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Section 4. Whistlers and Related Phenomena

Routine observations of whistlers and VLF/ELF emissions have been continued by means of magnetic tape recording in two minutes every hour at our observatories, Moshiri(L=1.6) and Kagoshima(L=1.2). VLF/ELF emissions have been also observed, using valley antenna, and hiss type emissions are identified by means of hiss recorders.

Routine observations for locating the distant atmospherics sources by the triangulation network(Moshiri, Sakushima, Kagoshima) have been continued for one period of 15 h20-15 h25m JST since July 4, 1985.

In order to clarify experimentally propagation of LF whistler-mode waves in the low-latitude magnetosphere and to elucidate the interaction of the LF waves with energetic electrons in the inner zone radiation belt, conjugate measurements of LF Decca waves have been continued since 1984. In 1984, the conjugate measurements of Decca signals transmitted at 85.725 kHz from Biei(L=1.6), Japan were successfully made at the geomagnetic conjugate point of the transmitter, Birdsville, QLD, Australia.

In 1986, the vertical component of electric field was observed at 85.725 kHz to find the arrival direction(incidental and azimuthal angles), and the similar system to 1984 was adopted for the measurement of the LF Decca signals at 85.725, 114.300 and 128.588 kHz in order to investigate the frequency dependence of the whistler-mode propagation as well as on the interaction with energetic electrons.

In 1987, the conjugate measurements of Decca signals from Kyusyu(L=1.2) were made at Daly River, NT, Australia. Moreover, the reception of the whistler-mode waves of the Decca signals transmitted from Port Hedland(L=1.38), Australia has been carried out at Kagoshima since July, 1986, in order to investigate the seasonal variation of the whistler-mode propagation and wave amplification during geomagnetic disturbances.

On the other hand, for the conjugate measurements of the signals transmitted from an Alpha station in Eastern USSR, at Ceduna(L=1.93), SA, Australia in 1984, 2 channel(geomagnetic NS and EW) wide-band(10-

20 kHz) signals including the 3 VLF transmitter signals(14.881, 12.649, 11.905 kHz) were recorded in the form of pulse codes in a VTR during 1 minute every 10 minutes, along with natural VLF/ELF signals(1-8 kHz) and NWC waveguide-mode signals(22.3 kHz). In 1986, the vertical electric fields were recorded to detect the arrival direction of the whistler-mode signals, and the phase variation of the NWC signal was recorded to detect the enhanced ionization due to precipitating electrons induced by the wave-particle interactions.

Along with the above-mentioned conjugate measurements, we carried out the simultaneous observations of natural whistlers, VLF/ELF emissions and geomagnetic pulsations, and the locating of atmospherics sources by means of the triangulation network in the Japanese Islands. As a result, it is confirmed that whistler activities at a middle latitude(L=1.93) correlate strongly with atmospherics activities within the area 1500 km distant from the conjugate point, and correlate moderately with those within the area 3000 km distant from the conjugate point when one includes the propagation condition in the ionosphere and magnetosphere.

Based on the direction finding results of auroral VLF hiss at Syowa(geomag. lat. -70°), an extensive ray tracing analysis, and an estimation of transmission loss in the simulated auroral ionosphere, the propagation characteristics of ground-based auroral hiss in the magnetosphere and ionosphere are deduced; incoherent transmission of impulsive hiss with a wide frequency range($\lesssim$100 kHz) from localized exit regions at the ionospheric level almost coincident with some localized region of bright electron auroras; non-ducted propagation of continuous hiss with a narrow frequency range($\lesssim$20 kHz) after emerging from a duct exit at higher altitudes(3000-5000 km), and coherent transmission from an exit region at the ionospheric level between Syowa and the location of a quiet auroral arc appearing poleward far from Syowa. Coupled with previous spacebased observations and model calculations of the auroral hiss power flux spectrum, we see that impulsive hiss emissions generated in a wide range of higher to low altitudes by the beam amplification are trapped in irregularities of decreased electron density outside the auroral arc at lower altitudes, propagation down to the ionosphere and are transmitted to the ground, and that after emerging from a duct exit at altitudes of 3000-5000 km, continuous hiss emissions are propagated in a non-ducted mode down to the ionosphere at different latitudes, corresponding to the initial wave normals at the duct exit, and are transmitted to the ground.

The organization of our institute based on the rigid section system has yielded sectionalism and difficulties not to respond flexibly significant change of scientific objectives and projects. And the reconsideration of research objectives and the reorganization of the institute have been discussed. As a consequence, the present form of activity report which cannot reflect recent research activities should be final in this issue.

Finally, we inform you of the retirement of Professor A. Iwai on 31st March, who has been engaged in studies on direction findings of atmospherics and whistler propagation for a long term of 40 years, and was the Director of the institute for 12 years since 1975.

March 10, 1988
--Akira IWAI--
--Yoshihito TANAKA--

Publications (1986-1988)

Hayakawa, M., Y. Tanaka, K. Ohta, and T. Okada, Absolute intensity of daytime whistlers at low and middle latitudes and its latitudinal variation, **J, Geophys., 59,** 67-72, 1986.

Ohta, K., H. Eguchi, M. Hayakawa, and Y. Tanaka, An automatic measurement of the polarization of magnetospheric whistlers, **Trans. IECE, Japan, E69,** 515-517, 1986.

Okada, T., M. Hayakawa, Y. Tanaka, and A. Iwai, On the polarization error of VLF direction finding for close ionospheric exit points, **Trans. IECE, Japan, J69-B,** 535-540, (in Japanese) 1986.

Okada, T., I. Nagano, K. Hashimoto, I. Kimura, H. Oya, and A. Morioka, Design of a small loop antenna system for receiving waves in VLF and MF bands using a series-transformer network, **Trans. IEICE, Japan, E70,** 550-561, 1987.

Okada, T., and A. Iwai, Natural VLF Radio Waves, in press, Research Studies Press, UK, 1988.

Nishino, M., and E. Ungstrup, Nonlinear effect for the Omega signals in the auroral ionosphere by rocket observations, **Memo. Natl. Inst. Polar Res., Special Issue, 47,** 26-35, 1986.

Nishino, M., and Y. Tanaka, Observations of auroral LHR noise by the sounding rocket S-310JA-6, **Planet. Space Sci., 35,** 1, 127-136, 1987.

Nishino, M., Y. Tanaka, and Y. Katoh, Detection of the whistler-mode signals from VLF transmitter and their intensity characteristics, **Trans. IEICE, Japan, J70-B,** No.11, 1400-1406, (in Japanese) 1987.

Nishino, M., and Y. Tanaka, Mid-latitude whistler activities deduced from simultaneous observations of causative atmospherics and conjugate measurements of VLF transmitter signals, **Proc. Res. Inst. Atmospherics, Nagoya Univ., 35**, 25-38, 1988.

Shimakura, S., K. Ohta, M. Hayakawa, and Y. Tanaka, The relationship between the polarization of whistlers and their dispersion, **J. Geophys., 59,** 140-141, 1986.

Tanaka, Y., D. Lagoute, M. Hayakawa, F. Lefeuvre, and S. Tajima, Spectral broadening of VLF transmitter signals and sideband structure observed on Aureol 3 satellite at middle latitudes, **J. Geophys. Res. 92,** A7, 7551-7559, 1987.

Tanaka, Y., M. Nishino, and M. Hayakawa, Conjugate measurements of VLF transmitter signals at middle latitude(L=1.93), **Planet. Space Sci., 35,** 8, 1053-1059, 1987.

Tanaka, Y., and M. Nishino, The propagation of auroral hiss observed on the ground as deduced from direction finding measurements, **Planet. Space Sci.,** in press, 1988.

Yumoto, K., T. Saito, and Y. Tanaka, Pc-3 magnetic pulsations observed at low latitudes:a possible model, **Memo. Natl. Inst. Polar Res., Special Issue, 47,** 139-147, 1987.