28C5 COMBINED AEROSOL–OZONE RAMAN LIDAR

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INTRODUCTION

The GKSS Raman lidar has successfully been used for the measurement of the atmospheric extinction and backscatter coefficients α and β (Ansmann et al. 1992a). However, the primary wavelength of 308 nm of the Raman lidar (XeCl laser) is not optimal because ozone absorption is not negligible. Infact, the uncertainty in the quantity and distribution of atmospheric ozone causes the largest systematic error contribution to this kind of measurement (Ansmann et al. 1993). To mend this situation, another, longer, primary wavelength has been added to the system along with a number of additional wavelength channels. With this new setup the ozone density can be determined along with the vertical profiles of moisture, the depolarization ratio, and aerosol properties. For stratospheric research, simultaneous detection of the particle surface-area concentration, as derived from α and β (Ansmann et al., 1994), and the ozone concentration are important. Tropospheric studies of moisture, the depolarization ratio as well as α and β and their wavelength dependence are of great interest for DIAL measurements of tropospheric pollutants such as O_3 and SO_2. A similar lidar setup as now developed at GKSS has already been proposed and realized (McGee at al. 1993). The aim pursued with this Raman DIAL was to determine correct stratospheric ozone profiles in the presence of a strong aerosol loading. After the eruption of Mount Pinatubo the conventional ozone DIAL technique could no longer be used for this task because of the large errors caused by aerosol scattering interference (Steinbrecht et al. 1993).

APPARATUS

The present system uses a frequency-tripled Nd:YAG laser along with the XeCl excimer laser as sources of primary radiation. The XeCl part has been described previously (Ansmann et al. 1992b). A schematic diagram of the combined apparatus is shown in Fig. 1. On the receiving end the elastic channels are duplicated, with the majority of the backscattered radiation being directed to the long-range channels which are protected from the intense short-distance signal by a mechanical chopper. Elastically backscattered radiation at 355 nm is also analyzed for the fraction of light depolarized in the scattering process. A survey of the wavelengths used is given in Table 1.

DATA EVALUATION

Following Ansmann et al. 1992a the profiles of the aerosol extinction coefficient α and the aerosol backscatter coefficient β are obtained from the data of the elastic channels 4, 5, 6 and of the Raman channel 7. In contrast to the XeCl laser channels 1 to 3 the Nd:YAG channels are not affected by ozone absorption. The largest systematic error in the evaluation of the particle scattering coefficients is thus eliminated. The ozone data are then obtained from either the elastic channels by the conventional DIAL technique under consideration of the aerosol distribution or by the aerosol-independent Raman DIAL technique. Although the aerosol dependency of the former is disadvantageous this technique is more sensitive than the latter and will have to be used particularly in cases of poor transmission or short measurement times. Moisture is obtained from the Raman channels 7 and 8, the phase of condensed

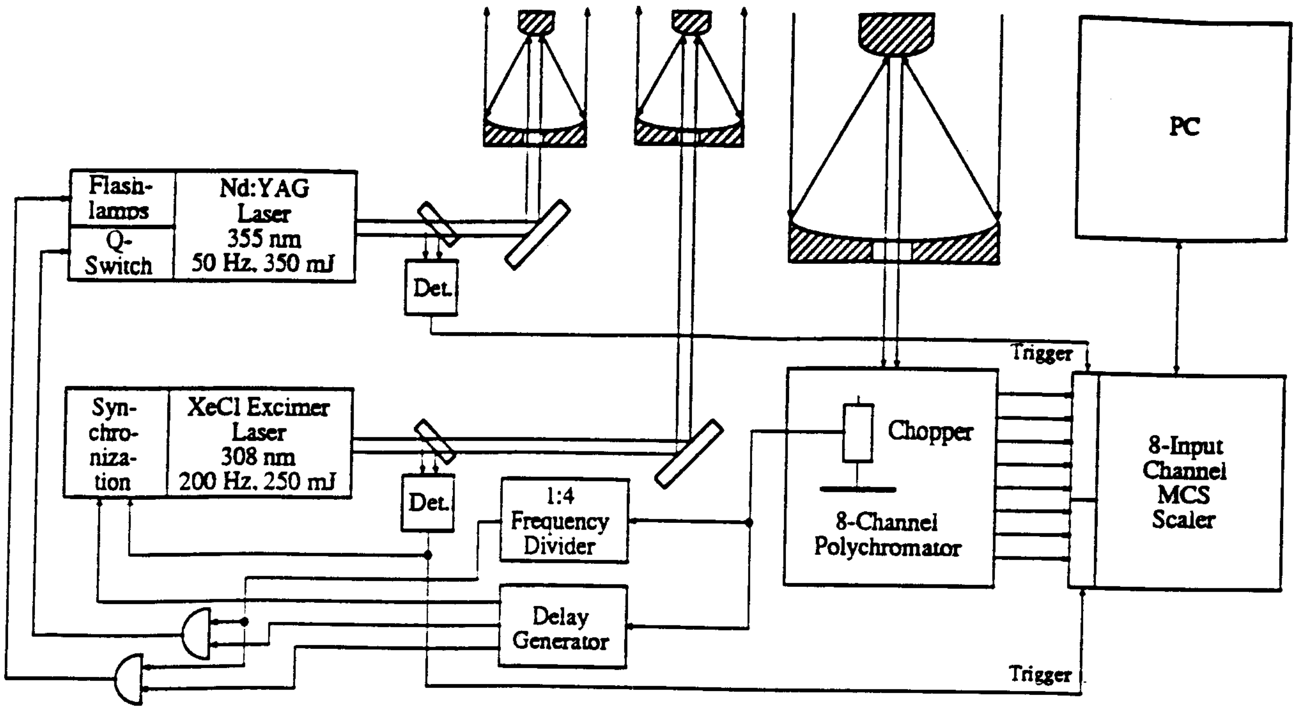

Fig. 1. Combined Aerosol–Ozone Raman lidar schematic diagram

Table 1. Wavelength channels of combined aerosol–ozone Raman lidar

Source of primary radiation	XeCl laser			Nd:YAG laser				
Detection channel number	1	2	3	4	5	6	7	8
Wavelength, nm	308		332	355			387	408
Process sensed	elastic backscatter		N_2 Raman	elastic backscatter			N_2 Raman	H_2O Raman
Short range/ long range	short	long	all	short	long	all		
Polarization with respect to laser beam polarization	not applicable			$\parallel$	all	$\perp$	all	

water from the polarization–sensitive elastic channels 4 and 6.

CONCLUSION

A lidar is described that uses a dual pair of Raman–elastic backscatter signals for atmospheric aerosol measurements. For ozone profiles two pairs of backscatter data, one elastic and one Raman, are analyzed. Moisture and the depolarization of one of the elastic signals are also measured. Whereas the 308–nm part of the system has been in operation for several years, first data from the combined 308–355 nm lidar will be presented at the Conference.

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