Atmos. Chem. Phys. Discuss., 14, C1686–C1688, 2014
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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "Characterisation of a stratospheric sulphate plume from the Nabro volcano using a combination of passive satellite measurements in nadir and limb geometry" *by* M. J. M. Penning de Vries et al.

**Anonymous Referee #2**

Received and published: 23 April 2014

In this paper an analysis of aerosols in the early plume of the 2011 Nabro eruption using UV satellite measurement is presented. The paper is a nice exploration of what can and cannot be achieved with UV nadir and limb measurements. Such measurements are not reported elsewhere and the analysis therefore complements the existing literature on the Nabro eruption. The challenging retrievals seem to prevent the authors from making strong quantitative conclusions. As such no major new findings on the specifics of the eruption are reported, while the presented results are broadly consistent with present knowledge. I recommend it for publication after a minor revision.



Minor comments and suggestions for improvement:

- Page 7741: 18-21. This gives the impression that the 'first volcanic plume' was confined to 18-19 km. The cited papers do not confirm does. Depending on the definition of 'first volcanic plume' (Nabro erupted almost uninterrupted for the first two weeks), it would be more correct to say 'above 10 km, with a maximum around 18-19 km.'

- Page 7741: 26. These 30-40 days for SO2 lifetime were derived for plumes above 25 km (Pinatubo and El Chichon eruptions). The lifetime is highly dependent on the altitude/water vapour content, and for lower plumes it will be much shorter. For example: Kasatochi (2009): 9 days (Krotkov, N. et al. J. Geophys. Res., 2010, 115, D00L20) Sarychev (2011): 10-14 days (Haywood, J. et al. J. Geophys. Res., 2010, 115, D21212) Cerro Hudson (1991): 6 days (Constantine, E. K. et al., AGU Monograph 116 - Remote Sensing of Active Volcanism, 2000, edited by P. Mouginis-Mark et al., pp. 45-64) For Nabro it was estimated to be around 5 days (Theys, N. et al. Atmos. Chem. Phys., 2013, 13, 5945-5968). In view of this, it is not surprising that stratospheric aerosols can be detected very early on.

- Page 7744: Section 2.2. It is discussed in the conclusion of the paper, but it would be very helpful if the effect of water and ice clouds on UVAI (and on the sign) could be described here.

- Page 7744: Section 2.2 first paragraph. The description of UVAI, AAI and SCI is confusing. Do all three refer to the same quantity and only differ in the sign? 'The positive part' is confusing, either it is positive or it is negative. Likewise 'the counterpart' is confusing. I would suggest rewriting/expanding this paragraph, starting with a definition of UVAI and then describing the effect of scattering or absorbing aerosols on the index using comprehensive examples (ash, sand, water, smoke, sulfates, trace gases(?) etc..). Why does the SCI not depend on the plume altitude, while the AAI does?

- Page 7750: As reported also in several other studies, ice particles were present in

great numbers in the Nabro plume on the 13th. As mentioned in the conclusion, they had an impact on the UVAI on the first day - and I think the right place to discuss this is here, and not in the concluding section. (another argument is that there is no reason the UVAI of sulfates alone would be stronger (more negative) on the first day than the second.

- Figure 4. Why is this shown at 18.6 km (while the profile maxima are at 13.5 and 16.5 km respectively)?

- Figure 5. The profiles shown in figure 5 are very broad ($\sim$10 km), surely broader than the actual plume. Could you comment on why this is the case?

- Figure 6. Why was the aerosol layer put at such high altitudes? 16-19 km would be more in line with what was actually observed in that part of the Nabro plume.

- Figure 7. The effect of a plume not centred at the tangent point is very interesting. Have any attempts been made to correct for this effect in the retrieval using collocated SO2 nadir retrievals?

- Page 7753: 14-22. this part is not very clear. Also line 17, the comment on pixel 3 and 4, does not seem to be consistent with what is shown in the figure.

- Page 7753: 27. there was no 'merging of plumes'; the early plume was continuous but slanted over an altitude range. What is seen in subsequent days (16/17 June) is a horizontal separation of the plume due to differential wind shear.

-Page 7755: 3-7. As far as I can tell, this is not seen in the figures. Please check and correct/clarify.

- Page 7758: 27: 17-20 km is not in agreement with the presented results. 15-20 km would be more in line with what is actually shown.

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Interactive comment on Atmos. Chem. Phys. Discuss., 14, 7739, 2014.