Effect of Radar Beam Pattern on Determination of Echo Center Using Coherent Radar Imaging

Jenn-Shyong Chen[1], Peter Hoffmann[2], Marius Zecha[2]
[1] Department of Computer and Communication Engineering,
Chienkuo Technology University, Taiwan
[2] Leibniz-Institut für Atmosphärenphysik, Kühlungsborn, Germany.

Abstract

Multiple-receiver radar interferometry, termed as coherent radar imaging (CRI) in the MST radar community, provides the ability of studying the atmosphere from the view of multiple scattering/reflecting centers of the echoes. However, previous works of CRI concentrated on small zenith angles of echo centers within the beam width. For large zenith angles outside of the main beam, the error of the estimated angles of echo centers may be significant due to the transmitting-receiving beam pattern, which should be examined in more detail. This issue was examined by simulation calculation in this study. Moreover, a study of the atmospheric echoes received by the OSWIN 53.5 MHz radar in Kühlungsborn (54°N,12°E), Germany, was carried out. The atmospheric echoes were collected in the height interval of mesosphere and by different observational modes, namely, vertical and oblique radar beams with the receiving configurations of 3×2, 6×1 (north-south alignment) and 1×6 (east-west alignment) antenna groups. We found that in the 6×1 and 1×6 antenna groups many echoes returned from large off-zenith angles (ranging between several and 20 degrees) and their off-zenith angles became larger as range height increased. Based on the observation and simulation calculation, the relationship between observed off-zenith angles of echo centers and radar beam pattern were investigated.

References

Capon, J., 1969: High-resolution frequency-wavenumber spectrum analysis. *Proc. IEEE*, 57, 1408-1419.

Chen, J.-S, P. Hoffmann, M. Zecha, J. Röttger, 2004: On the relationship between aspect sensitivity, wave activity, and multiple scattering centers of mesosphere summer echoes: A case study using coherent radar imaging, *Ann. Geophys.*, 22, 807-817.

Palmer, R.D., S. Gopalam, T.-Y. Yu, and S. Fukao, 1998: Coherent radar imaging using Capon's method, *Radio Sci.*, 33, 1585-1598.

Woodman, R.F., 1997: Coherent radar imaging: Signal processing and statistical properties, *Radio Sci.*, 32, 2372-2391.

Yu, T. Y, R. D. Palmer, and D. L. Hysell, 2000: A simulation study of coherent radar imaging, *Radio Sci.*, 35, 1129-1141.