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, a building, or an airplane often cause problems of observations with atmospheric radars. In order to suppress the clutter echoes, it is effective to use norm-constrained and directionally-constrained minimization of power (NC-DCMP) method, which makes null toward the direction of the clutter. We successfully implement the clutter rejection by NC-DCMP into the on-line processing system of the Middle and Upper atmospheric (MU) radar. Accordingly, the recording amount of observation data can be greatly reduced compared to the off-line processing. However, NC-DCMP mainly suppresses the clutter from a stationary target such as mountain or building, but it is insufficient to suppress the clutter from a moving target such as an airplane. We present the new clutter rejection system of the MU radar, which can be suppressed both the ground clutter and the airplane clutter.

We have applied the NC-DCMP real-time processing to the MU radar since November 2015. However, as mentioned above, NC-DCMP is insufficient to suppress the clutter from a moving target such as an airplane. In the previous study, a two-step NC-DCMP was proposed as a method to suppress the airplane clutter echoes. This method consists of two procedures: First, airplane clutter reproduced using the NC-DCMP based on the estimated the arrival direction of the airplane echo is subtracted from the original received signal. Next, ground clutter is suppressed using NC-DCMP. In the previous study, real-time processing is impossible, because all directions are searched to estimate the arrival direction. Therefore, we consider limiting the search area of the arrival directions by using Automatic Dependent Surveillance-Broadcast (ADS-B), which is the system in which the airplanes broadcast various information such as positions, altitude, and speed with high accuracy. The timing when airplane information is acquired by ADS-B depends on the airplane broadcasting timing. Therefore, if airplane information is required in the processing timing, in which airplane information is absent, airplane position and speed are predicted by using a α-β filter from the airplane information obtained by ADS-B.

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.