



Boğaziçi University  
Kandilli Observatory and Earthquake Research Institute  
Department of Earthquake Engineering

**Kahramanmaraş - Gaziantep Türkiye  
M7.7 Earthquake, 6 February 2023  
(04:17 GMT+03:00)**

**Strong Ground Motion and Building Damage Estimations  
Preliminary Report (v5)**

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Fatma S. Malcıoğlu, Kökcan Dönmez, Tuğçe Tetik, Nesrin Yenihayat, Hakan Süleyman,  
Şahin Dede, Şükran Acar*

13.02.2023 (v5)  
09.02.2023 (v4)  
08.02.2023 (v3)  
07.02.2023 (v2)  
06.02.2023 (v1)

## What is new?

### V5 (13.02.2023):

**Updated maps of ground shaking distribution and building damage estimations!**

**A fault rupture of 290 km length corresponding to the Erkenek, Pazarcık and Amanos segments of the East Anatolian Fault Zone (Emre et al., 2018) and station recordings within a distance of 100 km from the fault are considered in the ground motion and damage estimations.**

**Estimated intensity of the earthquake higher than XI on MMI scale!**

**More than 100,000 buildings in (D3+D4+D5) damage states!**

## Previous Versions

### V4 (09.02.2023):

**More info on the strong ground motion recordings!**

**Acc-vel-disp time histories, FAS and horizontal resp. spectra plots updated and vertical resp. spectra plots added!**

**Maps showing the PGA values of the stations along with the active fault lines provided!**

**Aftershock activity map presented!**

**PGA and PGV residual analyses with four GMPEs for the M7.7, M7.6 and M6.6 (6 Feb 2023) earthquakes provided!**

### V3 (08.02.2023):

**More info on the strong ground motion recordings!**

**Strong ground motion records, downloaded from AFAD website and processed! Acc-vel-disp time histories, FAS and elastic acc. resp. spectra plots!**

**Kahramanmaraş city scale building damage estimation with different methods: Modified Acceleration-Displacement Response Spectrum Method, Capacity Spectrum Method and Displacement Coefficient Method.**

**It is estimated that approximately 40% of the Kahramanmaraş's building inventory in (moderate+extensive+complete) damage state!**

### V2 (07.02.2023):

**Ground motion distribution maps with different GMPEs and intensity prediction equations!**

**Regional scale damage estimation maps with different ground motion inputs!**

**Kahramanmaraş city scale damage estimation maps with different ground motion inputs!**

**Acceleration, velocity and displacement time history plots, Fourier amplitude spectra plots of the recorded data!**



**V1 (06.02.2023):**

**Rapid estimation of spatial distributions of strong ground motion parameters!**

**Intensity based, regional scale, rapid building damage estimation!**

**Spectral acceleration-displacement based rapid building damage estimation for Kahramanmaraş city!**

**Note:**

**The information provided in this report is presented for scientific research purposes.**

**Ground motion and building damage estimation analyses conducted with ELER (Earthquake Loss Estimation Routine) software.**

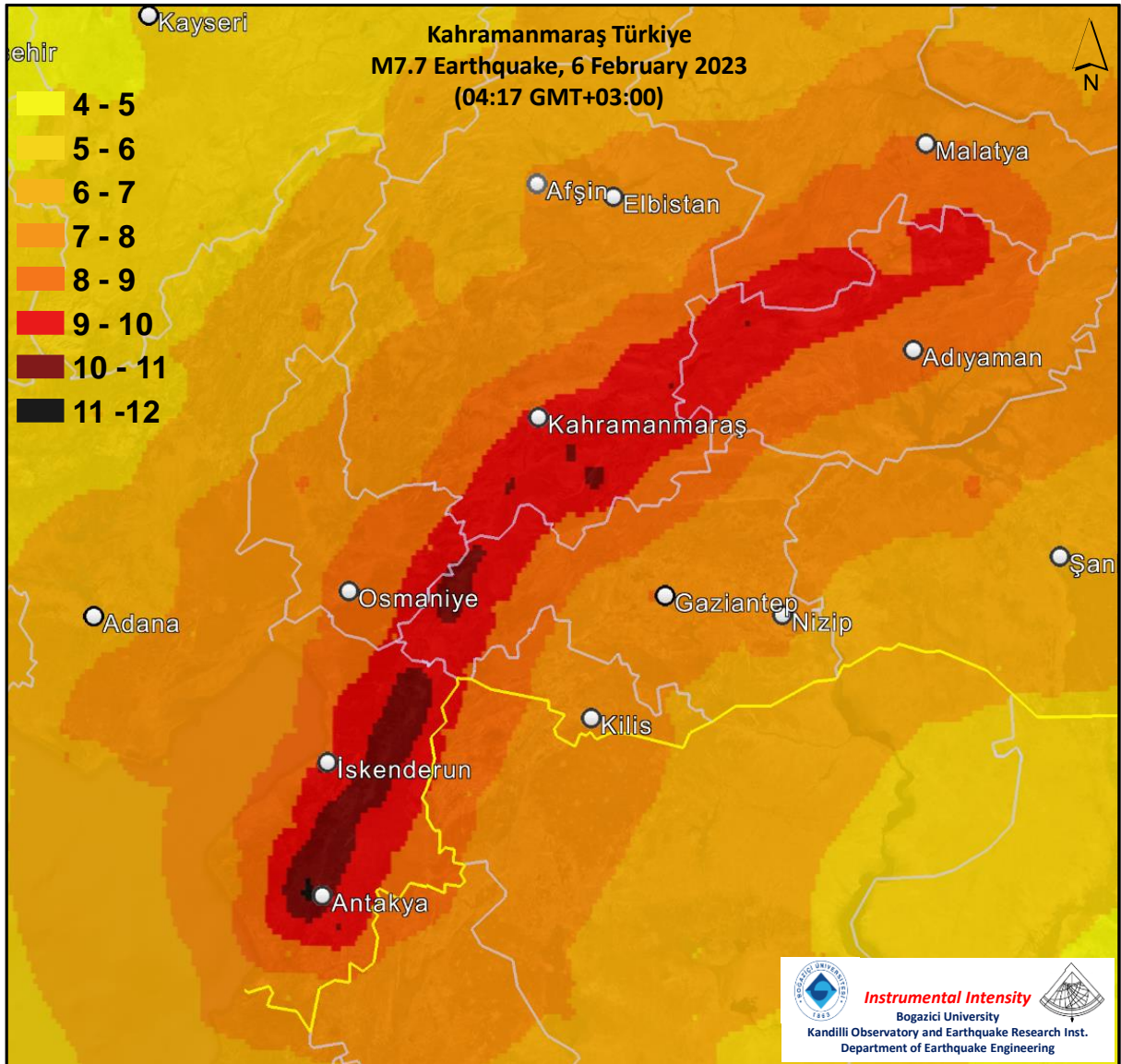
**<https://eqe.boun.edu.tr/en/eler-tool>**

## INTENSITY MAPS – Bias corrected

A fault rupture of 290 km length corresponding to the Erkenek, Pazarcık and Amanos segments of the East Anatolian Fault Zone (Emre et al., 2018) and station recordings within a distance of 100 km from the fault are considered in the ground motion estimation.

GMPE : CY2014

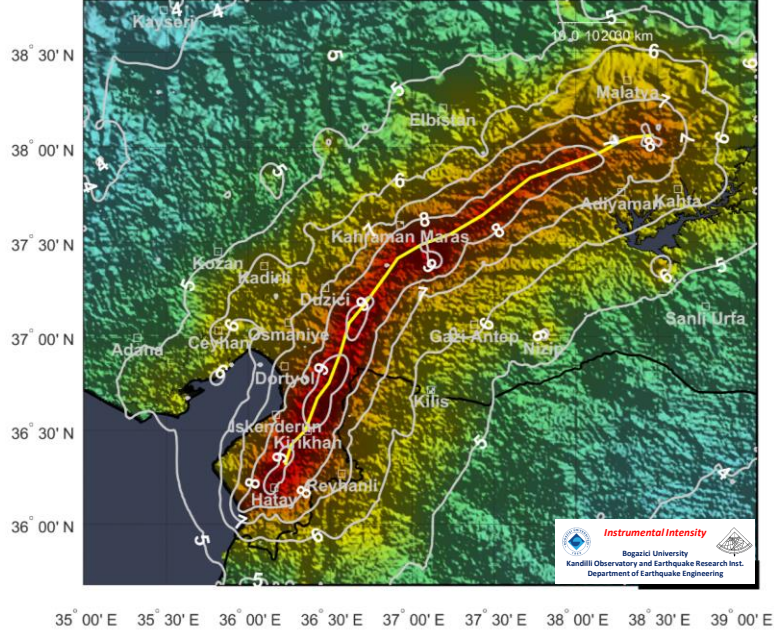
Intensity Equation : BA2014 Computed values ranging between 4.2 and 11.6



**GMPE : CY2014**

**Intensity Equation : WQHK1999** Computed values ranging between 3.4 and 10 (min. and max. computed values might not be visible on the contour map).

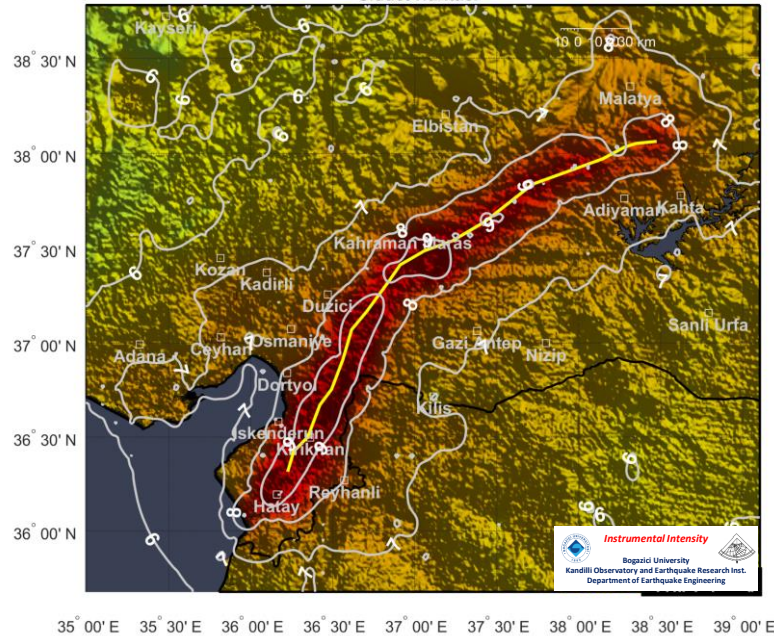
**M= 7.7 Derinlik= 8.6km Enlem= 37.228 Boylam= 37.043**  
**Siddet Haritasi**



**GMPE : CY2014**

**Intensity Equation : AK2007** Computed values ranging between 5.2 and 10.5 (min. and max. computed values might not be visible on the contour map).

**M= 7.7 Derinlik= 8.6km Enlem= 37.228 Boylam= 37.043**  
**Siddet Haritasi**



6 February 2023 (04:17) Kahramanmaraş-Türkiye M7.7 Earthquake

Preliminary Report (v5)

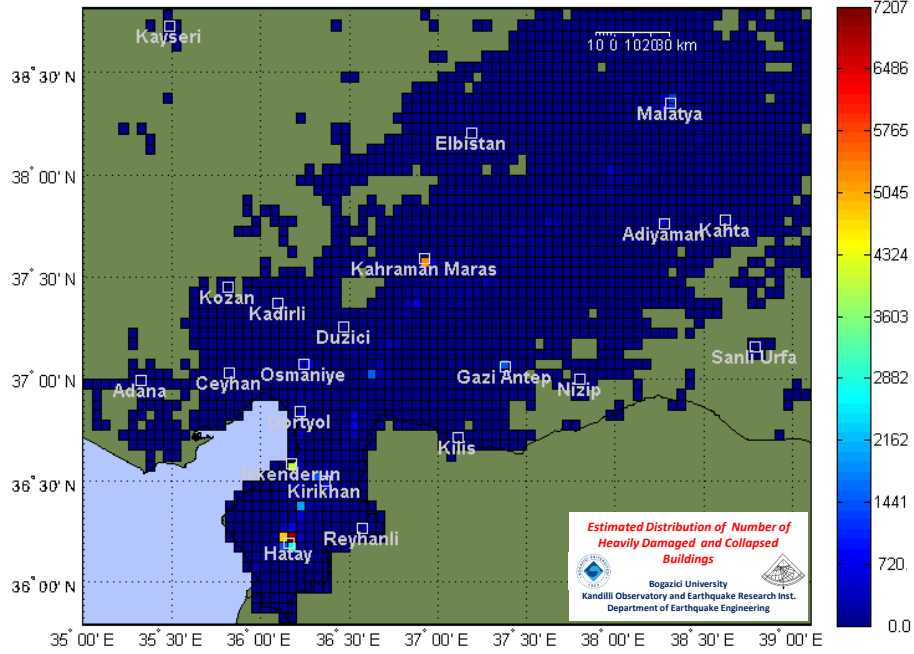
## INTENSITY BASED ESTIMATION of BUILDING DAMAGE DISTRIBUTION (REGIONAL SCALE)

### Estimated Number of Damaged Buildings

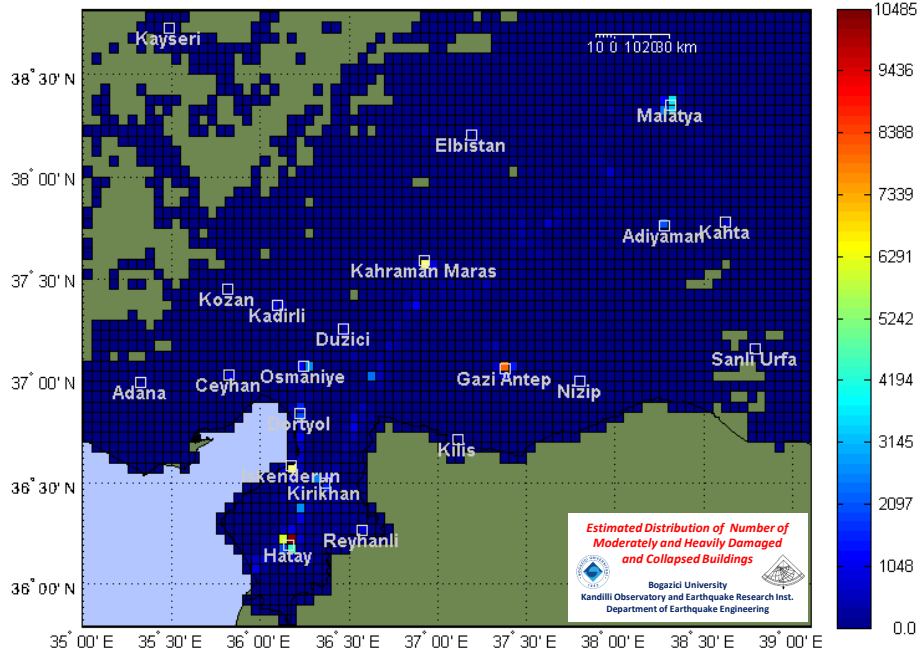
Damage State	BA2014	WQHK1999	AK2007	Average
D4+D5	75,311	16,523	30,261	40,698
D3+D4+D5	183,001	53,223	97,451	111,225

**GMPE : CY2014**  
**Intensity Equation : BA2014**

Distribution of Damaged Buildings [TOTAL] (D4 + D5)  
Total of: 75311

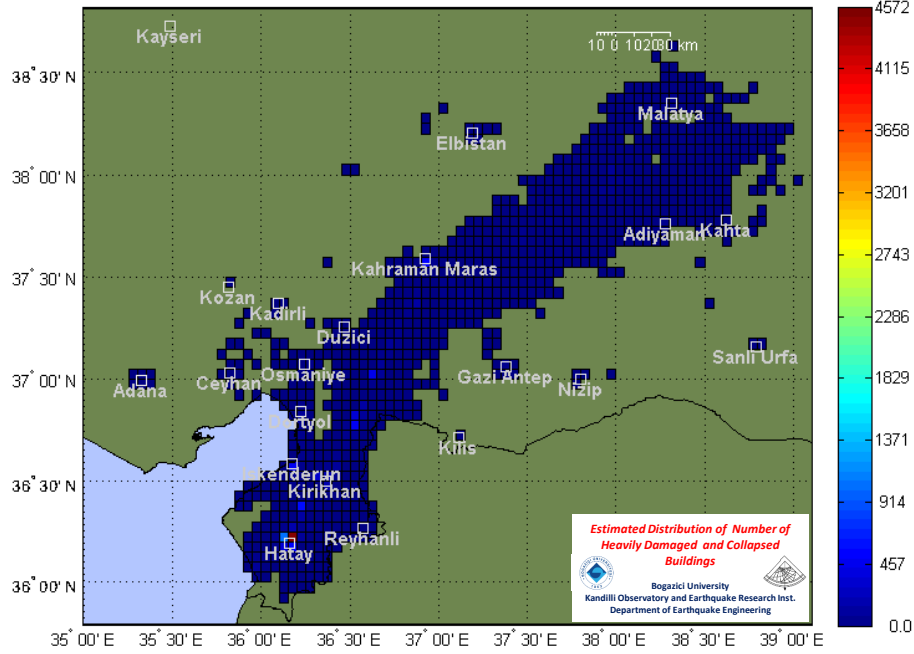


Distribution of Damaged Buildings [TOTAL] (D3 + D4 + D5)  
Total of: 183001

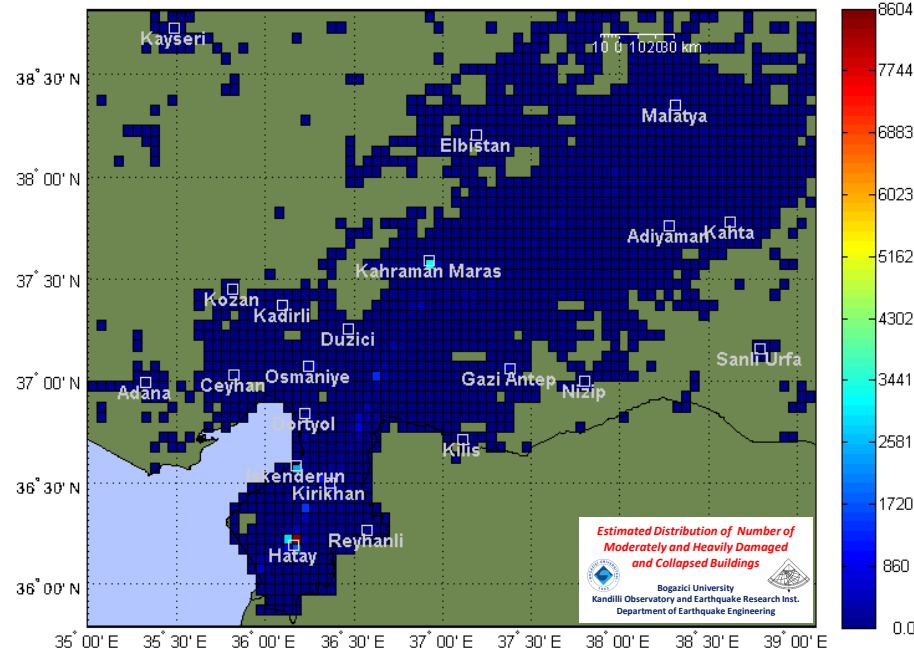


**GMPE : CY2014**  
**Intensity Equation : WQHK1999**

Distribution of Damaged Buildings [TOTAL] (D4 + D5)  
Total of: 16523



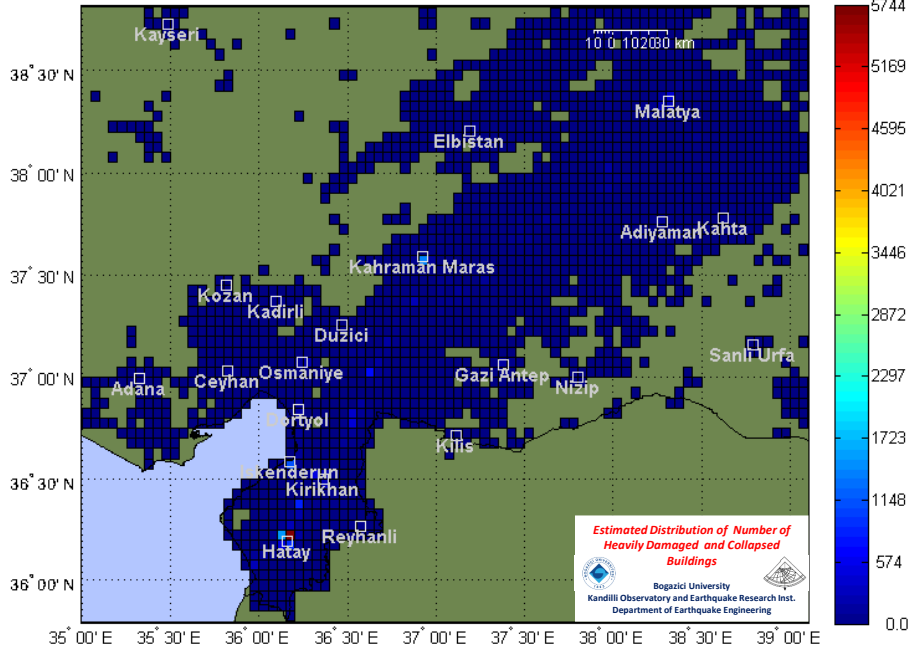
Distribution of Damaged Buildings [TOTAL] (D3 + D4 + D5)  
Total of: 53223



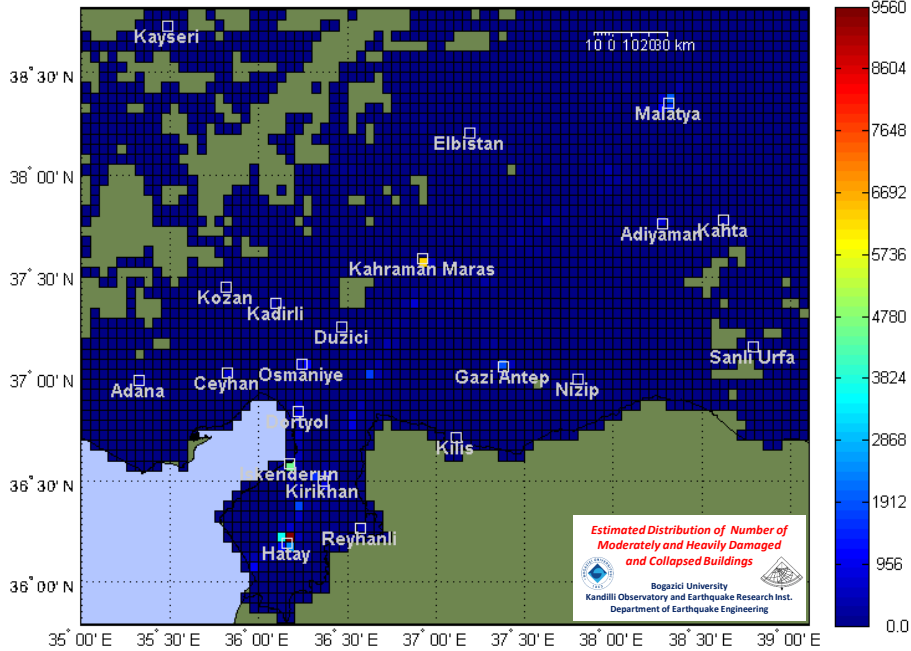


**GMPE : CY2014**  
**Intensity Equation : AK2007**

Distribution of Damaged Buildings [TOTAL] (D4 + D5)  
Total of: 30261



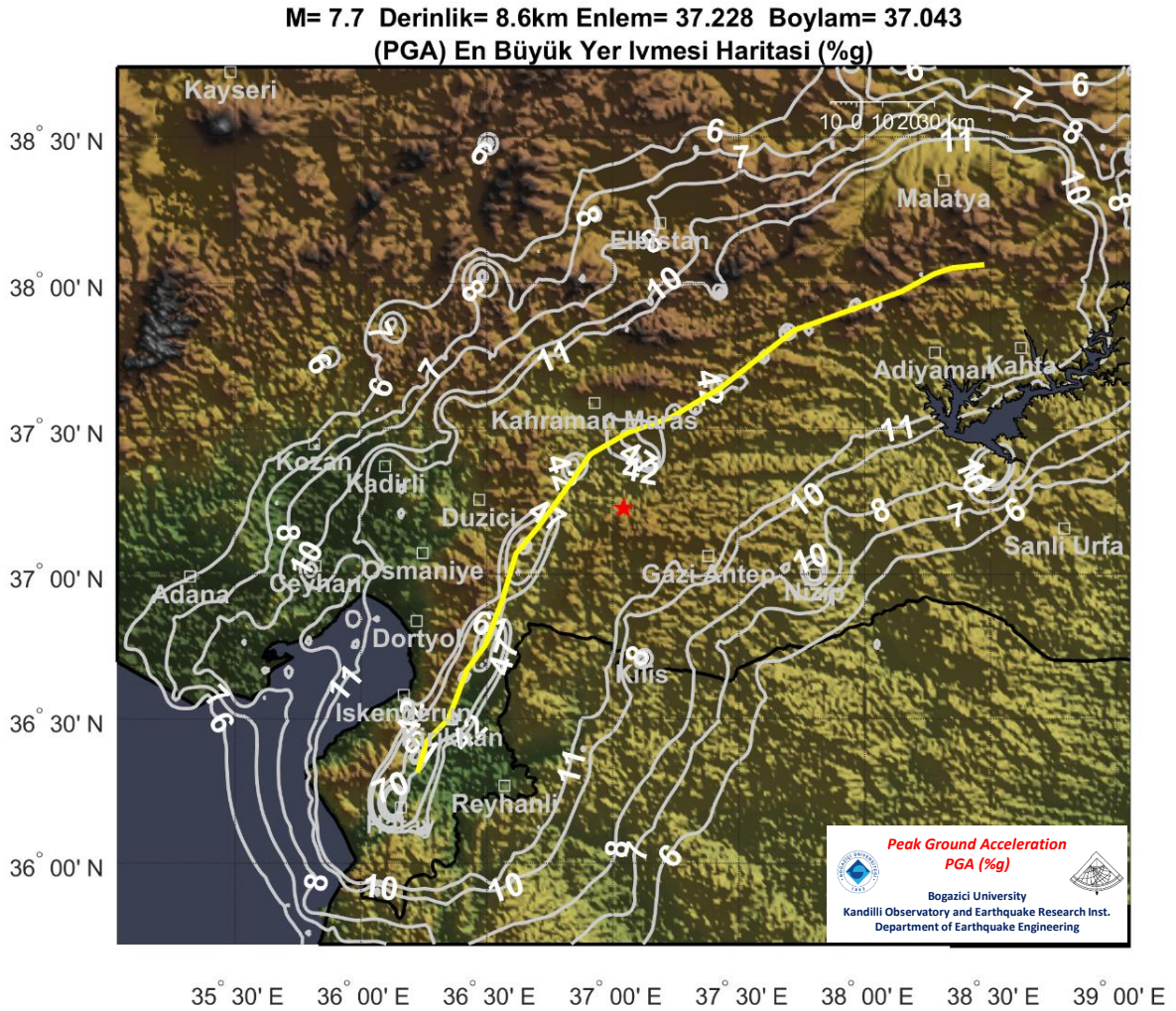
Distribution of Damaged Buildings [TOTAL] (D3 + D4 + D5)  
Total of: 97451



## PGA MAP – Bias corrected

A fault rupture of 290 km length corresponding to the Erkenek, Pazarcık and Amanos segments of the East Anatolian Fault Zone (Emre et al., 2018) and station recordings within a distance of 100 km from the fault are considered in the ground motion estimation.

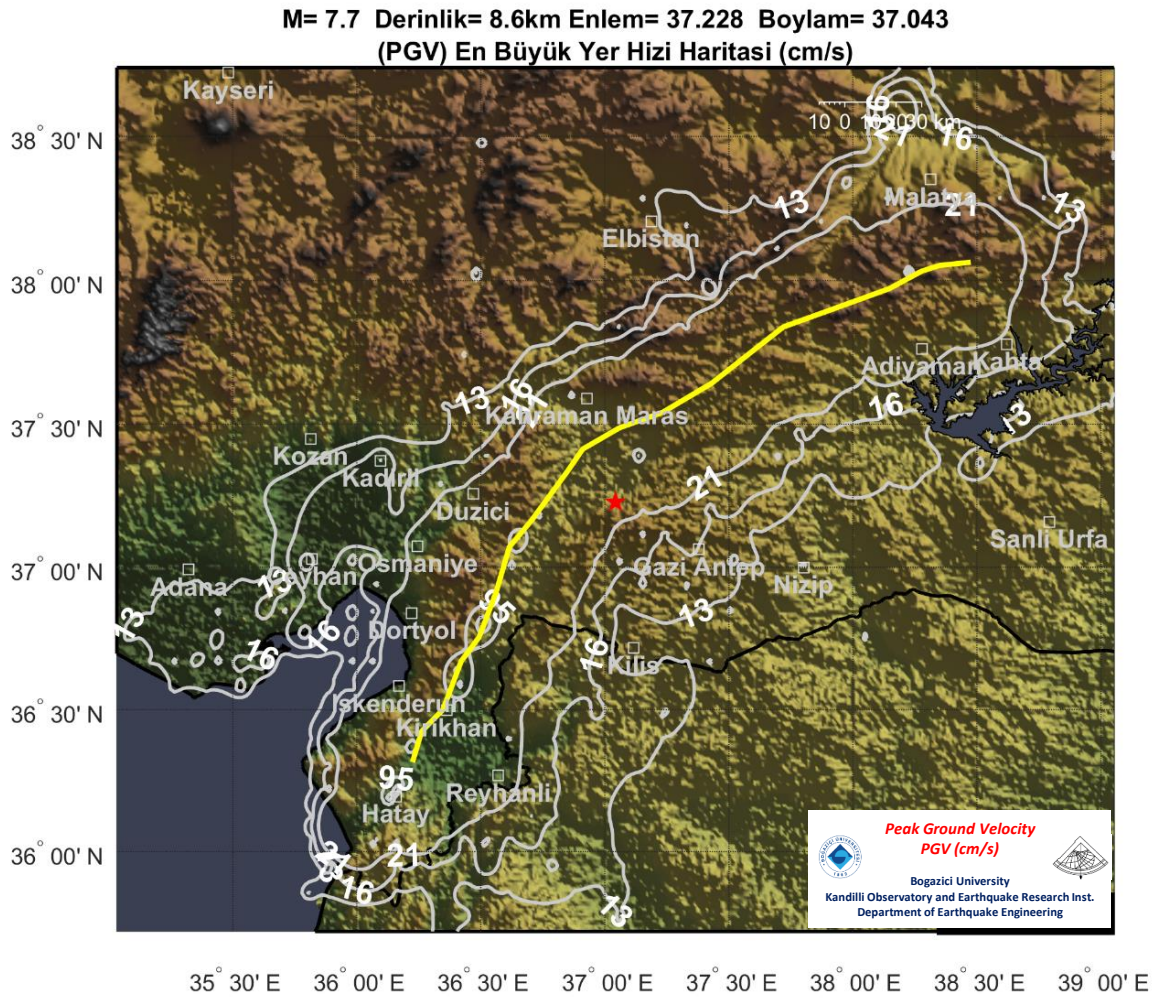
**GMPE: CY2014** Computed values ranging between 0.013g and 1.3g (min. and max. computed values might not be visible on the contour map).

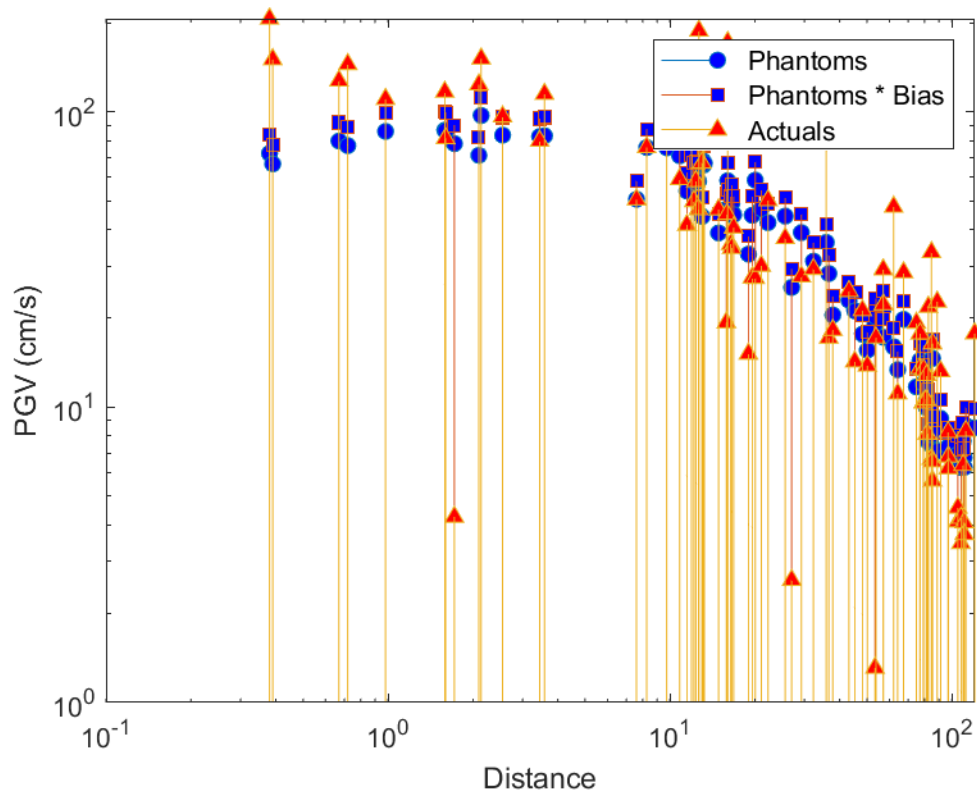
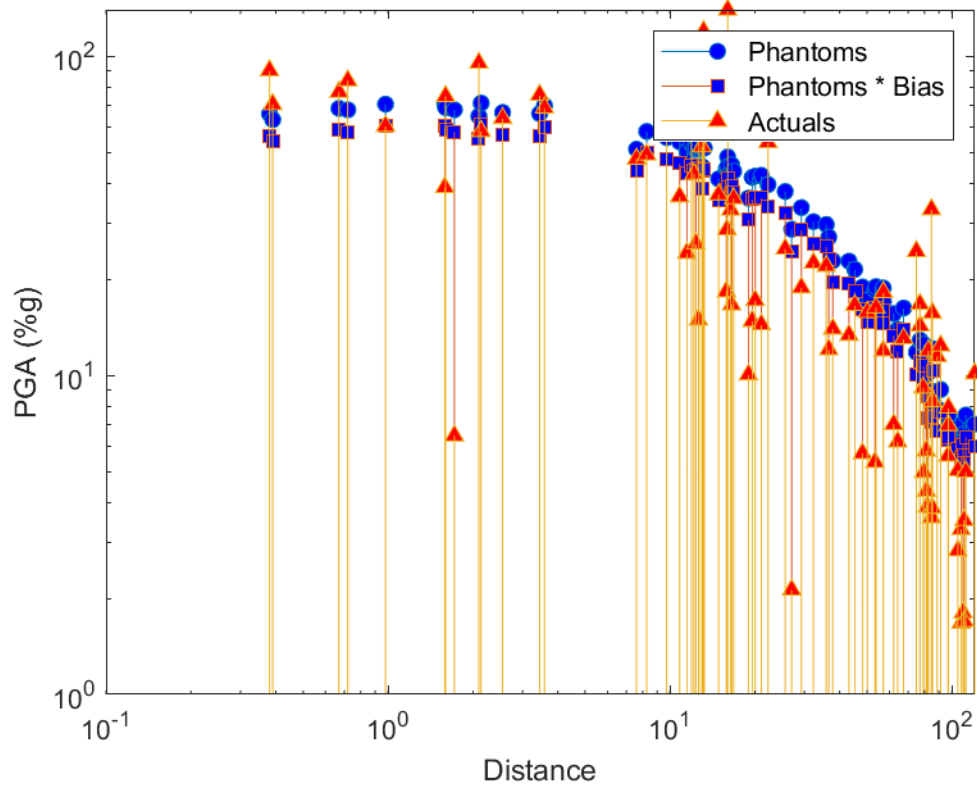


## PGV MAP – Bias corrected

A fault rupture of 290 km length corresponding to the Erkenek, Pazarcık and Amanos segments of the East Anatolian Fault Zone (Emre et al., 2018) and station recordings within a distance of 100 km from the fault are considered in the ground motion estimation.

**GMPE: CY2014** Computed values ranging between 3.6cm/s and 190cm/s (min. and max. computed values might not be visible on the contour map).





Bias correction plots for PGA and PGV

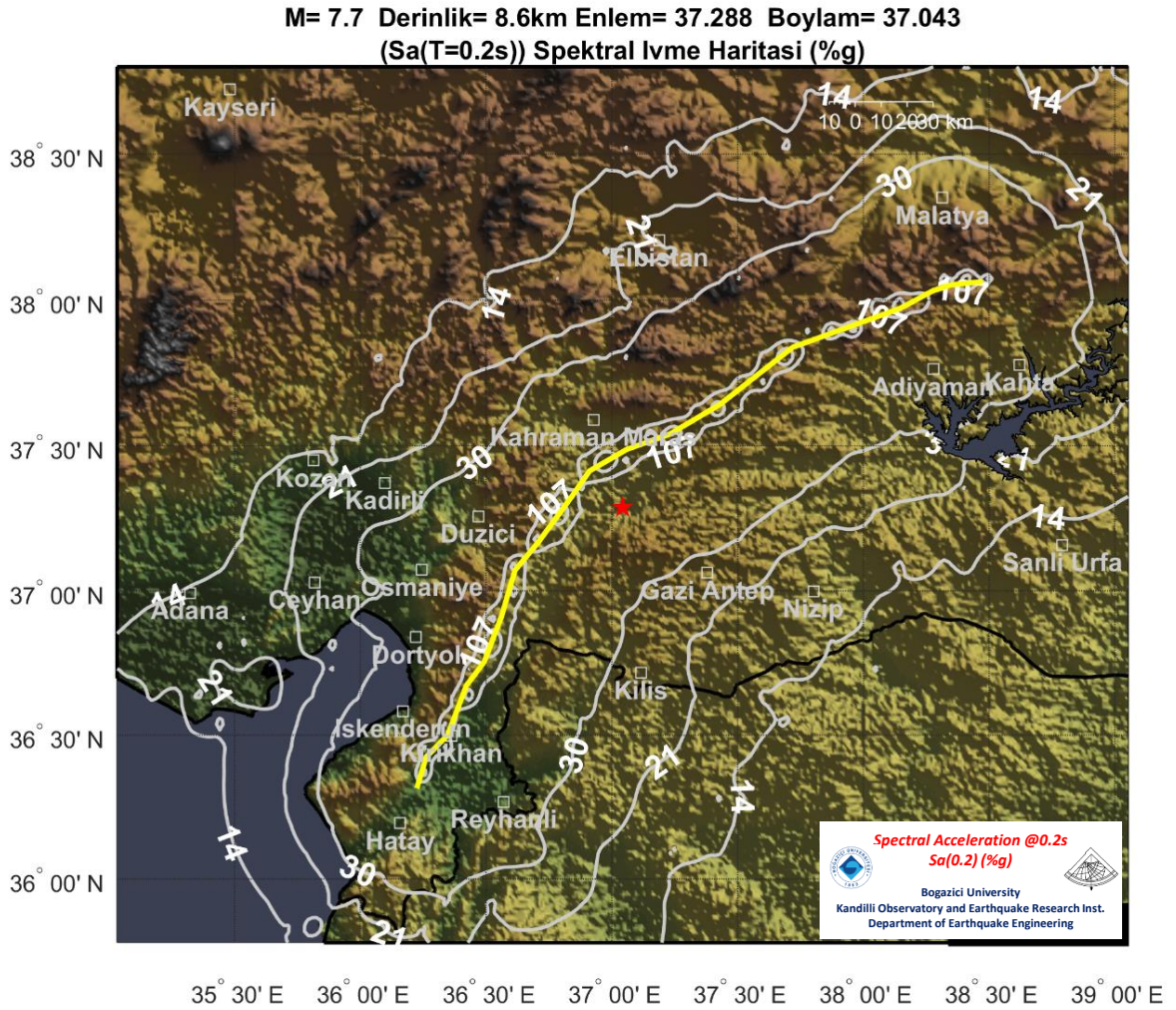
6 February 2023 (04:17) Kahramanmaraş-Türkiye M7.7 Earthquake

Preliminary Report (v5)

## Sa(0.2s) MAP

A fault rupture of 290 km length corresponding to the Erkenek, Pazarcık and Amanos segments of the East Anatolian Fault Zone (Emre et al., 2018) is considered in the ground motion estimation. Station recordings are not incorporated.

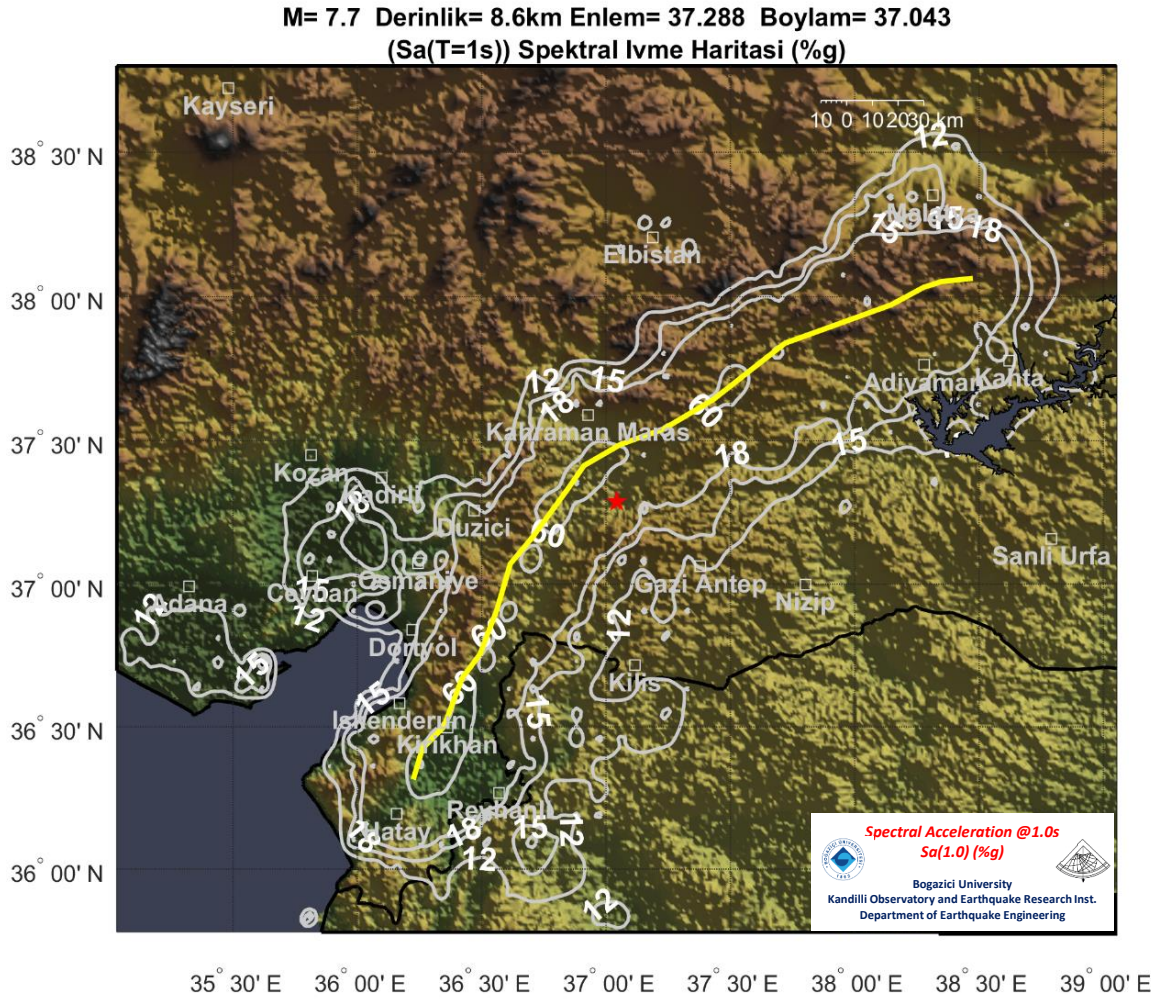
**GMPE: CY2014** Computed values ranging between 0.02g and 1.64g (min. and max. computed values might not be visible on the contour map).



## Sa(1.0s) MAP

A fault rupture of 290 km length corresponding to the Erkenek, Pazarcık and Amanos segments of the East Anatolian Fault Zone (Emre et al., 2018) is considered in the ground motion estimation. Station recordings are not incorporated.

**GMPE: CY2014** Computed values ranging between 0.015g and 1.22g (min. and max. computed values might not be visible on the contour map).



## SPECTRAL ACCELERATION-DISPLACEMENT BASED ESTIMATION of BUILDING DAMAGE DISTRIBUTION for KAHRAMANMARAS CITY

**It is estimated that approximately 45% of the city's building inventory in (moderate+extensive+complete) damage state.**

### Modified Acceleration-Displacement Response Spectrum (MADRS) Method

Damage State	Ground Motion Input		Average	% of total number of buildings
	CY2008	CY2014		
<b>Complete</b>	890	1159	<b>1025</b>	<b>2%</b>
<b>Extensive</b>	3934	4623	<b>4279</b>	<b>9%</b>
<b>Moderate</b>	12713	13443	<b>13078</b>	<b>29%</b>
<b>Slight</b>	13439	13188	<b>13314</b>	<b>29%</b>
<b>None</b>	14822	13385	<b>14104</b>	<b>31%</b>

### Capacity Spectrum Method (CSM)

Damage State	Ground Motion Input		Average	% of total number of buildings
	CY2008	CY2014		
<b>Complete</b>	2066	2780	<b>2423</b>	<b>5%</b>
<b>Extensive</b>	5673	6643	<b>6158</b>	<b>13%</b>
<b>Moderate</b>	12956	12802	<b>12879</b>	<b>28%</b>
<b>Slight</b>	11614	10540	<b>11077</b>	<b>24%</b>
<b>None</b>	13489	13033	<b>13261</b>	<b>29%</b>

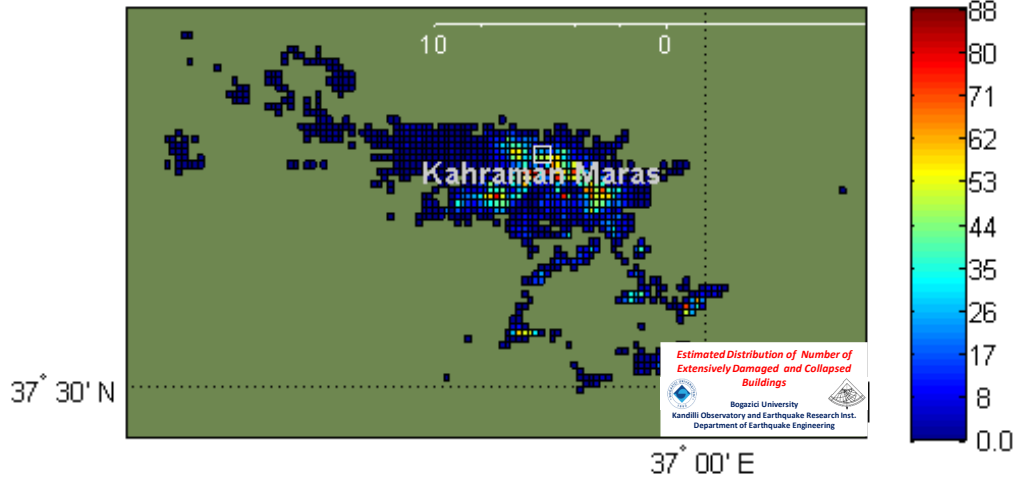
### Displacement Coefficient Method (DCM)

Damage State	Ground Motion Input		Average	% of total number of buildings
	CY2008	CY2014		
<b>Complete</b>	812	924	<b>868</b>	<b>2%</b>
<b>Extensive</b>	3997	4356	<b>4177</b>	<b>9%</b>
<b>Moderate</b>	13222	13679	<b>13451</b>	<b>29%</b>
<b>Slight</b>	13815	13695	<b>13755</b>	<b>30%</b>
<b>None</b>	13952	13144	<b>13548</b>	<b>30%</b>

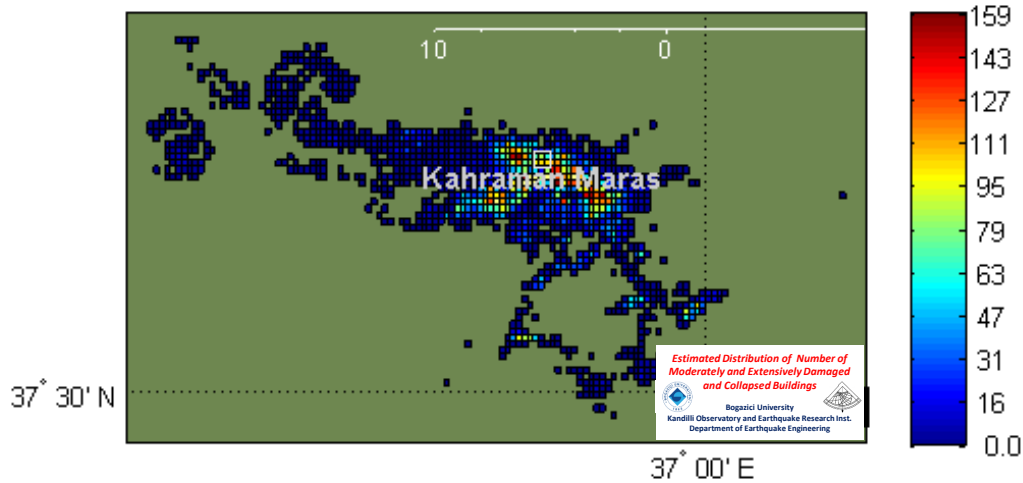
Spatial distributions of the number of damaged buildings from (CY2014)CSM method presented in the following maps.

## GMPE: CY2014

Distribution of Damaged Buildings [TOTAL] (Ext + Com)  
Total of: 9424



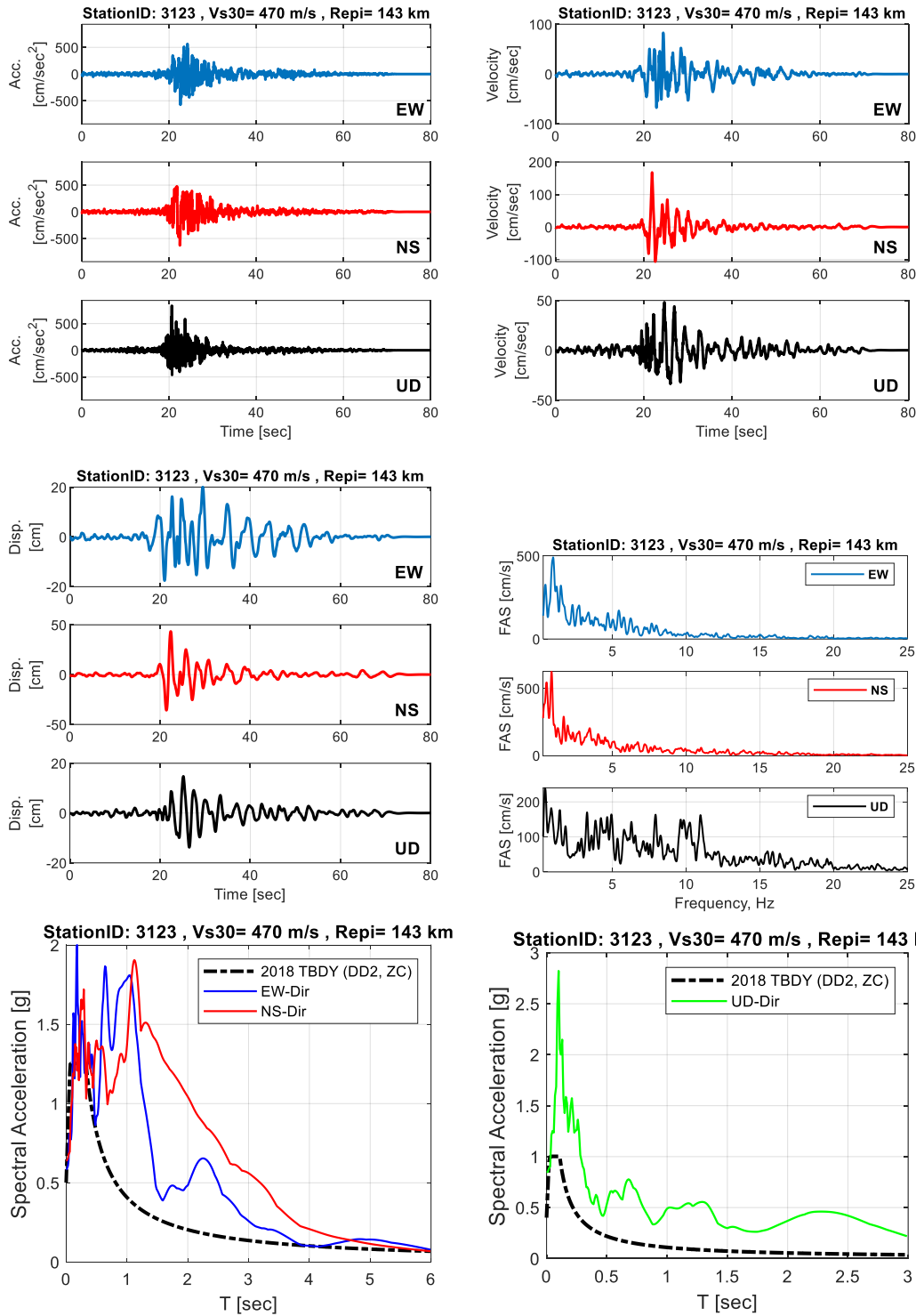
Distribution of Damaged Buildings [TOTAL] (Mod + Ext + Com)  
Total of: 22226

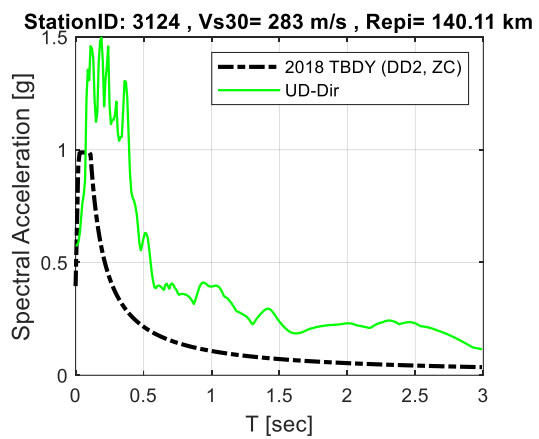
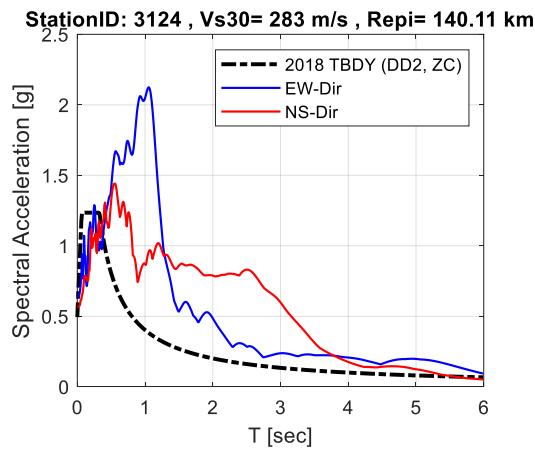
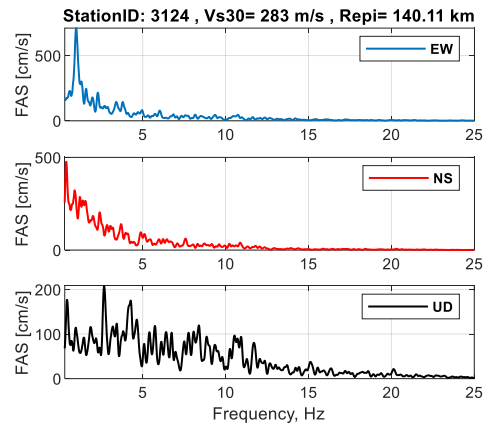
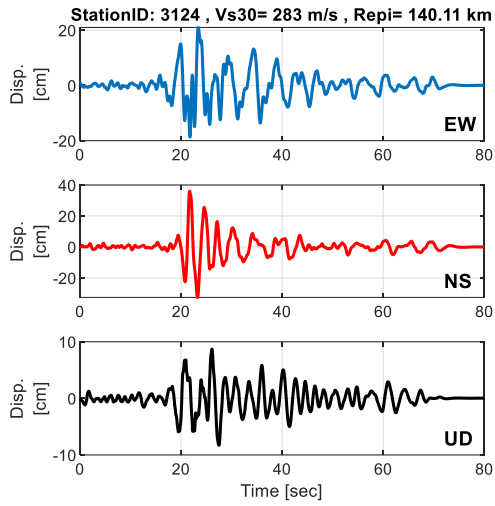
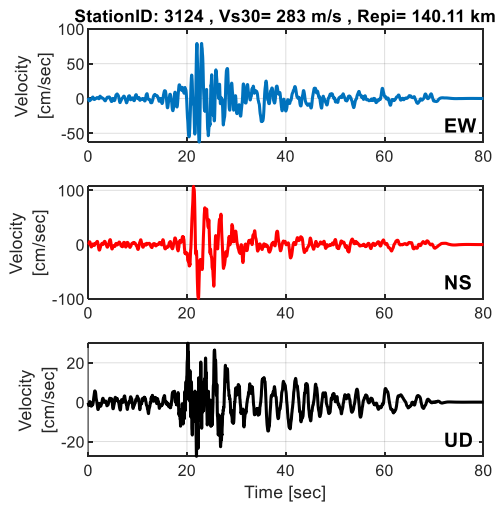
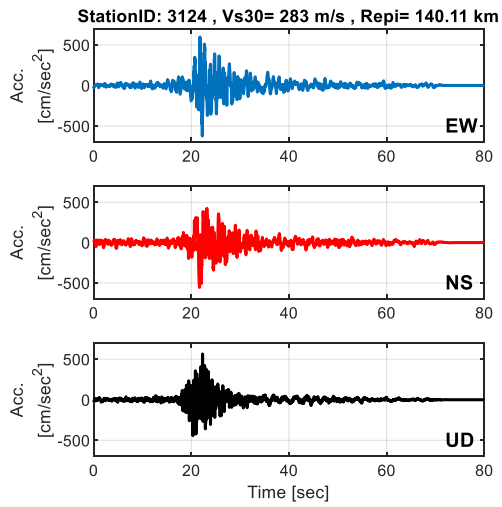


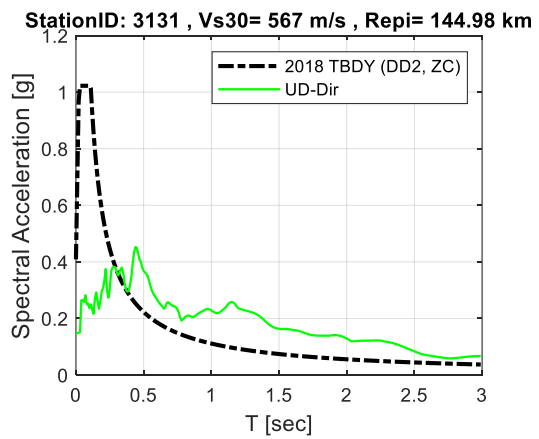
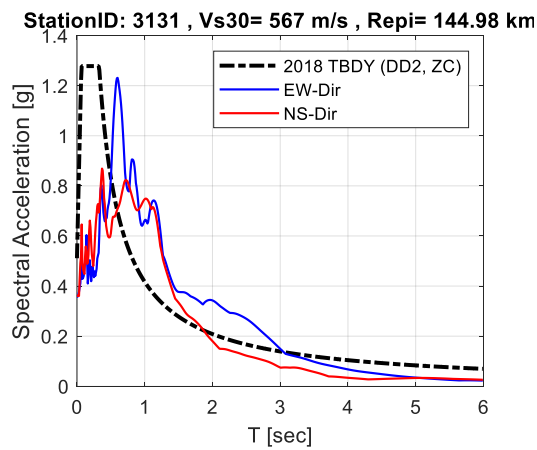
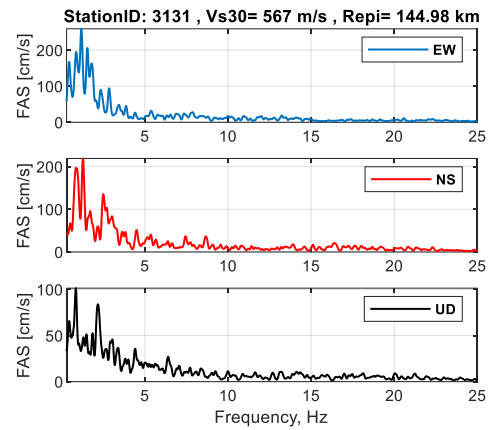
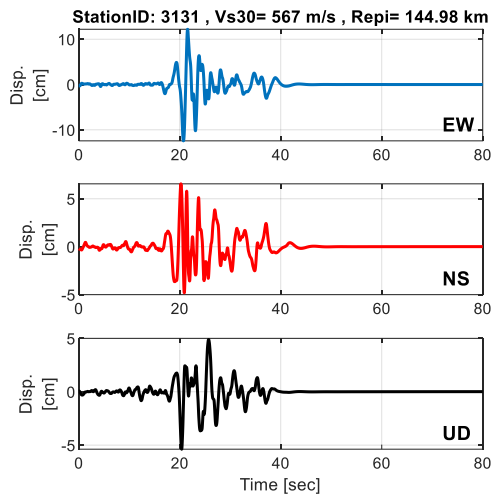
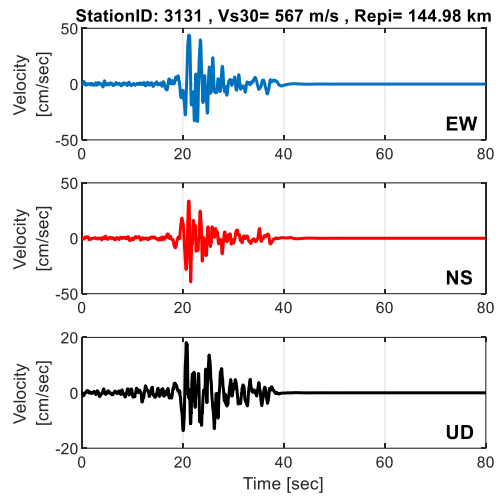
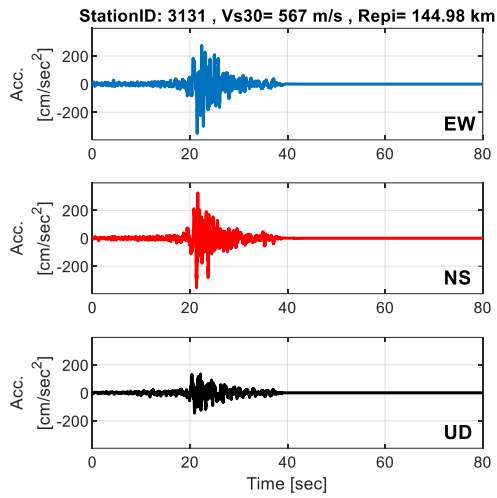


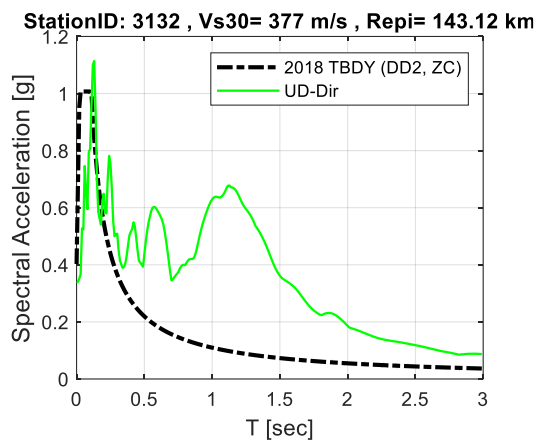
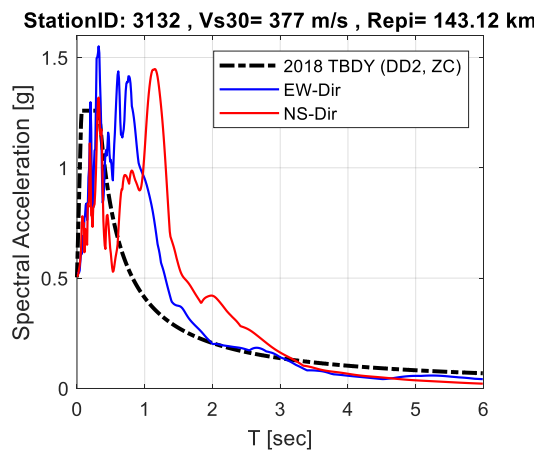
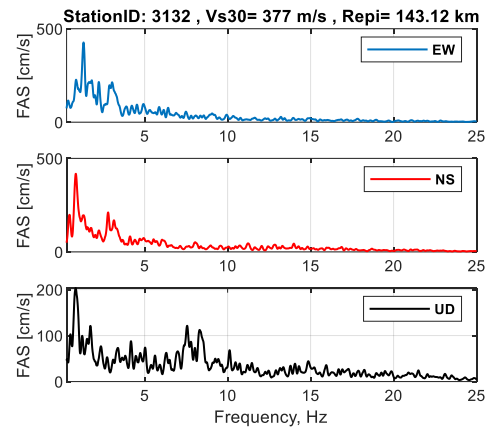
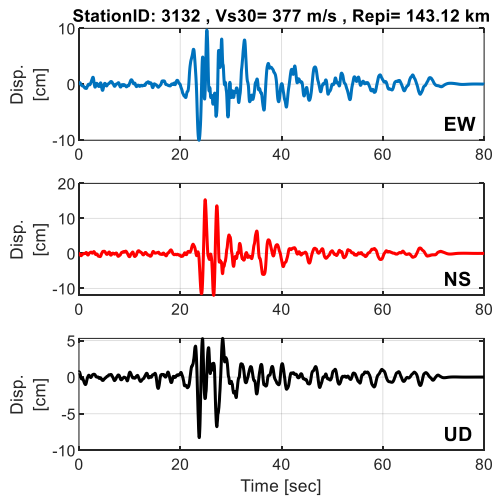
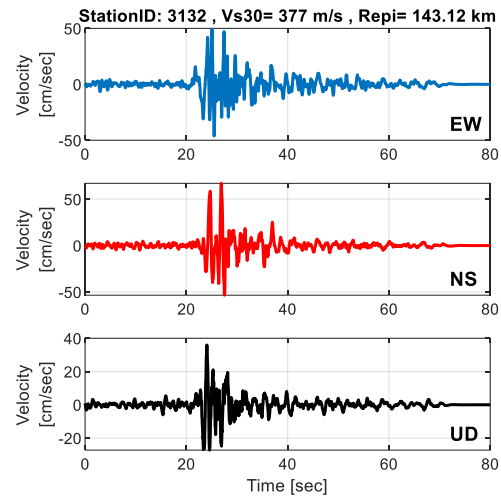
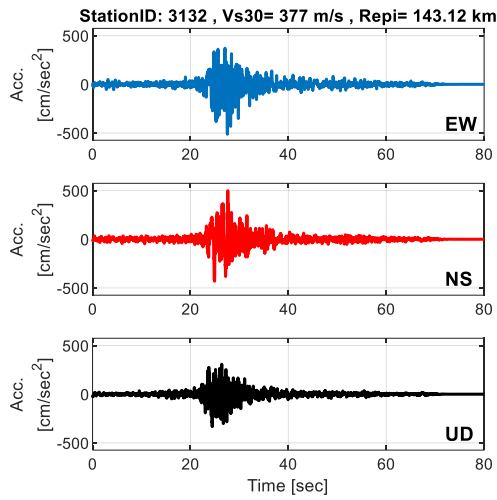
## STRONG GROUND MOTION RECORDINGS

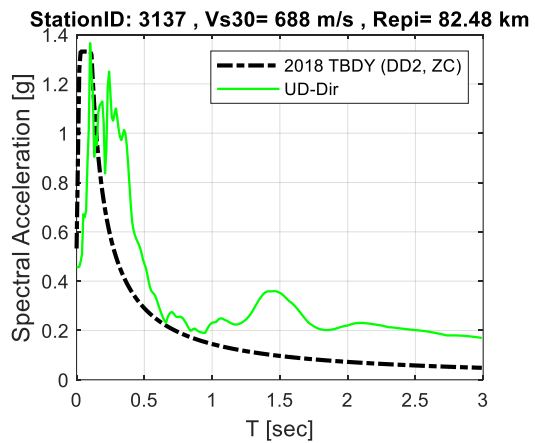
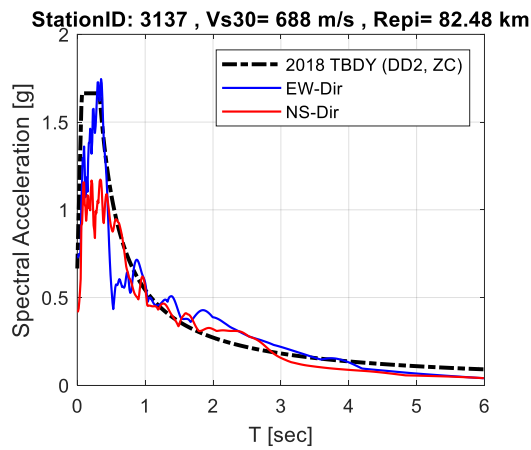
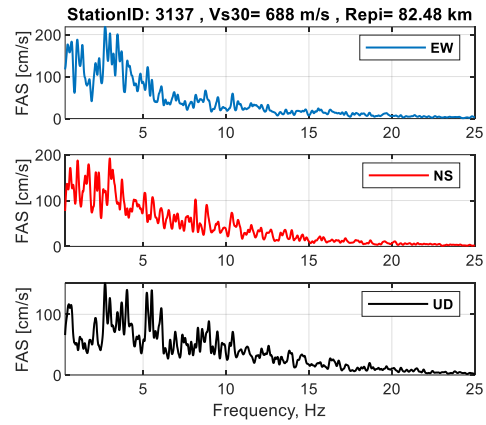
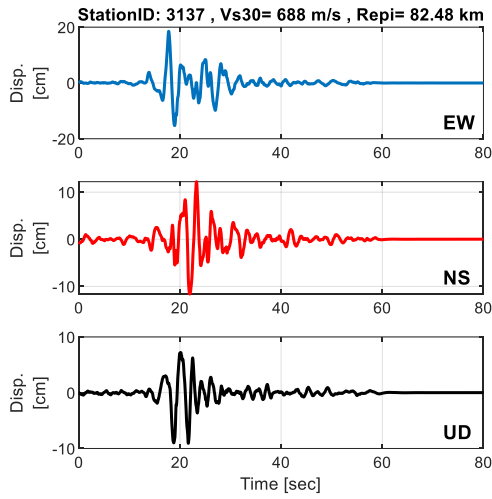
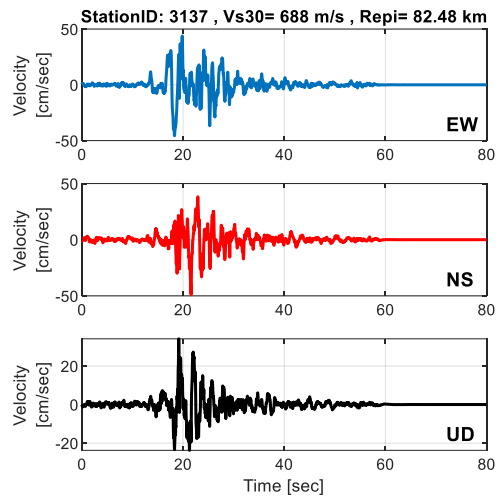
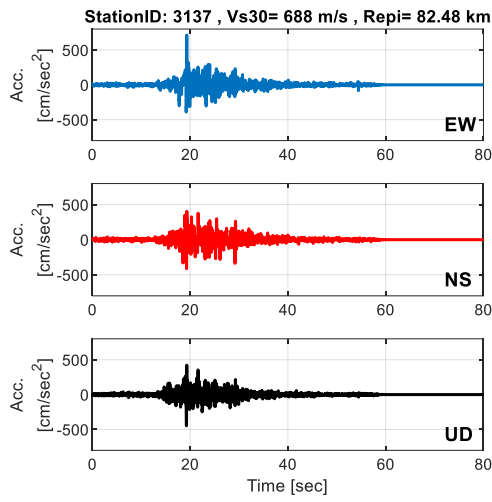
The recordings included herewith can not be reached at AFAD website as of 09.02.2023. Data may be under revision or the site overloaded. The data and thus the plots presented are subject to change.

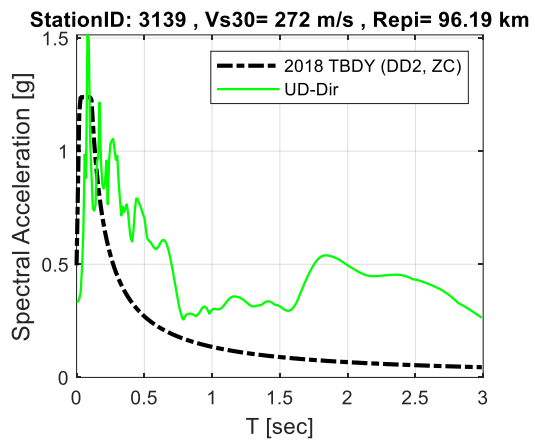
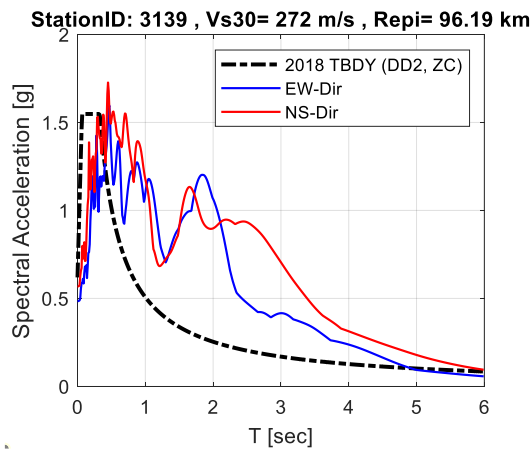
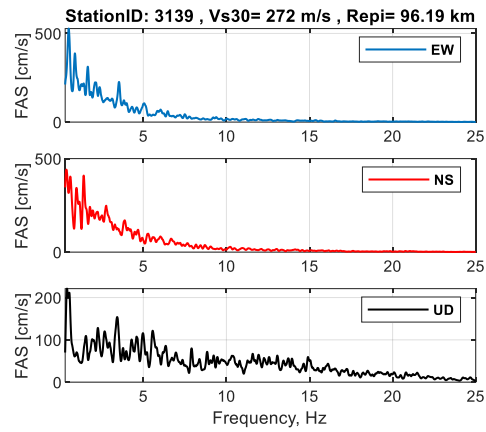
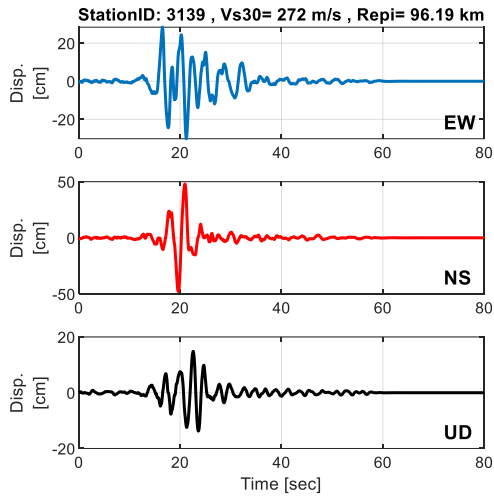
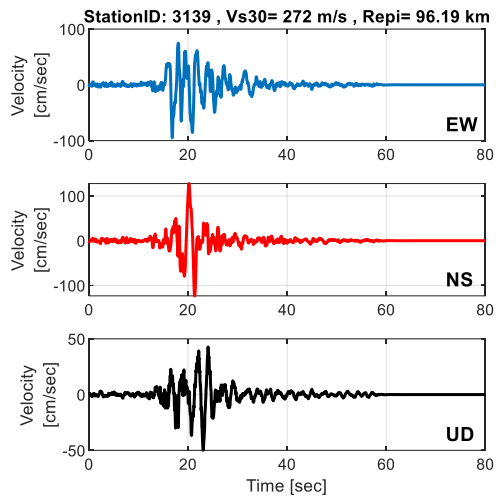
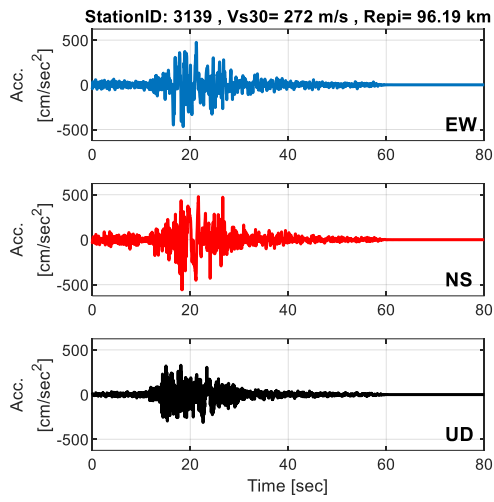


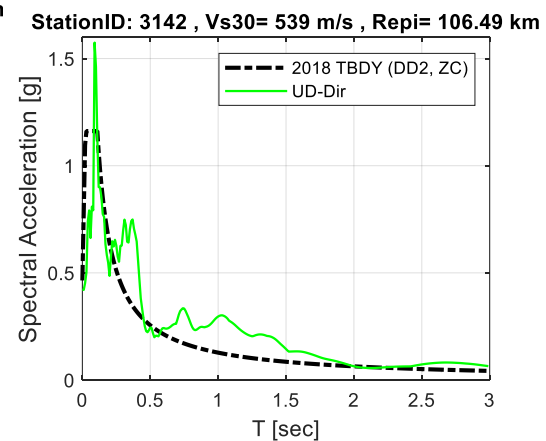
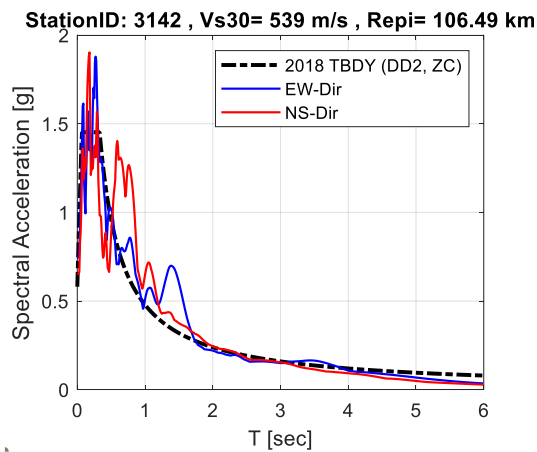
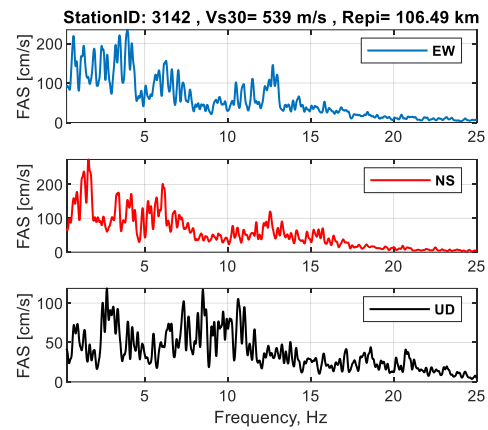
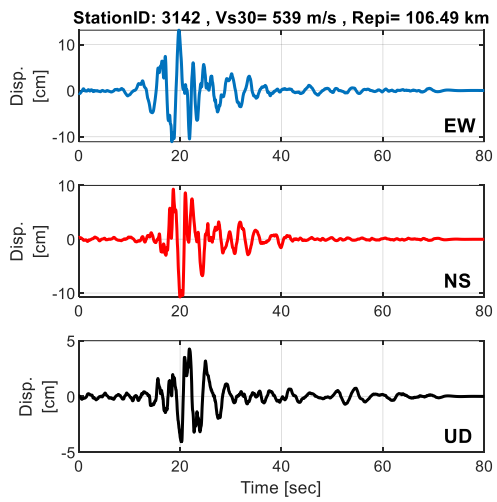
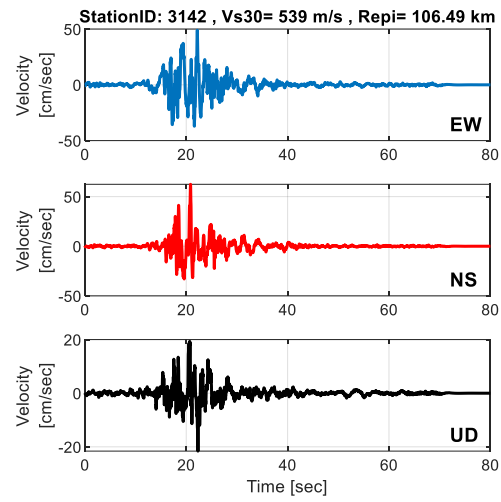
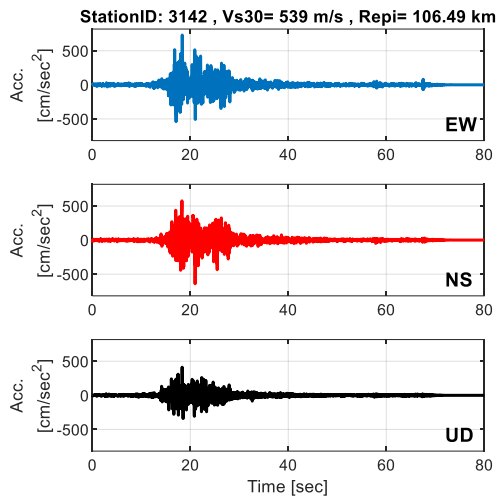


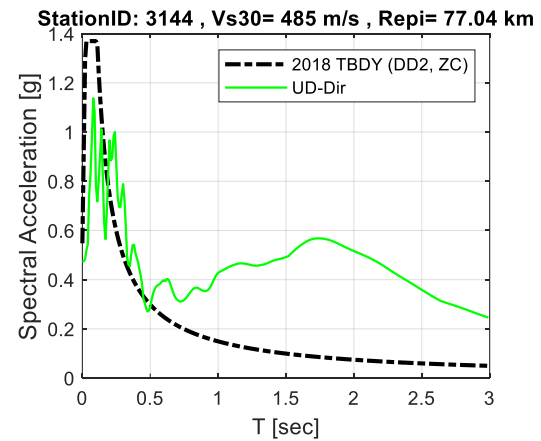
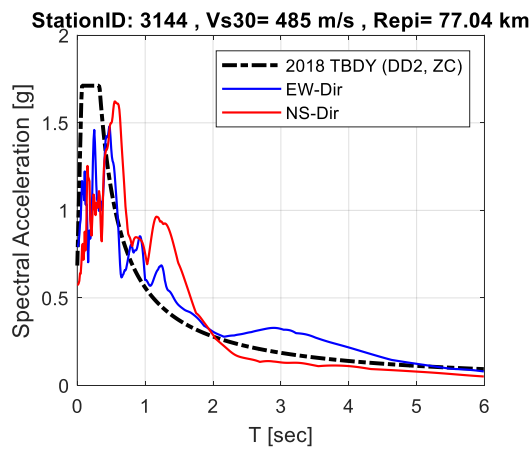
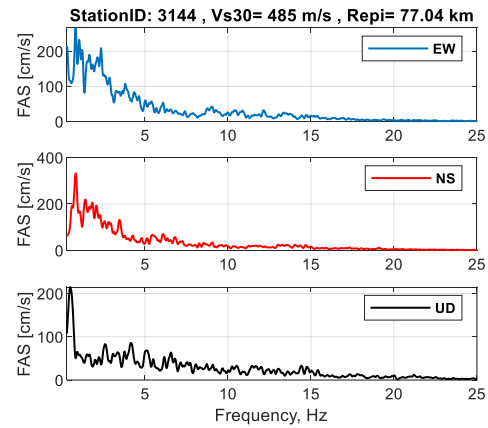
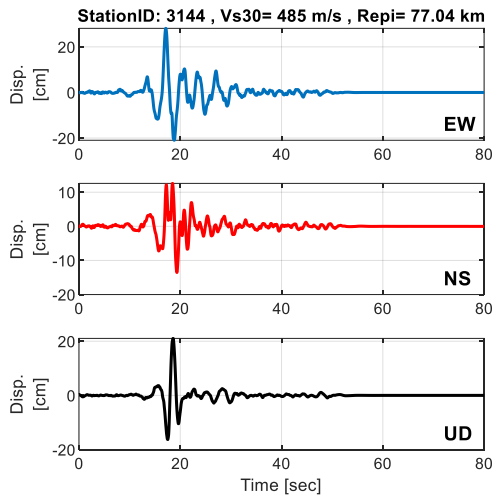
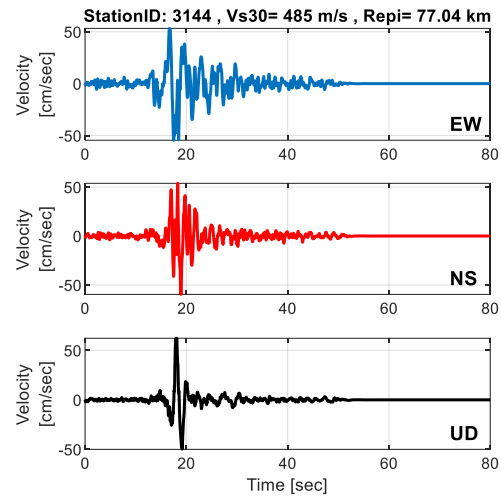
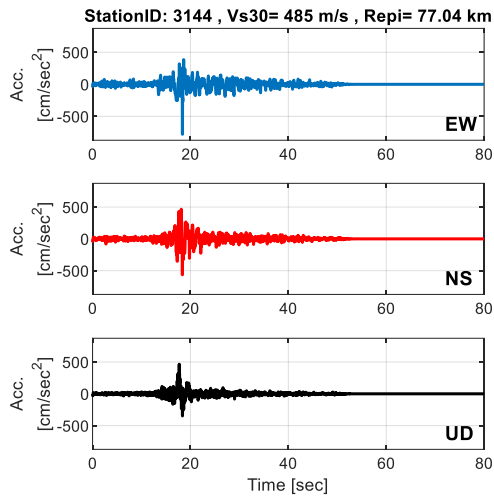




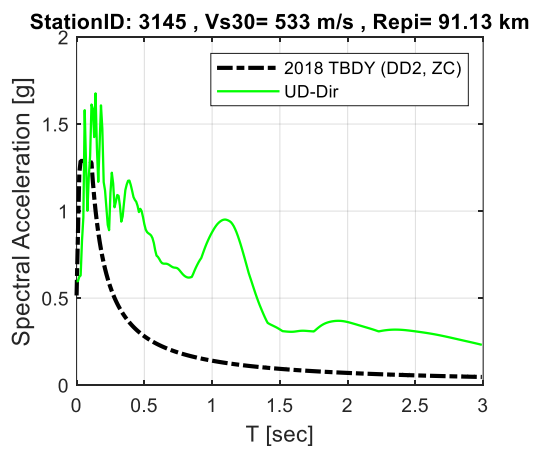
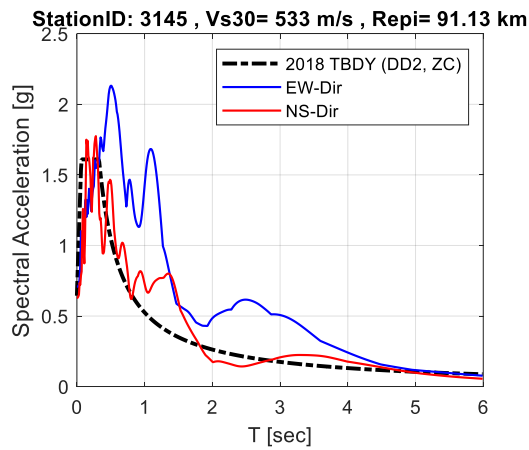
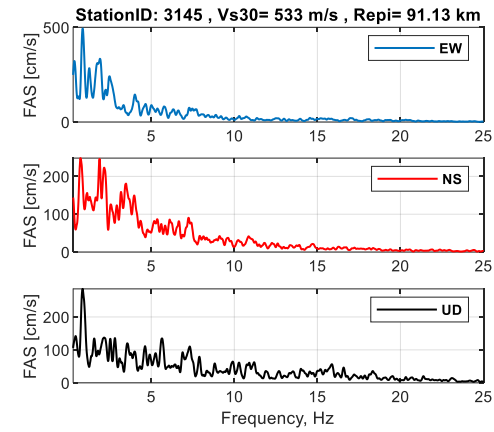
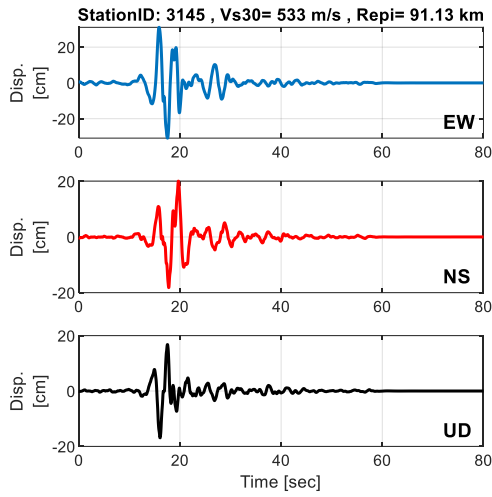
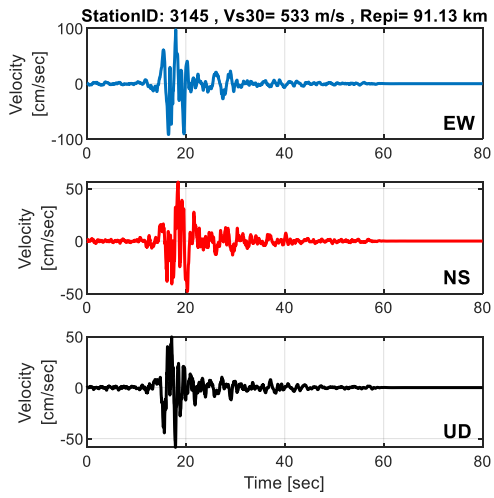
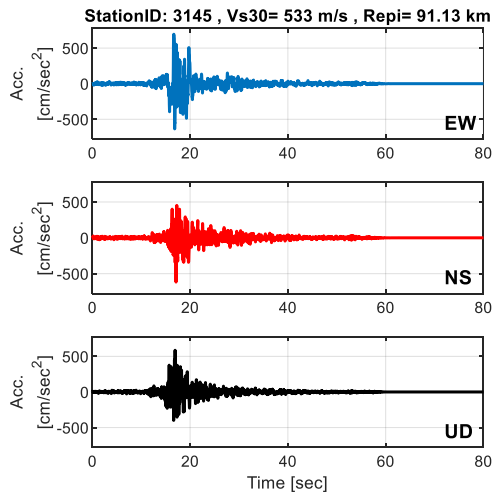






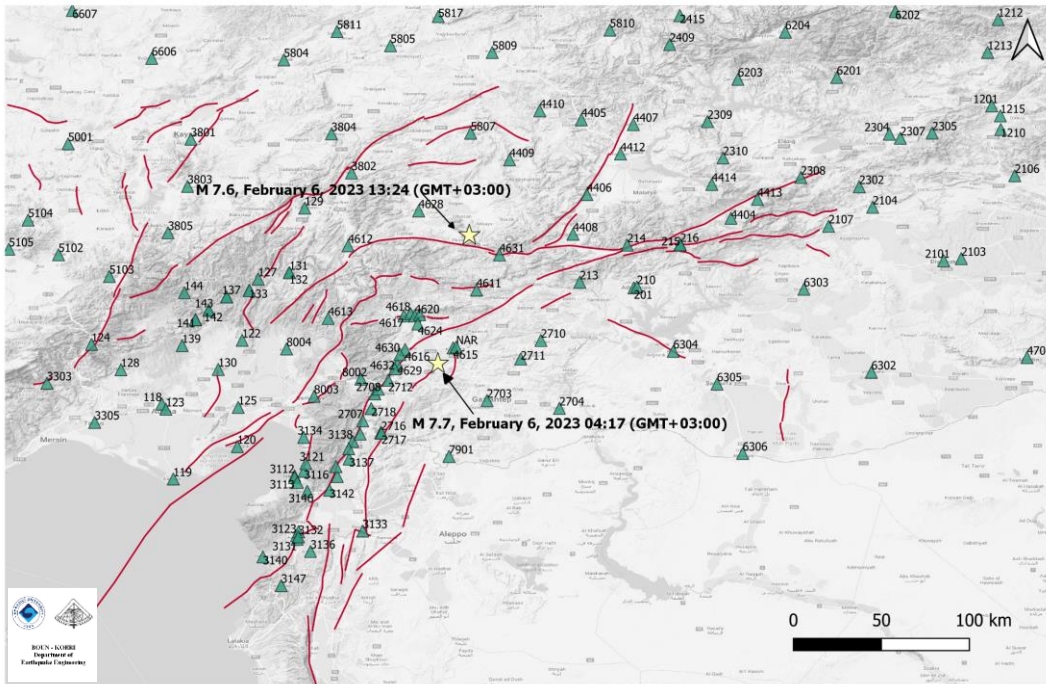




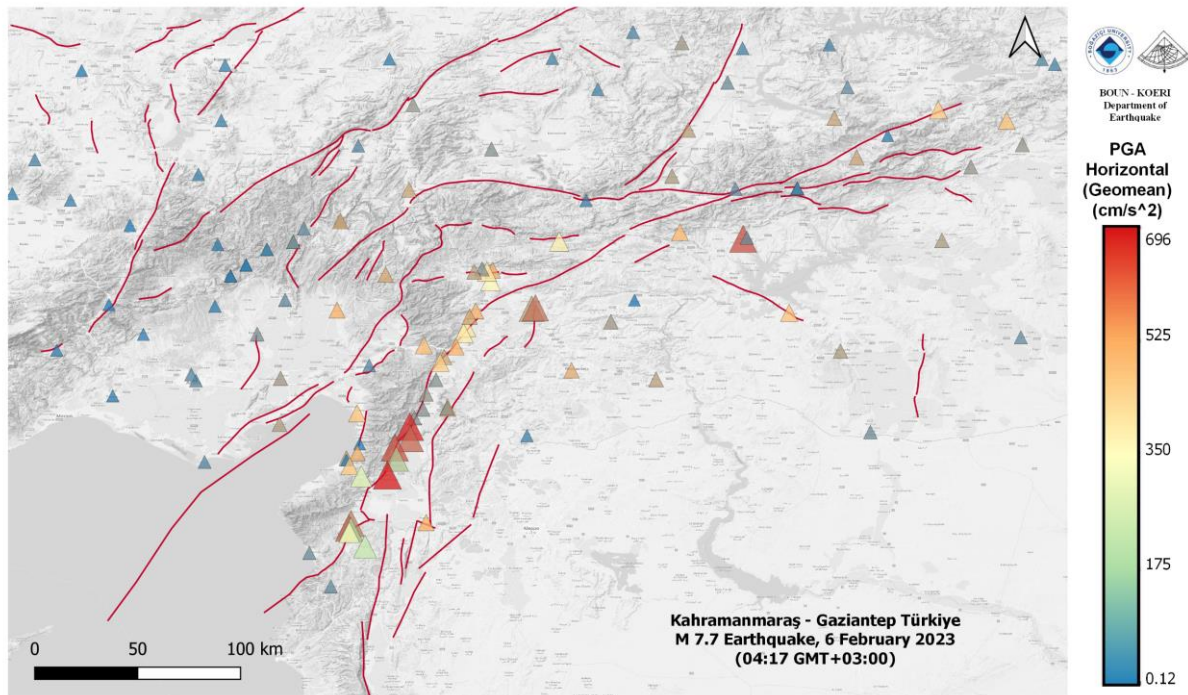


ID	Lat.	Lon.	Vs30 (m/s)	R <sub>epi</sub> (km)	Site Class (EC8)	Comp.	PGA (cm/s <sup>2</sup> )	PGV (cm/s)	PGD (cm)	AI (m/s)	Dur 5-95 (sec)	CAV (m/s)
213	37.7967	37.9296		96.5		EW	172.19	33.57	12.65	0.69	7.72	6.05
						NS	244.17	52.45	20.22	1.03	7.71	7.54
						UD	195.96	23.08	9.15	0.45	7.71	4.61
1213	39.2310	40.4774		372.1		EW	330.38	20.93	3.08	0.80	4.12	6.89
						NS	244.56	11.69	1.69	0.45	8.40	5.90
						UD	185.15	4.58	0.86	0.23	7.07	4.17
2302	38.3923	39.6754	907	261.7	A	EW	215.96	9.93	1.67	0.26	9.97	5.09
						NS	199.81	7.63	1.15	0.20	11.98	4.76
						UD	112.06	5.02	1.57	0.08	21.59	3.87
2308	38.4506	39.3102	450	237.3	B	EW	163.86	22.92	5.45	0.34	36.63	8.02
						NS	314.07	26.57	5.49	0.59	20.49	9.03
						UD	356.06	7.53	1.53	0.33	12.24	5.83
3115	36.5463	36.1646	424	113.6	B	EW	81.75	6.45	1.60	0.16	24.86	4.63
						NS	137.39	14.30	2.42	0.33	24.70	6.36
						UD	134.77	6.55	0.94	0.18	26.88	4.32
3123	36.2142	36.1597	470	143.0	B	EW	574.78	82.84	20.13	7.14	16.93	31.00
						NS	629.02	167.80	43.45	8.89	12.71	33.25
						UD	833.04	48.19	14.77	4.44	14.38	23.44
3124	36.2387	36.1722	283	140.1	C	EW	622.65	79.06	21.02	7.22	19.22	32.42
						NS	556.34	107.25	35.98	5.82	21.57	30.17
						UD	564.23	29.97	8.76	3.00	17.08	18.97
3131	36.1912	36.1633	567	145.0	B	EW	350.96	43.98	12.45	1.61	7.64	11.31
						NS	354.34	39.39	6.57	1.26	8.16	9.51
						UD	145.35	18.15	5.36	0.34	14.30	5.92
3132	36.2067	36.1716	377	143.1	B	EW	513.00	49.36	10.01	4.24	17.56	23.58
						NS	498.87	67.08	15.36	3.60	13.43	21.48
						UD	333.33	35.94	8.25	1.75	13.69	14.68
3136	36.1159	36.2472	344	148.4	C	EW	363.82	40.81	7.88	3.44	32.97	25.66
						NS	516.50	49.72	11.27	3.77	27.82	25.39
						UD	212.01	22.07	6.28	1.05	31.31	14.06
3137	36.6929	36.4885	688	82.5	B	EW	714.51	45.64	18.48	3.52	16.52	21.45
						NS	412.31	49.04	12.26	3.43	17.09	21.81
						UD	448.07	34.11	9.05	2.18	16.71	17.20
3139	36.5838	36.4144	272	96.2	C	EW	475.23	94.80	30.18	6.68	29.67	31.73
						NS	557.22	127.92	47.94	8.21	37.07	36.39
						UD	328.16	49.91	14.82	2.80	15.33	20.03
3142	36.4980	36.3661	539	106.5	B	EW	730.50	48.94	13.15	5.61	11.95	25.35
						NS	640.58	62.41	10.74	5.31	11.49	23.84
						UD	412.74	21.59	4.27	1.84	13.14	15.04

ID	Lat.	Lon.	Vs30 (m/s)	R <sub>epi</sub> (km)	Site Class (EC8)	Comp.	PGA (cm/s <sup>2</sup> )	PGV (cm/s)	PGD (cm)	AI (m/s)	Dur 5-95 EW (sec)	CAV (m/s)
3144	36.7569	36.4857	485	77.0	B	EW	779.18	54.53	28.12	3.47	41.68	24.61
						NS	564.00	59.66	13.56	3.36	33.42	21.19
						UD	465.47	62.19	21.05	1.27	16.50	12.09
3145	36.6454	36.4064	533	91.1	B	EW	694.72	97.38	31.06	6.20	11.30	22.81
						NS	617.10	56.16	20.09	3.64	13.84	20.21
						UD	585.57	58.57	16.92	2.93	10.53	16.64
3146	36.4908	36.2270		114.6		EW	317.18	27.55	7.17	2.90	16.99	18.10
						NS	448.17	22.61	6.85	4.35	16.82	21.47
						UD	253.10	15.68	4.80	1.48	17.76	13.52
4611	37.7472	37.2843	731	55.3	B	EW	312.54	34.70	7.87	2.42	44.01	22.23
						NS	327.28	29.99	6.64	2.63	43.13	22.95
						UD	162.42	10.22	2.39	0.69	47.99	12.23
4615	37.3868	37.1380	484	13.8	B	EW	556.63	111.20	24.18	5.78	47.10	31.95
						NS	580.24	75.61	22.11	5.42	46.86	30.79
						UD	658.44	46.61	9.57	2.75	35.99	19.93
4620	37.5857	36.8985	484	41.3	B	EW	313.00	23.79	9.12	2.49	43.89	21.83
						NS	296.32	21.22	5.37	2.21	42.10	20.18
						UD	174.21	9.76	2.33	1.03	46.75	14.72
4624	37.5361	36.9177	280	29.7	C	EW	312.52	44.23	13.68	4.29	45.85	29.28
						NS	339.40	41.39	13.34	3.77	46.05	27.10
						UD	152.14	24.28	4.80	1.06	43.82	14.75
4629	37.2874	36.7887	382	22.5	C	EW	246.73	17.51	3.16	1.34	10.38	8.70
						NS	337.84	27.84	4.61	2.02	9.73	10.41
						UD	121.93	6.47	1.72	0.24	12.53	3.98
4632	37.2560	36.7737	428	24.1	B	EW	282.83	31.60	7.22	1.48	9.90	9.38
						NS	349.34	43.02	8.07	2.09	9.36	10.52
						UD	186.63	11.77	1.91	0.57	12.00	6.11
NAR	37.3919	37.1574		15.4		EW	542.49	66.94	23.60	3.14	44.93	23.35
						NS	627.41	62.44	18.16	3.42	40.48	23.44
						UD	349.40	32.06	11.76	1.70	36.44	16.49



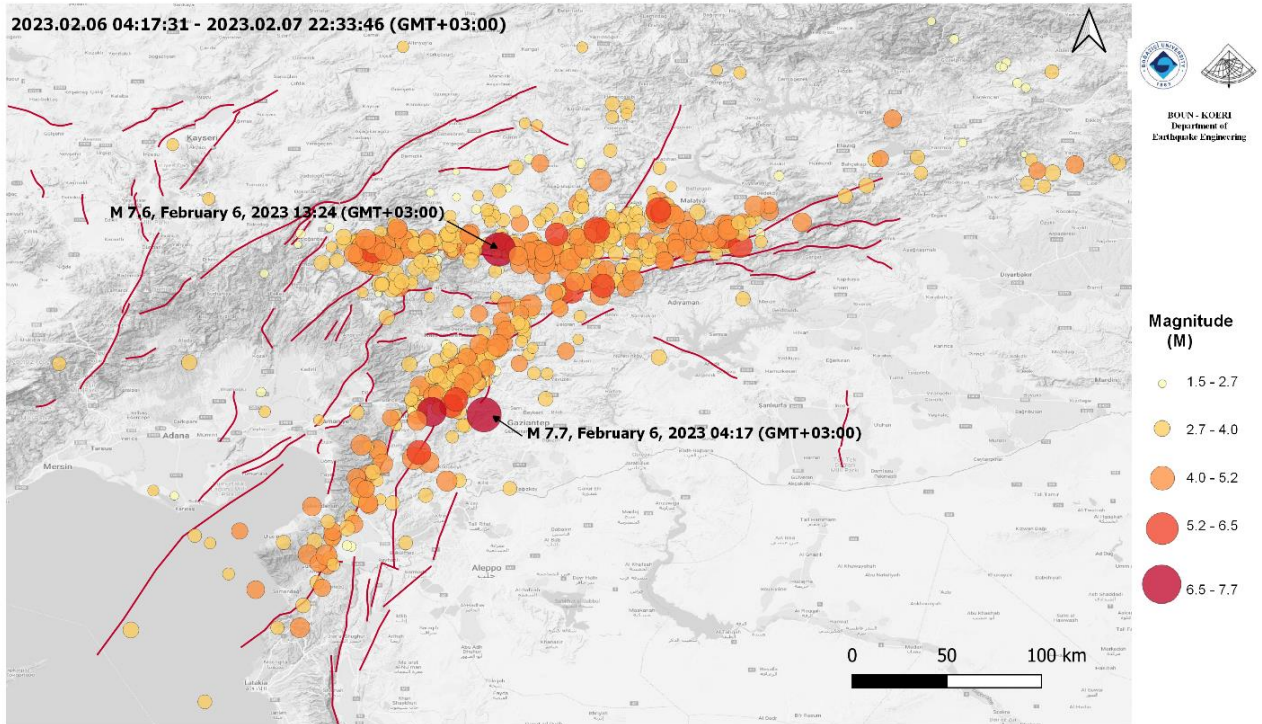
The yellow stars correspond to the epicenters of the M 7.7 Kahramanmaraş – Gaziantep and M 7.6 Ekinözü – Kahramanmaraş Earthquakes occurred on 6 February 2023. AFAD stations are shown with green triangles. Red lines represent the faults compiled from Active Fault Maps of Turkey, MTA (Mineral Research & Exploration General Directorate).



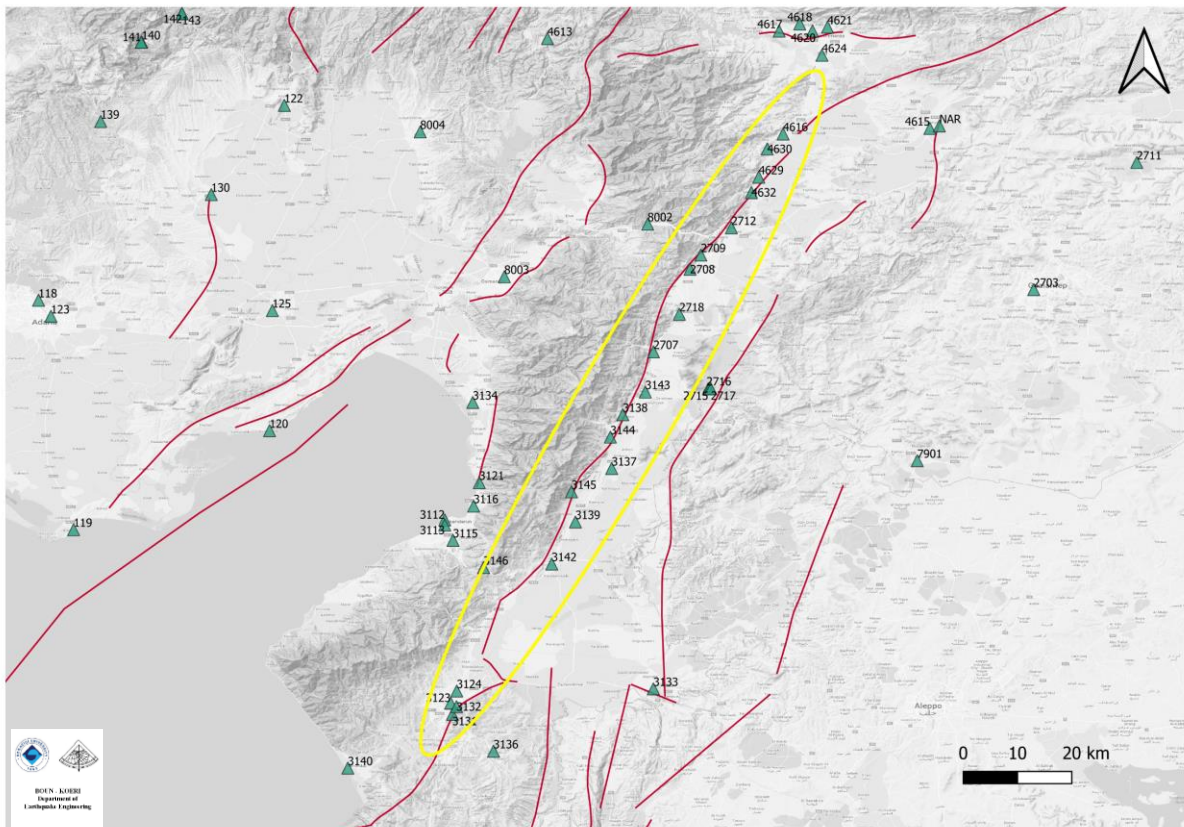
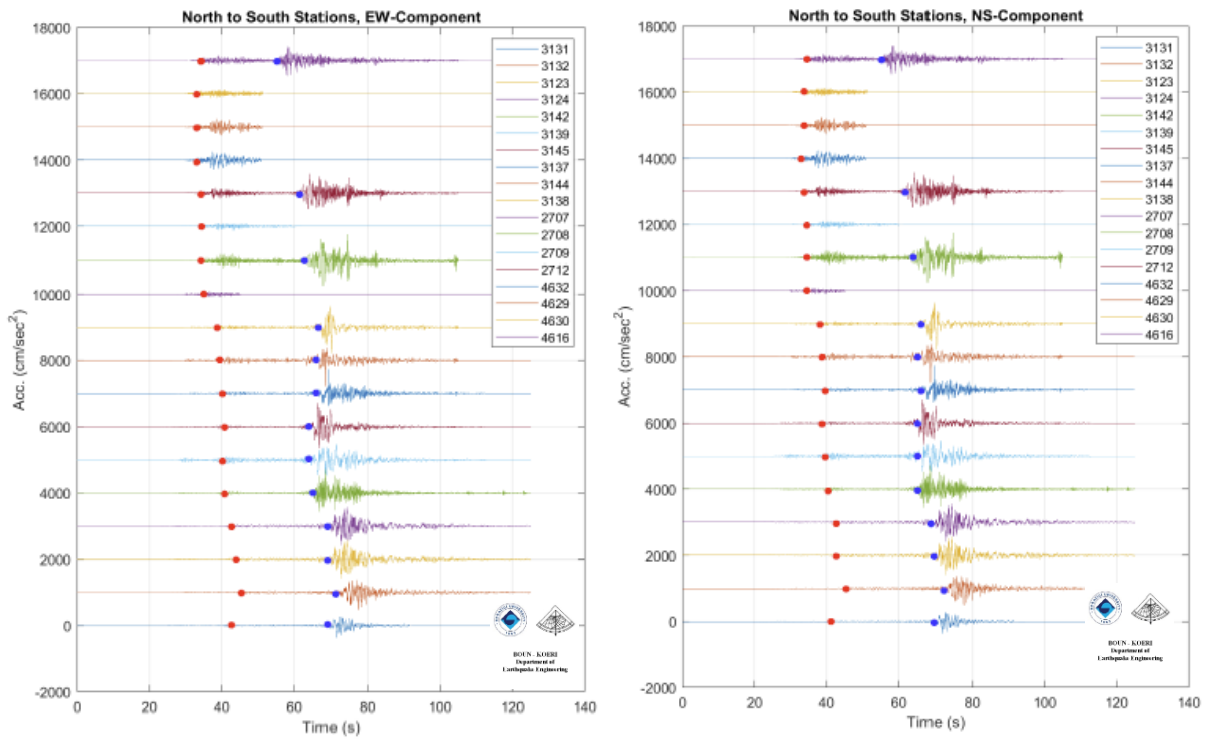
AFAD stations' PGA values from of the M 7.7 Kahramanmaraş – Gaziantep Earthquake. Red lines represent the faults compiled from Active Fault Maps of Turkey, MTA (Mineral Research & Exploration General Directorate).

6 February 2023 (04:17) Kahramanmaraş-Türkiye M7.7 Earthquake

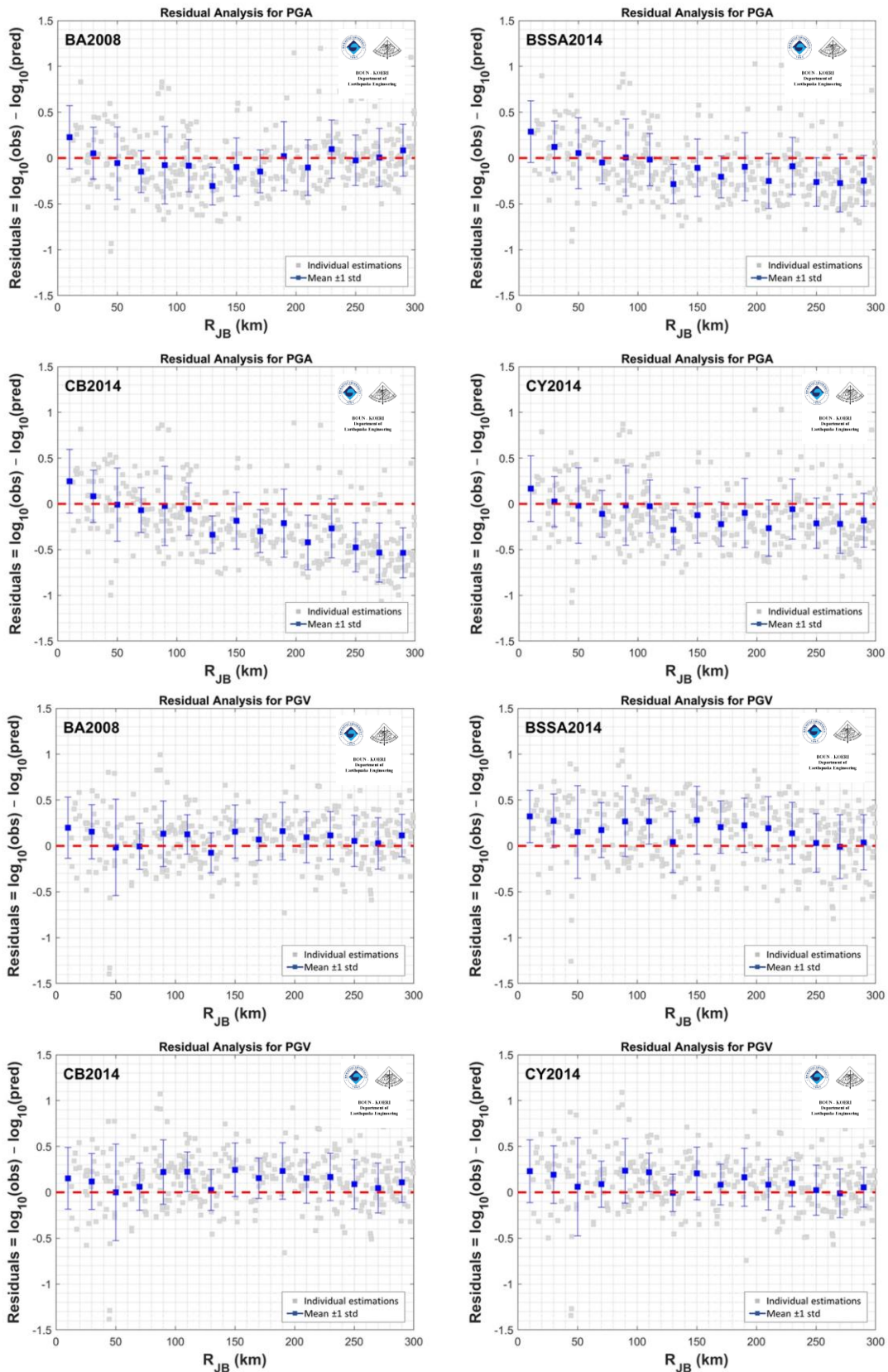
Preliminary Report (v5)



Aftershock activity. Data taken from KOERI (<http://www.koeri.boun.edu.tr/sismo/2/en/>). Red lines represent the faults compiled from Active Fault Maps of Turkey, MTA (Mineral Research & Exploration General Directorate).



Acceleration records of the stations on the Amanos segment (within the yellow ellipse) from SW to NE. Red lines represent the faults compiled from Active Fault Maps of Turkey, MTA (Mineral Research & Exploration General Directorate).



PGA and PGV residual analyses to investigate predictive capacity of four GMPEs for the M7.7, M7.6 and M6.6 (6 Feb 2023) earthquakes.

6 February 2023 (04:17) Kahramanmaraş-Türkiye M7.7 Earthquake

Preliminary Report (v5)

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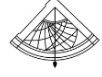
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