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AN OPTICAL STUDY

OF

ATMOSPHERIC AEROSOLS

by

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FRONTISPIECE. The author (right) and colleague, K. Bartusek, with the mobile instrumentation van housing the laser radar.

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SUMMARY

In recent years aerosols have become of increasing importance in several fields of meteorology. However, our knowledge of the properties and distribution of aerosols above the first few kilometres of the atmosphere has been limited by difficulties experienced using present techniques.

This thesis describes an investigation of aerosols in the atmosphere, by means of their light scattering properties, using a ruby laser radar. Since its advent in 1960, the laser beam has proved to be the most satisfactory of existing remote optical probes. The laser radar described here is capable of measuring atmospheric scattering from nearly ground level to altitudes of 60 km.

Interpretation of existing laser radar measurements using a single wavelength and scattering angle does, however, depend on a priori knowledge of certain aerosol properties. This shortcoming of the present laser radar technique, and other theoretical aspects of light scattering by aerosols, are discussed in some detail. Recent measurements of stratospheric aerosol number densities using balloon-borne optical counters indicate that the stratospheric aerosol is predominantly volatile and hence remains undetected by collection experiments. As little is known of the size distribution of volatile stratospheric aerosols, a theoretical investigation is made of their optical scattering characteristics. Aided

by the results of the theoretical analysis, present optical measurements are examined in order to deduce aerosol size distributions compatible with the observations.

Results of laser radar measurements of stratospheric aerosols conducted in South Australia are presented. The vertical profiles are broadly in agreement with observations reported by other workers in the northern hemisphere. An annual variation apparent in the laser radar observations is remarkably similar to that of ozone in the stratosphere, and the importance of large scale transport mechanisms in the stratosphere is discussed.

Results of tropospheric aerosol measurements are presented, showing vertical profiles typical of the coastal regions. The relation between temperature inversions, humidity and aerosol layers observed in the troposphere is investigated.

The reliability of the twilight scattering experiment used by several workers to study stratospheric aerosols is discussed, and a comparison is made of the results of twilight and laser radar experiments conducted at the same time and locality. A theoretical model of the twilight phenomenon based on primary scattering is developed, and calculations are performed to deduce the relative effects of the various aerosol layers in the troposphere and stratosphere on the twilight profile.

PREFACE

To the best of the author's knowledge, this thesis contains no material previously published or written by another person, except where due reference is made in the text. It contains no material which has been submitted or accepted for the award of any other degree or diploma in any University.

(D. J. Gambling)

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