Problems of identification of tectonic movements by satellite radiointerferometry methods

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Low-to-moderate magnitude earthquakes often induce small ground displacement. For such events, the ground deformation fields detected by satellite interferometry may be masked or not clearly distinguishable in the distribution of interference fringes due to the presence of error sources such as atmospheric influences, inaccuracies in the reference digital elevation model and orbital errors.

We have integrated the method of differential radar interferometry (DRI, DinSAR) according to the data of ALOS-1/2 PALSAR-1/2 radars and the method of permanent scatterers (Persistent Scatterers, PS) using Sentinel-1B and ALOS time series PALSAR. The zoning of moving blocks and the assessment of trends in the direction of movements were carried out using the DRI method. Using the PS method, the character of surface deformation was detailed. For these permanent scatterers, a set of interferometric phase relations is calculated with respect to one reference image, which makes it possible to more accurately estimate the magnitude and rate of deformations of discretely located permanent scatterers in comparison with DRI. An increase in accuracy is achieved by using several tens of interferograms. This allows you to significantly reduce the influence of the atmosphere and inaccuracies of the reference digital elevation model and orbital errors. The shortcoming of the PS method is the result in the form of individual points, so it is logical to combine it with DDT, the result of which is a continuous surface deformation field.

As a result of satellite measurements obtained for the period from May 06, 2017 to October 05, 2020 for the region of the Bystrinsky earthquake with a magnitude M = 5.5 (which occurred on September 21, 2020 near the southern tip of Lake Baikal), two blocks with different velocities were found positive deformations until 2020. In 2020, the uplift rate for these blocks stabilized, and before the earthquake, the difference in deformation values was 16–18 mm. The resulting deformations over 3 years averaged approximately 17 mm and 30 mm for different areas. Similar calculations performed for the period from January 1, 2007 to February 27, 2011 for the Kultuk earthquake with magnitude M=6.3 (occurred on August 27, 2008) made it possible to reveal comparable differences in the deformation values and block dynamics before this seismic event (of the order 12-13 mm). The smaller difference in the earth's surface deformations for the Kultuk earthquake compared to the Bystrinsky earthquake is probably due to the greater remoteness of the studied area from the epicenter of the seismic event.

The results obtained indicate the presence of slow tectonic movements leading to an earthquake and the prospects for the integrated use of satellite radar interferometry methods for recording earth surface deformations preceding seismic events.

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