

General Comments

The changes made by the authors address well the general comments I made in the first round of review. Specifically, the authors respond well to the comments about including modelling to examine processing of SO₂ and sulphate aerosols. The authors make it clear that this is a target for future work, but carrying out such work now goes beyond the current capabilities of their model and it would take months to carry out this additional work. In addition, the authors also discuss plans to develop improved methods (and cite current work to this end) for analysing volcanic plumes using satellite data that would allow a more detailed examination of gas phase and aerosol processes occurring in the volcanic plume.

In addition to the comments relating to plume process modelling, I also suggested that authors try to create a better exposition of how the different elements of their study interact and contribute to the understanding of the volcanic plume and the aerosol properties. The authors have largely dealt with problem by creating a schematic diagram that goes a long way to resolving this. I do have some specific remarks regarding this schematic though (see below).

Finally, the authors have also satisfactorily addressed the other specific comments I made in the previous round of review. I therefore recommend the article for publication following minor corrections to points raised below in the specific comments section.

Specific Comments

Figure 1 does a good job of explaining each element of this study and how they interact and contribute to different parts of the findings. I do have some brief comments on this, however. There are two letters on the linkage between Source and Evolution, M and Q, which seem to have no explanation or purpose. In some of the cases, the letter coding and accompanying explanation are not clearly linked to a specific arrow. This mostly relates to e) and g). The authors could try to resolve this perhaps by colour coding the arrows and comments, or by using small lines to link the comment and associated arrow. I found the comment for d) 'Comparison' to be a little too simplistic. Could the authors please elaborate shortly beyond this?

Lines 23-25 of the abstract. The authors state "...that sulphate particles played a large role, ...", but it is not stated in what. I presume that this is composition of aerosols and resultant radiative forcing, but the authors should make this a bit clearer.

Page 16, lines 9-10. The value of 2500 td⁻¹ is an average that presumably includes much larger eruptions and this accounts for why the average is actually higher than the size of this eruption. I found this to be slightly counter intuitive. It might help readers if the authors could provide a number for the quiescent degassing rate during no eruptive activity. This would add a little context that would help readers understand that 1200 td⁻¹ is still eruptive relative to background activity levels. For instance, Kilauea in Hawaii emits between 1,200 to 4000 td⁻¹ of SO₂ on a relatively constant basis with no sharp spikes in episodic activity, which is very different to what is implied for Etna by these numbers.

Page 27, line 19. "typical desert dust albedos...". Do you mean desert dust or surface? Please check and correct if needed. I would also add text to state that the radiative forcing varies significantly for aerosol layers over desert surfaces.

Page 27, lines 20-21. I found this sentence to be a bit confusing. You have described the aerosol layer as more absorbing, but this somehow implies that the aerosol properties themselves have changed. But, this test explores the effects of calculating the radiative forcing over a desert surface. I would just say that the aerosol layer has *less negative radiative forcing*.

Captions for Tables 2 and 3. I would mention that the tables also contain *f*. Perhaps also briefly define *f* as it is only mentioned in one location.

The captions for Figures 2 and 3 are mixed up. Also, there is no specific description of each MODIS image a) to d) in the captions. At the moment there is only (a) written with no specific mention of what it corresponds to. Please change this. For the MODIS image caption you describe the triangle as brown, but it appeared red to my eyes.

For Figure 5, 6, and 7, can you please use consistent legends for the locations of Etna and Lampedusa. At one point it changes in the sub figures for Fig. 5.

Figure 10 caption. Change to “Ash vertical concentration profiles in ($\mu\text{g m}^{-3}$) for the 6 aerosols classes listed in Table 1 along the trajectory T of Figs. 5, 6, 7 and 9.”

Figure 11. The vertical dotted lines highlighting the period after the eruption are barely visible on my printed copy of the manuscript. Please can you make the lines more visible? I found the same thing for the horizontal lines in Fig. b). I could not see the grey dotted line in the printed version at all, but I could see it in the pdf on my screen. Please can you make the horizontal average line thicker? There seems to be no explanation of the dots in the time series. Please can you explain that? Finally, change caption from “...depth measurements; (b) ...” to just “depth measurements, and (b) ...”.

Figure 12. The distinction between the two greens used for the line graphs was difficult to see. Please can you choose more distinct shades of green or pick different colours?

Technical Comments

Correction shown in italics or strikethrough.

Page 2, line 15. “...at a distance *of*...”

Page 3, line 23. “...which, in *the* presence of water...”

Page 4, line 1. “... conversion can occur *within* very different...”

Page 4, line 18. “...composition and *aerosols* in the...”

Page 4, line 26. “...the understanding *of* the...”

Page 4, line 27. “...different aerosol types to the *aerosols in the* Mediterranean region.”

Page 5, line 3. “...~~hardly~~ provide *little* detailed...”

Page 6, line 23. “Works ~~are~~ is ongoing...”

Page 6, line 23. Recommend adding “...*in future work.*” at the end of the sentence.

Page 8, line 22. “...calculated with ~~the~~ Mie theory...”

Page 10, line 15. “...sulphur dioxide emission ~~is over~~ *has finished* by that time...”

Page 12, line 20. “...humidity and gases concentrations are...”

Page 13, line 5. Missing fullstop at the end of the sentence.

Page 15, line 2. “...Etna towards *the South-West.*”

Page 15, line 5. “...*South-East.*”. Please check capitalisation of other directions of the compass in the text.

Page 16, line 3. “or under-estimates ~~of~~ the SO₂ burden...”

Page 16, line 20. “...study in more details the...”

Page 16, line 16. “...orientated towards *the*...”. Also note no capitalisation on “South-West”.

Page 17, line 18. “...the ~~far~~ *long*-range downwind...”

Page 17, line 18. “...consistent between ~~them~~ model and observations,...”

Page 20, line 17. “...~~small~~ *long*-range impact of...”

Page 23, line 10. “...parameters of ~~the~~ Mount Etna...”

Page 23, line 11. “...aerosol *plumes* by sun-photometry...”

Page 24, line 25. “This allows us to estimate the sensitivity...” of what? Radiative forcing? If so, please state sensitivity *of something* to aerosol absorption.

Page 25, line 7. “...in the lower troposphere, ~~and~~ *but* the...”

Page 26, line 10. “...would be a necessary *addition* in ~~this~~ *these* kind of impact studies...”

Page 27, line 12. “...the asymmetry parameter, *respectively*.”

Page 27, line 21. “...aerosol layer, ~~at~~ *for* fixed aerosol...”

Page 27, line 24. “...surface *albedos*, like...”

Page 27, line 25. “...would be important *steps* towards ~~most~~ *refining* radiative forcing...”

Page 28, line 2. “...spatio-temporal scales, ~~by~~ the injection...”

Page 29, line 3. “...are under ~~investigation~~ *development*.”

Page 29, line 4. “The sulphate aerosols ~~eventually~~ formed *in the plume* have...”

Page 29, line 11. “...role in the ~~local~~ *plume* aerosol population,...”

Page 29, line 13. “...albedo and ~~then~~ to the...”

Page 29, line 14. “...these *estimates* are performed...”

Page 29, line 15. “...to a pure marine albedo and ~~then~~ *therefore* these...”