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Midnight/Post-Midnight F-region ionospheric irregularities observed over Sao Luis, Brazil

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Nighttime Equatorial F-region irregularities (equatorial spread-F) have been extensively observed after sunset over Sao Luis, Brazil (2.33oS, 44.2oW, dip angle: -2.7) for several decades. The irregularities are most frequent in Equinoxes and December Solstice. The seasonal dependence of the irregularities is associated with the alignment between the terminator and geomagnetic field meridian. The occurrence rate of the irregularities peaks between October and March. On the other hand, during June Solstice, when the alignment is very low, and the pre reversal enhancement of electric field is very low or even absent, the irregularities are rarely observed and are generally restricted to the bottomside F-region. Recently we have conducted a multi-instrument campaign to investigate the characteristics of the irregularities during the prolonged solar minimum period of solar cycle 23, in which the plasma irregularities were frequently observed around midnight/post-midnight and at pre-dawn hours. In this work we present observations of these midnight/post-midnight/near dawn F-region irregularities observed by a digisonde and a 30 MHz coherent back-scatter radar data during June Solstice of 2011. We have observed unusual spread-F echoes in ionograms and unusual zonal plasma drifts. Additionally, 5 meter irregularities were detected by the Sao Luis radar up to 500 km altitude. The observed radar echoes are different from the usual post-sunset/pre-midnight spread-F echoes. We discuss the generation mechanisms for these irregularities.