Significant Decrease of Seismicity in the Northeastern Margin of the Japan Sea after the Mega Thrust Event on Mar. 11, 2011

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Since Matsu’ura (1986) first showed the quantitative way to detect relative quiescence in seismicity during aftershock sequences, the relative quiescence of seismicity has been a good index to prognosticate the occurrence of large earthquakes. Ogata (1988) extended it to the wider area with the proposal of ETAS model as the quantitative expression of the ordinary seismicity. Since we have the reliable catalogue of earthquakes of M6.0 and larger in and around Japan for more than 130 years, we could detect the largest relative quiescence lasting for 10 years in the area east off Tohoku district, prior to the M9.0 2011 earthquake off the Pacific coast of Tohoku (Matsu’ura, 2008). Here we report the current significant decrease of seismicity in the northeastern margin of the Japan Sea area.
The 2011 earthquake off the Pacific coast of Tohoku dramatically changed the seismicity in and around Japan, especially in the northeastern Japan. For example, many shallow earthquakes now frequently occur in the north Ibaraki area and Iwaki area, where the seismicity had been very low before the 2011 mega thrust event. The area currently showing the relative quiescence includes the seismic gap between the source areas of M7.7 1983 central part of the Japan Sea earthquake and M7.8 1833 Tenpo off Dewa district earthquake, without any known large event for the recent 400 years (e.g. Matsu’ura et al, 2012). Since JMA finished the revision of the hypocenter catalogue, which had been delayed after 2011, by the end of March in 2014, we used the JMA catalog for the period from October 1997 to January 2017. To avoid the intentional area or event selections, we firstly analyzed the whole earthquakes of M=2.5 and larger and depth=60km and shallower within the wide area of (37˚N, 137˚E) –(41.6˚N, 140.1˚E), where some major activities before 2011 and induced events after 2011 are included. Even though, it is apparent that the seismicity decreased since 2013 in that wide area. If the analyzed area is set narrower around the gap, it becomes clearer. In the figure 4(A) of Ogata (2011) showed the apparent relative quiescence prior to the M7.7 1983 event and M7.8 1993 event in the same region. We cannot conclude now whether the current quiescence represents the same physical status as those prior to 1983 and 1993 cases, or just shows the weakened compressional stress field in the northeastern margin of the Japan Sea due to the 2011 event. However, we should watch the area and search other clue to obtain the answer.

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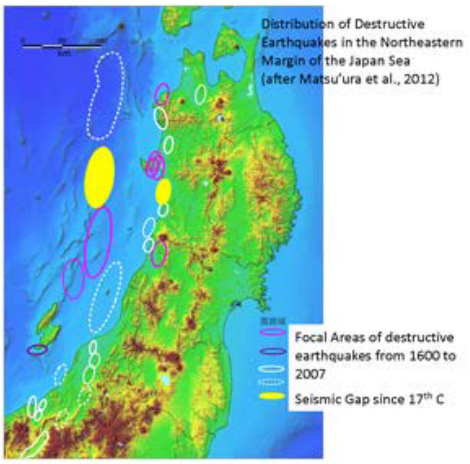
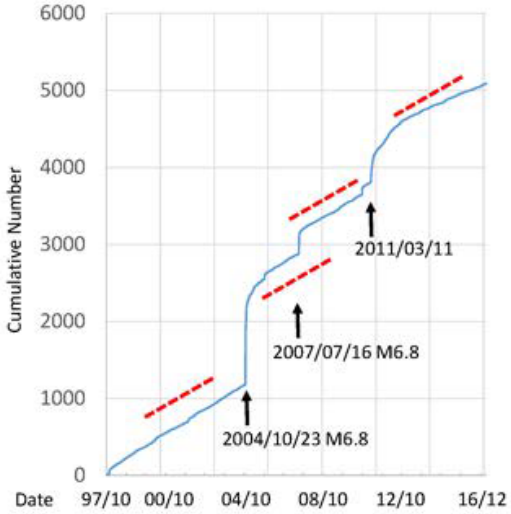


Fig. 1(a) Distribution of focal areas of the recent 400 years in the northeastern margin of the Japan sea and the gaps.



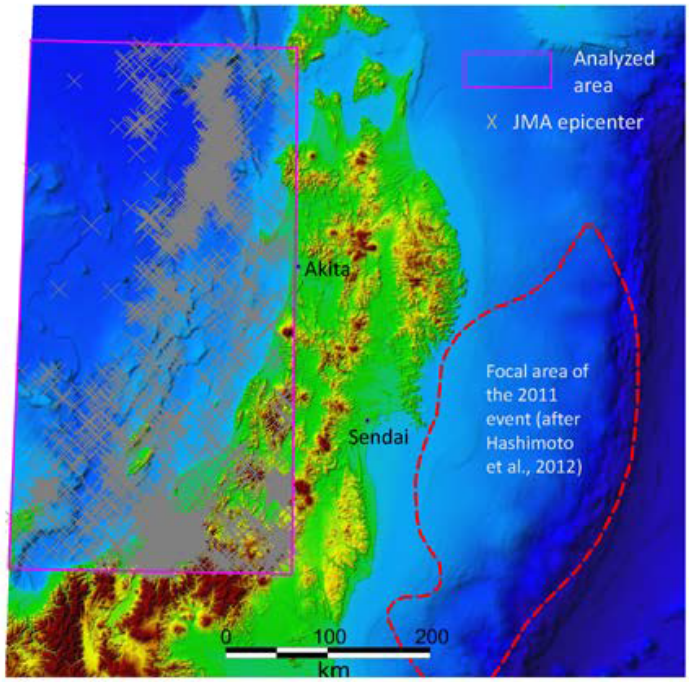


Fig. 1(b) Epicenters of counted events in (c). The focal area of M9.0 event in 2011 is also shown. Earthquakes of M>=2.5 and Depth<=60km in the area are all used in (c).

Fig. 1(c) Cumulative number of earthquakes since 1997 Oct. 1st. Times of two large events within the analyzed area shown in (b) and the M9.0 are shown by arrows. All red broken lines show the same occurrence rate.

