"ACCELEROMETER, VELOCIMETER DENSE-ARRAY, AND ROTATION SENSOR DATASETS FROM THE SINAPS@ POST-SEISMIC SURVEY (CEPHALONIA 2014-2015 AFTERSHOCK SEQUENCE)

Additional information

v. 22/01/2018 – F. Hollender

1 INTRODUCTION

This document provides additional information concerning the dabasets presented in: *"Accelerometer, velocimeter dense-array, and rotation sensor datasets from the Sinaps@ post-seismic survey (Cephalonia 2014-2015 aftershock sequence)"* by Perron V, Hollender F, Mariscal A, Theodoulidis N, Andreou C, Bard P, Cornou C, Cottereau R, Cushing EM, Frau A, Hok S, Konidaris A, Langlaude P, Laurendeau A, Savvaidis A, Svay A (2017), submitted to *"Seismological Research Letters"*.

The overall datasets can be divided in 5 subsets as given in Table 1.

Table 1: Main features of the different event datasets from the Sinaps@ post-seismic survey.

Dataset	Accelerometer	Broadband velocimeter (rock site dense-array)	Rotation sensor		
			ROSA (provided alone)	RORA (provided with velocimeter dense-array data)	ROAN (provided with colocated accelerometer data)
Number of events	4147	1843	421	118	834(2)
Date of the first event	Feb 6, 2014	Feb 6, 2014	Feb 6, 2014	Feb 19, 2014	Mar 11, 2014
Date of the last event	Jul 2, 2015	Mar 10, 2014	Feb 19, 2014	Mar 10, 2014	Jul 28, 2016(2)
Maximum peak value	3.72 m/s² (at ACAN)	3.4 mm/s(1)	2.06 mrad/s	0.23 mrad/s	6.29 mrad/s
Maximum magnitude (M_W)	6.0	4.8(1)	4.8	3.6	6.4(2)

(1) Maximum amplitude limited by velocimeter saturation. (2) Including the period extension using the Argonet data.

These 5 datasets are associated to 5 "flatfiles" in Ascii format (with tab separator) with rather extensive information about source metadata (e.g. source location, time magnitude…), main signal features (e.g. peak value, signal-to-noise ratio…), that may help user to focus on the events that are relevant for their own objectives. These flatfiles are named:

- Sinaps_Postseismic_Accelerometer_DB_flatfile.dat
- Sinaps_Postseismic_VelocimeterDenseArray_DB_flatfile.dat
- Sinaps_Postseismic_RotatioROSA_DB_flatfile.dat

- Sinaps_Postseismic_RotatioRORA_DB_flatfile.dat
- Sinaps_Postseismic_RotatioROAN_DB_flatfile.dat

The 5 datasets are provided in zip files in 3 different formats: SAC, Ascii and Matlab “mat files”.

For example, for the accelerometer dataset: one can choose one of these files:

- Sinaps_Postseismic_Accelerometer_DB_ASC.zip
- Sinaps_Postseismic_Accelerometer_DB_MAT.zip
- Sinaps_Postseismic_Accelerometer_DB_SAC.zip

For the broadband velocimeter dense array:

- Sinaps_Postseismic_VelocimeterDenseArray_DB_ASC.zip
- Sinaps_Postseismic_VelocimeterDenseArray_DB_MAT.zip
- Sinaps_Postseismic_VelocimeterDenseArray_DB_SAC.zip

etc. for the rotation sensor datasets…

Within the SAC and Ascii files headers, we tried to include as much information as possible. The data and metadata through the Matlab “mat file” is provided as a structure (detailed below).

For the SAC format, there is one sub-folder per event (name of the sub-folder corresponding to the event date and hour, eg. 20140206_085354) in which time-histories are stored. One SAC file per component and per station, the name of files being self-consistent in this form:
EventDate_EventHour.StationName.ComponentName.sac, for example: 20140206_085354.ACAN.E.sac

For the Ascii format, there is one sub-folder per event (name of the sub-folder corresponding to the event date and hour, eg. 20140206_085354) in which time-histories are stored. One file per station, all components within a single file per station, the name of files being self-consistent in this form:
EventDate_EventHour.StationName.dat for example: 20140206_091747.ACAN.dat

For the Matlab mat file format, there is no sub-folder, all component sof all signals corresponding to one event are stored in a single mat file. The name of files being self-consistent in this form:
EventDate_EventHour.mat, for example: 20140206_085354.mat

2 FLATFILES CONTENT

2.1 COMMON CONTENT

Here are the columns that are included in all flatfiles:

- Event_ID: a simple ID number of event starting from 1 to the number of event in the dataset per chronological order.
- Folder_Name: the name of the folder (SAC/Ascii format) or of the file (Matlab format) where signals are provided. This name corresponds to the date of the event according to the NOA catalog (or the Karakostas one if the event is not referenced within the NOA catalog).
- Event_date_NOA: date of the event according to the NOA catalog
- Event_Lat_NOA_[°]: Latitude of the event according to the NOA catalog
- Event_Long_NOA_[°]: Longitude of the event accordi ng to the NOA catalog
- Event_Depth_NOA_[km]: Depth of the event according to the NOA catalog

- Event_NOA_ML: Local magnitude event according to the NOA catalog
- Event_NOA_MW: Moment magnitude event according to the NOA catalog (only for strongest events, -9999 if not provided)
- Epicentral_distance_NOA_[km]: Epicentral distance computed according to the NOA catalog location and the ACWP station
- Hypocentral_Distance_NOA_[km]]: Hypocentral distance computed according to the NOA catalog location and the ACWP station
- Angular_distance_NOA_[°]: Angular distance computed according to the NOA catalog location and the ACWP station
- Back_azimuth_NOA_[°]: Back-azimuth computed according to the NOA catalog location and the ACWP station

Note that if the corresponding event is not referenced within the NOA catalog (and thus only the Karakostas catalog), the value “-9999” is affected to previous fields.

The following fields are comparable to the previous ones, but for the Karakostas catalog:

- Event_date_Kar
- Event_Lat_Kar_[°]
- Event_Long_Kar_[°]
- Event_Depth_Kar_[km]
- Event_Kar_MW (note that only moment magnitude are provided in Karakostas catalog)
- Epicentral_distance_Kar_[km]
- Hypocentral_Distance_Kar_[km]
- Angular_distance_Kar_[°]
- Back_azimuth_Kar_[°]

- First_sample_date: date of the first sample of the signals
- Number_of_samples: number of sample within the provided signal files (note that the length is usually higher for large magnitude events)
- Tp_[s]: picking of the arrival time of the P wave, expressed in second with respect to the first sample of the recording.
- Ts_[s]: picking of the arrival time of the S wave expressed in second with respect to the first sample of the recording.

Important notes: 1/ in some cases, several events can be seen on the same time history (sometime with even higher amplitude motions than the event of interest) so the Tp and Ts info are important in order to well identify in time history the event that are characterized by the corresponding earthquake metadata. 2/ The picking is done to identify the different signal phase but does not attend to be used for relocation. If you want to use these datasets for such relocation work, we invite you to pick arrival times by yourself.

2.2 SPECIAL CONTENT FOR ACCELEROMETRIC DATASET

- Is_ACWP: boolean indicating if station ACWP recorded (1) or not (0) the corresponding event
- Is_ACAN: boolean indicating if station ACAN recorded (1) or not (0) the corresponding event
- Is_ACIN: boolean indicating if station ACIN recorded (1) or not (0) the corresponding event

- Is_ACSI: boolean indicating if station ACSI recorded (1) or not (0) the corresponding event
- Is_ACVV: boolean indicating if station ACVV recorded (1) or not (0) the corresponding event
- ACWP_rawPGA_[cm/s/s]: PGA at ACWP measured on "raw" (unfiltered) data
- ACAN_rawPGA_[cm/s/s]: PGA at ACAN measured on "raw" (unfiltered) data
- ACIN_rawPGA_[cm/s/s]: PGA at ACIN measured on "raw" (unfiltered) data
- ACSI_rawPGA_[cm/s/s]: PGA at ACSI measured on "raw" (unfiltered) data
- ACVV_rawPGA_[cm/s/s]: PGA at ACVV measured on "raw" (unfiltered) data
- ACWP_filtPGA_[cm/s/s]: PGA at ACWP measured on pass-band filtered [1–20] Hz data
- ACAN_filtPGA_[cm/s/s]: PGA at ACAN measured on pass-band filtered [1–20] Hz data
- ACIN_filtPGA_[cm/s/s]: PGA at ACIN measured on pass-band filtered [1–20] Hz data
- ACSI_filtPGA_[cm/s/s]: PGA at ACSI measured on pass-band filtered [1–20] Hz data
- ACVV_filtPGA_[cm/s/s]: PGA at ACVV measured on pass-band filtered [1–20] Hz data

2.3 SPECIAL CONTENT FOR VELOCIMETER DENSE ARRAY DATASET

- flag_possible_saturation: boolean indicating if there is a suspicion of saturation (1) or not (0). **Some events show evident strong saturation, but we chose to keep all the data within the dataset, but users must be aware about this saturation issue and ensure by themselves if the data they are using are relevant for their own analysis**.
- flag_only_20_stations: boolean indicating if there is only 20 operating stations (1) instead of 21 stations (0) out of the total array of 21 stations.
- Missing_station_name: name of the possible missing station
- B0R0_rawPGV_[mm/s]: PGV at B0R0 station (central one) measured on "raw" (unfiltered) data
- B0R0_filtPGV_[mm/s]: PGV at B0R0 station (central one) measured on pass-band filtered [1–20] Hz data
- SNR: signal to noise ratio measured at B0R0 station (central one) (ratio of PGV values measured on signal and on noise before the event on pass-band filtered [1–10] Hz data).

2.4 SPECIAL CONTENT FOR ROSA DATASET

- ROSA_rawPGR_[rad/s]: PGR at ROSA station measured on "raw" (unfiltered) data
- ROSA_filtPGR_[rad/s]: PGR at ROSA station measured on measured on pass-band filtered [1–20] Hz data
- SNR: signal to noise ratio measured at ROSA station (ratio of PGR values measured on signal and on noise before the event on pass-band filtered [1–10] Hz data)

2.5 SPECIAL CONTENT FOR RORA DATASET

- flag_only_20_stations: boolean indicating if there is only 20 operating stations (1) instead of 21 stations (0) out of the total array of 21 velocimeter array stations (the RORA dataset being provided with both rotation sensor data and velocimeter dense array data).
- Missing_station_name: name of the possible missing station
- RORA_rawPGR_[rad/s]: PGR at RORA station measured on "raw" (unfiltered) data
- RORA_filtPGR_[rad/s]:]: PGR at RORA station measured on measured on pass-band filtered [1–20] Hz data
- B0R0_rawPGV_[m/s]: PGV at B0R0 station (central one) measured on "raw" (unfiltered) data

- B0R0_filtPGV_[m/s]: PGV at B0R0 station (central one) measured on pass-band filtered [1–20] Hz data
- SNR: signal to noise ratio measured at RORA station (ratio of PGR values measured on signal and on noise before the event on pass-band filtered [1–10] Hz data)

2.6 SPECIAL CONTENT FOR ROAN DATASET

- ROAN_rawPGR_[rad/s]: PGR at ROAN station measured on “raw” (unfiltered) data
- ROAN_filtPGR_[rad/s]: PGR at ROAN station measured on measured on pass-band filtered [1–20] Hz data
- ACAN_rawPGA_[m/s/s]: PGA at ACAN measured on “raw” (unfiltered) data
- ACAN_filtPGA_[m/s/s]: PGA at ACAN measured on pass-band filtered [1–20] Hz data
- SNR: signal to noise ratio measured at ROAN station (ratio of PGR values measured on signal and on noise before the event on pass-band filtered [1–10] Hz data)

3 DESCRIPTION OF THE MATLAB MAT FILES

The data provided in the Matlab “*.mat” format are stored in a structure form that can be loaded using this command (for example):

```
data_struc=load('20140206_085354.mat');
```

All data, metadata also stored in flatfile as well as few other information are available in this structure.

In all datasets, you will find this following information concerning the source metadata. Here, the associated example values are from the first event of the ROSA rotation sensor dataset.

data_struc.eventdate_NOA: '2014-02-06 08:53:54.800'
→Date of the event in string format according to the NOA catalog.

data_struc.eventdatenum_NOA: 7.3564e+05
→Date of the event according to the NOA catalog within the Matlab serial date number format.

data_struc.eventLat_NOA: 38.1945

data_struc.eventLon_NOA: 20.3495

data_struc.eventDepth_NOA: 8.3000
→Latitude, Longitude and Depth (respectively expressed in [°], [°] and [km]) according to the NOA catalog

data_struc.eventML_NOA: 3.1000
→Local magnitude event according to the NOA catalog

data_struc.eventMW_NOA: -9999
→Moment magnitude event according to the NOA catalog (only for strongest events, -9999 if not provided)

data_struc.Rhypo_NOA: 16.3926
→Epicentral distance (in [km]) computed according to the NOA catalog location and one given station (ACWP for accelerometric dataset, the rotation sensor for rotation datasets and B0R0 for the dense array dataset).

data_struc.Repi_NOA: 14.1360
→Hypocentral distance (in [km]) computed according to the NOA catalog location and one given station (ACWP for accelerometric dataset, the rotation sensor for rotation datasets and B0R0 for the dense array dataset).

data_struc.RepiAngu_NOA: 0.1272

→Angular distance (in [°]) computed according to the NOA catalog location and one given station (ACWP for accelerometric dataset, the rotation sensor for rotation datasets and B0R0 for the dense array dataset).

data_struc.BackAz_NOA: 283.8298

→ Back-azimuth (in [°]) computed according to the NOA catalog location and one given station (ACWP for accelerometric dataset, the rotation sensor for rotation datasets and B0R0 for the dense array dataset).

data_struc.eventdate_Kar: '2014-02-06 08:53:54.680'

data_struc.eventdatenum_Kar: 7.3564e+05

data_struc.eventLat_Kar: 38.1870

data_struc.eventLon_Kar: 20.3430

data_struc.eventDepth_Kar: 7.3900

data_struc.eventMW_Kar: 3.3000

data_struc.Rhypo_Kar: 16.2943

data_struc.Repi_Kar: 14.5221

data_struc.RepiAngu_Kar: 0.1307

data_struc.BackAz_Kar: 280.1047

→ Same fields according to the Karakostas et al. 2015 catalog.

In all datasets, you will find this following information concerning the stations and the signals. Here, the associated example values are from the first event of the ROAN rotation sensor dataset.

data_struc.site: {'ROAN' 'ACAN'}

→Name of the stations that provided validated signal for this event**, the order is important for the sorting of data within the structure**. Note that one given station is not always at the same position when signals of some stations are missing, so identify the right place of a given station before using them!

data_struc.siteLatWGS84: [38.1642 38.1642]

data_struc.siteLonWGS84: [20.5062 20.5062]

→ Latitude and longitude of the stations in WGS84 system with respect to the order given in data_struc.site

data_struc.siteElev: [2.3000 2.3000]

→Elevation of the stations with respect to the order given in data_struc.site

data_struc.recorddate: '2014-03-11 13:52:30.000'

→ Date of the first sample of the signals in "string" format

data_struc.recorddatenum: 7.3567e+05

→ Date of the first sample of the signals in Matlab serial number date format

data_struc.N: [48001×2 single]

data_struc.E: [48001×2 single]

data_struc.Z: [48001×2 single]

→ Data themselves in physical units (as given in data_struc.unit) for the North-South (N), East-West (E) and Up-Down (Z) components. Data from the first site given in data_struc.site are sorted within the first column; data for the second site given in data_struc.site are sorted within the second column, etc.

data_struc.unit: {'rad/s' 'm/s²'}

→ Unit of the data (here, for the ROAN rotation sensor dataset, there are two different units) .

data_struc.fs: 200

→ Sampling frequency of data.

data_struc.Tp: 119.1100

data_struc.Ts: 121.1200

→ Picking of the arrival time of the P wave (Tp) and the S wave (Ts), expressed in second with respect to the first sample of the recording. Time picking is done only on one sensor (ACWP for accelerometer database and all also for ROSA and ROAN rotation database; B0R0 for velocimeter database and RORA rotationdatabse). Important notes for Tp and Ts: 1/ in some cases, several events can be seen on the same time history (sometime with even higher amplitude motions than the event of interest) so the Tp and Ts info are important in order to well identify in time history the event that are characterized by the corresponding earthquake metadata. 2/ The picking is done to identify the different signal phase but does not attend to be used for relocation. If you want to use these datasets for such relocation work, we invite you to pick by yourself arrival times.

data_struc.pgN: [9.2093e-05 0.0415]

data_struc.pgE: [6.6780e-05 0.0407]

data_struc.pgZ: [6.8071e-05 0.0122]

data_struc.pg: [9.2093e-05 0.0415]

→ "Peak ground values" (units depending on the sensor type according to data_struc.unit) computed on raw signals, for each component individually (pgN, pgE, pgZ …) and for the whole signal (pg). One value per station: see data_struc.site for order. Note that for dataset with inly one type of sensor, this fields are names "pga", "pgv" or "pgr" for "peak ground acceleration", "velocity" or "rotation".

data_struc.pgNfilt: [6.6301e-05 0.0366]

data_struc.pgEfilt: [5.1633e-05 0.0327]

data_struc.pgZfilt: [3.6959e-05 0.0096]

data_struc.pgfilt: [6.6301e-05 0.0366]

→ "Peak ground values" computed on [1 - 20 Hz] passband filtered signals. Same convention than previously.

data_struc.snr: 45.6047

→ Signal-to-noise ratio roughly computed in time domain using peak ground values measured on signal and on noise before the event on passband filtered [1–10 Hz] data. This value is given for the rotation sensor signal for the three rotation sensor dataset, and for the central velocimeter station B0R0 for the broadband velocimeter dense array dataset.

For the broadband velocimeter dense array dataset as will than the RORA rotation sensor dataset that is provided with the corresponding broadband velocimeter dense array data), this additional field is included:

data_struc.flag_only_20_stations

→ Boolean indicating if there is only 20 operating stations (1) instead of 21 stations (0) out of the total array of 21 stations.

As for the broadband velocimeter dense array dataset, this additional field is included:

data_struc.flag_possible_saturation

→ Boolean indicating if there is a suspicion or evidence of saturation (1) or not (0) on at least one sensor of the whole array. **Some events show evident strong saturation, but we chose to keep all the data within the dataset, but users must be aware about this saturation issue and ensure by themselves if the data they are using are relevant for their own analysis**.

4 ADDITIONAL NOTES FOR SAC FORMAT

The "IDEP" fields for accelerometer data is set to "IACC" (8) and data are then given in nm/s².

The "IDEP" fields for velocimeter data are is to "IVEL" (7) and data are then given in nm/s.

The "IDEP" fields for rotation sensor data is set to "IUNKN" (5) and data are then given in rad/s.

The P-wave and S-wave arrival time picking is stored in the user defined time pick identifications (T_P in T0 and T_S in T1).

Other few fields are also set.

5 ADDITIONAL NOTES FOR THE ASCII FORMAT

Here are the typical first lines of an Ascii format file. Please refer to previous descriptions.

```
# Station Name: ACAN
# Station Latitude (°): 38.164152
# Station Longitude (°): 20.506248
# Station Elevation (m): 2.3
# NAO Event date: 2014-02-06 09:13:26.000
# NAO Event Latitude (°): 38.1665
# NAO Event Longitude (°): 20.4135
# NAO Event Depth (km): 8.4
# NAO Event ML: 2.1
# NAO Event MW: -9999.0
# Kar Event date: -9999
# Kar Event Latitude (°): -9999.0000
# Kar Event Longitude (°): -9999.0000
# Kar Event Depth (km): -9999.0
# Kar Event MW: -9999.0
# Recording first sample time: 2014-02-06 09:11:29.000
# Recording sampling frequency [Hz]: 200.000000
# Number of sample within recording: 48001
# Recording unit: cm/s2
# P wave arrival time (s relative to recording first sample): 119.355
# S wave arrival time (s relative to recording first sample): 120.745
# EW      NS      UD
-9.83E-02  -4.69E-02     4.47E-02
2.07E-02   -6.79E-02     1.06E-03
6.59E-02   -7.73E-02     -1.05E-01
...
```

6 GEOGRAPHICAL COORDINATES OF STATIONS

Stat_Name	Lat_WGS84	Long_WGS84 [°]	Lat_UTM34N [m]	Long_UTM34 [m]	Z [m]
ACAN	38.1641518	20.5062484	4224143.42	456746.61	2.3
ACIN	38.1623360	20.5067650	4223941.71	456790.79	3.0
ACSI	38.1617606	20.4967196	4223882.59	455910.43	37.7
ACVV	38.1582179	20.4904676	4223492.50	455360.56	126.0
ACWP	38.1662878	20.5104888	4224378.46	457119.33	8.0
B0R0	38.1509968	20.5313364	4222672.39	458936.99	47.3
B1R1	38.1510827	20.5313326	4222681.92	458936.71	47.0
B1R2	38.1512560	20.5313052	4222701.17	458934.40	46.5
B1R3	38.1518289	20.5312128	4222764.77	458926.62	44.3
B1R4	38.1526922	20.5311940	4222860.56	458925.46	40.9
B2R1	38.1510288	20.5314417	4222675.90	458946.23	47.3
B2R2	38.1510912	20.5316478	4222682.72	458964.33	47.4
B2R3	38.1513555	20.5322610	4222711.78	459018.20	48.3
B2R4	38.1516837	20.5331900	4222747.78	459099.78	50.8
B3R1	38.1509279	20.5314088	4222664.71	458943.29	47.7
B3R2	38.1507916	20.5315577	4222649.52	458956.26	48.3
B3R3	38.1504293	20.5320290	4222609.12	458997.36	50.7
B3R4	38.1498238	20.5326702	4222541.65	459053.20	54.3
B4R1	38.1509214	20.5312738	4222664.05	458931.47	47.5
B4R2	38.1507665	20.5311520	4222646.92	458920.70	47.9
B4R3	38.1503579	20.5308026	4222601.74	458889.86	47.8
B4R4	38.1497047	20.5303230	4222529.47	458847.47	48.8
B5R1	38.1510249	20.5312278	4222675.55	458927.49	47.0
B5R2	38.1510676	20.5310129	4222680.38	458908.68	46.1
B5R3	38.1512438	20.5303081	4222700.25	458847.03	44.8
B5R5	38.1513603	20.5293406	4222713.60	458762.32	41.7
ROAN	38.1641518	20.5062484	4224143.42	456746.61	2.3
RORA	38.1509780	20.5313383	4222670.30	458937.14	47.2
ROSA	38.1633117	20.5055559	4224050.53	456685.45	3.0