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Development and application of a quality-index composit

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1 Introduction

At the German Weather Service “Deutscher Wetterdienst” (DWD) a kilometre-scale numerical-weather-prediction system (LMK) for very short range forecasts (2h - 18h) is developed. The LMK has a grid-spacing of 2.8 km with about 50 vertical layers and an integration domain of about 1300 x 1300 km², which includes Germany and the surrounding areas. The system focuses on a model-based prediction of severe weather events on the meso-gamma scale, especially those related to deep moist convection or to interactions with fine-scale topography. To trigger the deep convection, assimilation of structures on the meso-gamma scale is necessary. At DWD the method of latent heat nudging is used. For this purpose high resolution and quality controlled radar precipitation composits are needed. To enhance the data quality an algorithm for the detection of radar errors was developed. Thus, quality information exists in an index field for each 1-km bin. In the following we present a method to use the determined quality information to create a quality controlled radar precipitation composit for the assimilation in the LMK using latent heat nudging.

2 Creation of a quality index at the radar stations

At all 16 German weather radar stations a precipitation scan (PCP; 600 Hz, 125 km) is performed every five minutes at the lowest elevation angle possible following the horizon line. From this scan a 1 byte product in polar coordinates with a horizontal resolution of $\Delta r \sim 1$ km and $\Delta\varphi \sim 1°$ is derived. Even though a Doppler filter is applied for this data set (Seltmann (2000)), there may still be clutter remnants. Also spikes and rings caused by obstacles or external transmitters occur in the data. Problems caused by the radar itself (‘corrupt image’) or by special meteorological conditions (‘German pancake’, anaprop) are very problematic for the data assimilation as well. To enhance the radar data quality an algorithm is applied, which identifies most of the problems (for more detail see: Hassler et al. (2005); Hassler et al. (2006)). All identified errors for each 1-km bin are stored in a quality-index field, which has the same format as the radar-data field itself. Figure 1 shows an example from 31 May 2006 at 7:50 UTC for the Munich radar station. The radar picture on the left hand side of Figure 1 shows many spikes in northern direction and randomly distributed clutter. Using the new algorithm for the detection of radar errors all spikes and most of the clutter pixels could be identified and flagged in the quality-index field shown on the right hand side of Figure 1. This offers the possibility to combine different bits to form separate quality measures adapted to the user’s application. For the latent heat nudging the additional quality information is used to create a precipitation composit and a quality-index composit as described in the next section.

3 Creation of a quality controlled composit

In order to create a composit the question arises which range bin should be used in the overlapping areas of several radars. Traditionally the range bin with the highest reflectivity value is accepted for the composit. Thus in most cases the radar errors will be emphasized as shown on the left hand side of Figure 2.

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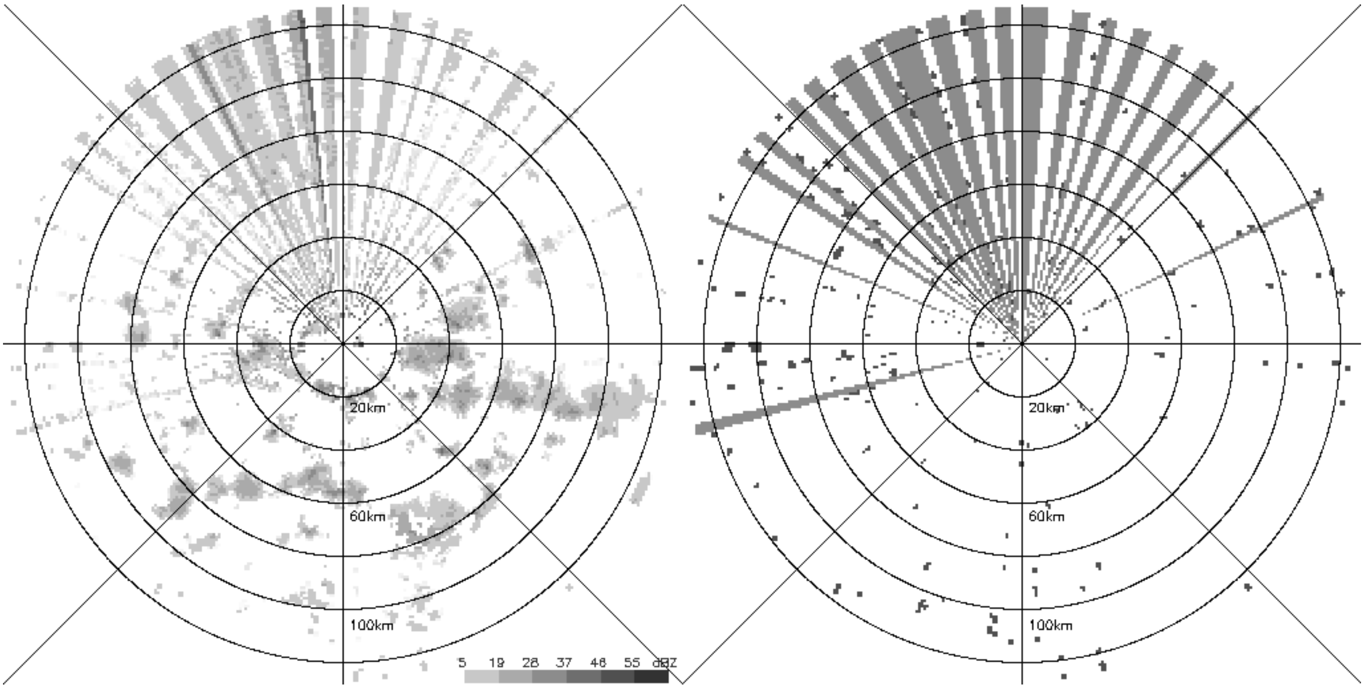

Fig. 1. Radar image from 31 May 2006 7:50 UTC at the radar station Munich (left) and the corresponding quality information (right)

A piecewise linear Z/R relation is used to derive precipitation rates from the radar reflectivity data. To distinguish between different cases the echo intensity is classified into three ranges. For the lowest intensity range the horizontal echo structure is taken into account as well. Thus an improved estimation of the precipitation amount is achieved compared to the standard Z/R relation

Table 1. Weighting of the quality information for use in LMK

Radar error	**Weighting**
Corrupt image	2
German pancake	3
Spikes and rings	4
stationary and dynamic clutter	5
Attenuation	6
Bright band	6
No error	20

In order to include the quality information for the creation of a composit, new rules of composit generation had to be developed. For this purpose a weighting is assigned to each radar error. Table 1 shows the current version of the weighting factors used for the composit generation. Error-free range bins have the highest weighting compared to range bins which are flagged in the quality-index field. Gross errors (e.g. corrupt image or German Pancake) get the lowest weighting whereas errors which affect the occurrence of precipitation (e.g. radial spikes, clutter etc.) get a medium value. Errors which affect the amount of precipitation (e.g. attenuation, bright band etc.) get a higher weighting than the errors mentioned before.

This weighting information is used to decide which range bin should be accepted in the overlapping areas of several radars. Both a precipitation composit and a quality-index composit are generated, in order to keep the quality information for the composit in an additional field as well. In the overlapping areas the information of the quality-index fields from the concerned radar stations is compared and the value of the range bin with the highest weighting is accepted for the quality-index composit. Then the reflectivity value of the corresponding radar station is accepted for the precipitation composit. For equal quality indices or if one quality index field is missing the heighest reflectivity value is accepted for the precipitation composit. Thus the quality index from the corresponding radar station or a missing value (in case of no quality-index field) is written into the quality-index composit. Presently, for the assimilation in the LMK, all flagged range bins in the quality-index composit are set as missing in the precipitation composit. On the right hand side of Figure 2 the radar composit generated with the described method is shown for the example of 31 May 2006 7:50 UTC. Taking into account the quality-index composit all flagged range bins are unconsidered in the precipitation composit. Thus the detected spikes at the radar station Munich are removed in the shown example.

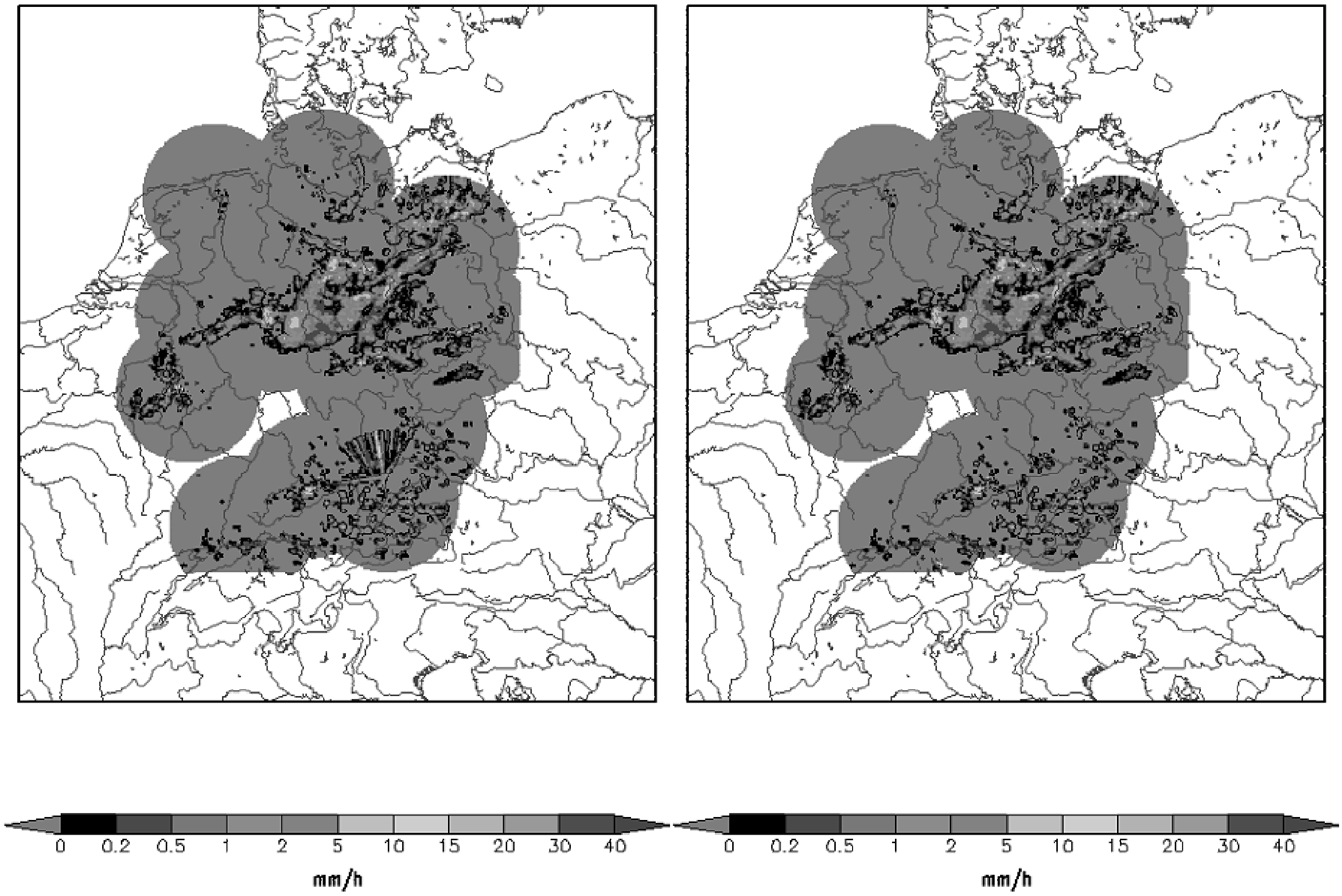

Fig. 2. Radar composit from 31 May 2006 at 7:50 UTC using the maximum method (left) and the quality information (right) for assigning pixel values in the overlapping areas. For the radar stations Rostock (in northeast Germany) and Frankfurt (in southwest Germany) no radar data was available at this time.

4 Summary and outlook

For very detailed short range forecasts, the Deutscher Wetterdienst has developed a kilometre-scale numerical-weather-prediction system (LMK). This system is aiming at the explicit prediction of deep convection, that requires the assimilation of spatial and temporal high resolution quality controlled radar data. The method described here identifies and marks radar errors in local quality-index fields which are used for the creation of both the precipitation composit and a quality-index composit. In result, the radar data quality for applications such as latent heat nudging and radar online adjustment could be increased. It is planned to further improve and extend the described detection algorithm (identification of more radar errors). Because the German radar network does not cover the whole LMK-model area it is planned to use quality assessed radar information from the neighbour countries as well.

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References

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