On the F-spread in the mid-latitude ionosphere before earthquakes

Liperovskaya E.V.[1], Rodkin M.V.[2],
and Parrot M.[3]

[1]Bolshaya Gruzinskaya, 10, United Institute of Physics of the Earth, 123995, Moscow, Russia
[2] Geophysical Centre RAS, Moscow, Russia
[2]L.P.C.E./C.N.R.S., 3 A, Avenue de la Recherche Scientifique, 45071 Orléans Cedex 2, France

Ionospheric disturbances in F-region above epicenters of forthcoming earthquakes was firstly mentioned 40 years ago. Seismoionospheric effects in F layer was observed using in-situ data obtained either by ionospheric sounders or by satellites. Acoustic and electromagnetic disturbances caused by earthquake preparation processes have a mosaic structure near the Earth's surface and are hardly detectable. Using ionospheric measurements it is possible to observe the integrated effect of different disturbances coming from different ground-based points. One could suppose that acoustical and electromagnetic disturbances of seismogenic nature propagate up from the Earth's surface to the ionosphere, act on separate ionospheric areas with horizontal dimension of the order of a few tens kilometers, in the first place on the E and Es layers, further by their propagation up act on F- region inhomogeneities, shift them up and then cause spread-F which is observed on ionograms as diffuseness of the F-layer track.

In the present study, the variations of spread-F were analyzed in a time interval of 2 months around the earthquake time (40 days before and 20 days after earthquake) to find out seismo-ionospheric effects with a characteristic time up to a few weeks. The hourly data from the two Japanese ionospheric stations Kokubunji and Akita have been analyzed. The data of nighttime from 23 LT till 04 LT were selected because spread-F is most intensive in these hours. Night hours were chosen also because it is very complicated task to separate seismoionospheric effects on the background of variations caused by direct Solar radiation. Earthquakes with magnitudes M>5 were taken into account. Only time intervals where geomagnetic and Solar variations are weak have been analyzed. A main characteristic of the spread-F is its occurrence probability of observations, which is defined as the ratio of the number of cases of spread-F to the total number of observations. It is shown that the probability of spread-F observations starts to decrease approximately 40 days before earthquakes, presents a minimum about 10 days before and then takes one month to recover the background level. This effect is observed on the both stations if the distance between epicenters and the sounding station is less than 500 km. At larger distances effect is not observed.