

Development of Software-Defined Multichannel Receiver for Equatorial Atmosphere Radar (EAR)

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Introduction

Equatorial Atmosphere Radar (EAR) is a 47-MHz Doppler radar operated with an active phased-array antenna system. It had originally been equipped with a single receiving channel system since its establishment in 2001 at the equator in Kototabang, West Sumatra, Indonesia (0.20S, 100.32E). We have developed a multichannel receiver system for the EAR using a combination of the Universal Software Radio Peripheral X300 (USRP X300) and GNU Radio software. There are a number of advantages to have multichannel receiver system such as to enable spaced-antenna method and spatial domain interferometry.

Software-defined multichannel receiver system

Two USRP X300 devices, corresponding to four receiving channels, were synchronized using 10 MHz reference clocks and a pulse per second (1 PPS) signal. The standard observation system of the EAR is retained by splitting the received echo signals through directional coupler which enabled simultaneous observation of the two different techniques, spaced-antenna and Doppler beam swinging. The signal for spaced-antenna application is fed to the USRP X300s for digital conversion, and then stored on a Hard Disk Drive (HDD). The ranging of the data is carried out by taking advantage of the leaked transmitted pulse, before demodulated and coherently integrated [1].

Experimental results

Performance analysis using multiple receiving antennas orientation for the application of spaced-antenna method on the EAR has been carried out through multiple experiments in 2019 [2]. Phase correction is applied to all channels for a single spectrum in the real time signal processing for improving the phase synchronization. The initial results show the existence of noticeable fluctuations in the estimated horizontal wind. Then, a comparison of the EAR spaced-antenna (SA) performance with five different orientations taking into consideration the size of receiving antenna and its separation distance has been presented, where the horizontal wind profiles using Full Correlation Analysis (FCA) were estimated and compared with the standard EAR data. Based on the results, the configuration with the largest aperture shows slight advantage over the other four configurations but with limited improvement.

Future plan

If we can receive signals independently from plural antennas, ground clutter echoes can be suppressed using Norm Constrained-Directionally Constrained Minimum Power method, which makes null toward the direction of the clutter [3]. We will apply this method to the EAR multichannel receiver system.

References

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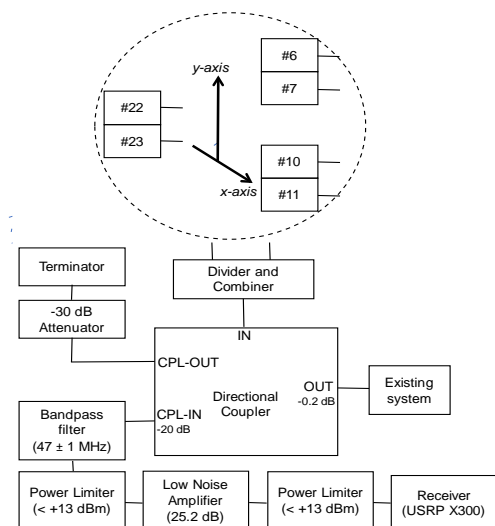


Figure 1. The configuration of the EAR multichannel receiver [2].