ESTIMATION OF METEOR RADAR PARAMETERS

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Low power all-sky meteor radar systems provide a method for estimating the neutral horizontal wind field and possibly the temperature field. Accurate determination of the horizontal wind field depends upon the estimation of the received Doppler frequency while temperature measurements are dependent upon estimation of the damping coefficient. Typically only underdense meteor echoes are used for wind determination and these signals can be accurately modeled as a single complex damped sinusoid in additive white Gaussian noise. This damped sinusoid can be represented using four parameters. These are frequency, damping rate, amplitude and phase. Once the frequency and damping rate of the signal have been estimated the amplitude and phase can be estimated using standard least squares techniques. While meteor radars have been utilized to determine the horizontal wind field for many years, little work has been presented regarding the parameter estimation techniques that have been utilized. One basic technique that has been historically used is to fit the complex phase of the signal to a linear model and the power of the signal to an exponential model using a least squares technique. A second method is maximum likelihood technique that utilizes a fast fourier transform (FFT). We will compare these estimators with a global search method, fast maximum likelihood (FML), a generalized version of Rifes estimator and an FFT augmented with a Newton-Raphson search. The results for both the estimator of frequency and damping coefficient will be compared with the Cramer-Rao lower bound (CRLB), a measure of the minimum variance that an unbiased estimator can obtain. Our results show that all of the estimators except the linear phase estimator achieve the CRLB for high signal to noise ratios. However the performance is variable for moderate signal to noise ratios and all of estimators diverge from the CRLB for signal to noise ratios below 0dB. Given our results we can choose the lowest variance and hence best estimator for Doppler frequency and damping coefficient. Additionally, as we have determined the statistical performance of the estimators we can determine a confidence estimate for every determination of Doppler frequency and damping coefficient. Accurate knowledge of confidence intervals associated with the estimated parameters will help to separate the natural atmospheric variability in the measurements from inherent instrumental variability.

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