Verification of Surface Weather Parameters at DWD

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1 Major Changes in the Operational Verification System

Starting with November 2002 verification for new elements was introduced into operational suite. These elements are:

– cloud cover for low clouds
– cloud cover for clouds with medium height
– cloud cover for high clouds
– gusts of 10m wind

Cloud covers for different heights are derived from the FM12 group NhClCmCh with N as the cloud cover of the lowest clouds. Gusts are the gusts within the W1W2-period, i.e. 6 hours before the observation for an observation hour of 00, 06, 12 and 18 UTC. For cloud covers the same verification procedure as for total cloud cover is used. For gusts thresholds of 12, 15, 20 and 25 m/s are used to calculate the traditional scores of contingency tables. The following graphics (Fig.1 – Fig.3) illustrate the typical output which is available for each month (Graphics are taken from the operational presentation in DWD-Inet. Therefore, legends are written in german.).

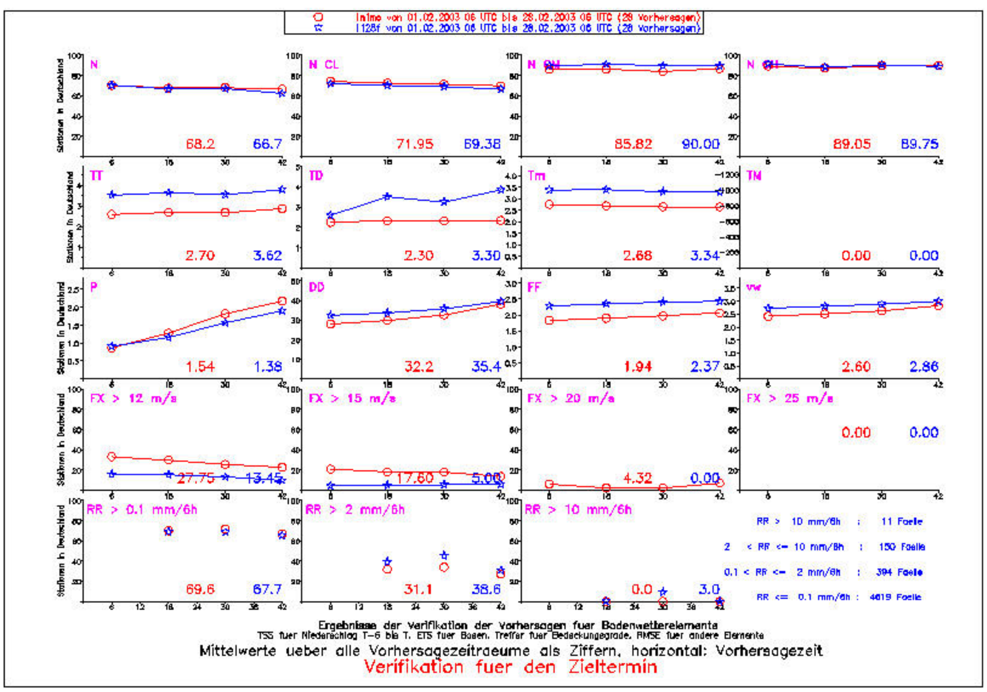

Figure 1: Percent correct for cloud covers, TSS for precipitation, ETS for gusts, Root mean square error for other elements (horizontal: forecast time, vertical: score).

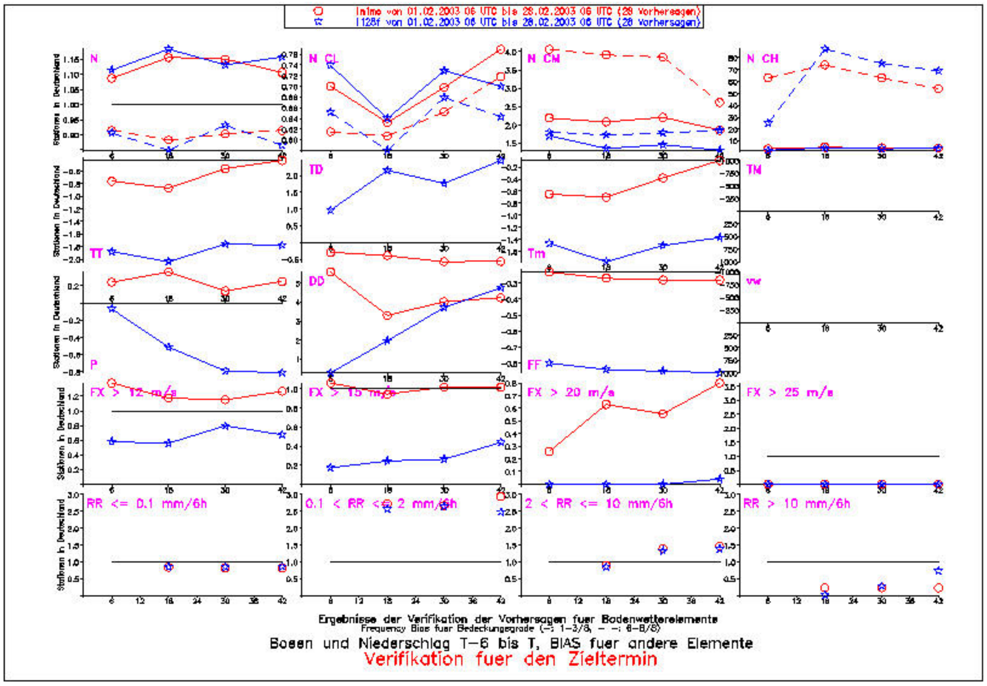

Figure 2: Frequency bias for cloud covers, precipitation, gusts; Bias for other elements (horizontal: forecast time, vertical: score).

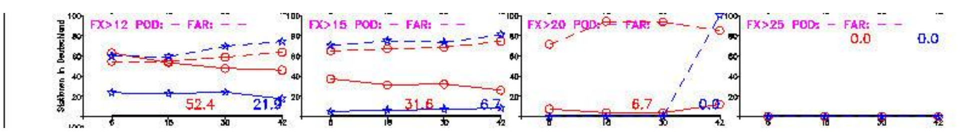

Figure 3: Probability of detection and False alarm ration for gusts (horizontal: forecast time, vertical: score).

2 Time Series of Forecast Quality During the Last two Years

The following graphics (Fig.4 – Fig.7) illustrate the temporal behaviour of forecast errors during the last two years. Valid times are 06 and 18 UTC.

From the graphics above the following main conclusions can be drawn:

- Cloud cover: best forecast results are got during winter periods, frequancy biases of low and high cloud covers are near 1. for the early morning. Low cloud covers are overestimated during the late afternoon (perhaps too long duration of convection).
- Cloud covers in different heights: Time series is too short to draw conclusions.
- Temperature: best forecasts for summer and autumn periods both for 06 and 18 UTC, worst for winter, biases relatively small for morning, strong negative bias for afternoon conditions, especially during winter time.
- Dew point depression: also best forecasts for summer and autumn periods both for 06 and 18 UTC, worst for winter, biases near zero for morning, too moist for afternoon conditions (The negative bias indicates underestimation of dew point depression.), especially during summer time.

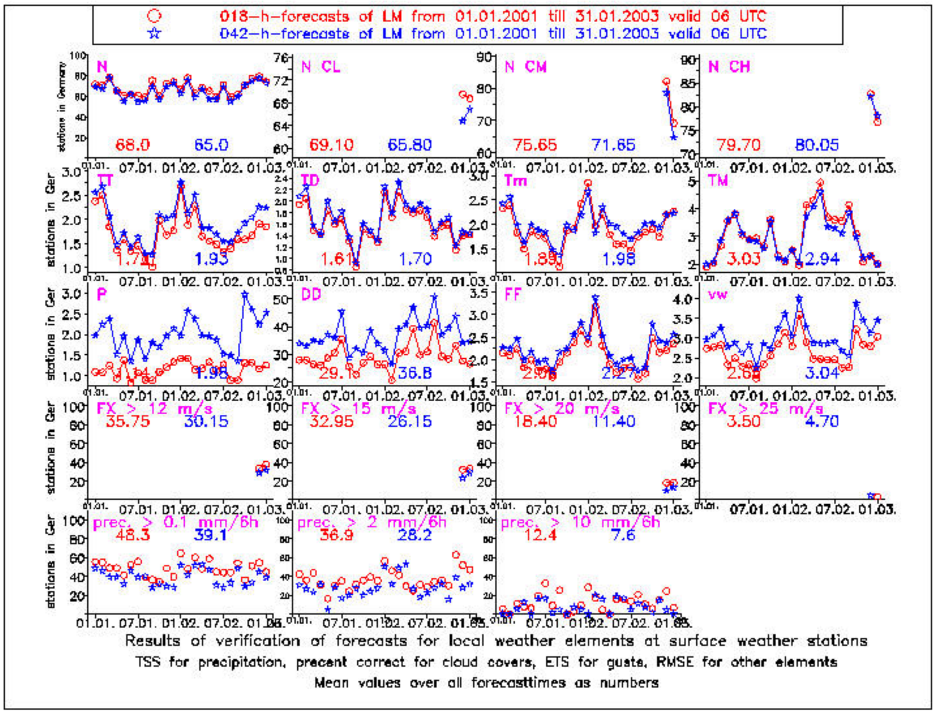

Figure 4: Percent correct for cloud covers, TSS for precipitation, ETS for gusts, Root mean square error for other elements (horizontal: time, vertical: score), valid time 06 UTC.

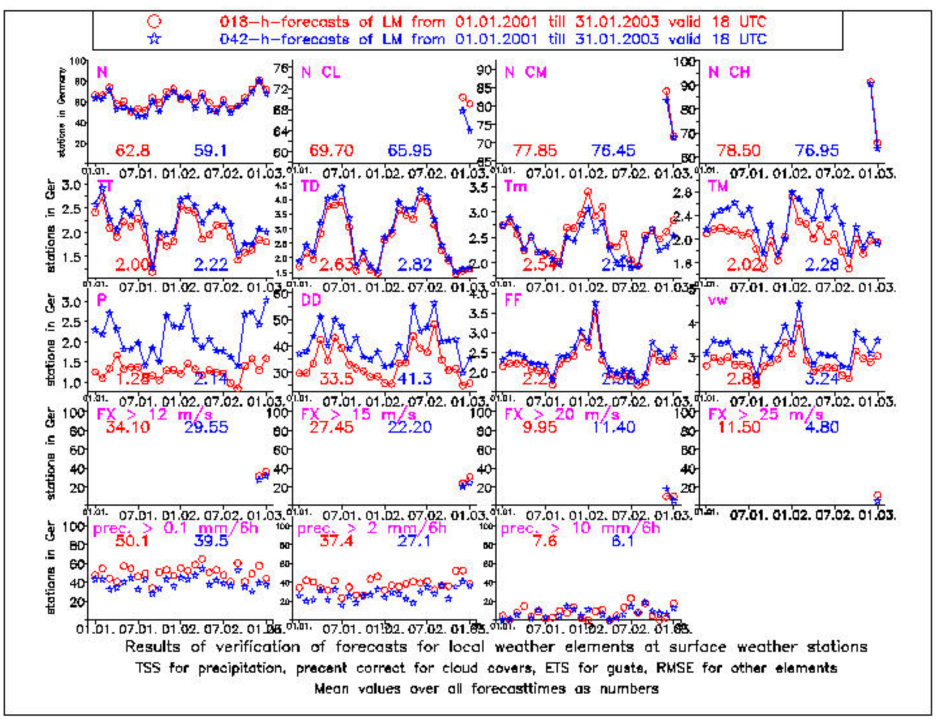

Figure 5: Percent correct for cloud covers, TSS for precipitation, ETS for gusts, Root mean square error for other elements (horizontal: time, vertical: score), valid time 18 UTC.

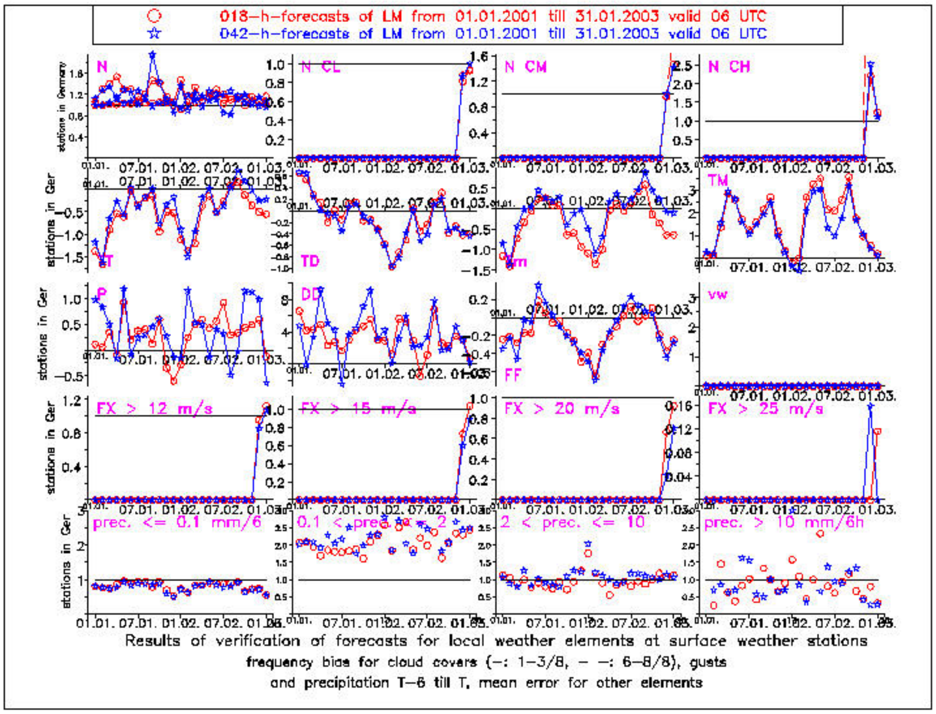

Figure 6: Frequency bias for cloud covers, precipitation, gusts, Bias for other elements (horizontal: time, vertical: score), valid time 06 UTC.

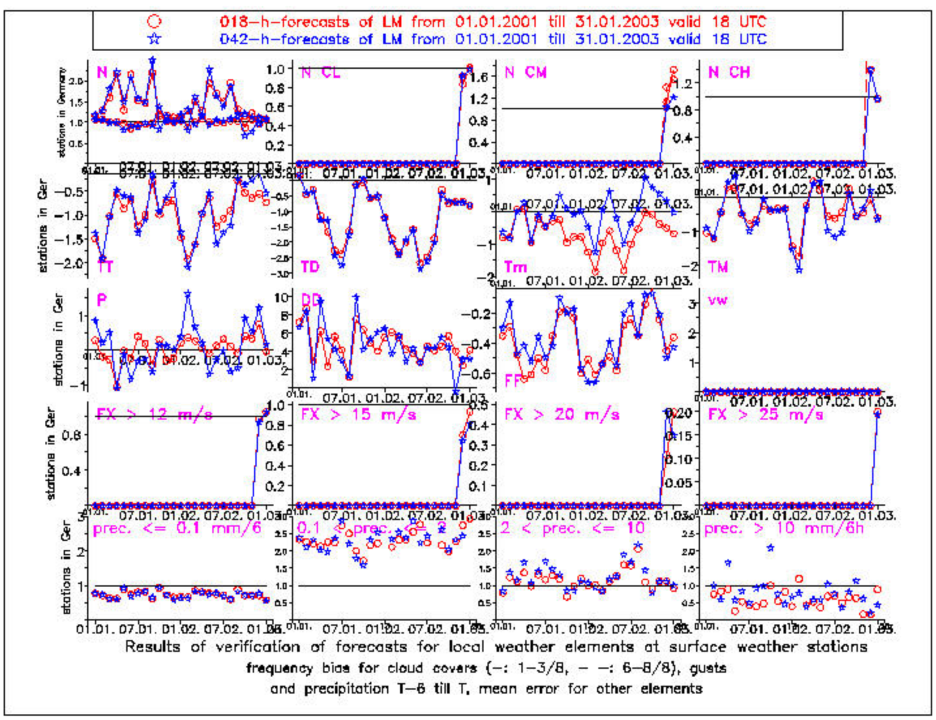

Figure 7: Frequency bias for cloud covers, precipitation, gusts, Bias for other elements (horizontal: time, vertical: score), valid time 18 UTC.

- Extreme temperatures: also best forecasts for summer and autumn periods both for 06 and 18 UTC (please note: Both minimum temperature Tm and maximum temperature TM are verified for valid times 06 and 18 UTC over Germany, because obeservations are available).
- Gusts: Time series is too short to draw conclusions.
- Precipitation: best forecasts during winter period, frequency biases indicate the overestimation of small precipitation amounts.

3 Diurnal Cycle of Forecasts and Observations for the Gridpoint Frankfurt/Main Airport

Graphics for diurnal cycles of different elements under different conditions for forecasted and observed cloud covers (see Fig.8 – Fig.11) demonstrate the following main properties in the model forecasts:

- Temperature: relatively good forecasts for summer conditions, better forecasts in January 2003 than in January 2002, problems of overestimation of temperature in cases of high cloud cover during summer months did not occur systematically. Old problem: phase shift of diurnal temperature wave, too fast decrease of temperature during afternoon, too fast increase during morning
- Dew point temperature: during winter overestimation of daily amplitude, too moist around noon, too dry during night; during summer good forecasts for the early morning, then generally too moist.

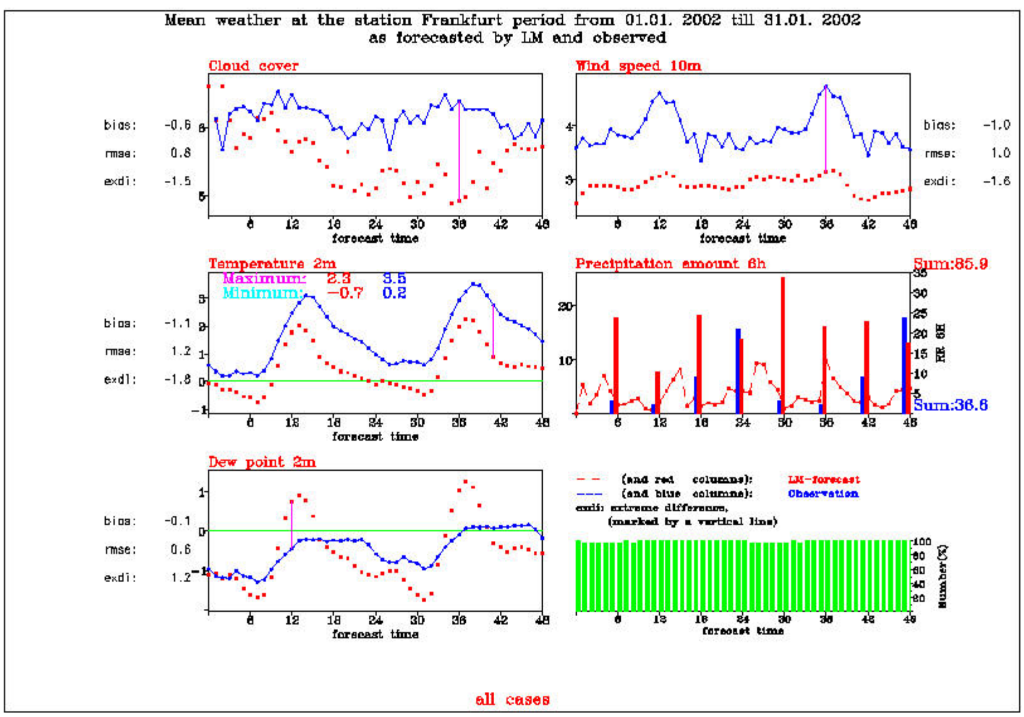

Figure 8: Diurnal cycle of different surface weather elements for the gridpoint Frankfurt/Main airport for January 2002.

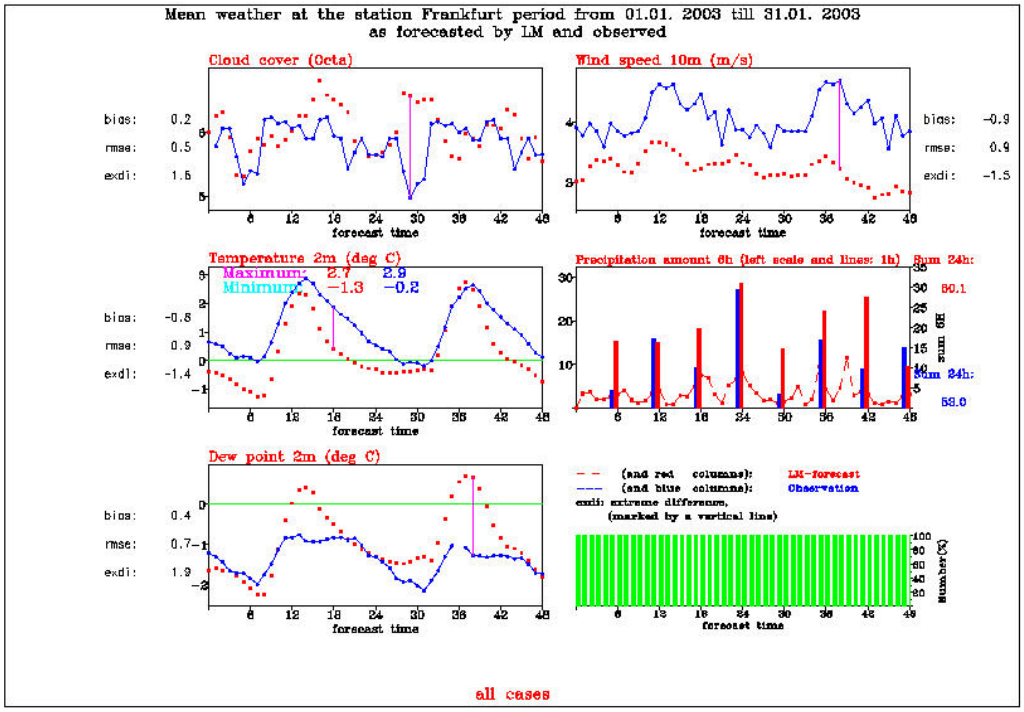

Figure 9: Diurnal cycle of different surface weather elements for the gridpoint Frankfurt/Main airport for January 2003.

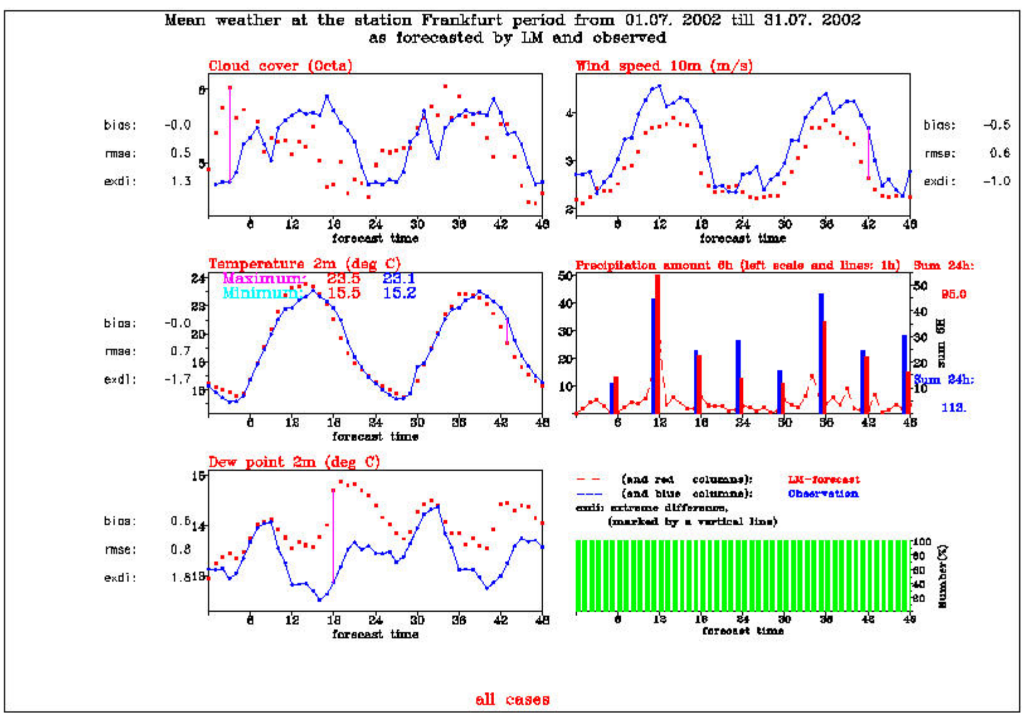

Figure 10: Diurnal cycle of different surface weather elements for the gridpoint Frankfurt/Main airport for July 2002.

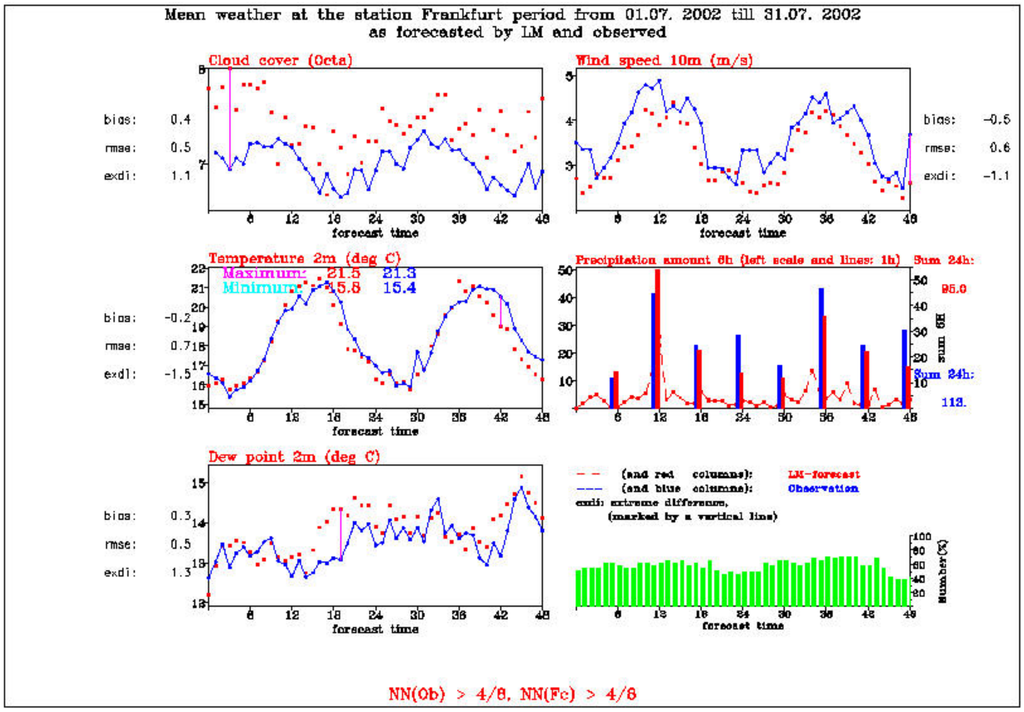

Figure 11: Diurnal cycle of different surface weather elements for the gridpoint Frankfurt/Main airport for July 2002, for high cloud covers observed and forecasted.

- Wind speed: small underestimation during winter for all forecast times; during summer: small underestimation of daily amplitude with good forecasts during night and underestimation during day.
- Cloud cover: Averaged values are no estimate of the expected mean value of a Gaussian distribution because of limitations of cloud cover. Therefore, mean values cannot be interpreted in a statistical sense.

4 Results of QPF Verification Using Stations of the High Density Network

The following Figures 12 – 17 demonstrate the behaviour of LM precipitation forecasts over the southwestern part of Germany. They illustrate the following main properties of forecasted precipitation over a region with small scale orography:

- The effect of decreasing precipitation on the leeward side of obstacles is overestimated. Precipitation amounts in these regions are too small.
- The effect of increasing precipitation on the windward side of obstacles is overestimated, especially during wintertime and over regions with strong gradient of orography. Precipitation amounts over these regions are too high. There is a shift of maximal precipitation in forecasts to the windward side compared to the observations.

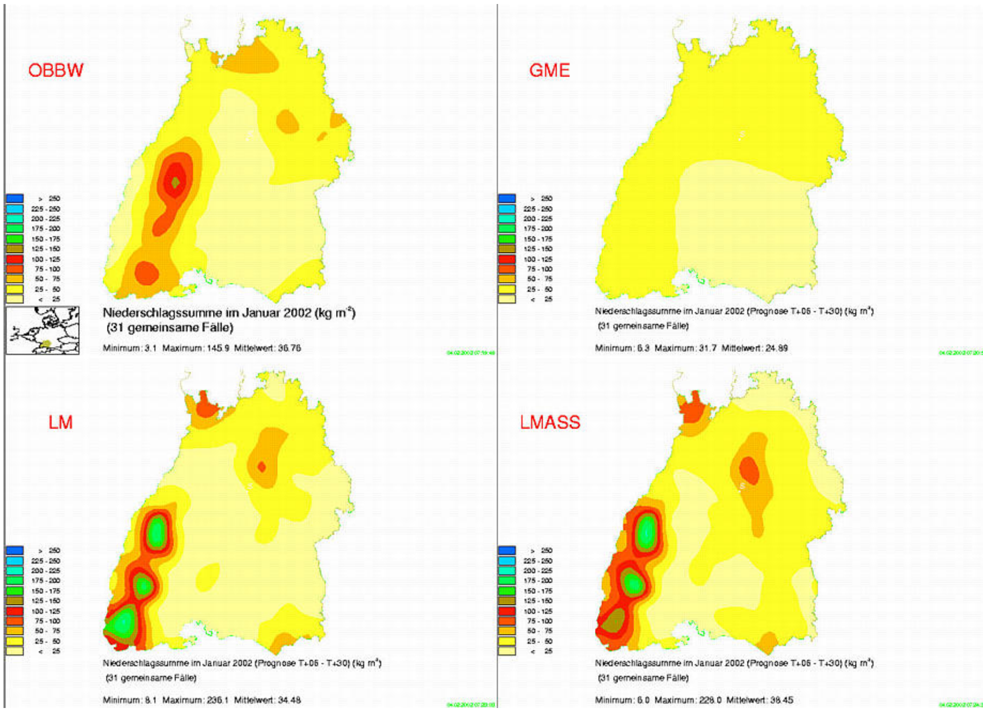

Figure 12: Horizontal distribution of observed and forecasted precipitation amounts during January 2002 over the southwestern part of Germany (OBBW: observation, GME: global model, LMASS: assimilation run of LM).

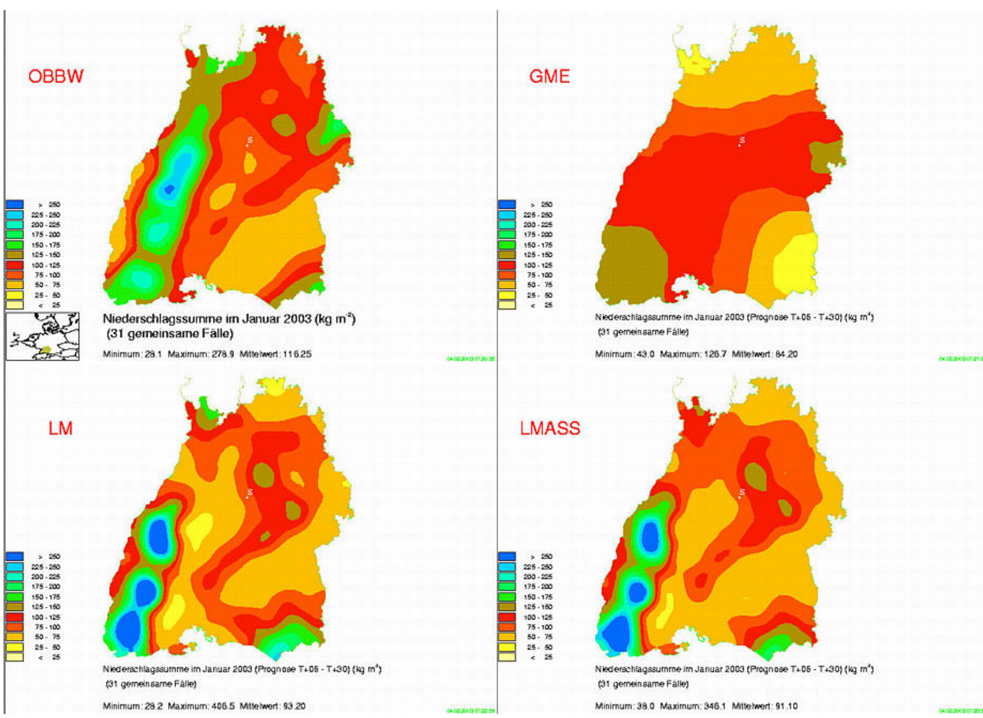

Figure 13: Horizontal distribution of observed and forecasted precipitation amounts during January 2003 over the southwestern part of Germany (OBBW: observation, GME: global model, LMASS: assimilation run of LM).

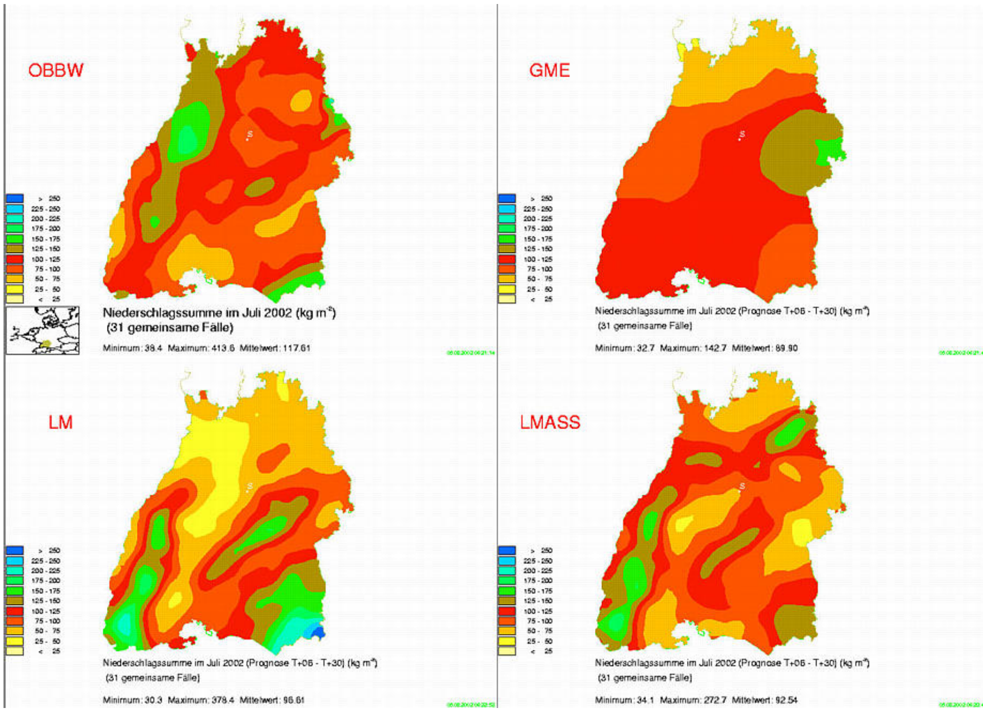

Figure 14: Horizontal distribution of observed and forecasted precipitation amounts during July 2002 over the southwestern part of Germany (OBBW: observation, GME: global model, LMASS: assimilation run of LM).

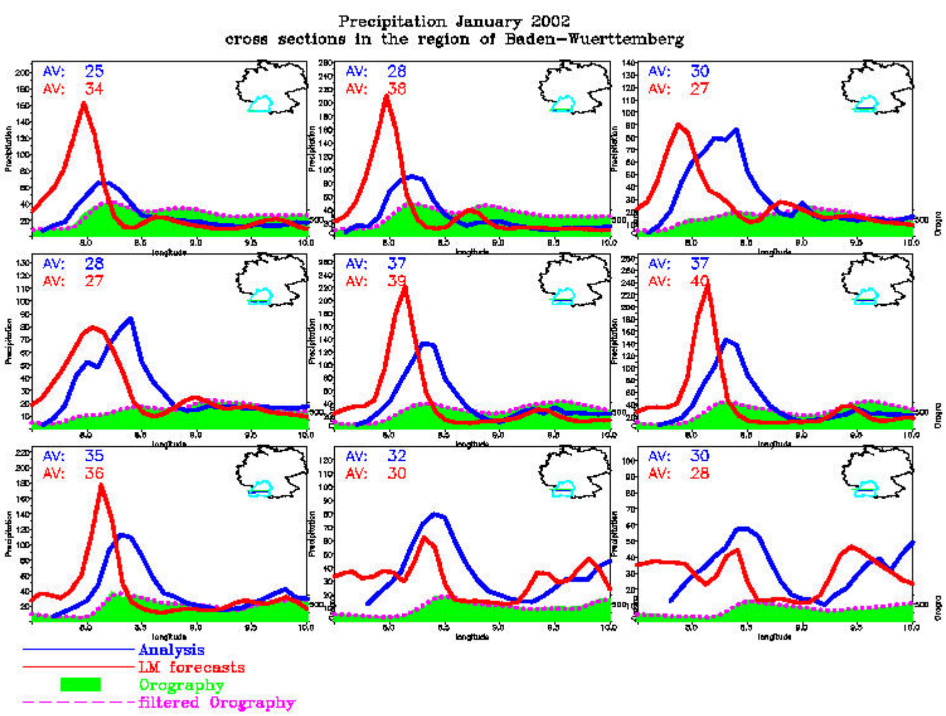

Figure 15: Cross sections of observed and forecasted precipitation amounts during January 2002 over the southwestern part of Germany.

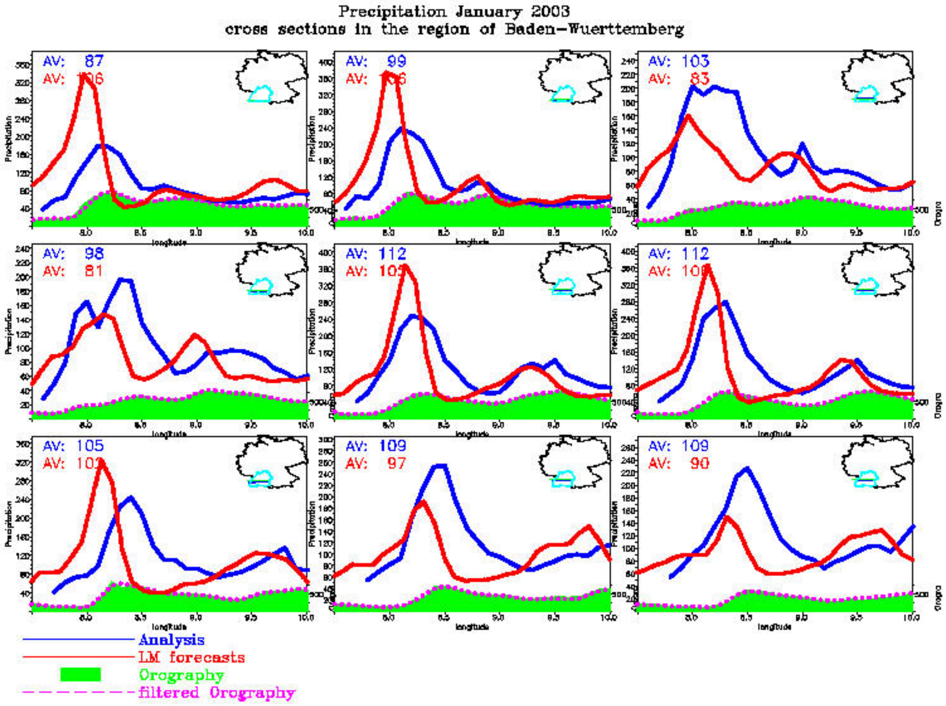

Figure 16: Cross sections of observed and forecasted precipitation amounts during January 2003 over the southwestern part of Germany.

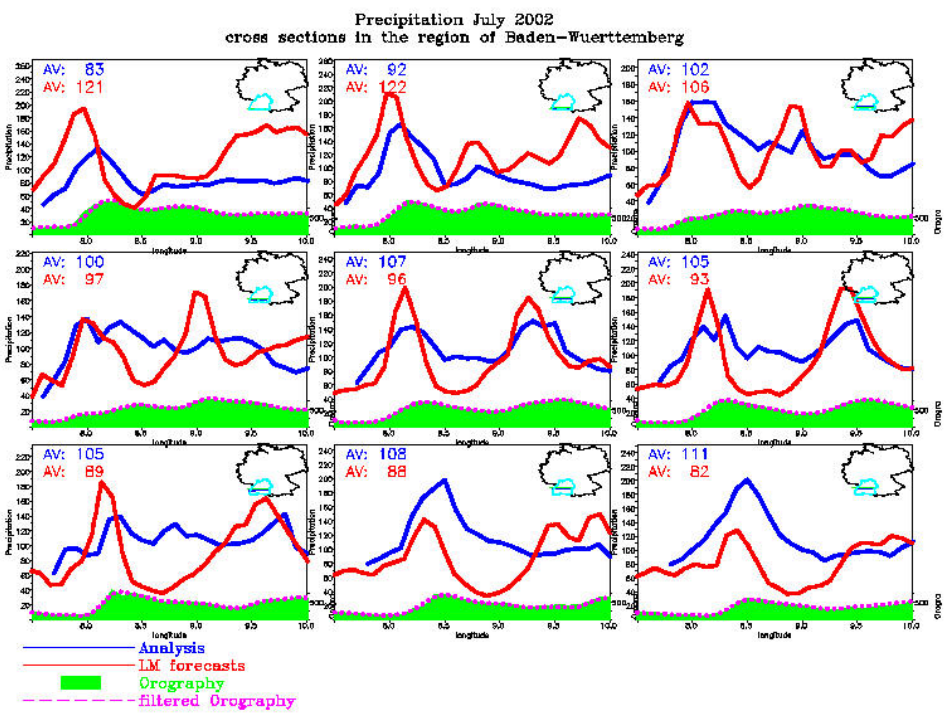

Figure 17: Cross sections of observed and forecasted precipitation amounts during July 2002 over the southwestern part of Germany.

Verification of Surface Weather Parameters at MeteoSwiss

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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.

1 High Resolution Verification of Daily Cycle over Switzerland

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). One of the main differences between aLMo and LMD is the prognostic TKE-scheme, operational at DWD, but not yet at MeteoSwiss. During 2002 several test versions of aLMo have been verified, such as the cloud ice scheme, the prognostic rain scheme and the multi-layer soil scheme. For latter: see report *Verification of the New LM Version LM 2.18 with Prognostic TKE and Multi-Layer Soil Model* in Section 9 of this Newsletter, which includes also Figures of operational verification of aLMo and LMD for Summer 2002.

The following points are of main interest:

- The 2m-temperature cooling in the night is too pronounced and the diurnal amplitude is too large (with the exception of Summer for gridpoints $<$ 800m) and the daily maxima is reached $\sim$ 1.5 hour too early. In LMD the diurnal amplitude was even $\sim$ 0.5 K larger than in aLMo (except in Winter). The 2m-temperature negative bias is most pronounced in Winter during nighttime: it was of the order of 2.5K for gridpoints $<$ 800m in the Winter 2001/2002 (but only 1.2 K in LMD with the TKE-scheme).
- The daily cycle of 2m dewpoint depression is much too little (aLMo always too dry during nighttime) and the daily cycle is not well reproduced. The TKE scheme, operational for LMD, corrects these errors.
- The results for precipitation are summarized in Table 1 with the scores of 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% (except Autumn). The high amounts (10 mm/6h) are underestimated, especially during the last Autumn (by 30%) when these cases where more frequent (4.2% of all cases). In Summer there is a strong diurnal cycle on the mountain gridpoints, that is not observed (due to a much too pronounced convection at daytime) and for gridpoints $<$ 800m the daily maxima are forecasted too early and are too high. Differences between aLMo and LMD, observed during 2001, were much littler during 2002: aLMo gave $\sim$ 10% less precipitation than LMD in winter, in spring aLMo gave $\sim$ 5% more and in summer 15% more than LMD, in autumn the amounts of both models were very similar. This means that the introduction of the nudging assimilation in aLMo in November 2001 solved the problem of great differences between both models (see report "WP3.8.1" by Marco Arpagaus in Section 9 of this Newsletter).