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Effect of the solar UV/EUV heating on the intensity and spatial distribution of Jupiter's synchrotron radiation

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Jupiter's synchrotron radiation (JSR) is the emission from relativistic electrons in the strong magnetic field of the inner magnetosphere, and it is the most effective probe for remote sensing of Jupiter's radiation belt from the Earth. Recent intensive observations for JSR reveal short term variations of JSR with the time scale of days to weeks. Brice and McDonough (1973) proposed a scenario for the short term variations (hereafter the B-M scenario); i.e, the solar UV/EUV heating for Jupiter's upper atmosphere drives neutral wind perturbations and then the induced dynamo electric field leads to enhancement of radial diffusion. If such a process occurs at Jupiter, brightness distribution of JSR is also expected to change. That is, it is expected that the dynamo electric field induced by diurnal neutral wind system produces dawn-dusk electric potential difference and dawn-dusk asymmetry in electron spatial distribution. Then, this makes dawn-dusk asymmetry of the JSR brightness distribution.

Preceding studies confirmed the existence of the short term variations in total flux density and its variation corresponds to the solar UV/EUV variations (Tsuchiya et al., 2011). However, the effect of solar UV/EUV heating on the brightness distribution of JSR has not been confirmed. Hence, the purpose of this study is to confirm the solar UV/EUV heating effect on total flux density and brightness distribution simultaneously, so as to evaluate the B-M scenario. In order to accomplish this purpose, we have made radio imaging analysis using the National Radio Astronomy Observatory (NRAO) archived data with the Very Large Array (VLA) obtained for about 10 days from January to February, 2000. We derived the total flux density and the dawn-dusk peak emission ratio of JSR and examined their relationship to the variation of the solar UV/EUV flux. From the VLA data analysis, following results were shown.

1, Total flux density variations occurred corresponding to the solar UV/EUV variations.

2, The dawn side emission was brighter than dusk side emission almost every day.

3, Variations of the dawn-dusk asymmetry did not correspond to the solar UV/EUV variations.

When we see a dawn-dusk ratio at the long term view (a week order), the second result supports the B-M scenario. However, from the third result, the observed variation feature of the dawn-dusk ratio cannot be examined solely by the solar UV/EUV heating. There is a possibility that variations related to the solar UV/EUV were masked by some other processes which dominated in the variations of the dawn-dusk ratio on the short time scale (day-order).

In order to explain the general features of the dawn-dusk ratio (the second result), we estimate the diurnal wind velocity from the observed dawn-dusk ratio by using the model brightness distribution of JSR. We construct the equatorial brightness distribution model and obtain the relation between the dawn-dusk ratio and neutral wind velocity. Estimated neutral wind velocity is 46 +/- 11 m/s, which reasonably corresponds to the numerical simulation of Jupiter's upper atmosphere (Tao et al., 2009). In order to explain short term variations of the dawn-dusk ratio (the third result), we examined the effect of the global convection electric field driven by tailward outflow of plasma in Jupiter's magnetosphere. As the result, it is suggested that typical fluctuation of the convection electric field strength was enough to cause the observed variations of the dawn-dusk ratio. It is also confirmed that some magnetospheric plasma parameters indicated the existence of substorm like event during the observation period. Hence, these results imply that fluctuations of tailward outflow affect Jupiter's deep inner magnetosphere.

Reference

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