2.4B DISCRIMINATION AGAINST INTERFERING SIGNALS AT THE POKER FLAT MST RADAR

D. A. Carter

Aeronomy Laboratory
National Oceanic and Atmospheric Administration
Boulder, Colorado 80303

At the Poker Flat, Alaska, MST radar several on-line and off-line data processing techniques are used to remove interfering signals due to ground clutter, aircraft, instrumental effects, and external transmissions from the desired atmospheric echoes. The on-line, real-time techniques are necessarily simple in order to minimize processing delays, but can be of great value in improving the data operated on by the more extensive off-line, post-processing algorithms.

At Poker Flat the return from ground clutter has a very narrow spectral width. Even at the finest radial velocity spectral resolution (down to 30 cm/sec or .01 Hz) the ground return is entirely at the dc frequency point and can be filtered out by simply subtracting the mean from the time series. A more significant problem with ground returns is the large dc offset which appears on the receiver outputs. The ground return at Poker Flat actually overdrives the receiver in the first 2-3 km. The dc offset greatly increases the dynamic range needed in the ADCs to sample the atmospheric signal. In order to detect the weakest signals, the receiver output level must be large enough so that the rms noise level occupies more than one resolution bit level of the ADC and the maximum signal must be less than the full-scale range of the ADC. In order to improve the low-altitude response of the radar, the dynamic range of the receiver would have to be improved and, if the ground return signal exceeds the ADC range, higher resolution ADCs or range-variable attenuators may need to be considered.

Both the Poker Flat and Platteville MST radars have used a very simple online scheme for detecting short-lived contamination such as airplanes. This algorithm examines the individual Doppler spectra which are computed every 2-4 seconds (for oblique antenna beams) rather than the spectral averages which are written to magnetic tape every 1-3 minutes. The total spectral power in each individual spectrum is computed by summing all the spectral points. If this integrated power increases from one spectrum to the next by a factor greater than a pre-selected threshold, then that spectrum is not added to the spectral sum. Succeeding spectra are compared to the last acceptable spectrum. Only a certain maximum number of spectra are allowed to be rejected in succession.

This algorithm seems to work quite well. The tropospheric and stratospheric atmospheric echo power changes rather slowly on a time scale of a few seconds. By using selection criteria on individual spectra every few seconds rather than on averaged spectra every few minutes, short-term interference, such as an airplane, is easier to detect and less data are lost. This is most helpful when high time resolution data are required. The above technique is no longer being used at the Platteville radar. The primary aim of that radar at present is to obtain long-term wind profiles. A sample random consensus technique is used on mean Doppler shifts obtained every few minutes to calculate an hourly mean velocity (see Strauch, this volume, p. 528). The consensus algorithm selects the largest subset of data values which fall within a specified range of each other. This algorithm could also be applied to the unaveraged velocities and signal-to-noise ratios.

At Poker Flat it is possible to use echoes from meteor trails to obtain wind estimates at heights and times when turbulence echoes may not be present. Each meteor echo lasts for only a few seconds and because of the narrow radar beam, only a few echoes occur per hour. These short-lived echoes are therefore greatly smoothed over when spectra are averaged for several minutes. The detection rate of these echoes would be significantly improved by applying the above short-term "interference" detection algorithm to segregate the meteor echoes from the longer-averaged turbulence echoes.

Several off-line processing techniques are applied to the spectral averages recorded at Poker Flat on magnetic tape. Most of these algorithms have been developed and refined by Anthony Riddle of CIRES.

Only spectra whose signal-to-noise ratios exceed a given threshold are considered significant and used in the succeeding analysis. The time series of both signal-to-noise ratio and mean Doppler velocity at each height are examined for values which deviate beyond a certain limit from a running mean of previous values. Occurrences of external RF interference can also be detected by discarding the spectra at all ranges if the number of ranges with significant echoes increases suddenly or if echoes appear in a group of range gates near 40-km height, where no turbulence echoes are expected to be seen with the current radar configuration. Another type of spectral interference whose source appears to be equipmental occurs in the first few range gates where extraneous spikes often appear in the Doppler spectra. The true signal is extracted by examining the shape of the spectrum and the location of the spikes (see Riddle, this volume, p. 546).

In summary, we have found that by using all of these techniques in combination, good success at removing interference can be achieved.