TREND Forecast Verification in the MET Alliance

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The MET Alliance is a group of national aeronautical MET service providers in Europe.
Members: Austria, Belgium, Germany, France, Ireland, Luxembourg, Switzerland, the Netherlands. Observer (2017): Croatia
A joint TAF Verification project is running since 2008. The TREND forecast verification was started in 2016 for six countries.

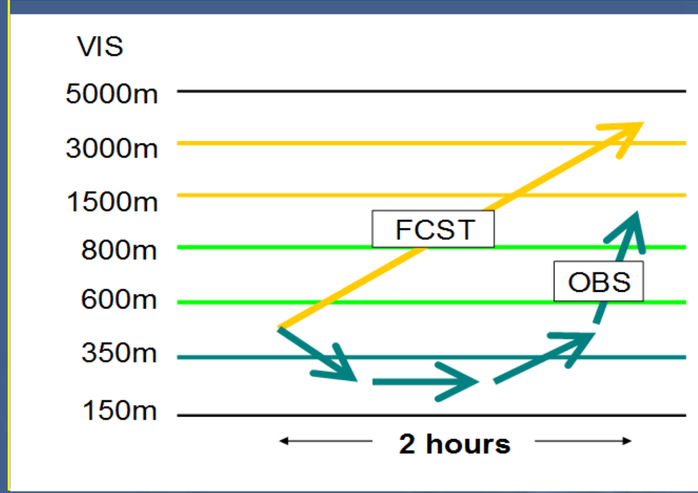
What is a TREND Forecast?

- ICAO Annex 3 (MET for aviation): TREND = Landing Forecast
- Valid 2 hours
- Forecast of significant changes
- Elements: visibility, cloud ceiling, wind and present weather
- Appended to actual METAR (every 30 mins) and SPECIAL Reports

Examples:

	Actual	…	Forecast
Wind (ddd ff max ffx):	12005KT	…	TEMPO 24020G35KT
Visibility (m):	0500	…	BECMG 4000
Cloud ceiling (hft):	OVC001	…	BECMG SCT020
Present weather:	-RA	…	TEMPO FM1400 TSRA
All in one:	…		TEMPO FM1400 24020G35KT 2500 TSRA BKN012CB

How are TREND Forecasts verified



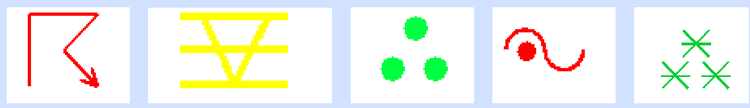
OBS reference: METARs

The TRENDs are verified by investigating if significant changes were:

- OBS and FCST
- not OBS but FCST
- OBS but not FCST
- not OBS, not FCST

More than 1 forecast group may be used.

- VISIBILITY and CLOUD CEILING are verified using threshold values that are significant for flight operations.
- For PRESENT WEATHER, significant event classes thunderstorms, rain, snow, freezing precipitation and freezing fog are investigated.

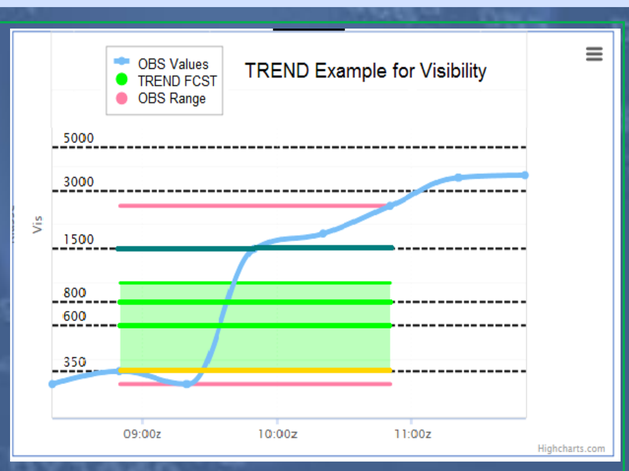


- SIGNIFICANT WIND CHANGES are verified using criteria:
  - Direction change ≥ 60° given that the speed is ≥ 10 KT
  - Speed change (increase or decrease) ≥ 10 KT
- Time groups (FM / TL / AT) and change types (BECMG, TEMPO) are not investigated.

Results

Forecasters
want get feedback on the quality of their forecasts

Thresholds:
- OBS and FCST
- OBS but not FCST
- not OBS but FCST



Initial VIS Class 350 - <600m
Minima

FCST \ OBS	<150	150 - <350	350 - <600	SUM
<150	0	0	0	0
150 - <350	0	0	0	0
350 - <600	0	1	0	1
SUM	0	1	0	1

Each TREND creates two entries in contingency tables:
- For minimum OBS / FCST
- For maximum OBS / FCST

Initial VIS Class 350 - <600m
Maxima

FCST \ OBS	350 - <600	600 - <800	800 - <1500	1500 - <3000	3000 - <5000	>=5000	SUM
350 - <600							
600 - <800							
800 - <1500				1			1
1500 - <3000							
3000 - <5000							
>=5000							
SUM				1			1

The contingency tables are evaluated by threshold or event class:
See example below: For all initial conditions < 3000m, the forecast performance for a VIS increase to ≥ 3000m is shown.

Initial VIS < 3000m:
Contingency table for „VIS improving to ≥ 3000m“

FCST \ OBS	YES	NO	SUM
YES	107 (a)	24 (b)	131 (a+b)
NO	143 (c)	513 (d)	656 (c+d)
SUM	250 (a+c)	537 (b+d)	787 (n)

Score	≥3000m	Average for all thresholds
p (E)	0,318	
H = POD	0,428	0,519
F	0,045	
FAR	0,183	0,306
Bias	0,524	
PSS	0,383	0,237
HSS	0,439	0,274
KPI	0,411	0,255
p(E) when fcst	0,817	
p(E) when not fcst	0,218	

Scores:
Key performance indicator KPI = (PSS + HSS) / 2
PSS, HSS for all relevant thresholds, improvement and deterioration

Peirce Skill Score PSS:
PSS = H - F = (a*d – b*c) / ((a+c)*(b+d))

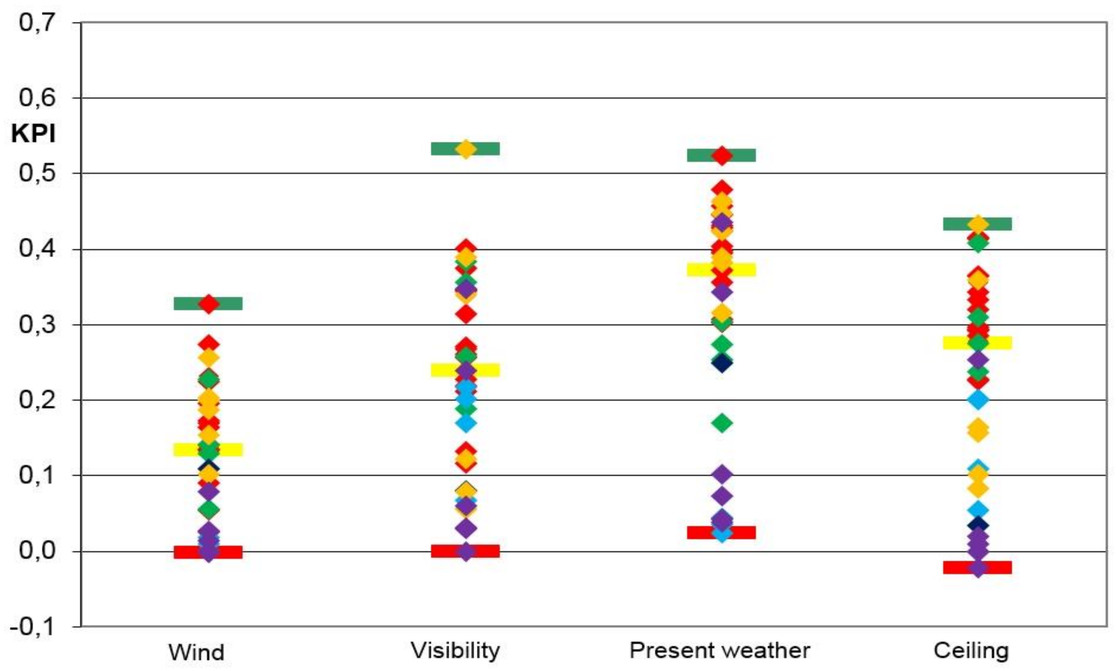
Heidke Skill Score HSS:
HSS = (a+d – E) / (n – E) with n = a + b + c + d and
E = PC by chance = ((a+b)*(a+c) + (b+d)*(c+d)) / n

Contingency Table: Example for Present Weather
Onset of significant weather within 2 hours

FCST \ OBS	0 Other	1 FZFG	3 RA	4 BL/DR SN	5 SN	6 FZ Prec	7 TS SQ	SUM
0 Other	15526	49	187	8	67	21	60	15918
1 FZFG	10	22	0	0	0	0	0	32
3 RA	279	0	151	0	7	0	18	455
4 BL/DR SN	0	0	0	0	0	0	0	0
5 SN	79	0	1	0	99	0	2	181
6 FZ Prec	23	0	0	0	0	2	0	25
7 TS SQ	6	0	12	0	2	0	37	57
SUM	15923	71	351	8	175	23	117	16668

Management wants to track quality over years.
It is important to use simple but proper scores – not so easy!
Scores are influenced by climatology, quality of guidance, forecasting process, training …

TREND Key Performance Indicators for the Met Alliance



These KPI scores are for April to September 2016 for 37 airports in six countries of the Met Alliance.
Colours are the same for all airports of one country.
Bars indicate highest median lowest scores.

First conclusions – what did we learn

- Airports have very different climatology, it is not really possible to compare forecast quality
- Point forecasts of visibility, cloud ceiling, wind and present weather are a challenge even for the short period of 2 hours
- Forecasters seem to be more focussed on catching the start of significant weather conditions than on forecasting their end
- Although the forecast period of 2 hours is fairly short, the focus is often on the change next to happen than on the whole period
- Training and qualification of personnel are very different
- Forecasting processes are set up very differently in the countries
- Large differences in scores between airports and countries: Many good scores, some problems