Advanced meteor echo observations using SuperDARN radars

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There are nearly 20 SuperDARN HF radars deployed surrounding the Arctic and Antarctic regions. Those radars employ an auto-correlation function (ACF) method to obtain Doppler information from F- and E-regions in spite of the fact that received signals are mostly coherent field aligned irregularity (FAI) echoes.
An ACF technique is used because the radars are specially designed to detect signals over 3000 km away from the radar site for the study of horizontal plasma convection pattern. On the other hand recent studies found that the radar data also contain non-FAI echoes such as meteor echoes and polar mesospheric summer echoes (PMSEs), showing the great potential of the SuperDARN radars for the study of mesosphere and lower thermosphere (MLT) [e.g., Hall et al, JGR, 1997; Ogawa et al, GRL, 2002]. For the analyses of these echoes, however, time series is more preferable than ACF data. There are also needs for time series analyses from ionospheric studies on physical mechanisms of a variety of Doppler spectral properties in various geophysical regions.

We therefore have developed a new raw time series analysis method (of all the receiver I/Q signals), but without changing the normal SuperDARN ACF pulse sequence. This was successfully achieved because one multi-pulse sequence (currently 7 pulses) is about 100 msec long, which can be regarded as unevenly spaced 'single pulse' operation for targets at relatively close to the radar such as meteor trails. Echoes overlapped by strong range aliasing echoes should be carefully removed before further analyses. We installed this new code at the SENSU Syowa SuperDARN radars in Antarctica in October 2001.This new technique was first applied to SuperDARN meteor wind measurements. The unevenly sampled raw time series is processed to detect only underdense meteor echoes to deduce line-of-sight neutral wind velocities and decay time constants. The decay constants are further used as height information [Yukimatu and Tsutsumi, GRL, 2002]. Applying the new method to all the SuperDARN radars will provide a unique longitudinally extended meteor radar network at high latitudes in both hemispheres, which can effectively contribute to MLT region dynamics.