A comparison of DMO and statistical adapted quantitative areal precipitation forecasts from different NWP-models

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Different costumers have a great interest in precise precipitation forecasts. These quantitative forecasts are often taken as input for hydrological models, which should provide chance to estimate the flow of the rivers in near future.

It is known, that there is some lack in the quantitative precipitation forecasts, especially in cases of moderate and heavy precipitation. Due to the different spatial resolution of global and limited area models the characteristics of the precipitation forecasts are different. For the former it is known, that there is tendency for underestimate peak orographic precipitation amounts, while for the latter overestimation is quite a common property especially in mountainous areas. For this reason some attempts were made to improve the forecast quality in using statistical methods, like MOS-technique, PPM or simple statistical combination of forecast results from these two kinds of NWP-models.

For this study the global model of ECMWF and the limited area model ALADIN/Lace were chosen. ECMWF-model is very suitable for statistical adaptation methods, cause a long time series is available.

For above mentioned reasons it also seems logical, that a combination of the forecast values should give the opportunity to make some step towards a more precise forecast of precipitation amount.

For the purpose of this study Austria was divided into 26 regions, which were chosen after hydrological criteria.

Due to the fact that Austria has numerous types of different landscapes, these areas include flat areas, alpine foreland (=upslope precipitation) areas and inneralpine areas as well.

For combining the two forecasts a simple weighing method was used.

$$RR = w * rrecm + (1 - w) * rrala \qquad (1)$$

with:

RR .... final forecast

rrecm ..... ECMWF-forecast

rrala ..... ALADIN-forecast

w .... weighting factor

The dataset used in this study consists of 6-hour precipitation forecasts from January 1997 to March 2000 from both models and the forecast range reaches from +6 up to +48 hours for ALADIN and for +18 up to +64hours for ECMWF model.

The optimal weighing factor was calculated from the dataset in such a way, that the mean absolute error of the 6-hour forecast should be a minimum. The weighting factor itself is a function of the forecast precipitation category (3 different categories for each model). This means that for different amounts of forecast precipitation different weighting factors occur.

As a final result of the calculating procedure one obtains 9 different weighing factors for each area. For one specific forecast linear interpolation between these 9 values takes place.

In the following figures 1-4 some results are presented for the combined model compared to the basic models for different regions.

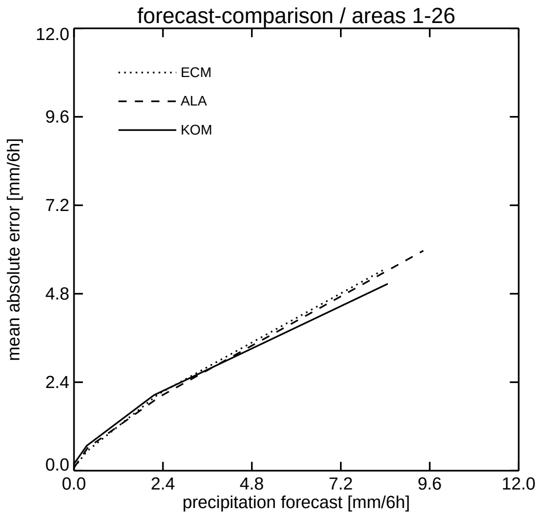

Figure 1: comparison of the mean absolute error for the ECMWF, ALADIN and the combined model for 6-hour precipitation – average over all areas

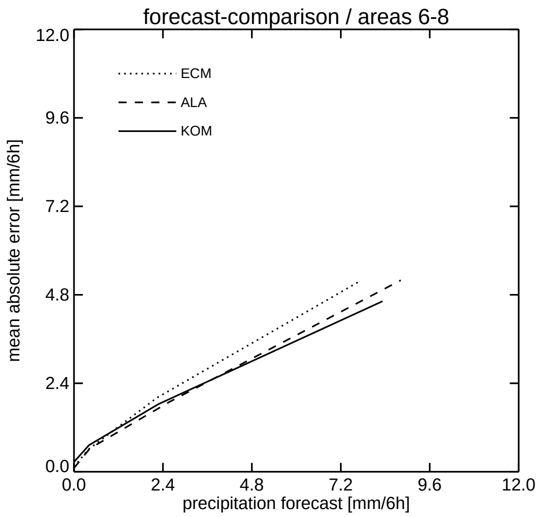

Figure 2: comparison of the mean absolute error for the ECMWF, ALADIN and the combined model for 6-hour precipitation – average over northern upslope precipitation areas

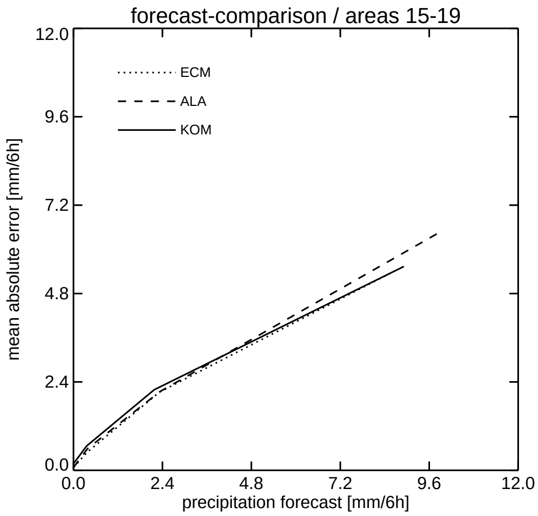

Figure 3: comparison of the mean absolute error for the ECMWF, ALADIN and the combined model for 6-hour precipitation – average over southern upslope precipitation areas

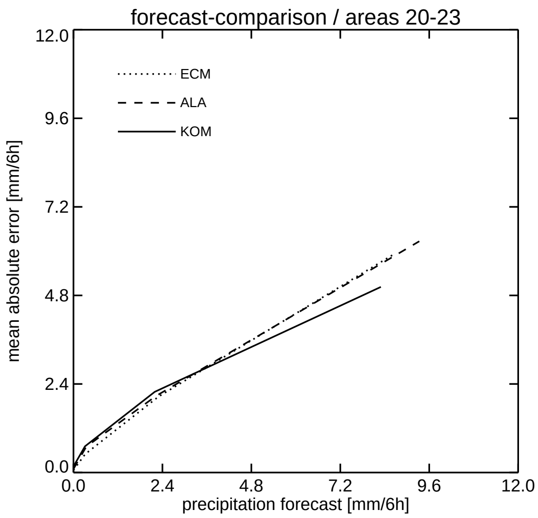

Figure 4: comparison of the mean absolute error for the ECMWF, ALADIN and the combined model for 6-hour precipitation – average over flat/hilly regions in the north east

It can be seen from Figures 1-4 that the improvement of the combined forecast is significant only at higher precipitation amounts ($\geq$5mm/6h). The reason for this can be explained as follows. The statistical method, based on minimizing the mean absolute error, gives more weight to the model which forecasts smaller amounts. Consequently, the number of cases in which high precipitation amounts are predicted is reduced. In other words, high precipitation amounts are predicted by the combined model only if both models give significant precipitation for the same time period. The number of cases in the smaller categories is increased in the combined model as compared to the individual models, i.e. many events 'shift to the left' in Figures 1-4, taking their relatively high error (resulting from underestimation) with them.

It was assumed that especially in mountainous areas the complementary behaviour of the two models would allow for improvements by model combination, but this turned out to be only partially true. In cases where both models forecast comparable precipitation amounts with a similar temporal and spatial pattern, the method works quite good, but the number of these situations is too small to compensate for those where differences between the models are very large.

As one tries to improve DMO by MOS-technique there occurs something similar. If the MOS is tuned in that sense, that it should focus mainly on the heavy precipitation events one obtains a higher POD(Probability of Detection), but has to accept that the FAR (False Alarm Rate) also increases. This could be understood as an 'risky' MOS, which is good for detecting most of the heavy events. If one compares the MAE's (Mean Absolute Errors), then one will find that a conservative MOS is more suitable to get a lower MAE.

Conclusion: The combination-method described in this paper gives moderate improvements of quantitative precipitation forecasts in cases of moderate to heavy precipitation. However, this gain is largely a result of a more conservative behaviour of the combined model (compared to the individual models) in such cases. This means that the FAR is being reduced, but at the cost of a decrease of the POD.

For the common statistical adaptation methods MOS and PPM the results show, that there also slight improvements can be reached, but still it is not possible to significantly reduce the forecast-errors with such methods. The reason for this could probably be found in the fact, that the forecasted precipitation amounts do not include a high systematic error, cause if this would be the case statistical methods should give better results.