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# LIDAR MEASUREMENTS AT THE NDSC STATION ASTRO IN THE CANADIAN ARCTIC

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In January of 1993 the Atmospheric Environment Service of Canada opened a new Arctic Stratospheric Observatory (AStrO) at Eureka (80N, 86W) in the Canadian arctic (1). This observatory is one of the Primary stations in the Network for the Detection of Stratospheric Change (NDSC). As part of this facility lidars for monitoring the stratosphere have been installed. These lidars which were developed and constructed by Optech Incorporated of Toronto include a Differential Absorption Lidar (DIAL) system for stratospheric ozone measurements and a dual- polarization, dual-wavelength Nd:YAG lidar. The DIAL system is being operated by the Lidar Group of the Institute for Space and Terrestrial Science (ISTS) at York University. The Nd:YAG system is being used by Japanese researchers from the Meteorological Research Institute in Tsukuba, the Communications Research Laboratory in Tokyo and Nagoya University.

This paper summarizes the initial results of the York group using the DIAL system. The data were collected during two winter observation periods at AStrO. (February and March of 1993 and November 1993 to March 1994). The lidar is based on a Lumonics 300 Hz XeCl laser operating at 308 nm with a power output of about 65 Watts. A hydrogen Raman shifter is used to produce an additional output at 353 nm (1). In addition to providing DIAL profiles of the stratospheric ozone up to altitudes of about 50 km, the 353 nm output of this lidar is used to make density and temperature measurements up to about 80 km.

Figure 1 shows sample temperature data for the month of February, 1993. The solid curves above 20 km are the nightly mean lidar profiles and the crosses below about 25 km are the radiosonde data. The shading on the lidar profiles indicates +/- one standard deviation of statistical uncertainty in the measurements. The lidar and sonde measurements are seen to agree well. Of particular interest is the stratospheric warming which occurred between the altitudes of 30 and 50 km commencing with the Feb 21 profile. It is seen that this upper stratospheric warming is accompanied by a cooling in the mesosphere and the lower stratosphere. Several such events have been noted in the lidar measurements to date and they appear to be associated with the movements of the polar vortex around Eureka. The fluctuations in the temperature are interpreted as arising from gravity wave propogation in the atmosphere. The behaviour of these gravity waves has been observed in some detail and substantial differences

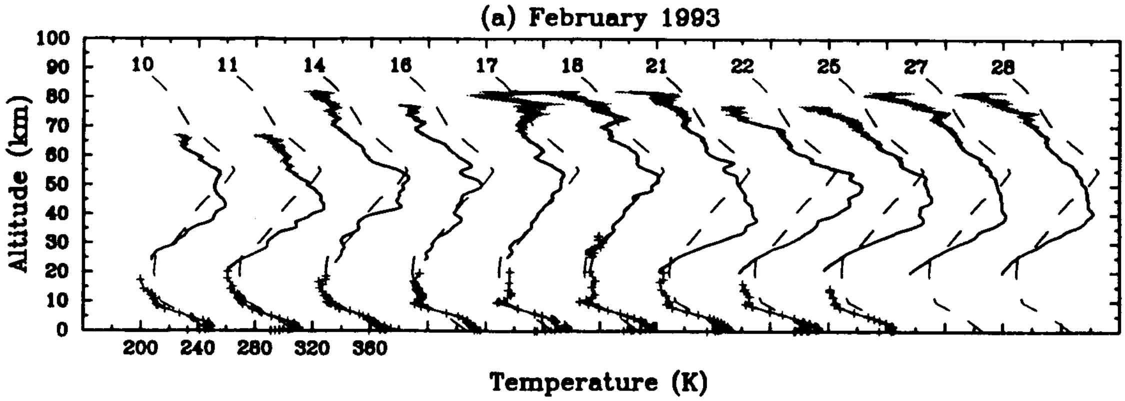


Fig. 1. Temperature profiles showing both lidar and radiosonde data.

in their characteristics between the warming and non-warming conditions have been observed (2).

The 353 nm signal has also been used to monitor the behaviour of the stratospheric aerosol layer. Since the eruption of Mt.Pinatubo this layer has been greatly enhanced. Figure 2 shows the scattering ratio, (total scattering)/(molecular scattering), plot for this layer during February/March of 1993. The vertical lines indicate the lidar measurement times. This aerosol layer is seen to vary considerably and values of R up to about 1.3 were still being recorded in March of 1994.

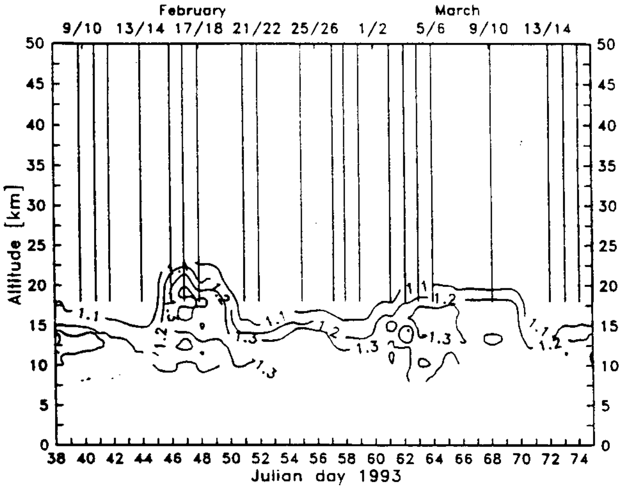


Fig. 2. Lidar scattering ratio at 353nm

This aerosol backscattering has strongly affected the DIAL measurements of ozone at altitudes below about 20 km at AStrO. As part of the ISTS program a detailed study has been carried out on the effects of the aerosol layer on DIAL measurements of stratospheric ozone (3). In this work the corrections necessary to derive accurate ozone values have been evaluated. In January of 1994, the DIAL system was modified to operate on the atmospheric nitrogen Raman return signal to avoid the aerosol perturbations. Results of ozone measurements for both the Rayleigh and Raman mode DIAL are presented in this paper.

Figure 3 shows the ozone distribution observed during February and March of 1993. It is seen from the plot that the ozone concentration shows considerable variation during the observation period. The fluctuations in ozone are strongly correlated with the observed temperature variations and these seem mainly to depend on the dynamics of the polar vortex. The 1993/94 observations are being analyzed and in the paper a summary of the current information will be included.

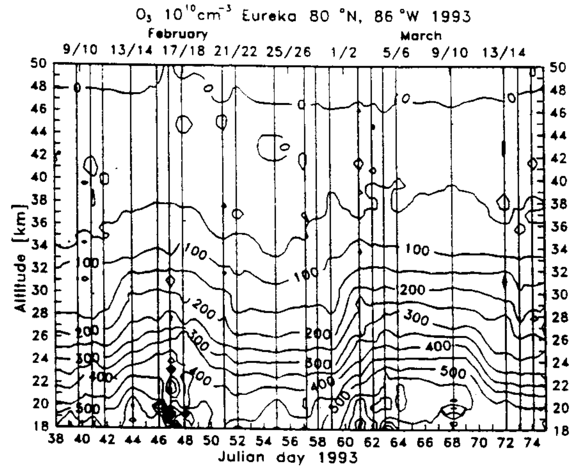


Fig. 3. Ozone distribution for Feb/March 1993

## References

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(3) W. Steinbrecht and A.I. Carswell, "Evaluation of the Effects of Mt. Pinatubo Aerosol on Differential Absorption Lidar (DIAL) Measurements of Stratospheric Ozone" Accepted for publication in J. Geophys. Res.- Atmos. (1994).