Università degli Studi di Napoli Federico II

Scuola politecnica e delle scienze di Base

Dipartimento di Strutture per l'Ingegneria e l'Architettura (DiSt)

Consorzio Interuniversitario ReLuis

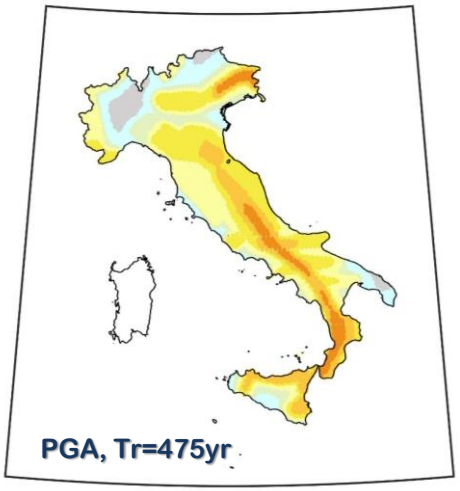
WORKSHOP: Approcci per la valutazione dei modelli di pericolosità sismica in Italia

Villa Orlandi, Anacapri, 7-8 settembre 2023

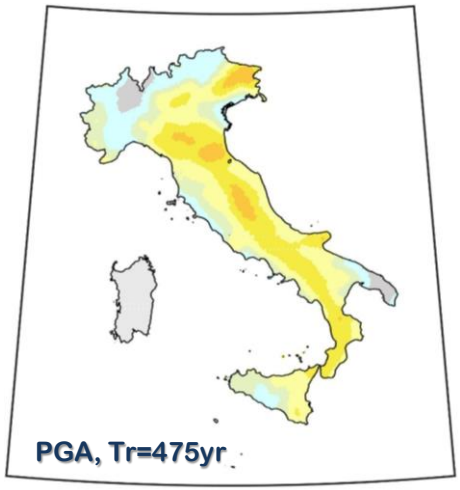
Iunio Iervolino, Università degli Studi di Napoli Federico II

Alcune valutazioni di modelli di pericolosità basate sui risultati (con applicazioni a MPS19, MPS04 e ESHM20

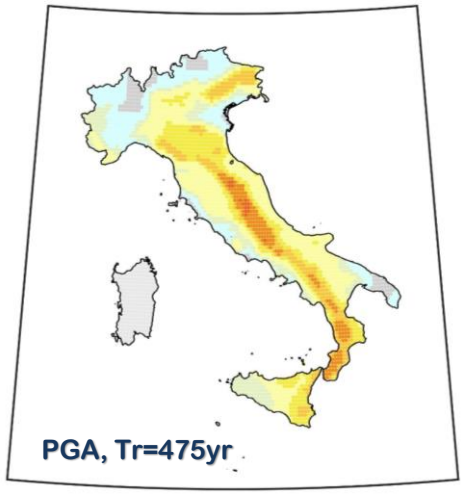
Testing seismic hazard models via multi-site observations



MPS04



MPS19



ESHM20 (v12e)

nature › nature italy › news feature › article

NEWS FEATURE | 29 June 2022

Internal rumblir seismic map

Scientists and government officials hav a crucial tool for preventing earthquak

nature › nature italy › news › article

NEWS | 19 May 2023

Italy's new seismic hazard map is back to square one

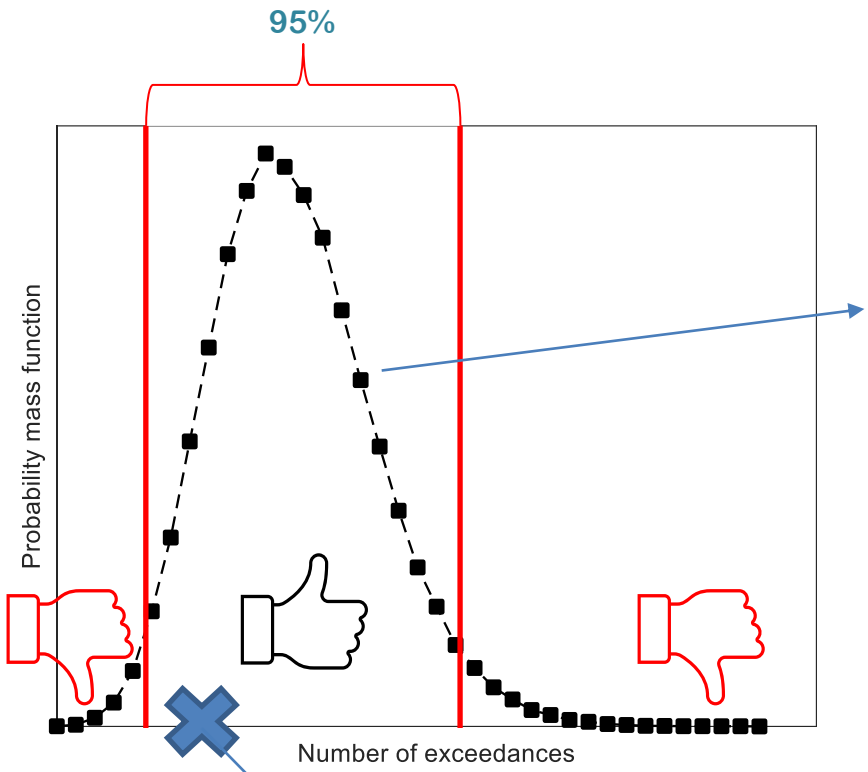
A review panel has rejected the updated map developed by INGV scientists, and already approved by the Civil Protection.

Can we test PSHA results at single site?

No.

Can we validate the total number of exceedances observed at multiple sites in a time interval?

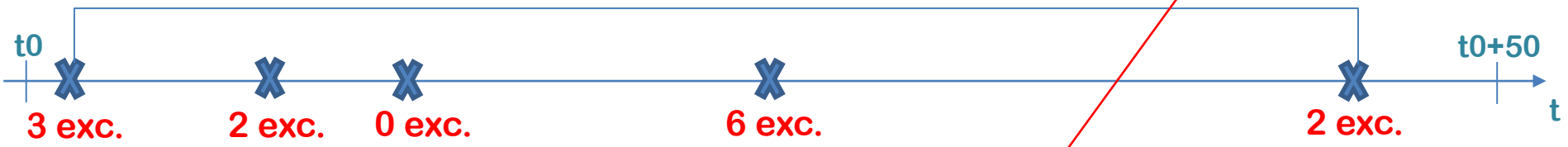
Yes, with caveats.



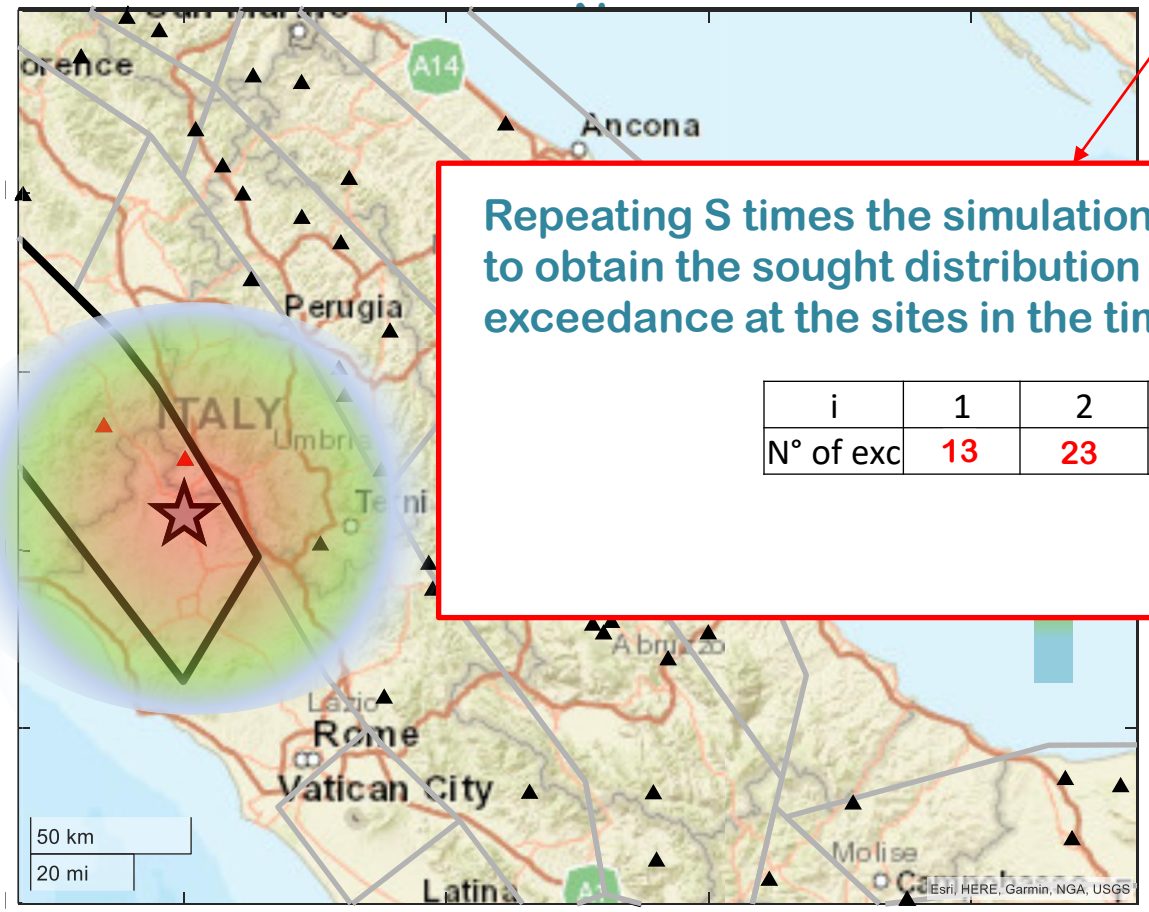
Simulation of a number (S) of synthetic catalogs

i	1	2	...	S
N° of exc	13	?		?

For the i-th simulation (i=1,…,S), sample a number of earthquakes in 50yr according to PSHA models.



TOT EXC.: 13



For each earthquake:

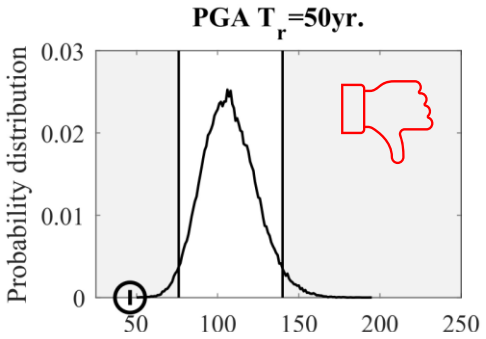
Repeating S times the simulation procedure allows one to obtain the sought distribution of the total number of exceedance at the sites in the time interval.

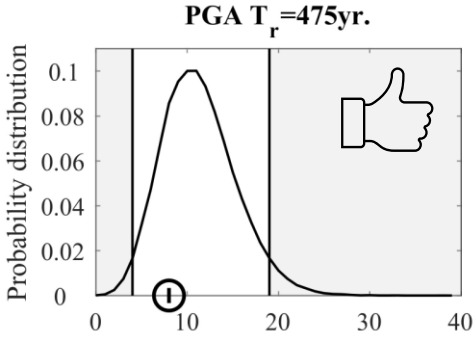
i	1	2	...	S
N° of exc	13	23		18

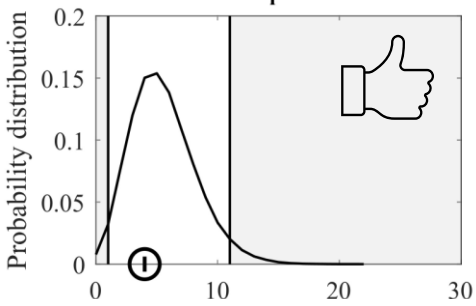
iv) Simulating IM realizations at the sites, including spatial correlation

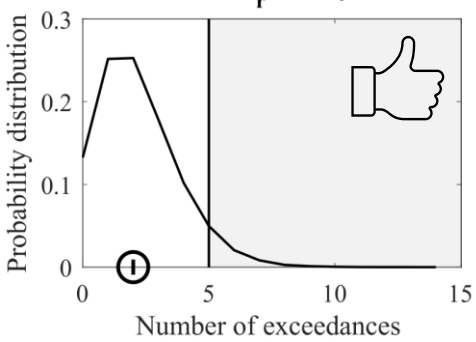
v) Checking exceedances

MPS04

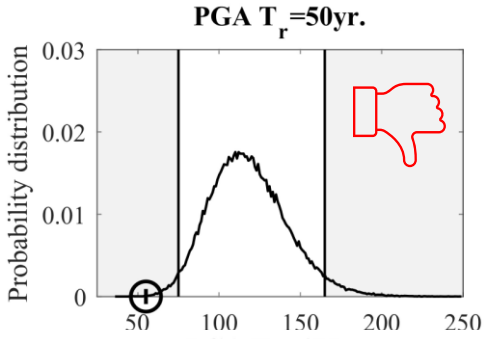


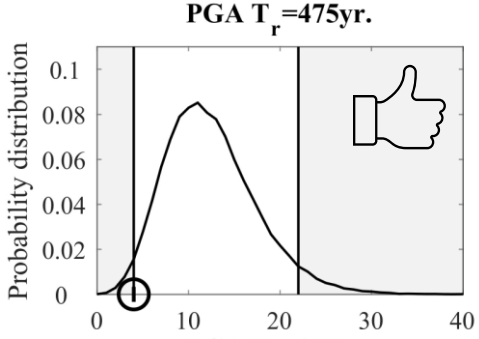


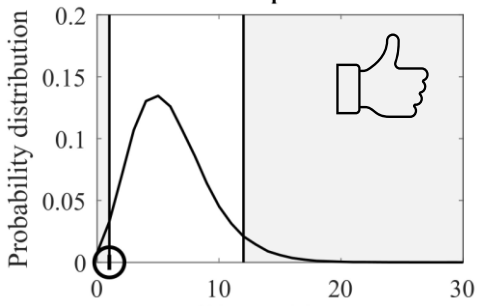


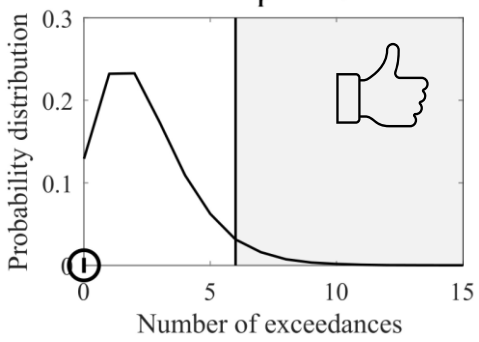


MPS19

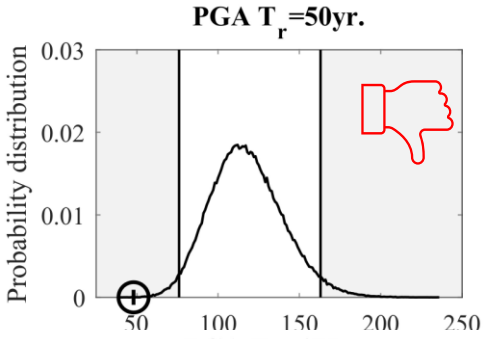


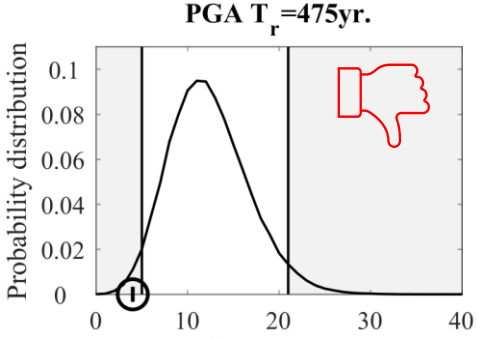


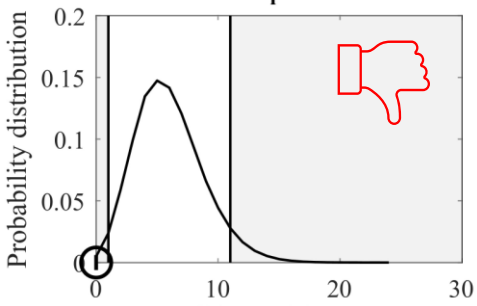


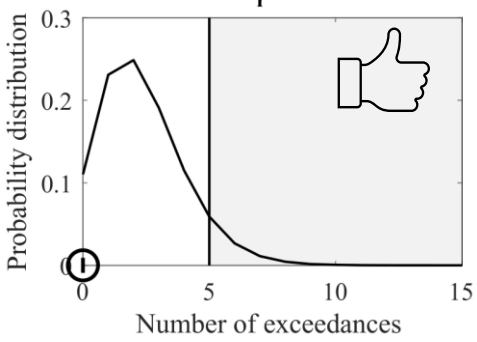


ESHM20







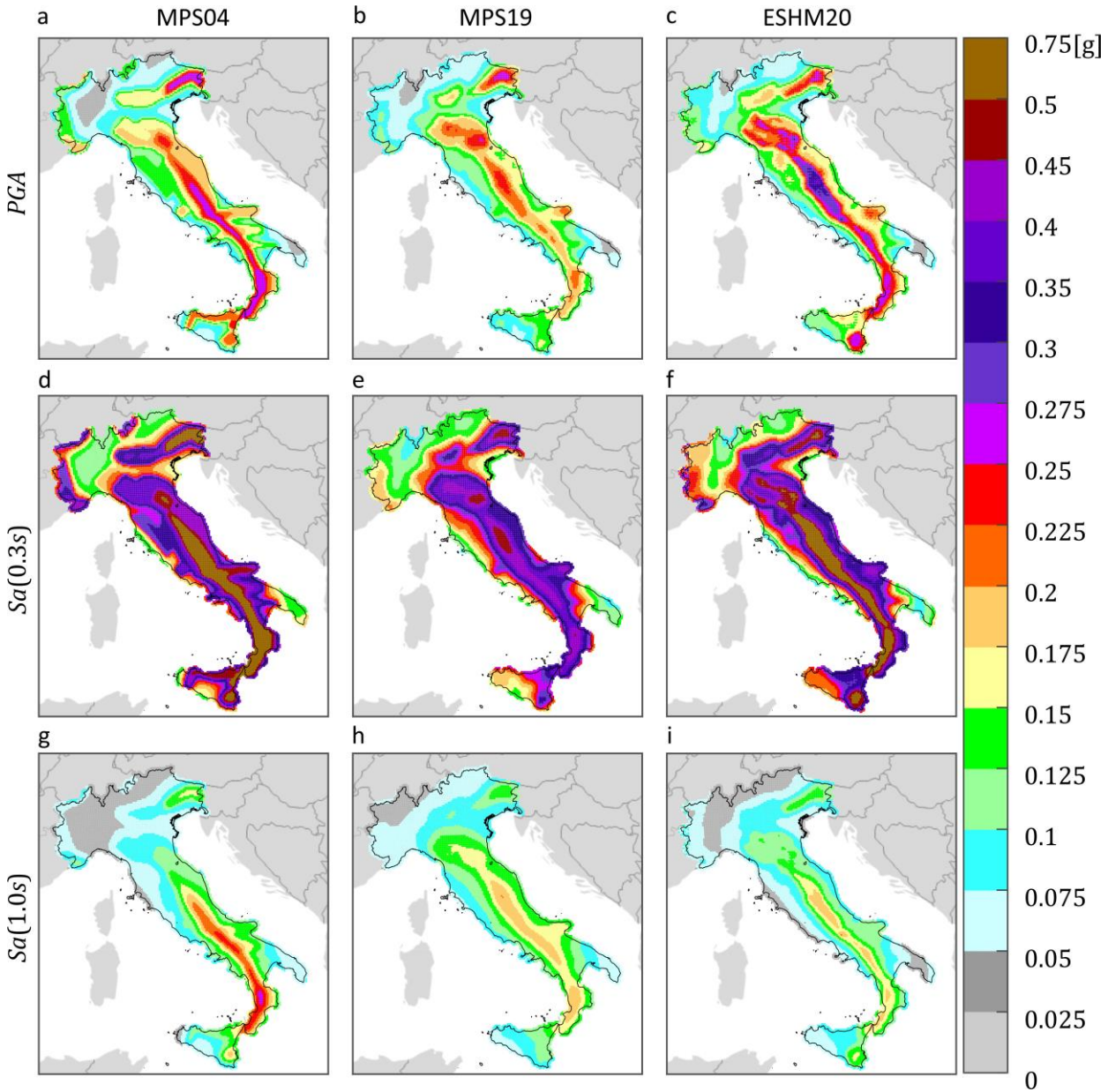


	$T_r = 50yr$		
	MPS04	**MPS19**	**ESHM20**
PGA	46 ∉ [76-140]	55 ∉ [75-165]	48 ∉ [76-163]
$Sa(0.3s)$	36 ∉ [71-145]	59 ∉ [67-174]	45 ∉ [74-164]
$Sa(1.0s)$	52 ∉ [55-165]	54 ∈ [45-201]	51 ∉ [61-179]
	$T_r = 475yr$		
	MPS04	**MPS19**	**ESHM20**
PGA	8 ∈ [4-19]	4 ∈ [4-22]	4 ∉ [5-21]
$Sa(0.3s)$	7 ∈ [4-20]	7 ∈ [3-25]	4 ∈ [4-21]
$Sa(1.0s)$	8 ∈ [2-23]	7 ∈ [0-29]	8 ∈ [3-23]
	$T_r = 975yr$		
	MPS04	**MPS19**	**ESHM20**
PGA	4 ∈ [1-11]	1 ∈ [1-12]	0 ∉ [1-11]
$Sa(0.3s)$	3 ∈ [1-11]	3 ∈ [0-13]	2 ∈ [1-12]
$Sa(1.0s)$	2 ∈ [0-12]	2 ∈ [0-16]	1 ∈ [1-13]
	$T_r = 2475yr$		
	MPS04	**MPS19**	**ESHM20**
PGA	2 ∈ [0-5]	0 ∈ [0-6]	0 ∈ [0-5]
$Sa(0.3s)$	1 ∈ [0-5]	1 ∈ [0-6]	0 ∈ [0-5]
$Sa(1.0s)$	2 ∈ [0-6]	1 ∈ [0-7]	1 ∈ [0-6]

Iervolino, I., Chioccarelli, E., & Cito, P. (2023). Testing three seismic hazard models for Italy via multi-site observations. PLoS one, 18(4), e0284909.

Territorial exceedance of probabilistic seismic hazard maps

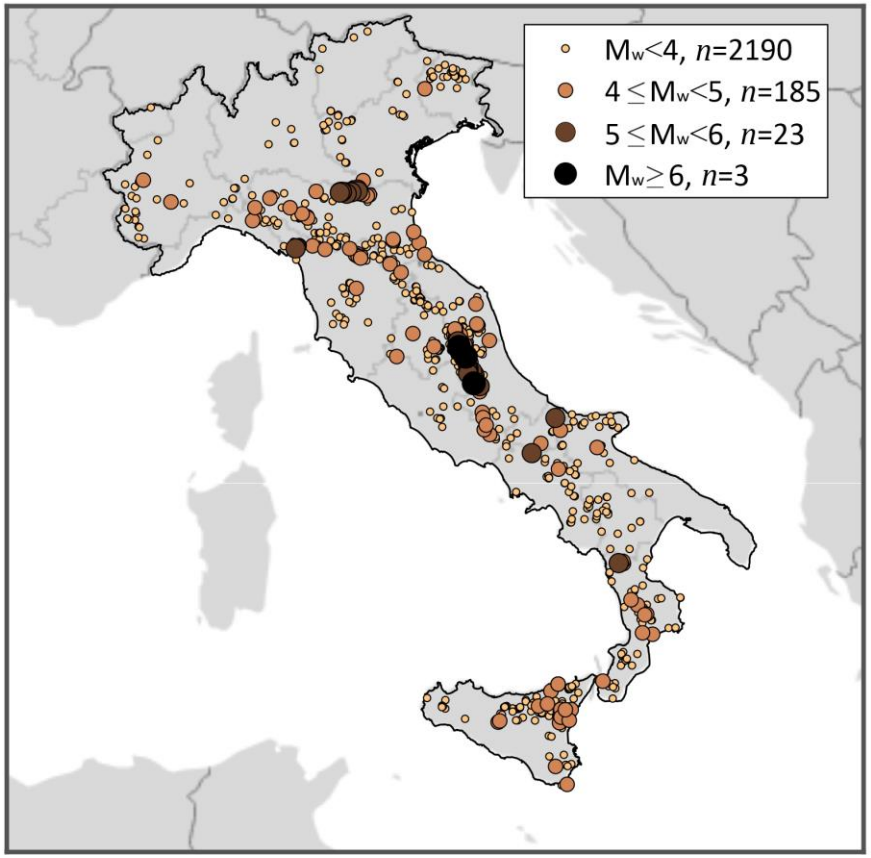
Goal: To assess how the estimated area subjected to at least one exceedance in actual earthquakes compares with what is expected from PSHA.



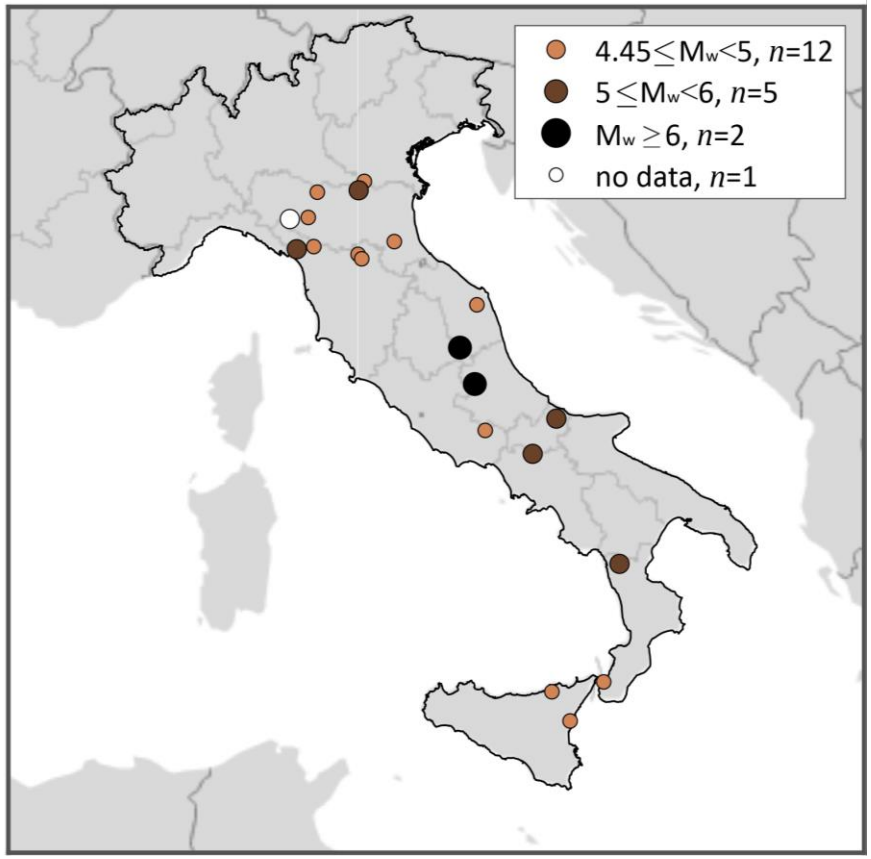
ShakeMap data for earthquakes occurred between 2008 and 2019 (http://shakemap.ingv.it/shake4/)

Removing non-mainshocks and magnitude filtering

a

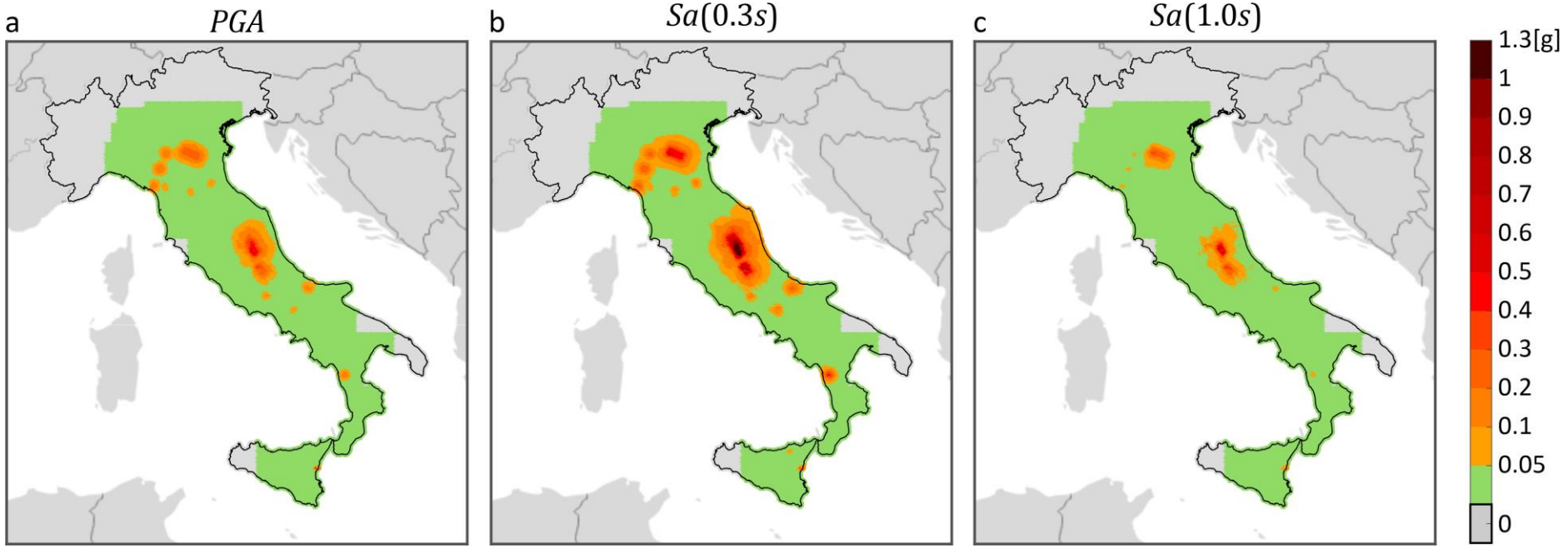


b

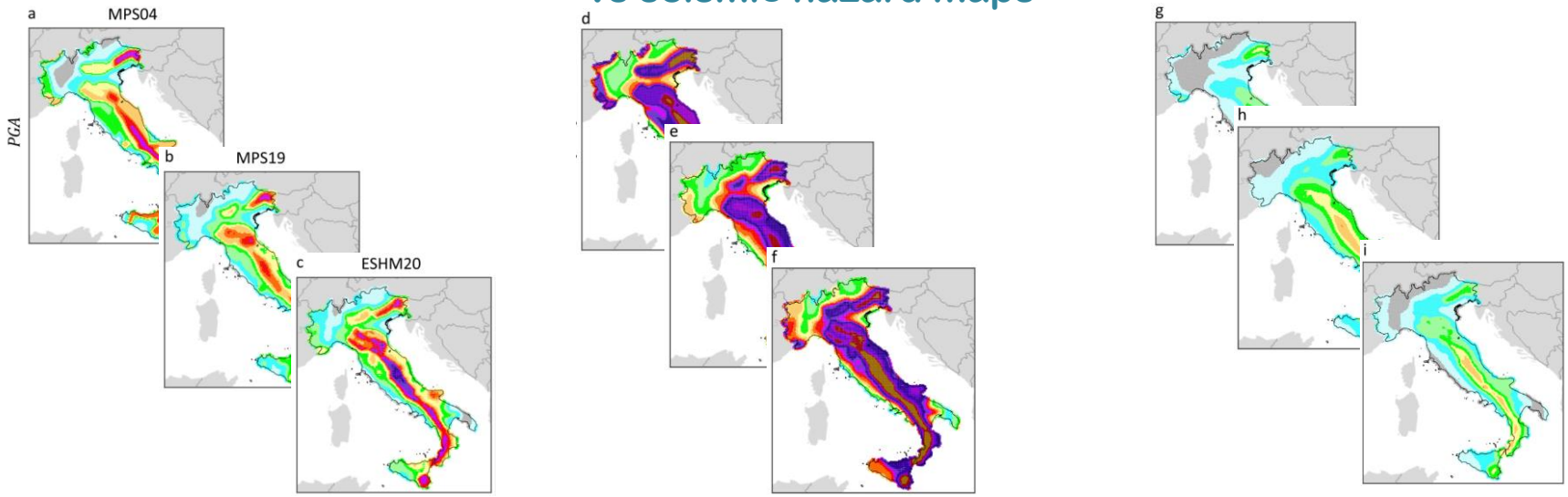


How do we get the area subjected to at least one exceedance in twelve years?

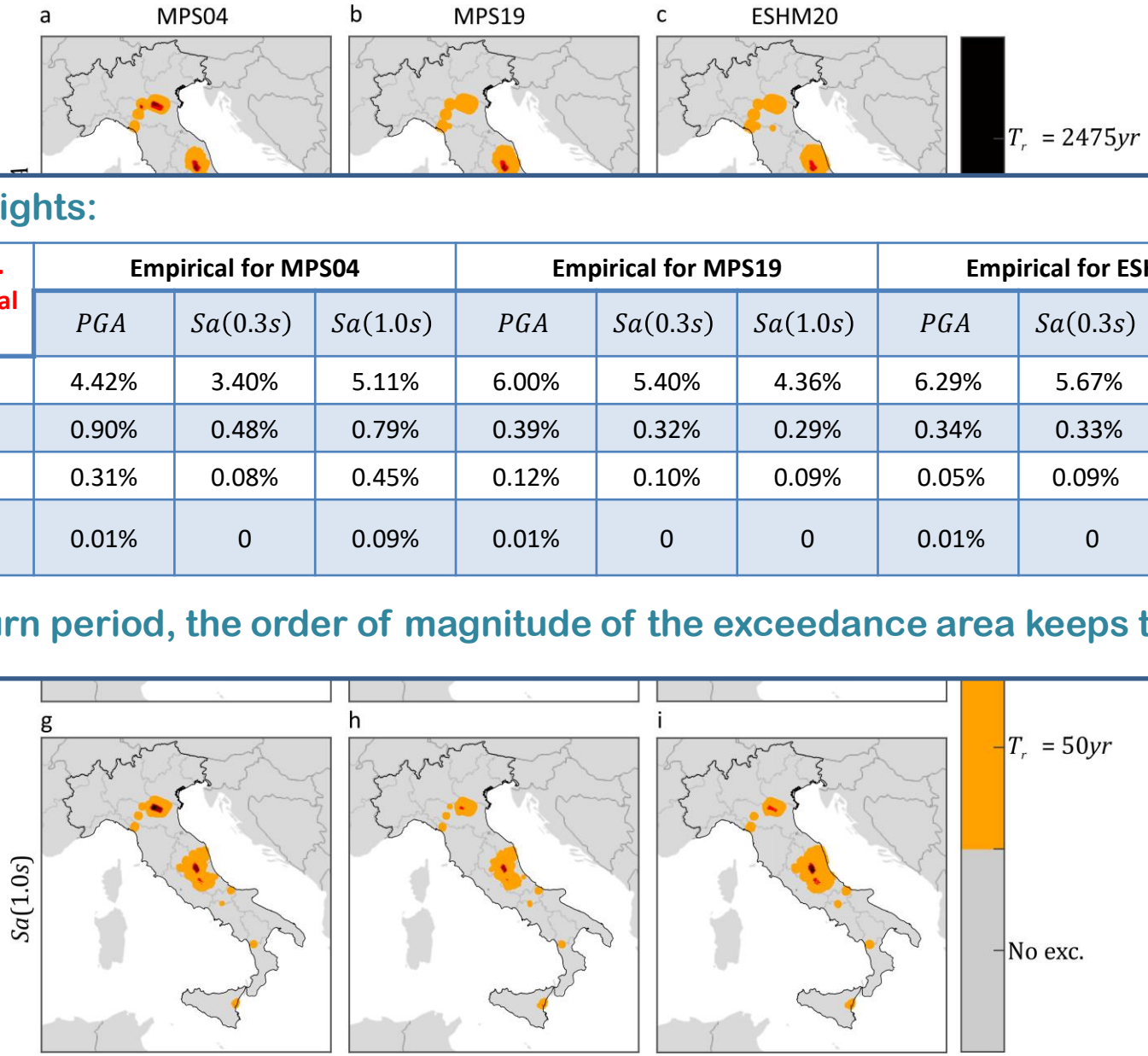
ShakeMap envelope



vs seismic hazard maps



The exceedance area is comparable for all hazard models, despite their differences.



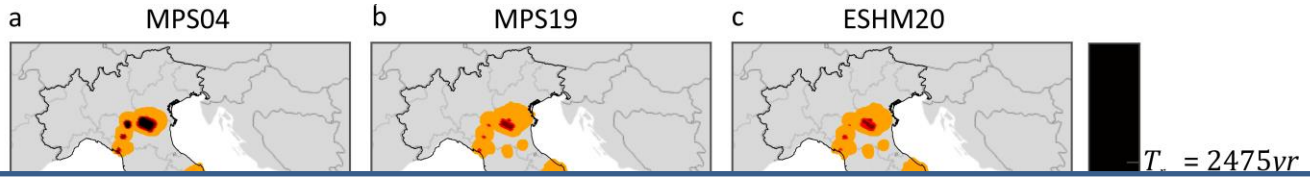
Numerical insights:

T_r	Expect. fractional area	Empirical for MPS04			Empirical for MPS19			Empirical for ESHM20		
		PGA	$Sa(0.3s)$	$Sa(1.0s)$	PGA	$Sa(0.3s)$	$Sa(1.0s)$	PGA	$Sa(0.3s)$	$Sa(1.0s)$
$50yr$	21.3%	4.42%	3.40%	5.11%	6.00%	5.40%	4.36%	6.29%	5.67%	6.33%
$475yr$	2.5%	0.90%	0.48%	0.79%	0.39%	0.32%	0.29%	0.34%	0.33%	0.64%
$975yr$	1.2%	0.31%	0.08%	0.45%	0.12%	0.10%	0.09%	0.05%	0.09%	0.23%
$2475yr$	0.5%	0.01%	0	0.09%	0.01%	0	0	0.01%	0	0.08%

Given the return period, the order of magnitude of the exceedance area keeps the same.

Effect of ShakeMap uncertainty

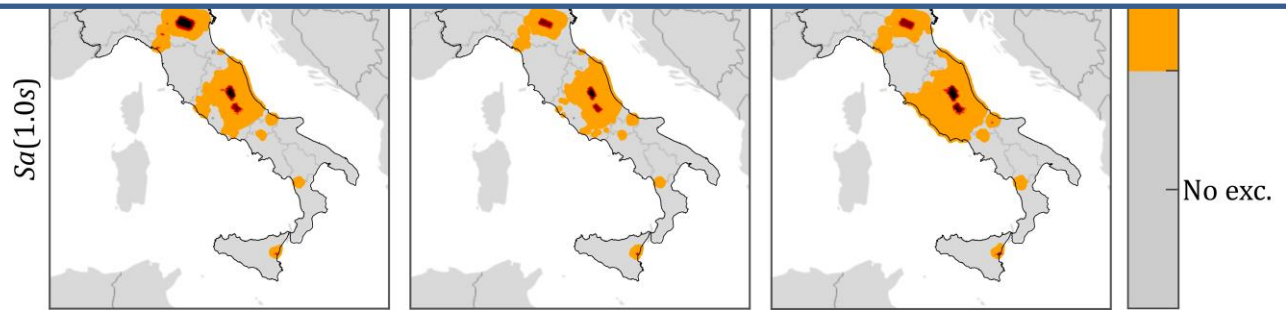
MRius *sigma*



Numerical insights:

T_r	Expect. fractional area		Empirical for MPS04			Empirical for MPS19			Empirical for ESHM20		
			PGA	$Sa(0.3s)$	$Sa(1.0s)$	PGA	$Sa(0.3s)$	$Sa(1.0s)$	PGA	$Sa(0.3s)$	$Sa(1.0s)$
$50yr$	21.3%	minus σ	1.60%	1.25%	1.79%	2.38%	2.09%	1.53%	2.5%	2.20%	1.98%
		plus σ	9.58%	8.22%	12.68%	13.07%	12.36%	11.15%	13.14%	12.33%	17.23%
$475yr$	2.5%	minus σ	0.02%	0.007%	0.23%	0.01%	0.01%	0.04%	0.007%	0.015%	0.16%
		plus σ	2.87%	1.89%	1.80%	1.96%	1.62%	1.04%	2.08%	1.88%	1.55%
$975yr$	1.2%	minus σ	0	0	0.02%	0.003%	0	0	0.002%	0	0.04%
		plus σ	1.93%	1.08%	1.13%	0.97%	0.84%	0.61%	0.89%	0.68%	0.95%
$2475yr$	0.5%	minus σ	0	0	0	0	0	0	0	0	0
		plus σ	0.95%	0.40%	0.58%	0.29%	0.19%	0.11%	0.22%	0.22%	0.33%

The sensitivity of the exceedance area to the PSHA model seems to be limited even when ShakeMap uncertainty is accounted for.



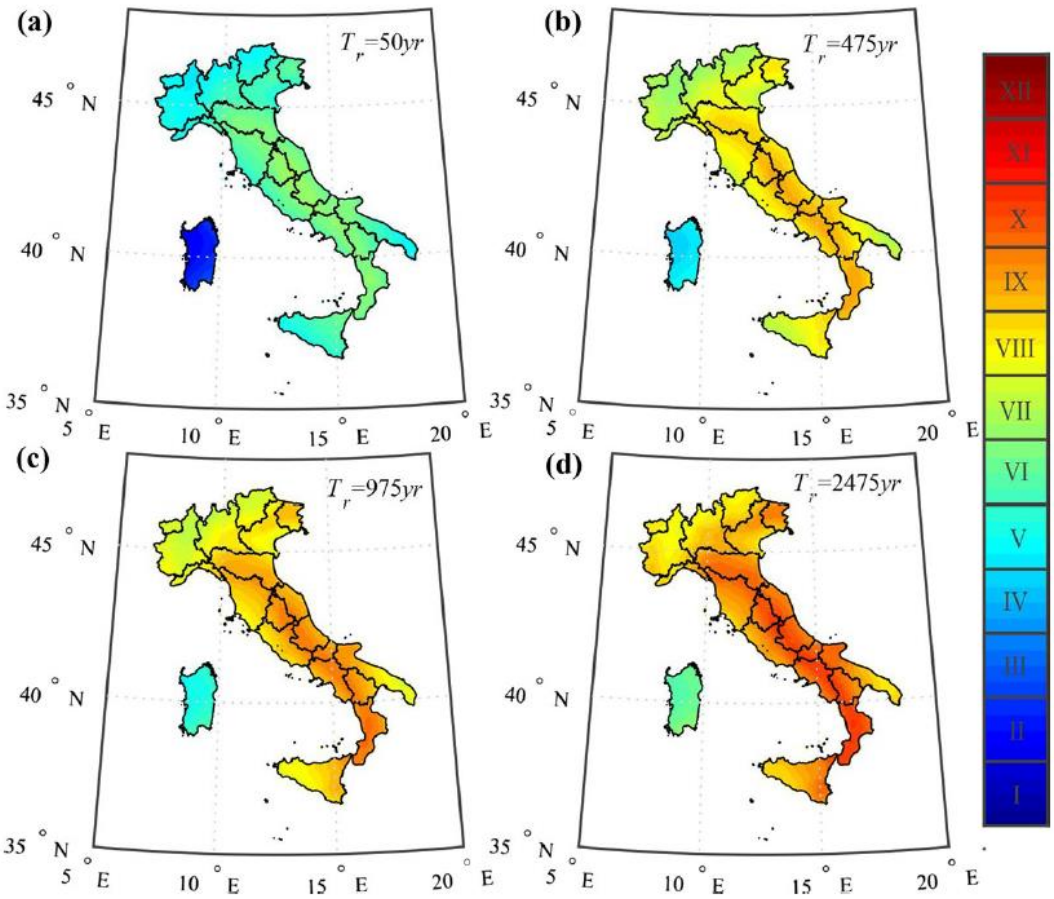
From macroseismic intensity to spectral accelerations: some examples (in collaboration with Prof. Paolucci)

Macroseismic intensity (MI) values from hazard curve derived via PSHA or empirically computed.

PSHA in terms of MI based on MPS19 (Cito, Chioccarelli and Iervolino, 2022)

Home > Bulletin of Earthquake Engineering > Article

Macroseismic intensity hazard maps for Italy based on a recent grid source model



Conversion fro … (2020; GC20) **…a**

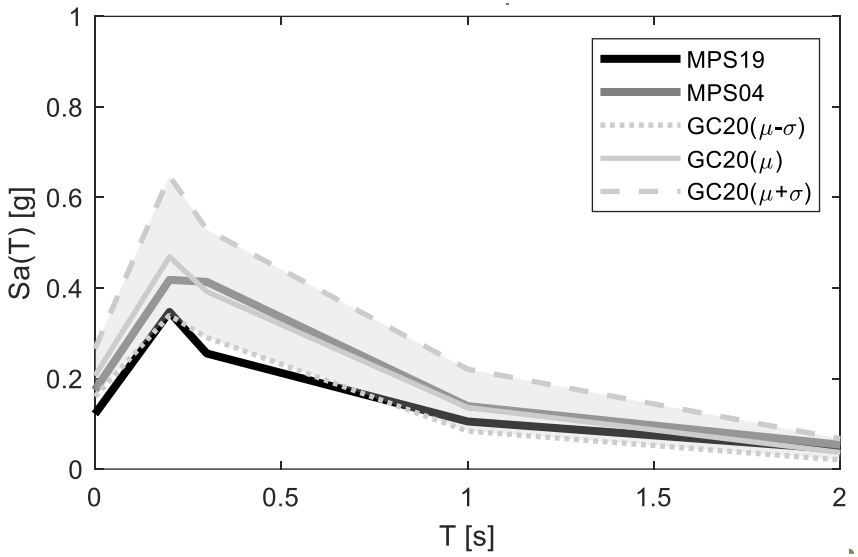
Comparison be… based on MPS… be comparable **…o**

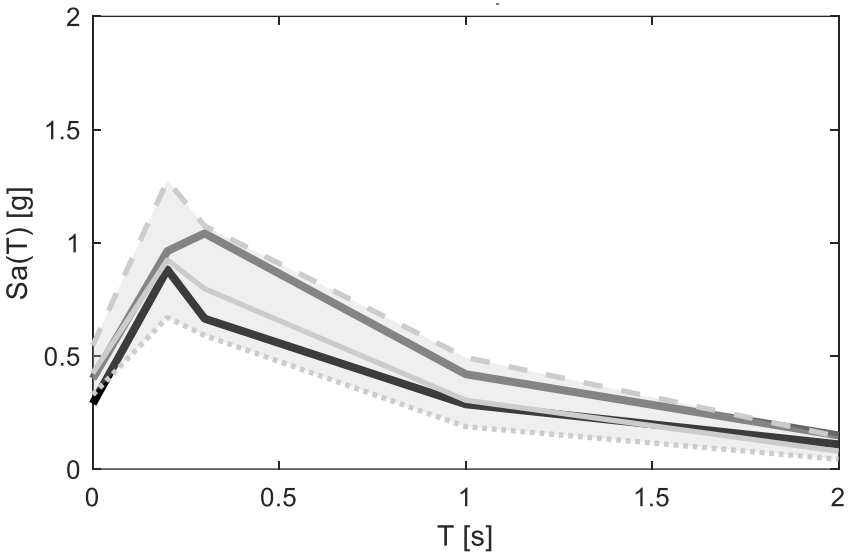
SIRACUSA

Tr=475yr

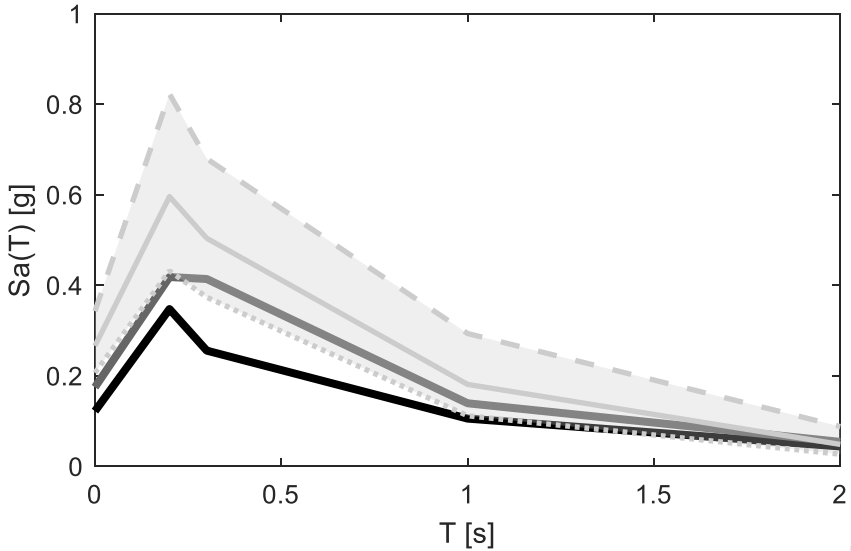
Tr=2475yr

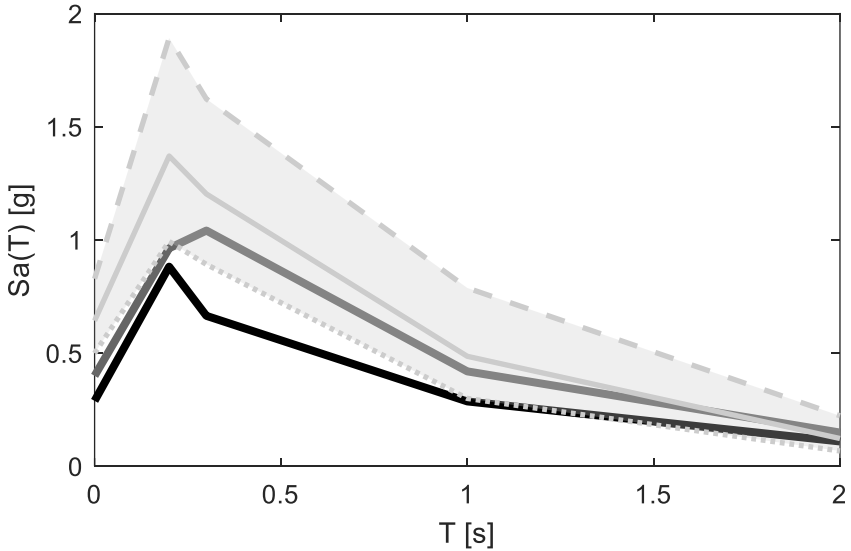
MI value from hazard curve derived via PSHA





MI value from empirical hazard curve



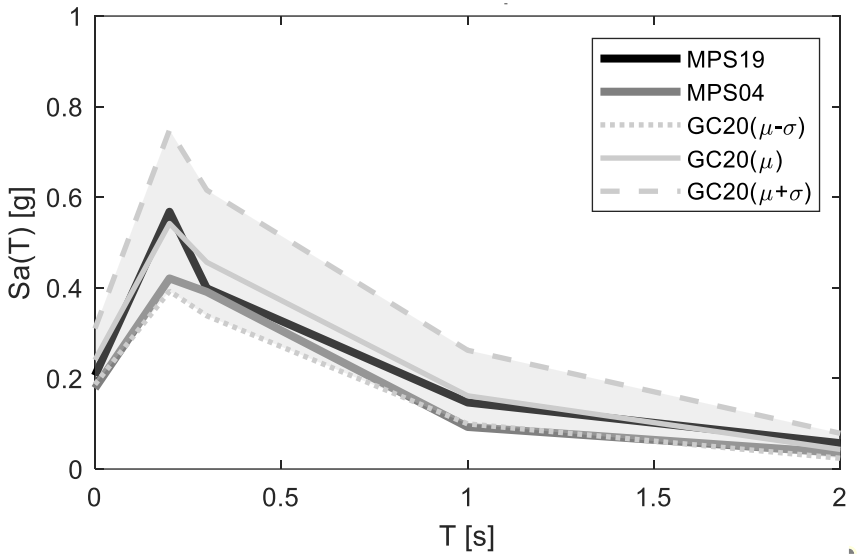


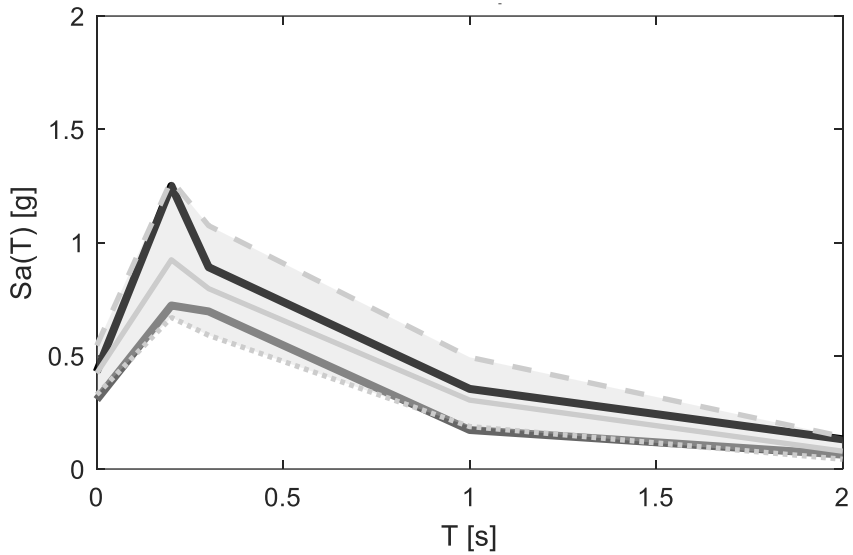
BOLOGNA

Tr=475yr

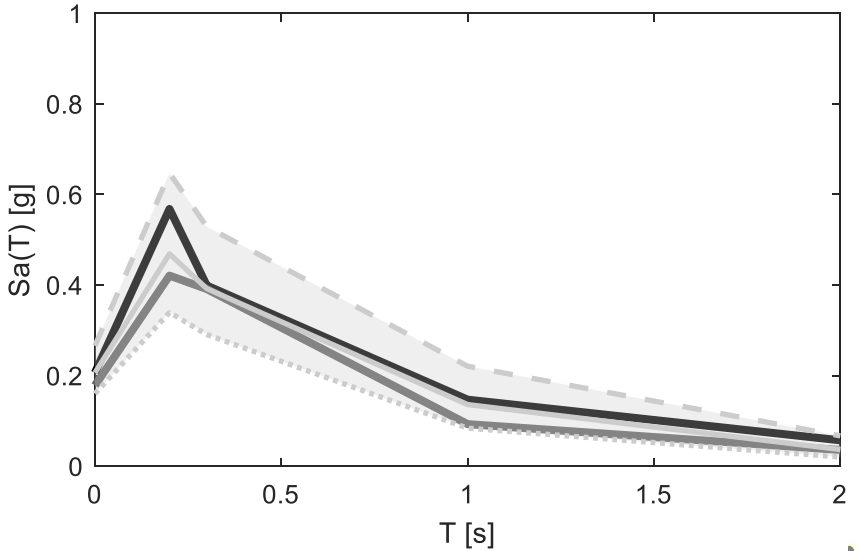
Tr=2475yr

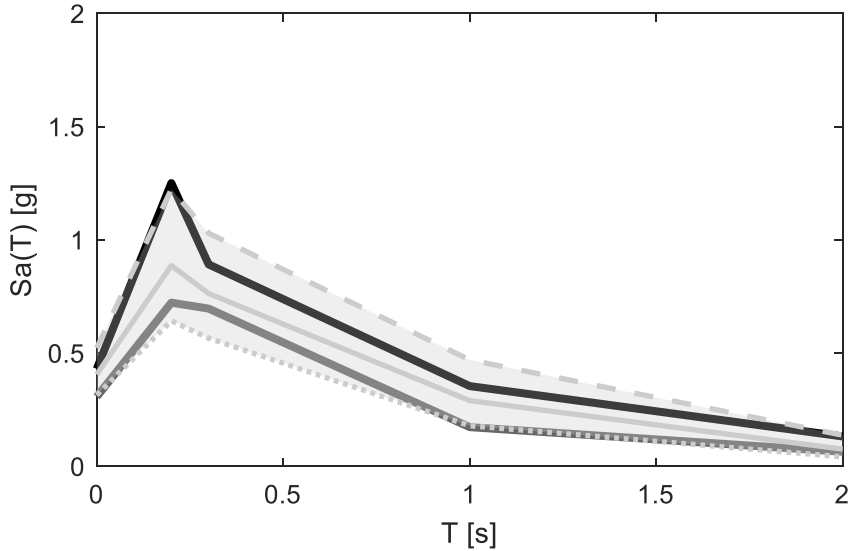
MI value from hazard curve derived via PSHA





MI value from empirical hazard curve



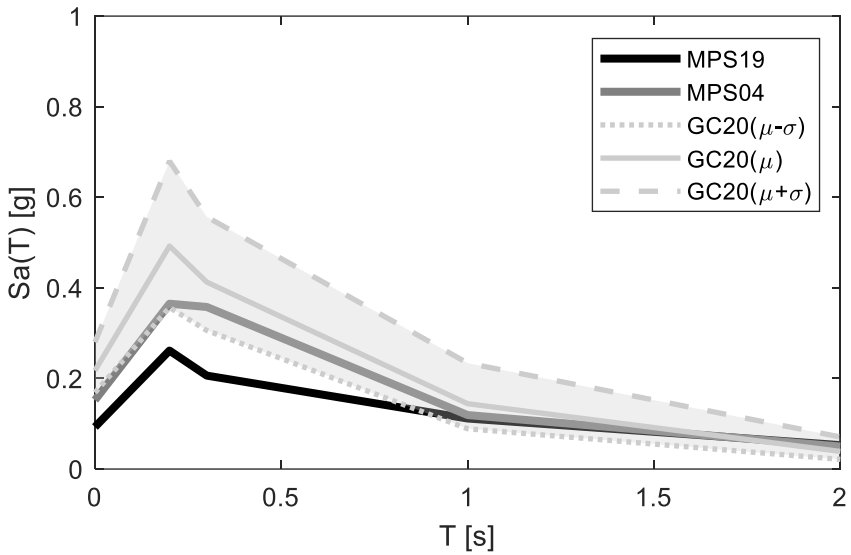


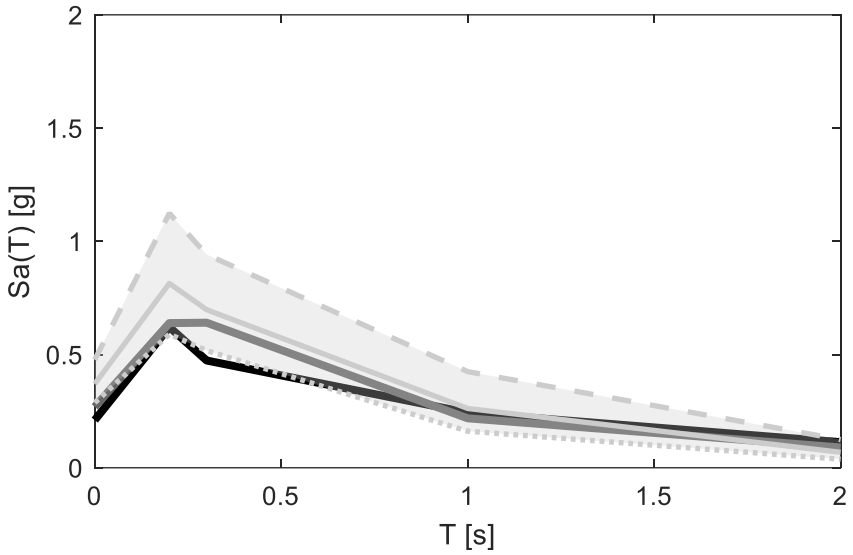
NAPOLI

Tr=475yr

Tr=2475yr

MI value from hazard curve derived via PSHA





MI value from empirical hazard curve