太陽風動圧変動により駆動された中低緯度ULF波動の伝播特性

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Propagation of ULF waves into mid-latitudes ionosphere directly driven by solar wind dynamic pressure variations

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ULF waves such as Pc5 in the magnetosphere have been observed using many methods such as ground-based magnetometers, HF radars, and satellites. It is thought that these magnetospheric ULF waves are generated either directly on the dayside by solar wind dynamic pressure pulses and/or, Kelvin-Helmholtz surface waves, or indirectly on the nightside by mechanisms such as substorms. ULF waves can play an important role in mass and energy transport within the inner magnetosphere. It is well known that energetic particles in the inner magnetosphere can be significantly affected by ULF waves and many studies have suggested their importance in the acceleration of radiation belt electrons. One outstanding problem in ULF studies is to clarify their global characteristics, especially, how energy for the acceleration is transported from the solar wind to the magnetosphere, and finally to the ionosphere.

In this study, we report on ULF wave events observed globally in the magnetosphere down to 43 degrees MLAT, at mid-latitudes ionosphere, at about 14:40 and 15:30UT January 31, 2008. During the events, the solar wind had a low speed of 350 km/s, a high density of 30 /cc, and large fluctuations in dynamic pressure from 6 nPa to 10 nPa. In order to investigate propagation characteristics of the ULF waves based on multi-point observations from geospace to the ground, data obtained by multiple satellite observations (Cluster, GOES, and THEMIS), ground-based magnetometer observations (210 MM of nightside and GBO of dayside), and SuperDARN Hokkaido HF radar are used. The power spectra of ULF waves observed in the magnetosphere by the satellites are similar to those of dynamic pressure fluctuation in the magnetosheath. Time delay of ULF waves in the magnetosphere to the dynamic pressure fluctuation in the magnetosheath estimated through cross-correlation indicates that the ULF waves propagated from dayside to nightside, and propagation speed of about 400 and 1000 km/s estimated through this time delay of the arrival is consistent with the fast mode propagation. The global coherence of the power spectra and its similarity to the dynamic pressure fluctuation in the magsnetosheath indicate that the ULF waves are directly driven by solar wind dynamic pressure variations, because it is difficult to explain this similarity with the Kelvin-Helmholtz instability. In addition, we report a statistical analysis of ULF wave event observed by the SuperDARN Hokkaido HF radar in 2007. According to this analysis, this kind of large-amplitude ULF events under low-speed solar wind condition is not frequently seen and most of the ULF events at mid-latitude ionosphere correspond to the high-speed solar wind condition.