The Front

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National Weather Service TAF, Forecaster's Perspective

Michael Graf, Aviation Weather Branch
Michael.Graf@noaa.gov

Ever wonder how the TAF is put together, who does it, and what the constraints are? Sometimes it's easier to understand the strengths and weaknesses of a forecast product if you're aware of the process used to prepare it.

The Terminal Aerodrome Forecast (TAF) is a concise statement of the expected meteorological conditions at an airport during a specified period (usually 24 hours). Each country is allowed to make modifications or exceptions to the World Meteorological Organization (WMO) code for use in each particular country. The TAF code and philosophy, as described here, is unique to the United States.

So how is the TAF written? For more than a half century the TAF has been hand typed by an individual. A forecaster would evaluate current observations and numeric model data to prepare a TAF. The TAF was then monitored by manually checking surface observations, satellite and radar data.

Over the past 10 years or so, this style has been evolving into a more computer oriented approach that looks at more than just current observations and data. Forecasters can use 30 year climatology to better anticipate the lifting of low clouds and fog. Numeric models now can look at 10-15 different weather solutions rather than just one. And later in the newsletter, you can read about improvements in software that help NWS forecasters prepare and monitor TAFs.

But this article focuses on rules a forecaster must follow, and those rules have been changing the past several years. These changes drive the look and feel of a TAF.

Over the past 10 years, the impact of the user community has ushered in tighter rules that govern how forecasters prepare TAFs. That's not a bad thing, it improves the product, but it also leaves some users wondering why the TAF may not appear to match a thunderstorm graphic, or why a TAF appears repetitive or very long. We'll investigate this by discussing the rules which govern BECMG, TEMPO and PROB groups in a TAF.

The BECMG group was deleted from the NWS TAF in 2004. The main reason was uncertainty and confusion from the users interpreting this group. Users expressed a need for more succinct timing on forecasted conditions, versus a two or three hour window. The result of being more exact can lead to more amended TAFs and additional TAF lines. For example, look below. Old rules permitted the forecast shown in the top of **Figure 1**. New rules generate a more specific TAF at the bottom of **Figure 1**.

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The Front

Managing Editor: Michael Graf
Michael.Graf@noaa.gov
Editor/Layout: Melody Magnus
Melody.Magnus@noaa.gov

Mission Statement

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

Naturally, by increasing the timing and exactness of the TAF, forecasters need to amend more often when the forecast does not work out.

So why discuss BECMG groups any further? Even though this group has been removed from NWS TAFs,

```
KMRB 221138Z 221212 05005KT 1/2SM FG OVC002
  BECMG 1315 VRB03KT P6SM NSW  SCT030
  FM2000 23005KT P6SM SKC

New rules generate a more specific TAF:

KMRB 221138Z 221212 05005KT 1/2SM FG OVC002
  FM1300 VRB03KT 1SM BR  OVC006
  FM1400 00000KT 3SM BR  BKN015
  FM1500 VRB03KT P6SM SCT030
  FM2000 23005KT P6SM SKC
```

Figure 1

it is still used heavily in US military and by other countries. Let's go back to the TAF at the top of **Figure 1** and review how this group is meant to be interpreted.

The example is for a TAF issued at 1138Z that goes into effect at 1200Z. The second line is a BECMG group covering the period from 13 to 1500Z. So the question is, when should the second line go into effect? The forecaster expects weather to improve between 13-15Z, but the forecaster is unsure. It's a best guess. As a user, you're expected to assume the first line remains in effect until 15Z. So even though the weather is expected to improve from 13 to 15Z, you still must plan on using the forecasted 200 and a ½ till 15Z. After 15Z it's VFR.

The TEMPO group is another area where rule changes have drastically affected the appearance of TAFs. Prior to a few years ago, forecasters could have TEMPO groups as long as 12 to 24 hours. Now forecasters must keep TEMPO groups to 4 hours or less. With new technology and better tools, forecasters are working to decrease false alarm, "cry wolf", by keeping TEMPO groups as short as possible.

While reducing false alarms is moving in the right direction, users sometimes are put off by TAFs that seem wordy or repetitive. For example certain meteorological conditions lead to a forecast that is tough to nail down and provide specifics for. These occurrences, combined with the 4 hour or less TEMPO rule, can generate wordy TAFs.

For example, **Figures 2** and **3** show TAFs for Elkins, WV. Both examples occurred in winter when Elkins

```
KEKN 251735Z 251818 32007KT P6SM OVC030
  TEMPO 1816 32010G20KT 1SM SHSN SCT005 OVC012
```

Figure 2

```
KEKN 251735Z 251818 32007KT P6SM OVC030
  TEMPO 1822 32010G20KT 1SM SHSN SCT005 OVC012
  FM2200 32007KT P6SM OVC030
  TEMPO 2202 32010G20KT 1SM SHSN SCT005 OVC012
  FM0200 32007KT P6SM OVC030
  TEMPO 0206 32010G20KT 1SM SHSN SCT005 OVC012
  FM0600 32007KT P6SM OVC030
  TEMPO 0610 32010G20KT 1SM SHSN SCT005 OVC012
  FM1000 32007KT P6SM OVC030
  TEMPO 1014 32010G20KT 1SM SHSN SCT005 OVC012
  FM1400 32007KT P6SM OVC030
  TEMPO 1416 32010G20KT 1SM SHSN SCT005 OVC012
```

Figure 3

was under cold air advection, or "northwest flow", in the low levels. Moisture from the Great Lakes was being forced up the western portion of the Appalachian mountain chain.

These upslope clouds are persistent and usually contain snow showers. This scenario can bounce between overcast skies and good visibility with no precipitation, to a partial obscuration with visibility ranging from 1/2 mile to maybe 3 miles in snow showers.

So what does the forecaster do? Several years ago, the TAF may have looked like the box above, with a 22 hour TEMPO group. This forecast may be meteorologically accurate, but lacks detail.

Now look at the same TAF, same circumstances, using the 4 hour maximum on a TEMPO. The user sees a rather long TAF. Forecasters obviously will try to narrow the window and pick the time snow showers and lower ceilings are most likely. But sometimes the meteorological conditions make it a tough call.

The PROB group is the last TAF modifier covered here. The PROB40 has been eliminated, only PROB30 is allowed now. Furthermore, the PROB group is restricted. User feedback over the last several years and verification scores suggested this modifier was over-used. As result, PROB30 groups **are no longer allowed in the first 9 hours of the TAF.**

So the point from this discussion on PROB30s is, "**forecasters cannot mention of certain aspects of the weather in the TAF, if the probability for that weather, is lower than 50 percent in the first 9 hours of that TAF.**"

For example a probability for thunderstorms less than 50 percent in the first 9 hours of a TAF, means they are not mentioned. What forecasters will do at times is utilize the VCTS remark. This remark means thunderstorms could be within a 5 to 10 mile radius of the terminal..

Finally, if the forecaster believes there is at least a 50 percent, or greater chance, of thunderstorms in **THE FIRST 9 HOURS** of the TAF, how is it mentioned? Forecasters will utilize a FROM or TEMPO group, but not PROB30s.

This can present obvious discontinuities to users not aware of the PROB30 restriction. Take a look

```
KLIT 261733Z 261818 22010KT P6SM SCT020 BKN250
  FM2000 22010KT P6SM SCT025 BKN250
  FM2300 19004KT P6SM BKN080
  FM1100 22004KT P6SM BKN050
```

Figure 4

at the Day One convective outlook from the Storm Prediction Center (SPC). This chart encompasses an area where the probability of a thunderstorm can be as low as 10 percent. Let's examine two TAFs in this con-

```
KTUL 261720Z 261818 19010KT P6SM OVC060
  TEMPO 1820 4SM -RA BR OVC015
  FM2000 19012KT P6SM OVC035
  TEMPO 2024 5SM -TSRA BR      OVC020CB
  FM0000 19007KT P6SM OVC040
  PROB30 0713 3SM TSRA OVC025CB
```

Figure 5

vective outlook. **Figure 4** shows the first one.

Why doesn't the Little Rock (KLIT) TAF mention thunderstorms? On this day, a frontal boundary was well west of KLIT. SPC included KLIT in the outlook because afternoon heating presented at least a 10 percent chance of thunderstorms in the KLIT vicinity.

The Little Rock Weather Forecast Office could not mention a PROB30 group in the afternoon, since the probability of the event was less than 50 percent.

Now shift to the Tulsa TAF (KTUL) shown in **Figure 5**. Here a frontal boundary was fairly close, and the likelihood of thunderstorms was 50 percent or greater from 20Z-00Z. From 00-07Z a quiet period is advertised in the TAF, then from 07-13Z the forecast office considered a chance of thunderstorms at Tulsa, but less than 50 percent. The PROB30 group is allowed because it's after the first 9 hours of the TAF.

In summary we have two TAFs in a convective outlook with different results. Seeing the big picture, plus familiarity with the TAF rules, allows us to recognize these differences. Remember TAFs help fine-tune the big picture, but reviewing weather products such as surface charts, 500 millibar charts, radar and satellite help us understand the big picture. ✈

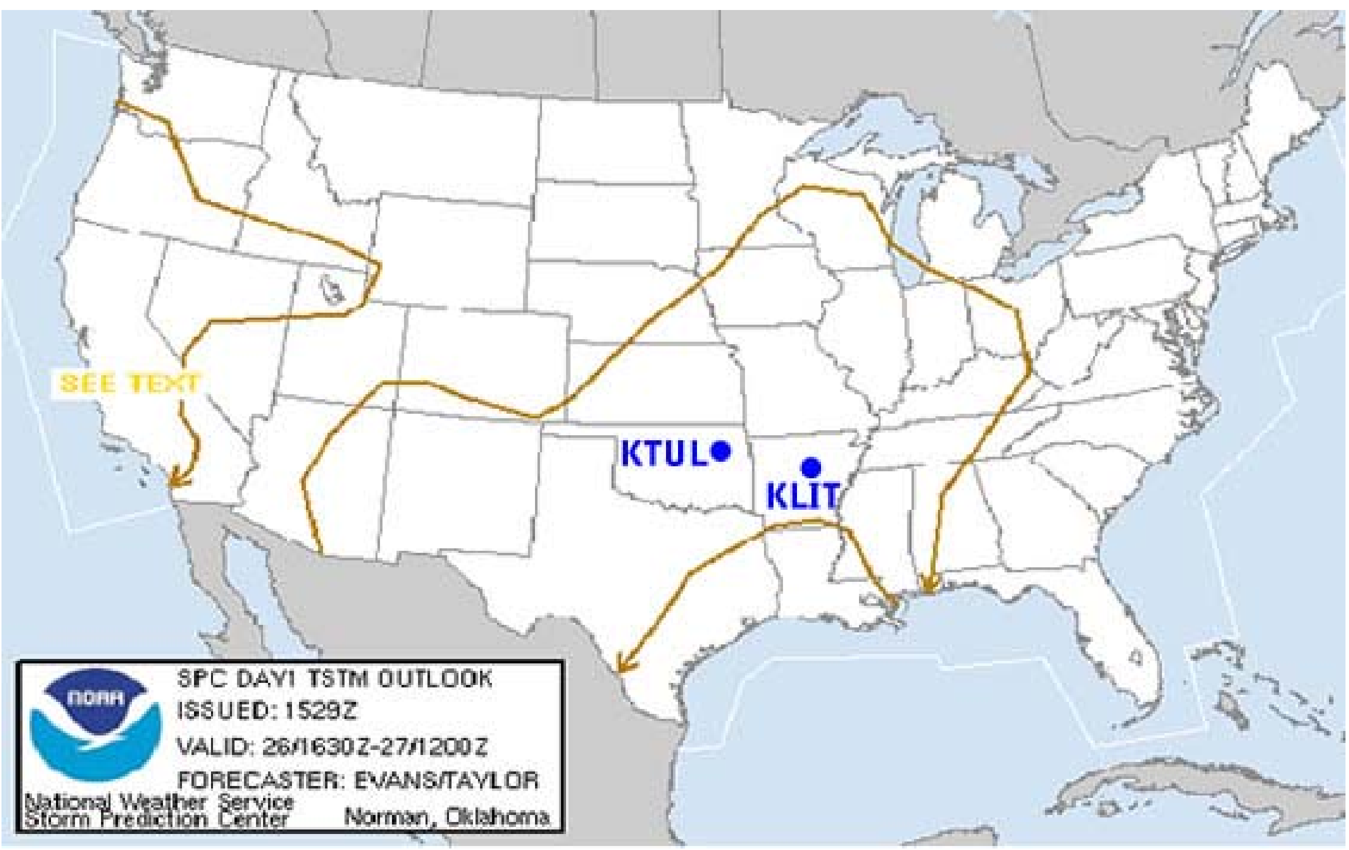

Figure 1: *Day 1 convective chart from the NWS Storm Prediction Center in Norman, OK.*

Future of Aviation Forecast and Preparation System (AvnFPS)

by David Hotz, Senior Forecaster, WFO Morristown, TN
David.Hotz@noaa.gov

The AvnFPS software was developed in late 2002 for the local National Weather Service (NWS) Forecast Offices. The National Oceanic and Atmospheric Administration (NOAA) vision was to improve TAFs and TWEBs by implementing software tools to aid forecasters in monitoring and composing of local aviation products.

At the time AvnFPS was being developed, it was recognized that field applications currently being used would be the best foundation for a national program. To achieve this vision, one of the goals was to ensure AvnFPS was constantly tested and evaluated by field forecasters. The input verified the operations concept; in late 2003 AVNFPS version 1.0 was released to the field. Presently, the AvnFPS is run operationally at more than 100 Weather Forecast Offices (WFOs) across the NWS and is very stable. The NWS will continue to improve the AVNFPS with new technology and techniques the coming years. An example of the AvnFPS monitor is shown in **Figure 1**.

Low Level Wind Shear

The AvnFPS software will continue to evolve over the coming years with several new features planned for the next version. One of the new features is the monitoring the potential of Low Level Wind Shear (LLWS). LLWS is a major concern for aviation operations. Software is being developed to compare METAR winds with the winds off the WSR-88D radar or wind profiler. If LLWS is detected, then the forecaster will be alerted to the problem.

Climate-Based Quality Control

In an attempt to analyze the meteorological content, algorithms under development will assess the climatological frequency of the weather element combinations found in the TAF. If the individual weather element has a low climatology frequency, then subsets of weather elements are compared to identify an "outlier". The aviation forecaster will be able to view the percent of frequency of each weather element.

Climatology Viewer

In conjunction with the climatology quality control, a climatology viewer has been developed which will allow the forecasters to visualize climatology frequencies in the observational data-sets (Figure 2). The lower portions of the viewer contain histograms that display the frequency of various weather elements in the climatology record.

To aid in the production of TAFs, the AvnFPS will provide "TAF-ready" text from forecast guidance. Generating "TAF-ready" text from guidance does present a complex set of challenges since specific values must be determined where guidance supplies only categories. Techniques are under development to combine various guidance sources

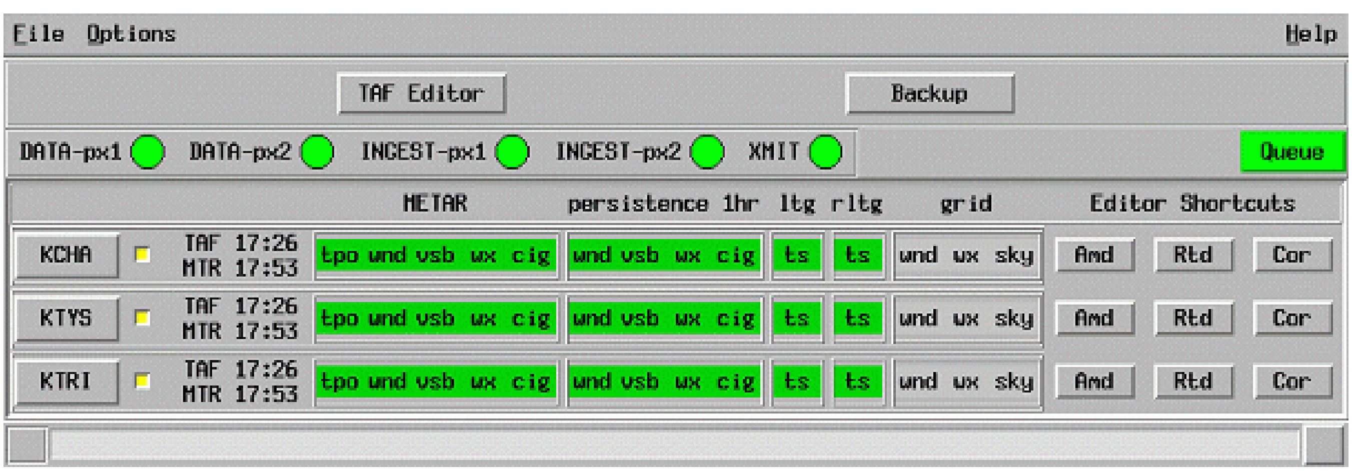

Figure 1: *AvnFPS Monitor*

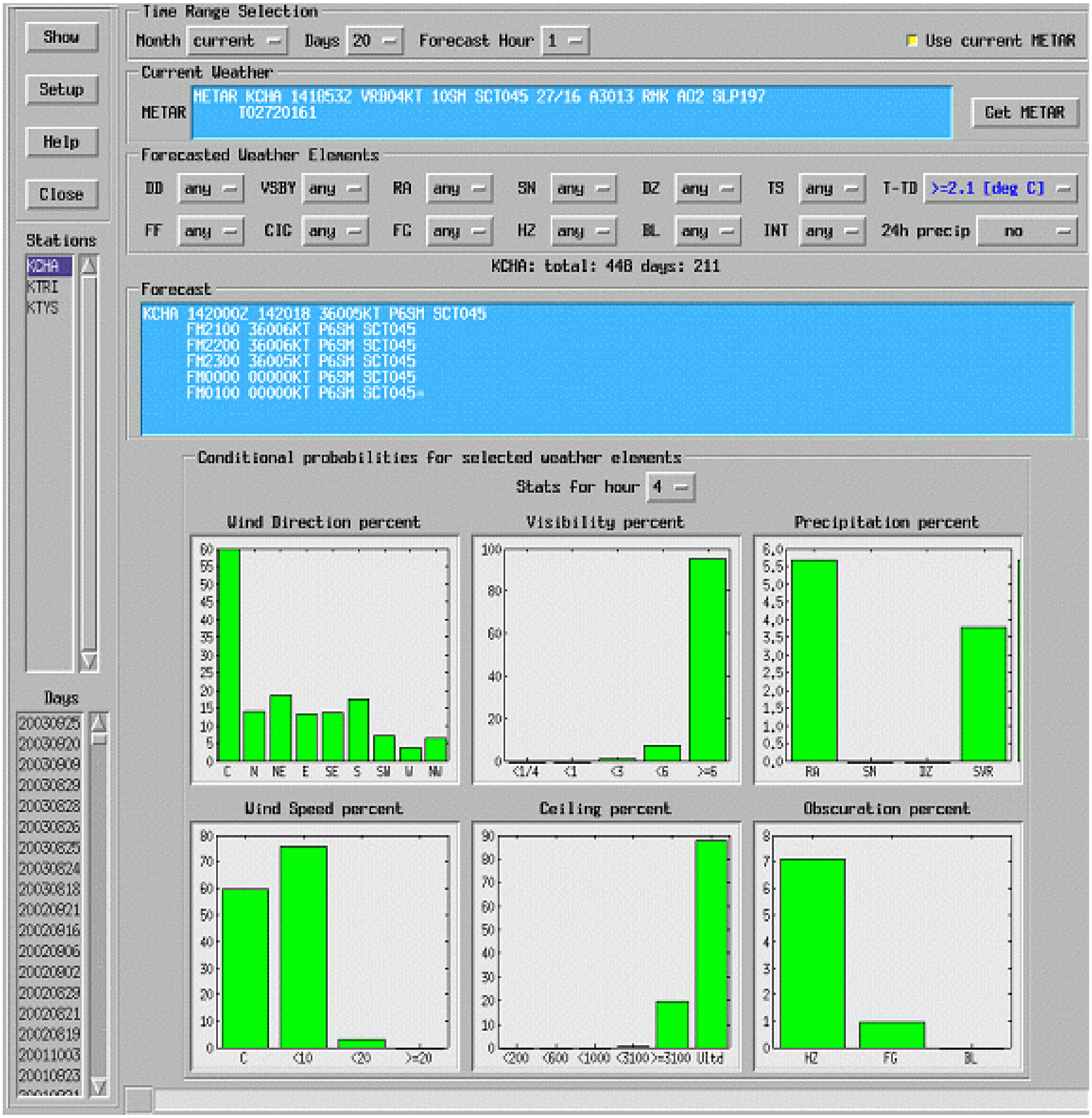

Figure 2: Climatology viewer improvements to formatted guidance.

and "fill in" data where needed. Conditional climatology may prove useful in choosing deterministic values.

Local Tools "Smart-tools"

At the center of the AvnFPS TAF Editor GUI is a menu labeled "Tools". The "Smart-tools" utility allows the individual forecast offices to utilize program scripts (programmed in python) to aid in the forecast process. Individual offices can modify and write additional tools to account for local climatology and terrain effects. The tools can also be used to account for timing and station elevation differences. An image of the TAF Editor is display in **Figure 3**.

Conclusion

The AvnFPS is a powerful aviation application that helps forecasters monitor weather conditions and prepare their forecasts. The AvnFPS software will continue to evolve and improve as additional tools are developed. The additional monitoring of LLWS will alert the forecasters of impending dangers of wind shear. Climatology quality control and viewer software will provide the forecasters with a easy access to past history of weather elements for each airport. ✈

References:

Peroutka, M.R., M.G. Oberfied, M. Graf, G. Trojan, and B. Li: The Aviation Forecast Preparation System of the National Weather Service. Poster Session, AMS Symposium.

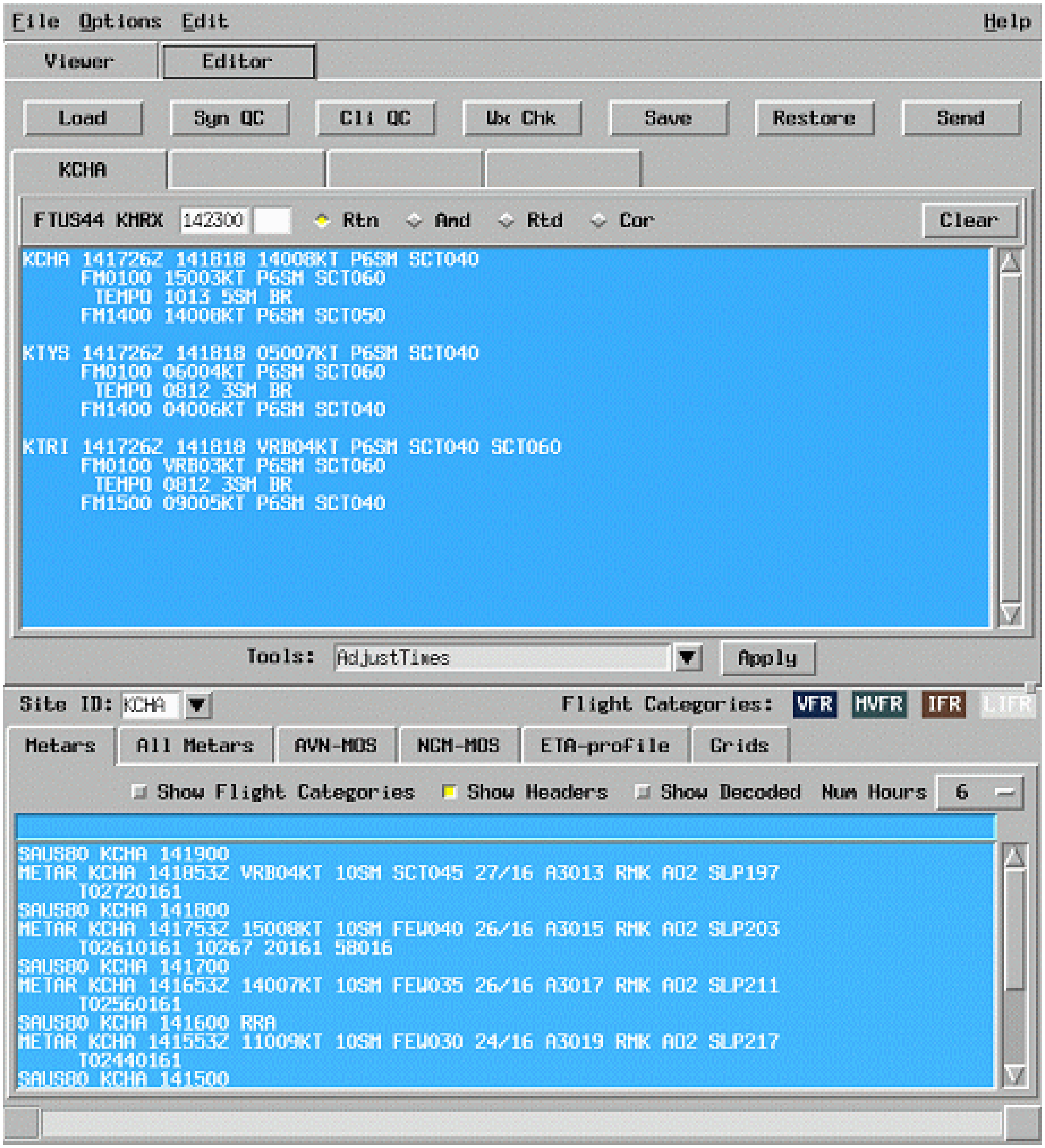

Figure 3: *TAF Editor.*

National Digital Forecast Database (NDFD) and Aerial Application

Dan Gudgel, WCM, NWS San Joaquin Valley
Dan.Gudgel@noaa.gov

The aerial application industry, more commonly known as crop dusters, much like the rest of agri-business, is extremely dependent upon weather and climate information for safety issues and ag-business decisionmaking.

NWS provides weather information and forecasts through NOAA Weather Radio, commercial radio and television broadcasts, print media or indirectly through the services of the private meteorological sector.

Along with many other customers, the aerial application industry stands to benefit from the potential improvement in weather information offered by the NWS through the National Digital Forecast Database (NDFD).

For the aviation aspects of the business, aerial application is concerned with many of those same safety-of-flight meteorological parameters in common with the remainder of the aviation industry:

- Wind
- Density altitude
- Turbulence
- Aero-medical aspects of temperature extremes
- Visibility restrictions
- Cloud clearance
- Severe-weather threats for aircraft operations and exposed equipment and personnel

The wind parameter has additional importance as efficient agricultural aircraft operations necessitate landing opposite the direction of takeoff, landing downwind is contrary to normal aircraft operations. Wind speed in excess of about 8 knots will influence airplane loading equipment placement on an airstrip or helicopter landing pad and possibly postpone the application operation altogether.

For the agricultural factors, the applicator must likewise consider:

- **Temperature and/or cloud cover:** Due to some production-enhancing materials' sensitivity to extreme heat, cold, or strong sun lowering product efficacy or even damaging crops.
- **Humidity:** Dew set hindering product deposition in spraying operations, lack of dew minimizing product adhesion in dusting operations, or adverse, crop-damaging chemical reactions in humidity range extremes.
- **Precipitation:** Protection material not adequately absorbed by the crop, or environmental problems due to surface runoff.
- **Wind:** Off-site movement of material causing adjacent-property economic damage and/or loss of application efficiency over the target field.

The importance of weather information for business planning in the aerial application industry cannot be overstated.

Aerial application is necessary to the agricultural industry because of its speed and efficiency in providing crop protection. The ability to move personnel and equipment costing hundreds of thousands of dollars to the most opportune and efficient location given the expected weather conditions saves money and time that often cannot be recaptured.

The seamless, topographic depiction of forecast weather parameters through NDFD such as temperature, humidity, wind speed and direction, cloud cover, precipitation probabili-

Figure 1: *Turbine Thrush Commander being loaded with fertilizer at Corcoran, CA*

ties and amounts add immeasurably to both the planning and operational decision-making involved in modern aerial application.

Terry Gage, President of the California Agricultural Aircraft Association said, “Weather is the single, most important variable in making application decisions. In our highly regulated, competitive industry, the NDFD will enable our association members to more soundly make those decisions necessary to meet their business needs as well as provide the nation a safe supply of food and fiber.”

Figure 2: *Thrush Commander applying fungicide spray on potatoes, southeast of Bakersfield, CA*

Since agriculture has expanded to use more diverse terrain and the difficulties being experienced by urban-rural lifestyle conflicts, the NDFD will provide forecast weather information for the actual application points rather than those adapted from generalized forecasts centered about widely dispersed points in a warning forecast area.

For the NDFD Forecaster, this potential benefit for the agricultural industry also comes with obligations. The availability of the graphical weather information will also demand an increased attention-to-detail by forecasters due to the inherent implication of accuracy. Information considered trivial in the past, such as “light and variable wind,” will need to be accurately outputted by NDFD formatters because the expected presence of a steady wind direction versus that of a variable, light wind has planning ramifications for ag operations.

Nonetheless, the sensitive business, regulatory and environmental aspects for aerial application will undoubtedly be improved as the NWS provides weather information through the features of the NDFD. ✈

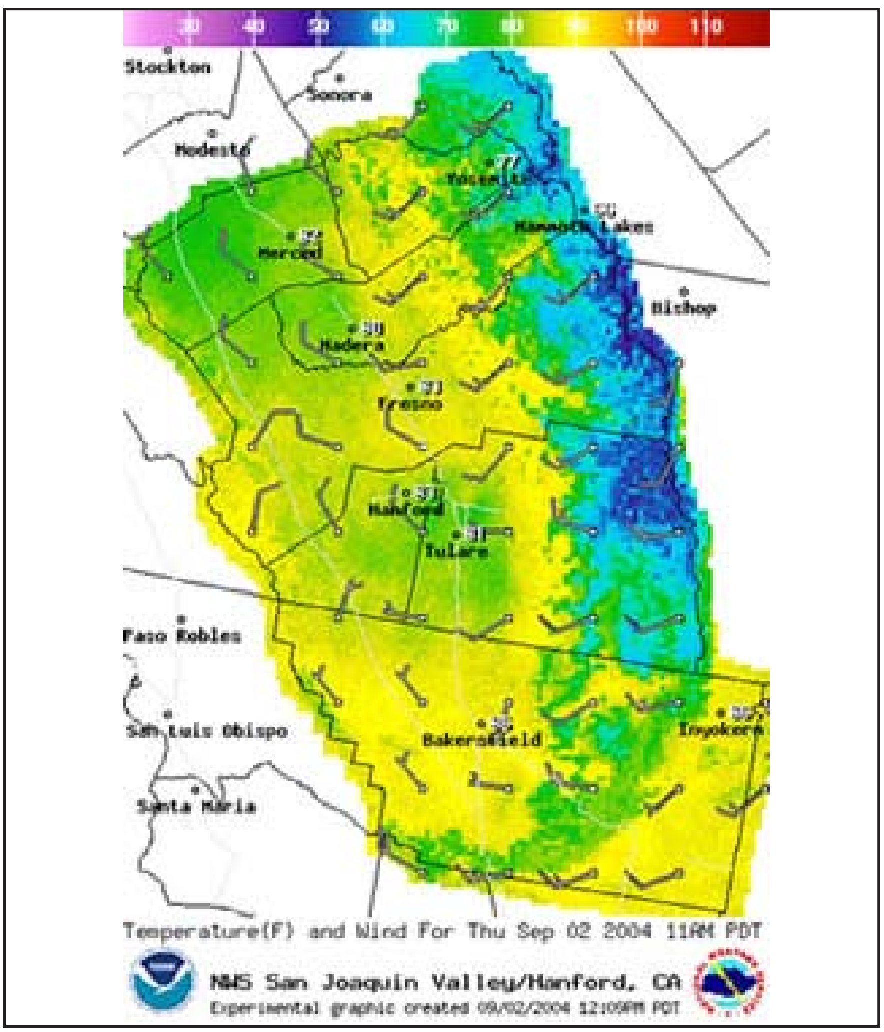

Figure 3: *NDFD Temperature and Wind Forecast*