Studies on coupling processes in the equatorial atmosphere with the Equatorial Atmosphere Radar

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The Equatorial Atmosphere Radar (EAR), a VHF Doppler radar with the similar active phased-array antenna system to that of the MU radar in Japan, was established right at the equator in West Sumatra, Indonesia (0.20S, 100.32E) in March 2001. The EAR operates at 47.0 MHz with peak output power of 100 kW. It has a circular antenna array, approximately 110 m in diameter, which consists of 560 three-element Yagi antennas. Each antenna is driven by a solid-state transmitter-receiver module. This system configuration allows the antenna beam to be steered electronically up to 5,000 times per second, and can be used to investigate rapidly changing processes like gravity waves, turbulence and ionospheric irregularities.

It is well recognized that the Indonesian Archipelago is one of the centers of intense atmospheric motions and global atmospheric changes. A scientific project for six years from September 2001 to March 2007, called the Coupling Processes in the Equatorial Atmosphere (CPEA), was successfully conducted to elucidate dynamical and electrodynamical coupling processes in the equatorial atmosphere from the near-surface region to the upper atmosphere by conducting various observations in this region.

The EAR is the core instrument of CPEA. Since the beginning of the project, various instruments have been assembled at and around the EAR site to cover as wide a height range as possible. There are radars: the EAR, a boundary layer radar (BLR), an X-band meteorological radar, a meteor radar, and an FM-CW ionosonde at the EAR site, plus an X-band Doppler radar near Bukittinggi, and in additionally two MF radars at Pontianak and Pameungpeuk in Indonesia; lidars: a Rayleigh/Mie lidar at the EAR site; GPS radiosondes; other instruments: RASS, an airglow imager and airglow temperature photometer at the EAR site, GPS receivers at the EAR site and at Padang in Indonesia; meteorological instruments: a radiometer, a rain gauge, a disdrometer, etc., at the EAR site. Now the EAR site has become one of the most substantial observatories in the equatorial region.

Two extensive CPEA campaigns were successfully conducted, one from March to May 2004 (CPEA-I) and the other from November to December 2005 (CPEA-II). The results of CPEA-I have been already summarized in the Special Issue of the Journal of Meteorological Society of Japan, Vol. 84A, 2006. In the present talk we will review some highlights primarily from the CPEA-I and -II: They include convection over Sumatra Island, whose features are quite different from those over open seas, direct evidence that inertia gravity waves of 12 hrs - 3 days period with vertical wavelength less than 3 - 5 km are excited by convection, behavior of cirrus clouds and convection, and growth rate of plasma bubbles associated with equatorial spread F, etc. It will be shown that height regions which are widely separated in the equatorial atmosphere are closely coupled in the vertical direction at various spatial scales, and that atmospheric waves have clear longitudinal variabilities which will make the vertical coupling processes more complicated.