SuperDARN 昭和 SENSU レーダーの高時間・空間分解能観測の現状と将来展望

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SuperDARN Syowa SENSU high temporal and spatial resolution technique: current status and the future perspective

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SENSU Syowa HF radars are important elements of SuperDARN (Super Dual Auroral Radar Network) and have significantly contributed to understanding not only magnetosphere - ionosphere physics and couplings but also MLT region dynamics. As SuperDARN radars were originally designed to reveal dynamics of global polar plasma convection patterns obtained in both hemispheres in real time, its temporal and spatial resolution has been relatively low. As the number of new scientific targets like comparison with meso- and small scale auroral phenomena and fine height profile of neutral wind distributions have been increasing, higher spatial and temporal resolution observations have been essentially desired.

To overcome these issues, we have tried to develop several new observational techniques. The most important technique is a raw I/Q time series analysis method which extracts unevenly sampled raw I/Q data that are not affected much by cross-range interference (CRI) and makes raw I/Q time series data almost purely obtained at each range of interest. If the echo power, i.e., S/N ratio is enough high, such data can be directly used for data analysis without integration (and of course we can also integrate them if required). This powerful method can be applied to many scientific issues. One of them is to investigate physical mechanisms of generation and decay processes of artificially induced field aligned irregularities (FAIs) to use heater echo data with very high temporal resolution (<0.1sec). Another highlighted application of this technique is to extract only underdense meteor echoes and to deduce accurate line-of-sight neutral wind velocity and echo height. Though it was very difficult to deduce scientifically important height information of neutral wind from conventional ACF data, it became possible with this new technique and the altitude resolution can even be improved with additional techniques like over-sampling and frequency domain interferometery (FDI) method. This technique can also be applied to detailed studies of natural transient phenomena like FTEs and TCVs.

Another newly developed technique is a new "Quick Scan" mode that switches beams every time after each pulse sequence so that high temporal resolution 2-D data can be obtained if echo power is enough high. This simple technique is useful, e.g., to investigate highly variable temporal evolution of 2-D fine structured electric field over transient aurora like break-up aurora and pulsating aurora.

Another important technique is spatial domain interferometry (SDI), namely, imaging radar technique to obtain much higher spatial resolution over azimuthal direction. To add FDI or pulse coding capabilities to obtain higher spatial resolution over radial direction, SuperDARN radars could have much higher 3-D spatial resolution.

SuperDARN has expanded its unique capability to study global and meso- and micro-scale upper atmospheric phenomena in a wider range of temporal scales from a few seconds. We try to summarize the scientific results using these new capability and its contribution to various research areas from SuperDARN studies, and discuss the unanswered scientific questions and the future prospects of scientific targets.