Axisymmetric conductivities of Jupiter's middle- and low-latitude ionosphere

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Ionospheric Hall and Pedersen conductivities are important parameters in determining the electric potential distribution and plasma convection in a magnetosphere-ionosphere system. At Jupiter, meteoric ions generated by meteoroid ablation are expected to play a major role in the ionospheric conductivities [e.g., Cloutier et al., 1978]. Hall and Pedersen conductivities are expected to be axisymmetric at Jupiter due to the long lifetime of meteoric ions. This study aims to evaluate the modification of the potential distribution and plasma convection in the inner magnetosphere caused by the axisymmetric ionospheric conductivities at Jupiter.

There have been observational constraints on the effect of the ionospheric conductivities to the plasma convection in the inner magnetosphere. Observations by the Hisaki satellite revealed that the brightness intensity of the Io plasma torus changed asymmetrically between the dawn and the dusk sides and this change coincided with a rapid increase in the solar wind dynamic pressure. Such change can be explained by the existence of a dawn-to-dusk electric field of ~4-9 [mV/m] around Io's orbit [Murakami et al., 2016]. The dawn-to-dusk electric field can be generated by the dawn-to-dusk asymmetry of the ionospheric electric potential caused by the Region 2 like field-aligned current.

In order to evaluate the contributions of meteoric ions to the Jovian ionospheric conductivities and dawn-to-dusk electric field in the inner magnetosphere, we developed a 3-D photochemical model and a 2-D ionospheric potential solver. Our 3-D photochemical model includes chemical reactions taken from Kim et al. [1994, 2001], vertical thermal diffusion of ions, mass deposition rate of meteoric atoms and ions by meteoroid ablation, and ionization by precipitating electrons. The input parameters of field-aligned current are the Region 2 like current with reference to Khurana [2001] and axisymmetric Hill current. Our 2-D ionospheric potential solver was developed using the methods in Nakamizo et al. [2012]. First, we calculated the global distribution of ionospheric conductivities using ion and electron density profiles acquired from the photochemical model. Second, we calculated the ionospheric potential distribution and the resulting dawn-to-dusk electric field in the inner magnetosphere.

Our simulation results showed that the largest contributions to the Hall and Pedersen conductivities occur in the meteoric ion layer, and the conductivities are axisymmetric in the middle and low latitudes. Meteoric ions dominate the ion densities between 300 km and 400 km altitudes. The peak electron number density is ~$3*10^{11}$ [m^{-3}], which located at the meteoric ion layer around 370 km, and ~$1*10^{11}$ [m^{-3}] at the H^+ peak around 1000 km. We confirmed that electron density profile is almost constant at any local time due to the long lifetime of H^+ and meteoric ions. We confirmed that the ionospheric conductivities reach their maxima at the meteoric ion layer, and the height-integrated Hall and Pedersen conductivities become axisymmetric at middle and low latitudes at Jupiter. At high latitudes, the conductivities indicate the dawn-to-dusk asymmetry associated with the Region 2 like field-aligned current.

We will discuss the modification of the potential distribution in the ionosphere and the dawn-to-dusk electric field in the inner magnetosphere at Jupiter, due to the axisymmetric conductivities at the middle and low latitudes caused by meteoric ions and the dawn-to-dusk asymmetric ionospheric conductivities at high latitude caused by the Region 2 like current. Furthermore, comparison between our results and the Hisaki observations will be also discussed in the presentation.