Ionospheric Profiles from Ultraviolet Remote Sensing

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LONG-TERM GOALS

The long-term goal of this project is to obtain ionospheric profiles from ultraviolet remote sensing of the ionosphere from orbiting space platforms.

OBJECTIVES

Remote sensing of the nighttime ionosphere is a relatively straightforward process due to the absence of the complications brought about by daytime solar radiation. Further, during the nighttime hours, the O^+-H^+ transition level in both the mid- and low-latitude ionospheres lies around 750 km, which is within the range of accuracy of the path matrix inversion. The intensity of the O^+-e^- recombination radiation as observed from orbiting space platforms can now be used to reconstruct the nighttime ionospheric profile including the O^+-H^+ transition height.

APPROACH

In the topside ionosphere, a distinct bend in the electron density profile marks the boundary between the F region (major ion O^+) and the plasmasphere (major ion H^+) (cf. Davies, 1990). During the nighttime hours, this level is situated around 750 km for both the mid- and low-latitude ionospheres. Also, during the nighttime, chemical equilibrium condition holds for altitudes of up to at least 800 km (Hanson and Ortenburger, 1961; Geisler, 1967).

The F region density profile is approximated by a 3-parameter Chapman layer model. The nighttime O^+ density profile is first determined by direct inversion of the intensity of the O^+-e^- recombination reaction at different observation angles. The H^+ density profile is next approximated by a 3-parameter Parabolic-Chapman profile, two of which are given by the transition level altitude and density.

WORK COMPLETED

Model ionospheric profiles based on observed nighttime profiles were reconstructed using this technique. Following are some examples:

1. Lima profile (12 deg S latitude) at 1515 LT on 17 February 1962 recorded by Bowles (1963);

2. ”Singapore” profile for a location over Indian Ocean (9 deg N latitude) at 2214 LT on 1 October 1962 recorded by King (1963);

3. Jicamarca profile (12 deg S latitude) at 2325 LT on 2 February 1965 recorded by McClure (1965); and

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4. Arecibo profile (18 deg N latitude) at 2230 LT on 10 February 1972 recorded by Hagen and Hsu (1974).

RESULTS

1. The Lima profile was approximated by an O^+ Chapman profile with N_m = 500,000 cm^{-3}, z_m = 275 km and H = 68 km; and by an H^+ Parabolic-Chapman profile with N_{tr} = 2,800 cm^{-3}, z_{tr} = 800 km and H =300 km.

2. The "Singapore" profile was approximated by an O^+ Chapman profile with N_m = 760,000 cm^{-3}, z_m = 250 km and H = 50 km; and by an H^+ Parabolic-Chapman profile with N_{tr} = 11,200 cm^{-3}, z_{tr} = 800 km and H = 125 km.

3. The Jicamarca profile was approximated by an O^+ Chapman profile with N_m = 105,000 cm^{-3}, z_m = 426 km and H = 50 km; and by an H^+ Parabolic-Chapman profile with N_{tr} = 6,500 cm^{-3}, z_{tr} = 725 km and H =155 km.

4. The Arecibo profile was approximated by an O^+ Chapman profile with N_m = 20,000 cm^{-3}, z_m = 350 km and H = 50 km; and by an H^+ Parabolic-Chapman profile with N_{tr} = 900 cm^{-3}, z_{tr} = 700 km and H = 190 km.

The reconstructed profiles all exhibited slightly underestimated topside O^+ densities and slightly overestimated H^+ and topside e^- densities.

IMPACT/APPLICATIONS

This study permits a more complete reconstruction of the topside ionosphere by ultraviolet remote sensing, including the lower protonosphere and the O^+-H^+ transition altitude.

TRANSITIONS

Several forthcoming ultraviolet remote sensing experiments to be conducted by the U. S. Naval Research Laboratory will monitor the ionosphere on a continuous basis from orbiting space platforms.. The present technique can be utilized in the data analyses of these measurements.

RELATED PROJECTS

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