm must process the signal return and decide whether to ignore the data or report the condition as a cloud layer. At rare times, ASOS may report a dense moisture layer as opaque clouds before the layer becomes totally visible to the human eye. This kind of report occurs before a cold front when the sensitive laser beam ceilometer detects the pre-frontal large scale lifting of moisture. There have been cases where ASOS reported a layer of clouds 20 minutes before an observer.

Rain and snow will contaminate both the transmission and return signal of the CHI. To compensate, ASOS incorporates an algorithm to evaluate the quality of the CHI signal.

If ASOS cannot confirm a cloud base, it will transmit a height value similar to that which human observers report when fog, rain, or snow obscures the base of clouds. This value more accurately reflects how far you can see into the phenomena than exactly where the base of the clouds will be. Therefore the value is sometimes perceived as a "phantom" cloud layer.

Pilots have reported this "phantom" scattered deck of clouds near the altitude where virga was evaporating. Other times, the "phantom" appeared while rain or snow was falling. A pilot remarked that there were times when automated observations reported cloud decks lower than actual conditions. But stay alert. The lower height often indicated the altitude below which a pilot had to descend before gaining enough forward visibility to see an airport and land.

Is ASOS wrong to attribute a scattered cloud layer to conditions such as virga, thin lower clouds (scud), or falling precipitation? A human observer often ignores, averages out, or misses these conditions when they have limited the forward visibility for pilots. In the February 1994 issue of *Flying Magazine*, an article titled "IFR Insight, Flying the Good Approach" contained the following remark:

"Scud is frequently not reported because it is far less obvious to the observer looking up from the ground than it is to a pilot looking down from an airplane. When you're looking straight down, scud may hardly appear to be a problem, but when the necessary slant range viewing path to the airport is considered, a little scud can obliterate the view of the runway completely if the arrangement of the scud clouds is just so. The visual illusions can be disorienting when flying through scud, and it can be quite difficult to divide your attention between looking outside for the runway and inside at the instruments."

ASOS will report only weather that passes over the ceilometer. It will not measure cap clouds over distant mountains or low clouds anchored over bodies of water near an airport. In the more tropical regions, where winds aloft are often very light, such as Florida, afternoon cumulus moves slowly. Observers have reported up to four-tenths of the sky covered by fair weather cumulus when ASOS reported CLR BLO 120.

At the transition between scattered and broken cloud coverage (one-half), humans often report too much cloud coverage. This is attributed to the "packing effect," a condition where an observer does not see the openings in the cloud decks near the horizon due to the viewing angle. Pilots tend to overestimate the coverage even more than ground observers because of visual compression. When flying on top of a deck of clouds at speeds of 300 to 400 kph, those breaks in the clouds appear even smaller as they flash past at 83 to 111 meters per second!

when the visibility is fluctuating widely and quickly.

The current reportable ASOS values of visibility in statute miles are: <1/4, 1/4, 1/2, 3/4, 1, 1 1/4, 1 1/2, 1 3/4, 2, 2 1/2, 3, 4, 5, 6, 7, 8, 9, 10+.

Siting the visibility sensor is critical. If the sensor is located in areas that favor fog, blowing dust, or near water, it may report conditions not representative of an entire airport. Airports covering a large area or near lakes or rivers may need multiple sensors to provide a representative observation.

Sensor and Eye Discrepancies

Although automated sensors are more objective and consistent than human observers, they are not perfect. There are times when the perception of the human eye and the sensor clarity measurements do not match.

The human observers face physical limitations, such as viewing angle, objects, contrasts, and individual eye response, in determining "representative visibility." ASOS can determine visibility only by sampling the air moving through the sensor. Thus, there will be times when ASOS and human observations will differ.

One condition that heavily affects the human eye is bright backscattered light, which sharply reduces visibility. These conditions usually occur during the daytime when clouds, fog, light snow, flurries, or light drizzle reflects sunlight in the atmosphere. It is comparable to the headlights of your automobile shining into the fog or snow. The brightly reflected light may blind you and limit your visibility. Yet the lights of an approaching vehicle seem to penetrate the fog; you can see the approaching vehicle further into the fog. The visibility difference is caused because the headlights of your vehicle are reflected back toward your eyes while the approaching vehicle's light is scattered toward you (forward scattered). Research has shown the visibility difference under these conditions between forward scattered and backscattered light is 2:1 and remember, the ASOS receiver measures only the light scattered forward.

If conditions are bright enough for a pilot or a controller to use sunglasses, you can expect the automated systems to report visibility approximately twice what the human eye perceives. Visibilities reported by observers on a hazy day may also be lower than those reported by ASOS. Again, brightness seems to be part of the problem. Yet pilots often find flight visibility better than the reported ground visibility.

If an ASOS observation reports a 4-mile visibility, you can expect a report of around 2 miles by a human observer. When denser clouds reduce the light, the visibilities of the human observer and the automated sensor compare quite closely.

At night, human observers seek distant lights to measure visibility. The human observer is using forward scattered light, the same principle applied by the ASOS sensor. Therefore visibilities tend to match more closely between observers and ASOS at night.

For many years, pilots have reported flight visibilities different from those of ground observers. Those differences will continue. No single point visibility may be right for the larger area surrounding an airport, especially in changing weather conditions. When these variations occur, controllers should solicit pilot reports (PIREP) to provide in-flight weather, including visibilities. PIREPs are especially important when the pilot's flight weather differs significantly from the reported surface weather.

Sky Condition

Although the concept of automated observations is relatively new, for years observers have used instruments to measure the height of clouds. From ceiling balloons and ceiling lights to the modern laser beam ceilometers, human observers have depended on measuring devices to determine the height of clouds above the ground.

Observers have used the most recent tool, the laser beam ceilometer, for nearly 10 years. ASOS employs an identical laser beam ceilometer to determine sky conditions.

In the past, human observers evaluated a trace on a graphical chart depicting the signal return of the ceilometer to measure a cloud height. They then viewed the sky to determine the number of cloud layers and amount of clouds. ASOS processes the ceilometer data through computers and employs mathematical logic, called algorithms, to ascertain the cloud height, the number of layers, and amount of coverage.

Sensor Operation-Cloud Height Indicator

How do these differences in measurement affect the way you interpret and apply the information? The cloud height indicator (CHI) transmits skyward approximately 9,240 pulses in 12 seconds. The returned signals are analyzed and processed into 30-second samples of cloud "hits." Each minute the algorithm processes 30 minutes of the samples to create values for sky coverage and cloud height for the observation. By to ensure it is what you want the observation to read.

In summary, an analogy everyone will understand: in the operation of a Boeing 747, the autopilot operates the aircraft perfectly, performs all the functions necessary for the safety of flight of the aircraft, possibly all the way down to touchdown. However, at no point does the captain of the aircraft relinquish ultimate responsibility for the safe operation of the flight. The autopilot is a tool for use in the operation of the aircraft, but it is not responsible or accountable for the safety of the aircraft. The same applies to weather reporting. ASOS automates most of the functions, does most of the observation for you, keeps you apprised of changes to the weather, even alerts you to significant operational weather changes. In the end, however, you the observer still have the ultimate responsibility and accountability for an accurate weather report.

After all, you are smarter than the machine, right? **(ARW-200)**

AVIATION WEATHER POLICY

/*TFE/ FAA Administrator Jane Garvey recently signed the following Aviation Weather Policy statement that stresses the FAA's need to assert itself as a lead agency in the national aviation weather program. The policy asserts FAA's vital interest in aviation weather in several areas including: (1) FAA's relationship to other governmental organizations; (2) the importance of strategic planning in aviation weather; (3) the need for more private sector involvement; (4) commitment to improved training; (5) commitment to improved weather products; and (6) the value of a sound requirements process to support the efforts. **(ARW-100)**

Aviation Weather Policy Statement:

The Federal Aviation Administration (FAA) recognizes that the aviation weather system is a national system and that continued safe and efficient air transportation requires FAA commitment and leadership to aviation weather services.

The FAA will support the operation and development of the national aviation weather system by working closely with each of the departments and agencies in the Federal Government concerned with aviation weather. It will take the lead in developing a comprehensive national aviation weather strategy and in developing a plan to meet stated strategic goals. The FAA will do this in a cooperative environment encouraging the maximum participation and involvement of all elements of government. The FAA will encourage the development of new and expanded roles for the private sector that will cover a wide range of aviation weather services and products.

The FAA is committed to improving the quality of aviation weather information and the application of that information by pilots, controllers, and dispatchers. The FAA acknowledges that training is a critical component of this objective, enabling the aviation community to make the best use of weather information to make sound operational decisions and to ensure safety and efficiency.

The FAA will work to ensure that the new aviation weather products for pilots, controllers, and dispatchers can be interpreted with a minimum of analysis. These efforts will be assisted by a requirements development process which ensures that the needs of the FAA and the aviation community are being addressed and that research, development, and acquisition are focused on products that will improve the safety and efficiency of the Air Traffic System.

Signed on September 24, 1997 by

Jane F. Garvey

Administrator, AOA-1

Example: An approved nonstandard formation flight of four is cleared from FL180 to FL280. The lead (#1) aircraft and the last (#4) aircraft in the formation are squawking discrete codes. Mode C on the lead aircraft indicates that aircraft is at FL220. The last aircraft's mode C indicates FL200. It would be wrong to assume that aircraft #2 and aircraft #3 are somewhere between FL200 and FL220. Aircraft #2 and aircraft #3 could be anywhere between FL180 and FL280. Asking the flight lead to "SAY ALTITUDE" will only verify the flight lead's altitude not the altitude of the rest of the flight. If you need to insure that an altitude is vacated by the entire flight, you must :
1) insure all aircraft in the flight squawk mode C, or
2) ask the flight lead to verify all aircraft in the flight have vacated the altitude.

The flight lead's responsibility is to report level at an altitude when all aircraft in the flight have attained the assigned altitude. (Reference FAA Order 7610.4, paragraph 12-138-c.) **(ATO-130)**

WEATHER OBSERVATIONS

/*TF/ Did you ever wonder who or what is responsible for weather reporting? Is it the Automated Surface Observing System (ASOS) or the observer?

In the constantly evolving world of ATC, we know that responsibilities shift as the job requirements change. As ASOS's are being commissioned, one new dynamic is the shift in roles for both the air traffic control specialist and the contract weather observer responsible for weather observations. Shakespeare wrote, "All the world's a stage, And the men and women merely players." We all must play our roles, while considering that the weather also plays its role -- sometimes very dramatically. Weather is the environment in which we all live and where aviation takes place. Regardless of how dramatic weather plays or changes its role, ATC must remain flexible and adapt accordingly.

Weather observing and reporting is a major role in this production. Responsibilities may vary from a full-blown observation at a service level "A" site, to an almost full-blown observation at a service level "B" site, to limited observation at a service level "C" site. The bottom line is, if you have weather observing duties, you are ultimately responsible for the quality, content, and accuracy of each observation.

It is important to understand that, at locations where an ASOS is commissioned, it produces the weather observation for you. It is an automated tool, assisting you in taking the observation. However, the key point here is, ASOS is not there to replace you. Case in point: the ASOS alerts you when it is ready to send an Aviation Routine Weather Report (METAR) or an Aviation Selected Special Weather Report (SPECI). It is asking if you agree with its observation because it knows you are the final approving authority. It is your responsibility to look at the ASOS-prepared observation and then apply your professional judgment to see if the observation is correct (by looking at the existing weather outside) and make any edits, additions, corrections, etc., as necessary.

ASOS is only a machine, with set programming to do set things. It can't think, can't improvise, can't do a lot of things that a human can, but what it does, it does constantly. It maintains a continuous weather watch, never takes a break, never needs lunch, and never needs to go to the bathroom, but it only does a limited set of things. That's why, at locations where we have observers, the ASOS gives you time to approve it, because it knows its limitations and asks you to check