TAFVER

version 0.3
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A collection of programs for TAF verification in AWIPS

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CONTENTS

OVERVIEW

TAFVER is a collection of programs for verifying TAF forecasts in the AWIPS environment. There are two main groups of programs: (1) decoder programs that maintain databases of decoded TAFs, observations and guidance products and (2) statistics programs that use the databases to calculate various statistics. The decoder programs are intended to be run as soon as each TAF, observation or guidance product arrives in the AWIPS system. Database triggers are used to run these programs automatically when each of these products is stored in the text database. The statistics programs are intended to be run infrequently on an "as-needed" basis. At the current time, only two statistics programs are available (hpverify and wrtafver) which do not have GUIs or sophisticated output options. These programs are intended to be run from the UNIX command line, and the output redirected to a file or a printer.

The statistics program hpverify, was written to mimic the output from the PC program PCVERIFY. As with any statistics, some of the output can easily be misinterpreted and misused, however no attempt has been made to deviate from the statistics that PCVERIFY currently produces. More detail on the statistics can be found in the **Statistics Programs** section below.

The statistics program wrtafver was written to provide statistics requested by Western Region Meteorological Services Division. More detail on the statistics can be found in the **Statistics Programs** section below.

Future versions of the programs will likely provide a GUI for the statistics programs, as well as more and different statistics. Database maintenance programs are also likely to be added. New decoder programs will likely be needed as new guidance products become available, such as the upcoming upgrade to AVN MOS. In addition, new programs may take advantage of some data that is currently being decoded, but not yet used in the statistics programs.

Changes for Version 0.3

The hpverify statistics program was modified to fix an error in the way that the prevailing ceiling and visibility was calculated.

The tafdecode.pl program was modified to put X characters in the weather field when no forecast is decodable, and spaces when no weather is forecast. This solves numerous problems with part-time stations. Also, the program was modified to fix a problem decoding amended forecasts for previous cycles that were made in the last hour before a new forecasts is typically issued.

The wrtafver statistics program was added to the suite of programs.

INSTALLATION

If updating a previous installation, perform only steps 5,6,7,8 and 9. If adding a new station to verifiy, perform only steps 5,6,12 (specify only the new stations),13,14,15,16,17,18.

CREATING A NEW DIRECTORY FOR THE TAFVER PROGRAMS

1. telnet into ds1 as root
2. cd /home
3. mkdir tafver
4. chown fxa:fxalpha tafver

GETTING THE TAFVER.TAR FILE FROM WR

5. telnet into ds1 as fxa
6. cd /home/tafver

7a. FOR WR WFOs: ftp into WR AWIPS development server and retrieve files (this is inside of AWIPS WAN.)
- ftp ????? (get IP address, login and password from WR-SSD if you don't know them)
- bin
- get tafver.tar
- bye

7b. FOR ALL OTHERS: ftp into WR anonymous ftp server and retrieve files
- ftp ftp.wrh.noaa.gov (This is outside of AWIPS WAN, so you may need to ftp files to your ldad server, then into AWIPS.)
- cd pub
- cd awips
- bin
- get tafver.tar
- bye

UNPACKING PROGRAMS OUT OF THE TAR FILE

8. tar -xvf tafver.tar

PRINTING OUT DETAILED DOCUMENTATION (this file)

9. lp -dlp1 tafver.ps

CREATING NEW DIRECTORIES FOR THE DATABASES AND LOGFILES

10. mkdir /data/fxa/verification/tafver
11. mkdir /data/logs/fxa/tafver

CREATING DATABASES FOR EACH TAF SITE

12. ./install_tafver
    answer the questions concerning sites you want to add, etc.

ADDING TRIGGERS TO RUN DECODER PROGRAMS AUTOMATICALLY

13. cat /data/fxa/siteConfig/textApps/siteTrigger.template triggers.add > /data/fxa/siteConfig/textApps/siteTrigger.new
14. cd /data/fxa/siteConfig/textApps
15. cp siteTrigger.template siteTrigger.template.save
16. mv siteTrigger.new siteTrigger.template
17. cd /awips/fxa/data/localization/scripts
18. ./mainScript.csh -trigger

DECODER PROGRAMS

These programs are normally run automatically by text database triggers to decode the various METAR observations, guidance products, and TAFs. These programs each decode the product and write the decoded information to the appropriate netCDF datafiles in /data/fxa/verification/tafver. The netCDF format of these files is described in the **Database Format** section.

Each program executes in virtually the same way, with error messages being written to files in /data/logs/fxa/tafver. The command line arguments for each of the programs are listed below.

METAR Decoder:

mtrdecode.pl key [vers]

key - AFOS keyname of METAR to decode (i.e., GTFMTRMSO)
vers - optional version (0 for latest version, 1 for next oldest version, 2 for next oldest, etc.) Defaults to 0.

Error messages are written to /data/logs/fxa/tafver/mtrdecode.log

TAF Decoder:

tafdecode.pl key [vers]

key - AFOS keyname of TAF to decode (i.e., GTFTAFMSO)
vers - optional version (0 for latest version, 1 for next oldest version, 2 for next oldest, etc.) Defaults to 0.

Error messages are written to /data/logs/fxa/tafver/tafdecode.log

NGM MOS Bulletin (FWC) Decoder:

fwcdecode.pl key [vers]

key - AFOS keyname of FWC product to decode (i.e., GTFFWCMSO)
vers - optional version (0 for latest version, 1 for next oldest version, 2 for next oldest, etc.) Defaults to 0.

Error messages are written to /data/logs/fxa/tafver/fwcdecode.log

LAMP Bulletin (FLP) Decoder:

flpdecode.pl key [vers]

key - AFOS keyname of FLP product to decode (i.e., GTFFLPMSO)
vers - optional version (0 for latest version, 1 for next oldest version, 2 for next oldest, etc.) Defaults to 0.

Error messages are written to /data/logs/fxa/tafver/flpdecode.log

STATISTICS PROGRAMS

The statistics programs hpverify and wrtafver (in /home/tafver) can be run at any workstation at any time by any user. Input is via command line arguments and output is to STDOUT. Future versions of the programs will likely implement a graphical user interface (GUI) as well as other statistics calculations. The output from the hpverify program is only intended to duplicate the PCVERIFY output. The output from the wrtafver program is only intended to provide the statistics requested by Western Region Meteorological Services Division. Details of the calculations are listed below.

COMMAND LINE ARGUMENTS

The command line arguments for both hpverify and wrtafver programs are identical.

hpverify *or* **wrtafve**r [station] [startdate] [enddate]

station - list of stations to create statistics for. Default is to use all installed verification stations

startdate - start date/time of statistics in YYYYMMDDHH format. If only YYYY are specified, MMDDHH default to the first day and hour of the year. If only YYYYMM are specified, DDHH default to the first day and hour of the month, etc. If not specified, the startdate defaults to the start of the current month, except during the first 10 days of the month, when it defaults to the start of the previous month.

enddate - end date/time of statistics in YYYYMMDDHH format. If only YYYY are specified, MMDDHH default to the last day and hour of the year. If only YYYYMM are specified, DDHH default to the last day and hour of the month, etc. If not specified, the enddate defaults to the end of the current month, except during the first 10 days of the month, when it defaults to the end of the previous month.

COMMAND LINE EXAMPLES (run from directory /home/tafver)

./hpverify

calculates hpverify statistics for all stations for all TAFs issued during the current month. If this command is run during the first 10 days of a month, the statistics are for the previous month.

./wrtafver mso fca

calculates wrtafver statistics for stations MSO and FCA, for all TAFs issued during the current month. If this command is run during the first 10 days of a month, the statistics are for the previous month.

./hpverify mso fca 199909 199909

calculates hpverify statistics for two stations (MSO and FCA) for TAFs issued during the month of September 1999.

./hpverify 1999091000 1999101023

calculates hpverifiy statistics for all stations for TAFs issued between 00Z September 10th 1999 and 23Z October 10th 1999.

./wrtafver mso 19991001 19991031 | /usr/bin/lp -dlp1
calculates wrtafver statistics for station MSO for TAFs issued during October 1999. Output is redirected to the AWIPS text printer.

./wrtafver mso >msostat.out
calculates wrtafver statistics for station MSO for all TAFs issued during the current month. If this command is run during the first 10 days of a month, the statistics are for the previous month. The output is redirected to the file msostat.out, which could be transfered through ls1 to other computers, or attached to e-mails, etc.

HPVERIFY

STATISTICS CALCULATION DETAILS

MOS COMPARISON STATISTICS:

The FORECASTS ISSUES, BUSTS, TOTAL CIG & VIS CATEGORY ERROR, CEILING ERRORS and VISIBILITY ERRORS groups are calculated using only the prevailing forecast conditions at forecast times that match a MOS forecast time (i.e., only 8 times per TAF forecast at 3, 6, 9, 12, 15, 18, 21 and 24 hours). The forecast prevailing ceiling and visibility values are converted to MOS categories (see **Database Format** section) for the comparisons. MOS bulletins from the 12Z model run are used for comparison with 18Z and 00Z TAF issuances, and MOS bulletins from the 00Z model run are used for comparison with 06Z and 12Z TAFs.

FORECASTS ISSUED

For each TAF the total ceiling and visibility category error is compared to the total for the corresponding MOS forecast. If the total category error for the TAF is less than MOS for the same period, then the forecast is counted as better than MOS, and if the total category error is higher than MOS, then the forecasts is counted as worse than MOS.

BUSTS

Each ceiling or visibility forecast that is in error by more than 1 MOS category is counted as a BUST. Note that since there are 8 possible forecast times and two variables (ceiling and visibility) this means that each TAF or MOS forecast can have 16 possible BUSTS.

TOTAL (AND MEAN) CIG & VIS CATEGORY ERROR

All the ceiling and visibility category errors are added together, yielding a total category error, and divided by the number of forecasts for an average category error. For each forecast where the forecast category and MOS category differ, a percentage improvement is calculated (the forecast category difference divided by the observed category). This percentage improvement will be higher for more critical forecasts, because in these cases the observed category is low and thus the division by a smaller number makes the percent improvement larger. The percent improvement values are then added together for all cases where the TAF and MOS forecast differ, and the average percent improvement is calculated (along with the standard deviation).

CEILING ERRORS and VISIBILITY ERRORS

When the ceiling and visibility forecast category differ from the observed category, they are counted as too optimistic if the forecast category is too high, and too pessimistic if the category is too low.

FORECASTER STATISTICS:

The IFR, THUNDERSTORMS, TEMPO and PROB groups do NOT depend on any MOS forecasts, and are dependent on TAF forecasts alone. Because of this, they can be calculated for each hour of the TAF forecast (24 possible forecasts per TAF). In each case, all METARs and SPECIs are used to determine the lowest ceiling and visibility for each hour. For the IFR and TSTM forecasts, the condition is considered “forecast” if it appears either in the prevailing or TEMPO conditions.

IFR and THUNDERSTORMS

Normal POD, FAR and CSI are calculated for these conditions. Note, for example, that 4 hours of IFR observations count as 4 events. If the TAF correctly had IFR for 3 of these hours, then there were 3 hits and 1 miss. If the TAF forecast 4 hours of IFR, but only 2 of them overlapped with the 4 hours that actually occurred, then there will be 2 hits and 2 misses.

TEMPO and PROB

Each TEMPO or PROB forecasts is compared to the prevailing forecast, and hits are counted if the observed conditions are at least halfway the distance from the prevailing conditions. For example, if the prevailing ceiling is 8000 feet, and the TEMPO group is 4000 feet, then if the lowest ceiling for that hour hits 6000 feet or less, it counts as a hit. Conversely, if the prevailing ceiling is forecast 4000 feet with a TEMPO group of 8000 feet, then if the highest ceiling for that hour hits 6000 feet or higher, it counts as a hit. Weather and TSTM are counted as a hit if the weather is observed in ANY METAR or SPECI in that hour.

OUTPUT EXAMPLE

```
TAF Verification for MSO
Period: 10/01/1999 00:00 UTC through 10/31/1999 23:00 UTC

FORECASTS ISSUED: 53   (18 were for periods of No Sig Wx)
   forecasts better than MOS:     17
   forecasts worse than MOS:      19 #

BUSTS >= 2 MOS categories...(808 fcsts)
   Fcstr:  54 (7%)
   MOS:    41 (5%)

TOTAL (and MEAN) CIG & VIS CATEGORY ERROR...(808 fcsts)
   Fcstr:    257 (0.3 cat)
   MOS:      210 (0.3 cat)
 avg ipvmt ovr MOS:   -3.2% #   (n = 153, std dev =  25.3%)

IFR (for fcstr)...
   hits/events:         1/8     = Prob of Detection:      0.12 #
   misses/forecasts:   12/13    = False Alarm Ratio:      0.92 #
   hits/(events+misses)         = Critical Success Index: 0.05 #

THUNDERSTORMS (for fcstr)...
   hits/events:         0/0     = Prob of Detection:      1.00 +
   misses/forecasts:    0/0     = False Alarm Ratio:      0.00 +
   hits/(events+misses)         = Critical Success Index: 1.00 +
```

```
TEMPO (for fcstr)...
   fcst item   obsvd/forecast = Reliability (.50 to .70 = ideal)
      all         51/271           0.19 #
      cig         39/190           0.21 #
      vis          4/29            0.14 #
     tstm          0/0             1.00 #
   wx(not T)       8/52            0.15 #
     gust          0/0             1.00 #

PROB (for fcstr)...
   fcst item   obsvd/forecast = Reliability (.30 to .50 = ideal)
      all         27/127           0.21
      cig          6/43            0.14
      vis          0/0             1.00 #
     tstm          0/0             1.00 #
   wx(not T)      20/75            0.27
     gust          1/9             0.11

CEILING ERRORS...        Fcstr            MOS
   too optimistic...    55 ( 37%)       109 ( 81%)
   too pessimistic...   92 ( 62%)        25 ( 18%)

VISIBILITY ERRORS...     Fcstr            MOS
   too optimistic...     5 ( 38%)         5 (100%)
   too pessimistic...    8 ( 61%)         0 (  0%)

Notes...
1. Only scheduled forecasts are verified - not amendments.
2. IFR or Thunderstorm is forecast if in prevailing or TEMPO group.
3. IFR, Tstm, TEMPO and PROB are verified agains all METARs including SPECIs.
4. Symbols '+', '#', '*' denote good, not-so-good, significant values.
```

WRTAFVER

STATISTICS CALCULATION DETAILS

These statistics are very similar to those in the hpverify program except that they are calculated for each 3 hour range of forecast times (1-3 hours, 4-6 hours, etc.) as well as for the entire forecast period, and ceiling categories are limited to only 6 values (the MOS category 7 of ceiling >12000 is combined with category 6).

MOS COMPARISON STATISTICS:

The CEILING CATEGORY ERRORS and VISIBILITY CATEGORY ERRORS are calculated using only the prevailing forecast conditions at forecast times that match a MOS forecast time (i.e., only 8 times per TAF forecast at 3, 6, 9, 12, 15, 18, 21 and 24 hours), The forecast prevailing ceiling and visibility values are converted to MOS categories (see Database Format section) for the comparisons, with the exception that ceiling category 7 is combined with ceiling category 6. MOS bulletins from the 12Z model run are used for comparison with 18Z and 00Z TAF issuances, and MOS bulletins from the 00Z model run are used for comparison with 06Z and 12Z TAFs.

MATCHING FCST

The total number of forecasts with matching MOS forecasts and observations, used in subsequent statistics.

F BUSTS HIGH

The total number of TAF forecasts 2 or more categories too high.

F HIGH

The total number of TAF forecasts 1 or more categories too high. Note this includes all forecasts also counted as ‘BUSTS HIGH’ in the previous line.

F HIT
The total number of TAF forecasts in the right category.

F LOW
The total number of TAF forecasts 1 or more categories too low. Note this includes all forecasts also counted as ‘BUSTS LOW’ in the next line.

F BUSTS LOW
The total number of TAF forecasts 2 or more categories too low.

% FCST BUSTS
The percent of time TAF forecasts were off by 2 or more categories. This is simply the ‘F BUSTS HIGH’ plus the ‘F BUSTS LOW’ divided by the number of ‘MATCHING FCST’.

M BUSTS HIGH
The total number of MOS forecasts 2 or more categories too high.

M HIGH
The total number of MOS forecasts 1 or more categories too high. Note this includes all forecasts also counted as ‘BUSTS HIGH’ in the previous line.

M HIT
The total number of MOS forecasts in the right category.

M LOW
The total number of MOS forecasts 1 or more categories too low. Note this includes all forecasts also counted as ‘BUSTS LOW’ in the next line.

M BUSTS LOW
The total number of MOS forecasts 2 or more categories too low.

% MOS BUSTS
The percent of time MOS forecasts were off by 2 or more categories. This is simply the ‘M BUSTS HIGH’ plus the ‘M BUSTS LOW’ divided by the number of ‘MATCHING FCST’.

F BETTER MOS
The total number of times the TAF forecast category was closer to the observed category than the MOS forecast category.

AVG % IMPROV
Average ‘percent improvement’ for the forecasts counted on the previous line that were better than MOS. The ‘percent improvement’ is calculated by taking the difference in the category errors between the MOS and the TAF forecasts, and dividing by the observed category. This gives more ‘credit’ for forecast improvements

when conditions are ‘poor’ than when conditions are ‘good’. For example, if the observed category is 1, and the TAF forecast category is 1 and the MOS forecast category is 2, then the improvement is ((2-1)-(1-1))/1, which is 1. On the other hand, if the observed category is 6, and the TAF forecast category is 6 and the MOS forecast category is 5, then the improvement is (6-5)-(6-6))/6, which is 0.17.

F EQUAL MOS

The total number of times the TAF forecast category was as close to the observed category as the MOS forcast category.

F WORSE MOS

The total number of times the TAF forecast category was further away from the observed category than the MOS forecast category.

AVG % DETRIM

Average ‘percent detriment’ for the forecasts counted on the previous line that were worse than MOS. The ‘percent detriment’ is calculated in the exact same was as the percent improvement described above.

MOS CHG

The total number of times that the TAF forecast category differs from the MOS forecast category. Note that this is always greater than, or equal to the sum of the “# F BETTER MOS’ and the ‘# F WORSE MOS’ values described above. Note that they do not have to be equal because a TAF forecast may be different from MOS, but have the same category error as MOS (i.e., when TAF forecast category is 2, MOS forecast category is 4 and the observed category is 3).

% MOS CHG

The percent of time that MOS forecast categories are changed by the TAF. This is simply the ‘# MOS CHG’ value divided by the ‘# MATCHING FCST’ value.

FORECASTER STATISTICS:

The MVFR, IFR, LIFR, THUNDERSTORMS, TEMPO and PROB statistics do NOT depend on any MOS forecasts, and are dependent on TAF forecasts alone. Because of this, they can be calculated for each hour of the TAF forecast (24 possible forecasts per TAF). In each case, all METARs and SPECIs are used to determine the lowest ceiling and visibility for each hour.

MVFR, IFR, LIFR and THUNDERSTORMS statistics

For each hour, the condition is considered “forecast” if it appears either in the prevailing or TEMPO conditions, and is considered ‘observed’ if it appears in any METAR or SPECI observation.

EVENTS

The number of hours with observed conditions

FCSTS

The number of hours with forecast conditions

HITS

The number of hours that conditions were forecast AND observed

MISSES

The number of hours that conditions were forecast and NOT observed

POD

Probability of detection. This is simply HITS divided by EVENTS. Should be 1 if all events are forecast.

FAR

False Alarm Rate. This is simply MISSES divided by FCSTS. Should be 0 if conditions are never forecast when they do not occur.

CSI

Critical Success Index. This is simply HITS divided by (EVENTS plus MISSES). Should be 1 if all events are forecast and conditions are never forecast when they do not occur.

TEMPO and PROB

Each TEMPO or PROB forecast is compared to the prevailing forecast, and Ceiling, Visibility and Wind Gust hits are counted if the observed conditions are at least halfway the distance from the prevailing conditions. For example, if the prevailing ceiling is 8000 feet, and the TEMPO group is 4000 feet, then if the lowest ceiling for that hour hits 6000 feet or less, it counts as a hit. Conversely, if the prevailing ceiling is forecast 4000 feet with a TEMPO group of 8000 feet, then if the highest ceiling for that hour hits 6000 feet or higher, it counts as a hit. Weather and Thunderstorm forecasts are counted as a hit if the weather is observed in ANY METAR or SPECI in that hour.

OUTPUT EXAMPLE

```
TAF Verification for BTM,FCA,MSO
Period: 11/01/1999 00:00 UTC through 12/15/1999 00:00 UTC

---------------------- CEILING CATEGORY ERRORS ----------------------
                  1-3   4-6   7-9 10-12 13-15 16-18 19-21 22-24 TOTAL
# MATCHING FCST   518   515   518   514   518   514   518   517  4132

# F BUSTS HIGH:    21    24    25    27    35    38    42    39   251
# F HIGH:         107    99   112   108   122   111   120   114   893
# F HIT:          350   331   336   314   320   314   320   306  2591
# F LOW:           61    85    70    92    76    89    78    97   648
# F BUSTS LOW:      6    11    10    11     9    10    11    16    84
% FCST BUSTS:    0.05  0.07  0.07  0.07  0.08  0.09  0.10  0.11  0.08

# M BUSTS HIGH:    32    30    36    32    37    34    39    38   278
# M HIGH:         107    99   100   101   108   110   115   120   860
# M HIT:          343   343   353   345   344   339   343   332  2742
# M LOW:           68    73    65    68    66    65    60    65   530
# M BUSTS LOW:     10     8     5     7     5     9     2     4    50
% MOS BUSTS:     0.08  0.07  0.08  0.08  0.08  0.08  0.08  0.08  0.08

# F BETTER MOS:    87    69    73    60    60    66    58    62   535
AVG % IMPROV:    0.74  0.65  0.79  0.58  0.57  0.30  0.25  0.21  0.53
# F EQUAL MOS:    363   379   362   370   374   360   376   362  2946
# F WORSE MOS:     68    67    83    84    84    88    84    93   651
```

AVG % DETRIM:	0.24	0.26	0.22	0.21	0.23	0.24	0.23	0.23	0.23
# MOS CHG:	158	139	158	150	151	162	152	166	1236
% MOS CHG:	0.31	0.27	0.31	0.29	0.29	0.32	0.29	0.32	0.30

--------------------- VISIBILITY CATEGORY ERRORS ---------------------

	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	TOTAL
# MATCHING FCST	518	515	518	514	518	514	518	517	4132
# F BUSTS HIGH:	16	19	17	18	17	19	23	20	149
# F HIGH:	37	40	44	47	45	49	48	49	359
# F HIT:	466	448	444	434	444	442	446	440	3564
# F LOW:	15	27	30	33	29	23	24	28	209
# F BUSTS LOW:	6	7	3	7	4	4	4	5	40
% FCST BUSTS:	0.05	0.07	0.07	0.07	0.08	0.09	0.10	0.11	0.08
# M BUSTS HIGH:	15	12	14	16	21	21	24	23	146
# M HIGH:	36	40	37	41	46	47	49	51	347
# M HIT:	444	429	439	424	431	427	449	443	3486
# M LOW:	38	46	42	49	41	40	20	23	299
# M BUSTS LOW:	23	23	21	18	17	14	10	9	135
% MOS BUSTS:	0.08	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08
# F BETTER MOS:	38	49	42	49	49	50	31	33	341
AVG % IMPROV:	0.55	0.33	0.40	0.40	0.55	0.34	0.46	0.34	0.42
# F EQUAL MOS:	466	444	448	436	441	438	460	452	3585
# F WORSE MOS:	14	22	28	29	28	26	27	32	206
AVG % DETRIM:	0.43	0.46	0.30	0.41	0.36	0.35	0.24	0.24	0.34
# MOS CHG:	54	71	70	80	79	76	58	66	554
% MOS CHG:	0.10	0.14	0.14	0.16	0.15	0.15	0.11	0.13	0.13

------------------------------ MVFR ------------------------------

	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	TOTAL
# MVFR EVENTS:	207	214	207	208	201	200	183	184	1604
# MVFR FCSTS:	434	465	349	292	251	245	225	218	2479
# MVFR HITS:	176	174	134	112	82	84	68	55	885
# MVFR MISSES:	258	291	215	180	169	161	157	163	1594
MVFR POD:	0.85	0.81	0.65	0.54	0.41	0.42	0.37	0.30	0.55
MVFR FAR:	0.59	0.63	0.62	0.62	0.67	0.66	0.70	0.75	0.64
MVFR CSI:	0.38	0.34	0.32	0.29	0.22	0.23	0.20	0.16	0.28

------------------------------ IFR ------------------------------

	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	TOTAL
# IFR EVENTS:	132	137	131	129	123	119	111	105	987
# IFR FCSTS:	144	123	122	105	92	81	53	47	987
# IFR HITS:	87	64	56	47	37	31	19	12	353
# IFR MISSES:	57	59	66	58	55	50	34	35	414
IFR POD:	0.66	0.47	0.43	0.36	0.30	0.26	0.17	0.11	0.36
IFR FAR:	0.40	0.48	0.54	0.55	0.60	0.62	0.64	0.74	0.54
IFR CSI:	0.46	0.33	0.28	0.25	0.21	0.18	0.13	0.09	0.25

------------------------------ LIFR ------------------------------

	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	TOTAL
# LIFR EVENTS:	75	82	74	71	68	66	52	49	537
# LIFR FCSTS:	73	53	42	33	35	23	10	6	275
# LIFR HITS:	42	37	30	18	21	12	1	0	161
# LIFR MISSES:	31	16	12	15	14	11	9	6	114
LIFR POD:	0.56	0.45	0.41	0.25	0.31	0.18	0.02	0.00	0.30
LIFR FAR:	0.42	0.30	0.29	0.45	0.40	0.48	0.90	1.00	0.41
LIFR CSI:	0.40	0.38	0.35	0.21	0.26	0.16	0.02	0.00	0.25

-------------------------- THUNDERSTORMS --------------------------

	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	TOTAL
# TS EVENTS:	0	0	0	0	0	0	0	0	0
# TS FCSTS:	0	0	0	0	0	0	0	0	0
# TS HITS:	0	0	0	0	0	0	0	0	0
# TS MISSES:	0	0	0	0	0	0	0	0	0
TS POD:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TS FAR:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TS CSI:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

-------------------- TEMPO (.50 to .70 = ideal) ---------------------

	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	TOTAL
ALL:	0.30	0.30	0.30	0.27	0.27	0.24	0.31	0.29	0.29
CEILING:	0.37	0.38	0.37	0.33	0.36	0.30	0.41	0.40	0.37

VISIBILITY:	0.22	0.19	0.21	0.22	0.16	0.17	0.22	0.17	0.20
THUNDERSTORM:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WEATHER:	0.29	0.28	0.28	0.23	0.27	0.24	0.28	0.21	0.27
WIND GUST:	0.25	0.20	0.19	0.00	0.00	0.00	0.00	0.00	0.16

--------------------- PROB (.30 to .50 = ideal) ---------------------

	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	TOTAL
ALL:	0.00	0.26	0.28	0.26	0.27	0.27	0.23	0.25	0.26
CEILING:	0.00	0.25	0.32	0.32	0.31	0.34	0.33	0.35	0.33
VISIBILITY:	0.00	0.24	0.19	0.12	0.18	0.13	0.08	0.15	0.14
THUNDERSTORM:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WEATHER:	0.00	0.27	0.29	0.26	0.25	0.27	0.22	0.22	0.25
WIND GUST:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DATABASE FORMAT

In order to make statistics programs run faster, the netCDF databases contain *decoded* rather than *raw* forecast, guidance and observation data. These databases contain only information that might reasonably be verified in TAF forecasts. For example, scattered clouds are not saved in either forecasts or observations. Also, some information is decoded and stored that is not currently used in the statistics programs. For example, LAMP forecasts are saved in anticipation of future verification programs using this data. Data for Amended TAFs are decoded and stored in the databases, but they are currently not used in any statistics. The observation database contains information from both METAR and SPECI observations .

For TAFs, values of prevailing, TEMPO and PROB conditions are stored for each hour. TAFs can be written with FM groups that do not start at an even hour (although this is rare). In those cases, the FM group is rounded to the nearest hour. BECMG groups are decoded with the conditions becoming the prevailing conditions on the ending hour of the BECMG time group.

For MOS forecasts of Ceiling and Visibility, only categories are available:

MOS Ceiling Categories	MOS Visibility Categories
1 = <200 ft	1 = <½ mile
2 = 200 - 400 ft	2 = ½ - 7/8 mile
3 = 500 - 900 ft	3 = 1 - 2 3/4 miles
4 = 1000 - 3000 ft	4 = 3 - 5 miles
5 = 3100 - 6500 ft	5 = >5 miles
6 = 6600 - 12000 ft	
7 = >12000 ft	

The netCDF databases are described below:

TAF databases (stored in files tafxxx.nc for each station, where xxx is the station identifier):

- For each TAF:
  - Reference Time (the valid time of the start of the TAF forecast, in seconds since 1970)
  - Issue Time (time the forecasts was actually issued, in seconds since 1970)
  - Forecast Type (0 for a scheduled issuance, 1 for an amendment)
  - Forecaster Number (not currently available)
  - For each hour (0 through 25) of the TAF forecast:
    - Valid Time (in seconds since 1970)
    - Prevailing Ceiling Type (0=none, 1=BKN, 2=OVC, 3=VV)
    - Prevailing Ceiling Height (-1 if none, otherwise in feet)
    - Prevailing Visibility (-1 if undecodable, otherwise in miles, P6 is stored as 7 miles)
    - Prevailing Weather (string of up to 10 characters, X if not forecast, spaces if none)
    - Prevailing Wind Direction (-1 for variable, -99 for missing, otherwise degrees)
    - Prevailing Wind Speed (-1 for missing, otherwise in knots)
    - Prevailing Wind Gust (-1 for missing, otherwise in knots)
    - TEMPO Ceiling Type (0=none, 1=BKN, 2=OVC, 3=VV)
    - TEMPO Ceiling Height (-1 if none, otherwise in feet)
    - TEMPO Visibility (-1 if undecodable, otherwise in miles, P6 is stored as 7 miles)
    - TEMPO Weather (string of up to 10 characters, X if not forecast, spaces if none)

TEMPO Wind Direction (-1 for variable, -99 for missing, otherwise degrees)
TEMPO Wind Speed (-1 for missing, otherwise in knots)
TEMPO Wind Gust (-1 for missing, otherwise in knots)
PROB Ceiling Type (0=none, 1=BKN, 2=OVC, 3=VV)
PROB Ceiling Height (-1 if none, otherwise in feet)
PROB Visibility (-1 if undecodable, otherwise in miles, P6 is stored as 7 miles)
PROB Weather (string of up to 10 characters, X if not forecast, spaces if none)
PROB Wind Direction (-1 for variable, -99 for missing, otherwise degrees)
PROB Wind Speed (-1 for missing, otherwise in knots)
PROB Wind Gust (-1 for missing, otherwise in knots)

NGM MOS (FWC) databases (stored in files fwcxxx.nc for each station, where xxx is the station identifier):

- For each FWC bulletin:
  - Reference Time (the time of the model run, in seconds since 1970)
  - For each forecast time (6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36):
    - Valid Time (in seconds since 1970)
    - Ceiling Type (0=none, 1=BKN, 2=OVC, 3=VV)
    - Ceiling Category (1-7, see above)
    - Visibility Category (1-5, see above)
    - Wind Direction (in degrees)
    - Wind Speed (in knots)

Observation (MTR) databases (stored in files mtrxxx.nc for each station, where xxx is the station identifier):

- For each MTR observation:
  - Valid Time (in seconds since 1970)
  - Observation Type (1=METAR, 3=SPECI)
  - Ceiling Type (0=none, 1=BKN, 2=OVC, 3=VV)
  - Ceiling Height (-1 if none, otherwise lowest ceiling in feet)
  - Visibility (-1 if missing, otherwise in miles)
  - Weather (string of up to 10 characters)
  - Wind Direction (-1 for variable, -99 for missing, otherwise in degrees)
  - Wind Speed (-1 if missing, otherwise in knots)
  - Wind Gust (-1 if missing, otherwise in knots)

LAMP (FLP) databases (stored in files flpxxx.nc for each station, where xxx is the station identifier):

- For each FLP bulletin:
  - Reference Time (time of model run, in seconds since 1970)
  - For each hour (1-20):
    - Valid Time (in seconds since 1970)
    - Ceiling Type (0=none, 1=BKN, 2=OVC, 3=VV)
    - Ceiling Height (-1 if none, otherwise lowest ceiling in feet)
    - Visibility Category (1-5, see above)
    - Wind Direction (-99 if missing, otherwise in degrees)
    - Wind Speed (-1 if missing, otherwise in knots)