BETA MEASUREMENTS

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Significant Accomplishments:

This report covers the research undertaken during the second year of the BETA project. This program is divided into two areas (1) aerosol modification and climatology in the trade wind region and (2) the climatology of BETA(CO_2) on remote mountain top locations. These areas will be discussed separately in the following sections.

Aerosol modification and climatology in the trade wind region

Little information is available on the aerosol climatology of the marine free troposphere (MFT) in the trade wind region. This region, extending approximately 15 degrees either side of the equator, is characterized by a warm, moist conditionally unstable boundary layer capped by a strong inversion. Cumulus convection is wide spread throughout this region. The capping inversion limits the growth of these clouds which only rarely precipitate.

There is little land mass in the trade wind region and transport of aerosol from higher latitudes is also weak. As a result, the aerosol in this region are little influenced by land or anthropogenic sources. Trade wind cumulus convection is the likely source of aerosol modification and transport between the marine boundary layer and the MFT. An understanding of how these clouds transport and modify the aerosol should lead to a better understanding of the climatology of BETA for this region.

In order to study the effects of cumulus convection on the MFT values of BETA, a cloud model has been developed to simulate the evolution of a typical Pacific trade wind cumulus cloud. The stages involved in this development are outlined below.

A. Cloud microphysical equations have been developed. A paper has been submitted to JAS entitled "A Re-examination of the Derivation of the Equilibrium Supersaturation Curve for Soluble Particles" 8 April 1991.

B. Turbulence plays an important role in the mixing of outside air throughout the cloud. A closure method especially suited for gridded calculations, termed Transillient theory, has been developed by Stull and is used in this model.

C. The sulfur chemistry of the cloud droplets in relation to soluble gases (sulfur dioxide, ammonia, carbon dioxide, ozone, hydrogen peroxide, nitrous oxide, formic acid and formaldehyde) have been considered in detail. The cloud droplets are treated in twenty bins of one micron width.

Bistatic CW Lidar

The development of the bistatic lidar has proceeded more slowly than had been anticipated. The main reason for this delay was the death of Octavian Funariu, the student primarily involved in this portion of the research program. The accomplishments during the past year are as follows

A. The assembly of the major optical components of the lidar.

B. Tests have been run of the spectral bandwidth of the Synrad laser when a portion of the beam is mixed with a component which has traveled 450 meters corresponding to a delay of 1.5 microseconds. The bandwidth of the beat signal was measured to be 3KHz. This value corresponds to a velocity width of approximately 0.02 M/sec.

C. The data processing system has been completed. The system is based upon a parallel processing filter bank analyzer utilizing true time squaring detectors at each filter. The output of each filter is analog integrated and the output read by computer controlled A/D board.

Current Research and Plans for Next Year

Aerosol modification in Trade Cumuli

A. The numerical evaluation of the cloud model developed during year 2 will be completed. Tests will be performed on the turbulence algorithm employed in this model.

B. Questions exist concerning the residue that remains after the cloud droplet evaporates with respect to the back scattering cross-section. The simplest assumption (and the one normally assumed) is that the soluble components form a single sphere of uniform index of refraction. An attempt will be made to evaluate this hypothesis.

Bistatic CW Lidar

A. Assembly, testing and calibration of the lidar will be completed. A vertical scanning system will be developed using a folding flat. An attempt will be made to utilize a composite flat constructed from a front surfaced mirror, expanded aluminum hex and float glass epoxied sandwich. This technique has been used successfully in an earlier project.

B. The data processing system will be completed and tested. Algorithms to test the ability of the system to distinguish noise like signals from system noise will be developed.

C. The completed lidar will be taken to Mount Lemmon to obtain an extended data set of Beta(9.2 microns).