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Methodological comparison of macroseismic magnitude estimates for events along the French-Italian border

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Union Géodésique et Géophysique Internationale



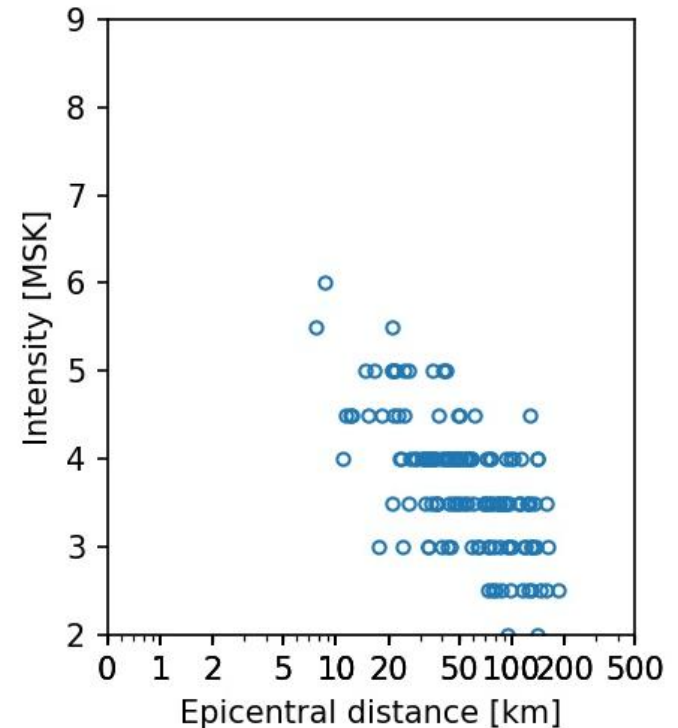
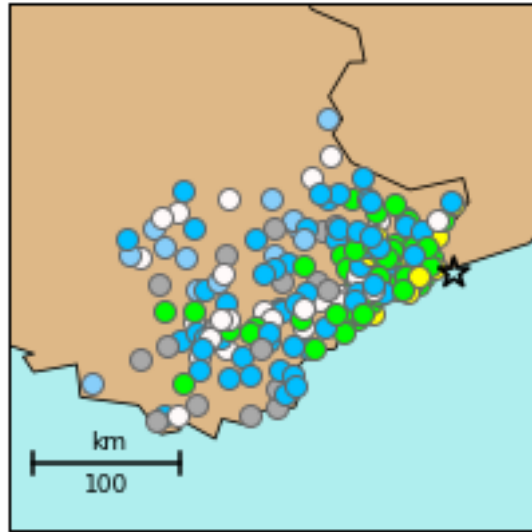
IUGG

International Union of Geodesy and Geophysics

Macroseismic Intensity data

21/04/1995 Mw=4.4 (Si-Hex)

- ☆ Epicentre
- I / I-II
- II / II-III
- III / III-IV
- IV / IV-V
- V / V-VI
- VI / VI-VII
- VII / VII-VIII
- VIII / VIII-IX
- IX / IX-X
- Non-Ressenti
- Ressenti



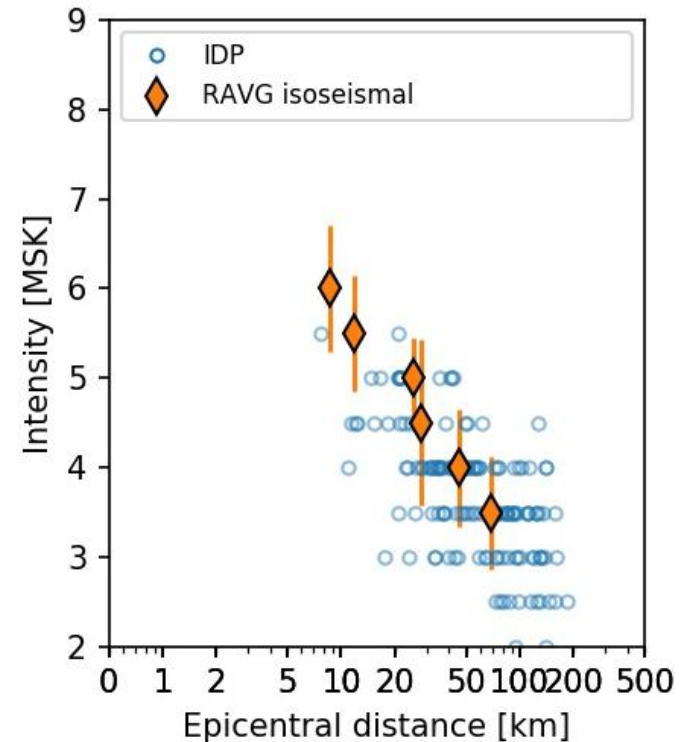
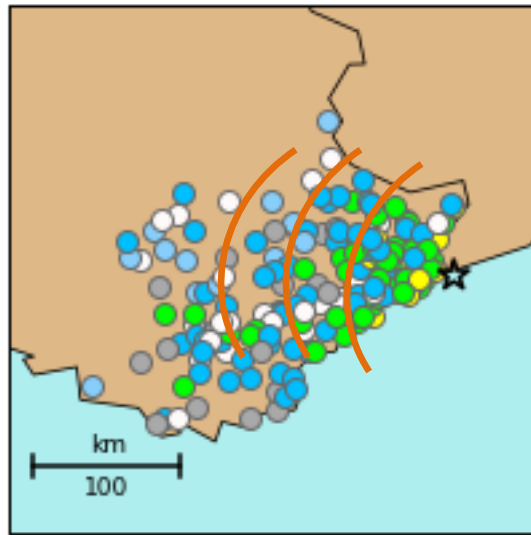
V → Strong : felt by most people, fall of small objects, visible damage to masonry structures

II → Hardly felt: felt only by individuals at rest

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Intensity prediction equation (IPE) : $I=f(M, \text{distance})$

Questions

- Different methodologies to estimate historical earthquake parameters from macroseismic intensity data
 - ➔ How do 2 different methodologies (Boxer/Italy – INGV and QUake-MD/France-IRSN) impact magnitude estimates?
 - ➔ Compare estimated magnitudes using the same macroseismic intensity data set

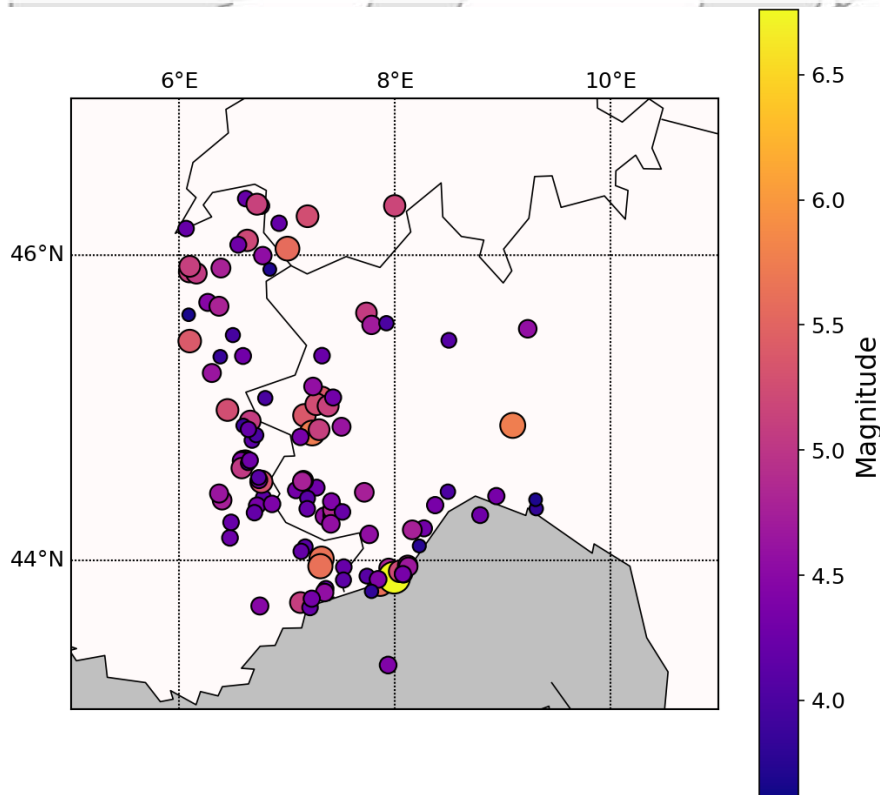
Plan of presentation

1. Macroseismic data set used for the comparison exercise
2. BOXER and QUAKE-MD methodologies
3. Comparing QUAKE-MD/BOXER magnitude estimates
4. Conclusions and perspectives

1. Macroseismic data set used for the comparison exercise

117 earthquakes along the French Italian border:

- More than 3 intensity classes
- 2 intensity classes and more than 5 macroseismic data point

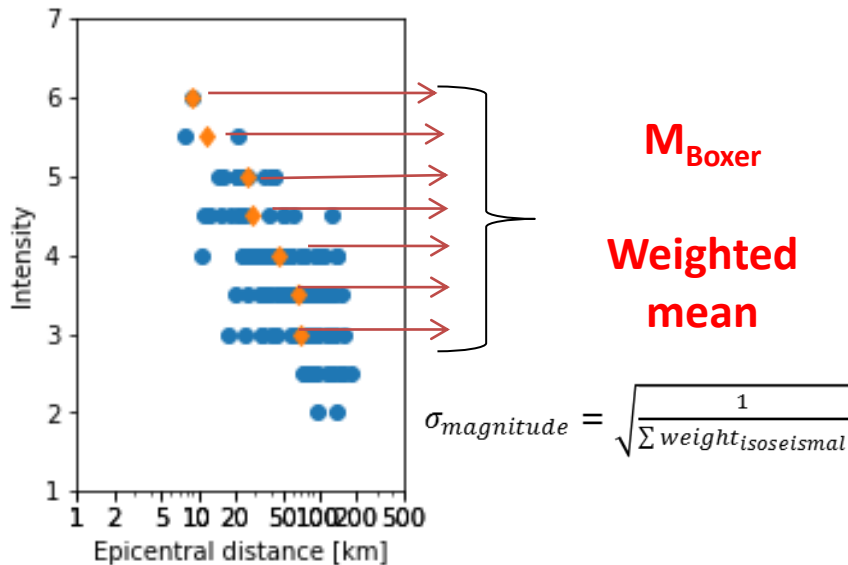


Macroseismic magnitudes are estimated by applying QUAKE-MD and BOXER to **Sisfrance macroseismic intensity data points**

2. Boxer and QUake-MD methodologies

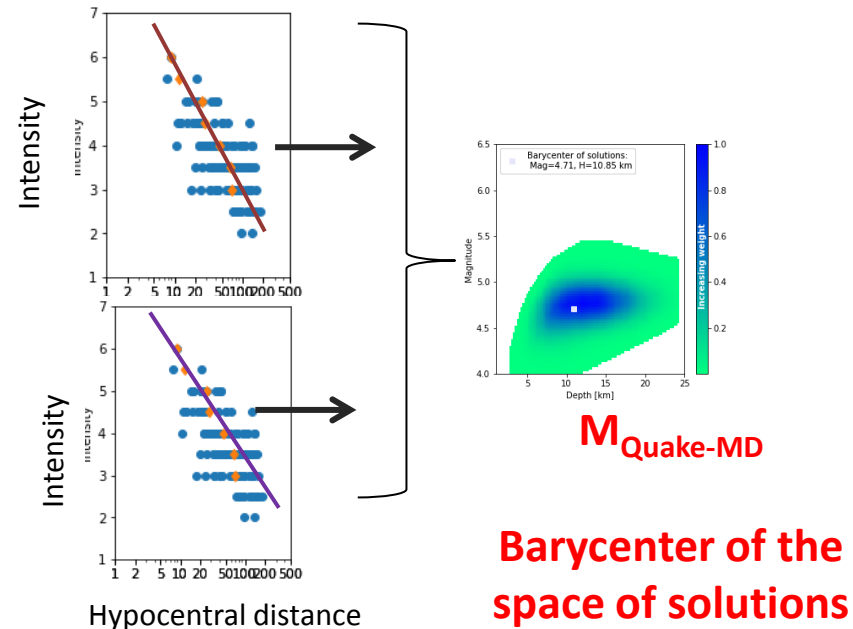
Boxer (INGV)

- Boxer calibration events
- $M(I) = a(I) + b(I)I_0 + c(I)[\log(\pi D_{epi})]^2$
- Depth implicitly taken into account
- Magnitude are computed for each **intensity level**
- Quantified uncertainties = f(#data)



QUake-MD (IRSN)

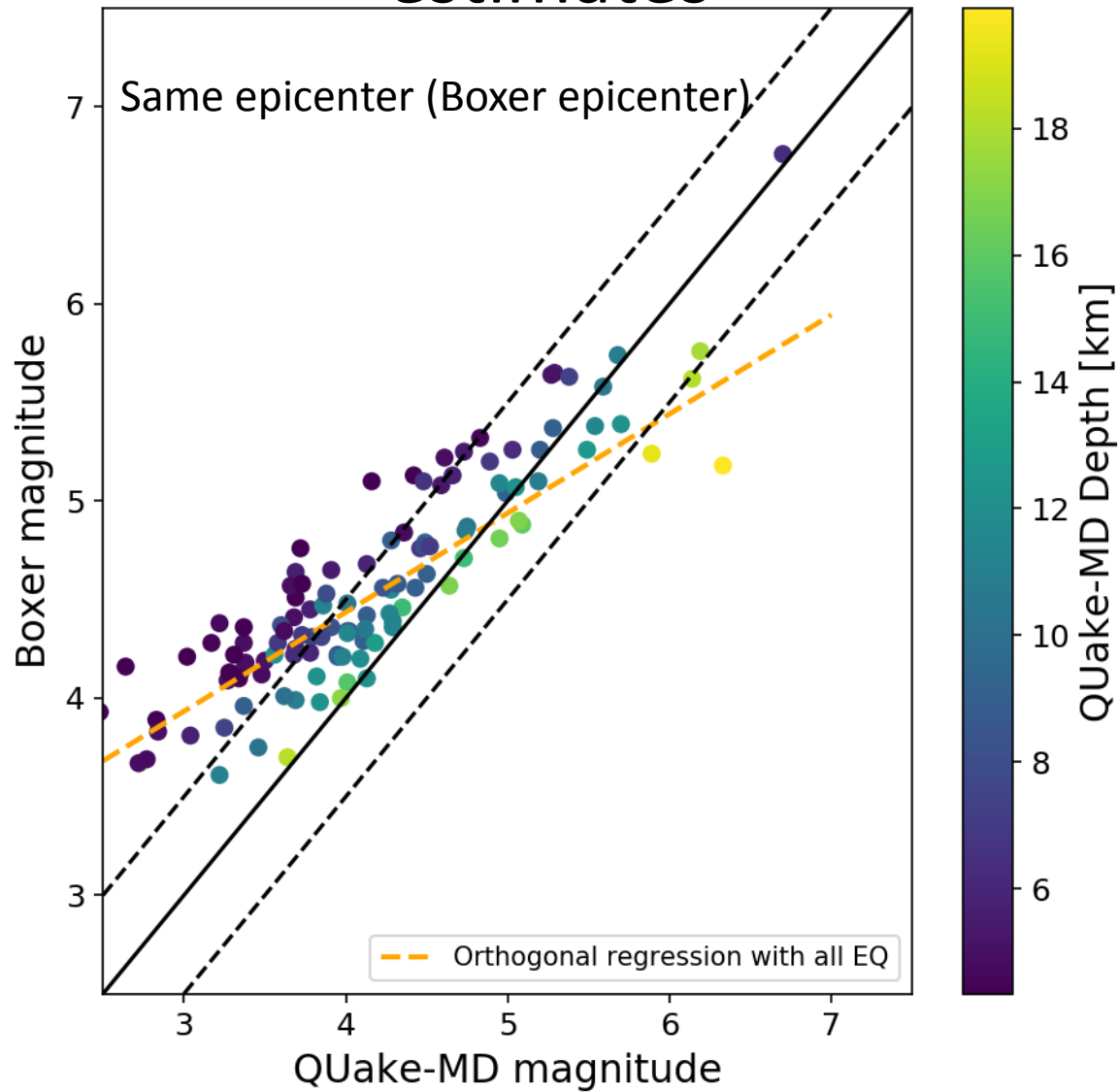
- QUake-MD calibration events
- $I = C_1 + C_2M + \beta \log(D_{\text{hypo}})$
- Depth explicitly taken into account
- Magnitude and depth are computed **to fit the macroseismic field**
- Uncertainty on I_0 taken into account
- Quantified uncertainties = f(data quality, numerous IPE)



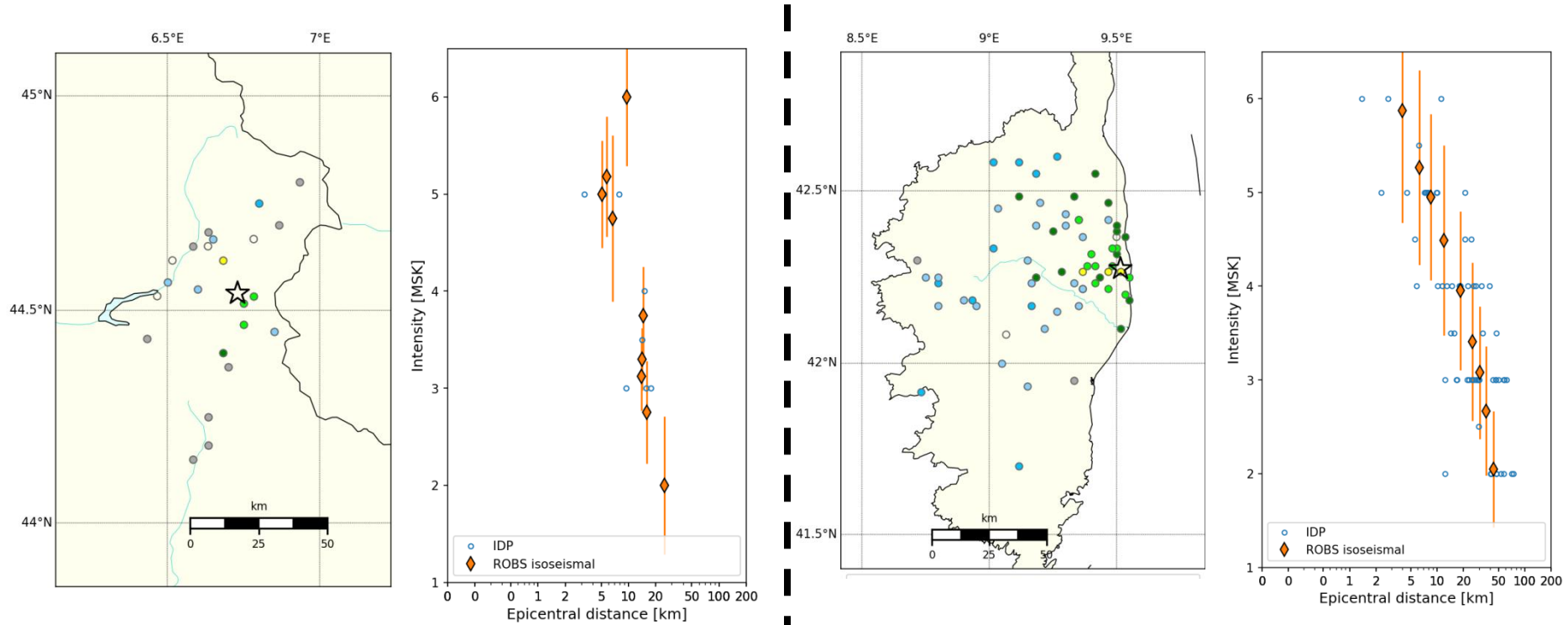
3. Comparing QUAKE-MD/BOXER magnitude estimates

- First comparison : same epicenter (I_0 and xy), Boxer's epicenter
- Second comparison : for Boxer, Boxer's epicenter, for QUake-MD SisFrance epicenter

3. Comparing QUAKE-MD/BOXER magnitude estimates



3. Comparing QUAKE-MD/BOXER magnitude estimates



Sparse data → rapid decrease of intensity data

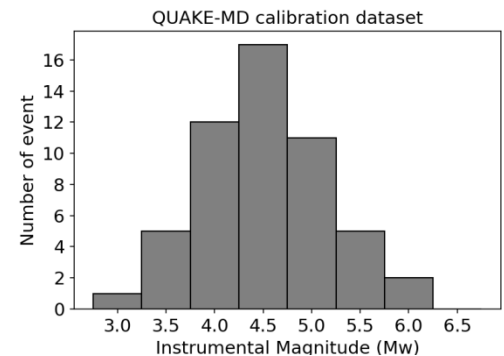
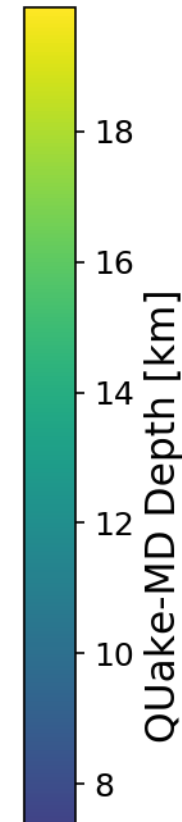
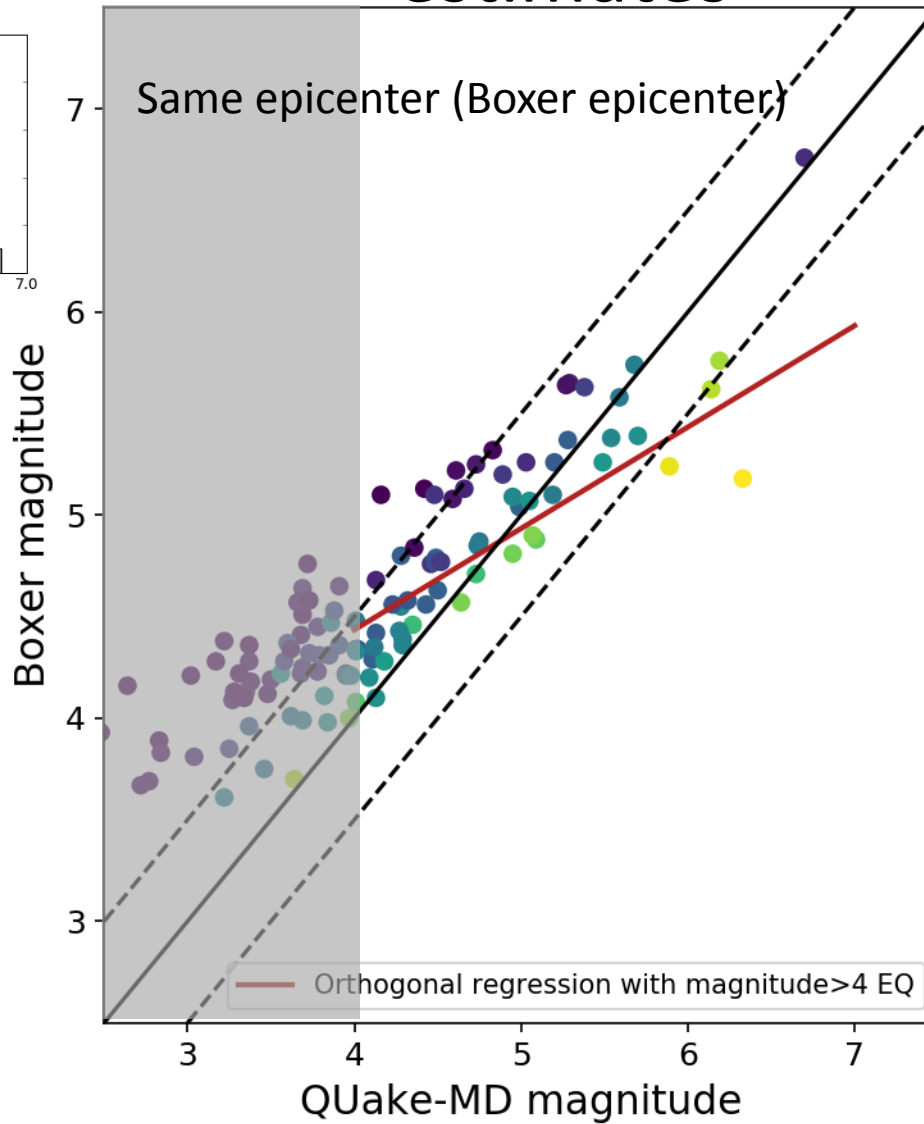
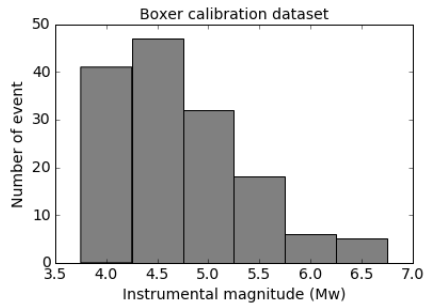
Rapid decrease of intensity data

- | | |
|----------------|------------------|
| ☆ Epicenter | ● VII / VII-VIII |
| ○ I / I-II | ● VIII / VIII-IX |
| ● II / II-III | ● IX / IX-X |
| ● III / III-IV | ● X / X-XI |
| ● IV / IV-V | ● XI |
| ● V / V-VI | ● Not-Felt |
| ● VI / VI-VII | ○ Felt |

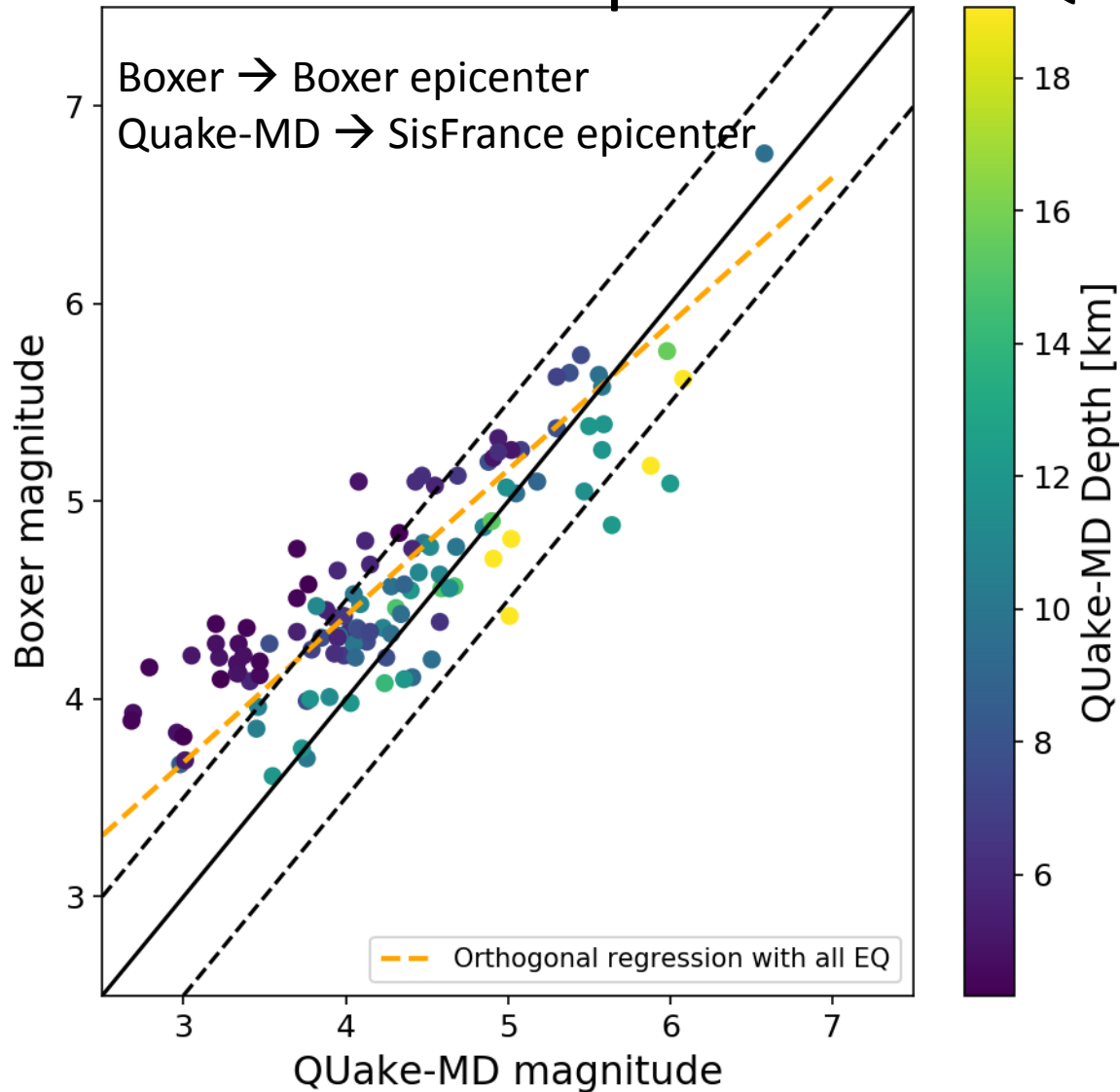
QUAKE-MD:

1. Rapid decrease of intensity data → Shallow depth
2. Shallow depth → small magnitude

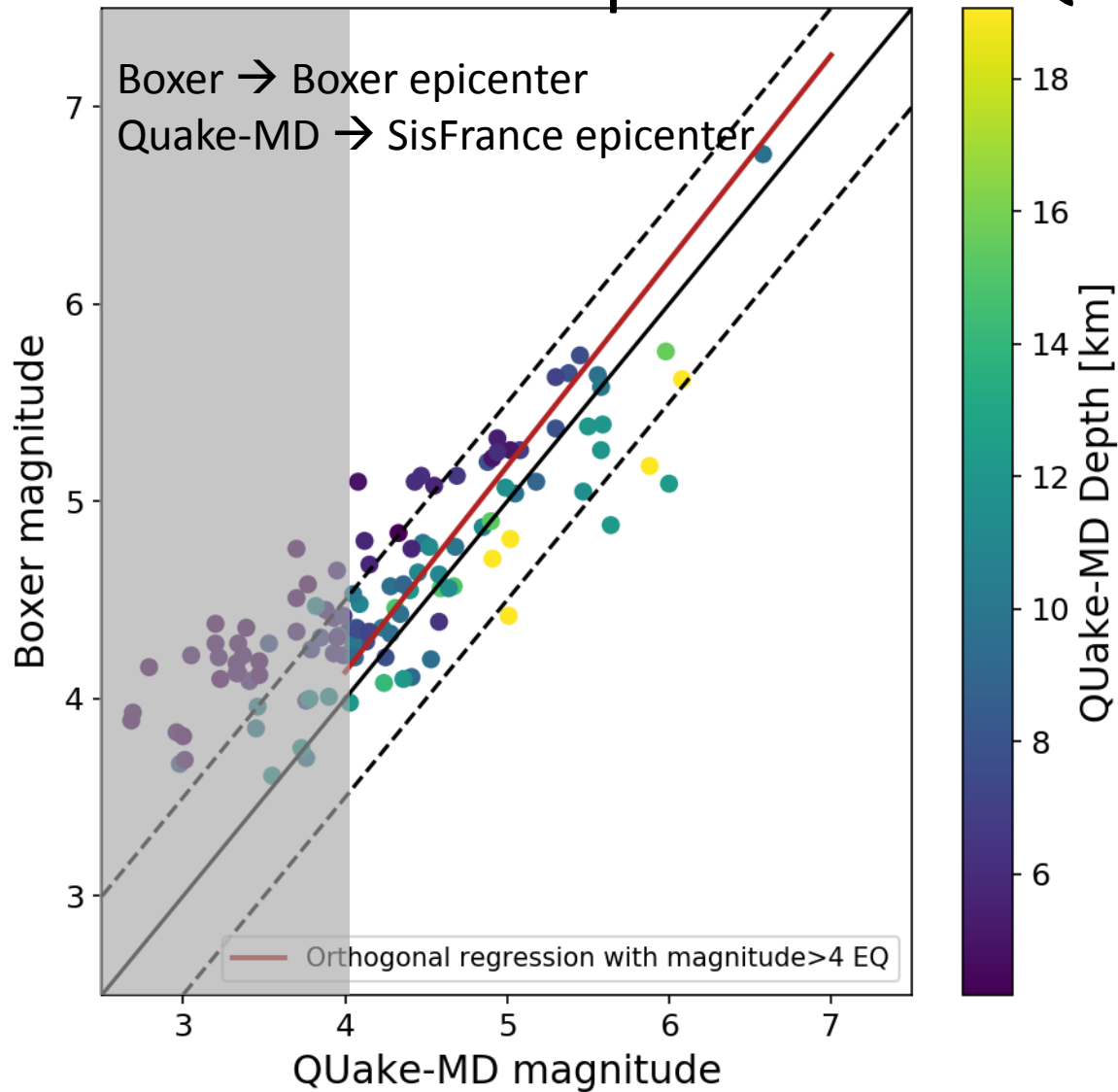
3. Comparing QUAKE-MD/BOXER magnitude estimates



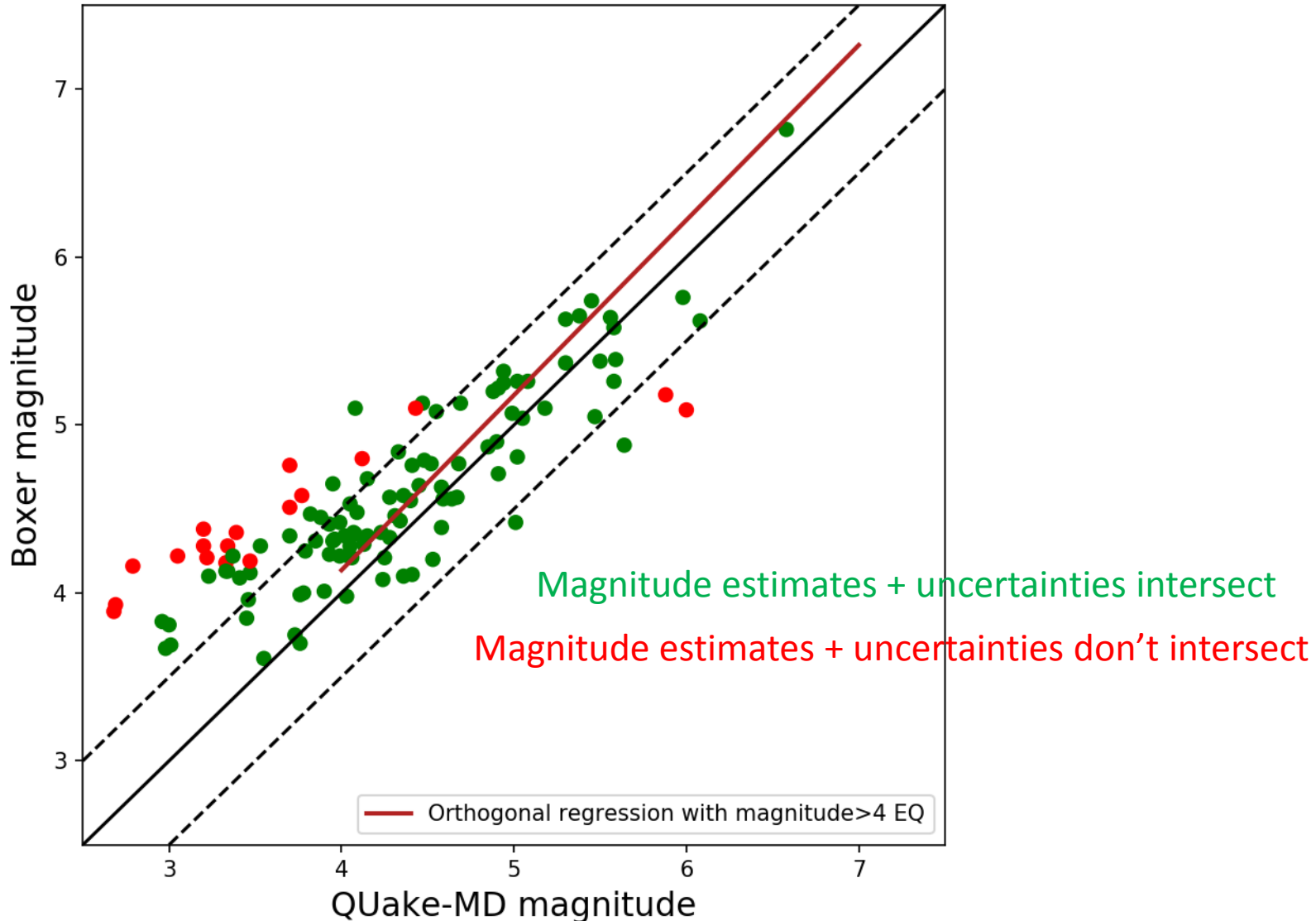
3. Comparing QUAKE-MD/BOXER magnitude estimates with SisFrance epicenter for Quake-MD



3. Comparing QUAKE-MD/BOXER magnitude estimates with SisFrance epicenter for Quake-MD



3. Comparing QUAKE-MD/BOXER magnitude estimates with SisFrance epicenter for Quake-MD



Conclusions

Comparing QUAKE-MD/BOXER magnitude estimates

- Good agreement between the two magnitude estimates (**with the uncertainties**)
- **No bias** between the two magnitude estimates
- **Epicenter** ($xy + 10$): part of the methodologies

NB IPEs should not be extrapolated beyond their limits of applicability