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Hydrology and Earth System Sciences Discussions

Interactive comment on "Uncertainties in rainfall retrievals from ground-based weather radar: overview, case study, and simulation experiment" *by* R. Uijlenhoet et al.

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1. General comments

In the field of rainfall radar in hydrology there seem to be two communities: (a) Radar meteorologists: These are mainly interested in technical and meteorological aspects of this technique e.g. dealing with detailed problems of rainfall microstructures, combining different radar types (e.g. dual polarization, Doppler, vertical and horizontal scanning antennas, etc.). Mostly applications are limited to specific sites with a wealth of high quality radar data. (b) Hydrologists: These are looking for adequate spatial and temporal resolution of rainfall to arrive at correct estimates of catchment rainfall

for hydrological applications. Caused by their focus (analysis of hydrological systems) this community cannot include all technical aspects of radar techniques, mostly relies on available operational conventional radar data (often those of C-band networks) and often applies rather simple “ground truthing” algorithms to compare radar reflectivities with ground measured data).

Following the scientific discussion the gap between these groups seems to have grown in recent years. The present paper tries to contribute to bridge this gap by proposing a correction algorithm for attenuation effects which seems to be well applicable also to operational “conventional” one-parameter radars. Hence it addresses relevant scientific questions for the scope of HESS and as such should be seen as a valuable contribution for the HESS-readership. The proposed correction procedure for attenuation effects is nicely described and of relevance for the hydrological community. The abstract gives a concise overview.

However, there are still weak points in the manuscript which mainly stem from the fact that it claims to be an overview paper. More credit to multi-parameter radars should be given and the historical overview section should be re-structured. Also the discussion of uncertainties using radar hydrology should be completed to facilitate adequate classification of the proposed correction procedure.

2. Specific comments

2.1 In the introduction (p. 2386) it is stated that ground-based radar measurements are well suited to predict rainfall, since “their spatial and temporal resolution is generally higher than what can be obtained using rain gauge networks”. While for the spatial resolution this is clearly the case, it seems misleading to be stated in general terms also for temporal resolution. New generation ground stations, e.g. using an accurate weighting system may give signals in temporal resolutions down to single minutes, while operational weather radars (e.g. C-band) typically offer scans only every five minutes.

HESSD

3, S1012–S1016, 2006

2.2 In the same page (p.2386) it is stated that weather radars “measure the electromagnetic properties of rain in the air”. This might also lead to misunderstandings, because in principle radar measures back-scattered signals from particles in the atmosphere and these are normally parts of clouds (water in the liquid or solid phase). This may be largely different to falling (and arriving!) rain, which is a fundamental problem using rainfall radar and should be stated in this way and further discussed

2.3 On p 2387 it is stated that the spatial representativeness of raingauges can be enhanced by temporal averaging. While in flat regions this may be true (e.g. the Netherlands), it surely does not apply to mountaineous terrain with strong influences of topography.

2.4 The subdivision into “weather radar” (chapter 2.2, p 2389 f) defined as the historical use of one-parameter radars by statistical raingauge adjustment and “radar hydrology” (chapter 2.3) using approaches with more physical basis seems artificial and arbitrary. Moreover, aspects of both approaches re-occur in later chapters (e.g. 3.1). While the content should be kept more or less, the paper should re-structured to combine chapters 2.1, 2.2 and parts of 3.1 to arrive at a chapter e.g. “historical development of rainfall radar”. Therein it is important to show the historical developments in the field of rainfall radars from the very beginning up to multi-parameter radar systems stated in p 2393.

2.5 More space should be devoted to these multi-parameter radar systems, which should form a separate chapter. Since the paper terms itself to be an overview paper, the principles of these techniques (e.g. using Doppler effects or dual polarization) should be described in detail with applications and also operational uses. This would also add value to the proposed correction procedure: is this procedure in general also applicable to multi-parameter radars?

2.6 Discussing the different sources of uncertainty (chapter 3.2) is important and is adequate in the details outlined in the present manuscript. However, again the sub-

HESSD

3, S1012–S1016, 2006

division into “instrumental effects” and “environmental effects” seems artificial. This is admitted by the authors themselves when they state that ”the first environmental effect could have been grouped as well as under instrumental effects” (p2396).

2.7 Also it seems that the list of uncertainties is not complete, since it is stated in the last paragraph that “additional aspects of assumptions, errors and uncertainties” are discussed elsewhere. For an overview paper, however, it would be nice to have all sources of uncertainty included. Even if excluded error sources are non-relevant these should be mentioned.

2.8 Another point that largely would contribute to the quality of the paper is the fact that once error sources are mentioned also possible solutions to overcome these errors should be discussed. One example (CAPPI) is given. However, other procedures (e.g. to eliminate ground clutter by clutter maps or Doppler procedures, etc.) are missing. A complete list of error sources and all existing solutions to overcome these errors is vital for an overview paper. Moreover it would be more straightforward for the remaining paper to group these error sources according to the proposed correction procedure: For which sources of uncertainty does the proposed procedure apply and do alternatives exist?

2.9 The stated example discusses the 19th September 2001 comparing ground measured rainfalls with radar reflectivities. In the beginning however the entire month is described being the second wettest month ever in the Netherlands. This discussion should be omitted, since monthly values are not further used.

2.10 The proposed and nicely described stochastic simulation model is only applied for X-band radar (Fig 11). It would be nice if also simulations for C-band and S-band radars would be presented to compare the applicability of this Monte Carlo framework also for longer wave lengths where attenuation is not so enhanced.

3. Technical corrections

HESSD

3, S1012–S1016, 2006

3.1 Figures 1 and 9 should be combined. Also coordinates should be added to the map. 3.2 Figure 7 could be omitted, since figure 8 contains the same information 3.3 Figures 12 and 13 should be combined 3.4 Figures 14 and 15 should be combined

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 3, 2385, 2006.