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THE STANFORD STUDY OF THE MARINER IV OCCULTATION DATA

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THE STANFORD STUDY OF THE MARINER IV OCCULTATION DATA

Research conducted under NASA contract NGR-05-020-065 involves analysis of data obtained from the Mariner IV-Mars occultation experiment and theoretical studies of models for the Martian atmosphere.

Data Analysis

The radio occultation experiment conducted with the tracking and telemetry system of the Mariner IV spacecraft provided precise data on the refractive index profile in height of the Martian atmosphere (Ref. 1). From the lower portion of this profile we deduce the molecular number density of the neutral atmosphere near the surface, while the upper portion of the profile is used to calculate the ionospheric electron number density.

The measurements made during occultation entry over the bright area Electris in the southern hemisphere of Mars yield an atmospheric temperature of about 180° K, and an atmospheric surface number density of about 1% of the density at sea level on the earth (Ref. 1). The ionospheric part of the measurements over Electris gives the daytime electron density profile shown in Fig. 1 (Refs. 2, 3).

Ionospheric measurements were also made during exit from occultation. In that case, the radio energy probed through the midnight ionosphere above Mare Acidalium in the northern hemisphere of Mars. However, the S-band telemetry frequency is not very sensitive to the low electron densities encountered on the night side of Mars, and we can therefore only use the data to estimate an upper limit (about 5×10^4 elec/cm^3) to the electron number density above Mare Acidalium.*

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* Investigators from Stanford have suggested a different scheme in which two or more harmonically related frequencies may be used to probe planetary atmospheres (Refs. 2, 4, 5,6). By choosing the lowest frequency at a few hundred Mc/s, this would provide a more sensitive measurement of ionospheric electron densities. This technique also has the advantage of enabling one to separate the effects of the electrons and the neutral molecules due to their different dispersive properties, and thereby increase the frequency of the measurements of the densities in the lower neutral atmosphere.

Studies of Atmospheric Models for Mars

This part of the research program is aimed at developing atmospheric models from the occultation data. One of the models we are studying appears to be more probable than the others based on present information about the critically important rate coefficients for ion loss processes. The number density, temperature, pressure, and mass density profiles in altitude for this atmospheric model are shown in Figs. 2, 3, 4, and 6, respectively. These figures are taken from reference 3 where the details of this work are discussed.

3. G. Fjeldbo, W. C. Fjeldbo, and V. R. Eshleman, Science, in press.

4. V. R. Eshleman, "Radar Astronomy of Solar System Plasmas," ch. 14 from Solar System Radio Astronomy, ed. J. Aarons, Plenum Press, Inc., New York, 1965.

5. G. Fjeldbo, V. R. Eshleman, O. K. Garriott, and F. L. Smith, III, J. Geophys. Res., 70, 3701, (1965).

6. Proposal to NASA for "Bistatic Radar Astronomy Experiments on Voyager for Planetary-Orbital and Interplanetary-Cruise Studies of the Surface and Atmosphere of Mars and of the Interplanetary Medium," proposal no. RL 29-65, submitted by the Center for Radar Astronomy, Stanford University, Stanford, California, November 19, 1965.

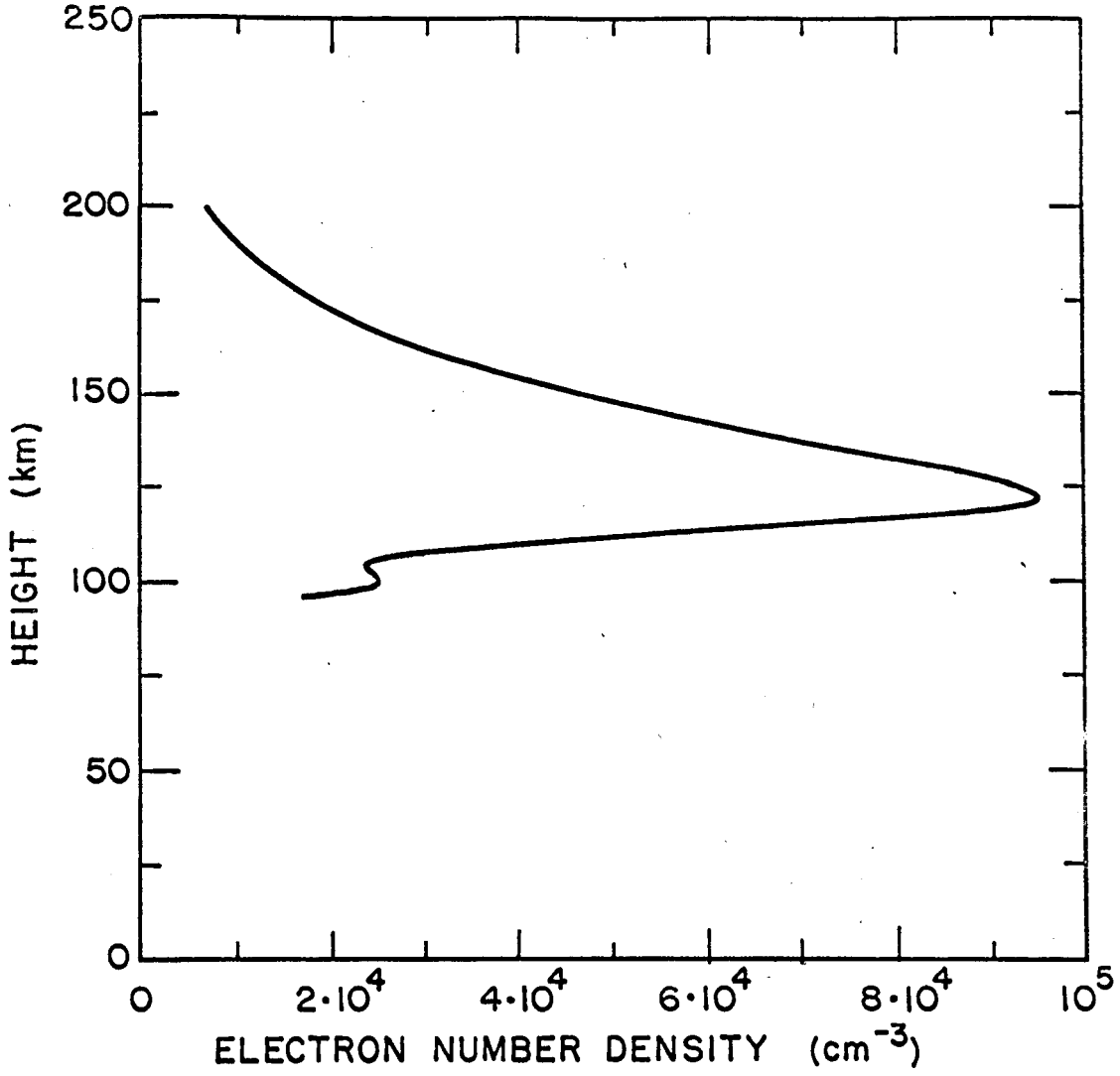

Fig. 1: ELECTRON NUMBER DENSITY VS ALTITUDE ABOVE ELECTRIS AT THE TIME AND LOCATION CORRESPONDING TO IMMERSION INTO OCCULTATION (50°S latitude, 177°E longitude, 1300 local time, late winter, solar zenith angle 67°)

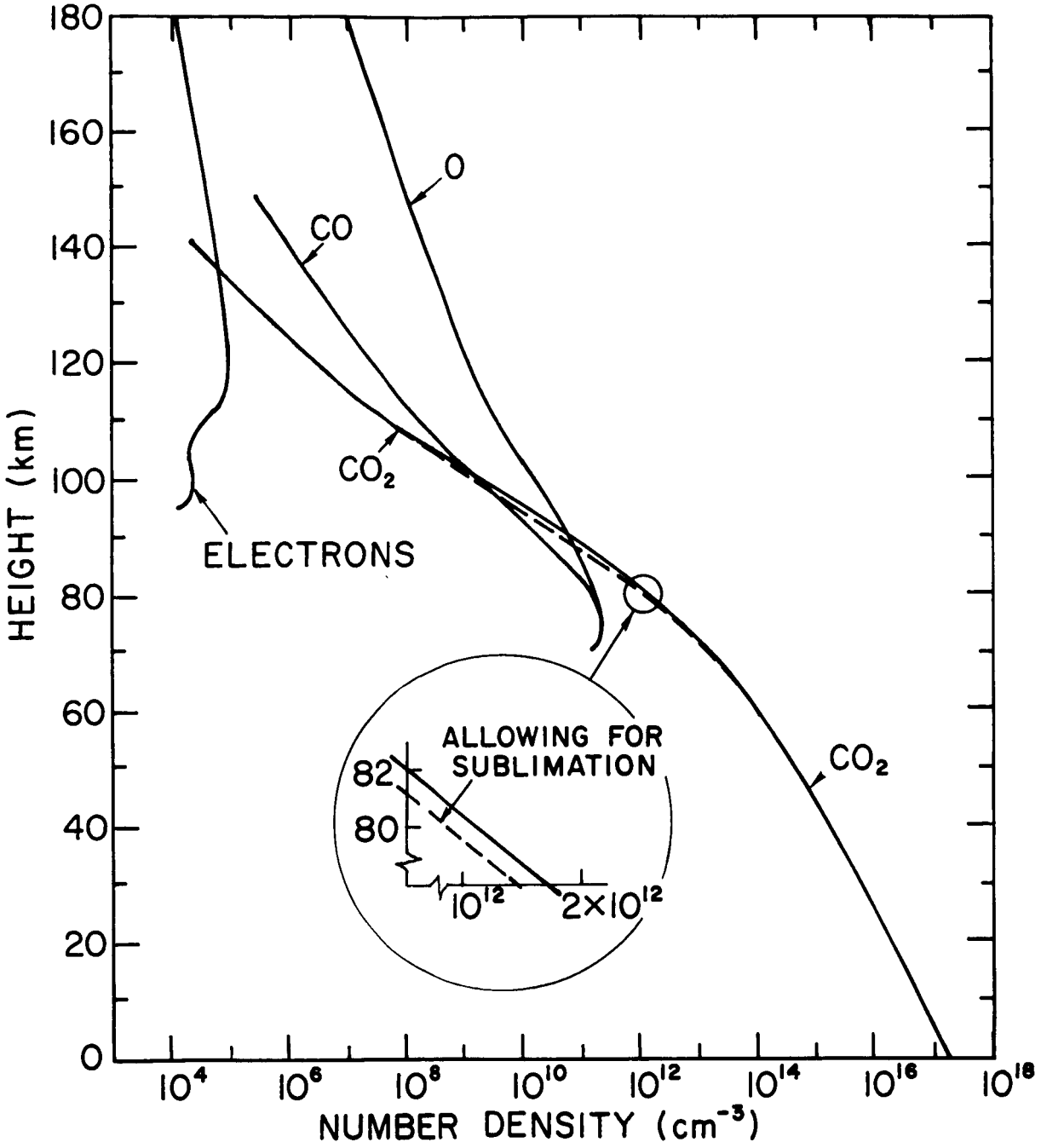

Fig. 2: NUMBER DENSITY VS ALTITUDE ABOVE ELECTRIS AT THE TIME OF IMMERSION INTO OCCULTATION. The limiting ion loss process in the main ionospheric layer is assumed to be $O^+ + CO_2 \rightarrow CO + O_2^+$ with a rate coefficient of 10^{-9} cm^3/sec.

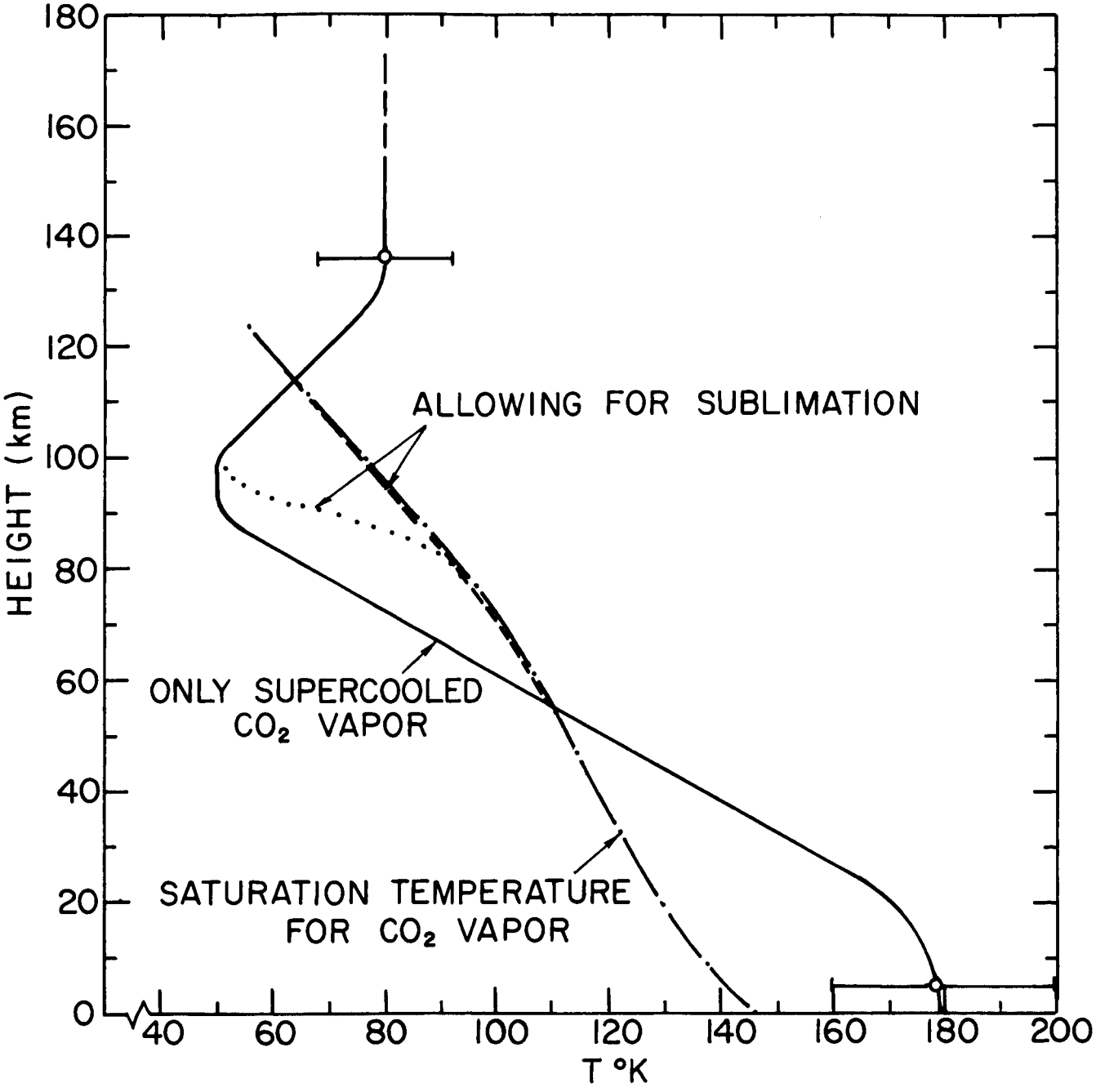

Fig. 3: TEMPERATURE VS ALTITUDE ABOVE ELECTRIS AT THE TIME OF IMMERSION INTO OCCULTATION. The limiting ion loss process in the main ionospheric layer is assumed to be $O^+ + CO_2 \rightarrow CO + O_2^+$ with a rate coefficient of 10^{-9} cm^3/sec.

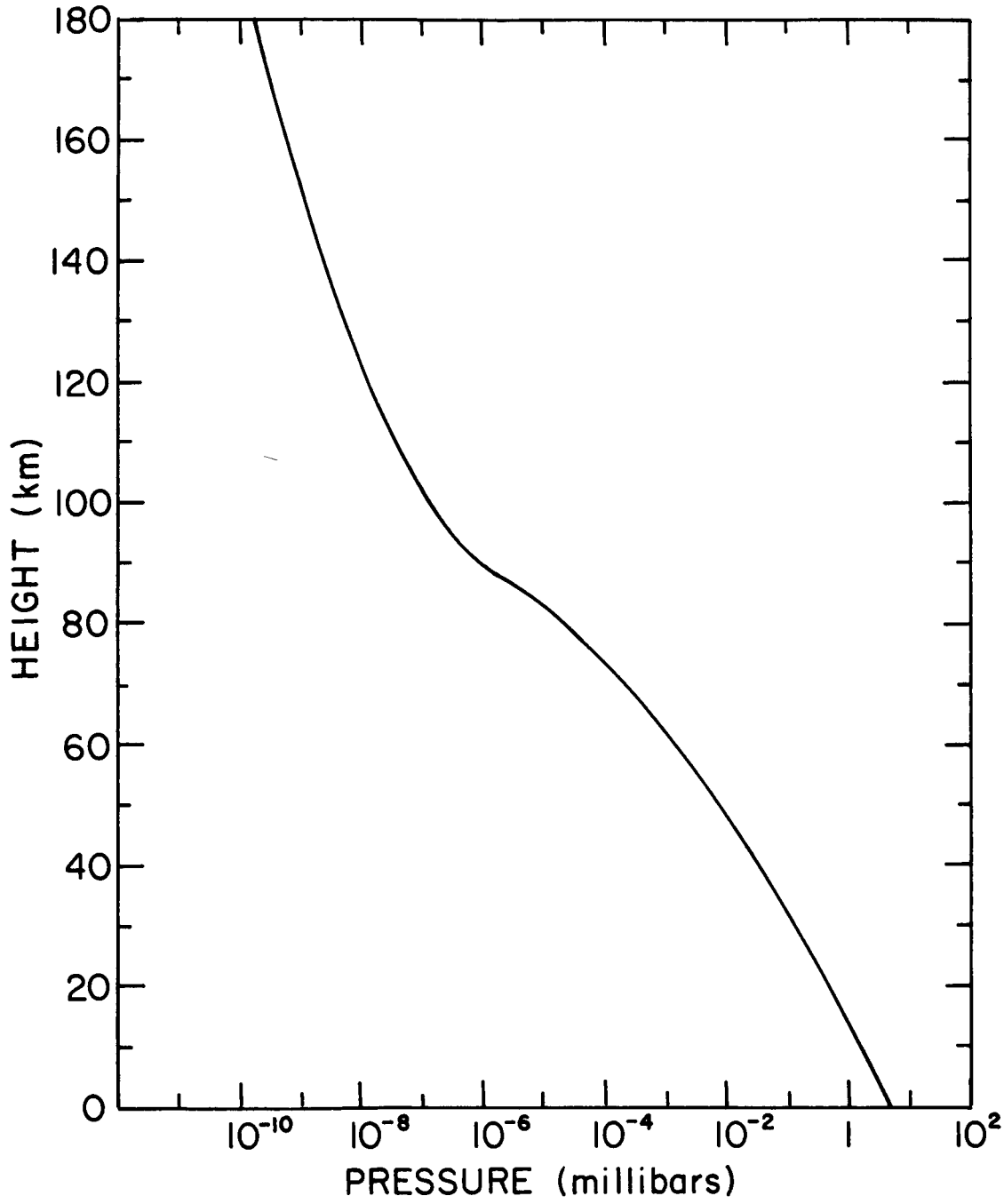

Fig. 4: PRESSURE VS LATITUDE ABOVE ELECTRIS AT THE TIME OF IMMERSION INTO OCCULTATION. The limiting ion loss process in the main ionospheric layer is assumed to be $O^+ + CO_2 \rightarrow CO + O_2^+$ with a rate coefficient of 10^{-9} cm^3/sec.

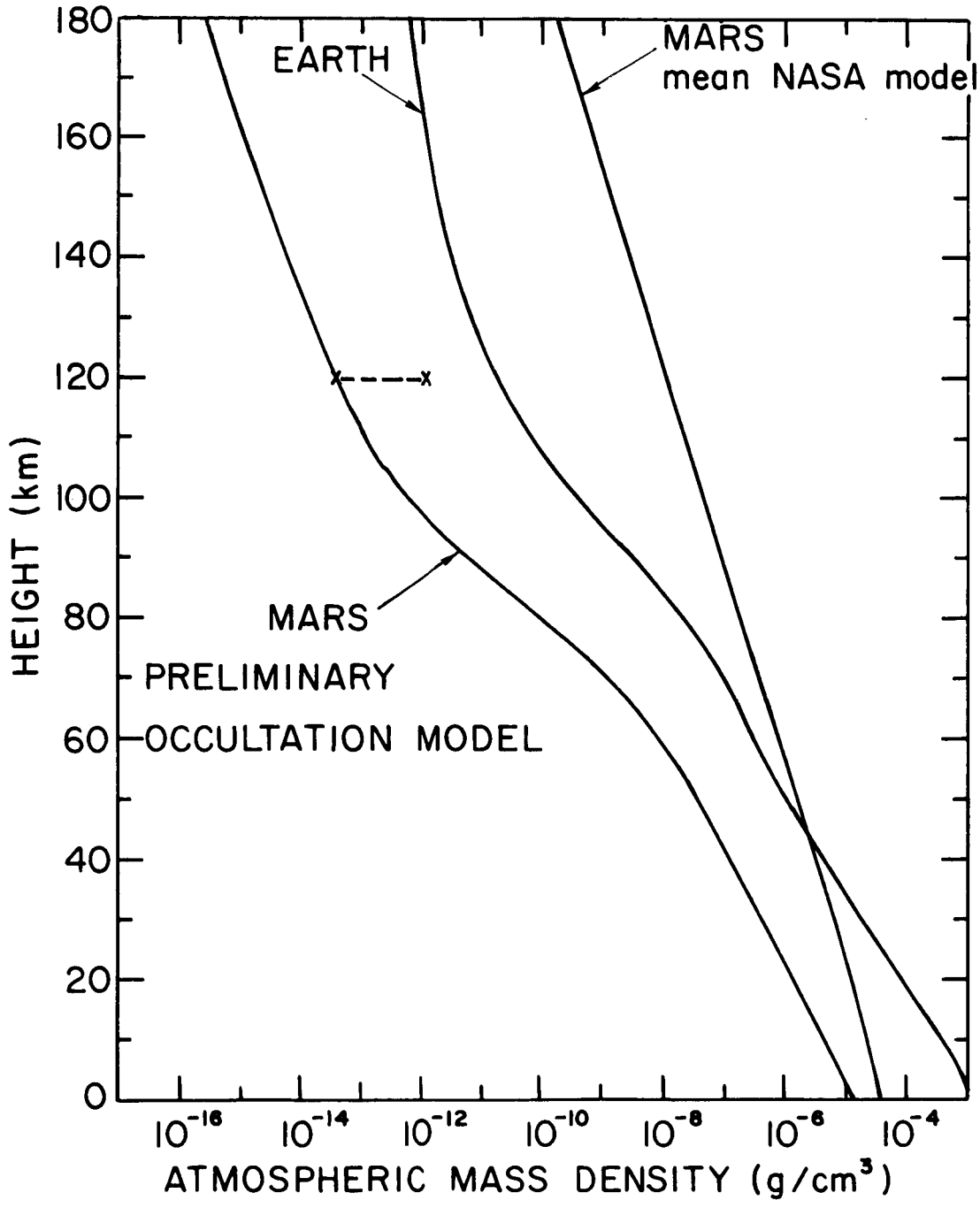

Fig. 6: ATMOSPHERIC MASS DENSITY VS ALTITUDE ABOVE ELECTRIS AT THE TIME OF IMMERSION INTO OCCULTATION.