

Increasing critical sensitivity of the Load/Unload Response Ratio before large earthquakes with identified stress accumulation pattern

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Abstract

The Load/Unload Response Ratio (LURR) method is proposed for short-to-intermediate-term earthquake prediction [Yin, X.C., Chen, X.Z., Song, Z.P., Yin, C., 1995. A New Approach to Earthquake Prediction — The Load/Unload Response Ratio (LURR) Theory, *Pure Appl. Geophys.*, 145, 701–715]. This method is based on measuring the ratio between Benioff strains released during the time periods of loading and unloading, corresponding to the Coulomb Failure Stress change induced by Earth tides on optimally oriented faults. According to the method, the LURR time series usually climb to an anomalously high peak prior to occurrence of a large earthquake. Previous studies have indicated that the size of critical seismogenic region selected for LURR measurements has great influence on the evaluation of LURR. In this study, we replace the circular region usually adopted in LURR practice with an area within which the tectonic stress change would mostly affect the Coulomb stress on a potential seismogenic fault of a future event. The Coulomb stress change before a hypothetical earthquake is calculated based on a simple back-slip dislocation model of the event. This new algorithm, by combining the LURR method with our choice of identified area with increased Coulomb stress, is devised to improve the sensitivity of LURR to measure criticality of stress accumulation before a large earthquake. Retrospective tests of this algorithm on four large earthquakes occurred in California over the last two decades show remarkable enhancement of the LURR precursory anomalies. For some strong events of lesser magnitudes occurred in the same neighborhoods and during the same time periods, significant anomalies are found if circular areas are used, and are not found if increased Coulomb stress areas are used for LURR data selection. The unique feature of this algorithm may provide stronger constraints on forecasts of the size and location of future large events.

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1. Introduction

Over the past decade an earthquake prediction method named the Load/Unload Response Ratio (LURR) has been developed by Yin and others (e.g. Yin et al., 1995, 2000, 2004). Before the occurrence of a large earthquake ($M > 6.0$), anomalous increase in the time series of LURR

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