R009-09
Zoom meeting D ：11/1 AM2 （10:45-12:30）
11:30-11:45

ひさき衛星観測との比較を目指した木星内部磁気圏プラズマ動径方向拡散モデルの開発

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Radial diffusion model of Jovian inner magnetospheric plasma with HISAKI observation

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We developed a time-dependent radial diffusion model to evaluate chemical reactions and radial transport of ions and electron in the Jovian inner magnetosphere. We compared equilibrium plasma distribution with the HISAKI observation to validate the model, then investigated mass and energy flows in the magnetosphere when plasma source from Io temporally changed.
Jovian first satellite Io has lots of active volcanoes and SO_2 rich atmosphere [Pearl et al., 1979; Fanale et al., 1979] and supplies ~tons/s of neutral gases to the magnetosphere. The gases are ionized and picked up by magnetic field, and distribute in a donut shape called Io Plasma Torus (IPT). About 90% of total mass of the magnetospheric plasma is supplied from IPT [Hill, Dessler, and Goertz, 1983]. The plasma diffuses outward on the time scale of several tens of days while obtaining the rotation angular momentum of Jupiter. Revealing the mass and energy balance of plasmas is an important subject to understand the macroscopic physical phenomena in the Jovian inner magnetosphere.
The radial distribution of the plasma has been examined based on steady state models and observations of Voyage 1, 2 and Cassini spacecraft. However, the time dependent model and comparison of the model with continuous observations have not been reported yet. The purpose of this study is to develop a model that has a capability to track the time variation of the radial distribution and compare it with HISAKI observation.
In the model, we track mass and energy balances of major heavy ions of Io origin (O^{+}-O^{3+} and S^{+}-S^{4+}). The equation system is based on the mass and energy transport model (Delamere et al. 2005). The radial gradient of the density and temperature were set to 0 at the inner boundary (Io's orbit, 5.9 R_J from Jupiter), and they are fixed with extrapolated values of HISAKI observation at the outer boundary (30R_J). We considered several chemical interactions: charge exchange, electron impact ionization, electron recombination, Coulomb interaction and radiation through electron collision excitation (Delamere & Bagenal 2003). The initial values of temperature and density of ions and thermal electrons were given from the HISAKI observations in November 2013 when Io's volcanic activity was stable [Yoshioka et al. 2018]. The density of neutral atoms (O, S) were also given by HISAKI observation [Koga et al. 2018] as initial values, and their total source rate is a free parameter. To express the radial diffusion physically realistic, we adopted the diffusion coefficient $D_{LL} = -k_{\Omega}L^{p+4}(dNL^2/dL)$ driven by the interchange instability in Jovian inner magnetosphere [Siscoe & Summers 1981].
In order to verify the validity of the model, the steady state temperature and density of ions and electrons in the region of 6-10 R_J were compared with the HISAKI observation and we tried to get the parameters that best matched with the observation.
Electron temperature and density of the lower charged ions and electron are almost matched the HISAKI observation. However, we found that highly ionized ions have low density with HISAKI, and ion temperature is almost stable around 200 eV except S^{+} which has 300 eV. Under this condition, we obtained three parameters: the hot electron fraction is 0.3 (%), the neutral source rate is 7.0×10^{-4} (/m^3/s), and k_{Ω} is estimated to be 1.2 $\times10^{-19}$ near Io's orbit. The source rate and hot electron fraction is consistent with the Cassini observation. k_{Ω} is also consistent with the theoretical estimation: 6.2×10^{-20} to 7.8×10^{-18}.
As for the time variations of density and temperature, we compared our model with the previous model with static radial diffusion coefficient.
In our model, diffusion increases during the volcanic event because the diffusion coefficient depends on the gradient of density and the radial profiles return to the equilibrium status after the event faster than the static radial diffusion model. In this presentation, we will show the correspondence between the mass/energy balance in the time variations and the HISAKI observation results.