URBAS_RADAR -
an approach to flash flood statistics

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Introduction

The project URBAS (prediction and management of flash floods in urban areas) funded by the German Federal Ministry of Education and Research (BMBF) addresses the problem of flash-floods in urban areas. One major task is the generation of hazard maps showing regions affected by flash-floods.

URBAS_Radar covers the meteorological aspects in this project and focuses on meteorological hazard maps. Therefore, data from the cell tracking radar product CONRAD is statistically analysed. As small variations can lead to big effects in a statistical analysis, data quality requires certain corrections.

Corrections

NO correction

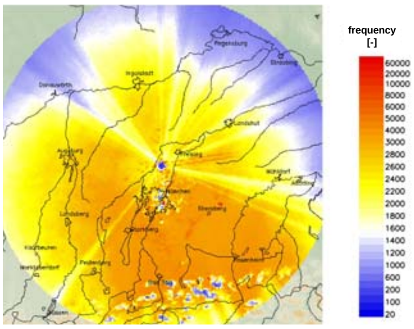

Fig. 1. Absolute frequency of occurence of pixels > 28 dBZ for the operational Munich weather radar 2000 - 2006.

For the generation of hazard maps a homogeneous data basis is essential. Therefore, corrections based on statistics become necessary. These algorithms correct the effects, but neglect the causes of the discrepancies. The assumption the statistical corrections are based on, is a homogeneous distribution of frequencies of occurence of light rain echoes for the whole radar image. Sharp gradients indicate falsified regions.

Figure 1 shows the frequency of occurence of moderate rain for the Munich weather radar for the years 2000 to 2006. Spikes resulting from obstacles near the radar as well as clutter clusters like the Alps in the southern part become apparent.

Before using statistical corrections, physically-based corrections shall be applied. For the identification of slow changes and small variations, as well as a mixture of causes falsifying data, however these statistical corrections do a good job.

Altitude correction

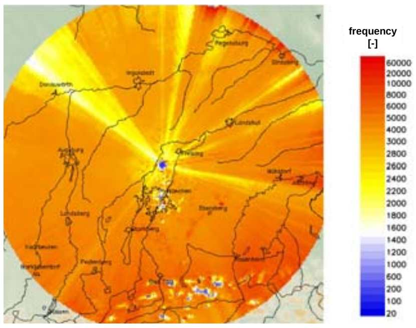

Fig. 2. Same as Fig. 1, but corrected for altitude.

An altitude correction becomes necessary as the frequency of occurence of rain echoes declines with distance from and height above the radar, resulting from natural decrease of reflectivity with height.

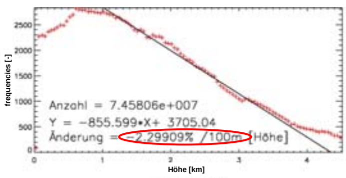

Fig. 3. Behaviour of the median of frequency of occurrence for pixels > 28 dBZ with height for the Munich weather radar.

So, the aim is to ascertain the mean behaviour of this decline with height above the radar, which is shown in figure 3. The steady slope of -2.3 % per 100 m height can be used as a correction factor.
Figure 2 reflects this correction with a conspicuous improvement.

Correction of beam blockage and clutter

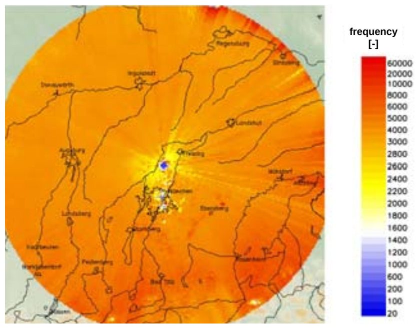

Fig. 4. Same as Fig. 2, but corrected for spikes and single clutter.

One main aim of the correction of spikes and single clutter is to preserve the measured natural patterns as far as possible. Accordingly, spikes with remaining patterns were adjusted to the closer environment, whereas for clutter interpolation algorithms are used.

Figure 4 shows the result of these corrections with a much smoother distribution compared to the uncorrected figure 1. According to figures 5 a) and b) some modifications have to be taken into account, as the distribution of frequency of occurence changes with season. The influence of snow and a lower vertical extension of rain echoes are responsible for this difference.

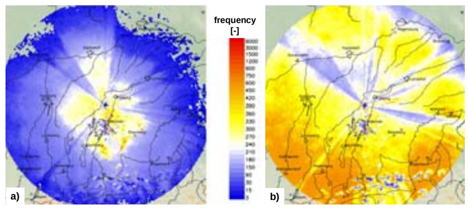

Fig. 5. Same as Fig. 1, but for January (a) and July (b).

Statistical analysis

Cell tracks

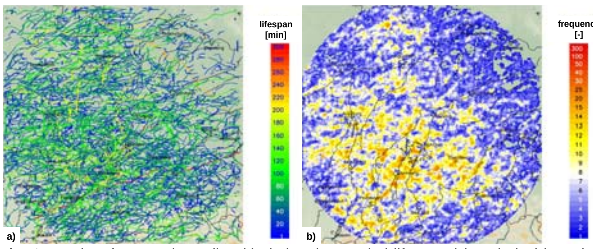

Fig. 6. Tracks of convective cells with their colour coded lifespan (a) and pixel based (b) for the operational Munich weather radar from 2000 to 2006.

The statistic of cell tracks is a novelty which is not possible on the basis of tipping buckets. This analysis is both meteorologically interesting and serves as a basis for hazard maps.

In figure 6a all cell tracks of strong convective cells from the Munich weather radar for the years 2000-2006 are plotted. The colours indicate the life-span of each cell which can be used for further detailed studies.

Figure 6b reveals the same data but on a pixel basis. The frequency of how often a certain pixel is affected by a convective cell is shown. As expected, regions of higher frequencies in the southern and western part of the radar image become apparent.

Composit of intense rain frequency

Figure 7 gives an example of a hazard map of intense rain in Germany. Results of the analysis of single radar data have to be normalised first and then composited. The normalisation is necessary because of different radar heights asl, different data amounts or instrument settings.

For statistical analysis a span of 7 years is relatively short, but nevertheless the resulting patterns of intense rain agree well with the known distribution of heavy precipitation derived from tipping buckets with high frequencies e.g. in the Black Forest or the Swabian Alb (south-western part of Germany).

This result is preliminary with respect to the statistical corrections.

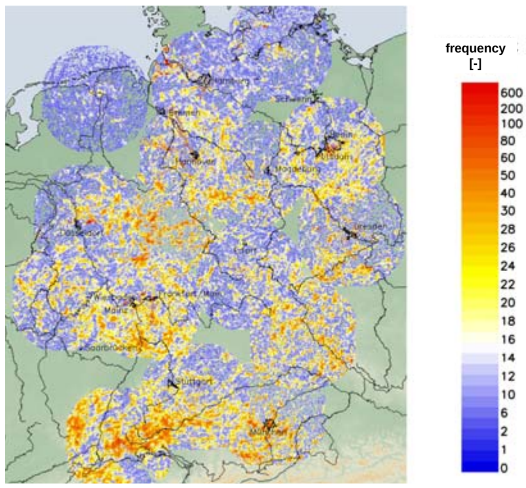

Fig. 7. Composit of frequency of intense rain (> 12 mm / 30min) for all 16 operational weather radars in Germany.

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