

USGS 3D San Francisco Region Seismic Velocity Models

v21.0.0 and v21.1.0

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Summary

- **New releases of USGS 3D San Francisco Bay region seismic velocity model**
 - v21.0.0 Re-release of v08.3.0 in new storage scheme
 - v21.1.0 Updates to East Bay based on 3D ground-motion simulations of moderate earthquakes
- **GeoModelGrids**
 - New HDF5-based storage scheme for georeferenced 3D raster models
 - Build on CMU Etree and IRIS EMC
 - API for serial access with binary packages for Linux and MacOS

GeoModelGrids

Storage scheme and API for raster-based Earth models

- **Goal**

Portable, flexible, efficient storage of raster-based Earth models

- **Requirements**

- Storage

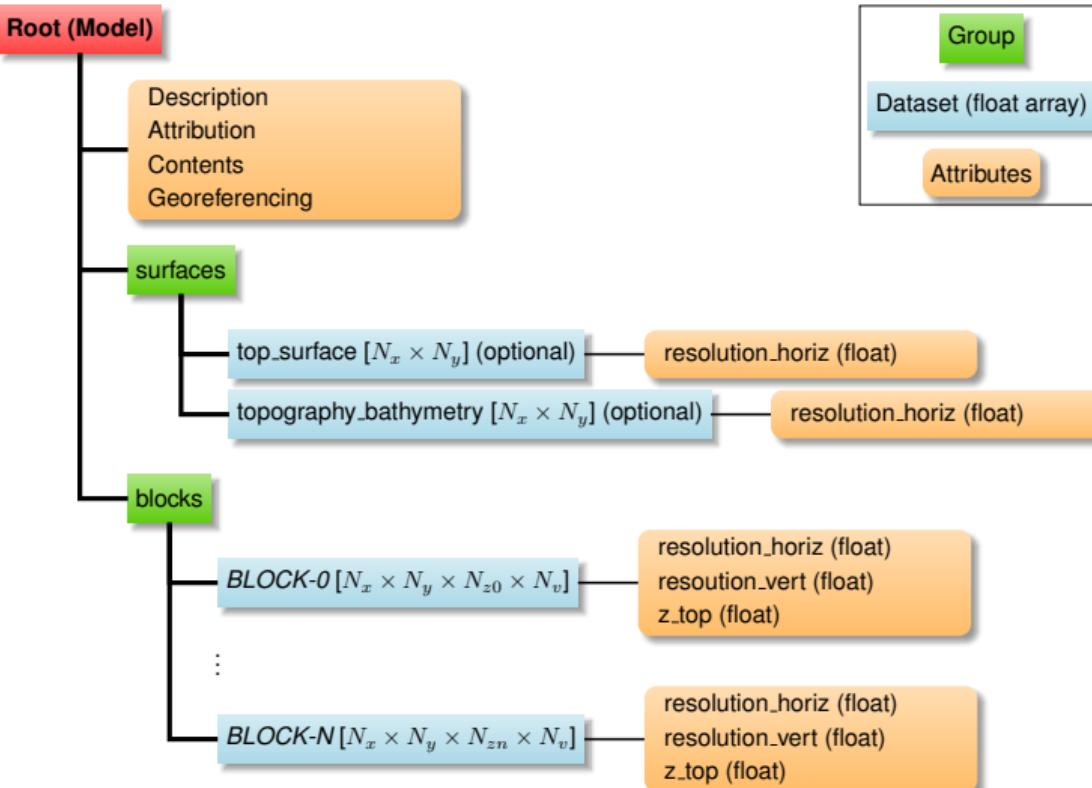
- Self-describing binary format
 - Models with and without topography
 - Independent of model coordinate system
 - Resolution can vary with depth
 - Vertical resolution independent of horizontal resolution

- API

- Serial: Allow loading only a piece of the model into memory
 - Parallel: Efficient loading of models on massively parallel computers

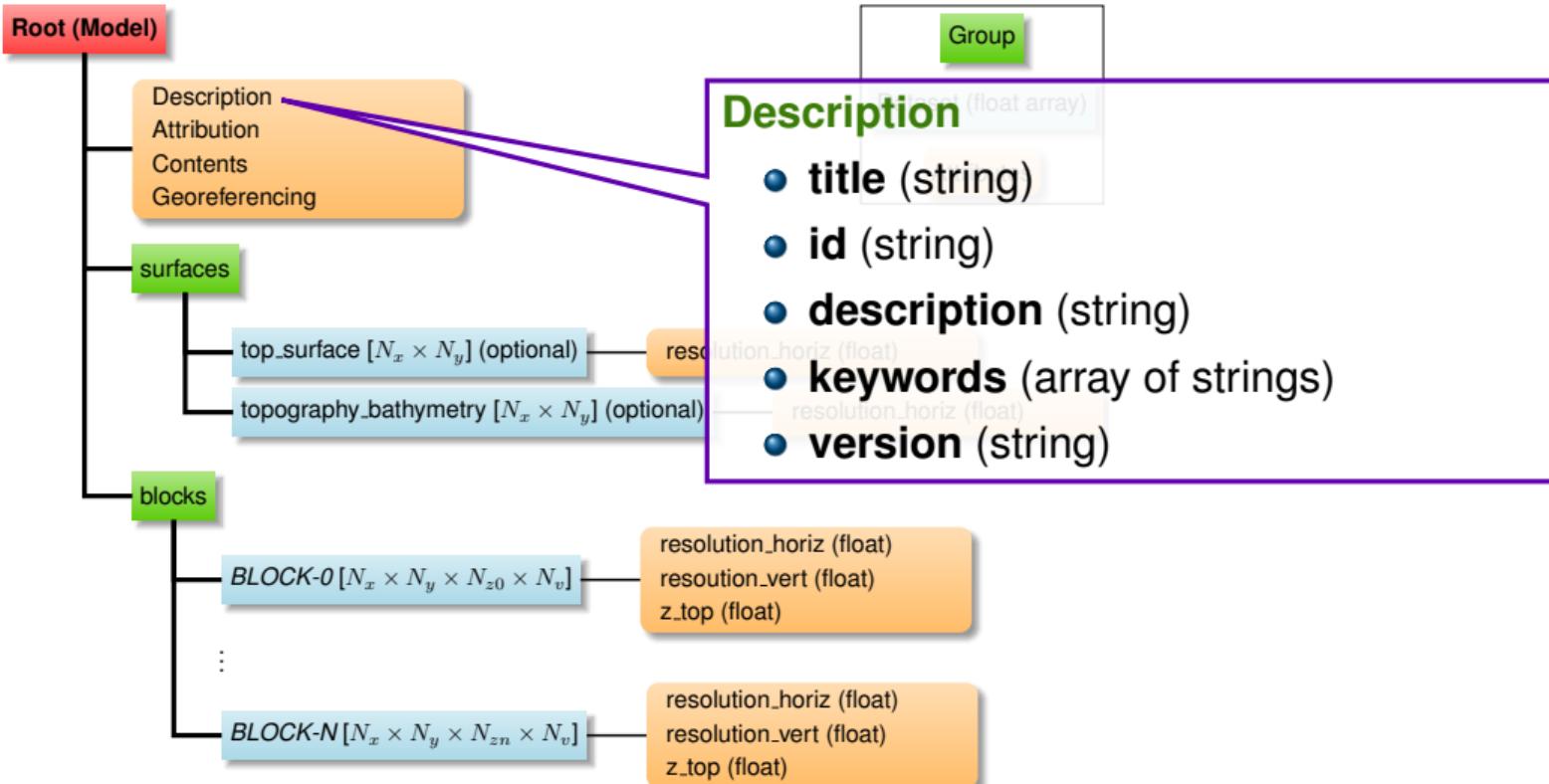
GeoModelGrids: Storage Scheme Implementation

HDF5 File: Widely used self-describing binary layout



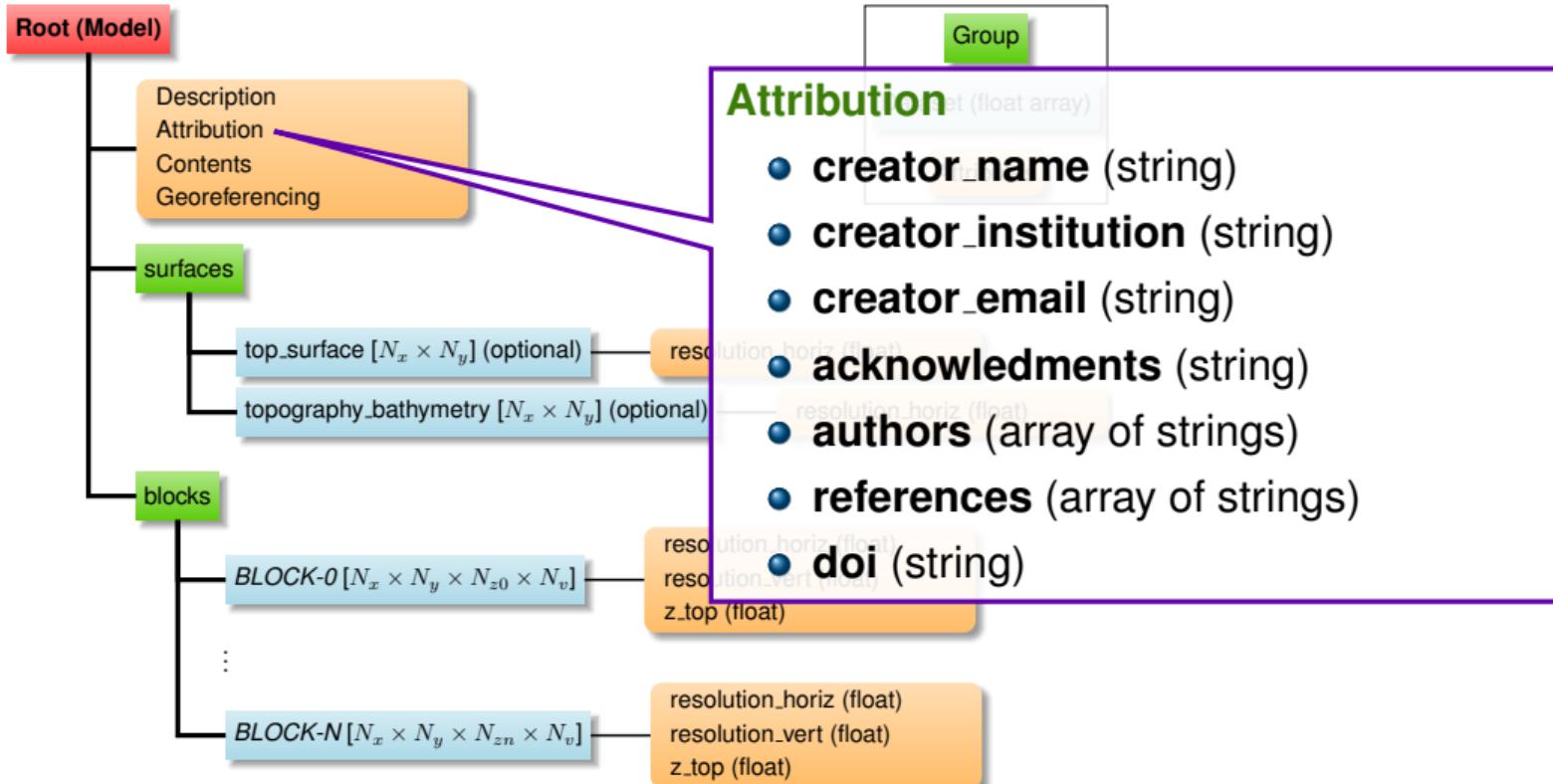
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HDF5 File: Widely used self-describing binary layout



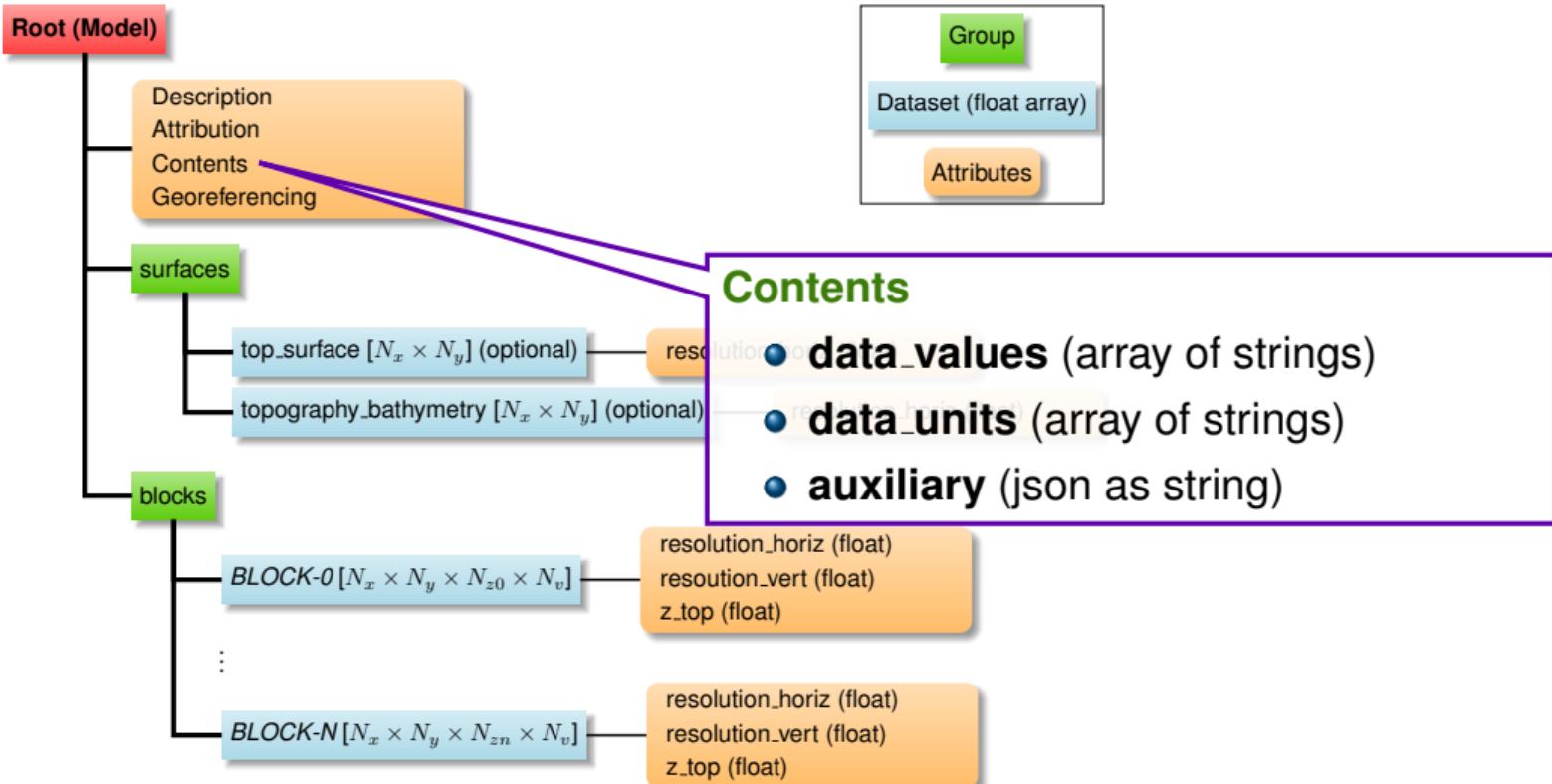
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HDF5 File: Widely used self-describing binary layout



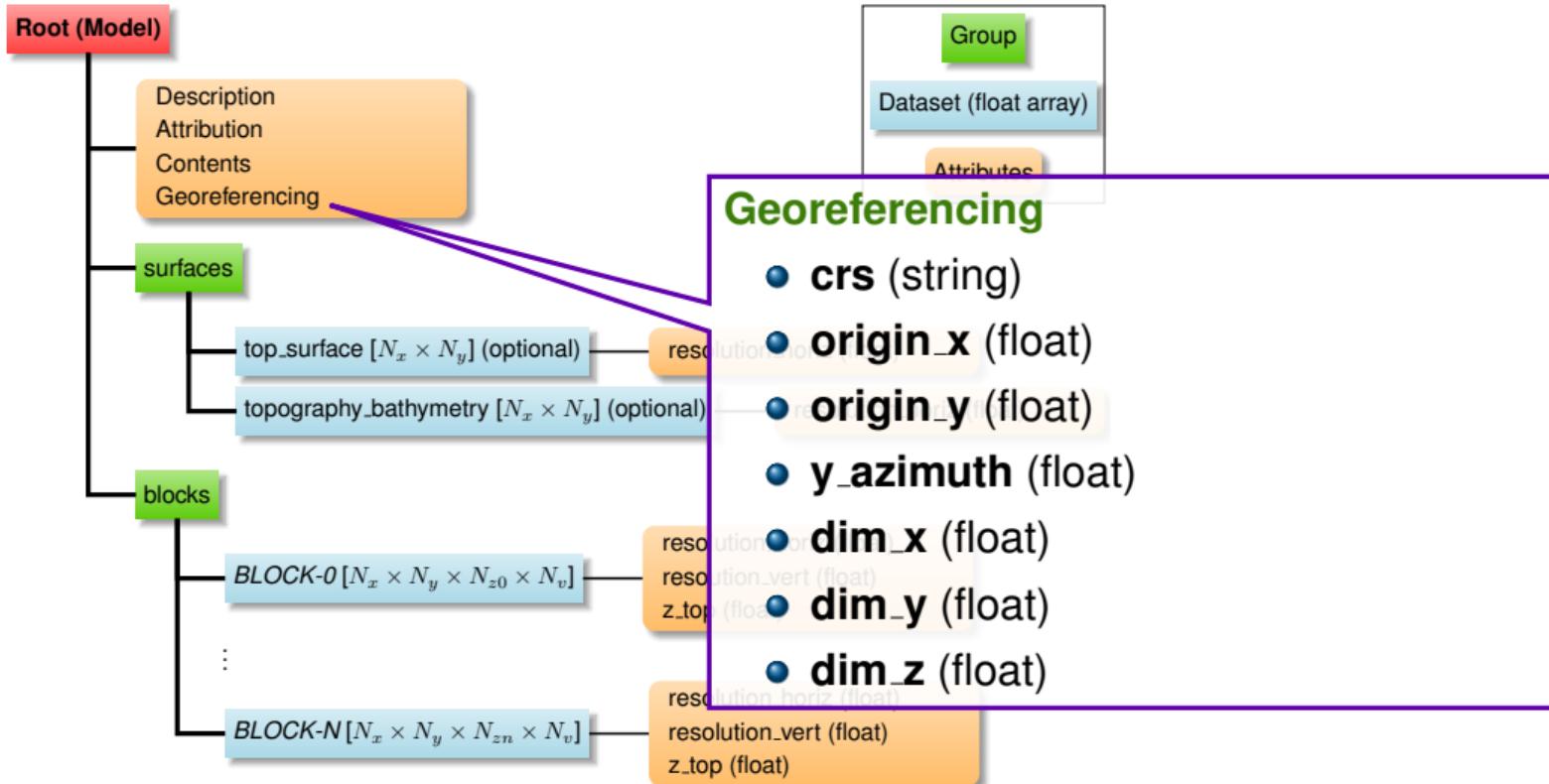
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HDF5 File: Widely used self-describing binary layout



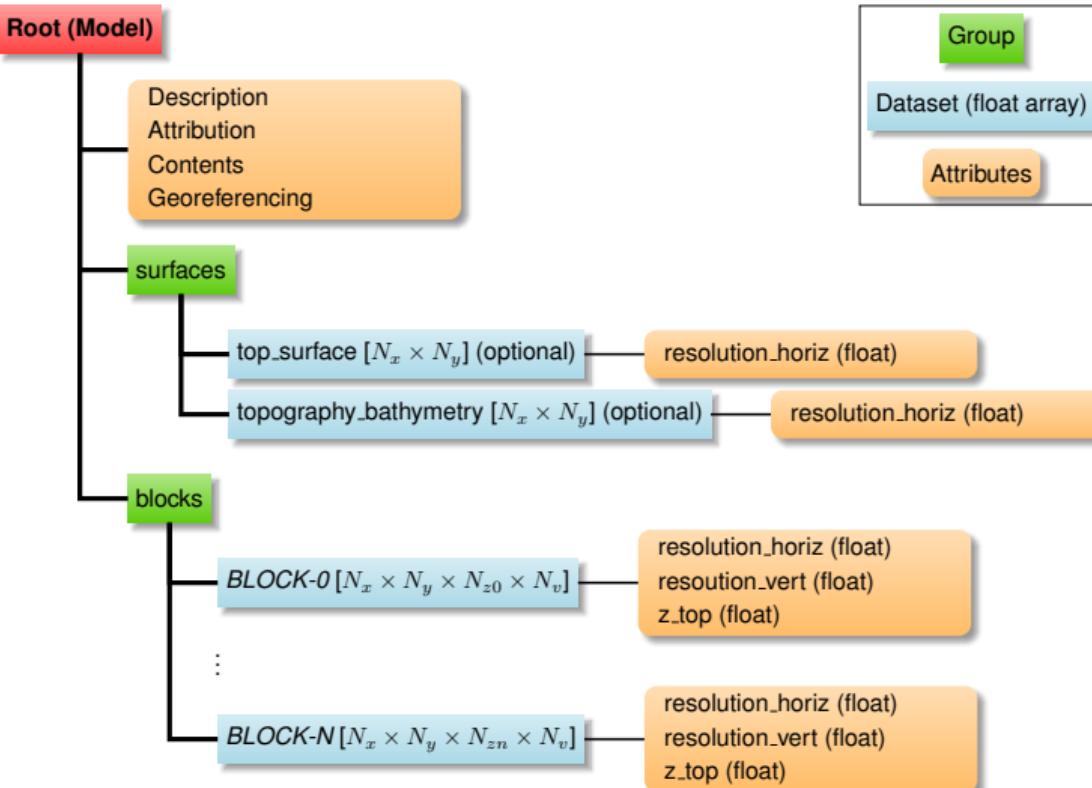
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GeoModelGrids: Command Line Tools and API

<https://baagaard-usgs.github.io/geomodelgrids/>

- **Command line tools**

`geomodelgrids_query` Query for values in models

`geomodelgrids_queryelev` Query for elevation of top surface or bathymetry

`geomodelgrids_info` Display model metadata

`geomodelgrids_borehole` High-level interface for 1D profiles

- **C/C++ API**

- Library for accessing models in serial with 98% test coverage
- Seeking collaborations for implementing MPI-based parallel API

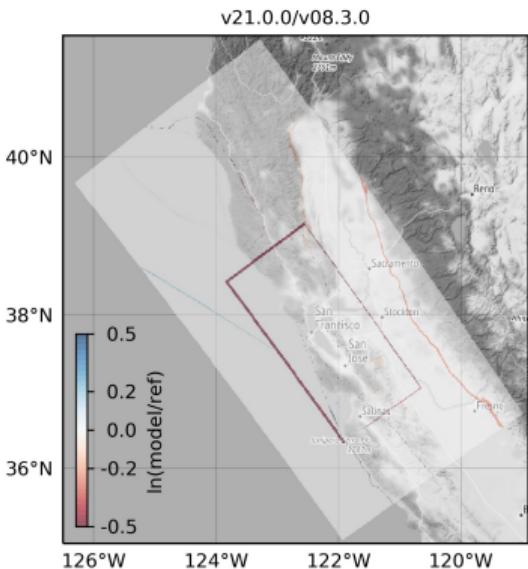
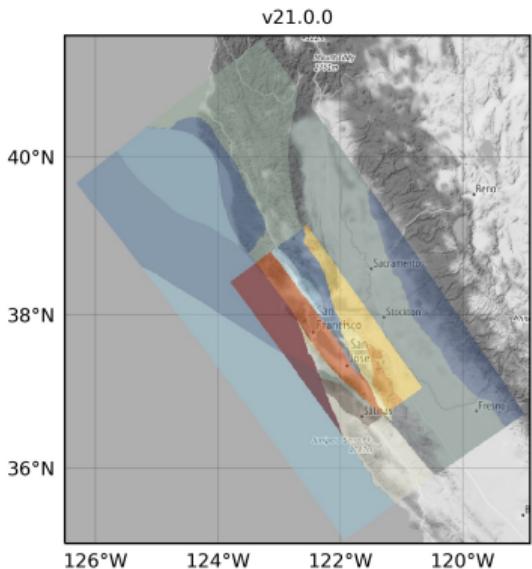
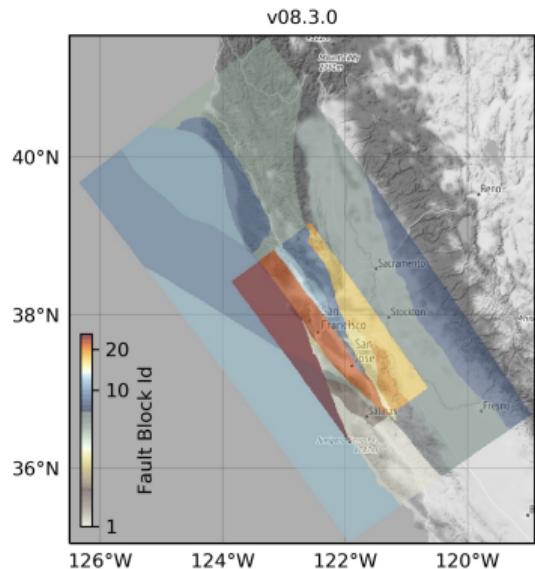
- **Known limitations**

- Vp and density are interpolated across the water/solid interface.
- Fault block and zone ids are interpolated across block and zone boundaries.

v21.0.0

Regenerate v08.3.0 (CenCalVM/Etree) as v21.0.0 (GeoModelGrids/HDF5)

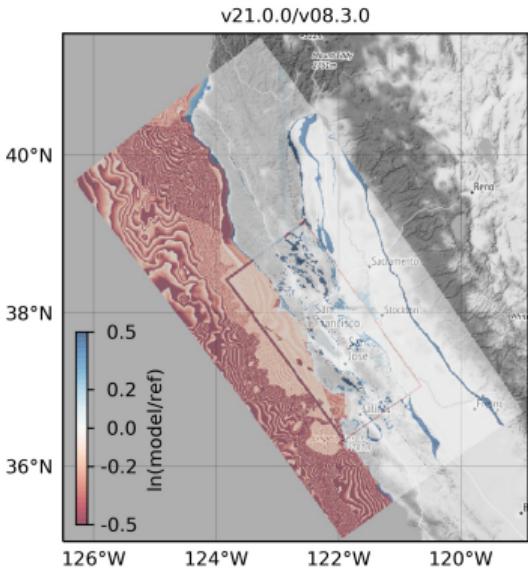
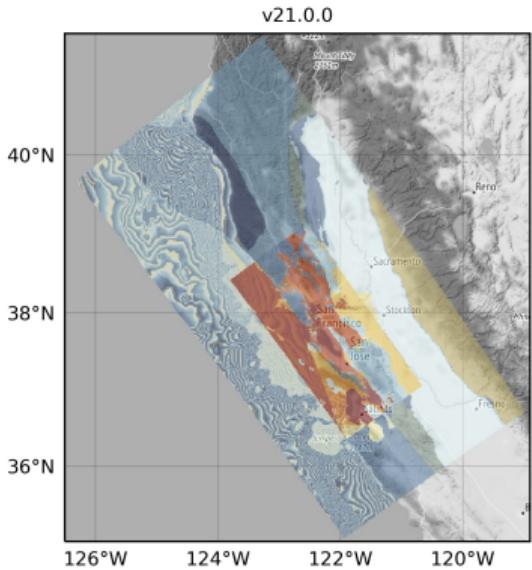
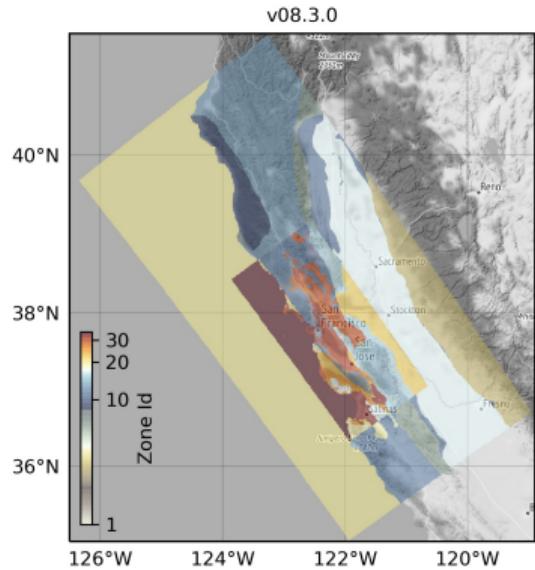
Fault Block Id @ 10m depth



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Regenerate v08.3.0 (CenCalVM/Etree) as v21.0.0 (GeoModelGrids/HDF5)

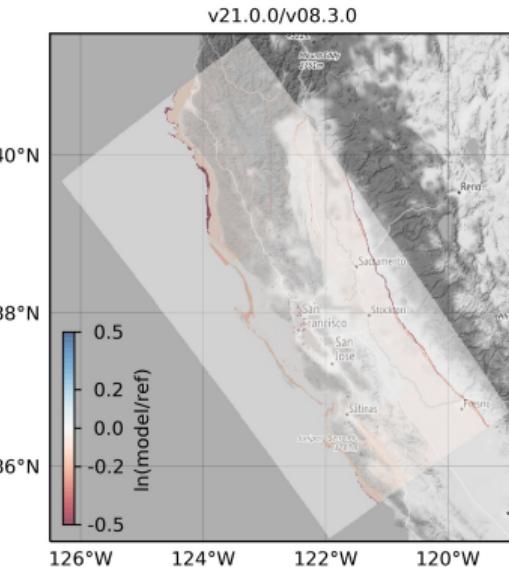
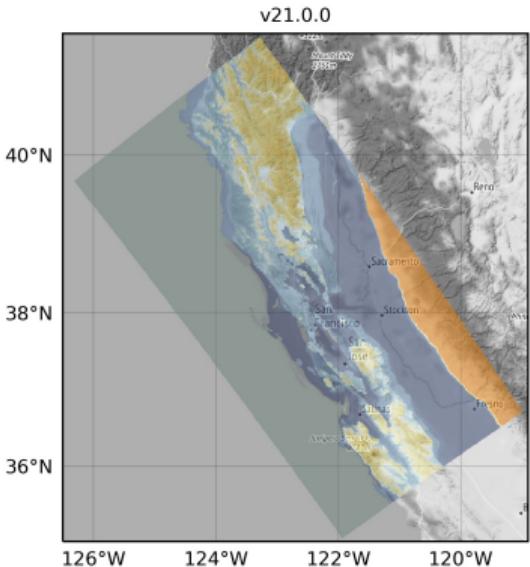
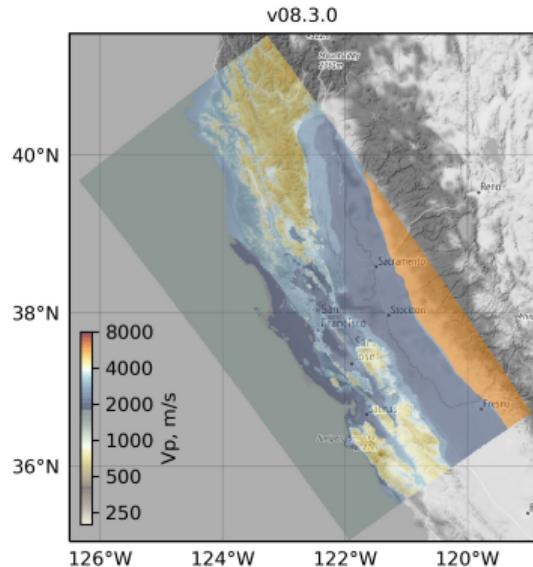
Zone Id @ 10m depth



v21.0.0

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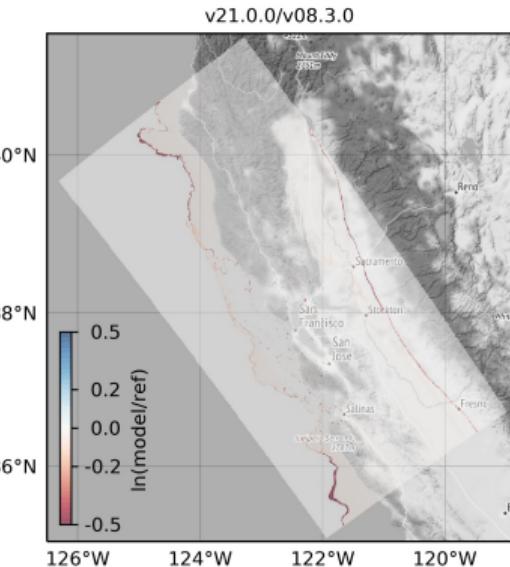
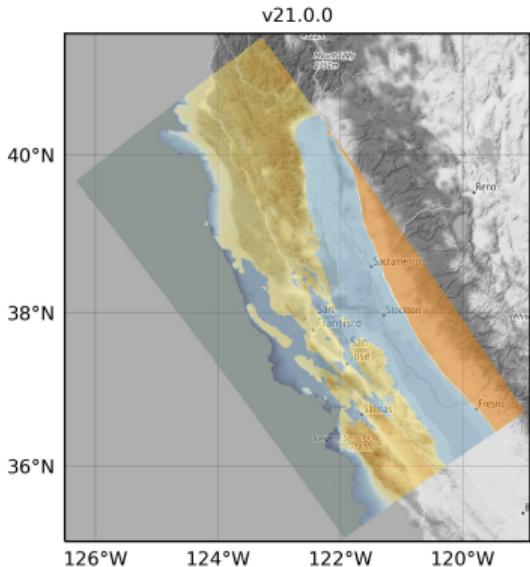
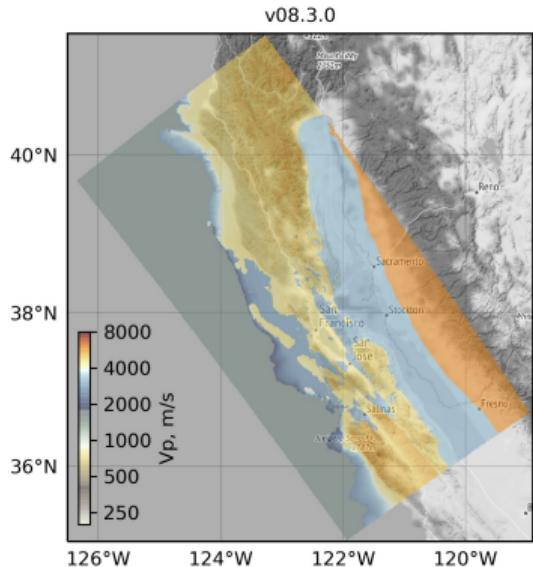
Vp @ z=-101m



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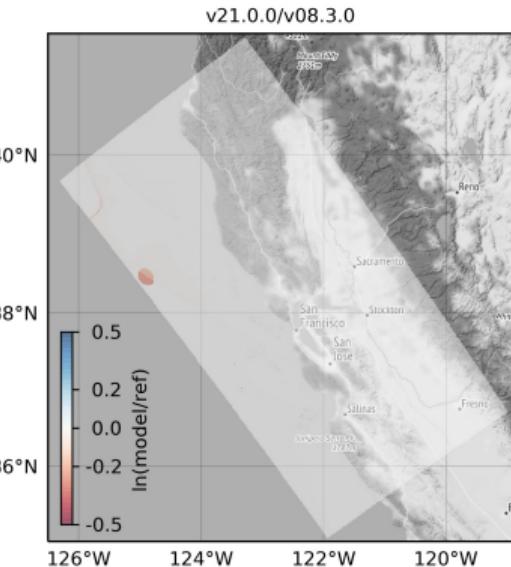
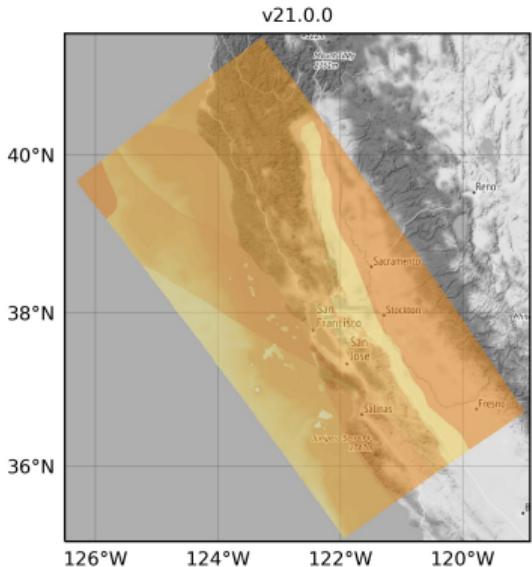
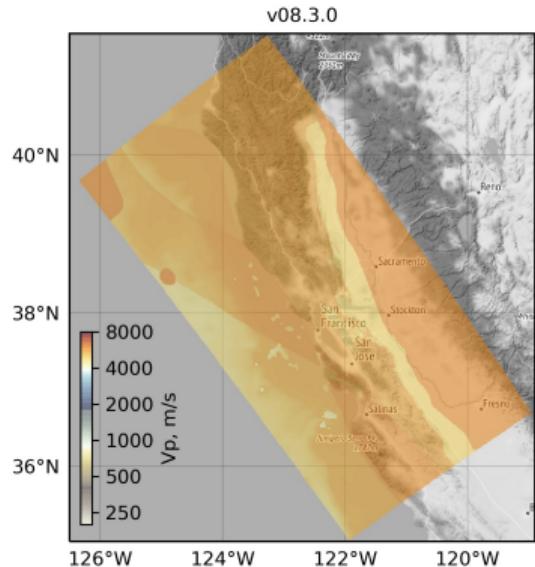
Vp @ z=-1km



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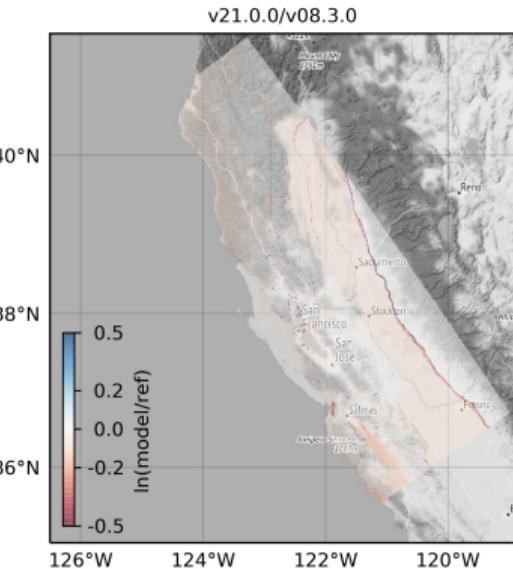
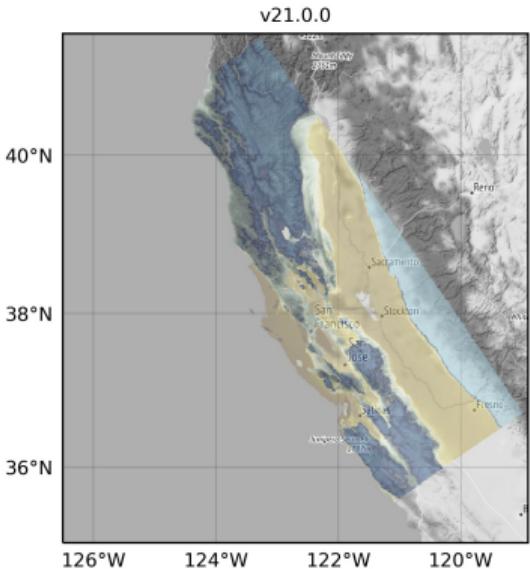
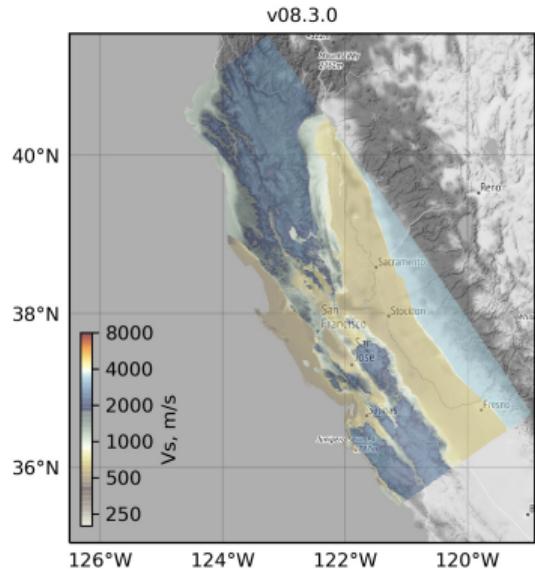
Vp @ z=-5km



v21.0.0

Regenerate v08.3.0 (CenCalVM/Etree) as v21.0.0 (GeoModelGrids/HDF5)

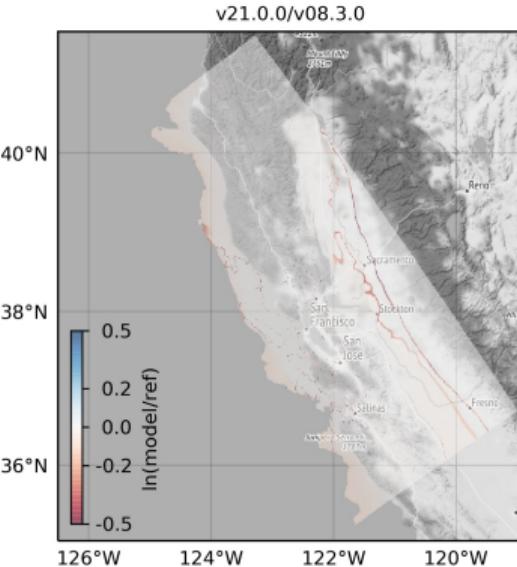
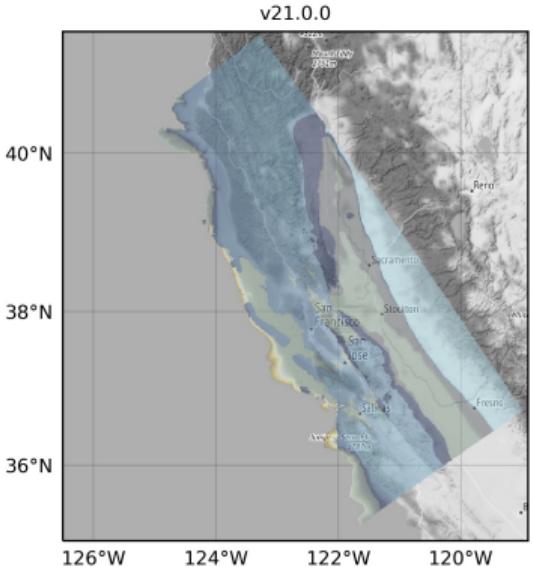
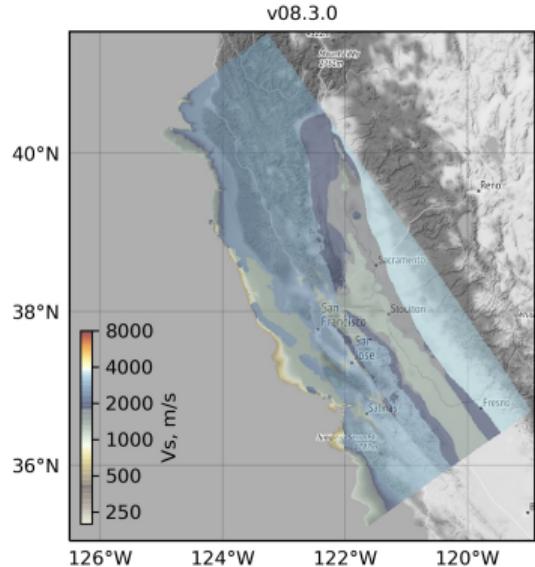
Vs @ z=-101m



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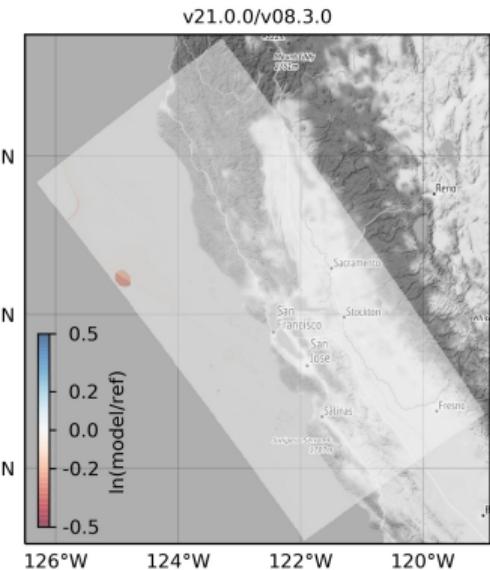
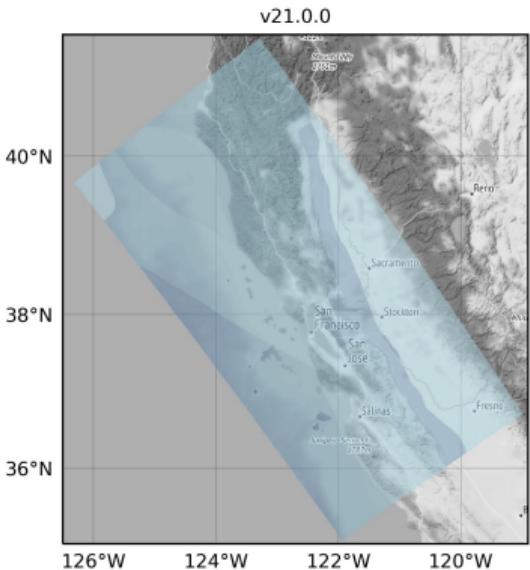
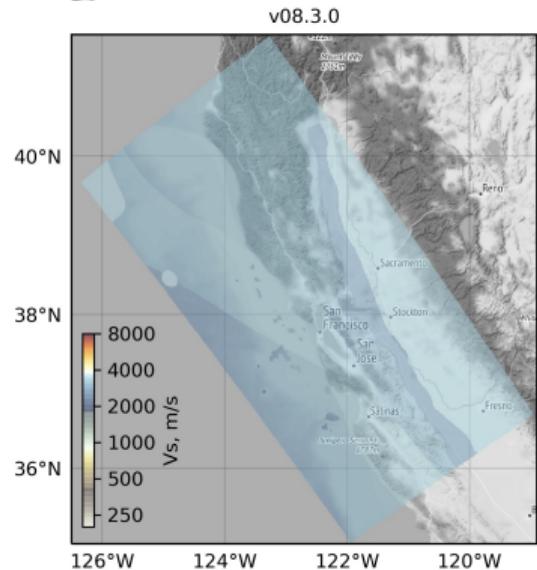
Vs @ z=-1km



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Regenerate v08.3.0 (CenCalVM/Etree) as v21.0.0 (GeoModelGrids/HDF5)

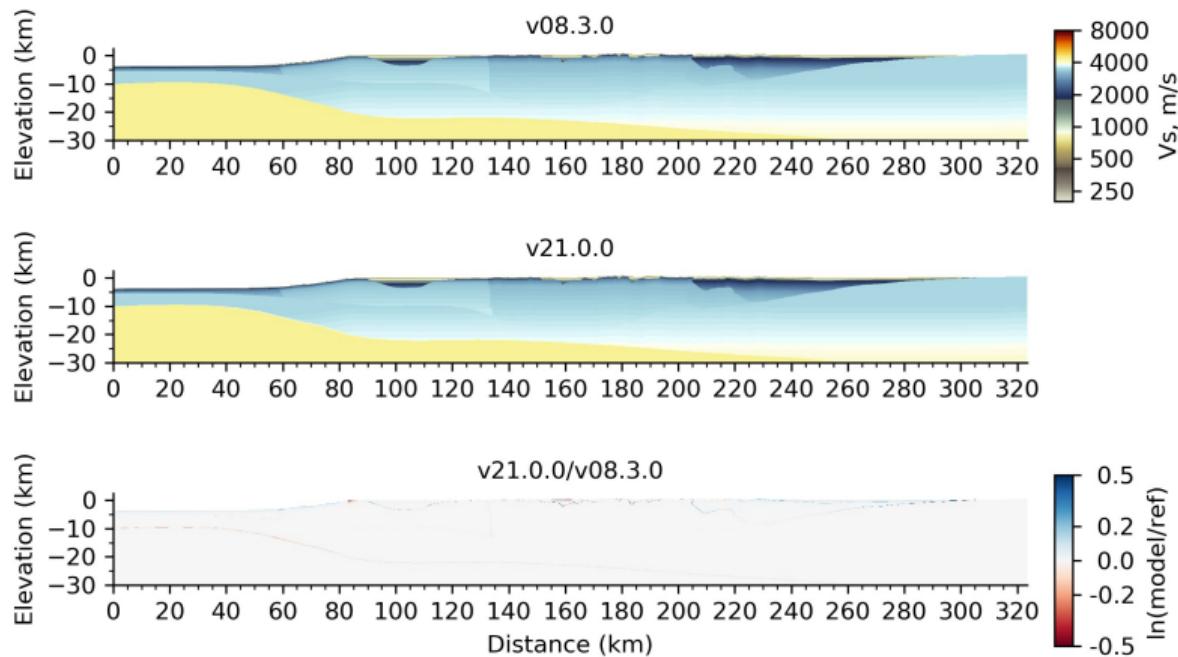
Vs @ z=-5km



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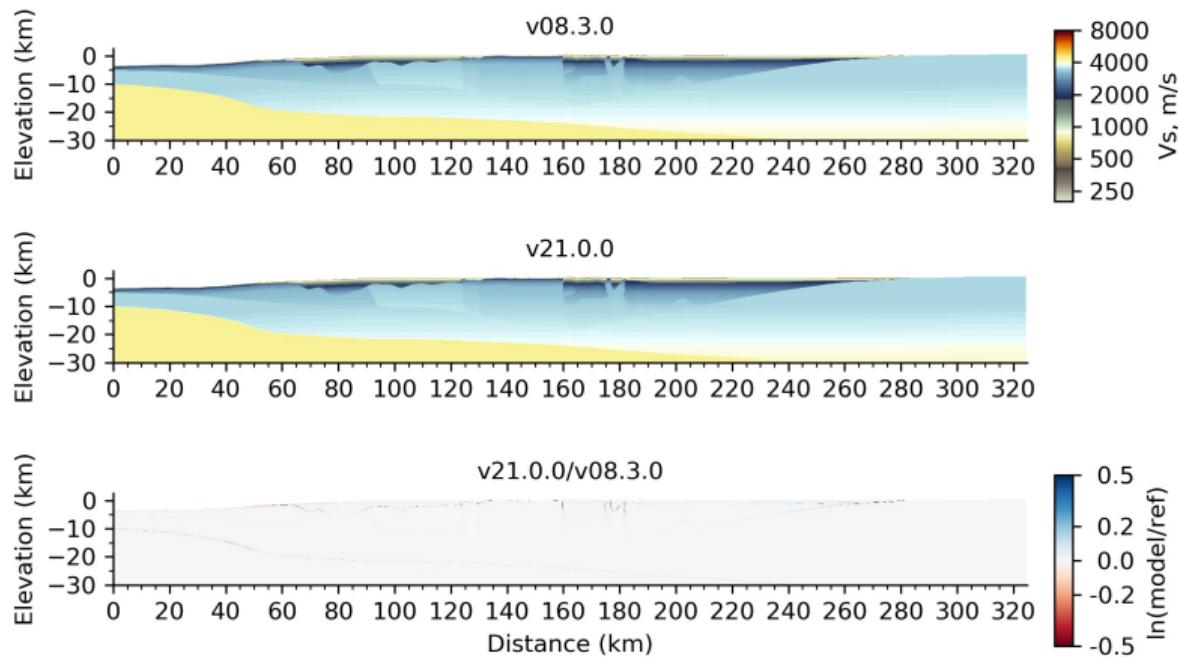
V_s on Santa Rosa West-East Cross-Section



v21.0.0

Regenerate v08.3.0 (CenCalVM/Etree) as v21.0.0 (GeoModelGrids/HDF5)

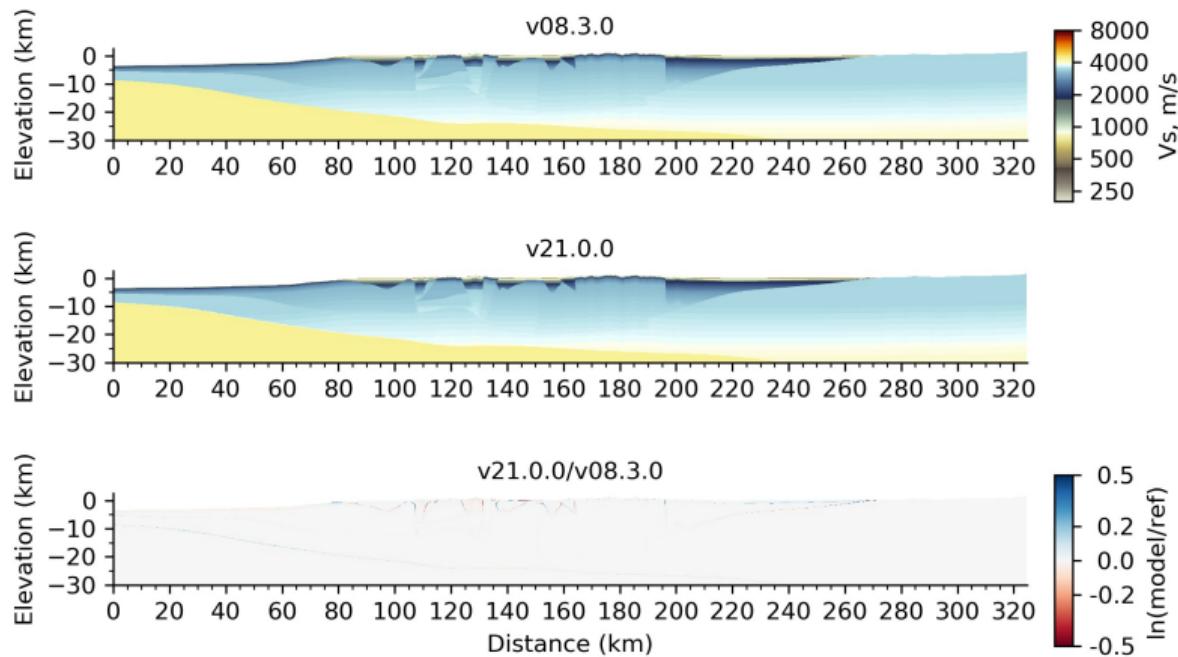
V_s on San Francisco West-East Cross-Section



v21.0.0

Regenerate v08.3.0 (CenCalVM/Etree) as v21.0.0 (GeoModelGrids/HDF5)

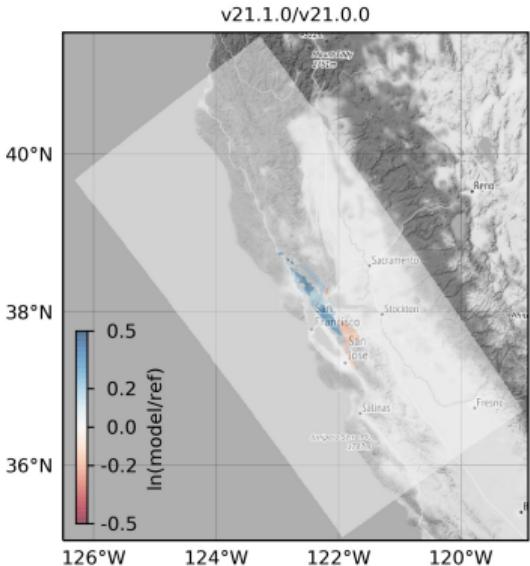
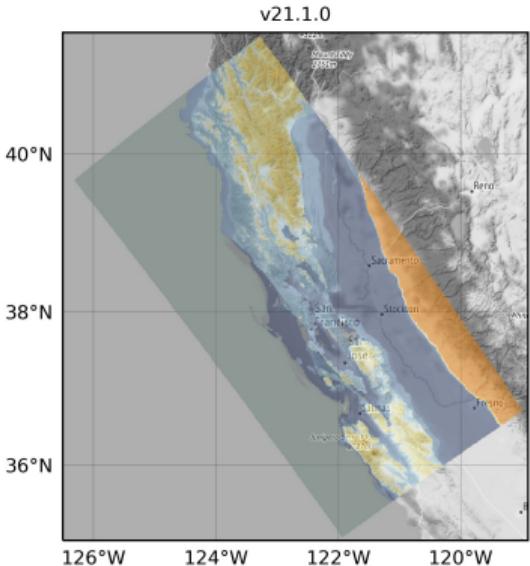
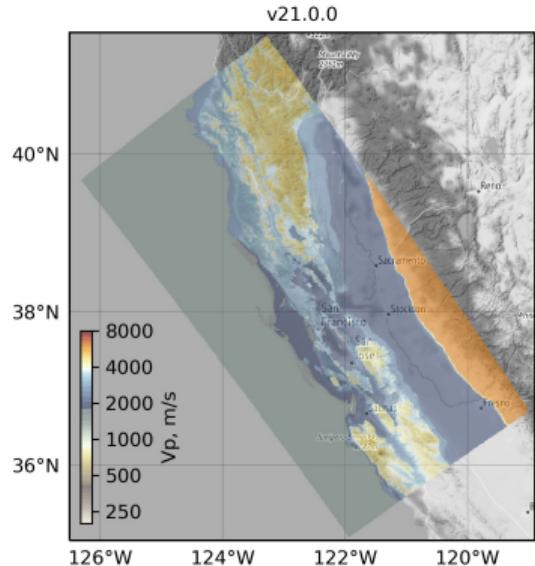
V_s on San Jose West-East Cross-Section



v21.1.0

Updates to East Bay (detailed domain only)

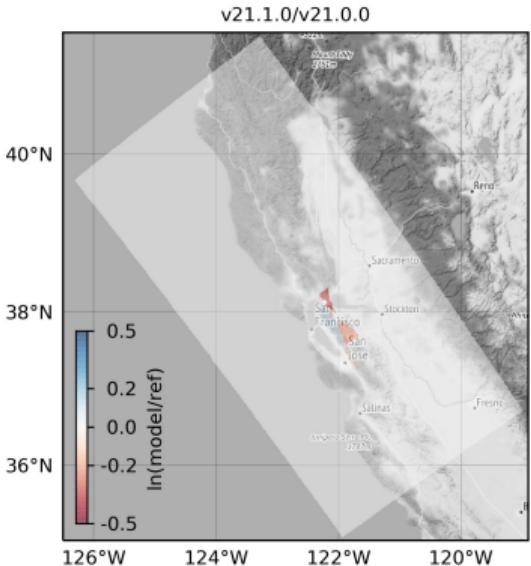
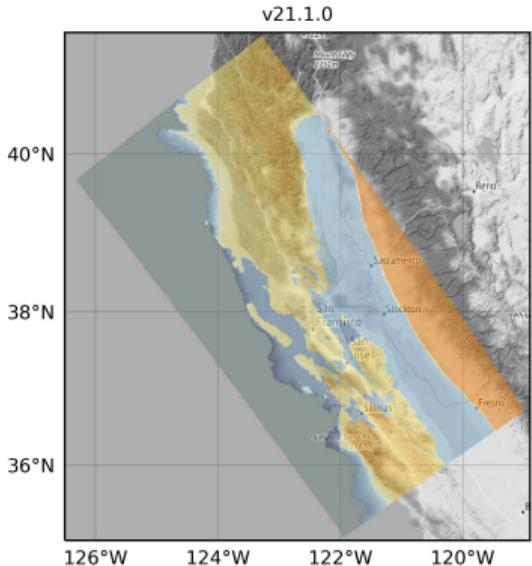
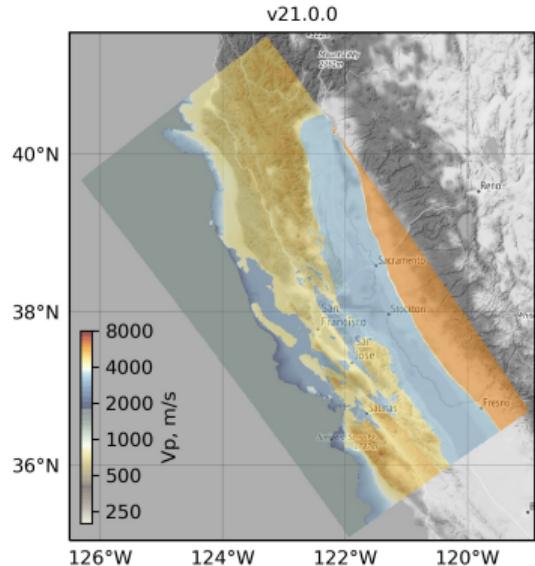
Vp @ z=-101m



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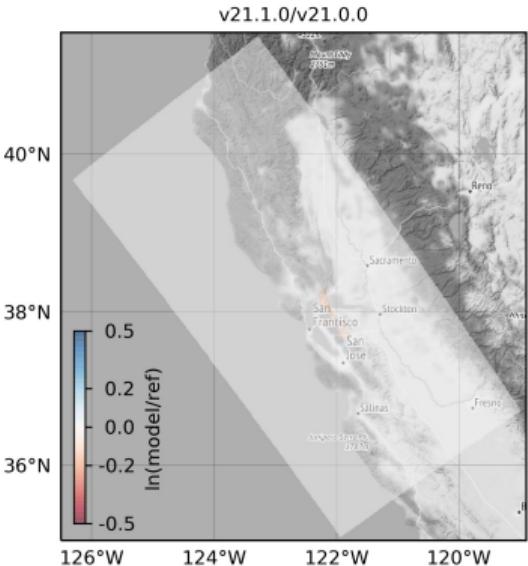
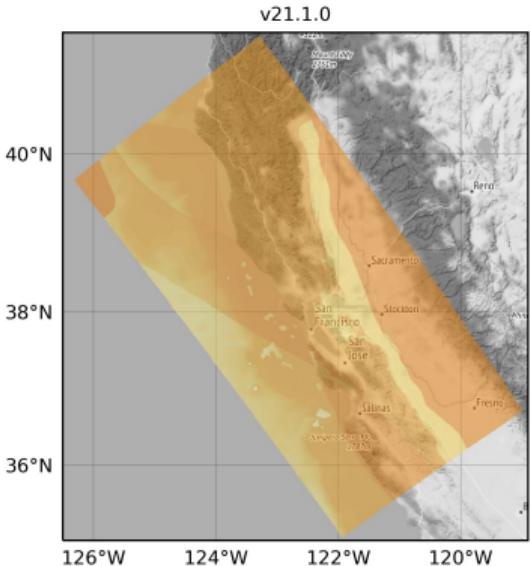
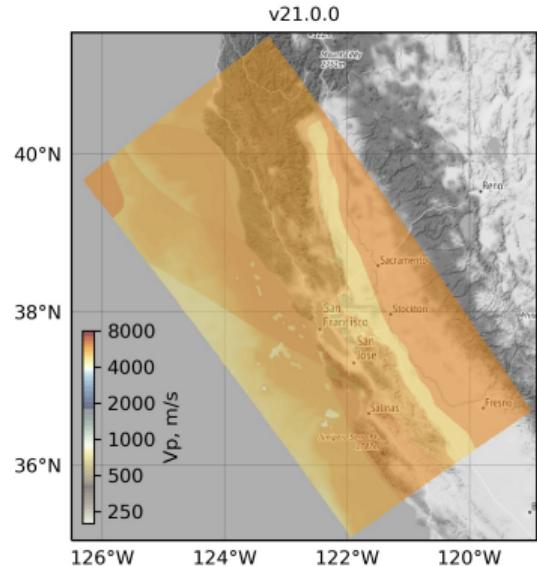
Vp @ z=-1km



v21.1.0

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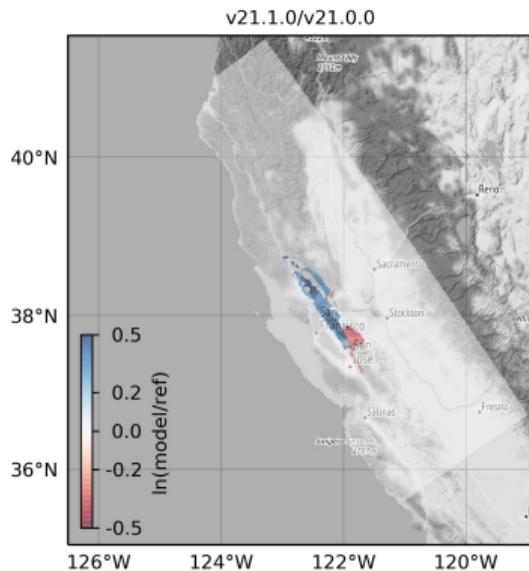
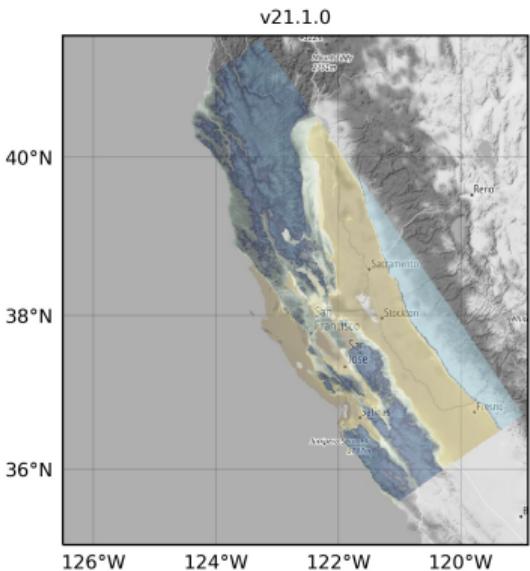
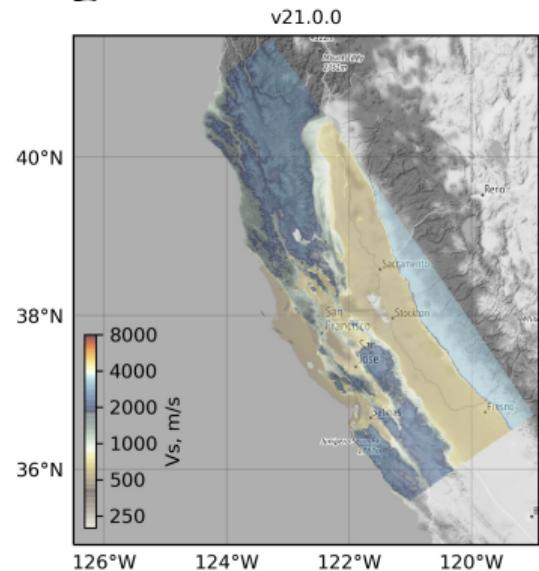
Vp @ z=-5km



v21.1.0

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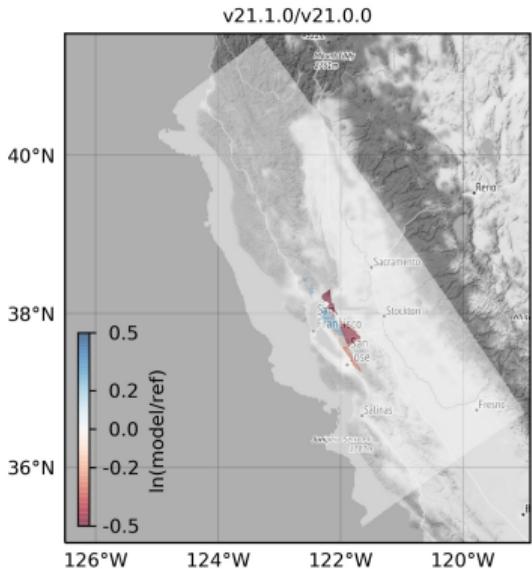
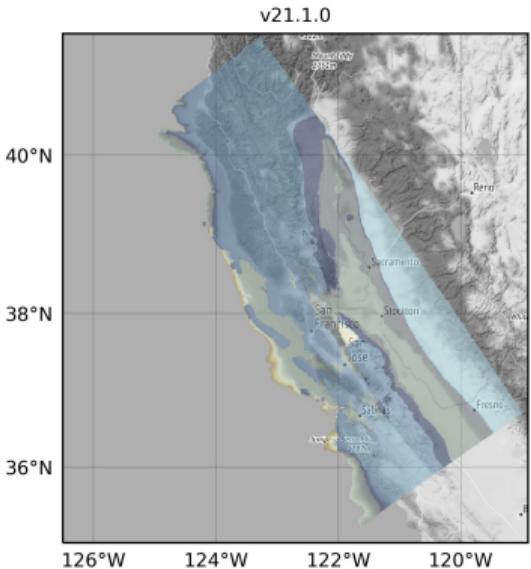
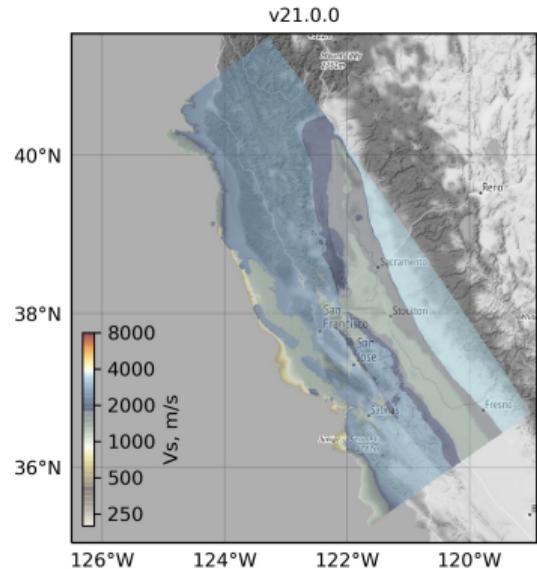
V_s @ z=-101m



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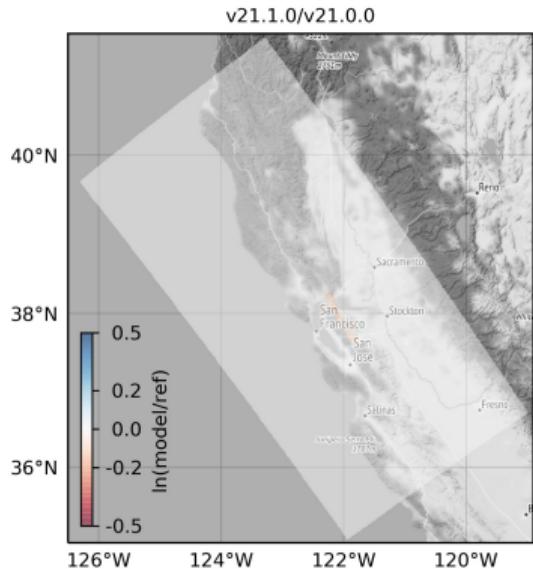
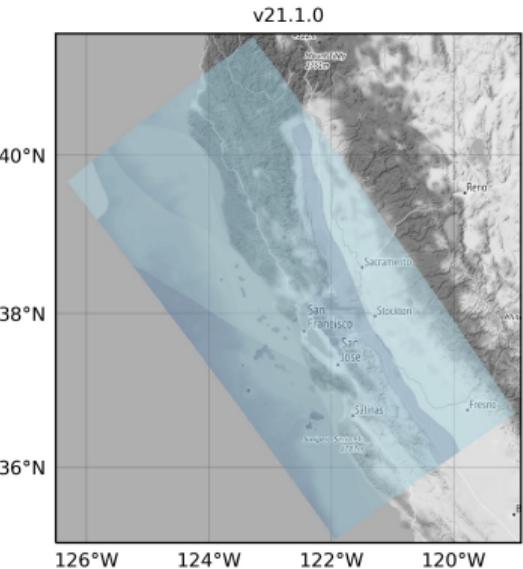
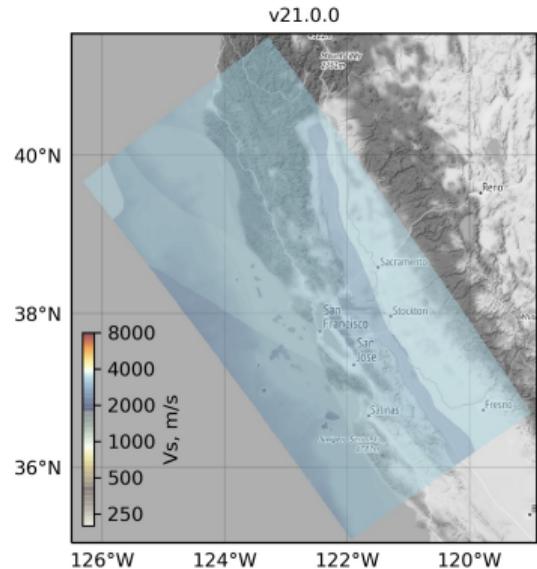
V_s @ z=-1km



v21.1.0

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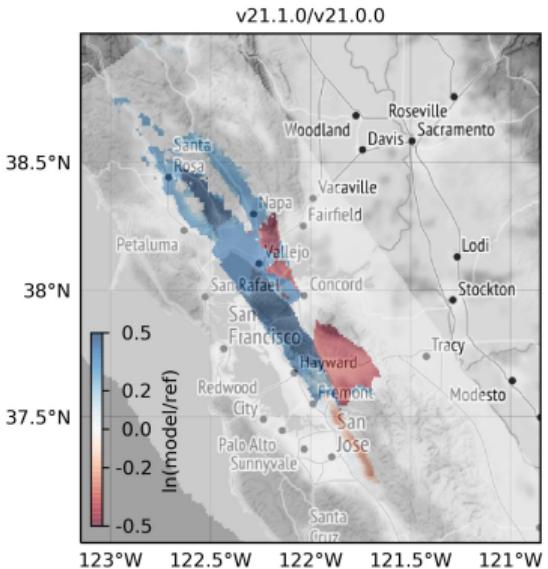
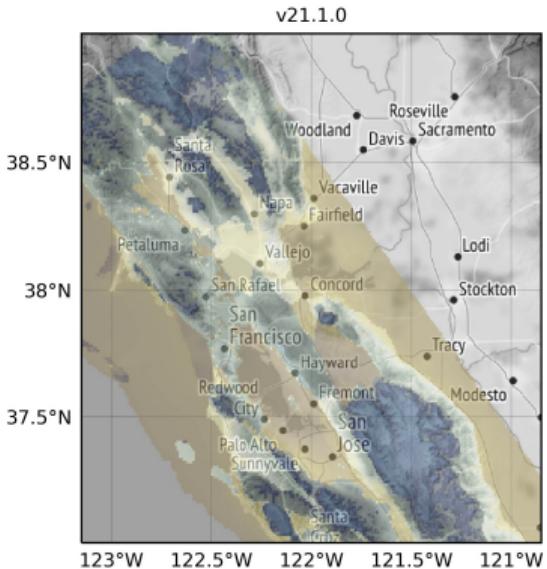
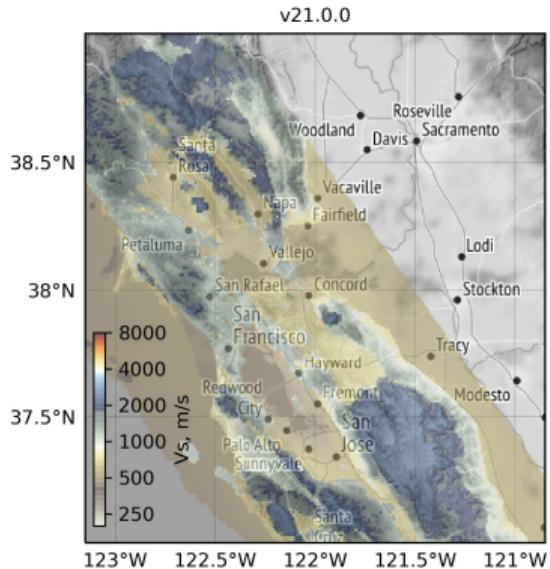
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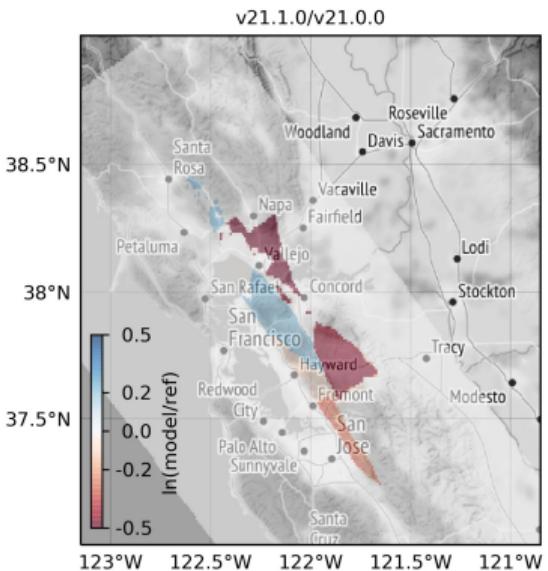
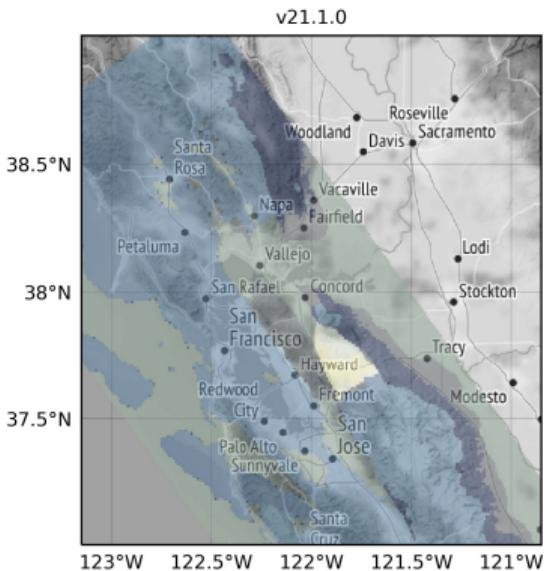
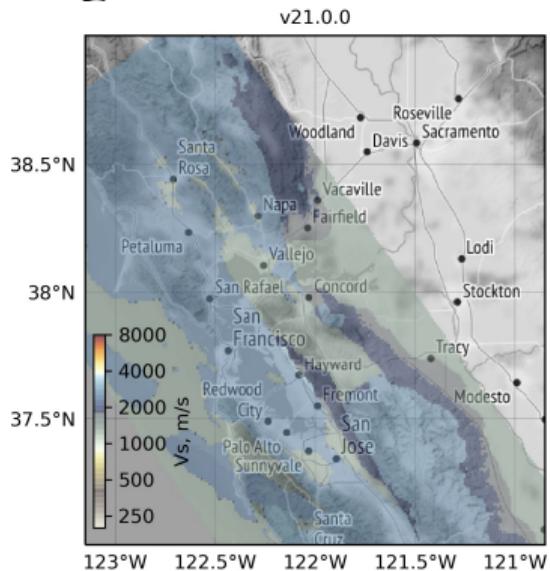
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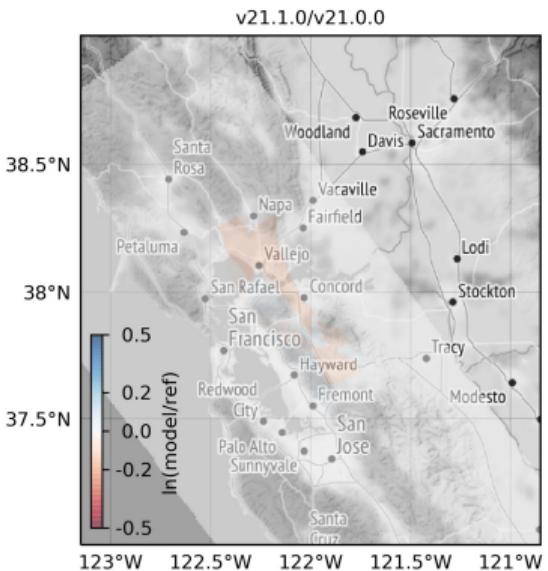
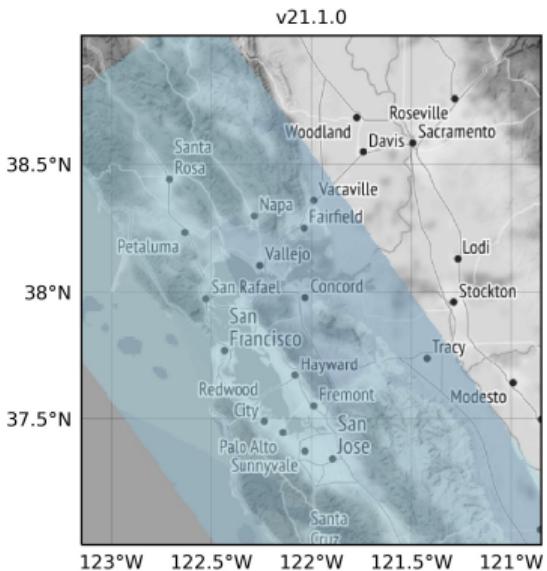
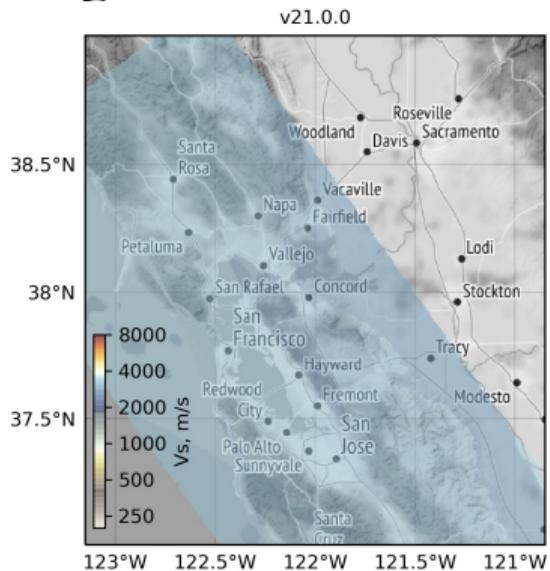
Vs @ z=-1km



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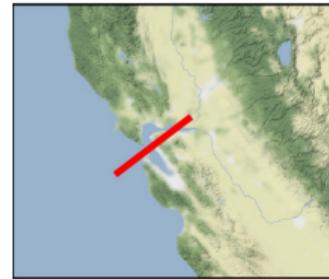
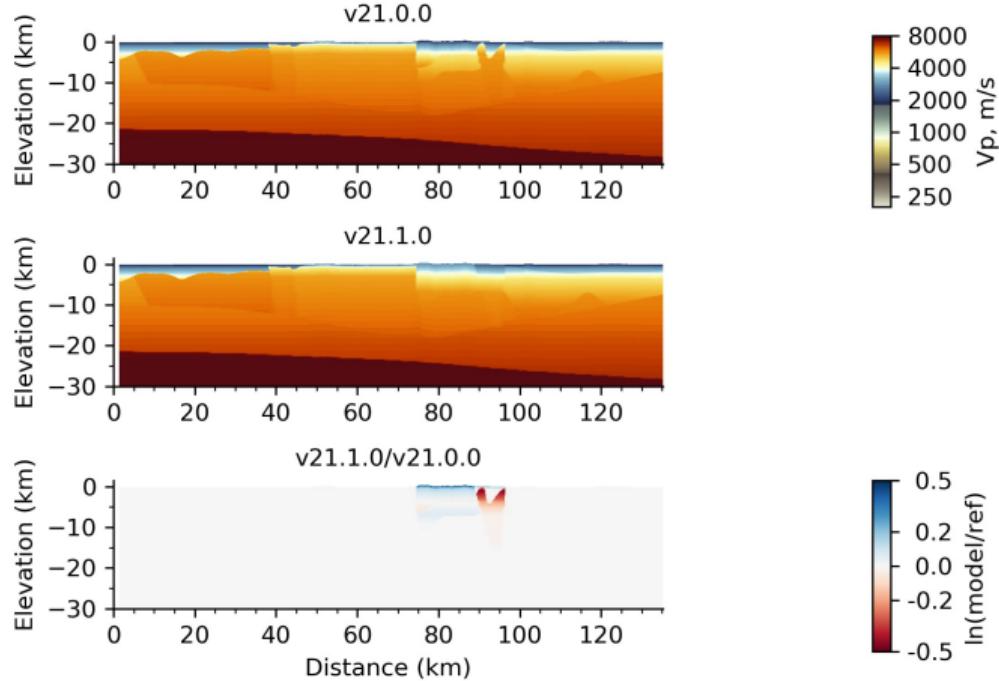
Vs @ z=-5km



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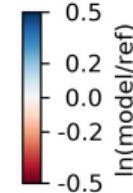
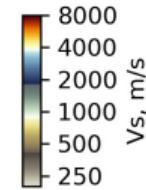
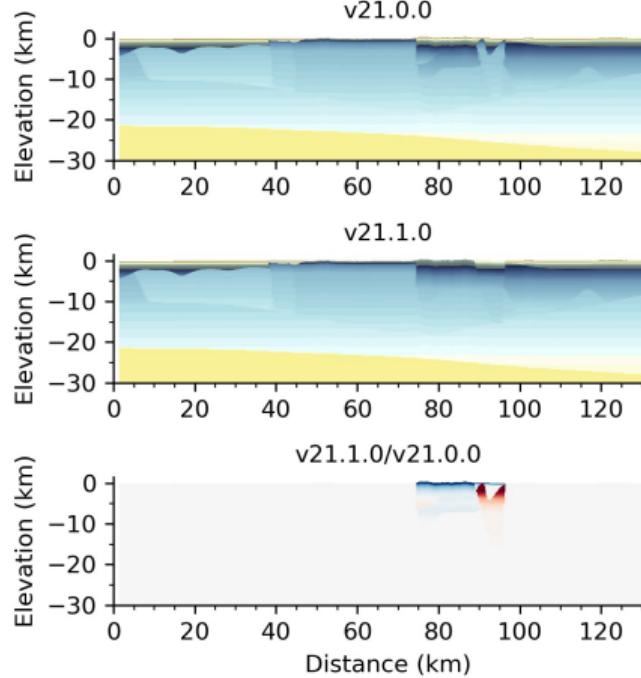
Vp on San Francisco West-East Cross-Section



v21.1.0

Updates to East Bay (detailed domain only)

V_s on San Francisco West-East Cross-Section



Release Information

- **Release Candidates**

- v21.0.0 and v21.1.0 – <ftp://ehzftp.wr.usgs.gov/baagaard/sfbaycvm>
 - Models for detailed and regional domains as HDF5 files
 - Z1.0 and Z2.5 as GeoTiff file
- GeoModelGrids v1.0.0rc1
 - Source and binaries –
<https://github.com/baagaard-usgs/geomodelgrids/releases>
 - Documentation – <https://baagaard-usgs.github.io/geomodelgrids/>

- **Forthcoming Products**

- v21.0.0 and v21.1.0 – USGS Data Releases on ScienceBase.gov
- USGS Open-File Report – Construction of 3D geologic model and seismic velocity models
- Hirakawa and Aagaard paper – ground-motion modeling behind v21.1.0
- GeoModelGrids v1.0.0 – USGS Software Release
- Aagaard paper – GeoModelGrids software design