1 Quotation of the general comment: “1) the authors state in the title the term "Earthquake Early Warning System" (EEWS). I suggest to remove this term from the title since the authors fail to prove the relation of their proposal to the purposes of an EEWS. More specific: a) all the introduction section presents a classical historical review of EEWSs without pointing the (possible) relation between authors proposal and EEWS. b) In section 4, the only reference to the (possible) embedding of results to an operational EEWS are given by the statement at the end of p.15: "It will have good potential application in the future EEW system". This is obviously not adequate and does not prove the usability of the proposed method for the purposes of EEWS. What the reader will expect to see is for example, block diagrams of where and how the proposed method will co-integrate with other elements of EEWS, the performance of EEWS with the addition of proposed method (even in simple term of false alarms/missed alarms) and so on. c) In addition, at discussion section, the authors didn’t provide a satisfactory discussion of how an EEWS will be benefited from the proposed method. ”

Reply: In fact, this method could be used to real-time or near real-time seismic hazard mitigation system, such as the seismic intensity repaid report system and the earthquake early warning system. Usually, in the real-time and near-time seismic hazard mitigation system, the site amplification factor was given as a scalar value. So it could not reflect the different amplification for different frequency. The proposal that completely remove the term “earthquake early warning system” is reasonable. Then the title of this paper could be changed to” Study on real-time site amplification correction”.

Yes, we presents a classical historical review of EEWs, we need to point the relation between our paper and EEWS clearly.

These EEWs include the current conventional system in the world, many of present EEWs needs to quickly determine the earthquake hypocenter and magnitude based on amplitude or frequency content of start portion of waveform firstly, then predict the strengths of ground motions at various sites by applying a ground motion prediction equation (GMPE) that uses the hypocenter distance and magnitude.

In fact, The EEW magnitude is not important to the public. We need to predict the ground motion more accurately for giving useful information to the public. This method based on the front detection station to predict ground motion real-timely at the target station without any hypocentral parameters. It skips the procedure to calculate the EEW magnitude use the start potion of the waveform. We can obtain the waveform real-timely at the target station. We compared the simulation waveform at the target station with the observed waveform, then compared the seismic intensity. For the damaged area, the more accurate seismic intensity and peak ground acceleration prediction is useful and important. In this method, we do not need to give the EEW magnitude to the public and we just predict waveform at target stations, then predicted ground motion are calculated based on the predicted waveform. So we could not give the term of false alarms/missed alarms. We compare the prediction acceleration and statistic the seismic intensity with the observed one and compare our simulation results with other methods. For the ARV method and station correction method, the seismic intensity residual within +-0.5 is 55% and 59% respectively. The seismic intensity residual within +-1 is 84% and 93% respectively for ARV method and station correction method. The average 1 degree seismic intensity error of the current JMA EEW system (JMA, 2018) is 74.74% for all the eleven years statistical data. The best result is 93.7% in 2017, the worst result is 34.6% in 2010.So we can conclude that frequency-dependent correction of site amplification method show better performance than the scalar value site amplification methods (ARV, Station Correction) and the operational current JMA EEW system in predicting ground motion.

For "c) In addition, at discussion section, the authors didn't provide a satisfactory discussion of how an EEWS will be benefited from the proposed method." We will make more detailed and clearly discussion of how an EEWS will be benefited from the proposed method in the revised manuscript. How an EEWS will be benefited from the proposed method?

A: This method based on the front detection station to predict ground motion real-timely at the target station without any hypocentral parameters. It skips the procedure to calculate the EEW magnitude and epicenter distance or hypocenter distance using the start potion of the waveform. We can obtain the waveform real-timely at the target station. It highly improve the accuracy of predicting ground motion real-timely compared with the scalar value site amplification factor.

B: Usually， the JMA seismic intensity is calculated in the frequency domain, if we adopted the procedure proposed by Kunugi et al. (2013) for real-time calculation of JMA seismic intensity in the time domain. This allowed this method to be applied in real time. It is could be used for the next generation of earthquake early warning system.

We also provide a paragraph discussing potential pitfalls and drawbacks for application to the earthquake early warning system. Please refer to the 8th Reply.

2 Quotation of the general comment: “The abstract must be reorganized in a more concise form. At the current version this is not informational because there are many unnecessary details. Authors must provide very clearly what is the problem, the method and materials used and what is the contribution”

Reply: Thank you very much for your valuable suggestion. We will reorganized the abstract in a more concise form and remove many unnecessary details. We will provide clearly what is the problem, the method and material used and what is the contribution. After revised, the abstract shows as follows:

"The site amplification factor was usually considered as scalar values, such as amplification of peak ground acceleration or peak ground velocity, increments of seismic intensity in the earthquake early warning system or seismic intensity repaid report system. This paper focus on evaluation of infinite impulse recursive filter method that could produce frequency-dependent site amplification and compare the performance of the scalar value method with the infinite impulse recursive filter method. A large amount of strong motion data of IBRH10 and IBRH19 of Kiban Kyoshin network (Kik-net) triggered in more than one thousand earthquakes from 2004 to 2012 were selected carefully and used to get the relative site amplification, then we model the relative site amplification factor by casual filter. Then we make simulation from borehole to surface and also simulation from front-detection station to far-field station. Compare different simulation cases, it can easily be found that this method could produce different amplification factor for different earthquakes and could reflect the frequency-dependent of site amplification. Through these simulation between two stations, we can find that the frequency-dependent correction for site amplification shows better performance than the ARV method and station correction method. It also shows better performance than the average level and the highest level of Japan Meteorological Agency (JMA) earthquake early warning system in ground motion prediction. This method pays attention to the amplitude and ignore the phase characteristic, this problem may be improved by the seismic interferometry method. Although there are some problems needed to be considered and solved carefully, frequency-dependent correction for site amplification in the time domain highly improve the accuracy of predicting ground motion real-timely."

3 Quotation of the general comment: "A native English speaker must furnish the grammar and syntax of the manuscript. In the present form it is not recommendable for publication."

Reply: Thank you very much for your valuable suggestion. We will seek professorial help to the native English speaker to furnish the grammar and syntax of the revised manuscript.

4 Quotation of the general comment: "Authors must check the presentation of their tables. There are abbreviations that are not explained before. There are titles that are not properly aligned (i.e Table 3 "Amplifi-cation((IBRH....)" and units are missed."

Reply: Thank you very much for carefully checking the manuscript. We will check the manuscript carefully and explain the related abbreviations in proper position. We check and revised all the table in the manuscript.

We make the titles aligned proper and improve the units in the revised manuscript. In the table, the abbreviation for Amplification is Amp. The abbreviation for Observation is Obs. The abbreviation for Simulation is Sim. The abbreviation for Component is comp. The abbreviation for Residual is Res. The abbreviation for Borehole is Boh. The abbreviation for Surface is Suf.

Table 3 Information for M5.2 earthquake (IBRH10 & IBRH19 for 201202191454)

	PGA(gal)			PGA Amp.		Ijma			
	IBRH19	IBRH10		Amp. (IBRH10/IBRH19)		IBRH19	IBRH10		Res. (Obs.-Sim.)
Comp.	Obs.	Obs.	Sim.	Obs.	Sim.	Obs.	Obs.	Sim.	
NS	17.7	50.9	69.7	2.8	3.9	2.2	3.5	3.7	0.2
EW	13.6	45.7	53.2	3.3	3.9				
UD	11.2	23.7	38.9	2.1	3.5				

5 Quotation of the general comment: “Please provide the same level of information on each figure caption. For example at fig.7, authors define each graphic element where at fig.5 they don’t.”

Reply: Thank you very much for carefully checking the manuscript. We define each graphic element at fig.3, fig.4, fig.5 in the same level of information as fig.7.

Figture 3. Surface to Borehole Spectral Ratios at IBRH10: (a) EW2/EW1, (b) NS2/NS1, (c) UD2/UD1. The blue lines stand for the spectra ratio for every earthquake event and the black one stands for the average spectra ratio for all the events.

Figture 4. Surface to Borehole Spectral Ratios at IBRH19: (a)

EW2/EW1, (b) NS2/NS1, (c) UD2/UD1.The blue lines stand for the spectra ratio for every earthquake event and the black one stands the average spectra ratio for all the events.

Figture 5. spectral ratios of IBRH10 to IBRH19 for: (a) EW1, (b) EW2, (c) NS1, (d) NS2.The blue lines stand for the spectra ratio for every earthquake event and the black one stands the average spectra ratio for all the events. (to be continued)

Figture 5. spectral ratios of IBRH10 to IBRH19 for: (e) UD1, (f) UD2. The blue lines stand for the spectra ratio for every for every earthquake event and the black one stands the average spectra ratio for all the events. (Continued)

6 Quotation of the general comment: "What averaging method was used for smoothed spectra?"

Reply: In this study, Parzen window of 0.3 bandwidth was used to smooth the spectra.

7 Quotation of the general comment: "Authors must provide a paragraph discussing the performance of their method to similar ones as they refer to them in introduction in order to strength their findings."

Reply: Thank you very much for your suggestion. In this paper, we provided some sentence to discussing the performance of the method to the similar ones in the induction section.

The ARV method: amplitude ratio of peak ground velocity at the ground surface relative to the engineering bedrock of averaged S-wave velocity 700 m/s based on topographic data. So it is a scalar value site amplification correction method determined by the PGV increment.

Station Correction method: It is also a kind of scalar value method determined by comparing the attenuation relation with observed seismic intensities from recent earthquakes proposed by Iwakiri et al. 2011.

We will reorganized these related sentence to one paragraph in the revised manuscript.

We compared the frequency-dependent correction of site amplification factor with ARV method and Station correction method. The station correction method based on site amplifications obtained empirically from observed seismic intensity data. For the ARV method and station correction method, the seismic intensity residual within +-0.5 is 55% and 59% respectively. The seismic intensity residual within +-1 is 84% and 93% respectively for ARV method and station correction method. The average 1 degree seismic intensity error of the current operational JMA EEW system (JMA, 2018) is 74.74% for all the eleven years statistical data. The best case is 93.7% in 2017, the worst case is 34.6% in 2010.When we use the causal filter to model the frequency-dependent site amplification factor.69.7% of the seismic intensity residual is less than 0.5. 98.1% of the seismic intensity residual is less than 1.From the analysis and compared with two method and one operational EEW statistical report, we can conclude that this method could highly improve the accuracy of the ground motion estimation.

The method we compared in the manuscript represents two kinds of scalar value site amplification method. We will collect much more material about ground motion estimation accuracy of the operational EEW system in the world except for the Japan EEW system. Then we can compare their performance with this method to strength our findings.

8 Quotation of the general comment: “Authors must provide a paragraph discussing potential pitfalls and drawbacks or their proposal in relation to local conditions and/or network density”

Reply: Thank you very much for your suggestion. We provide a paragraph discussing potential pitfalls and drawbacks or their proposal in relation to local conditions and network density. The paragraph shows as follows:

Through compare different simulation cases, it can be easily find that frequency-dependent correction of site amplification factor could produce different amplification factor for different earthquakes. It could produce the frequency-dependent site amplification factor. It highly improves the situation that scalar value site amplification methods which could not produce different amplification factor for different earthquakes. The simulation from borehole to surface is not suitable for earthquake early warning system. But it shows that this method shows good performance for real time simulating waveforms of the target station. Compare the two different simulation cases, it shows that the smaller distance between two stations, the seismic intensity prediction is more accurate. But for earthquake early warning purpose, we need to save much lead time for warning to the public that needs the distance between two stations much larger. It means that the method have relation with network density. We could use the frequency-dependent site implication factor to predict the seismic intensify more accurately in the seismic intensity quick report system with high network density. For earthquake early warning purpose, we need to use large amount of historical ground motion records to model the relative site amplification and search the optional casual filter parameter firstly. In the area with sparse network and low seismicity, we could not get the relative site amplification easily because of little amount of strong motion records. We need to consider other methods to estimate relative site amplification factor. We can adopt the method such as coda normalization method (Philips and Aki, 196), generalized spectrum inversion method (Iwata and Irikura, 1986; Kato et al., 1992). There are the cases that some simulation did not work very well.1.9% of the seismic intensity residuals is larger than 1.One of possible reason is azimuth dependency of site amplification(Cultrea et al.2002). We did not consider azimuth dependency in designing the frequency-dependent site amplification factor filter. If we design multiple frequency-dependent site amplification factor correction filter regarding the azimuth dependency of site amplification, we would be able to predict the target ground motion more precisely. Another possible reason is the accuracy of the input relative spectrum ratio, this situation may be improved by more precisely characterize the input spectral ratio and complicated filter design. For example, we can use a large number of first and second order filter to model the spectral ratio, but it is more complicated and time consuming for the hardware design when the number of filter grows larger. We need to make trade between the accuracy of the input spectral ratio and the difficulty of the filter design. This method pays attention to the amplitude characteristic and ignore the phase characteristic, there are few research on how to consider the phase in the earthquake early warning system. This situation may be improved the seismic interferometry method (Yamada et al. 2010). Because the site amplification factor was assumed as linear system, so the nonlinearity of weak ground motion and strong ground motion (Noguchi et al .2012) was not taken into consider in this study. More research are needed to solve these problems.

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