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Measurements of Aerosol Properties needed to Infer Backscatter Characteristics in Support of the NASA Doppler Lidar Program

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SIGNIFICANT ACCOMPLISHMENTS

During the first year of this program two areas of work were emphasized, analysis of aerosol data to provide improved estimates of backscatter over the Pacific ocean and to develop a global model for backscatter at different wavelengths and preparation and planning for the aircraft flights of the GLOBE program. Significant progress was made in each of these areas.

The analytical work is a continuation of the GAMETAG analysis, and has been directed toward the development of a backscatter model for the Pacific oceanic free troposphere. This has included a further evaluation of relationships between the optical effects at different wavelengths, a comparison of modeled optical effects at differing temporal resolutions, and an investigation of the effects of sampling on the modeled results. We have also made an initial investigation of the predictability of 9 to 10 μm β values from other data sets as well as some preliminary comparisons of our modeling results with experimental data.

The comparison of the optical effects has been extended to make the comparisons for different sets of time bases between 1 and 20 minutes. The longer time period comparisons have provided a reduced scatter in the data relative to the one minute comparisons. These other comparisons have strengthened the idea that there are consistent relations in the data for the aerosol measurements over the Pacific. These data also suggest that short wavelength data, including appropriate combinations of short wavelength data, are of use in predicting the backscatter values at CO_2 wavelengths. The comparisons do indicate, however, that the relationships are non linear and depend on the concentration of materials.

The modeling results at the different temporal resolutions had another goal, the investigation of the uniformity of aerosol populations, as measured during the Pacific flights. This investigation was undertaken because of the observation that the data, especially the southernmost data, had many very small backscatter values, and we wanted to determine whether these values were a statistical artifact of

the data or whether the low values were characteristic of large areas of the southern hemisphere free troposphere. This question was investigated by a calculation of backscatter distribution means and 10% values for the different time bases and by determinations of the log-normality of the different distributions. The results of each of these approaches indicated that the very low values calculated were an artifact of the aerosol measurement process and that on volume scales comparable to that to be measured by the LAWS system the aerosols are log-normally distributed. These results have been presented at GLOBE panel meetings and are discussed in detail in the attached paper (Patterson and Bowdle, 1988) which has been submitted to the Journal of Geophysical Research.

One of the questions that is asked of any atmospheric model is how well it matches actual conditions. Although there are limited experimental data with which to compare the model, limited comparisons of northern hemispheric model means and standard distributions with NOAA and with JPL long term data show a good deal of consistency. In addition, a set of simultaneous measurements of RSRE backscatter data and SAGE II sensor attenuation data have been reported. These data sets have provided a basis for comparisons between the modeled optical effect ratios and the experimental data. To date, only preliminary comparisons have been made; but these comparisons indicate that our modeled optical values are quite consistent with the experimental data. In addition, our modeled relationship between 1 micron attenuation and 10.6 micron backscatter agrees with the relation inferred from the SAGE II-RSRE comparison.

Results of these modeling efforts were presented at the Topical Meeting on Coherent Laser Radar: Technology and Applications, held at Aspen, Colorado July 27-30, 1987 in a paper entitled "Use of Aerosol Microphysical Measurements to Model IR Backscatter in Support of GLOBE."

The planning and preparation for the aircraft flights included further sensitivity analysis of the flows needed to achieve the required particle concentrations, a redesign of some of the sampling equipment of take advantage of some of the capabilities of virtual impactor designs, and coordination of our air flow needs with those of other microphysical experimenters.

PLANNED ACTIVITIES

The following specific activities have been planned for the following year of the project:

Completion of the preparation of the aircraft sampling equipment for the GLOBE flights and installation of the equipment on the Aircraft.

Participation in the aircraft flights.

Participation in a set of ground based measurements with our equipment in Hawaii in the fall 1988.

Participation in a set of calibration studies at the Marshall Space Flight Center in the fall of 1988.

Participation with NASA Ames personnel in the initial analysis of the aircraft particle counter data.

Extension of optical modeling efforts to additional wavelengths for comparisons with NOAA integrating nephelometer data.

The major experimental effort will be in the preparation for and the participation in the series of GLOBE flights. The goal of these air chemistry measurements is to provide microphysical support for the Lidar measurments to better relate modelling results to the experimental efforts. Such efforts are needed because the GLOBE flights are survey flights rather than an attempt to determine a climatology for backscatter. The survey flight results must then be extended to develop a long term climatology by means of modelling results as well as direct experimental comparisons.

The planned Mauna Loa experiment may be viewed as a paradigm for the GLOBE flights. One of the goals of this experiment is the determination of relationships between short wavelength scattering data and 10 micron backscatter data. Microphysical measurements will be used to model beta values as well as to model relationships between short and long wavelength optical values. The result will be a set of beta estimates to compare with actual measured values. These data will aid in the interpretation of the mauna Loa data set in terms of a backscatter climatology.

PUBLICATIONS

E. M. Patterson and D. A Bowdle, 1987: Use of Aerosol Microphysical Measurements to Model IR Backscatter in Support of GLOBE. presented at the Topical Meeting on Coherent Laser Radar: Technology and Applications, Aspen, Colorado, July 27-30.

E. M. Patterson and D. A. Bowdle, 1988: Use of Aerosol Microphysical Measurements to Model IR Backscatter in Support of GLOBE, submitted to J. Geophys. Res.