



How to deal with macroseismic magnitudes at borders: a methodological comparison of their estimates along the French-Italian border

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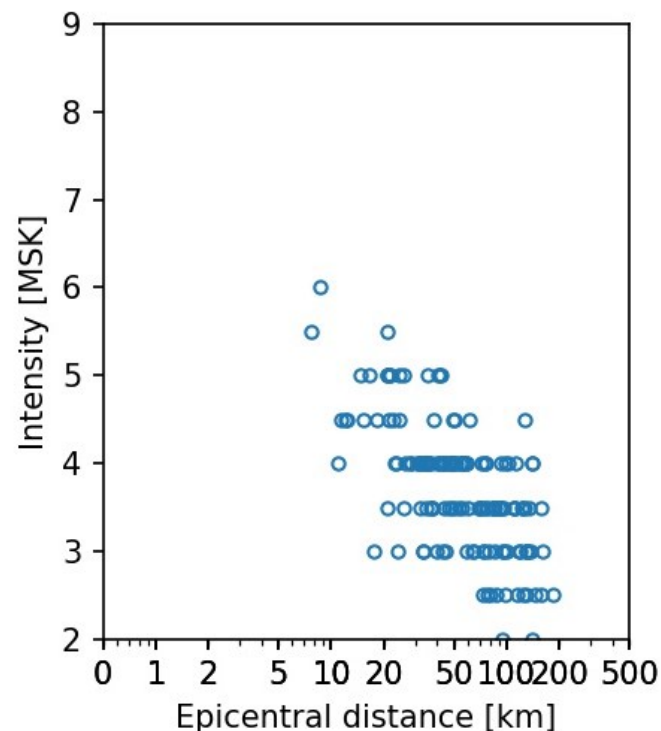
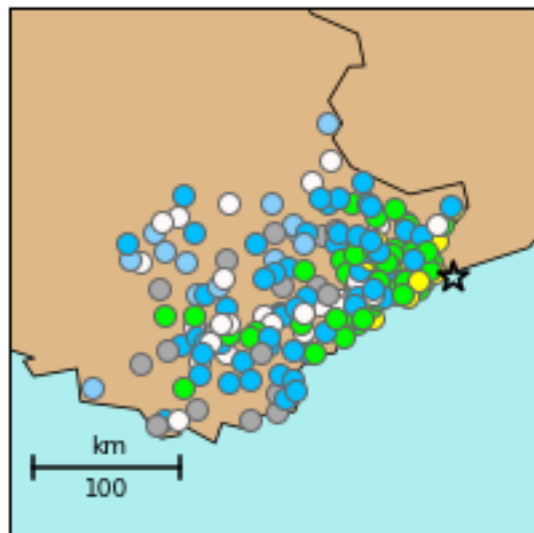
Methodological comparison of macroseismic magnitude estimates for events along the French-Italian border

Provost L., Scotti O., Antonucci A., Rovida A.



Macroseismic Intensity data

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

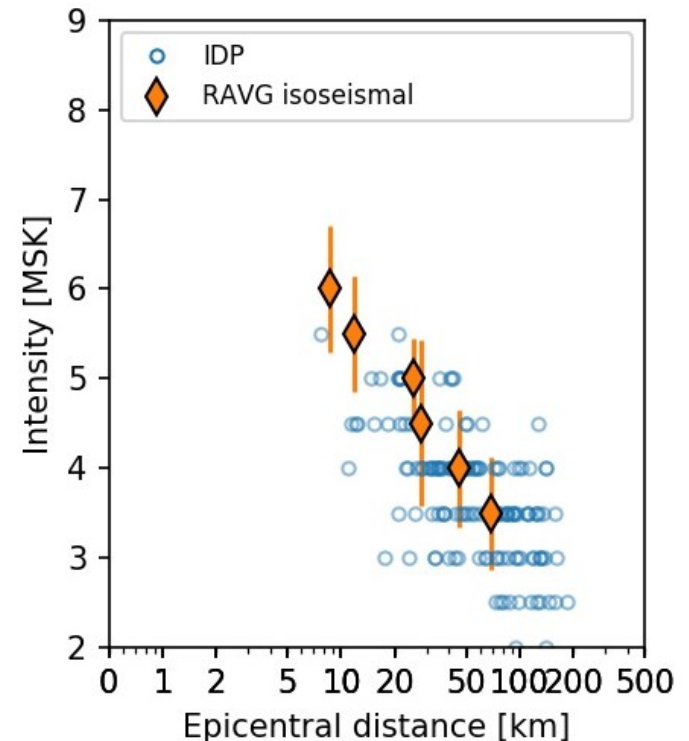
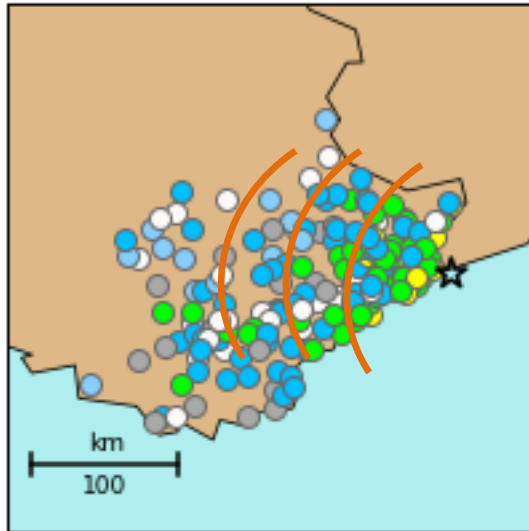


V → Strong : felt by most people, fall of small objects, visible damage to masonry structures

II → Hardly felt: felt only by individuals at rest

Macroseismic Intensity data

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



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

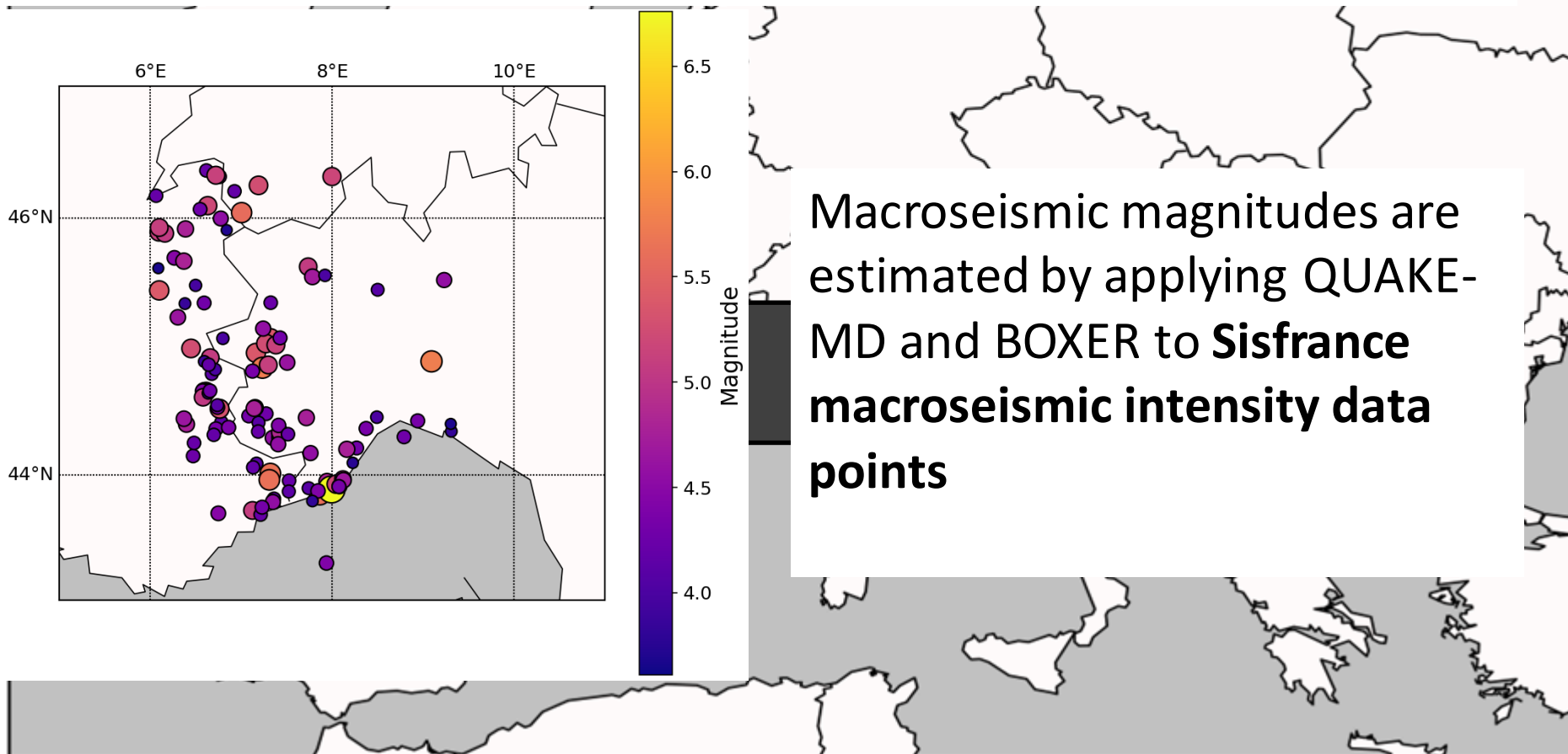
Plan of presentation

1. Macroseismic data set used for the comparison exercise
2. BOXER and QUAKE-MD methodologies
3. Comparing QUAKE-MD/BOXER magnitude estimates
4. Present conclusions
5. Next step of the comparison work

1. Macroseismic data set used for the comparison exercise

117 earthquakes along the French Italian border:

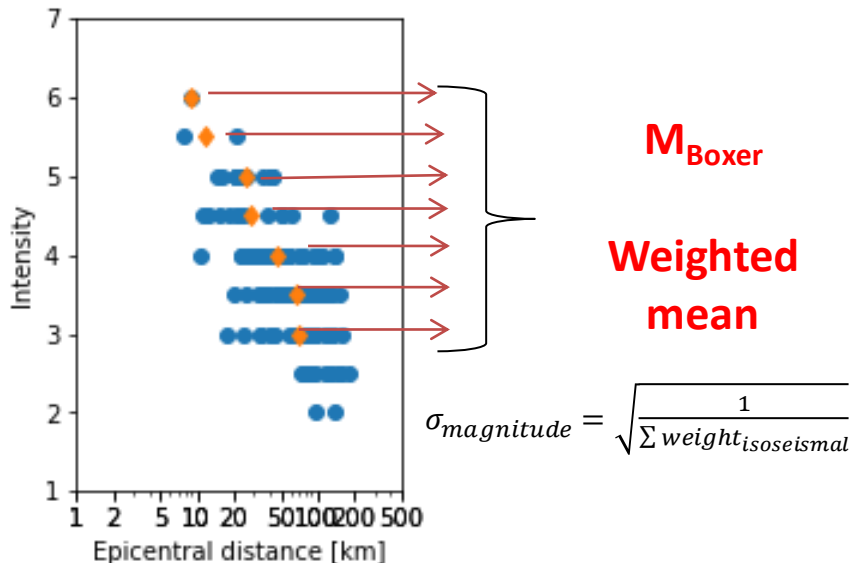
- More than 3 intensity classes
- 2 intensity classes and more than 5 macroseismic data point



2. Boxer and QUake-MD methodologies

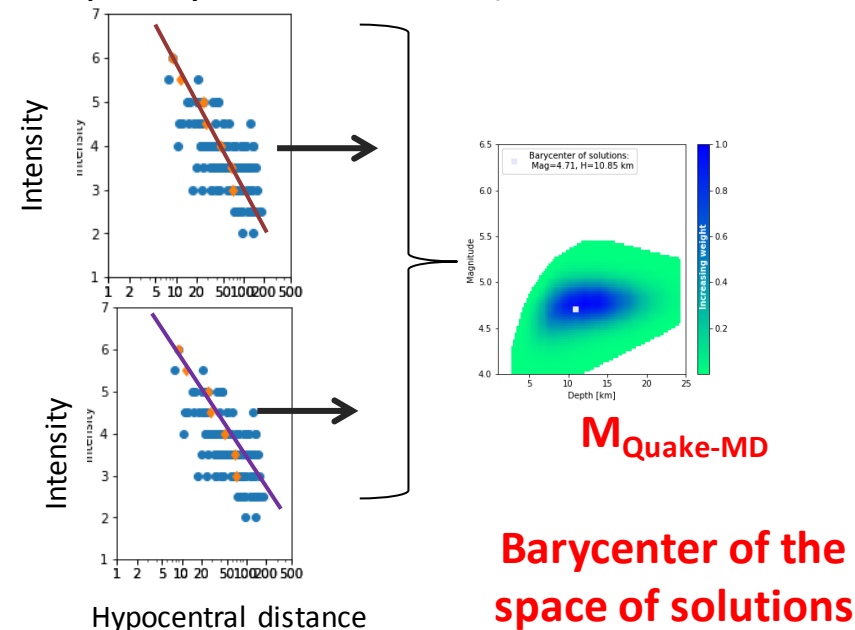
Boxer (INGV)

- 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)

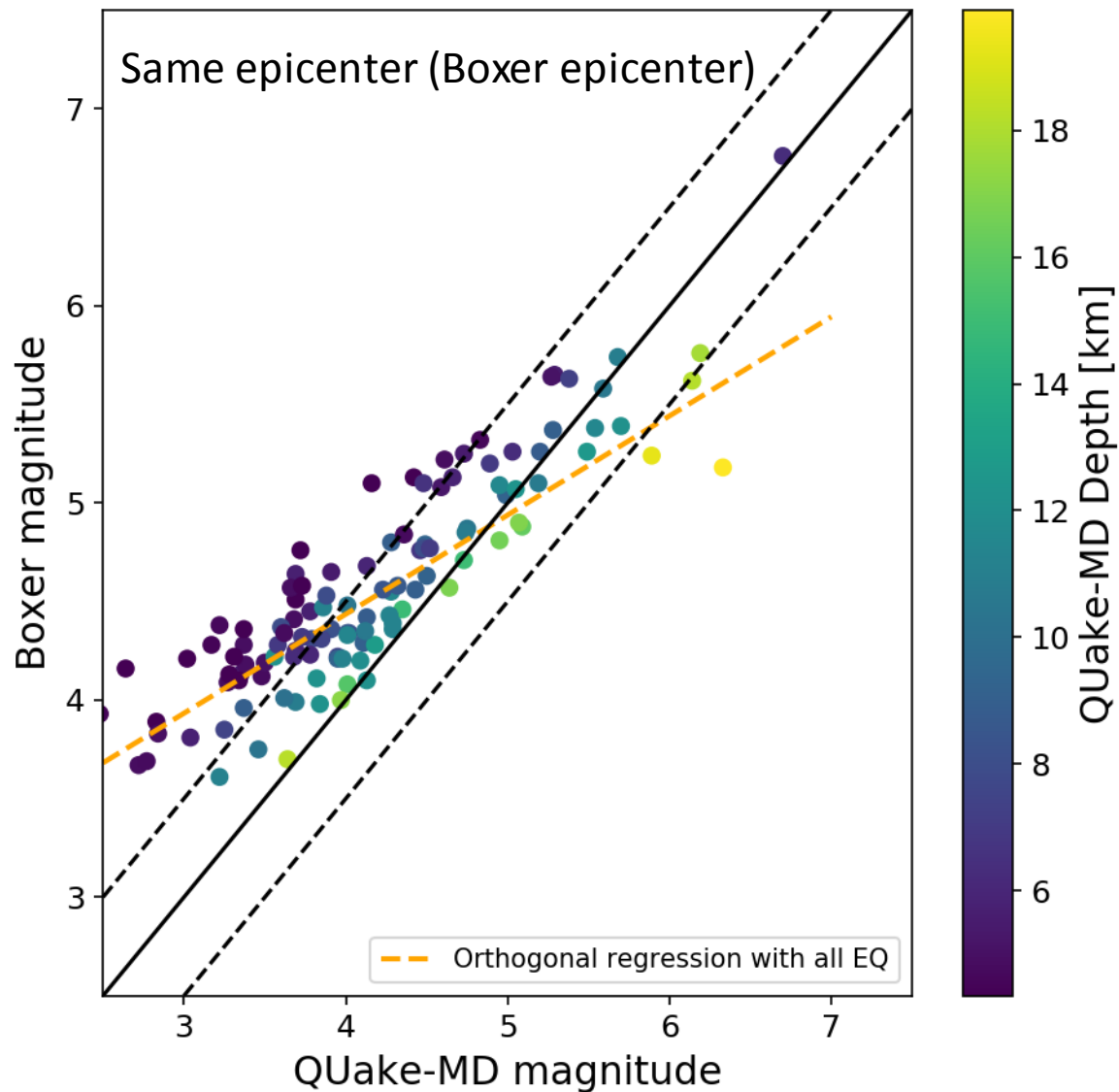
- QUake-MD calibration events
- $I = C_1 + C_2M + \beta \log(D_{hypo})$
- Depth explicitly taken into account
- Magnitude and depth are computed **to fit the macroseismic field**
- Uncertainty on I_0 taken into account
- Quantified uncertainties = f(data quality, numerous IPE)



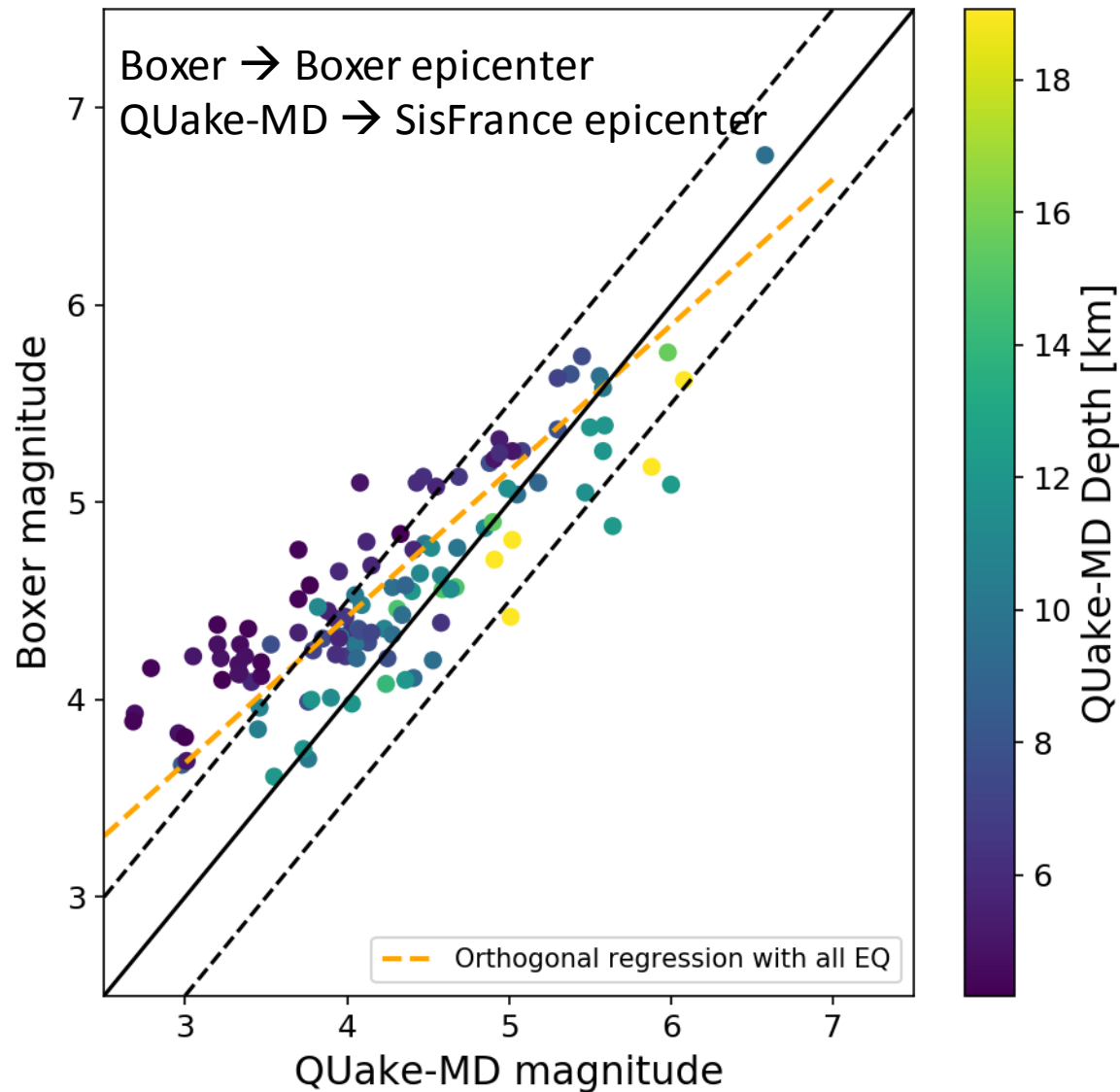
3. Comparing QUAKE-MD/BOXER magnitude estimates

- First comparison : same epicenter (l_0 and xy), Boxer's epicenter
- Second comparison : for Boxer, Boxer's epicenter, for QUake-MD SisFrance epicenter

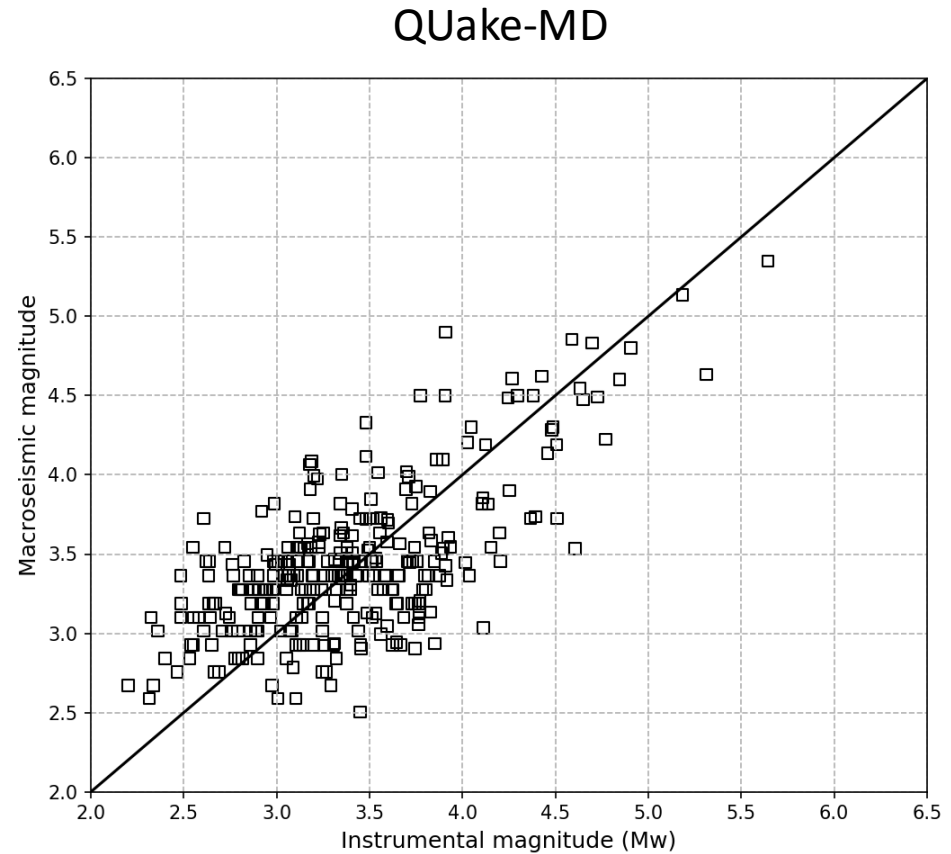
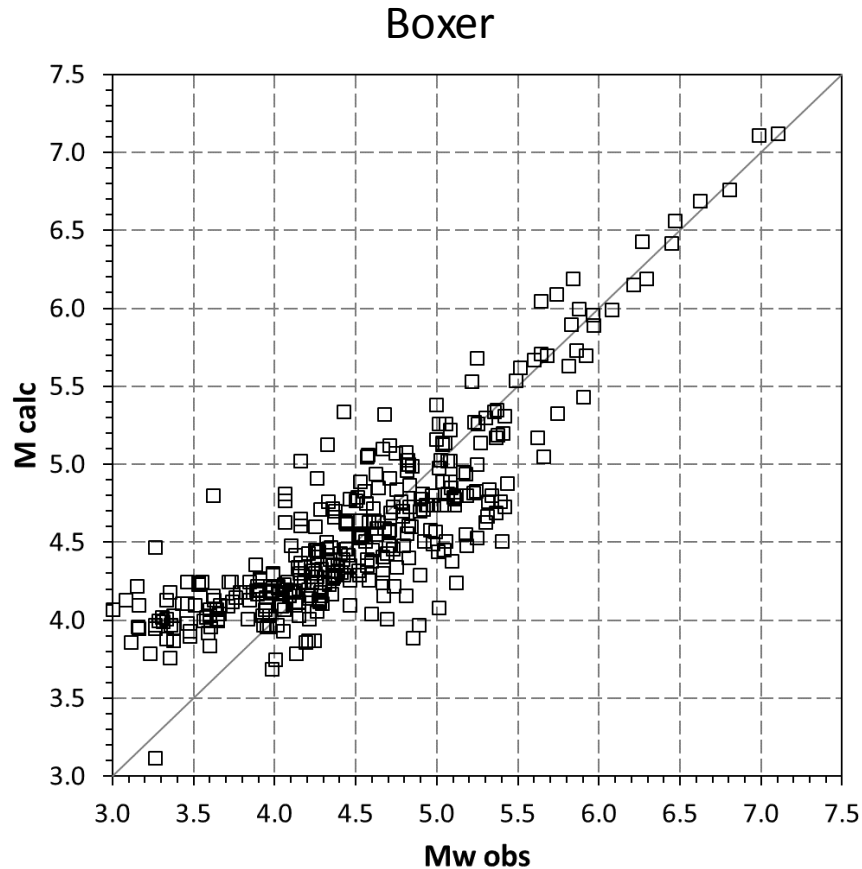
3. Comparing QUAKE-MD/BOXER magnitude estimates



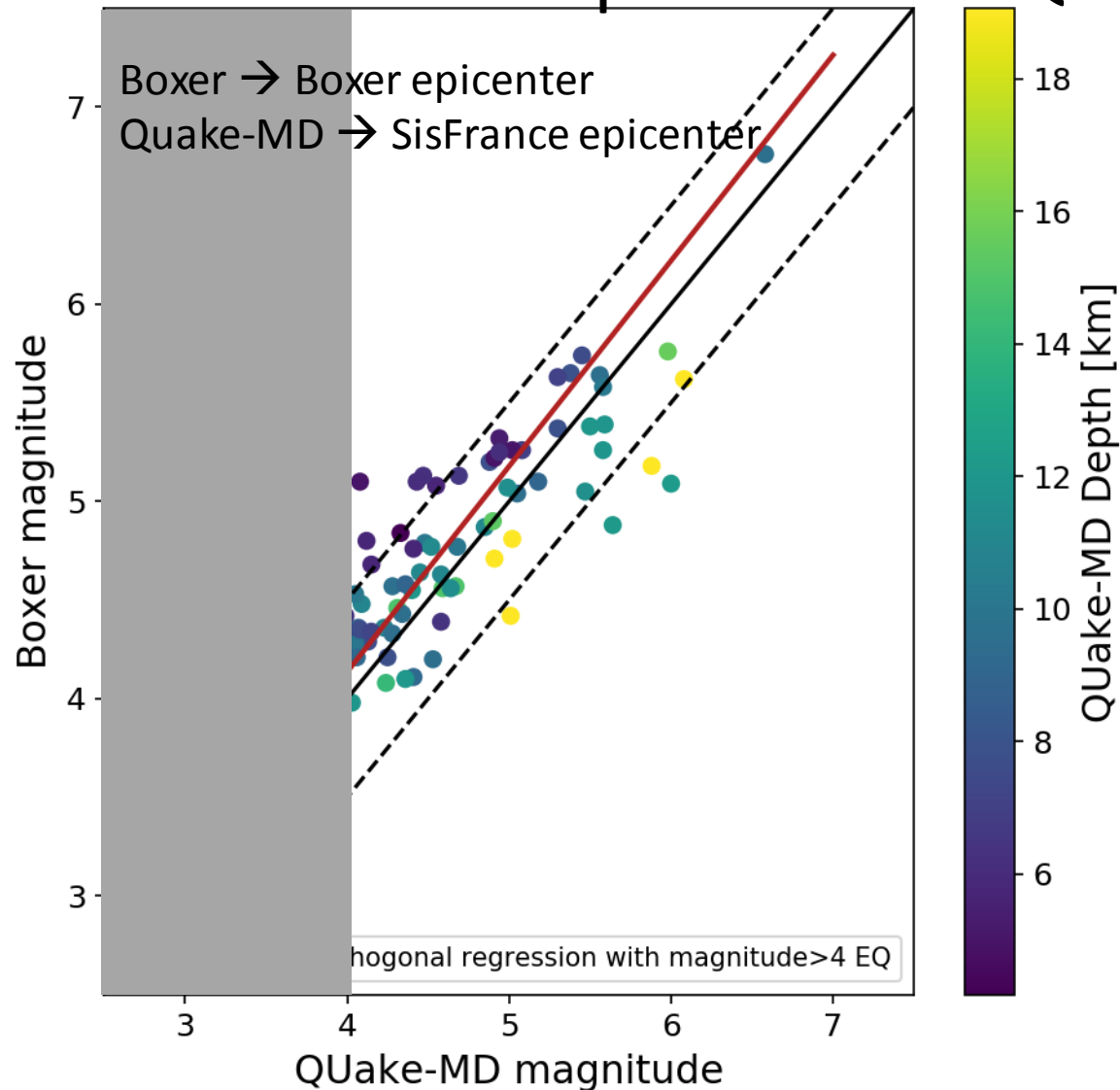
3. Comparing QUAKE-MD/BOXER magnitude estimates with SisFrance epicenter for QUAKE-MD



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

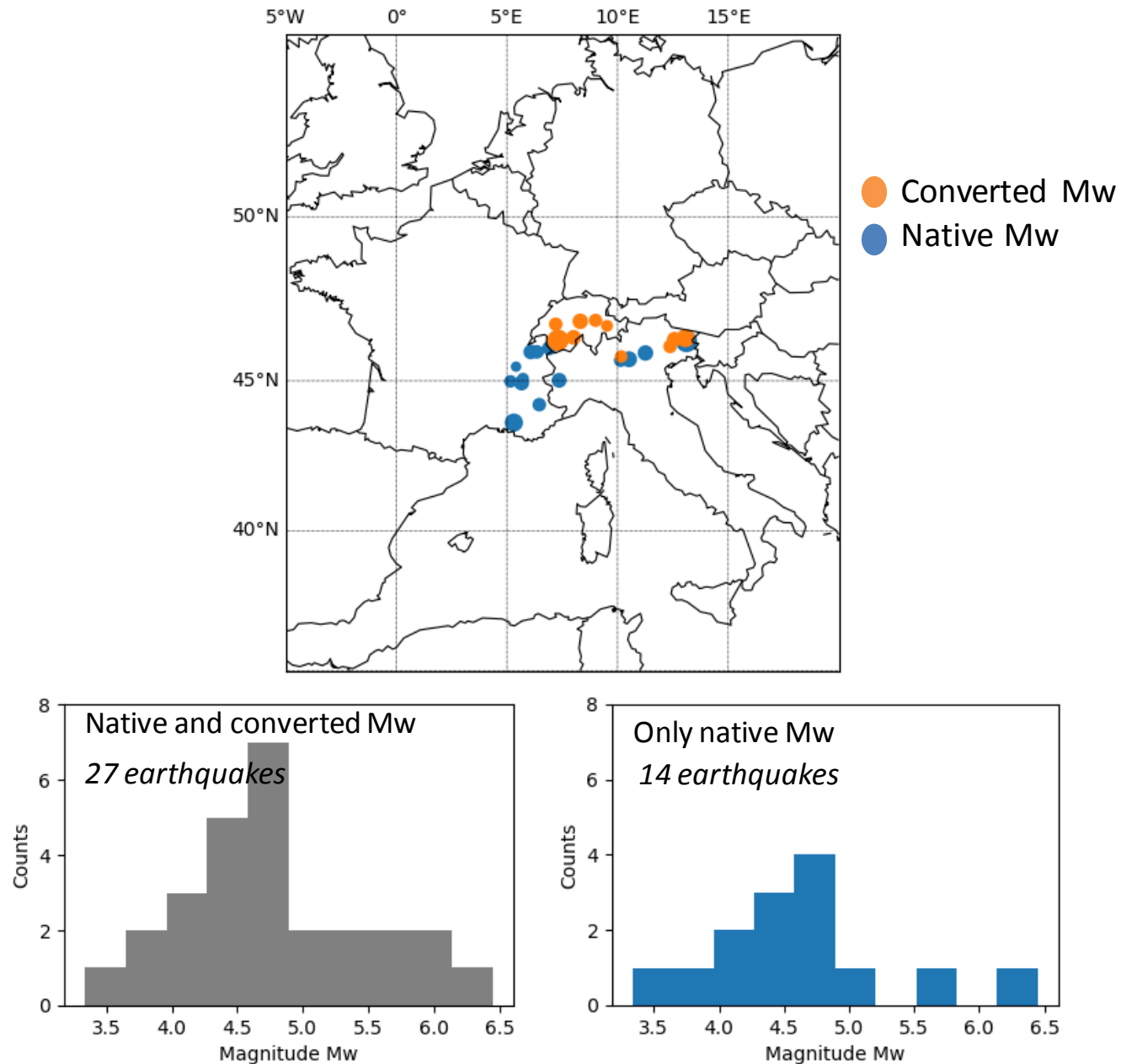
- **Epicenter** (xy + l0): not a data point
- Good agreement between the two magnitude estimates (**with the uncertainties**)
- **No bias** between the two magnitude estimates as a function of magnitude
- Trend in magnitude estimates that depend on depth

NB IPEs should not be extrapolated beyond their limits of applicability

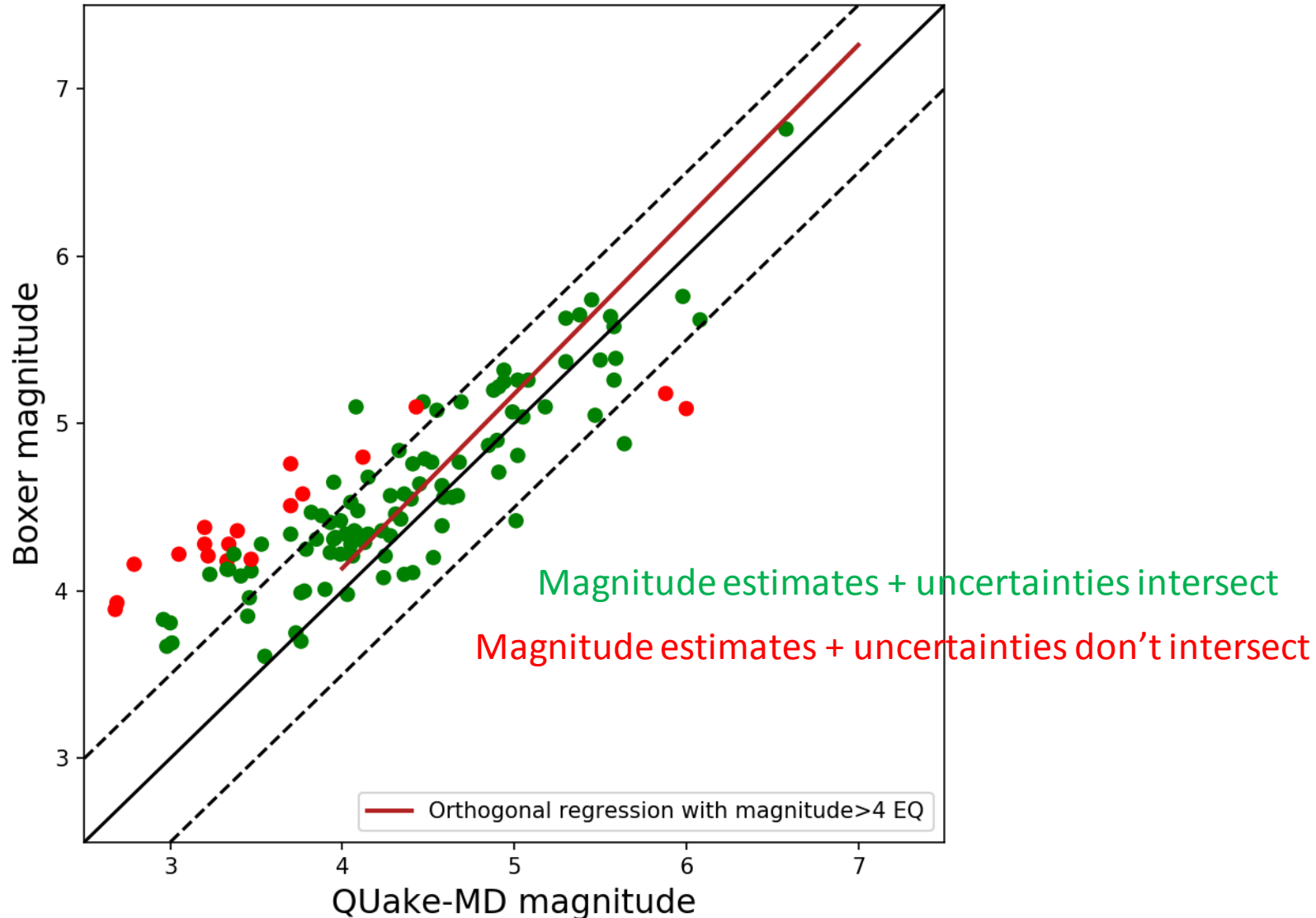
Next step of the comparison work : calibration
of the respective IPEs on the same calibration
dataset

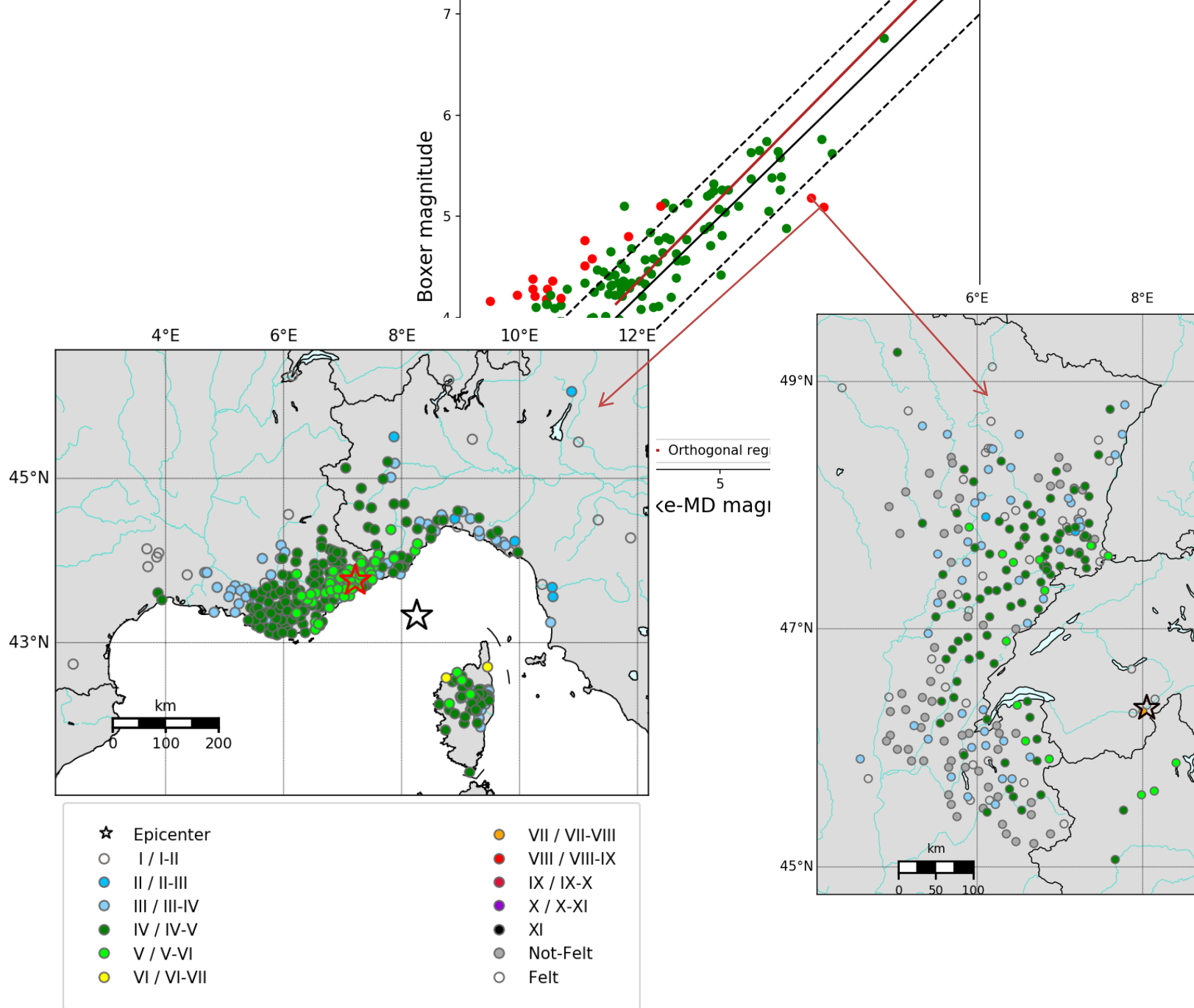
- Each earthquake of the calibration dataset should meet the exigency level of each methodology
- Good range of magnitude
- Enough earthquakes in the calibration dataset
- Good instrumental parameters

Next step of the comparison work: some questions

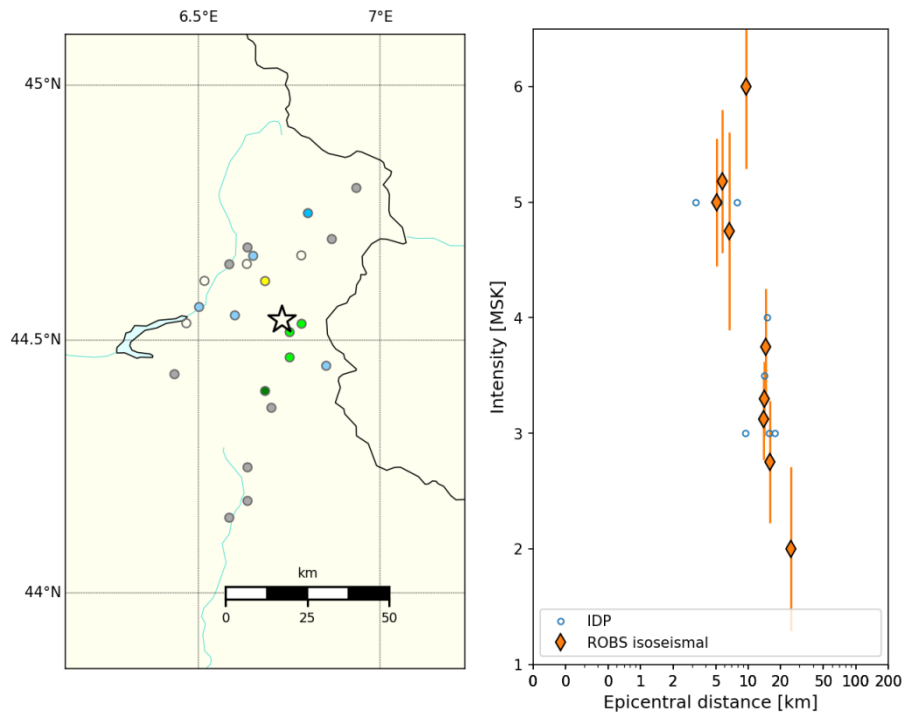


3. Comparing QUAKE-MD/BOXER magnitude estimates with SisFrance epicenter for Quake-MD

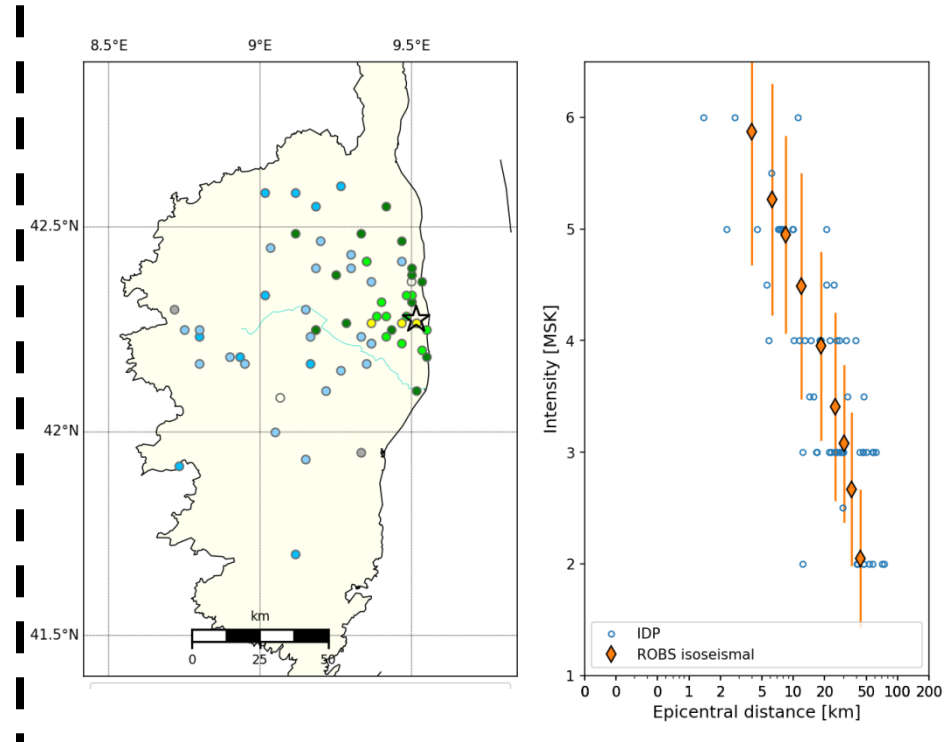




3. Comparing QUAKE-MD/BOXER magnitude estimates



Sparse data → rapid decrease of intensity data



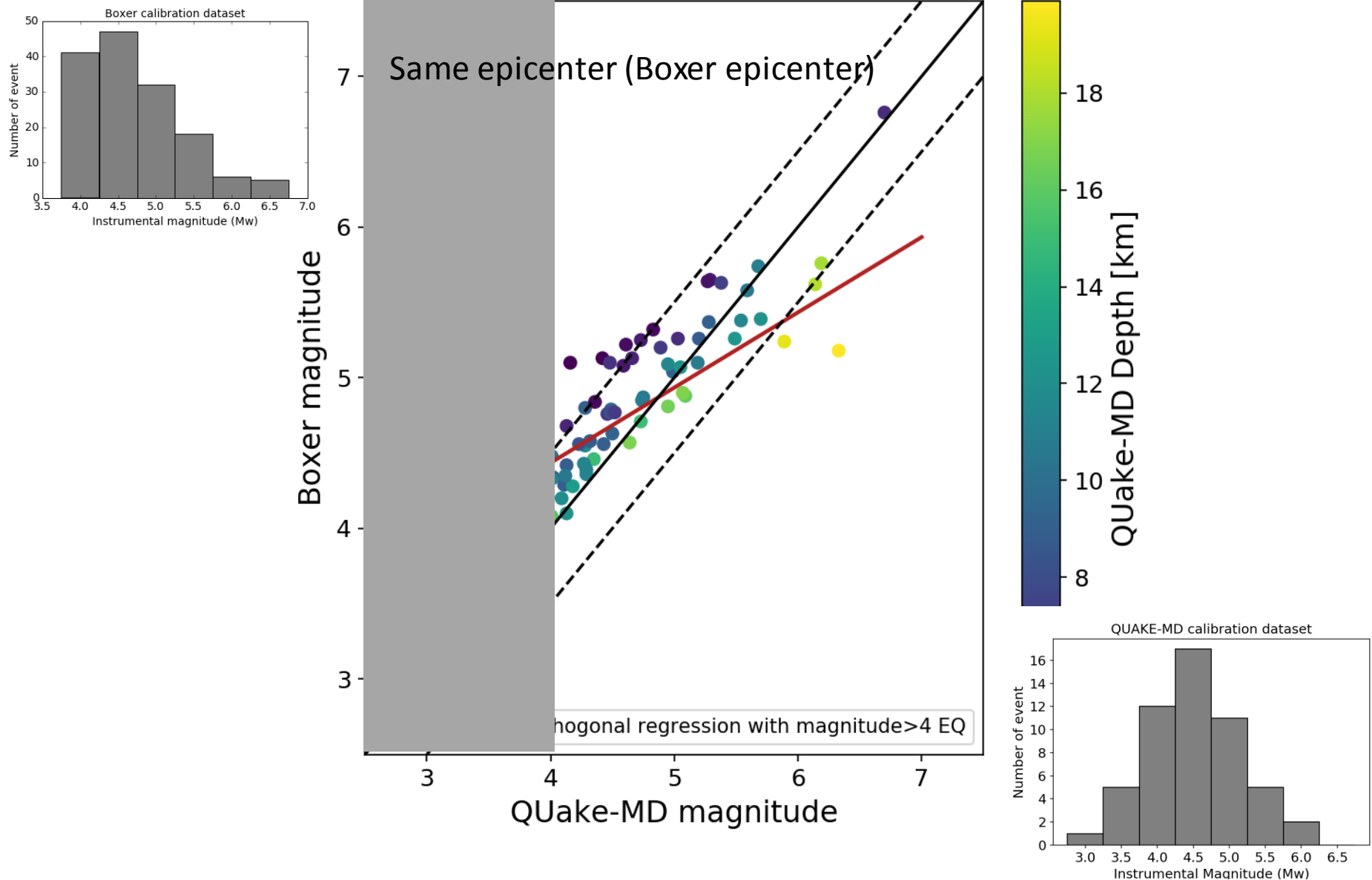
Rapid decrease of intensity data

- | | |
|----------------|------------------|
| ☆ 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 |

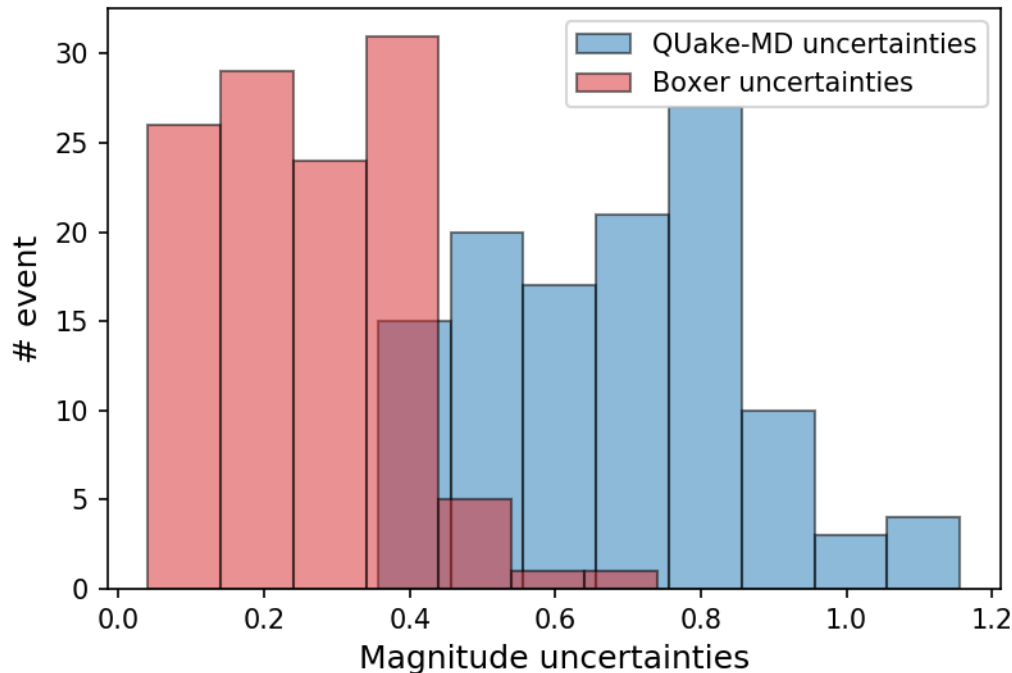
QUAKE-MD:

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

3. Comparing QUAKE-MD/BOXER magnitude estimates



4. Comparing QUAKE-MD/BOXER M-uncertainty estimates

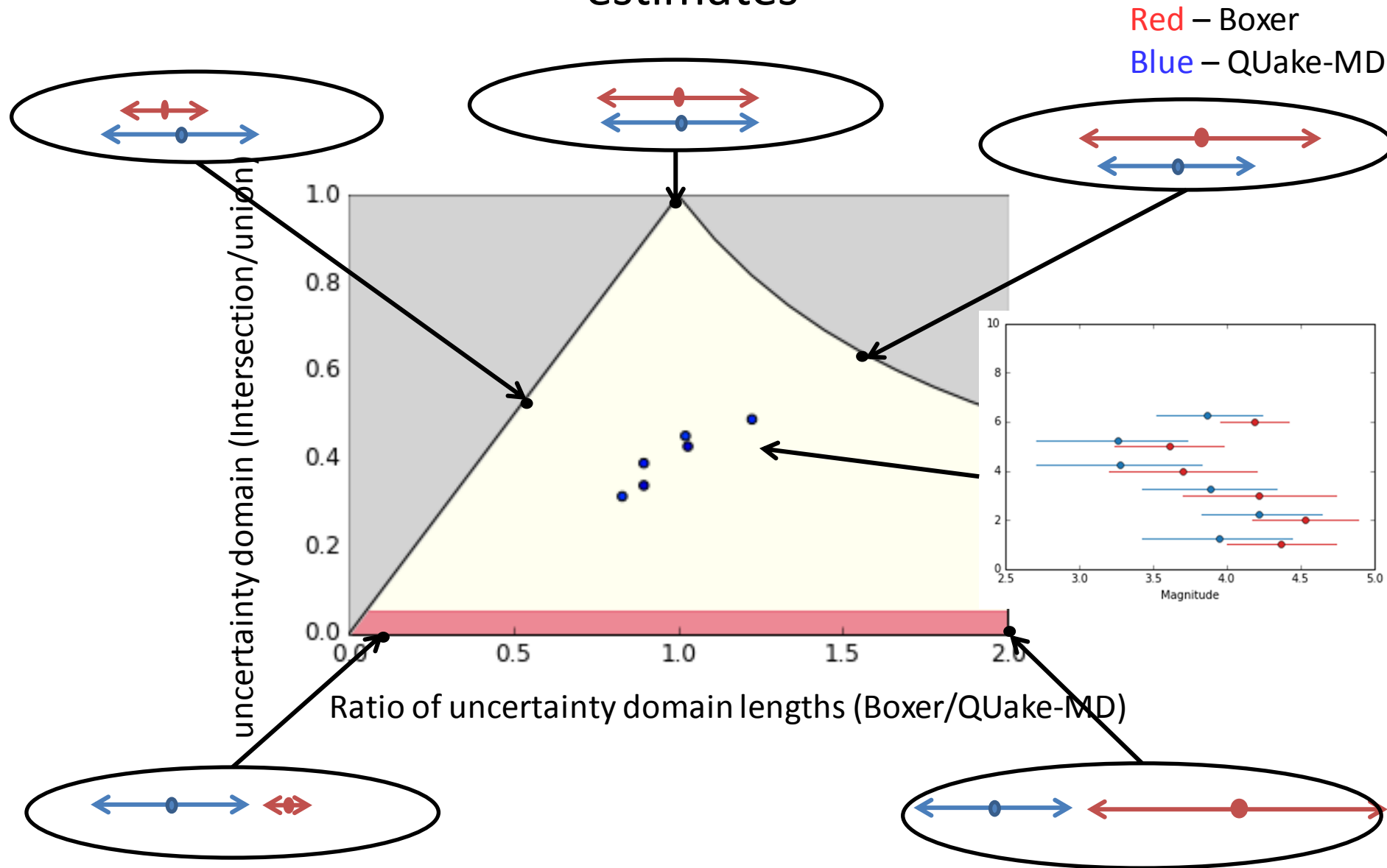


How to compare magnitude and uncertainties event by event ?

uncertainty domains : BOXER < QUAKE-MD

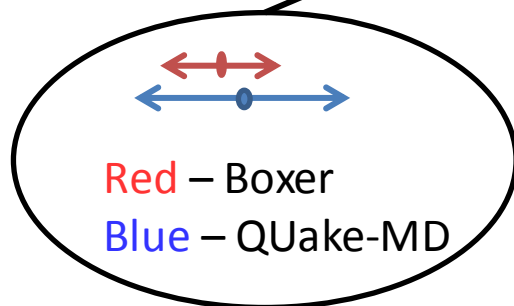
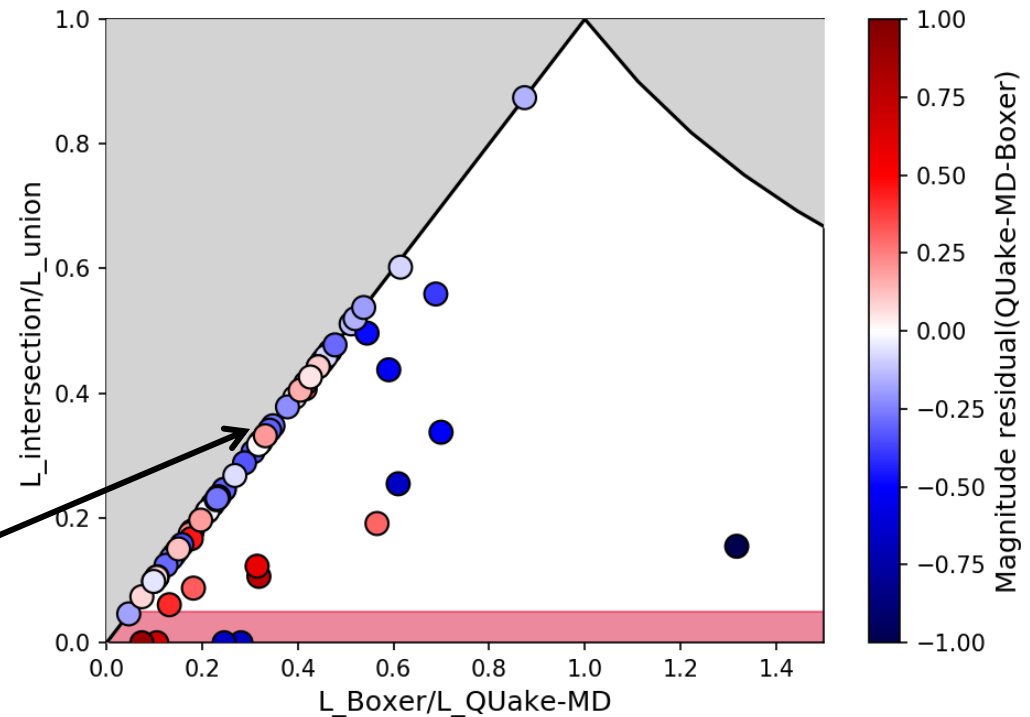
max uncertainty : QUAKE-MD >> BOXER

4. Comparing QUAKE-MD/BOXER M-uncertainty estimates

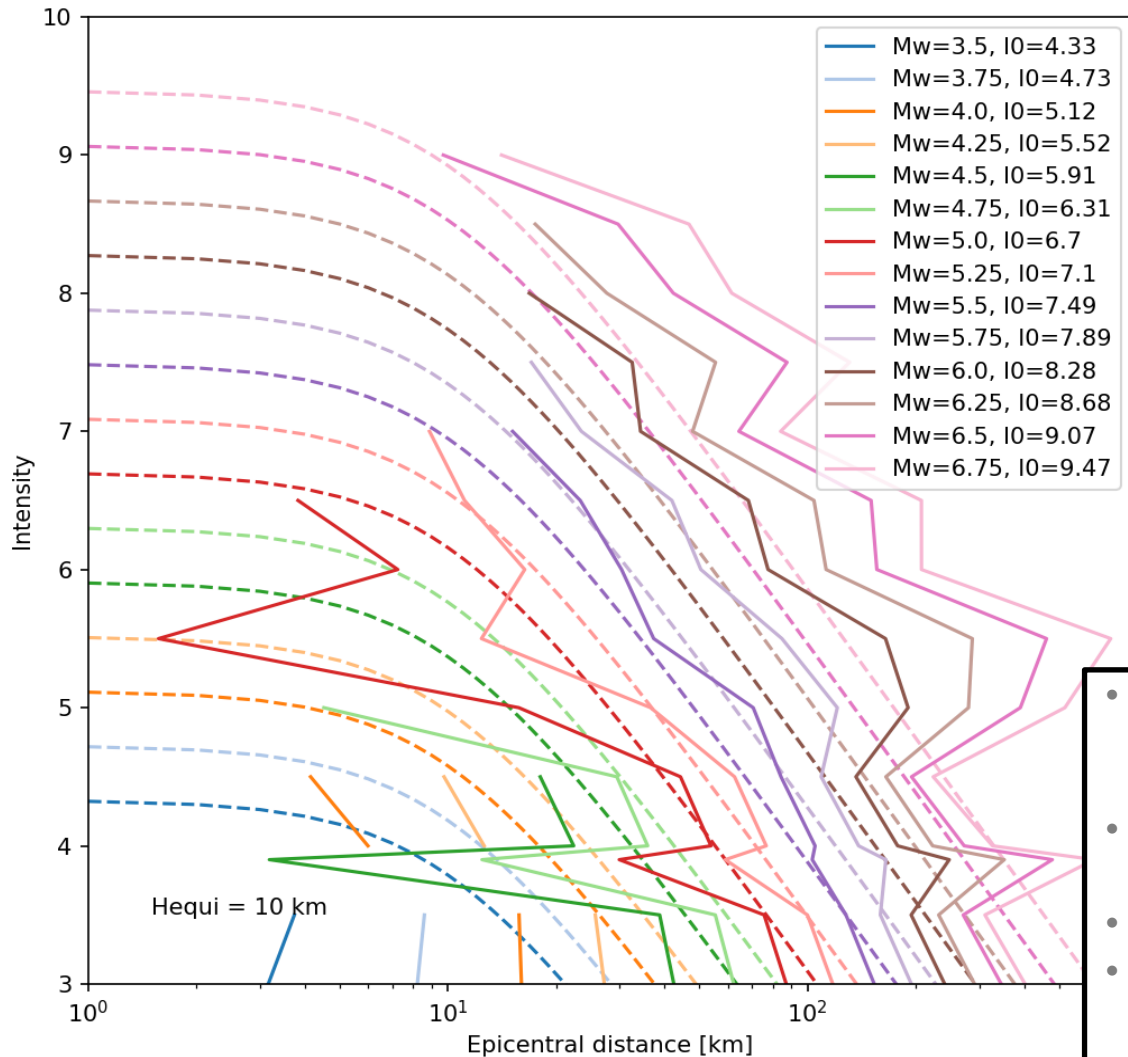


4. Comparing QUAKE-MD/BOXER M-uncertainty estimates

- Very heterogeneous uncertainty estimates
- Most of BOXER uncertainty included in QUAKE-MD uncertainty domains



Comparing QUAKE-MD/BOXER magnitude estimates



Full lines → Boxer

Dashed lines → QUAKE-MD

- Boxer:
 - $M(I) = a(I) + b(I)I_0 + c(I)[\log(\pi D_{epi})]^2$
- Quake-MD:
 - $I = C_1 + C_2M + \beta \log(D_{hypo})$
- Depth fixed at 10 km in Quake-MD
- I_0 computed from Quake-MD with epicentral distance equal to 0

Comparaison 2 → comparaison des décroissances d'intensité pour quelques séismes

