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Natural time analysis for seismicity in Japan

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The VAN method has been the only working short term earthquake prediction system for more than two decades. The indeterminacy of a few weeks for the occurrence time of main shocks has been a drawback.

If earthquake is a critical phenomenon as defined in statistical physics, prediction is synonym for identifying the approach to criticality. Varotsos and colleagues proposed that by analyzing the seismicity in a newly introduced time frame called "natural time", the approach to criticality can be clearly identified. In natural time, based on the premise that a system has its own clock, the time is assumed to proceed only when an event takes place. It was found empirically that if the analysis is started at the time of SES (Seismic Electric Signals in the VAN method) appearance, the main shock occurs a few days after the criticality has been recognized. This means, seismic catalogs can play an amazing role in short term prediction to reduce the prediction lead time when combined with SES data.

We made a statistical analysis on seismicity in both natural and conventional times and confirmed that natural time is more efficient and the order and magnitude of earthquakes do play an important role in recognizing criticality. We also tried the natural analysis on major $M > 7$ earthquakes in Japan, including 1995 M7.3 South Hyogo Pref. (Kobe), 2000 M7.3 Western Tottori Pref., 2003 M8.0 Tokachi Oki, 2004 M7.1 Off Kii Peninsula, 2005 M7.0 West-off Fukuoka Pref., 2008 M7.2 Iwate-Miyagi Nanbu earthquakes for which no SES data exists and 2000 earthquake swarm in Izu island region. Some positive results were obtained except for Tokachi and Iwate-Miyagi cases.

Keywords: Natural Time, Seismicity, Critical phenomena