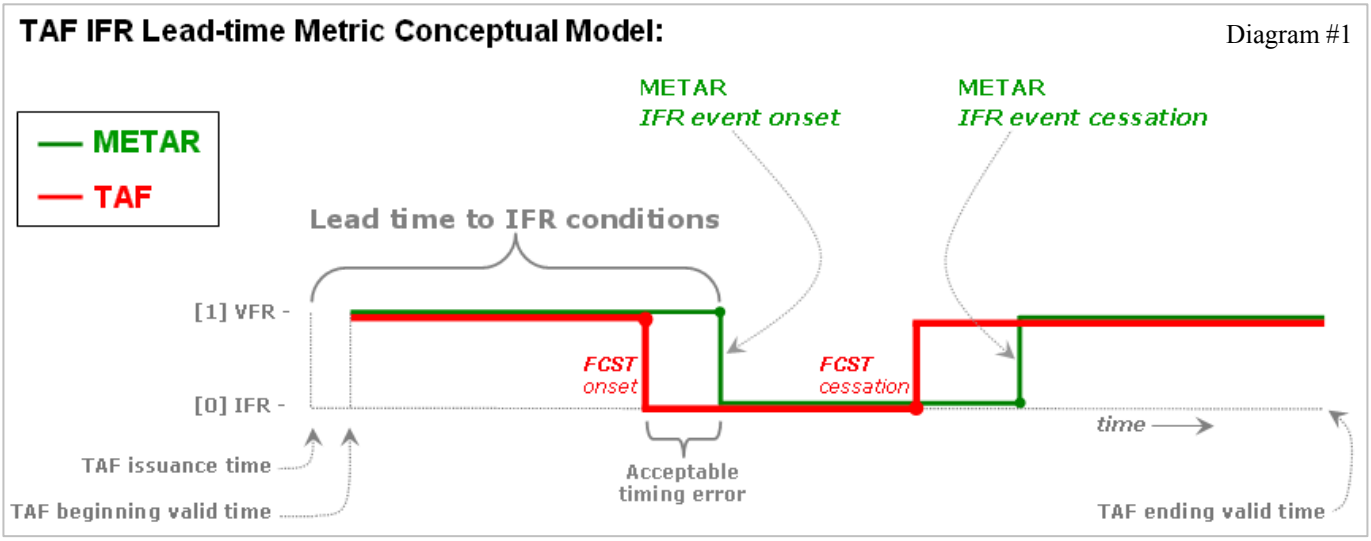
Description of Analysis Types from the TAF IFR Lead-time Metric Statistical Tool



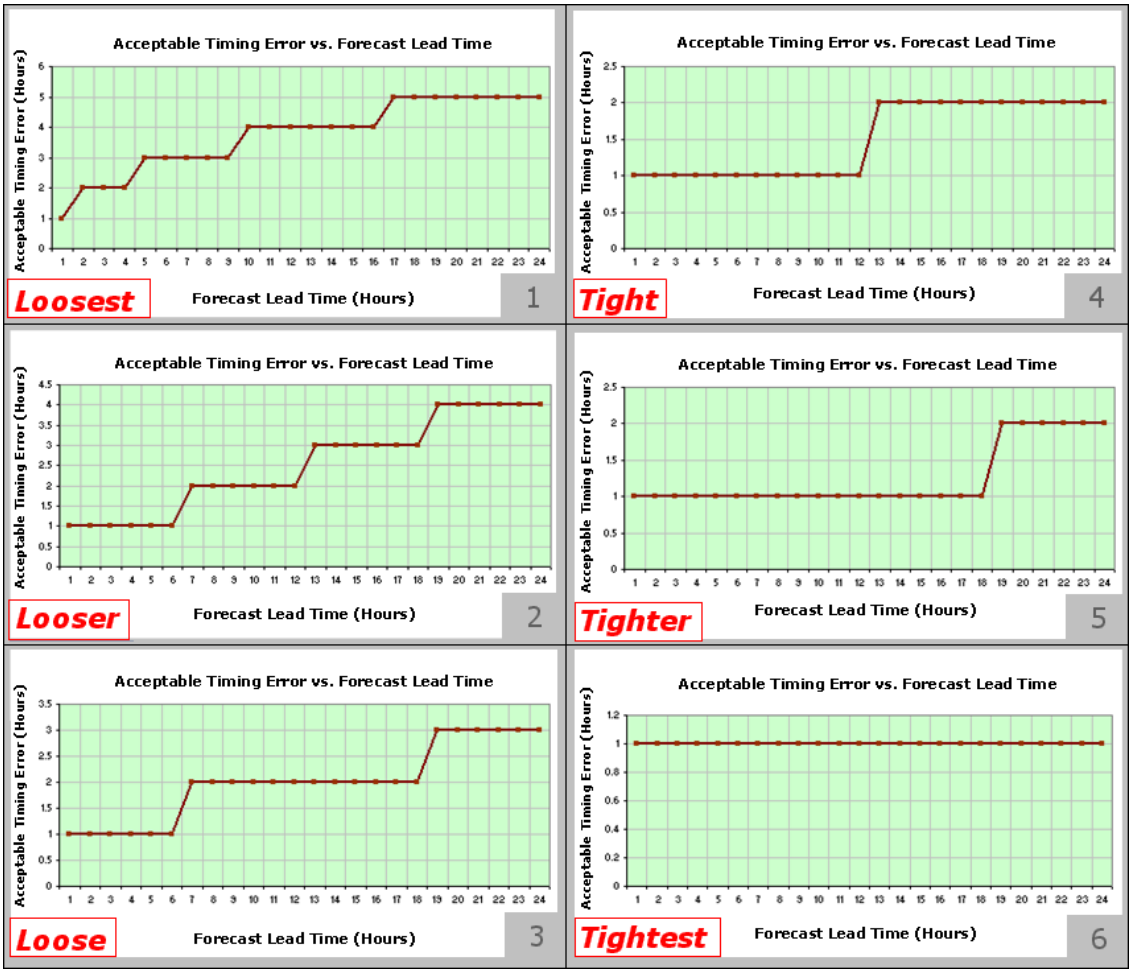


Figure 1: Acceptable timing error for matching a forecast IFR event with an observed IFR event. For the "Tight" criteria, if the forecast onset of IFR conditions is within 1 hour of the observed onset for a forecast lead time of 12 hours or less, then the forecast registers a hit on the observed IFR event. For a lead time greater than 12 hours, the forecast onset can be within 2 hours to register a hit. For the "tight" matching criteria, any forecast outside of this acceptable timing range is **not** credited with a hit on the observed event.

Histograms:

This style of plot presents results in a series of tallies (simple counts) that are binned into ranges according to the units given along the x-axis. The magnitude of the tally within a given binned range is indicated by the length of the bar. Collectively, these bars comprise a histogram. If you divide each individual tally by the total number of events (N), then you have created a frequency histogram. You can see from the histogram in figure 2 that of the 36,226 forecast hits, 6,156 offered a 1-2 hour lead time for the onset of IFR conditions, and 1,592 offered a 5-6 hour lead time. IFR is when the ceiling is below 1,000 ft. and/or the visibility is less than 3 miles. For this binary approach, VFR is any condition that is more favorable than IFR: ceiling ≥ 1,000 ft and visibility ≥ 3 miles.

(1) Lead Time to IFR Conditions (hits), Histograms. The onset time of an IFR event is also referred to as the leading edge of an event, while the cessation time is also referred to as the trailing edge of an event. If one forecasts an event to occur 6 hours prior to its actual onset, then the forecast is said to have a 6-hour lead time on the event. The histogram in figure 2 shows a distribution of lead times for forecasting the onset of IFR conditions at the selected stations and over the given time period. From the web tool, you may choose all weather events, or a special stratification of weather type, and specific issuance hours for the TAFs (00, 06, 12, 18 UTC). It is important to note that many METARs do not report present weather, so:

The number of precipitation events + The number of non-precipitation events ≠ The total number of events

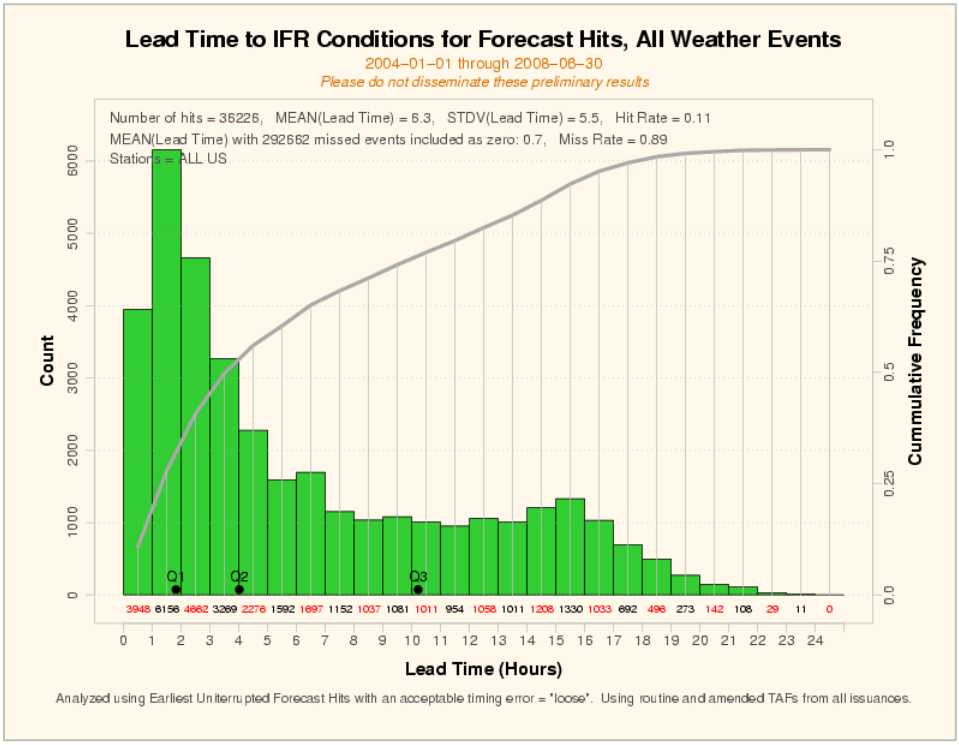


Figure 2: This histogram shows the distribution of lead time for forecasting the onset of IFR conditions. The plot titles indicate that this analysis is for all U.S. stations (~680) for the time period 01 JAN 2004 through 30 JUN 2008. Forecast hits are tallied in each bin. The x-axis represents lead time (forecast length) ranging from 0 to 24 hours. For this particular analysis, hits were computed from the context of an Earliest Uninterrupted Forecast Hit (EUFH), using "loose" matching criteria for the onset of forecast and observed events (see Fig. 1). All TAF types were included (ROU and AMD), and the results have been tallied for TAFs that were issued every hour throughout the day, not just the routine issuance hours of 00, 06, 12, 18Z, which is an option in the web tool.

By analyzing this figure, one can see that 6,156 TAFs offered a 1-2 hour lead time for the onset of IFR conditions. If you consider all of the events, you will find that the mean lead time is 6.3 hours., and the median leadtime (given by Q2 on the x-axis) is 4 hours. The 1st and 3rd quartiles of the distribution are indicated by Q1 and Q3, respectively.

If you were to include all 292,662 missed IFR events as contributing a zero-hour lead time, and then re-compute the mean lead time with all of these zeros included, you would find that the mean lead time drops from 6.3 hours down to 0.7 hours. For this analysis, the missed events are computed from the context of an Earliest Uninterrupted Forecast Hit (EUFH). If you re-computed this entire diagram from the perspective of an Earliest Forecast Hit (EFH), the mean lead time would greatly increase.

(2) METAR Climatology Histograms.

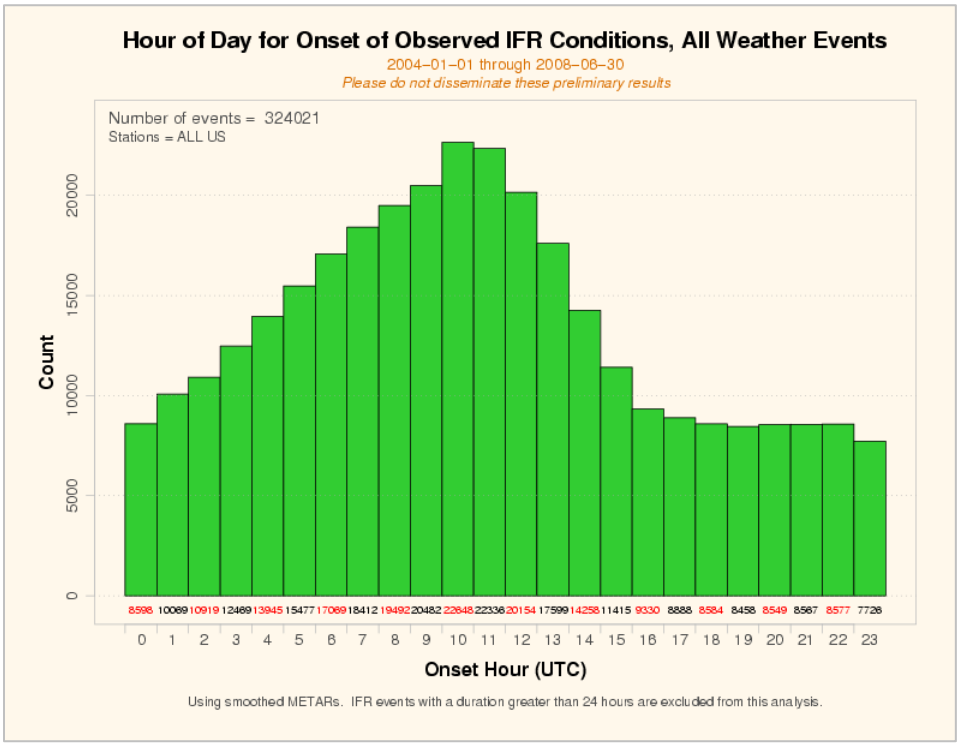


Figure 3: This histogram shows the distribution of observed IFR onset hour in units of UTC. The plot titles indicate that this analysis is for all U.S. stations (~680) covering the time period 01 JAN 2004 through 30 JUN 2008. As one can see, IFR events are observed to occur most frequently across the United States from about hours 4 to 14 UTC (late evening to early morning hours), with a noticeable decrease in the onset hour of observed IFR events from hours 15 through 3 UTC (throughout the daytime). The total number of observed events for these selected stations, and throughout this time period, is 324,021. There were 22,648 events observed during hour 10 UTC, 22,336 during hour 11, and only 7,726 during hour 23. In the web tool, this same analysis can be stratified by weather type. We use all available METAR data, including SPECIs.

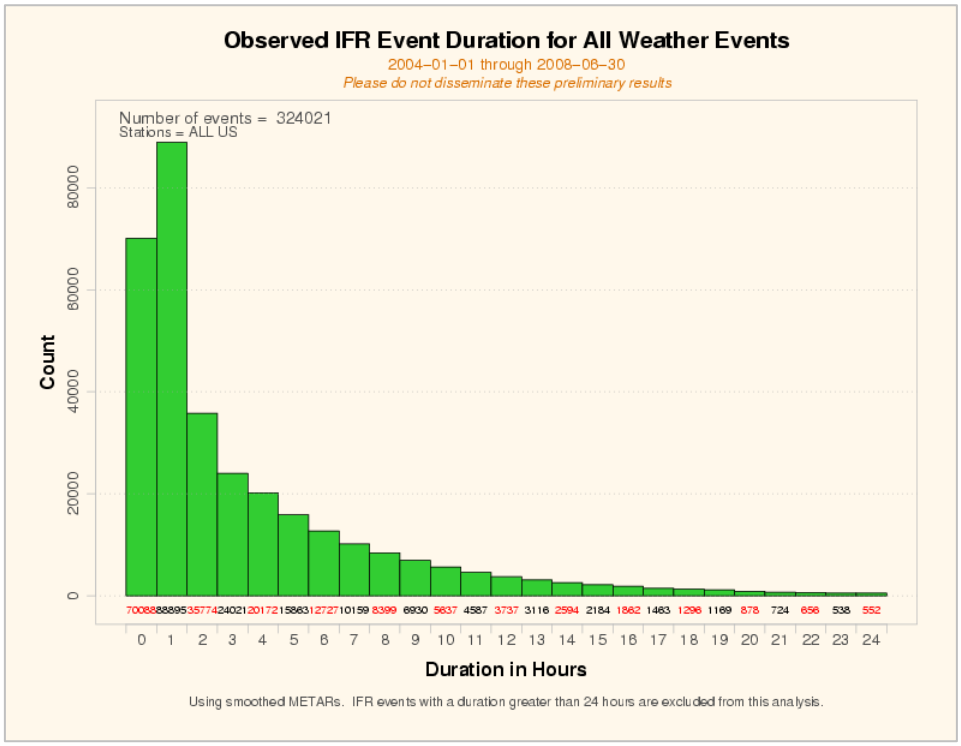


Figure 4: This histogram shows the distribution of *observed* IFR event length in units of hours. The plot titles indicate that the analysis is for all U.S. stations (~680) covering the time period 01 JAN 2004 through 30 JUN 2008, and that very short-lived events have been "smoothed over". Of the 324,021 events that persisted less than 24 hours, the vast majority of observed events (88,895) lasted between 1 and 2 hours. Throughout the day, the full record of observed IFR events shows a number of short-lived events that are broken by short periods of favorable weather conditions, followed by a continuation of IFR conditions. Figures 5, 6, and 7 represent the total number of *forecast* IFR events during this same time period, and for these same stations.

(3) TAF Climatology Histograms.

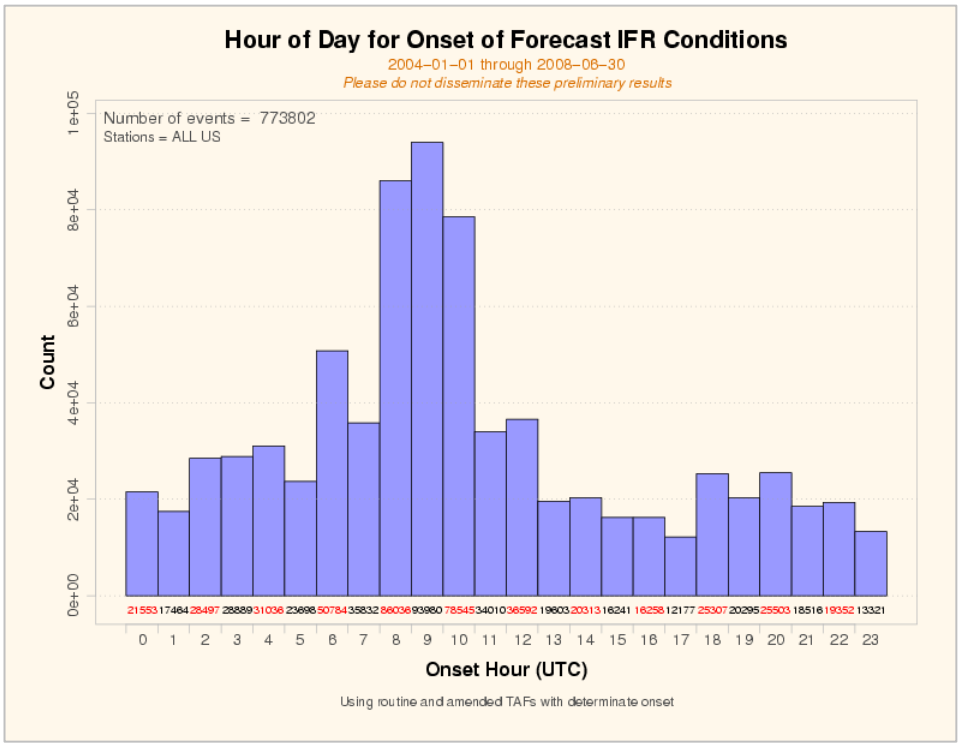


Figure 5: This histogram shows the distribution of *forecast* IFR event onset hour in units of UTC. The plot titles indicate that this analysis is for all U.S. stations (~680) covering the time period 01 JAN 2004 through 30 JUN 2008. Only TAFs with determinate IFR event onset were included (some forecasts indicate IFR conditions from the very beginning of the forecast period, so it is not possible to determine the precise time the VFR/IFR transition was forecast to begin). Of the 773,802 IFR events that were forecast to occur, most were expected to begin between the hours of 8 and 10 UTC.

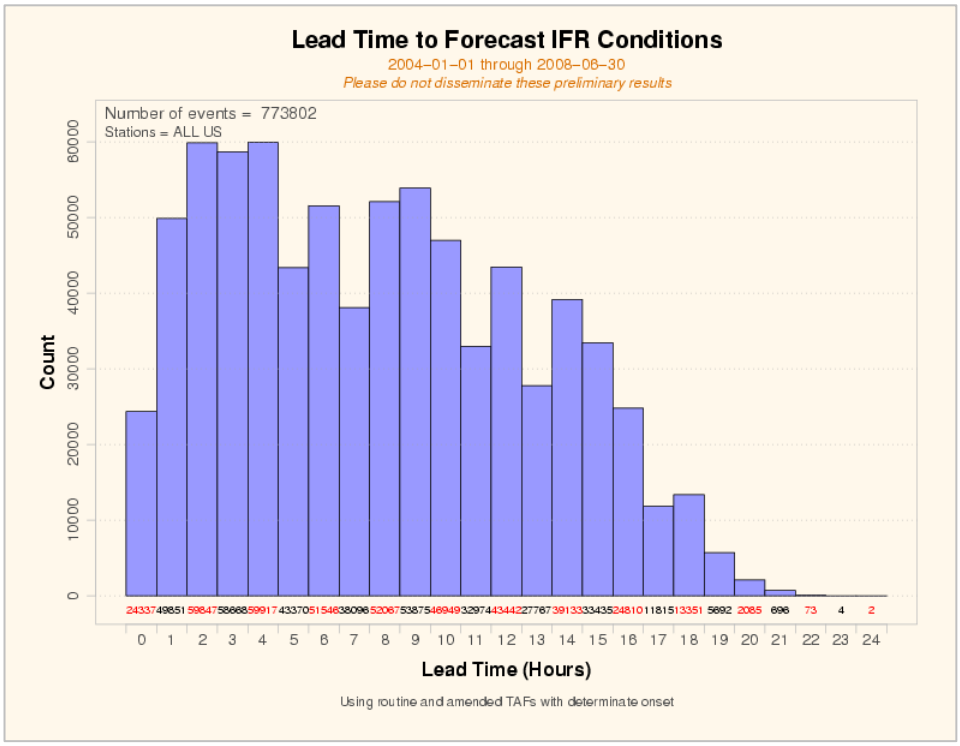


Figure 6: This histogram shows the distribution of lead time to the onset of *forecast* IFR conditions in units of hours. The plot titles indicate that this analysis is for all U.S. stations (~680) covering the time period 01 JAN 2004 through 30 JUN 2008. Only TAFs with determinate IFR event onset were included (some forecasts indicate IFR conditions from the very beginning of the forecast period, so it is not possible to determine the precise time the VFR/IFR transition was forecast to begin). Of the 773,802 TAFs that were forecast to occur 59,917 had a lead time of 4 hours from the issuance of the TAF to the predicted beginning of an IFR event. This analysis does not reflect "hits" on observed events, but the lead time from the issuance of a TAF to the beginning of *forecast* IFR events.

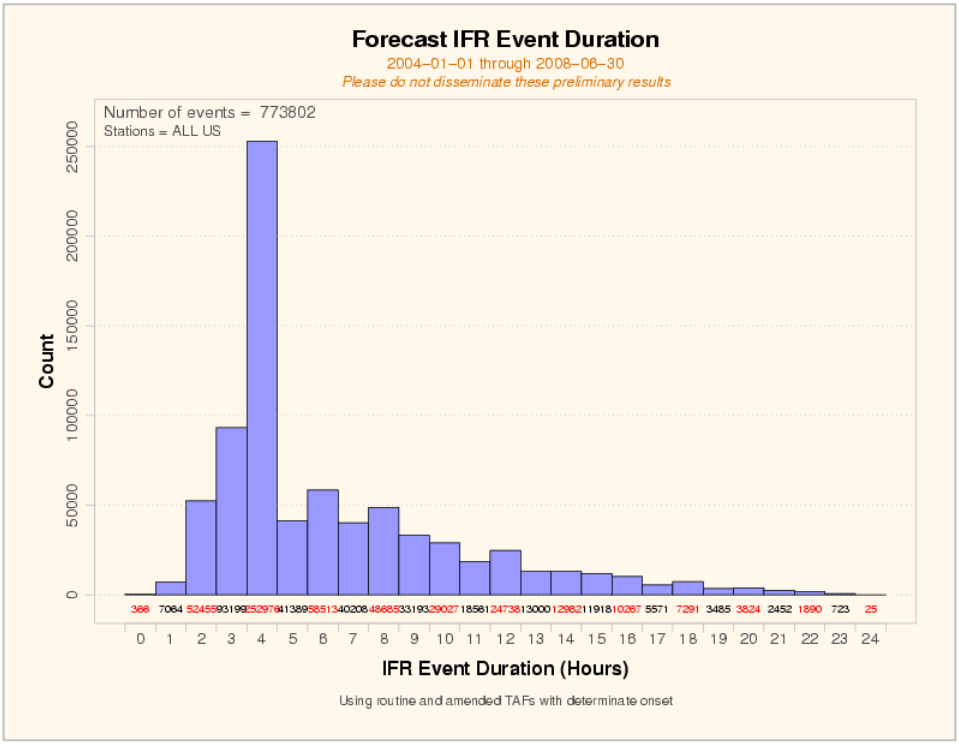


Figure 7: This histogram shows the distribution of *forecast* IFR event duration in units of hours. The plot titles indicate that this analysis is for all U.S. stations (~680) covering the time period 01 JAN 2004 through 30 JUN 2008. Only TAFs with determinate IFR event onset were included (some forecasts indicate IFR conditions from the very beginning of the forecast period, so it is not possible to determine the precise time the VFR/IFR transition was forecast to begin). Of the 773,802 TAFs that were included in this analysis, there were 252,976 with a predicted duration of 4 hours for IFR conditions.

<u>Box Plots</u>: (4) Lead Time to IFR Conditions by Weather Type and Issuance Hour.

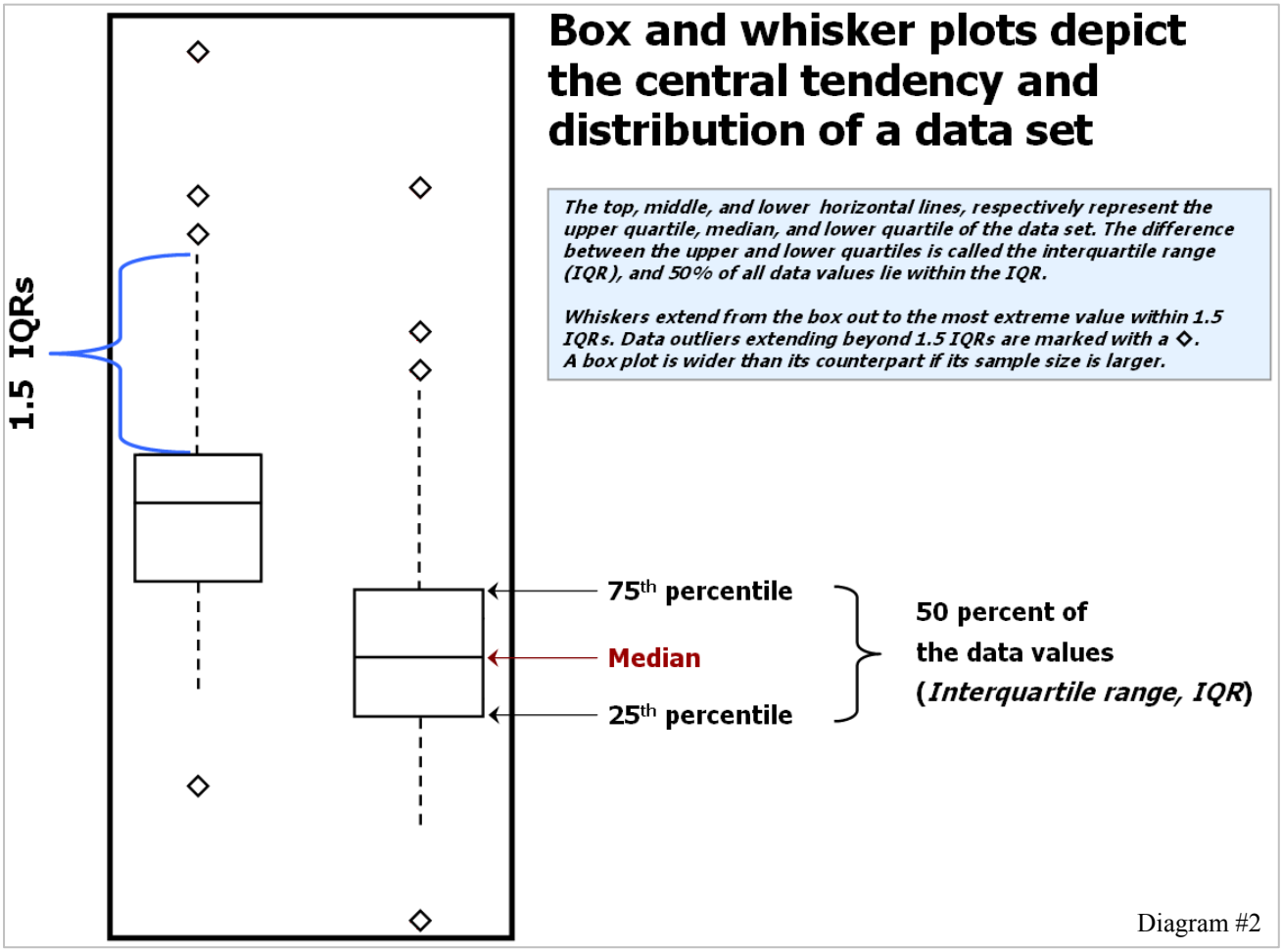


Diagram #2

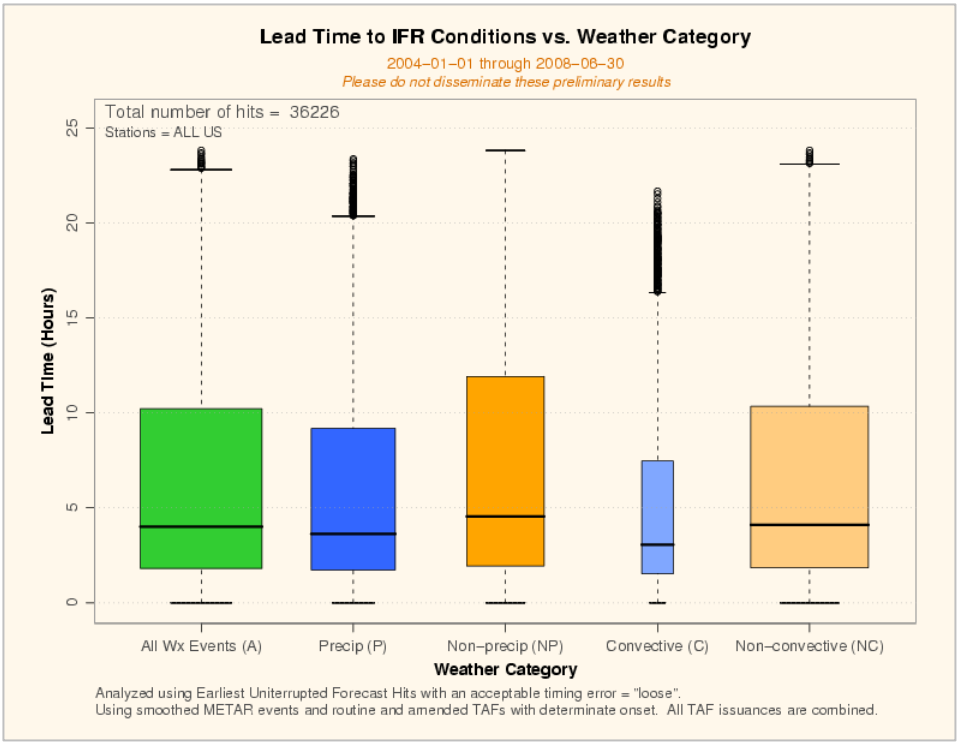


Figure 8: This boxplot shows the distribution of forecast IFR event lead time in units of hours (y-axis). Color represents different weather types. The dark horizontal lines show the position of median values. The width of each box provides an indication of the number of events included in each analysis. The plot titles indicate that this analysis is for all U.S. stations (~680) covering the time period 01 JAN 2004 through 30 JUN 2008. Only TAFs with determinate IFR event onset were included. Of the 36,226 TAFs that recorded "hits" over this time period (for all weather cases), the median lead time for all weather conditions was approximately 4 hours. For these results, all TAF issuance hours are included together. Not all METARs report present weather so, for example, the number of PRECIP + NON-PRECIP events does not usually equal the total number of events. Convection is recorded whenever thunderstorms or funnel clouds are reported.

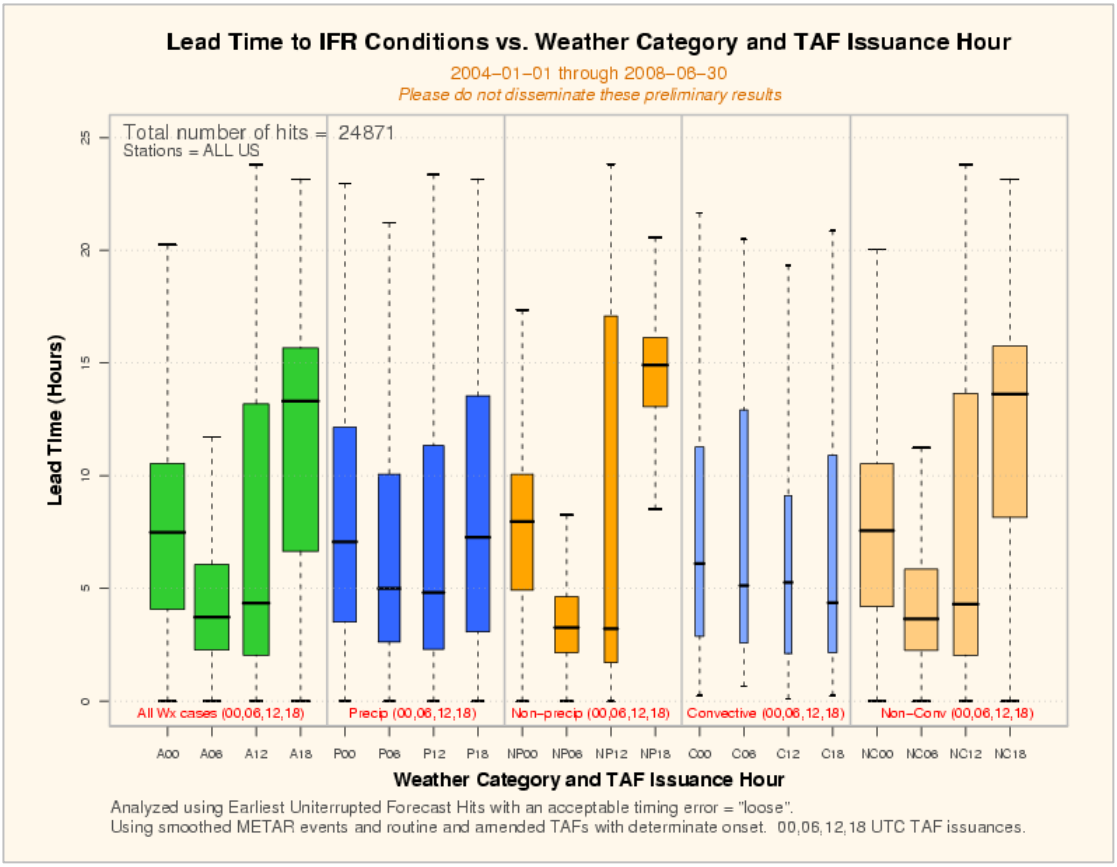


Figure 9: This box plot shows the distribution of forecast IFR event lead time in units of hours (y-axis). Color represents different weather types. Different TAF issuance hours are indicated along the x-axis. The dark horizontal lines show the position of median values. The width of each box provides an indication of the number of events included in each analysis. The plot titles indicate that this analysis is for all U.S. stations (~680) covering the time period 01 JAN 2004 through 30 JUN 2008. Only TAFs with determinate IFR event onset were included. This plot shows how the distribution of forecast lead time varies by weather type and issuance hour. Not all METARs report present weather so, for example, the number of PRECIP + NON-PRECIP events does not usually equal the total number of events. Convection is recorded whenever thunderstorms or funnel clouds are reported.

<u>Bar Plots</u>: (5) Simple Counts.

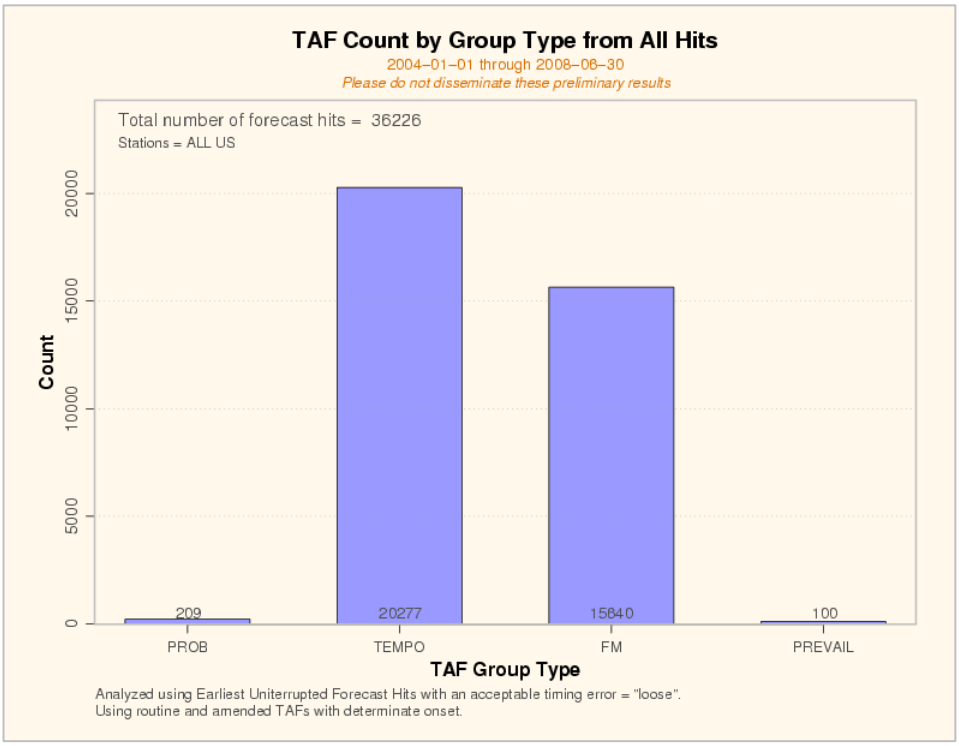


Figure 10: This bar plot shows the TAF count by group type for all forecast hits. The plot titles indicate that this analysis is for all U.S. stations (~680) covering the time period 01 JAN 2004 through 30 JUN 2008. Only TAFs that correctly forecast an observed event are included in this analysis, also only those TAFs with determinate IFR event onset (some forecasts indicate IFR conditions from the very beginning of the forecast period, so it is not possible to determine the precise time the VFR/IFR transition was forecast to begin). For this particular analysis, hits were computed from the context of an Earliest Uninterrupted Forecast Hit (EUFH), using "loose" matching criteria for the onset of forecast and observed events. Prevailing groups contain determinate onsets only when the TAF issuance time is the same as the onset time for observed IFR conditions.

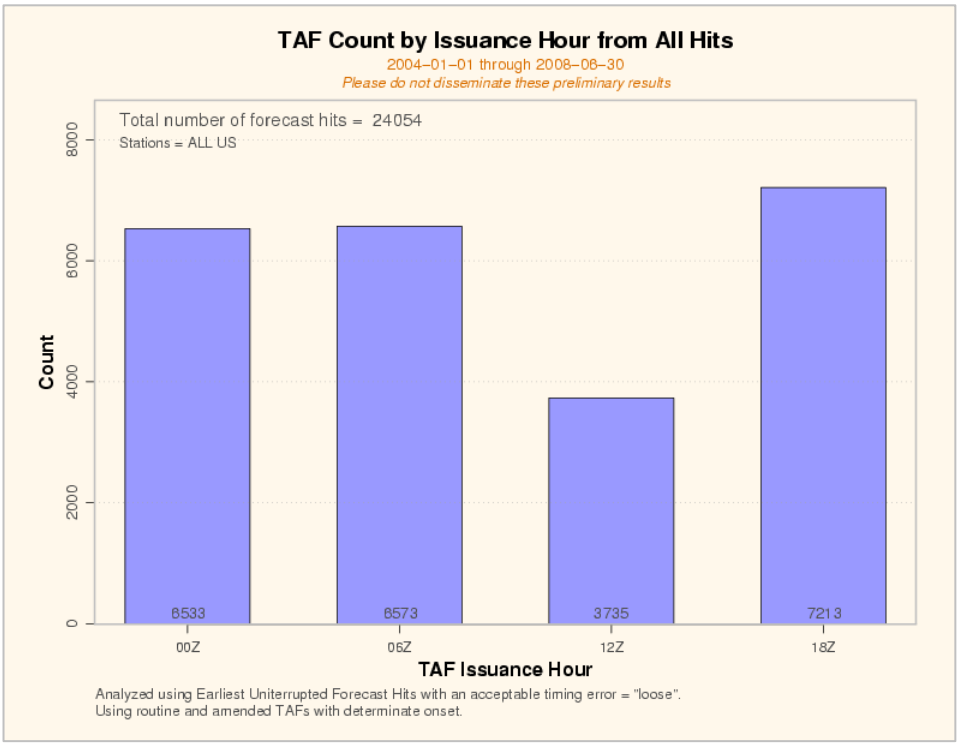


Figure 11: This bar plot shows the TAF count for all hits by issuance hour for routine issuance times 00, 06 12, 18Z. The plot titles indicate that this analysis is for all U.S. stations (~680) covering the time period 01 JAN 2004 through 30 JUN 2008. Only TAFs that correctly forecast an observed event are included in this analysis, also only those TAFs with determinate IFR event onset (some forecasts indicate IFR conditions from the very beginning of the forecast period, so it is not possible to determine the precise time the VFR/IFR transition was forecast to begin). For this particular analysis, hits were computed from the context of an Earliest Uninterrupted Forecast Hit (EUFH), using "loose" matching criteria for the onset of forecast and observed events.

VFR ←→ IFR Transition Line Plots: (6) Analysis of Forecast and Observed IFR Conditions.

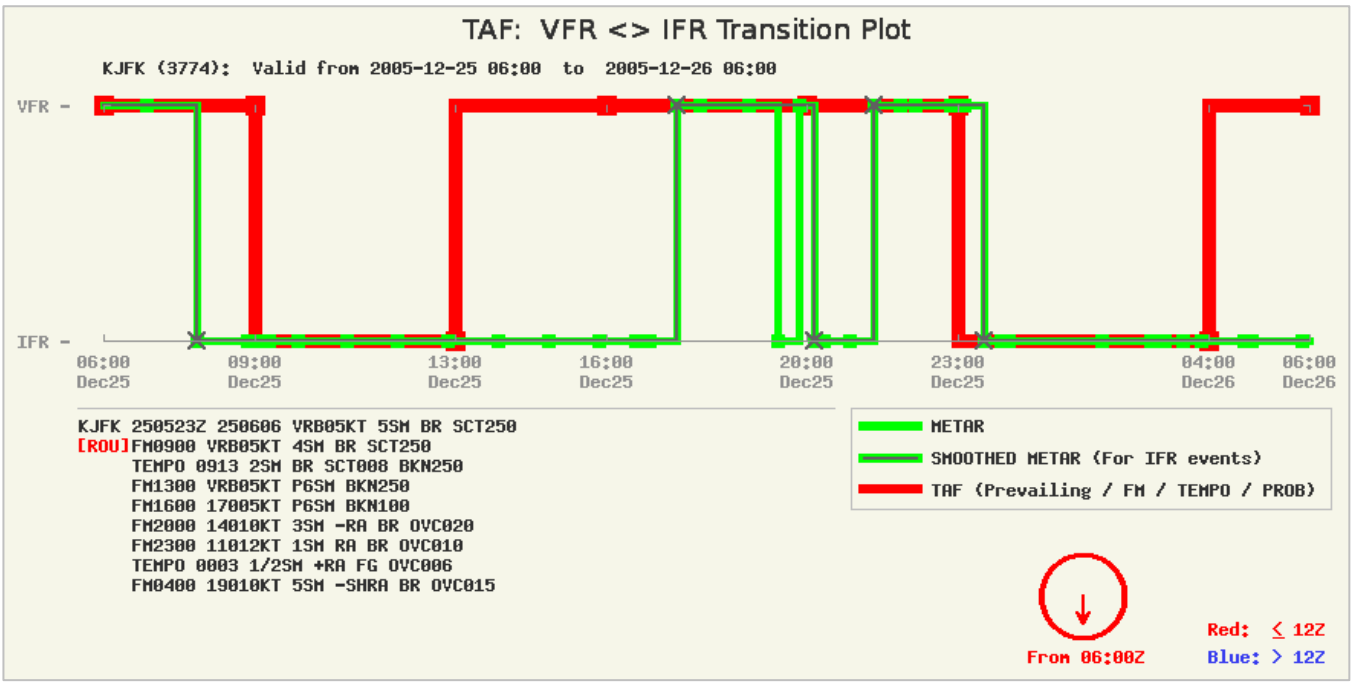


Figure 12: This sample VFR ←→ IFR transition plot from KJFK shows the forecast (red) and observed (green) transitions from VFR to IFR, and back. The full text of the TAF is printed at the bottom left corner of the plot. This particular TAF is a routine TAF issued at 0523Z on 25 DEC 2005. VFR is given a value of 1 along the y-axis, and IFR a value of 0. Valid time in units of UTC is along the x-axis. Each METAR report is indicated by a thick, green dot. The "smoothed" METAR transitions are shown by the solid black line, while the "raw" METAR transitions are shown by the solid green line. The first IFR event was forecast to occur at 0900, when it actually occurred at about 0800. It was forecast to end at 1300Z, but did not actually end until about 1730Z. For this TAF, the forecaster would be credited with a 2.5 hour lead time for the first observed event at 08Z, and an 18.5 hour lead time for the IFR event that occurred near 00Z.