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Atmospheric Chemistry and Physics Discussions

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Interactive Comment

Interactive comment on "Interpretation of FRESCO cloud retrievals in case of absorbing aerosol events" *by* P. Wang et al.

P. Wang et al.

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We would like to thank referee #2 for the comments and helpful suggestions. The manuscript has been revised according to the referee's suggestions. The simulations are performed using Mie scattering phase functions for biomass aerosols and dust aerosols in clear-sky and cloudy cases. We have used more aerosol optical thickness values in the simulations.

Interactive comment on 'Interpretation of FRESCO cloud retrievals in case of absorbing aerosol event' by P. Wang et al. Anonymous Referee #2 Received and published: 27 January 2012

Wang et al. presents a study showing that FRESCO results using measurements in the O2A band region contain information on the aerosol height for pixels with elevated Absorbing Aerosol Index. This is a promising work as a first step towards a quantitative aerosol product from a UV sensor like GOME-2. Nevertheless I think the paper -in its current state- is a bit misleading and could be improved in several ways. In line with the comments of referee #1, it is not clear to me when FRESCO is really providing useful results. In my opinion, the author should establish the conditions where FRESCO provide information on the absorbing aerosols height.

Comment #1: In figures 1 and 2, only two values of AOT are presented for the sensitivity tests. I would recommend using a lot more of intermediate values so that the reader can have an idea of the range of AOTs where FRESCO is useful (the same holds true for the SSA values). For Figs 1 and 2, the results are plotted as a function of solar zenith angle but I have the impression that it doesn't really bring something to the discussion. Instead, the author might want to plot the results as a function of AOT for some representative SZA values.

A: We have used AOT values of 0, 0.1, 0.2, 0.5, 1, 1.5, 2, 2.5, 3, 4 in the new simulations. The FRESCO cloud retrievals are plotted as a function of AOT in Fig. 1 and 2 for two solar zenith angles at 30 and 60 degrees.

Comment #2: In figures 1 and 2, the tests are performed for an aerosol layer high in the atmosphere (9-10 km). In my opinion, it is mandatory to show and discuss the results for an aerosol layer close to the surface as well. Indeed, the absorbing aerosol events of sections 4.2, 4.3 and 4.4 correspond to aerosol layers close to the ground (at least partly). E.g. on page 10, the author write: âÂĂÂIJBecause we selected largely cloudfree areas, the FRESCO cloud parameters can be regarded as aerosol parameters.âÂĂÂİ Strictly speaking, this is not true. Fig 1 only addresses the case

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where the aerosol layer is high in the atmosphere (9-10 km).

A: We agree with referee #2 that it is more realistic to show a simulation with aerosols at lower altitude. In the revised manuscript, the aerosol layer is set at 4-5 km for the biomass burning aerosols and at 9-10 km for dust (volcanic ash) aerosols.

Comment #3: In section 3, all results are shown as a function of AOD and SSA while in section 4 all results are plotted as a function of AAI. This is misleading (AAI is a qualitative index). The author should provide some information on possible/typical values for AOD and SSA for the different types of events (ash, biomass burning, desert dust, wild fires). On page 6, it is written 'The single scattering albedo of biomass burning aerosols is normally between 0.6 and 0.9'. The reader really would like to know about the other types of aerosols and the typical values for AODs. For the sensitivity tests, it would be very nice to have a correspondence between the aerosol parameters used (AOD, height, SSA) and the AAIs corresponding to these aerosol settings. This information could be provided in a Table or using additional axis in Figs 1 and 2. All this should help the reader to estimate what are the conditions where the FRESCO is useful for the absorbing aerosols and if these conditions are often encountered or not.

A: Thank you for asking for the AAI values of the corresponding aerosol settings. We have now included computations of the AAI for the aerosol settings used in the FRESCO retrievals. Results are shown in two figures of the AAI in sect. 3. In section 4, the FRESCO results are plotted as a function of AAI because we do not know AOD or SSA from GOME-2 data.

Comment #4 (in relation with my previous comments): What is exactly the added-value

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of section 4.2? Of course close to the source, the height of the dust plume is close to the ground. The reverse would have been surprising. It would have been much better to make the exercise for an (aged) desert plume much higher in the atmosphere. I suspect that in this case the AOD is to small and the technique is not working anymore. In summary it is not clear from this paper what are the conditions where this technique is working (and thus useful). Similar remark for section 4.3.

A: We have now included some small AOT values in the simulations. The FRESCO retrievals will work for small AOT for cloud-free scenes. For an aerosol layer above a cloud layer, FRESCO retrieves aerosol height for optically thick absorbing aerosols but retrieves cloud layer height for optically thin aerosols. The added-value of section 4.2 is to demonstrate that FRESCO retrievals work for desert dust cases in an almost cloud-free scene. We agree that an aged desert dust plume higher in the atmosphere would be a good case. However, if the desert dust is over clouds, FRESCO may retrieve cloud height, not aerosol height. Actually, in section 4.3 we show that FRESCO retrieves cloud height when optically thin biomass burning aerosols are on top of stratiform clouds.

Comment #5: Validation of the retrieved aerosol pressure is missing. - For Puyhue, the retrieved ash layer pressure might be validated using CALIPSO data or back trajectories (e.g. HYSPLIT). -In Section 4.4, page 12: The cloud pressure and scene pressure values mostly vary between 400 hPa and the surface, which indicates the variation ofthe smoke plume height. Is there any validation possible?

A: We have looked at CALIPSO data for the four examples of Sect. 4. However, there is no overlapped CALIPSO data for these cases. It is only possible to get some CALIPSO data close to the GOME-2 measurements with a few hours time difference. Therefore we can not really validate the FRESCO retrievals. We have included some values from CALIPSO to support our conclusions in section 4.

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We have calculated the trajectories using the HYSPLIT trajectory model and HYSPLIT for volcanic ash. The trajectory run was started at 18 UTC on 4 June 2011, and continued for 48 hours. It was reported that the volcanic ash plume height was about 12 km on 4 June 2011 (see http://www.volcanodiscovery.com/puyehue/news.html, http://volcanism.wordpress.com/2011/06/05/puyehue-eruption-update-3500-evacuated/ , http://volcanism.wordpress.com/2011/06/06/puyehue-cordon-caulle-update-6-june-2011/). Therefore we set the plume top height at 12 km in the HYSPLIT volcanic ash model. The ash clouds (eruption + 42 UTC, left column in Fig.1) have similar shape and location as that observed by GOME-2 at 1300 UTC on 6 June 2011. The ash clouds between FL350 and FL 200 have good agreement with the GOME-2 FRESCO cloud pressure or scene pressure between 400 -200 hPa for the plume in the right box in Fig. 7. The HYSPLIT forward trajectory shows that the plume top altitude is at about 10-12 km at 12 UTC (close to GOME-2 overpass time) (see Fig. 2). We will include the HYSPLIT results in the paper but we will not include the figures.

Comment #6: AAIs are retrieved in the UV and FRESCO operates in the IR. Does it imply some difficulties? I wonder about the meaning of correlation plots like scene pressure vs AAI (e.g. for desert dust). AAI is a qualitative index and is retrieved in a region where the albedo is very different from the one in the IR (FRESCO).

A: It is difficult to determine a quantitative relationship between the AAI and FRESCO products. The correlation plots show a qualitative relationship between AAI and FRESCO. One of the difficulties is that we do not know the wavelength dependence of the AOT in the GOME-2 measurements. The wavelength dependence of AOT is determined by the aerosol type, particle size, and the refractive index of the aerosol composition. We have used biomass burning aerosols and dust aerosols in the new simulations. The scattering phase functions for the aerosols and clouds are calculated

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using the Mie theory. We have presented the aerosol models and the aerosol optical properties calculated from the Mie code in Table 1 and 2. In Table 2, the extinction efficiency shows the wavelength dependence of AOT in the UV and the O2 A band.

Comment #7: Page 9: 'As shown in Figs. 4a and 4c, some pixels have small AAI values, small effective cloud fraction values and large cloud pressures. ' It is not possible to identify these pixels. Generally speaking this is also true for all the correlation plots.

A: We removed this explanation.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 32685, 2011.

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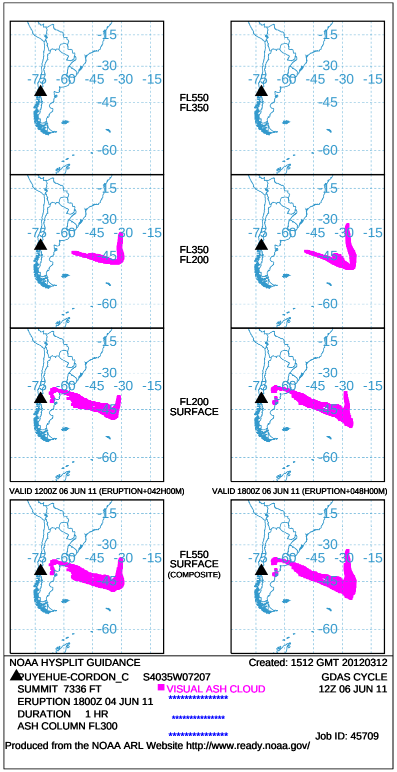

Fig. 1. Puyehue volcanic ash cloud on 6 June 2011, simulated by the HYSPLIT volcanic ash model for different altitude ranges.

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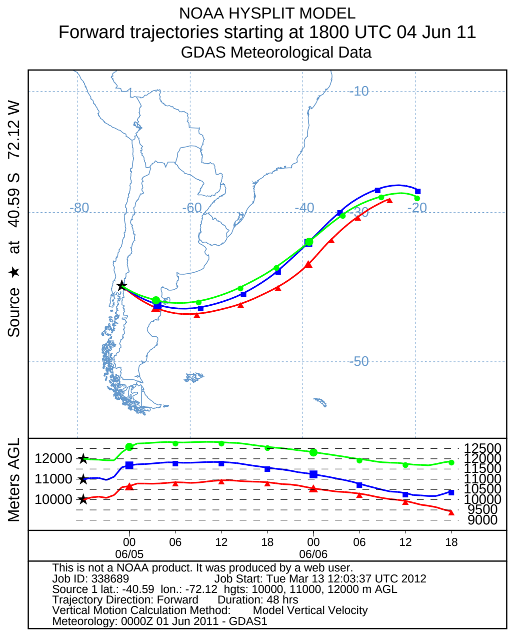

Fig. 2. Puyehue volcanic ash trajectory from on 6 June 2011, simulated by the HYSPLIT trajectory model for different altitudes.

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