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Long-term seismic quiescence lasting 22 years before the 2011 off the Pacific coast of Tohoku earthquake ($M=9.0$)

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A long-term seismic quiescence started 22 years before the 2011 off the Pacific coast of Tohoku earthquake ($M=9.0$) is found by analyzing an earthquake catalog compiled by Japan Meteorological Agency (JMA). The catalog includes 5,770 earthquakes shallower than 60 km with $M \geq 4.5$. A detailed analysis of the earthquake catalog between 1965 and 2010 using a gridding technique (ZMAP) shows that the 2011 Tohoku earthquake is preceded by a seismic quiescence anomaly that starts in the middle of 1989, and lasts about 22 years, until the occurrence of the main shock. The quiescence anomaly area is located around the deeper edge of the asperity ruptured by the main shock, and the Z-value is +4.9 for a time window of $T_w=15$ years, using a sample size of $N=150$ earthquakes. The seismicity rate clearly decreases from 3.0 to 1.5 events/year (a drop of 50%). A hypothesis is presented in this study that seismic quiescences lasting more than 20 years are a long-term precursor to giant earthquakes ($M \sim 9.0$) in subduction zones.

Keywords: seismic quiescence, the 2011 Tohoku earthquake, JMA earthquake catalog, ZMAP, Z-value