Ionospheric and seismic effects caused by the North Korea nuclear tests realized on 2006-2017

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Using data from GPS/GLONASS receivers and seismic networks, we studied the ionospheric and lithospheric effects caused by six underground nuclear tests realized in North Korea on 2006-2017.
To investigate the ionospheric disturbances, we analyzed data from several continuous GNSS-networks (GPS and GLONASS) operating in Asia - Western Pacific region: IGS, GEONET, FEB RAS and FEFU complex geodynamic network, a set of stations belonging to China and South Korea GNSS-networks. Sites close to the Korean Peninsula were selected for the analysis. Series of total electron content (TEC) in the ionosphere were calculated on the base of dual-frequency phase measurements of GNSS receivers. To detect disturbances caused by the nuclear tests, TEC series were filtered in the range of periods from 1 to 10 minutes. Despite the small magnitudes of seismic events associated with the nuclear tests, we were able to identify ionospheric disturbances which were most likely generated by these explosions. Such disturbances were detected for 4 out of 6 nuclear tests. The main parameters of the disturbances were determined. From our analysis we concluded that characteristics of ionospheric disturbances caused by the underground nuclear tests differed significantly from the parameters of disturbances that are usually observed after earthquakes.
For seismic analysis, we used data from the broadband seismic station networks located at distances up to 23 degrees from the Korean Peninsula: II, IC, IU, TW, JP, G, KS, and KG given by IRIS, and regional seismic network BY. The frequency content of P and surface Rayleigh waves registered by 46 broadband stations was analyzed. For some events, the P-wave frequency content showed the prevalence of low frequencies in spectra (~0.45 Hz). The peak frequencies of the surface Rayleigh waves was in the 0.05-0.45 Hz range. Preliminary analysis of the peak frequencies spatial distribution showed that the continental massive area is characterized by the relatively high frequencies (0.14-0.50 Hz) while for the areas adjacent to marginal seas the low values of peak frequencies are observed (from 0.13 Hz and less).
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