Application of Radar Remote-Sensing Technique to Measure Atmospheric Temperature and Humidity to the Tropical and Subtropical Region

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Behaviors of various meteorological phenomena are determined by wind velocity, atmospheric temperature, and humidity. It is very important to observe them simultaneously to reveal the mechanism of such atmospheric phenomena. Because severe meteorological phenomena such as a typhoon and heavy rainclouds, which sometimes bring severe disasters for us, have short lifetime, it is essential to observe them simultaneously with a good temporal resolutions. Our laboratory has been developing the new radar remote-sensing technique to monitor them with a good temporal resolution regardless weather conditions.

A wind profiling radar detect an echo backscattered by the turbulence in the atmosphere. Three dimensional wind profiles are calculated from the Doppler shift of turbulence, since atmospheric turbulences are advected by the background wind. The Radio Acoustic Sounding System (RASS) can measure virtual temperature profiles by combining the acoustic source with a wind profiling radar. In the RASS measurements, the acoustic wave is transmitted by the ground-based acoustic source. The wind profiling radar detects the RASS echo backscattered by the acoustic wavefront in the atmosphere. Atmospheric temperature can be derived from the Doppler shift of RASS echo since the acoustic velocity is determined by the atmospheric temperature.

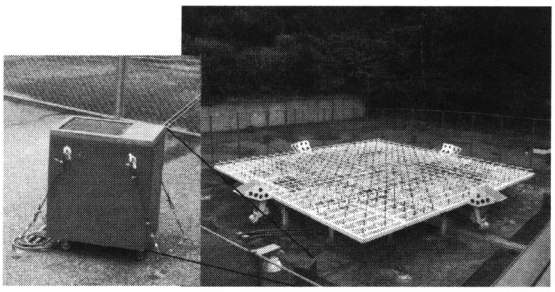

Figure 1. (right) appearance of 443MHz-WPR antenna array. (left) the acoustic horn developed for RASS measurements of 443MHz WPR.

We have also been developing a new remote-sensing technique to estimate humidity profiles from the atmosphere radar. Humidity profiles are calculated from the turbulence echo intensity, since the echo power intensity is mainly determined from the vertical gradients of atmospheric humidity.

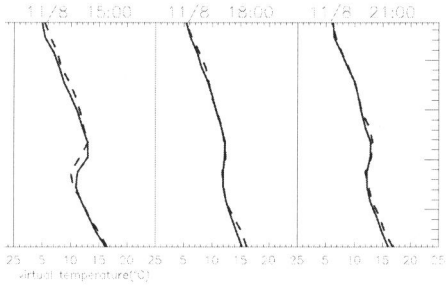

Figure 2. Successive temperature profiles obtained with RASS (solid) and radiosonde (dashed) measurements.

The above techniques have originally been developed with the MU radar of Research Institute for Sustainable Humanosphere. These techniques are recently applied to the other wind profiling radars under the collaboration with domestic or international research laboratories. In the Equatorial region, where the cumulus convections are actively generated, the RASS observations are operated with the Equatorial Atmosphere Radar (EAR) at the Sumatra Island and the MST (Mesosphere, Stratosphere, and Trposphere) radar of National Atmospheric Research Laboratory (NARL) in India.

For applying our techniques to the Okinawa subtropical region, we collaborate with National Institute of Communication and information Technology (NICT) to develop the RASS system for the 443MHz wind profiling radar (443MHz-WPR) (Figure 1) at NICT Ogimi wind profiling observatory (Ogimi observatory). RASS observation in the Okinawa subtropical region has been continuously operating everyday during 0700-2000 LT. The solid lines in Figure 2 show the successive atmospheric temperature profiles obtained by 443MHz-WPR with RASS. The results of radiosondes launched at the Ogimi observatory are also shown by dashed lines. The both results shows good agreements including the structure of temperature inversion layers at 1.5 km.