Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2015-974-RC1, 2016

Atmospheric Chemistry and Physics Discussions

Interactive comment on "A novel technique including GPS radio occultation for detecting and monitoring volcanic clouds" *by* Riccardo Biondi et al.

Anonymous Referee #3

Received and published: 1 February 2016

In this paper the author describe results on ash cloud detection as well as volcanic ash cloud top height determination using GPS radio occultation measurements of two volcanic eruptions (Puyehue and Nabro) in 2011. This is a well written and convincing study using two quite different eruptions, one being rich in ash and no SO2 the other being very SO2 rich. The paper however falls short in convincing me if this technique would also be applicable to eruptions including lower ash or SO2 content. Admittedly, this was not the main aim of this work but the introduction builds on this argument (L36 and following), plus smaller eruption do threaten airways also considerably and techniques to monitor those are also necessary. The ability to detect smaller eruptions should in some way be addressed in the paper, the best place being most likely the

Full screen / Esc

Printer-friendly version

Discussion paper

discussion section.

As mentioned by the authors the ash of the Puyehue eruption circled the earth leading to airspace closure quite far away from the eruption. It would be of particular interest up to what distance from the volcano RO techniques could be used to detect ash. This should also be addressed in the paper.

I have listed several references which should be included in this paper to give better cerdit to other work which has been done in this field.

Overall I feel this is an interesting paper and should be published after moderate to major revisions. Please find more specific comments below.

Specific comments:

L27: These references are ok, but there are some better ones for volcanic plumes reaching the stratosphere. A good reference could be the book by Sparks et al (1997) on Volcanic Plumes.

L31: The Pinatubo effect was as far as I know first published by MacCormick et al 1995, Nature, 373:399-404 and should be referred to in addition to the Robock paper.

L48: It is not the total ejected mass, but the mass flux which controls the height of the eruption cloud (see e.g. Woods, 1988, Bull. Volcanol, 50: 169-193). Furthermore eruption clouds typically overshoot the level of neutral buoyancy so there are certainly different height levels at which ash and aerosols are injected into the atmosphere during a single eruption.

L87: There is a quite comprehensive paper on observation of ash clouds using radar by Sawada 2004 (http://www.ofcm.noaa.gov/ICVAAS/Proceedings2004/pdf/entire-2ndICVAAS-Proceedings.pdf) that summarizes all observations of ash clouds with radar until 2004. This could be referenced here.

L99: From here on you refer only to RO techniques. Goals of your study are a) the

detection of volcanic clouds and b) the determination of cloud top height. L89-98 summarize briefly what has been done on the detection of ash clouds. Previous work on the determination of cloud top heights are missing however completely and there have been other approaches to determine cloud top height which should also be referenced here. Following is a list of papers which I feel should be included in your summary of the state of the art, as some techniques referred to in those papers (e.g. reflectance ratio measurements, photogrammetry) have not been referred to. (Chang, F.-L., et al., 2010. J. Geophys. Res. 115, D06208. doi:10.1029/2009JD012304; Dubuisson, P., et al., 2009. Remote Sens. Environ. 113, 1899–1911. doi:10.1016/j.rse.2009.04.018; Frey, R.A., et al., 1999. J. Geophys. Res. Atmospheres 104, 24547–24555. doi:10.1029/1999JD900796, Poulsen, C.A., et al., 2012. Atmos Meas Tech 5, 1889–1910. doi:10.5194/amt-5-1889-2012; Stohl, A., et al., 2011. ACP, 11, 4333-4351. doi:10.5194/acp-11-4333-2011)

L 214: I am not sure if I understand this correctly. For the reference climatology you average all profiles in an area of 5°x5°. Here you are referring to the climatology for the eruption in line 213 which is now sampled at 1°x1°. In case this is the eruption climatology than what is the possible error by substracting the average taken over 5°x5° which is a much larger area. But maybe I am misunderstanding this paragraph.

L215: Considering a spatial distance of 200 km between the CALIOP data and the volcano, can those profiles be considered representative for the cloud top, especially because the plume may have overshooted significantly near the vent. I note, for the main cloud at the neutral buoyancy level, though, this may be valid verification.

Fig1: Legends are missing on both maps. L555 there are no numbers in brackets. What are the black circles in the top right diagram?

Fig2c,d,e,g: From this figure it is very hard to see how often e.g. a certain bending angle has been measured in the individual profiles. Instead of plotting each single profile on top of each other, maybe a kind of density plot would be better in this case

indicating how often a certain bending angle has been observed at what height. This would also apply to Fig4bcd as well as to all panels in Fig5.

L230: It is worth to note that the RMSE of RO is comparable to the estimated ash cloud photogrammetry (see Genkova, I., et al, 2007. Remote Sens. Environ. 107, 211–222. doi:10.1016/j.rse.2006.07.021; Virtanen, T.H., et al., 2014. Atmos Meas Tech 7, 2437–2456. doi:10.5194/amt-7-2437-2014; Zakšek, K., et al., 2013. ACP. 13, 2589–2606. doi:10.5194/acp-13-2589-2013) Those should be referenced.

L239: The references to the work of Woods et al. are somewhat confusing. Woods and Self in their 1992 paper refer to studies by Maston as well as Harris et al. regarding the cooling effect, they only use this observation to state that this is also observed in their model. The way this paper is cited here one thinks Woods and Self did those observations which they did not. The same is actually true for the reference to the Woods et al, 1995 paper. Again this paper only used observations made by others, so again this reference should be removed and replaced by references to those papers where the processed the satellite data have been published first.

L 258: I am a bit confused, here it's a 10°x10° area, above it's a 1°x1° area (L214 and above).

L270: Instead of strength I would write buoyancy flux because the strength of an eruption is not well defined.

L317: Please provide a figure similar fig5 for the Puyehue eruption to see how this eruption evolved over time, especially because the eruption of Puyehue contained only volcanic ash.

L334: Is this method fast enough to be used as a real time monitoring system. Could it be used in a similar way as MODVOLC (doi:10.1016/j.jvolgeores.2003.12.008) from HIGP (http://modis.higp.hawaii.edu/) which is used to detect hotspots?

Fig4: In that figure you show one mean value (at least that how it looks like). Is that the

one for the deep or non-deep convective environment?

Fig5: Why are there 2 black lines in the upper right panel. I assume it is the average for the profiles before and after the eruption but this should be stated somewhere in the caption.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2015-974, 2016.