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## 2011年日本东北大地震特低频地磁信号的分形标度特征研究

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Non-uniform scaling behavior in Ultra-Low-Frequency (ULF) geomagnetic signals possibly associated with the 2011 M9.0 Tohoku earthquake

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摘要

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**摘要** 本文选择2011年3月11日M9.0日本东北大地震震中附近三个地磁台站16个月(2010/01/01—2011/04/30)的特低频地磁观测资料,采用去倾扰动分析方法,得到了这三个台站地磁记录的非均匀标度特征随时间的变化,提出了一种能反映地磁三分量非均匀标度特征同步变化的指标,并据此探讨了特低频地磁信号分形标度特征变化与日本东北大地震之间的可能关联性,初步结果表明,这三个台站的特低频地磁信号分形标度特征指标在日本东北大地震前25~50天左右呈现出同步的异常增加,基于磁静日观测资料的随机合成地磁数据的统计检验结果可知前述异常并非随机异常,而是一种具有统计显著性的异常,可能反映了日本东北大地震对周边地磁信号内在的非线性系统特征产生了有统计意义的影响。

**关键词** 去倾扰动分析(DFA), 非均匀标度特征, 地震

**Abstract:** We analyze the daily scaling properties of Ultra-Low-Frequency (ULF) geomagnetic time series from January 01, 2010 to April 30, 2011 observed at three stations near the epicenter of the 2011 M9.0 Tohoku earthquake. By means of the detrended fluctuation analysis (DFA) method, deviations from uniform power-law scaling were identified and quantified using a scaling index. We also proposed a new non-uniform scaling index taking into account the information of the three components of geomagnetic data. Our results suggest that a significant increase of non-uniform scaling index in ULF geomagnetic data appeared about 25~50 days before the Tohoku earthquake. The further stochastic test using synthetic geomagnetic data with randomized disturbances indicates that the fractal anomalies revealed by the non-uniform scaling index in the geomagnetic data are likely non-random anomalies. Thus one may conclude that the scaling properties of the local nonlinear system are possibly affected by the Tohoku earthquake.

**Keywords** Detrended Fluctuation Analysis (DFA), Non-uniform scaling behavior, Earthquakes

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