First report of multipoint observation to study the propagation mechanism of natural VLF waves in Antarctica

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In order to estimate the dynamic structure of the ionospheric exit points of natural VLF whistler-mode waves such as polar chorus, we have set up a low-power magnetic flux observation system at unmanned three sites [West Ongul (69.0 degrees latitude South, 39.5 degrees longitude East), Skallen (69.7 degrees latitude South, 39.4 degrees longitude East), and H100 (69.3 degrees latitude South, 41.3 degrees longitude East)] in Antarctica, which are located at the tips of a triangle of about 80 km.

The polar chorus of magnetospheric origin can propagate along the geomagnetic field lines (ducts) or by ray theory (non-ducts), penetrate in the ionosphere, and be observed on the ground. The intensity and polarization distributions on the ground of down-going whistler-mode waves strongly depend on the locations of their ionospheric exit points. Down-going whistler-mode waves entering the earth-ionosphere waveguide above an observation site will generally appear to be right-hand polarization. At a distant observation site, the wave will appear as linear or left-hand polarization. Therefore, the ionospheric exit point and its spatial extent can be determined by the ground-based observations of VLF waves at multiple sites.

We have developed a new observation system with maintenance free and possible remote control of observation mode at an unmanned site. This system has three VLF magnetic flux receivers installed at the three sites. Each receiver consists of two crossed vertical loop antennas to pick up NS and EW magnetic components and a multi-channel analyzer which measures continuously [with the time resolutions of 0.5 second at West Ongul, and 6 seconds at Skallen and H100] the mean power and phase difference of NS and EW components in 4 spaced frequency bands (500, 1 k, 2 k, and 6 kHz). The observational data at Skallen and H100 sites located distant from SYOWA station are transmitted to Kanazawa University, Japan, almost in real time by using the IRIDIUM communication system. The time accuracy among three sites is kept by GPS. Each receiver has four temperature sensors for house keeping, and has a 512-MBytes flush memory for observational data backup. The power consumption of each system is less than 1 watt, which is supplied with four batteries (each battery has 12 V/100 Ah) charged by a solar panel.

Three sets of receivers were successfully installed in December 2005 and January 2006. Since then our multipoint unmanned observation of natural VLF waves is stably running. In the presentation, we will report the initial VLF observation data in Antarctica.