



Quantifying Uncertainties for earthquakes' Magnitude and Depth

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Quantifying Uncertainties for earthquakes' Magnitude and Depth

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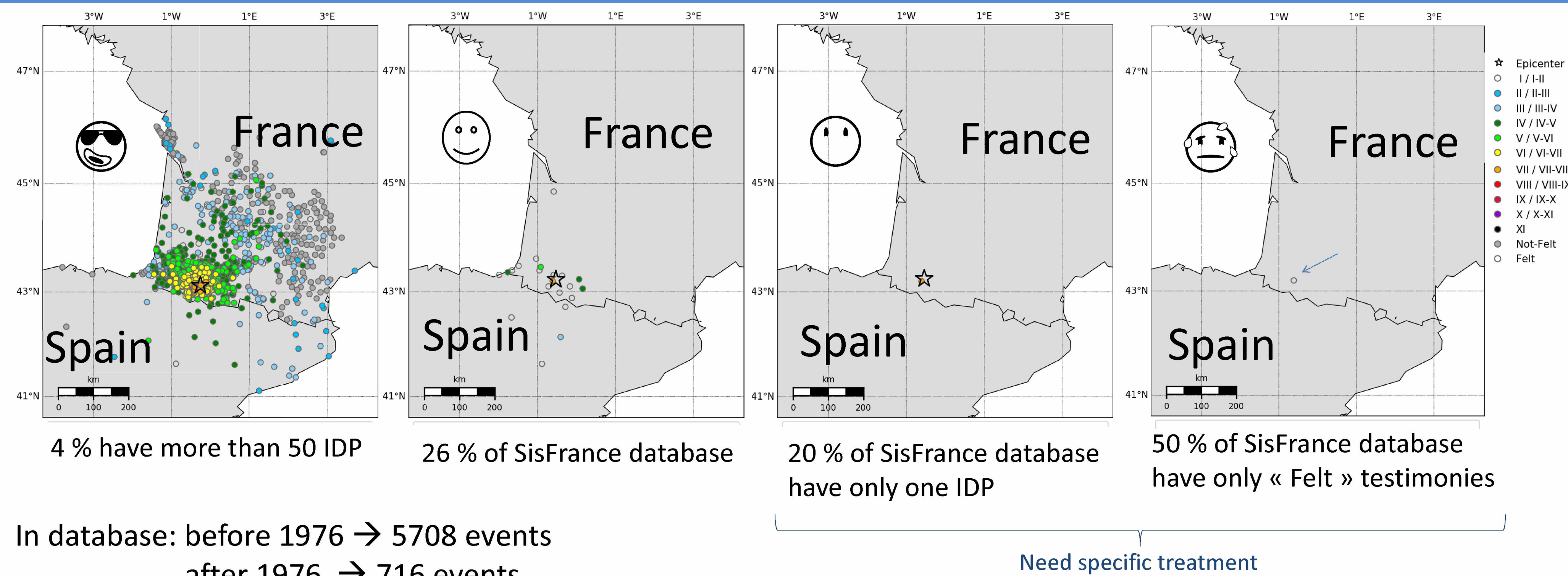


INTRODUCTION

We develop a methodology that quantify uncertainties for earthquakes' (M, H) by giving a space of possible (M,H) solutions based on intensity data uncertainties as well as on IPE epistemic uncertainties: the QUAKE-MD methodology.

The only data available on historical earthquake are the information provided by historical sources. This information can be translated into intensity through the use of intensity scale. Magnitude and depth (M, H) can be estimated from macroseismic intensity by using empirical intensity prediction equations (IPE). However both intensity data and the IPE are marred by uncertainties. Intensity data of one earthquake can be very sparse and their attributed intensity value are often based on one historical source, which can be a secondary source. Calibration of IPE is a challenging task. Indeed IPEs are sensitive to the choice of calibration earthquake, to the (M, H) instrumental parameter values and associated uncertainties, regional heterogeneities of attenuation, etc. M, H estimates from macroseismic intensity are thus uncertain. The application of one IPE on macroseismic data gives one couple of (M, H) solution, with eventually an associated uncertainty but is it enough?

Database used for the poster: SisFrance (www.sisfrance.net, consortium BRGM, EDF, IRSN)

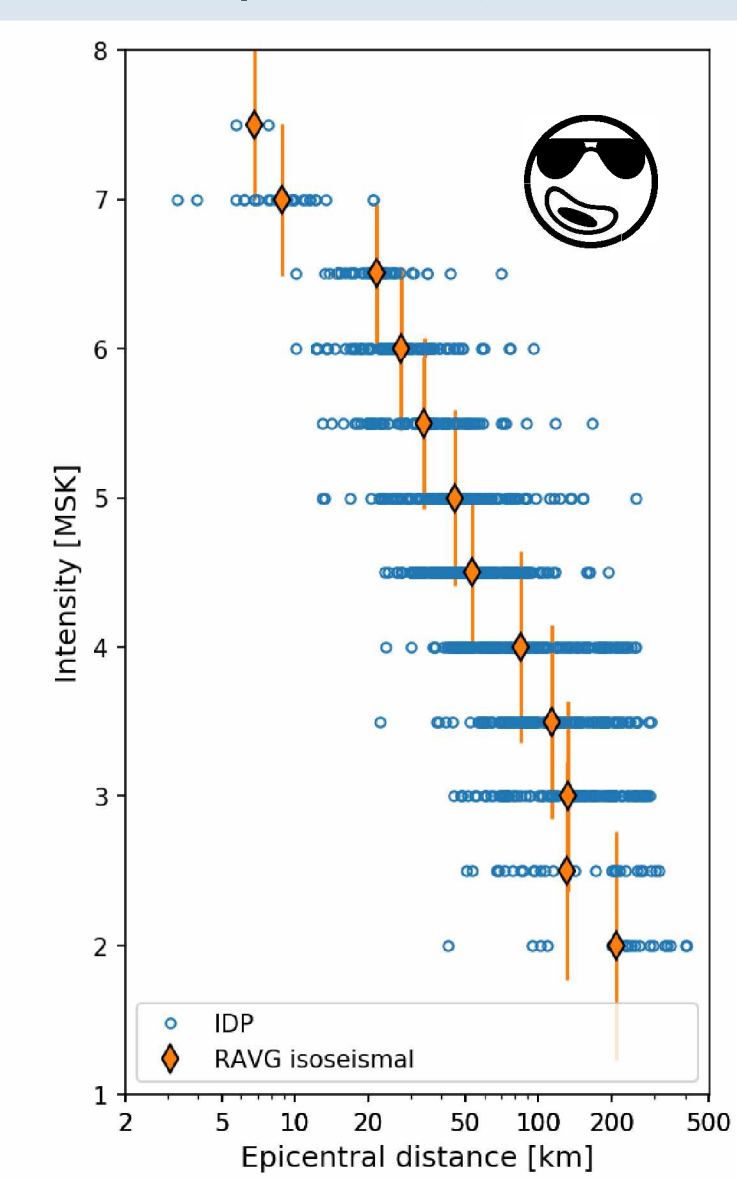


Need specific treatment

QUAKE-MD : QUANTIFYING UNCERTAINTIES FOR EARTHQUAKES' MAGNITUDE AND DEPTH

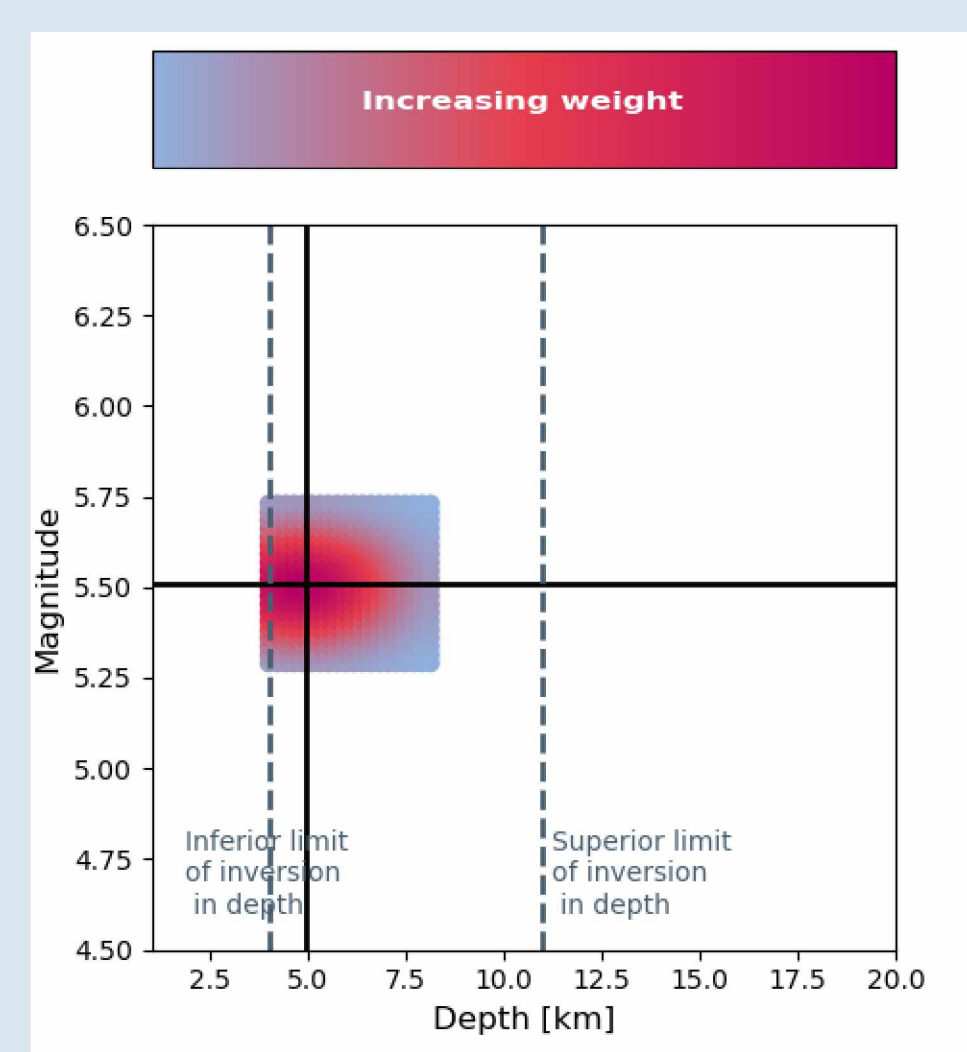
Quantifying intensity data uncertainties

Example of QUAKE-MD application on one calibration earthquake (Arudy, 1980, instrumental Mw=5.1)

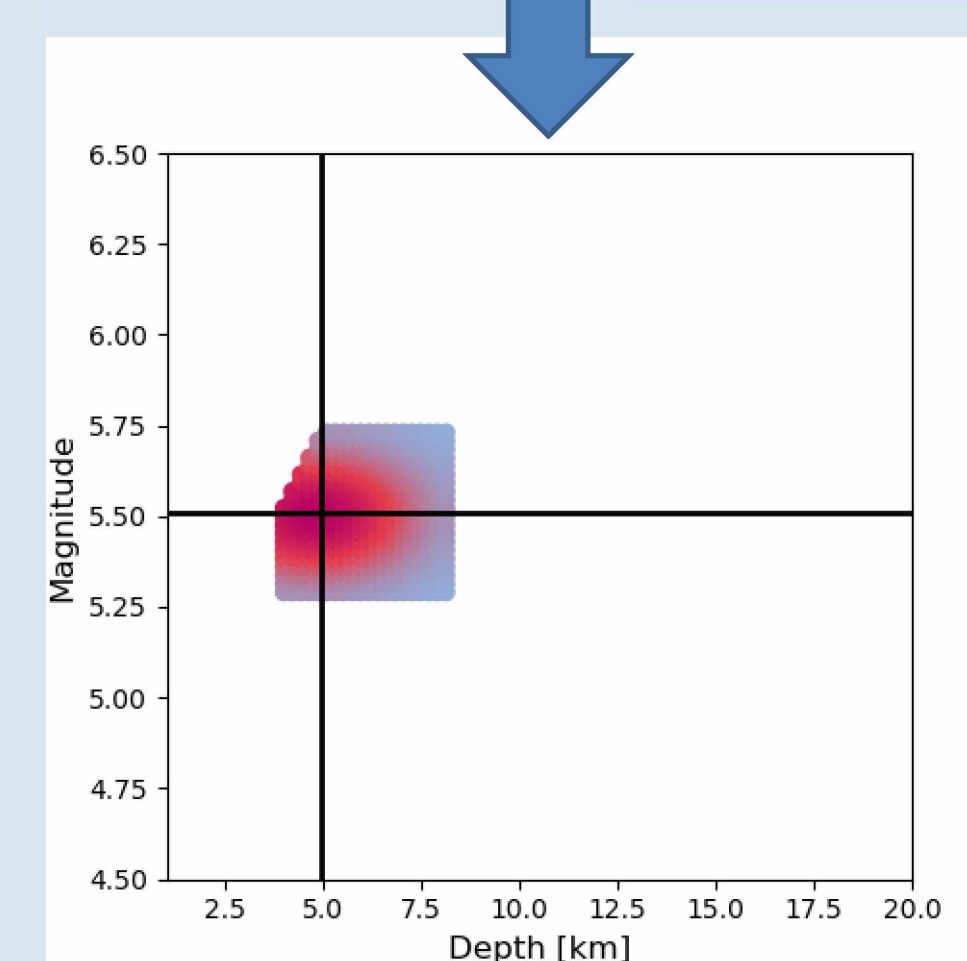


Least square inversion with constraints for depth on data with one IPE
Intensity data weighted by their quality factor

Quality factor	Weight
A	4
B	3
C	2



I_0 + uncertainties filtering



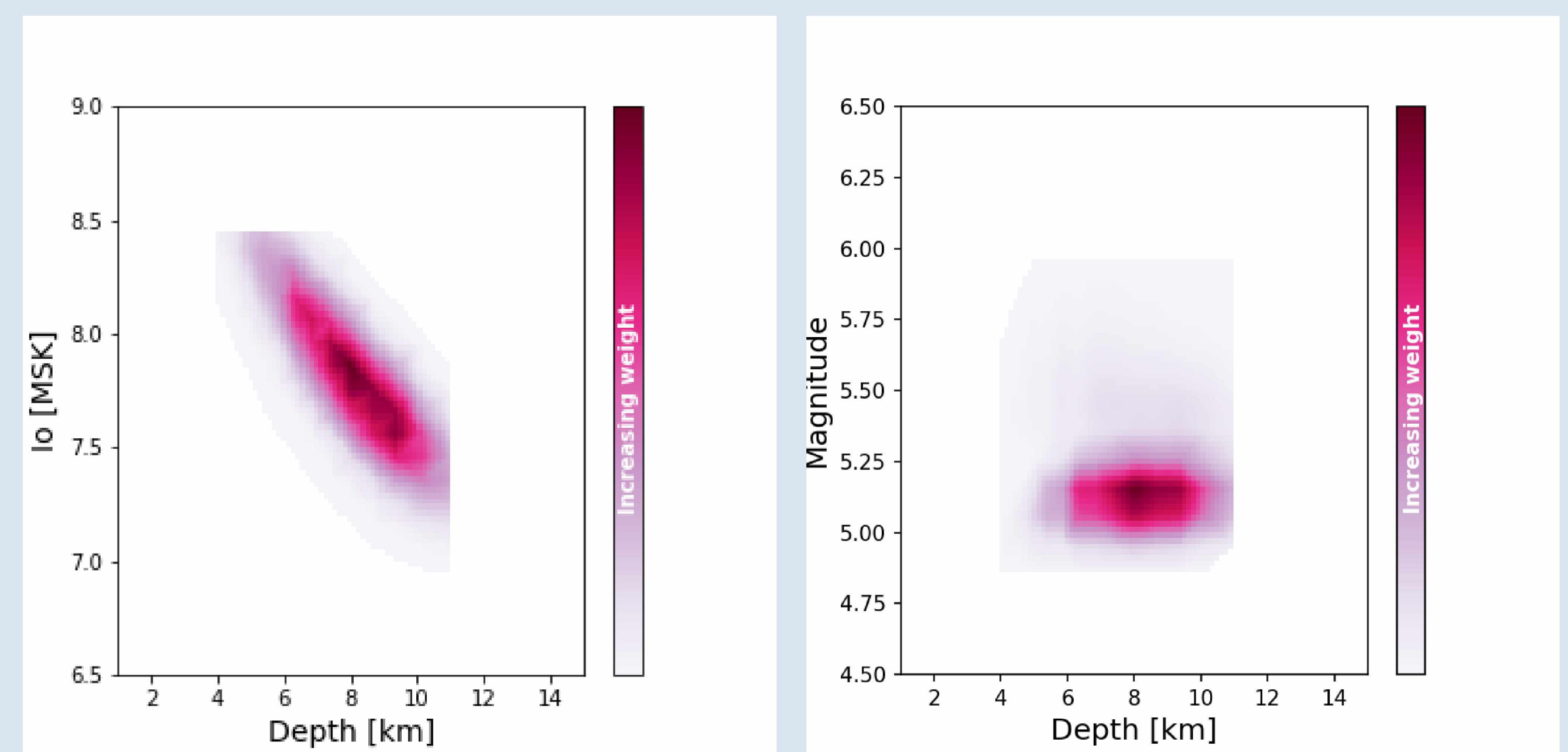
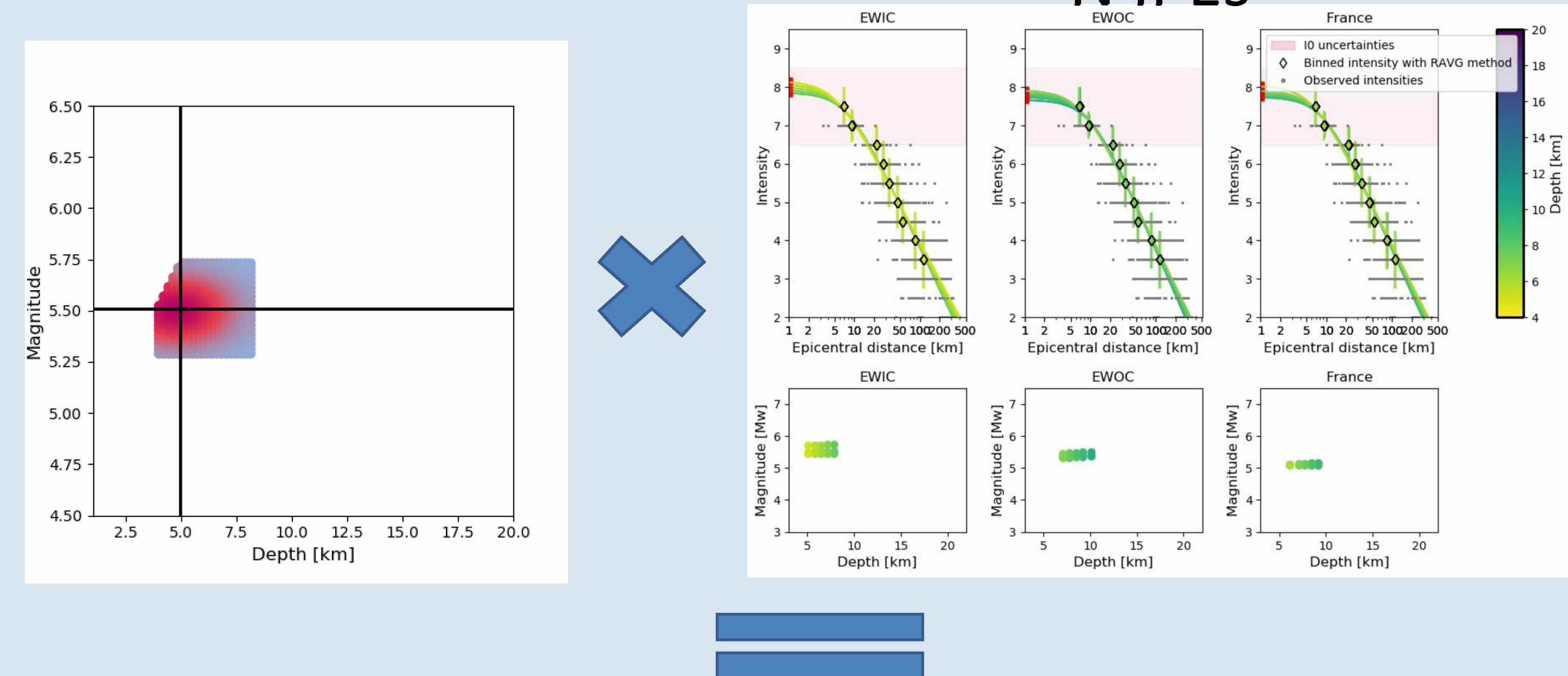
One space of solution for one IPE

Required

- An IPE with the following mathematical formulation:
 $I = C1 + C2M + \beta \log(D_{hypo}) + \gamma D_{hypo}$
- Quality factor associated to each intensity data points
- Epicentral intensity I_0 with associated uncertainties or $I_{0\min}$ and $I_{0\max}$
- Depth limit $H_{\min}$ and $H_{\max}$ for the application of the IPE to estimate (M, H)

Quantifying IPE epistemic uncertainties

N IPEs

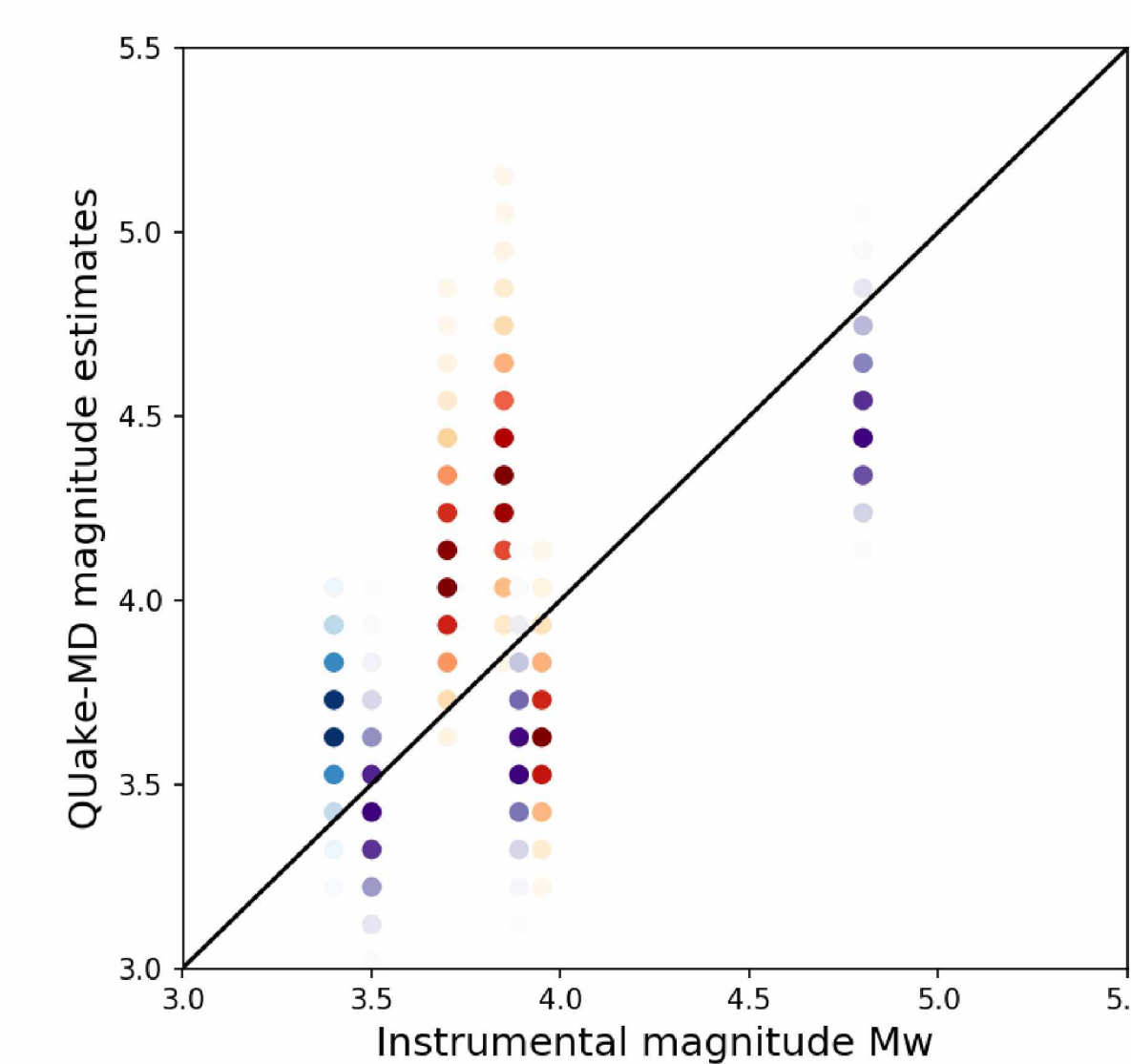
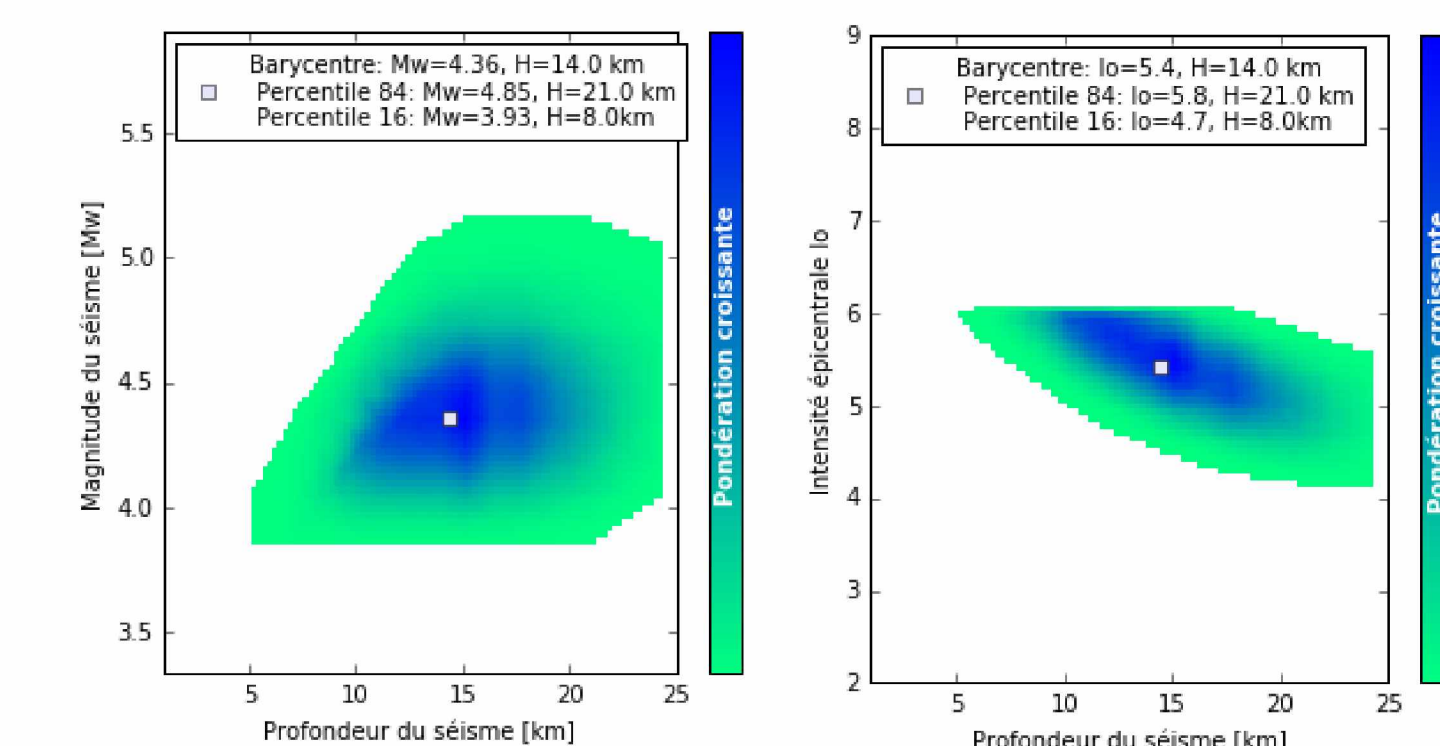


Testing Quake-MD on recent earthquakes using internet intensities

Internet intensity (BCSF) from the 06/21/19, 06:50 pm

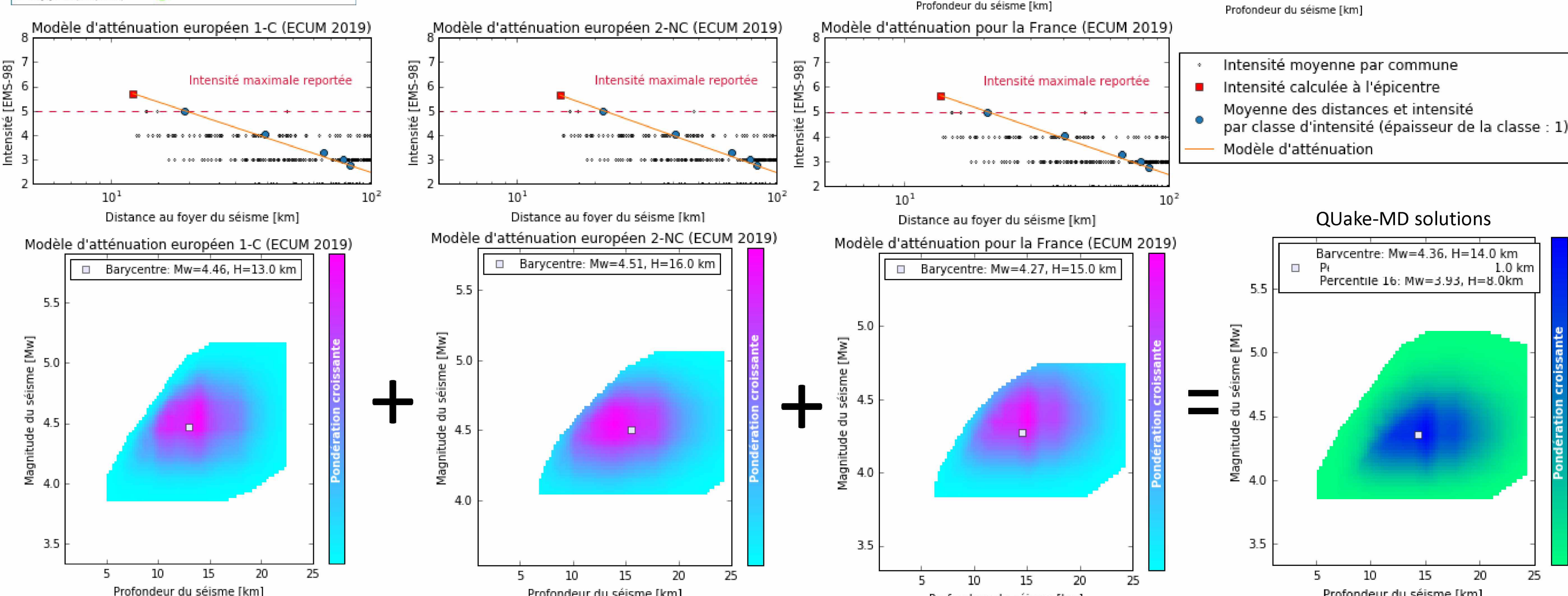
Latitude: 47.1505°N
Longitude: 0.3367°W
Date : 21/06/2019
Local time: 09h50
Local magnitude MI(source Renass): 4.8
Local magnitude MI(source LDG): 5.2
Magnitude Mw: 3.9 (Satriano)

QUAKE-MD solutions



8 recent earthquakes with available instrumental Mw compared.

Source of the instrumental Mw:
C. Satriano and B. Delouis



➔ Need for accurate estimates of instrumental Mw and depth to test Quake-MD

Name of the earthquake	Date	Inst. Mw	Mmin - Mmax Quake-MD	H Quake-MD barycenter	Macroseismic field quality
Barcelonnette (SE France)	07/04/2014	4.7-4.8	4.2-5.1	9 km	A
Barcelonnette (SE France)	06/11/2015	3.9	3.2-4.2	11 km	C
La Rochelle (W France)	28/04/2016	3.8-3.9	3.7-4.9	12 km	A
Digne-les-Bains (SE France)	10/11/2016	3.5	3-4	9 km	C
Saint-Hilaire-de-Voust (W France)	12/02/2018	3.9-4	3.2-4.1	4 km	C
Bourg-en-Bresse (E France)	21/11/2018	3.4	3.2-4	12 km	B
Montendre (W France)	20/03/2019	3.7	3.6-4.9	9 km	B
Layon (W France)	21/06/2019	3.9	3.9-5.1	14 km	A