Improved Spectrum Width Estimators for Doppler Weather Radars

David Warde
CIMMS, University of Oklahoma and NOAA/OAR/NSSL, USA
Torres, Sebastian (CIMMS, University of Oklahoma and NOAA/OAR/NSSL, USA)

E-mail: david.a.warde@noaa.gov

On Doppler weather radars, the spectrum width is commonly estimated from a ratio of autocorrelation estimates at two different lags. These estimators, referred to as pulse-pair processing (PPP), perform better and are computationally less expensive than frequency-domain estimators based on the Doppler spectrum. PPP estimators have been used for decades on operational weather radars and have well known properties. For example, out of all PPP estimators, the R0/R1 estimator, which is based on the ratio of lag-0 to lag-1 autocorrelations, performs the best for wide spectrum widths but has poor performance for narrow spectrum widths and relies on accurate noise measurements. The R1/R2, which is based on the ratio of lag-1 to lag-2 autocorrelations, and other estimators based on higher-lag autocorrelations provide better narrow spectrum-width estimates than the R0/R1 estimator and improved performance when accurate noise measurements are not available; but, they are severely biased for wide spectrum widths. Thus, to provide better estimates over a wide range of spectrum widths, a few PPP estimators can be suitably combined. This so-called hybrid spectrum-width estimator can take advantage of the best characteristics of each estimator for different regimes. However, the performance of all PPP estimators degrades when the number of samples is small. This degradation is evident as a higher number of invalid estimates (negative spectrum widths) and increased biases and variances for narrow spectrum widths. In this work, we propose a new class of PPP spectrum-width estimators that are based on “matched” autocorrelation ratios. Autocorrelation estimators are said to be “matched” if they use the time-series samples in the same manner. When compared to conventional PPP estimators, the proposed estimators exhibit improved performance for small numbers of samples. This is quantified and illustrated using simulations and real data collected with operational WSR-88D radars.