Modulation of chorus intensity and UHR frequency in the off equatorial regions observed by the Arase satellite.

*Yuri Ampuku[1], Fuminori Tsuchiya[1], Yasumasa Kasaba[1], Satoshi Kurita[2], Yoshiya Kasahara[3], Shoya Matsuda[4], Atsushi Kumamoto[5], Ayako Matsuoka[6]

1. Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University, 2. Research Institute for Sustainable Humanosphere, Kyoto University, 3. Graduate School of Natural Science and Technology, Kanazawa University, 4. Institute of Space and Astronautical Science, JAXA, 5. Graduate School of Science, Tohoku University, 6. Graduate School of Science, Kyoto University

The whistler mode chorus is a type of plasma wave generated near the geomagnetic equator by the wave-particle interactions. The chorus waves scatter the pitch angle of electrons by the wave-particle interactions, and the scattered electrons precipitate into the polar region and cause diffuse aurora. In particular, chorus waves which propagate to high latitudes could scatter the relativistic electrons, thus its propagation is of great importance for loss of radiation belt electrons and impact on the middle atmosphere. The mechanism of the chorus propagation from the source region at the equator to higher latitudes has not been clarified. However, the leading theory is chorus propagation along the duct (a field-aligned increase of the plasma density).

Plasma wave experiment (PWE) / Onboard frequency analyzer (OFA) on board Arase satellite observed modulations of chorus intensity which were correlated with variations in the UHR frequency with a period of a dozen seconds at geomagnetic latitude ~17° and Mallwain parameter L~6.0 at 00:06-00:10 UT, March 29, 2017. Interpretations of the phenomenon are as follows: (1) chorus propagating along the duct structure, (2)overlapping of another wave whose frequency is close to the UHR frequency, (3)electron density modulation caused by chorus. The simulation study reported (1) chorus propagation with duct structure (Hanzelka and Santolik, 2019). However, there is no report on observation of duct structure and the chorus propagating along the duct at off-equator. The case of (3) electron density modulation caused by chorus was reported by Nishimura et al. (2015).

In this study, we analyzed this plasma wave data at off-equator to consider whether the corresponding modulation of chorus intensity and UHR frequency could be explained by duct propagation. We assumed that Arase satellite crossed through ducts. We estimated the duct structure (width and relative density increase) from changes in UHR frequency and orbit data of Arase satellite. We identified UHR frequency by fitting the Gaussian function in the frequency direction to narrow band continuous emission observed by OFA with 1 s time resolution and calculated electron density by using magnetic field intensity observed by Magnetic Field Experiment (MGF). We obtain 20 examples of the presumed duct structure which correlated with chorus intensity modulation. Full width at half maximum of the duct structures and relative density increase in the center of the ducts are 5.9 km and 1.3 % (minimum), 17 km and 1.8 % (maximum), 10 km and 1.4 % (average), respectively. Hanzelka and Santolik (2019) simulated ducting chorus with various scales of duct and reported limits of the spatial scale and the relative density increase which were needed for ducting. Comparing our result with their simulation, the scale of density changes observed by Arase satellite was that the chorus could propagate up to geomagnetic latitude 45° or more at their propagation angle 15 degrees or loss.

We will investigate another possibility of (2) overlapping of other waves by using polarization information of the waves and look for similar events from the observation of the Arase satellite.

Reference:
Hanzelka, M., and Santolik, O. 2019, Geophysical Research Letters, 46, 5735– 5745. doi:10.1029/2019GL083115
Nishimura, Y. et al. 2015, Geophys. Res. Space Physics, 120, 7433– 7446, doi:10.1002/2015JA021330.

Keywords: whistler mode chorus, electron density, Arase satellite

