P-06

Study on adaptive clutter rejection system using external receiving antennas for the MU radar

Ryo Yabuki [1], Hiroyuki Hashiguchi [1], Issei Terada[1], and Mamoru Yamamoto[1]

[1] Research Institute for Sustainable Humanosphere (RISH), Kyoto University, Japan

Introduction

Strong clutter echoes from a hard target such as a mountain or building sometimes cause problems of observations with atmospheric radars. In order to reject or suppress ground 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 [1, 2]. It has been demonstrated that the NC-DCMP method is effective to real observation data with the MU (Middle and Upper atmosphere) radar [3]. Although NC-DCMP method suppresses clutter echoes with almost maintaining the shape of main lobe to add pseudo-noise compared with the conventional DCMP method, the signal-to-noise ratio (S/N) of atmospheric echoes is somewhat degraded. We studied the clutter suppression method with little S/N degradation by using external antennas.

System and experimental result

Four turnstile antennas are installed in the MU radar site. The signal from the antenna is sent to the MU radar observation room through the coaxial cable after amplified by the low noise amplifier (LNA) with the limiter and band-pass filter (BPF). It is further amplified by the LNA in the observation room, and then down-converted to intermediate frequency (5 MHz) signal to input to the multi-channel receiving system of the MU radar. We compared the NC-DCMP method using the each received data of 25 channels, which is a conventional clutter suppression method, and the NC-DCMP method using the simple combination of 25 channels and 4 channels of external antennas. In the former case, the S/N of the atmospheric echoes is somewhat degraded, but in the latter case the main lobe shape is guaranteed by 25 channel simple synthesis, so the S/N degradation is not observed. In the latter case, the clutter suppression is sometimes insufficient. This cause is considered to be that the current positions of external antennas are biased to the north side. Antenna positions should be optimized in the future.

Figure 1. Left: MU radar antenna. Right: An example of external receiving antennas.

Future plan

We can apply the achievement of this study to the Equatorial Atmosphere Radar (EAR), which is a VHF-band active phase-array radar located at West Sumatera, Indonesia. The EAR system is the similar as the MU radar, but its receiving channel is only one. We have been developing a multichannel receiver system for the EAR using a combination of the Universal Software Radio Peripheral X300 (USRP X300) and GNU Radio software.

References

[1] Kamio, K., K. Nishimura, and T. Sato, Adaptive sidelobe control for clutter rejection of atmospheric radars, *Ann. Geophys.*, **22**, 4005-4012, 2004.

[2] 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.

[3] Hashiguchi, H., T. Manjo, and M. Yamamoto, Development of Middle and Upper atmosphere radar real-time processing system with adaptive clutter rejection, *Radio Sci.*, **53**, doi:10.1002/2017RS006417, 2018.