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Istituto Nazionale di Geofisica e Vulcanologia

Catania, 30 November 2015

Dear **Anonymous Referee 2**,

Herewith, we report our answers to revisions regarding the manuscript "**PM_{10} measurements in urban settlements after lava fountain episodes at Mt Etna, Italy: Pilot test to assess volcanic ash hazard on human health**" by Daniele Andronico and Paola Del Carlo for possible publication in **NHESS.**
The manuscript now comprises 20 double-spaced pages (submission item: "REVISION") and includes 10 figures and 1 table.

We made the revisions as requested modifying the text and figures 4 and 6, inverting figures 2 and 3, and adding the new figure 9 (with the previous 9 becoming now figure 10). In this letter we explain how and where the reviewer comments have been incorporated in the manuscript.

In our opinion, the main focus of this work is to prove the formation of PM10 during and immediately after the tephra fallout deposition in urban areas produced by Etna explosive activity. On this basis, our contribution would help guide future studies on the potential risk related to the exposure of PM10 particles in this area. Thus, in the revised version, we have stressed this point in order to convince the reviewers and the Editor that our results can represent a starting point to stimulate new studies about this much undervalued problem in the Etnean territory, as is clearly proved in a recent medical study that acute respiratory and cardiovascular diseases, and ocular disturbances, have significantly increased during the ash exposure caused by the 2002 Etna eruption.
We indicated the changes in an annotated version of the revised manuscript file (submission item " Revision_AndronicoDelCarlo_nhess-2015-145").

I certify that the Co-Author Paola Del Carlo is aware of this revision.

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Yours sincerely,
Daniele Andronico

Answer to Anonymous Referee 2

GENERAL COMMENTS

The manuscript describes the measurements of PM10 ash in the atmosphere as a consequence of ash emissions from Etna volcano and, in particular, from the 15 November 2011 episode. The measurements were carried a few hours after the beginning of the eruption and repeated, in the same places after one month (in absence of ash emission).

Results show that, after one month, the concentration of PM10 in the atmosphere is low, compared to the measurements carried out during ash emission.

The paper is interesting, but the limits of the measurement procedures and the reported data need to be commented. In particular, the presence of PM10 in the atmosphere is mainly related to two main processes: 1) the deposition of ash on the ground; 2) the grinding of the ash with production of the fine ash and its resuspension due to the passage of the cars on the roads. The tephra deposit is described by its loading, the size distribution and characterization of the particles. This part is sufficiently described in the paper. However, the effect of the production of PM10 by abrasion of the ash due to the passage of the cars and its resuspension in only marginally described. The secondary production of fine ash seems to be an important factor. In fact, samples collected at SITES 2 and 3 (see figure 4d) mostly contain coarse particles (about 1-2 mm in diameter) with a negligible component of PM10 in the falling ash. Moreover, the resuspension depends on atmospheric turbulence, including that generated by the wind and that induced by the passage of the cars. These two processes (grinding and resuspension) are not quantified by the authors and, for this reason, the measurements are difficult to interpret.

We added a new part concerning the secondary production of finer particles due to car traffic; the example is referred to another lava fountain event occurring in 2007, showing that the grain-size of two samples (the one unmodified and the other ground by passing cars) not only differ by about 1 phi in the mode, but that the latter sample is composed of a high percentage of particles less than 1 mm with respect to the unmodified sample. We support this part adding a new figure 9. Concerning the quantification of the resuspension we have added some considerations in the Discussion chapter "In other terms, as occurred during our measurements following the 15 November 2011 lava fountain, the grinding by the car passage was able (a week after the end of the tephra fallout) to cause the remobilization of volcanic particulate matter and its resuspension in the air, the effects of which have been quantified by the high PM_{10} concentrations measured by DustTrak." (new lines 335-339).

Moreover, ash concentration was measured at different heights form the ground in the three sites. For this reason, the measurements are difficult to compare. I suggest the authors to shortly describe the limits of the measurements and the possible sources of uncertainties.

Following the suggestion of Referee 2, we inserted a few sentences describing the limits of our methodology in the field at the end of the "Methods" chapter (3.1 DustTrak measurements) at new lines 175-183.

SPECIFIC COMMENTS

• *Line 144: PM1, PM2 and PM3 ... do you mean SITE1, SITE2 and SITE3?*

Yes. To avoid misunderstanding with the term "PM_{10}" or "$PM_{2.5}$" and also because the problem has already been referred by another Reviewer, we changed the previous sample names into NSEC1, NSEC2 and NSEC3, respectively.

• *Paper Horwell et al., 2006, cited at line 40 is not reported in the bibliography (do you mean Horwell and Baxter, 2006?).*

You are right, it was an oversight but we meant 2007, and now we changed "2006" into "2007" (new line 39).

• *Paper Andronico et al., 2009 cited at line 55 is not reported in the bibliography.*

It is true. We inserted in the references the missing citation (Andronico, D., Cristaldi, A., Del Carlo P., and Taddeucci, J.:. Shifting styles of basaltic explosive activity during the 2002-03 eruption of Mt Etna, Italy., J. Volcanol. Geotherm. Res., 180 (2-4), 110-122, doi:10.1016/j.jvolgeores.2008.07.026, 2009a.)

• *The document (EU, 2001) cited at line 209 is not reported in the bibliography; instead it is reported (EU, 2008).*
It was erroneously reported; we replaced it with the right reference "EC, 1999" and inserted it in the bibliography (new line 51).

• *Document WHO, 2005, cited at line 225 is reported in the bibliography as WHO, 2006.*
The document is 2006; we corrected it at new line 84.

• *Papers Damby et al., 2013 and EU (2008), reported in the bibliography are not cited in the text. Itemize.*
The first paper is now cited at new line 39. The latter has been reported after "EU directive 99/30" at new line 55. Directive 2008/50/EC (reported in EU, 2008) merged into a unique act some previous directives, among which the 1999/30 itself.