Recent advances in precipitation nowcasting at the RMI of Belgium: storm severity product

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I. INTRODUCTION

We report on the development at the RMI of an operational storm severity product, in which radar data are combined in real-time with Intensity-Duration-Frequency (IDF) information, in order to get an overview of the return period of an ongoing event. The product is designed to be useful especially in situations with extreme local rainfalls causing flash floods. A stationary precipitating storm cell is a typical example of such a situation. This can happen for example if the cell movement is opposite to the direction of the global flow. Such situations can be dangerous since large amounts of rain are accumulated in the same basin in a short period of time. These situations are, however, hard to recognise on single images, and are only discovered when studying closely the radar animations. An example of such a situation is shown in Fig. 1.

II. IDF MAPS AND RADAR DATA

IDF curves give the relation between rainfall intensity (I), the duration (D) of the accumulation and the return period (F). IDF maps for Belgium were recently determined by the RMI (Mohymont & Demarée, 2006). The RMI has gauge data of roughly 375 stations. 345 of these stations are part of the climatological network, reporting daily accumulation values; the remaining 30 stations have an update frequency of 10 minutes. In order to achieve a homogeneous data set to calculate the IDF curves, only those stations were selected with a time series of minimum 25 years, starting before 1968 and ending not sooner than 1993, and in which not more than 10% of the values were missing. With these criteria, the final number of daily stations used in the project decreased to 184, while the number of 10-min stations decreased to 22.

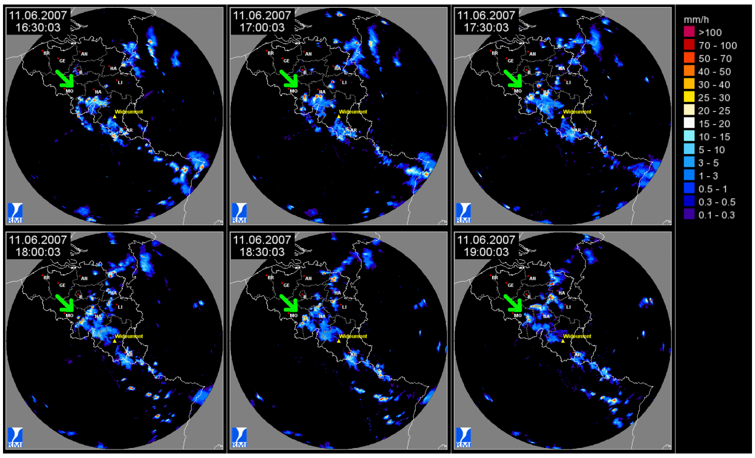

FIG. 1: An example of an event with stationary cells (Wideumont radar, 11 June 2007, 16h30-19h00 UT). The green arrow indicates such a cell.

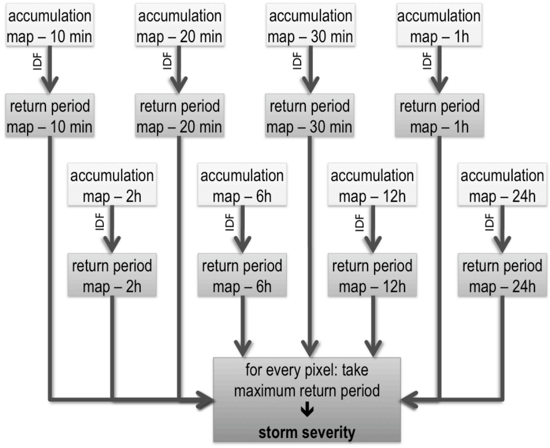

FIG. 2: Scheme of the dataflow of the storm severity product.

The storm severity product was implemented for **two radars**. The first one is the weather radar of Wideumont (2001), in the south of Belgium, which is owned and operated by the RMI. The second one is the radar de l'Avesnois (2005), installed by Météo-France, with a financial participation of the Walloon Region. Both radars are C-band radars and generate a pseudo-CAPPI every 5 minutes, which is used here as input for the product. The relation $Z = aR^b$ with $a = 200$ and $b = 1.6$ is applied to convert radar reflectivities into rainrates.

III. METHOD

The preparatory work consisted of the interpolation of the IDF maps to the radar grid of the accumulation images. In the operational context, the following steps are executed every time a new radar image (pseudo-CAPPI) becomes available:

- Calculate the precipitation accumulations for different time windows in a computational cheap way. The accumulations are real-time, so the time windows for these accumulations are “running”;
- Combination of the calculated accumulations with the IDF grid to real-time “return-period images”;
- Combination of “return-period images” to one single return-period image as the final output of the product. For every pixel on the map, the maximum of the return

periods for that pixel is taken. This maximum is then a measure for the "severity" of the event as it develops.

The method is schematically illustrated in Fig. 2. The real-time accumulations are calculated for the following eight durations: 10 min, 20 min, 30 min, 1 h, 2 h, 6 h, 12 h and 24 h. Every time a new radar image arrives (in normal operation, every five minutes for both radars), the product is updated using this latest image.

IV. RESULTS AND DISCUSSION

In Fig. 3 an example of the final product is shown. It is the same case that was shown in Fig. 1. The map on top shows the maximum return period of the rainfall for the past durations mentioned above, and calculated following the scheme in Fig. 2. Since the IDF curves were only calculated for the Belgian territory, the return period map is limited to Belgium as well. The region that was marked in Fig. 1 with a green arrow as the location of a stationary cell producing very large local rainfalls, is indeed characterised by a very long return period in Fig. 3. The second map (bottom) specifies for which duration this maximum return period is reached, so it expresses at which timescale the most severe rainfall occured.

The real-time return period map can be used to quickly estimate the "severeness" of a given event. However, the end-users should certainly be aware of the limitations of the product. For example, it is well known that for high radar reflectivities, the calculation of a reliable rainrate is hampered by the contamination of hail. Therefore the highest return periods (say >30y) are the least reliable, and should only be used qualitatively. In general, the return periods produced by the product should never be used as real and validated climatological values, but only as indicative values.

Another source of error is the fact that the real-time accumulated rainrates are calculated with radar data, while the IDF curves are based on historical gauge data. A possible solution to decrease this uncertainty could be the merging of the radar data with real-time gauge data. Our group (Goudenhoofdt & Delobbe, 2009) recently studied different methods to merge radar data and rain gauge data. However, since the storm severity product must be available as soon as possible after the receipt of a new radar file, this merging cannot be applied here: the gauges in our network do not have the same update frequency as the radar images. Moreover, the product also focusses on events with very local rainfall; in these situations, the radar-gauge merging is less efficient due to the high spatial variation of the rainfield that cannot be accurately captured by a gauge network, even if it is very dense.

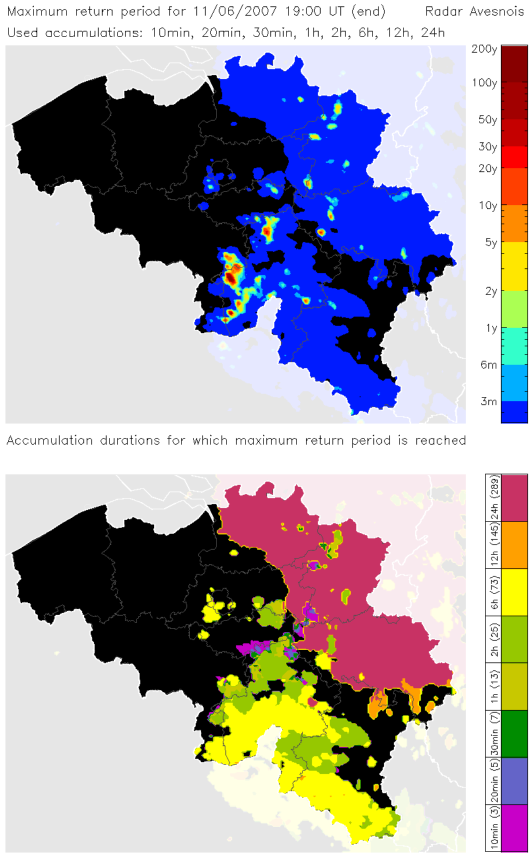

FIG. 3: Result of the storm severity product for the same situation that was shown in Fig. 1 (radar de l'Avesnois). The numbers between brackets in the legend of the bottom map denote the number of radar files that were used for that particular accumulation duration.

V. CONCLUSIONS

We have developed a new product at the RMI for the real-time detection of heavy local rainfall. Due to the large uncertainties in radar-based rainfall accumulations and the derived return periods, it offers only a *qualitative* view on the storm severity. Nevertheless, the product will be a valuable nowcasting tool for the real-time evaluation of the severity of an ongoing event, and it will allow fast reaction by the hydrological service in case of potential flash floods, without running a time-consuming hydrological model.

VI. ACKNOWLEDGEMENTS

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VII. REFERENCES

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