Removal of antenna contribution to Tropospheric scatterer correlation length estimates in MU radar Spaced Antenna data

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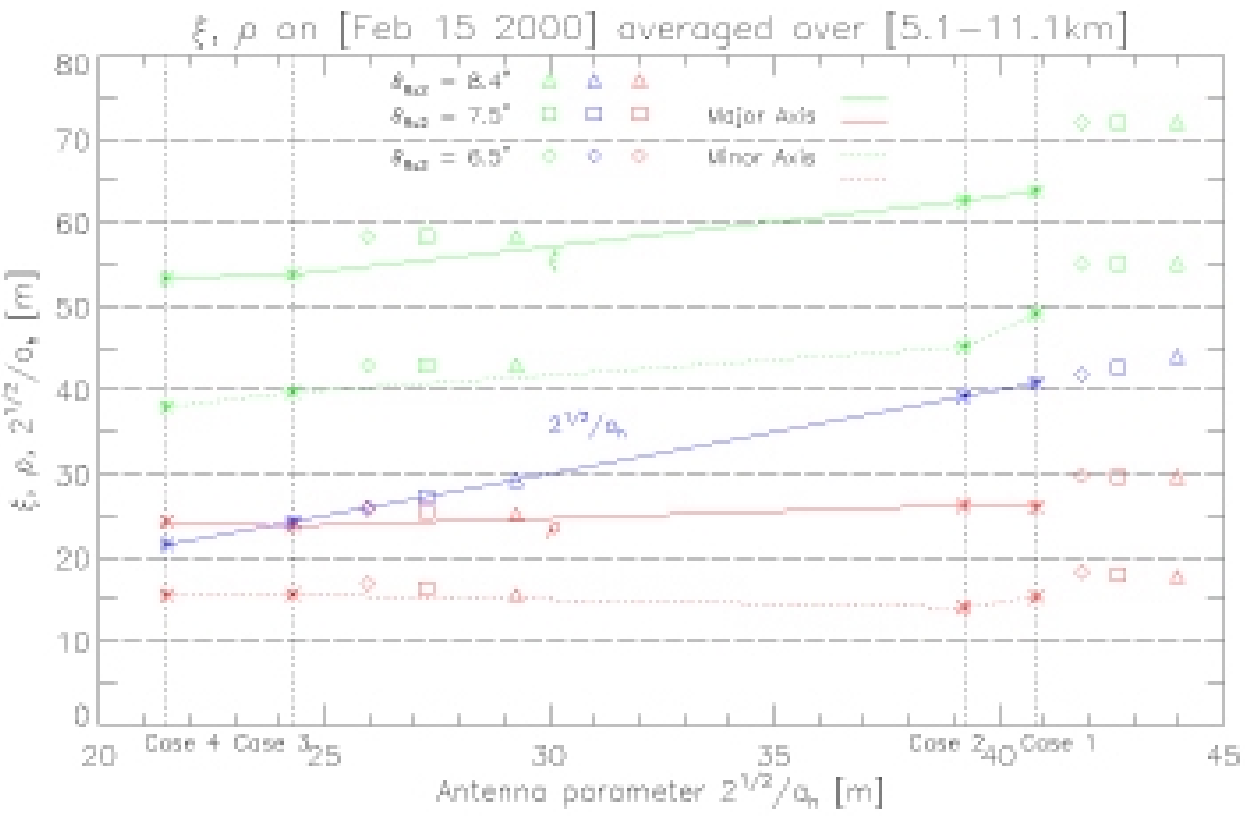
Full correlation analysis (FCA) is a tool for the estimation of horizontal wind fields and properties of the refractive index irregularities in the troposphere using a spaced antenna configuration with MF/VHF/UHF radars. The basic problem is to relate the properties of uniform or turbulent wind and properties of refractive index irregularities in the radar's resolution volume to the complex cross-correlation of echoes received in pairs of spaced antennas. Analysis is based on a volume-scattering model of the physical process of scattering in the antenna beam volume, and relates the spatial spectrum of scatterers to the cross-correlation of the diffraction pattern of the scattered field, and hence to the cross-correlation of echoes received at spaced antennas.

An enhancement to the FCA algorithm is the modeling of the antenna geometric effect on the estimates of scatterer correlation lengths. . The antenna aperture contribution to correlation length estimates can be expressed in terms of transmitter and receiver antenna parameters. This geometric contribution can therefore be calculated for a given transmitting/receiving antenna configuration. The effectiveness of the antenna aperture model is demonstrated on the MU radar, utilizing the spaced antenna technique with six combinations of large and small transmitting and receiving antennas, and comparing the results of the diffraction pattern correlation lengths obtained with different antenna combinations. A transmitter and three independent receivers are used. Two sizes of transmitting antennas are defined; the transmitting antenna array elements synthesize a vertically-directed beam. Three sizes of receiving antennas are defined.

Troposphere data was obtained on 15 February 2000 over a one-hour period. The relationship between the estimated diffraction pattern and scatterer correlation lengths is compared between different configurations. It is seen that the scatterer correlation ellipse axis lengths are independent of the antenna parameter, whereas the diffraction pattern correlation lengths are related to the changing antenna parameter. The model therefore reliably corrects for the contribution of the antenna to the estimates of correlation lengths for each of the different antenna configurations used. To minimize the contribution of the antennas on the correlation length estimates, a wide beam is desirable for both transmitter and receiver, in other words the antenna dimensions should be as small as possible. In contrast, larger transmitting and receiving antennas result in higher signal to noise ratio, which is required for reliable detection of scatterers, and which enables spaced antenna observations at longer ranges. The number of usable data points at given range also increases. Therefore a trade-off is required between desired signal to noise ratio for reliable detection of echoes, and antenna contribution effects that affect the estimation of correlation length estimates from the data.


ξ, ρ on [Feb 15 2000] averaged over [5.1–11.1km]
δ_scr = 8.4°
δ_scr = 7.5°
δ_scr = 6.5°
Major Axis
Minor Axis
ξ
ρ
2^1/2/a_n
Case 4
Case 3
Case 2
Case 1
ξ, ρ, 2^1/2/a_n [m]
Antenna parameter 2^1/2/a_n [m]
0
10
20
30
40
50
60
70
80
20
25
30
35
40
45