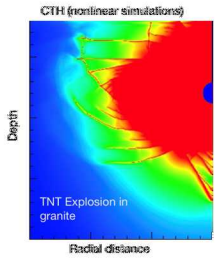
Nonlinear to Linear Modeling

SAND2019-2646PE

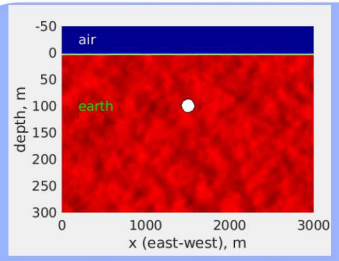
Finding the effects of near-source properties on far field observations, modeling, and source inversions

Background/State of the Art



- Coupling nonlinear to linear simulations is increasingly common
- However, it is poorly understood how near-source properties affect the far-field observations and source characterization
- LLNL and LANL are working on general nonlinear to linear simulations

Innovation



Heterogenous Earth Model

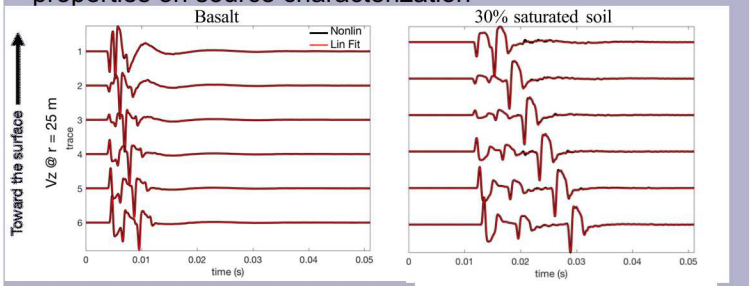
- When and how well can linear source models match nonlinear simulations?
- How does unknown earth heterogeneity near the source affect source models?
- Will define when expensive nonlinear modeling is needed
- Will provide uncertainty estimates for source characterization

Defense Nuclear Nonproliferation R&D

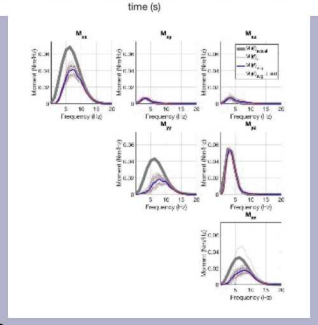
Approach, Metrics and Outcomes

MAIN ACHIEVEMENT

- To place uncertainties and quantify effects of near-source properties on source characterization



Above: Fit of purely linear source model to nonlinear waveforms
Right: Effects of near-source heterogeneity on source models



HOW IT WORKS

- Simulate in the nonlinear regime, changing the near-source environment, and document effects on linear source models
- Modify linear elastic codes to use time varying boundary conditions from nonlinear simulation output
- Will verify modeling with PE-1 and other observed data

ASSUMPTIONS AND LIMITATIONS

- Only a limited parameter space can be explored
- As frequency content and spatial extents of model expand, computational effort increases greatly
- Currently only information from the nonlinear regime passes to linear one

Impact

- Will identify when costly and time-consuming nonlinear simulations are necessary for source characterization
- Will quantify uncertainty caused by faster, linear source modeling and near-source properties on source characterization
- Thus, decision makers in DOE or elsewhere will be better informed as to the uncertainty and quality of source characteristics for events of interest

TRLs: Start: TRL 3. Finish: TRL 6.

Publications

Preston, L., M. Eliassi, and C. Poppeliers, Linear Equivalent Seismic Sources from Simulations of Underground Chemical Explosions, 2018 Fall AGU

Goals/Action Plan

Current FY

- Improve nonlinear material models and vet nonlinear simulation codes
- Quantify effects of stochastic perturbations on source models for simple earth models

Future FY

- Increase complexity of earth models to explore wider range of parameters and effects
- Comparison of modeling results with PE-1 and other observed data

Team

SNL partnering with LANL and LLNL

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