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USGS UPDATE OF EARTHQUAKE LOADING DATA PROVIDED IN 2013 EDITION OF *UNIFIED FACILITIES CRITERIA 3-301-01: STRUCTURAL ENGINEERING*

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ABSTRACT

On June 1 of 2013, the U.S. Department of Defense released an updated edition of the design document entitled *Unified Facilities Criteria 3-301-01: Structural Engineering* (*UFC 3-301-01*). This document governs the structural design of military installations inside the U.S., within its territories, and outside the U.S. The U.S. Geological Survey (USGS) was tasked with bringing the *UFC* earthquake ground motions (compatible with the *2005 American Society of Civil Engineers (ASCE) 7 Standard* and the *2006 ASCE 41 Standard*) up to date with the most recent building code standards available at the time (*2010 ASCE 7 Standard* and *2013 ASCE 41 Standard*).

In addition to updating the ground motions for domestic and international sites for compatibility with *ASCE 7-10* and *ASCE 41-13*, the USGS incorporated several new national and regional probabilistic seismic hazard assessments into this update. The combined effects of these updates on the *UFC* ground motion values are presented, with ratios of post- to pre-update values provided on a global scale. While this work incorporated new regional and national seismic hazard data sets, future efforts will be needed to incorporate numerous other data sets that could not be included during this update.

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In addition to updating the ground motions for domestic and international sites for compatibility with *ASCE 7-10* and *ASCE 41-13*, the USGS incorporated several new national and regional probabilistic seismic hazard assessments into this update. The combined effects of the updates on the *UFC* ground motion values are presented, with ratios of post- to pre-update values provided on a global scale. While this work incorporated new regional and national seismic hazard data sets, future efforts will be needed to incorporate numerous other data sets that could not be included during this update.

1 Introduction

The U.S. Department of Defense "Unified Facilities Criteria *3-301-01*: Structural Engineering" document (*UFC 3-301-01*) contains tables of seismic ground motion demand values for locations both inside (designated "CONUS") and outside (designated "OCONUS") of the U.S. and its territories and possessions [1]. More specifically, the areas designated as "CONUS" include the following: the 50 United States of America, Puerto Rico, the U.S. Virgin Islands, American Samoa, and the Northern Mariana Islands (including Guam). The ground motion values provided for CONUS sites in the 2010 edition of *UFC 3-301-01* were taken directly from the 2005 edition of the American Society of Civil Engineers standard entitled "Minimum Design Loads for Buildings and Other Structures" (*ASCE 7-05*), and the 2006 edition of the ASCE standard "Seismic Rehabilitation of Existing Buildings" (*ASCE 41-06*) [2, 3]. For OCONUS sites, the ground motion values in the 2010 edition of *UFC 3-301-01* were, in concept, consistent with *ASCE 7-05* and ASCE *41-06*.

ASCE 7-05 and *ASCE 41-06* have recently been updated to, respectively, 2010 (*ASCE 7-*

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10) and 2013 (*ASCE 41-13*) editions [4, 5]. The ground motion values in the 2013 update of *UFC 3-301-01* are now from (for CONUS locations), or are consistent with (for OCONUS locations), *ASCE 7-10* and *ASCE 41-13*.

The ground motion values mapped in *ASCE 7-10* are different than those in *ASCE 7-05* in four ways: (1) they are derived from the 2008 rather than 2002 USGS National Seismic Hazard Maps [6, 7]; (2) the probabilistic ground motions that partially underlie the maps in *ASCE 7-10* are "risk-targeted" (1%-probability-of-collapse-in-50-years) rather than "uniform-hazard" (2%-probability-of-ground-motion-exceedance-in-50-years, or 2/50) ground motions [8]; (3) the corresponding deterministic ground motions in *ASCE 7-10* are 84th percentile rather than median-multiplied-by-1.5 ground motions (as provided in *ASCE 7-05*) [9]; and (4) both the probabilistic and deterministic ground motions are maximum-direction rather than geometric-mean ground motions [9]. The new values in *ASCE 7-10* are referred to as Risk-Targeted Maximum Considered Earthquake (MCE_R) ground motions, rather than just *MCE* ground motions, as was the case in *ASCE 7-05*.

The ground motions specified in *ASCE 41-13* are different than those in *ASCE 41-06* in three ways: (1) *ASCE 41-13* incorporates MCE_R ground motions from *ASCE 7-10* rather than *MCE* ground motions from *ASCE 7-05*; (2) in addition to MCE_R and 10%-probability-of-exceedance-in-50-years (10/50) ground motions, *ASCE 41-13* also specifies ground motions for 5% and 20% probability of exceedance in 50 years (5/50 and 20/50, respectively); and (3) as with those in *ASCE 7-10*, the *ASCE 41-13* ground motions are maximum-direction rather than geometric-mean ground motions.

This paper documents our update of the tabulated ground motion values in the 2013 edition of *UFC 3-301-01*, for consistency with *ASCE 7-10* and *ASCE 41-13*. Sections 2 and 3 summarize our update of, respectively, the CONUS and OCONUS values. Section 4 illustrates the resulting numerical changes with respect to the ground motion values consistent with *ASCE 7-05* and *ASCE 41-06* that were previously in the 2010 edition of *UFC 3-301-01*.

2 CONUS Update

In *ASCE 7-10*, seismic design loads are specified by the two MCE_R ground motion parameters S_S and S_1, and the peak ground acceleration parameter *PGA*. S_S and S_1 represent values of the 5%-damped response spectral acceleration at periods of, respectively, 0.2s (representing short periods) and 1.0s (representing longer periods). Values of S_S and S_1 from *ASCE 7-05* were given in the 2010 edition of *UFC 3-301-01*; those values have been revised in this update to be consistent with *ASCE 7-10* (conceptual differences were outlined in the Introduction). In addition, this update has introduced, for the first time in *UFC 3-301-01*, corresponding 2/50 *PGA* values compatible with *ASCE 7-10*. See the site-specific ground motion procedures of *ASCE 7-10* Chapter 21 for more information on the S_S, S_1, and *PGA* parameters.

In *ASCE 41-13*, response spectral acceleration parameter values corresponding to a 5% probability of exceedance in 50 years (5/50), $S_{S,5/50}$ and $S_{1,5/50}$, a 10% probability of exceedance in 50 years (10/50), $S_{S,10/50}$ and $S_{1,10/50}$, and a 20% probability of exceedance in 50 years (20/50), $S_{S,20/50}$ and $S_{1,20/50}$, are specified. These ground motion parameter values, as well as the S_S, S_1, and *PGA* values, were obtained using the USGS *U.S. Seismic Design Maps* web application (*Design*

Maps): http://earthquake.usgs.gov/designmaps/usapp/ for each CONUS site. The Batch option was used to calculate the seismic design parameter values for multiple locations at once.

3 OCONUS UPDATE

As was the case for the CONUS sites, all of the OCONUS seismic design parameter values in the 2010 edition of *UFC 3-301-01* were compatible with either *ASCE 7-05* (S_S and S_1) or *ASCE 41-06* ($S_{S,10/50}$, and $S_{1,10/50}$); these all needed to be updated for compatibility with *ASCE 7-10* and *ASCE 41-13*, respectively. In addition, new parameters compatible with *ASCE 7-10* (2/50 *PGA*) and *ASCE 41-13* ($S_{S,5/50}$, $S_{1,5/50}$, $S_{S,20/50}$ and $S_{1,20/50}$) have been introduced into *UFC 3-301-01* for the first time in the 2013 edition. The S_S, S_1, *PGA*, $S_{S,10/50}$ and $S_{1,10/50}$ values were drawn from the sources described below in Sections 3.1 through 3.5. Although $S_{S,5/50}$, $S_{1,5/50}$, $S_{S,20/50}$, and $S_{1,20/50}$ values for the OCONUS sites are not explicitly provided in the 2013 edition of *UFC 3-301-01*, the following equations are suggested to interpolate (Eq. 1 and 2) or extrapolate (Eq. 3 and 4) them from the *ASCE 7-10* and *ASCE 41-13* parameter values that have been provided:

$$S_{S,5/50} = (S_{S,10/50})^{0.5642} \times (S_S)^{0.4358} \quad (1)$$

$$S_{1,5/50} = (S_{1,10/50})^{0.5642} \times (S_1)^{0.4358} \quad (2)$$

$$S_{S,20/50} = (S_{S,10/50})^{1.4544} / (S_S)^{0.4544} \quad (3)$$

$$S_{1,20/50} = (S_{S,10/50})^{1.4544} / (S_S)^{0.4544} \quad (4)$$

A secondary objective of this update was to incorporate international seismic design parameter values from sources that were not already utilized for the 2010 edition of *UFC 3-301-01*. Some of these new sources have been incorporated into the 2013 edition, as described in subsections 3.2 through 3.5.

For most of the OCONUS sites, the values from the 2010 edition of *UFC 3-301-01* have been updated in accordance with the procedure detailed in Section 3.1. These values were only replaced if values from more recent or geographically specific probabilistic seismic hazard analyses were available. For sites where no values were available from the aforementioned sources, the gaps were filled with values from the following sources (in order of decreasing priority): Geologic Survey of Canada *Open File 5814* (*OF 5814*), *2009 Overseas Building Operations-International Code Supplement* (*2009 OBO*), and the Global Seismic Hazard Assessment Program (*GSHAP*). In total, updated values based on the 2010 edition of *UFC 3-301-01* were used for ~82.5% of the 474 sites in the 2013 edition. New region-specific values were used for ~15.25% of the sites, and updated values from GSHAP were used for ~1.25% of the sites. Values from *OF 5814* and the *2009 OBO* accounted for the remaining ~1% of sites.

3.1 2010 Edition of *UFC 3-301-01*

The OCONUS S_s and S_1 values from the 2010 edition of *UFC 3-301-01* were used as starting points for the 2013 update of *UFC 3-301-01*. As mentioned above, these values were *MCE* ground motions compatible with *ASCE 7-05*. In order to be compatible with *ASCE 7-10*, the S_s and S_1 values have been converted from geometric mean *MCE* spectral acceleration values to maximum-direction MCE_R (risk-targeted) spectral acceleration values. The conversions from geometric mean to maximum direction were done by scaling the S_s and S_1 values by 1.1 and 1.3, respectively [9]. To convert to risk-targeted ground motion values, we applied so-called risk coefficients calculated in accordance with the procedure described in *ASCE 7-10* Section 21.2.1.2 and [8]. For this calculation, we used simple hazard curves (of exceedance probability vs. ground motion value) defined by the S_s and S_1 and 10%-probability-of-exceedance-in-50-years (10/50) spectral acceleration values in the 2010 edition of *UFC 3-301-01*. The S_s and S_1 values were assumed to correspond to a 2% probability of exceedance in 50 years (2/50), because deterministic ground motion caps analogous to those considered for CONUS in *ASCE 7-10* are rarely available for OCONUS sites. Since the slopes of the simple hazard curves (i.e., the ratios of S_S to $S_{S,10/50}$ and S_1 to $S_{1,10/50}$) for most of the OCONUS sites in the 2010 edition of *UFC 3-301-01* were ~2, the risk coefficient we applied is ~0.95 for most sites (for both 0.2s and 1.0s), in accordance with the methodology outlined in [8].

To arrive at corresponding *PGA* values compatible with *ASCE 7-10* for the OCONUS sites, the S_S values from the 2010 edition of *UFC 3-301-01* were divided by 2.5. This is based on the approach used for previous editions of *UFC 3-301-01* (confirmed by a quick comparison of the values) whereby the S_S values were approximated by multiplying 2/50 *PGA* values by 2.5.

Lastly, to convert $S_{S,10/50}$ and $S_{1,10/50}$ values from the 2010 edition of *UFC 3-301-01* to values that are compatible with *ASCE 41-13*, the same maximum-direction scale factors described above for S_S and S_1 (1.1 and 1.3, respectively) were applied.

3.2 Regional Probabilistic Seismic Hazard Analyses (PSHAs)

Relatively recently (2007 and later), the USGS conducted country- or region-specific PSHAs for the following OCONUS areas: Afghanistan, Haiti, South America, Southeast Asia, and Samoa [10, 11, 12, 13]. For Afghanistan, country-specific *MCE* ground motions compatible with *ASCE 7-05* were included in the 2010 edition of *UFC 3-301-01*. Similarly, analogous values for Haiti were added in a minor update of the 2010 edition of *UFC 3-301-01* designated *Change 1*. For the 2013 edition, we used the USGS hazard curves for Afghanistan, Haiti, South America, and Samoa to derive MCE_R ground motion (S_S and S_1) and *PGA* values that are compatible with *ASCE 7-10* (Sections 21.2.1.2 and 21.5.1, respectively, like for CONUS), and $S_{S,10/50}$ and $S_{1,10/50}$ values that are compatible with *ASCE 41-13*. The Southeast Asia hazard curves were not used because they were in the process of being updated. The Haiti results included both probabilistic and deterministic ground motion values (see Sections 21.2.2 and 21.5.2 of *ASCE 7-10* for the latter); to remain consistent with *ASCE 7-10* in this instance, we used the lesser of the two values for each Haitian site.

The Geologic Survey of Canada (GSC) calculated the spectral acceleration values provided in the *National Building Code of Canada (2010 NBCC)* for Site Class C soils to match the predominant local soil conditions in Canada [14]. However, the seismic design parameters in *ASCE 7-10* (and *ASCE 7-05*) are for Site Class B, which is also the case in *UFC 3-301-01*. To account for this difference, we referred to Table 2 in the underlying GSC report [15] to convert the Site Class C hazard curves to Site Class B hazard curves that were used to derive ground motion values that are compatible with *ASCE 7-10* and *ASCE 41-13*.

Likewise, we used hazard curves from *NZS 1170 Part 5:2004 Earthquake actions – New Zealand* [16] to derive ground motion values compatible with *ASCE 7-10* and *ASCE 41-13*. The Italian Instituto Nazionale di Geofisica (INGV) provides analogous hazard curves, through its "Interactive Seismic Hazard Maps" web application [17], that we also used.

The values from these regional/national-scale studies were prioritized over all other sources (including the 2010 edition of *UFC 3-301-01*) during this update.

3.3 Geologic Survey of Canada (GSC) Open File 5814

In *Open File 5814 (OF 5814),* Adams, Halchuk, and Awatta of the GSC provide seismic design parameter values for specific sites in Canada and around the world [18]. This GSC document includes 2/50 values for *PGA* as well as 0.2s and 1.0s spectral acceleration. These ground motions are based upon the *GSHAP* values of 10/50 PGA. The GSC document notes that the slopes of hazard curves (and hence the ratios of 2/50 to 10/50 ground motions) in two areas with significantly different seismic hazard will not be the same, and therefore should not be represented by a globally uniform ratio. To address this, the GSC authors define four characteristic region types based upon trends in the slopes of hazard curves around the world. Whereas the approach described in Section 3.1 uses a uniform ratio of ~2, the authors of *OF 5814* proceed to use a slightly different ratio for each of the four characteristic region types when converting from GSHAP 10/50 *PGA* values to 2/50 values for *PGA*, S_s, and S_1.

To convert the 2/50 spectral response acceleration values at 0.2s and 1.0s for compatibility with *ASCE 7-10*, we applied the steps described in Section 3.1. To obtain corresponding 10/50 values for *ASCE 41-13*, we divided the 2/50 values by the GSC hazard-curve-slope factors for converting 10/50 to 2/50 *PGA*. *OF 5814* values were incorporated into this update of *UFC 3-301-01* when (1) regional-scale values were unavailable and (2) values from the 2010 edition of *UFC 3-301-01* were unavailable.

3.4 U.S. State Department Overseas Building Operations (OBO)

The U.S. State Department *2009 Overseas Building Operations–International Code Supplement* (*OBO*) provides seismic design parameter values needed to design U.S. embassy and consulate buildings abroad [19]. We used *OBO* values for the OCONUS sites that lacked specified values in previous editions of *UFC 3-301-01*, and that were not covered by the sources described in Sections 3.2-3.4.

The *OBO* provides 2/50 spectral response acceleration values for 0.2s and 1.0s; we approximated corresponding 10/50 values by simply dividing by 2, for consistency with many of the 2/50 and 10/50 values in the 2010 edition of *UFC 3-301-01*, as mentioned above in Section 3.1. We then applied the maximum-direction scale factors described in Section 3.1 to produce $S_{S,10/50}$ and $S_{1,10/50}$ values compatible with *ASCE 41-13*. Then, we converted the 2/50 values to S_S and S_1 values compatible with *ASCE 7-10* using the methodology detailed in Section 3.1. To arrive at 2/50 *PGA* values for *ASCE 7-10*, the 2/50 spectral response acceleration values for 0.2s from the *OBO* were divided by 2.5, in keeping with the approach described in Section 3.1.

3.5 Global Seismic Hazard Assessment Program (GSHAP)

In 1992, the Global Seismic Hazard Assessment Program (*GSHAP*) was established by the United Nations to develop a global-scale seismic hazard map using probabilistic seismic hazard analysis (PSHA) [20]. The global map is a compilation of multiple continental-scale 10/50 *PGA* maps that have been spliced together to offer significant coverage of the landmass of the Earth. The resulting values are the only vetted, publicly accessible global-scale set of seismic hazard values. The GSHAP values were used as the primary source of OCONUS seismic values in the 2010 edition of *UFC 3-301-01*.

In order to convert the 10/50 *PGA* values from GSHAP to the desired *ASCE 7-10* and *ASCE 41-13* values for each OCONUS site, we applied a series of conversions. The 10/50 *PGA* values were factored by 2 to approximate 2/50 *PGA* values. Then, they were factored by 2.5 and 1.0 to approximate 0.2s and 1.0s spectral response acceleration values, respectively. These conversions are the same as those applied in order to arrive at the ground motion values in the 2010 edition of *UFC 3-301-01*. In addition, we followed the approach detailed in Section 3.1 to arrive at the S_S, S_1, *PGA*, $S_{S,10/50}$, and $S_{1,10/50}$ values. These GSHAP-based values were used for sites that did not have suitable values from the sources described in Sections 3.1 through 3.4.

3.6 Other Sources

Several other sources of seismic hazard values were available or were being computed at the time of the *UFC* update. Although they were not included in the 2013 update of *UFC 3-301-01*, they may serve as valuable sources for a future update. The following are two good examples.

The GEM Foundation has undertaken to compute and harmonize (amongst other resources) a global-scale seismic hazard and risk map, the Global Earthquake Model [21]. The GEM project was still in progress when this update was conducted, and hence its results could not be incorporated. Once the GEM project is completed, the resulting hazard values could provide an excellent resource for future updates of the *UFC* seismic design parameter values.

As with *OF 5814* (described in Section 3.4), Lubkowski examined the factor of 2 often used to convert 10/50 *PGA* values to 2/50 *PGA* values [22]. Noting that the slope of a hazard curve often depends upon the severity of ground shaking, Lubkowski built upon a *Eurocode 8* methodology to provide a more refined conversion factor. Although the Lubkowski approach is promising, further study is warranted before these conversions can be included in *UFC 3-301-01*.

4 Results

4.1 CONUS: ASCE 7 Parameters

In the 2013 update of *UFC 3-301-01*, values of the ground motion parameters S_s and S_1 (calculated according to *ASCE 7-10*) are provided for 366 CONUS sites. Forty-six of these sites, and their corresponding data, are new additions to *UFC 3-301-01*. We compared the updated values for the remaining 320 sites to their previous values. An overall decrease of ~15% is observed for S_S and an overall increase of ~2% is observed for S_1 values across all CONUS sites.

The magnitude of these changes differs from region to region. Average changes (ratio of 2013 to 2010 values, averaged over a region) for CONUS regions are summarized in Table 1. Observed changes are in part due to differences between definitions of MCE_R and *MCE* ground motion parameters. For the continental U.S., advances introduced by the 2008 USGS hazard model (and incorporated into *ASCE 7-10*) have also contributed to the changes quantified in Table 1. The impact of these combined changes is also represented in *2009 NEHRP* Tables C11.4-2 and C11.4-3 [9]. In the cases of American Samoa and the Mariana Islands (which includes Guam), the new parameter values are from the first regional PSHAs for these islands [13, 23]; previously, parameter values based on assumed seismic zones had been used. Ratios for PGA values are not available because the PGA parameter is being introduced into *UFC 3-301-01* for the first time in the 2013 edition.

Table 1. Comparison of seismic design parameter values provided in the 2013 versus 2010 edition of *UFC 3-301-01* for CONUS sites

Region	Mean S_S Ratio	Mean S_1 Ratio	Mean $S_{S,10/50}$ Ratio	Mean $S_{1,10/50}$ Ratio
Western U.S. (*CA, NV*)	0.975	0.976	0.915	0.931
Intermountain West (*AZ, CO, ID, MT, NM, UT, WY*)	0.917	0.965	0.888	1.078
Subduction Zone (*OR, WA*)	1.017	1.152	1.069	1.277
Charleston (*NC, SC*)	0.756	0.942	0.892	0.965
New Madrid (*AR, IL, KY, MO, TN*)	0.811	1.018	1.035	1.295
Midwest & TX (*IA, IN, KS, MI, MN, ND, NE, OH, OK, SD, TX, WI*)	0.803	1.022	0.884	1.393
East Coast (*CT, DC, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VA, WV*)	0.786	1.008	0.761	1.020
Southern States (*AL, FL, GA, LA, MS*)	0.822	1.038	0.972	1.251
Alaska	0.978	1.309	1.087	1.484
Hawaii	0.936	0.915	0.976	0.988
Puerto Rico & U.S. Virgin Islands	1.115	1.302	1.066	1.076
American Samoa	0.414	0.390	0.418	0.408
Mariana Islands	1.520	0.937	1.620	1.002

4.2 CONUS: ASCE 41 Parameters

The ground motion parameters for use in *ASCE 41-13*, $S_{S,5/50}$, $S_{1,5/50}$, $S_{S,10/50}$, $S_{1,10/50}$, $S_{S,20/50}$ and $S_{1,20/50}$ are also provided as part of this study for all 366 CONUS sites. As described previously, $S_{S,5/50}$, $S_{1,5/50}$, $S_{S,20/50}$ and $S_{1,20/50}$ are new parameters in *ASCE 41-13*; so only the updated $S_{S,10/50}$ and $S_{1,10/50}$ values can be compared against their previous values. Values of these parameters were not available, or only the upper and lower bounds were provided, for 56 of the CONUS sites in the 2010 edition of *UFC 3-301-01*. For the remaining 310 sites, the updated values were compared against the values from the 2010 edition of *UFC 3-301-01*. We observed an overall decrease of 10% and an overall increase of 11%, respectively for $S_{S,10/50}$ and $S_{1,10/50}$ parameters. These changes, separated by region, are presented in Table 1. Recall that these changes are partly due to the maximum-direction scale factors described in Section 3.1 (1.1 and 1.3 for 0.2s and 1.0s, respectively), and partly due to the hazard model updates described in the preceding section.

4.3 OCONUS: ASCE 7 Parameters

In the 2013 edition of *UFC 3-301-01*, values of the ground motion parameters S_S, S_1, and *PGA* (calculated according to *ASCE 7-10*) are provided for 474 OCONUS sites. Of these 474 sites, 13 are new additions to the 2013 edition of *UFC 3-301-01*. Comparisons of the updated parameters for the remaining 461 sites to their values in 2010 reveal minimal changes to S_S values, on average. Values of S_S for sites where parameter values are derived from the 2010 edition of *UFC 3-301-01* increased by ~5%, resulting from the application of both the risk coefficient (0.95) and the maximum-direction scale factor (1.1 for 0.2s) as described in Section 3.1. Overall, S_1 values have increased by ~24% for the same subset of sites. This too is a result of the combined effects of the risk coefficient (0.95) and the maximum-direction scale factor (1.3 for 1.0s) both being applied. As noted in Section 4.1, ratios for *PGA* are not available because the parameter is being introduced into *UFC 3-301-01* for the first time in the 2013 edition.

There are exceptions to the trends described above for specific regions where the parameter values were updated based upon a region-specific source. Comparison ratios for some of these OCONUS regions, namely Afghanistan, Italy, Canada, South America, Haiti, New Zealand, and Samoa, are isolated and shown in Figure 1. With the exception of the values for Afghanistan (which were already incorporated into the 2010 edition), we clearly see the influence of the new parameter value sources. The spread within each group of values (e.g., the South America subset) illustrates the importance of the updates with respect to the GSHAP results that were the basis of many of the parameter values in the 2010 edition of *UFC 3-301-01*. Note that many of the extreme ratios in Figure 1 relate to sites for which only a floor value (0.5%g or 0.25%g for S_S and S_1, respectively) had been used in the 2010 edition of *UFC 3-301-01*. The other extreme cases generally represent small absolute differences. For example, the S_S value for Recife, Brazil, increased from 4.1%g in the 2010 edition to 11%g in the 2013 edition; whereas the ratio between the two values exceeds 2.5, the actual difference and implications for design are not as significant as such a high ratio would suggest. Analogous cases are represented by the extremely low ratios shown in Figure 1.

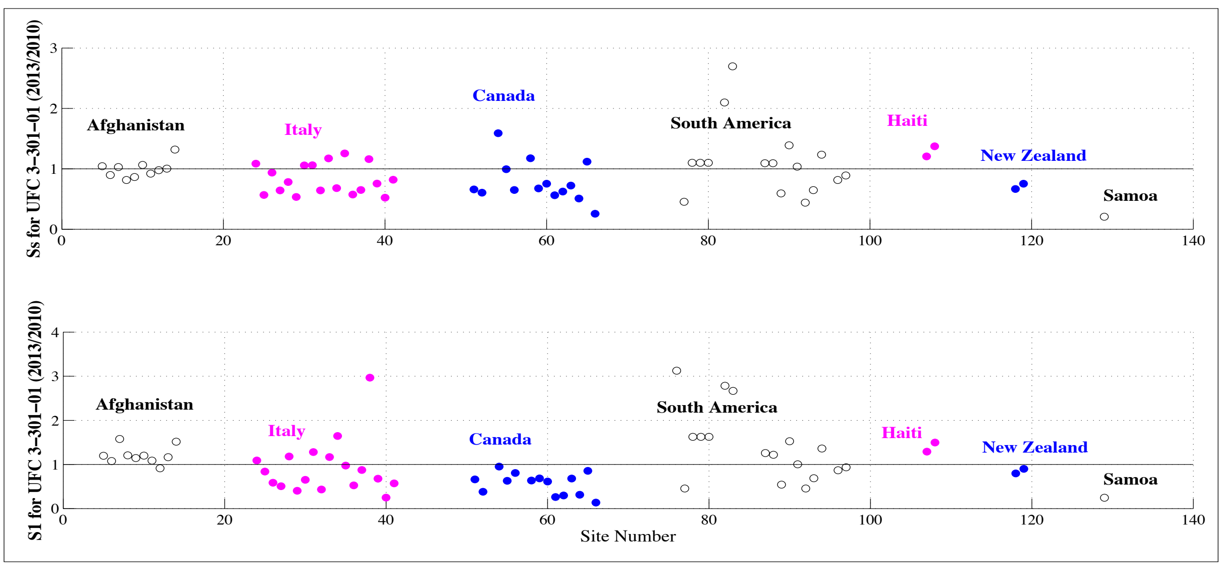

Figure 1. Ratios of 2013 to 2010 *UFC* S_S and S_1 values for selected OCONUS regions (outliers excluded).

4.4 OCONUS: ASCE 41 Parameters

Values of the ground motion parameters for use in *ASCE 41-13*, $S_{S,10/50}$ and $S_{1,10/50}$, are also provided for the 474 OCONUS sites. New values are provided for 33 of these sites that previously had no $S_{S,10/50}$ and $S_{1,10/50}$ values. For the remaining 441 sites, the values were updated. Similar to *ASCE 7* parameters, there were a few outliers, but for the majority of locations we see increases of 10% and ~25% for $S_{S,10/50}$ and $S_{1,10/50}$, respectively. These changes are mainly due to the maximum-direction scaling.

5 Conclusions

The seismic design parameter values of *UFC 3-301-01* have been updated for the specified locations listed in the CONUS and OCONUS tables. Missing values have been filled, and values from additional regional studies have been included. New sites, and their respective parameter values, have been added to the tables. Values previously compatible with *ASCE 7-05* have been updated for compatibility with *ASCE 7-10*. In addition, CONUS values that were previously compatible with *ASCE 41-06* have been updated for compatibility with *ASCE 41-13*; equations that can be used to calculate *ASCE 41-13* values for OCONUS sites have been provided.

As described in Section 3.7, there are a number of potential sources of seismic design parameter values that could be considered for the next update of *UFC 3-301-01*. The scientific merits as well as the manner in which these values could be incorporated into a future update should be considered.

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