Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC2
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Comment on amt-2022-253

Anonymous Referee #2

Referee comment on "Investigation of three-dimensional radiative transfer effects for UV–Vis satellite and ground-based observations of volcanic plumes" by Thomas Wagner et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-253-RC2, 2022

Review of the manuscript "Investigation of 3D-effects for UV/vis satellite and ground based observations of volcanic plumes" by Wagner et al. 2022

The manuscript "Investigation of 3D-effects for UV/vis satellite and ground based observations of volcanic plumes" investigates the impact of the 3D structure of volcanic plumes on the satellite and ground based retrieval of trace gas species in the UV for which usually 1D scenarios are assumed. In detail, four effects are investigated that partly have a strong effect on the retrieved VCDs, especially for high spatial resolution instruments like e.g. TROPOMI. This paper is particularly interesting for the UV trace gas-retrieval community that observes narrow plumes of volcanic and anthrophonic sources and is well within the scope of AMT.

General comments

Although in the first part of the paper BrO and IO are introduced, the second part focuses mainly on the short wavelength UV range covering SO2. I would therefore suggest to only focus on SO2 in the paper and show some more results (see my comments below) and replace the 440nm results with the 370nm results

For some of the effects investigated you mainly focus on a plume around 5-6 km and sometime 10-11km, whereas other effects (i.e. the Plume side effect) only considers a plume on the ground. It would be nice to see (or discuss) the impact of each effect as a function of plume height. What I would like to see (if possible) a high-altitude plume around 15-17km in addition.

Detailed comments

Abstract, Line 25: „systematic underestimation” of which quantity? AMF? VCD? Please add

Section 1, 83: “the true plume amount” – what amount do you mean, i.e. which quantity? Mass?

Section 2, Line 164: “one grid cell from 555 km to 20°” – it is a bit confusing to suddenly switch from km to degrees – suggest to use km instead of 20°

Section 2, Line 166: “The surface albedo was set to 5%” Please add a short justification why you use this albedo and which kind of surface this would represent.

Section 2, Line 171: “rectangular FOVs corresponding to the nominal ground pixel sizes of the different satellite instruments are used”. Perhaps add in a table the ground-pixel diameters of the different instruments such that the reader can compare between the instruments and the narrow FOV.

Section 2, Line 224: Would it be possible to also add a high-altitude plume at 15-16km?

Section 2.1.2 & 2.1.3: Suggest to remove these and focus on SO2 in the following, see my general comment above

Section 2.1.4 Line 270: The La Palma eruption occurred from September-December 2021, so I would either remove “Summer” or replace with “September to December 2021”.

Figure 6: Although the figure shows the SO2 fit ranges of the "MPIC analysis", this is nowhere described or mentioned in the text. Please remove this from the figure

Figure 8: Can you also show the results for different plume heights in the plot and/or different wavelengths?

Figure 10: Can you also show the results for different plume heights in the plot?

Figure 13 and Section 4.0 Line 429: You refer to scenarios "strong,1" and "strong,4" and also use this in the title of the plots- this is confusing since one automatically asks, what about strong,2 and strong,3. Suggest to remove this rather arbitrary scenario naming

Section 4 Line 438-439: “Accordingly, with increasing plume height a stronger reduction of the observed radiance for plumes with high SO2 amounts is found” Where do I see this? Only one plume height result is shown.

Section 4.1 Line 456. Perhaps add a sentence here about the thresholds used to switch to other fit windows.

Figures 18: Why is the peak observed in radiance not at the same distance as for the AMF? What is the VZA for the bottom AMF plots as a function of SZA?

Section 6: You have investigated this effect only for a plume located at the surface – please also add results for other plume heights

Section 8: Line 625: “…to a strong and systematic underestimation if 1D…”. Underestimation of which quantity? Please specify

Section 8, Line 627: Perhaps specify for which conditions a 100% saturation or 50% light mixing effect occurs.