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The interannual earthquake distributions and its peculiarity.

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The study of the periodicity of seismic process activation at different energy levels represents a topical problem in seismology, and it might help to illuminate the physical mechanisms that govern the processes of preparation and generation of earthquakes. It was observed during written history, that the seismic events occur in various regions of the Earth in some months of a year significantly more often than in another. In the last decade, there has been growing interest in problems related to searching for global spatiotemporal regularities in the distribution of seismic events on the Earth.

The objective of our work is to test of hypothesis about within-year variability existence for the events of various energy levels, to determine the lithosphere depth boundary which divided the seismic events on two groups (subjected to external (tidal) forces and no subjected to these forces) and to search the global regularity in spatio-temporal distributions of the seismic events in the Pacific.

The whole region was subdivided into 31 subregions, which are located along the perimeter of the Pacific. All events in each subregion were subdivided into five subsets according to following magnitude levels: 4 < =Mb < 4.5; 4.5 < =Mb < 5; 5 < =Mb < 5.5; 5.5 < =Mb < 6.0; 6 < =Mb. Then the events in each magnitude level were subdivided once more into two groups: "shallow" events (H < = Htr) and "deep" events (H > Htr), where H is the hypocenter depth and Htr is the threshold value of the EQ source depth. For the first time Htr was set equal to 80 km. Then we were checking if the distributions of the events during the year period are uniform or these distributions are non-uniform. Our data sets are binned data. We obtained simultaneously two discrete time scale (monthly and 10-days). We are testing it separately for each region, for each magnitude level and for every depth level. The null hypothesis about uniform EQ distributions in the course of year was disproved for the most samples with "shallow" EQ. But the null hypothesis was confirmed for "deep" earthquakes. We use the Chi-Square test for well-filled sequences (no less than 5 events in each discrete interval) and the method of statistical testing (Monte-Carlo) for poor-filled sequences.

The average probability (Psp), that EQ distributions of the"shallow" events are nonuniform is equal to 0.975 (for all subregions and all magnitude levels), but for the deep events the Psp value is equal to 0.65. It was used 184 samples for analysis (more than 200000 events). The noticeable increase of the EQ number in short time intervals as a rule two times in year, and significant reducing of seismic activity in the rest part of the year was observed. It was shown, that the main maximum of the seismic activity take place in December-February (minimum of the Earth-Sun distance) for both Hemispheres (southern and northern) and the minimum – in April (minimum of the Earth rotation speed). The position of the seismic activity peak depends on the latitudinal location of the investigated subregion. For the some near-equatorial subregions the maximum of the seismic activity shifted to the autumn. The stability of the within year distribution for shorter periods of observations (10, 5 years) was proved.

If the within-year variability exists, then occurrence of the seismic events depends on the position of the Earth -Moon system on ecliptic plane or on factors that are varied during motion of the Earth-Moon system along ecliptic plane

Then we let vary the Htr value by using special software procedure from 20 up to 300 km for searching the optimal Htr value (Hopt). The Hopt lets us to make the cluster decomposition whole set of seismic events in every subregion in two nonoverlapping subsets. It was found, that the Hopt boundary between the "shallow" and the "deep" events for the most subregions was arranged in deep 50-80 km. But the Hopt value may shifted to 120 -160 km for latitude belt 100 – 400 S. Thus the EQs with sources located above this boundary are affected by external (astronomical) factors, while the external factors don't influence on the EQ sources located below this boundary.

The direct relationship between the EQ origination and tidal forces is not adequately validated now. Moreover it

was shown [Morgounov et al, 2005, 2006] that influences of weak but long-period tidal forces (fortnightly and monthly) are more effective than influence of several times more powerful short-period tidal forces (diurnal and semi-diurnal). It was noted also [Avsuk, Barkin], that total influence of tidal forces (Sun and Moon) may have distinct nonlinear effect (total influence several times more than simply sum of these forces).

It is well known that seismic events may be partitioned into three subsets in compliance with depth of the EQ source: the crust EQs, the intermediate EQs and the deep EQs. The 2D distribution analysis (in depth and in latitude) of the EQ energy released [Levin, Sasorova, 2009] shows, that full interval of the depth in each latitudinal belt is disintegrate into three isolated parts (clusters) with close-cut separation boundaries (K1 - with 0<H<=80 km, K2 - with 120<H<=240 km and K3 - with H>=500 km). Full observation period was from 1966 to 2004. Every year was divided into 26 intervals (14-days). The total number of the time intervals in full period of observation was equal to 995. It was calculated the EQ number in every time interval for each depth cluster and each magnitude level. These values formed time series (TS). Then the spectrum analysis for each TS was carried out. We calculated power spectrum density (PSD) and 95% confidence interval for every TS. It should be noted, that all TS with M>=6 were poor-filled TS and reasonable spectrum analysis for such TS is impossible. Thus it was detected the representative periods for all well-filled TS. For shallow EQs it was detected following periods: 10-13, 6.7, 2-3, 1 and 0.5 years for events with M>=4. For intermediate events it was detected periods: 13, 6.7-5.5, 4.4, 3 and 0.5 years for events with M>=4. We failed to find the characteristic periods for TS of the deep events. These events are distributed in a random way.

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