EGU General Assembly 2020

EGU2020-7008

# Insights on the European Fault-Source Model (EFSM20) as input to the 2020 update of the European Seismic Hazard Model (ESHM20)

R. Basili, L. Danciu, M.M.C. Carafa, V. Kastelic, F.E. Maesano, M.M. Tiberti, R. Vallone, E. Gracia, K. Sesetyan, J. Atanackov, B. Sket-Motnikar, P. Zupančič, K. Vanneste, and S. Vilanova

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## INTRO

Main characteristics

## DATA

Input data

## METHOD

Collation and harmonization

## RESULTS

EFSM20 Crustal faults and Subduction systems

## USE

How to access the model



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www.sera-eu.org

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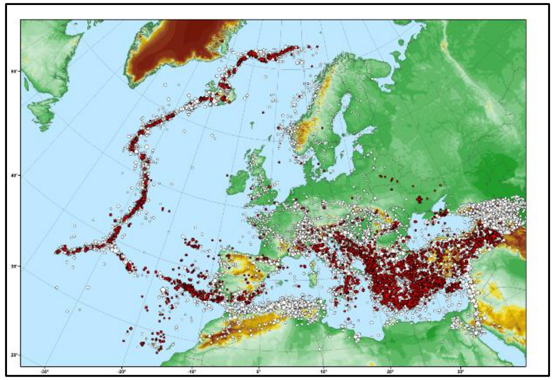
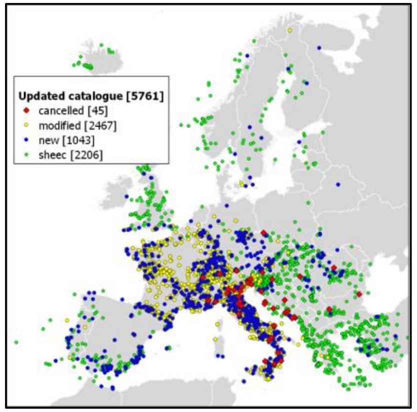
## INTRO

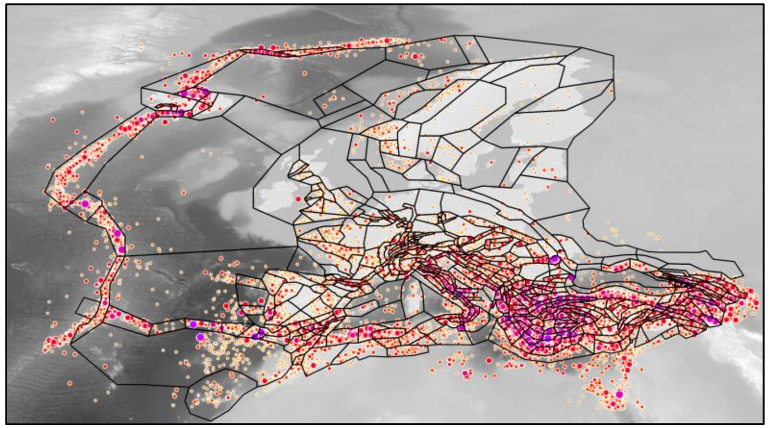
The H2020 Project SERA (WP25-JRA3; http://www.sera-eu.org) is committed to updating and extending the 2013 European Seismic Hazard Model (ESHM13; Woessner et al., 2015) to form the basis of the next revision of the European seismic design code (CEN-EC8).



Harmonized Instrumental Catalog 1900-2014 (EMEC*)
G. Wheatherill, S. Lammers, F. Cotton and GFZ Section 2.6 Working Group




Harmonized Historical Catalog 1000-1900 (SHEEC*)
A. Rovida, A. Antonucci (INGV Milano)



Area Source Model
- Contribution from Spain, Belgium, Germany, Switzerland, Slovenia, Romania, Turkey, Macedonia, Bulgaria, France, Portugal
- Northern Africa and Eastern Europe (Russia, Ukraine, Belarus) from Global Mosaic of Hazard Models by GEM Foundation

Following the probabilistic framework established for ESHM13, the 2020 update (ESHM20) requires a continent-wide seismogenic model based on input from **earthquake catalogs**, **tectonic information**, and **active faulting**. The development of the European Fault-Source Model (EFSM20) fulfills the requirements related to active faulting.



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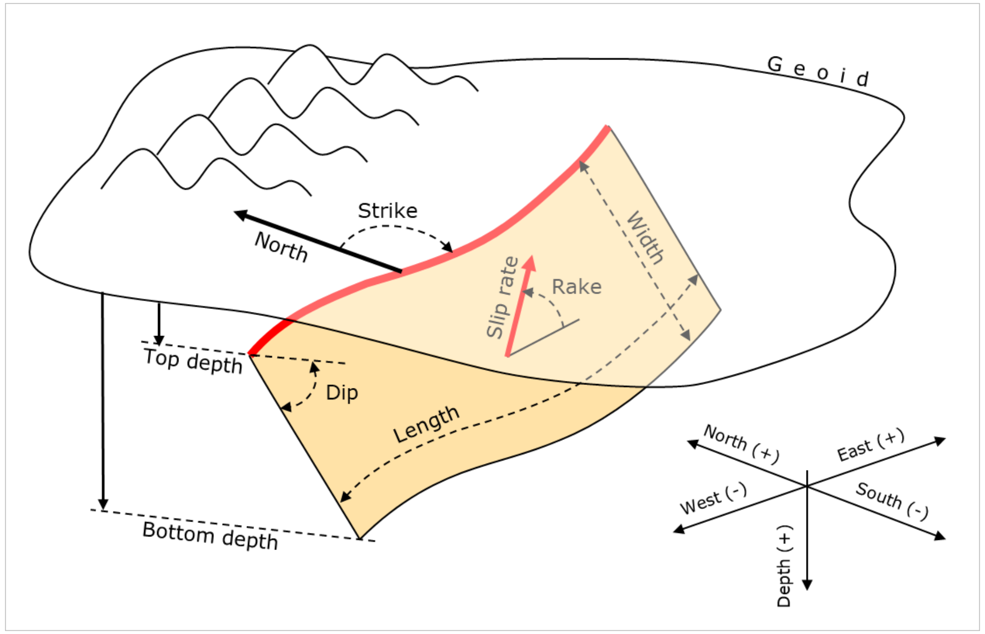
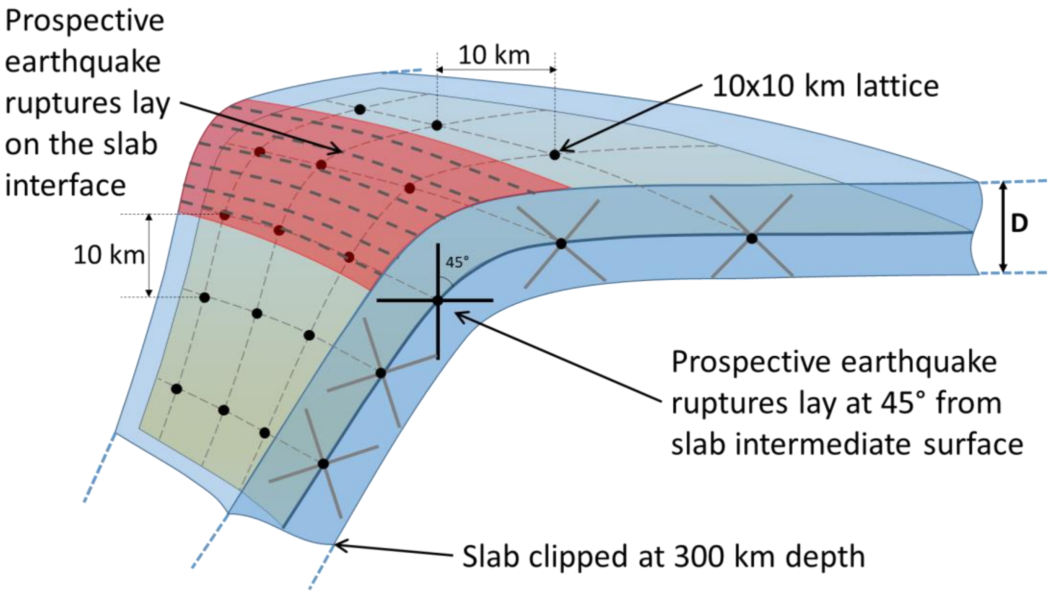
# INTRO

The European Fault-Source Model (EFSM20) has two main categories of seismogenic faults: crustal faults and subduction systems. Crustal faults are meant to provide the hazard model with seismicity rates in a variety of tectonic contexts, including onshore and offshore active plate margins and plate interiors. Subduction systems are meant to provide the hazard model with both slab interface and intraslab seismicity rates. The model covers an area that encompasses a buffer of 300 km around all target European countries (except for Overseas Countries and Territories, OTCs), and a maximum of 300 km depth for slabs.

## SCHEMATIC FOR CRUSTAL FAULTS




## SCHEMATIC FOR SUBDUCTION SYSTEM





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## DATA

The compilation of EFSM20 relies heavily on publicly available datasets (see tables below) and voluntarily contributed datasets spanning large regions, as well as solicited local contributions in specific areas of interest.

## CRUSTAL FAULTS

| TITLE | REFERENCE | URL | COVERAGE |
|---|---|---|---|
| EDSF 2013 | Basili et al. (2013); Giardini et al. (2013) | http://diss.rm.ingv.it/share-edsf/ | Europe and Mediterranean |
| QAFI 3 | IGME (2015) | http://info.igme.es/qafi/ | Iberia |
| DISS 3.2.1 | DISSWG (2018) | http://diss.rm.ingv.it/diss/ | Central Mediterranean |
| GREDASS 2.0.0 | Caputo & Pavlides (2013) | http://gredass.unife.it/ | Aegean |
| LRGM | Vanneste et al. (2013) | -- | Lower Rhine Graben |
| AFCD | Emre et al. (2018); Demircioğlu et al. (2017) | http://www.mta.gov.tr/eng/maps/active-fault-1250000 | Anatolia |
| EMME FAULT SOURCES | Danciu et al. (2018) | http://www.efehr.org/en/Documentation/specific-hazard-models/middle-east/active-faults/ | Middle East |
| NOAFAULTS | Ganas et al. (2013) | -- | Greece |
| BDFA | Jomard et al. (2017) | https://www.nat-hazards-earth-syst-sci.net/17/1573/2017/ | France |
| SLOVENIAN FAULT SOURCE MODEL | Atanackov et al. (2017) | -- | Slovenia |

## SUBDUCTION SYSTEMS

| TITLE | REFERENCE | URL | COVERAGE |
|---|---|---|---|
| EDSF 2013 | Basili et al. (2013); Giardini et al. (2013) | http://diss.rm.ingv.it/share-edsf/ | Central-Eastern Mediterranean |
| DISS 3.2.1 | DISSWG (2018) | http://diss.rm.ingv.it/diss/ | Central-Eastern Mediterranean |
| CALABRIAN ARC MODEL | Maesano et al. (2017) | https://www.nature.com/articles/s41598-017-09074-8 | Central Mediterranean |
| SLAB 2.0 | Hayes (2018); Hayes et al. (2018) | https://doi.org/10.5066/F7PV6JNV | World |
| GEM-FE SICP 2.0 | Berryman et al. (2015) | -- | World |
| SUBMAP 4.2 | Heuret & Lallemand (2005) | http://submap.gm.univ-montp2.fr/index.php | World |
| PB2002 | Bird et al. (2003) | http://peterbird.name/publications/2003_PB2002/2003_PB2002.htm | World |



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# METHOD: CRUSTAL FAULTS

## Requirements for consideration

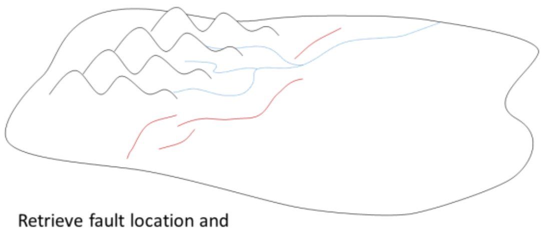
Fault must have been declared active by the authors/contributors, and be provided with

- fault trace coordinates,
- upper and lower seismogenic depths,
- dip angle,
- strike or dip direction,
- rake or sense of movement,
- slip rate,
- and optionally an estimate of the expected maximum magnitude

## Prioritization for inclusion

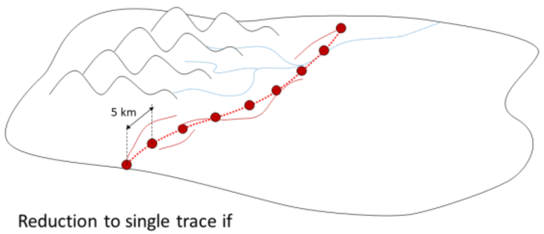
- Priorities for collating:
  1. EDSF 2013
  2. Replacement of EDSF with regional datasets
     a. Publicly available datasets
     b. Voluntarily contributed datasets
     c. Solicited local contributions
- Priorities for handling overlaps:
  1. Newer data / National data
  2. Accuracy and justification
  3. Coherence with surrounding faults

## Geometric reconstruction and homogenization



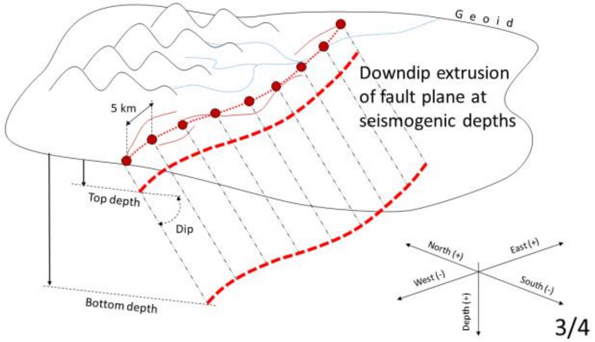
Retrieve fault location and geometry considering the original topographic reference

1/4

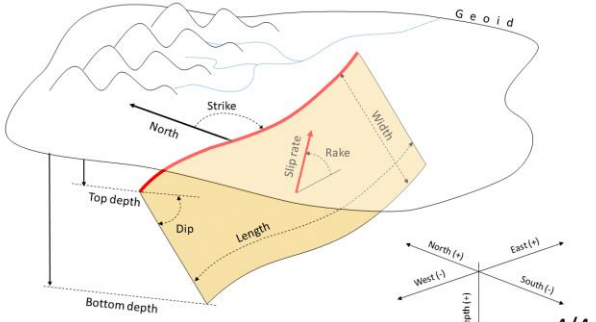



Reduction to single trace if necessary, smoothing and resampling at regular spacing

2/4




3/4




Complete fault plane parameterization

4/4



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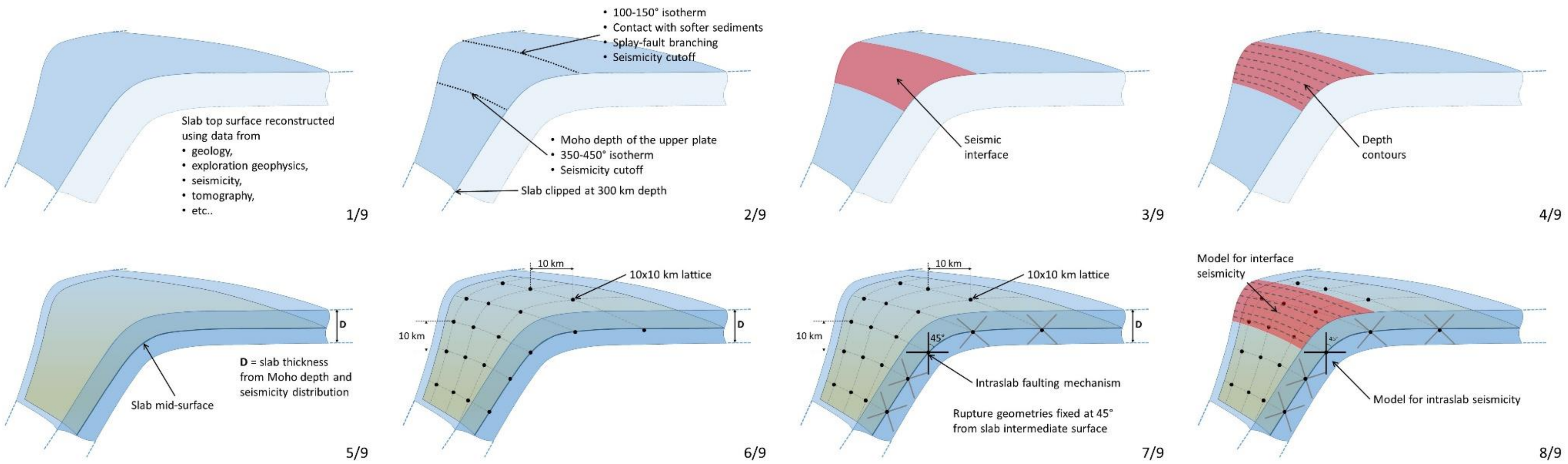
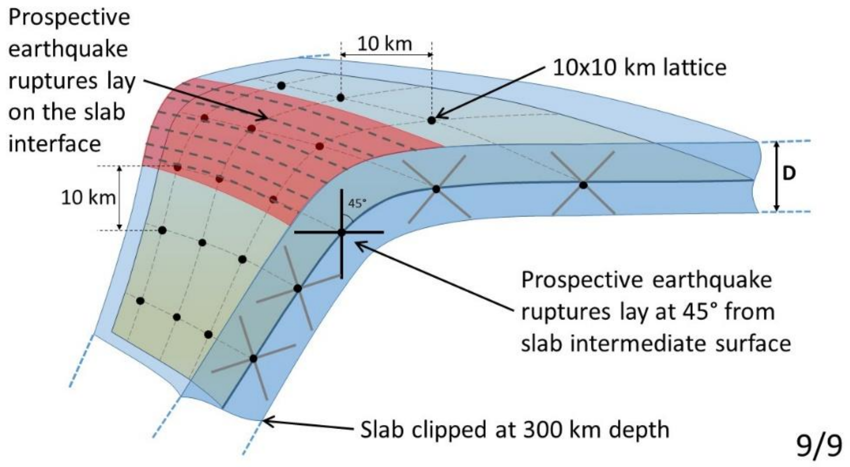
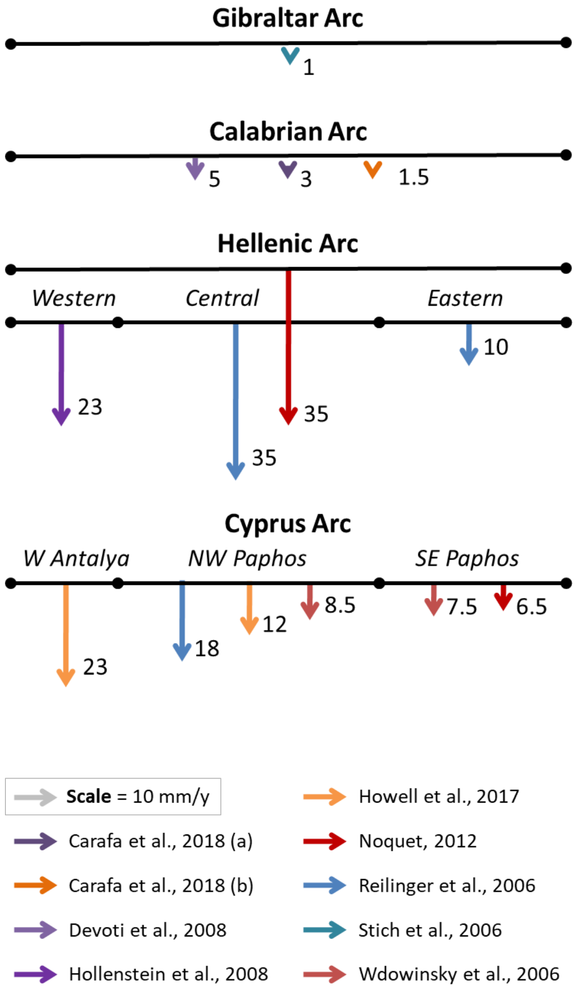
# METHOD: SUBDUCTION SYSTEMS




**Geometric reconstruction and tectonic rate characterization summary**



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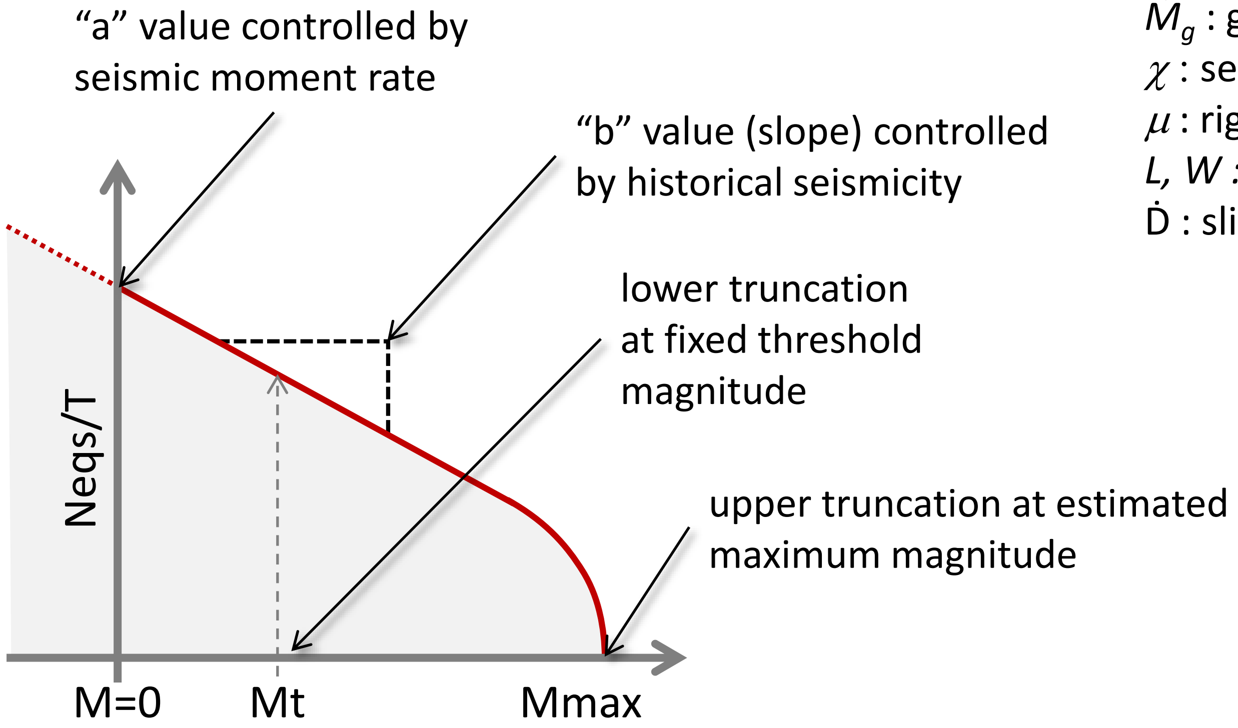
# METHOD: EARTHQUAKE ANNUAL RATES ARE BASED ON THE MOMENT-BALANCED PARADIGM

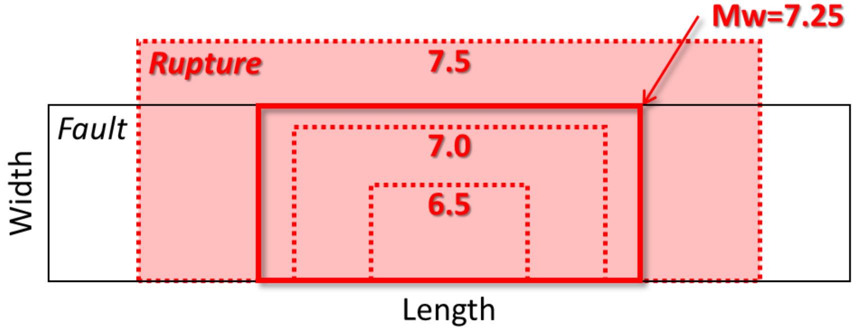
Double-truncated frequency-magnitude distribution from alternative formulations, such as Anderson & Luco (1983), Kagan (2002).




$$\dot{M}_s = \chi \dot{M}_g = \chi \mu L W \dot{D}$$

$\dot{M}_s$ : seismic moment rate
$\dot{M}_g$ : geologic moment rate
$\chi$ : seismic efficiency
$\mu$ : rigidity
$L$, $W$ : fault length and width
$\dot{D}$ : slip rate

Mmax is estimated as the value that corresponds to the largest rupture area fitting inside the fault without violating the assigned seismogenic depths and considering aspect ratio. Rupture dimensions from Leonard (2014) for crustal faults and Allen & Hayes (2017) for subduction interfaces.





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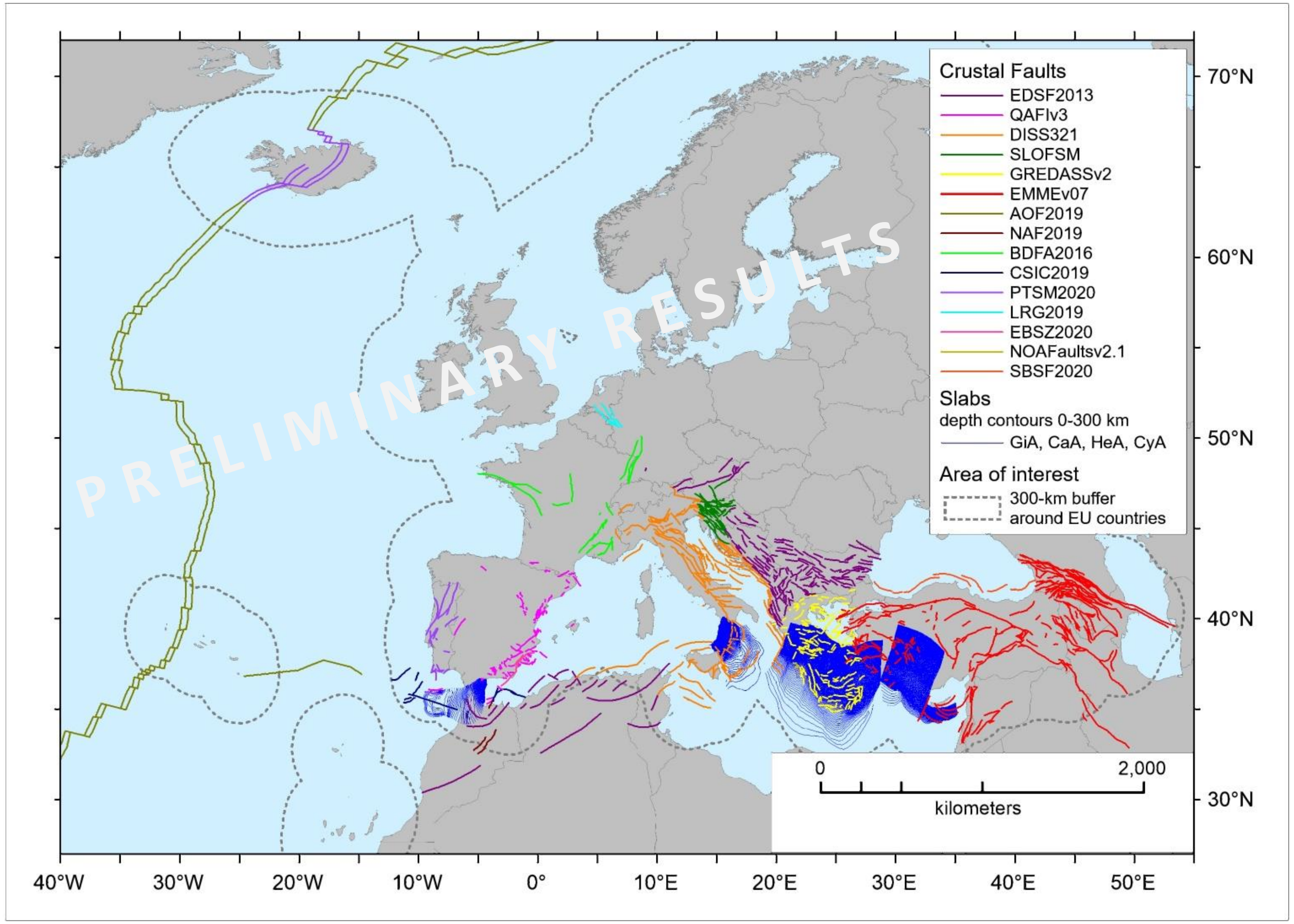
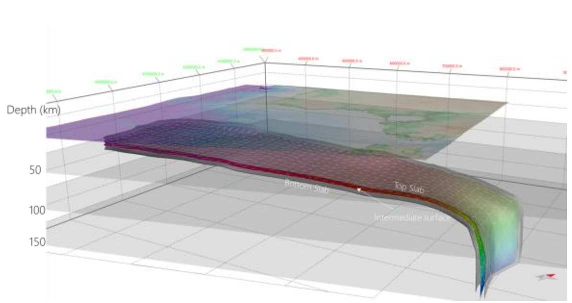
## RESULTS: GEOMETRY

### Map view of the collated DBs

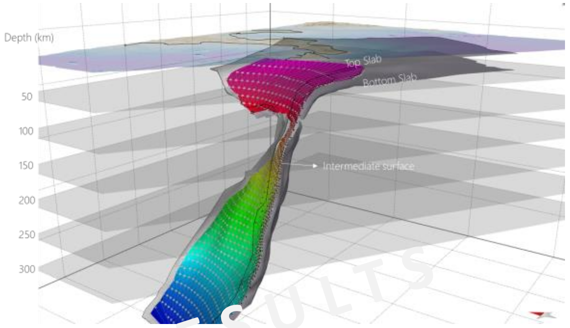



### Oblique views of 3D slabs

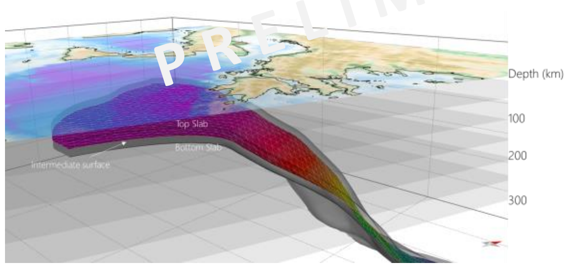
Gibraltar Arc



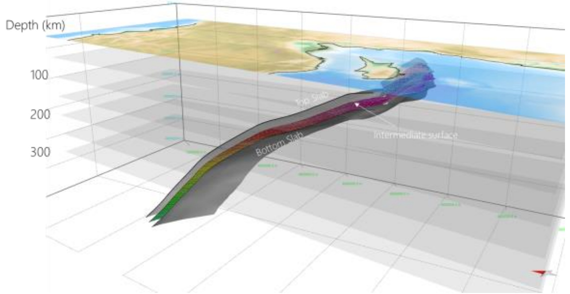

Calabrian Arc




Hellenic Arc




Cyprus Arc





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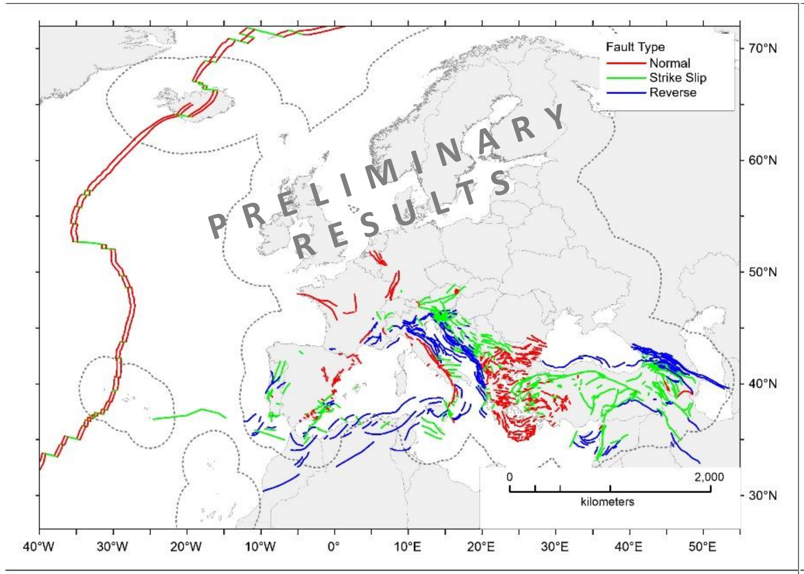
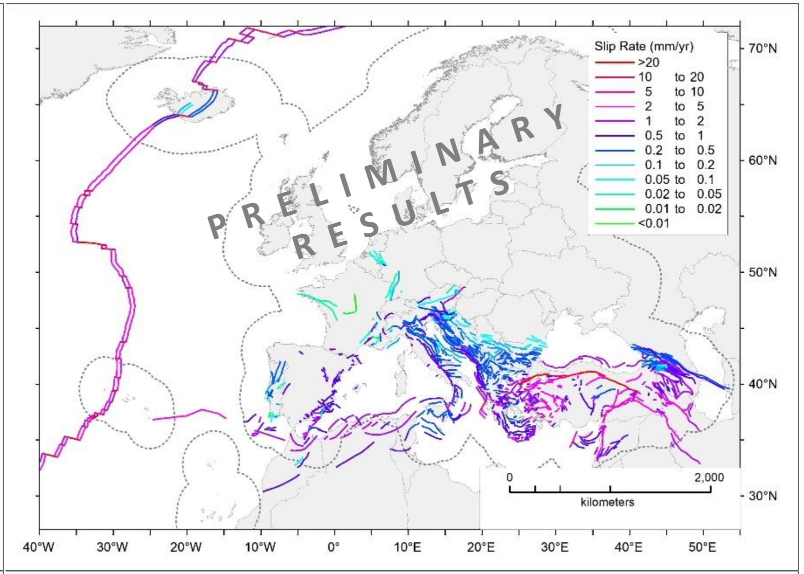
## RESULTS:

## CRUSTAL FAULTS

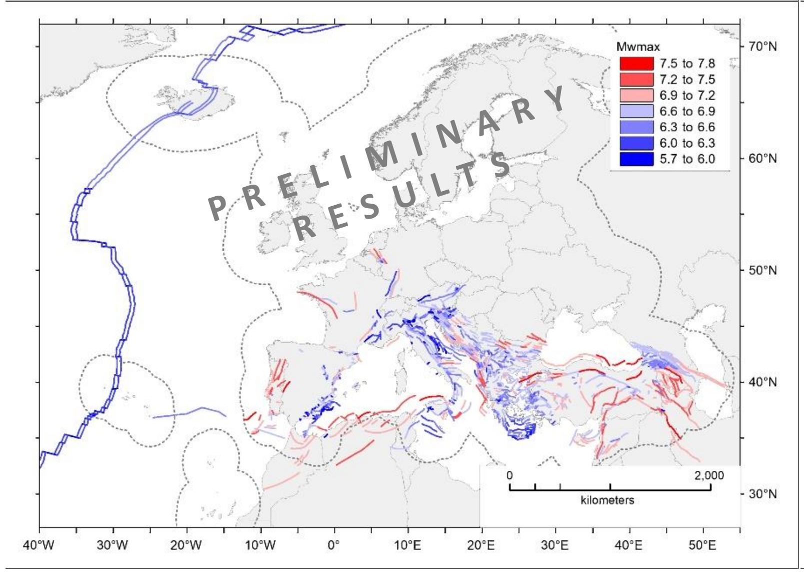
Faulting types

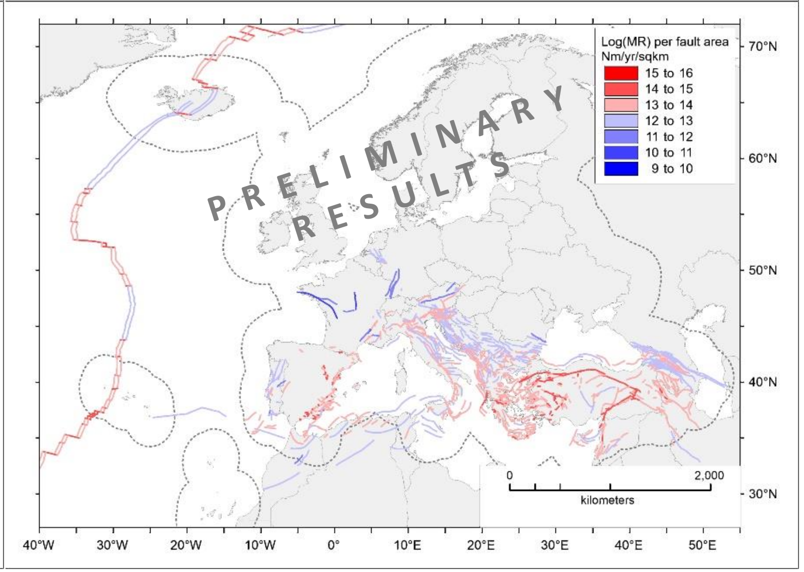



Slip rates

Maximum magnitudes




Normalized tectonic moment rates



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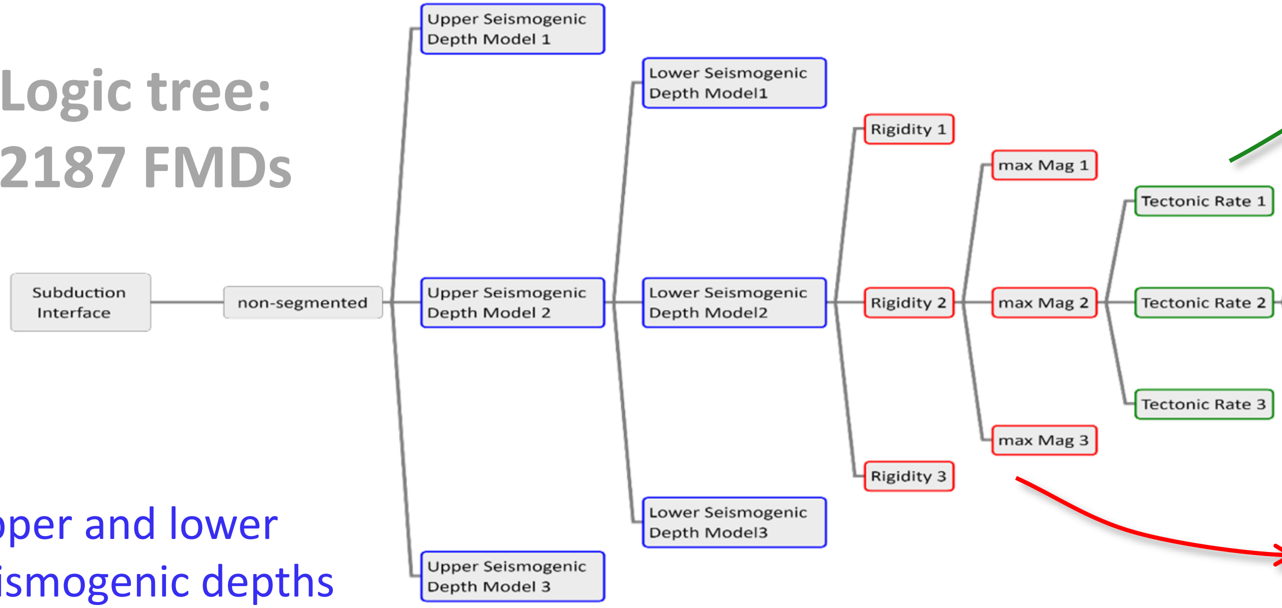
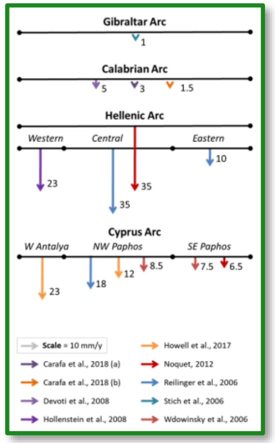
HOME

# RESULTS: SUBDUCTION INTERFACES

Logic tree:
2187 FMDs

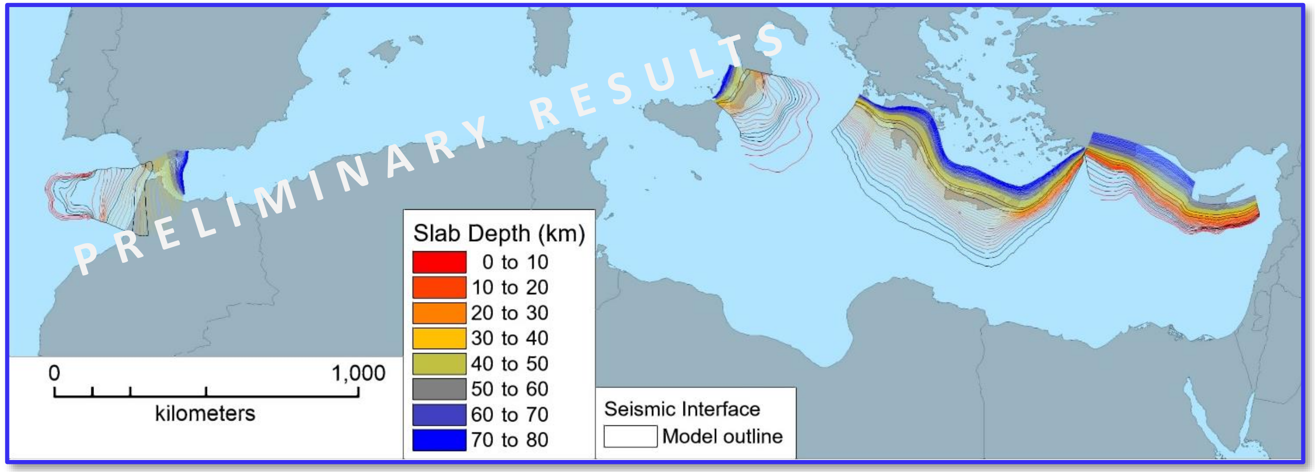



Tectonic rates: see slide #6

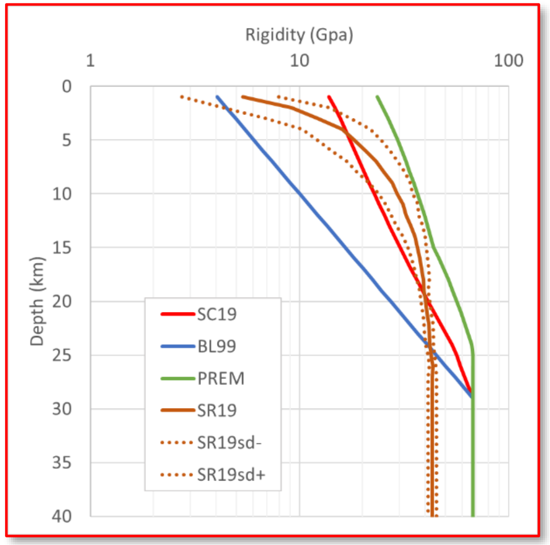



Coupling and b-value fixed alternatives

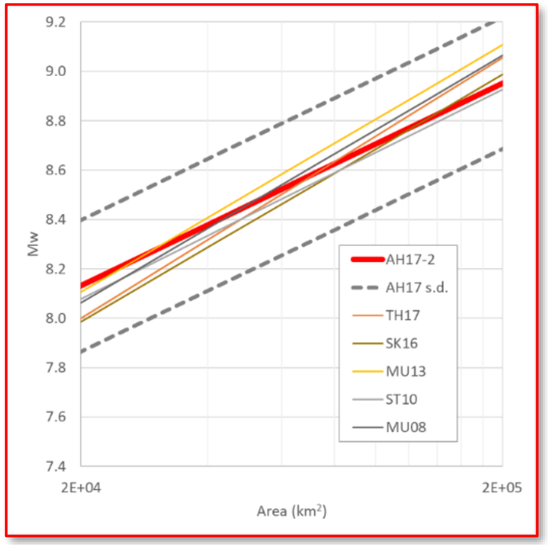
Upper and lower seismogenic depths




Rigidity




Max Magnitude



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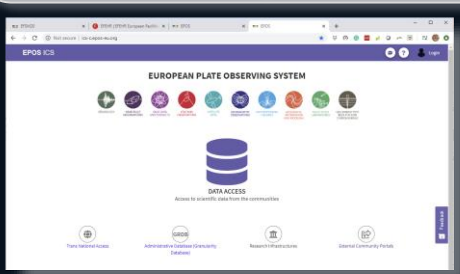
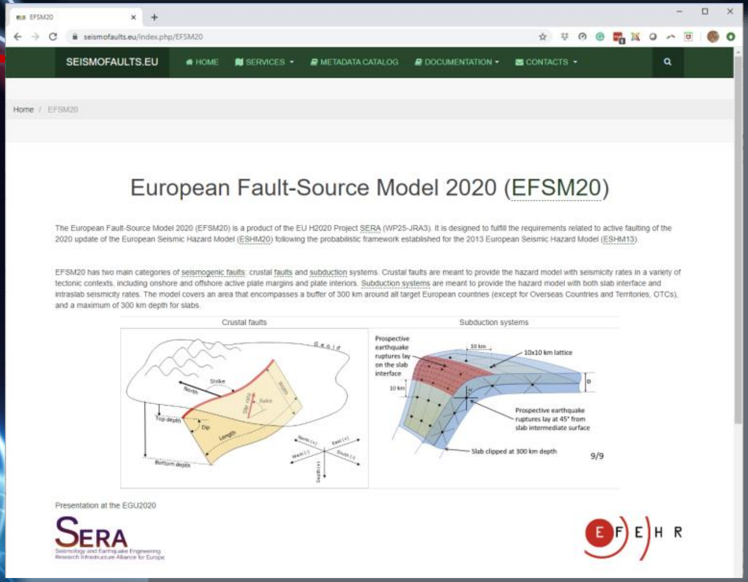
## USE

*Online by late 2020*

www.ics-c.epos-eu.org

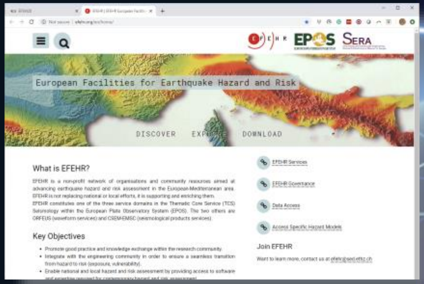



www.seismofaults.eu/EFSM20/





www.efehr.org




Findable Accessible Interoperable Reusable



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# Thank you!

EGU General Assembly 2020

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[6]Geological Survey of Slovenia, Ljubljana, Slovenia
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https://doi.org/10.5194/egusphere-egu2020-7008

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