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A PROGRAM FOR THE ENVIRONMENTAL MONITORING BY LASER RADAR OF METRO MANILA, PHILIPPINES

Minella C. Alarcon
Department of Physics, Ateneo de Manila University
Loyola Heights, Quezon City 1108, PHILIPPINES
Tel: +63-2-924-4601 ext 2517 FAX: +63-2-924-4690
E-mail: alarcon@sisig.admu.vut.edu.au

Susana V. Dorado, Ma. Cecilia D. Galvez and Edgar A. Vallar
National Institute of Physics, University of the Philippines
Diliman, Quezon City, PHILIPPINES

INTRODUCTION

The Philippines is an archipelago made up of more than 7000 islands and approximately situated 15°N, 120°E. It is populated by more than 60 million people about 15% of which reside in Metro Manila. Metro Manila is the center of political, administrative and economic activities of the Philippines.

Due to the concentration of factories, industrial sites and other employment opportunities, people from all over the country flock to the urban area of Greater Manila. As a result, its population has grown so dense and so has the number of vehicles roaming the metropolis. Trucks, buses, jeepneys and cars ply the crowded highways and streets of Metro Manila. The number, as well as the age, of these vehicles are generally unregulated. Furthermore, emissions to the atmosphere from factories and primarily vehicles have been largely uncontrolled and have caused widespread air pollution. Consequently, the quality of air in Metro Manila is rapidly deteriorating.

PROGRAM FOR LASER RADAR MONITORING OF METRO MANILA

In this paper, the program to monitor the environment of Metro Manila by the laser radar technique is presented. Its principal objective is to assess and characterize the air quality in the metropolis. To achieve this, it has been proposed that a Mie scattering lidar be built and operated. The atmospheric constituents to be measured are summarized in Table I.

Table I. The atmospheric constituents to be measured by the proposed Mie lidar system

PURPOSE	CONSTITUENT	R_{max} (km)
Pollution monitoring	Suspended particulated matter	5
Meteorological	Cloud	10
Meteorological	Wind	5
Meteorological	Stratospheric aerosol	30

The lidar system will measure the spatial and temporal distribution of aerosols in the atmosphere. It will observe aerosol patterns which can reveal the height of the mixing and temperature inversion layer and, thus, characterize the structure of the boundary layer. This system will detect smoke plumes and particulate emissions with high sensitivity and will provide information on their transport and diffusion.

Several years after the eruption of Mt. Pinatubo, it will be interesting to perform lidar measurements of the stratospheric aerosol layers at 20-25 km altitude in this region. It provides the possibility to participate in global efforts, such as the Project EPIC of the Meteorological Research Institute of Japan, to investigate the effects of the eruption on climate.

The operation of a Mie scattering lidar in Metro Manila provides the opportunity to observe clouds and wind under tropical conditions. By utilizing a linearly polarized transmitter and observing the depolarization in the backscattered signal, valuable information can be obtained about the properties of the atmosphere. The polarization of the scattered signal varies considerably with meteorological conditions. Furthermore, it has been demonstrated that wind profiles can be determined from measurements of aerosol distribution patterns by a correlation technique such as that described in References 7-9.

Table II. System parameters of the proposed Mie lidar system

Compact Q-Switched Nd:YAG Laser		
Wavelength	1.06 μm	532 nm
Energy per pulse	100 mJ	
Pulse width	5 ns	
Repetition rate	10 Hz	
RECEIVER SIZE	30 cm	
DETECTOR	Si-APD	PMT

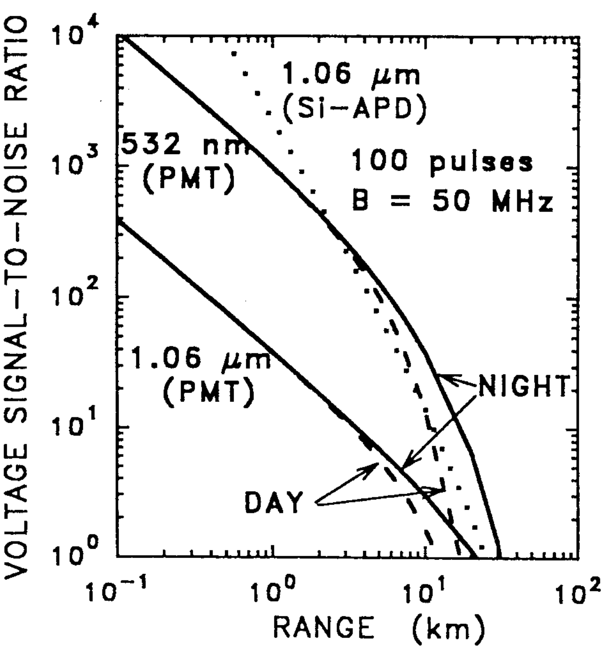

Fig. 1. Range dependence of voltage signal-to-noise ratio for detecting molecular scattering using a compact laser source.

LIDAR SYSTEM PARAMETERS

The proposed Mie lidar is a typical system designed to operate in the fundamental and second harmonic wavelengths. Its parameters are summarized in Table II. The range capability of a compact flashlamp-pumped Q-switched Nd:YAG laser is estimated and is shown in Fig. 1. The detection signal-to-noise ratios are plotted for night and daytime operation under clear air conditions. A lidar system operating with these parameters will be capable of measuring the constituents shown in Table I. A compact laser has definite advantages considering mobility and transportability. Calculations also demonstrate the high sensitivity that can be obtained by using an avalanche photodiode as detector instead of a photomultiplier tube when operating at 1.06 μm.

CONCLUSION

The atmospheric monitoring of Metro Manila by laser radar will demonstrate the feasibility of a new technology outside the laboratory and the practical benefits that can be derived from modern instrumentation. This remote sensing technique will make an impact on the general populace and in the long run will prove relevant to Philippine progress and development.

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