Replies to Referee #1

Specific comments:

(a) The present study for the Prediction of fault size, motion, magnitude and rupture time must be extended for all the cases with a magnitude over a specific threshold for the better evaluation of the suggested method.

Reply to (a):

The successful evaluation of our deterministic prediction model is made for the events whose M are larger than about 6 throughout Japan except for the motion analyses by using JMA unified hypocenter catalogs. For example, one evaluation has 15 cases presented at:

Takeda, F., The precursory fault width formation and critical stress state of impending large earthquakes: The observation and deterministic forecasting; AGU, Fall Meeting 2009, NH13A-1126, http://adsabs.harvard.edu/abs/2009AGUFMNH13A1126T

This reference should be added to the current article in relation to referrer #2's comments.

Reference (Takeda, 2015) has other events included. One of them is the 2011 great Tohoku EQ. The reference is the 130 page Japanese patent with 85 figures most of which are those figures like Fig. 2a-c, 3.a, 5, 6, 7a-b and 8a-b.

(b) The present study must be framed by the appropriate statistical analysis of the results including the false alarm rate.

Reply to (b):

One of our objectives is to show how to extract deterministic physical laws for precursory phenomena of impending large or great events by using a mathematical tool (physical wavelets). The extraction then allows us to build the physical models for CQK and CQT by which to predict impending large events. A few cases, which are related to EQ swarm and CQK stress loading, require some refinements on the deterministic prediction model as stated in the text. Since the model is based upon physical laws, the refinements are supported by physics as described in (Takeda, 2015). Our prediction model does not have a false alarm rate as the statistical prediction model should have.

(c) This analysis is closely related to the natural time analysis in which the order of the event (as an index) is also considered as one of the main characteristics of the examined time series. I am suggesting the following two references to be included: Natural-time analysis of critical phenomena: The case of seismicity PA Varotsos, NV Sarlis, ES Skordas, S Uyeda, M Kamogawa EPL (Europhysics Letters) 92 (2), 29002 Natural time analysis of critical phenomena P Varotsos, NV Sarlis, ES Skordas, S Uyeda, M Kamogawa Proceedings of the National Academy of Sciences 108 (28), 11361-11364

Reply to (c):

The natural time becomes a probabilistic quantity in its statistical model describing one aspect of seismicity. The references suggested by referee #1 have the seismicity in EQ catalogues studied within the framework of the statistical model studied in other branches of Statistical Physics.

The use of the chronological index as a time in the time series analyses has been established for many decades. The index does not become a probabilistic quantity so that one can study the statistical properties of the observations (time series data) as those (including DNA sequence in page 15) in 'Fractal Concepts in Surface Growth / A.-L. Barabási and H. E. Stanley'; Cambridge University Press 1995, and those in 'Is the Normal Heart Rate Chaotic?'; Chaos 19, 028501, 2009. Their studies are to find statistical quantities to characterize their physical systems.

In our EQ source parameter time series $d(c, m)$, where $c$ = *LAT*, *LON*, *DEP*, *INT* and *MAG*, the chronological index (time $m$ or $t$ ) is not a probabilistic quantity so that we can define time derivatives of $d(c, m)$ to find physical laws for precursory phenomena of impending large EQ.

In the seismic observation of $d(c, m)$, the virtual particle can change discontinuously in direction and speed just like a small particle (a colloidal particle) immersed in a large volume of liquid (Disperse systems / Makoto Takeo; Wiley-VCH, 1999, ISBN 3-527-29458-9, page 43 - 46). Thus it is not differentiable with respect to time.

Physical wavelets solve this issue of finding velocity and acceleration of the particle so that one can find physical laws for precursory phenomena of impending large EQs. The laws build a deterministic physical model of EQ prediction stated in section 4.2. The model can also be compared with other seismic (seismogenic) observations made by Jin and Aki as stated in the text. Our model, of course, must be refined by the observations to be made at various tectonically active regions.

Thus, the index time in time series data is not closely related to natural time in both many established statistical analyses and our deterministic analyses.

In the time series $d(c, m)$ of the daily displacement observed by GPS as stated in the text, the index $m$ is a day. The environmental noises of GPS prohibit time derivatives of $d(c, m)$; however, physical wavelets solve this issue. If there exists unique relationship between the real time and the index m, any index may be used as a time for its time derivatives of non-differentiable time series. Natural time cannot be used for the differentiations (see page 45 in Disperse systems / Makoto Takeo; Wiley-VCH, 1999).

(d) The analysis of the "Automatic detection of anomalies leading to the catastrophes of physical systems" needs improvement including for example among others a cross-correlation diagram respect to the time.

Reply to (d):

The examples of the cross correlation diagrams are given in references (Takeda, 1994, 1995, 1996;

Takeda et al., 2000; TEC21, 2017d). I can also add one of my Japanese patents, (Takeda, F.; Detecting Systems of Changes in Motion, Japanese Patent 2787143, J–PlatPat, JP, 1995-146161, A.1998), which was used for my consultant works of the industrial systems at large heavy industrial companies. The contracts prohibit any disclosure of detailed information. The principles and simulated experimental tests used in these projects are in the references stated above. I should have placed the references stated above in appropriate places.

Technical corrections:

(a) The quality of the figures needs improvement

Reply to (a);

I plan to improve the figure quality as much as I could.

(b) Grammatical errors:

Reply to (b):

I very much appreciate your corrections.

Page 1, line 26: with Global -> by Global

Page 1, line 30: on crustal surface -> on the crustal surface

Page 2, line 4: As an example of many test -> As an example of many tests

My correction to this is:

As an example of many hindsight and real-time extractions

Page 4, line 23: oscillometeric -> oscillometric C2

Page 4, line 26: complete -> a complete

Page 6, line 26: Similarly -> Similarly,

Page 7, line 31: reginal -> regional

Page 8, line 4: Similarly -> Similarly,

Page 8, line 14: every large and great events -> every large and great event

Page 10, line 2: Similarly -> Similarly,

Page 10, line 14: by arrow -> by an arrow

Page 11, line 16: and main event, -> and main event

Page 11, line 17: The sequence appears as a cycle of strain energy accumulation and release to the M9 event, -> release: wrong grammar

My correction to this is:

The sequence appears as a cycle of strain energy accumulation and decrease to the M9 event,

Page 11, line 24: characterized with magnitude -> characterized by magnitude

Page 12, line 12: about a year and half -> about a year and a half

Page 12, line 19: which appear -> which appears

Page 12, line 28: prediction on the fault size and motion -> prediction of the fault size and motion