Wavelet denoising technique for 2.5 MHz Partial reflection radar at Trivandrum((8.5^{0}N, 77^{0}E)

Karanam Kishore Kumar

Space Physics Laboratory, Vikram Sarabhai Space Centre, Trivandrum 695022, India.

Abstract

Partial reflection radars operating at MF have been used for measuring atmospheric winds in the 60-100km regions. For the past five decades these systems have been placed at a high pedestal in the field of radio science for their unique technique for probing the middle atmosphere. Basically, these systems makes use of Fresnel or partial reflections caused by horizontally stratified regions of refractive index irregularities. When these irregularities are illuminated with suitable radio wave, it is possible to get the backscatter from this medium. It is well established that these backscattering signals form a diffraction pattern on the ground. If this diffraction pattern is sufficient sampled at the ground one can in principle draw some inference about the scattering medium. The diffraction pattern should be sampled at least by three receivers at the ground to infer any useful information. There are well-established techniques to analyze the diffraction pattern viz., full correlation analysis, full spectral analysis and structure functions etc.

Recently, as a off-shoot of Indian middle atmosphere dynamics programme, a powerful sate of the art partial reflection radar has been developed at space physics laboratory to explore the middle atmosphere. In the first phase of radar operation, it has been noticed that some of the useful weak signals are overwhelmed by the noise and it is often difficult to extract useful information from these signals. In this regard, a wavelet denoising algorithm is developed by using the Matlab wavelet functions. The received complex signals from various altitudes are separated into details and approximations. By examining these separated signals only useful information are added together to reconstruct the original signal. Often the high frequency noise is removed readily from the signal by this technique. However, it is very important to characterize the noise before it can be removed from the signal and efforts are under way to precisely identify the noise both from the ambient atmosphere as well as by the radar system. Signal to noise ratio of denoised signal do show improvement after processing. Efforts are also underway to construct an application specific mother wavelet for the present purpose. The present study aims at discussing the various aspects involved in wavelet denoising technique and to show its applicability for partial reflection radar signal processing.