

An Innovated Earthquake Modelling Technique for Near Source Modelling

T1.2-P4

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Summary

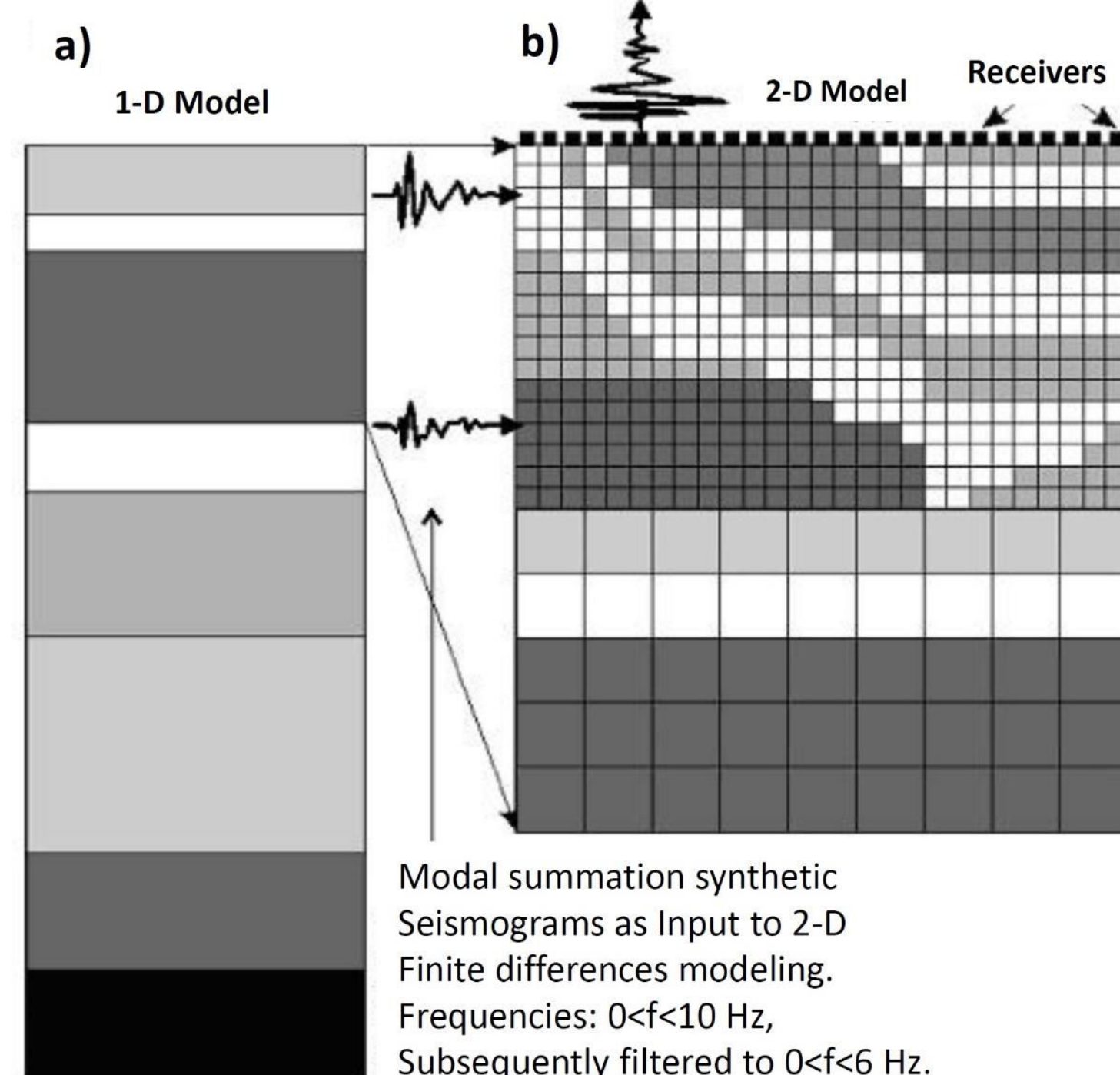
A combination of Modal Summation (MS) and Finite Difference (FD) techniques with Green Function (GF) to generate synthetic signals is used. In this procedure we try to synthetically generate a small event using the hybrid of MS and FD as green function to simulate target event through GF method.

This modeling procedure is suggested since the simulation of small events is more reliable with numerical and analytical methods and it could be more useful while scaling to desired magnitude with GF method because of extended fault evaluation.

This is tested using an aftershock recorded following the Bam earthquake. The result of synthetic signals by this method and observed records of Bam are compared both in time and frequency domains and shows good agreement.

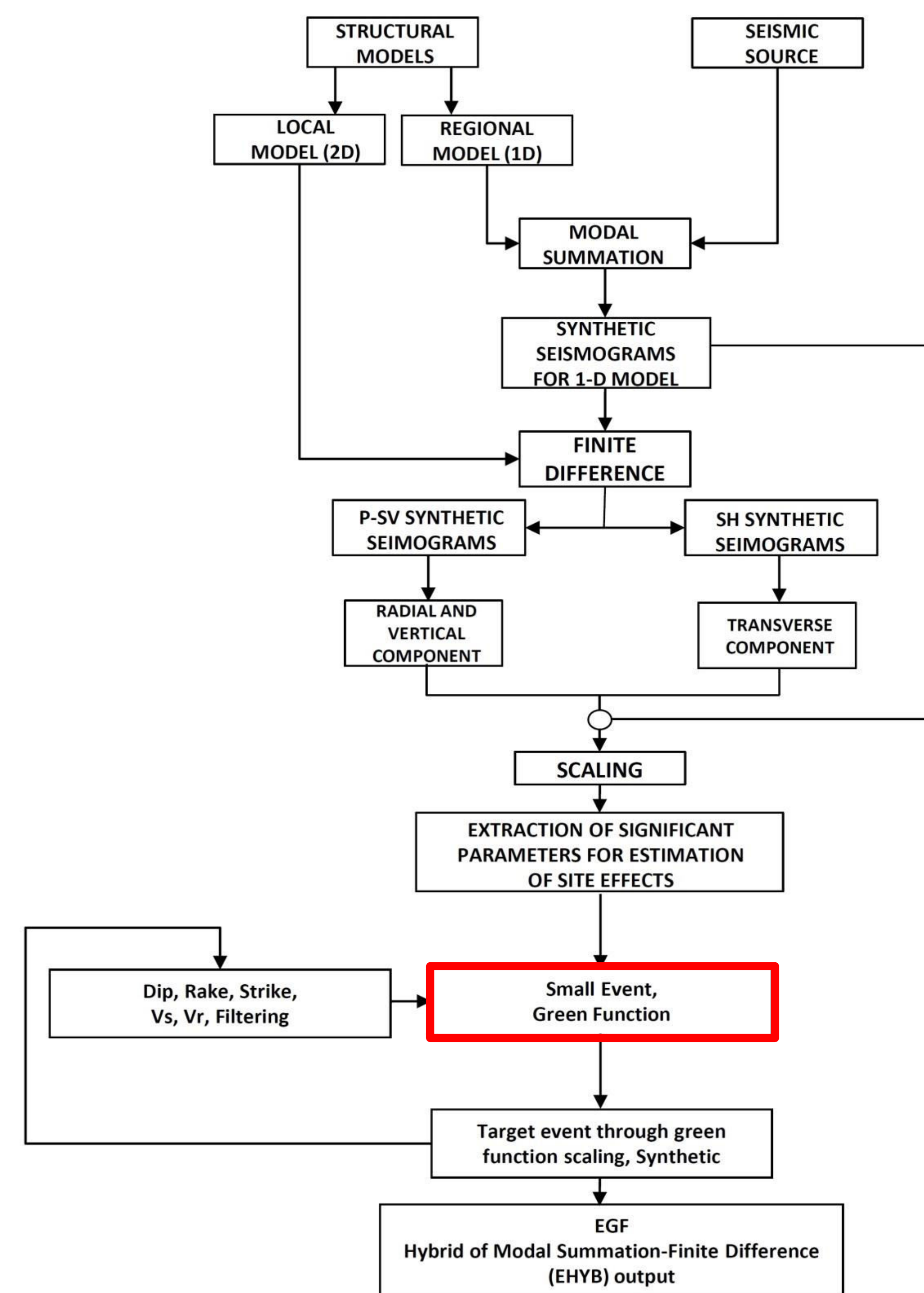
Methodology

A hybrid method developed by Fäh et al. (1994) is used that combines the Modal Summation (MS) technique, valid for laterally homogeneous anelastic media, with Finite Difference (FD), which permits the modeling of wave propagation in complicated and rapidly varying velocity structures, as it is required when dealing with sedimentary basins, and optimizes the advantages of both methods. The method permits the accurate computation of the earthquake ground motion in two-dimensional (2D), laterally heterogeneous, anelastic media (Panza et al. 2001). This procedure is used to generate small event as a start for scaling to target event using Green Function method.

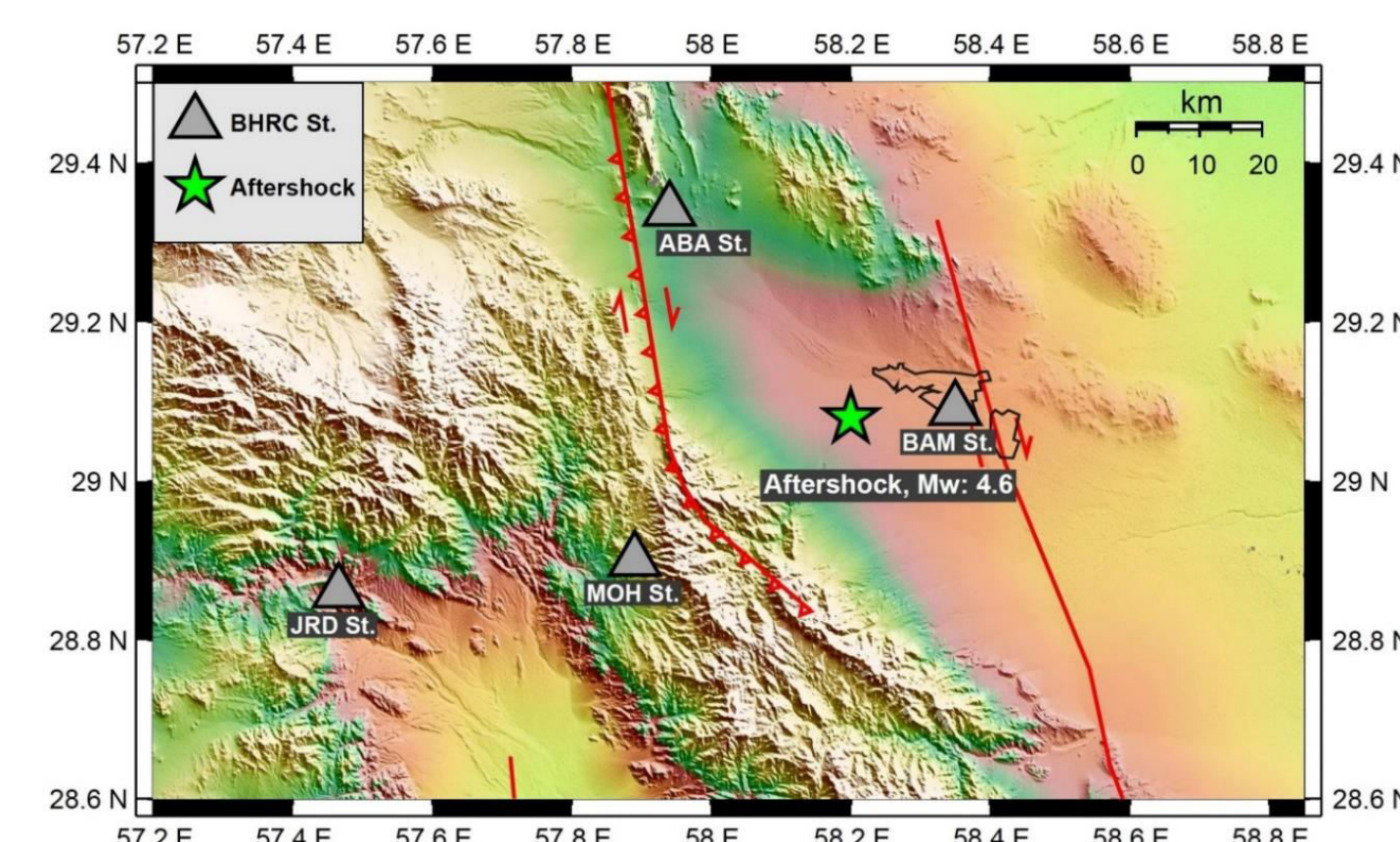


Propagation is treated by means of the analytical MS technique in a laterally homogeneous anelastic 1D structural model from the source (a) to the close vicinity of the local, heterogeneous anelastic 2D structure that we may want to model in detail. The wavefield generated by modal summation is then (b) introduced in the grid that defines the local heterogeneous area and come up to the surface with FD. Both homogeneous regional and heterogeneous local structures characterize by attenuation, velocity and density structures. After simulating the small event (aftershock) by this method the result is used to scale to desired target event by green function technique.

Schematic plan of the methodology

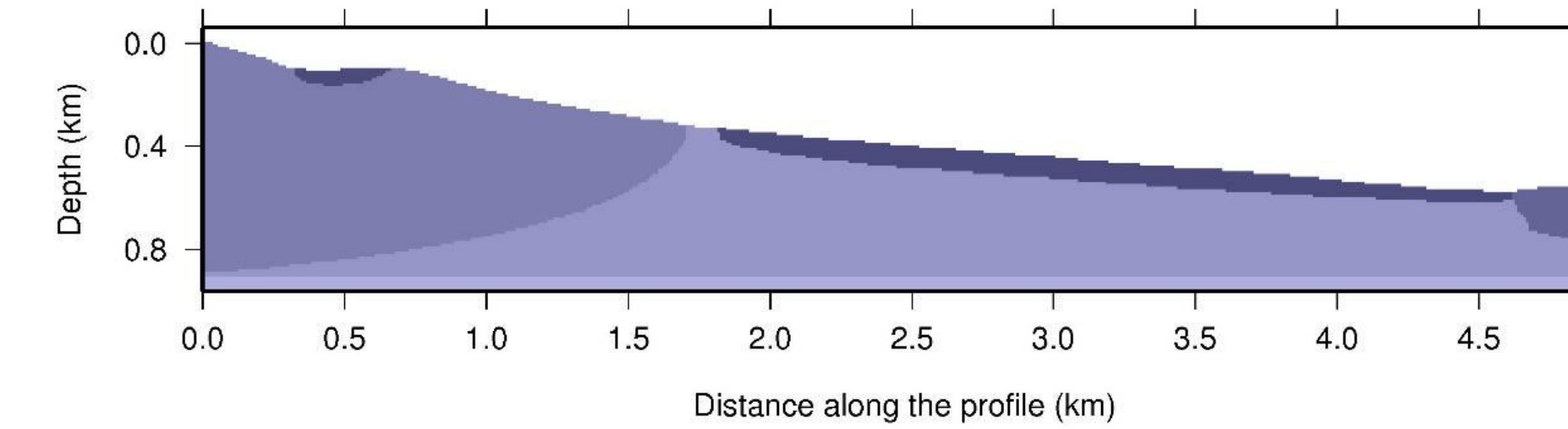


Selected aftershock



An aftershock of bam earthquake is selected to simulate synthetically to be the base of green function method as small event. The target event is the bam earthquake main shock. The event is simulated in 3 stations of Mohamad Abad, Abaraq and Jiroft.

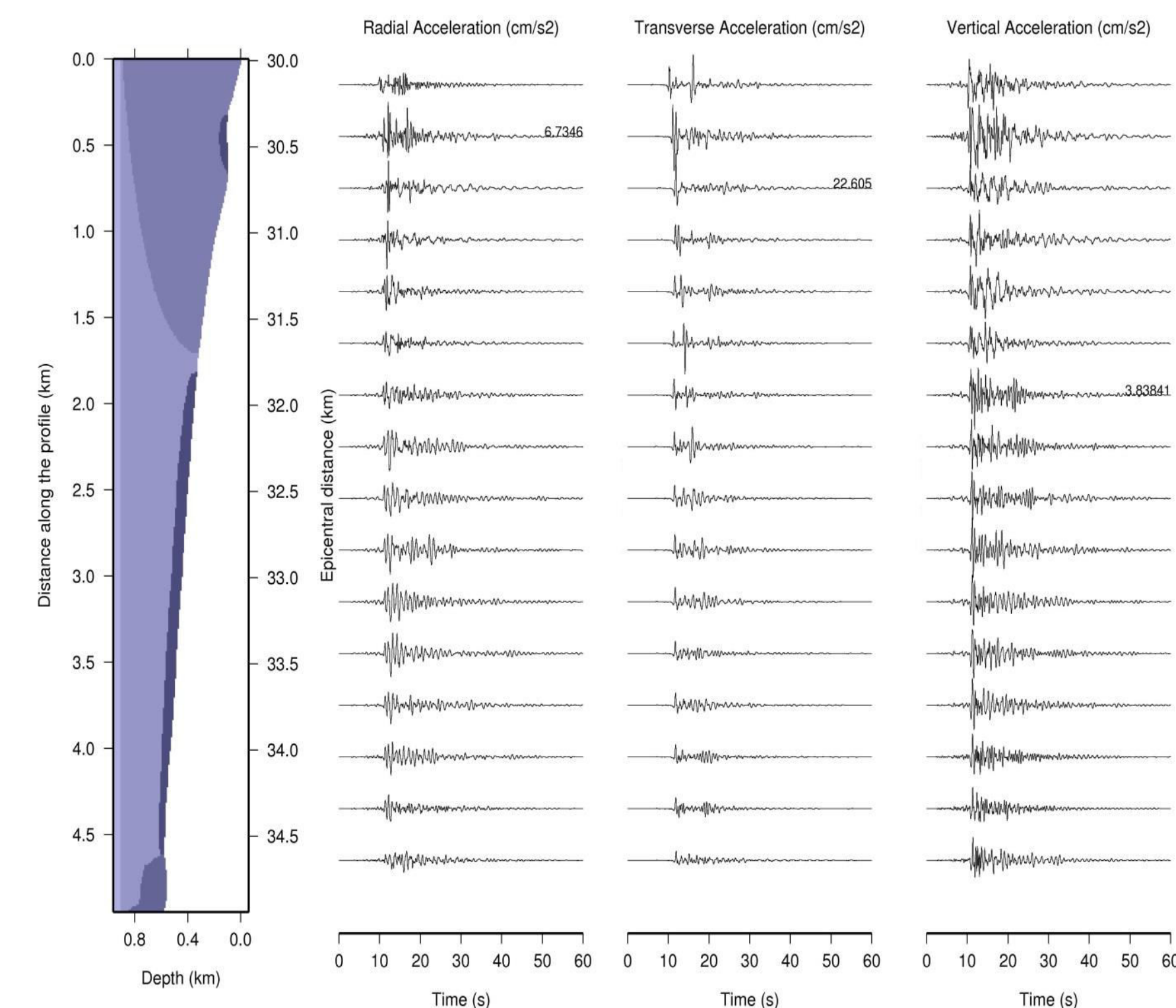
2D structures and simulation of small event



Layer Number	Density (g/cm ³)	V _p (km/s)	V _s (km/s)	Q _p	Q _s
1	1.6	0.44	0.27	44	20
2	1.9	0.80	0.30	100	50
3	2.2	1.20	0.42	140	70
5	2.4	1.70	0.75	180	90

Up: 5km 2D structure down to depth of 800 meters for MOH station and value of parameters for each layer to use in finite difference modeling. Various color indicate the layers.

Down: the generated signals along the 2D profile. 3 components are simulated. Values on traces show the max along the profile. Site effects are seen clearly.



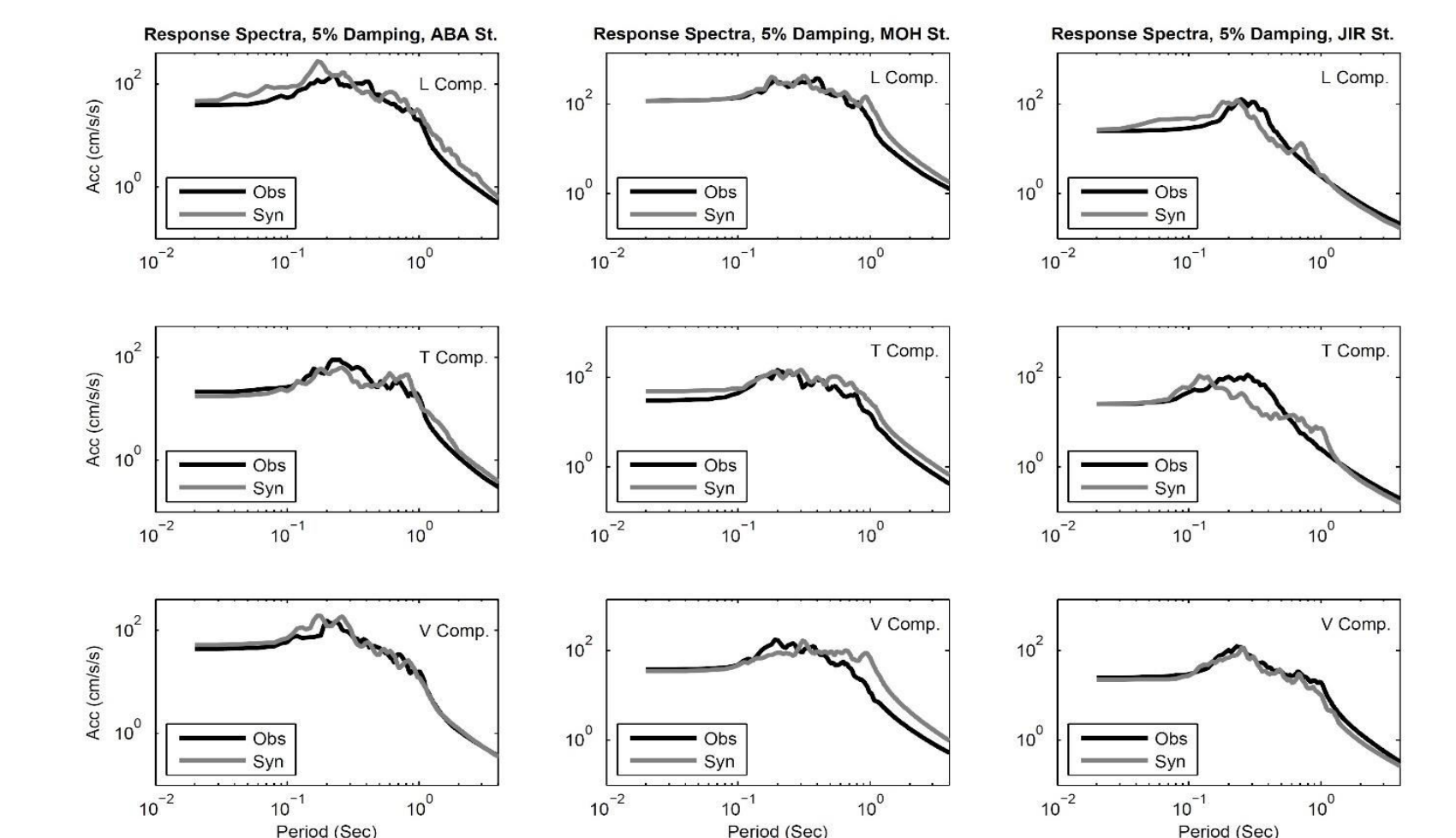
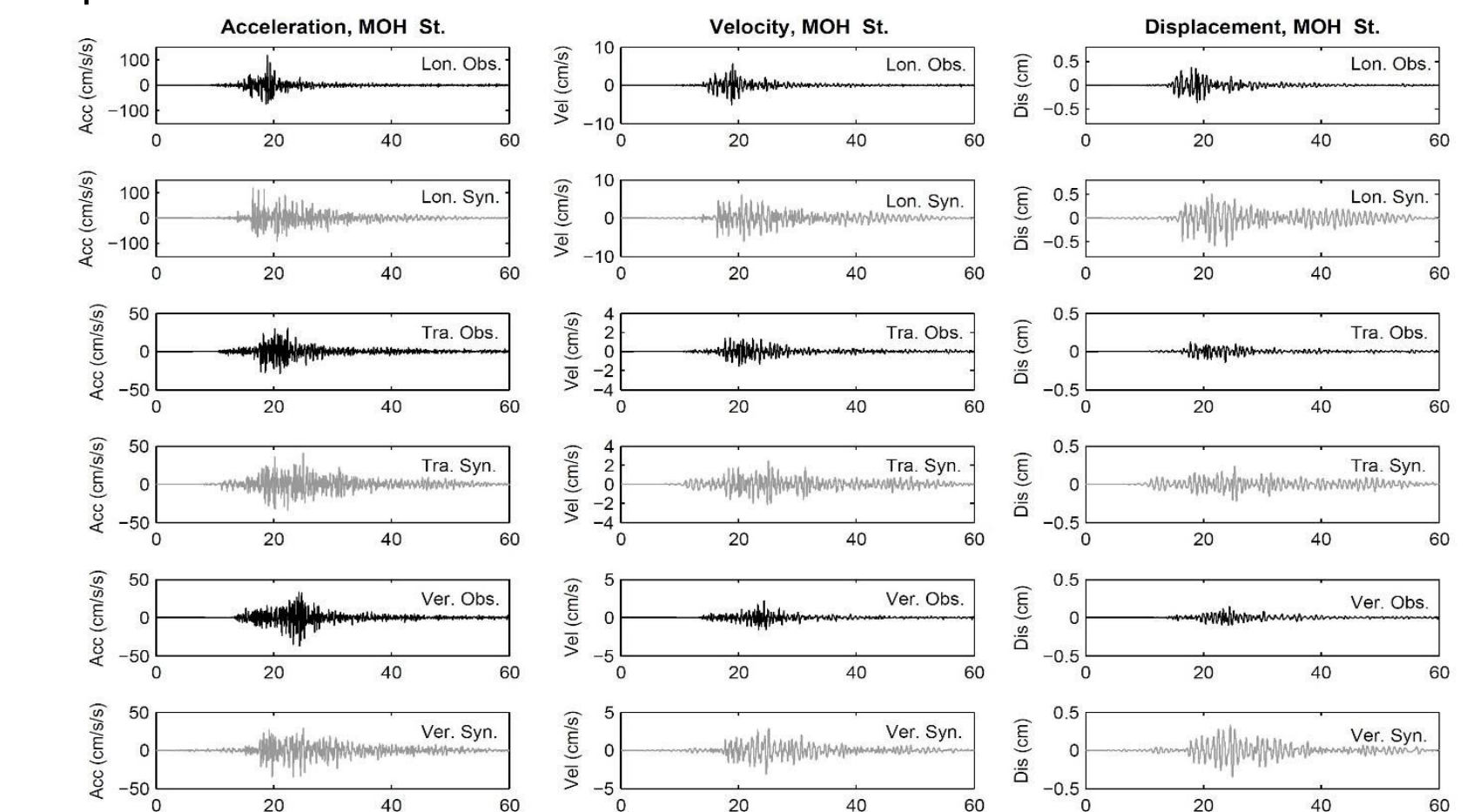
Parameters for green function scaling to target event

Number	Parameter	Value
1	Fault Length and width	20, 15 km
2	Target event epicenter	N29.04 E58.35
3	Small event epicenter	N29.03 E58.21
4	Mw, Target and small event	6.6, 4.6
5	Sub faults	6*6
6	Length and width of sub faults	3.3, 2.5 km
7	V _s	3.06 km/s
8	V _r	2.80 km/s

Using Irikura technique the small simulated event is used to scaled to target event. The scaling is done and target event is simulated.

Results

Synthetic signals and related response spectra are generated and compared with observed records. MOH station results are presented as sample.



Conclusion

Simulation procedure using a hybrid method is performed and results shows good agreement comparing the synthetic and observed record both in time and frequency domains.

The procedure use a combination of analytical, numerical method to generate a small event where the complexity of finite fault is not needed. Then the simulated small event is scaled to the desired target event of bam earthquake main shock.

Parametric test on simulation procedure shows a high reliability of the method to use as a sophisticated method where there is no real data.

Selected references

Panza G F and Suhadolc P (1987) Complete strong motion synthetics. In Seismic strong motion synthetics (B. A. Bolt editor), Academic Press Orlando 153-204.

Fäh D, Suhadolc P, Mueller St, & Panza G F (1994) A hybrid method for the estimation of ground motion in sedimentary Basin: quantitative modeling for Mexico City. Bull. Seismol. Soc. Am. 84:383-399.

Irikura, K., 1983. Semi-empirical estimation of strong ground motions during large earthquakes, Bull. Disast. Prev. Res. Inst. Kyoto Univ. 33, 63-104.

Gholami V, Hybrid Simulation of Strong Ground Motion, International Institute of Earthquake Engineering and Seismology (IIEES), PHD thesis, August 2013.

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