SOCIETÀ ITALIANA DI FISICA

ATTI DI CONFERENZE

CONFERENCE PROCEEDINGS

4^{th} Workshop
Italian Research on Antarctic Atmosphere

edited by M. Colacino, G. Giovanelli and L. Stefanutti

Porano, 21-23 October 1991

EDITRICE COMPOSITORI · BOLOGNA

Conference Proceedings Vol. 35
«Italian Research on Antarctic Atmosphere»
M. Colacino, G. Giovanelli and L. Stefanutti (Eds.)
SIF, Bologna, 1992

RESULTS OF AEROSOL AND OZONE MEASUREMENTS IN PRESENCE OF THE PINATUBO VOLCANIC CLOUD

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Abstract. We present the results of simultaneous aerosol and ozone measurements in the Lidar Station of the University of L'Aquila (SLAQ from now on) after the eruption of the Mount Pinatubo. Data were obtained using an ozone DIAL system, $\lambda_{on} = 308nm$ $\lambda_{off} = 351nm$, and an aerosol lidar in the visible at $\lambda = 590nm$. The ozone profiles are corrected for the volcanic aerosol presence and validated with ECC soundings. The correction is works even in presence of a large amount of aerosols and a good agreement between the DIAL and ECC soundings is shown. We propose this method of correction for DIAL ozone measurements in polar region also in presence of Polar Stratospheric Cloud.

INTRODUCTION

The eruption of Mount Pinatubo (15.14°N, 120.35°E) in the Philippines on June, 15 1991, produced a large amount of volcanic aerosol in the stratosphere. This is a very interesting event for testing the effect of the heterogeneous chemistry on the ozone destruction rate. The DIAL technique may also provide ozone profiles in the stratosphere, so that a large series of ozone data can be easily stored. However the presence of large amount of aerosols affects the DIAL signals, then a suitable corrections is required. The main problem is to determine a correct aerosol profile in the visible channel (i.e. backscattering ratio) taking into account both the ozone and aerosol absorption. The obtained backscattering aerosol profile is used to correct the *on* and *off* DIAL signals with an appropriate wavelength scaling.

SLAQ OZONE AND AEROSOL MEASUREMENTS

The SLAQ (42°N, 13°E) includes two separate instruments. The aerosol lidar is the same as described in D'Altorio and Visconti (1983) with a more powerful pulsed dye laser ($> 1\ J$ per pulse) operating at about $0.15Hz$ and a new data acquisition system based on photocounting. The DIAL system makes use of an excimer laser emitting at $308nm$ and $351nm$ with typical output energies of $90mJ$ and $70mJ$ respectively and a repetition rate ranging between $1Hz$ and $80Hz$. A detailed description of the DIAL system is given in Masci et al. (1991) and in Rizi et al. (this issue). In a typical measurement session ($2 \div 3$ *hours*), $1000 \div 2000$ laser shots are accumulated in the aerosol system and $1 \times 10^5 \div 5 \times 10^5$ shots are accumulated on the DIAL system. For the aerosol lidar the signal was averaged over $0.3km$ while for the DIAL a running mean was performed over $3km$ range with $0.3km$ step. The ozone profiles were recovered with an algorithm similar to that described in Rizi et al. (this issue). Starting from the beginning of August 1991 simultaneous aerosol and ozone measurement were taken in SLAQ whenever possible. Validation of the SLAQ ozone profiles was made with independent measurements such as ozonosonde soundings (Masci et al, 1991, D'Altorio et al., 1992). Other works are in course to compare ozone and aerosol backscattering profiles with SAGE II and UARS data; the preliminary results are comfortable (G. Yue and J. Miller personal communications).

AEROSOL OPTICAL PARAMETERS

The most delicate part of these results is the possibility to correct ozone with enough precision to extract effects related to the presence of sulfate aerosols. The procedure we have followed is that once obtained the backscattering ratio in the visible channel, $R(590nm, z)$, assumptions are made about the wavelength dependence of the backscattering cross section. That dependence may be taken as λ^{-m} where the value of m can change from 0 to 2 (Uchino and Tabata, 1991). Then, the backscattering mixing ratio, $R(\lambda, z) - 1$ can be scaled as λ^{4-m}. Like this, the DIAL signals at the $308nm$ and $351nm$ wavelengths can be corrected using $R(590nm, z)$. A further correction has to be introduced to take into account the aerosol extinction. In this case it is necessary to convert the backscattering into extinction and this could be done via a factor (C) which again depends on the optical features of the aerosols and their size distribution. As example we have chosen the January, 30 1992 measurements. Fig. 1 shows the comparison between the DIAL uncorrected and corrected profiles with the ECC sounding taken at the German station of Hohenpeissemberg

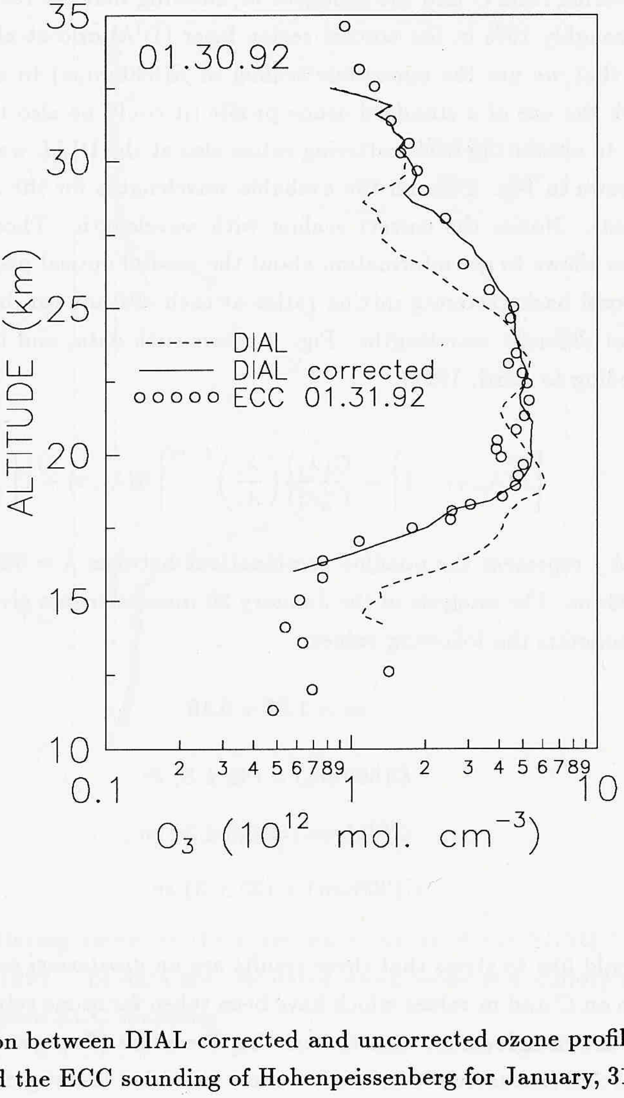

Fig.1. Comparison between DIAL corrected and uncorrected ozone profiles for January, 30 1992 and the ECC sounding of Hohenpeissenberg for January, 31.

(48°N, 11°E). It appears that the correction works quite well and help to reconcile the DIAL data with the ECC data in those regions where the backscattering ratios are large (see Fig. 2). The corrected ozone profile is inferred using m=1 and $C = 50\ sr$ according to the values proposed for sulfate aerosols by Hayashida-Hamano et al. (1991). Sensitivity tests have been carried out for different choices of the extinction to backscattering ratio C and the exponent m, showing that the retrieved ozone may change by roughly 10% in the aerosol region layer (D'Altorio et al, 1992). In spite of the fact that we use the opportune scaling of $R(590nm, z)$ to correct the DIAL signals, with the use of a standard ozone profile (it could be also the ECC profiles) we are able to obtain the backscattering ratios also at the DIAL wavelengths. These data are shown in Fig. 2 for all the avaliable wavelengths for the January, 30 1992 measurements. Notice the correct scaling with wavelength. Those backscattering ratio profiles allows to get information about the aerosol optical properties. The calculated aerosol backscattering mixing ratios at each altitude can be plotted against the values at different wavelengths. Fig. 3 shows such data, and the curves can be fitted according to (Rizi, 1992):

$$\left[R(\lambda_i, z) - 1\right] = \frac{C(\lambda_j)}{C(\lambda_i)}\left(\frac{\lambda_i}{\lambda_j}\right)^{4-m}\left[R(\lambda_j, z) - 1\right] \qquad (1)$$

where i and j represent the possible combinations between $\lambda = 308nm$, $\lambda = 351nm$ and $\lambda = 590nm$. The analysis of the January 30 measurements gives for the aerosol optical parameters the following values:

$$m = 1.07 \pm 0.10$$

$$C(590nm) = (45 \pm 5)\ sr$$

$$C(351nm) = (28 \pm 5)\ sr$$

$$C(308nm) = (25 \pm 5)\ sr$$

We would like to stress that these results are an *aposteriori* confirmation of the assumption on C and m values which have been taken for ozone retrieving. Although our results are in agreement with the existing literature (Papayannis et al, 1990), a rigorous aerosol characterization needs a more extended investigation.

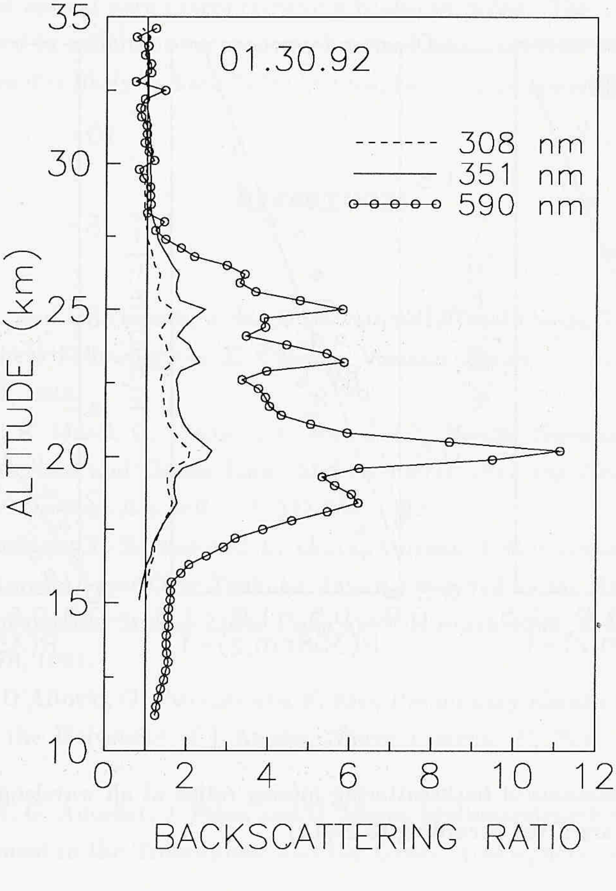

Fig.2. Backscattering ratios at the three wavelengths of the SLAQ lidar systems for January, 30 1992. The data are calculated using ozone and atmospheric number densities taken from ECC sounding.

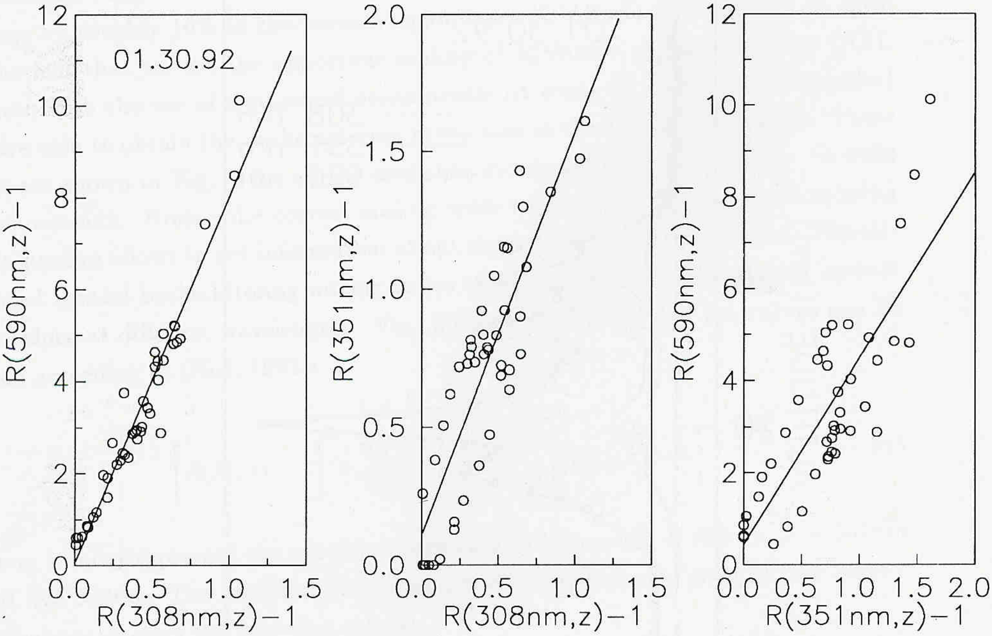

Fig.3. Intercorrelations of backscattering mixing ratios at all wavelengths available at SLAQ. Data are fitted according to Eq.(1).

CONCLUSIONS

Results of simultaneous measurements of volcanic aerosol and ozone taken at SLAQ are presented. The purpose is to propose a simple method to correct the DIAL ozone profiles by the presence of a large amount of aerosol. A short discussion on the aerosol optical parameters retrieving is also included. The proposed method can be adopted in simultaneous ozone and aerosol measurements taken in the polar regions, where it is likely to have Polar Stratospheric Cloud aerosols.

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EDITORIAL NOTE

The following paper ("The lidar station in L'Aquila: setup for the European Polar Campaign, by V.Rizi, F.Masci, G.Visconti and A. D'Altorio") should have been published on the proceeding volume for "Porano 3" (October 1990). For editorial technical problems the publication has been postponed on the present volume.

The paper describes what was the initial stage of the lidar instrumentation in L'Aquila (SLAQ), which has later produced continuous results on the Pinatubo aerosols. The latter are summarized in a separate paper, which was presented at "Porano 4".