SuperDARN raw time series analysis of ionospheric cusp and artificial irregularities

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SuperDARN Doppler spectral analysis using unevenly spaced multipulse technique and the fitted physical parameters (echo power, line-of-sight Doppler velocity and Doppler spectral width, etc.) from the vast fields of view over polar regions in both hemispheres have provided us with abundant (large- and meso-scale) geophysical information to a wide geophysical research targets. However, more detailed physical information (than ACFs and fitted physical parameters averaged over each beam integration time (typically several seconds)) is sometimes desired in order to fully understand micro-scale physical processes, to validate theoratical explanations of a variety of phenomena, and to try to deduce new physical parameters, etc. Therefore, we have developed a new raw time series analysis method (of all the receiver I/Q signals) without degrading normal SuperDARN ACF observations in order to investigate other physical processes that condition the averaged ACFs. 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 to extract only underdense meteor echoes and to extract new physical parameters in success [Yukimatu and Tsutsumi, GRL, 2002].

We can further obtain temporal variation of ACFs and dynamic (moving) Doppler spectra during each beam integration time from all the raw I/Q samples. These new methods can also be applied to other atmospheric physics issues, e.g., polar mesospheric summer echoes (PMSEs) recently detected by SENSU SuperDARN Syowa radars [Ogawa et al., GRL, 2002], and also to ionospheric studies on physical mechanisms of a wide variety of Doppler spectral properties in various geophysical regions, e.g., on physical mechanism of broad Doppler spectra in the cusp region and of double-peaked spectra in outer LLBL region,

and on micro-scale physical processes in transient phenomena such as FTEs and TCVs, in order to shed light on real but hidden physical processes behind ACFs.

We have tried to analyse cusp FAI echoes using this new technique obtained with SENSU SuperDARN radars at Syowa, Antarctica, in order to investigate the cause of the broad Doppler spectral width and the existence of any phenomena related to any Pc1-like pulsation activities and FTE phenomena etc. We'll also present raw time series echo data from artifically induced FAI produced by EISCAT Tromso heater obtained by CUTLASS SuperDARN radars. High time resolution (more than 10 Hz) raw time series data provide us the details of temporal and spatial developments of the FAI echoes at hear on/off timing. Detailed physical mechanisms will be discussed.