Joule heating hot spot at high-latitudes in the afternoon sector

L. Cai and A. Aikio, S. Milan

Ionospheric Physics, P.O. Box 3000, FIN-90014 University of Oulu, Finland
email: lei.cai@oulu.fi

Solar wind is the main driver of the dynamical processes in the Earth's coupled magnetosphere-ionosphere system. A major part of the solar wind energy transferred into the magnetosphere dissipates as Joule heating in the high latitude ionosphere. Joule heating, calculated by the product of the current and the electric field in the reference frame of neutrals, mainly represents the frictional heating between the neutrals and and ions. The heating plays an important role in ionospheric and thermospheric energetics.

The incoherent scatter radar is a powerful tool for probing the ionospheric parameters. Based on 39 days of data measured by the EISCAT incoherent scatter radar in Svalbard, Cai et al. [1] found a Joule heating hot spot exists persistently at 75.4° cgmLat in the afternoon sector.

Recently, we extend the database in Cai et al. by collecting 320 days of measurements between 2000 and 2014 and by analyzing the the simultaneous observations from the (Active Magnetosphere and Planetary Electrodynamics Response Experiment) AMPERE project data during 2010-2013. The main findings are shown as follows. The Joule heating hot spot values are larger in summer than in winter, which can be explained by the higher Pedersen conductances during summer than winter. The afternoon Joule heating hot spots are located close to the reversals of the large-scale field-aligned current systems. The most common location is close to the Region 1/Region 2 boundary and those events are associated with sunward convecting F-region plasma. In a few cases, the hot spots take place close to the Region 1/Region 0 boundary and then the ionospheric plasma is convecting anti-sunward. The hot spots may occur both during slow (<450 km/s) and high (>450 km/s) speed solar wind conditions. During slow-speed solar wind events, the dominant IMF direction is southward, which is the general requirement for the low-latitude magnetic merging at the dayside magnetopause. During high-speed solar wind, also northward IMF conditions appear, but those are associated with large values of the IMF $|B_y|$ component, making again the dayside magnetopause merging possible.

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[1] L. Cai, A. Aikio, and T. Nygrén J. Geophys. Res. **119**, 10,440–10,455 (2014).