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Global ionospheric responses to interplanetary shocks as observed by the digisonde Global Ionospheric radio Observatory (GIRO)

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The digisonde Global Ionospheric Radio Observatory (GIRO) has recorded strong ionospheric responses to two powerful interplanetary shock passages on November 7, 2004 and January 21, 2005. Both events provide excellent opportunities to study geospace response processes to strong interplanetary forward shocks in great detail. The angle between the normal of the November 7, 2004 shock front and the sun-Earth line was 3 degrees, indicating that the shock hit the equatorial magnetosphere at 12 LT (local noon). The subsequent dayside shock-induced ionospheric phenomena were found to have marked longitudinal and latitudinal distributions. Comparative studies of the intense interplanetary shocks associated with northward and southward interplanetary magnetic fields (IMF) revealed their different geospace effects on the dayside ionospheric region. The equatorial ionosphere responds to the interplanetary shock rather quickly, and if the shock is associated with southward IMF the plasma electrons in the equatorial ionosphere are rapidly uplifted. During the November 7, 2004 event the averaged uplift velocity was close to 67 m/s, and the ionospheric total electron content (TEC) increased from the original 16 TECU) to 38 TECU, which may be due to the shock effect. When the interplanetary shock is associated with northward IMF, the plasma in the equatorial ionosphere moves downward, causing a sudden drop in the total electron content. During the January 21, 2005 event, the averaged downward velocity was 120 m/s, and the TEC dropped from 75 TECU to 22 TECU at the time of maximum solar wind dynamic pressure, and then recovered to 68 TECU in about 2 hours after the shock passage. The mid and high latitude ionospheric TEC enhancements may be due to particle (ion and electron) precipitation ionization losses caused by the strong impacts of the interplanetary shocks.