Storm severity nowcasting by real-time return period imaging

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Abstract

We report on the implementation of a real-time product at the Royal Meteorological Institute of Belgium (RMI) that combines radar data with Intensity-Duration-Frequency (IDF) curves, in order to get an estimate of the return period of an ongoing event, as a measure of the storm severity. The product was developed on request of the hydrological service of the Walloon region (South of Belgium). Experience in this hydrological service has shown that the hydrological model that is used for issuing flood warnings over the Walloon river catchments, performs well in widespread, large-scale precipitation, but that it largely fails in extreme local rainfalls causing flash floods. Therefore, a specialised product allowing fast reaction is needed in these situations. For this purpose, precipitation accumulation images with different durations from two C-band radars are compared in real-time with IDF curves recently determined by the RMI. We will show that, despite the large uncertainties in the rainfall accumulations based on radar data, the product is a very useful nowcasting tool in the case of extreme events.

1 Need for a specialised product

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 (Fig. 1). Such situations can be dangerous since large amounts of rain are accumulated in the same basin in a short period of time.

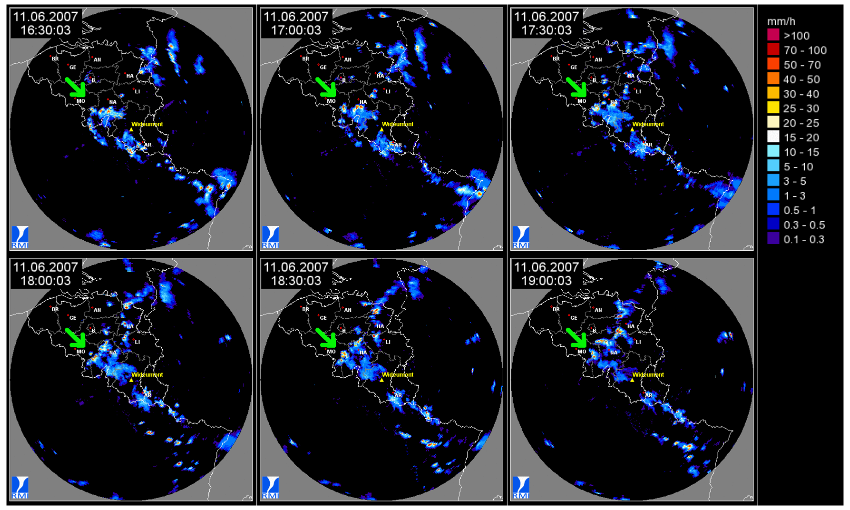

Fig. 1. An example of an event with stationary cells (Wideumont radar, 11 June 2007, 16h30-19h00 UT). The green arrow indicates such a cell.

2 Input: IDF maps and radar data

IDF curves (Intensity-Duration-Frequency) give the relation between rainfall intensity (in mm h^{-1} or mm) in function of the duration (D) of the accumulation and the return period (T). IDF maps for Belgium were recently determined by the RMI (Mohymont & Demarée, 2006). Examples of these maps are given in Fig. 2.

Radar data are supplied (one image every 5 min) by two C-band radars:

- Wideumont radar (RMI, 2001), South of Belgium, range 240 km (Fig. 3)
- Avesnois radar (Météo-France, 2005), Northeast of France, range 256 km

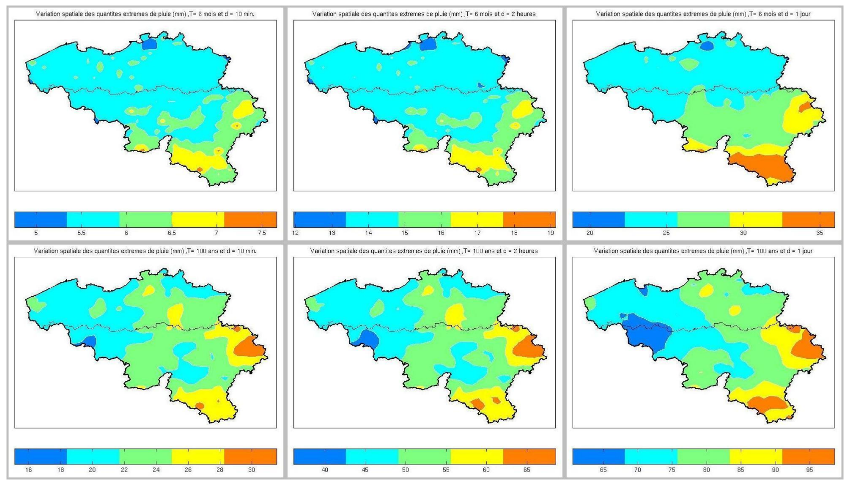

Fig. 2. IDF maps (in mm) for a return period of 6 months (upper row) and a return period of 100 years (lower row). For each return period, durations of 10 minutes (left column), 2 hours (middle column) and 1 day (right column) are shown. Note the different scale for each image.

3 Method

The following steps are executed every time a radar image becomes available (Fig. 4):

- Calculate precipitation accumulations (Fig. 5) for the last n minutes ($n = 10$ min, 20 min, 30 min, 1 h, 2 h, 6 h, 12 h and 24 h);
- Combination of these calculated accumulations with the IDF grid to real-time "return-period images";
- Combination of the "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.

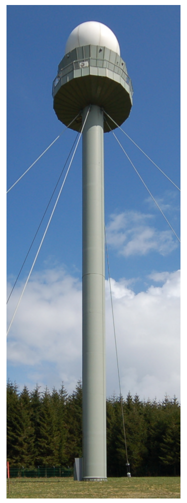

Fig. 3. radar Wideumont.

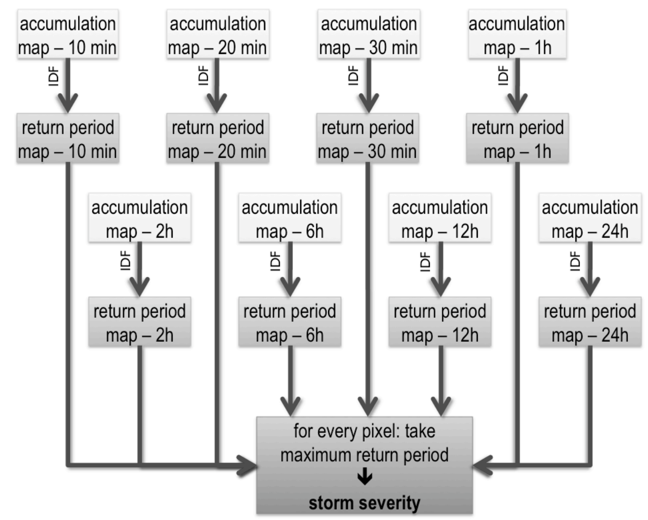

Fig. 4. Scheme of the dataflow of the new product.

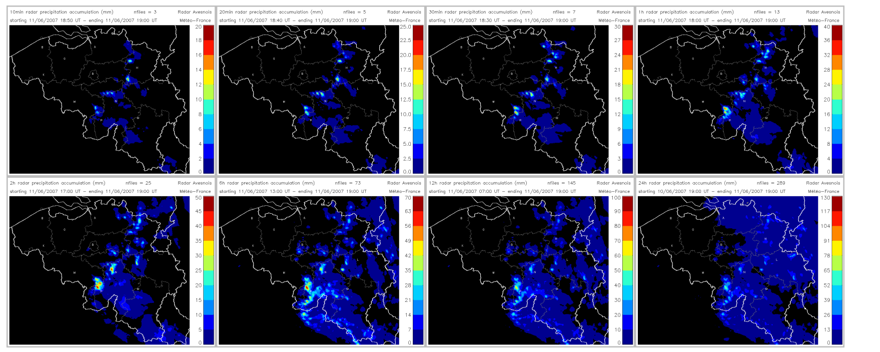

Fig. 5. Accumulations (Avesnois radar) with different durations and end time 19h00 UT for the episode shown in Fig. 1. Note the different scale for each panel.

4 Results

In Fig. 6 an example of the final product is shown. It is the same case as in Figs. 1 and 5. The left map shows the maximum return period of the rainfall for the past durations mentioned above, and relies for this on the real-time accumulations discussed in the previous section and calculated following the scheme in Fig. 4. The right map specifies for which duration this maximum return period is reached, so it expresses at which timescale the most severe rainfall occured.

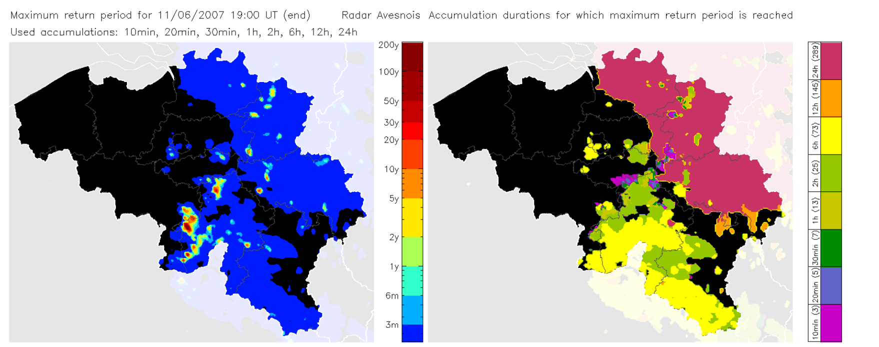

Fig. 6. Result of the storm severity product for the same situation that was shown in Fig. 1 (Avesnois radar).

5 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. The product allows fast reaction by the hydrological service in case of potential flash floods, without running a time-consuming hydrological model.

References

Mohymont B. and Demarée G.R., 2006, final report IDF curves for the Walloon region, Ministère Wallon de l'Équipement et des Transports, Cahier spécial des charges MS/212/2003/08, available on `http://voies-hydrauliques.wallonie.be/`

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