Verification of aLMo Runs at SYNOP-Stations

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1 Introduction

The surface fields of the Alpine Model (aLMo) of MeteoSwiss has until recently been verified for Swiss stations only. With the development of a new verification tool, using GRIB and BUFR as input formats, MeteoSwiss has started to verify the aLMo surface fields for the whole model domain. For the verification before summer 2002, the surface data are retrieved from the ECMWF MARS database. For verifications after that date, the local MARS database at the Swiss Center for Scientific Computing (CSCS) in Manno is used.

2 Seasonal surface verification

The aLMo has been verified for all seasons back to December 2001. Each season consist of three calendar-moths. The BIAS (mean error) and STDE (standard deviation of the error) are computed for the following parameters: Pressure reduced to mean sea level (PMSL), pressure at station height (PS), temperature at 2 m (T_2M), and dewpoint at 2 m (TD_2M). The verification is made in three modes: A temporal verification, a spatial verification and a total verification depending on forecast range.

The temporal verification calculates a verification score for each verification time. Currently, 6-hourly observations are used. It can be used to determine at which times the aLMo performed well, and at which times there where large errors. The latter aLMo integrations are prime candidates for case studies aiming at model improvement.

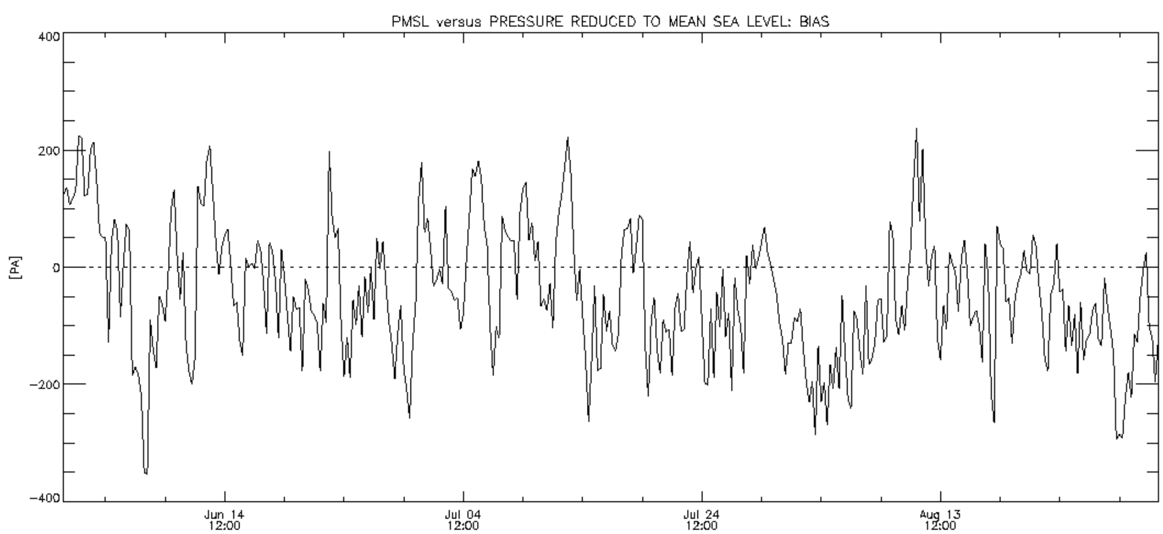
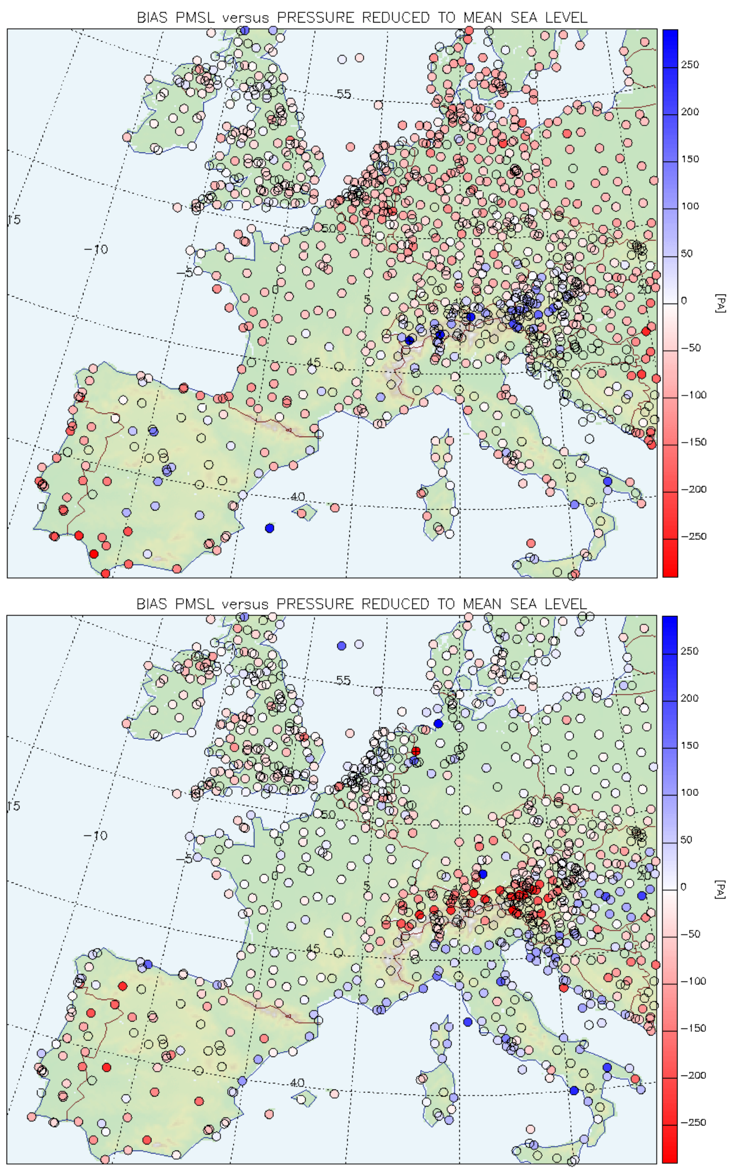


Figure 1: Model bias for +42 h and +48 h forecast ranges against 6-hourly observations of PMSL, from 1 June 00:00 UTC to 31 August 2002 18:00 UTC.

Figure 1 shows the mean error for each 6-hourly verification time from 1 June 2002 to 31 August 2002 (summer 2002). Here, the forecast ranges +42 h and +48 h of all 00 UTC and 12 UTC aLMo integrations are verified together providing a seamless time series of 6 hourly values. The parameter is PMSL in Pascal.

The mean error varies 2 hPa around the total mean error of -0.46 hPa. Two distinct outliers are visible at 7 June 18:00 UTC and 8 June 00:00 UTC: These are the two forecast ranges +42 h and + 48 h of the 6 June 00:00 UTC integration. A comparison of the forecast fields in question with the analysis of the verification time (not shown) shows a large region where the aLMo forecast develops an elongated low pressure system across most of northern Europe. The center pressure of this large scale low is below 995 hPa, whereas the corresponding trough in the analysis is much weaker with a center pressure above 1000 hPa. Hence, a model error in excess of 5 hPa exists over a large area. This error exceeds the threshold value of 4 hPa proposed by Hall (1987) and Damrath (1996) for the quality check of PMSL observations against model analyses. This demonstrates that a quality control of observations against forecasts has to allow for larger error margins, especially for longer forecast ranges.



a)

b)

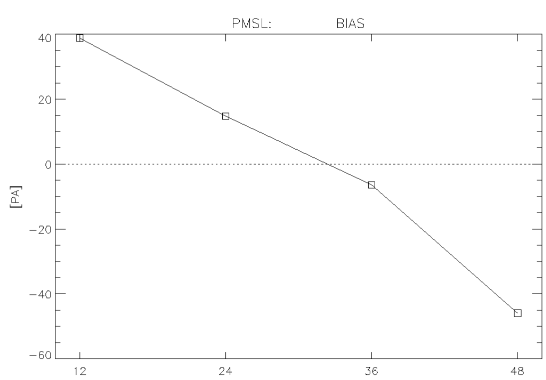
Figure 2: Spatial distribution of model error for a) summer 2002 and b) winter 2001/02.

The spatial verification gives a score for each station separately. It is presented in Figure 2 for PMSL at the +42 h / +48 h forecast ranges of all 00 UTC and 12 UTC aLMo integrations. The two panels a) and b) show the mean error at each station for summer 2002 and winter 2001/02, respectively. In summer, there is a general underestimation of the reduced pressure over northern Europe and along the coasts (Figure 2a). The dominance of the red color in this picture corresponds to the negative sign of the total mean error (-0.46 hPa, as mentioned above). The inland stations on the Iberian island and the Alpine stations indicate on the other hand a positive bias of the aLMo pressure in these regions.

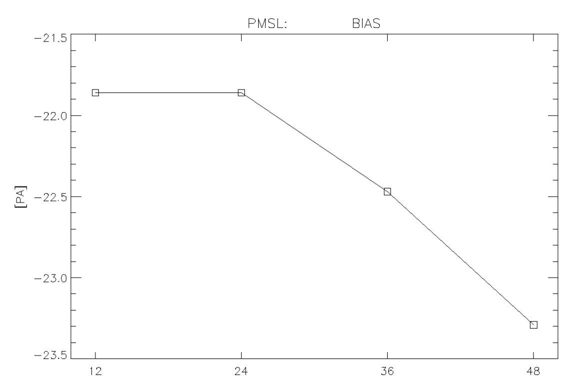
Almost the opposite picture is given by the mean error in winter (Figure 2b). In winter, the Iberian inland stations and the Alpine stations have relatively large negative mean errors (up to 2.5 hPa). France, the Benelux countries, Germany, and Poland are on average very well predicted by the aLMo. 3 stations in northern Germany deviate grossly from the general picture. It is very unlikely that this is due to model deviations. They would have to be very small scale gross errors of the model. Rather, the data of stations in question probably contains spurious erroneous outliers. For two of the stations, this suspicion is supported by the verification of the pressure at station height, that does not show anomalous errors. The other stations in question do not provide station pressure in their SYNOP bulletins. Stations with obviously erroneous data have been excluded manually in the summer verification (Figure 2a), but not in the winter verification (Figure 2b). Such erroneous data poses a problem to the verification because they offset the model error. Especially the quadratic measures like the standard deviation of the error or the root mean squared error are very sensitive to the often large errors in the observations. The database does have a built-in data quality control, but it seems to be insufficient to eliminate all errors.

The contradictory spatial distribution of the mean error in the reduced pressure between summer and winter poses the question if these deviations indeed indicate a property of the model, or if it may in fact be a property of the reduction algorithm used to calculate the reduced pressure. The difference between summer and winter would then probably be explained by the difference in the average temperature used for the reduction.

Finally, the spatial and temporal aggregations are brought together to calculate a total verification score for all stations together and the whole season. Figure 3a shows the bias



a)



b)

Figure 3: Model bias of PMSL against forecast range for a) summer 2002 and b) winter 2001/02.

(mean error) for summer 2002, depending on the forecast range. It starts with a positive bias of 0.4 hPa and then successively sinks to the -0.46 hPa mentioned before. The model seems to have a tendency to reduce the average pressure with increasing forecast range. The same can be diagnosed from the respective plot for the winter season (Figure 3b), but to a much smaller extent, decreasing only from -0.22 to -0.23 hPa. In addition, there is a plateau at the beginning indicating a constant pressure bias for the first 24 hours.

3 Outlook

The verification will in the future be extended to include the vertically integrated water vapor content derived from GPS (Global Positioning System). The station pressure and temperature are currently not corrected for the height difference between model topography and station height. This correction will be included to allow the verification of these two parameters to be used in mountainous terrain. Also, a method to exclude erroneous observations will have to be implemented. In a fist version, a threshold error will be used to determine unlikely deviations between model and observations.

References

Damrath, U., 1996: On common Verification of NWP models in Europe (Version 1996). EWGLAM Newsletter 26, 111-114.

Hall, C. D., 1987: A common verification scheme for limited-area models. EWGLAM Newsletter 15, 144 - 146.