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The new IGS ionospheric product - TEC fluctuation maps and their scientific application

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The GPS signals fading due to presence of the plasma irregularities in the ionosphere can decrease an operational availability of navigation systems. This effect can be estimated by measuring its impact on phase of the received GPS signal. The new IGS ionospheric fluctuation maps product is based on estimates of the TEC rapid changes. For an overall representation of the spatial evolution of the ionospheric irregularities, which caused the GPS signal fluctuations over the Northern Hemisphere in middle and high latitudes, a daily map of the ROTI index is produced basing on data derived from a representative set of 700 permanent GPS stations. We use the corrected geomagnetic (CGM) coordinates with DGRF/IGRF models. For daily ROTI maps, we averaged and binned all ROTI values collected during 00–24 UT period of a considered day. The grid size is 8 min MLT by 2° MLAT, with the latter covering 50° - 90°. The averaged ROTI value in each MLAT-MLT bin corresponds to probability of the GPS signals phase fluctuations caused by passing of radio signals through the ionospheric irregularities. The resulted ionospheric fluctuation product is represented in the ASCII IONEX-like data format and can be visualized. This data format is described in details.
We demonstrate the IGS ionospheric fluctuation map product performance for scientific research application on set of test-cases (geomagnetic storms occurred in the years 2013-2015) for comparative analysis of the resulted daily ROTI maps for quiet and geomagnetically disturbed periods. The intense phase scintillations depicted in the diurnal ROTI maps can provide an important information about development of the severe storm-induced gradients in the ionospheric plasma density, both caused by auroral particle precipitation and plasma flows. It is possible to conclude that IGS ionospheric fluctuation maps product can be effectively used for monitoring of the plasma irregularities with different origin. The independent ground-based and satellite measurements supported our results and conclusions.