

Interactive comment on “Multi-sensor analysis of convective activity in Central Italy during the HyMeX SOP 1.1” by N. Roberto et al.

Anonymous Referee #3

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General Comments:

This paper makes a combined analysis of polarimetric radar data, 2-DVD disdrometer data and LINET lightning detector network, for 3 events observed in Central Italy during the HyMeX campaign in autumn 2012. The authors describe a method to retrieve graupel ice water content from radar measurements and relate the total graupel mass to the number of total lightning, showing a linear relationship between the two. It is a very interesting study and mostly well written, but some points deserve to be clarified and discussed in the paper.

Major issues:

- 1) Parameters used in the T-matrix simulations, section 3.1.1: The authors mention

that for spheroidal shapes axis ratios vary between 0.9 and 1 but no reference is cited (page 9, lines 13-14). Some parameters described in this section and in table 1 are known for being a function of size as is the case of the axis ratio (ex.: Ryzhkov et al, 2011) and particle oscillations (ex.: List and Schemenauer, 1971). The authors should discuss why they chose a random variation of these quantities, and the impact of this choice in the simulated parameters. The intervals chosen for D0 and N0 should be discussed or backed up by a reference. The reference cited for the ranges of axis ratios in the case of conical graupel doesn't mention graupel anywhere.

Roland List and Robert S. Schemenauer, 1971: Free-Fall Behavior of Planar Snow Crystals, Conical Graupel and Small Hail. *J. Atmos. Sci.*, 28, 110–115.

A. Ryzhkov, M. Pinsky, A. Pokrovsky, and A. Khain, 2011: Polarimetric Radar Observation Operator for a Cloud Model with Spectral Microphysics. *J. Appl. Meteor. Climatol.*, 50, 873–894.

2) Deriving a relation for graupel IWC, section 3.1.3: The derivation of relation (2) needs to be clarified. The authors should describe in detail how this was done. Was this done by finding the best fit through the points? I suggest showing a figure to illustrate.

3) The problem of TAG at great distances from the radar: This problem could be minimized if instead of using the TAG the authors used average ice water path (columnar) for graupel or just average IWCg. Even for atmospheric charging purposes, the same amount of graupel mass should have different effects if the graupel is very concentrated in a small volume or if it is more widespread.

Minor issues:

1) The terminology generally used for “columnar IWCg” is graupel ice water path, consider changing this, check for all occurrences. The terminology TAG, referring to the total amount of graupel in mass, needs to be consistent. For example Figures 7 and 8 are labeled “Total amount of IWCg” both in the vertical axis and in the figure legend.

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2) Abstract, page 2, line 16: “Parameters of the gamma raindrop size distribution (...) and where related.” This sentence is not clear, what do the authors mean by “where related”?

3) Section 1, page 6 line 2: “can be found in” instead of “can be founded in”.

4) section 3.1, page 7, line 21: “sensitive to cloud properties”, should be changed to “precipitation properties”. At the wavelengths considered the radar cannot see cloud particles. Check for more occurrences throughout the paper.

5) page 9, line 17: “While Z_{dr} was between 0 and 1 for spheroidal shapes, and it covered ...”, substitute with: “While Z_{dr} was between 0 and 1 for spheroidal shapes, it covered ...”.

6) section 3.1.4, page 11, line 10: LIRE acronym?

7) section 3.2, page 12, lines 25-27: Insert reference here. It is only mentioned much later in the legend of figure 9. Also, be consistent, both equations are slightly different. Assign a number to the equation so it can be referred to later (section 5.2).

8) section 4, page 13, line 14: Substitute “described in details” with “describe in detail”.

9) section 4.1, page 14, line 4: Suggest substituting “At 20:00 UTC at 80 km South the Polar 55C...” with “At 2000UTC, 80 km to the South of the Polar 55C...” UTC times do not usually have “:”. Check for other occurrences.

10) section 4.2, page 14, lines 26-27 Replace “... was located southwesterly respect to the radar” with “... was located southwesterly with respect to the radar”.

11) section 4.2, pages 14 (line 27) and page 15 (line1): Consider rephrasing this sentence, it is not clear what you mean by “(that was the third of the event)”.

12) section 4.3, page 15, line 25: “costly co-located”, do you mean: “closely co-located”?

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13) section 5.1, page 16, line 8: It is mentioned the RHI at 17:55UTC (delete ":"), should include the date of the event too.

14) section 5.1, page 16, line 10: Substitute "... and hydrometeor classes..." with "...and the hydrometeor classes...".

15) section 5.1, page 17, line 23: Typo: "higer" is spelled "higher".

16) section 5.1, page 17, line 27: Replace "...around the 70%" with "... around 70 %".

17) section 5.1, page 17, line 28: Formenton et al. (2014) is incorrect, should be Formenton et al. (2013).

18) section 5.1, page 18, line 1 typo in "estension"

19) section 5.1, page 18, line 10 suggestion of replacing "farther 80km" with "farther than 80 km".

20) section 5.1, page 18, line 23-14 replace "In order to quantify this reducing" with "In order to quantify this reduction"

21) section 5.1, page 18, line 26 suggest replacing "... for a height of 3.9km respect to 2.9km..." with "... for a height of 3.9km with respect to 2.9km..."

22) section 5.1, page 18, line 28-29 suggest replacing "Concerning the causes (ii)" with "Concerning cause (ii)"

23) section 5.1, page 19, line 25 replace "...the rather good linear fit provide a quantitative means..." with "...the rather good linear fit provide quantitative means..."

24) section 5.1, page 19, line 26 consider replacing "...based upon the cloud ice mass due to graupel..." with "... .based upon graupel ice mass..."

25) section 5.1, page 19, line 29 replace "conditions respect to the radar geometry" with "conditions with respect to the radar geometry"

26) section 5.1, page 20, line 28 You mention a threshold on the graupel amount here,

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and say it is confirmed by the radar observations, but you never mention a threshold while describing the results. Please discuss and show how your observations confirm this.

- 27) section 5.2, page 21, line 4 delete double RSDs
- 28) section 5.2, page 21, line 14 Correct “It worth noting” with “It is worth noting”
- 29) section 5.2, page 21, lines 17-18 Consider revising last sentence. Suggestion: “Results confirm that the radar classification of convective vs stratiform from Baldini and Gorgucci (2006) is in fairly good agreement with the C/S threshold from Z-Zdr (number of the equation in section 3.2)”.
- 30) section 5.2, page 22, line 24 “different phases of precipitation” (not cloud).
- 31) section 5.2, pages 22-23 Suggest including these scores POD, ETS and FAR in table 6, to make it clearer to the reader.
- 32) section 6, page 23, line 6 replace “Convective event occurred...” with “Convective events that occurred...”
- 33) section 6, page 23, line 25 Suggest replacing “Among three important case studies were selected...” with “Among the three important case studies that were selected...”
- 34) section 6, page 24, line 6 replace “more farther than 80 km” with “further than 80 km”, then delete “also”.
- 35) section 6, page 24, line 7 suggest changing “While the flux hypothesis suggest that there were differences in the updraft...” with “Moreover, the flux hypothesis from (reference) suggest that there might be differences in the updraft...”
- 36) section 6, page 24, line 18-19 Suggest deleting the times here.
- 37) table 4, page 34 Legend says Figure 9, but should be related to figure 7. Also, misspelling of “obtained” twice in this legend.

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38) Figure 7, page 43 Formenton et al. (2013) (not 2014) This threshold should be discussed in the text together with the discussion of this image.

39) figure 9, page 45 In the image, transition is misspelled. The transition points were never defined at this point. Please do so in the text, alongside with the discussion of this figure.

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