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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Lightning and electrical activity during the Shiveluch volcano eruption on 16 November 2014" *by* B. M. Shevtsov et al.

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Q: question R: reply

Q: The manuscript presents a analysis of electrical activity detected by the WWLLN on 16 November 2014, which is related by the authors to the explosive eruption activity of Shiveluch volcano, Kamchatka occurring during that time. The authors make use of meteorological, seismological and satellite data to correlate the electrical activity to the onset of the eruption at Shiveluch and the following evolution stages of the ash plume and ash cloud. The work presented is surely valuable and present further evidence of electric activity generated by volcanic plumes. Given the growing number of observations of this phenomena and the many questions still open on the interpretation of

such phenomena and related geophysical and volcanological observations, I strongly support the publication of this work. However I think the manuscript at this stage is not yet ready for publication and needs a major revision in terms of structure and form data are presented (including usage of english), technical terminology used and interpretation of data. Here follow some general comments to the manuscript while specific comments and corrections are attached in the annotated manuscript file.

R: The authors are very grateful to Dr. C. Cimarelli who read the manuscript thoroughly and made significant comment. Almost all the remarks and advices of Dr. C. Cimarelli have been taken into account. The given references are partially known to the authors, and the gaps will be corrected. The literature will be useful to the authors in their future work.

Q: The manuscript is quite concise, which usually is a good thing, in this case however it seems that some more paragraph would add to the clarity of the paper, this is particularly true for what concerns the introduction and the section with discussion and interpretation of data. I encourage the authors of adding some more lines in the introduction to introduce more appropriately the aim of their work in light of the previous relevant works done by other authors on the topic. Thomas, R.J., McNutt, S.R., Krehbiel, P., Rison, W., Aulich, G., Edens, H., Tytgat, G., and Clark, E., (2010) Lightning and electrical activity during the eruptions of Augustine volcano, in Power, J.A., et al., eds., The 2006 eruption of Augustine Volcano, Alaska: U.S. Geological Survey Professional Paper 1769-25, p. 579–608. Bennett, A.J., Odams, P., Edwards, D., and Arason, P., (2010), Monitoring of lightning from the April-May 2010 Eyjafjallajökull volcanic eruption using a very low frequency lightning location network: Environmental Research Letters, v. 5, 044013, doi:10.1088/1748-9326/5/4/044013. Behnke, S.A., McNutt, S.R., (2014). Using lightning observations as a volcanic eruption monitoring tool. Bulletin of Volcanology 76.

R: The authors did not aim at investigation of the physic of ash cloud electrification. The paper makes emphasis on the experimental data obtained by the WWLLN network and

by the fluxmeter at KZY site.

Q: The terminology used to describe the volcano phenomenology is inappropriate. I understand the authors are not volcanologists therefore I have made some corrections in the text. In particular the authors often refer to "ash fragmentation" when referring to the initial stages of the eruption. Ash is already a product of magma fragmentation. The fragmentation process usually happens within the volcanic conduit. Several experimental studies have investigated the occurrence of electrical discharges by fragmentation of magma/pyroclasts (fracto-electrification) and by rubbing/collision (triboelectrification) of volcanic particles ejected during an eruption.

R: The incorrectness is due to the bad quality of translation.

Q: It is still unclear to which extent these two processes contribute to the electrification of the volcanic plume and how much overlap there is between the two. I invite the authors to read this recent literature and add few lines of discussion about experimental constraints on the mechanisms of ash charging in the introduction to better discuss advantages and limitations of their methodology: Cimarelli, C., Alatorre-Ibarguengoitia, M.A., Kueppers, U., Scheu, B., Dingwell, D.B., (2014) Experimental generation of volcanic lightning. Geology 42, 79-82. James, M.R., Lane, S.J., and Gilbert, J.S., (2000), Volcanic plume electrification: Experimental investigation of a fracture-charging mechanism: Journal of Geophysical Research, v. 105, p. 16641–16649, doi:10.1029/2000JB900068. Méndez-Harper, J., Dufek, J., McAdams, J., (2015) The Electrification of Volcanic Particles during the Brittle Fragmentation of the Magma Column. Proc. ESA Annual Meeting on Electro-statics Houghton, I. M. P., K. L. Aplin, and K. A. Nicoll (2013), Triboelectric charging of volcanic ash from the 2011 Grimsvötn eruption, Phys. Rev. Lett., 111, 118501, doi:10.1103/PhysRevLett.111.118501 As a general comment, WWLLN detects only cloud-to-ground lightning and we know from direct observations that volcanic plume often produce numerous intra-cloud lightning. The efficiency of WWLLN in detecting volcanic lightning is hence relatively low compared to other detection systems/arrays (see Behnke and McNutt, 2014 for a

review). Another thing that is not really discussed in the

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/3/C2816/2015/nhessd-3-C2816-2015-supplement.pdf

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