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Spectral analysis of the Earth crust microdeformations in the land-ocean transition zone

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Characteristics of microdeformations corresponding to strains in the upper layers of the Earth crust have being measured with the help of laser strainmeter during several years at the Marine Experimental Station of the V.I.Il'icv Pacific Oceanological Institute. With the device used we can register processes in the very large range of amplitudes and frequencies. One of the main goals is investigation of effects of processes in the ocean and atmosphere on the background seismicity in the region of high tectonic activity. This is important as for detection and identification of dangerous phenomena (earthquakes, tsunami, typhoons), so for remote registration of specific processes in the adjacent sea and atmosphere (tides, surface and internal waves, sea level fluctuations, cyclones etc.).

The processes measured are highly non-stationary and nonlinear, so the classic spectral analysis Fourier and its modifications do not lead to correct physical interpretation of measurements. In most cases we used the Hilbert-Huang method for spectral analysis of non-stationary and nonlinear processes (Huang et al., 1998).

Joint analysis of sea level and microdeformations has shown that fluctuations with diurnal and semidiurnal periods are not always in phase, they sometimes are absent in the laser data, and time shift 2-4 h between them can change sign. That means that explanation of microdeformations with such periods as tidal loading on the crust near the shore is not always correct. We suggest that internal tides, bores and hydraulic jumps in the shelf zone can also be the mechanism for microdeformations in crust.

Fluctuations of air pressure, that are due mainly to the atmosphere two-dimensional and three-dimensional waves and eddies, have spectra that are similar to the spectra of

the crust microdeformations. The both obey exponential law ω^{-2}. The conclusion can be made that transfer of energy of strain in the Earth crust from low to high frequencies or from large to small scales follow the same law as in hydrodynamic nonlinear waves or inertial turbulence, but with much higher velocity. Using the Hilbert-Huang method we discovered the zones of very sharp gradients of energy in time-frequency space. After such zones spectra are monotonous and similar to white noise in higher frequencies, though they have considerable picks and hollows in lower frequencies.

Interesting results were obtained when analyzing Hilbert-Huang spectra of natural earthquakes and artificial explosions. Detailed analysis of the Izmit earthquake in August 1999 and explosion in North Korea in September 2004 revealed principal differences in their spectral structure, that can be used for remote identification of such phenomena. Distance to the explosion source was estimated from the time shift between longitudinal and transversal waves registration.

Referencies

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