8.6C PARAMETERIZATION OF SPECTRUM

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Typical of many radars used for wind sounding, the Poker Flat, Alaska, radar generates Doppler power spectra as output. For compact data archiving purposes, as well as for data analysis, it is desirable to produce a few parameters to characterize each spectrum. The parameters chosen are noise level, echo signal strength, velocity and width. Both because this is an experimental radar and because the derived parameters may be the only quantities available for future analysis, it is important that the parameters do not contain biases imposed by the derivation techniques. This consideration has led to a processing scheme in which the parameters are derived independently for each spectrum.

The parameterization scheme adopted for use at Poker Flat (D. A. Carter, NOAA) commences with a noise level determination based on the HILDEBRAND and SEKHON (1974) method. The Hildebrand and Sekhon method utilized the expected relationship between mean and variance for the spectrum of white noise source. In the Carter implementation the quantity

$$R_n = \{\sum^{n} {S_i}^2 - \frac{1}{n}(\sum^{n} S_i)^2\} \,/\, \{\frac{1}{n}(\sum^{n} S_i)^2 \cdot \frac{1}{M}\} \qquad (1)$$

(where the S_i, i = 1, n, are the n lowest values of all the spectral points evaluated and M is the number of independent transforms used to generate the spectrum) is evaluated over all values of n. The noise level is chosen to be the mean value of the N lowest points for which $R_n > 1$ for all $n > N$. Although Hildebrand and Sekhon developed this objective method for determination of noise levels on spectra with many hundreds of points, this implementation has been found to work surprisingly well on spectra with as few as 32 points.

Once the noise level has been determined, the normal method used to identify the signal is to look for the largest value in the spectrum and assign to the echo all those contiguous points with values that are above the noise level and include the peak. The zeroth, first and second moments of the components of the selected points above the noise level are taken to be the signal strength, velocity and half-width parameters characterizing this spectrum. Over an ensemble average these parameters are unbiased. However, for an echo whose width is comparable to the spacing between points, or whose power is comparable with the noise power fluctuations, the strength and width are underestimated and the velocity is biased towards the nearest spectral point.

The parameterization above is maximally unbiased by considerations of past values, expected echo profiles or other expectations. However, in our subsequent analysis the spectral parameters are routinely checked against expectations and past values in order to cull out erroneous data. It is found that this post-parameterization selection process is usually effective.

However, we have experienced a class of interference that puts a false echo on the spectrum. Typically, this false echo increases slowly in strength and then weakens. This causes the derived velocity to slowly transfer from the true echo velocity to the false one and back. Under these circumstances the post-parameterization selection processes often fail. We are experimenting with another method of signal selection to eliminate this problem. The newer method uses expectations of the genuine echo shape. In particular, the method makes use of the fact that genuine echoes are generally compact and without extreme multiple peaks. The technique initially selects as potential echoes those regions between minima in the spectrum. Adjacent regions are then examined and are combined only if the minimum between them is significantly above the noise when compared with the peak values in each region. This process often separates genuine and false echoes when the earlier method would have combined them. Although it is still possible to "lock-on" to the false echo the transition from true to false echo selection is likely to be abrupt and hence more obvious to the post-parameterization selection criteria. Further investigation of this process is in progress.

REFERENCE

Hildebrand, P. H. and R. S. Sekhon (1974), Objective determination of the noise level in Doppler spectra, J. Appl. Meteorol., 13, 808-811.