Progress report on the imaging receiver system at the SuperDARN Hokkaido East radar (2023)

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Super Dural Auroral Radar Network (SuperDARN) is a network of High-Frequency (HF) radars deployed to monitor ionosphere dynamics. More than 35 SuperDARN radars are in both hemispheres, covering the polar cap, auroral, sub-auroral, and mid-latitude regions.

Typical SuperDARN operation mode is the normalscan program, which scans the whole radar field of view every 1 to 2 minutes. Traditional SuperDARN radars generally have one receiver channel (scanning one beam direction simultaneously). Therefore the typical Nyquist frequency of the traditional normalscan SuperDARN radar data is 4 to 8 mHz. This temporal resolution is unsuitable for dealing with short-term variations such as Pi2 / Pc3 pulsations and coseismic ionospheric disturbances.

A plan to implement an imaging receiver system on the SuperDARN Hokkaido East radar, one of the mid-latitude SuperDARN radars, was presented two years ago in this symposium. This time, the latest progress report of this system will be introduced. This system utilizes the USRP SDR unit, which has been used in the remote receiver of the SuperDARN Hokkaido East radar signal in Nagoya (Nishitani et al., 2021). We already manufactured the 4-channel subset prototype system (out of the 20-channel system) and successfully tested it on the radar site in July 2020. We have been developing a 20-channel full-spec system. Figure 1 shows the devices now under development and testing. In addition, in February 2023, we invited a few scientists and technical staff from the University of Saskatchewan group, which developed a Borealis imaging system for the high-latitude SuperDARN radars, to Nagoya University and discussed the designing of the system and possible scientific objectives.

With the new imaging receiver system, we expect to obtain the data with a temporal and spatial resolution a few times higher than the existing system. We can study various scientific phenomena, such as (a) ULF waves with a period shorter than 1 minute (e.g., Pi2 / Pc3). (b) Transient responses excited by external (IMF / solar wind) and internal (e.g., substorm expansion onsets) environmental changes in the ionosphere and magnetosphere. (c) Traveling Ionospheric Disturbances triggered by sudden changes on the earth's surface, such as earthquakes and volcano eruptions. Details of the latest progress report of the imaging receiver system will be presented.

Figure 1. Photo of the main amplifier (left) head amplifier (right) for the 20-channel imaging receiver system, now under development and to be installed at the SuperDARN Hokkaido East radar site.

References

Nishitani, N., Y. Hamaguchi, and T. Hori, Development of remote HF wave receiver in the backlobe direction of the SuperDARN Hokkaido East radar: Initial observations, Polar Sci., https://doi.org/10.1016/j.polar.2021.100669, 2021.