Appendix K—The UCERF3 Earthquake Catalog

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The Uniform California Earthquake Rupture Forecast, version 3 (UCERF3) earthquake catalog is an update of the catalog compiled for UCERF2, which is documented in Felzer and Cao (2008). The present document summarizes the updates and changes from the previous catalog. These include:

The current catalog covers seismicity through the end of 2011.

The current catalog includes an earthquake ID if one was assigned by the original network. This is listed in column 15. If no ID was assigned, there is a "99" in this column.

The current catalog includes earthquakes down to M2.5 that occurred after 1984, when the seismic network was updated and catalog completeness improved. Prior to 1984 only earthquakes $M \geq 4.0$ are included. The UCERF2 catalog was $M \geq 4.0$ throughout.

In UCERF2 the catalog of origin was often listed as ANSS (Advanced National Seismic System), which is a summary catalog compiled from contributing networks. The catalog now indicates the actual member network that contributed the event solution.

Please note that no changes have been made to the pre-1932 portion of the catalog. Felzer and Cao (2008) provide documentation for this era.

The UCERF3 catalog is given in a 17-column format as follows:

1. Year
2. Month
3. Day
4. Hour
5. Minute
6. Second
7. Latitude
8. Longitude
9. Depth
10. Magnitude
11. Magnitude type (currently given as "0" for all pre-1932 magnitudes)
12. Magnitude source
13. Magnitude uncertainty (standard error; given as "0" if unknown)

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14. Magnitude rounding (for example, given as 0.1 if magnitudes are rounded to the nearest tenth.)
15. Earthquake ID assigned in source catalog (given as "99" if not assigned by the source catalog)
16. A one is written in this field if the event qualifies as an aftershock under the Gardner and Knopoff (1975) declustering algorithm; a zero is given otherwise
17. A one is written in this field if the event qualifies as a foreshock under the Gardner and Knopoff (1975) declustering algorithm; a zero is given otherwise

We find that seventy-five percent of the total catalog qualifies as either a foreshock or aftershock according to the Gardner and Knopoff (1975) definition.

The magnitude type and magnitude source are given as numerical codes as follows:

Table K1. Codes for magnitude types used in the catalog.

Code	Magnitude type
1	M_L
2	M_b
3	M_c
4	M_d
5	M_h
6	M_S
7	M_W
8	M_X
9	Unk

Table K2. Codes for magnitude sources.

Code	Magnitude source
1	UCERF 2 catalog
2	Southern California Seismic Network
3	Northern California Seismic Network
4	U.C. Berkeley Seismic Network
5	Nevada Seismic Network
6	Global CMT catalog
7	Ellsworth (1990)
8	NEIC
9	ECX (Mexico)
10	University of Washington
11	UNAM (Mexico)
12	USGS, not otherwise specified
13	Tsai and Aki (1969)

The source catalog for an earthquake's location and magnitude are the same, with two exceptions: (1) if an earthquake is assigned a magnitude from the Global CMT (Centroid Moment Tensor) catalog, its location is from the local network; and (2) events from 1966–1984 along the San Andreas system in Northern California are assigned magnitudes from the Berkeley

catalog but locations from the NCSN (Northern California Seismic Network). In the ANSS catalog these earthquakes are given NCSN locations and magnitudes. Bill Ellsworth advised, however, (oral commun., 2012) that while the NCSN locations are good in the San Francisco Bay Area, errors were introduced to the magnitudes throughout Northern California in the 1966–1984 time period during a recent conversion to M_d. Therefore, all Northern California earthquakes in this time period have been assigned the original Berkeley M_L magnitudes. Outside of the Bay Area, Ellsworth judged the Berkeley locations to be better. The area with the Berkeley magnitudes but NCSN locations is bounded by the following lat/long: 35.17,-121.06; 36.67,-122.67; 38.75,-123.91; 38.81,-122.05; 36.45, -118.99; 35.06,-121.06.

The instrumental catalog is constantly in flux, as results are reanalyzed and magnitudes, locations, and times are recalculated. A new magnitude recalibration was recently devised for California, and new magnitude solutions are gradually being added to the catalog, going backwards in time (Tormann and others, 2010). The 1932–2011.9.30 catalog given here contains the earthquake solutions available on October 11, 2011. The portion of the catalog for October 1–December 31, 2011 was downloaded on April 27, 2012. More than one hundred events that were in the UCERF2 catalog are no longer present because new magnitude calculations placed them below the magnitude thresholds for this catalog.

Our base source for the 1932–2011 catalog is the composite ANSS catalog. This catalog was compared against the catalogs provided separately by the Northern and Southern California Earthquake Data Centers (NCEDC and SCEDC); where magnitude solutions differed the magnitude was taken directly from the NCEDC or SCEDC catalog, which sometimes contained a more updated result. The ANSS catalog was also compared to the Berkeley catalog, and Berkeley magnitudes were given precedence from 1966–1984 in Northern California, as noted above. Some earthquakes found to be missing in the ANSS listing were also added from the SCEDC, NCEDC, or Berkeley catalogs. When the Global CMT catalog contained a moment magnitude solution for an earthquake, it was used in the catalog. In general the moment magnitude (M_W) was preferred and used whenever possible.

Magnitude errors are listed for many events in the NCEDC catalog, and given directly here. The SCEDC catalog does not include errors but many could be calculated from the spread in the original station magnitudes. The data for calculating station magnitudes was provided by Ellen Yu (CalTech). When a magnitude error was not available for a SCEDC or NCEDC earthquake, one was estimated from neighboring earthquakes using the following algorithm, which differs from the much more simple approximation used for missing errors in Felzer and Cao (2008):

1. Select all earthquakes within ±0.5 magnitude units.
2. For all of the selected earthquakes, measure the metric D between these earthquakes and the earthquake that is missing an error where D=Difference in latitude + difference in longitude + difference in time.
3. Take the mean uncertainty of the 10 earthquakes with the smallest value of D.
4. Round the uncertainty to the nearest 0.01 and then add 0.00333 to indicate that the uncertainty is an estimated value.
5. For all earthquakes from the Global CMT catalog, a standard magnitude uncertainty of 0.09 was assigned based on the findings of Kagan and others (2006). All Berkeley magnitudes were assigned the catalog average magnitude uncertainty of 0.14 on the advice of Robert Uhrhammer (UC Berkeley, oral commun., 2012). Nevada events prior

to 1990 were assigned a standard magnitude uncertainty of 0.4 and events after 1990 an uncertainty of 0.27 based on the recommendations of John Anderson and Glenn Biasi.

All catalogs have completeness problems because small earthquakes may be missed; this problem can become especially acute in the active aftermath of a large earthquake. For estimates of the completeness of the California catalog, we refer readers to Felzer (2008).

Catalog Sources

Advanced National Seismic System (ANSS):
http://www.ncedc.org/anss/catalog-search.html; downloaded on Oct. 11, 2011.

Northern California Earthquake Data Center (NCEDC):
http://quake.geo.berkeley.edu/ncedc/catalog-search.html; downloaded on Oct. 11, 2011, and April 27, 2012.

Berkeley Catalog (BSL):
http://quake.geo.berkeley.edu/ncedc/catalog-search.html; downloaded on Oct. 11, 2011, and April 27, 2012.

Southern California Earthquake Data Center (SCEDC):
http://www.data.scec.org/eq-catalogs/date_mag_loc.php; downloaded on Oct. 11, 2011, and April 27, 2012.

Global Centroid Moment Tensor Catalog (Global CMT):
http://www.globalcmt.org/CMTsearch.html; downloaded on May 3, 2012.

References for the historical part of the catalog are given in Felzer and Cao (2008).

References

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