ABSTRACTS (MASTER THESIS)

Development of MU radar real-time processing system with adaptive clutter rejection

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Strong clutter echoes from a hard target such as a mountain or building sometimes cause problems of observations with atmospheric radars (Figure 1). In order to reject or suppress clutter echoes, it is effective to use NC-DCMP (Norm Constrained-Directionally Constrained Minimum Power) method, which makes null toward the direction of the clutter, if we can receive signals independently from plural antennas. The MU (Middle and Upper atmosphere) radar which located in Shigaraki, Shiga Prefecture, Japan is one of the most powerful VHF-band atmospheric radars, which can observe atmospheric motion and circulation between the troposphere and the upper atmosphere and which has contributed to a wide variety of research areas. Its operational frequency, occupied frequency bandwidth, and peak output power are 46.5 MHz, 3.5 MHz and 1 MW, respectively. The MU radar has an active phased array system. Its antenna consists of 475 elements of crossed Yagi antennas and is divided into 25 groups. Each group has 19 antenna elements. After installing the ultra multi-channel digital receiving system in 2004, we can receive signals from each 25 group, independently. It has been demonstrated that the NC-DCMP method is effective to real observation data with the MU radar, but it was processed in off-line [1].

The objective of this study is to implement the clutter rejection by NC-DCMP method into the on-line processing system of the MU radar. Namely, we can adaptively suppress clutter echoes in real time without changing any MU radar hardware and can reduce volume of data so that we can continue observation for a long time without taking care of storage capacity. Moreover, applying NC-DCMP method enables us to estimate velocity of the vertical wind more accurate. When we use NC-DCMP method, we need to determine a value of Norm-Constrain. The optimize value of it will change depending on the environment of the clutter. In this study, we discussed it and the way how we introduce this method into the existing system optimally and smoothly. Then we practiced it and have made sure that it works in real-time. Through the discussing and analyzing the data we have got, it is suggested that higher mountains exist in the almost same range where we receive strong clutter echoes and that the environment of the clutter will change depending on distribution of temperature. We can apply the achievement of this study to the Equatorial MU radar (EMU), which is proposed to be constructed at West Sumatera, Indonesia. The EMU system is the similar as the MU radar, but its antenna consists of 1045 Yagi antennas with 55 groups.

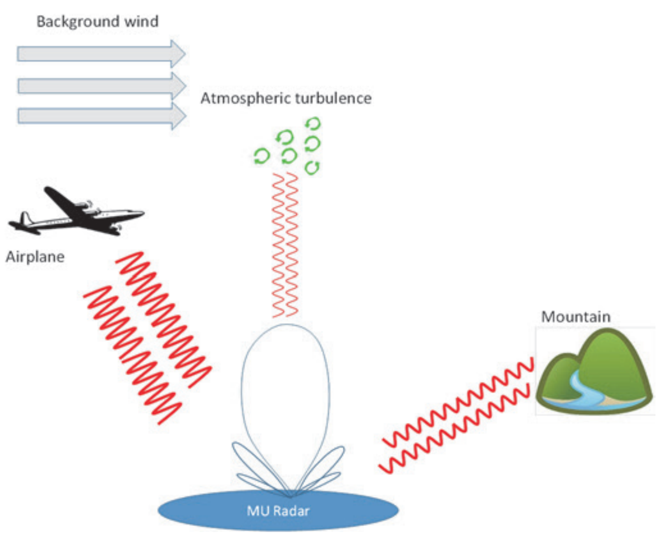

Figure 1. Clutter echoes from mountain, airplane etc. are received with antenna sidelobe, while atmospheric echoes with mainlobe.

Reference

[1] Nishimura, K., T. Nakamura, T. Sato, and K. Sato, "Adaptive Beamforming Technique for Accurate Vertical Wind Measurements with Multichannel MST Radar," *J. Atmos. Ocean. Tech.*, 29, 1769-1775, 2012.