Improving web-based access tools for the SCEC Community Models

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Introduction

SCEC Community Models (CXM) are a set of community models that describe many features of the southern California lithosphere and asthenosphere. Most of the models have domain datasets that are very large with some updated on a regular schedule. The sheer amount of research data and domain complexity poses a challenge to present the models to the curious public and researchers alike.

Since 2018, we have been working on web-based model viewers for CXM models with the goals of providing easy access to the underlying data and data visualization capabilities when appropriate. SCEC currently hosts an official Community Fault Model (CFM) web viewer, and several other provisional web viewers for other CXM and their components including the Community Geodetic Model (CGM), the Geological Framework Model (GFM), Community Thermal Model(CTM), and Unified Community Velocity Model (UCVM).

Recent Developments

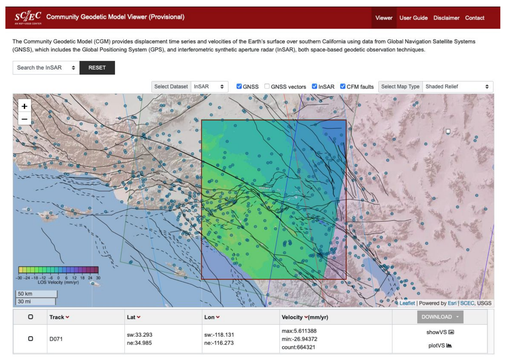

Figure 1: A plot of InSar line-of-sight velocities from track D071 on CGM web viewer. More than 664k data points are being displayed as Leaflet.js layers. The blue circles shows the GNSS station location, the rectangle borders are boundaries of 4 InSAR tracks. The light green rectangle is track D071. An overlay of CFM5.3 fault object is added.

CGM Web Viewer

We added a vector magnitude filtering method for GNSS data product. We also incorporated InSAR line-of-sight velocities and displacement time series as data product into the web viewer. Both time series and InSAR LOS velocities can be viewed and downloaded.

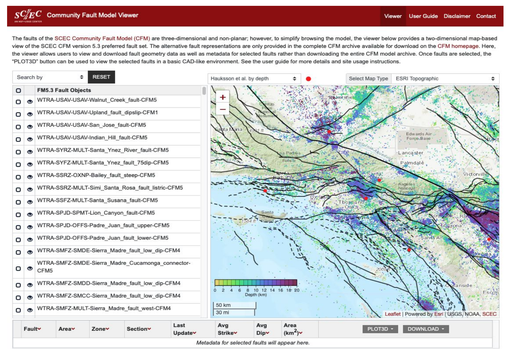

Figure 2: A plot of CFM v5.3 Fault objects with relocated seismicity dataset from Hauksson et al.(2012) catalog. There are more than 700k data points in this catalog. The displayed points are colored by depth. Other display options are color by magnitude and by occurrence time. Another catalog to choose from is Ross et. al.(2019) catalog which has more than 900K data points.

CFM Web Viewer

We added a cascade filtering search method to allow search for fault objects with multiple criteria. We also added a new filtering method using average strike or dip values of a fault object. In addition, We have extended both leaflet.js and VTK.js to visualize relocated seismicity with point cloud layers that contain more than 1.5 million data points.

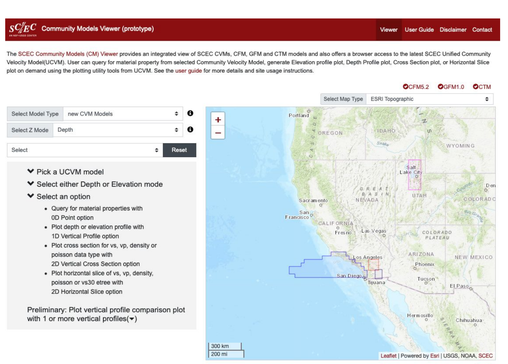

Figure 3: The mapview show boundaries of the 4 new CVM models in CM web viewer. The upper right corner is the Wasatch Front North-eastern Utah Velocity Model, the light purple irregular shaped is the ALBACORE, and the orange rectangle and smallest rectangle to the right are the SSIP Coachella Valley and SSIP Imperial Valley Velocity Models.

CM Web Viewer

We added 4 new community velocity models with very different model parameters: Southern California Offshore Velocity Model (ALBACORE). Wasatch Front North-eastern Utah Velocity Model, SSIP Imperial Valley Velocity Model and SSIP Coachella Valley Velocity Model.

Behind the Scenes

A web-based solution has many advantages over others in term of code reusability, portability and infrastructure support. We use common browser based solutions with HTML, PHP and Javascript to create CXM web viewers. For CFM and CGM web viewer, we use Docker engine/Compose for code dependency management and for setting up the service environment.

On the server side, a Postgres database with PostGIS, the database extender that can process geographic objects, is used to store model data products and also for location query. In the case of the CGM web viewer, we integrated a Python engine into server to take advantage of the python package provided by the domain scientists. Similarly, for the CM web viewer, we were able to leverage original python based UCVM plotting tools to generate cross section, horizontal slice and depth profile from the supported Community Velocity Models.

On the client side, all of the CXM model viewer has a Leaflet.js mapview with map services from various open sources. Customized extensions and plugins for each CXM model were created and used but the core code is shared across the viewers. For CFM web viewer, VTK.js is used for the CAD-like 3D interactive visualization. Several new VTK.js data ingest modules were created for handling CFM data products. For CGM web viewer, Plotly.js is used to generate the interactive scatter plot for the time series and surface contour plot to display InSAR's line-of-sight velocities.

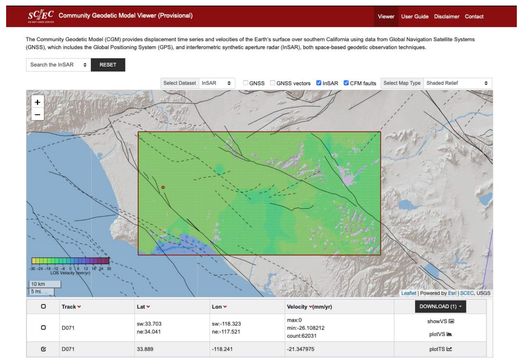

Figure 4.1: A InSAR LOS velocities 2D plot with 62k data points from InSAR track D071. The velocities ranges from 0 to -26 mm/yr.

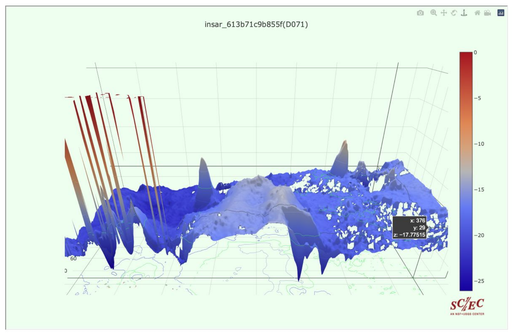

Figure 4:2: This figure is the 3D surface contour plot of the velocities from figure 4.1. The Z axis is the magnitude of the velocity data point. On the xy axis is the 2D contour lines. The light green projection on the xy axis is the 2D contour lines when there is a slice through at the selected velocity value. In this case, -17.77515.

Summary

The web-based viewers for CXM allow users to browse through complete model data product, preview the selected set and retrieve the relevant data product to local directory. An added benefit, the web-based CXM viewers greatly improve accessibility on mobile devices. Users can now lookup CTM smoothed heat flow value, view CFM faults, retrieve CGM time series, or plot a CVM depth profile on a tablet or a smartphone.The figures below were taken from an iPad.

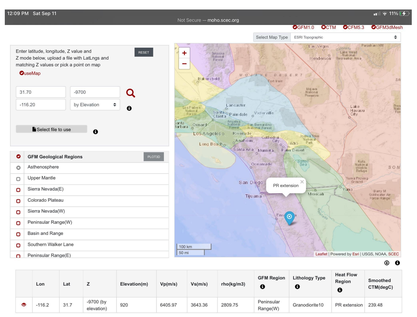

Figure 5.1: Retrieve CTM smoothed heat flow value from the GFM web viewer. This can be interactive or in batch mode.

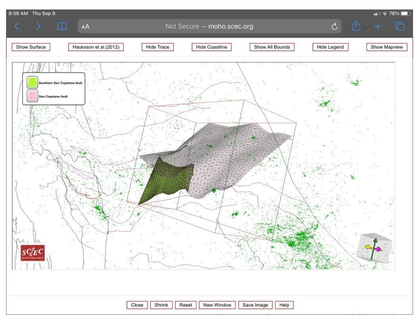

Figure 5.2: A plot3D plot of 2 fault objects in wireframe and surface form with relocated seismicity from Hauksson et al. (2012) from CFM web viewer.

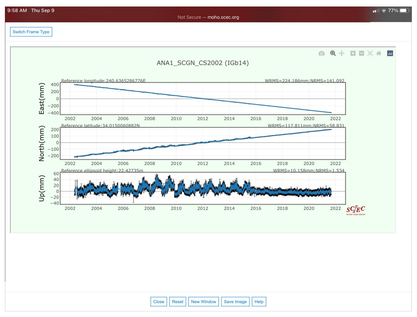

Figure 5.3: The GNSS velocity time series plot from CGM web viewer for station ANA1. The raw data is retrieved remotely from a data server at MIT and processed locally before displaying with Plotly.js.

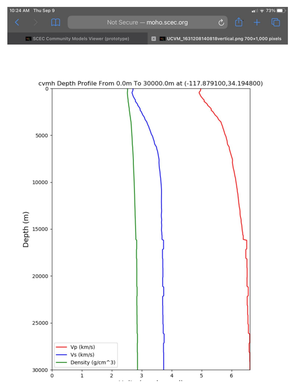

Figure 5.4: A depth profile plot from CM web server from CVM-H V15.1.1. The plot includes Vp, Vs and Density profiles for depth from 0 to 30 KM.

Acknowledgements

We would like to thank Andreas Plesch, Daniel Bowden, Ekaterina Tymofyeyeva, John H. Shaw, Kathryn Z. Materna, Monica Kohler, Patricia Persaud, Rasheed Ajala, Yehuda Ben-Zion for their contribution to this work.

Links to provisional web viewers, please send feedbacks to software@scec.usc.edu

(CTM/GFM) http://moho.scec.org/GFM_web/web/viewer.php

(UCVM/CVM) http://moho.scec.org/UCVM_web/web/viewer.php