Application and verification of ECMWF products 2016

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2. Use and application of products

2.2 Use of ECMWF products

In the spring of 2014, an automated warning system based on predicting the 'Wet Bulb Globe Temperature' index ($WBGT$) and using probabilities computed from ECMWF ensemble forecasts was implemented for the Public Service of Wallonia. Every Friday morning, the occurrence or non-occurrence of high values of $WBGT$ is predicted in three geographical zones (labelled "B", "D", "E") for the following Monday, Tuesday, Wednesday and Thursday (time horizons of 3 to 6 days). The forecasts are simply expressed by means of the logical values "False" ($WBGT < 20°C$) or "True" ($WBGT >= 20°C$). The logical values are systematically set to "False" where the predicted 2-m temperature is less than $25°C$ so as to better reflect human discomfort due to heat stress. The reader is referred to Mailier (2014) for a more complete description of this product.

The performance of the forecasts produced by the system has been assessed objectively for the last two years 2014 and 2015 (from May to October). Hourly observations of 2-m temperatures and dewpoints from a set of synoptic stations were used to estimate the 'observed' $WBGT$. The verification results are presented in Tables 1 and 2 below. Please see e.g. Jolliffe and Stephenson (2012) for a detailed discussion of the verification metrics used. The statistics are given separately for each zone "B", "D" and "E", for 3 to 6 days ahead and for these four time ranges pooled together.

2014	Zone "B"					Zone "D"					Zone "E"				
Forecast range [days]	3	4	5	6	All	3	4	5	6	All	3	4	5	6	All
Hits	1	2	3	4	10	1	2	3	2	8	1	1	1	1	4
Misses	2	1	0	1	4	0	0	0	1	1	0	0	0	0	0
False alarms	0	0	2	2	4	0	0	1	2	3	0	1	1	2	4
Correct rejections	20	20	18	16	74	22	21	19	18	80	22	21	21	20	84
# events / # non-events	0.15	0.15	0.15	0.28	0.18	0.05	0.10	0.15	0.15	0.11	0.05	0.05	0.05	0.05	0.05
Accuracy	0.91	0.96	0.91	0.87	0.91	1.00	1.00	0.96	0.87	0.96	1.00	0.96	0.96	0.91	0.96
Bias	0.33	0.67	1.67	1.20	1.00	1.00	1.00	1.33	1.33	1.22	1.00	2.00	2.00	3.00	2.00
Hit rate	0.33	0.67	1.00	0.80	0.71	1.00	1.00	1.00	0.67	0.89	1.00	1.00	1.00	1.00	1.00
False alarm rate	0.00	0.00	0.10	0.11	0.05	0.00	0.00	0.05	0.10	0.04	0.00	0.05	0.05	0.09	0.05
Success ratio	1.00	1.00	0.60	0.67	0.71	1.00	1.00	0.75	0.50	0.73	1.00	0.50	0.50	0.33	0.50

Table 1 – Verification results for the year 2014 (23 forecasts from 23rd May to 24th October).

The ratios of the numbers of events to the corresponding numbers of non-events indicate that the 2015 season was more prone to alerts than the 2014 season. In both samples, the high accuracy (large proportion of correct forecasts) is largely due to the predominant number of correct rejections in situations that were not difficult to predict. Indeed, conditions well below the decisional thresholds (25°C for 2-m temperature and 20°C for $WBGT$) make up the majority of the cases. The high hit rates (except in 2014, zone "B", day+3) would suggest a good detection power, however it is difficult to draw a safe conclusion here as the number of cases involved is rather small. Furthermore, when looking at the past data, a number of misses and false alarms happened in marginal situations where temperature and $WBGT$ values were critically close to the decisional thresholds. The system performed best in hot-spell situations during summer. The success ratios are larger in 2014 than in 2015, but here again, these numbers must be interpreted with care because of the small sample sizes. The higher false-alarm rates in 2015 also explain the lower success ratios in comparison with 2014. This does not come as a surprise: the system was purposedly tuned to minimise the number of misses by selecting low probability thresholds, which naturally results in a higher risk of false alarms. As a final observation, these results do not show a clear relationship between forecast performance and range, but once more we must bear the limited number of forecasts in mind.

2015	Zone "B"					Zone "D"					Zone "E"				
Forecast range [days]	3	4	5	6	All	3	4	5	6	All	3	4	5	6	All
Hits	4	4	6	4	18	3	4	3	4	14	2	3	2	4	11
Misses	2	0	0	1	3	1	0	1	1	3	0	0	0	0	0
False alarms	3	3	2	5	13	3	2	2	3	10	3	3	3	3	12
Correct rejections	17	19	18	16	70	19	20	20	18	77	21	20	21	19	81
# events / # non-events	0.30	0.18	0.30	0.24	0.25	0.18	0.18	0.18	0.24	0.20	0.08	0.13	0.08	0.18	0.12
Accuracy	0.81	0.88	0.92	0.77	0.85	0.85	0.92	0.88	0.85	0.88	0.88	0.88	0.88	0.88	0.88
Bias	1.17	1.75	1.33	1.80	1.48	1.50	1.50	1.25	1.40	1.41	2.50	2.00	2.50	1.75	2.09
Hit rate	0.67	1.00	1.00	0.80	0.86	0.75	1.00	0.75	0.80	0.82	1.00	1.00	1.00	1.00	1.00
False alarm rate	0.15	0.14	0.10	0.24	0.16	0.14	0.09	0.09	0.14	0.11	0.13	0.13	0.13	0.14	0.13
Success ratio	0.57	0.57	0.75	0.44	0.58	0.50	0.67	0.60	0.57	0.58	0.40	0.50	0.40	0.57	0.48

Table 2 – Verification results for the year 2015 (26 forecasts from 1st May to 23rd October).

The performance of the forecast system is summarised in the categorical performance diagram in Fig. 1, with all forecast ranges pooled together. Assuming that forecast 'goodness' is measured through simultaneously achieving high success ratios and high hit rates, the 'better' forecasts must reach closer to the top right corner of the plot. In this sense, 2014 appears to have been to some extent a 'better' year than 2015 – more particularly zone "D".

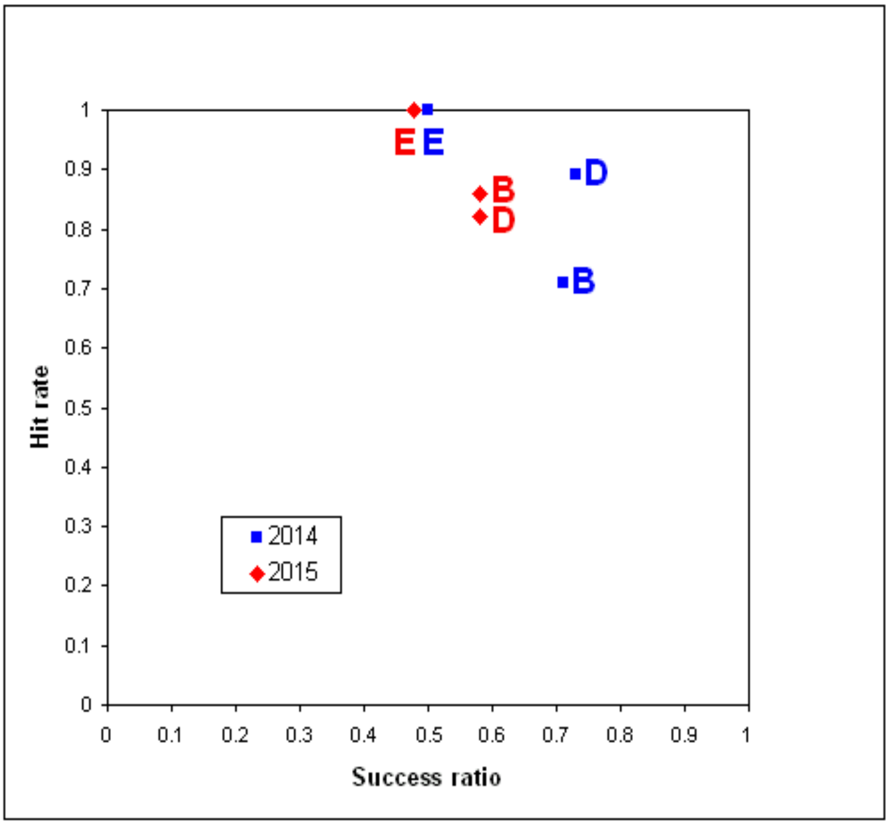

Figure 1 – Categorical performance diagram for the years 2014 and 2015. Explanation in main text.

Forecasts are produced three times a week since the summer of 2016. Plans have been made to upgrade the system in order to improve its performance. It is intended to use a larger number of reference synoptic stations so as to have a more complete geographical distribution over the three zones of interest. Furthermore, the cut-off probability thresholds will be re-examined and re-tuned if necessary.

5. References to relevant publications

Jolliffe, I.T., and **D.B. Stephenson**, 2012: *Forecast Verification: A Practitioner's Guide in Atmospheric Science. 2nd Edition*. Wiley and Sons Ltd, 274 pp.

Mailier, P.J., 2014: Application and verification of ECMWF products 2014. Belgian contribution to ECMWF Green Book 2014