The SCEC Unified Community Velocity Model (UCVM) Software Models and Tools

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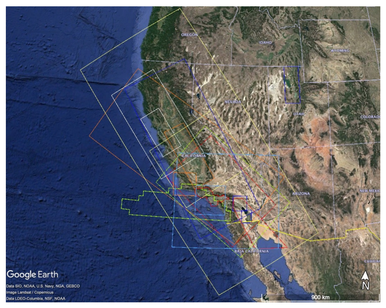

Model Name	Description	UCVM Abbreviation	Size
CVM-H v15.1	Southern California Velocity Model developed by Harvard Structural Geology Group with optional geotechnical layer	cvmh	1.6G
CVM-S4	Southern California Velocity Model developed by SCEC, Caltech, USGS Group with geotechnical layer	cvms	326M
CVM-S4.26	Tomography improved version of CVM-S4 with optional geotechnical layer(Ely-Jordan GTL, default is off)	cvms5	1.2G
CVM-S4.26.M01	CVM-S4.26 with added geotechnical layer	cvmsi	1.6G
CCA06	Central California Velocity Model with optional geotechnical layer (Ely-Jordan GTL, default is off)	cca	9.2G
CS17.3	Cypershake study 17.3 Central California Velocity Model and optional geotechnical layer (Ely-Jordan GTL, default is off)	cs173	72G
CS17.3-H	Cypershake study 17.3 Central California Velocity Model with San Joaquin and Santa Maria Basins data from Havard's group and optional geotechnical layer (Ely-Jordan GTL, default is off)	cs173h	72G
USGS Bay Area Velocity Model 0.8.3	USGS developed San Francisco and Central California velocity model	cencal	17G
Albacore	Albacore California off-shore Velocity Model	albacore	2.3M
IVLSU	SSIP Imperial Valley Velocity Model developed by LSU	ivlsu	1M
CVLSU	SSIP Coachella Valley Velocity Model developed by LSU	lvlsu	1M
WFCVM	Wasatch Front Community Velocity Model	wfcvm	50M
Southern California 1D	Modified Hadley Kanamori 1D model based on Hadley-Kanamori model	1d	8k
Northridge Region 1D	Los Angeles Region 1D model used in SCEC Broadband Platform	bbp1d	-

Figure 1:

Fig 1: (left) Integration of Additional Velocity Models: Fourteen velocity models have been integrated into UCVM. The most recent version of UCVM contains four additional velocity models including the ALBACORE Offshore model, Coachella and Imperial Valley Models, and an updated Wasatch Front Utah model were registered into UCVM this year.

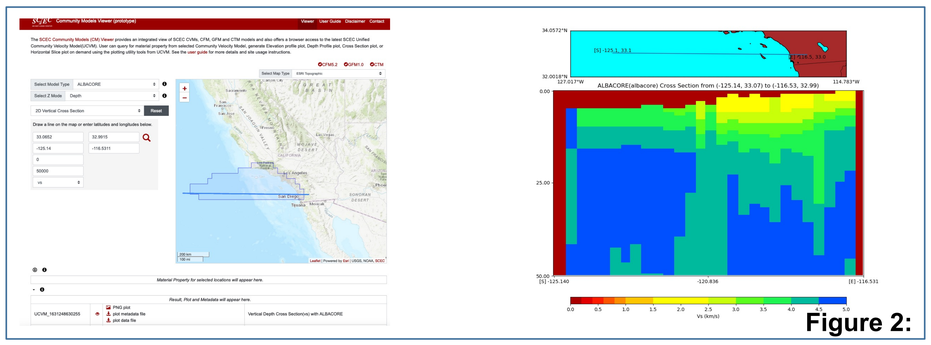

Figure 2:

Fig 2: (above right) ALBACORE Velocity Model: The ALBACORE shear-wave velocity model offshore southern California images plate boundary deformation including both thickening and thinning of the crustal and mantle lithosphere at the westernmost edge of the North American continent. The ALBACORE ocean bottom seismometer array, together with 65 stations of the onshore Southern California Seismic Network, were used to measure ambient noise correlation functions and Rayleigh-wave dispersion curves which are inverted for 3D shear-wave velocities. The resulting velocity model defines the transition from continental lithosphere to oceanic. **Reference**: Bowden, D. C., Kohler, M. D., Tsai, V. C., & Weeraratne, D. S. (2016). Offshore southern California lithospheric velocity structure from noise cross-correlation functions. Journal of Geophysical Research, 121(5), 3415-3427. doi: 10.1002/2016JB012919.

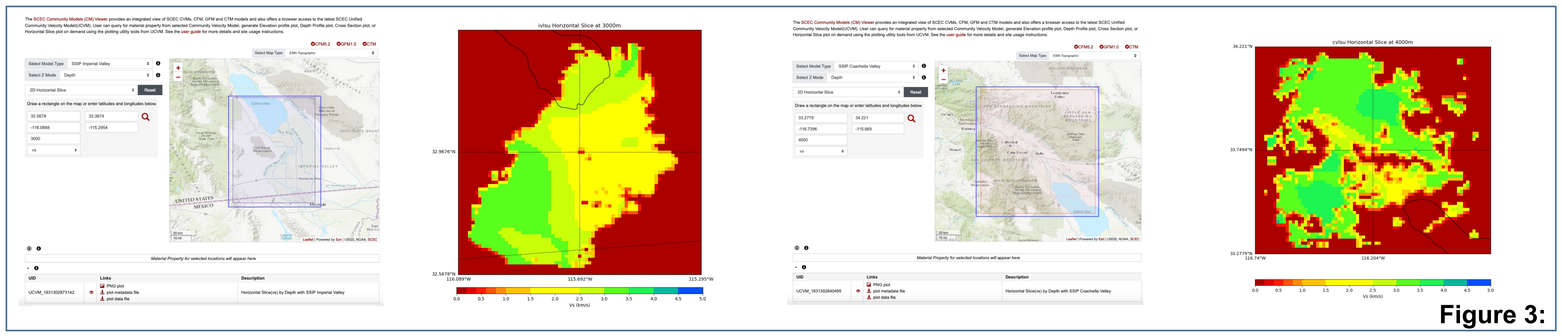

Figure 3:

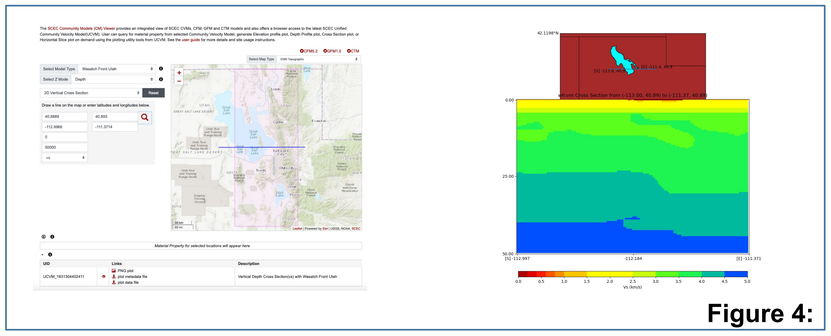

Figure 4:

Fig 3: (above left) Imperial Valley and Coachella Valley Velocity Models : The Coachella Valley model was developed by inverting travel times from explosive shots along with earthquake data and utilizing a set of 48,105 P-wave arrival times from 126 explosive shots in the 2011 Salton Seismic Imaging Project (SSIP) recorded at both the SSIP and Southern California Seismic Network (SCSN) stations. In addition, SCSN station-derived first arrivals from 39,998 local earthquakes with a maximum focal depth of 10 km were incorporated to produce a comprehensive 3-D P-wave velocity model. This model has a grid spacing of 1-km and exhibits good resolution (~ 50 rays/cubic km) to a depth of at least 7 km. The Imperial Valley model has similar properties. **Reference**: Persaud P., Y. Ma, J. M. Stock, J. Hole, G. Fuis and L. Han (2016), Fault zone characteristics and basin complexity in the southern Salton Trough, California , Geology, 44(9), p. 747-750, doi:10.1130/G38033.1. **Reference**: Ajala, R., Persaud, P., Stock, J. M., Fuis, G. S., Hole, J. A., Goldman, M., & Scheirer, D. (2019). Three-Dimensional Basin and Fault Structure From a Detailed Seismic Velocity Model of Coachella Valley, Southern California. *Journal of Geophysical Research: Solid Earth*,. doi: 10.1029/2018JB016260. https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2018JB016260

Fig 4: (above right) Wasatch Front Model: The Wasatch Front Community Velocity Model (CVM) is a three-dimensional model of the subsurface that incorporates shallow shear-wave velocity (Vs), deep-basin structure, and other effects. To aid in producing this model, the developers including Harold Magistrale have compiled well logs, databases of Vs, and deep-basin geophysical data, and the resulting CVM includes Cache, Weber/Davis, Salt Lake, and Utah basins. The Wasatch Front Utah model is a rule-based arbitrary precision model similar to SCEC's CVM-S software. **Reference**: https://geology.utah.gov/hazards/assistance/consultants/cvm-geophysical/

UCVM Community Software Development Practices: SCEC's UCVM research software development group is adopting community open-source software development practices including Git-based version control, and continuous integration testing for the codebase. In order to create a more modular version of UCVM, we have split the UCVM codebase into two public repos: (1) the core C-language UCVM framework (https://github.com/SCECcode/ucvm) and (2) UCVM plotting codes (https://github.com/SCECcode/ucvm_plotting). The regional velocity models registered into UCVM are stored in their own Github repositories and the model files are downloaded from AWS S3 during installation to improve reliability.

Improved UCVM Access: Users can now access the UCVM software in several ways. (1) **SCEC Community Model Web viewer**: – http://moho.scec.org/UCVM_web/web/viewer.php This website provides a map-based interface to UCVM and it allows users to query velocity models and to create basic plots of model properties, useful for reviewing the available CVMs and for querying a limited numbers of points. (2) **UCVM Images on Dockerhub:** SCEC has posted UCVM images in a public repository on Dockerhub. Linux, Mac, and Windows users that install Docker on their systems can download and run UCVM in a Docker container on their computer without performing a full UCVM installation on a Linux server. (3) **UCVM Source code installation on Linux:** UCVM supports the creation of large simulation meshes using MPI on Linux clusters. Advanced users can retrieve UCVM from Github and install it on a Linux system using automake tools and GNU compilers. SCEC performs UCVM development on USC Center for Advanced Research Computing (CARC) Linux cluster. The UCVM software version described on this poster is in SCEC's github repository: https://github.com/SCECcode/ucvm.git on the target branch, with scheduled release in October 2021

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Abstract: The Unified Community Velocity Model (UCVM) software framework facilitates the registration and distribution of seismic velocity models to the SCEC community. It is designed to provide a standard query interface to multiple, alternative velocity models, even if the underlying velocity models are defined in different formats or use different geographic projections. The UCVM framework helps researchers compare seismic velocity models and build equivalent simulation meshes from alternative velocity models. The UCVM framework provides a comprehensive set of open-source tools for querying seismic velocity model properties, combining regional 3D models and 1D background models, visualizing 3D models, and generating computational models in the form of regular grids or unstructured meshes that can be used as input for ground-motion simulations. In this poster, we describe recent improvements made to UCVM. We have registered additional velocity models into UCVM including the ALBACORE offshore model, Coachella and Imperial Valley models, and an updated Wasatch Front model. We have developed a UCVM web interface that provides access to the velocity models registered in UCVM and allows users to query the models and create plots without installing UCVM. And, to simplify the installation of UCVM, we have posted UCVM images on Dockerhub which can retrieved, installed, and run on a wider variety of computers including Mac, Windows, and Linux systems.