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RADFLOOD21 User Guide

Version

2

Motivation

An extreme flood event occurred during 13-16 July 2021 and affected particularly the Ardennes-Eifel region, covering parts of Belgium, Germany and Netherlands. This product provides a high resolution radar-based quantitative precipitation estimation of the event.

Method

The product is obtained after a careful processing of the weather radar measurements and a merging with rain gauge measurements. Some of the main challenges of radar-based precipitation estimation are discussed in details in Goudenhoofdt and Delobbe (2016). The method is under a continuous improvement process based on research and quality control. The current processing steps are summarized below. In particular, the significant underestimation of the operational product during the flood event, has led to several improvements. More details can be found in this presentation (m5GPzkyzZN).

Rain gauge measurements

The following automatic rain gauge networks are used:

- 91 weighted gauge OTT2, Service Public de Wallonie (SPW), Belgium
- 42 weighted gauge OTT2, Vlaamse Milieumaatschappij (VMM), Belgium
- 19 weighted gauge OTT2, Waterbouwkundig Laboratorium (WL), Belgium

The rain gauge measurements have a resolution of 5 minutes.

There is some limited automatic quality control by SPW and VMM.

A manual quality control is performed by RMIB for the SPW and WL data.

Weather radar measurements

Radars emit electromagnetic pulses, typically with a length of 500m and a beam width of 1 degree. Part of the energy of this pulse is reflected back to the radar by precipitation. Radars performs scans at different elevations (3D) in about 5 minutes. Estimating rainfall from radar measurements is a challenge because of the many sources of error and uncertainty (Fig.1).

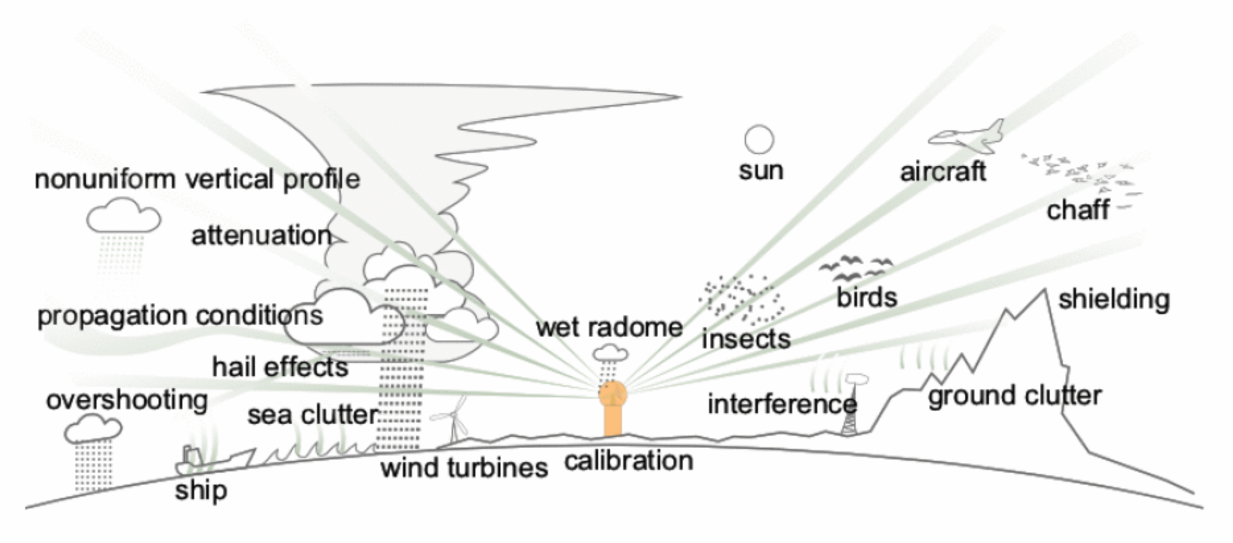

Figure 1. Phenomena affecting the radar data quality. From Ivan Holleman, KNMI, 2006.

The product is based on the 3D reflectivity measurements of the following radars:

- Helchteren, Vlaamse Milieumaatschappij (VMM), Belgium
- Jabbeke, Royal Meteorological Institute of Belgium (RMIB), Belgium
- Wideumont, Royal Meteorological Institute of Belgium (RMIB), Belgium
- Neuheilenbach, Deutsche Wetterdienst (DWD), Germany
- Essen, Deutsche Wetterdienst (DWD), Germany

- Avesnois, MeteoFrance (MF), France

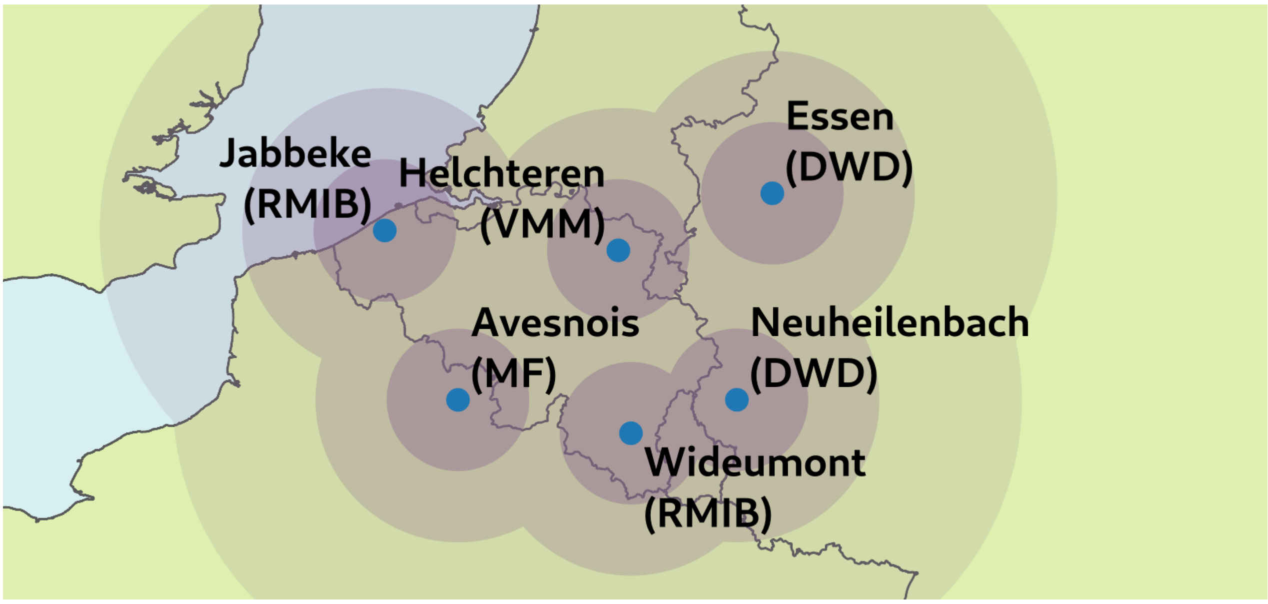

Figure 2. Radar coverage with 50 km, 100 km and 200 km radius

These radars use different kind of technology, scanning strategy and data processing, which can evolve over time. One particular challenge is to mitigate the inhomogeneity between the radars and loss of information in the data processing chain.

Quality control of the radar measurements

- Estimation of the calibration bias based on the median of 24h biases against rain gauges for the past two months
- Identification of measurements contaminated by static non-meteorological echoes (e.g. hills, wind farms or radio interferences).
- Correction for radar beam partial blockage by terrain
- Identification of clutter (i.e. non meteorological echoes) based on satellite cloudiness products
- Identification of clutter based on vertical profiles of radar reflectivity
- Identification of clutter based on image texture

From radar measurements to ground rainfall rate estimation

1. Identification of convective precipitation
2. Extrapolation to ground of non convective precipitation using an averaged vertical profile of reflectivity
3. Filling of missing data with data from higher elevations and horizontal interpolation up to 500 m.
4. Conversion of reflectivity into rain rates based on precipitation type (snow, hail, convective rainfall, stratiform rainfall) and orography

Compositing, accumulation and radar-gauge merging

1. The single radar rain rates are combined into a composite by taking the maximum value of the 3 closest radars within 180 km.
2. From the instantaneous rain rates available every 5 minutes, rainfall accumulation are made for the past 5 minutes and past 1 hour using optical flow techniques.
3. Every 5 minutes, the 1 hour accumulation is combined with rain gauge measurements using Kriging with external drift (which is an interpolation method based on the hypothesis of Gaussian process)
4. The spatial correction factor derived from the previous step is applied to the 5 minutes accumulation

Product

Spatial resolution

The Belgian Lambert 2008 is used as projection. The composite has a spatial resolution of 1 km with each estimate representing the averaged precipitation on a square of size 1 km. Note that the contributing single radar products have a typical range of 250 km but their resolution decreases due to broadening of the radar beam with distance. The composite covers an area from 0.3W to 9.7E in longitude and from 47.4N to 53.7N in latitude.

Temporal resolution

The Coordinated Universal Time (UTC) is used as reference.

The product is available from 2021-07-11 at 00:00 UTC to 2021-07-18 at 00:00 UTC.

The following rainfall accumulations are available:

- 5 minutes accumulation every 5 minutes
- 1 hour accumulation every hour

The timestamp corresponds to the end of the accumulation period

Visualisation

A simple visualisation product is available for Belgium in the PNG format (Fig.3)

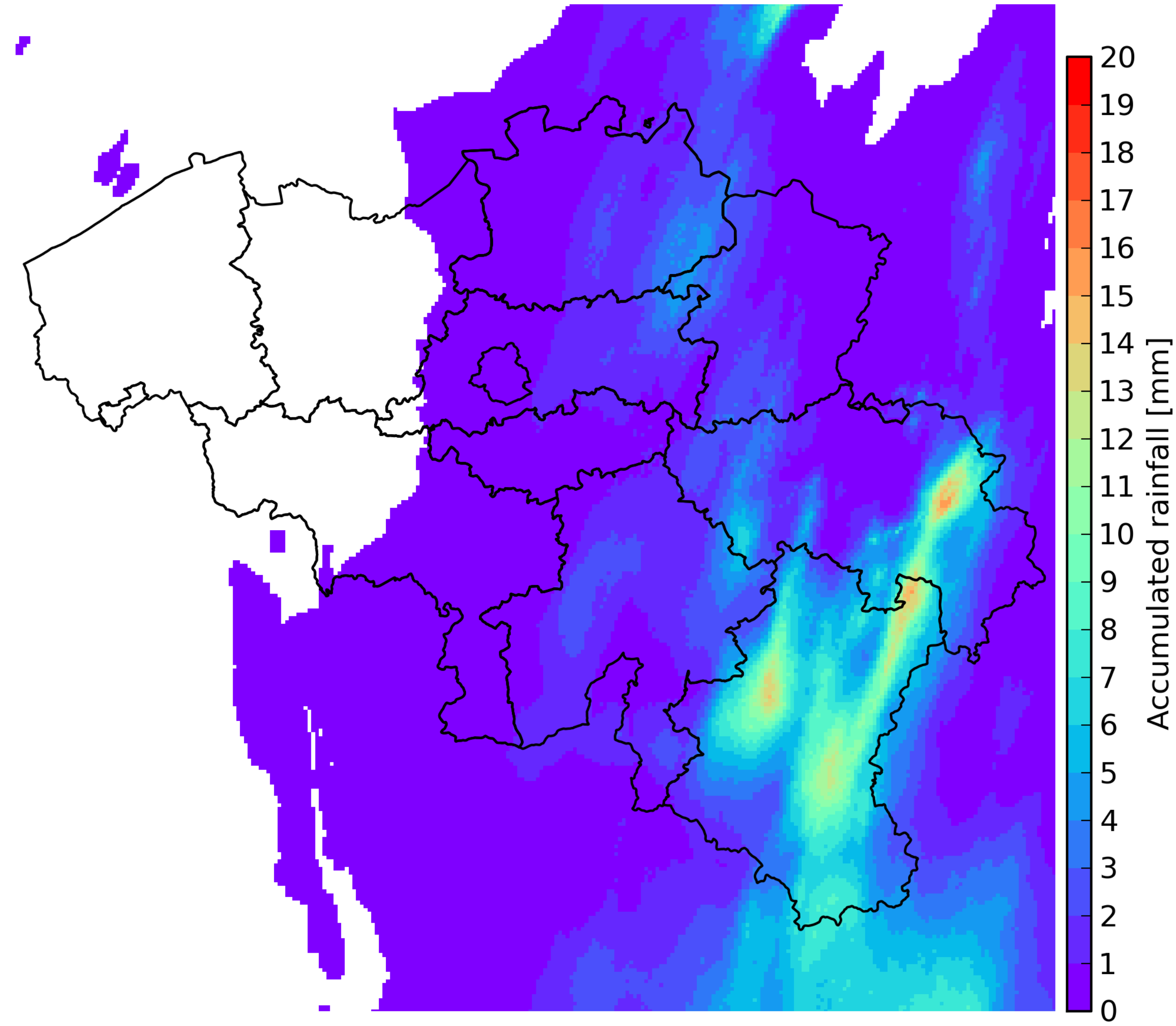

Figure 3. Visualisation of the product

Data format

The product is available in the standard georeferenced raster format GeoTIFF. The values are coded as integers (int16) after a scaling of 100 (1 = 0.01 mm).

For advanced processing, the product is also available as single precision floating point values in the HDF5 format following the European weather radar information model(ODIM). The model is supported by the Geospatial Data Abstraction Library (GDAL), which is available in many softwares and programming langages. This is the recommended way to read the data. Alternatively, a manual access to data and metadata is possible using the HDF5 library (see quick guide below).

Quick guide to ODIM

The data in an HDF5 file is made of groups and several attributes associated to a given group. An ODIM file contains several datasets (e.g. in /dataset1) which are defined by :

- geolocalisation : several attributes in the ”where” group (e.g. /dataset1/where)
- time information : "startdate", "starttime", "enddate" and "endtime" attributes in the ”what” group (e.g. in /dataset1/what)
- product type : "product" attribute in group ”what”

Additional information regarding the processing might be provided in the "how" group. Each dataset contains one or several physical quantities (e.g. in /dataset1/data1) which are identified by the "quantity" attribute in the "what" group (e.g. in /dataset1/data1/what). The data values (e.g. in /dataset1/data1/data) are stored as one long unpadded binary string starting in the upper-left corner and proceeding row by row (north to south), from left (west) to right (east).

The geolocalisation of a dataset is defined by the following attributes:

- xscale and yscale : the grid resolutions
- xsize and ysize : the grid sizes (number of pixels)

- UL_x and UL_y : the native coordinates of the upper left corner of the upper left pixel (this is specific to RMIB)

The projection of the datasets is stored as a PROJ4 string in the attribute ”projdef” of the group "/where". Based on the geolocalisation information one can construct the native coordinates of the grid of pixels. The native projection definition can then be used to reproject the data in any projection.

Contact

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