Technical Report

The standard definition of site amplification characterizes the effects and resonances of vertically-incident body waves, but is inadequate to also describe surface waves. This difference in response to a geologic structure or profile can be shown through preliminary analytic and numerical simulations, indicating a different amount of amplification and a different frequency of peak amplification for surface waves. We propose a more thorough study to understand the extent to which this difference affects seismic hazard estimates for southern California.

The major outcomes at this time are primarily a test of the one-dimensional (1D) theory of Bowden & Tsai (2017) on data from northeast China. The outcome is favorable, with observed amplifications within and around the Songliao Basin being well predicted with the 1D theory. Fig. 1 shows the stations used, Fig. 2 shows the predictions at one basin site relative to a reference site, and Fig. 3 shows observed versus predicted amplifications across the entire array for vertically propagating SH waves, Love waves, horizontal-component Rayleigh waves and vertical-component Rayleigh waves. Most discrepancies in Fig. 3 are thought to be due to inaccuracies of the velocity model used. All figures are taken from Chen et al. (2018).

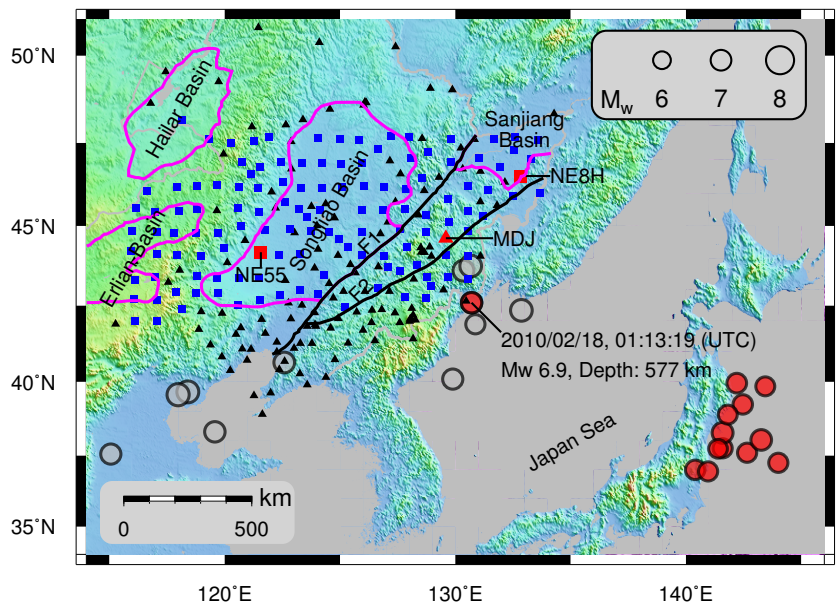

Fig. 1: Map of stations (triangles, permanent and squares, temporary) used for analysis. Red circles are the earthquakes used; they are primarily aftershocks of the 2011 Tohoku earthquake, except for one deep earthquake (labeled) used for the vertically propagating SH analysis.

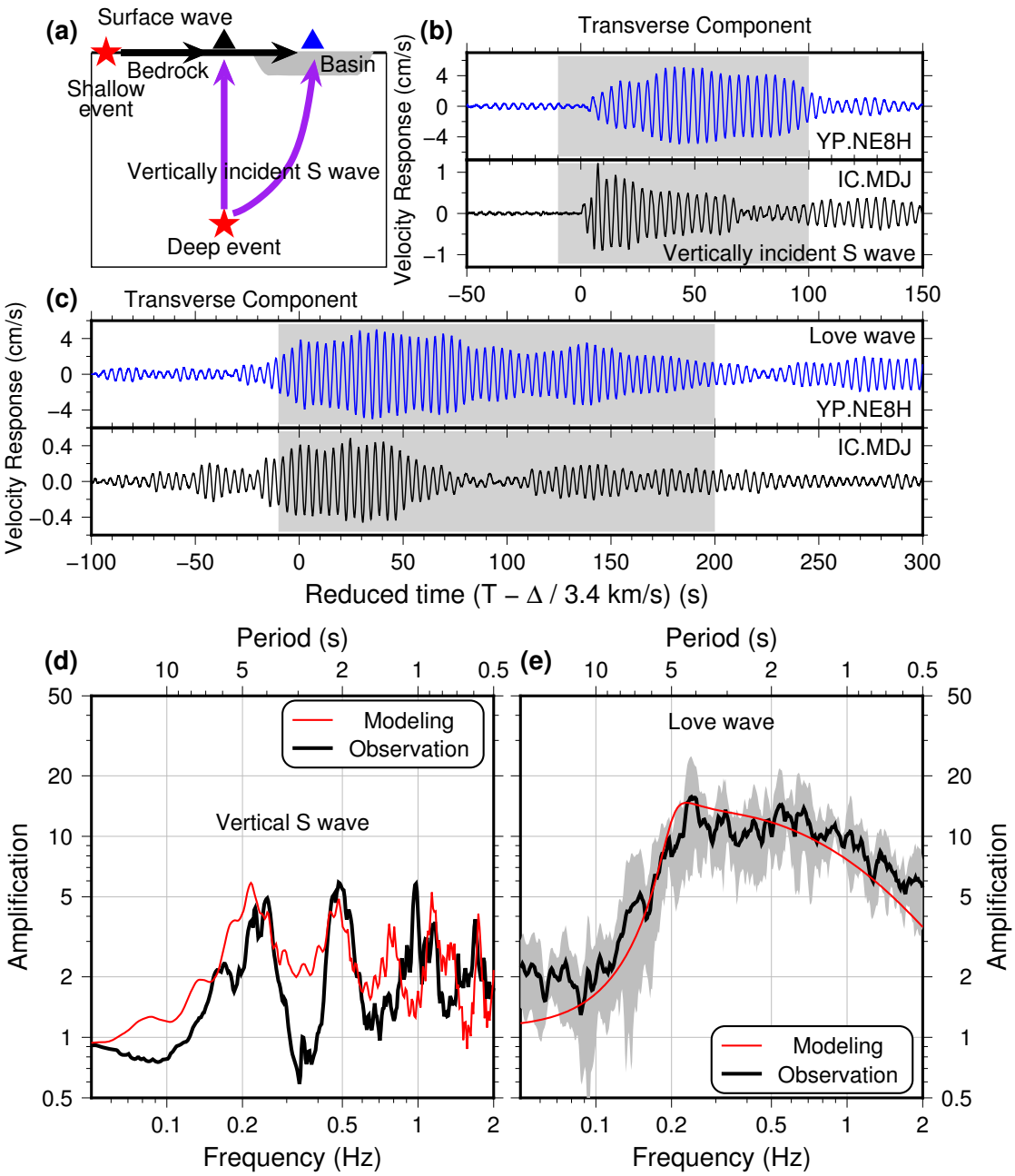

Fig. 2: (a) Schematic of the 2 cases examined. (b) Observed vertically incident SH waves at a basin site (NE8H) and reference site (MDJ). (c) Observed Love waves at a basin site (NE8H) and reference site (MDJ). (d) Observed and modeled vertically-incident SH amplification. (e) Observed and modeled Love-wave amplification, averaged over all near-surface earthquakes.

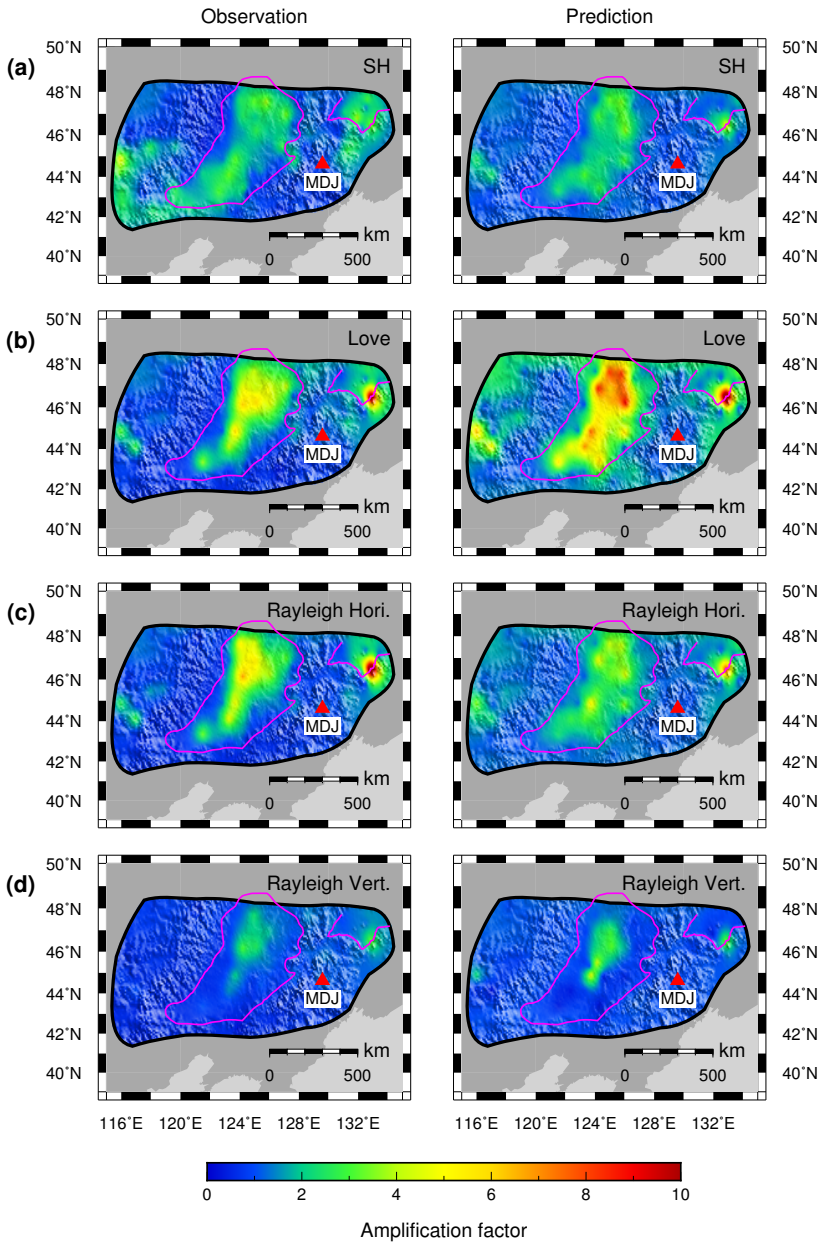

Fig. 3: Observed (left) and predicted (right) amplification for the various wave types at a period of 4-5 s. (a) Vertically incident SH waves, (b) Love waves, (c) horizontal-component Rayleigh waves, and (d) vertical-component Rayleigh waves.

References

Bowden, D. C., and V. C. Tsai (2017). "Earthquake ground motion amplification for surface waves", Geophys. Res. Lett., 44, 121-127, doi:10.1002/2016GL071885.

Chen, H., V. C. Tsai, and F. Niu (2018). "Observations and modeling of long-period ground-motion amplification across northeast China", Geophys. Res. Lett., doi:10.1029/2018GL078212.