Interactive comment on "Multi-wavelength Raman lidar observations of the Eyjafjallajökull volcanic cloud over Potenza, Southern Italy" *by* L. Mona et al.

Anonymous Referee #1

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Review of the paper "Multi-wavelength Raman lidar observations of the Eyjafjallajökull volcanic cloud over Potenza, Southern Italy" by L. Mona et al.

The paper presents aerosol lidar observations taken during the eruption phase of the Eyjafjallajökull volcano in Southern Italy.

The paper is interesting to read because it gives valuable insights in the properties of the volcanic ash cloud in Southern Europe. In contrast to Central Europe, this region was not heavily affected by the ash cloud during the first eruption phase in April 2010. Consequently the observed ash particles travelled a long way and can be described as aged aerosol. The use of an advanced Raman lidar technique allows for a distinc-

tion between Saharan dust particles and volcanic ash, which were observed in similar heights on the same days.

The paper presents good science but it needs to be rewritten at several places because some descriptions are too detailed and the style is too narrative. I recommend publication after the necessary changes have been applied.

Specific major comments

page 12764, line 6/7: The difference between 'multi-wavelength Raman lidar measurements' and 'EARLINET measurements' is not clear for the reader. You may omit this.

page 12764, line 14: 'In the April-May period ...' You may omit this sentence. It is not important here.

page 12764, line 22-28: This is too detailed. Try to describe it in a short way in the abstract.

page 12765, line 2-8: This is a typical sentence that makes the paper difficult to read. It is too long and therefore difficult to understand.

page 12765, line 18-25: This sentence is too long

page 12766, line 7/8: Matthias et al. present reconstructions, too, but they use a different type of model (Eulerian model) than Stohl et al. (Lagrange model).

page 12766, line 8: What is meant by 'border conditions'?

page 12766, line 13-16: How could this affect the Mediterranean eco-system? I do not immediately see which effects this might be.

page 12767, line 21-24: The 3+2 measurements include the 1064 nm backscatter don't they? How can they then be used to retrieve the 1064 nm backscatter? Additionally, you need to explain what is meant with 3 backscatter and 2 extinction measurements. It is not clear that they are taken at different wavelengths.

page 12768, line 1-9: This paragraph can be omitted, it is not necessary to understand the paper.

page 12768, line 19 - page 12769, line 20: This is described in too much detail. It is not important why you couldn't perform measurements in this or the other case. It is sufficient to describe what you have.

page 12769, line 21: In this Methodology section, some of the results are already explained and this leads to some confusions with the Results section. In particular fig. 6 is doubled in fig. 7. You should avoid this, shorten the Methodology section to what is really needed to explain the methods and then give the details in the Results section.

page 12771, line 24/25: This feeble layer is almost not visible in Fig. 1. Besides that, this paragraph is misplaced in the Methodology section.

page 12772, line 9-15: I do not see the argument why it is better to use backscatter profiles instead of the range corrected signals. The normalization has to be done, too.

page 12772, line 16: 'an ill-posed procedure'. What does it mean? Is it of importance here?

page 12772, line 24/25: '... evaluated by using the Rayleigh criterion ...' This is too specific and cannot be understood even if the reference is given.

page 12773, line 25-27: What is meant here if you say the 'models run every 6 hour'? The models run continuously with a time step of a few minutes over the whole period, concentration fields are stored every hour.

page 12774, line 1-3: 'The iterative procedure reported in Di Girolamo et al. (1999) is applied for the 1064nm backscatter retrieval, with lidar ratio values selected on the basis of the 3+2 measurements performed at CIAO.' This has been said before.

page 12774, line 8-19: From Figure 2 it is difficult to believe that you can distinguish different layers above 7 km. To me this looks too noisy to be sure about these layers.

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page 12774, line 20: Couldn't you also use the depolarization measurements to distinguish clouds from aerosols?

page 12776-12780: this paragraph needs to be shortened drastically. You describe in very much detail, what has been observed. This is not necessary to explain the method. You may do it later in the Results section.

page 12775/76: You describe three different trajectory products but you use only one. It is not important in this context what is available besides the product you use here.

page 12778, line 23-26: Why can you be sure that volcanic ash has different properties than Saharan dust?

page 12778, line 11-12: 'The feeble feature extending between 3.4 and 4.3 km a.s.l. is characterized by ...' I cannot see a value for the Angstrom exponent at 6:00 UT in Fig. 5.

page 12779, line 24/25: If you classify mixed aerosols it would be of interest to know which types are mixed. How many types in total can you distinguish in youe classification? Are there other types which were not observed during these days?

page 12781, line 3: What is SEM analysis?

page 12781, line 14-18: It is not of interest here what other obligations you have.

page 12782, line 21-25: Wouldn't you expect that the volcanic ash is not hygroscopic? Eventually formed sulfate particles may be connected with the ash and change the hygroscopicity, but do you have any indication that this was the case? Additionally, most particles, even hygroscopic ones, will not be largely affected by water uptake at 50 % RH.

page 12784, line 14-15: '... while Å ngström exponents are smaller': How small? Small compared to what?

page 12786, line 1-3: This sentence is not well formulated. The emissions cannot be

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directly observed at Potenza. If you observe high concentrations this does not necessarily mean that the emissions were high because only a small fraction reaches the measurement station. You may reformulate this.

page 12786 line 3 and later: How can I interpret the ratio of lidar ratios? It would be good if you would say something about this quantity, what it is and how it can be used to characterize aerosol particles.

page 12787 line 12: This paper of Pappalardo et al. may be cited if it is submitted and may be included in the final version of the paper as accepted. Otherwise you should omit this reference.

page 12787 line 18-23: How do your observations compare to other lidar and sun photometer observations of the Eyjafjalljökull ash cloud?

page 12787 line 28 - page 12788 line 4: This is again one of the sentences that is quite hard to get. You may rearrange it and explain a bit more clearly what is meant.

Figure 2: How are the 'layers' above 7 km distinguished? Can you really identify different layers?

Figure 4: What is seen in Fig a,b,c,d? Better start with 'HYSPLIT backtrajectory analysis during the transition regime between Saharan dust observation and the volcanic aerosol arrival on 13 May 2010.'

Figure 6: The maximum investigated altitude is not visible for many hours: why? If you classify 'mixed aerosols', could this be specified a bit more? Can you show which types are mixed, e.g. Saharan dust and volcanic aerosols?

Figure 7: This is not a nice figure, it is too small, it looks not well arranged and it includes a figure that was already shown (fig. 6). You might think about having a separate figure for each episode and/or putting some figures in an appendix.

Figure 8: You might use different colors for the different days/heights to facilitate a com-

parison of the different aerosol properties for one observation. The labels are too small and difficult to read in this figure.

Minor comments / expressions which are difficult to understand

page 12764, line 15/16: doubling of observed'

page 12764, line 20: are discussed

page 12765, line 12: omit 'has been'

page 12765, line 21: Emeis et al., 2011

page 12765, line 28: Gasteiger et al., 2011

page 12765, line 9/10: doubling of occurrence/occuring

page 12766, line 21: state-of-the-art

page 12766, line 21: for ground based

page 12766, line 14: studies

page 12766, line 26: of the PEARL set-up and the retrieved products

page 12769, line 22/25: the term 'in order to' is used quite frequently, maybe you can try to avoid it at some places or find something else

page 12770, line 9: 'for the provision' or 'for providing'

page 12771, line 19: 'seems to occur' this is not a good expression for a scientific text. You have to be more precise: Did it occur? Could it be seen? If yes, write it down clearly.

page 12771, line 19: 'Measurements started ...' The sentence may be omitted.

page 12772, line 9: With respect to ... . Please check this through the whole document.

page 12772, line 21: see my comment page 12771, line 19

page 12773, line 4/5: 'the aerosol backscatter scattering ratio' This not a nice term. Couldn't you name it 'scattering ratio' and explain what it is.

page 12780, line 14: Which models?

page 12783, line 5/6: 'As reported above, the measurements stopped on 23 - 24 April due to rain.' This is not important.

page 12785, line 1: better: 'Optical properties of volcanic aerosol'

page 12785, line 2: You may list the intensive properties that you can determine and that are investigated here.

page 12785, line 16: You need to introduce S_{uv} and later S_{vis}

page 12786, line 14: 'For all the other cases ...' this sounds like a lot, but aren't there only 2 other cases?

page 12786, line 18-23: The sentence is too long, you may rearrange it in two or three separate sentences. '... no simultaneous Raman lidar ...' is not a good expression.

page 12787, line 4/5: better: These measurements can be a reference point for the testing of atmospheric transport models. The observations are taken far from the source and the amount of volcanic aerosol reaching the area is low.

page 12787, line 8: in detail

Figure 4: 'highly noisy' is colloquial. Better describe it with 'large statistical errors'. What about error bars between 1 and 4 km?