Preliminary Multi-scale Community Velocity Model for Southern California Improves Fit to Seismic Recordings

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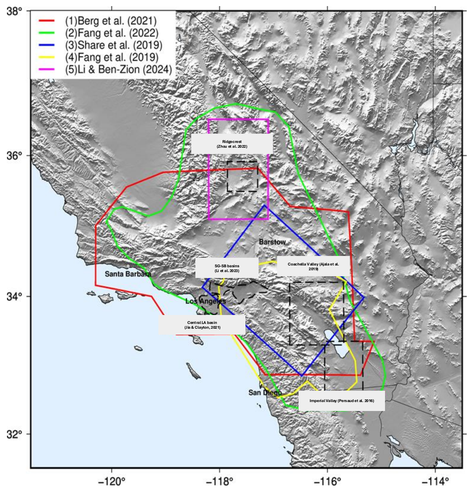
Objectives

- Develop methodology to effectively merge existing velocity models for of varying resolution in one superior 3D model – test for southern/central CA
- Perform validation against observations for the multi-resolution CVM
- The methodology retains model sections that improve the fit and discard sections that do not

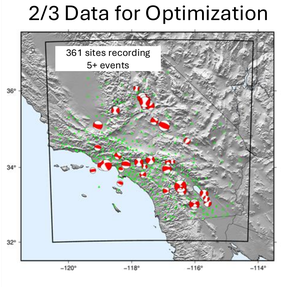
Model Area



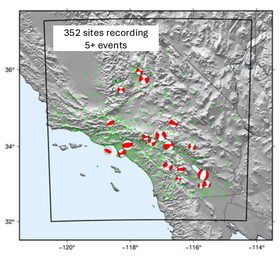
3D velocity models for southern and central CA developed by different methods (tomography, reflection seismic data, noise cross correlation imaging, etc.), and research groups, available for construction of a multi-scale CVM

Approach

2/3 Data for Optimization

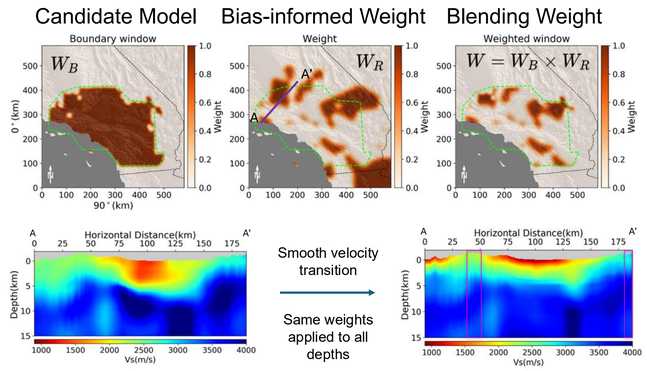


1/3 Data for Validation



- Simulation of 60 M4.2-4.6 events from CI and NP networks and SCEDC moment tensor solutions
- 2/3 used for optimization, 1/3 for validation
- Using AWP-ODC (Cui et al., 2013) physics-based simulations with a discontinuous mesh (Nie et al., 2017) and topography with a curvilinear mesh (O'Reilly et al., 2022)

Bias-informed Refinement



Goodness-of-fit Metrics

FAS bias (for component j): $\epsilon^j_{FAS} = \frac{1}{N_f}\Sigma_{i=1}^{N_f} log_{10}\frac{FAS^j_{syn}(i)}{FAS^j_{obs}(i)}$

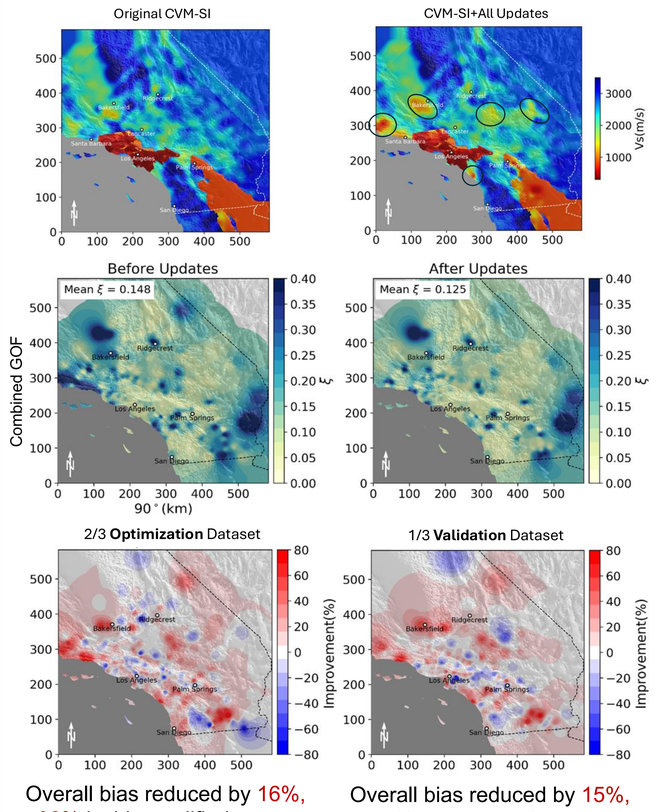
CAV bias (for component j): $\epsilon^j_{CAV} = log_{10}\frac{\Sigma_{i=1}^{N_t}|v^j_{syn}(i)|}{\Sigma_{i=1}^{N_t}|v^j_{obs}(i)|}$

PGV bias (for component j): $\epsilon^j_{PGV} = log_{10}\frac{PGV^j_{syn}}{PGV^j_{obs}}$

PGA bias (for component j): $\epsilon^j_{PGA} = log_{10}\frac{PGA^j_{syn}}{PGA^j_{obs}}$

Combined metric: $\xi = \frac{\Sigma_{j=1}^{3}(|\epsilon^j_{FAS}|+|\epsilon^j_{CAV}|+|\epsilon^j_{PGV}|+|\epsilon^j_{PGA}|)}{12}$

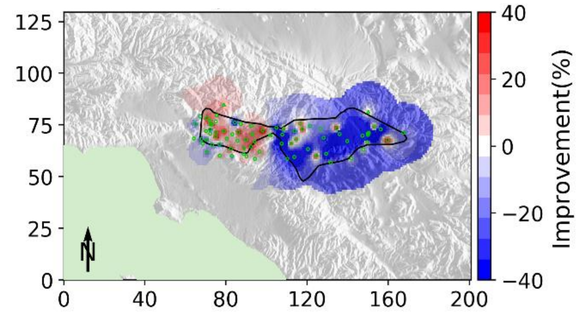
Model Improvement



Overall bias reduced by 16%, 32% inside modified areas

Overall bias reduced by 15%, 29% inside modified areas

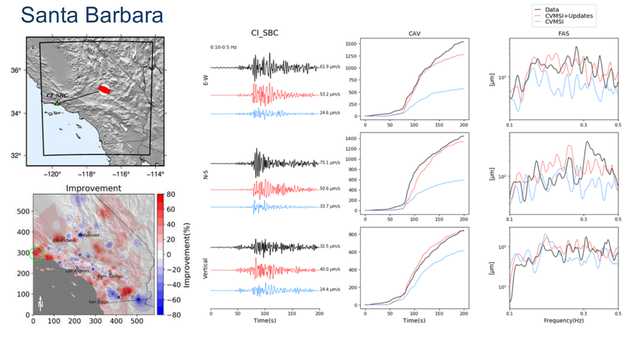
Model Improvement from Li et al. (2022)



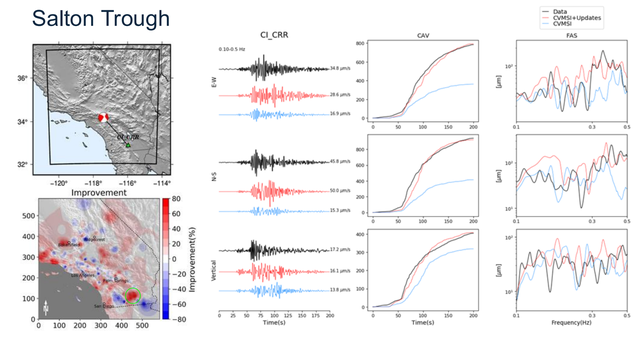
9% improvement in the San Gabriel Valley, but 35% degraded fit in the San Bernardino and Chino basins from the Li et al. (2022) model.

Illustration of Improvement

Santa Barbara



Salton Trough



Conclusions

- We propose an effective bias-informed approach to merge multiple existing velocity models into a single 3D multi-scale model with superior ground motion prediction capability
- Improvements from CVM-S4.26.M01 are most profound (60-80% bias reduction) in coastal areas to the northwest (e.g., Santa Barbara), into the Central Valley (e.g., Bakersfield), in the High Desert and in Salton Trough (30-50% bias reduction)

References

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