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Ionospheric Disturbances Over Indonesia and their Possible Association with Atmospheric Waves from Below

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We have been conducting ground-based optical and radio observations of the ionosphere and lower thermosphere at Kototabang in Indonesia (0.2 S, 100.3 E; dip lat.10.4 S). This paper makes a brief survey of some results obtained until now, paying special attention to vertical coupling between the ionosphere and the lower atmosphere in the equatorial region. Medium-scale traveling ionospheric disturbances (MSTIDs) detected with a 630-nm all-sky imager at Kototabang appear within and in the south of the southern equatorial anomaly crest. They have a high occurrence in May and June and, on the average, a phase velocity of 300 m/s toward the south, a period of 40 min, and a wavelength of 700 km. The most spectacular and attractive phenomenon at night is plasma bubbles that are deep depletions in the equatorial F region plasma. The Kototabang imager have often detected plasma bubbles in equinoctial months. Interestingly, giant geomagnetic-conjugate plasma bubbles were simultaneously observed with all-sky imagers in Japan and Australia. They were embedded within wavy plasma structures, with an east-west scale of about 1000 km, in the northern and southern equatorial anomaly crests. Continuous 1.6-GHz GPS ionospheric scintillation measurements in 2003 and 2004 at Kototabang indicate that the scintillations appear predominantly from sunset to midnight in equinoctial months, a characteristic of equatorial plasma bubble occurrences. Origin of the electron density structures (MSTIDs and bubbles) with scales of 100-1000 km and seeding process of bubbles are still unknown, though atmospheric gravity waves (AGWs) from below are thought to play a role. As a first step to disclose the dynamical coupling between the ionosphere/thermosphere and the lower atmosphere over the equator, we examine two-year data of GPS scintillation, Earth brightness temperature (Tbb), and neutral wind at around 90 km altitude over Kototabang. We find the following: 1) the scintillation occurrence and temporal variations of Tbb and neutral wind have planetary-wave periods, i.e., periods from a few days to several tens of days, and 2) the scintillations tend to be enhanced when high and low Tbb regions are located over the Indian Ocean in the west of Kototabang, suggesting that AGWs propagating upward from the troposphere through the mesosphere may, more or less, contribute to the seeding of plasma bubbles. Possible processes to seed plasma bubbles are discussed.