An empirical method to improve rainfall estimation of dual polarization radar using ground measurements

*H*ESS-2016-27

Revision

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Manuscript revision

The manuscript *H*ESS-2016-27 deals with the estimation of rainfall by means of polarimetric weather radar data, in particular with the optimization of polarimetric measurements from the point of view of an operational weather service.

Many weather services own polarimetric radars, but polarimetric rainfall estimates are still not currently applied to obtain operational products. The topic is therefore of interest both for the hydrological and for the remote-sensing scientific and operational communities.

I see some potential and interesting novelties in the manuscript. However, several major issues in the current version do not allow one to conduct a proper review. My recommendation would be to re-submit the manuscript after a major revision of contents and form, for a new complete revision.

The following sections list the general and specific issues of the paper, and provide some suggestions for its reorganization.

General issues

1. English Language: i am not a native English speaker, and i sympathise with the authors for the difficulties that all the non-native speakers encounter during the revision of a manuscript. However, i felt in this case that the quality of the language is preventing me from providing a good and helpful review.

2. Manuscript presentation: the manuscript is short. This is not necessarily a bad aspect, but the sections deserve much more details than what actually provided. I believe that this is true for all the section, but to provide some examples:

    - Sec. 2. No information is given (in the text) about the technical specification of the radar or about the (detailed) characteristics of the 4 storms. If only 4 storms have to be used, they should be described with a high level of detail in order to properly comment on the generality and robustness of the results.
    - Sec. 3.2. This is the core of the manuscript, and half a page is not enough for the reader to understand how the method works. By looking at the diagram of Fig. 2 and by reading the text, i feel that there is a good idea but i do not have enough information to fully grasp it and see its merits (or faults).
    - Sec 3.3. This section should also explain how the same set of rain-gauges is used both in the optimization and in the validation of the novel method. If no additional information is given it is not surprising that, after optimization on raingauges, the accuracy (with respect to the raingauges themselves) increases.

3. Dataset. The manuscript is based on a dataset of 4 events that show two different behaviours in the optimization (as seen in Fig. 5). This dataset, unless additional explanations are provided, is very limited: it becomes hard to generalize the results and it is difficult to explain the reason of the different behaviours of Fig. 5.

4. Scope. The manuscript is relatively technical and in my opinion it should have been submitted to a different Copernicus journal: Atmospheric Measurement Techniques (AMT).

Major merit

The main merit of the paper (to be clarified and better explained) is the idea to adapt the bivariate distributions of polarimetric variables by moving their centres of mass towards an expected mutual behaviour, as illustrated in Fig. 2.

Specific issues

1. Introduction. Some relevant literature may be helpful here, to complete the overview. I suggest Matrosov et al. (1999); Illingworth (2004); Matrosov (2010); Wang and Chandrasekar (2010).

2. Page 1, Line 25: "Chandra" should be "Chandrasekar".

3. Page 2, Line 1: Z_{DR} is a ratio if Z_H and Z_V are expressed in linear units.

4. Page 2, Line 29: you should definitely comment on the fact that you compare ground measurements with measurements collected at much higher altitudes (1.5 km) and on the possible sources of error that comes from the microphysical processes occurring below 1.5 km.

5. Page 3, Line 8: here the term "eleven magnitudes" appears, but it has not been defined. The reader may be lost.

6. Page 3, Line 17: is the PARSIVEL used in this study? If not, he can also not be mentioned.

7. Page 3, Line 27: could you show on Fig. 3 also these relations?

8. Page 4, Line 8: why only positive magnitudes are considered?

9. Page 4, Lines 13-15: this sentence needs some visual support (a figure), to guide the reader to understand the algorithm.

10. Page 4, Line 18 (Table 4): add references for all the relations in the table.

11. Page 5, Line 18: You should comment about those 2 behaviours (maximum around 5 dB of events 1 and 3 vs asymptotic behaviour of events 2 and 4), and here it would be helpful to understand if the type of rainfall was very different in those cases.

12. Page 6, Line 25 (Fig 7): could you specify which K_{dp} estimation method you employ? Sometimes the estimates of K_{dp} seem poor (as in Event 1)

Tables and Figures

1. Provide more complete information in the caption of Figures and Tables. Captions are often too short and not complete.

2. Table 2: it is a good starting point, but the description of the events should be more detailed and supported by actual radar images (PPI or CAPPI) for each event.

3. Table 4: add a reference for the algorithms, in the same table.

4. Figure 2: i like this figure, but it needs to be explained step by step with additional details in the text.

5. Figure 4: add an indication of vertical distance between the radar measurement and the gauge.

Bibliography

Illingworth, A. J., 2004: Improved precipitation rates and data quality by using polarimetric measurements. *Weather radar: principles and advanced applications*, P. Meischner, Ed., Springer, 130–166.

Matrosov, S. Y., 2010: Evaluating polarimetric X-band radar rainfall estimators during HMT. *J. Atmos. Oceanic Technol.*, **27 (1)**, 122–134, doi:10.1175/2009JTECHA1318.1.

Matrosov, S. Y., R. A. Kropfli, R. F. Reinking, and B. E. Martners, 1999: Prospects for measuring rainfall using propagation differential phase in X- and K_a-radar bands. *J. Appl. Meteor.*, **38 (6)**, 766–776.

Wang, Y. T. and V. Chandrasekar, 2010: Quantitative precipitation estimation in the CASA X-band dual-polarization radar network. *J. Atmos. Oceanic Technol.*, **27 (10)**, 1665–1676, doi:10.1175/2010JTECHA1419.1.