Geophysical Research Abstracts
Vol. 14, EGU2012-4667, 2012
EGU General Assembly 2012

Rapid processing of data based on high-performance algorithms for solving inverse problems and 3D-simulation of the tsunami and earthquakes

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We consider new techniques and methods for earthquake and tsunami related problems, particularly - inverse problems for the determination of tsunami source parameters, numerical simulation of long wave propagation in soil and water and tsunami risk estimations. In addition, we will touch upon the issue of database management and destruction scenario visualization. New approaches and strategies, as well as mathematical tools and software are to be shown.

The long joint investigations by researchers of the Institute of Mathematical Geophysics and Computational Mathematics SB RAS and specialists from WAPMERR and Informap have produced special theoretical approaches, numerical methods, and software tsunami and earthquake modeling (modeling of propagation and run-up of tsunami waves on coastal areas), visualization, risk estimation of tsunami, and earthquakes. Algorithms are developed for the operational definition of the origin and forms of the tsunami source.

The system TSS numerically simulates the source of tsunami and/or earthquakes and includes the possibility to solve the direct and the inverse problem. It becomes possible to involve advanced mathematical results to improve models and to increase the resolution of inverse problems. Via TSS one can construct maps of risks, the online scenario of disasters, estimation of potential damage to buildings and roads.

One of the main tools for the numerical modeling is the finite volume method (FVM), which allows us to achieve stability with respect to possible input errors, as well as to achieve optimum computing speed. Our approach to the inverse problem of tsunami and earthquake determination is based on recent theoretical results concerning the Dirichlet problem for the wave equation. This problem is intrinsically ill-posed. We use the optimization approach to solve this problem and SVD-analysis to estimate the degree of ill-posedness and to find the quasi-solution.

The software system we developed is intended to create technology «no frost», realizing a steady stream of direct and inverse problems: solving the direct problem, the visualization and comparison with observed data, to solve the inverse problem (correction of the model parameters). The main objective of further work is the creation of a workstation operating emergency tool that could be used by an emergency duty person in real time.