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MULTI-INSTRUMENTAL STUDY OF THE IONOSPHERIC RESPONSE TO THE 2015 ST. PATRICK'S DAY STORM

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The geomagnetic storm of 17-18 March 2015 (the St. Patrick's Day 2015 storm) was the strongest one in the 24th solar cycle (minimum SYM-H value of -233 nT). In this study we: 1) analyze the ionospheric response on a global scale by making use of numerous ground-based and space-born instruments; 2) study the occurrence of the plasma density irregularities in the topside ionosphere. The instruments used are ground-based GPS-receivers as well as GPS-receivers onboard several Low-Earth-Orbit (LEO) satellites: the three Swarm satellites (A, B, C), TerraSAR-X, GRACE and Jason-2 satellites (Figure 1). We select multi-site chains of the ionospheric sounding stations at different longitudinal sectors and co-located GPS receivers for detailed study the ionospheric response in the F region and the ionospheric total electron content (TEC).

Our analysis revealed that the storm provoked quite complex ionospheric effects throughout the globe. At high-latitudes, negative storm signatures were recorded in all longitudinal regions. The negative storm phase was found to be strongest in the Asian sector, in particular in the northern hemisphere (NH), but developed globally on March 18 at the beginning of the recovery phase. At mid-latitudes, inverse hemispheric asymmetries occurred in different longitudinal regions: in the European-African sector, positive storm signatures were observed in the NH, whereas in the American sector, a large positive storm occurred in the southern hemisphere (SH), and the NH experienced a negative storm. At low-latitudes, data from multiple satellites revealed the strongest storm-time effects in the morning (~100-150% enhancement) and post-sunset (~80-100% enhancement) sectors in the topside ionosphere. These dramatic VTEC enhancements were observed at different UT, but around the same area of Eastern Pacific region.

We report the significant intensification of the topside (above 500 km) plasma density irregularities at the main and recovery phases of the geomagnetic storm. The most intense irregularities the two specific zones of: 1) the region of the auroral oval and main ionospheric trough at high latitudes of both hemispheres; 2) the low- and equatorial latitudes in the Atlantic and Pacific region. Main peculiarities of the observed ionospheric plasma density redistribution, interhemispheric differences and physical mechanisms are discussed in the paper.