Last edited by **Edouard Goudenhoofdt** just now

RADCLIM User Guide

Version

2

Motivation

RADCLIM provides high resolution radar-based quantitative precipitation estimation for Belgium and its surroundings.

Method

The RADCLIM 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.

Rain gauge measurements

The following automatic rain gauge networks are used by RADCLIM:

- 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

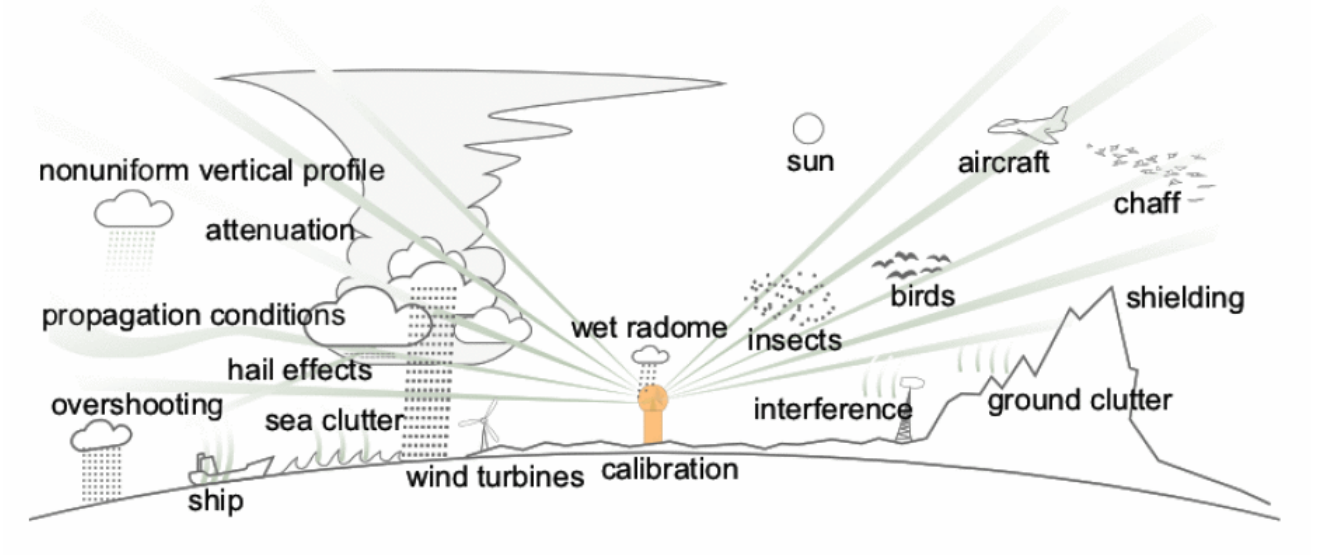
The rain gauge measurements have a resolution of 5 minutes.

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 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 in about 5 minutes. Estimating rainfall from radar measurements is a challenge because of the many sources of error and uncertainty.

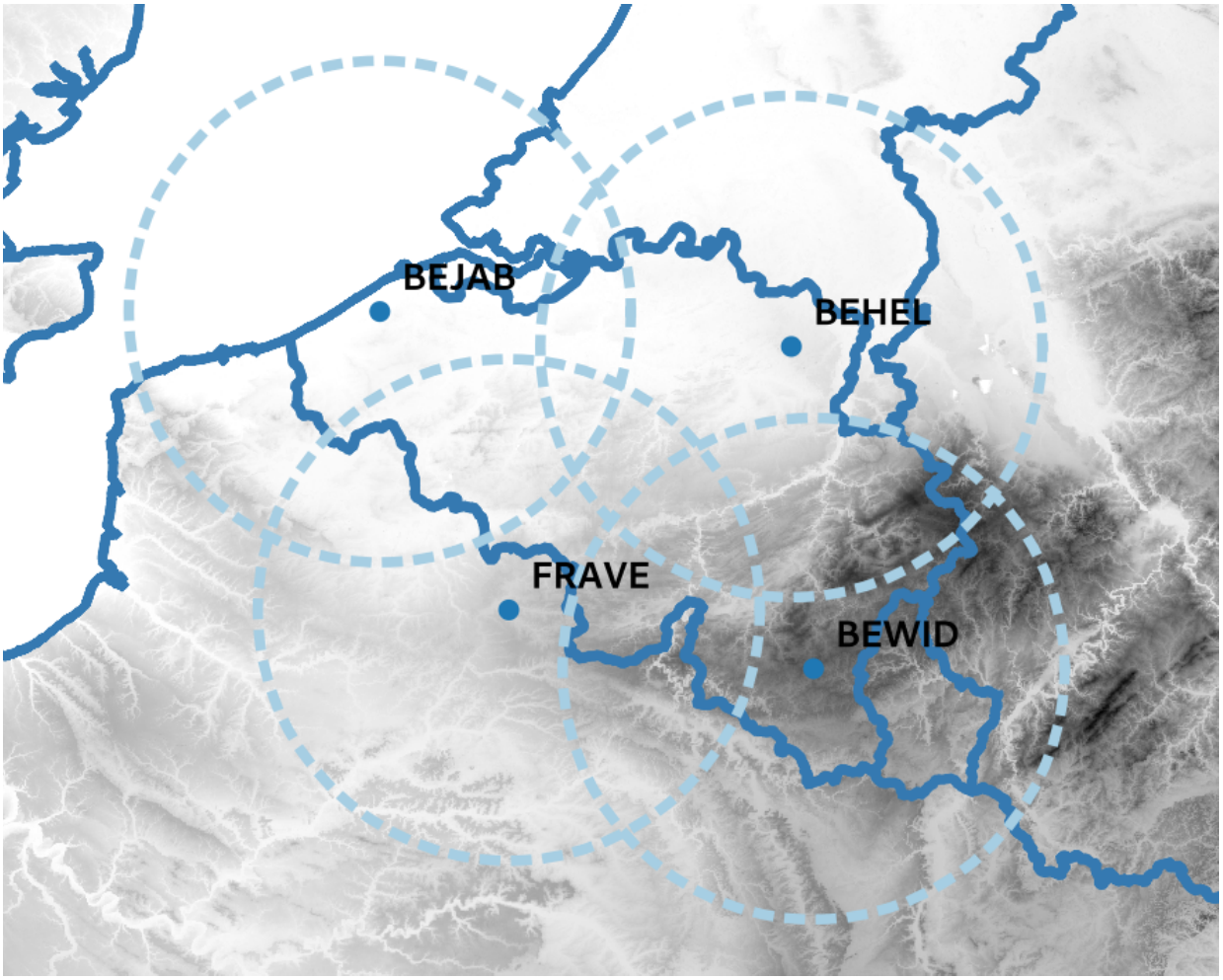


Phenomena affecting the radar data quality. From Ivan Holleman, KNMI, 2006.

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

- Wideumont, The Royal Meteorological Institute of Belgium (RMIB), Belgium, since 2001
- Avesnois, MeteoFrance (MF), France, since 2005

- Jabbeke, The Royal Meteorological Institute of Belgium (RMIB), Belgium, since 2013
- Helchteren, Vlaamse Milieumaatschappij (VMM), 2016



The Wideumont radar has been updated to dual-pol technology in 2022.

These radars exhibit various 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 interference).
- Correction for radar beam blockage by terrain (up to 15 ,%)
- 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. For other months, the composite is based on all values weighted based on the distance to the radar.
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 with the distance to the radar. The composite covers an area from 0.3W to 9.7E in longitude and from 47.4N to 53.7N in latitude.

It is important to note that the quality of the product decreases outside Belgium.

Temporal resolution

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

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 standard visualisation product is available for Belgium and hourly accumulations.

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 = 0.01mm).

For advanced or high performance processing, the product is also available as single precision floating point values in the HDF5 format following the [European weather radar information model] (📎 https://www.eumetnet.eu/wp-content/uploads/2019/01/ODIM_H5_v23.pdf).

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. The native projection definition can then be used to reproject the data in any projection.