Improving the representation of apparent anelastic attenuation variability in regionalised Ground Motion Models in Europe with a focus in mainland France

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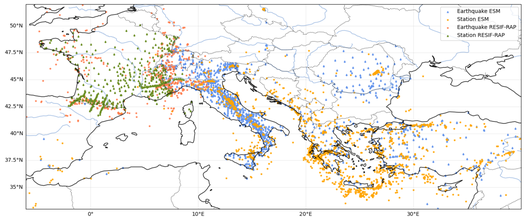
Abstract

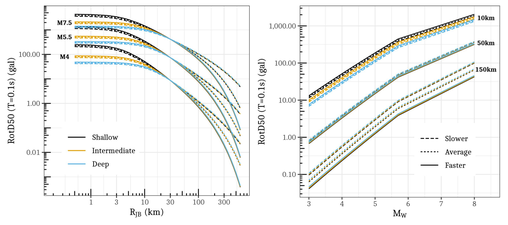
Context of the study and Methods

Ground motion records from shallow earthquakes in Europe



- RESIF-RAP dataset for France
- ESM dataset for Europe
-1459 earthquakes
-2220 stations
-34060 records of SA

An Ergodic Ground Motion Model (GMM) for all Europe



A fixed model with:
- Magnitude scaling
- Geometrical spreading
- Apparent anelastic attenuation

-> Mean model for all Europe constrained with a linear regression from data

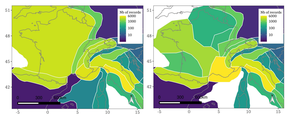
Limits of the Ergodic Ground motion model

Increase of data is not sufficient to reduce uncertainties in the model due to heterogeneities of the geology and tectonics in Europe

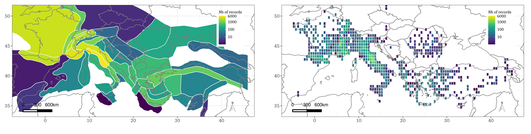
→ **Regionalisation of Ground motion model**:
- site effect
-between event variability
- locality to locality variability
- Apparent anelastic attenuation variability

Regionalisation of apparent anelastic attenuation

Current Regionalisation used: Basili model based on homogeneous tectonic processus region



Crustal properties-based regionalisation: Rayleigh wave group velocities for Metropolitan France

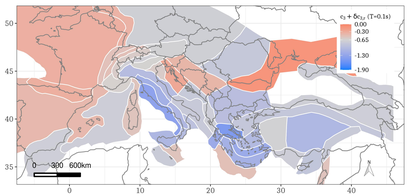


Null hypothesis based regionalisation: Regular Grid of size 0.5°*0.5°

Objective : Improve the uncertainties in Ground motion model
-> Ground motion model: model that predict Ground motion produced by earthquakes with source, path and site effects parameters, used in seismic hazard studies
Creation of homogeneous region in term of attenuation
-> decrease the uncertainty in Ground Motion Model
-> Improve the Seismic Hazard studies

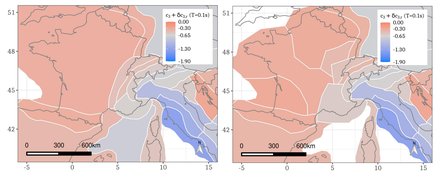
Results: Attenuation in Europe from various regionalisation

Regionalisation from Basili



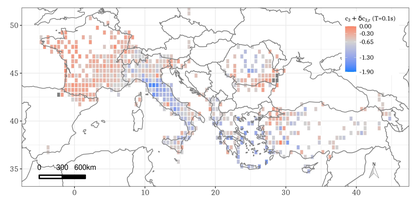
- Variation of apparent anelastic attenuation In Europe
- Italy and Greece with higher attenuation (lower Ground Motion (GM))
-France, Pyrennes and Alps with low attenuation

Regionalisation from velocities



- Small variation of attenuation in France
- Variation of attenuation with modification of region
- Some region could be merged
- AIC criteria : statistical comparison of model
  - Basili : 69 247
  - Tomography : 69 337
  - Grid : 68 622

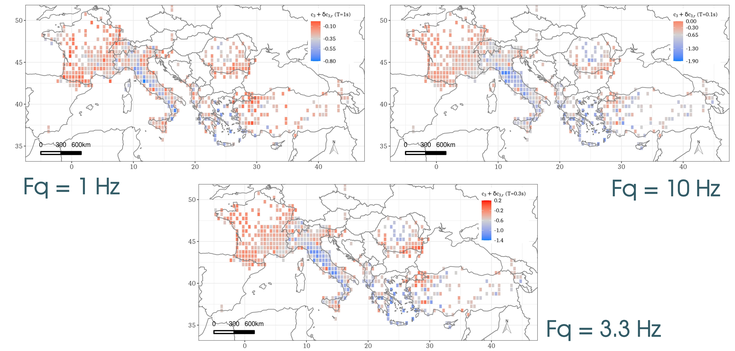
Regionalisation as a Grid



- Same general attenuation in Europe
- Some regions with extrapolated data (Dinarides)
- Some variation between polygons not observed in Grid (Apennines)
-Some variation inside a polygon (France)

Variation of attenuation with frequencies

Variation of apparent anelastic attenuation



Frequency dependance of the attenuation :
- Higher variation of attenuation at high frequency and a lower average attenuation at high frequencies
- France with lower attenuation than average and stronger attenuation in the East part
- Greece and Italy with higher attenuation than the average
- Heterogeneous attenuation in the Alps around the average value

In adequation with state of the art for France (Mayor et al. 2018)
Correlation of higher attenuation with higher seismicity (Mitchell et al. 2008)

Take home message

Seismic hazard studies requires precise Ground Motion model. Due to heterogeneous geology and tectonics in Europe, regionalisation of parameters in the model are necessary. In this study, we are focusing on creating homogeneous region in term of attenuation. Grid-based regionalisation allowed a better model and representation of attenuation and is also more precise to study and compare the attenuation with other crustal properties. However, the Grid-based regionalisation does not provide clear distinction between two homogeneous region in term of attenuation easily applicable for seismic hazard studies.

References

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