RECENT RESEARCH ACTIVITIES

RASS (Radio Acoustic Sounding System): A new radar observation technique for profiling atmospheric temperature

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The operational weather station of a meteorological agency normally employs a balloon-borne radiosonde to measure temperature (T) profiles. However, the temporal resolution of radiosondes is 12-24 hr, which is insufficient to investigate details of the medium (meso)-scale meteorological phenomena such as the cumulonimbus convection accompanying a severe rain event with time scales of a few hours in their generation and development processes. Radio Acoustic Sounding System (RASS) has been developed as a radar remote-sensing technique to continuously observe atmospheric temperature profiles. RASS consists of a wind profiling radar (WPR), such as the MU radar, Equatorial Atmosphere Radar (EAR), and a boundary layer radar (BLR), and an acoustic transmission system. Figure 1 shows the basic principle of RASS. A large power sound is emitted high up into the sky, then, refractive index (n) variations are artificially created associated with the upward propagation of the sound waves. WPR can detect faint radio wave scattering by the n perturbations, which is called the RASS echo. The speed of sound (C_s) is measured from the Doppler frequency shifts of the RASS echo. Then, we can determine a T profile using a relationship that C_s is proportional to $\sqrt{T}$.

When RASS is applied to WPR operated on the 50 MHz band, like the MU radar and EAR, we use sound waves with a frequency of about 100 Hz, considering the Bragg condition for obtaining strong RASS echoes. Because such low frequency sound can propagate up to high altitudes without suffering dissipation due to atmospheric turbulence, RASS with the MU radar was able to measure T profiles up to 23 km under an ideal condition, exceeding the tropopause at 10-15 km altitude. The accuracy of T with RASS was about 0.2 K in comparison to simultaneous radiosonde results.

RASS is also applied to BLR that is designed to measure the lowest part of the atmosphere from 100 m to several kilometers in altitude. Figure 2 shows the time variations of T observed by RASS with BLR at PUSPIPTEK, Serpong, near Jakarta in Indonesia, showing a clear diurnal variation of T due to heating of the surface by the solar radiation. RASS can visualize time and height variations of the temperature associated with meso-scale meteorological phenomena, and it is also useful to observe transport and mixing of minor atmospheric constituents and aerosol particles.

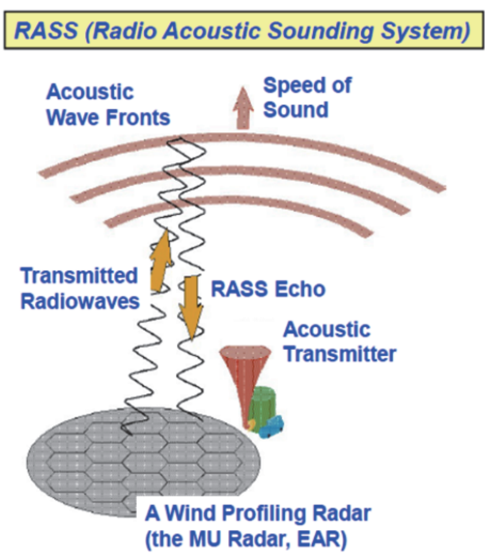

Figure 1. Basic concept of RASS

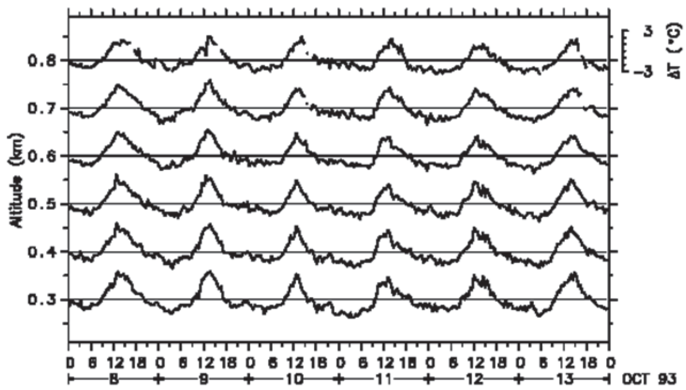

Figure 2. Time variations of temperature perturbations at 0.3-0.8km altitude, observed with a BLR-RASS (1357.5 MHz, peak power=1 kW) on October 8-13, 1993. Original time resolution is 3 min., but, results are averaged for 30 min. Difference from simultaneous radiosonde soundings was within 0.5 K. Amplitude of 24-hour oscillation was 1.8 K with maximum at 14 LT.