The DesignSafe Ground Motion Database (for California) and Regional Seismic Velocity Models for the US Atlantic and Gulf Coastal Plains

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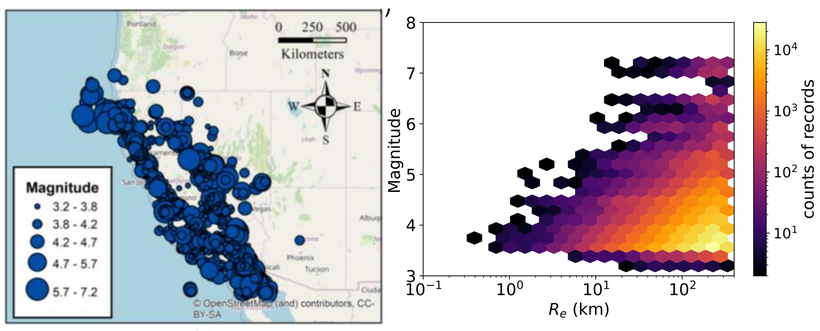
MOTIVATION

DATA AVAILABILITY	DATA FORMAT	DATA PROCESSING	DATA STORAGE,MINING & VISUALIZATION	DATA EXCHANGE
Unprece-dented amounts	Common usage	Efficient	Flexibility	Easy to transfer (even in large volumes)
Different types	Adaptable	Simple	Reliability	Timely
	Combines waveform and meta data in a single file	Robust	Organization	Reliable
		Fast	Open access	Enables Reproducibi-lity
		Standardized	Supports HPC and research workflows	Reusable
		Adhered to state of the art; yet adaptable	Publishable, trackable	Optimizes bookkeeping
		Open source	Analysis and visualizat-ion	

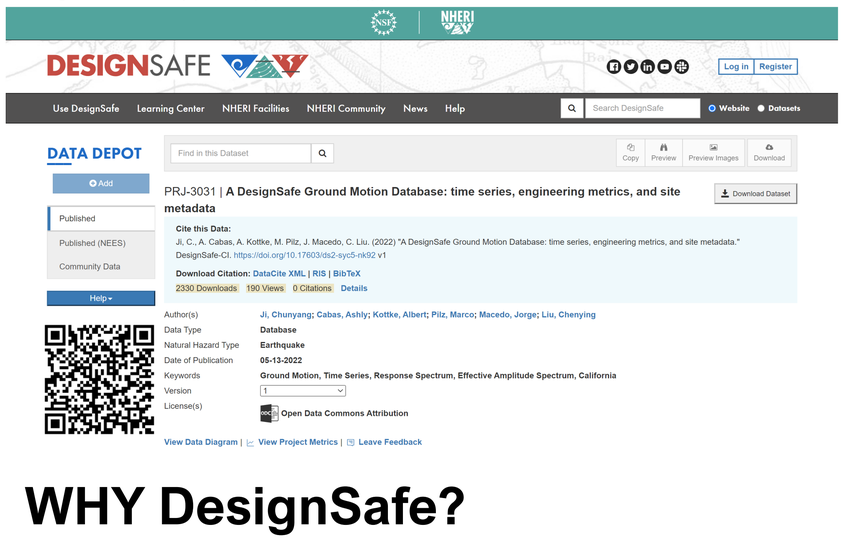
1. No single network consistently processes and archives ground motion and site metadata in California.
2. Need seismic velocity models to support regional ground motion (GM) simulations in Central and Eastern US.

DESIGNSAFE GM DATABASE

- **2,641** earthquakes in CA and near the border in Nevada, Oregon, and Arizona; from 1999 to 2021.
- **287,804** surface three-components ground motions.
- **3,709** recording stations.



Ji, C., Cabas, A., Kottke, A., Pilz, M., Macedo, J., & Liu, C. (2023**). A DesignSafe earthquake ground motion database for California and surrounding region**s. *Earthquake Spectra*, *39*(1), 702-721.



WHY DesignSafe?

- Cyberinfrastructure component of the NHERI collaboration.
- Embraces a cloud strategy for the big data generated by natural hazards engineering research.
- Supports high-performance computing, research workflows, data curation and publication, and data analysis & visualization

WAVEFORM DATA AND SITE METADATA

Waveform Data and Event Metadata

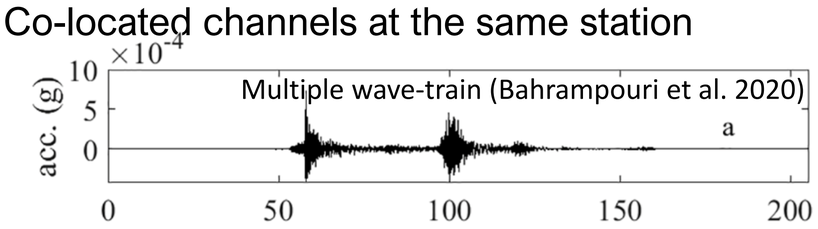
- Uniformly processed GMs
- Path measures (epicentral, and rupture distances)
- Mw (53%) and local magnitudes (ComCat 01/22)
- GM Intensity Measures (e.g., PGA, SA, duration)

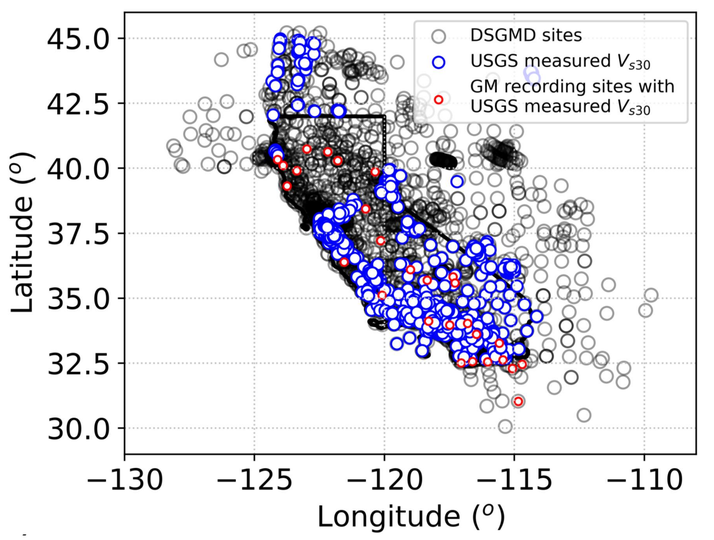
Site Metadata

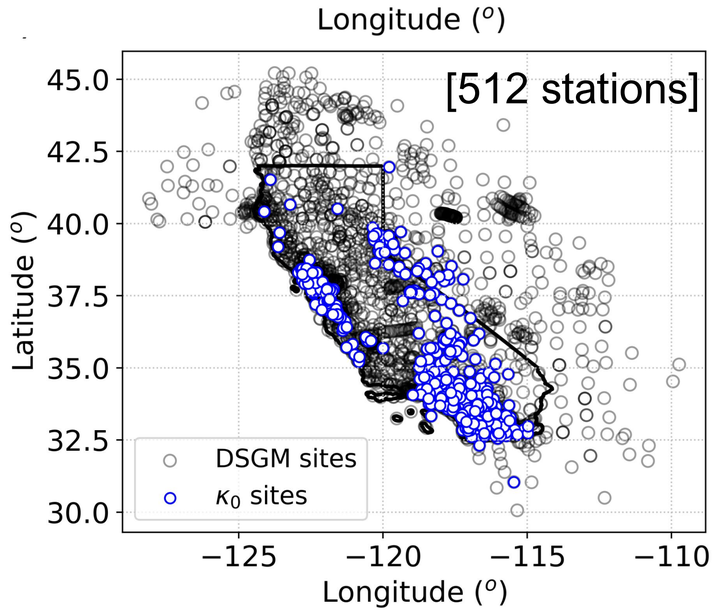
- USGS proxy-based and measured V_{s30} values
- UCLA VSPDB V_{s30} values, V_s/V_p profiles
- Predominant frequency from UCL HVSR database
- Site-specific κ_0

QUALITY CONTROL

- Quality check during the signal processing performed by **gmprocess**
- PGA outlier check
- Multiple-wave train check
- Outlier detection based on residuals of applicable GMMs and machine-learning
- Co-located channels at the same station



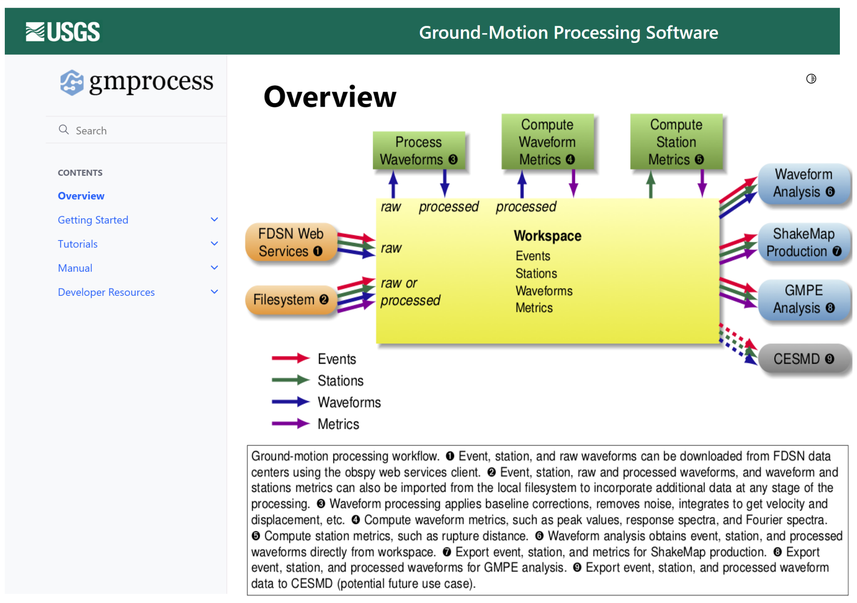




FUTURE WORK ON THE DSGMDB

- Incorporation of larger magnitude events
- Add GMs from borehole arrays in the region.
- Expand site meta data.
- Develop strategies for sustainable and timely maintenance/update of the DSGMD.
- Continue efforts to increase accessibility

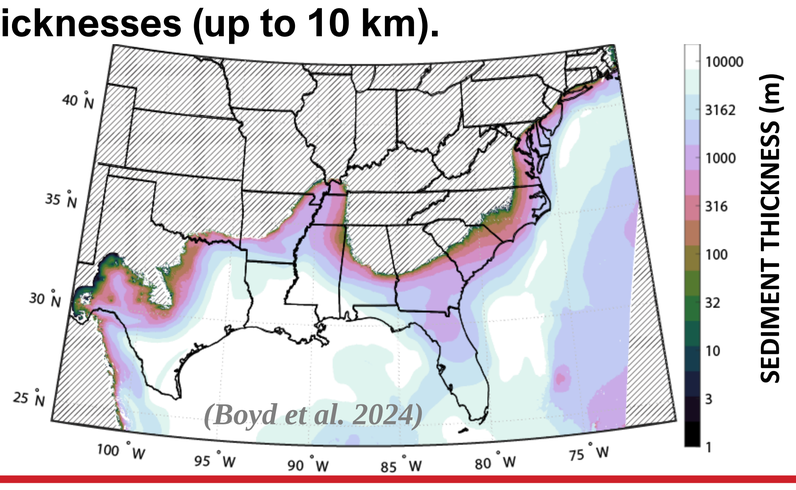
GROUND-MOTION PROCESSING SOFTWARE



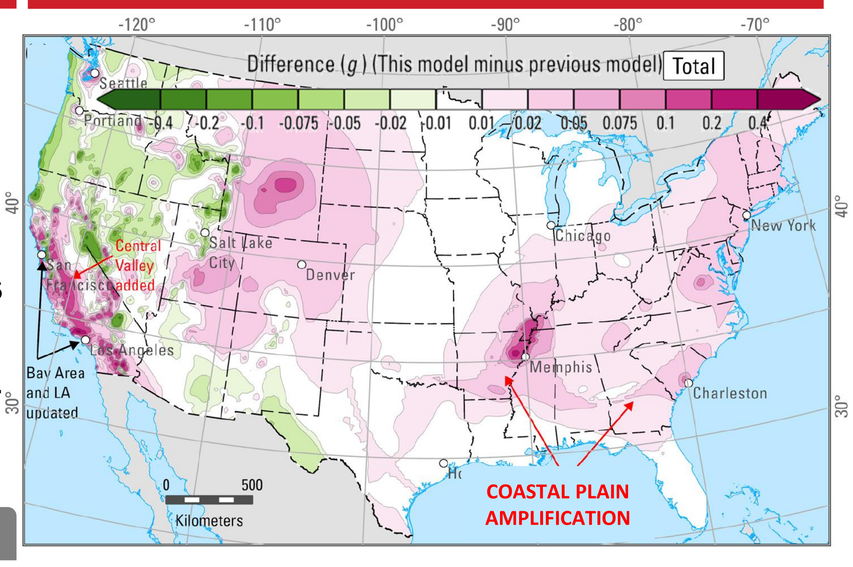
Ground-motion processing workflow. ❶ Event, station, and raw waveforms can be downloaded from FDSN data centers using the obspy web services client. ❷ Event, station, raw and processed waveforms, and waveform and stations metrics can also be imported from the local filesystem to incorporate additional data at any stage of the processing. ❸ Waveform processing applies baseline corrections, removes noise, integrates to get velocity and displacement, etc. ❹ Compute waveform metrics, such as peak values, response spectra, and Fourier spectra. ❺ Compute station metrics, such as rupture distance. ❻ Waveform analysis obtains event, station, and processed waveforms directly from workspace. ❼ Export event, station, and metrics for ShakeMap production. ❽ Export event, station, and processed waveforms for GMPE analysis. ❾ Export event, station, and processed waveform data to CESMD (potential future use case).

REGIONAL SEISMIC VELOCITY MODEL

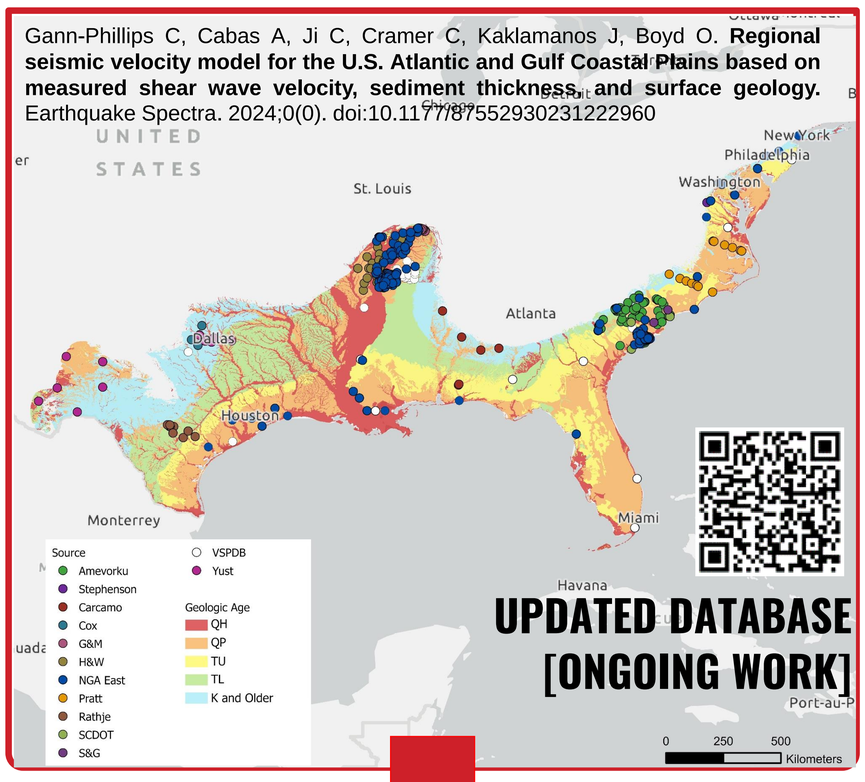
The Atlantic and Gulf Coastal Plains (CPs) host the areas of largest seismic hazard to the central and eastern US. They have **varying sediment thicknesses (up to 10 km).**

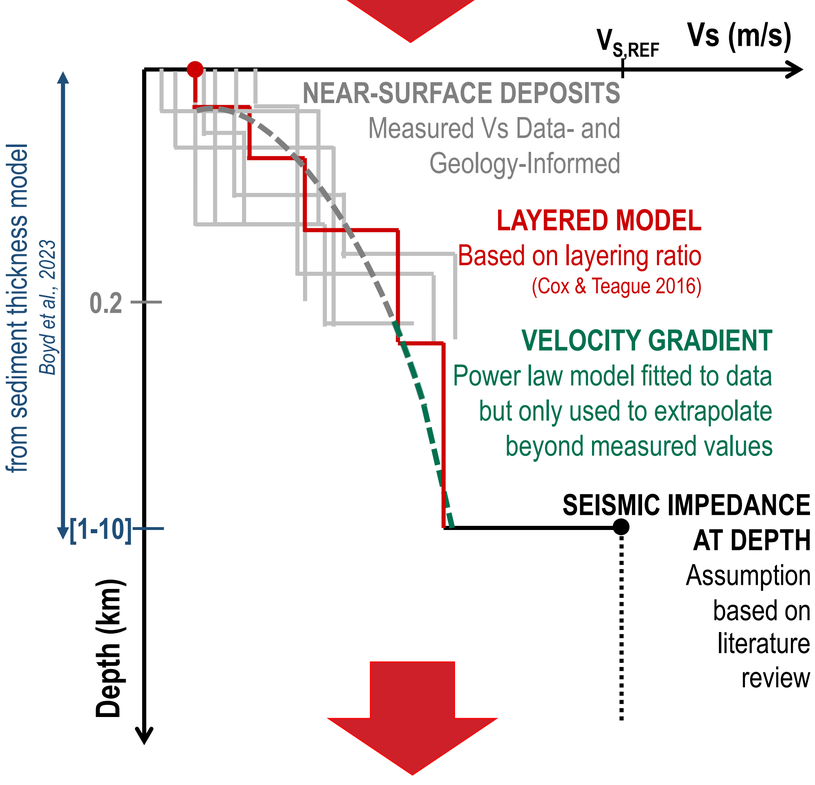


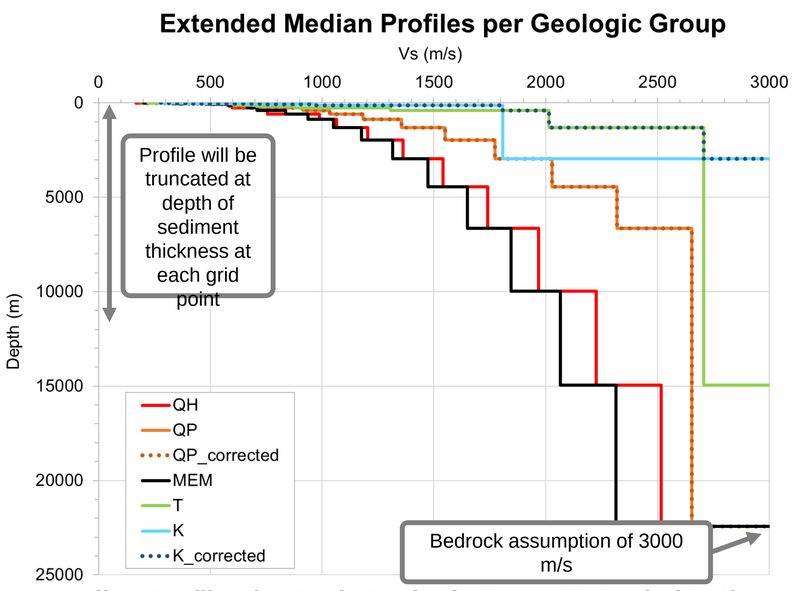
REGIONAL SEISMIC VELOCITY MODEL



Gann-Phillips C, Cabas A, Ji C, Cramer C, Kaklamanos J, Boyd O. **Regional seismic velocity model for the U.S. Atlantic and Gulf Coastal Plains based on measured shear wave velocity, sediment thickness, and surface geology.** Earthquake Spectra. 2024;0(0). doi:10.1177/87552930231222960







Median Profiles for Each Geologic Group Extended to the Layer of the Largest Sediment Thickness

CONCLUSIONS [Vs MODEL]

The CPs need a regional site amplification model that captures changes in ground motion due to variations in sediment thickness.

Our collective effort for more data collection, curation and sharing is key for future advances!

The use of geology to inform regional characterization of Vs is helpful, particularly when integrating geophysical and geotechnical data**.**

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