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INVESTIGATION OF IONOSPHERE AND AIRGLOW RESPONSE TO CUSP ELECTRONS

Contract NASw 2550

FINAL REPORT

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The three major objectives of this investigation were:

1. Compute the ionospheric quantities and airglow emission expected from the interaction of measured energetic electron input spectra within and near the polar cusp region and contrasting nightside auroral region;

2. Compare the computed electron density profile and airglow emission with the corresponding electron density profiles and airglow intensities measured in the precipitation region by aircraft and spacecraft; and

3. Infer the adequacy or inadequacy of the physics and parameters encompassed by the computer model from the above comparisons.

These three objectives have been accomplished as documented in [redacted] "Magnetospheric Convection and the High-Latitude F_2 Ionosphere," by W. C. Knudsen, which was published in the Journal of Geophysical Research, Volume 79, page 1046, March 1, 1974.

At the beginning of the investigation, it was assumed that the polar cusp ionosphere would be in an approximate steady state. This assumption is appropriate when the ionization rate and electron heating rate are changing slowly when compared with a diffusion time constant. The steady-state ionospheres expected at two locations, one within the cusp electron precipitation zone and one just equatorward of the cusp zone, were computed for comparison with topside ionograms from the ISIS-2 satellite and bottomside ionograms from the AFCRL flying ionospheric observatory. The ionization rates at the two locations were computed from measured cusp precipitating electron spectra and from known solar photon spectra. The observed and computed electron concentration profiles were in reasonable agreement just equatorward of the cusp, but were in obvious disagreement within the cusp (see Figure 3 of the Journal article [redacted]).

Investigation of possible causes of the disagreement between the observed and computed electron concentration profiles within the cusp finally led to the conclusion that rapid convection of the ionospheric plasma across the cusp was taking place and was responsible for the lack of diffusive equilibrium. A tube of plasma was being transported into the cusp region where additional ionization was being added to the tube and out of the region in a time which was short compared with the time required for significant diffusion of the plasma at the altitude of the F_2 peak.

After recognizing the significance of convection at the cusp, I was led to investigate its possible influence over the entire polar region. I did not have a time-dependent ionospheric computer model at my disposal and, hence, investigated the expected behavior in the semi-quantitative way described in the attached reprint.

I consider the Journal arctile [redacted] as a very significant addition to the ionospheric literature. The significant role of magnetospheric convection in modifying the ionosphere within the cusp and auroral regions, in maintaining it over the polar cap, and in producing the nightside midlatitude trough is postulated and evaluated semi-quantitatively therein.

It is my intention in a desired future contract to use a time-dependent ionospheric computer model together with measured precipitating particle data to compute the behavior of a tube of ionization as it is convected around the hypothesized flow line presented in Figure 1 of the Journal article [redacted].