Coupled Inverse Problems and Visualization of Atmosphere-Ocean System

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ABSTRACT

Atmosphere-Ocean system is mathematically described by system of hyperbolic equations. The parameter identification of Atmosphere-Ocean system using combined additional measurements is called coupled inverse problem for hyperbolic equations. These problems are ill-posed, *i.e.* their solutions are not unique or/and unstable, and should be regularized [1-3].

As an example we consider coupled inverse source problem for the linear shallow water equations that use for describing long waves (tsunamis). First, we investigate two different inverse problems of determining a tsunami source using two different additional data: measurements of the height of a passing tsunami wave at several given points of the coastal area (for example, Deep-ocean Assessment and Reporting of Tsunamis (DART) measurements) [2] and measurements of the wave distribution at a fixed time (for example, satellite altimeters data) [3]. We consider the operator form of each inverse problem $Aq=f$ and describe the regularization algorithm based on truncated singular value decomposition of A. We reduce each inverse problem $Aq=f$ to the problem of minimization the misfit function $J(q)=||Aq-f||^2$. To calculate the gradient of the misfit functions, the adjoint problems are solved. In numerical experiment we used conjugate gradient method for solving inverse source problems.

The main idea consists of combination of two measured data to reconstruct the source parameters. Results of numerical experiments of the tsunami source reconstruction are presented and discussed. We show that using a combination of two types of data allows one to increase the stability and efficiency of source reconstruction.

Non-profit organization WAPMERR (World Agency of Planetary Monitoring and Earthquake Risk Reduction) in collaboration with GeoSystema Ltd. and ICM&MG SB RAS developed the Integrated Tsunami Research and Information System (ITRIS) to simulate tsunami waves and earthquakes, river course changes, coastal zone floods, and risk estimates for coastal constructions at wave run-ups and earthquakes. The special scientific plug-in components are embedded in a specially developed GIS-type graphic shell for easy data retrieval, visualization and processing.

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