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AEROSOL, OZONE, AND TEMPERATURE MEASUREMENTS WITH A MULTI-WAVELENGTH LIDAR AT SPITSBERGEN

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INTRODUCTION

Lidar investigations of the polar stratosphere are a very useful tool to investigate simultaneously the ozone layer and the aerosol content in the same altitude. The lidar system is installed in Ny-Ålesund, Spitsbergen (79^{O}N, 12^{O}E), a site of the Network for the Detection of Stratospheric Change (NDSC). It uses laser wavelengths at 308, 353, 532, and 1064 nm. Receiver systems have been developed for all Rayleigh wavelengths and the N2-Raman back scattered intensities of the shorter three wavelengths. Conventional and Raman-DIAL technique is used to derive ozone concentration profiles. The combination of the longer three wavelengths allows to calculate several properties of stratospheric aerosols like profiles of the surface, mass, and number density. An additional depolarization channel at 532 nm provides information on the shape of the aerosol particles. Recently a specially designed chopper blade had been installed, which provides near constant intensities over several kilometers at the lower altitude range. More details of the instrument are in a companion poster (von der Gathen et al.).

VOLCANIC AEROSOLS

First signs of the Mt. Pinatubo cloud had been observed above Spitsbergen already in August 1991. The following temporal development was recorded with emphasize on the winter months in 1991/92, 1992/93 and 1993/94. During the first winter the temporal development of the aerosol content above Spitsbergen marked very well the shape of the polar stratospheric vortex. Especially the break-up of the vortex was clearly seen by a strong increase in the aerosol content. In the following winter 1992/93 volcanic aerosols as well as polar stratospheric clouds (PSCs) were observed, sometimes in overlapping altitudes. The application of three wavelengths and a depolarization channel allowed the determination of several aerosol quantities. Figure 1 shows the monthly means of the mass and surface densities, which were calculated using an aerosol model for spherical particles consisting mainly of sulphuric acid.

POLAR STRATOSPHERIC CLOUDS

Different types of polar stratospheric clouds (types Ia and Ib) were distinguished e.g. by their depolarization characteristics. Both types occurred sometimes very close to each other in time and space. Together with back-trajectory analyses the dependence of the PSC types on their temperature history can be revealed. Rapid cooling leads to formation of PSC particles on many condensation nuclei, resulting in small, almost non-depolarizing particles, while slow cooling produces few, but large non-spherical particles. The temporal development of the PSC signals around 19 km altitude are shown in Fig. 2 for Jan. 93. In the monthly mean for January 1993, the chemically important surface density of spherical PSCs (type Ib) became as large as the surface density of the volcanic aerosols (see Fig. 1). In 1994 PSCs appeared rather late in the year, in early March.

OZONE PROFILES

Investigations of the ozone layer focus mainly on short time variations in the lower part of the stratosphere, where troposphere - stratosphere exchange processes become important. The Raman DIAL technique proves especially useful here, as volcanic aerosols are still present several years after an volcanic eruption.

TEMPERATURE PROFILES

Conventional analysis of relative air density profiles obtained from two backscatter lidar wavelengths is used to derive temperature profiles. They compare well with local meteorological sonde observations and extend these above the balloon burst points up to more than 40 km altitude.

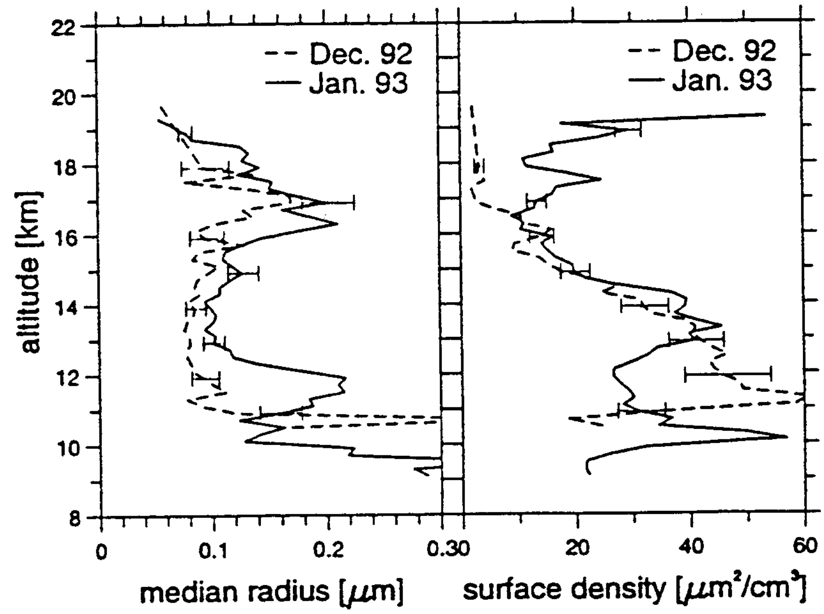

Fig. 1: Properties of Pinatubo aerosols above Spitsbergen in Dec. 92 and Jan. 93: monthly means of the median radii and the surface densities as calculated from three wavelength back scatter lidar. In Jan. 93 surface densities above 17 km altitude increase due to the occurrence of PSCs of type Ib.

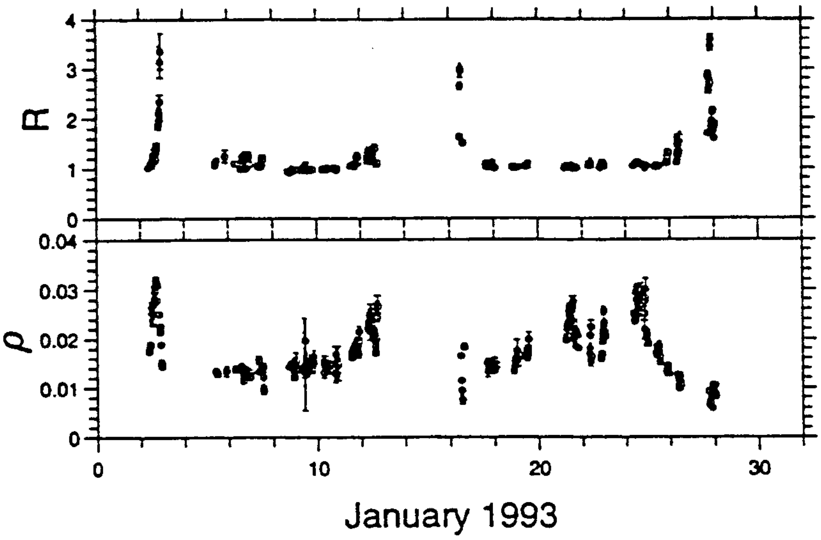

Fig. 2: The temporal development of PSC properties during Jan. 93. The upper panel shows the back scatter ratio at 532 nm and the lower one the depolarization ratio at 532 nm.