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Adaptive Harmonic Wavelet Transform based Method for Intermittent Clutter Suppression in L-band Radar Wind Profiler

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The boundary layer radar wind profilers (L-band) frequently encounter a significant problem from the contamination of intermittent clutter, that produced by seasonal and nocturnal migrating birds. The clutter often yields erroneous wind velocity and boundary layer information. Therefore, it is mandatory to remove the contamination from the radar data before wind velocity estimation. Fourier transforms are localized in the frequency domain only and not in the time domain. Thus, they are not suitable to describe transient signal characteristics. Hence, it is necessary to remove the bird migration effects prior to the spectral estimation. Bird clutter removal from time series (raw) data is more effective than the frequency domain. Wavelet transforms (WT) are highly localized in both time and frequency domain; and therefore WTs can effectively describe the characteristics of the transient signals. Thus, WTs are efficient at distinguishing/eliminating the clutter contamination from the time series data.

The classical harmonic discrete wavelet transform (HWT) based method was first explored by Jordan et al. [1] to remove the bird contamination from radar data. However, while the HWT is able to distinguish the bird clutter when it is weak, this method is inadequate when the bird contamination is strong or dense, due to the poor time localization property of HWT. This limitation can be overcome by adaptive complex harmonic discrete wavelet transform (AHWT), which provides good time and frequency localization. In this study, we implement an AHWT with an advanced statistical method to overcome the shortcomings of the HWT. AHWT is typically a multilevel of HWT procedure. The level of AHWT is identified based on strength of the bird contamination. The strength of the bird contamination (whether to increase the level or not) is identified based on the histogram of HWT coefficients. The strong bird migration can produce a large variance in histogram coefficients (HC) and a statistical criterion used to describe its contamination. The AHWT based method includes several processing techniques: i) The db20 wavelets used to remove the ground clutter, ii) AHWT employed to classify the bird clutter from the radar data, following a statistical approach used to detect and filter the bird contamination. Finally, a multiple peak picking algorithm has been added to select true atmospheric signals and to estimate accurate moments. We compared the present method with the conventional (CN) and intermittent clutter removal algorithm (ICRA) methods. The RCSNR, spectral width, and horizontal winds were computed from the data filtered by CN, ICRA and AHWT methods for the comparison. The comparison results showed that the AHWT method more effectively removes the bird contamination compared to CN and ICRA.

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Reference

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