Verification of aLMo in the Year 2005

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1 Operational Verification

1.1 Verification with European SYNOP (WP 5.1.1 / 5.1.7) [Pirmin Kaufmann]

The operational verification of the Alpine Model (aLMo) has been extended to include the visualization of categorical scores. A number of categorical scores are calculated for total cloud cover (CLCT) and precipitation (TOT_PREC) as reported by Kaufmann (2005). Here, these newly added plots, which are now available back to 2001 on the COSMO verification pages, are presented. While the cloud cover verification is done with 6-hourly SYNOPs like the other parameters, the precipitation is currently verified with 12-hourly sums. The model lead time used for the verification is 42 hours (i.e. the 30 h to 42 h sum) and 66 hours (i.e. the 54 h to 66 h sum). The following results are valid for 42 hours lead time.

The thresholds 30% (2.5 octa) and 80% (6.5 octa) are used for the categorical statistics of total cloud cover. In summer, the occurrence of over 30% total cloud cover is generally underestimated (not shown). The underestimation is considerably higher towards the south of the model domain. In winter, the agreement is much better. Only over the Alps, there is a clear positive frequency bias with up to 60% overestimation of the occurrences of partial cloud coverage.

The frequency bias is considerably higher with the threshold of 80% cloud coverage. In summer, there is usually an overestimation over the Mediterranean region and an underestimation over central Europe (Fig. 1). The variability of the bias from station to station is relatively high even over flat parts of the domain, which is an indication of a possibly too large station-to-station variability in the observations.

The summer 2003 was exceptional with the prevailing sunny and hot weather. The frequency of occurrence of over 80% cloud coverage is overestimated by aLMo by a factor that reaches up to 5 at some stations, especially over the Mediterranean. This large factor is however at least partially due to the very low observed frequency.

In winter, the frequency bias of the 80% cloud coverage threshold is again larger than for the 30% threshold, but smaller than for the 80% threshold in summer. The spatial structure is somewhat similar as in summer, with underestimation over central Europe and overestimation over the Mediterranean. Winter 2004/2005 is shown as a typical example (Fig. 1). A particularly well forecasted season was the winter 2003/2004.

The categorical verification for the 12-hourly precipitations sums uses thresholds of 0.1, 1 and 10 mm. Other thresholds (2, 5, 20, 30, 50 mm) are also calculated but currently not visualized. The frequency bias for the occurrence of precipitation (threshold 0.1 mm) is greater than one at most stations and for all seasons. The spatial structure and extent however vary. In summer, the frequency bias is around 1.5 over the northern half of the domain, but much larger over the regions south of the Alps and the Pyrenees (Fig. 2). In winter, the overestimation is considerably larger over the northern half of the model

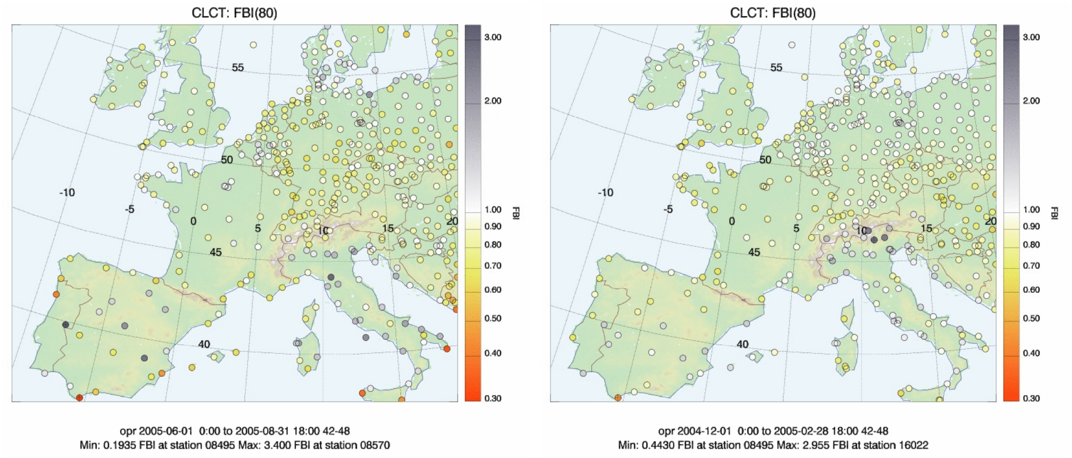

Figure 1: Frequency bias of cloud coverage above 80% for (a) summer 2005 and (b) winter 2004/05, lead times 42 h and 48 h.

domain (Fig. 2). Especially the regions with complex terrain show large factors (up to 5) of overestimation.

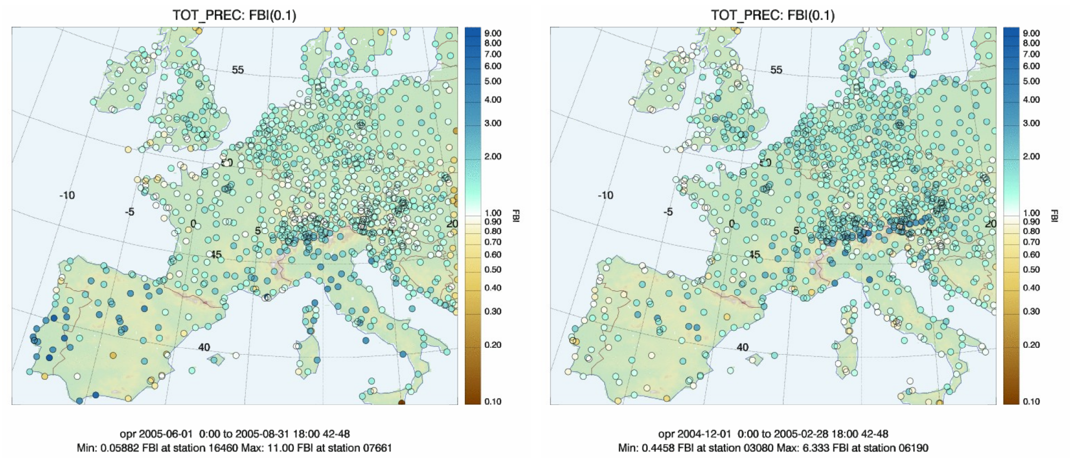

Figure 2: Frequency bias of 12 hourly precipitation sums for (a) summer 2005 and b) winter 2004/05, lead times 30 42 h.

The large model bias leads to a considerable false alarm rate around 40-50% north of the Alps. It is even higher south of the Alps and over the northern half of the Iberian Peninsula, where the observed frequency is very low. The observed frequency is equally low over the southern half of the Iberian Peninsula, but despite this, the false alarm rate here is lower than over the northern half of the peninsula and at the same level as over northern Europe.

1.2 Verification of daily cycle over Switzerland (WP 5.1.1 / 5.1.7) [Francis Schubiger]

No new developments in this package have been done this year and the main results of the verification of aLMo and LM inclusive Winter 2004/05 have been published by Schubiger (2005). The most important feature that should be investigated (by WG3) concerns the cloud cover in case of convection. Results for summer over the Alps suggest that the cloud amount in convective situations is too low (Fig. 3). While the observed cloud coverage shows a clear diurnal cycle (lower panel) in accordance with the observed precipitation (upper panel), the diurnal variation is absent in the model cloud coverage.

The results for precipitation are summarized in Table 1 with the scores for the frequency bias of the five seasons (from Summer 2004 to Summer 2005) for the thresholds 0.1, 2, 10 and 30 mm/6h for aLMo and LM. It shows an overestimation for low amounts (0.1 mm/6h) of 20-40% in summer and up to 60-80% in winter: this overestimation is most pronounced in the Prealps (altitude range 800-1500m). The high amounts (10 mm/6h) show a tendency towards higher values since begin of 2004 (each season of 2004 compared to the corresponding season in 2005): the underestimation of 15-25% in Summer 2004 changed into a slight overestimation of 5-15% in Summer 2005.

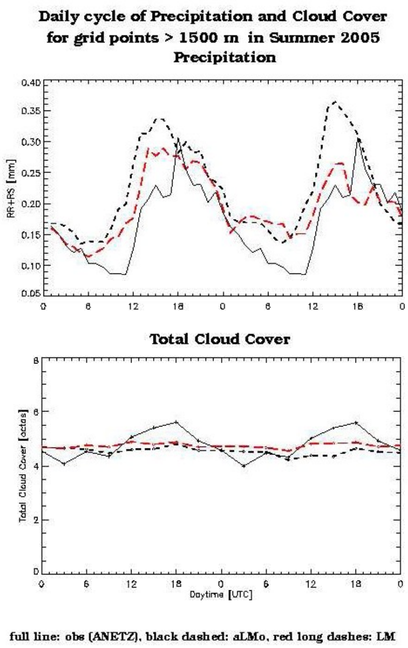

Figure 3: Verification of the daily cycle of precipitation (upper part) and total cloud cover (lower part) for grid points > 1500m over Switzerland in Summer 2005. Observations (ANETZ): full line black; aLMo: black dashed; LM: red long dashed.

1.3 Verification of the vertical profiles at TEMP stations (WP 5.2.2 / 5.2.6) [André Walser]

In Winter 2004/2005 the mean error for temperature shows a clear cold bias of up to 0.6 K between 1000 hPa and 300 hPa, which is increasing with forecast time. Above the tropopause height, an unprecedented cold bias of up to 2 K at 50 hPa can be observed, also increasing with forecast time (Fig. 4). Although this cold bias in the stratosphere is known from other seasons, its magnitude is considerably larger than previously seen. This negative temperature bias is at least partly due to the IFS boundary conditions. ECMWF confirmed to see a larger negative bias in the IFS forecasts for the northern hemisphere than a year or two before (but it was worse earlier). It is a model generated drift and as such sensitive to many aspects of the model formulation including physics, numerics and vertical resolution.

2 Verification studies

2.1 Weather situation dependent verification of upper-air data (WP 5.3.3) [Marco Arpagaus]

A weather situation dependent verification of the vertical structure of the Alpine Model (aLMo) based on the Schüepp classification (Schüepp 1979) is performed over the full data-set since the beginning of the climatic year 2004. The most interesting results are:

- Significant differences between classes high, flat, and low for temperature (1000 - 700 hPa) and relative humidity (900 - 700 hPa)
- Distinct differences between advective classes, especially west and east, for wind direction and wind speed.

Table 1: Frequency bias (%) of predicted precipitation over Switzerland. For all 6h-sums from +6h until +48h of all 00 UTC- and 12 UTC-forecasts, compared to 69 ANETZ stations. The LM and aLMo precipitation is the mean over 5 grid points. For the high amounts (10 and 30 mm/6h) the percentage of occurrences (%) is given. The columns give the values for the seasons since Summer 2004.

Threshold	Summer 04	Autumn 04	Winter 04/05	Spring 05	Summer 05
0.1 mm/6h					
aLMo	120	135	162	136	136
LM	121	145	183	143	129
2 mm/6h					
aLMo	101	109	162	122	113
LM	97	112	219	136	102
10 mm/6h					
aLMo	84	106	91	113	118
LM	76	94	231	140	102
30 mm/6h					
aLMo	114	268	0	51	216
LM	82	166	7	85	154

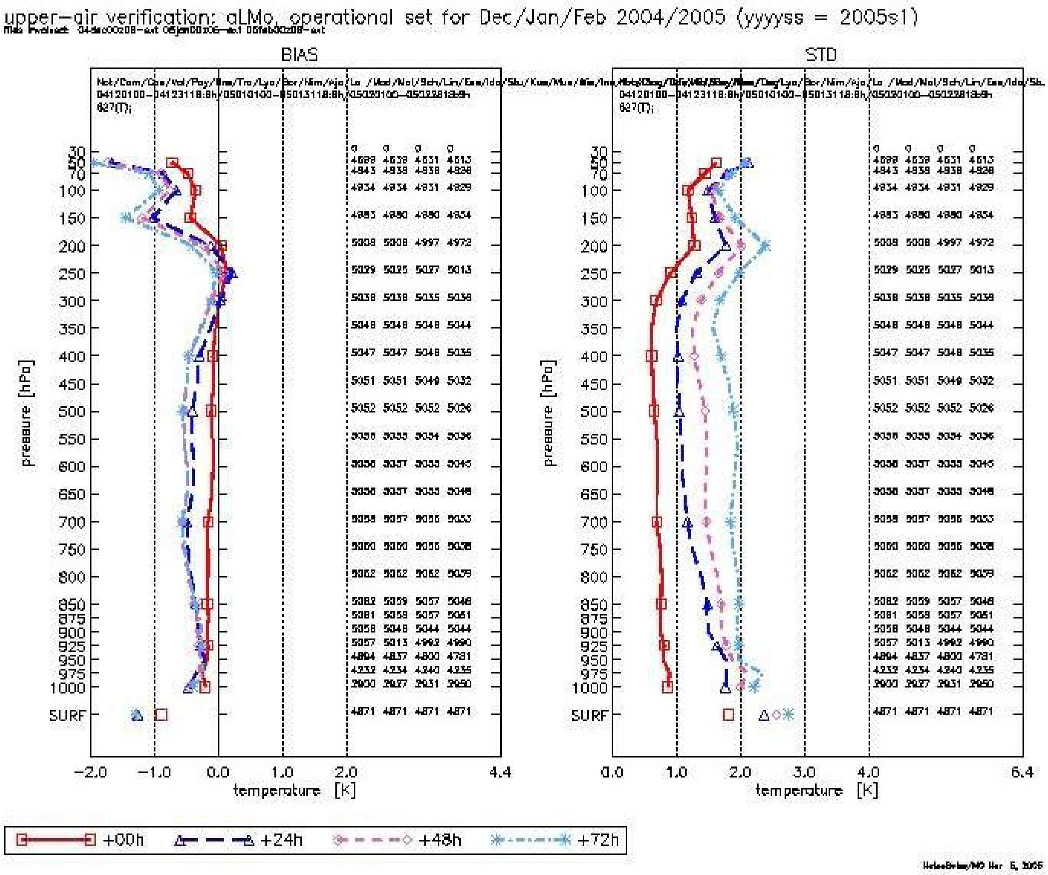

Figure 4: Vertical profile of temperature bias (left) and standard deviation (right) for winter 2004/05.

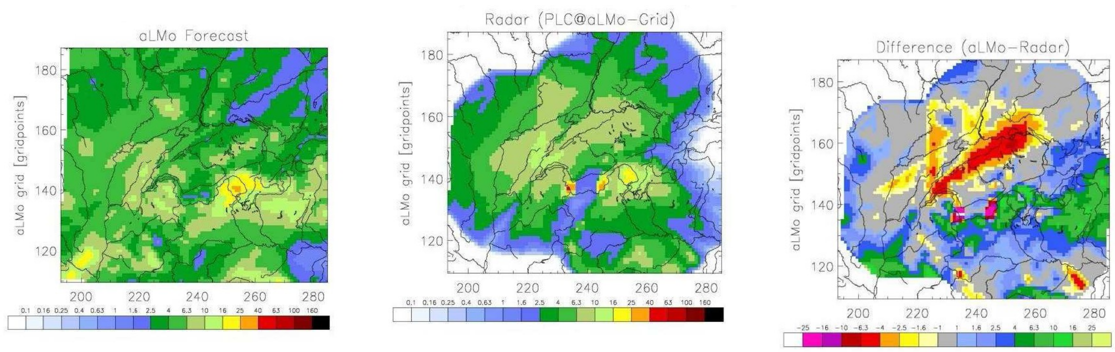

Figure 5: Precipitation sum for the southwest weather situation, (a) aLMo forecast, (b) Swiss radar composite, (c) model bias.

Large regional differences can be observed (e.g., wind speed for all stations and for Alpine stations only, respectively), as can many other interesting features.

2.2 Verification of aLMo precipitation forecast using radar composite network (WP 5.4.2) [Emanuele Zala]

A weather situation-dependent verification of aLMo precipitation based on Swiss radar composite data was performed over the climatic year 2004. Two weather classification were used: the Schüep classification (Schüep 1979), which is used daily by MeteoSwiss forecast office, and a simple experimental classification based mainly on 500 hPa winds and surface pressure distribution over the alpine region. Both classifications deliver similar results, the signal however is clearer in the experimental classification.

Main results:

- significant differences of aLMo QPF for different weather classes
- confirmation of the aLMo QPF overestimation over the relief, but only in situations with advection (Fig. 5)
- significant underestimation of precipitations over Swiss plateau, specifically in SW regimes (Fig. 5)
- generally good performance in situations with weak advection.

2.3 Verification with wind profilers [Dominique Ruffieux]

Wind speed and wind direction are verified on a daily basis for Payerne with wind profiler and radio soundings (Fig. 6). For Kloten, profiles have been verified with a wind profiler from autumn 2004 to Spring 2005.

3 Verification of different test suites

3.1 Hourly boundary conditions [Guy de Morsier]

During the Olympic and Paralympic Games of summer 2004 (from August 4 to September 30), ECMWF increased the update frequency of the LBCs from 3 to 1 hour. The largest impact of this higher frequency was found in the upper-air verification of the geopotential field (Fig. 7). Although some impact was also present in the temperature, wind speed and slightly in the wind direction after a forecast time of 24h, there was no signal in the humidity

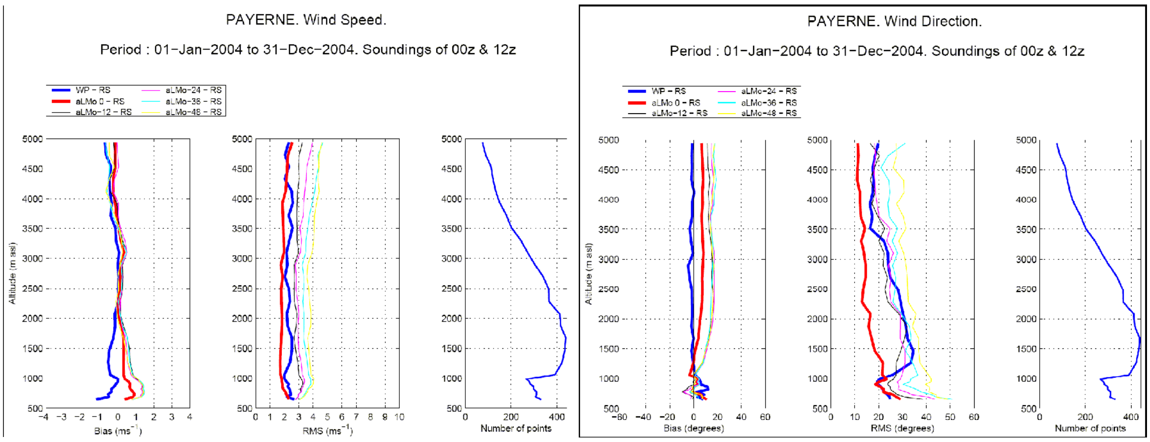

Figure 6: Verification against profiler data of (a) wind speed and (b) wind direction.

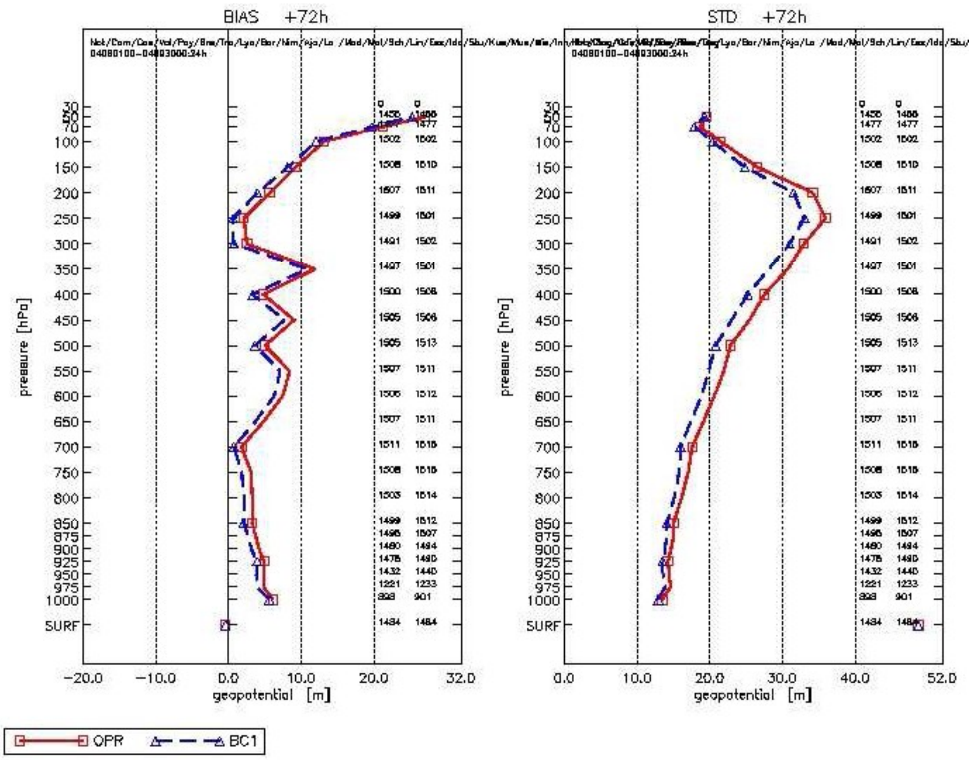

Figure 7: Vertical profile of geopotential height bias (left) and standard deviation (right) for winter 2004/5.

fields. The success of this first test suite with hourly LBCs was quite remarkable for a summer period.

Last winter (from January 5 to February 7, 2005) a second test phase was started at ECMWF. MeteoSwiss took this opportunity to run another parallel test suite of aLMo with hourly LBCs and to compare it with the production suite. This time the positive impact on the geopotential field could only be found for 6 TEMP stations west of the Alps and only for the standard deviation of the errors. This result was somewhat disappointing, as we expected the most positive impact of the hourly BC during strong winter synoptic developments. A problem could be the inadequacy of our local verification based on low frequency observations (SYNOPs each 6h and TEMPs each 12h).

A case study verification for the strongest storm during this winter period was then performed: It was the storm called Erwin (January 8, 2005) which caused a lot of damage in the UK, Denmark, Germany and Sweden. The forecasts valid at January 8, 2005 12UTC have been verified with SYNOPs and TEMPs. It was the time of the maximum development of the storm on the northern part of the domain. As opposed to our expectation, the results showed a greater standard deviation of the errors in the vertical structure of the geopotential and in the surface pressure for the forecasts with the hourly BC as compared to those with 3 hourly BCs. This suggests that a problem could also be the inadequacy of our relaxation scheme to cope with such high temporal non-linear BCs. The forecast with hourly BCs exhibits a greater bias over the northern part of the domain, although in the region with more than 12 hPa differences between forecast and analysis, the isolines in the hourly BC forecast are smoother and thus more realistic.

3.2 New LM-versions [Guy de Morsier]

In 2005 the following aLMo test suites have been verified with SYNOPs, hourly data from ANETZ and TEMPs (the verification has been documented on internal web pages that could be made available on request:

- LM version 3.15 with/without Rayleigh damping in the upper layers from 8-22/3/2005
- multilevel soil model (assimilation for March / April 2005; forecasts from 7-20/4/2005)
- lowest model at 10m and new vertical layering from 7-20/4/2005
- SLEVE (Smooth LEvel VErtical coordinates) for two periods (1-23/8/2004 and 7-20/4/2005)
- new divergence damping from A. Gassmann for two periods (1-23/8/2004 and 7-20/4/2005).

References

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