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# *Interactive comment on* "Stochastic consideration of relationship between occurrences of earthquake and fluctuations in the radio wave propagation" *by* Kuniyuki Motojima et al.

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Reply to comments by anonymous referee 2

Thank you for reviewing and commenting about our paper. We think that your comments are important and quite right, and they remind us the lack and unclear points in our paper. We added statistical results and modified unclear points. Additional and modified points are given as follows.

1. The ROC analysis. We conducted the ROC analysis with varying the threshold level for determining anomalous fluctuation. In our verification by the ROC graph, let the Positive instance be the day earthquake occurred, and the Negative instance be



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the day NOT occurred. For the predicted classes, let the predicted Positive instance be the day anomalous fluctuation occurred, and the predicted Negative instance be the day NOT occurred. Therefore, true positive rate, which is vertical axis in the ROC graph, is the ratio of the number of days both anomalous fluctuation and earthquake occurred to the number of days earthquake occurred. False positive rate, which is horizontal axis, is the ratio of the number of days anomalous fluctuation occurred without earthquake to the number of days earthquake NOT occurred. The diagonal line in ROC graph presents strategy of randomly guessing test, which means that there is no relation between anomalous fluctuation and earthquake. When the result appears in the higher left triangle, it performs good determination, which means that there is some relation between both phenomena. The outsider from the diagonal is the better for determination. Low threshold levels for determining anomalous fluctuation are plotted in right-hand of ROC graph, and high threshold levels are plotted in left-hand. For high threshold levels the results of our determination show good performance, because they are depicted away from the diagonal. For low threshold levels the results appear around the diagonal, they are nearly random guess. We use the threshold level of wavelet coefficient th =3.0, which is indicated by arrow in the ROC graph. Results of other threshold level around th =3.0 take the position away from diagonal line too. It means that the result by th =3.0 is not particular, it is reasonable threshold level. The PG is denoted in a way similar to the ratio of true positive to random guess. Therefore, higher threshold levels, which have low random guess, indicate good result of the PG, not low threshold levels. The result of ROC analysis is added into the paper.

2. Extension of horizontal axis in Fig. 4 (Fig. 5 in revised paper). The probability gain (PG ) was recalculated with the horizontal extension (t_per ) and taking short time steps. Figure 4 shows the PG with varying the defined length of time period t_per. New short time step size of t_per is 6-hours, because the time duration of Morlet mother wavelet has about 6-hours in case of the scale of mother wavelet a=9.775. Moreover, horizontal period of t_per is extended to -720 $\sim$ +720 hours, -30 $\sim$ +30 days. Both before and after earthquake the PG converges to one with the increasing absolute of

t_per. It means that the longer t_per has the less relation between anomalous fluctuation and earthquake. Additionally, we can get higher value of the PG , which has maximum value 9.59 at t_per = -12 hours before earthquake in NHK FM Tokyo wave. For t_per =-1 day the PG was 7.21. It indicates that the anomalous fluctuations occur closer to the seismic time frequently. The PGs in Table 3 are recalculated by short time steps, 6-hours. They show higher PGs than the result by 1-day time steps.

3. EQs catalogue de-clustered. We used not the de-clustered EQs catalogue, because our target earthquakes are smaller magnitude. Maximum magnitude in our analyzed period is 6.3. Almost earthquakes not require de-cluster. However, the statistical result may be contaminated a little.

4. Short time steps of horizontal axis in Fig. 4 (Fig. 5 in revised paper). The referee 's comment about time steps in Fig. 4 hits the nail on the head. We recalculated with short time steps, 6-hours. It was described above 2.

5. Missing epicenter location. The location of epicenters was missed in Fig. 1. We added the epicentral locations into new figure, Fig.4.

6. Tables of earthquakes and anomalous fluctuations. For table 3, catalogs of all earthquakes of N_eq, occurrence of anomalous fluctuations N_anom and the PGs with varying t_per are uploaded as supplementary materials. The person who get an interest in our paper can derive same statistical results by using these supplementary materials.

We would like to review our paper again.

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2016-379/nhess-2016-379-AC2-supplement.zip

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