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Earth System Science Data Discussions

Interactive comment on "Two weather radar time series of the altitude of the volcanic plume during the May 2011 eruption of Grímsvötn, Iceland" *by* G. N. Petersen et al.

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[GENERAL COMMENTS The article is interesting and clear and the dataset appears to be of good quality and easily accessible. The paper moreover presents interesting data and observation. The use of X-band radar to monitor ash plumes position and evolution is quite an innovative method that, in perspective, promises to give good chance in supporting the aviation authorities in air traffic management. The comparison between two different kinds of radar, constitutes an interesting and useful approach that helps to clarify the limits and strength-points of each one of them. The similarity with the paper from P. Arason. "Observations of the altitude of the volcanic plume during the

eruption of Eyjafjallajökull, April–May 2010", pointed out by the editor, appears not to be detrimental, and doesn't compromise the good quality and added value of the present paper, since, as asserted by the editor himself, the present paper refers to a different volcanic eruption (Grimsvotn 2011) and moreover presents data from the X-band radar, that during 2010 Eyjafjallajokull eruption was not available.

SPECIFIC COMMENTS The use of weather radars for real time monitoring of the ash-column height, and the consequent frequent data communication to the competent VAAC, represents a very good opportunity to feed the VAAC dispersion models with real and updated data and obviously it is of great help for a more reliable prevision and for a better air traffic management worldwide. Nevertheless there are some aspects that need to be analyzed and are briefly exposed below.

Operational conditions In the mentioned case, the observations of the eruptive column was assisted by the presence of clean sky, without clouds, that in Iceland are supposed to be frequent. Authors should deeper verify the possibility to detect ash particles, also in heavy cloud conditions, and the real possibility to distinguish ash particles from ice particles (hailstones). It would be advisable therefore to exploit at their best the potentialities offered by the X-band radar in this field, even if no resolutive method has already been developed to solve the problem. Exploitation of X-band radar potentiality Moreover ground-based X-band radar systems can also provide data for determining the ash volume and total mass, besides the simple height of the eruptive columns, and this could allow to know the real ash concentrations (essential for air traffic management) and for initializing different and more accurate kinds of dispersal models. A possible and desirable evolution, would be represented by the possibility to detect not only the elevation of the eruptive column, but the real concentration and position of the ash plume time to time, in order to give a feedback control to the VAAC simulation models.]

A volcanic plume is a complex feature. One can expect a mixture of ash particles of different size and shape, hail, hail encompassing ash as well as cloud and rain drops.

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Weather radars detect precipitation and precipitating clouds and in some sense that is what a volcanic plume is. Given that the location of the volcano is known, for any plume reaching above the meteorological cloud cover the detection and estimation of altitude is rather straight forward. However, distinguishing ash particles from ice particles is difficult, even when applying a depolarization radar as ice particles may have irregular shape and furthermore an ice particle may contain ash. There have been made some attempts to develop algorithms to detect the size distribution but to our knowledge these have not been tested rigorously. This paper cannot exploit the potential of the X-band radar for this purpose, that is outside of the scope of ESSD. Here we simply provide data on the altitude of the plume. The text has been amended to emphasize this. Further research on the volume data from the X-band radar is ongoing by the Italian Civil Protection and Sapienza University of Rome.

[Integration with other ground-based monitoring systems It would be interesting also to know if the integration with other ground based monitoring system has been developed during the mentioned eruption. In order to better and certainly identify the occurrence of the eruption and the generation of an eruptive column able to spread ashes, it would be very useful the full integration with the infrasonic array of the University of Florence, located near Hella, in addition to the seismometric network. For instance, with reference to the sudden variations registered in the elevation of the eruptive column mentioned in the paper, it should be useful to know if they were due always to real variations, or maybe to possible functioning problems of one of the radars (since authors declare that some problems occurred). The integration with other monitoring system should avoid any misinterpretation, even in no visible sky condition.]

Data on volcanic activity and volcanic tremor shows similar periodic variations as the echo-top plume altitudes. The variation are therefore real and linked to geophysical activity. This is explained clearer in the text now, although the detailed interpretation is outside the scope of ESSD. Integration with other ground-based monitoring system was limited during the eruption but afterwards some of the data has been compared.

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A large European project, FUTUREVOLC, is starting in the autumn and has as one of its goals to integrate not only ground-based but also remote sensing of the whole geophysical system. This is an exciting project that will undoubtedly result in increased understanding of the volcanic system.

[Location of the radar A special mention has to be addressed to the effort made in finding the most suitable location of the mobile radar in a very short time and under heavy ash fall condition. It would be advisable for the future, consider the individuation of a possible barycentric location, furnished with electric power, that should allow the possibility to detect the greatest number of active volcanoes expected to erupt in the near future, or, where necessary, the displacement of the radar in a very short time. IMO should consider also the possibility of the use of an helicopter S64 for the transportation, although the cost of such a mean is considerable.]

The work on selecting suitable locations for the X-band radar for monitoring any explosive eruption in Iceland started in 2011 and is ongoing. However, transporting a radar by a helicopter is not feasible due to the cost. The text has been amended.

[Conclusions Regarding the conclusions drawn in the paper, it is important to make clearer that the detection resolution depends not only on the distance of the instrument from the volcano, but strongly on the kind of radar and on its wave-length; in case of minor eruptions the C-band radar could be useless even if located at short distance. In the conclusions the differences in the use of the two kinds of radar (X-band and Cband), seem to be not sufficiently analyzed. Unfortunately the X-band radar was used only to detect the column height, without exploiting its potentiality, nevertheless a few lines of details regarding the two tools would be important. However the simultaneous use of both the instruments together is for sure a good choice.]

A text regarding this has now been included in the conclusions.

[References References mentioned in the paper, are almost completely limited to Icelandic experience and authors.]

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This is true. We have now included other relevant references.

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