

TECHNICAL BACKGROUND INFORMATION

CALIFORNIA HAZARD MAPS

2014 versus 2008 California Hazard Maps: Should Caltrans Update to 2014?

In 2010, Caltrans adopted a new procedure for developing the design response spectrum. This procedure, described in Appendix B of SDC 2.0, includes for the first time a probabilistic criterion. The design spectrum was specified as the envelop of the deterministic spectrum and a probabilistic spectrum, calculated at a 975-year hazard level, based on the 2008 California hazard map. The 2008 map was based on the UCERF¹2 source model and the first generation of the Next Generation Attenuation (NGA) ground motion models. For design, the envelop of these spectra was adjusted for possible basin amplification and for directivity effects.

Effective September 1, 2019, Caltrans adopted SDC 2.0. An important change in SDC 2.0 is the elimination of the deterministic criterion for the design spectrum. This change reflects Caltrans' desire to move to a fully-probabilistic criterion.

Following Caltrans' adoption of the USGS California Hazard Map in 2010, the USGS released a new map in 2014. This map incorporates several important advancements:

- UCERF 3 source model
- NGA-2 ground motion models
- Update of the Cascadia source model

UCERF 3 represented an ambitious update of the California source models. The most important change was that it considered earthquake scenarios that were more complex than previous models. In past models, scenario ruptures were based on fault segments or combinations of fault segments that followed existing fault traces and were judgmentally limited by historical record or geologic evidence. The new UCERF 3 source models considered rupture scenarios that were more varied, including different faults rupturing together even when it involved a deviation in direction or required a step-over from one fault to the next.

NGA-2 models were updates of the original NGA ground motion models. Due to several large earthquakes and increased levels of instrumentation, the NGA-2 model developers were able to utilize about 3 times as much data as they had for the original models. Generally, the changes to the updated models were small. However, the formulation of the basin amplification terms in the models was changed with the net effect of reducing the basin amplification.

¹ UCERF: Uniform California Earthquake Rupture Forecast. UCERF is a joint product of the USGS and California Geological Survey.

Following the release of the 2008 National Hazard Maps, mounting geologic evidence suggested that the southern portion of the Cascadia subduction zone tended to rupture more frequently than the central and northern regions of the fault. This increased activity resulted in an increase in shaking hazard along the northern California coast and northern central valley.

What do these changes mean for California hazard?

Figure 1 presents a comparison of 2008 and 2014 hazard at 1-second spectral acceleration developed by USGS. The comparison is made at 2475-year hazard level instead of Caltrans' 975-year hazard. The bottom left panel, depicting ratios of the 2014 and 2008 hazard, should be largely unaffected by the hazard level difference. The bottom right panel, being a difference between the 2014 and 2008 maps, overstates the differences for 975-year hazard by approximately 30%.

These maps demonstrate a mostly neutral effect in most regions of the state. However, there are moderate increases along some faults due to changes in the source models, and moderate increases along the north coast and northern central valley due to changes in the Cascadia model. These maps do not include changes resulting to updates of the basin amplification models. Those changes will result in decreases in basin amplification in the LA basin and Ventura basin. At the deepest portions of these basins, the 2008 increase of about 60% has been reduced to approximately 30% in the 2014 models.

Recommendation

Caltrans has continued to use the 2008 California hazard map primarily because the more current 2014 hazard map was only available at 4 spectral periods, insufficient to construct a response spectrum without resorting to formulaic spectrum construction schemes. Recently, DRISI devised an interpolation scheme that uses 2008 hazard data and 2014 hazard data to construct an 11 period 2014 spectrum. This method has been implemented in a new version of ARS Online. Given the advancements of the 2014 California hazard map relative to the 2008 map, the 2014 map should be adopted. Continuing with the 2008 map will prove increasingly difficult to justify.

Prepared by Tom Shantz, August 2019

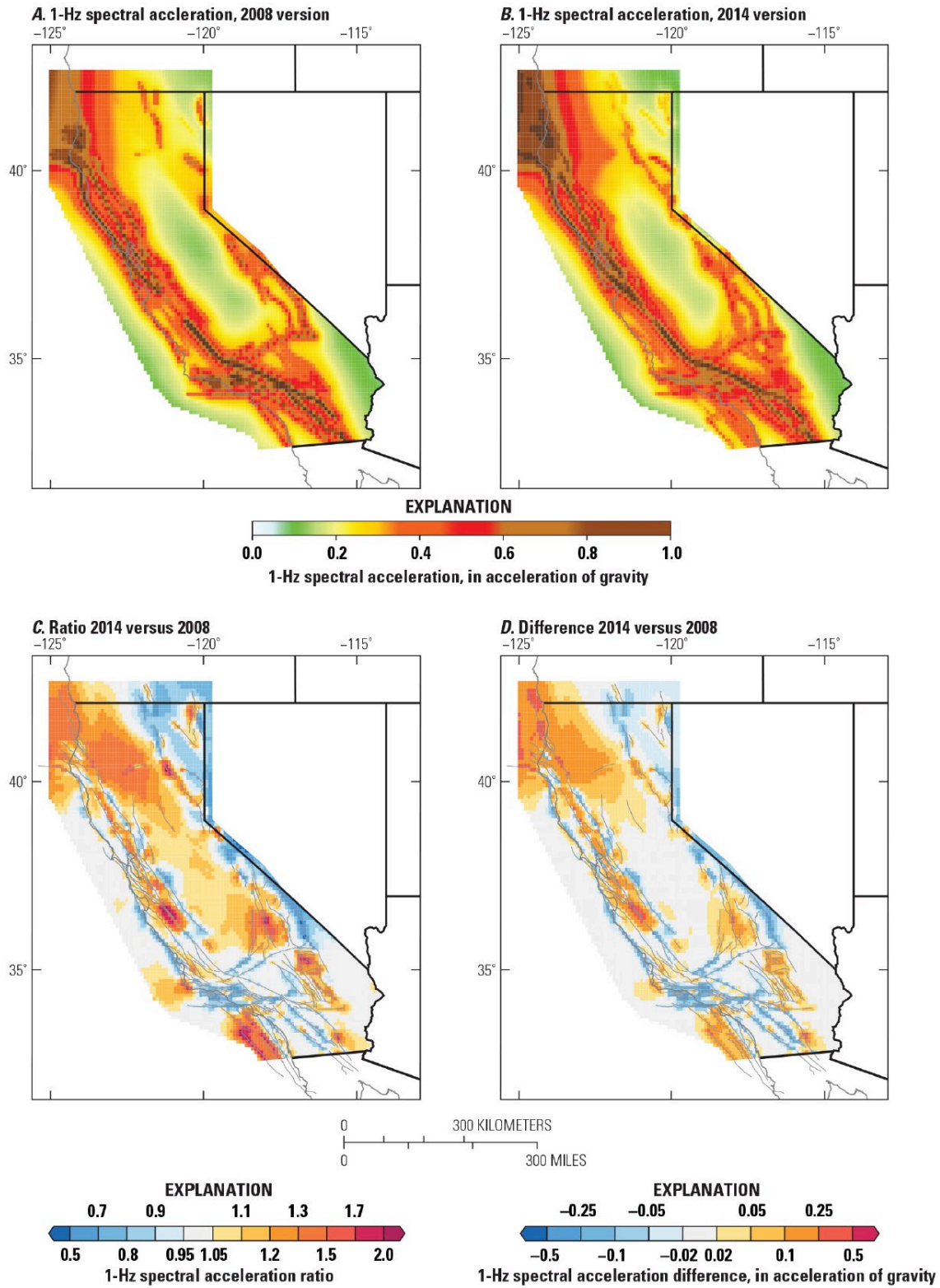


FIGURE 1: Comparison of 2008 and 2014 2% in 50-year (2475-year) $S_a(1s)$ hazard (soft rock conditions). Source: USGS Open-File Report 2014-1091 (Figure 154).