

## Tidal Variations of Seismic Noise as Earthquake Precursors: Monitoring and Results in 2013-2018

**Saltykov V., Kugaenko Yu., Volovich O., Voropaev P.**

*Geophysical Survey of Russian Academy of Sciences, Kamchatka Branch,  
Petropavlovsk-Kamchatsky, Russia*

The analysis of the data obtained during the last 30 years has revealed a number of features that indicate the modulation of high-frequency seismic noise (HFSN) by tides and connection of the HFSN with various geophysical processes, including changes in the stress state of the medium during the preparation of earthquakes. An important property of the tidal influence upon the HFSN was found: the HFSN response is not stable over time. In the 1990s, based on the results received in Kamchatka, a hypothesis about the connection between the variations of the tidal component of the HFSN and the geodynamic processes in the region was proposed. Later, on the basis of long-term field observations, it was shown that the tidal sensitivity of the HFSN is most stable and statistically significant during the preparation of large local earthquakes.

The observed effect of synchronization of these processes is the basis for the technique of forecasting of large local earthquakes. The originality of this technique is the use of the Earth tides as the reference signal with known characteristics for studying the microseismic radiation features. The basic element of the methodology is experimentally revealed in 1992-1995 effect of stabilization of the phase shift  $\Delta\varphi$  between the selected wave of the tidal gravitational potential and the harmonic selected from the HFSN envelope with the same tidal period before earthquakes. Synchronization of the HFSN with the tides is considered as a predictive feature and is a new, previously unknown precursor of earthquakes.

The current version of the approach is described in (Saltykov, 2017), and its key points include description of precursor, alarm condition, parameters of the expected earthquake and probability of the successful forecast.

Taking into account that the prognostic technique described in (Saltykov, 2017) is based on the HFSN observation before the middle of 2013, it is of interest to consider the results of its use in the subsequent time. From Sep. 2013 till Apr. 2018 there were ~20 earthquakes, corresponding to the predicted type (by the ratio of magnitude-distance  $\lg R \leq \frac{M + 3.64}{4.06}$ ). For earthquakes with precursor the temporal variations of the phase shift by the data of two Kamchatka stations (Nachiki and Karymshina) with the marked earthquake time, the position of its epicenter, and the date of submission of the forecasted conclusion to the Kamchatka Branch of the Russian Expert Council for Earthquake Prediction are shown. Published in (Saltykov, 2017) features are confirmed.

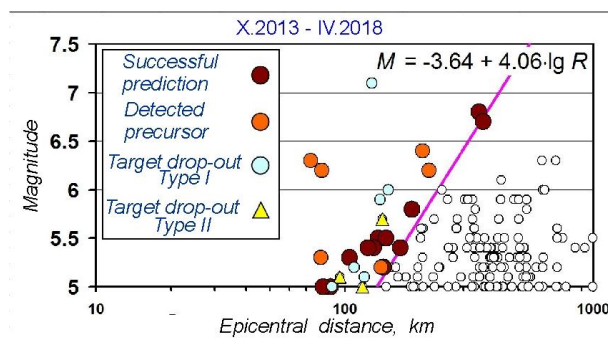


Fig. 1. Dependence of magnitude  $M$  from epicentral distance  $R$  for considered set of earthquakes.

**Acknowledgement.** The work was supported by the RFBR (project no. 17-05-00185).

### References

Saltykov V. On the possibility of using the tidal modulation of seismic noise for forecasting earthquakes. *Izvestiya, Physics of the Solid Earth*. 2017. 53 (2). 250–261.