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Neural network approach to the prediction of seismic events based on the VLF/LF signal monitoring of the Kuril-Kamchatka region

I.V. Popova (1), A.A. Rozhnoi (1), M.S. Solovieva (1), B.V. Levin (2), M. Hayakawa (3), K. Schwingenschuh (4), and P.F. Biagi (5)

(1) Institute of Physics of the Earth, RAS, Moscow, Russia, (2) Institute of Marine Geolog&Geophysics, RAS, Yuzho-Sakhalinsk, Russia, (3) University of Electro-Communications, Chofu-Tokyo, Japan, (4) Space Research Institute, Austrian Academy of Sciences, Graz, Austria, (5) Department of Physics, University of Bari, Bari, Italy

A method of estimating of the VLF/LF signal sensitivity to seismic processes using neural network approach is proposed. To predict a seismic events we apply the error back-propagation technique, based on a three-level perceptron. Backpropagation technique involves two main stages of solving the problem: the training of the network and recognition (the prediction itself). In order to train a neural network, we first create a so-called "training set". The "teacher" specifies the correspondence between chosen input and output data. In our case a representative data base has been collected that includes both the VLF/LF data received during three-year monitoring (2005-2007) at the station in Petropavlovsk-Kamchatski and the seismicity parameters of the Kuril-Kamchatka region. At the first stage neural network established the relationship between the characteristic features of the LF signal (mean and dispersion of phase and amplitude in night-time for a few days before the seismic event) and corresponding level of correlation with the seismic event or lack of it. Teaching procedure is based on gradient descent technique, minimizing the error between the target values of outputs specified "teacher" and those that produce the neural network in the process of error minimization. The procedure of recognition (prediction) uses the neural network interpolation and extrapolation properties. Unlike the training procedure requiring many steps of iteration process the prediction requires only one passage of the recognizable signal from input to output. The final result formed at the output may be treated as a level of correlation with the seismic event or lack of it. To predict a seismic event from LF data we have chose twelve time intervals in 2003, 2005, 2006, 2007. The time intervals were lasting from 6 to 8 days including the day of seismic events of magnitude $M \geq 5.5$. For six of the twelve time intervals the neural network has detected changes in LF signal indicating the earthquake of magnitude $M \geq 5.5$ a few (2-3) days in a row before the earthquake, including the day itself. For the other three time intervals neural network has detected changes in a signal indicating an earthquake on the third and fourth day before the earthquake, including the prediction of the earthquake in day itself. However, changes in the signal were not detected in the first and second day before the earthquake. For the rest three time intervals correlations between the seismic events of magnitude $M \geq 5.5$ and changes in the signal were not found.