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VLF electromagnetic signal observation for possible short-term earthquake forecast

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Recent devastating earthquakes such as Japan 2011, Nepal 2015, Italy 2016 etc. have proved the dangerous effects of earthquakes and the importance of detailed studies to mitigate risk resulted from such disasters. One of the important problems to be solved is earthquake short-term forecast.
Electromagnetic observation is a promising field to solve this problem. Such observations can be of two types: 1) direct observation of electromagnetic waves from earthquake hypocenter and 2) indirect effects of earthquakes on earths ionosphere using pre-existing radio signals (radio sounding). In this research we concentrate radio sounding of ionosphere as recent studies have shown it to be very sensitive to seismic activity.
For the study we use signals from Very Low and Low Frequency (VLF/LF) transmitters operating by different countries and primarily used for submarine communications. Most of energy radiated form these transmitters is trapped between earths surface and lower ionosphere, so changes in ionosphere conditions can be detected observing VLF/LF waves propagating in earth-ionosphere wave-guide. When the ionosphere is affected by different reasons such as magnetic storms, solar flares, lightning discharge, meteors, seismic activity, their effect can be seen in the VLF/LF signal anomalies.
First receiver antenna system is located at Tbilisi State University Ionosphere observatory, in Tabakhmela near Tbilisi. VLF signals are received from 10 transmitters in frequency range of 15-25 kHz. Most of these transmitters are located in Western Europe, with distance to receiver $\sim$1500-3500 km. The receiver system has been operating and collecting data since Spring 2011.
We present some of the results from observing strong earthquakes. Data analysis has shown two different effects: 1) amplitude and phase fluctuations start a few hours before earthquake on all observed frequencies and last few hours after earthquake. 2) day-night terminator effect can't be observed from few days to two weeks before earthquake on one of the transmitter signals. This effect lasts few days after earthquake.
An additional antenna system is being prepared and will soon be installed in Dusheti, about 50 km north of the first system to decrease noise effect.
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