Application and Verification of ECMWF Products 2021

Royal Meteorological Institute of Belgium – Pascal Mailier

1. Summary of major highlights

Forecast verification results of HRES and ENS mean (ENSM) direct model outputs used operationally at the Royal Meteorological Institute of Belgium (RMIB) are presented for 2-metre minimum and maximum temperatures, 2-metre temperature, 2-metre dew point, 10-metre wind speed and direction, total cloud cover and 6-hour accumulated precipitation. Scores of statistically post-processed (MOS) ENSM temperature forecasts are also displayed. It is shown that MOS ENSM provides the most accurate temperature forecasts up to a few days ahead. At short time ranges, ENSM forecasts can achieve levels of accuracy close to HRES, and even outperform it where the predicted variables are particularly volatile.

2. Verification of ECMWF products

The RMIB uses HRES and ENS forecasts along with several other NWP model outputs to produce fully automated forecast products out to 15 days. HRES end ENS forecasts are also used extensively by weather forecasters. At the RMIB, a MOS correction of the ENS is also applied daily on the raw model output of 00 UTC (Vannitsem and Demayer, 2020) and work is currently in progress to extend this procedure operationally to 12-UTC runs in the near future.

3.1 Objective verification

3.1.1 Direct ECMWF model output (both HRES and ENS), and other NWP models

The verification results presented here report on bias and accuracy of HRES and ENSM operational forecasts based on both 00-UTC and 12-UTC analyses out to time horizons of 168 hours and 13 days. Results for MOS ENSM forecasts based on 00-UTC analyses are also shown. Forecast outputs have been compared against synoptic observations at five Belgian reference stations over a period of twelve months (from July 2020 to June 2021). Aeronautical stations were selected owing to the regular availability of cloud observations. They are listed in Table 1 below together with their respective geographical coordinates.

WMO Code	Name	Latitude (N)	Longitude (E)	Elevation (m)
06407	Ostend/Middelkerke	51°12’	2°52’	5
06450	Antwerp/Deurne	51°12’	4°28’	14
06451	Brussels/Zaventem	50°54’	4°32’	58
06456	Florennes	50°14’	4°39’	299
06478	Liège/Bierset	50°39’	5°27’	178

Table 1 List of the 5 Belgian synoptic stations that were selected for this report.

The following meteorological variables have been considered: 2-metre minimum and maximum temperatures, 2-metre temperature, 2-metre dew point, 10-metre wind speed and direction, total cloud cover and 6-hour accumulated precipitation. MOS ENSM forecasts are not produced for all these variables and only results for temperature forecasts are shown in this report. Mean errors (ME) as well as root mean squared errors (RMSE) and mean absolute errors (MAE) have been computed to estimate forecast bias and accuracy, respectively – see e.g. Jolliffe and Stephenson (2012) for a thorough discussion of these scores. For assessing predicted 10-m wind direction, cases with light, variable surface winds (wind speed ≤ 4 ms^{-1}) have been censored.

The plotted scores are presented in Figs. 1 to 5 below (one figure per station). HRES and ENSM errors often show distinct diurnal cycles that can be reduced substantially through statistical post-processing. This is demonstrated by MOS ENSM, which clearly delivers temperature forecasts with minimal biases and best accuracy overall at least for the first few days.

Coastal station 6407 (Ostend/Middelkerke) features large systematic errors that are more related to gridpoint choice than to actual forecast performance. As can be expected at later ranges, ENSM scores tend to be better than HRES scores by dint of ensemble averaging, but ENSM can achieve levels of accuracy comparable to HRES at short ranges already. The smoother ENSM can even perform better than HRES where the predicted variable is particularly volatile, as is the case with wind speed, cloud cover and precipitation. Predictions of cloud cover and precipitation also appear to be rather well calibrated despite a slight, but consistent drift in ENSM (positive in the former case, negative in the latter).

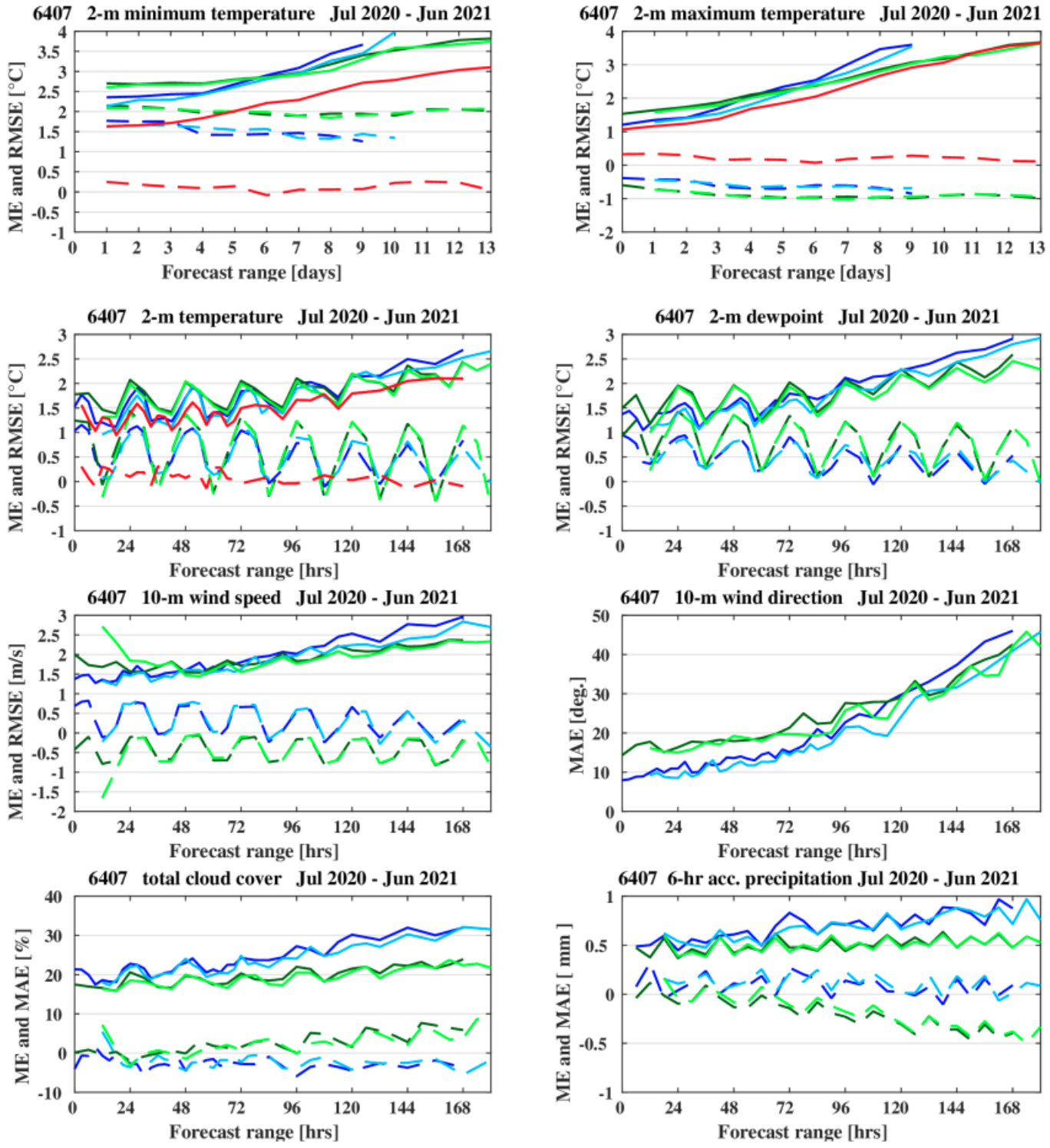

Fig. 1 Forecast bias and accuracy in Ostend/Middelkerke (6407).

Mean errors (ME, dashed lines), root mean squared errors (RMSE, solid lines) and mean absolute errors (MAE, solid lines) of ECMWF HRES and ENSM forecasts based on 00-UTC (dark blue/green) and 12-UTC analyses (light blue/green), and of MOS ENSM forecasts based on 00-UTC ENSM (red). Variables considered are: 2-metre minimum and maximum temperature, 2-m temperature, 2-metre dew point, 10-metre wind speed and direction, total cloud cover and 6-hour accumulated precipitation. For assessing predicted 10-metre wind direction, mean absolute error (MAE) scores only are shown. Forecasts from July 2020 to Jun 2021 (12 months).

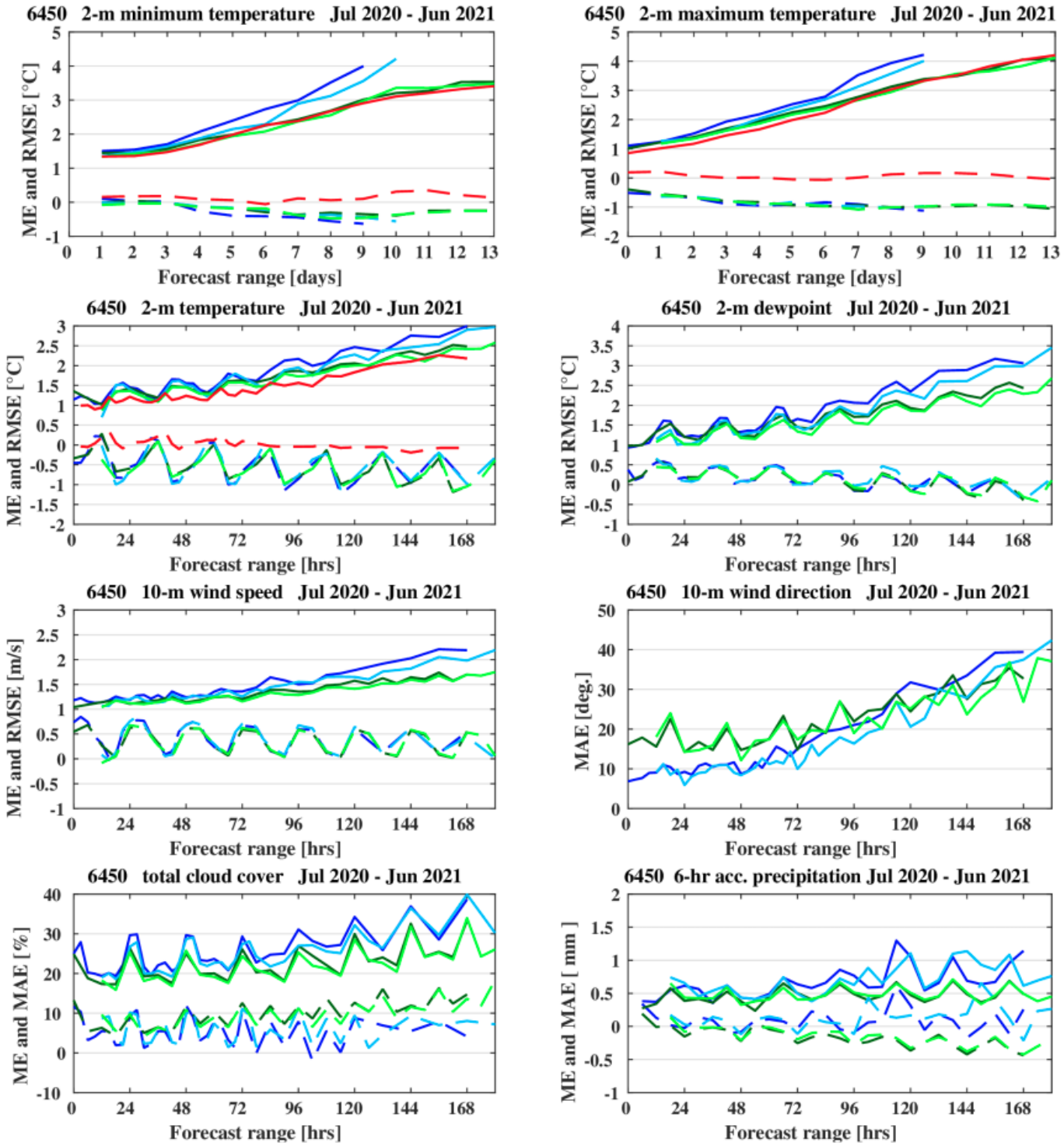

Fig. 2 Forecast bias and accuracy in Antwerp/Deurne (6450).

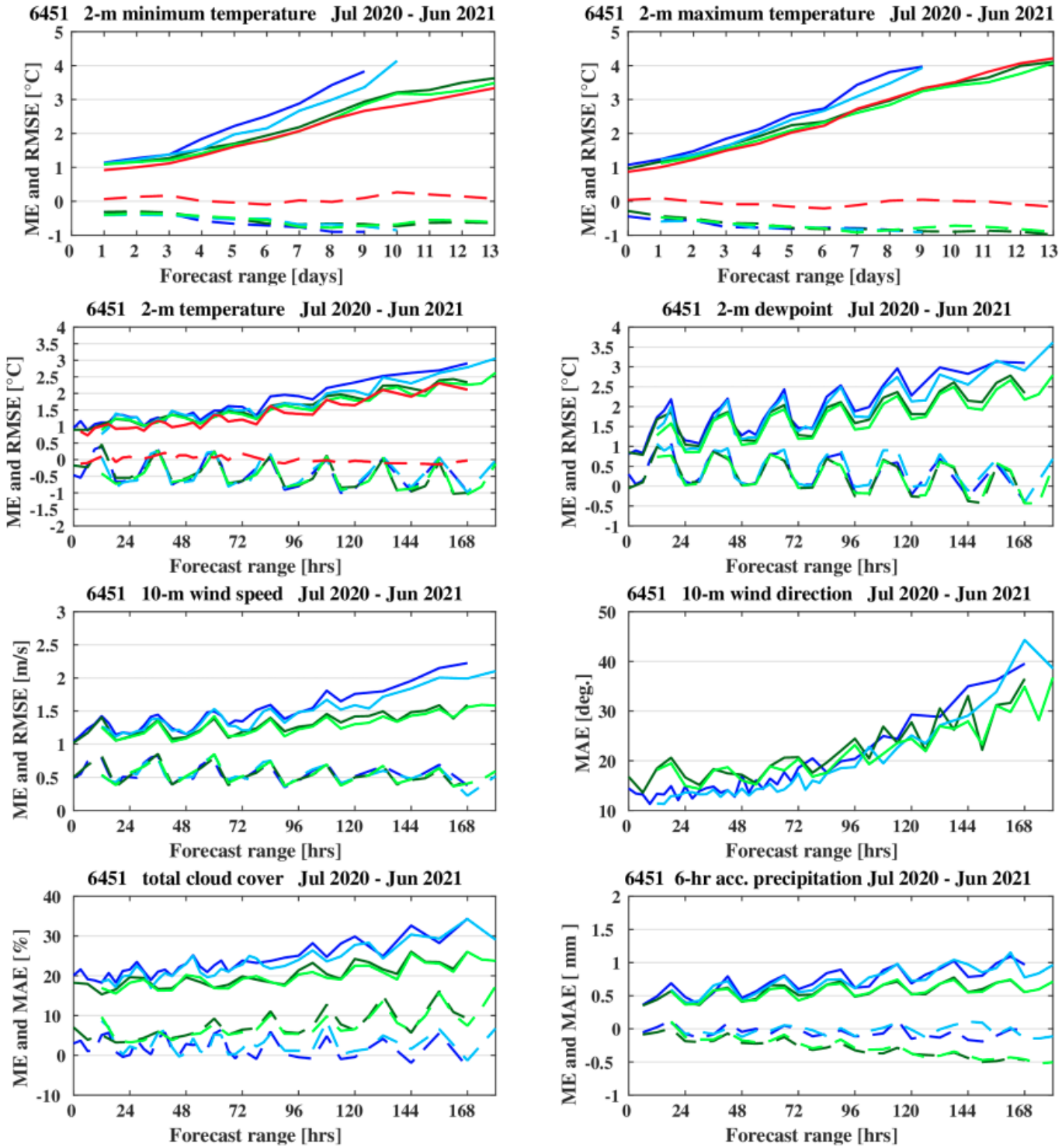

Fig. 3 Forecast bias and accuracy in Brussels/Zaventem (6451).

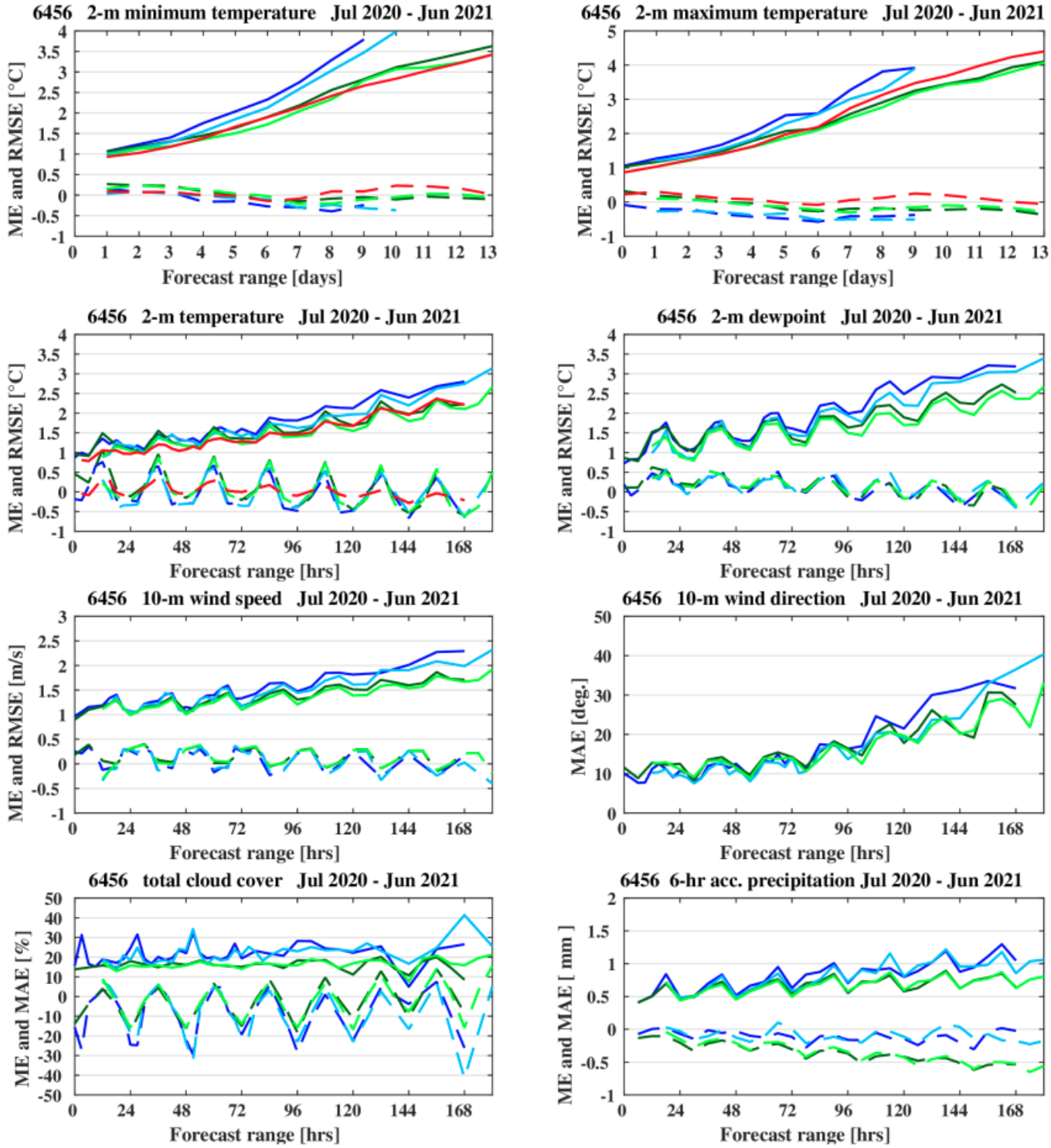

Fig. 4 Forecast bias and accuracy in Florennes (6456).

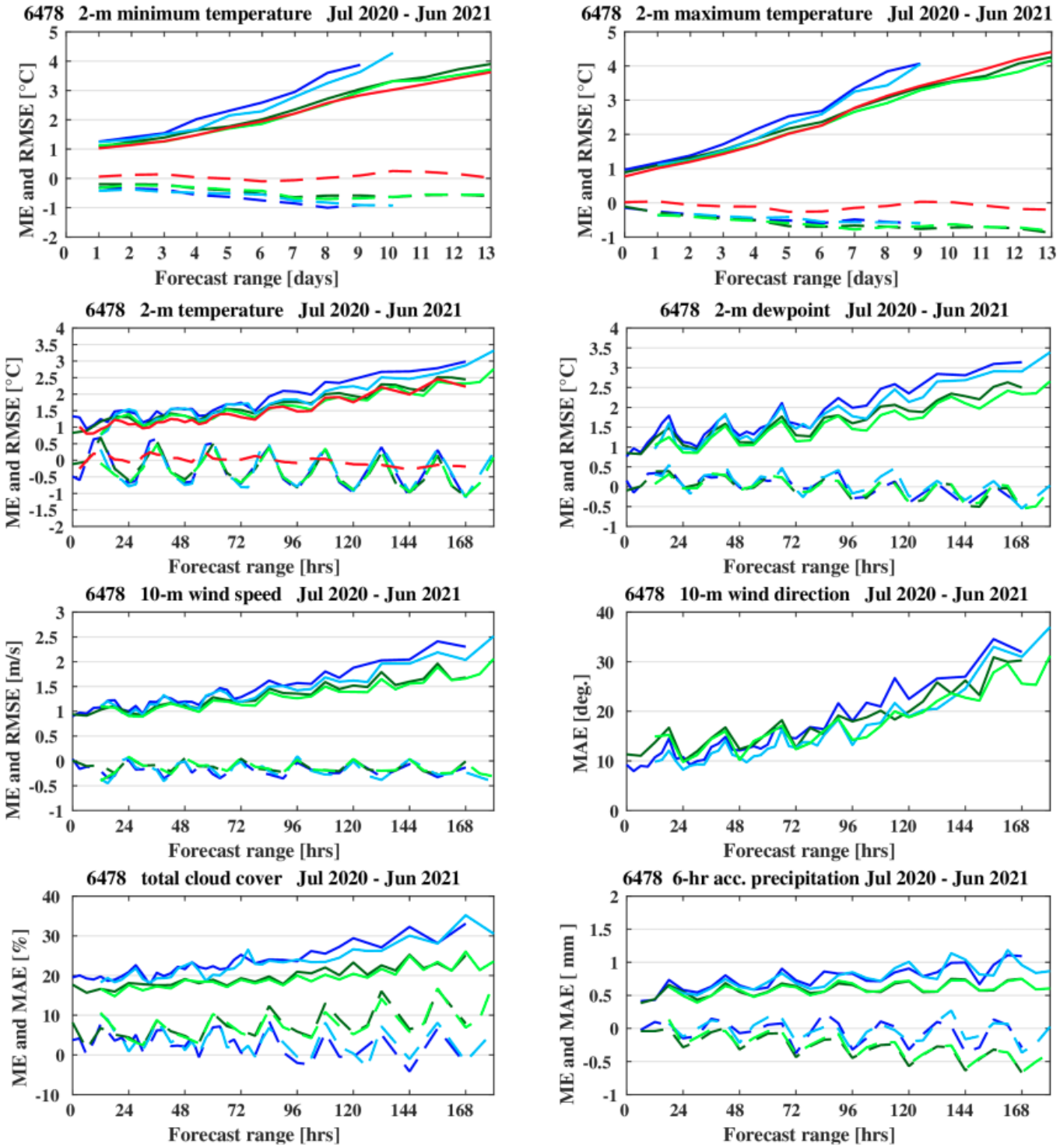

Fig. 5 Forecast bias and accuracy in Liège/Bierset (6478).

6. 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.

Vannitsem, S., and Demayer, J., 2020: Statistical post-processing of ECMWF forecasts at the Belgian met service. ECMWF Newsletter N° 164.