High Resolution Verification of Daily Cycle over Switzerland

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The following nomenclature for LM is used in the text below: aLMo means "Alpine Model", the LM version operational at MeteoSwiss and LMD means the operational LM version at DWD.

Results of aLMo and LMD have been computed monthly and seasonally for 2m-temperature, 2m-dewpoint and 2m-dewpoint depression, 10m-wind, precipitation (hourly sums for daily cycle and 6h sums for scores) and for cloud cover (3-hourly intervals).

Two of the main differences between aLMo and LMD are the prognostic TKE-scheme and the soil-moisture analysis (operational at DWD, but not at MeteoSwiss). Since 16 September 2003 aLMo runs with boundary conditions from ECMWF (IFS-frames) and it renders the interpretation of the differences with LMD (boundary conditions from GME) more difficult.

The following points are of main interest:

(1) The 2m-temperature cooling in the evening is too pronounced and there is a negative bias in Winter and Spring during night-time (up to 1.5-2.0 K in the late evening). The diurnal amplitude is too large (with the exception of Summer for gridpoints < 800m) and is a little bit larger in LMD than in aLMo. The daily maxima is reached ~ 1.5 hour too early. In LMD (with prognostic TKE and soil moisture analysis) the daily maxima is $\sim$ 1K higher than in aLMo (i.e the bias was littler in LMD especially in the hot Summer 2003 where aLMo's maxima was too low). See Figure 1 (left side) for results of Winter 2002/2003 and Summer 2003 for gridpoints < 800 m.

(2) The daily cycle of 2m-dewpoint depression is not well reproduced and especially in Winter much too little (aLMo too moist during daytime and too dry during night-time). The TKE scheme, operational for LMD, corrects partly (in Summer and Autumn mostly) this cycle but the values are too low in Winter and Spring (constant negative bias, i.e. too moist). See Figure 1 (right side) for results of Winter 2002/2003 and Summer 2003 for gridpoints < 800 m.

(3) The results for precipitation are summarized in Table 1 with the scores for the frequency bias of the four seasons for the thresholds 0.1, 2, 10 and 30 mm/6h for aLMo and LMD. It shows an overestimation for low amounts (0.1 mm/6h) of 50-80% (except in Autumn only 30%): this overestimation is most pronounced in the Prealps (altitude range 800-1500m). The high amounts (10 mm/6h) are slightly underestimated by 10% (except during last Summer). In Summer there is a too strong diurnal cycle on the mountain gridpoints (due to a too pronounced convection at daytime) and the daily maxima are forecasted about 4h too early (see Figure 4). Differences between aLMo and LMD are little in Winter and Spring; during the hot and dry Summer 2003 aLMo gave $\sim$ 30% more precipitation (overestimation) than LMD, probably due to the missing of the soil-moisture analysis operational at DWD. Since Autumn 2003 the differences between aLMo and LMD are partly due to the different lateral boundary conditions (aLMo runs with IFS-frames) and the comparison between aLMo and LMD is not obvious. Table 1 shows also the scores for the test period (23.05-31.08.03) where aLMo run both with boundary conditions from GME and IFS (each with an own assimilation cycle). The overestimation of precipitation in aLMo is partly removed with the IFS-frames.

Table 1: Frequency bias (%) of predicted precipitation over Switzerland. For all 6-h sums from + 6h till + 48h of all 00 UTC and 12 UTC forecasts, compared to 69 ANETZ stations. The LM precipitation is the mean over 5 gridpoints. For the high amounts (10 and 30 mm/6h) the percentage of occurrences (%) is given. The columns give the values for the four seasons and (on the right part) for the period where aLMo run both with GME- and IFS-boundary conditions.

Threshold	**Winter 2002/3**	**Spring 2003**	**Summer 2003**	**Autumn 2003**	23.05 - 31.08.03 **aLMo-opr**	**aLMo-IFS**
0.1 mm / 6 h						
aLMo	157	168	189	129	198	181
LMD	154	162	150	129	162	–
2.0 mm / 6 h						
aLMo	127	128	144	101	158	143
LMD	124	121	112	109	123	–
10 mm / 6 h	0.94	0.88	1.82	1.88	1.79	–
aLMo	91	89	110	81	118	100
LMD	87	83	77	115	84	–
30 mm / 6 h	0.021	0.038	0.126	0.143	0.117	–
aLMo	77	47	245	94	263	223
LMD	59	53	140	178	132	–

(4) Verification of 10m-wind (for representative stations corresponding to a gridpoint < 800m) gave an overestimation of the wind speed of $\sim$ 0.5-0.8 m/s both in aLMo and LMD (except in Summer daytime with almost no overestimation). The diurnal cycle is qualitatively better in LMD (due to TKE-scheme) but the daytime values are even higher, i.e. positive bias greater (see also COSMO Newsletter 2, page 201). For the gridpoints > 1500m the wind speed is strongly underestimated, due to the same PBL-parametrization over mountains than over flat terrain. See Figure 2 for results of Winter 2002/2003 and Summer 2003 for gridpoints < 800 m.

The mean error in 10m-wind direction (verified for observed wind speed > 3 m/s) is very little, in the range of +5 to +10 degrees (i.e. a little bit biased in clockwise direction). During Summer the errors are a bit larger (up to 15 degrees during night-time).

(5) The diurnal cycle of total cloudiness is not well reproduced in Spring and Summer: there is a positive bias during the night (up to 0.5-1.0 octa). Results in aLMo and LMD are very similar. See Figure 3 for results of Winter 2002/2003 and Summer 2003 for gridpoints < 800 m and > 1500m. In Winter the low cloud amount (stratus) seems quite well reproduced at analysis time in aLMo and LMD (due to the nudging assimilation scheme): the cloud amount for gridpoints < 800 is 1 octa higher than for those > 1500 m (in the observation even 2.3 octa). It is interesting to compare the following two behaviours on the diurnal cycle for mountain gridpoints in Summer: missing of the cycle for cloud cover and much too exaggerated cycle for precipitation (See Figure 4). It could suggest that cloud amount in convective situations is too low.

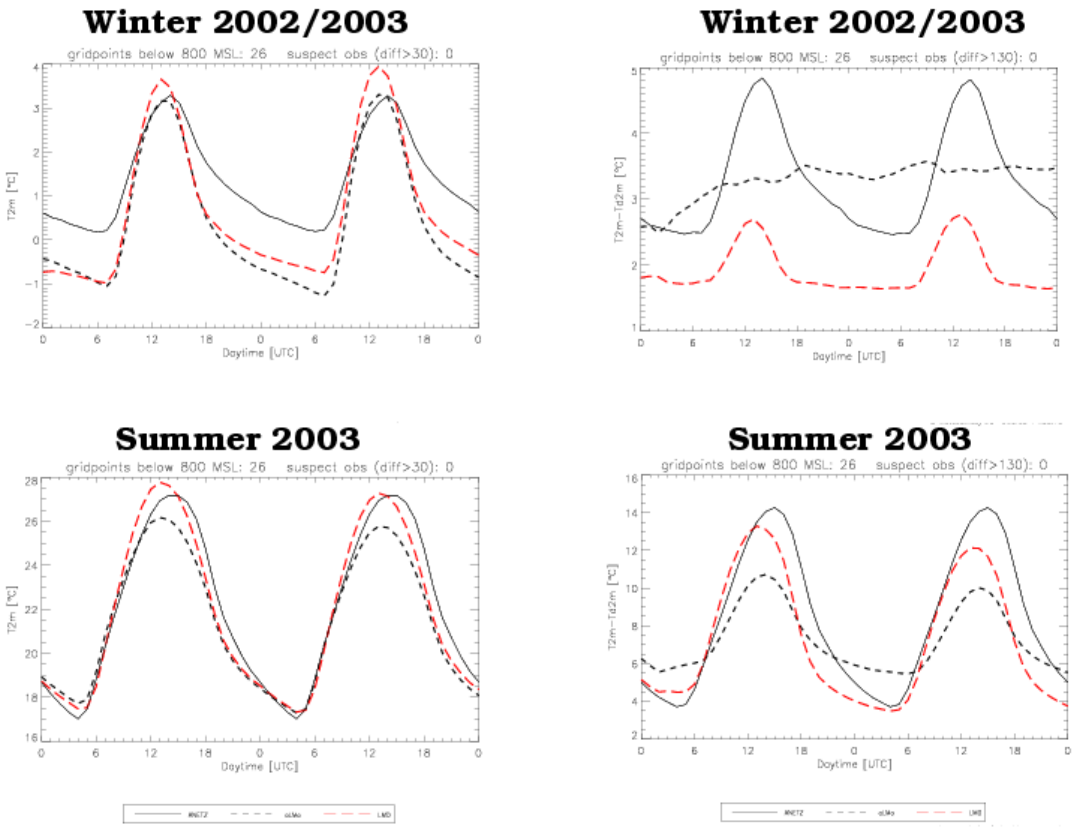

Figure 1: Verification of the daily cycle of 2m-temperature (left) and 2m-dewpoint depression (right) for gridpoints < 800m over Switzerland in Winter 2002/2003 (upper part) and Summer 2003 (lower part). Observations (ANETZ): full line black; aLMo: black dashed; LMD: red long dashes.

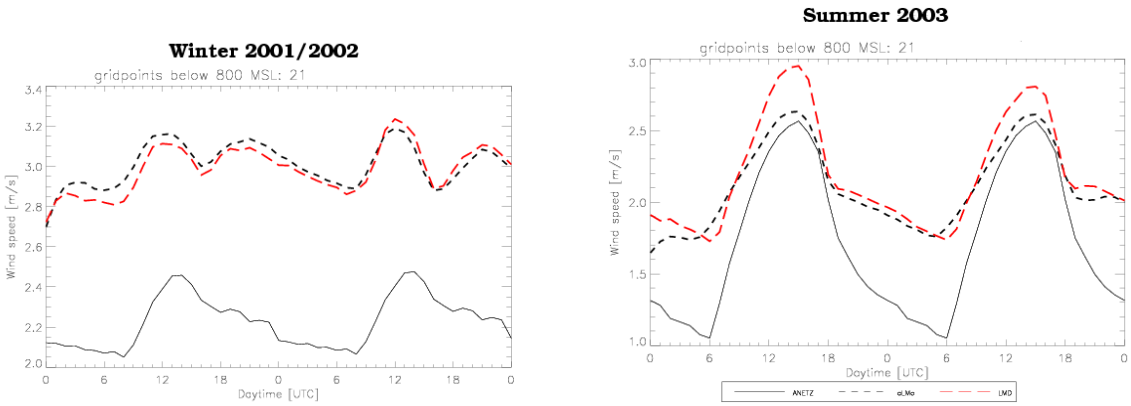

Figure 2: Verification of the daily cycle of 10m-wind speed for gridpoints < 800m over Switzerland in Winter 2002/2003 (upper part) and Summer 2003 (lower part). Observations (ANETZ): full line black; aLMo: black dashed; LMD: red long dashes.

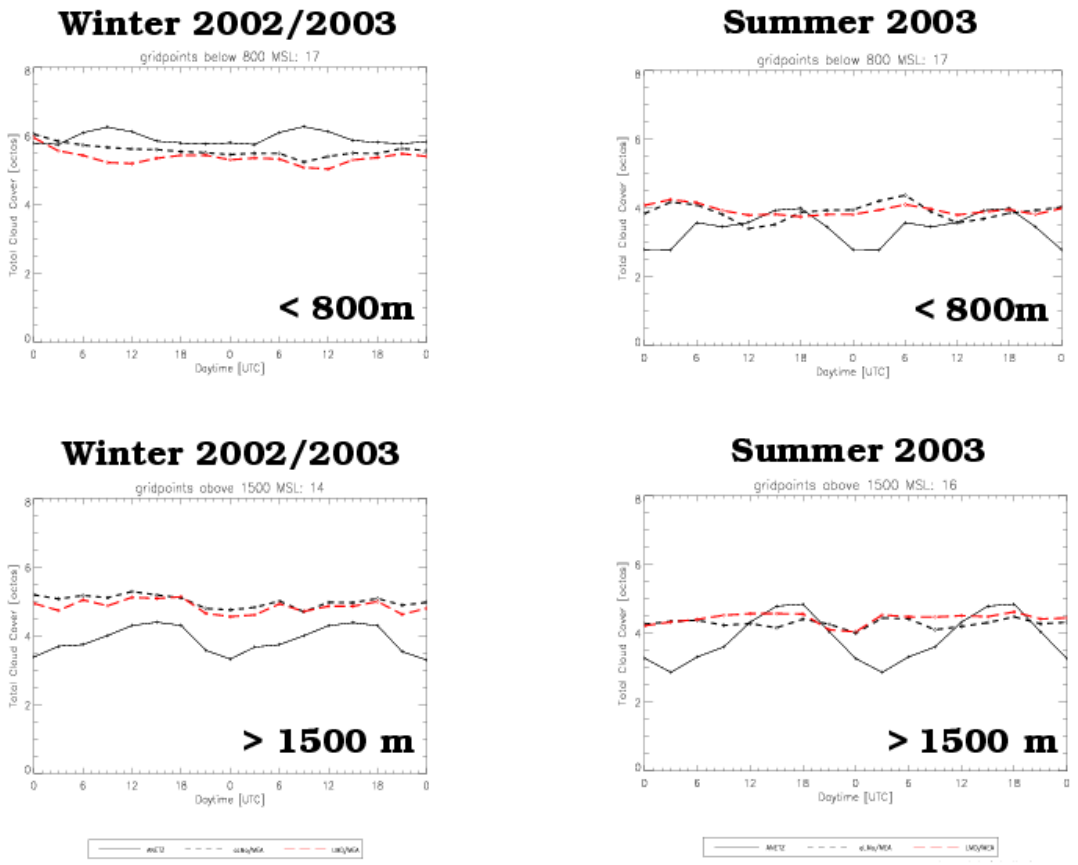

Figure 3: Verification of the daily cycle of total cloud cover over Switzerland in Winter 2002/2003 (left) and Summer 2003 (right) for gridpoints < 800m (upper part, 17 locations) and for gridpoints > 1500m (lower part, 16 locations). Observations (ANETZ): full line black; aLMo: black dashed; LMD: red long dashes. The LM total cloud cover is the mean of 41 gridpoints around the observation station and for three hours, to take in account that an observer sees in the mean a sky radius of ∼ 30 km.

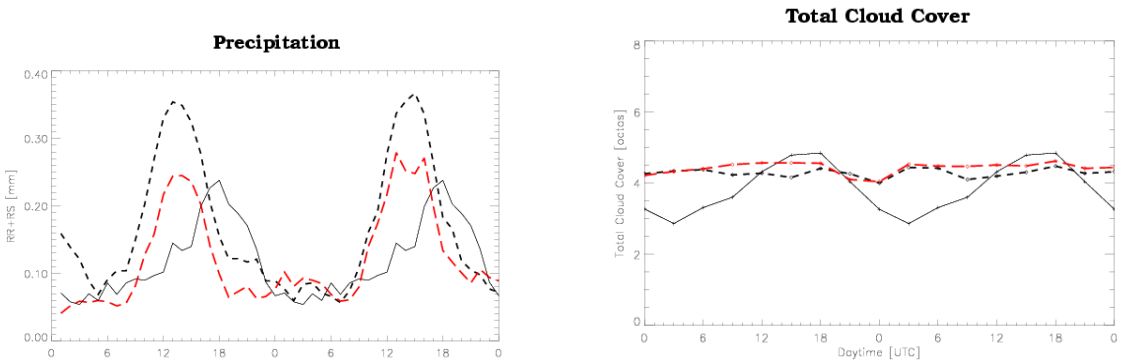

Figure 4: Verification of the daily cycle of precipitation (upper part) and total cloud cover (lower part) for gridpoints > 1500m over Switzerland in Summer 2003. Observations (ANETZ): full line black; aLMo: black dashed; LMD: red long dashes.