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A simulation for laser scattering experiment and a cloud monitoring for telescope array atmospheric monitoring

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Abstract. R&D of atmospheric monitoring for the Telescope Array Project has been studied at Utah, USA and at Akeno, Japan. As a part of these R&D, a simulation for laser scattering experiment to understand atomospheric properties and a cloud monitoring to determine the fiducial volume for the detection area using infra-red(IR) camera have been studied. As to cloud monitoring, a basic method to recognize the cloud region is trying to stablished. In this report these R&D for the Telescope Array Project are presented in brief. They will be reported at ICRC in detail.

1 Introduction

There has been studied on the propagation of light induced by EAS of cosmic rays in the transparent atmosphere. This detection technique is called air fluorescence method to detect very weak ultra violet(UV) light using light sensitive sensor. To understand atmospheric properties is very important subject for next generation experiments which use air fluorescence technique to detect huge air shower events within several ten kilometers from detector. We have been studing atmospheric properties, especially focusing on the transparency of atmosphere for Telescope Array Project by means of UV laser light experiment in much moisture condition at Japan and in desert condition at US(N.Hayashida (1999) and M.Chikawa (1999)). Also there is another important technique, a cloud monitoring to recognize obscure region for the detection volume of EAS. A basic method of cloud monitoring was establishied preliminarily.

2 Determination of transmittance of atmosphere A simulation of scattered laser light

Many papers have been published on this matter(A.S.Zachor (1978), F.Riewe (1978), and C.Lavigne (1999)). A simple simulation has done to reproduce the intensity of scattering UV light at observing location for the laser large angle side scattering experiment to calculate including effects of Mie(aerosol) and Rayleigh(molecular) scattering in the atmosphere. A method of analytical calculation, recursive method, is applied to multiple scattering of laser light. Fig.-1 shows the calculation result for first-order and 2nd-order scattering. Results will be reported at ICRC in detail.

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3 Recognition of obscure region Cloud monitoring

Cloud monitoring has been studying using an Infra-red(IR) camera at Akeno observatory. The IR images taken by the camera are performed offline analysis to determine the cloud in night sky background. The cloud monitoring system is developping at Akeno Observatory with weather proof dome and with network connection. Following basic subjects have been done at present:
(1)calculates temperature distribution to distinguish the cloud from night sky bakground,
(2)calculates the centre of gravity of cloud region,
(3)extracts cloud region to determine the edge by means of differential method.
(4)installs IR camera system on a steerable drive system and controlls through network.
Two samples of calculation of edge from IR images are shown in Fig.-2. In those figures, upper images are original IR images and lower images are results of edge calculation. Determination of edge is depending on the threshold values of pixels sensitively.

4 Sammary and discussion

A recursive calculation is in good agreement with the preliminary data in condition of overwhelming dominance of Rayleigh scattering.
However, prediction of total intensity is well reproduced the

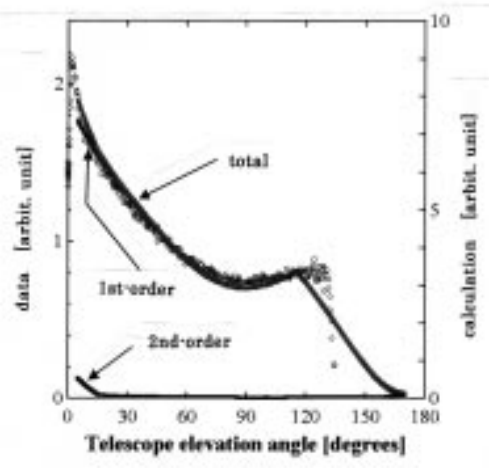

Fig. 1. A result of recursive calculation. First-order and 2nd-order are drawn in the figure.

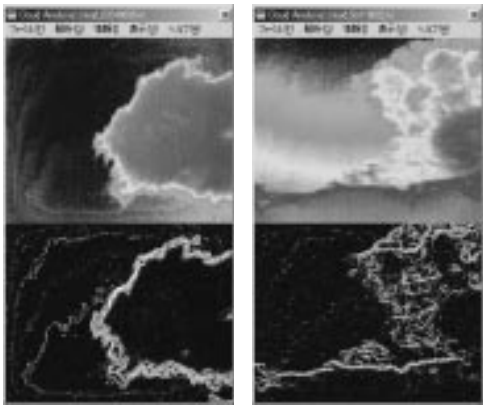

Fig. 2. Schematic representation of n-th order scattering with geometric parameters.

data in quality, the absolute quantitative values is several times different from the calculation and the data. This may be undarstood to be misestimate of device constants, such as reflection efficiency of mirror system, quantum efficiency of a PMT, or transmittance of UV filter.
Basic cloud monitoring system and the laser shooting steerable system are established controllable through network simultaneously.

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