# Enhancement of Io's volcanic activity and its influence on local electron heating in the Io plasma torus

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Io continuously supplies volcanic gases to the Jovian magnetosphere with typical rate of 1 ton/sec and is a primary source of plasmas in the magnetosphere. The supply of neutral atoms and molecules from Io produces pickup ions and causes significant inputs of mass and energy to the inner magnetosphere. 10-20% of the energy is immediately converted to produce hot electron population downstream of Io while the electrons quickly lose their energy by radiation of ions in the extreme ultraviolet (EUV) range with a time scale shorter than the rotation period of Jupiter. Due to these processes, longitudinal distribution of electron temperature has a maximum downstream of Io. This phenomenon was discovered by EUV spectroscopic observation of the Voyager spacecraft and confirmed by the HISAKI satellite observation in 2014. Based on the HISAKI observation, the Io phase dependence is accompanied by the 5-hour periodicity which is a half of Jupiter's rotation period. This means that the energy production rate at Io depends on the local plasma density since Io crosses the center of the torus twice during one Jovian rotation (10h). However, the Io phase dependence has not been detected by the similar EUV observations by EUVE and Cassini and the origin of the local electron heating is still open question. This study examines unresolved problems on the Io phase dependence using the HISAKI observation data in 2015. The EUV spectroscope, EXCEED, onboard HISAKI measures ion and atomic emission lines in EUV range. The 2nd campaign of Io plasma torus observations has been done from the end of Nov. 2014 to middle of May 2015. On middle of Jan. 2015, EXCEED observed gradual increase in $S^+$ brightness. The brightness showed a maximum at the end of Feb. and $S^{2+}$ and $S^{3+}$ intensities also showed maxima subsequently. Ground based observation of the sodium nebula showed increase in the emission intensity from the middle of Jan. to the beginning of Mar. These observations suggest that enhancement of the volcanic activity began at the middle of Jan. The brightness of ions returned to the pre-increase level by the middle of May 2015. These are the first complete data set which shows influence of Io's volcanic activity change to the Io plasma torus from start to finish. Characteristics of the Io phase dependence also changed during the volcanic event. Before the volcanic enhancement, ion brightness shows the Io phase dependence with the similar amplitude as the 2014 data. It kept appearing during the increasing phase but amplitude became large. In the declining phase the amplitude of the Io phase dependence reduced significantly. Periodogram analysis of ion brightness showed significant peaks at Io's orbital period, around Jupiter's rotation period (system III and IV periods), and at a half of it (5-h) and confirmed that the significance of the Io orbital periodicity became small during the declining phase. It is also found that the 5-h periodicity was significant before and during the increasing phase but it disappeared during the declining phase. Hypotheses to account for them is change in the latitudinal distribution of plasmas and longitudinal extend of neutral cloud in the Io torus. If the neutral cloud is primary source of the pickup ions, the longitudinal extend of the cloud cause the extension of the mass and energy production region. This could cause reduction of both the Io phase dependence and 5-h periodicity. The increase of pickup ion causes to increase in ion temperature along the magnetic field line and extend latitudinal distribution of ions. This could reduce local plasma density change at Io and is responsible for decreasing the Io phase dependence. The latitudinal distribution of ion and longitudinal extend of neutral cloud could be derived from EXCEED and ground based observations and will be compared with the Io phase dependence to validate the hypotheses.