Effect of Filtering the Drift Records on the Drift Parameters Obtained by the Full Correlation Method

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Fading records obtained by the close-spaced receiver method are treated with low-pass filters of different cut-off frequencies and the effect of filtering on the drift parameters obtained by the full correlation method of analysis (FCA) is discussed. It is shown that the ground diffraction pattern observed by the close-spaced receiver method could be an aggregate of simpler patterns, possessing different characteristics.

1 Introduction

The full correlation method (FCA) of analyzing drift records obtained by the close-spaced receiver method assumes that, during the period of observation, the irregularities observed belong to a single class that can be described statistically by a set of structure and movement parameters. If more than one class of irregularities are present, the FCA method might be expected to give values for the parameters that correspond to weighted means of the individual diffraction patterns produced by the different classes of irregularities. To explain certain observed results it is sometimes suggested that irregularities with different structure sizes move with different velocities.\(^1\) Also, evidence is available from earlier investigations at this station\(^2\) and elsewhere\(^3\) that the true drift velocity, \(V_d\), and the structure size \(\alpha\) increase towards a limiting value when the size of the receiving triangle is progressively increased. Since a smaller receiving triangle is expected to be less sensitive to larger structures, the above results are consistent with each other.

Chandra and Briggs\(^4\) and Chandra\(^5\) to \(^10\) have argued that too low a separation of the receiving aerials makes the correlation values very high and instrumental limitations will underestimate the correlation function. This would result in an underestimation of the scale size and true drift velocity, \(V_d\). The problem can be looked at from another angle, if we try to see whether the observed triangle size effect could also result from the violation of one of the basic assumptions of the FCA method, viz. the ground diffraction pattern is produced by a single class of moving irregularities.

2 Analysis

The method adopted here is to numerically filter the drift data with a low-pass filter before subjecting them to FCA. If the ground diffraction pattern is an aggregate of several component patterns and if it is assumed that the FCA method gives a weighted mean of the structure size and mean speed of the component patterns, filtering the data is equivalent to reducing the effect of smaller structures on the estimates of drift obtained by the FCA. The filtered data should yield estimates of drift and structure size that correspond to irregularities of larger structure sizes.

In all, 40 drift records belonging to E-region are analyzed by the FCA method. The drift records are then filtered with a low-pass filter by taking a moving average of the signal amplitudes. The moving average is taken for 8, 16 and 24 successive values of the amplitude for the three low-pass filters respectively. The sampling interval being 0.24 sec, these filters designated as LP1, LP2 and LP3 would correspond to cut-off periods of 1.92, 3.84 and 5.76 sec. respectively. These cut-off periods correspond to structure sizes of 76.8-192 m, 153.3-384 m and 230.4-576 m respectively, assuming E-region drift speeds to be 20-50 m/sec. These filters are chosen in view of the usually observed values of 100-300 m for the structure sizes of ionospheric irregularities.

3 Results and Discussion

The results for the apparent velocity, \(V_a\), the true drift velocity, \(V_d\) and the structure size, \(\alpha\), are shown in Figs. 1-3 respectively, for the four cases, namely, (i) the unfiltered data and the data using (ii) LP1 (iii) LP2 and (iv) LP3 separately. The statistics of these results are summarized in Table 1.
Table I—Statistics for the Apparent Velocity ($V_a$), True Drift Velocity ($V_d$) and Structure Size ($a$)

<table>
<thead>
<tr>
<th>Filter</th>
<th>Apparent velocity ($V_a$)</th>
<th>True drift velocity ($V_d$)</th>
<th>Structure size ($a$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean m/sec</td>
<td>Mode m/sec</td>
<td>Median m/sec</td>
</tr>
<tr>
<td>Unfiltered data</td>
<td>159</td>
<td>149</td>
<td>153</td>
</tr>
<tr>
<td>LP1</td>
<td>181</td>
<td>187</td>
<td>188</td>
</tr>
<tr>
<td>LP2</td>
<td>286</td>
<td>276</td>
<td>282</td>
</tr>
<tr>
<td>LP3</td>
<td>221</td>
<td>201</td>
<td>225</td>
</tr>
</tbody>
</table>

Table I shows that $V_a$ increases with the cut-off period of the filter and approaches a limiting value, though this trend is not systematically noticed when the data is filtered using LP3. It is quite probable that when LP3 is used, all the genuine components in the ground diffraction pattern have been filtered out. Table I shows that $V_d$ also increases with the cut-off period of the filter and approaches a limiting value. The same is also true of the structure size, $a$.

Since a smaller receiving triangle is less sensitive to larger structures and increasing the cut-off period of the low-pass filter is equivalent to progressively eliminating the effect of smaller structures, the results of the present study regarding the 'triangle size effect' indicate that whenever the ground pattern is an aggregate of several patterns, the observed increase of $V_a$, $V_d$ and $a$ could be real. This, of course, adds to the probable instrumental errors, as discussed by Chandra.

4 Conclusions

It is possible that the observed 'triangle size effect' could be as much due to instrumental errors as the violation of one of the assumptions of the full correlation method of analysis, viz, that the observed ground diffraction pattern arises because of a single class of irregularities.
References
7 Chandra H, Indian J Radio & Space Phys, 7 (1978) 125.
10 Chandra H, Indian J Radio & Space Phys, 8 (1979) 62.