

## **Review of the manuscript amt-2015-171:**

**“Characterization of Mediterranean hail-bearing storms using an operational polarimetric X-band radar**

**by G. Vulpiani, L. Baldini, and N. Roberto”.**

The manuscript by Vulpiani et al., describes two convective events observed by the X band radar in Catania, Italy, which is operatively used by the Italian civil protection. The work is well written and clear and surely the measurements shown are interesting. However I do not understand which is the final goal of the paper.

From the methodology point of view there are no improvements with respect to the state of the art. Some methodological aspects are highlighted whereas others are sketchy. A balance among the methodological arguments is needed.

From the scientific point of view the microphysical analysis should be further expanded and accompanied by the explanation on how the analysis performed by the Authors, would benefit the future operational activities of civil protection.

The conclusions are really weak. After reading the paper I am not enriched by a sort of indication on how to improve the precipitation estimation at X band nor on which are the most critical aspects to take into account to avoid wrong interpretations of radar products. The only conclusion seems to be that the MP Z-R gives a larger error with respect to the use dual pol. rain estimator alone or in a combined form.

After the characterization of the hail bearing storms, which would be the indications given by the Authors to do a step forward in an operational environment as such that described in the manuscript?

I suggest major revision.

### **Additional comments**

- *Section 2.1 Operational scenario*: Why do you show the visibility maps based on DEM and standard atmosphere assumption instead of using the clutter map (Vulpiani et al., 2012) as starting point to produce the same pictures taking into account anomalous propagation effects?

However, I recognize that this is not really important for the final goal of the paper.

### *- Section 2.2 Processing methodology*

Some processing steps are really scarcely described with respect to other ones.

*Differential Reflectivity*: For example how do you performed the ZDR calibration? Since the Authors emphasize in the manuscript the value of the operational environment I would expect at least an indication of how ZDR is calibrated operationally (automatic rain identification form vertical profiles?, wet radome effects equally impair H and V channels? How often the operational calibration is

performed?). Could you please provide a scatterplot (as reply to this review is fine) of the corrected and calibrated ZH and ZDR samples in rain for the collected events? Just to have a more robust evidence of the correct calibration procedure. The vertical profiles provided later on in the main text are representative only of an instant. I suggest providing a statistic (even two numbers of the average and standard deviation of ZDR in rain would be fine)

- *Specific differential phase estimation*: Could you please add the curve of filtered  $\phi_{dp}$  in figure 2 as would come out from Figueras and Ventura, 2013, that you mention in the text for comparison? Looking at figure 2 I have two doubts: The original raw phase is not so noisy thus probably the highlight on the iterative phase filtering appear to me unmotivated in the context of the current stage of the manuscript; The initial part of the reconstructed phase seems to me to underestimate the raw phase. Do you have any explanation? There has been any adaptation in the phase reconstruction algorithm from C band (in Vulpiani et al,) to X band?

- *Attenuation*. Could you please add some comments on the gamma attenuation coefficients? How they differ from those used in the reference literature that you cited? What does it mean DSD collected in Italy? Are DSD collected all over the Italian country? If DSD collection refers to a specific site, do you think that this can have an impact on the choice of the coefficient that you used in the paper for the Sicily events?

Just to put units to gamma, could you please specify the units on the attenuation (A) in the  $A = \gamma * Kdp$  relationships?

page 8, line 15. Is it  $\gamma_H = 0.29$  and  $\gamma_{DP} = 0.048$ ?

- Eq. 2 What “K” stands for? R and  $R_C$  have the same meaning? The same equation is not fully clear to me. Is  $R_C$  calculated for each (x,y,h) available coordinate. How do you produce the final precipitation map  $R_C(x,y)$ ? Is there any additional threshold or criteria, with respect to those of the clutter removal and quality check to filter out unrealistic values of  $Z(x,y,h)$  and  $KDP(x,y,h)$ ? Please more details are needed on this methodological aspect of the paper.

- *Hydrometeor Classification*. How the altitude of the melting layer is obtained? In the classification scheme I noticed you use the cross correlation coefficient RHV. Do you compensate it for SNR depressions? I noticed after in the manuscript that you specify this point. I suggest to mention the RHV compensation in the methodology section. How did you calculate the constant SNR constant (C) to compute the SNR? Have you assumed  $SNR_H = SNR_V$  in Horizontal and Vertical polarization?

Figure 3. Could you please put a marker to highlight the radar position? This would facilitate the reader while she/he is trying connecting the main text to the figure. In figure 3 I noticed that the peak depression of RHV is mismatched with respect to the maximum peak shown by Z. Can you please add more comments on this aspect in the main text?

Pag 10, lines 5-15. The radome attenuation is really evident from the VMIs at 16:00 and 17:00 UTC. From what I understand, the radome effects are not taken into account for the operational radar in Catania. Could you please at least spend some words for indicating a possible future strategy to way out from the wet radome issue in the light of an operational framework?

- Pag 10 lines 20-25. Do you have some physical arguments to explain why Kdp does not show two double columns of the same intensity?

The “first reflectivity nucleus” ranges between 5 and 6 km in terms of radial distance from the radar. In that range distance  $RHV \geq 0.95$  and the peak of Kdp does not match with that of ZH. In the main text the Authors state that for the first reflectivity nucleus, “RHV is mostly below 0.95” which is in contrast with what one can extract by the visual inspection of figure 6. Thus, I would suggest to better support their conclusion on the presence of rain and hail coexistence in the “first reflectivity nucleus”. In general, from figure 6 I note that there is a spatial mismatch from ZH, RHV and KDP that makes me confused when thinking to the Author’s conclusions. Figure 7 confirms the mismatch of the radar variables noted in figure 6.

-Pag 11, line 15. Why you show 3h rain accumulation [15-18 UTC] in figure 8 while you are calculating the error scores in table 1 on hourly basis for the whole event? In figure 8, I would show the rain accumulated in the same interval which is used for the values in table 1. Just next to figure 8, I would insert the rain map from rain gauges that were available at that time for operational purposes. Please specify the time interval of accumulation. Additionally, is it not clear if the error scores in table 1 are calculated using only one rain gauge in Catania or all the available gauges nearby.

- pag 12, line 5. Lightnings are in the lower right panel of figure 9 and not in the left one as has been written in the main text.

- pag 14, line 18. The Authors say that the radome effects are negligible for the events that they analyzed. This statement is not consistent with what is shown in figure 5, lower panels.