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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Lidar observation of the 2011 Puyehue-Cordón Caulle volcanic aerosols at Lauder, New Zealand" *by* K. Nakamae et al.

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Reply to the reviewer's #1 comments Manuscript title: "Lidar observation of the 2011 Puyehue-Cordón Caulle volcanic aerosols at Lauder, New Zealand" MS No.: acp-2014-14

We thank reviewers for reading our manuscript carefully and for giving useful comments. We extensively revised our manuscript along the reviewer's comments, and below are our responses to them. Reviewer's comments are shown in italic and our responses are continued after them. The page and line numbers refer to those published in Atmos. Chem. Phys. Discuss.

p. 13466 l. 21: Please shortly introduce the volcanic explosivity index to readers who

may not be familiar with this. Also indicate how the index is related to injection height. We added the follow paragraph in page13466 line21. "The VEI was developed as a simple and semi-quantitative scheme for estimating the magnitude of historic eruptions by Newhall and Self (1982). Eruptions are assigned to a VEI on a scale of 0 to 8, using the criteria such as the volume of ejecta, column height and qualitative of the eruption. Especially, the volume of ejecta and the column height are important."

p. 13467 l. 11: It might be worth mentioning, that also windshield abrasion and reduction of visibility and sight are volcanic hazards to aviation. We added the sentence in page13467 line13. "The volcanic hazards for aircraft have been recognized that are the stop of aviation engines, reduction of visibility and the damage to windshield due to volcanic ash (Bernard, 1990)." Additional reference: The Injection of Sulfuric Acid Aerosols in the Stratosphere by the El Chichon Volcano and its Related Hazards to the International Air Traffic, Bernard, 1990.

p. 13468 ll. 1ff.: Derivation of the tropopause height is a key element of this study. Nevertheless the authors do not explain how the tropopause height is determined (e.g. by temperature minimum, by wind speed maximum, by potential temperature slope, by potential vorticity. There are a lot of definitions of "tropopause" out there). It would be good to add a short paragraph on this method here. We added the sentence in page13468 line4. "We use the tropopause height as the lowest level at which the temperature lapse rate is less than 2 K/km for higher levels within 2 km defined by the WMO (WMO 1957)." Additional reference: WMO, 1957: Definition of the tropopause. WMO Bull., 6, 136.

p. 13469 l.14: I agree with the value of the lidar ratio, nevertheless the authors are encouraged to reference section 3.3 here in order to reduce confusion for the reader. We corrected in manuscript. (We added sentence in page13469 line14.) "We assumed the lidar ratio S to be 50 sr at both 532 and 1064 nm in this study from some previous studies (see section 3.3)."

p. 13469 ll. 21ff.: Which radiative transfer model has been used for calculating the molecular backscatter coefficient? We didn't use the radiative transfer model. We need the molecular backscattering coefficient and the extinction coefficient to calculate the aerosol backscattering coefficient from lidar signals. The molecular backscattering (Rayleigh scattering) coefficient and the extinction coefficient are taken from Bucholtz et al. (1995) using the atmospheric density profiles obtained from radiosonde data launched at Invercargill.

p. 13470 ll. 4f.: A reference to non-spherical particles being related to positive delta would be appreciated. We corrected our manuscript and added references. Because backscattering by spherical particles does not change the laser polarization, δ=0 for spherical particle. The depolarization ratio is sensitive to the non-spherical particles. When δ>0, the scattering by non-spherical particles is recognized (Sassen 1991). Additional reference: Sassen, K.: The polarization lidar technique for cloud research: A review and current assessment, Bull. Amer. Meteor. Soc., 72, 1848-1866, 1991.

p. 13472 ll. 16ff.: Do the authors have any explanation, why delta is significantly lower for the Eyjafjalla case compared to PCC? Might the reason be the different mineralogical composition (mid-ocean ridge volcano versus subduction zone volcano), the amount of ejected SO2/H2SO4 , or anything else? We cannot explain the reason for difference of kind of ejected components from two volcanoes, the Eyjafjallajökull and the PCCVC eruption. The significant difference in δ might be due to the difference in distance between the volcano and the observation site, or the difference of the amount of each volcanic ejecta.

eq. (6): It would be good to shortly explain which assumptions go into this equation (as it is a strong simplification of the radiative transfer problem). Uchino et al. (1983) did not use assumptions and simplifications for deriving Eq.(6) from Lidar equation.(Lidar chapter1 .p20) Reference: Weitkamp, C. (Ed.): Lidar -Range-Resolved Optical Remote Sensing of the Atmosphere-, Springer Series in Optical Sciences, Vol. 102, chapter1 .p20, 2005.

p. 13474 l. 1: A value of 13% AOD difference is quite a close coincidence given the uncertainties and simplifications. How does it relate of the lidar ratios discussed above (i.e. could the difference be explained by the spread of potential lidar ratios)? A value of 13% is the difference between the AOD derived by IBC and the AOD derived by Eq.(6). Whereas the AOD derived by IBC have the error depending on uncertainty of lidar ratio, the AOD derived by Eq.(6) does not depend on the lidar ratio, and its value has 0.08 in analysis error, that is the range of AOD=0.44-0.6. Hence, it is presumed that 13% error contains both the above analysis error and the uncertainty of lidar ratio.

p. 13474 l.2: How do the authors get the uncertainty of about 20% for the AOD from IBC? A short explanation would help understanding these numbers. We corrected and added our manuscript in page13474 line1-2. "; this AOD value is 13 % larger than the AOD derived from the IBC and S. The values of AOD derived by Eq.(6) are 0.17 and 0.12 on 24 June and 6 June, respectively. On average, the AOD derived by IBC was about 20 % smaller than AOD derived by Eq.(6). If the lidar ratio is assumed to be 60 sr, AOD will be consistent each other."

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/14/C6993/2014/acpd-14-C6993-2014-supplement.zip

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 13465, 2014.