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Short-term variations in Jupiter's synchrotron radiation: Comparison between observations and numerical simulations

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Multi-frequency observations of Jupiter's synchrotron radiation (JSR) were made at 325 and 785 MHz by the Iitate plaentary radio telescope (IPRT) and 2.3 GHz by the 34-m radio telescope at NICT in 2007 and it is found that the flux density of JSR shows the short-term increase and subsequent decrease with a time scale of several days.

Comparison between the variation in JSR and the solar UV/EUV indices shows positive correlations, but the variations in JSR were preceded by those of the solar indices by several days.

A two-dimensional numerical simulation on the radial diffusion model has been made in order to examine the time variation in JSR quantitatively.

The model includes fundamental physical processes in the Jupiter's radiation belt such as the radial diffusion, energy degradation by the synchrotron radiation, and loss processes (sweeping effects by satellites and rings, wave-particle interaction, and coulomb interaction with thermal magnetosphetic electrons).

Two kind of diffusion model are considered: the nominal diffusion model in which the radial diffusion coefficient is adopted from Goertz et al. (1979) and a fast diffusion model where the diffusion coefficient is ten times greater than the nominal value.

First of all, we tried to find equilibrium solutions which were consistent with an empirical radiation belt model (Devine and Garrett 1983).

The factors in each loss rate were adjusted to bring the numerical results into correspondence with the empirical model.

From this, we found reasonable radial profiles which matched those of the empirical model at four electron energies of 1, 5, 10, and 20 MeV for both the nominal and fast diffusion models.

By using the equilibrium distribution as an initial condition, the time variation in JSR was investigated.

We examined a hypothesis that temporal changes in the radial diffusion rate associated with the solar UV/EUV heating in Jupiter' thermosphere could be an origin of the short-term variation.

It is found that the both models reproduced the increase in JSR but the nominal model did not account for the fast decrease seen by the observation.

In the case of the fast diffusion model, we found a suitable solution which accounted for not only the increase but the decrease and the time delay between the variations in JSR and the solar UV/EUV.

This suggest that the radial diffusion dominates the variablity in Jupiter's radiation belt and the diffusion rate is faster than it has previously been thought.