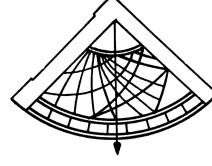




BOĞAZIÇI ÜNİVERSİTESİ
KANDİLLİ
RASATHANESİ VE
DEPREM ARAŞTIRMA
ENSTİTÜSÜ

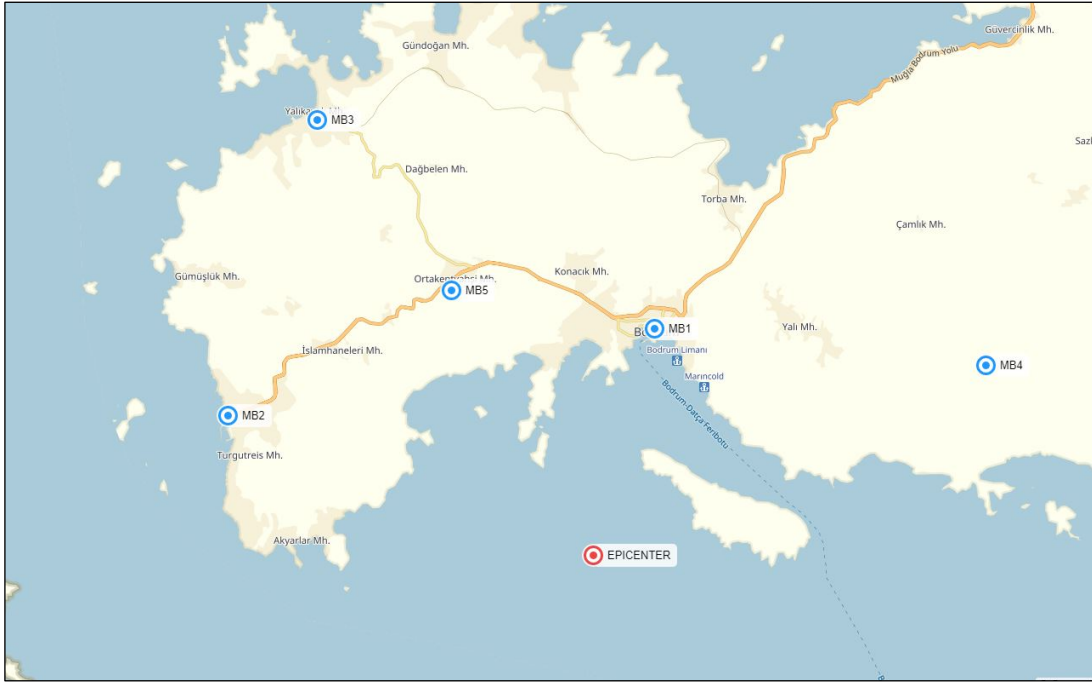


Deprem Mühendisliği Anabilim Dalı

21 TEMMUZ 2017 KOS ADASI - GÖKOVA KÖRFEZİ DEPREMİ İVME KAYITLARI VE ÖZELLİKLERİ

Hakan Alçık, Ahmet Korkmaz, Oktay Çırağ, Erdal Şafak

Kandilli Rasathanesi ve Deprem Araştırma Enstitüsü
Deprem Mühendisliği Anabilim Dalı



21 Temmuz 2017

GİRİŞ

Bodrum yarımadasını etkileyebilecek bir çok deprem kaynağı bulunmaktadır. En etkili de Bodrum'a yakınlığı açısından Gökova graben sistemidir. Bölgede son olarak, Ağustos 2004 ve Ocak 2005 aylarında yoğun deprem aktivitesi gözlenmiştir. Deprem hareketliliğinin yakından izlenmesi, ve bilimsel ve mühendislik çalışmalarına yönelik kaliteli deprem ivme kayıtlarının toplanması amacıyla Mayıs 2015 tarihinde Boğaziçi Üniversitesi BAP projesi desteğiyle Deprem Mühendisliği Anabilim Dalı tarafından Bodrum yarımadasında beş adet kuvvetli yer hareketi kayıt istasyonundan oluşan bir ivmeölçer ağı (Bodrum-Net) kurulmuştur. İstasyonların yerleri Şekil 1 de, koordinatları Tablo 1 de verilmiştir.



Şekil 1 - Bodrum yarımadası ve çevresinde Boğaziçi Üniversitesi, Kandilli Rasathanesi, Deprem Mühendisliği Anabilim Dalı tarafından kurulan istasyonlar.

Tablo 1 - Kuvvetli yer hareketi istasyonlarının koordinatları

İSTASYON NO	ENLEM (N)	BOYLAM (E)	YER
MB001	37.03539	27.42998	Bodrum
MB002	37.00722	27.25756	Turgutreis
MB003	37.10267	27.29374	Yalıkavak
MB004	37.02340	27.56398	Yalı-Çiftlik
MB005	37.04756	27.34774	Ortakent

21 TEMMUZ 2017, M=6.5, KOS ADASI-GÖKOVA KÖRFEZİ DEPREM KAYITLARI

21 Temmuz 2017 tarihinde, yerel saat ile 01:31'de Kos Adası-Gökova körfezi sınır bölgesinde, büyüklüğü Kandilli Rasathanesi ve Deprem Araştırma Enstitüsü (KRDAE) tarafından ML=6.2 (Mw=6.6), derinliği 5 km olarak belirlenen şiddetli bir deprem meydana gelmiştir. Kos adasında ve Bodrum'da kuvvetlice hissedilen bu deprem BodrumNet'in tüm istasyonları tarafından kaydedilmiştir.

Beş istasyonda alınan kayıtlardan hesaplanan maksimum ivme ve hızlar, CAV, CAV5, Arias Intensity, ve Housner's Spektrum Intensity değerleri Tablo 2 de verilmiştir. Yer hareketi parametreleriyle ilgili formüller EK 1 de verilmiştir.

Tablo 2 - Kayıtlardan hesaplanan yer hareketi parametreleri

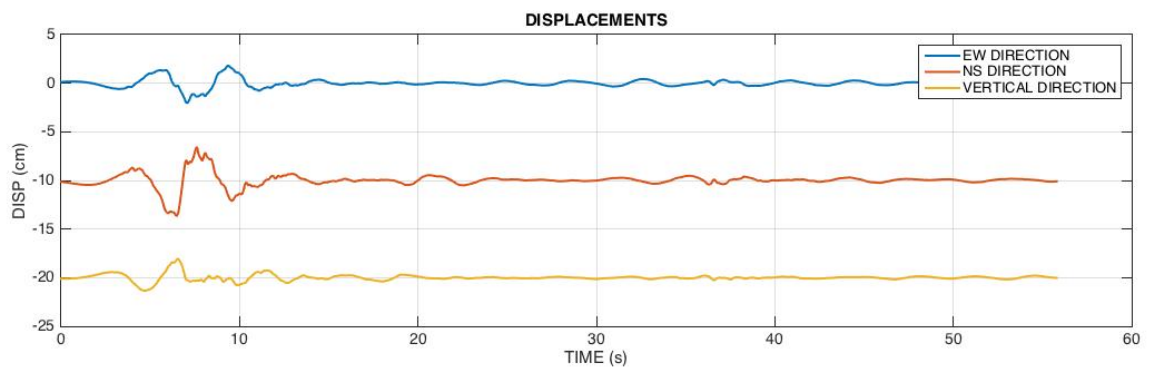
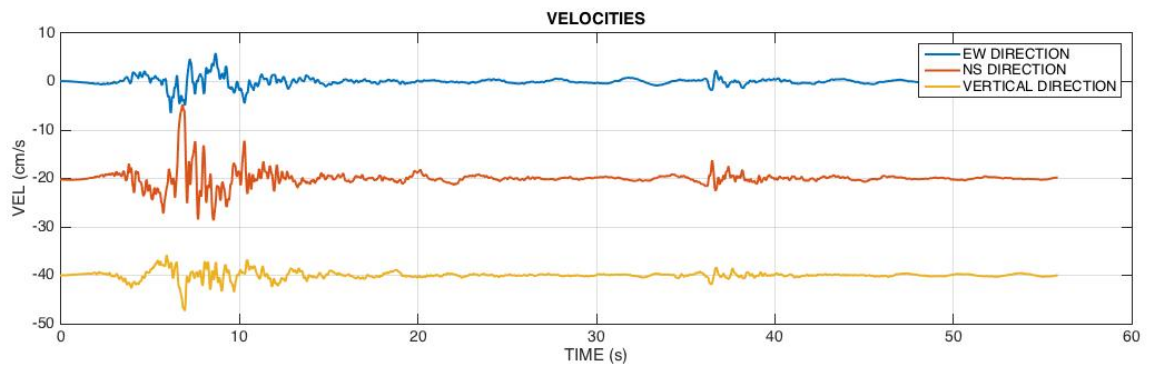
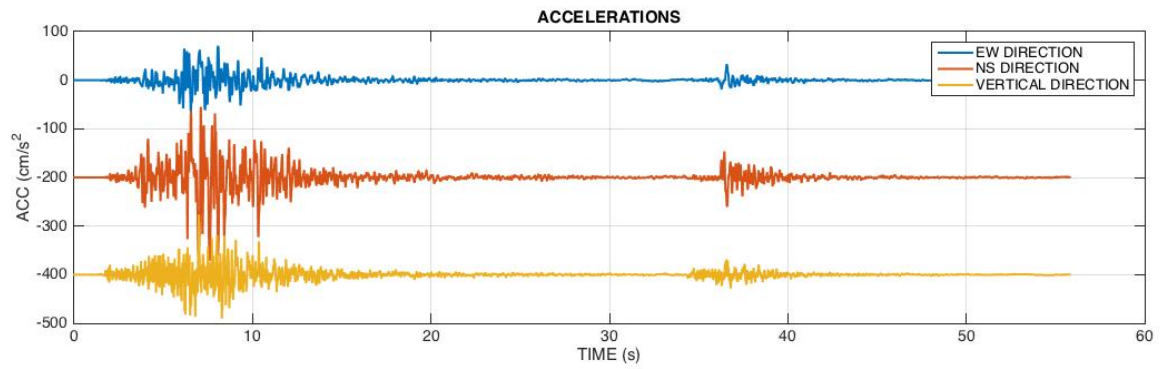
İstasyon No	PGA (cm/s ²)			PGV (cm/s)			CAV (Cum. Abs. Vel.) (cm/s)		
	EW	NS	VER	EW	NS	VER			
1	69.77	175.26	96.37	6.44	15.18	7.25	196.80	419.70	217.80
2	142.61	212.48	97.78	11.94	22.14	5.84	544.76	647.95	255.30
3	173.86	118.94	79.78	11.55	9.10	4.61	617.87	536.30	285.51
4	265.23	295.03	223.60	15.48	22.97	11.66	730.28	739.13	607.96
5	130.48	97.24	73.45	10.51	9.68	4.84	362.75	428.40	238.51

İstasyon No	CAV5 (5% Cum. Abs. Vel.) (cm/s)			Arias Intensity (cm/s)			Spectral (Housner) Intensity (cm)		
				EW	NS	VER	EW	NS	VER
1	144.05	358.94	159.16	5.85	30.17	6.51	6.42	18.92	6.86
2	488.19	588.64	188.51	29.81	62.63	8.39	14.15	28.07	5.28
3	558.66	474.19	229.30	45.24	32.89	10.99	15.52	11.27	4.48
4	668.36	678.13	546.78	87.63	94.45	65.24	16.71	22.75	13.98
5	296.14	364.71	180.09	17.58	19.39	6.02	11.14	9.63	6.07

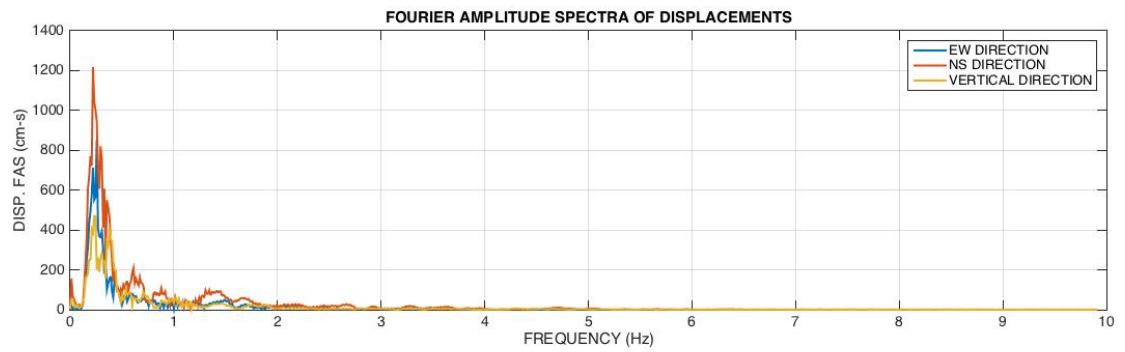
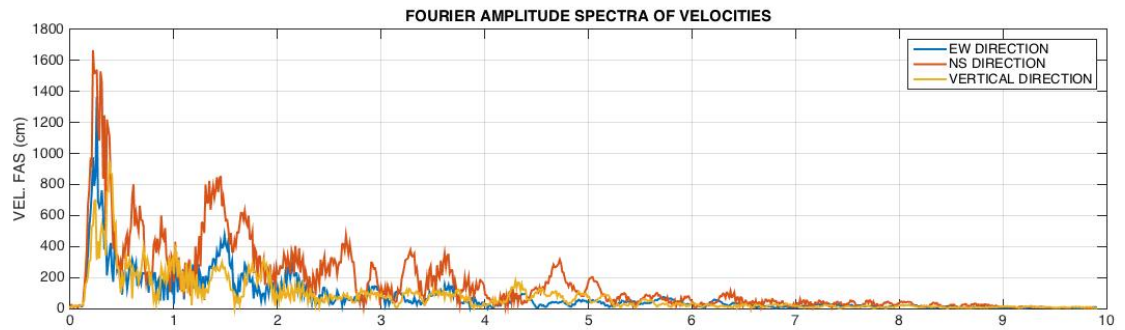
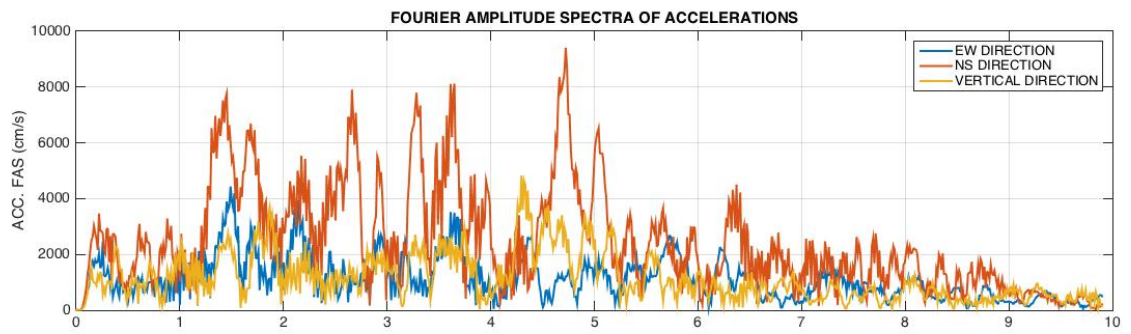
Her istasyon için ölçülen ivmeler, hesaplanan hız ve deplasmanlar, ve her bir kayda karşı gelen Fourier genlik spektrumları, ve tepki spektrumları aşağıdaki şekillerde verilmiştir.

Tablo 2 deki değerler ve aşağıdaki şekiller yer hareketinin impulsive tipte, kuzey-güney yönünde daha etkin, ve düşey yönde de kuvvetli bir hareket olduğunu göstermektedir.

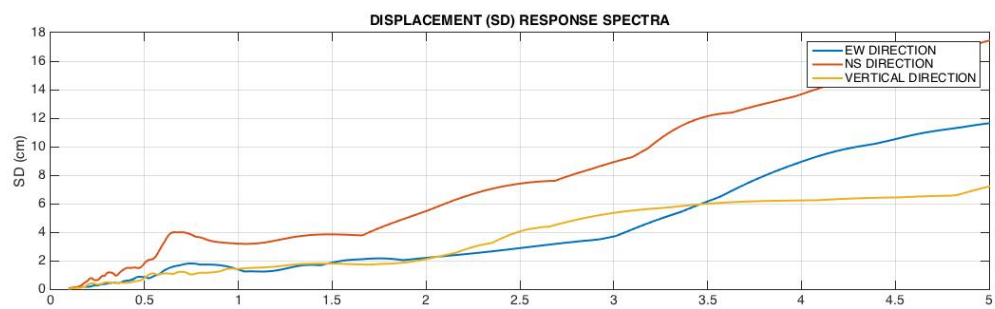
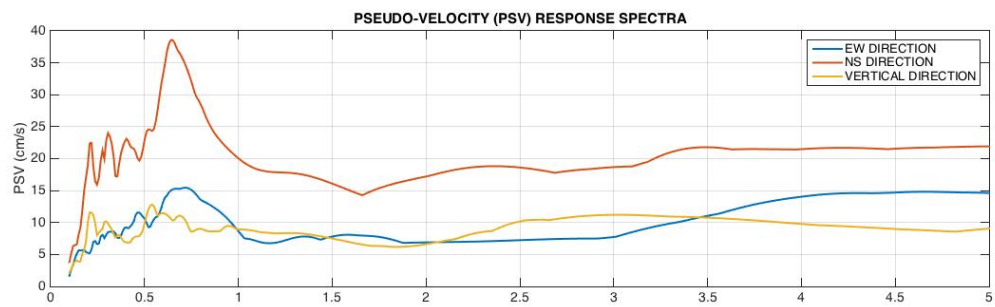
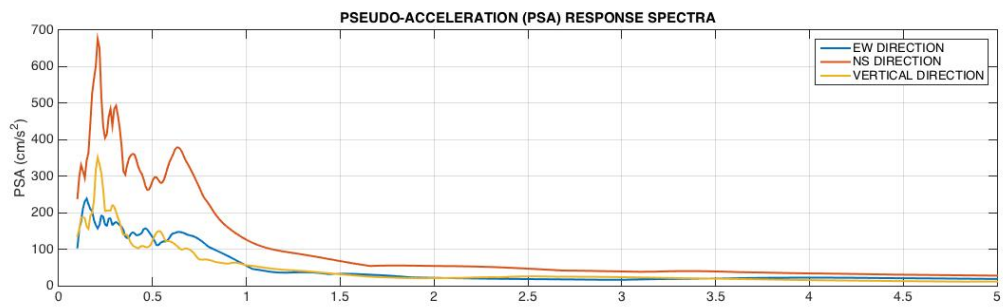
STATION 1



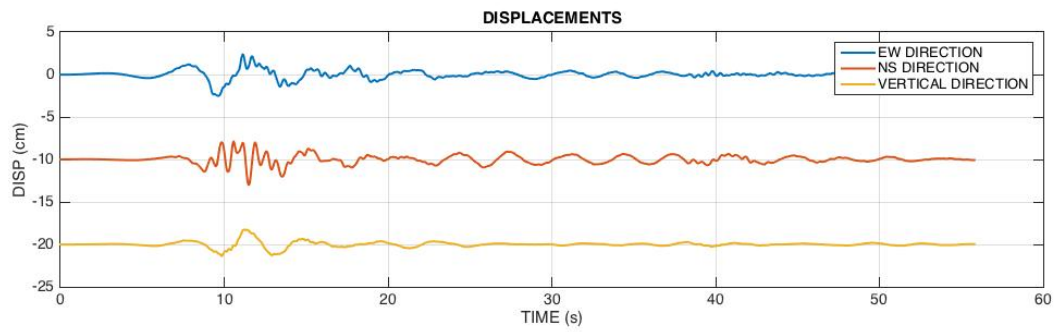
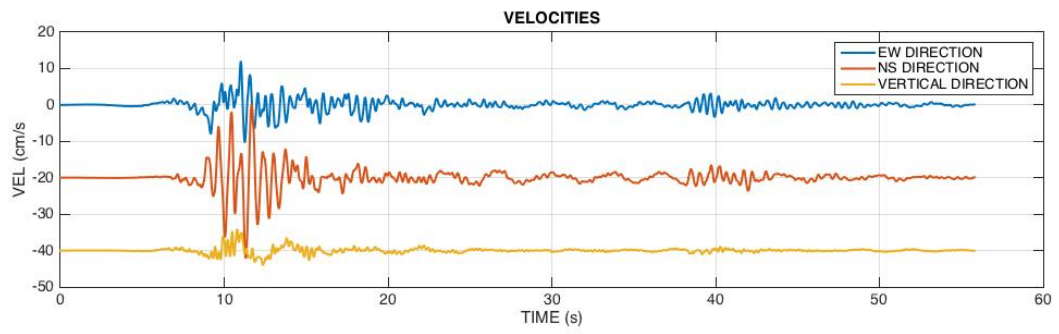
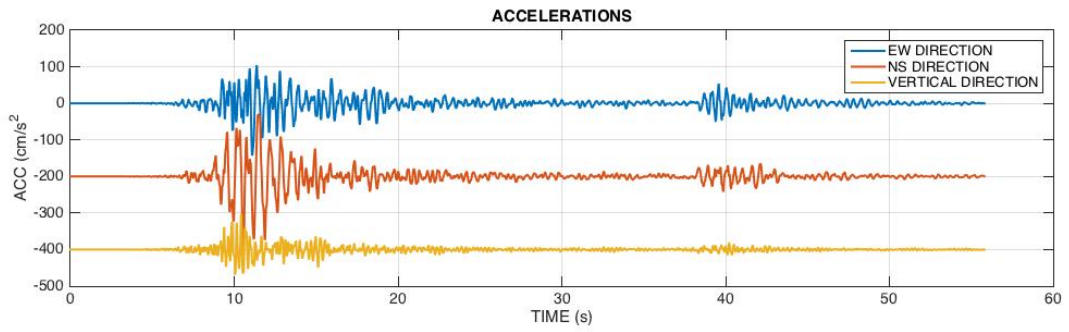
STATION 1



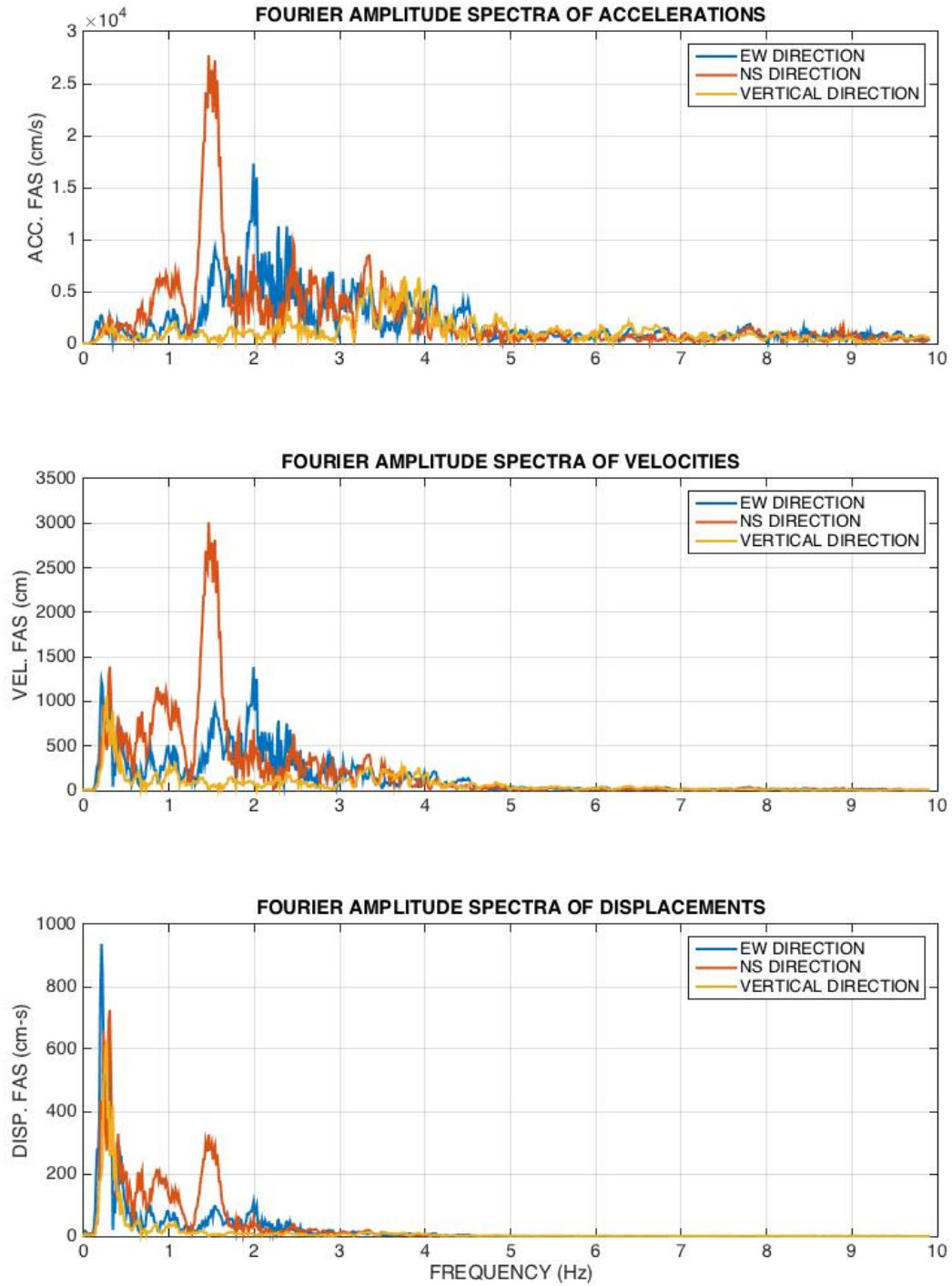
STATION 1



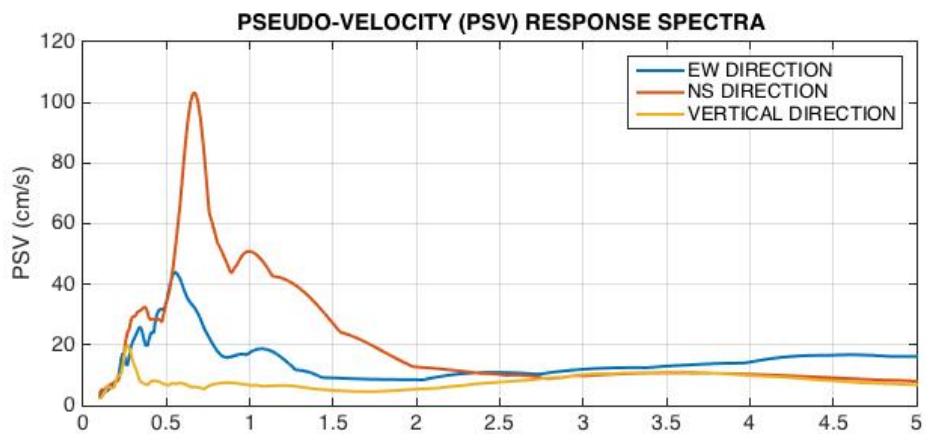
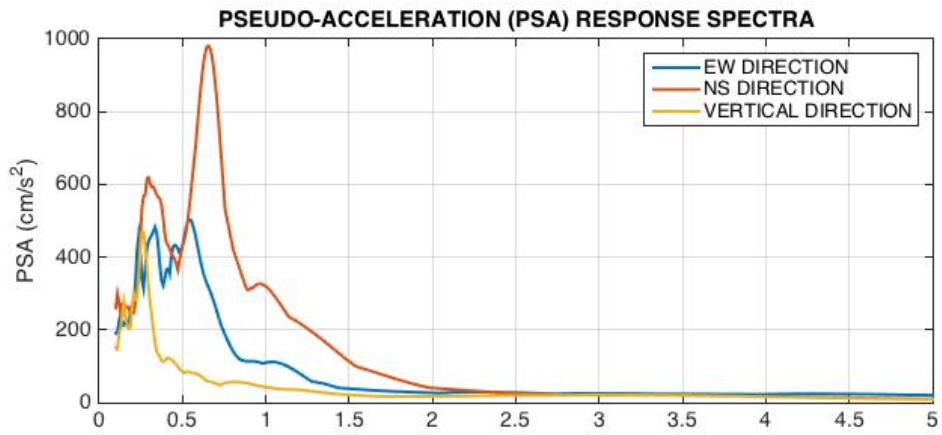
STATION 2



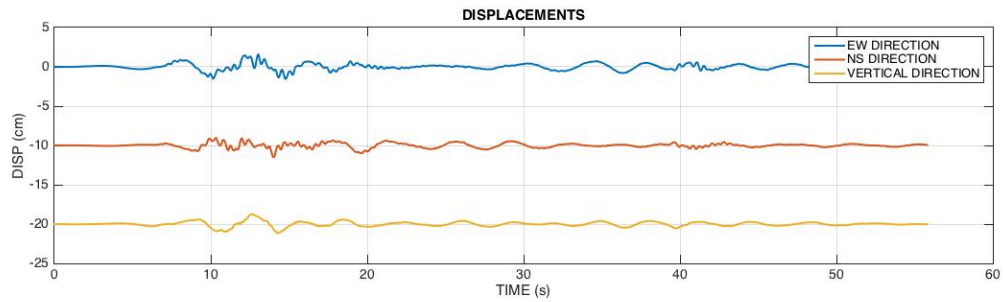
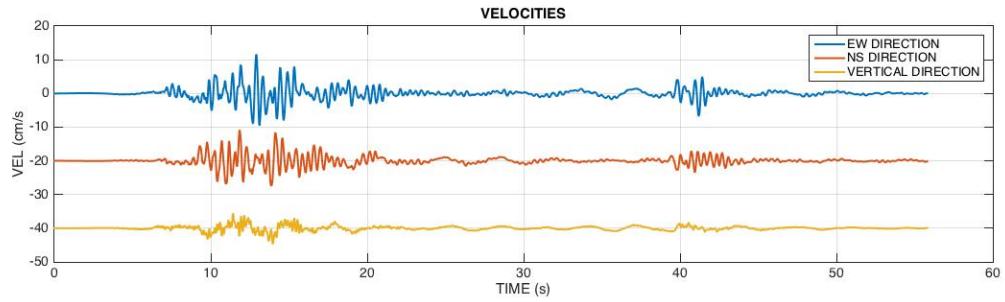
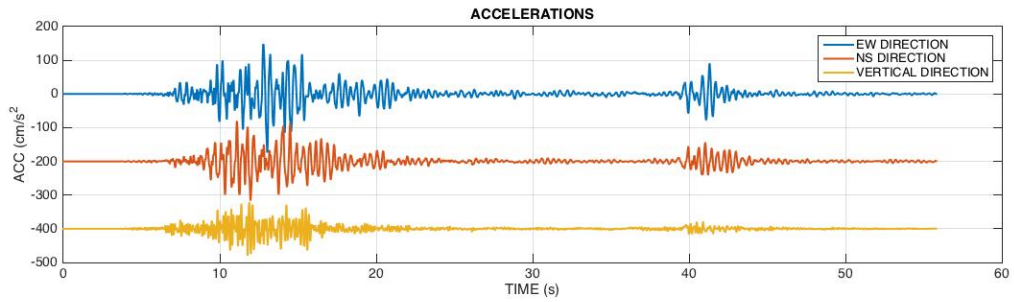
STATION 2



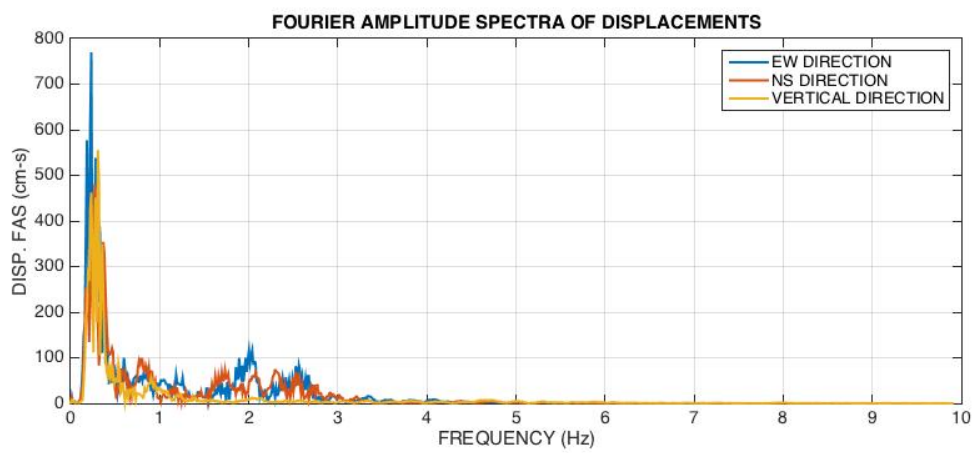
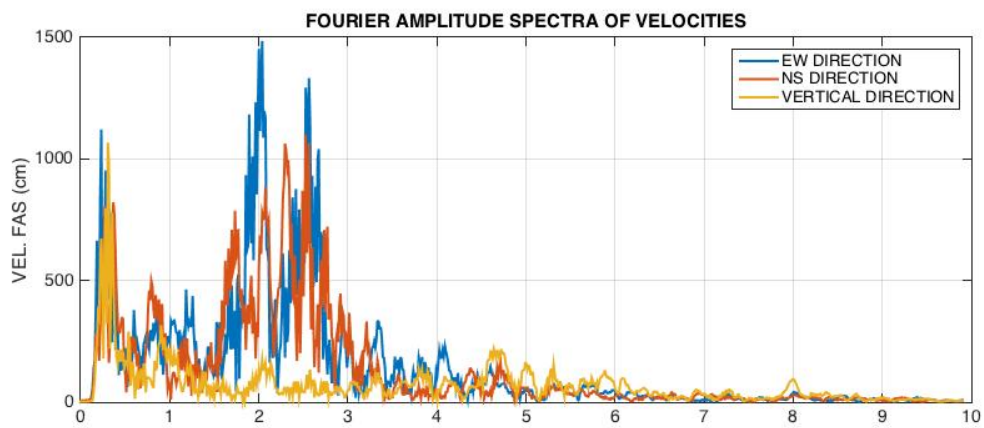
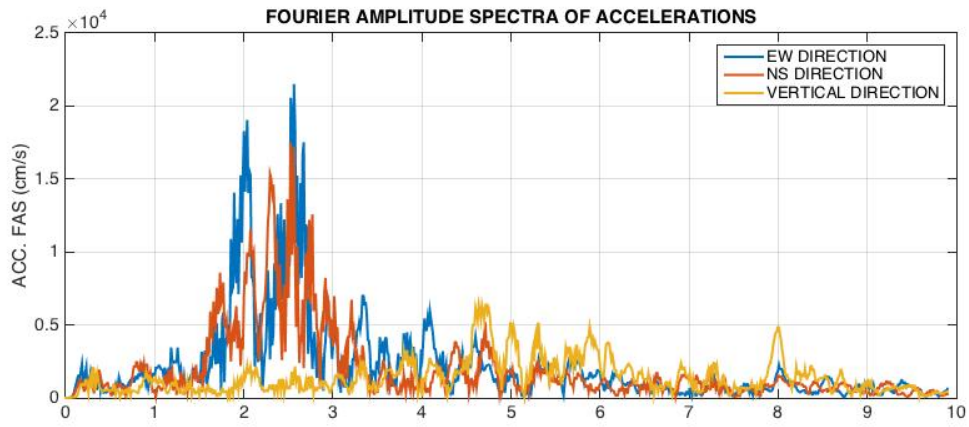
STATION 2



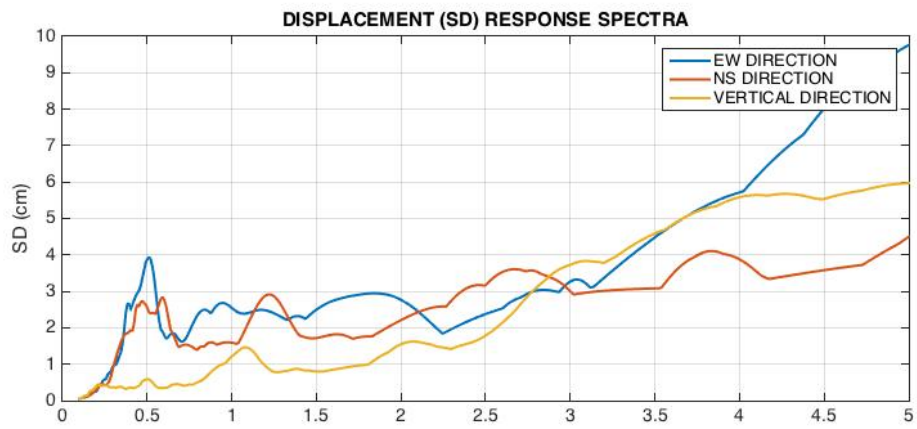
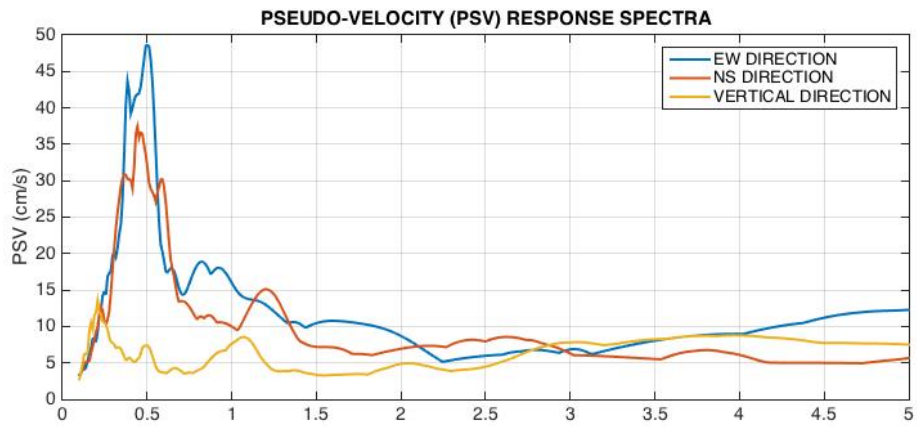
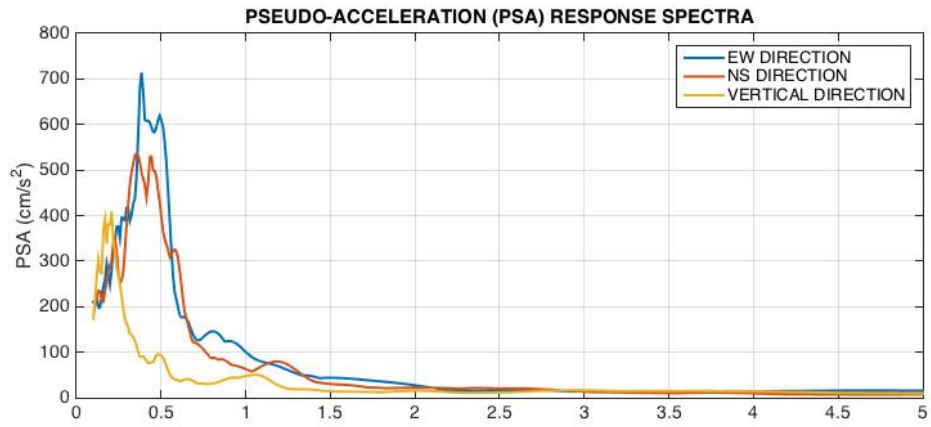
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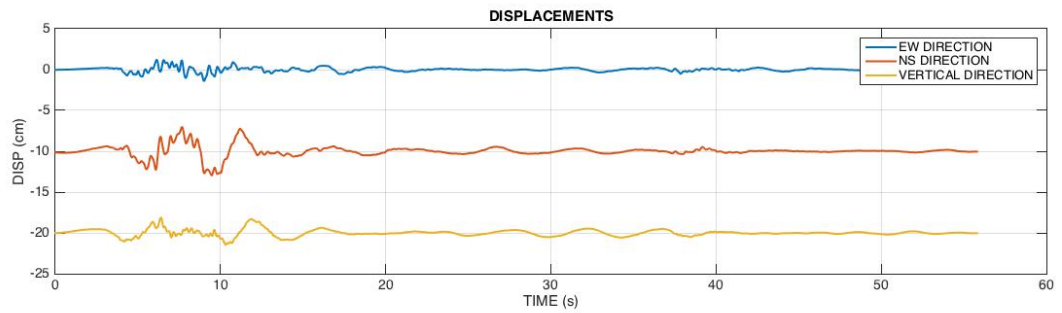
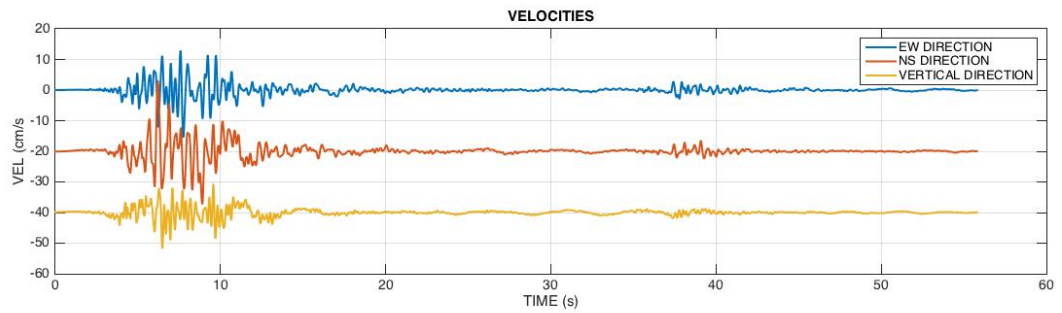
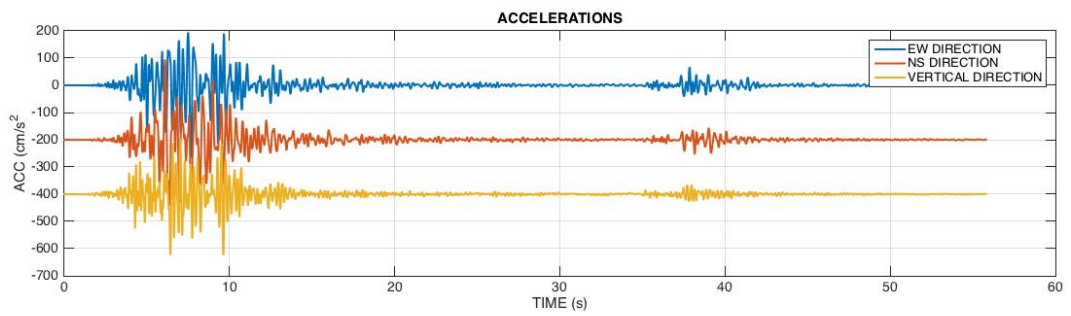
STATION 3



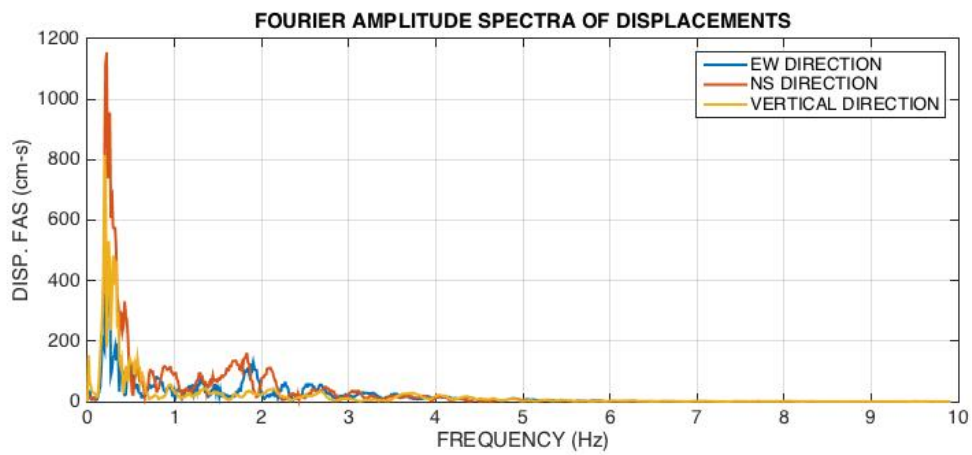
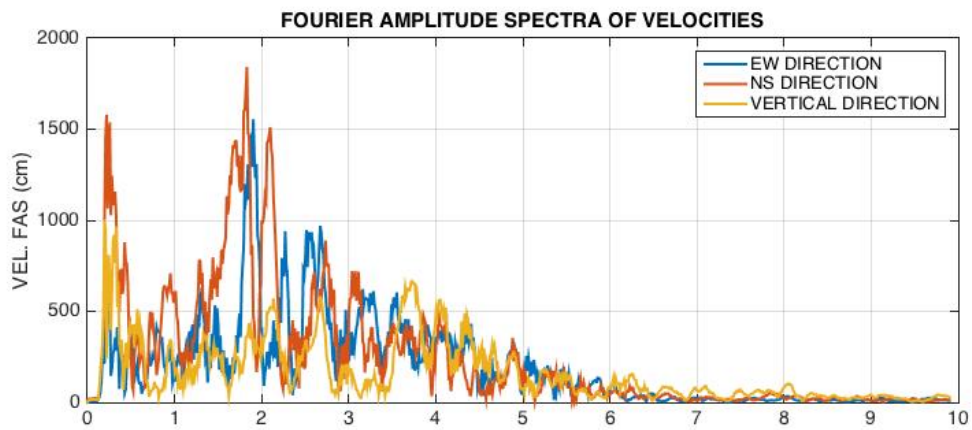
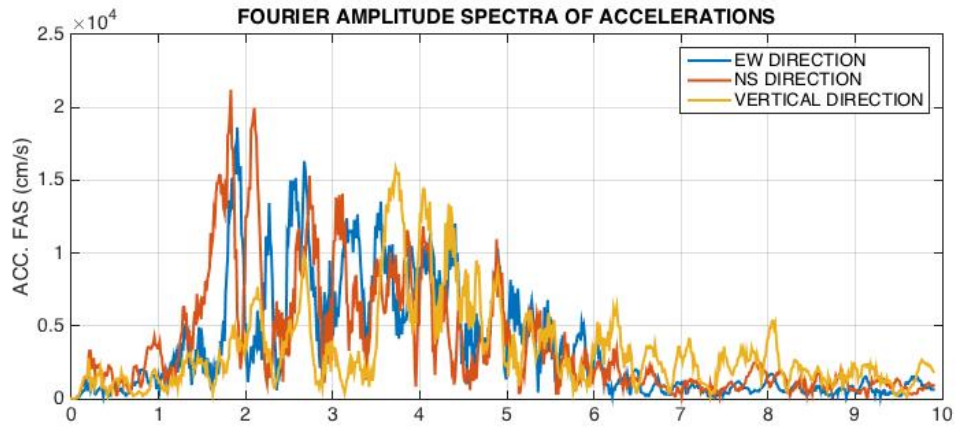
STATION 3



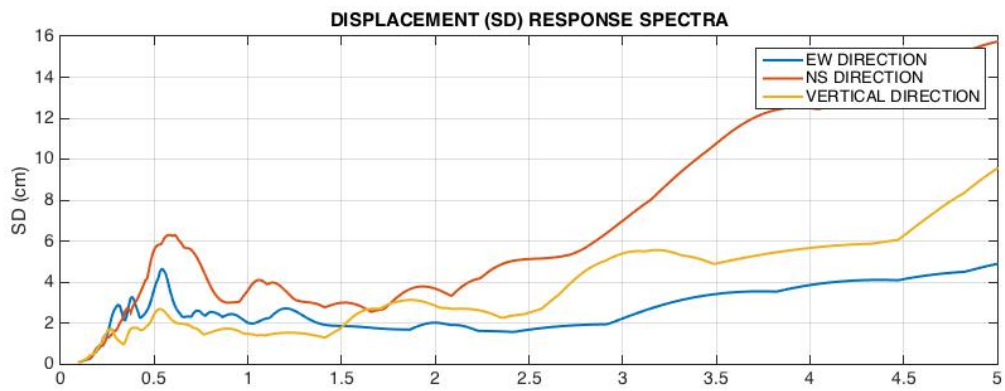
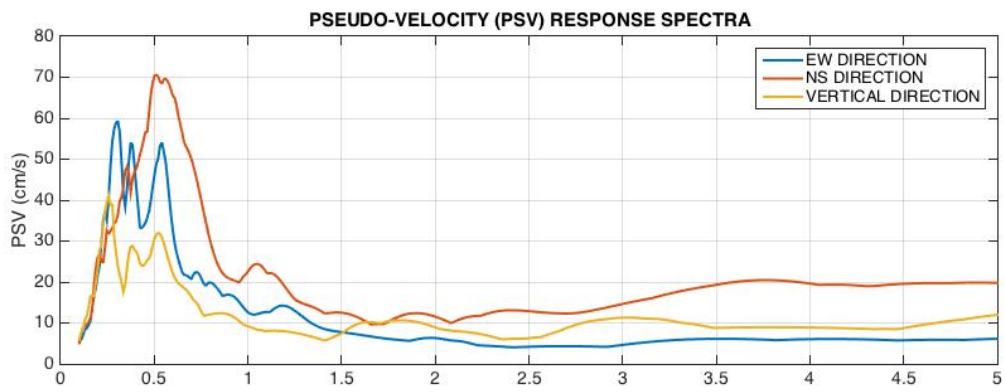
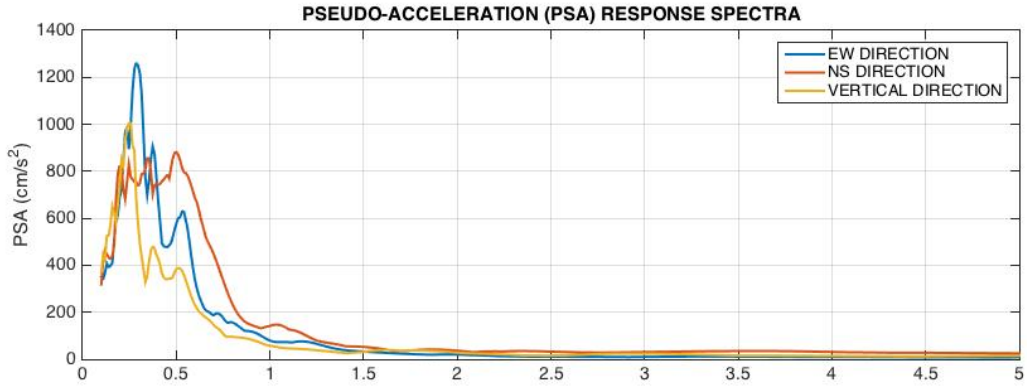
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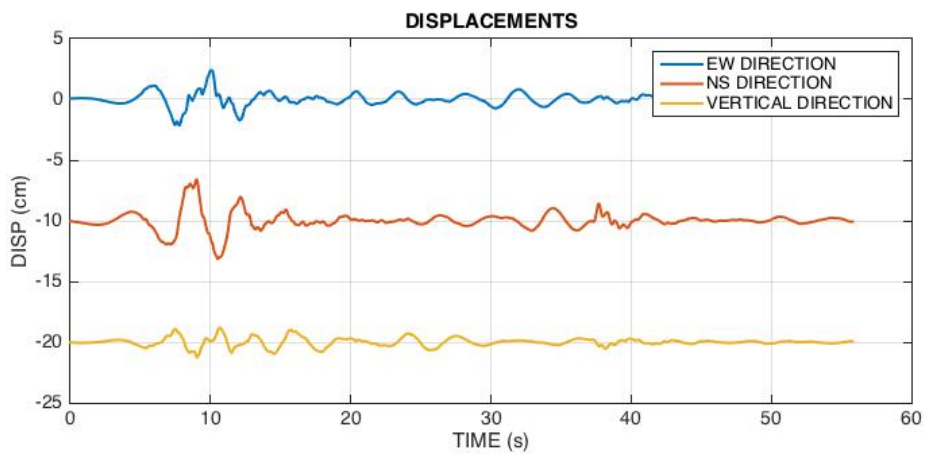
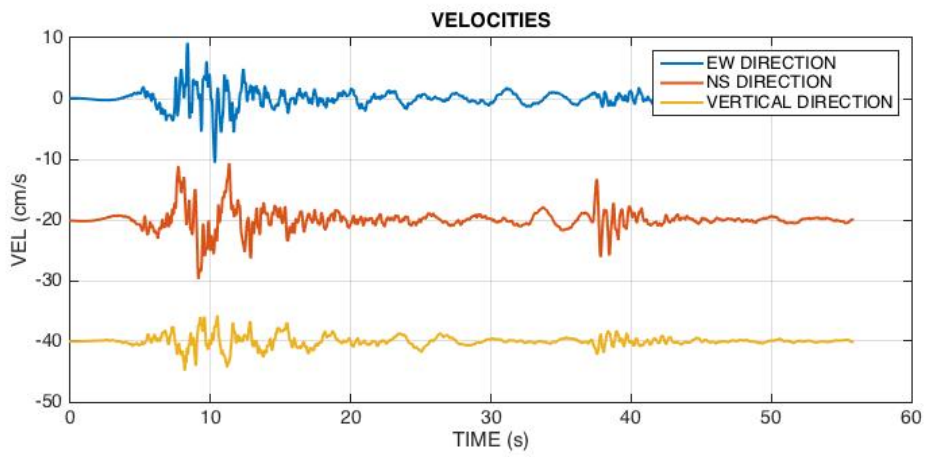
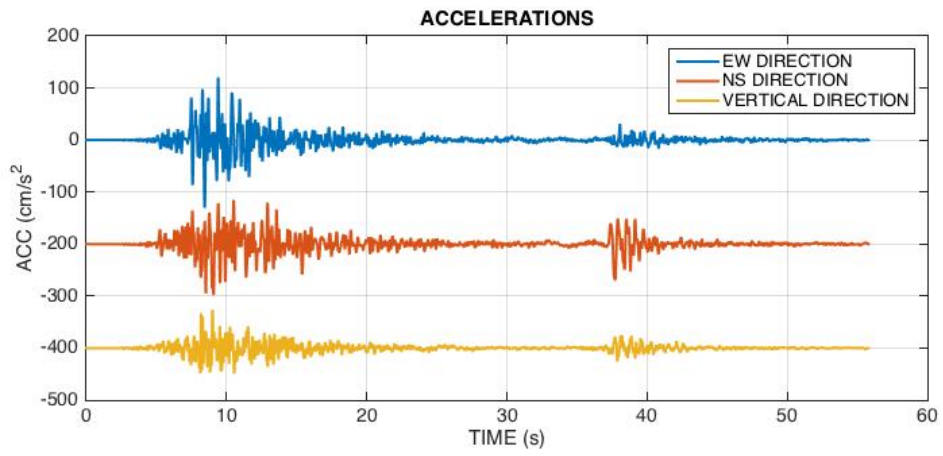
STATION 4



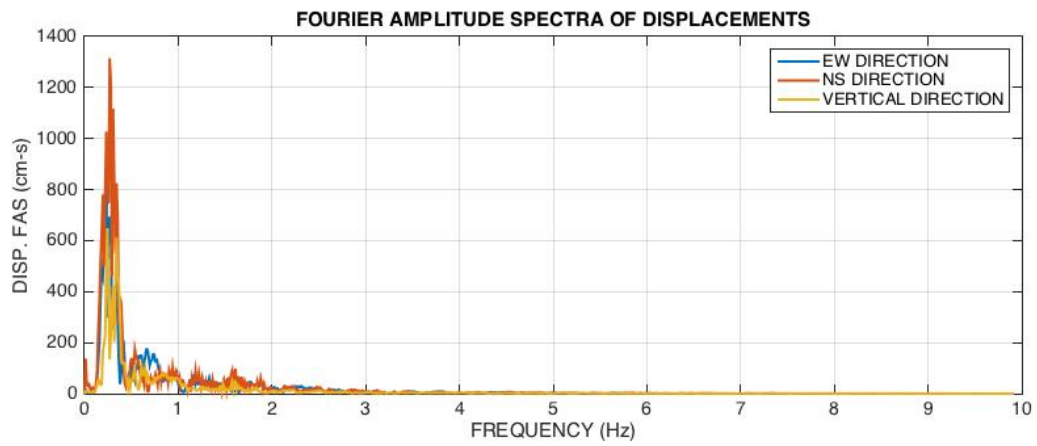
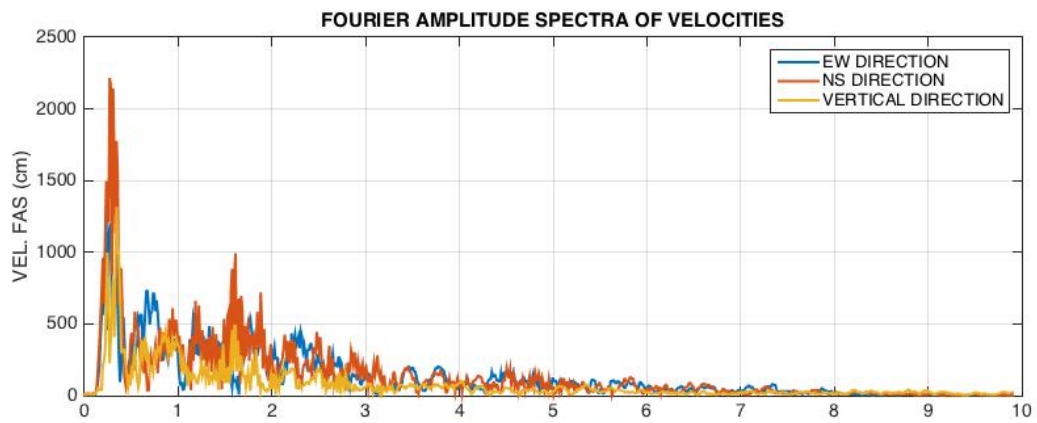
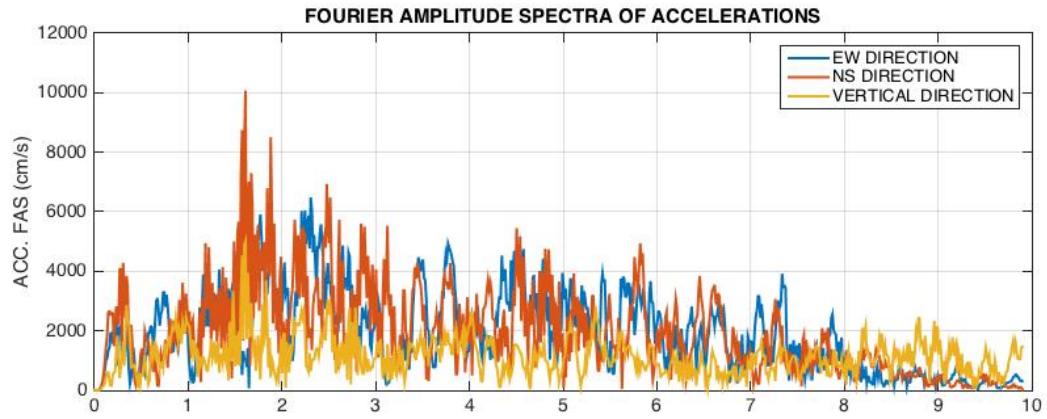
STATION 4



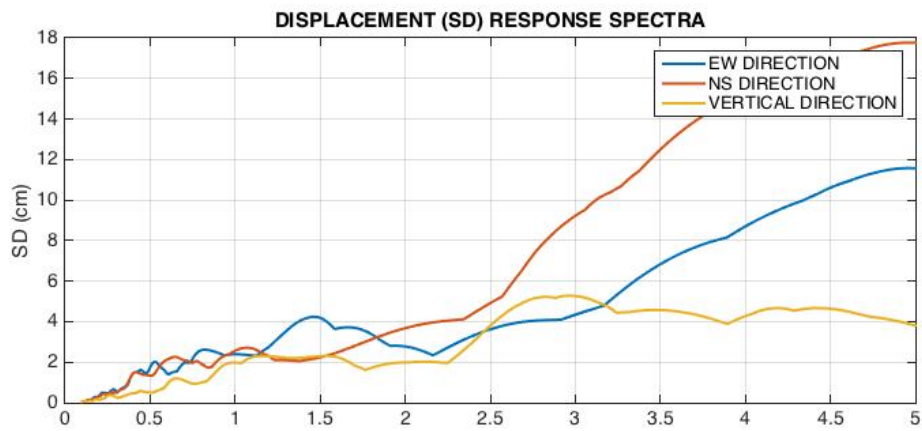
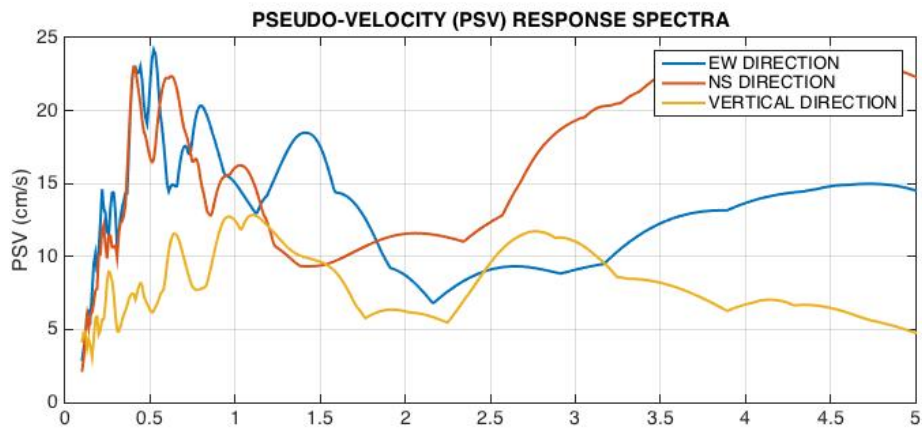
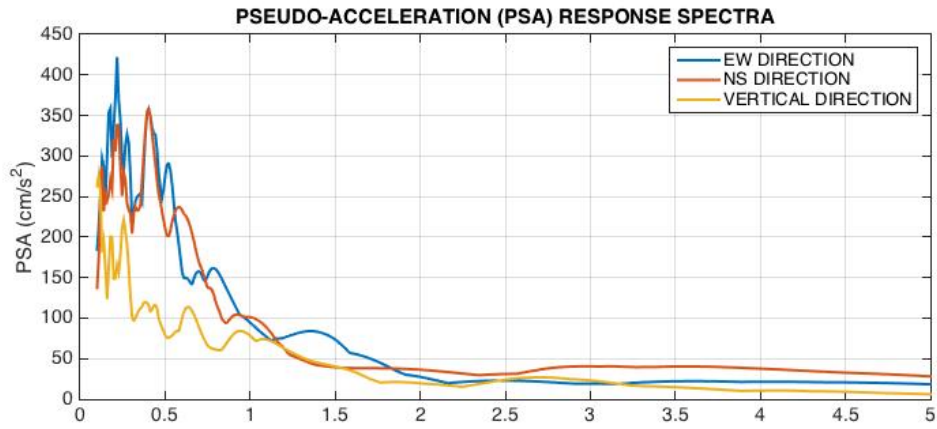
STATION 5



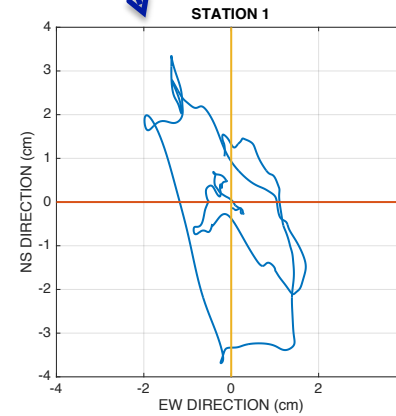
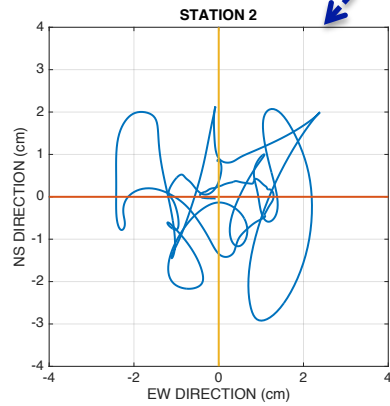
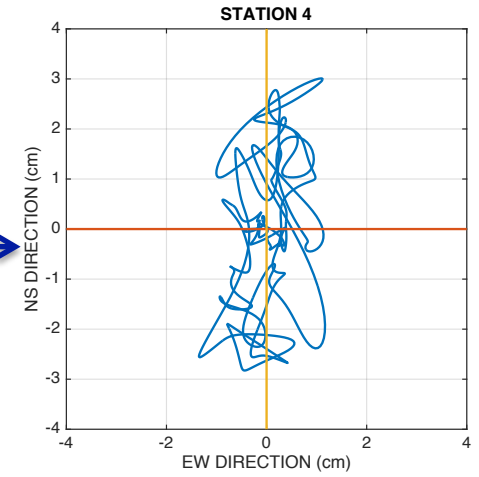
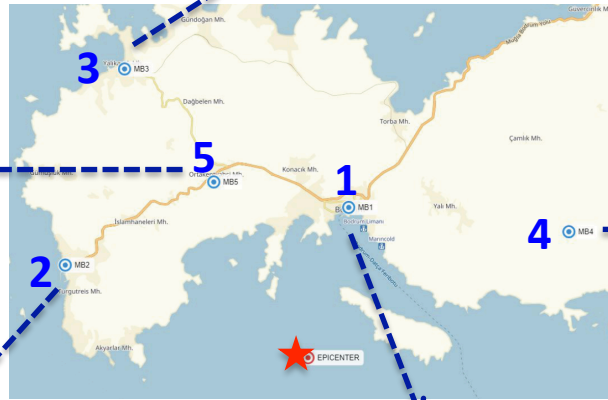
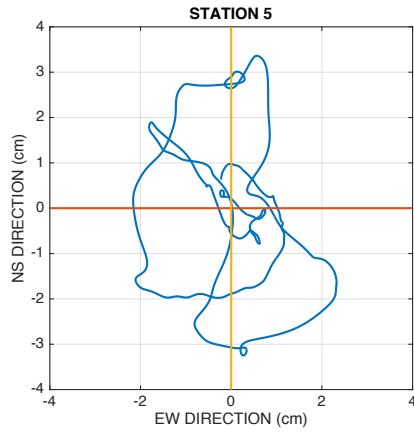
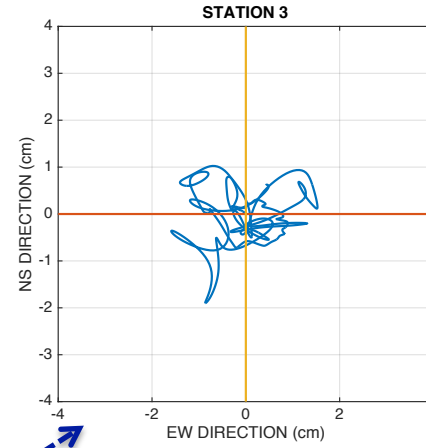
STATION 5



STATION 5



21 TEMMUZ 2017 KOS ADASI - GÖKOVA KÖRFEZİ DEPREMİ
Bodrum-Net stations particle displacements for the strong-motion part
(Note that the axis limits are equal in all figures)



EK-1

GERÇEK-ZAMANLI OLARAK HESAPLANMASI GEREKEN PARAMETRELER

1. **PGA – Peak Ground Acceleration:**

$$PGA(t) = \max_t |a(t)|$$

2. **PGV – Peak Ground Velocity:**

$$PGV(t) = \max_t \left| \int_{s=0}^t a(s) \cdot ds \right|$$

3. **$I_a(t)$ - Arias intensity for ground accelerations $a(t)$:**

$$I_a(t) = \frac{\pi}{2g_0} \int_0^t [a(s)]^2 \cdot ds; \quad g = 981 \text{ cm} / \text{s}^2 \quad (\text{gravitational acceleration})$$

4. **$SI(t)$ – Housner's Spectrum Intensity:**

$$SI(t) = \frac{1}{2.4} \cdot \int_{T=0.1s}^{2.5s} SV(t,T) \cdot dT$$

$SV(t)$ is **Spectral Velocity** at time t of the earthquake, which is the maksimum relative velocity of a 20% damped SDOF (Single-Degree-Of-Freedom) oscillator for a range natural periods between $T=0.1\text{sec}$ to 2.5 sec .

5. **CAV(t) - Cumulative absolute velocity:**

$$CAV(t) = \int_0^t |a(s)| \cdot ds$$

6. **CAV5(t) - Cumulative absolute velocity calculated for absolute accelerations over 5 cm/sec² threshold:**

$$CAV5(t) = \sum_{i=1}^n \int_{t_{i-1\text{sec}}}^{t_i} p \cdot |a(s)| \cdot ds$$

and

$$p = 0 \text{ for } |a(s)| < 5 \text{ cm/sec}^2 ; p = 1 \text{ for } |a(s)| \geq 5 \text{ cm/sec}^2$$

where t is the total duration of the record, $a(s)$ is the acceleration time history in one-second intervals, where at least one value exceeds the acceleration threshold value 5 cm/sec^2 and $i = 1, \dots, n$ denotes the total record length in seconds.

7. **SD(t), PSV(t), PSA(t)- Time-varying Spectral Displacement, Pseudo-Spectral Acceleration, and Pseudo-Spectral Velocity:**

SD(t) is the maximum relative displacement of a 5% damped SDOF (Single-Degree-Of-Freedom) oscillator for a range natural periods T at time t of the earthquake.

PSV(t), PSA(t) are calculated as:

$$PSV(t) = \frac{2\pi}{T} \cdot SD(t) \quad \text{and} \quad PSA(t) = \left(\frac{2\pi}{T} \right)^2 \cdot SD(t)$$