Verification of COSMO-LM in Poland

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1 Introduction

The results of the verification of COSMO-LM in Poland from January 2005 to June 2005 are shown below. In our research we verified the following parameters: the surface meteorological parameters, the 24-hour precipitation amounts and the upper-air parameters.

2 Results

2.1 Verification of surface parameters using 56 Polish SYNOP stations

The mesoscale LM model was verified daily (operational verification) and monthly. For the fields generated by the model the following parameters were extracted: the temperature at 2 m above ground level, the dew point temperature at 2 m a.g.l, the air pressure at sea level, the wind speed at 10 m a.g.l. and cloud cover. For operational verification we compared the present data with 6 earlier forecasts for the same hour. For monthly verification, the mean error (ME) and the root mean square error (RMSE) were calculated using a 12 forecast range (every 6 hours) for a 72 hour forecast starting at 00 UTC. The error estimators were calculated by stations throughout Poland.

2.1.1 The temperature at 2 m above ground level.

We observed the diurnal and monthly cycle of the RMSE and ME. (Fig. 1) The diurnal cycle in the spring and summer (March, June) was bigger than in the winter and achieved a maximum at 12 UTC and a minimum at 6 UTC. The biggest amplitude of RMSE and ME occurred in March. The overestimation of temperature was observed in the summer and the underestimation of temperature was observed in the winter. (Fig. 2). In Fig. 3 is shown the distribution of ME for all synoptic stations (the two highest mountain stations are not shown). In this case, the temperature was overpredicted for almost all stations. The mean errors on each station are different and depend on the location of the station to the nearest grid points and the altitude of the station. (Fig. 3)

2.1.2 The dew point temperature at 2 m a.g.l.

The diurnal cycle of RMSE only occurred in May and June. In January and April we observed the growth of the RMSE with forecast time. In January, the ME was negative regardless of the diurnal cycle. In February and March, the ME was negative at night and positive during the day, with the maximum at 12 UTC. From April to June, the ME was positive. The ME achieved a maximum at 18 UTC and a minimum at 6 UTC in May and June. The value of the diurnal amplitude of the ME was small for almost all months, except February and March. The mean error for each station is different (Fig. 4 - Fig. 6).

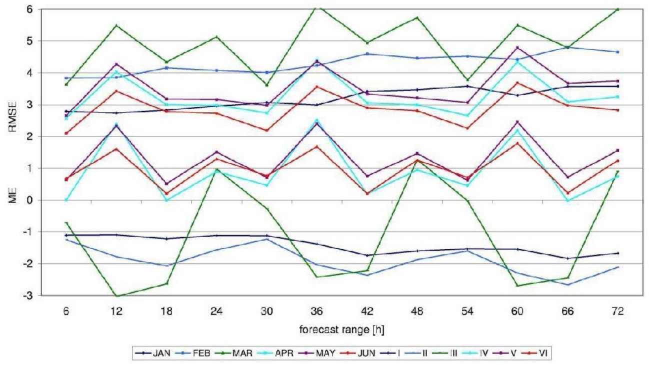

Figure 1: RMSE, ME, Temperature 2m [°C], January - June 2005.

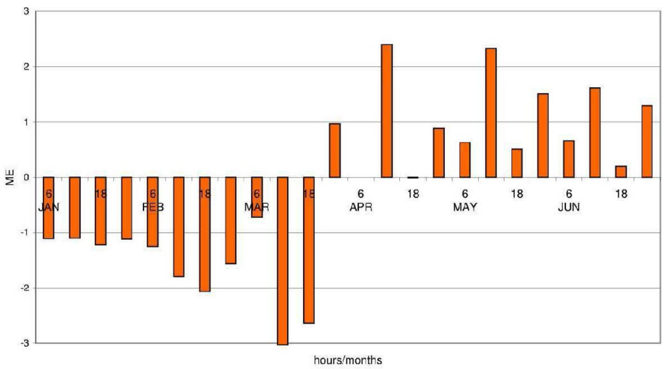

Figure 2: ME, 1st day, Temperature 2m [°C], January - June 2005.

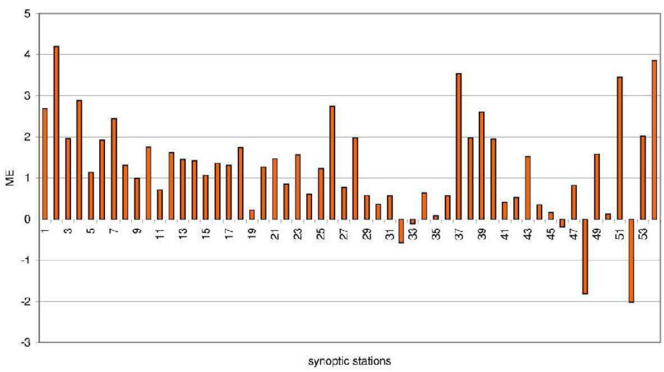

Figure 3: ME, Temperature 2m [°C], 36h-forecast, June 2005.

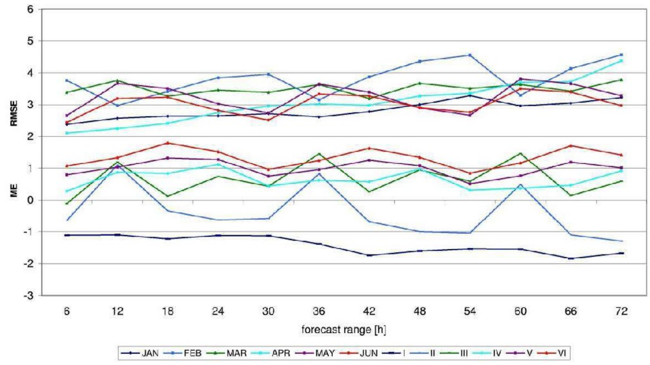

Figure 4: RMSE, ME, Dew point temperature 2m [°C], January - June 2005.

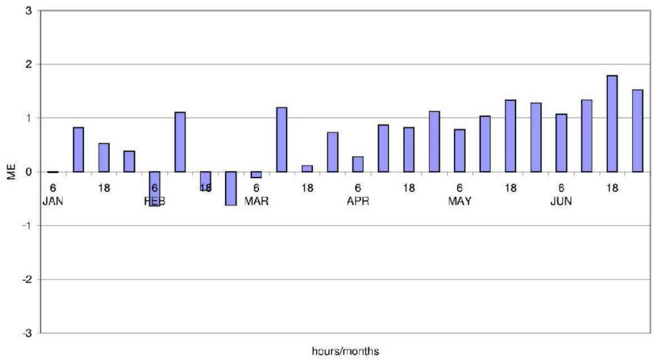

Figure 5: ME, 1st day, Dew point temperature 2m [°C], January - June 2005.

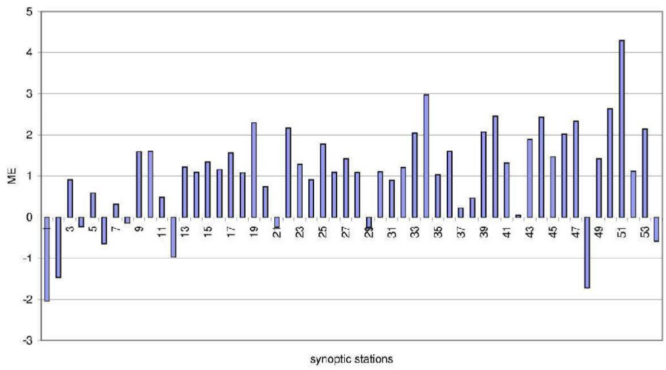

Figure 6: ME, Dew point temperature 2m [°C], 36h-forecast, June 2005.

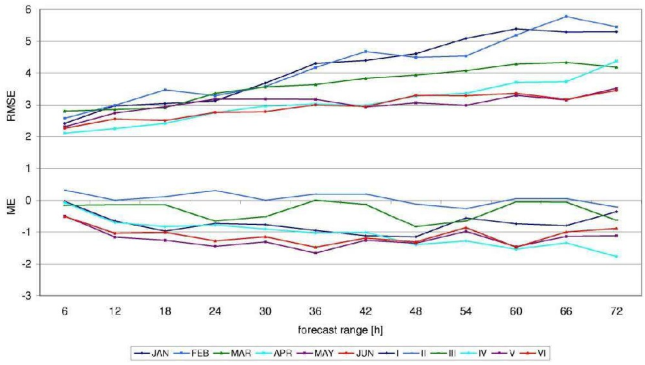

Figure 7: RMSE, ME, Pressure [hPa], January - June 2005.

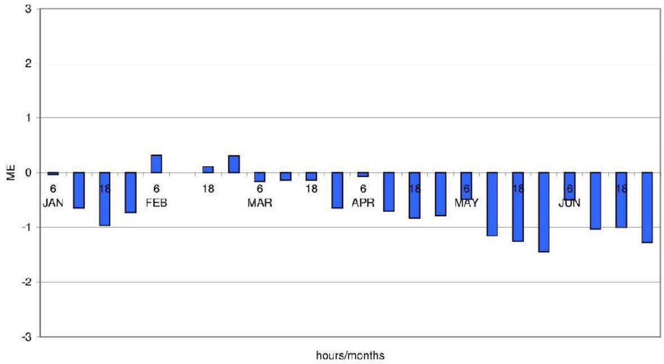

Figure 8: ME, 1st day, Pressure [hPa], January - June 2005.

2.1.3 The air pressure at sea level

The RMSE clearly increased with forecast time. The growth was smaller in the summer than in the winter. The ME in January was closed to 0 hPa. During the winter the range of ME is from -1.0 hPa to 0 hPa and during the summer the range is from -1.5 hPa to 1.0 hPa (Fig. 7 - Fig. 9).

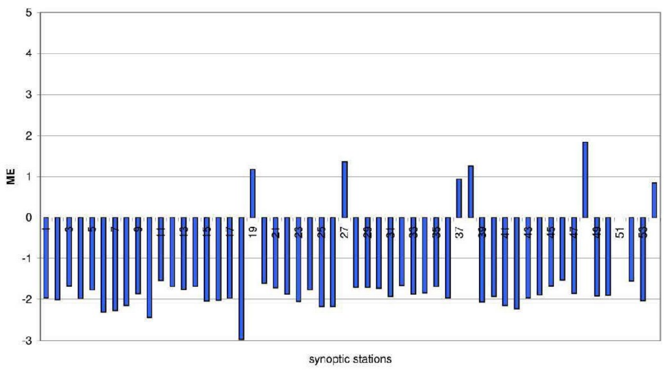

Figure 9: ME, Pressure [hPa], 36h-forecast, June 2005.

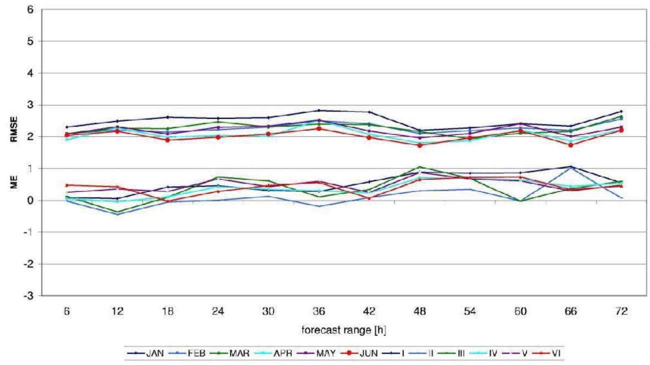

Figure 10: RMSE, ME, Wind speed [m/s], January - June 2005.

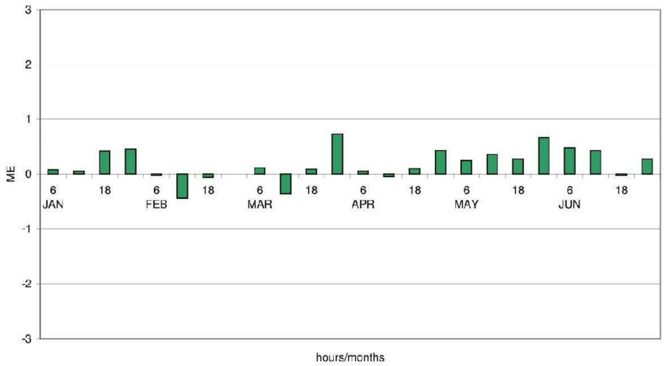

Figure 11: ME, 1st day, Wind speed [m/s], January - June 2005.

2.1.4 The wind speed at 10 m a.g.l.

The mean error is almost positive during the whole period. The ME increased with the forecast time. For 1st day and 2nd day is about 0.5 m/s and for 3rd day is 1 m/s. The RMSE is bigger in the winter than in the summer. We observed the diurnal cycle of RMSE from April to June (Fig. 10 - Fig. 12).

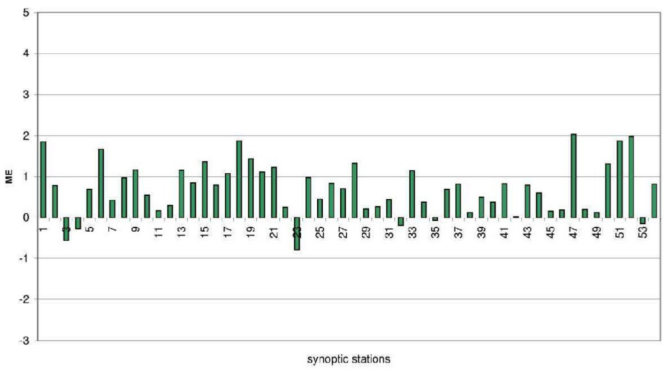

Figure 12: ME, Wind speed [m/s], 36h-forecast, June 2005.

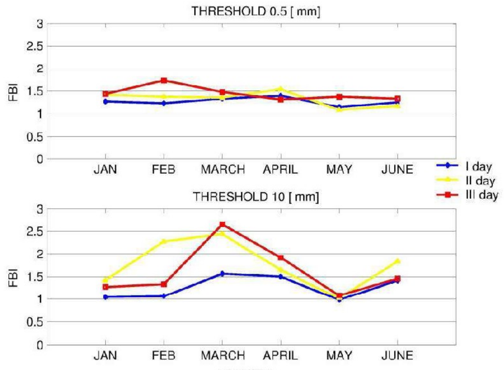

Figure 13: Frequency bias index, January -June 2005.

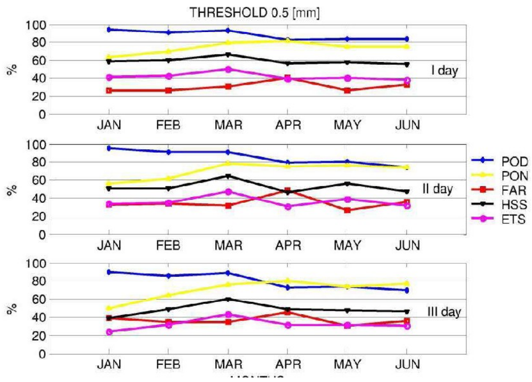

Figure 14: Indices for 24h accumulated precipitation, January -June 2005, threshold 0.5 [mm].

2.2 Verification of 24-hour precipitation amounts using 308 rain gauge stations

For the calculations we interpolated the gridded forecast values on the station points where observations are available. The interpolation of the forecast values on the station points was performed by averaging the values on the four nearest grid points. For this purpose we used the bilinear interpolation. We verified the 24-hour precipitation amounts using 7 indices from the contingency table for the 3 day forecast range (1st day, 2nd day, 3rd day). For verification of the precipitation thresholds 0.5, 1, 2.5, 5, 10, 15, 20, 25, 30 mm were used. For each threshold the following scores were calculated: frequency bias index (FBI), probability of detection of event (POD), false alarm rate (FAR), true skill statistic (TSS), Heidke skill score (HSS) and equitable skill score (ETS) (Fig. 13 - Fig. 16). The figures shown the overestimation of precipitation amount. This overestimation was bigger in 2nd day and 3rd day than in 1st day. Especially it was apparent for threshold 10.0 mm. The forecast of precipitation amount was better from January to March than in next months. For threshold 0.5 mm in 1st day of forecast the POD index was always bigger than 80 % and the FAR index was smaller than 40 %. Those indices did not deteriorate significantly in subsequent days of the forecast. For higher precipitation the FAR index significantly increased and exceeded the POD index.

2.3 Verification of upper-air parameters using 3 TEMP stations

The quality of 72- hour mesoscale forecast of DWD model for Poland was estimated through comparison of forecast results with upper-air soundings, carried out at three Polish stations, located in Leba, Legionowo and Wroclaw. The results of COSMO-LM were compared to

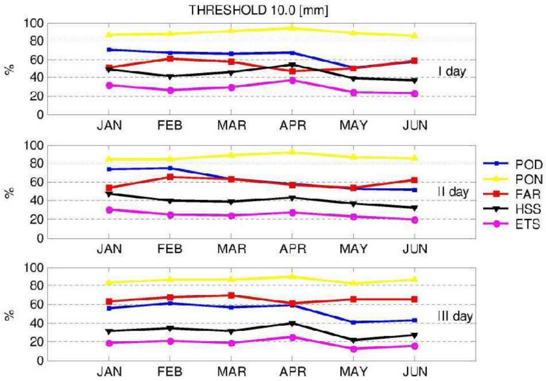

Figure 15: Indices for 24h accumulated precipitation, January -June 2005, threshold 10 [mm].

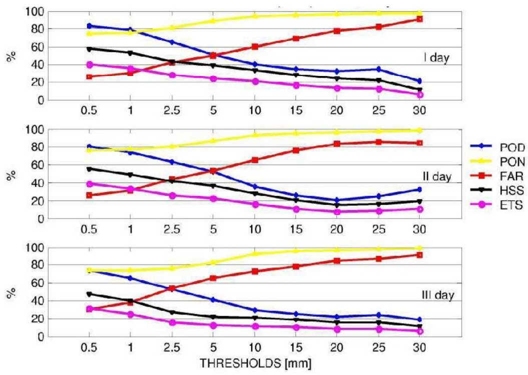

Figure 16: Indices for 24h accumulated precipitation, May 2005.

actual values, observed at the stations. Following meteorological elements (at standard pressure levels 1000, 850, 700, 500, 400, 300, 250 and 200 hPa) were concerned:

- Air temperature;
- Relative humidity;
- Height of a pressure level (air pressure);
- Wind speed.

Verification was carried out for 0, 12, 24, 36, 48, 60 and 72 hour forecast. Mean Error and Root Mean Square Error were calculated as basic scores (Fig. 17 - Fig. 19).

3 Conclusions

3.1 The 2 m temperature

- A monthly and seasonal variation for the scores of temperature is observed.
- The mean error is negative in the winter and positive in the spring and summer.
- In the summer we observed a large diurnal amplitude of mean error and amplitude of RMSE with maximum value during a day.

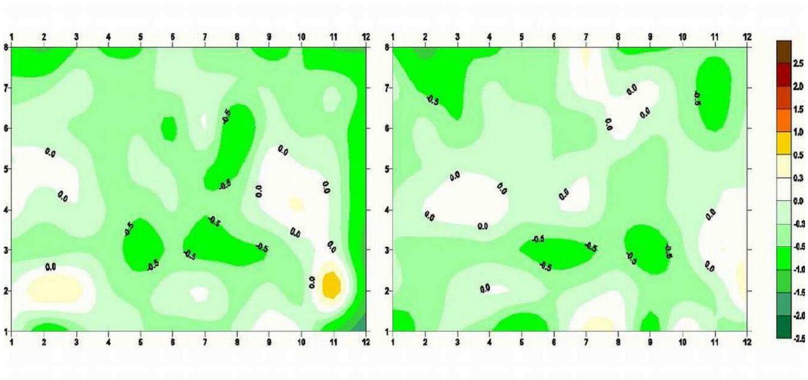

Figure 17: Mean error (observed-predicted) for temperature, soundings in Leba, 2003 (left chart) and 2004 (right chart).

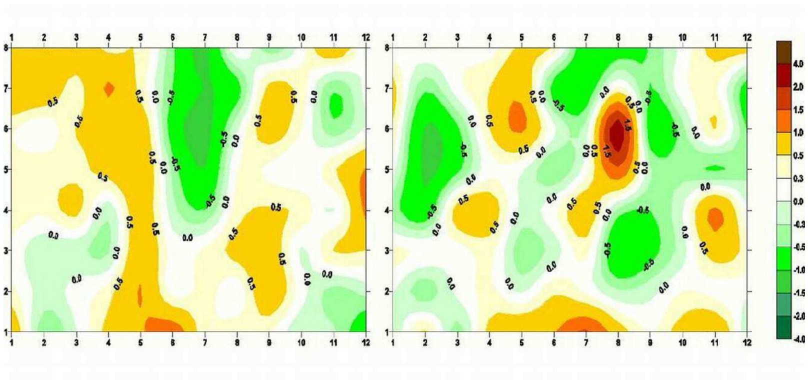

Figure 18: Mean error (observed-predicted) for windspeed, soundings in Leba, 2003 (left chart) and 2004 (right chart).

3.2 The dew point temperature at 2 m a.g.l.

- The monthly variation of mean error is observed. The bias is negative in January, positive in the summer and diurnal amplitude in the spring.
- The RMSE increased with the forecast time.

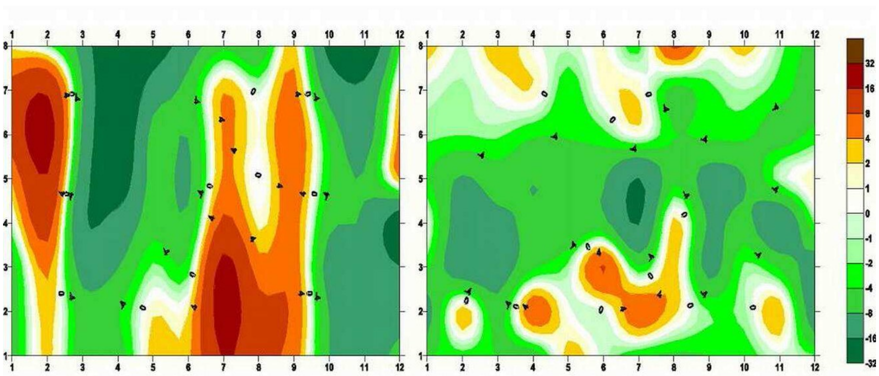

Figure 19: Mean error (observed-predicted) for relative humidity, soundings in Leba, 2003 (left chart) and 2004 (right chart).

3.3 The air pressure at sea level

- The RMSE increased with the forecast time.
- The error is smaller in the summer and higher in the winter.
- The ME is quite smooth (about zero in the winter and negative in the summer).

3.4 The wind speed at 10 m a.g.l.

- The ME is mostly positive and increases with the forecast time.
- The RMSE is quite smooth, bigger in the winter than the summer (with daily amplitude in the summer).

3.5 24-hour precipitation amounts

- The model overestimates the amount of precipitation.
- The precipitation forecast quality in the period from January to June in 2005 are better than in 2004.
- The plots of the indices for the 24-h accumulated precipitation for the threshold 0.5 mm in 2005 show smaller variability than in 2004.
- The quality of the forecast does not deteriorate significantly in subsequent days of the forecast.

3.6 Upper-air parameters

- Forecasts seem to be good as far as temperature and wind speed are concerned (ME about 0 and 1 m/s, respectively).
- Model still seems to be ”too wet” (ME about 30%, in extreme case relative error ∽50%).
- However, this looks like it improved, comparing results for 2003 with these for 2004, probably due to changes in (some) parameterizations.
- The quality of forecast, which is naturally expected tendency, decreases monotonously with time, especially for relative humidity. For other parameters this tendency is not so clearly seen.

References

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