ORFEUS Services for Coordinated High-Quality Seismic Waveform Data Access in Pan-Europe

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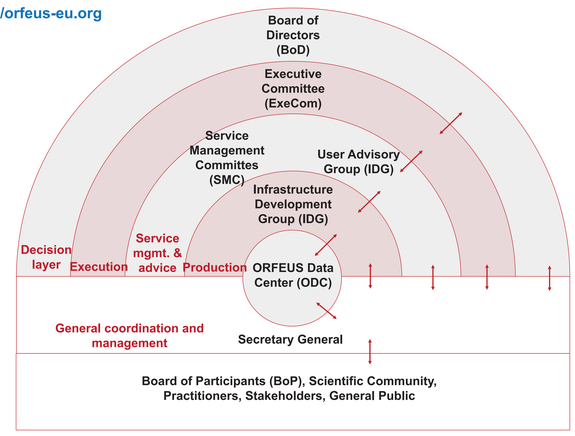
EGU General Assembly 2020

ORFEUS (Observatories and Reasearch Facilities for EUropean Seismology) promotes seismology in Europe through the collection, archival and distribution of digital seismic waveform data, metadata and associated services and products.

ORFEUS is the waveforms domain in EPOS SEISMOLOGY

> http://orfeus-eu.org



> Existing SMCs: EIDA & Strong-Motion;
being established: Mobile Pools including OBS (& Services for Computational Seismology).

ORFEUS & Big Data

EOSC-hub · RISE · SERA

Data archival & dissemination by seismological data centers need to be improved to distribute massive datasets, e.g.:

- very dense (~10^3) arrays of seismic instrumentation;
- fibre-optic and DAS (like ~10^6 seismic instruments operating at high sps).

Main issues:

> (meta)data quality;
> (real-time) data acquisition and processing;
> (rapid) accessibility to the data;
> scalability;
> long-term archival.

ORFEUS and its associated data centers started to address these issues in EC-funded projects and via global collaborations (IRIS).

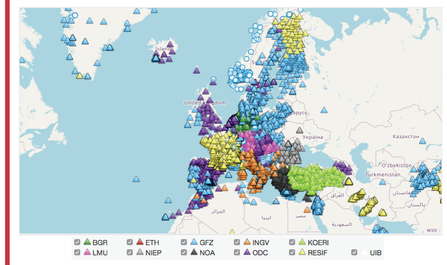
Activities:
> Investigation, evaluation & implementation of emerging solutions, e.g.:

- alternative data formats, e.g., ASDF / HDF5 / TDMS / PH5;
- dedicated data processing engines like Apache Spark;
- HPC & cloud solutions, e.g., OpenStack, IBM Cloud; Amazon Cloud.

> New logging system to provide reliable KPIs and to measure the load on the EIDA system.
> Workflows to improve (meta)data quality including QC metrics and tools.
> New automated system to transport information from the data contributors.
> Improved Web Services.
> Focus on users needs (surveys & workshops).

ORFEUS EIDA: the European Integrated Waveform Data Archive and Associated Services (orfeus-eu.org/data/eida)

EPOS · SERA · NERA



Royal Netherlands Meteorological Institute · GFZ Helmholtz Centre Potsdam · Epos Résif · INGV · INFP · Kandilli Observatory and Earthquake Research Institute · Schweizerischer Erdbebendienst · BGR · Universitas Bergensis

> Federated strategy: data archived at distributed nodes, standardized services for data discovery, access and download.
> Presently 11 nodes; ~ 11600 stations; 272 networks.
> Active collaborations with IRIS and FDSN (Big Data, PIDs, StationXML).

EIDA Web Interfaces

> http://orfeus-eu.org/webdc3/

> Allows for:
- searching events in global and regional catalogues (EMSC, GFZ, INGV, USGS);
- searching stations contributing to the EIDA federated archive;
- downloading raw waveform data (SEED format) and associated metadata (SEED and XML) for user-defined time windows, including OT-based start and end times.

COMING SOON: new Web Interface chiefly based on Web Services.

> http://orfeus-eu.org/stationbook/

> Allows discovery and download of metadata of stations contributing to EIDA.

(Meta)data quality/availability tools

> https://www.orfeus-eu.org/data/eida/quality/
Data metrics & availability
Waveform plots
Instrument responses

Documentation and user feedback

> https://www.orfeus-eu.org/data/eida
> https://orfeus-eu.readthedocs.io
> https://github.com/EIDA/userfeedback

EIDA Web Services

> http://orfeus-eu.org/data/eida/webservices/

FDSN webservice fdsnws-dataselect
Provides waveform data in MSEED format
http://www.orfeus-eu.org/fdsnws/dataselect/1/query?

FDSN webservice fdsnws-station
Provides station metadata in XML and text format.
http://www.orfeus-eu.org/fdsnws/station/1/query?

EIDA webservice eidaws-routing
Provides routes to different EIDA data and services
http://www.orfeus-eu.org/eidaws/routing/1/query?

EIDA webservice eidaws-wfcatalog
Provides metadata and quality parameters of wf data
http://www.orfeus-eu.org/eidaws/wfcatalog/1/query?

EIDA Federator
Provides a single, unified access point to the entire EIDA data holdings
http://eida-federator.ethz.ch/fdsnws/station/1/query?
http://eida-federator.ethz.ch/fdsnws/dataselect/1/query?
http://eida-federator.ethz.ch/eidaws/wfcatalog/1/query?

Advanced examples available at:
https://www.orfeus-eu.org/data/eida/webservices/examples/workflow/

Other clients and tools

> Seismo-Live (Jupiter Notebooks)
> Obspy
> fdsnws_scripts

Managed and developed by the EIDA SMC of ORFEUS:
C Evangelidis (**Chair**, NOA, Greece), H Pedersen (**Co-Chair**, RESIF, France), R Sleeman (ODC – KNMI), A Strollo (GFZ, Germany), K Stammler (BGR, Germany), P Danecek (INGV, Italy), A Marmureanu (NIEP, Romania), J Clinton (ETHZ, Switzerland), D Cambaz (KOERI, Turkey), L Ottemöller (UiB, Norway) & **the EIDA IDG**: J Bienkowski (Chair), J Quinteros, D Armbruster, K Boukouras, P Evans, M Fares, S Heimers, A Heinloo, M Hoffmann, P Kästli, M Koymans, V Lauciani, E O Muhire, C Neagoe, M Ozer, L Palangeanu, M Quintiliani, J Schaeffer, L Trani, N Triantafyllis, J Michalek. **UAG**: T Meier, F Fuchs, P Boué, S Rondenay, L Krischer.

ORFEUS Strong-Motion Databases and Associated Services (orfeus-eu.org/data/strong)

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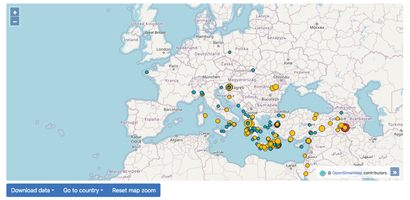
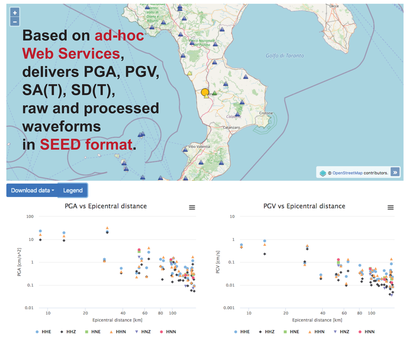
Rapid Raw Strong-Motion (RRSM) Products

> http://orfeus-eu.org/rrsm/



- Triggering by EMSC reports of any earthquake with M (any scale) >= 3.5 in the Euro-Med region.
- Collection of input data in near-real-time from EIDA
- Automatic processing based on SC3 module scwfparam and SC3 SM database extension – Cauzzi et al., SRL 2016.



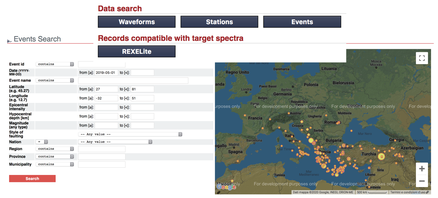
> Web Services deliver input files to USGS-style ShakeMap v3.5, raw and processed waveforms, event and peak-motion information in json and text formats.

- http://www.orfeus-eu.org/odcws/rrsm/1/shakemap?...eventid=20190325_0000105&type=event
- http://www.orfeus-eu.org/odcws/rrsm/1/shakemap?...eventidid=20190325_0000105

COMING SOON: improvements for engineering use, better identification of outliers, improved processing.

Engineering Strong-Motion (ESM) Products

> http://orfeus-eu.org/esm/



- Manual processing software based on Puglia et al., BEE 2018: https://esm.mi.ingv.it/processing/
- First EMSC magnitude and location, updated using the best manual solution, including finite fault if available; M (any scale) >= 4.
- Input data from EIDA & other Euro-Med SM datasets = more than 3300 SM stations.

Delivers PGA, PGV, selected spectral ordinates, response spectra, engineering parameters, raw and and processed waveforms - also spectrum-compatible (REXELite) - in engineering formats including ASCII and SAC.

> Web Services deliver manually revised input files to USGS-style ShakeMap (event, peak-motion and fault data)

- https://esm.mi.ingv.it/esmws/shakemap/1/query?...eventid=20190228_0000099&catalog=EMSC& ...format=event
- https://esm.mi.ingv.it/esmws/shakemap/1/query?...eventid=20190228_0000099&catalog=EMSC& ...format=event_fault
- https://esm.mi.ingv.it/esmws/shakemap/1/query?...eventid=20190228_0000099&catalog=EMSC& ...format=event_dat &flag=all

COMING SOON: new database & webinterface (as ITACA); improved processing and user interaction.

Managed and developed by the Strong-Motion SMC of ORFEUS:
G Lanzano (**Chair**, ESM & INGV, Italy), L Luzi (ESM & INGV, Italy), R Sleeman (ODC & RRSM), A Michelini & C Cauzzi (EU ShakeMap), E Maufroy (ISTerre, France), G Weatherill (GFZ, Germany), I Kalogeras (NOA, Greece), K Pitilakis (AUTH, Greece), N Theodoulidis (ITSAK, Greece), R Rupakhety (EERC, Iceland), M Shahvar (BHRC, Iran), A Marmureanu (NIEP, Romania), J Clinton (CH, Switzerland), E Tepeuğur (AFAD, Turkey), D Kalafat & E Çaktı (KOERI, Turkey) & the **SM IDG**: E Russo, M D'Amico, R Puglia, M Koymans, J Bienkowski, P Kästli, T Kilic, K Konstantinidou, L Manea, N Melis, D Senturk et al. **UAG**: O-J Ktenidou, J Douglas, F Gallovic.

Please always cite seismic network DOIs in your publications!

www.orfeus-eu.org/data/eida/networks/