Resonator of Dispersive Alfven Waves in the Cusp Topside Ionosphere

Yumi Hirano[1], Hiroshi Fukunishi[2], Ryuho Kataoka[3], Tsutomu Nagatsuma[4]

[1] Department of Geophysics, Graduate School of Science, Tohoku Univ., [2] Department of Geophysics, Tohoku Univ., [3] Dep. of Geophysics, Tohoku Univ., [4] CRL

The dayside polar cusp is the open field line region of the Earth's magnetosphere, where the magnetosheath plasma penetrates down to the atmosphere. The cusp topside ionosphere is characterized by occurrences of localized, burst-like disturbances of electric and magnetic field and concurrent precipitation of ions with energy-time dispersion and low energy (less than a few hundred eV) electrons. Recently several researchers have proposed new generation mechanisms for the excitation of small-scale turbulences. One of these mechanisms is the ionospheric Alfven resonator (IAR) and the other is dispersive Alfven wave (DAW). However, past results are obtained from measurements of low-altitude (1500-4000 km) satellites such as Freja and FAST. The purpose of this thesis is to clarify the excitation mechanisms of burst-like disturbances in the dayside cusp region and its vicinity by analyzing electric and magnetic field data obtained from the Akebono satellite which covers a wide altitude range from 1500 to 8000 km.

During the period between 1991 and 1992, thirteen typical cusp events are selected and the electric and magnetic field data are analyzed in detail. In order to get evidence for the existence of IAR, the cross spectra between electric and magnetic field perturbations are calculated by the wavelet analysis. Then we calculated the phase relation between electric and magnetic perturbations above the 95% confidence level of cross power. The observed phase relation is compared with the theoretical phase relation given by the Lysak '91 model. Moreover the ratios of electric field to magnetic field perturbations are calculated to identify the existence of DAW, and are compared with theoretical values. The main results obtained by these analyses are summarized as follows.

1) For a high altitude (6000-8000 km) event on February 26, 1990 and a middle altitude (3000-5000 km) event on February 27, 1992, observed ratios of electric to magnetic field perturbations are found to be close to theoretical values calculated for DAW in the wide horizontal wavelength range 0.3-10 km. Furthermore the phase relation between electric and magnetic field perturbations is consistent with the phase relation of IAR given by the Lysak '91 model. These signatures of the coexistence of DAW and IAR are found in the frequency range of 1-3 Hz for the high altitude event and 1-4 Hz for the middle altitude event.

2) For the low altitude event (1500-2000 km) on March 26, 1992, observed ratios of electric and magnetic field perturbations are much lower than theoretical values for DAW. On the other hand, the phase relationship between electric and magnetic field perturbations is consistent with the phase relationship of IAR given by the Lysak '91 model. The case of low ratio is interpreted as follows. The theoretical values are calculated for plane waves propagating in one direction. In the ionospheric Alfven resonator region, however, downward and upward propagating waves interfere and resonant waves are produced. The ratios of the electric to magnetic perturbations of these resonant waves are expected to become small at low altitudes close to the ionosphere which is the lower boundary of IAR, since the electric field approaches zero at this boundary.

All these facts imply that DAW is excited and is coupled to IAR in the wide altitude range from 3500 to 8000 km of the cusp region.