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DEPARTMENT OF SUPPLY

AUSTRALIAN DEFENCE SCIENTIFIC SERVICE

WEAPONS RESEARCH ESTABLISHMENT

TECHNICAL MEMORANDUM HSA 188

SATELLITE (WRESAT) MEASUREMENT OF UPPER ATMOSPHERIC MOLECULAR OXYGEN DENSITIES

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Summary

The satellite 1967-118A, WRESAT, determined molecular oxygen profiles above 90 km and in the lower thermosphere by the absorption of solar ultra-violet radiation at satellite sunrise and sunset.

Significant differences above 110 km were indicated by the data from the longitudinally separated groups of stations (Australia, South Africa and South America).

A shelf of almost constant molecular oxygen density appears at altitudes of 110 to 120 km.

May 1969

NOTE: Technical Memoranda are of a tentative nature, representing the views of the authors, and do not necessarily carry the authority of this Establishment.

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1. INTRODUCTION

The satellite 1967-118A, WRESAT, was launched from Woomera Australia at 0435 U.T., on November 29, 1967, into a nearly polar orbit. Included among the experiments were two sets of ion chambers sensitive to the vacuum ultraviolet. These were designed to determine the density of molecular oxygen in the mesosphere and lower thermosphere, by the measurement of the absorption of solar radiation by the atmosphere, as the vehicle went through satellite sunrise and sunset.

Satellite sunrises were recorded by groups of tracking stations in South America, Australia and South Africa, while sunsets were recorded by one tracking station in Alaska. The local times associated with the sub-minimum ray height point, at first observation, extend from 0330 to 0430 L.T. for the sunrise observations, and from 1200 to 1300 L.T. for the sunset observations.

2. EXPERIMENTAL RESULTS

Sunrise data from the ion chamber sensitive to Lyman α radiation has been reduced for a number of passes recorded by the southern stations. No difference is apparent between the intensity vs. minimum ray height response curves derived from the data received by the Australian stations, so that these results have been combined to give a mean response curve. The longitudes of the locations to which these response curves refer, extend over the range 160°E to 163°W, their latitudes range from 44°S to 51°S. With due allowance for the finite size of the sun, as observed by the sensor, a molecular oxygen density distribution has been determined (figure 1) from the mean response curve. The method used to derive this density distribution, involved the production of a theoretical response curve for an assumed atmosphere, then by an iteration procedure, an atmosphere was obtained which gave a response curve in accord with the observed data. The value of the absorption cross section of molecular oxygen at Lyman α employed in these calculations, was 1.0×10^{-20} cm^2 as given by Watanabe (1), rather than the more recent determination of Ogawa's (2), so as to allow comparison with other published density measurements which have used the former value. Reduction of some of the data from the other southern stations, has given response curves which indicate molecular oxygen distributions that differ significantly from that in figure 1 for altitudes above 110 km.

The main feature of the present results is the shelf of almost constant density which appears at altitudes of about 110 to 120 km. This feature does not appear in either the U.S. Supplementary (3), or COSPAR standard atmospheres (4). Relatively few measurements of the molecular oxygen distribution have been made in the critical region of the atmosphere between 100 and 120 km. Such measurements that have been made in this region (3), do not clearly define the shape of the profile over this altitude range, (figure 1).

The fact that different density profiles above 110 km are indicated by the data from the three groups of southern tracking stations, is not inconsistent with the results of Stewart and Wildman (5), who have observed longitudinal variations in the molecular oxygen density at 180 km.

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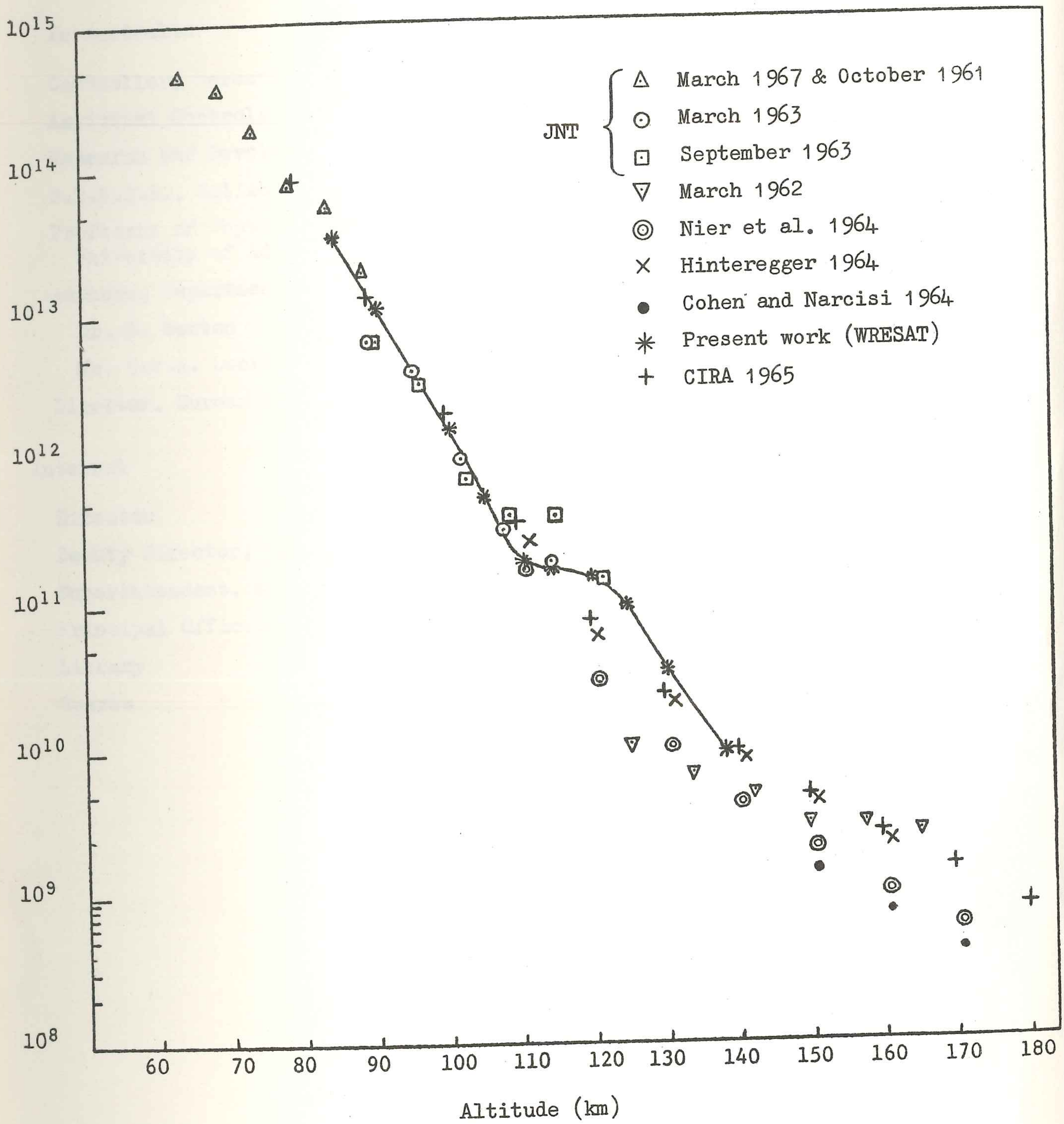

FIGURE 1. MOLECULAR OXYGEN DENSITIES