

# **Manuscript amtd-8-9241-2015 “Multi-sensor analysis of convective activity in Central Italy during the HyMeX SOP 1.1”**

By N. Roberto et al.

## **Reply to Reviewer #2 comments**

The authors are grateful to the Reviewer for his/her time spent reading the manuscript. We are confident that we can significantly improve it by taking into account the Reviewer's comments and suggestions.

In the following paragraphs, we reply item-by-item to the Reviewer's comments enumerated and copied in blue color.

### **Major comments:**

#### **1 Comment:**

In the paper the terms strokes and lightning are somewhat confused. The authors consider all analysis performed in the paper using the strokes of the LINET network. At the same time they refer and compare their results with works using lightning. Some grouping of the strokes must be performed to compare the results of this paper with findings in other works (see for example Yair et al. 2014).

#### **Reply**

We agree with your observation and we are sorry for the confusion arisen by the use of two terms “strokes” and “lightning” along the manuscript. However, in this work we had chosen to use “strokes” and not to group them into “flashes”. We think that it is better to show direct measurements, such as strokes, instead of grouping them into flashes. Furthermore, it is known that no absolute criteria exist to convert strokes into flashes (Yair et al., 2014). In fact, conversion depends on the “flash” definition, i.e., how to group strokes registered in a certain time interval and spatial range. Yair et al (2014) showed different methodologies of conversion that could be applied to group strokes. Formenton et al., 2013 in the comparison with their lightning model chose to use LINET strokes without grouping them into flashes, pointing out that there is no absolute criterion to convert strokes into flashes (see Answer to Comment 2).

#### **Action**

The incorrect use of “lightning” words will be corrected in the revised manuscript.

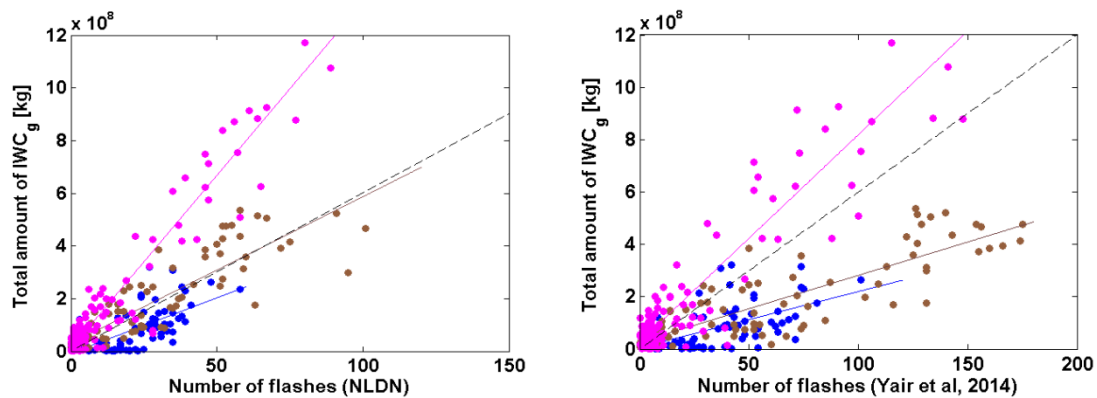
#### **2 Comment:**

One of the interesting finding of this paper is the linear correlation between the graupel ice water content and the lightning activity. The linear correlation coefficients, however, are rather different between the 15 October case study and the other two cases considered ( 12 October and 13 September). The authors discuss this difference also in light of the findings of Formenton et al. (2013). I suggest to correlate the graupel IWC with the lightning number (not the stroke number) to see if there is a better agreement among the cases.

#### **Reply**

In the work of Formenton et al. (2013) comparisons between flashes obtained by the model and LINET measurements were made using strokes without grouping them into flashes. The use of

strokes was justified by the following sentence: “[...] being aware that there is no absolute criterion to convert strokes into flashes, for the purpose of this paper we decided to use LINET strokes”. For the same reason, also in our work we had decided to maintain LINET strokes and not to group them into flashes and compare strokes/graupel relation with simulated flashes/graupel relation (Figure 7). However, following the reviewer suggestion, flash/graupel relations have been computed and the results are shown in the figure below demonstrating the variability of the results when strokes are converted into flashes. *Figure I* shows the relation between graupel (TAG) and number of flashes measured in the radar area in 5 minutes. Flashes were obtained using two different approaches: i) the National Lightning Detection Network (NLDN) method, in which strokes registered by LINET are grouped over a 10-km<sup>2</sup> area within 1.0 s time period (left panel) and ii) Yair et al. (2014) method for which spatial/temporal range is associated to lightning network characteristics, that in the case of LINET, is 1-km<sup>2</sup> within 0.2 s time period (right panel). As shown in *Figure I*, the relation between flashes and graupel is strongly dependent on the flash definition, and using Yair et al (2014) approach the relations found for the three case studies are very similar to the graupel/strokes relation shown in Figure 7.



*Figure I* The total number of flashes in the area coverage by Polar 55C in relation to the total amount of graupel IWC 13 September 2012 (blue), 12 October 2012 (brown) and 15 October 2012 (magenta). In the left panel flashes are obtained using NLDN approach, while in right panel using Yair et al (2014) approach.

### **Action**

Since the aim of this work is to find a relationship between graupel and lightning activity that can be used in NWP models and climatological models, we accept the reviewer’s suggestion to convert strokes into flashes. In the revised manuscript, we will show both the linear relation between graupel and strokes and that between graupel and flashes. Flashes will be calculated following the Yair et al (2014) approach because this methodology highlights the LINET performance in terms of detection efficiency, with respect to standard approach of NLDN. Furthermore, the threshold found by Formenton et al (2013) will be shown in relation to flashes instead to strokes. In summary, the plot shown in right panel of *Figure I* will be added (as a separate panel) to the current panel shown in Figure 7. The text and the caption of Figure 7 will be also changed accordingly to the new panel that will be shown.

### **3 Comment:**

I found several errors in the paper (sometime typesetting errors, sometime English error, etc.). A careful and thorough review of the paper must be done to avoid as much as possible those errors.

**Reply**

Thanks for your reporting. We agree with you.

**Action**

The revised manuscript will be carefully reviewed in order to correct typesetting and English error.

**Minor comments**

**1 Comment**

Page 9247 line 19: the acronyms (IWC) must be introduced the first time they appear in the paper.

**Reply**

Agreed.

**Action:**

The revised manuscript will be corrected accordingly.

**2 Comment**

Page 9252 line 21: 0° level is 0°C level. Sometime you wrote 0°C, sometimes 0 deg, sometime 0°. Please uniform.

**Reply**

Agreed.

**Action:**

The revised manuscript will be corrected accordingly.

**3 Comment**

Page 9252 line 22: “Main rainfall activity were located...” few lines above it is stated that the event involved mainly NE Italy, while Naples is to the South. Explain. Also review the English.

**Reply**

Agreed.

**Action:**

The sentence at page 9252 line 22 will be rephrased as follows : “*Concerning the Centre South Italy ~~Main~~ the most of rainfall activity were located ~~more to the south-east~~ in (Naples area), while scattered deep convection occurred over the CI site.*”

**4 Comment**

Page 9254 line 9: Fig. 2e---g should be Fig. 2d---f. Check.

**Reply**

Agreed.

**Action:**

The revised manuscript will be corrected accordingly.

**5 Comment**

Page 9254 line 20: “the night”

**Reply**

Agreed.

**Action:**

The revised manuscript will be corrected accordingly.

**6 Comment**

Page 9255 line 2: “move” should be “moved”.

**Reply**

Agreed.

**Action:**

The revised manuscript will be corrected accordingly.

**7 Comment**

Page 9255 line 21: there are more than 11 strokes in Fig. 4. Check.

**Reply**

We have checked and we found that the strokes shown in Fig. 4a within the radar coverage area (120 km shown in black range rings) are 14.

**Action:**

The revised manuscript will be corrected as follows “(~~11~~ 14 strokes detected by LINET in five minutes within 120 km of ray from radar)”.

**8 Comment**

Page 9258 line 19: 0° ---> 0°C. Also throughout the paper.

**Reply**

Agreed.

**Action:**

The revised manuscript will be corrected accordingly.

**9 Comment**

Page 9258 line 28. “Concerning” starts a new paragraph here.

**Reply**

Agreed.

**Action:**

The revised manuscript will be corrected accordingly.

**10 Comment**

Page 9260 line 27--28. The point (ii) is not clear because it is unclear from where the authors draw this conclusion. A better explanation of this result is necessary.

**Reply**

Agreed.

**Action:**

The sentence in line 27-28 page 9260 “*the modelling results of Formenton et al. (2013) , in which there exists a minimum threshold of columnar IWC required to produce lightning and this threshold increases with the enhancement of electrical activity, is confirmed by radar observations of 15 October.*” will be rewritten as follow “*The relation between the mass of graupel and number of strokes found using radar observations are in agreements with other results (Petersen et al, 2005; Lopez and Aubagnac, 1997). Moreover, for the October 15 case study the linear relation found*

*grouping strokes into flashes is in agreement with the model results obtained by Formenton et al. (2013). ”*

#### 11 Comment

Page 9261 line 4: RSDs is repeated.

##### **Reply**

Agreed.

##### **Action:**

The revised manuscript will be corrected accordingly.

#### 12 Comment

Page 9261 line 7: I cannot see any coloured circle in Figure 9. Moreover, the colour legend is missing.

##### **Reply**

Right.

##### **Action:**

In the revised manuscript “circle” will be substituted with “stars”. Also legend and caption will be corrected in Figure 9.

#### 13 Comment

Page 9261 line 26: “the 15 October” ---> “on 15 October”, also the following line.

##### **Reply**

Right.

##### **Action:**

The revised manuscript will be corrected accordingly.

#### 14 Comment

Page 9270: Pruppacher and Klett bibliography. The year is wrong.

##### **Reply**

Right.

##### **Action:** I

In the revised manuscript the year of publication will be corrected from “1997” to “1978”.

#### 15 Comment

Page 9274 : Table 4 caption “obtaned” ---> “obtained”.

##### **Reply**

Agreed.

##### **Action:**

The revised manuscript will be corrected accordingly.

#### 16 Comment

Page 9281: “Optimezed” both legend and graph. Moreover change “0 deg” with “0° C”.

##### **Reply**

Right.

##### **Action:**

The revised manuscript will be corrected accordingly.

### 17 Comment

Page 9283: Figure caption: “between for” ---> “on”.

#### **Reply**

Right.

#### **Action:**

The revised manuscript will be corrected accordingly.

### 18 Comment

Page 9285: Figure 9 caption. “According to Baldini and Gorgucci (2006)”.

#### **Reply**

Right.

#### **Action:**

The revised manuscript will be corrected accordingly