ORFEUS Services and Activities to Promote Observational Seismology in Europe and beyond (EGU21-6119)

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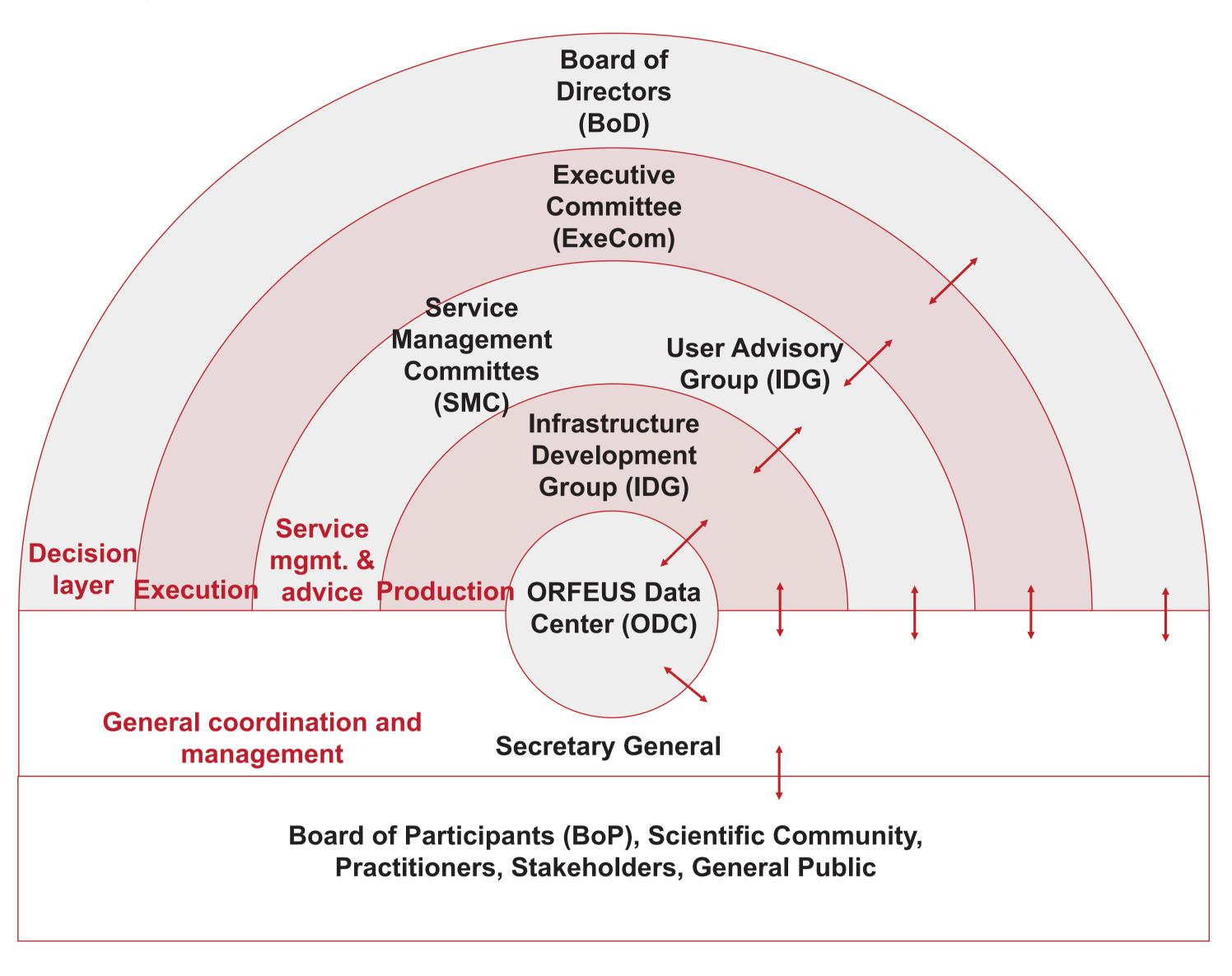
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ORFEUS (**O**bservatories and **R**easearch **F**acilities for **EU**ropean **S**eismology) promotes seismology in Europe through the **collection, archival and distribution of digital seismic waveform data, metadata and associated services and products.**

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

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

- very dense (~10³) arrays of seismic instrumentation;
- fibre-optic and DAS (like ~10⁶ 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.**
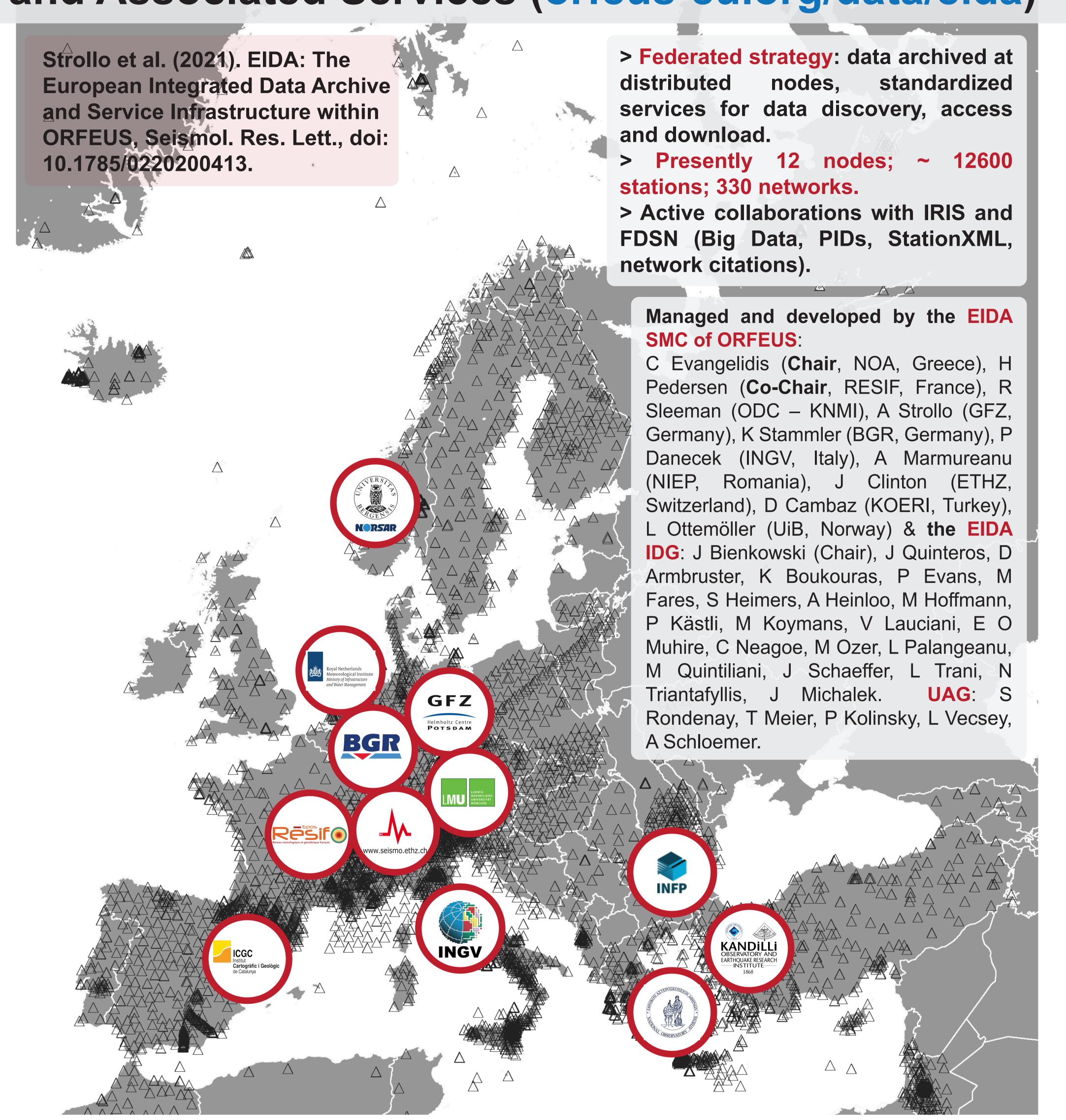> **Focus on users needs** (surveys & workshops).

Quinteros J et al. (2021). Exploring Approaches for Large Data in Seismology: User and Data Repository Perspectives, Seismol. Res. Lett., doi: 10.1785/0220200390.

ORFEUS Community Services

> **Conference sessions** (e.g., https://meetingorganizer.copernicus.org/EGU21/session/39308)
> **Journal special issues** (e.g., SRL Focus Section on European Seismic Networks and Associated Services and Products, https://pubs.geoscienceworld.org/srl/issue/92/3)
> **Workshops and webinars (http://orfeus-eu.org/other/workshops/)**
> **Seismological standards** (e.g., http://docs.fdsn.org/projects/stationxml/en/latest/index.html)
> **Software and travel grants**
> Joint activities with other international organisations (e.g. IRIS DMC, COSMOS)

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

Strollo et al. (2021). EIDA: The European Integrated Data Archive and Service Infrastructure within ORFEUS, Seismol. Res. Lett., doi: 10.1785/0220200413.

> **Federated strategy:** data archived at distributed nodes, standardized services for data discovery, access and download.
> **Presently 12 nodes; ~ 12600 stations; 330 networks.**
> **Active collaborations with IRIS and FDSN** (Big Data, PIDs, StationXML, network citations).

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), 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:** S Rondenay, T Meier, P Kolinsky, L Vecsey, A Schloemer.

EIDA Web Interfaces

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

ORFEUS Data Center WebDC3 Web Interface

Explore events | Explore stations | Submit request | Download data | Console

> **Allows for:**
- searching events in **global and regional catalogues** (EMSC, GFZ, KNMI, INGV, ETH, 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 (Jupyter Notebooks)
> Obspy
> fdsnws_scripts

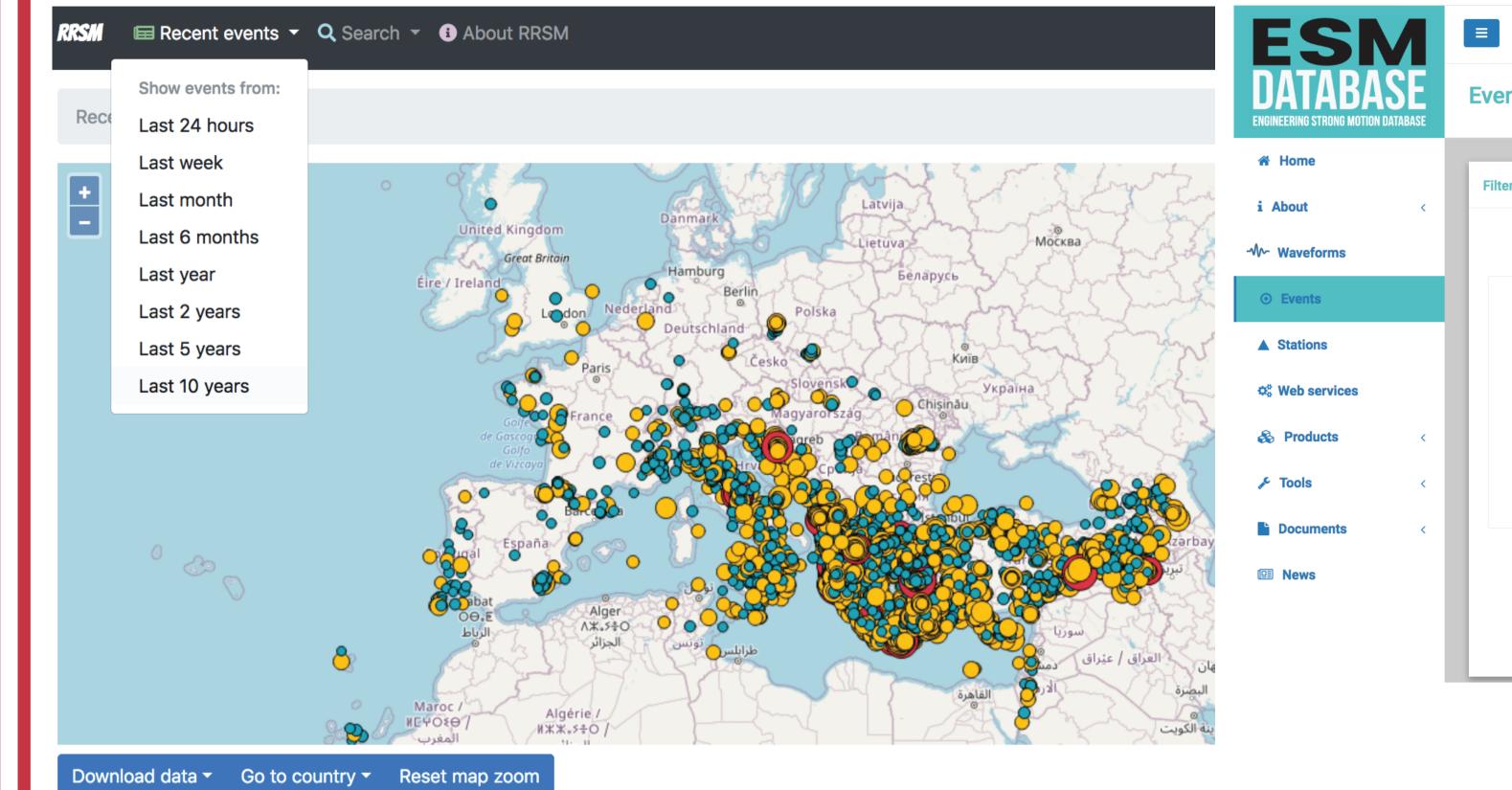# ORFEUS Strong-Motion Databases and Associated Services
(orfeus-eu.org/data/strong)

Rapid Raw Strong-Motion (RRSM) Products
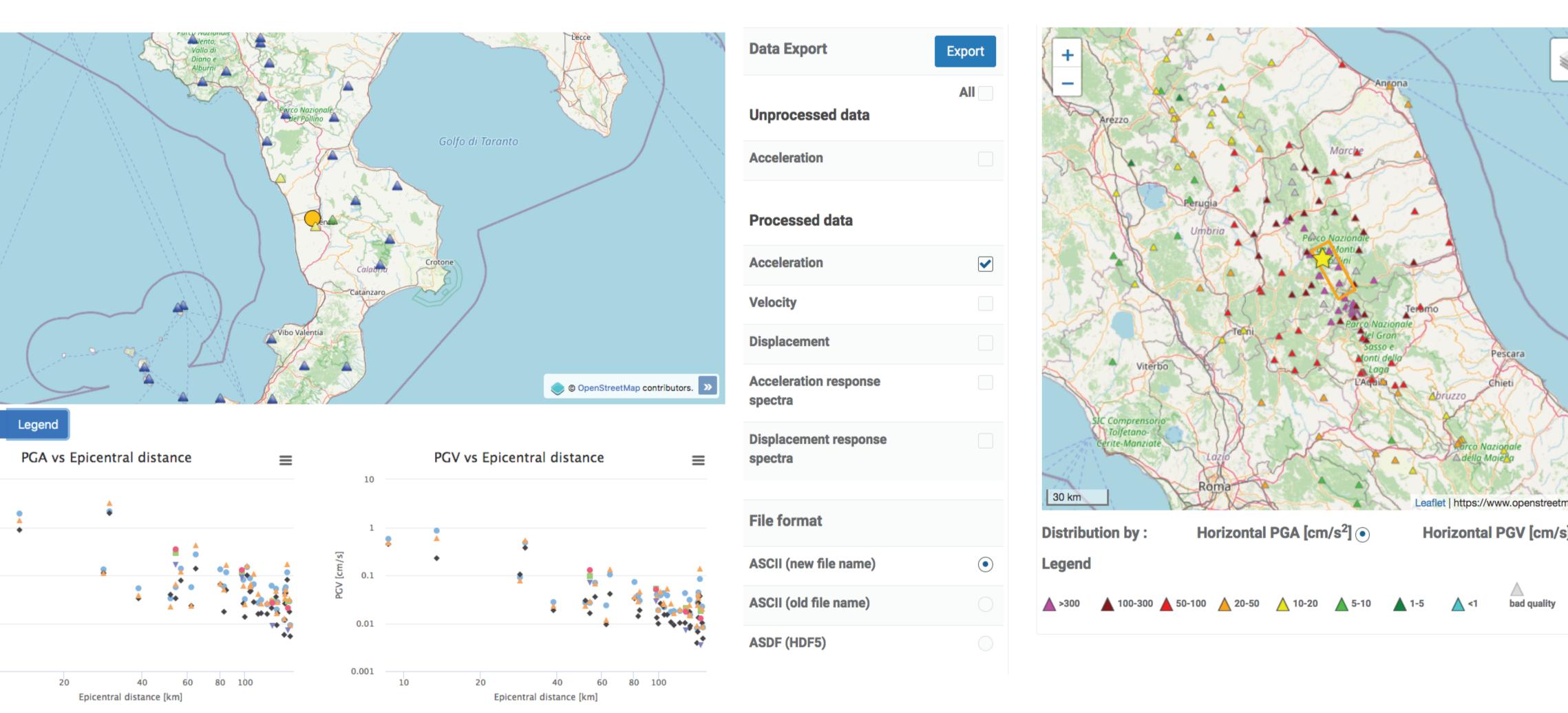
> http://orfeus-eu.org/rrsm/

- **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.

Based on **ad-hoc Web Services**, delivers PGA, PGV, SA(T), SD(T), raw and processed waveforms in **SEED format.**

> 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?... eventid=20190325_0000105

COMING SOON: better identification of outliers, Jupyter nootbooks for self processing, improved automated processing.

Engineering Strong-Motion (ESM) Products

> http://orfeus-eu.org/esm/ (https://esm-db.eu/)

- **Manual processing** software based on Puglia et al., BEE 2018: https://esm-db.eu/processing/select
- 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 3600 SM stations.**

Delivers PGA, PGV, selected spectral ordinates, response spectra, engineering parameters, raw and and processed waveforms - also spectrum-compatible (**REXELweb**) - 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-db.eu/esmws/shakemap/1/query?... eventid=20190228_0000099&catalog=EMSC& ... format=event
- https://esm-db.eu/esmws/shakemap/1/query?... eventid=20190228_0000099&catalog=EMSC& ... format=event_fault
- https://esm-db.eu/esmws/shakemap/1/query?... eventid=20190228_0000099&catalog=EMSC& ... format=event_dat&flag=all

COMING SOON: additional formats, new licence for processed data and products.

Lanzano et al. (2021). Accessing European Strong-Motion Data: An Update on ORFEUS Coordinated Services, Seismol. Res. Lett., doi: 10.1785/0220200398.

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, Doruk Senturk, Tugbay Kilic, Selim Sezer (AFAD, Turkey), D Kalafat & E Çakti (KOERI, Turkey) & the **SM IDG:** E Russo, M D'Amico, C Felicetta, R Puglia, M Koymans, J Bienkowski, P Kästli, T Kilic, K Konstantinidou, L Manea, N Melis, D Senturk et al. **UAG:** O-J Ktenidou, D Bindi, F Gallovic.