Geophysical Research Abstracts
Vol. 14, EGU2012-12519, 2012
EGU General Assembly 2012

Calculation of Tectonic Block Rotation Parameters from GPS Data

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Any motion on spherical surface can be interpreted as a rotation around a single axis which crosses the center of the sphere. Hence, the movement of tectonic blocks also is a rotation. Usually, the motion of the blocks (or clusters) is described by two parameters: the location of rotation pole and the absolute value of angular velocity.
The objectives of the present work are the following:
- to develop a method for determination of block's rotation parameters from a set of linear velocities measured (e.g., by GPS) within the block;
- to compare the results with the outcome from several existing geodynamic models;
- to develop an automatic clusterization algorithm (i.e. a method for identifying separate blocks within a region) based solely on the field of Earth crust velocities.
This method uses the least squares fit. The locations of observation points and the corresponding velocities of the Earth crust are used as the input data. To test the method, we applied the GPS (Global Positioning System) data on the lithospheric plates. The method is universal and can be implemented with any data of linear velocities obtained at 3 observation points, at least. The quality of the results depend on the number of points and the accuracy of the velocity measurements. The outlier data values may produce large uncertainties and do not reflect the real block movement. Such points can deteriorate the general results. Therefore, the method follows 3 stages: calculating of the rotation parameters from the original input; identifying and filtering out the outliers; and subsequent recalculation of the rotation parameters based on the corrected data.
We compared the results of the method with the outcome from the NNR-NUVEL1a and MORVEL models. The agreement between the modeled rotation parameters and those obtained from the proposed method was satisfactory. The automatic clusterization algorithm is based on the method above. To validate it, we also used the GPS data. The results were compared with the established map of the lithospheric plates. In about 80% of cases, the method yielded correct identification of the blocks.