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Electric field-driven currents in the ionosphere of Mars

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Abstract

Mars has a complex magnetic topology. Crustal magnetic fields can interact with the solar wind magnetic field to form magnetic cusps. On the nightside, solar wind electron precipitation can produce regions of enhanced ionization at cusps while closed field regions adjacent to cusps can be devoid of significant ionization. Previously, using an electron transport model, we calculated the electron density and spatial structure of the nightside ionosphere of Mars using Mars Global Surveyor electron measurements as input. Localized regions of enhanced ionospheric density were found to occur at magnetic cusps adjacent to low density voids [1]. Additionally, we calculated the horizontal ionospheric currents driven by strong plasma gradients and by thermospheric neutral winds. In the dynamo region of the ionosphere, the collisional ions move in the direction of the applied force (the plasma gradient or neutral wind) while the magnetized electrons move perpendicular to both the applied force and ambient magnetic field. This difference in motion drives horizontal currents. Subsequently, we considered the existence of wind-driven cusp electrojets created by secondary currents arising from polarization electric fields which form in the presence of strong conductivity gradients [2].

At Earth, ionospheric currents at high latitudes are driven predominantly by externally imposed (magnetospheric) electric fields. Here, we compute the horizontal ionospheric currents in the vicinity of magnetic cusps resulting from external electric fields. In the absence of electric field observations, we use the electric field calculated from a global model of the Mars-solar wind interaction as input. We compare the magnitude of these currents with those driven by neutral winds and plasma gradients. Additionally, we estimate the magnitude of the electric field-driven electrojets, analogous to Earth's auroral electrojets. These enhanced currents can lead to localized, enhanced Joule heating. Closure of these horizontal currents may require field-aligned currents which may play a role in high altitude acceleration processes. Finally, we estimate upper bounds on the amount of Joule heating and on the field-aligned currents required to close the horizontal currents.

References

[1] Fillingim, M. O., Peticolas, L. M., Lillis, R. J., Brain, D. A., Halekas, J. S., Lummerzheim, D., and Bougher, S. W.: Localized ionization patches in the nighttime ionosphere of Mars and their electrodynamic consequences, Icarus, Vol. 206, pp. 112-119, 2010.

[2] Fillingim, M. O., Lillis, R. J., England, S. L., Peticolas, L. M., Brain, D. A., Halekas, J. S., Paty, C., Lummerzheim, D., and Bougher, S. W.: On wind-driven electrojets at magnetic cusps in the nightside ionosphere of Mars, Earth Planets Space, in press. 2011.