AIRBORNE LASER POLAR NEPHELOMETER

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ABSTRACT

A polar nephelometer has been developed at NCAR to measure the angular variation of the intensity of light scattered by air molecules and particles. The system has been designed for airborne measurements using outside air ducted through a 5-cm diameter airflow tube; the sample volume is that which is common to the intersection of a collimated source beam and the detector field of view within the airflow tube. The source is a linearly polarized helium-neon laser beam. The optical system defines a collimated field-of-view (0.5° half-angle) through a series of diaphragms located behind a 172-mm focal length objective lens. A photomultiplier tube is located immediately behind an aperture in the focal plane of the objective lens. The laser beam is mechanically chopped (on-off) at a rate of 5 Hz; a two-channel pulse counter, synchronized to the laser output, measures the photomultiplier pulse rate with the light beam both on and off. The difference in these measured pulse rates is directly proportional to the intensity of the scattered light from the volume common to the intersection of the laser beam and the detector field-of-view.

Measurements can be made at scattering angles from 15° to 165° with reference to the direction of propagation of the light beam. Intermediate angles are obtained by selecting the angular increments desired between these extreme angles (any multiple of 0.1° can be selected for the angular increment; 5° is used in normal operation). Pulses provided by digital circuits control a stepping motor which sequentially rotates the detector by pre-selected angular increments. The synchronous photon-counting system automatically begins measurement of the scattered-light intensity immediately after the rotation to a new angle has been completed.

The instrument has been flown on the NASA Convair 990 airborne laboratory to obtain data on the complex index of refraction of atmospheric aerosols. A particle impaction device is operated simultaneously to collect particles from the same airflow tube used to make the scattered-light measurements. A size distribution function is obtained by analysis of the particles collected by the impaction device. Calculated values of the angular variation of the scattered-light intensity are obtained by applying Mie scattering theory to the observed size distribution function and assuming different values of the complex index of refraction of the particles. The calculated values are then compared with data on the actual variation of the scattered-light intensity obtained with the polar nephelometer. The most probable value of the complex refractive index is that which provides the best fit between the experimental light scattering data and the parameters calculated from the observed size distribution function.

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