

ROCKET STUDIES
OF THE
LOWER THERMOSPHERE

by

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SUMMARY

This thesis is primarily concerned with the study of the lower thermosphere region of the earth's atmosphere, a region in which although the occurring aeromic phenomena are fairly well understood there are still uncertainties in many parameters needed to describe the morphology of the region. The uncertainties are to be found mainly in the:

- (a) concentration of the atmospheric constituents, particularly those of the atomic, ionic and minor species.
- (b) intensities of the solar flux in the extreme ultraviolet (E.U.V.) and X-ray spectral regions and in its temporal variation.
- (c) overall dynamics of the atmosphere.
- (d) reaction rates necessary for the understanding of the chemistry and photochemistry of the atmosphere.

These uncertainties arise mainly because this region (altitude 90 - 200 Km) is above the balloon ceiling (>35 Km) and below most of the satellites' paths except for the few short-lived satellites with a low perigee (≈ 135 Km). Therefore the lower thermosphere is a region accessible only by rocket borne probes and the difficulties are in the fact that since the advent of rockets and satellites for atmospheric and space research only very few payloads have been adequately instrumentated to measure simultaneously the necessary parameters of the neutral and ionized species and the physical or chemical phenomena resulting from their mutual interactions. This lack of fundamental data coupled with the fact that it is not possible to simulate the upper atmosphere in

the laboratory has made the task of understanding the many processes involved in the aeronomic phenomena not an easy one.

In this dissertation a series of rocket borne experiments flown from the Woomera Rocket Range during the period from late 1972 to early 1977 are described and the data from the earlier flights are presented. The experiments are:

- (a) X-ray and E.U.V. detectors which measured the attenuation of the E.U.V. and X-ray solar flux in the atmosphere as a function of the altitude from which it has been possible to derive the densities of the neutral constituents.
- (b) electrostatic energy spectrometers used to measure the energy spectrum of the photoelectrons and ions.
- (c) neutral and ion quadrupole mass spectrometers for the determination of the composition and concentration of both the neutral and the ionized components of the atmosphere in the altitude range of interest.

During the course of this work the author has been involved with 10 rocket firings but, unfortunately, due mainly to technical problems associated with the vehicles, successful flights have been few. The rocket vehicles which were available and the experiments prepared and flown by the author on these vehicles have been:

- (1) four Cockatoos, rocket vehicles carrying X-ray detector experiments to an altitude of 130 - 135 Km.
- (2) two Lorikeets, vehicles each carrying a neutral mass spectrometer to an altitude of about 140 Km.
- (3) two Skylarks, rockets, the first carrying only

X-ray detectors while the second carried X-ray detectors, a grazing incidence spectrometer and an electrostatic energy analyzer to measure the photoelectron energy spectra.

- (4) one Super-Chief vehicle carrying an electrostatic energy analyzer to measure the energy spectra of the superthermalized electrons and conjugate photoelectrons in the night-time ionosphere.
- (5) one Aerobee rocket. This vehicle which was successfully launched on the 22nd of February, 1977, carried X-ray detectors, an ion and a neutral mass spectrometer, a high resolution (2%) 127° electrostatic analyzer and an ion and electron retarding potential analyzer.

Out of all of these flights only three firings have been successful: the two Skylarks and the Aerobee flights. The results from the Skylarks are presented in the thesis, while those of the Aerobee will be published in the near future in scientific journals.

The total density of the lower thermosphere derived from the solar X-ray measurements on the first Skylark and those determined from the X-ray and E.U.V. (grazing incidence spectrometer) absorption measurements with the instruments flown on the second Skylark vehicle are presented in chapter III while the results from the electrostatic energy analyzer experiment aboard the second Skylark are presented in chapter VI. However, samples of the Aerobee's preliminary data are also presented and are illustrated in Appendix B. The X-ray and E.U.V. absorption experiments are described in detail in chapter II, and those of the mass spectrometers in chapter IV and V.