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Total Electron Content Variations during an HSS/CIR driven storm at high and middle latitudes

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Magnetic storms are caused by the interactions between the solar wind and the Earth's magnetosphere. Many studies have been carried out for strong magnetic storms. However, moderate or weak storms and their impacts on the ionosphere are less explored. This study investigates the large-scale and mesoscale structures in ionospheric total electron content (TEC) during a moderate storm (Sym-H index minimum: -63 nT) driven by two interacting solar wind high-speed streams (HSSs) and associated co-rotating interaction regions (CIRs) during 14-21 March 2016. For the solar wind, the IMF Bz minimum is -20 nT and the solar wind speed maximum 612 km/s. The long storm starts with a strong storm sudden commencement (SSC) with a peak close to 19 UT on 14 March 2016. The GNSS/TEC maps are obtained from the Madrigal database. The associated field-aligned currents (FACs) from AMPERE, ionospheric convection maps from SuperDARN, and the O/N_2 ratio from TIMED/GUVI are also studied for understanding the physics behind.

The focus of the study is on the changes of TEC at high and middle latitudes and the possible coupling between the two. To better characterize the changes, we subtract from the TEC maps the quiet time background (13 March 2016). Our analysis shows the different responses of TEC changes during the storm initial, main, and recovery phases. During the initial phase, TEC enhancements and depletions are found mainly at high latitudes within the auroral oval and close to the cusp, plausibly associated with auroral precipitation and variations in the upward and downward field-aligned currents (FACs). After the onset of the main phase, the TEC is enhanced at mid-latitudes with a maximum of ~10 TECU. During the main phase, we observe the evolution of a storm-enhanced-density (SED) plume and a transient enhancement of TEC in the polar cap. During the late main and the recovery phases, a strong TEC depletion at high and middle latitudes is

found on the dayside and in the evening sector. The depletion is associated with the decrease of the O/N_2 ratio indicating upwelling of the neutral atmosphere. The possible physical mechanisms associated with the observed TEC variations will be discussed.