Influence of seismogenic source geometrical accuracy on PTHA: a test case for the Calabrian subduction interface

Roberto Basili, Manuela Volpe, Francesco E. Maesano, Mara M. Tiberti, Stefano Lorito, Fabrizio Romano, Roberto Tonini
Istituto Nazionale di Geofisica e Vulcanologia (INGV), Rome, Italy

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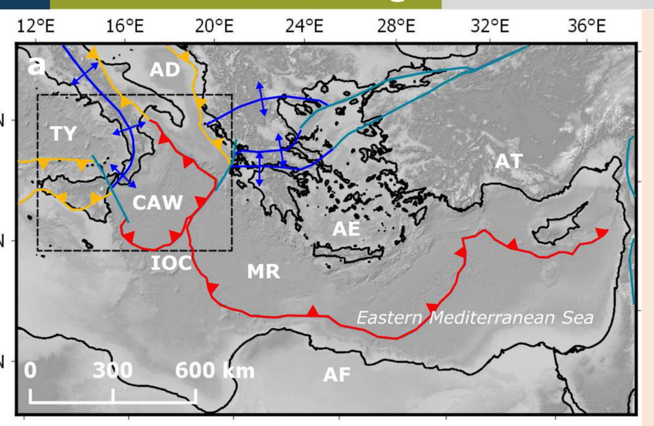
OBJECTIVES

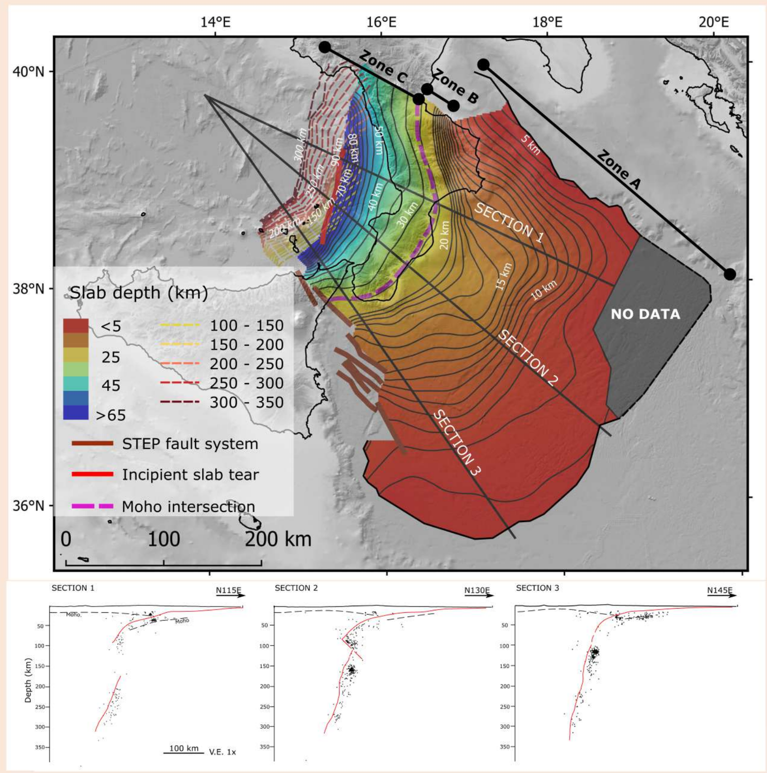
Exploring different degrees of complexities in the geometry of seismic tsunami sources to optimize PTHA

Comparing 3 simplified sources (planar, dip variation, strike variation) with a detailed 3D geological model to estimate the effect of the source geometry on the tsunami generation and propagation pattern.

1 Tectonic setting



A 3D model of the subduction interface was obtained from the original interpretation of a grid of ca. 60 (9000 km length) seismic reflection profiles (Spectrum – INGV collaborative framework CA-60) coupled with the detailed analysis of the seismicity, providing a highly detailed 3D surface geometry for the first 100 km depth. This model includes both the first order information on the curvature and changes in strike and an accurate reconstruction of the 3D subduction interface, and can be scaled to different levels of detail.



Seismic acquisition parameters, detailed interpretation of the seismic profiles were presented in: Maesano et al. (2016) AGU Fall meeting

The Calabrian subduction, located in the Mediterranean Sea, has occasionally be blamed to have generated some past large earthquakes and tsunamis, despite it shows no sign of significant seismic activity on the shallow portion of the interface. Significant in-slab seismicity is recorded below 40 km depth and a rate of 1-5 mm/yr characterize the convergence between the two plates involved, Africa and Europe.

References

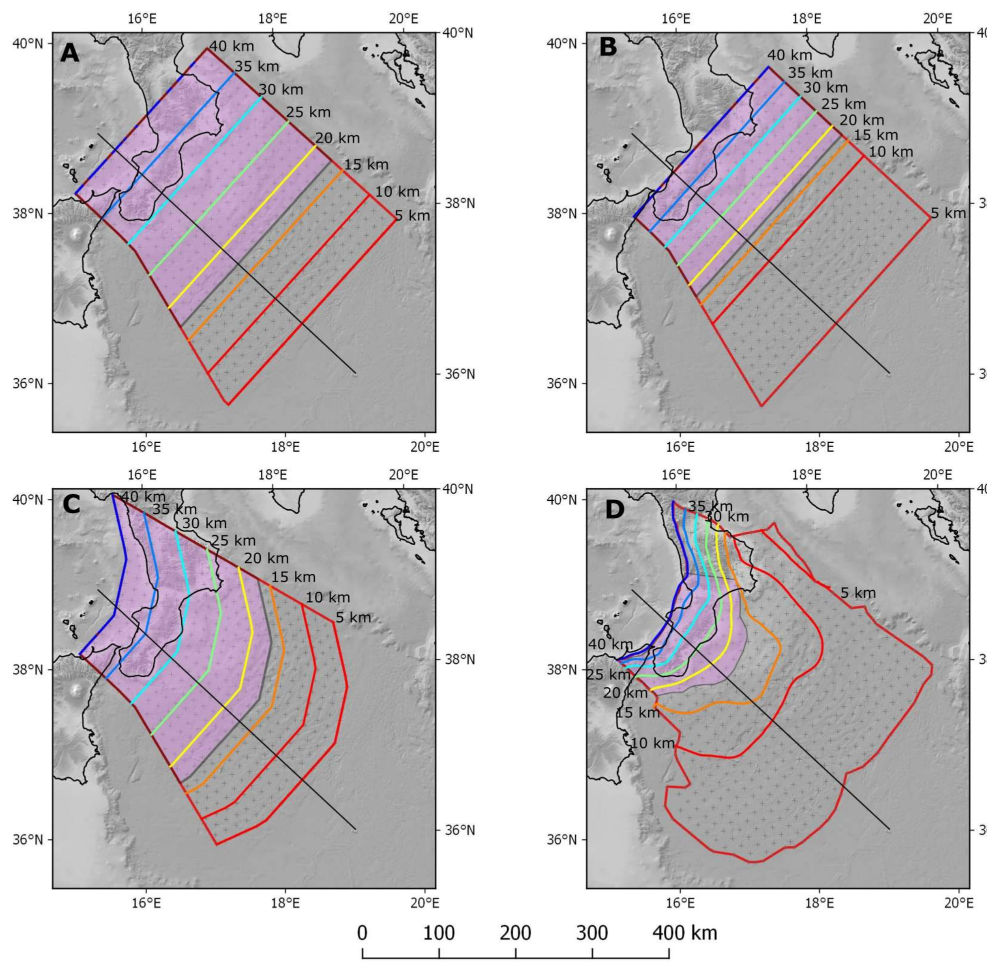
De la Asunciòn et al., Comput Fluids, 2013
Maesano et al., AGU Fall meeting, 2016

Acknowledgments

Multichannel seismic reflection surveys in the Ionian sea are kindly provided by Spectrum under a Confidentiality Agreement (CA-60) with INGV.
CROP seismic profiles are provided by CNR-ISMAR.
The bathymetric Digital Terrain Model is derived from SRTM30 Plus V6.0 data files. Beckeret al. (2009), Global Bathymetry and Elevation Data at 30 Arc Seconds Resolution: SRTM30_PLUS, Marine Geodesy, 32:4, 355-371, 2009.
Midland Valley Ltd is acknowledged for making available the Move software to INGV under Academic Software Initiative (ASI) in 2016.
This poster benefits from the financial support of the TSUMPAS-NEAM, co-financed by the European Union Civil Protection Mechanism, Agreement Number: ECHO/SUB/2015/718568/PREV26, RITMARE, Porto Empedocle, and PON Massimo Projects.

2 Input data

Test surfaces

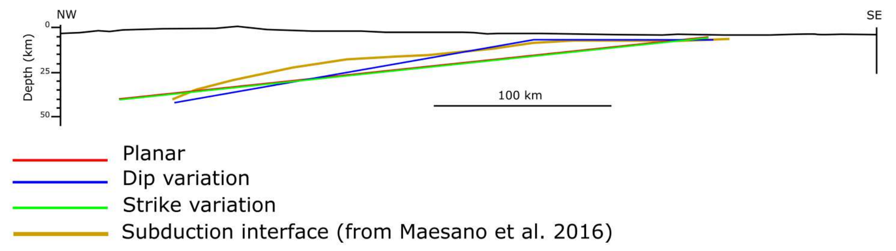


A - Planar
Strike 222°; Dip 6°; Top: -5 km; Bottom: -40 km

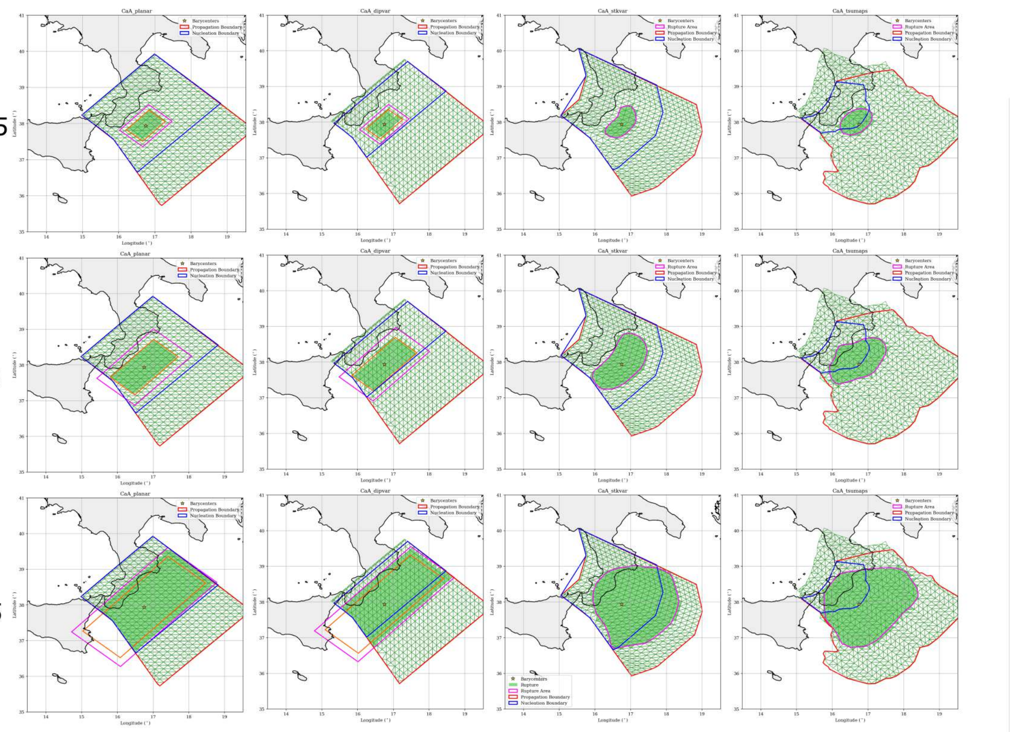
B - Dip variation
Strike 222°; Dip1: 0°; Dip2: 10°; Top:-6.2 km; Bottom: -40 km

C - Strike variation
Strike: 167°, 192°, 221°, 245° ; Dip: 6°; Top: -5 km; Bottom: -40 km

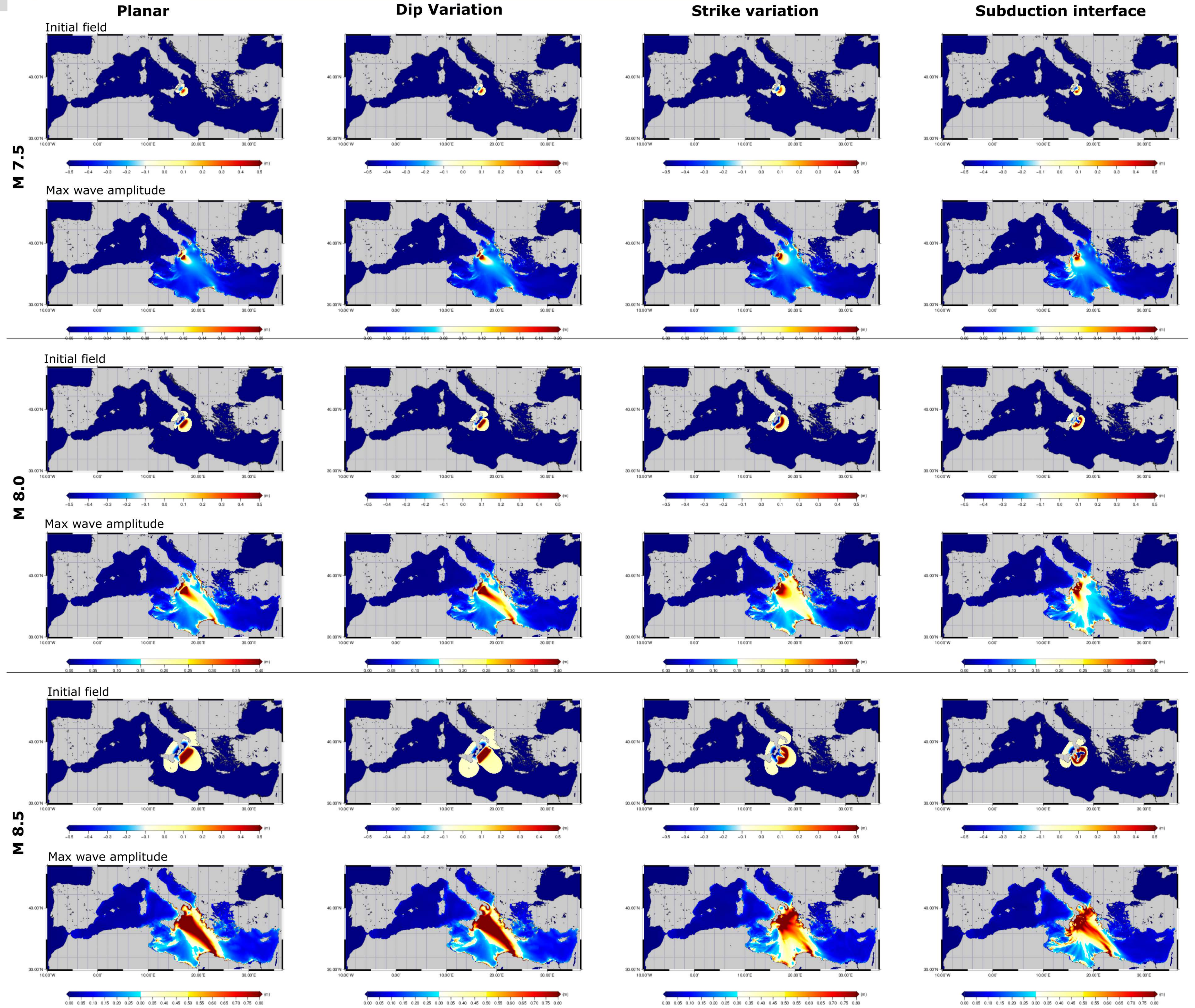
D - Subduction interface (from Maesano et al. 2016)
Complex geometry; Top: -5 km; Bottom: -40 km



Sample Ruptures

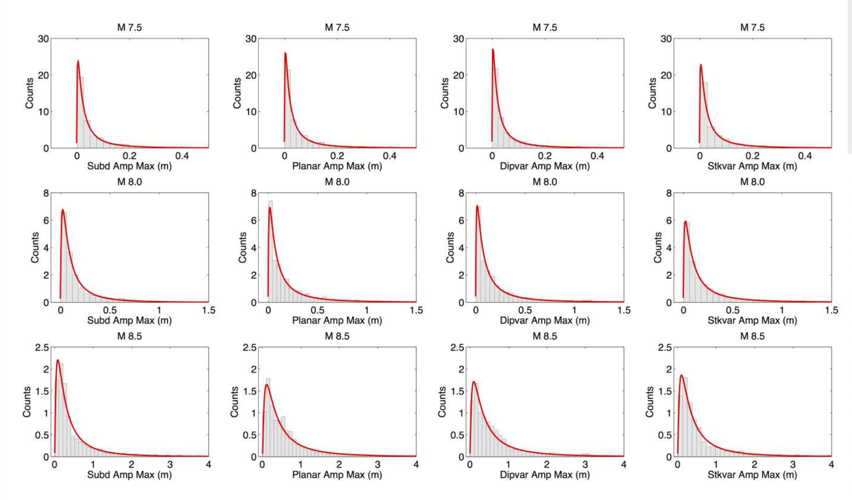


3 Simulations



Tsunami simulations (8 hrs propagation) performed by means of HySEA GPU code (De la Asuncion et al., 2013) that solves nonlinear shallow water equations; computational grid has a spatial resolution of 30 arc-sec.

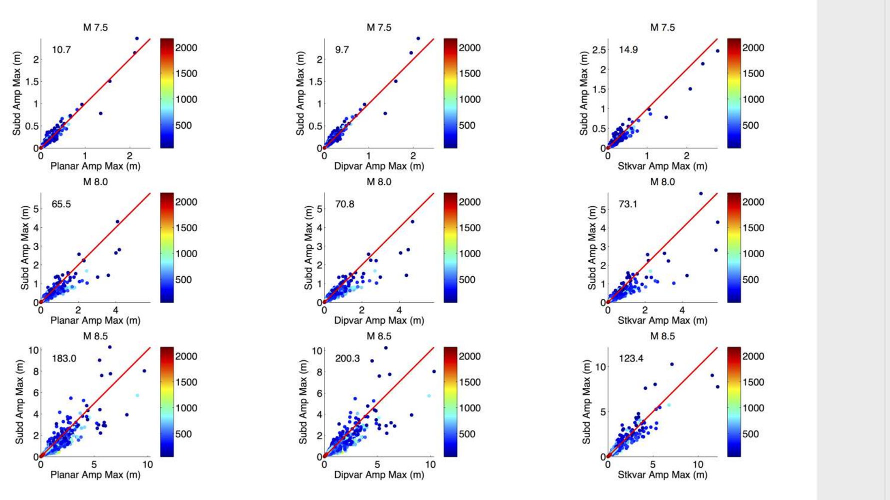
MAX TSUNAMI WAVE AMPLITUDES DISTRIBUTION



The figures to the left show histograms of all the maximum offshore amplitudes (amplified with the Green's law) generated by each source. The histograms have been fitted with a log-normal distribution whose parameters are reported below.

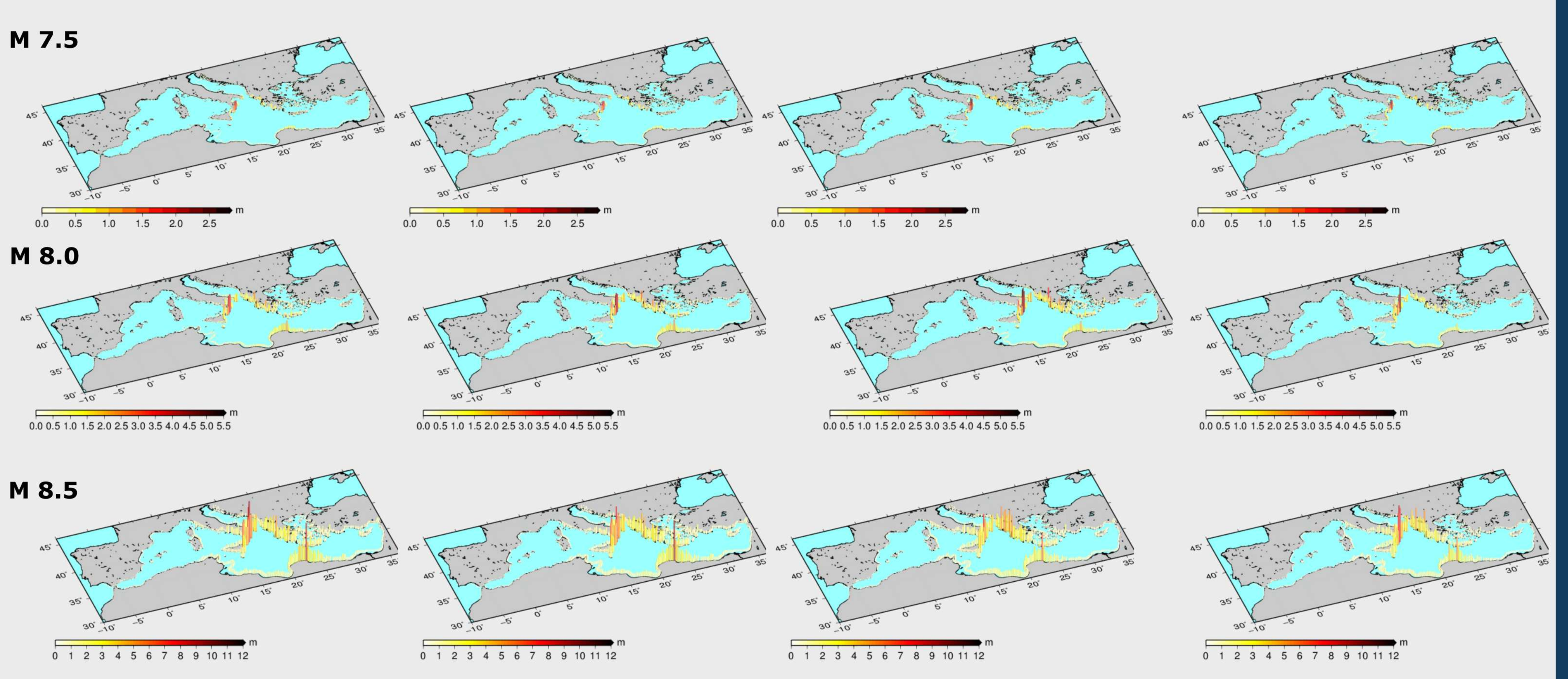
	Subd	Planar	Dipvar	Stkvar
Magnitude	M7.5	M7.5	M7.5	M7.5
Mean	*0.0708*	*0.0699*	*0.0678*	*0.0781*
Standard Deviation	*0.1474*	*0.1456*	*0.1417*	*0.1720*
Median	*0.0285*	*0.0268*	*0.0262*	*0.0285*
16th percentile	*0.0045*	*0.0038*	*0.0035*	*0.0043*
84th percentile	*0.1192*	*0.1194*	*0.1136*	*0.1322*
Magnitude	M8.0	M8.0	M8.0	M8.0
Mean	*0.2007*	*0.2436*	*0.2494*	*0.2690*
Standard Deviation	*0.3560*	*0.4185*	*0.4521*	*0.4830*
Median	*0.0952*	*0.1085*	*0.1095*	*0.1137*
16th percentile	*0.0278*	*0.0221*	*0.0190*	*0.0261*
84th percentile	*0.3569*	*0.4090*	*0.4002*	*0.4521*
Magnitude	M8.5	M8.5	M8.5	M8.5
Mean	*0.5836*	*0.7359*	*0.7378*	*0.6620*
Standard Deviation	*0.9129*	*0.9909*	*1.0226*	*0.9714*
Median	*0.2811*	*0.4419*	*0.4260*	*0.3492*
16th percentile	*0.1055*	*0.1525*	*0.1317*	*0.1277*
84th percentile	*0.9840*	*1.1277*	*1.1421*	*1.1104*

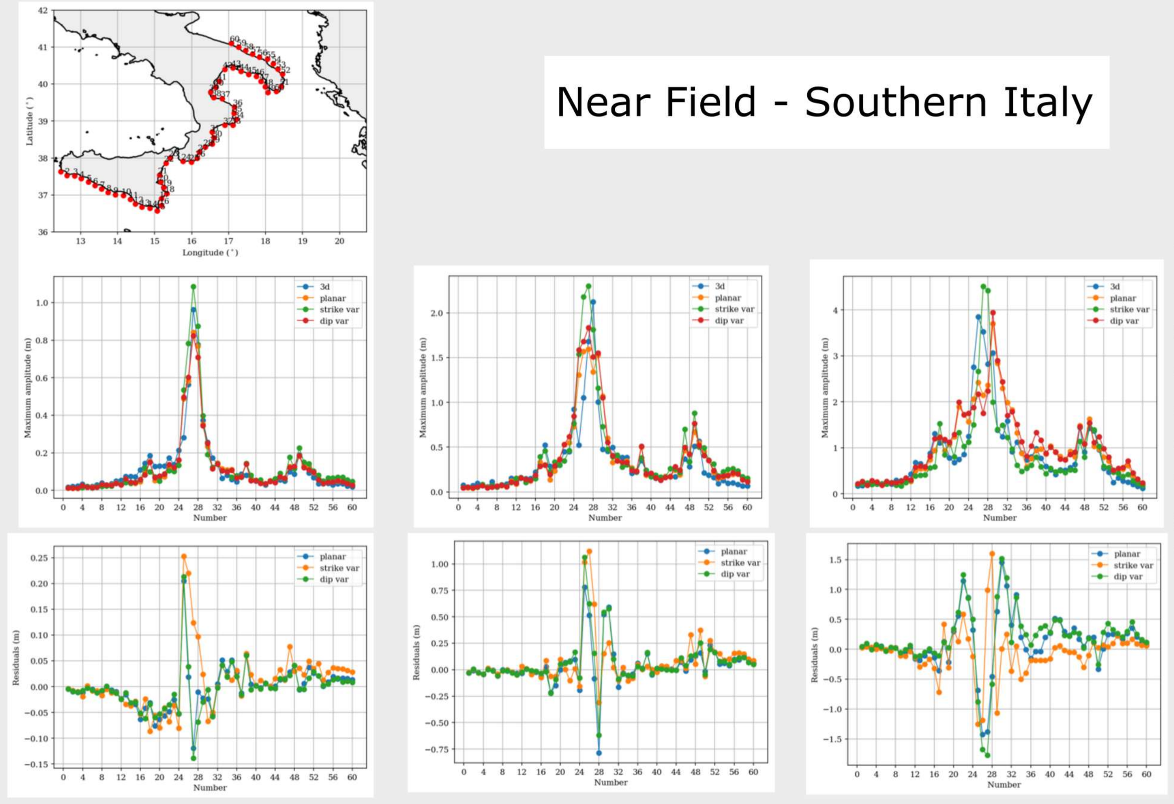
SCATTER PLOTS FOR MAX WAVE AMPLITUDES GENERATED BY THE 3D MODEL OF THE SUBDUCTION INTERFACE VS SIMPLIFIED MODELS



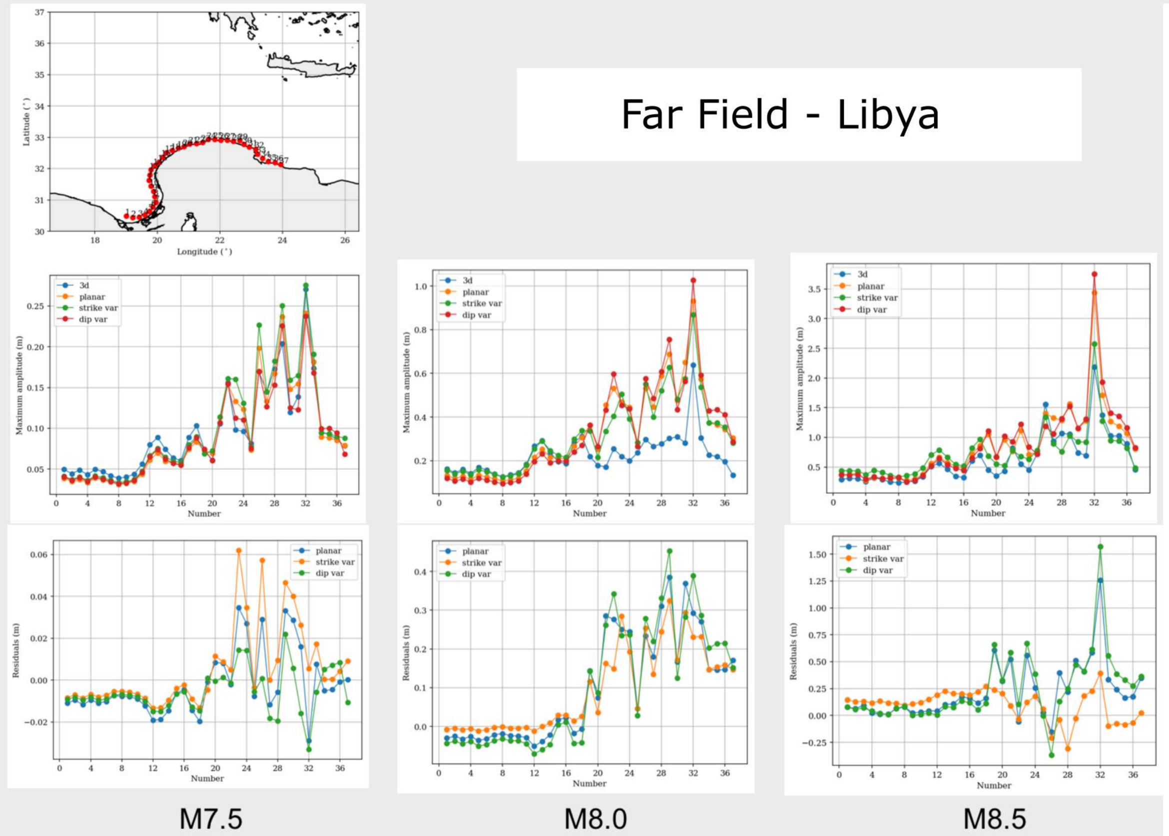
4 Results

We analyzed the effect of the fault geometry for three different earthquake magnitudes in terms of maximum tsunami amplitudes computed along the 50 m isobaths and amplified by means of the Green's law.





The figures show:
- the maximum wave amplitude for the coast of Southern Italy and Northern Libya for different magnitudes and different geometries.
- the residuals between the maximum wave amplitudes generated by the simplified geometries with respect to the 3D model of the subduction interface



CONCLUSIONS

Our preliminary results show that:

1) geometrical complexities of the subduction interface significantly influence the modelled tsunami;

2) building realistic 3D subduction interface models is relevant for applications such as hazard analysis;

3) although the general pattern of coastal wave amplitudes is controlled by the tsunami propagation on a comaplex bathymetry, the maximum wave amplitudes are controlled, at the first order, by the model adopted for the subduction interface.