Coupling Processes in the Equatorial Atmosphere (CPEA): Highlights from its First International Campaign

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It is well recognized that the Indonesian Archipelago is one of the centers of intense atmospheric motions and global atmospheric changes. The mechanisms of these atmospheric changes, however, have not yet been made clear due to sparseness of observational data. The Coupling Processes in the Equatorial Atmosphere (CPEA) is a scientific project for six years from September 2001 to March 2007. The goal of CPEA is to elucidate dynamical and electrodynamical coupling processes in the equatorial atmosphere by conducting various observations in the Indonesian equatorial region.

The core facility of CPEA is the Equatorial Atmosphere Radar (EAR) located right at the equator in West Sumatra, Indonesia. Since the beginning of the project, various instruments have been assembled at and around the EAR site to cover as wide height range as possible. They are Radars: EAR, boundary layer radar, X-band meteorological radar, meteor radar, and FM-CW ionosonde (by NiCT, Japan) at the EAR site, X-band Doppler radar near Bukittinggi, two MF radars at Pontianak and Pameungpeuk in Indonesia; Lidars: Rayleigh/Mie lidar at the EAR site; Balloon experiment: GPS radiosondes launched from four sites in Indonesia, and from three additional sites in Malaysia and Singapore; Other instruments: RASS, airglow imager and airglow temperature photometer at the EAR site, GPS receivers at the EAR site and Padang in Indonesia; Meteorological instruments: Radiometer, rain gauge, disdrometer etc. at the EAR site.

Two international observation campaigns of CPEA were successfully conducted as scheduled, one from March to May 2004 (CPEA-I) and the other from November to December 2005 (CPEA-II). In the present talk we will review some highlights from the CPEA-I.

The period of CPEA-I was divided into two parts. During March 10–April 3, 2004, we conducted collaborative observations targeting the middle to upper atmosphere. Interaction between the equatorial Spread-F and the neutral atmosphere was a specific topic in the period. On the other hand, we concentrated on observations of the lower to middle atmosphere during April 10–May 9, 2004. Significance of the following results will be discussed from the point of view of the dynamical and electrodynamical coupling processes in the equatorial atmosphere.

(1) It has been found that convection over Sumatra Island features quite differently from that over open seas: Deep convection is observed in the inactive phase of Madden-Julian Oscillation (MJO), while shallow convection is dominant in the active phase. The lightning activity and rainfall structure are found to be consistent with this feature of convection.
(2) A clear evidence that inertia gravity waves of period ranging from 12 hrs to 3 days with vertical wavelength less than 3 - 5 km are excited by convection has been directly obtained.
(3) Kelvin waves with periods 10-12 days near the tropopause and 5.5-8 days in the lower stratosphere that were found by rawinsondes have been confirmed to be consistent with a global feature observed by satellite CHAMP/GPS.
(4) Growth rate of plasma bubbles associated with equatorial spread F has been first estimated by direct observations by EAR. It has been suggested that gravity waves near 100 km in altitude will contribute to generation of the bubbles.