Terminal Aerodrome Forecast (TAF) Verification in the MET Alliance

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The MET Alliance is a group of national aeronautical MET service providers from Austria, Belgium, Germany, Ireland, Switzerland and the Netherlands. Each Member has a unique knowledge of its own area of operations. Within the MET Alliance, this expertise is shared and resources are brought together.

Why are we interested in the quality of our TAFs?

- For Pilots: to know how sure they can be when using them
- For Airlines: to make the most efficient flight planning possible
- For Air Traffic Control: to optimize capacity management
- For Forecasters: to know where they are good and where they should improve

The MET Alliance Verification Project

was started in 2008. By cooperating, the credibility of internationally recognized methods, common performance indicators and a cost-efficient project conduction are ensured. The TAF verification method was originally developed in Austro Control. It was presented first on the Third International Workshop on Verification Methods, ECMWF, January 2007. The extension to other types of aviation forecasts is planned.

How are TAFs verified

TAF VIS: 4000 TEMPO 0107/0109 0700 BCFG

OBS: 8000 0400 3000 8000 (m) 2000 1800 6000 9999

VIS \ TIME	06-07	07-08	08-09	09-10
5000 - 9999				
3000 - <5000				
1500 - <3000				
0800 - <1500				
0600 - <0800				
0350 - <0600				
0150 - <0350				
0000 - <0150				

VIS \ TIME	06-07	07-08	08-09	09-10
5000 - 9999	■		■	■
3000 - <5000	■		■	
1500 - <3000	■	■	■	
0800 - <1500		■		
0600 - <0800		■		
0350 - <0600		■		
0150 - <0350				
0000 - <0150				

The highest FCST / OBS category AND lowest FCST / OBS category are verified for each hour.

For each hour, the "best" and "worst" forecast vs. observed conditions are compared. Timing errors are fully "punished".

The most important questions in TAF verification are:

- Have bad weather conditions been forecast,
- Have forecasts of bad conditions come true.

- VISIBILITY, CEILING and WIND SPEED are verified using operational threshold values.
- For PRESENT WEATHER, significant events like thunderstorms, snow and freezing precipitation are investigated.

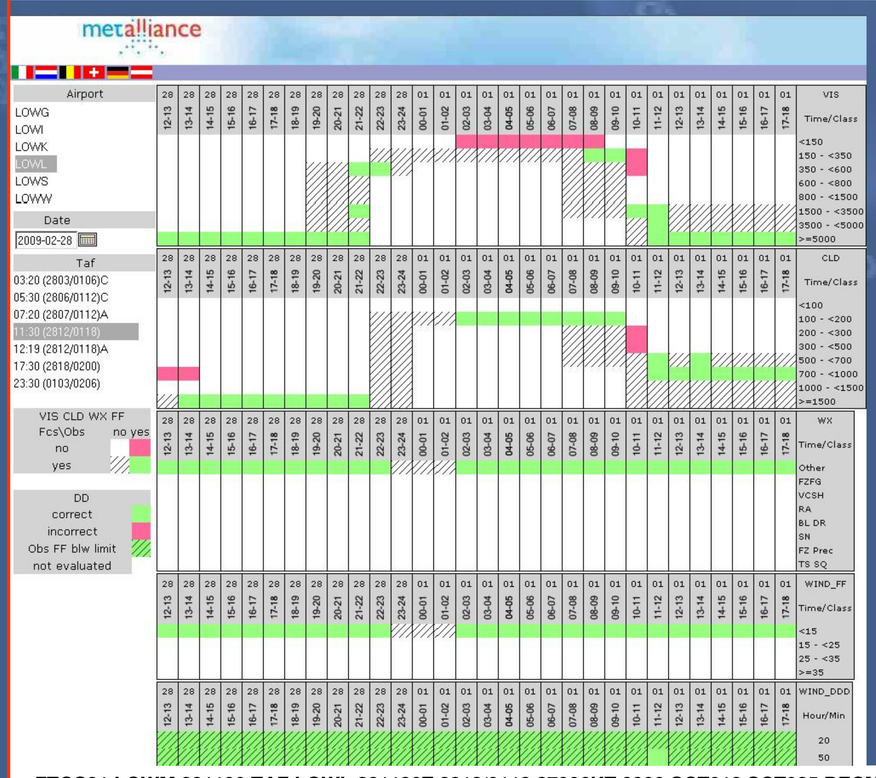
- WIND DIRECTION is verified using deviation criteria (e.g. >20° when ff≥7kt).

Result Presentation

For Forecasters

Every forecaster wants to see how correct his/her TAF was!

FC and OBS | OBS but not FC | FC but not OBS



Many critics,
no defenders,
weathermen
have two regrets:
when they hit,
no one remembers,
when they miss,
no one forgets...

FTOS31 LOWM 281100 TAF LOWL 281130Z 2812/0118 27006KT 9999 SCT012 SCT025 BECMG 2819/2822 VRB02KT 0500 BCFG FEW012 BECMG 2822/2824 0200 FG VV001 BECMG 0107/0110 09005KT 3000 BR OVC005 TEMPO 1018 6000 SCT010=

For Management:

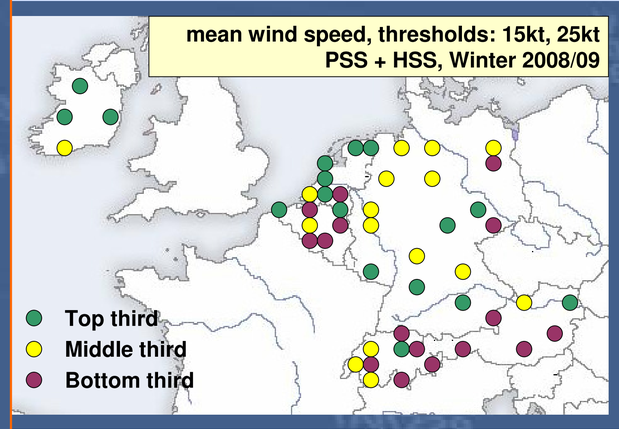
Whose TAFs are best?

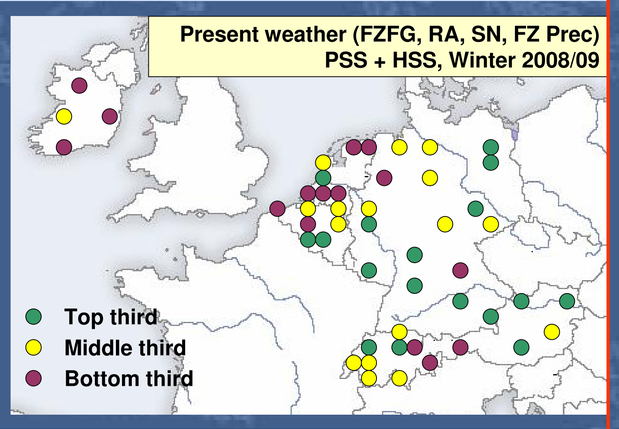
Depending on score! We look for a score with:

- good correlation to hits → PSS, Gerrity Score GS, hit rate (POD)
- good (negative) correlation to false alarms → HSS, FAR
- low correlation with base rate p(E) → PSS, GS < HSS~POD < FAR

Scores like the ICAO Annex 3 hit rate, the contingency table diagonal, and Percent Correct, show negative correlation with p(E) and POD and positive correlations with FAR. They are simple to understand, but they do not tell anything about forecast quality.

Alternative: The ranking of a "proper" score is easy to understand AND informative.





Scores may depend on: situation (flat, mountains, coast, …), nearby stations (shore!), MET element and criterion, frequency of MET conditions, available tools, methods and guidance, Forecaster training, quality of observations used for verification, luck ;-)

What can Forecasters learn from Contingency Tables

LOWG VISIBILITY - Maxima over all FCST hours, Period 2008 11 10 – 2009 03 31

FCST \ OBS	<150	150-<350	350-<600	600-<800	800-<1500	1500-<3500	3500-<5000	≥5000	SUM
<150	7	7	2	3	3	10	6	25	63
150 - <350	20	41	11	14	4	32	24	79	225
350 - <600	5	42	8	5	3	7	7	49	126
600 - <800	0	0	0	0	0	0	0	0	0
800 - <1500	2	7	5	6	2	9	6	74	111
1500 - <3500	3	35	24	10	26	207	107	188	600
3500 - <5000	6	81	40	8	45	422	250	637	1489
≥5000	15	140	75	27	92	522	754	9606	11231
SUM	58	353	165	73	175	1209	1154	10658	13845

LOWG VISIBILITY - Minima over all FCST hours, Period 2008 11 10 – 2009 03 31

FCST \ OBS	<150	150-<350	350-<600	600-<800	800-<1500	1500-<3500	3500-<5000	≥5000	SUM
<150	79	127	72	10	17	83	50	146	584
150 - <350	25	192	86	23	52	180	90	459	1107
350 - <600	0	23	38	4	15	63	60	149	352
600 - <800	0	0	0	2	4	3	2	17	28
800 - <1500	1	13	23	4	62	216	74	215	608
1500 - <3500	3	49	53	19	86	550	335	790	1885
3500 - <5000	11	50	36	10	56	256	241	1015	1675
≥5000	14	77	53	8	67	244	216	6926	7606
SUM	133	531	361	81	359	1595	1068	9717	13845

Many misses in Maxima, moderate rate of misses in Minima for low visibilities

Hit rate ~60% for low visibilities (Minima)

Many false alarms for low visibilities (Max, Min)

Maximum visibility is regarded less important for flight operations than minimum visibility.

Forecasters are cautious not to miss events of visibility reductions.

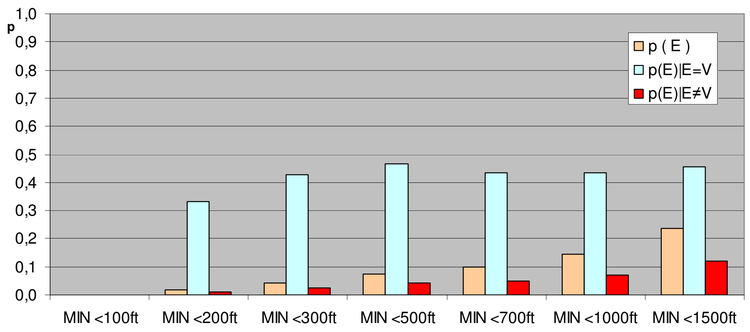
At long forecast ranges (up to 30 hours), missed events are hard to avoid.

Bias: low Min visibilities are forecasted too often, mostly by TEMPO, PROB

Many false forecasts of "slight" visibility reductions

For Forecast Users

Ceiling LOWL Winter 2008/09: Probabilities of Events and Dependance on Forecast



Flight operators and ATC are interested in thresholds.

- For an airport, p(E) indicates the relevance of an event.
- p(E) when E was fcst indicates if forecasts are specific or too cautious.
- p(E) when E was not fcst indicates the "remaining risk".

FORECAST VALUE

is a very interesting issue with TAFs. The costs of airline operations are dependent on weather-related delays and safety aspects. Planning ahead is able to reduce these costs. Forecast value can be determined if average weather-related costs and cost reduction potentials are known.

Dependance of Gerrity Score on Lead Time