CSIR NLC– MOBILE LIDAR OBSERVATIION OF CIRRUS CLOUD

V. Sivakumar[1,2,3] A. Sharma[1], K Chiloane[4], S. Naidoo[4] and E.Lynch[4]

[1] *Council for Scientific and Industrial Research, National Laser Centre, Pretoria. South Africa*
[2] *University of Pretoria, Department of Geography Geoinformatics and Meterology, Lynnwood road, 0001, Pretoria, South Africa*
[3] *University of Kwa-Zulu Natal, Department of Physics, Durban, South Africa*
[4] *Eskom Holdings - Resources & Strategy Division, Rosherville, South Africa.*

svenkataraman@csir.co.za

1. INTRODUCTION

Light Detection and Ranging (LIDAR) is one of the most powerful remote sensing techniques to probe the earth's atmosphere. Recent developments leading to the availability of more powerful, relatively rugged and highly efficient solid state lasers and improvements in detector technology as well as data acquisition techniques have resulted in the great potential of LIDARs for atmospheric studies. A mobile LIDAR system is being developed at the Council for Scientific and Industrial Research (CSIR) National Laser Centre (NLC), Pretoria (25°5′ S; 28°2′ E), South Africa (see Figure-1). At present, the system is capable of providing aerosol/cloud backscatter measurements for the height region from ground to 20 km with a 10 m vertical height resolution. For more details about the system and its capability, one may refer to Sharma et al., (2009) and Sivakumar et al., (2009).

Figure-1: CSIR-NLC-Mobile LIDAR system

The major advantage of the LIDAR is to provide the vertical cross-section of clouds including thickness information which is important for better understanding the cloud dynamics and the earth-radiation budget. The cloud information is also useful for predicting the convective systems and rain.

Higher level clouds tend to develop at or just above the top part of the troposphere. These clouds can vary in shape and thickness. Sunlight can be observed passing through the higher level clouds most of the time. The amount of light that penetrates depends on the density and thickness of the layers. The high-level clouds are of Cirrus, Cirrostratus and Cirrocumulus. Cirrus and cirrostratus generally does not produce precipitation except when it results from dissipating thunderstorms. Cirrocumulus is brilliant white but with a spotty appearance created by the many small turrets. These turrets indicate vertical turbulence within the cloud. This cloud can develop in conjunction with any other clouds as well as with cirrostratus clouds. Cirrocumulus clouds do not produce precipitation and are normally associated with fair weather.

Here, in this paper, we present a night-time continuous CSIR-NLC mobile observation of high-altitude cirrus cloud. The LIDAR measurements will also elucidate the aerosol concentration, optical depth, cloud position, thickness and other general properties of the cloud which are important for a better understanding of the earth-radiation budget, global climate change and turbulence.

2. RESULTS

The LIDAR was operated for ~24 hours at Elandsfontein from 01-02 December 2010. Elandsfontein is surrounded by different industries that emit pollutants into the atmosphere. We shall present the results obtained based on this observation. The temporal evolution of the LIDAR backscatter signal for the corresponding night from 23:23:10 to 04:22:38 Local Time (LT) is shown in Figure-2. The figure represents the glued photon count signal which is obtained from the initial raw analog and photon count signals acquired through the data-acquisition system with a high range resolution (10 m). Figure-2 clearly distinguishes the cloud observation from normal scattering from background particulate matter. It shows the sharp enhancement during the presence of cloud above 8 km and slowly has moved down to 6.5 km. This figure demonstrates the capability of LIDAR to observe the cloud thickness (less than ~300 m). The high resolution data in the figure also shows the temporal changes in the cloud shape and size which is important when studying cloud morphology. Such kinds of clouds are often termed as Cirrus and are classified into optically thick or thin with respect to the observed optical depth [sivakumar et al., 2003]. In the present case, the observed cirrus is found to be optically thick which has turbulent characteristics. The falling streaks of such clouds are clearly visible during the middle of the observations. In general, cirrus clouds are composed of ice crystals and with less frequent content of super-cooled water. Apart from the cirrus cloud observations, the figure clearly illustrates the temporal evolution of the planetary boundary layer (PBL). At the beginning of the observation, the PBL is observed at the height range just above 2 km and later it gradually decreased to 1.2 – 1.5 km during the middle of the observation. Thereafter, a slow increase in the PBL is noted indicating the decrease in atmosphere stability.

It is important to note here that the experiment was carried out with neutral density (ND) filters which attenuate the received signal. The ND filters are employed to avoid detector saturation due to high backscattering from dense clouds. In future, we will remove the filters to allow a greater percentage of the backscattered signal to observe and investigate higher altitude regions.

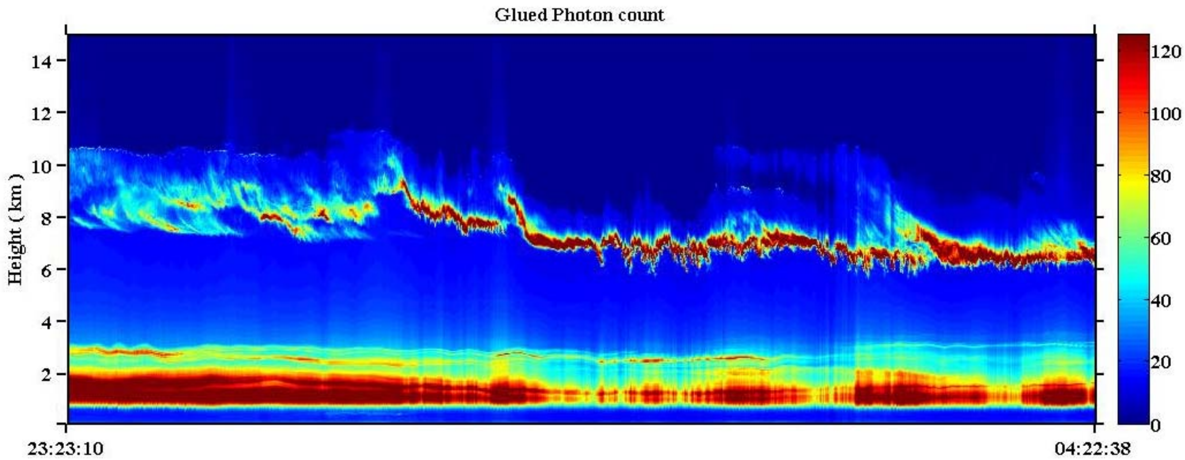

Figure-2 : Height-time-color map of LIDAR backscatter signal returns for the night of 01-02 December 2010.

3. FUTURE PERSPECTIVES

Future plans include further field campaign measurements in South Africa including qualitative industrial pollutant measurements, 3-D measurements using an XY scanner and the water-vapour measurement.

4. ACKNOWLEDGEMENTS

We are thankful to the different South Africa funding agencies in addition to the Council for Scientific and Industrial Research-National Laser Centre (CSIR-NLC), Department of Science and Technology (DST), National Research Foundation (NRF) (Grant no: 65086/73449), African Laser Centre (ALC), Centre National de la Recherché Scientifique (CNRS) (France), French Embassy in South Africa (France) and ESKOM.

5. REFERENCES

Sivakumar, V., Y. Bhavanikumar, P. B. Rao, K. Mizutani, T. Aoki, M. Yasui, and T. Itabe, Lidar observed characteristics of the tropical cirrus clouds, *Radio Sci*., 38(6), 1094, doi:10.1029/2002 RS002719, 2003.

Sharma A, Sivakumar V, Bollig C, C van der Westhuizen and D Moema, System Description of the mobile LIDAR of the CSIR, South Africa, *South African J. of Science,* 105, 456-462, 2009.

Sivakumar V, Tesfaye M, Alemu W, Moema D, Sharma A, Bollig C and Mengistu G, CSIR South Africa Mobile LIDAR – First scientific results : comparison with satellite, sun photometer and model simulations, *South African J. of Science,* 105, 449-455, 2009.