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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A comparison of DOAS observations by the CARIBIC aircraft and the GOME-2 satellite of the 2008 Kasatochi volcanic SO₂ plume" *by* K.-P. Heue et al.

Anonymous Referee #1

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General comments

The manuscript, 'a comparison of DOAS observations by the CARIBIC aircraft and the GOME-2 satellite of the 2008 Kasatochi volcanic SO2 plume, by Heue et al. described the comparison of the SO2 plume observed by the DOAS instrument onboard CARIBIC with the GOME-2 measurements. The trajectory model was used to calculate the location of the SO2 plume because of the temporal difference between CARIBIC and GOME-2 observations. The interesting part of the paper is that the authors have tried to include the aerosol and clouds information in the calculation of SO2 air mass factors. I can see that lots of efforts have been made to get accurate SO2 vertical columns.

However, limited by the cloud and aerosol data, wind data, there are still uncertainties in the SO2 vertical columns. The authors have provided lots of details about the data analysis and finally the agreement between the CARIBIC and GOME-2 SO2 VCD are very good.

Specific comments

Page 527, line 17. In this paragraph the authors explained the Box AMFs and the sensitivity of the different telescopes. I suppose the Box AMFs is calculated by the McArtim model. Can you introduce the RTM model first, and then explain the Box AMF and the AMF to convert the SCD to VCD?

Fig.1 What are the cloud bottom heights for the two clouds? The box AMF seems decreased to 0 rapidly below the cloud top. Is it related to the assumed cloud optical thickness and geometric thickness? Can you include the cloud properties in the caption of Fig. 1 or in the texts? The flight altitude is indicated in Fig. 1 at 11 km. Can you add the flight altitude in the caption?

Page 528, Line 25. As I understand the Ring spectrum used in the DOAS fit for the CARIBIC is different as the Ring spectrum used in the GOME-2 DOAS fit because you used different references. What is the reason for that? Does it effect the fit?

Page 529, Line 2, 'As the reference SCD is unknown it might add an offset (+/-6.5E15 molec/cm2) to the time series. . .' Where does this SO2 value come from? Is it the background SO2 value?

Fig. 3 Could you indicate the region where the SO2 plume was observed by CARIBIC? This is a nice plot to show the SO2 pattern but not clear for the plume that is analyzed in this paper.

Page 532, Line 22. The cloud top altitude is determined from the rapid increase of cloud liquid water. I wonder if the cloud water is really liquid water or ice. If the cloud top is at 11 km there could be more ice particles than water droplets. Is the cloud water

only measured at the cloud top? If these are continuous measurements, you could know the cloud water along the flight track when the aircraft pass through the clouds.

Page 532, Line 23, '. . . the cloud optical thickness (COT) was adjusted to approximate the clouds' optical properties.' What clouds' optical properties do you mean?

I assume that the SO2 AMF is calculated at one or several wavelengths between 312 and 330 nm. The single scattering albedo of 0.99 is relative low for clouds, which can cause large absorptions, 0.999 might be a better value for clouds in the UV wavelength. Do you use ice or water clouds in the RTM model and what kind of scattering phase functions is used?

Page 533, Line 1. The authors explained that it was not possible to compare the COT with MODIS. Have you tried to use the COT product from SEVIRI/MSG? There are more cloud products available from SEVIRI besides COT.

Do you have any information about the SO2 plume height along the trajectory?

What is the error in the ECMWF wind? Probably the 1 degree resolution is not enough to resolve all the variations in the wind field. Actually from the GOME-2 images SO2 peak close to 20 degree east seems separated from the main plume, it suggests that there are variations in smaller scale.

Fig. 4 The telescope with -10 degree detected the SO2 plume earlier than the +10 degree telescope. Is it an extra piece of information about the plume altitude and distance from the aircraft?

It is difficult to distinguish thin and thick clouds from Fig. 5. What is the cloud type for the thick clouds? Do you have vertical velocity measurements when the aircraft is inside the clouds?

Fig. 6. What is the unit for the cloud water?

Page 533, Line 24. ' . . . the sharp decline in the observed SO2 column might be

a reduced SO2 concentration due to scavenging by the cloud droplet.' Do you have measurements about the chemical components in the cloud water? Do you see the aerosol composition is different inside and outside of the clouds?

Page 538, Line 17. The aerosol layer was assumed to be extended from 11 to 12 km. So the aerosol layer is above the clouds. Why it is not possible that the aerosols are also partly inside the clouds? In this case aerosol reduces the total SSA more efficiently.

Page 539, Line 10. The authors find that the influence of the different clouds on the SO2 AMFs is almost negligible for CARIBIC. Could you explain the reasons?

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 523, 2010.