Observations of the ionospheric response to the 15 December 2006 geomagnetic storm: long duration positive storm effect

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The long duration positive ionospheric storm effect that occurred on 15 December, 2006 is investigated using a combination of ground-based Global Positioning System (GPS) total electron content (TEC), TOPEX and Jason-1 TEC, and topside ionosphere/plasmasphere TEC, GPS radio occultation and tiny ionospheric photometer (TIP) observations from the Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) satellites. This multi-instrument approach provides a unique view of the ionospheric positive storm effect by revealing the storm-time response in different altitude regions. The ground-based GPS TEC, TOPEX/Jason-1 TEC, and topside ionosphere/plasmasphere TEC all reveal significant enhancements at low-mid latitudes over the Pacific Ocean region during the initial portions of the storm main phase from 0-4 Universal Time (UT) on 15 December. At low latitudes, the topside ionosphere/plasmasphere TEC increase represents greater than 50 percent of the TEC enhancement that is observed by ground-based GPS receivers. Moreover, electron density profiles obtained using the technique of GPS radio occultation demonstrate that the F-layer peak height increased by greater than 100 km during this time period. The effects of soft particle precipitation are also apparent in the COSMIC observations of topside ionosphere/plasmasphere TEC. The positive storm effects over the Pacific Ocean region remain present in the equatorial ionization anomaly crests regions beyond 12:00 UT on 15 December. This long-lasting positive storm effect is most apparent in ground-based GPS TEC and COSMIC TIP observations while only a small increase in the topside ionosphere/plasmasphere TEC after 4 UT is observed. This indicates that the long-lasting positive storm effect occurs predominantly at F-region altitudes and, furthermore, that refilling of the topside ionosphere and plasmasphere is not the primary mechanism for producing the long-lasting positive storm phase during this event. The observations suggest that the enhanced eastward electric field and equatorward neutral wind are likely to play a significant role in the generation of long-lasting positive storm effects.