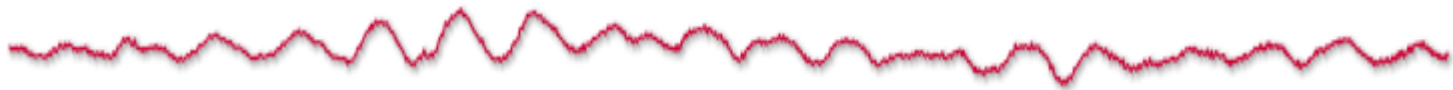


EPOS-S Waveform Services

Reinoud Sleeman
for
TCS Seismology
and
ORFEUS

*ORFEUS Annual Workshop & Open EPOS Seismology meeting
25-27 October, Lisbon, Portugal*



Context

EPOS TCS Seismology (EPOS-S) builds on existing and new European Infrastructures to provide services for waveform data, earthquake parametric data and hazard data, and integrate these within the EPOS architecture:

ORFEUS (1987) | seismological waveform data services (incl. Comp. Seism.)
EMSC (1975) | seismological products services
EFEHR (2017/18) | services for earthquake hazard and risk

ORFEUS (Observatories and Research Facilities for European Seismology), founded in 1987, is the non-profit foundation that coordinates digital, broadband seismology in the European-Mediterranean area.

ORFEUS coordinates archiving of, and access to, earthquake waveform data from seismic stations in the European Mediterranean region through **EIDA** (European Integrated waveform Data Archive; 2013) in Europe.

EPOS-S Waveform Services

Providing access to:

- **Raw seismic waveforms** and associated quality information provided by the **EIDA** federation (currently 11 nodes; more to come) in ORFEUS
- **Processed accelerometric waveforms** and **strong motion parameters** (derived from waveforms) provided by ORFEUS/ODC (**RRSM**) and INGV (**ESM**)
- **Station Book** (EIDA station information data base) provided by ORFEUS/ODC
- **Waveform modeling** Portal (U. Liverpool)

EIDA - The European Integrated Data Archive

EIDA is the European Integrated Data Archive infrastructure within ORFEUS to provide access to seismic waveforms in European archives.

Currently 11 archives are distributing their own data (self operated networks) as well as data on behalf of other network operators in standard formats.

EIDA data holdings:

- 8000 stations
- 99 permanent networks
- 97 temporary deployments
- 400 TB federated in 11 nodes

European Integrated Data Archive EIDA

EIDA, an initiative within ORFEUS, is a distributed federation of datacenters established to securely archive seismic waveform data and metadata gathered by European research infrastructures, and provide transparent access to data for the geosciences research communities. EIDA's **organization and management** is handled by the EIDA Management Board. The **EIDA nodes** are data centres that collect and archive data from seismic networks deploying broad-band sensors, short period sensors, accelerometers, infrasound sensors, and other geophysical instruments.

Seismic networks that participate in EIDA are listed as **contributing networks**.

Webinterface
Graphical Interface for waveform and metadata access.

Webservices
APIs for data and metadata access.

Station Book
Access to the entire EIDA station inventory.



EIDA - The European Integrated Data Archive

EIDA Management Board (EMB) and Technical Commission (ETC)

EIDA Management Board

Board Members

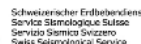
- Helle Pedersen, RESIF (Chair)
- John Clinton, ETHZ
- Angelo Strollo, GFZ
- Klaus Stammler, BGR
- Peter Danecek, INGV
- Ali Pinar, KOERI
- Constantin Ionescu, NIEP
- Reinoud Sleeman, ODC - KNMI
- Christos Evangelidis, NOA

EIDA Technical Commission

Commission Members

- Javier Quinteros, GFZ (Chair)
- Luca Trani, Mathijs Koymans, ODC - KNMI
- Andres Heinloo, Peter Evans, GFZ
- Matthias Hoffmann, Erich Odon Muhire, BGR
- Daniel Armbruster, Stefan Heimers, Philippe Kaestli, Carlo Cauzzi, ETHZ
- Valentino Lauciani, Andrea Bono, Massimo Fares, INGV
- Costanza Pardo, IPGP
- Mustafa Comoglu, KOERI
- Cristian Neagoe, Lucian Palangeanu, NIEP
- Gregory Arneodo, RESIF
- Nikos Triantafyllis, Kostas Boukouras, NOA

How to become an EIDA node: www.orfeus-eu.org/data/eida/guidelines/



ORFEUS EIDA waveform services

EIDA Node	FDSNWS-Dataselect	FDSNWS-Station	EIDAW S-Routing	EIDAW S-WFCatalog
ODC	Online 1.1.0	Online 1.1.0	Online 1.1.0	Online 1.0.0
GFZ	Online 1.1.1	Online 1.1.1	Online 1.1.1	Online 1.0.0
RES IF	Online 1.1.0	Online 1.1.0	In development	Online 1.0.0
INGV	Online 1.1.0	Online 1.1.34.9	Timed Out	Online 1.0.0
ETHZ	Online 1.1.0	Online 1.1.0	Online 1.0.3	Online 1.0.0
BGR	Online 1.1.0	Online 1.1.0	Online 1.1.0	Online 1.0.0
NIEP	Online 1.1.0	Online 1.1.0	In development	Online 1.0.0
KOERI	Online 1.1.0	Online 1.1.0	Online 1.0.2	Offline
IPGP	Online 1.1.0	Online 1.1.0	Online 1.0.3	In development
LMU	Online 1.1.0	Online 1.1.0	Online 1.0.3	Online 1.0.0
NOA	Online 1.1.0	Online 1.1.0	Online 1.1.0	Online 1.0.0



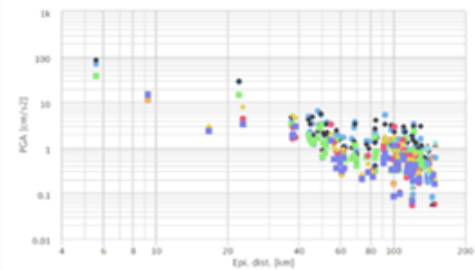
Graphical Interface for waveform and metadata access.



APIs for data and metadata access.



Access to the entire EIDA station inventory.



Rapid Raw Strong Motion RRSM



Engineering Strong Motion ESM

Schematic overview of (raw) waveform and metadata services currently up and running.

- EIDA interactive portal
- web services
- Station Book

- EIDA stations map

Derived products and services via:

- RRSM
- ESM

EIDA interactive portal

Explore events | Explore stations | Submit request | Download data | View console

select earthquake catalogue

Events Controls

Event Information

Catalog Services: User Supplied

Catalog Service: USGS GFZ ISC via IRIS USGS EMSC

Date Interval (yyyy-mm-dd):
 -

Minimum Magnitude:

Depth from to km

Coordinates: (Use -ve for S/W; +ve for N/E)

N

W E

S

Event and Station Map

1.30, 23.05

Use left SHIFT + drag mouse to select regions. [Legend](#) [Help](#)

Event and Station List

Request:

Events (2 events)

<input type="checkbox"/>	Origin Time	Mag.	Type	Lat.	Long.	Depth	Region
<input checked="" type="checkbox"/>	2017-08-17T06:44:56	4.2	mb	39.03	-9.08	10.0	Portugal
<input type="checkbox"/>	2017-08-15T14:50:43	4.7	mb	35.65	5.80	10.0	Northern Algeria

EIDA interactive portal

Explore events **Explore stations** Submit request Download data View console [doc Help](#)

Stations Controls

Station Information

Browse Inventory User Supplied

Networks

Year from 1980 to 2017:

Network Type:
All permanent nets

Network Code:

Stations

by Code by Region by Events

Filter stations by region:

N 44.22

W -14.4 E 3.09

S 27.27 Clear

Streams

by Code by Sampling

Choose the desired set of channels:
Use SHIFT and CTRL to extend the set.

HH
BH
LH
HN

Event and Station Map

Use left SHIFT + drag mouse to select regions.

10.09, 25.47

Event and Station List

Request: Freeze Delete Stations Save Stations

Events (2 events)

<input type="checkbox"/>	Origin Time	Mag.	Type	Lat.	Long.	Depth
<input checked="" type="checkbox"/>	2017-08-17T06:44:56	4.2	mb	39.03	-9.08	10.0
<input type="checkbox"/>	2017-08-15T14:50:43	4.7	mb	35.65	5.80	10.0

Stations (104 stations)

<input type="checkbox"/>	Network	Station	Lat.	Long.	O/R	Streams
<input checked="" type="checkbox"/>	CA	CADI	42.34	1.84	O	.BHE,.BHN,.BHZ
<input checked="" type="checkbox"/>	CA	CBRU	42.29	2.18	O	.HHE,.HHN,.HHZ
<input checked="" type="checkbox"/>	CA	COBS	40.71	1.36	O	.HHE,.HHN,.HHZ
<input checked="" type="checkbox"/>	CA	CSOR	42.38	1.13	O	.BHE,.BHN,.BHZ
<input checked="" type="checkbox"/>	CA	CTRE	42.32	0.77	O	.HHE,.HHN,.HHZ
<input checked="" type="checkbox"/>	CA	EBR	40.82	0.49	O	.HHE,.HHN,.HHZ

select station(s)

select network(s)

All Networks

- AD (1980) - National Seismic Network of Azerbaijan [ODC]
- AC (2002) - Albanian Seismic Network [INGV]
- AF + (1980) - South Africa National Seismograph Network (SANSN-Net) [GFZ]
- AI (1980) - Antarctic Seismographic Argentinean Italian N [ODC]
- AW (1980) - AWI Network Antarctica (AWI-Net) [GFZ]
- BA (2005) - Universita della Basilicata Seismic Network [INGV]
- BE (1980) - Belgian Seismic Network [ODC]
- BN (1980) - UK-Net, Blacknest Array [ODC]
- BS (1980) - Bulgaria Seismic Network [NIEP]
- BW (1980) - BayernNetz [LMU]
- CA (2017) - CERW Seismic Network [SED]
- CA (1980) - Catalan Seismic Network [ODC]
- CH (1980) - National Seismic Networks of Switzerland [SED]
- CK (1980) - CAREMON, Central Asian Cross-border Network (CAREMON) [GFZ]
- CL (2000) - Corinth Rift Laboratory Network [RESIF]
- CH (1980) - Canadian National Seismograph Network [GFZ]
- CQ (2013) - Cyprus Broadband Seismological Network [NOA]
- CR (1980) - CR network [ODC]
- CX (1980) - IPOC Seismic Network (Integrated Plate boundary Observatory Chile) [GFZ]
- CZ (1980) - Czech Regional Seismic Network [GFZ]
- DK (1980) - Danish National Seismic Network [GFZ]
- D2 (1980) - Algerian National Seismic Network [ODC]
- EB (1980) - SINGLE STATION [ODC]
- EE (1980) - Estonian Seismological Network [GFZ]
- EG (1993) - EUROSEISTEST Strong Motion Network (SDGEE_AUTH) [NOA]
- FI (1980) - Irish National Seismic Network, DIAS, Dublin, Ireland [GFZ]
- ES (1980) - SPANISH DIGITAL SEISMIC NETWORK [ODC]
- FN (1980) - Northern Finland Seismological Network [GFZ]
- FR (1994) - RESIF and other Broad-band and accelerometric permanent networks in metropolitan France [RESIF]

EIDA interactive portal

Explore events | Explore stations | **Submit request** | Download data | View console

Make Request ?

Time Window selection:

Relative Mode | Absolute Mode

Use time windows relative to events, by phase and onset time.

Start (minutes before)
 -

End (minutes after)
 +

Request Information:

ArcLink request type:

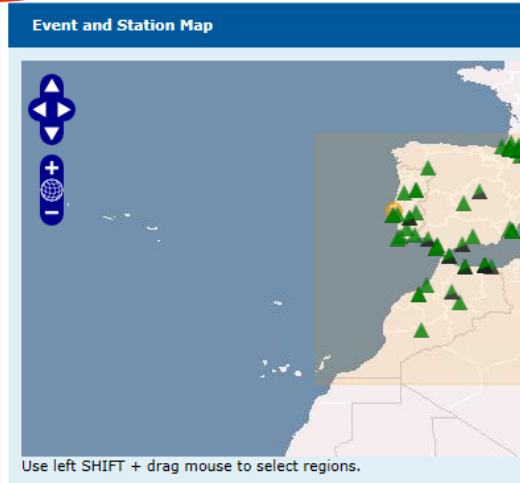
Waveform (Mini-SEED)
 Waveform (Full SEED)
 Metadata (Dataless SEED)
 Metadata (Inventory XML)

Use compression?
 Yes No

Authentication:

Your e-mail address:

Remember me?



Event and Station List

Request:

Events (2 events)

<input type="checkbox"/>	Origin Time	Mag.	Type	Lat.	Long.
<input checked="" type="checkbox"/>	2017-08-17T06:44:56	4.2	mb	39.03	
<input type="checkbox"/>	2017-08-15T14:50:43	4.7	mb	35.65	

Stations (104 stations)

<input type="checkbox"/>	Network	Station	Lat.	Long.	O/R
<input checked="" type="checkbox"/>	CA	CADI	42.34	1.84	0
<input checked="" type="checkbox"/>	CA	CBRU	42.29	2.18	0
<input checked="" type="checkbox"/>	CA	COBS	40.71	1.36	0
<input checked="" type="checkbox"/>	CA	CSOR	42.38	1.13	0

Package 1508414723292

download your requested data from different EIDA nodes

INGV (Italian Seismic)

Request ID: 16044073, **Type:** WAVEFORM, **Encrypted:** No, **Args:** format=MSEED
Description: Package 1508414723292
Status: READY, **Size:** 0, **Info:**

Volume ID: INGV, **Status:** NODATA, **Encrypted:** No, **Size:** 0, **Info:**
[+] 12 lines in this volume

RESIF Data center

Request ID: 290240, **Type:** WAVEFORM, **Encrypted:** No, **Args:** format=MSEED
Description: Package 1508414723292
Status: PROCESSING, **Size:** 0, **Info:**

Volume ID: RESIF, **Status:** PROCESSING, **Encrypted:** No, **Size:** 0, **Info:**
[+] 108 lines in this volume

Volume ID: UNSET, **Status:** UNSET, **Encrypted:** No, **Size:** 0, **Info:**
[+] 111 lines in this volume

GEOFON Data center

Request ID: 111118707, **Type:** WAVEFORM, **Encrypted:** No, **Args:** format=MSEED
Description: Package 1508414723292
Status: PROCESSING, **Size:** 0, **Info:**

Volume ID: GFZ, **Status:** PROCESSING, **Encrypted:** No, **Size:** 0, **Info:**
[+] 55 lines in this volume

Volume ID: UNSET, **Status:** UNSET, **Encrypted:** No, **Size:** 0, **Info:**
[+] 227 lines in this volume

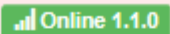
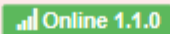
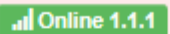
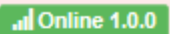
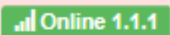
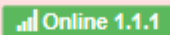
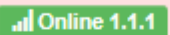
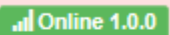
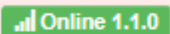
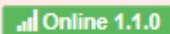

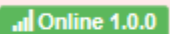
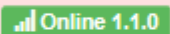

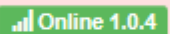
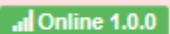
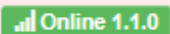
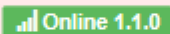
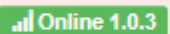
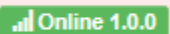
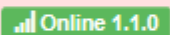
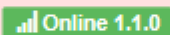
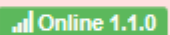
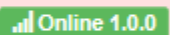
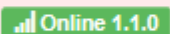
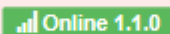

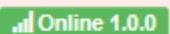
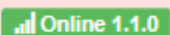
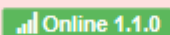
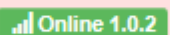
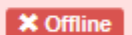
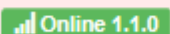
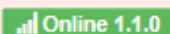
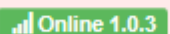

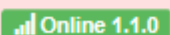
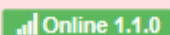
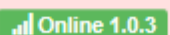
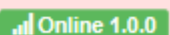
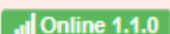
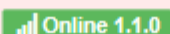
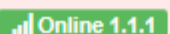
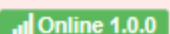
KNMI/ODC (Orfeus Data Center)

Request ID: 459594, **Type:** WAVEFORM, **Encrypted:** No, **Args:** format=MSEED
Description: Package 1508414723292
Status: READY, **Size:** 3323904, **Info:**

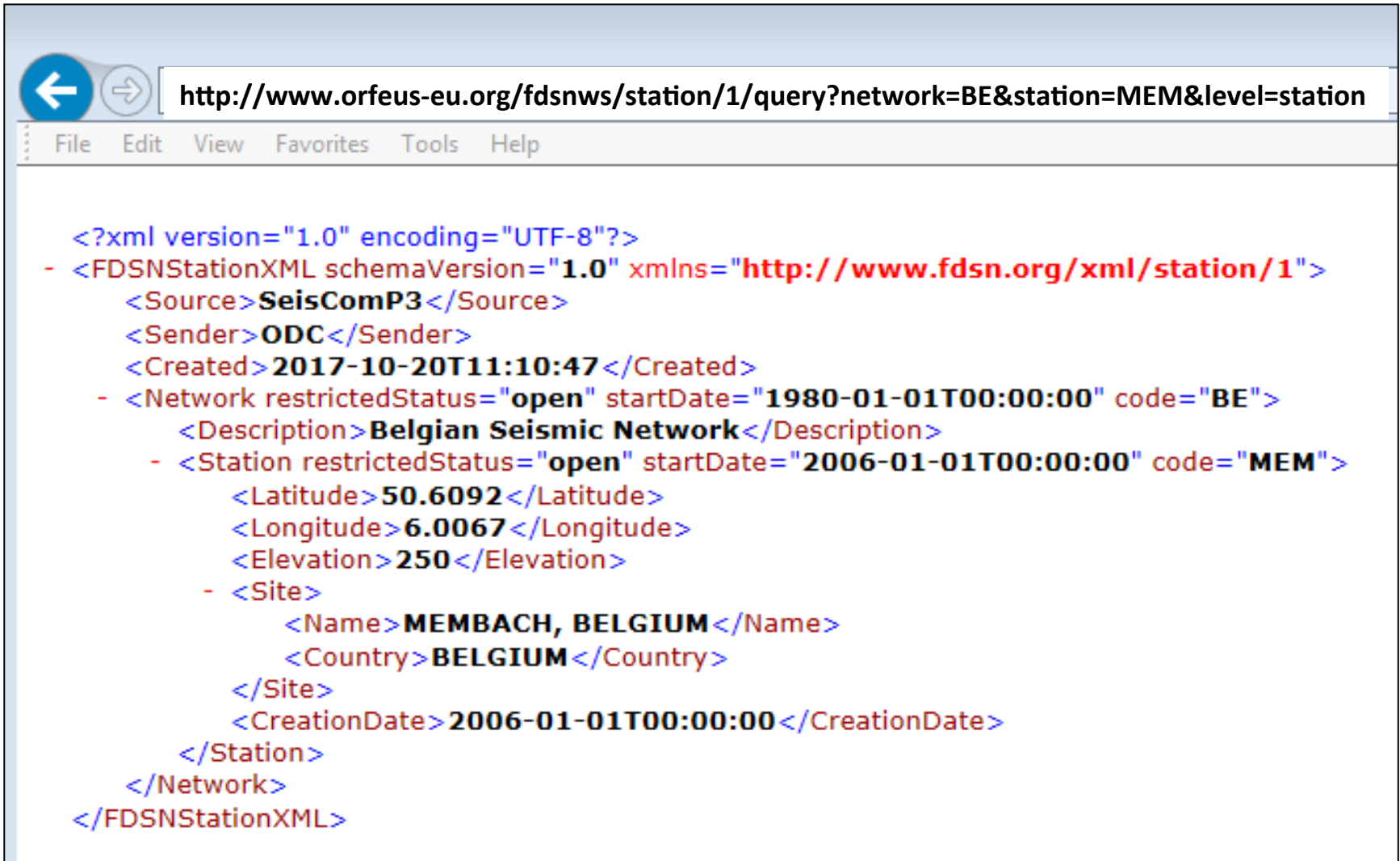
[Download Volume](#)
Volume ID: ODC, **Status:** OK, **Encrypted:** No, **Size:** 3323904, **Info:**
[+] 111 lines in this volume

EIDA webservices

- fdsnws-dataselect** | FDSN standardized webservice for mini-SEED waveform data.
- fdsnws-station** | FDSN standardized webservice for station metadata.
- eidaws-routing** | EIDA standardized webservice for routing between EIDA services.
- eidaws-wfcatalog** | EIDA standardized webservice for waveform metadata.

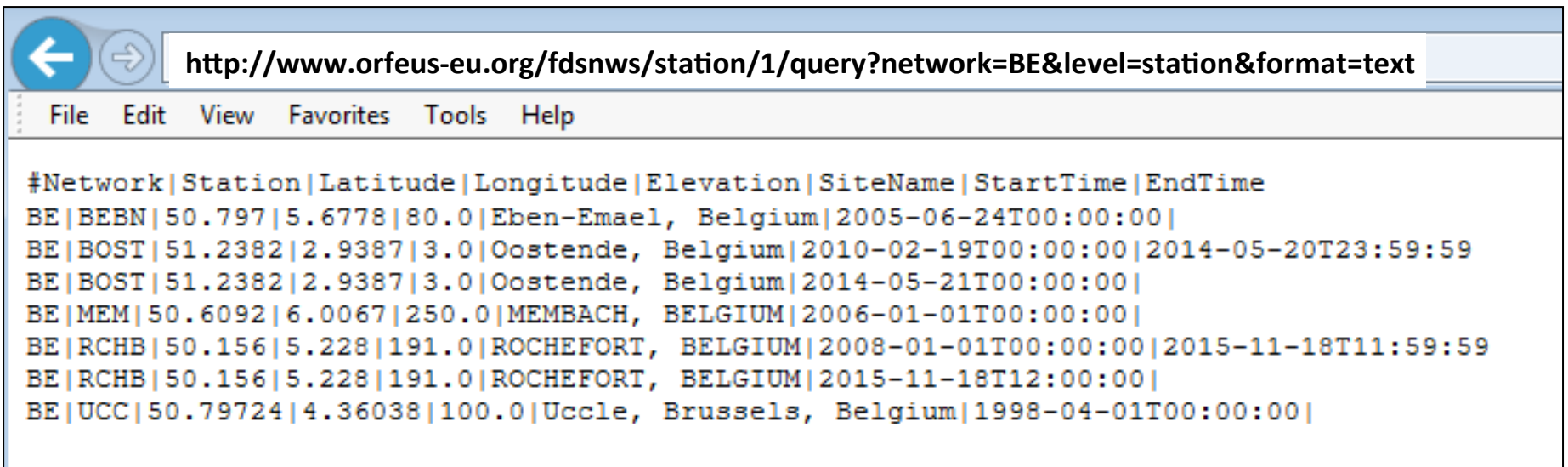
EIDA Node	FDSNWS-Dataselect	FDSNWS-Station	EIDAWS-Routing	EIDAWS-WFCatalog
ODC				
GFZ				
RESIF				
INGV				
ETHZ				
BGR				
NIEP				
KOERI				
IPGP				
LMU				
NOA				

EIDA webservices: example fdsnws-station



```
<?xml version="1.0" encoding="UTF-8"?>
- <FDSNStationXML schemaVersion="1.0" xmlns="http://www.fdsn.org/xml/station/1">
  <Source>SeisCompP3</Source>
  <Sender>ODC</Sender>
  <Created>2017-10-20T11:10:47</Created>
  - <Network restrictedStatus="open" startDate="1980-01-01T00:00:00" code="BE">
    <Description>Belgian Seismic Network</Description>
    - <Station restrictedStatus="open" startDate="2006-01-01T00:00:00" code="MEM">
      <Latitude>50.6092</Latitude>
      <Longitude>6.0067</Longitude>
      <Elevation>250</Elevation>
      - <Site>
        <Name>MEMBACH, BELGIUM</Name>
        <Country>BELGIUM</Country>
      </Site>
      <CreationDate>2006-01-01T00:00:00</CreationDate>
    </Station>
  </Network>
</FDSNStationXML>
```


EIDA webservices: example fdsnws-station



The screenshot shows a web browser window with the following URL in the address bar: <http://www.orfeus-eu.org/fdsnws/station/1/query?network=BE&level=station&format=text>. The browser's menu bar includes File, Edit, View, Favorites, Tools, and Help. The main content area displays a text-based table of station data.

#Network	Station	Latitude	Longitude	Elevation	SiteName	StartTime	EndTime
BE	BEBN	50.797	5.6778	80.0	Eben-Emael, Belgium	2005-06-24T00:00:00	
BE	BOST	51.2382	2.9387	3.0	Oostende, Belgium	2010-02-19T00:00:00	2014-05-20T23:59:59
BE	BOST	51.2382	2.9387	3.0	Oostende, Belgium	2014-05-21T00:00:00	
BE	MEM	50.6092	6.0067	250.0	MEMBACH, BELGIUM	2006-01-01T00:00:00	
BE	RCHB	50.156	5.228	191.0	ROCHEFORT, BELGIUM	2008-01-01T00:00:00	2015-11-18T11:59:59
BE	RCHB	50.156	5.228	191.0	ROCHEFORT, BELGIUM	2015-11-18T12:00:00	
BE	UCC	50.79724	4.36038	100.0	Uccle, Brussels, Belgium	1998-04-01T00:00:00	

EIDA webservices: example fdsnws-routing

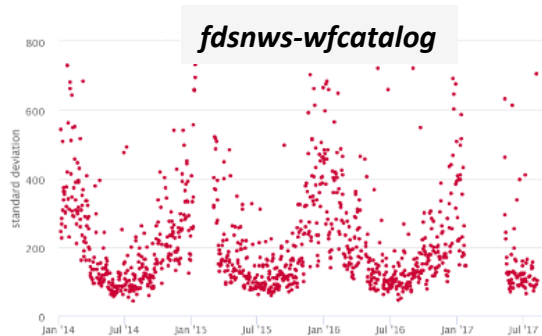


The screenshot shows a web browser window with the address bar containing the URL: `http://eida.gein.noa.gr/eidaws/routing/1/query?network=PM&service=-wfcatalog`. The browser's menu bar includes File, Edit, View, Favorites, Tools, and Help. The main content area displays an XML document with the following structure:

```
<?xml version="1.0"?>
- <service>
  - <datacenter>
    <url>http://geofon.gfz-potsdam.de/eidaws/wfcatalog/alpha/query</url>
    - <params>
      <loc>*</loc>
      <end/>
      <sta>*</sta>
      <cha>*</cha>
      <priority>1</priority>
      <start>1980-01-01 00:00:00</start>
      <net>PM</net>
    </params>
    <name>wfcatalog</name>
  </datacenter>
</service>
```

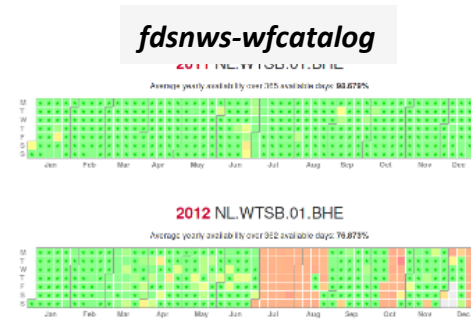
EIDA webservices – example clients

<http://www.orfeus-eu.org/data/odc/quality>



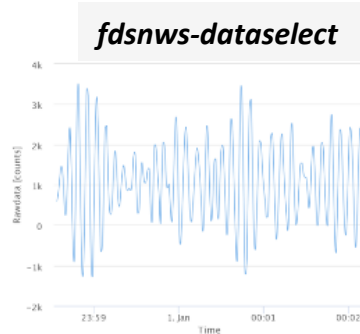
Data Metrics

Graphical interface showing daily waveform metrics.



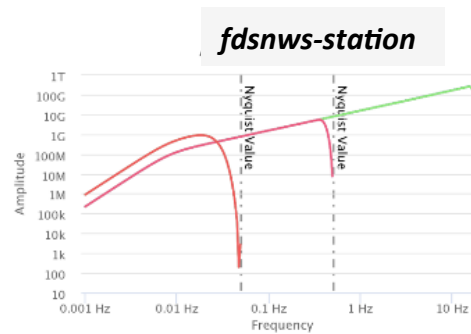
Data Availability

Graphical interface showing daily data availability.



Waveform Viewer

Graphical interface showing for viewing waveform data.



Instrument Response

Interface showing instrument response characteristics.

EIDA webservices – example clients

`fdsnws_fetch` - distributed data request tool

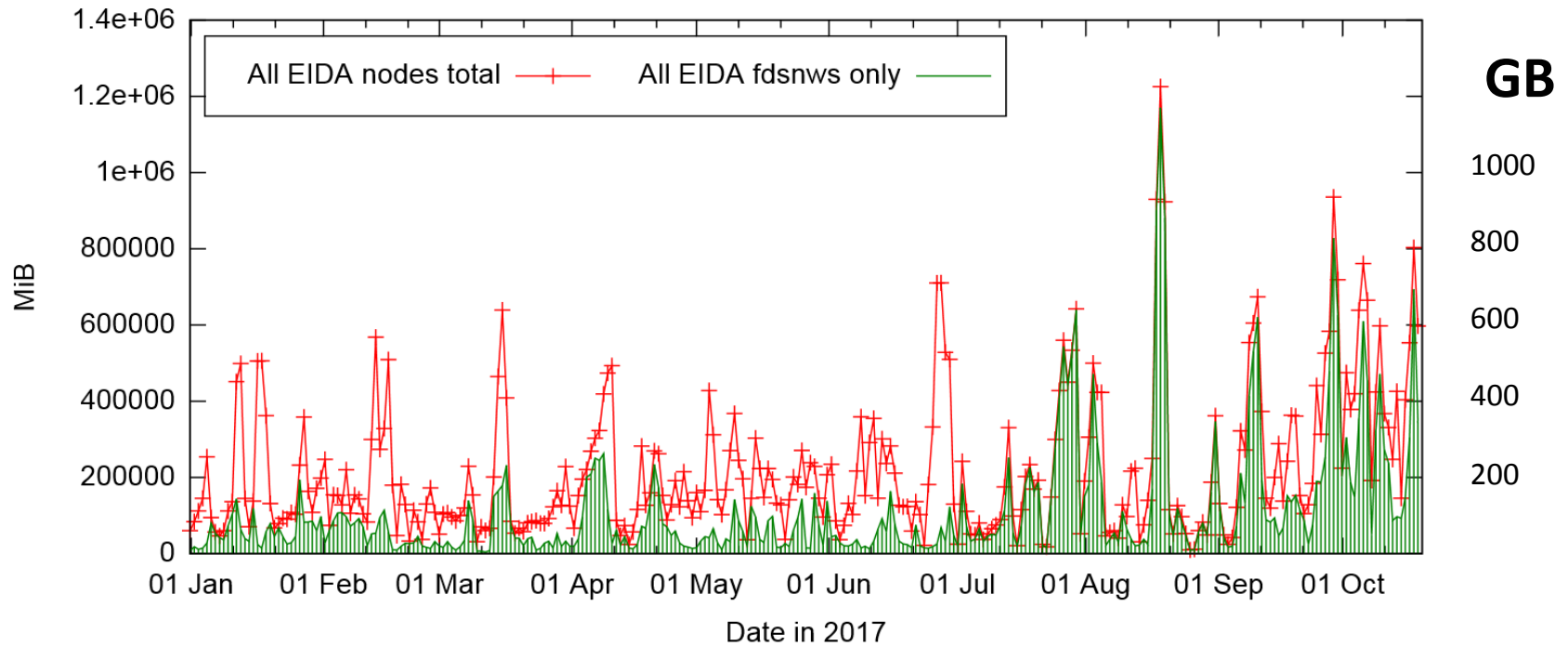
- Uses FDSN web services and EIDA routing service
- Supports tokens released by EIDA Authentication Service.
- Client included in ObsPy (next release).
- Provides citation support for each data request (FDSN DOI).

EIDA webservices in development

- eida federator** | webservice to provide catalog of data and services at one EIDA node
- eida mediator** | webservice for advanced selection of data across EIDA based on user criteria
- authentication service** | webservice for managing user attributes (e.g. authentication)

EIDA dissemination tool

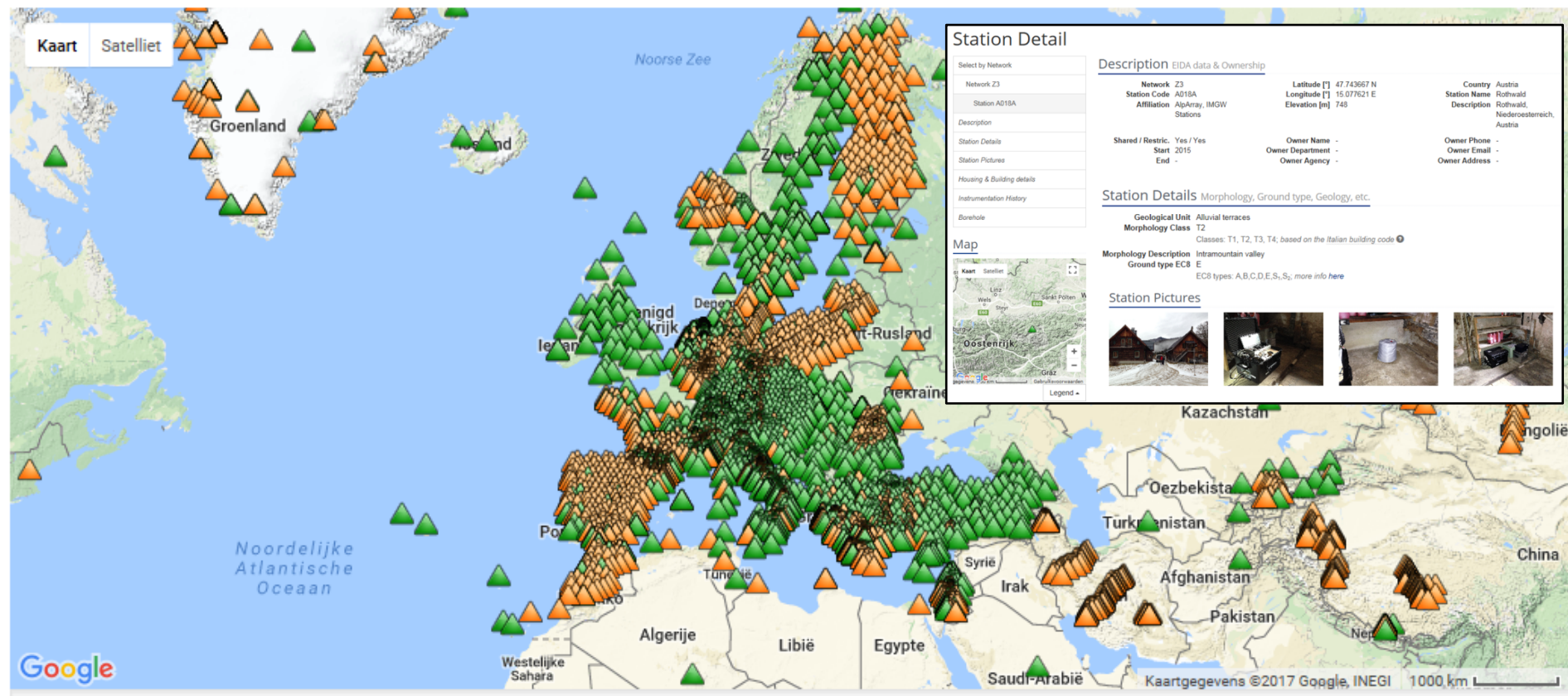
Total megabytes requested and requests by fdsnws-dataselect to 2017-10-20



European Station Book

www.orfeus-eu.org/stationbook

All stations by time frame



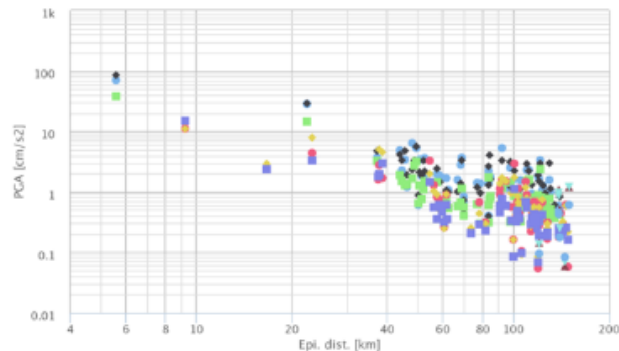
Common network and station metadata: collected automatically from EIDA.
Station and site characteristics: added/edited by network operators.

Strong Motion Data Portals

The Rapid Raw Strong Motion (RRSM) is an entirely automated system that uses open data from **EIDA**. It provides earthquake information and strong motion parameters including PGA and PGV within minutes of any event.

The Engineering Strong-Motion database (ESM) is a reviewed archive of accelerometric waveforms from events with magnitudes above 4.0 recorded in Europe and the middle-East since 1969. It provides unprocessed acceleration time-series, manually processed acceleration, velocity, and displacement waveforms, acceleration and displacement response spectra, and other relevant engineering parameters.

www.orfeus-eu.org/rrsm

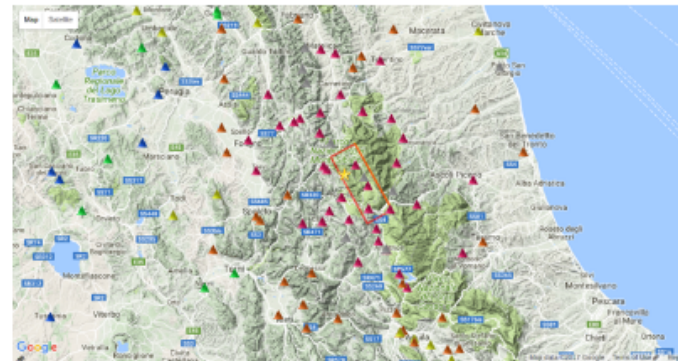


Rapid Raw Strong Motion RRSM

The RRSM portal exposes earthquake information, peak ground motion parameters, and response spectral amplitudes. Waveform data can be downloaded within minutes after an event exceeding magnitude 3.5 in the European-Mediterranean region.

Introducing the European Rapid Raw Strong-Motion Database. C. Cauzzi et al., 2016, Seismol. Res. Lett. 87, 4, doi: 10.1785/0220150271

www.orfeus-eu.org/esm



Engineering Strong Motion ESM

ESM allows users to query earthquake and station information and download earthquake waveforms and response spectra for events with magnitudes above 4.0 recorded in the European-Mediterranean and the middle-East regions.

The Engineering Strong-Motion Database: A Platform to Access Pan-European Accelerometric Data. L. Luzi et al., 2016, Seismol. Res. Lett. 87, 4, doi: 10.1785/0220150278

RRSM

- Fully automated system (SC3; scwfparam)
- Near real-time
- EIDA waveforms
- EMSC notification ($M > 3.5$); 2005 - present
- Provides waveforms and strong-motion parameters (peak values, spectral ordinates)
- Web interface and webservice

ESM

- Strong motion data (1969 – present) $M \geq 4$
- EIDA waveforms + offline data (e.g. Italian Civil Protection)
- Manual processing (interactive software)
- Provides waveforms and strong-motion parameters (peak values, spectral ordinates)
- Web interface and webservices: ESM parameters, ESM event-dataselect, ESM fdsnws-event, ESM fdsnws-station (e.g. non-EIDA stations)
- Additional products: Parametric flat-file (for Ground Motion Prediction Models).

Shakemap webservice (RRSM, ESM): provides output for USGS shakemap software
Event webservice to direct automatically to RRSM or ESM (in dev.)

European shakemaps

RRSM

Automatically processed wfs

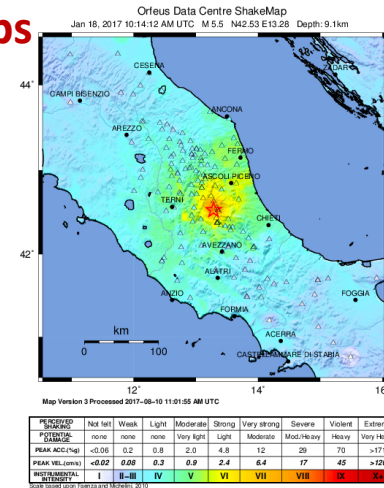
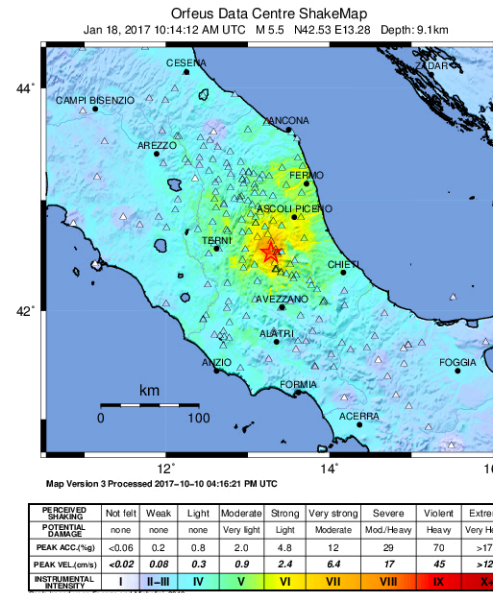
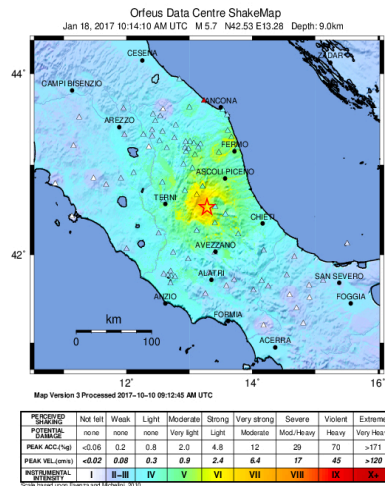
ESM

Manually processed wfs

RRSM
Shakemap ws

ESM
Shakemap ws

Integrated European Shakemaps



Other:

- Various hands on sessions (26/10)

Hands-on 1 **14:00 – 14:50**

ISEL C 2.21	ISEL C 3.01	ISEL C 3.16	ISEL C 3.15	ISEL C 2.23	ISEL C 3.07	ISEL F -1.11
<i>EIDA-1</i>	<i>EMSC Services-1</i>	<i>Site Response-1</i>	<i>StationBook-1</i>	<i>ESM</i>	<i>Hazard Portal-1</i>	<i>Waveform Modeling</i>

Hands-on 2 **14:50 – 15:40**

ISEL C 2.21	ISEL C 3.01	ISEL C 3.16	ISEL C 3.15	ISEL C 2.23	ISEL C 3.07	ISEL F -1.11
<i>RRSM</i>	<i>Mobile Pool-1</i>	<i>Site Response-2</i>	<i>StationBook-2</i>	<i>EDSF-1</i>	<i>AHEAD-1</i>	<i>Waveform Modeling</i>

Coffee break **15:40 – 16:10** **ISEL building C**

Hands-on 3 **16:10 – 17:00**

ISEL C 2.21	ISEL C 3.01	ISEL C 3.16	ISEL C 3.15	ISEL C 2.23	ISEL C 3.07	ISEL F -1.11
<i>EIDA -2</i>	<i>EMSC Services-2</i>	<i>Mobile Pool-2</i>	<i>AHEAD-2</i>	<i>EDSF-2</i>	<i>Hazard Portal-2</i>	<i>Waveform Modeling</i>

- EPOS-S technical workshop for OBS: coordination for OBS and integration of OBS seismological waveforms in EIDA; *6-7 Nov, IPGP, Paris*