Development of the Broad-band Radar

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Rainfall observations with weather radar have a great advantage in the point that it is possible to observe precipitation widely in a short time. However, the precipitation from the conventional weather radar output does not necessarily correspond to that from the instruments on ground such as rain gauge. One of the most causes of these disagreements is that the conventional radars cannot acquire the high range-resolution profiles of precipitation in low altitude. Because these range-resolution is mainly tens of meters and these antenna are mono-static.

In this study, high temporal and spatial resolution radar for meteorological application has been developed and tested. The radar utilizes the broadband signal of 80 MHz bandwidth at the 15.75 GHz central frequency using the bi-static cassegrain antenna, and can accurately acquire the vertical profile of the Z-factor with high resolution from low altitude. In this radar system, we use the Arbitary Waveform Generator (AWG) to make the signal for transmitting, and directly digitize the IF-signal of the received echo. On the PC, we perform the pulse compression processing, which is that we spread the transmitted pulse out in time and then processes the received echo with a matched filter to despread it, therefore, we can obtain high range resolution and high SNR. The FM chirp signal in the 20 to 100 MHz frequency range, that the pulse width is 128 us, is generated by the AWG, upconverted to 15.71 – 15.75 GHz, and amplified to about 100 mW. The downconverted signal is sampled by the 12 bit/ 400 MHz digitizer. In the pulse compression processing, we processed the cross-correlation between the received and the reference signal. The reference signal is pre-sampled in the state of directly connecting the transceiver output of the transmitting end to the input of the receiving end through the attenuator. In the cross-correlation processing, we perform the FFT to the received signal. Before the FFT processing, the data is converted the complex data consisting of the in-phase (I) and the quadrature (Q) components using the Hilbert transformation.

The installation location of the broad band radar is in the campus of the Osaka Prefecture University, Osaka, Japan. At the site, we have been observing the rainfall event continuously in vertically looking mode from August, 2004. On September 21, 2004, some thunderstorms overpassed the campus and the convective type rainfall events were observed. In this observation, the pulse repetition frequency was about 6.8 kHz and the number of the successive pulses was 64, enabling the in-coherent integration and the extracting of the doppler shift.

The initial observation shows a good agreement with the JW disdrometer. The time height cross section of the radar reflectivity shows a fine vertical structure of precipitation near the surface.