

Significant fluctuations in the atmospheric radon concentration in Fukushima before the 2011 Tohoku Earthquake

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Introduction The Tohoku earthquake ($M_W = 9.0$) occurred in 11 March 2011. From the continuous GPS measurement of the northeastern Japan before the earthquake, Suito et al. (2011) reported that the significant post-seismic deformation of three GPS sites in Fukushima after M7-class interplate earthquakes occurred along the Japan trench in 2005, 2008 and 2010. We obtained the atmospheric radon concentration at Fukushima Medical University (FMU: Fukushima city), University of Tokyo (IMSUT: Minato-ku, Tokyo) and Keio University (KU: Shinjuku-ku, Tokyo). The daily minimum Rn-222 concentration (radon data) is considered to reflect the wide area radon concentration in the atmosphere. Before the Kobe earthquake, the fluctuations in the radon data were linked to the fluctuations in crustal strain of the order of 10^{-6} to 10^{-8} (Yasuoka et al., 2011). In this paper, we analyzed whether the variations in daily minimum radon concentration at FMU, IMSUT and KU were changed significantly before the Tohoku earthquake.

Method The 3 radon data were measured with air flow ionization chambers (DGM-101 Hitachi Aloka Medical, Japan: exhaust air monitors at the radioisotope institutes) at FMU (outside air from about 7 m), IMSU (outside air from about 6.5 m) and KU (outside air from ground level). The variations of the radon data were smoothed during the measured period with exponential smoothing. The normal period (before 2007) was decided before the occurrence of the 3 peaks at FMU (see results and discussion). The seasonal variations during the normal period, which were calculated by using the daily minimum, were smoothed with exponential smoothing. The residual radon variations represented the smoothed radon data with the smoothed normalized seasonal variations removed (Yasuoka et al., 2012). Predicted value with ARIMA model (Yasuoka et al., 2011) is used to evaluate whether random variation is exceeding its range of normal variation. Using the residual radon variations before 2007, we estimated the predicted values (the upper 95% confidence limit, fitting line and lower 95% limited confidence) after 2008 (Yasuoka et al., 2011).

Results and discussion The residual radon variations started to decrease from around 2003 at FMU, IMSUT and KU. The residual radon variation at FMU had the 3 peaks exceeding 95% limited confidence line from 2008 to 2010. The residual radon variation at IMSUT had the 2 peaks in 2009 and 2010, which could be linked to the 2 peaks at FMU in the same period, while, they remained between the upper and lower confidence limit. The variation of the radon data at KU showed the same trend of the variation at IMSUT. From the comparison with the GPS time series of E-W component before the 2011 Tohoku earthquake (Suito et al., 2011), it is possible that the 3 peaks in FMU could be linked to the coseismic and postseismic deformation of the earthquakes that occurred along the Japan trench in 2008 and 2010.

Reference

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