Approximating Midlatitude Fall-off Velocity Profiles in the Dawn and Dusk Sectors of the High Latitude Convection Pattern

JANELLE V. JENNIGES1, JAN J. SOJKA1, RODERICK A. HEELIS2, and MICHAEL DAVID3

(1) Utah State University, Logan, UT, United States, (2) The University of Texas at Dallas, Dallas, TX, United States

BACKGROUND

The high latitude convection pattern has been extensively studied and modeled by Volland (1978), Hopper and Maynard (1987), Heelis et al. (1982), Weimer (1995), and many others. While it is well known that the convection pattern is highly dependent on geomagnetic activity and interplanetary magnetic field (IMF) orientation, less understood are the dependencies of the midlatitude fall-off region. This region connects the high latitude polar convection to the region where the ring currents cancel out the low latitude electric field. The electric field in this midlatitude region is typically modeled as a simple fall-off, but magnetosphere-ionosphere dynamics may create structure that has been neglected by ionospheric models.

DUSK VS. DAWN BOUNDARY MOVEMENT

Representative curves for the exponential and sine functions show that the gradient of the curve and the peak velocity increase with higher Kp. The equatorward movement of the peak is four times larger on the duskside as on the dayside.

POLAR CAP RADIUS

Both IMF and Kp dependencies were determined for the polar cap radius. Separate trends were obtained for negative and positive IMF values.

- Negative IMF: 11.8° ± 0.5° × IMF
- Positive IMF: 12.4° + 2.0° × IMF
- Kp: 12° + 1.1° × Kp

USU TDIM RESULTS

The USU Time Dependent Ionospheric Model was run using the original Volland configuration and then using the Kp-dependent radius and sine functions. The top panels show the unmodified (left) and modified (right) results for Kp = 1.0 and the bottom panels show the results for Kp = 4.0.

- Use of the Kp-dependent radius function results in a smaller polar cap for Kp = 4.0 but a similar size polar cap for Kp = 1.0.
- The modified TDIM output also shows a more pronounced Kp minimum just inside the auroral zone than the unmodified output, especially for the 1100 UT and 2300 UT plots in Figure 14.

A 43% increase in TEC occurs in the pre-dawn sector of the auroral oval for the 1700 UT Kp = 4.0 plot while an 87.5% decrease occurs near 72° MLAT in the dusk sector. A large increase of 120% occurs in the same region for the 1700 UT Kp = 1.0 plot but the dusk sector does not show as large of a decrease. The TEC decrease just inside the auroral oval for the 1100 UT Kp = 4.0 plot ranges between 50% on the duskside to 60% on the dayside.

CONCLUSIONS

- Results valid for LOW solar & geomagnetic activity
- Kp-dependent polar cap radius: 12.2° ± 1.1° × Kp
- Only 30% of the data approximated by analytical functions
- Other 70% not a good fit for multiple reasons
- Unable to remove instrument error
- Quiet conditions; no discernible peak velocity
- Analytical functions cannot capture structure
- Kp-dependent sine function: y = 86 + 0.75 × Kp
- Fall-off curves depend on all function parameters
- Boundary expansion 2–4 times greater on duskside

REFERENCES