Spatial and temporal variations of ionospheric plasma structures during the prompt penetration phase of intense magnetic storms

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During intense magnetic storms the ionospheric electron density, electron content and the irregularities of electron density at low and middle latitudes exhibit pronounced spatial and temporal variations. In this paper, we investigate the variations of ionospheric plasma structures in the prompt penetration phase of superstorms during the October – November, 2003 and November, 2004 periods. The near simultaneity of mid-latitude and equatorial scintillation during these storms indicates the prompt penetration of storm time high latitude electric fields to equatorial latitudes. In the equatorial region, DMSP satellites at 840 km recorded large plasma bite-outs, as well as smaller plasma bubbles flanked by regions of enhanced plasma density. The plasma bite-outs observed by DMSP satellites correspond to the rapid increase of the ionospheric height recorded by ionosondes and to sharp decreases of the total electron content of the ionosphere measured by ground-based GPS receivers. During all these storms, equatorial scintillations were found to be longitudinally confined and occurred where post-sunset (19 LT – 22 LT) conditions prevailed at the time of the prompt penetration of electric fields. Indeed, as the prompt penetration phase of these three storms occurred progressively at later universal times, the disturbed equatorial region marched westward from the African subcontinent, through Brazil to the Peruvian sector. Based on the localization of disturbances in the equatorial ionosphere during intense magnetic storms, models are being developed to specify severe scintillation effects in VHF/UHF satellite links and GPS navigation systems.