

Make Me A TAF

You may need a weatherman to tell which way the wind blows. But it doesn't take a TWEB dweeb to decode the forecasters' IFR secrets.

R by Scott C. Dennstaedt
Recently I had the pleasure of visiting the Baltimore/Washington National Weather Service Forecast Office (WFO) in Sterling, Virginia. Besides issuing the local forecast and official weather warnings for the public, WFOs are responsible for preparing two familiar aviation weather products that include the Transcribed Weather Broadcast (TWEB) and the Terminal Aerodrome Forecast (TAF).

While TWEBs are not highly scrutinized by many pilots these days, TAFs are used heavily in the IFR world. Everyone from general aviation pilots to commercial carriers utilize TAFs to anticipate weather conditions at takeoff and landing.

Below: *The TAF (terminal forecast) covers a relatively small area—within five statute miles of the center of the airport's runway complex. But the conditions in close determine much of your planning decisions.*

Without question, TAF content can have a strong impact on fuel loads, the need for alternates, and other aspects of aviation operations due to their stringent regulatory nature.

Not including Alaska and Hawaii,

“Forecasters are careful not to make an amendment for small fluctuations in the observation.”

each WFO is typically responsible for producing a terminal area forecast for up to 10 airports within its region of coverage. For example, the Baltimore/Washington WFO has the responsibility for preparing TAFs for six local terminal areas.

Background And Definitions

A scheduled TAF consists of the expected meteorological conditions sig-

nificant to aviation at an airport for a specified period, normally 24 hours. Once issued, they are monitored continuously and unscheduled TAFs—a politically correct way of saying amendments to the forecast—are issued as conditions warrant.

The U.S. definition of a terminal area is the area within five statute miles of the center of the airport's runway complex. This is a key point that should not be overlooked. The TAF may or may not be representative of the area forecast that's independently generated by the Aviation Weather Center (AWC) in Kansas City, Missouri. TAFs often take into account sub-synoptic local effects. Additionally, locally derived forecast rules can cause the two forecast products to vary.

Scheduled TAFs are issued four times a day (every six hours) at 0000 UTC, 0600 UTC, 1200 UTC and 1800 UTC. In most circumstances, the TAF is normally transmitted between 20 minutes and 40 minutes prior to the beginning of the forecast period.

The Weather Watch

A WFO forecaster normally begins his shift by receiving a briefing from the previous forecaster on duty. This allows the new forecaster to come up to speed quickly with the synoptic weather picture and become familiar with any developing or continuing issues or concerns.

Once he has relieved the other forecaster and in addition to his other duties, the forecaster immediately goes into a “weather watch” or monitor mode. Any amendments to the forecast are usually directly related to changing meteorological conditions reported by the terminal area in the form of an Aviation Routine Weather Report (METAR).

Other weather products such as



radar, satellite, pIREPS, computer model output and radiosonde observations can also cause a forecast to be amended. Amendments are the best method to provide the pilot with the highest quality forecast.

To assist the forecaster in this monitoring process, the computer at the WFO monitors the current scheduled or previously amended TAFs and alerts the forecaster to whenever actual weather conditions at the airport meet, or are expected to meet, specified amendment criteria (more on this later).

This is essentially the forecaster's running score card. This system literally points out what element requires an amendment by highlighting it in red. An amendment can also occur if the forecaster judges the TAF to be unrepresentative of occurring or expected weather independent of the current reported conditions.

Just like an instrument pilot is trained not to chase the needles, a forecaster is trained not to chase weather observations. It's highly tempting for a forecaster to constantly align the forecast to the current conditions. This is where the rubber meets the road. Will the change persist or is it just a temporary condition? Should an amendment be made now or can it wait until the next scheduled TAF is issued? These are just a couple of the tough questions that must be answered before an amendment can be made.

The decision to amend the TAF relies on the forecaster's assessment of existing conditions and expectations. If the conditions change earlier or later than forecast, but the TAF already shows the expected trend, an amendment may not be necessary. Forecasters are careful not to make an amendment for small fluctuations in the observation unless there are sound meteorological data to support such an update.

For example, let's assume a forecast of P6SM BKN020 and subsequent observation of 6SM -RA SCT011 BKN022. The TAF is already forecasting marginal VFR conditions (MVFR:

Ceiling 1000 to 3000 feet and/or visibility 3 to 5 miles inclusive.)

The observation is clearly indicating worsening conditions with a lower scattered cloud layer (SCT011), decreased visibility, and light rain (-RA). However, the observed conditions are still marginal VFR.

The rain event is not making a significant impact and is not expected to worsen based on observed radar data. Given this forecast and observation, it does not serve any purpose to amend the TAF. The TAF already demonstrates a forecast for marginal VFR conditions.

Next, let's assume a forecast of 241120Z 241212 5SM SHRA SCT010 OVC040. Then, a SPECIMETAR pops up at 1330 UTC containing 2SM -RA BR OVC008. If this change was unforeseen and therefore unrepresentative of the original forecast, the forecaster must then amend the TAF to 241340Z 241412 2SM OVC008 in order to provide the most accurate information to the pilots. Notice the shift in time period from 1212 to 1412; this signifies an amendment has occurred.

Amendment Criteria

Amendment criteria are based on flight categories that are familiar to pilots. This is not an amazing coincidence. Forecasters must be savvy enough to understand the impact these changes have on aviation operations. For example, forecasters understand the impact when they forecast a ceiling of OVC005. They realize this means that most operators cannot use the airport as an IFR flight planning alternate.

In order to understand amendment criteria, you need to understand the flight categories used by forecast-



Above: The forecaster's work station—a brace of computer screens to dissect the terminal area.

ers. These flight categories include Low IFR (LIFR), IFR, MVFR, and VFR. The NWS has added a new category, namely, Very Low IFR (VLIFR) to this list. When the weather observation crosses through one of these ceiling or visibility thresholds—for better or for worse—and the change was not forecasted to occur, the forecaster will likely amend the associated TAF.

Besides ceiling and visibility, other events can also warrant a TAF amendment. Wind direction and wind speed forecasts are especially important to airports with a significant volume of traffic. A shift in the wind direction or wind speed will likely force a change in runway takeoff and landing directions. Sustained winds greater than 15 knots, wind direction changes of 30 degrees or more with wind speeds greater than or equal to 12 knots, or wind gust spread greater than or equal to 10 knots all significantly impact aviation operations. If any of those conditions occur, chances are an amendment will be prepared and sent.

If thunderstorms, freezing precipitation, or ice pellets occur and are not forecasted, or if forecasted do not occur, an amendment is normally is-

sued. Similarly, a TAF should be amended if non-convective low-level wind shear (LLWS) is forecasted and does not occur, or if LLWS occurs and isn't forecasted.

Just like the pilot-in-command is the final authority for the operation of the aircraft, the forecasters are the final authority and are ultimately responsible for the forecasts they issue. In effect, these criteria alone don't necessarily justify an amendment. It's still up to the forecaster's judgment whether or not an amendment gets generated.

Composing the TAF

As the weather watch process continues, the forecaster is also beginning to prepare the next set of scheduled TAFs. Up to this point, the forecaster has a good handle on the synoptic picture and must begin to put together a forecast that spans the next 24 hours. Within this 24 hour forecast period, the period between hours two through six is the most critical to aviation operations.

As a result, the forecaster must

wait until all of the numerical weather guidance is available before transmitting the final TAFs.

Forecasters have been given the directive to "give it their best shot." Without question, aircraft safety is paramount. However, the forecaster's

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job is not to prepare a forecast that simply speaks to the worst possible scenario. A grossly exaggerated forecast can lead to delays and will undoubtedly lead to economic impacts to the airlines and public.

At first, one might think that a doom-and-gloom forecast actually increases safety by preparing flight crews ahead of time. In the long run

however, poor credibility of the forecast could ultimately lead to a decrease in safety.

Even so, a forecaster can drop hints in his forecast that there's the possibility for a worst-case scenario. For example, consider the following two forecasts: 5SM OVC012 and 5SM SCT005 OVC012. In the case of worsening conditions, placing SCT005 in the forecast tells the pilot that there may be a chance for a lower cloud layer to form without actually taking the airport to a low IFR flight category by using PROB or TEMPO groups with an ephemeral broken layer. Similarly, this method can be used to tell a pilot that IFR conditions may linger even though improving conditions are anticipated.

Not all forecasters are created equal. In other words, forecasters are given the latitude to construct a TAF in any way they see fit within a broad set of guidelines. A good example of this is the use of the PROB and TEMPO groups. Some forecasters avoid the use of these two elements altogether. A PROB30 group (only PROB30 groups are used in NWS TAFs) cannot be used within the first nine hours of the forecast period anyway.

Devil In The Details

Terminal forecasting has some extreme challenges. The terminal area forecast is considered a point forecast and not a zone or area forecast. The terminal area is so tiny that it is literally smaller than the resolution of what the best numerical guidance forecasts can achieve.

Consequently, a forecaster is generally not concerned about what happens outside of five statute miles except for the occurrence of weather phenomena expected to occur in the airport's vicinity. The airport vicinity is defined as the area between 5 and 10 statute miles from the center of the airport.

The forecaster always starts with the big picture view of the weather. The synoptic weather picture sets the stage for carving out the details of the

FORECASTERS' AMENDMENT CRITERIA

In order to understand amendment criteria it's important to know the forecasters' flight categories

VFR is 3000-foot ceilings or vis greater than 5 miles

VFR goes Marginal (MVFR) when ceilings range between 1000 and 3000 feet and/or vis is 3 to 5 miles

Forecasters see IFR if ceilings fall to 500 to 1000 feet and/or vis 1 to 3 miles

When ceilings are expected to drop to 500 feet or vis to a mile, it's called Low IFR (LIFR)

The low-down stinker is Very Low IFR (VLIFR) with ceilings less than 200 feet and/or vis less than a half mile...stinkol

When observed weather crosses through one of these threshold and the change was not forecasted, the TAF is amended.

TAF. The forecaster must understand the surface wind (speed and direction), visibility, and obstructions to visibility, clouds, low-level wind shear and any expected significant changes of these elements throughout the specified time period.

The forecaster begins to gather data from a variety of different sources. Pilots are familiar with some of these such as pireps, radar, METARs and surface analysis charts. In addition to these sources, the forecaster also relies on computer model guidance.

The computer at the WFO creates an initial cut at the TAFs automatically by using persistence. In other words, the current conditions represent the first period of the forecast. This is not unreasonable because persistence is a good forecast strategy especially when the weather is not changing rapidly.

Once the initial conditions are understood, the forecaster then needs to project what will happen over the next 24 hours. To say the least, many variables must be considered that also include various TAF construction rules (NWS directives). To that end, one of the most useful tools a forecaster possesses is the output from several computer forecast models.

The output from these models can be seen in both a graphical and textual format. Model Output Statistics (MOS) is a textual by-product of the numerical weather prediction model that relates observed weather elements to appropriate variables via a statistical approach at selected stations.

Thus, MOS helps the forecaster predict events forced by synoptic-scale systems. MOS also corrects for certain systematic model biases and accounts for some local effects as well as incorporates climatic considerations.

It would seem that the forecaster would simply look at the MOS and "plug and chug." If that were the case, the forecast could be entirely automated. Instead, the forecaster is charged with the task of doing better

One Tool In The Forecaster's Bag

You won't find this on your FBO's computer, but it's good for getting that glimpse behind the forecaster's secret curtain. MOS (Model Output Statistics) helps the forecaster predict events forced by synoptic-scale systems. The following is an example of the Nested Grid Model (NGM) MOS, which provides textual guidance at three-hour intervals over a 48-hour period.

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FOUS14 KWBC 060357 (Forecast office and name, date/time)
DCA ESC NGM MOS GUIDANCE 3/06/02 0000 UTC
DAY /MAR 6 /MAR 7 /MAR 8
HOUR 06 09 12 15 18 21 00 03 06 09 12 15 18 21 00 03 06 09 12
MX/MN 59 39 54 24
TEMP 37 34 33 38 45 53 52 49 46 43 40 42 47 51 42 39 35 30 24
DEWPT 27 28 28 30 32 36 40 38 41 41 37 33 28 27 25 21 20 19 19
CLDS OV BK BK BK SC SC SC CL CL CL
WDIR 26 18 08 12 14 14 15 18 24 27 28 29 29 29 29 33 01 02 00
WSPD 01 04 06 10 11 12 16 18 13 15 12 20 24 22 14 12 14 08 00
CIG 4 5 4 4 5 6 7 6 3 2 1 5 6
VIS 3 4 3 5 5 5 5 4 2 2 1 3 4
OBVIS H H H N N N N F F F F H N
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The MOS guidance has some familiar elements such as wind direction (WDIR), wind speed (WSPD), clouds (CLDS), ceiling (CIG), visibility (VIS) and obstruction to visibility (OBVIS) broken down into three-hour intervals. Here's the key to understanding the ceiling numbers above; elements like ceiling, visibility and obstructions to visibility are encoded as follows:

CIG:	VIS:	OBVIS:
1 = Less than 200 feet	1 = Less than 1/2 mile	H = Haze
2 = 200 to 400 feet	2 = 1/2 to 7/8 mile	F = Fog
3 = 500 to 900 feet	3 = 1 to 2 3/4 miles	N = No haze
4 = 1000 to 3000 feet	4 = 3 to 5 miles or fog	
5 = 3100 to 6500 feet	5 = Greater than 5 miles	
6 = 6600 to 12,000 feet		
7 = Greater than 12,000 feet		

MOS also corrects for certain systematic model biases and accounts for some local effects as well as incorporates climatic considerations. Problem is, pilots really won't ever have access to this stuff, and even if you did, the MOS is only one piece in the giant forecasting puzzle. Don't forget to look out the window.

than the models. He must examine the MOS from several models and make an hour-by-hour determination for the forecast period based on his expert judgment. In addition to MOS, the forecaster is expected to utilize pireps, surface analyses and observations, radar, RAOBs, graphical model output as well as apply locally derived forecast rules.

Few pilots understand that terminal forecasting is perhaps the most challenging kind of weather forecasting, often reaching the existing limits

of meteorological science. The detail and accuracy each TAF must specify is often beyond the guidance and analysis available to forecasters.

Last but not least, the forecaster is aware of the needs of the aviation community and the impact his forecast poses on its operations and safety.

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