Work package 3.8.1: Cause for Precipitation Differences between LM Runs at MeteoSwiss and DWD

Marco Arpagaus

MeteoSwiss, Krähbühlstrasse 58, 8044 Zurich, Switzerland

1 Summary

The precipitation differences seen between the operational LM implementations at MeteoSwiss and DWD essentially vanished after MeteoSwiss introduced a nudging assimilation cycle and DWD switched to the new 4^{th} order linear monotonic horizontal diffusion scheme with orographic limiter in late 2001, resulting in only minor (with respect to predicted precipitation ...) configuration differences between the two operational LM suites.

2 Report

Work package 3.8.1 for the COSMO period 2002 was put up to answer the following question: "The precipitation amounts over Switzerland are very different for the operational LM versions run at MeteoSwiss and DWD — Why?"

Table 1 summarises the average monthly precipitation amounts over Switzerland for different months of 2001 and 2002, predicted by the LM version run at MeteoSwiss ("aLMo") and DWD ("LMD"; columns one and two), respectively, together with the average and the difference (aLMo – LMD) of these numbers and the ratio "difference"/"average" (columns three to five). As an indicator for the observed differences (*c.f.* report by Francis Schubiger in COSMO Newsletter 2, 59–60), we refer to the ratio difference/average: large numbers (coloured in red for values above 0.3) are obtained for May up to October of 2001.

A number of model configurations, which were different for the LM implementations at MeteoSwiss and DWD at the time, have been tested to check whether they could explain the significant differences:

- The number of vertical levels (45 at MeteoSwiss, 35 at DWD).
- Averaging of the forcing fields before calling the convection scheme (MeteoSwiss: on, DWD: off).
- Horizontal diffusion scheme (4^{th} order linear monotonic with orographic limiter at MeteoSwiss, 4^{th} order linear at DWD)
- Assimilation scheme (interpolation from GME for MeteoSwiss, LM nudging analysis for DWD).

Largest differences were observed for different assimilation schemes, followed by different horizontal diffusion schemes which caused minor differences. The impacts of the number of vertical layers and the averaging of the forcing fields before calling the cumulus parameterisation scheme were marginal.

For other reasons than eliminating the reported precipitation difference, both MeteoSwiss and DWD changed their operational configurations in October/November 2001: MeteoSwiss started to run a nudging assimilation cycle (31.10.2001) and DWD switched to the new 4^{th} order linear monotonic horizontal diffusion scheme with orographic limiter (8.11.2001), *i.e.*, the two configuration differences expected to explain at least some or even most of the large precipitation differences were changed. The effect was a substantial one, indeed: Table 1 documents that the large differences (*i.e.*, difference/average above 0.3) were not observed for the entire climatic year 2002!

month	**aLMo**	**LMD**	**avg**	**diff**	**diff/avg**
2000 12	33	28	31	5	0.15
2001 01	56	51	54	6	0.10
2001 02	54	43	49	11	0.22
2001 03	140	113	126	27	0.21
2001 04	90	72	81	18	0.23
2001 05	82	48	65	34	0.51
2001 06	122	86	104	35	0.34
2001 07	92	60	76	32	0.42
2001 08	81	46	63	35	0.55
2001 09	94	72	83	22	0.26
2001 10	45	29	37	16	0.42
aLMo starts from nudging LMD switches to new horizontal diffusion scheme					
2001 11	54	52	53	3	0.05
2001 12	52	59	55	–7	–0.13
2002 01	19	24	22	–4	–0.21
2002 02	82	87	85	–5	–0.06
2002 03	55	55	55	0	0.00
2002 04	43	41	42	2	0.05
2002 05	102	102	102	1	0.01
2002 06	90	73	82	18	0.22
2002 07	100	89	94	10	0.11
2002 08	92	82	87	10	0.12
2002 09	51	48	50	3	0.06
2002 10	57	60	59	–3	–0.04
2002 11	153	156	154	–3	–0.02

Table 1: Average predicted precipitation over Switzerland, in mm.

The same conclusion can be drawn from Table 2, which shows the average frequency bias (in %) for all 6-h precipitation sums from +6 h up to +48 h (average of forecasts started at 00 UTC and 12 UTC) compared to 69 automatic stations in Switzerland: the large differences observed in 2001, especially for high precipitation thresholds, have essentially disappeared.

	01q1	**01q2**	**01q3**	**01q4**	**02q1**	**02q2**	**02q3**	**02q4**
				threshold 0.1 mm/6 h:				
aLMo	139	137	148	130	164	151	157	112
LMD	121	112	107	112	176	141	141	114
				threshold 2 mm/6 h:				
aLMo	101	124	115	112	133	108	135	87
LMD	86	92	80	89	145	102	119	88
				threshold 10 mm/6 h:				
aLMo	69	113	93	105	106	69	96	66
LMD	52	66	51	72	123	70	87	68
				threshold 30 mm/6 h:				
aLMo	74	133	182	112	100	66	132	105
LMD	22	14	73	62	132	70	114	88

Table 2: Frequency bias (in %) of predicted precipitation over Switzerland. Average of all 6-h sums from +6 h until +48 h forecast time (average of forecasts started at 00 UTC and 12 UTC) compared to 69 automatic stations in Switzerland. The model precipitation is the mean over 5 grid-points.