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MULTI-WAVELENGTH LIDAR CONFIGURATIONS FOR POLAR STRATOSPHERIC RESEARCH

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INTRODUCTION

Since 1988 lidar investigations of the polar stratosphere are performed at Ny-Ålesund, Spitsbergen (79°N, 12°E). Currently the system consists of two lasers (XeCl excimer laser and NdYAG solid state laser), which can produce light pulses at 308, 353, 532, and 1064 nm. Different detectors have been constructed to use these wavelengths for various measurements. The two UV-wavelengths are employed for DIAL measurements of the ozone concentration profile. The three longer wavelengths were used simultaneously for investigations of stratospheric aerosols (Polar stratospheric clouds (PSCs) and volcanic aerosols). Recently the detection of Raman scattered lines was added in order to improve the DIAL as well as the aerosol measurements. A new designed chopper blade was added to the detector in 1993, which increases the usable altitude range to lower heights by partially blocking the back scattered light from the troposphere. Since 1992 the instrument is part of the Arctic NDSC station at Spitsbergen.

EARLY CONFIGURATIONS

Lidar investigations at Spitsbergen began with a mobile ozone DIAL system in 1988 (Steinbrecht et al., Appl. Opt., *28*, 3616 - 3624, 1989). As the investigations are focused on the winterly polar ozone layer it soon became necessary to study stratospheric aerosols, in particular PSCs, which were first observed to hamper the ozone DIAL evaluation. However, their important role in heterogeneous stratospheric chemistry was quickly appreciated and a second laser was added to the instrument in order to facilitate aerosol measurements. In fall 1991 the two-wavelength DIAL detector was replaced by a 4 channel detector, able to discriminate and record back scattered intensities at 308, 353 and 532 nm simultaneously. The fourth channel was used for depolarization measurements at 532 nm, as the employed NdYAG laser emits parallel polarised light at this wavelength. Photomultiplier tubes were used for all wavelengths, while the wavelength separation was obtained by dichroitic mirrors. In winter 1992/93 a fifth channel was added to the detector, employing a dedicated IR sensitive photo diode to record the back scattered light at 1064 nm from the fundamental wavelength of the NdYAG laser. This configuration allowed the determination of several aerosol parameters (see companion paper by Neuber et al.), which was especially useful for the observation of the temporal development of the volcanic aerosol load after the Mt. Pinatubo eruption.

PRESENT CONFIGURATION

When the volcanic aerosol load declined again, focus shifted once more to the improvement of the DIAL measurements. During 1993/94 the Raman approach was used to employ the Raman-DIAL technique (McGee et al., Geophys. Res. Lett., *20*, 955 - 958, 1993) for measurements of the ozone profile in regions of enhanced aerosol concentrations. Additionally a new chopper blade was developed, which in contrast to conventional lidar systems opens the field of view of the telescope only slowly over a comparatively large altitude range. This stems on the fact that the DIAL evaluation employs only the difference in the gradients of the back scattered intensities instead of the absolute count rates. However, also the aerosol data evaluation is improved, as the corresponding Raman channel supplies the aerosol independent normalization signal which is affected in the same way as the laser wavelengths.

FUTURE CONFIGURATION

Further technical improvements are anticipated for the NDSC lidar system at Ny-Ålesund. A new building will greatly improve the capabilities. New lasers will be employed, a more powerful XeCl excimer laser with increased pulse repetition rate and a dedicated Titan Sapphire laser, which will allow a better selection of appropriate wavelengths for aerosol investigations. These will be combined with other instruments on the site, namely a tropospheric cloud ceilometer instrument and multi channel photometers, which in combination will provide continuous aerosol profiles from the ground up into the middle stratosphere together with column density spectral information. In addition to the ongoing investigations within the NDSC, these instruments will also participate in calibration and validation of the Global Ozone Mapping Experiment GOME on the ERS-2 satellite. An overview about the used wavelengths in the past and future is given in Table 1.

	308 nm	332 nm	353 nm	385 nm	532 nm			607 nm	700 – 900 nm	1064 nm
					u	p	s			
1988–91	x		x							
1991/92	x		x			x	x			
1992/93	x		x			x	x			x
1993/94	x	x	x	x	x			x		
future	x	x	x	x		x	x	x	x	x

Table 1. Detected wavelengths during different campagnes. Nitrogen Raman wavelengths are 332 nm, 385 nm, and 607 nm. The letters u, p, s stand for unpolarized, parallel and perpendicular polarized detection, respectively. The 700 nm – 900 nm stands for the range covered by the first fundamental of the Titan Sapphire laser.