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On the Role of Hall and Pedersen Conductivities in Determination of Ionospheric Joule Heating

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Ionospheric Joule heating is defined as the frictional heating which results from the collisions between the neutrals and charged particles at the ionospheric heights. These collisional processes gain importance around 120 km in the E and F regions of the ionosphere where there are more neutral atoms, and particularly at the auroral altitudes, where Hall and Pedersen conductivities are comparable to each other. The most conventional ways of calculating ionospheric Joule heating relies on the relationship between electric field and Pedersen conductivity. The role of Hall conductivity in the calculation of Joule heating still remains unclear, and in general its contribution is accepted to be minor when compared to the Pedersen currents at the first approximation. However, results from the MHD simulations show that Joule heating is reduced in the regions where Hall conductivity is close to or higher than Pedersen conductivity. These local variations also modify the global Joule heating pattern and distribution. MHD models take into account the magnetosphere and ionosphere interaction and incorporate with the ionospheric modules which include the interaction between the neutral winds and charged paricles. In this study, we have selected two isolated substorm events that occurred in March, 2008 to investigate the effects of Hall conductivity on the Joule heating. We run NASA/CCMC MHD models, e.g. SWMF/BATSRUS, during these times under concurrent solar wind and IMF conditions. The outputs from the models will be used to calculate Joule heating with the Hall conductivity effects properly included. In this presentation, we will show our preliminary results on the Joule heating rates from the models, quantify the degree of Pedersen and Hall conductivity contributions on the Joule heating, and address on their contributions on the global distribution of the Joule heating. We will also compare and discuss our findings with those available in the literature.