

## A MODEL STUDY OF EFFECT OF ELECTRON TEMPERATURE ENHANCEMENTS ON D- AND E-REGION ELECTRON DENSITIES

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IMMENSE heating of the ionosphere due to absorption when irradiated by high-power, high-frequency radio waves raises the temperature in the region. The consequent (and corresponding) rise in the electron neutral particle collisional frequency is believed to be one of the causes of the observed changes in propagation parameters of LF/VLF waves passing through the disturbed ionosphere. It is generally believed that electron density does not get modified because of the short duration of the heating pulse and the long time-scales required to affect chemical reactions. However, from partial reflection measurements and model calculations, Utlaut and Violette<sup>1</sup> observed that the electron density profile, along with collision frequency, get modified by the heater to different degrees at different altitudes. They also suggest the atmospheric chemistry reaction times are modified. Holway and Meltz<sup>2</sup> suggested that in the D-layer, ohmic heating produces an increase in electron density owing to a decrease in the rate of dissociative recombination. Although there is no direct experimental evidence for this effect, absorption measurements<sup>1,3</sup> have clearly shown that electron density enhancements are possible following sustained heating. This electron density modification is due to a change in temperature and takes place through temperature-dependent chemical reactions. So a study of the behaviour of electron density profiles under enhanced temperature conditions is of great significance for LF/VLF communications, particularly when high-power medium or high-frequency transmitters are operating in their propagation path. In this note we present the results of such an investigation using a model-derived electron density profile relevant to low latitudes.

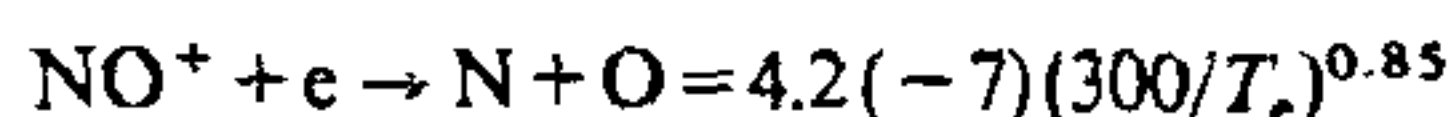
### The electron density profiles

The altitude distribution (60–120 km) of electron density appropriate to a moderate solar activity and winter noontime conditions at low latitudes is considered in this study. The neutral atmosphere model, including the minor species, necessary to

obtain ion production rates, is adopted from Solomon *et al.*<sup>4</sup> The required solar ionizing radiation and GCR fluxes are taken from recent literature. A comprehensive ion-chemical scheme given by Reid<sup>5</sup>, which considers minor constituent ions like  $\text{NO}^+$  and metastable oxygen and water cluster ions as well as negative ions along with the major ion species  $\text{O}_2^+$  and  $\text{N}_2^+$ , is used to obtain electron densities. A detailed description of the ion-chemical scheme and derivation of electron density is given elsewhere<sup>6</sup>. The electron density profile thus obtained is shown in figure 1.

### Effect of temperature enhancement on electron density profiles

There are several reactions in the ion-chemical model assumed whose reaction rates are dependent on electron temperature, for example



To bring out the influence of temperature rise on the electron density, the electron temperature values used in model development were increased by 30%, since a 30% increase is normally expected in an ionospheric heating experiment<sup>7</sup>. Using the modified electron temperature values, the altitude distribution of electron density is computed as described earlier. The modified electron density profile thus obtained is also shown in figure 1. It is interesting to see that, consequent to a rise in electron temperature, the change in electron density is different in different altitude zones. First there is a small reduction below about 74 km, then a significant increase between 74

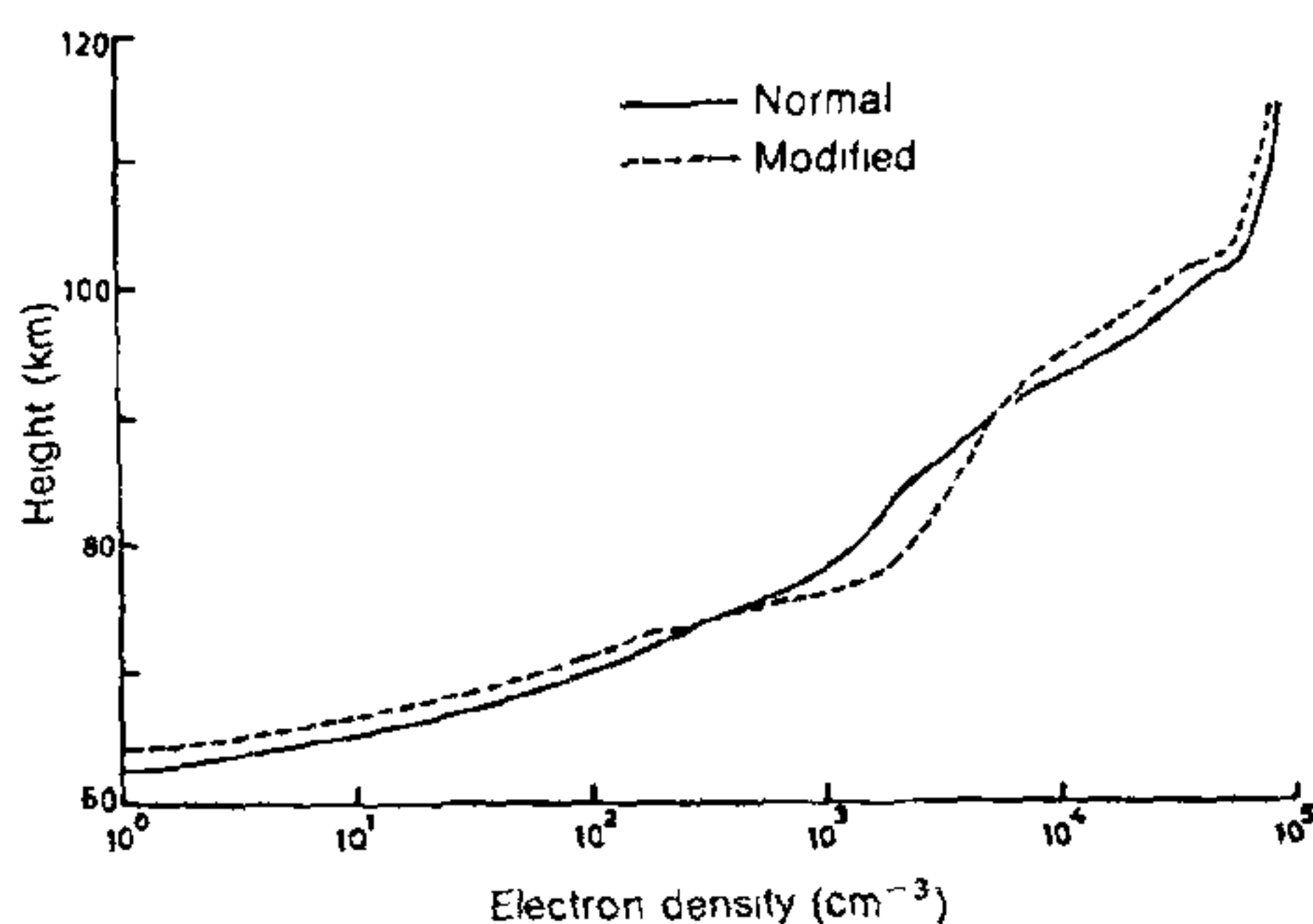


Figure 1. Electron density profile for low latitudes derived from a neutral atmosphere model and ion-chemical scheme.

and 90 km with electron density change maximizing at 80 km, and a decrease again beyond 90 km.

It is not strictly valid to assume a uniform temperature enhancement in an ordinary heating experiment, since the region (altitude) of maximum absorption of radiation (and thereby temperature rise) depends on the frequency of the disturbing transmitter and also the mode of excitation. Nevertheless, the present result is significant in the sense that it brings out the variation in the effect of temperature enhancement on the various chemical processes. It may be of interest to note that the regions of crossover (figure 1) coincide, respectively, with the region of transition from negative ion to electron-dominant regime (at around 74 km) and the region where  $O^+$  ions dominate over  $NO^+$  ions. A detailed investigation using a realistic temperature distribution under disturbed conditions is being carried out and the results will be published elsewhere.

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## POLAROGRAPHIC STUDIES OF MIXED-LIGAND COMPLEXES OF THE In(III)-1-METHYLIMIDAZOLE-TARTRATE SYSTEM

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STUDIES on mixed-ligand complexes, particularly those of biological significance, have been of interest

during the past decade. Earlier work from this laboratory and elsewhere<sup>1-3</sup> has indicated that in the combination of metals with serum albumin the principal binding sites are the imidazole groups of the protein molecule. Norman *et al.*<sup>4</sup> have studied polarographically the overall formation constant of cadmium and copper complexes of imidazole and 1-methylimidazole. The results indicated that the site of binding on the imidazole molecule was the pyridine-nitrogen rather than pyrrole-nitrogen. A survey of data cited in the literature revealed that further studies are required. Also, there has been no report on mixed-ligand complexes of In(III)-1-methylimidazole-tartrate system. The present work is devoted to a polarographic investigation of the composition and stability constants of simple and mixed-ligand complexes of the above system.

All chemicals used were of BDH reagent grade. Solutions were prepared in conductivity water. The ionic strength was maintained constant at  $\mu=2.0$  using  $NaNO_3$  supporting electrolyte. The concentration of Cd(II) was kept at  $1 \times 10^{-3}$  M. All measurements were made at  $25 \pm 0.1^\circ C$  and pH 8. The pH measurements of the solutions were made using a Beckman extended scale digital pH meter model 4500 with accuracy  $\pm 0.002$  pH units. The pH meter was calibrated by means of saturated buffer solutions (Burroughs Wellcome, England).

Polarographic measurements were carried out using a PAR model 174A polarographic analyser in conjunction with a three-electrode cell system, with a saturated Ag/AgCl as reference, platinum as the counter electrode and a dropping mercury electrode as working electrode. The polarograms were recorded on Houston Omnigraphic model RE 0074 X-Y recorder. All the test solutions were degassed with pure nitrogen.

The stability constants of simple complexes of In(III) with 1-methylimidazole and tartrate were determined separately prior to a study of the mixed-ligand system. Identical conditions were maintained in both the simple and mixed-ligand systems.

The reduction of In(III) in 1-methylimidazole and tartrate media, separately, was found to be reversible and diffusion-controlled. The same was true with the mixed system. The slopes of linear plots of  $\log(i/i_d - i)$  vs  $E_{de}$  were of the order of 33 mV and the plots of  $i_d$  vs  $i_{corr}^{\frac{1}{2}}$  were linear and passed through the origin.

### In(III)-1-methylimidazole

A plot of  $E_{\frac{1}{2}}$  vs  $\log [1-MeIm]$  indicated that two