Expanding Capabilities of Super Dual Auroral Radar Network in Monitoring Space Weather at High Latitudes

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1. Extended abstract.

Super Dual Auroral Radar Network (SuperDARN) covering polar to mid-latitude regions in both Northern and Southern hemispheres has been successfully used for studying Space Weather effects in high-latitude ionospheric plasma for more than two decades. The major information parameter provided by these high-frequency (HF, 10-15 MHz) installations represents Doppler frequency shift of the signals scattered by small-scale (10-15 m) ionospheric irregularities. Combining measurements from multiple radars allows to recover ionospheric plasma circulation patterns at high latitudes, which are then used to map ionospheric electric filed over polar regions. While these maps contain very important information about Solar Wind – Magnetosphere – Ionosphere interactions, currently the diagnostic capabilities of SuperDARN are not exploited to their full extent yet.

One of the most important omissions is the vertical angle-of-arrival (elevation) of the HF returns which could provide an unambiguous identification of propagation modes (e.g. ionospheric and ground scatter, E and F region backscatter, etc.). In order to enable elevation measurements, a typical SuperDARN installation is equipped with a secondary (interferometer) array so that elevation can be derived from the phase shift with respect to the main antenna. However, until recently this parameter has been rarely used due to the intrinsic complexity of the phase calibration and an apparently unphysical elevation values for some of the echo populations. This situation has changed within the last few years when the SuperDARN group at the University of Saskatchewan has invested significant time and effort in understanding details of ionospheric HF interferometry. The obtained expertise allowed us to resolve the above problems with data interpretation and to design an effective data-based phase calibration technique which does not even require accessing the respective hardware [1]. Besides improving identification of the modal structure of the radar echoes, this provided an opportunity for estimating the background plasma density [2]. This new information parameter can potentially turn SuperDARN into a network of oblique ionosondes covering areas of the high-latitude ionosphere inaccessible for regular monitoring by other existing instrumentation.

In a parallel development, the whole set of data analysis procedures has been critically reassessed in order to implement algorithms optimally adjusted to SuperDARN's specifics, and a new software package is about to be released to the users. Major changes were made in order to account accurately for statistical fluctuations and background noise. Compared to the previous software, these modifications led to a significant increase in the amount of reliable information extracted from a typical data record. The users will also be provided with more accurate estimates of the measurement errors. In addition to the software changes, we designed and implemented a new common operational regime utilising two emission frequencies and thus filling gaps in range coverage occurring due to the multi-hop nature of ionospheric HF propagation.

2. References

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2. P.V. Ponomarenko, A. V. Koustov, J.-P. St. Maurice, and J. Wiid, "Monitoring the F-region peak electron density using HF backscatter interferometry", *Geophys. Res. Lett.*, **38**, L21102, November 2011, doi:10.1029/2011GL049675.