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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Temporal variations of flux and altitude of sulfur dioxide emissions during volcanic eruptions: implications for long-range dispersal of volcanic clouds" *by* M. Boichu et al.

Anonymous Referee #2

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General

The paper deals with a very important and modern research topic: long term dispersal of volcanic clouds, with focus on sulfur dioxide emissions and fluxes in the troposphere. The paper includes satellite observations (passive as well as active with the CALIPSO lidar) of a recent Etna volcanic activity in the Mediterranean (April 2011). The paper is well written and contains a comprehensive discussion of the findings and on potential uncertainties in all the retrieval approaches.

I have only a few comments (minor points)!

Abstract: The abstract is too long. The abstract is not an introduction section, in which the motivations of the paper is presented. Please briefly provide the goals of the paper, the used techniques and the main findings. Only that, and not more.

Introduction:

Page 5034, lines 7-13: You can find a good example for enhanced air pollution by volcanic sulfate particles after the Eyjafjallajoekull eruption in April 2010 (e.g. 19 April 2010) in the EARLINET/AERONET paper of Ansmann, JGR, 2011.

Page 5035, lines 23-26: Can you really be sure that the volcanic aerosol and sulfur emissions and transport were at all well defined in terms of height assignment after the Eyjafjallajoekull eruption. Is passive remote sensing sensitive enough to see all the traces of volcanic aerosols and gases? I have my doubts! Traces of volcanic material were at all heights within the troposphere according to the Eyjafjallajoekull JGR special issue, as for example shown by Seifert et al., JGR, 2011, in this special issue.

By the way, ground based lidars are much more powerful than the CALIPSO lidar, so they can detect all the volcanic traces, whereas the CALIPSO lidar observations often suffer from strong signal noise, as you show also, later on in the paper.

Page 5036, lines 15-30: The approach is fine, but you still have no potential to obtain clear vertical SO2 profiling. Should one discuss the potential of an SO2 Differential Absorption Lidar (SO2 DIAL)? Would such a lidar be helpful? Or are the SO2 concentrations too small? Please check the literature regarding SO2 DIAL observations.

Page 5038, line 25: you write: radar, but you prefer to write: LiDAR! Why? Usually the lidar scientists report lidar observations, and not LiDAR observations.

Page 5038, line 25: How can a radar help you regarding the altitude of SO2 emissions?

Page 5040, lines 12-19: The approach is reasonable, but leaves still open many questions regarding the uncertainties in this retrieval (as mentioned in lines 23-24)!

Page 5041, lines 12-30: How can the CALIPSO lidar track the volcanic aerosol plumes? The spaceborne lidar provides just snapshots (as you use one: 00:26 UT on 11 April 2011). The lidar crosses the same location every 16th day only. The horizontal resolution is rather coarse. And as mentioned, the spaceborne lidar is not just a powerful lidar as all these ground-based lidars presented by Ansmann (2011), Pappalardo (2013), and many other papers in a variety of special issues in Atmospheric Research or Atmospheric Environment and ACP (search for authors like Papayannis, Gross, Sicard, Lucas Arboledas and others). You may even mention airborne (UK) lidar activities of Franco Marenco (in JGR? or ACP?). Sure, the CALIOP lidar is unique, but all the ground-based and airborne lidar activities were much more helpful to describe the Eyjafjallajoekull plumes over Europe.

Page 5042, lines 5-11: Please provide uncertainties in all the HYSPLIT trajectory computations. Many groups no longer use just single trajectories, they prefer to use products of ,e.g., FLEXPART and other dispersion models.

Page 5047: Concerning the CALIPSO lidar comparison, I have some remarks:

Line 14: How is the color ratio defined (attenuated backscatter (1064 nm) / attenuated backscatter (532nm)) or just 1064nm backscatter coefficient divided by 532nm backscatter coefficient.

Line 15: meteorological clouds are just clouds (or cloud layers)

Line 23: particle depol ratio in volcanic plumes is always less than 0.4

Silke Groß, Volker Freudenthaler, Matthias Wiegner, Josef Gasteiger, Alexander Geiß, Franziska Schnell, Dual-wavelength linear depolarization ratio of volcanic aerosols: Lidar measurements of the Eyjafjallajökull plume over Maisach, Germany, Atmos. Environment, pages 85-96, 2012.

What is the uncertainty in all these CALIPSO products, must be large for these optically

thin layers.

Around the cirrus, the backscatter may not be caused by aerosols but by remnants of cirrus. Color ratio is not so helpful when signals are low and very very noisy!

Particle depolarization ratios of 0.3 indicate ash, 0.1 a mixture of ash and spherical particle (maybe volcanic sulfate particles). 0.2-0.5 indicates cirrus.

When discussing cirrus and volcanic layers, please add Seifert, JGR, 2011 to the reference list (not only Sassen et al., 1989).

Figure 8: Total attenuated backscatter. . ..! What does that mean? Rayleigh plus particle attenuated backscatter?

Figure 9: If the volume depolarization ratio is so low (2% or so), the particle depolarization ratio is not very trustworthy at the low backscatter coefficient conditions. Please provide uncertainty range.

Also the color ratio is always 0.2-0.3 outside of clouds, more information can not be extracted, So there is not only ash!

Page 5052, lines 7-10: Again, what about the use of a SO2 DIAL, please discuss, would that be sensitive enough. One could think about deployiong several SO2 lidars on the Mediterrranean islands (close to Etna, Crete, Cyprus. . .).

Page 5055, section 4.3.: SO2 DIAL, please discuss again, would that be helpful? And again, please mention ground-based lidar activities in addition (such as, e.g., presented by Ansmann 2011). For lidar people it is joke to say that the CALIPSO lidar is much more powerful than ground-based lidars regarding high altitude plume detection.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 5031, 2015.