Atmos. Chem. Phys. Discuss., 3, S2567–S2573, 2003
www.atmos-chem-phys.org/acpd/3/S2567/

Atmospheric Chemistry and Physics Discussions

ACPD

3, S2567–S2573, 2003

Interactive Comment

Interactive comment on "The vertical distribution of aerosols, Saharan dust and cirrus clouds at Rome (Italy) in the year 2001" *by* G. P. Gobbi and F. Barnaba

G. Gobbi

gobbi@lux.ifa.rm.cnr.it

Received and published: 12 February 2004

The vertical distribution of aerosols, Saharan dust and cirrus clouds at Rome (Italy) in the year 2001; by G. P. Gobbi and F. Barnaba, Atmos. Chem. Phys. Discuss., 3, S2088-S2090, 2003

Authors replies to Referee #2 (referee comments indicated by the symbol #). Page and line numbers refer to the PDF version of the ACPD on-line manuscript.

General Comments

In this paper, the authors perform a climatological analysis of tropospheric aerosols from a set of 813 lidar profiles of aerosol extinction and depolarization coefficients

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

obtained in Italy in 2001-2002. They determine yearly and seasonal averages of the contribution of cirrus clouds and Saharan dust episodes to the total observed optical depth, using typical values of backscatter and depolarization ratios for these conditions.

The paper is correctly written and well presented. The authors provide a clear description of the instrumentation and the signal processing. The statistics are well documented and the figures correctly explained. The data seem to be of good quality and the authors make a noticeable effort to explain the observed variations of the extinction and depolarization ratios in the various seasons. This analysis should provide a valuable input for trend studies of tropospheric aerosols or validation of future satellite missions dedicated to tropospheric aerosol measurements. However, the paper lacks a clear explanation of the data discrimination for dust and cirrus cloud conditions. Lidar profiles representative for the various conditions are presented but the threshold values necessary for the discrimination are not given.

There is no clear-cut way of discriminating between various aerosol and cloud types on the basis of lidar traces alone; this could only be done via chemical analysis. However, some good inference can be performed employing the lidar data. We do that via manual single-profile analysis, comparison with model aerosol forecasts and, if necessary, backtrajectory analysis. Clearly, backtrajectory analysis of 800 profiles, each one made of 140 points, each point requiring at least 5 backtrajectories (i.e. approximately 560,000 trajectories) is not a simple task.

In the manuscript aerosol-cloud discrimination was discussed in Section 3 (from line 13 of page 7). The data discrimination for dust and cirrus clouds conditions followed starting at line 6, page 8, and was illustrated in Figure 1. Figures 2 and 3 of the manuscript clearly showed the existence of a height separation between dust and cirrus-cloud layers.

However, to respond to the reviewer comment we added to section 3 the following two sentences:

ACPD

3, S2567–S2573, 2003

Interactive Comment

(*)

There is no clear-cut way of discriminating between various aerosol and cloud types on the basis of lidar traces alone. However, some good inference can be done employing the polarization lidar data. Our classification has been performed via manual single-profile analysis, comparison with model aerosol forecasts and, when necessary, by back-trajectory analysis.

And:

Saharan dust has depolarization levels similar to cirrus clouds, while backscatter ratios are mostly one order-of-magnitude smaller and lifetimes one order-of-magnitude larger. Together with a broader vertical extent of Saharan dust layers, all this allows for a good discrimination between cirrus clouds and dust.

Furthermore, to rule-out any doubts about identification of Saharan dust we computed 1,830 5-day backtrajectories for the dates affected by Saharan dust conditions. This analysis has been inserted in section 3 of the revised manuscript together with an additional new Figure (Fig. 2). These backtrajectories demonstrate the good reliability of our original classification. The person who carried-out the backtrajectory runs (L. Ammannato) has been included as co-author of the paper.

Furthermore, the authors should put their analysis in perspective with other climatological studies of tropospheric aerosols. Very few references are provided on this subject although to my knowledge, several networks for tropospheric aerosols measurements such as the European EARLINET have been implemented recently and have provided results.

In the original manuscript Introduction (lines 6-15 of page 3) we did provide a rather large number of references to long and short-term lidar observations and analyses of the lidar-derived aerosol data (including EARLINET and Asia-NET results). However, we could not find climatological profiles of aerosol extinction or depolarization for various aerosol types in the literature. As a matter of fact, this lack is clearly stated in the IPCC 2001 report (Chapter 5.6 of the Scientific basis volume)in the following way: II. Systematic Vertical Profile Measurements. There is a paucity of systematic vertical profile measurements of size-segregated or even total atmospheric aerosol physical, chemical and optical properties. For these parameters, no climatological database exists that can be used to evaluate the performance of climate models that include aerosols as active constituents. The COSAM model comparison (Barrie et al., 2001) had to use vertical profile observations from a few intensive aircraft campaigns of only a few months duration to evaluate climate model aerosol predictions.

In order to respond to the reviewer's comment and to better depict the context of climatological lidar observations reported in the literature, we completely re-formulated the Introduction paragraph in the following way:

In fact, our knowledge about height-resolved aerosol properties over long-term periods is still rather poor and, as also stated in Penner et al. (2001), mostly limited to localized observations performed by balloon or aircraft-borne instruments (e.g., Hofmann, 1993, Gasso et al., 2000) or by lidar systems. In fact, lidar observations represent a convenient technique to collect long-term aerosol records (e.g., Hamonou et al., 1999, Balis et al., 2000; Franke et al., 2001, Matthias and Bosenberg, 2002; Schneider and Eixmann, 2002). Nevertheless, lidar-derived climatological profiles of aerosol optical properties in the whole troposphere are still uncommon in the literature. Lidar studies more often address aerosol properties integrated over the whole PBL (e.g., Matthias and Bosenberg, 2002; Del Guasta, 2002), or over the lower troposphere (e.g., Sakai et al., 2000, Balis et al., 2000, Franke et al., 2001, Schneider and Eixmann, 2002). Conversely, lidar profiles are more often presented in case studies of specific aerosol events (e.g., Hamonou et al., 1999, Murayama et al., 2001; Muller et al., 2003, De Tomasi and Perrone, 2003). To our knowledge, no climatological profiles of tropospheric aerosol extinction and depolarization are currently available in the literature.

Of course, we might have missed some published material which could disproof our

ACPD

3, S2567–S2573, 2003

Interactive Comment

last statement. If the reviewer can suggest any we shall be happy to mention that in our study.

"Specific comments" # 1.Methods # Specify the aerosol-free height at which the lidar profile is calibrated.

As indicated in the manuscript (p. 4, line 20), this analysis is performed manually. For each profile the operator determines by visual inspection an aerosol-free region where to calibrate the lidar trace against the model atmosphere. Therefore, each of the 813 profiles has a different calibration height. It would be difficult, and probably not useful, to list the calibration heights for the whole set of profiles presented.

What is the model atmosphere used for computing the molecular backscatter profiles?

It was specified at the end of the Methods first paragraph (page 4, line 10) that the model atmosphere is a monthly standard atmosphere, obtained from a ten-year climatology of radio-soundings launched 30 km West of our site.

The error analysis is based on one reference only. This part should be expanded.

The method for error analysis of aerosol observations made by single wavelength lidars is fully discussed in the given reference (Russel et al., 1979). As stated in the manuscript, we compute the error in our measurements of backscatter coefficients according to Russel et al. (1979) since this method well describes the error expected to affect our measurements. It is not clear how/why should we use additional ones.

To respond to the reviewer comment we re-phrased the relevant sentence (p. 5, line 2) in the following way: Errors in the retrieval of BETAa (z) depend on range and measurement conditions as background noise, accuracy of the model atmosphere, of the SIGMAa / BETAa ratio and of the calibration (e.g., Russell et al., 1979; Measures, 1984). By taking into account all these parameters and following the error analysis method of Russell et al. (1979), typical errors of dBETA/BETA of about 20% are found

ACPD
3, S2567–S2573, 2003

Interactive Comment

to characterize the backscatter coefficients discussed in this paper.

How exactly are the data discriminated for dust and cirrus clouds condition? Are threshold values for the the basckacstter and depolarization ratios determined?

As previously mentioned, there is no clear-cut way of discriminating between various aerosol and cloud types on the basis of lidar traces alone. Aerosol-cloud discrimination was discussed in Section 3 of the original manuscript (following line 13 of page 7). The data discrimination for dust and cirrus clouds conditions was discussed starting at line 6, page 8 of the manuscript and based on Figure 1. Figures 2 and 3 of the manuscript clearly show the height separation between dust and cirrus-cloud layers.

However, since the reviewer comment highlighted a weakness of the manuscript on this point, in the revised version we provided new explanations on this topic as detailed above in our reply to the reviewer General comments (*);.

2. Yearly averages # Figure 2b: Why the depolarization ratio increases to 5% in the NC curve (pale blue)?

The following statement has been added to section 3.1 to answer the reviewer question:

Conversely, the small increase (to about 5%) in the NC curve depolarization ratio observed at altitudes above 6 km is mainly due to noise.

3. Monthly averages # Page 8: explain RH-enhanced

The relevant sentence has been changed into: higher relative humidity (leading to enhanced growth of soluble particles)

Figure 3: I don not see any mention of tropopause height for the cirrus cloud condition analysis. Is there a dependance of cirrus appearance to the tropopause height? What is the tropopause height seasonal variation above Rome?

In this paper we wanted to address the climatology of aerosol and cirrus extinction and depolarization with the aim of providing an input to modelers. Hopefully, we shall

ACPD

3, S2567–S2573, 2003

Interactive Comment

address cirrus clouds formation mechanisms, aerosol to cloud transition as well as aerosol origin and dispersion in further papers. Here we would prefer to restrict the discussion to lidar profiles alone.

Comparison with sunphotometer aerosol optical depth: it is difficult to see thinner cirrus clouds on an average figure since the clouds can be located at different altitude ranges.

Since cirrus clouds are sporadic, their imprint remains visible in the seasonal averages. In Figure 3, the Autumn cirrus-cloud extinction profile definitely shows many more thin (about 0.5 km) features than the Spring one.

4. Conclusions # As already mentioned, the sentence on the few yearly climatologies of tropospheric aerosol profiles in the literature is surprising.

This point has been answered in the General comments section above.

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 5755, 2003.

ACPD
3, S2567–S2573, 2003
Interactive Comment