SOFIA UNIVERSITY
ST. KLIMENT OHRIDSKI

3rd Scientific Seminar
"Physics and chemistry of the Earth System"
3-5 October 2021 | BANYA

Funded by Sofia University Research Science Fund
project 80-10-120/26.03.2021

Registered tsunami waves in the region of Aegean Sea for the last 5 years

Lyuba Dimova

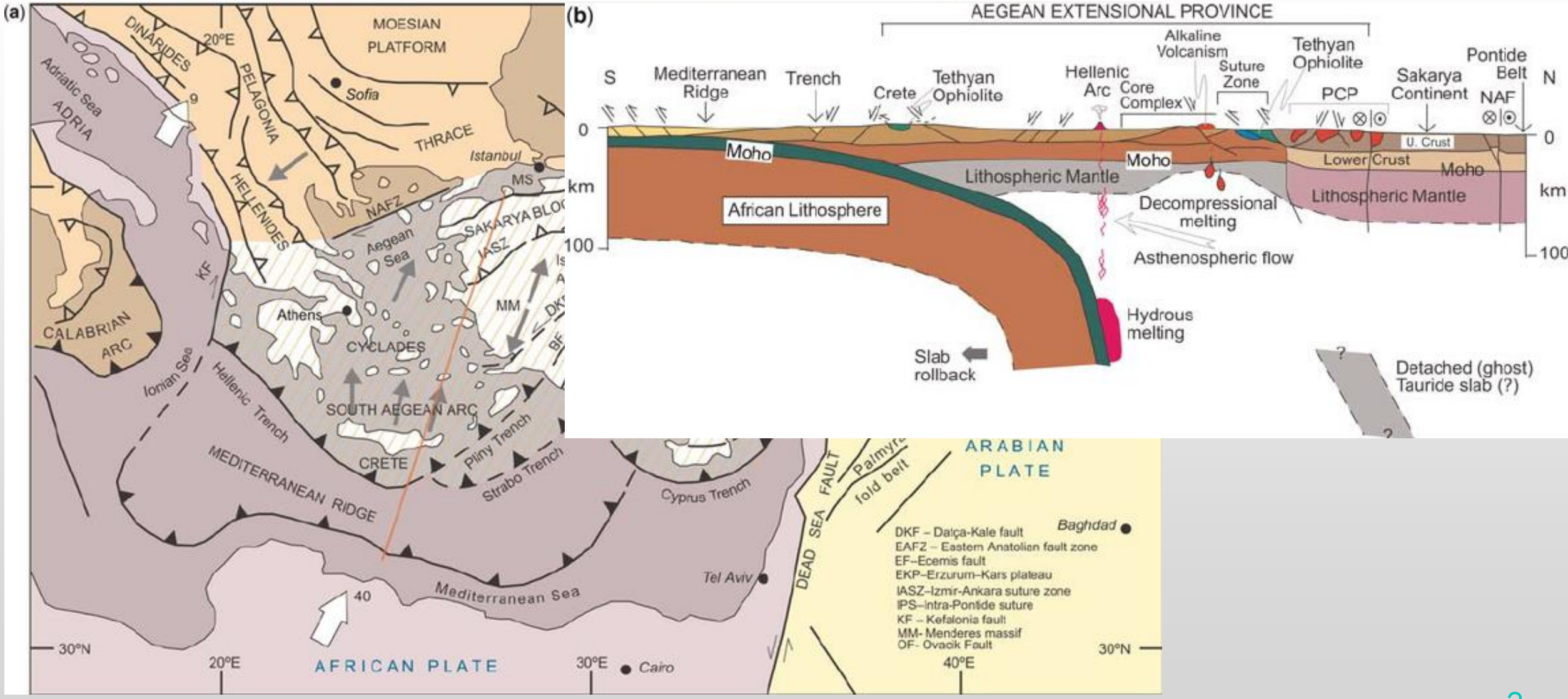
Department of Meteorology and Geophysics
Faculty of Physics, Sofia University "St. Kliment Ohridski"

e-mail: lyuba_dimova@phys.uni-sofia.bg

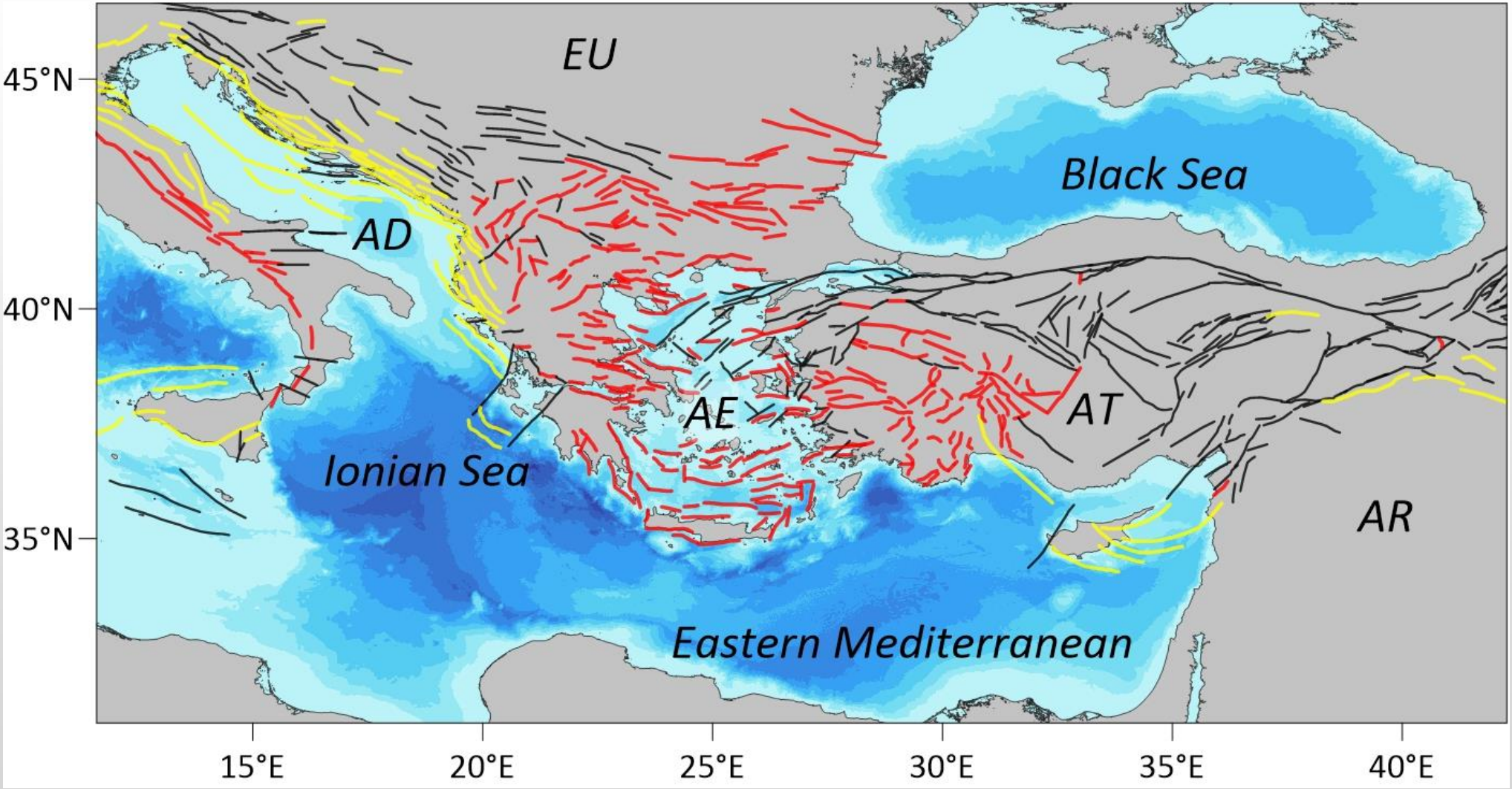
OUTLINE

- Overview of tsunami waves, seismic activity and tectonic structures in the Southeast Europe and in the Aegean region
- Registered tsunami waves in the past 5 years
- Tsunami numerical simulations:
  - October 30, 2020 (Samos-Izmir);
  - May 2, 2020 (Crete Island);
  - July 20, 2017 (Bodrum-Kos);
- Conclusions

Southeastern Europe – TECTONIC STRUCTURES



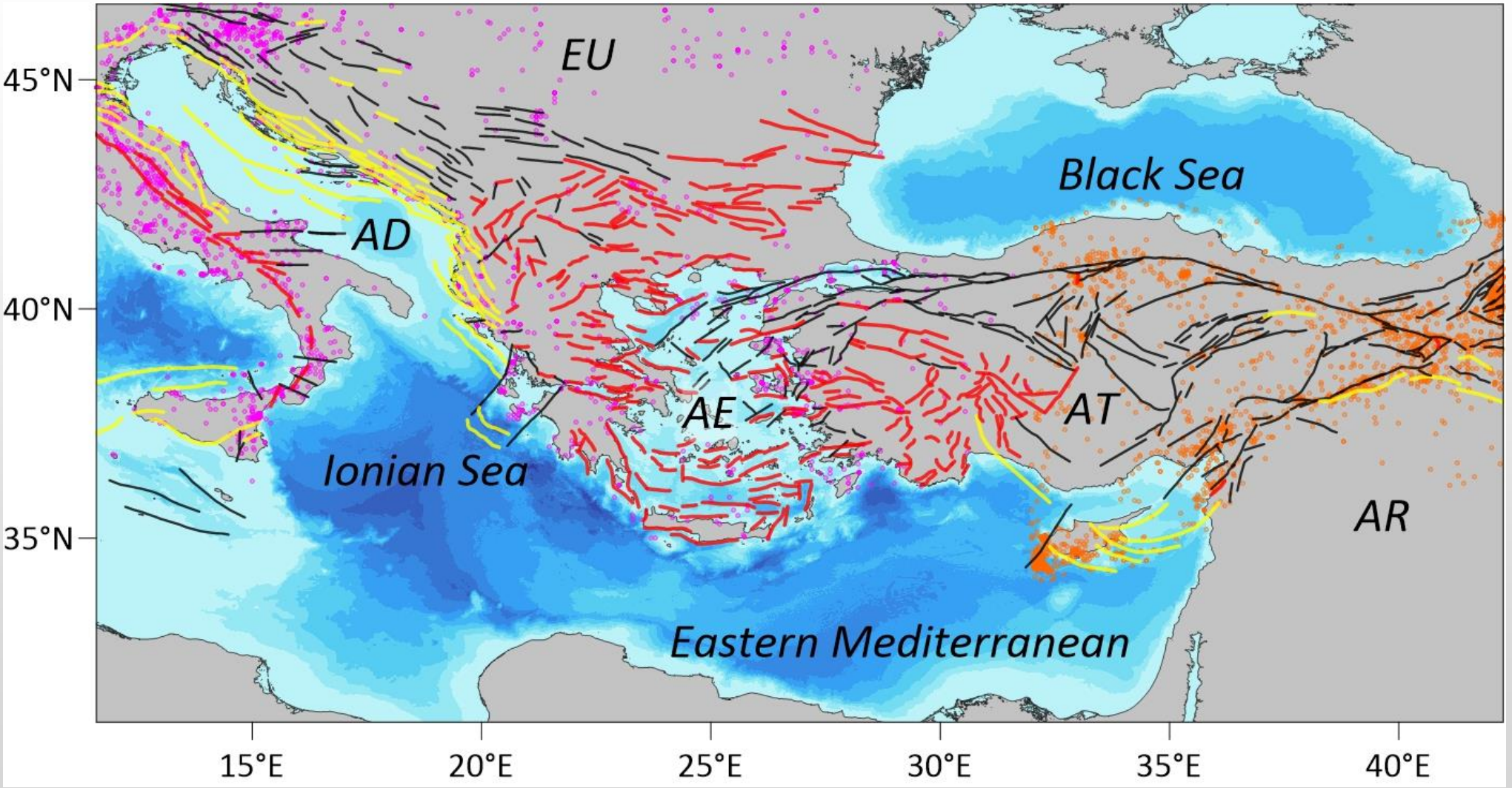
Southeastern Europe – TECTONIC STRUCTURES



Legend:
AD-Adria;
AE-Aegean;
AR-Arabian;
AT-Anatolian;
EU-Eurasian;
[normal, reverse, left- and right-lateral faults]

The European Database of Seismogenic Faults *compiled for SHARE (Seismic hazard HARmonization in Europe*

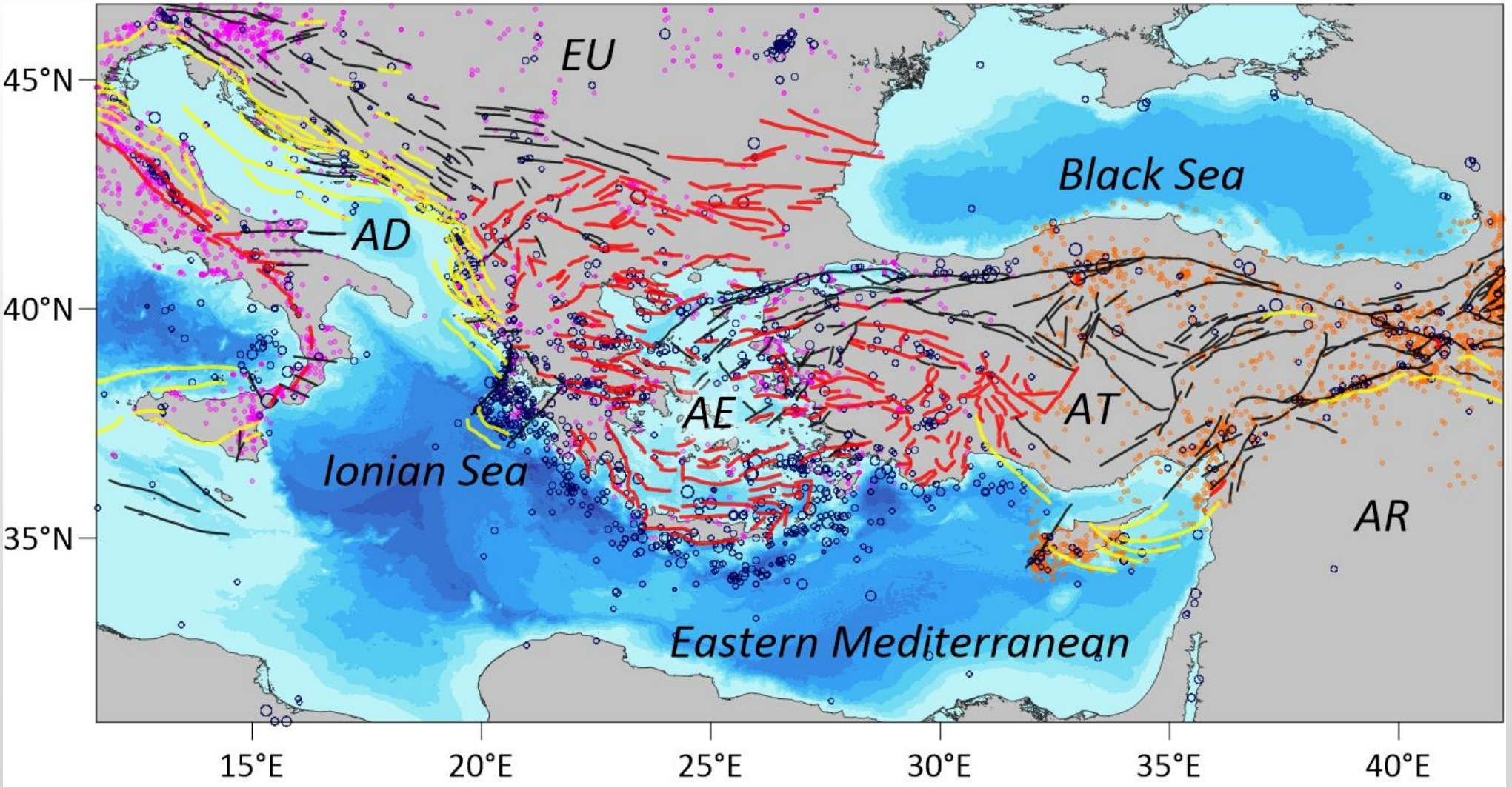
Southeastern Europe – SEISMICITY



Seismicity 1000-1899 – data from SHEEC (SHare European Earthquake Catalogue)

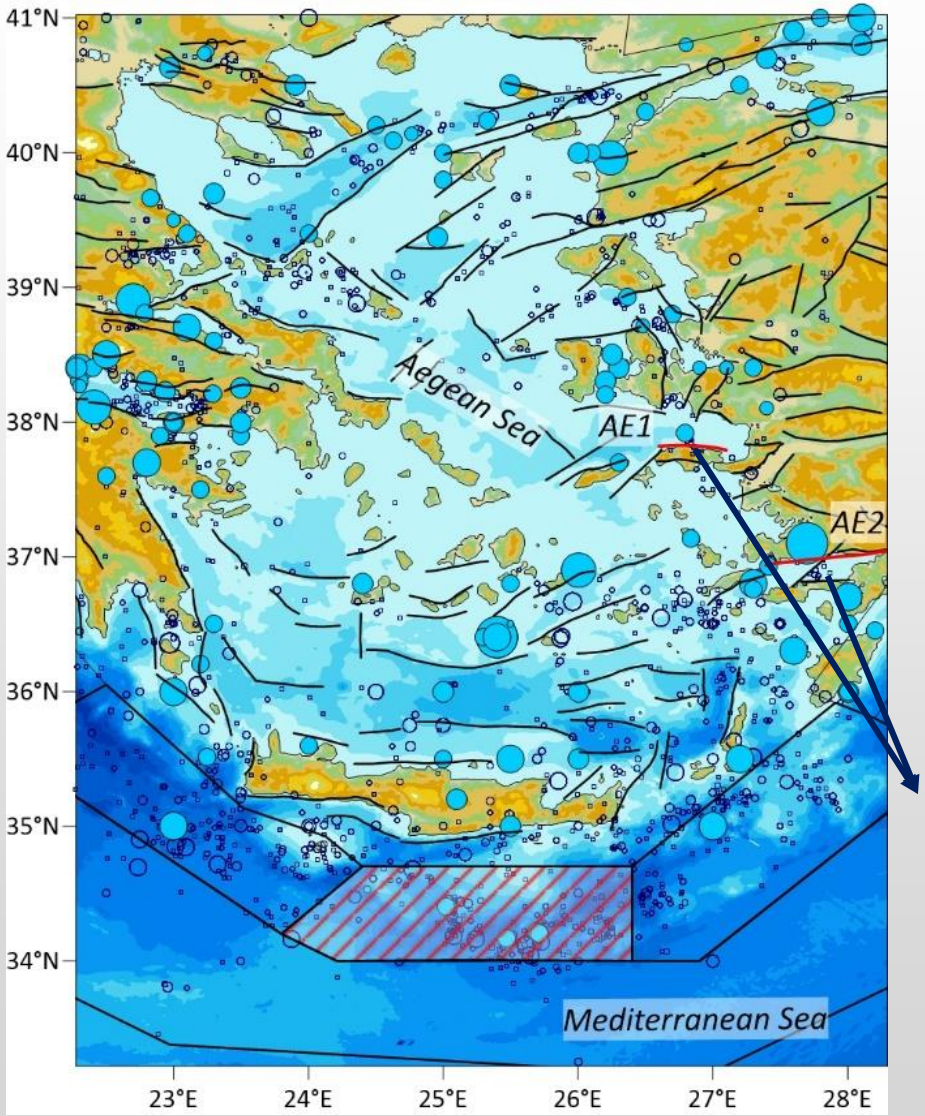
Seismicity 1000-2006 – for Central and Eastern Turkey and Cyprus from SHEEC (SHare European Earthquake Catalogue)

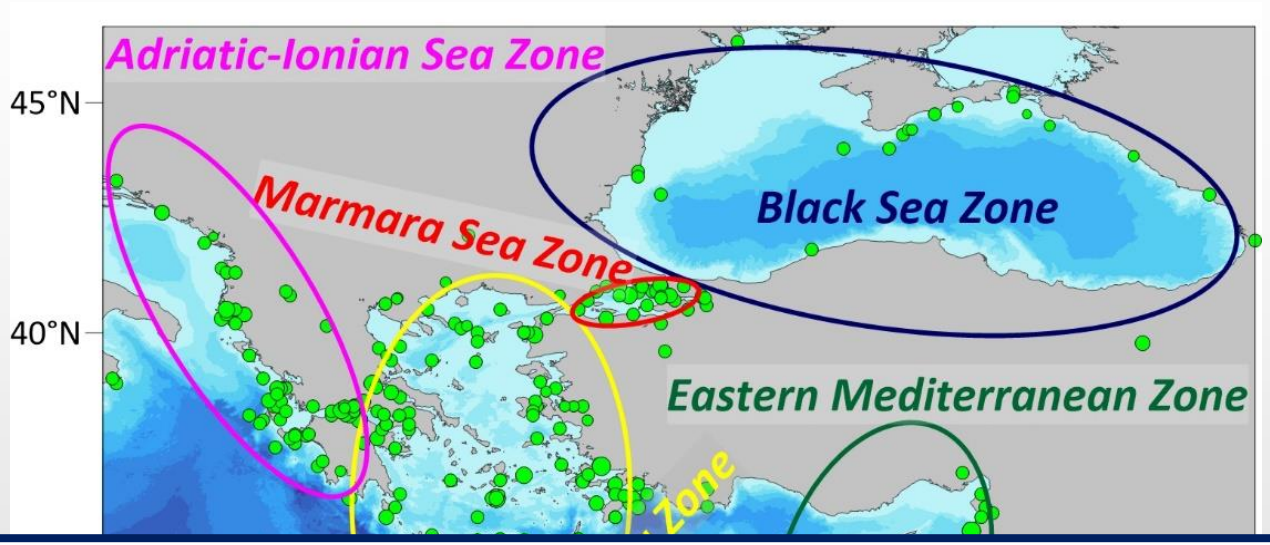
Southeastern Europe – SEISMICITY



Seismicity 1000-1899 – data from SHEEC (SHare European Earthquake Catalogue)
Seismicity 1000-2006 – for Central and Eastern Turkey and Cyprus from SHEEC (SHare European Earthquake Catalogue)
Seismicity 1900-2021 – data from ISC catalogue

Eastern Mediterranean – TSUNAMI SOURCES

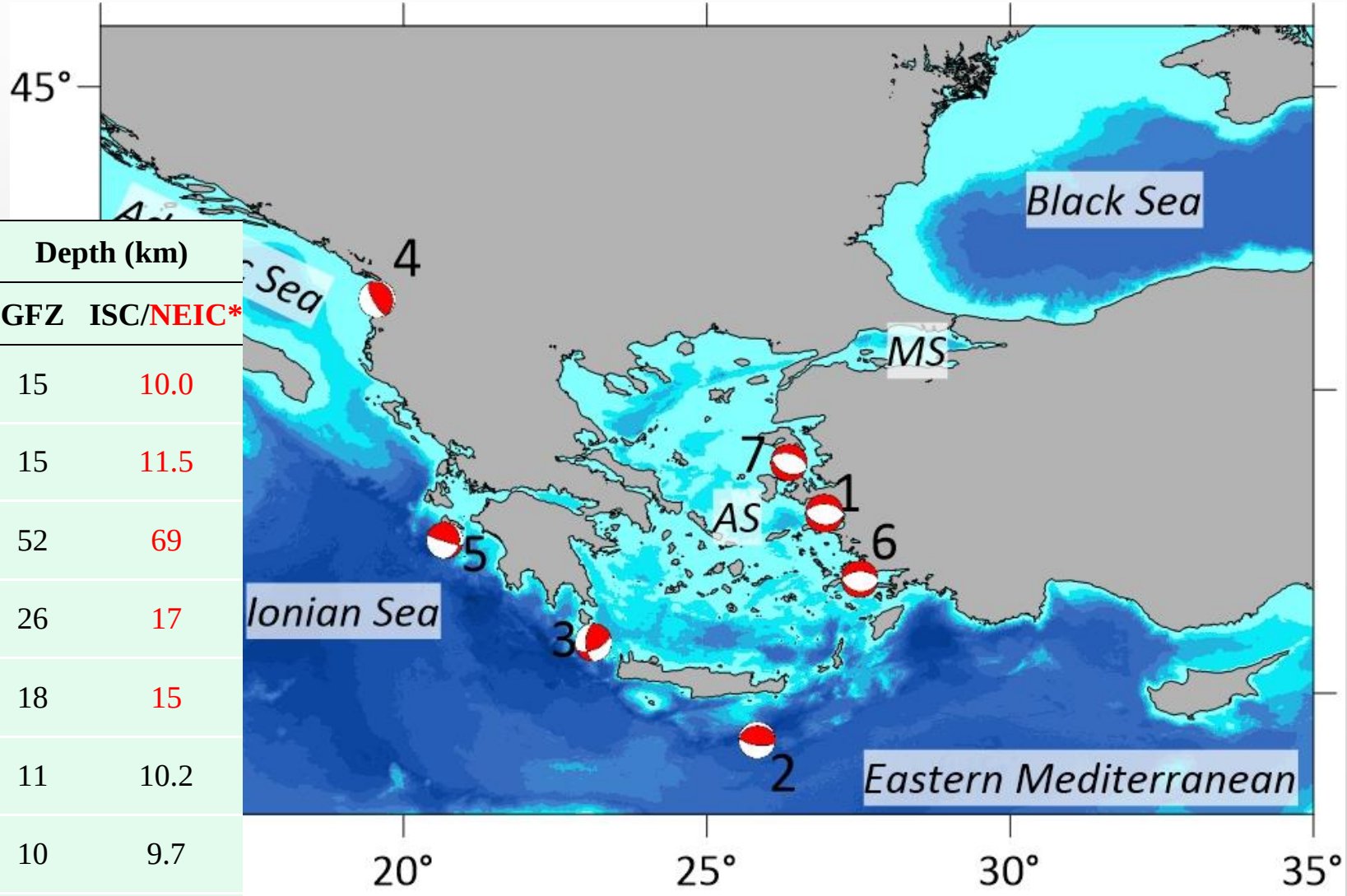




ID Source	Type	Strike	Dip	Rake	Length	Width	Depth	Slip rate mm yr^{-1}	Moment Magnitude		
			deg		km				Mw Orig	Mw min	Mw max
AE1 GRCS912	NN	260-290	45-70	260-280	44.3	18.0	0.5-15	0.1-2.0	6.9	6.69	6.98
AE2 TRCS913	NN	70-85	50-75	260-290	84.3	17	0-14.5	0.5-3.0	7.09	6.64	7.08

STRONG OFFSHORE EARTHQUAKES

	Origin Time UTC	M_w	Lat (°N)	Lon (°E)	Depth (km)	
					GFZ	ISC/NEIC*
1	2020-10-30 11:51:27	7.0	37.90	26.82	15	10.0
2	2020-05-02 12:51:06	6.6	34.24	25.75	15	11.5
3	2019-11-27 07:23:40	6.0	35.71	23.22	52	69
4	2019-11-26 02:54:12	6.4	41.46	19.58	26	17
5	2018-10-25 22:54:50	6.8	37.52	20.66	18	15
6	2017-07-20 22:31:12	6.6	36.93	27.47	11	10.2
7	2017-06-12 12:28:39	6.4	38.83	26.34	10	9.7



RECENT TSUNAMI WAVES IN THE AEGEAN SEA

30 October 2020 M7 (Samos-Izmir)
3.8 m max run-up
155 observed run-ups
118 deaths due to the earthquake
1054 injuries
>400 million $ total damage

Vathy (Samos).
Security camera

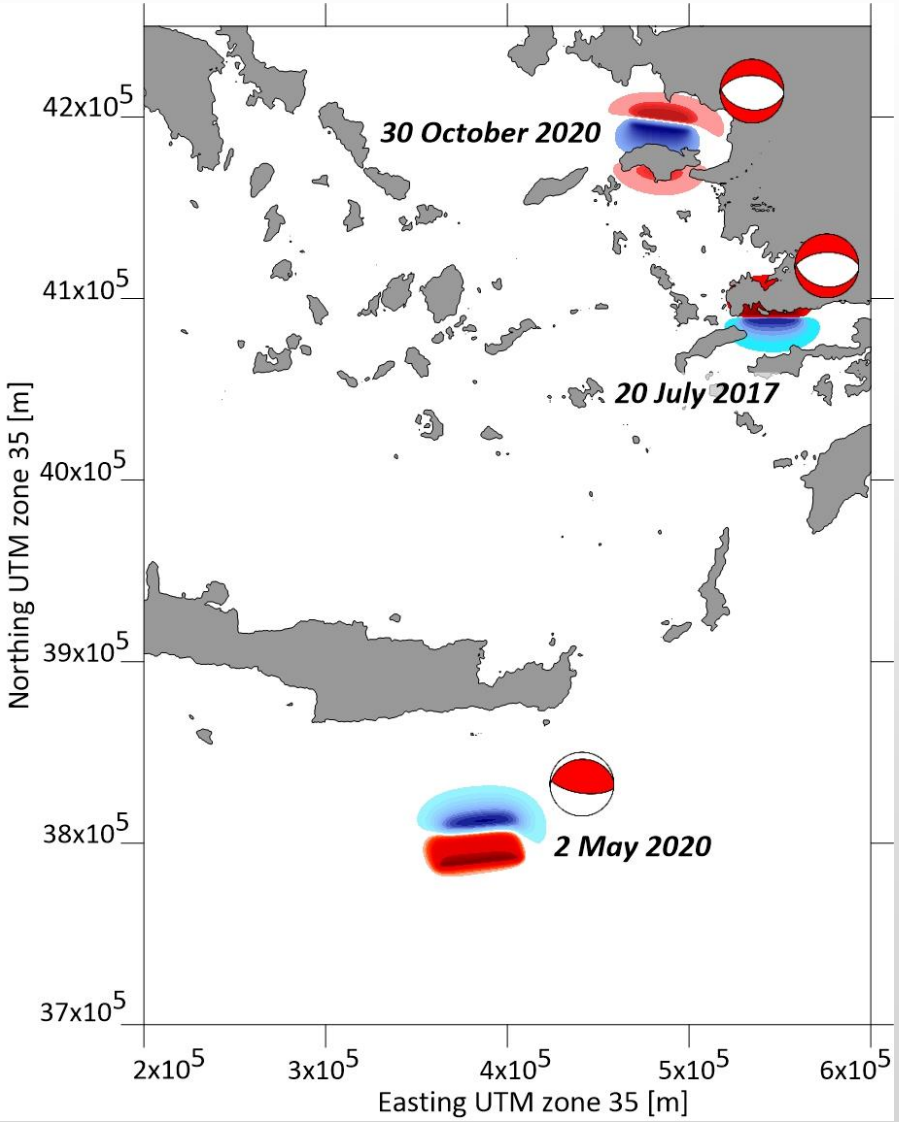
2 May 2020 M6.6 (Crete)
0.35 m max run-up,
7 observed run-ups
The tsunami was recorded in Alexandria tide-gauge

20 July 2017 M6.6 (Bodrum-Kos)
1.9 m max run-up
40 observed run-ups
1 casualty due to tsunami
500 injuries
less than 1 million $ total damage

METHODOLOGY

- Assessment of the strong earthquakes induced tsunami;
- Tsunamigenic source selection;
- Focal mechanism determination;
- Preparation of the geometry of the faults;
- Building the computational grids (bathymetry and topography data);
- Initial conditions for tsunami generation (Okada`s method [1985]);
- Tsunami propagation and inundation (UBO-TSUFD model [Tinti & Tonini, 2013])

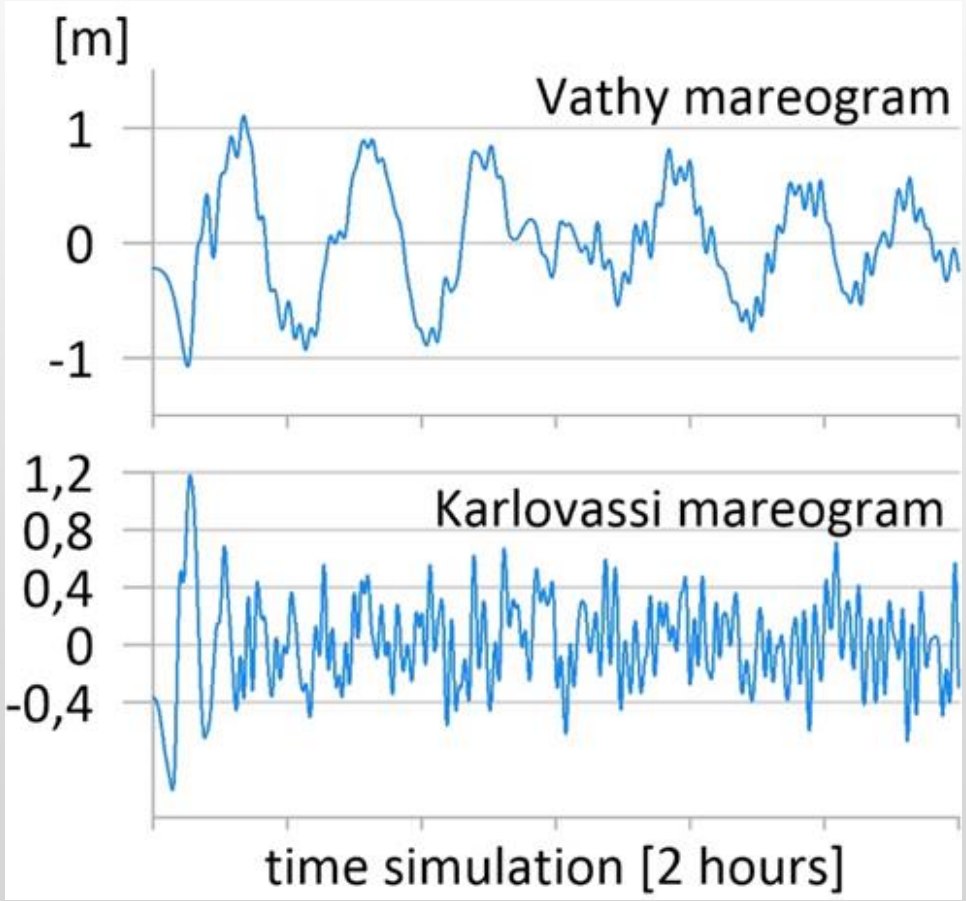
INITIAL TSUNAMI CONDITIONS



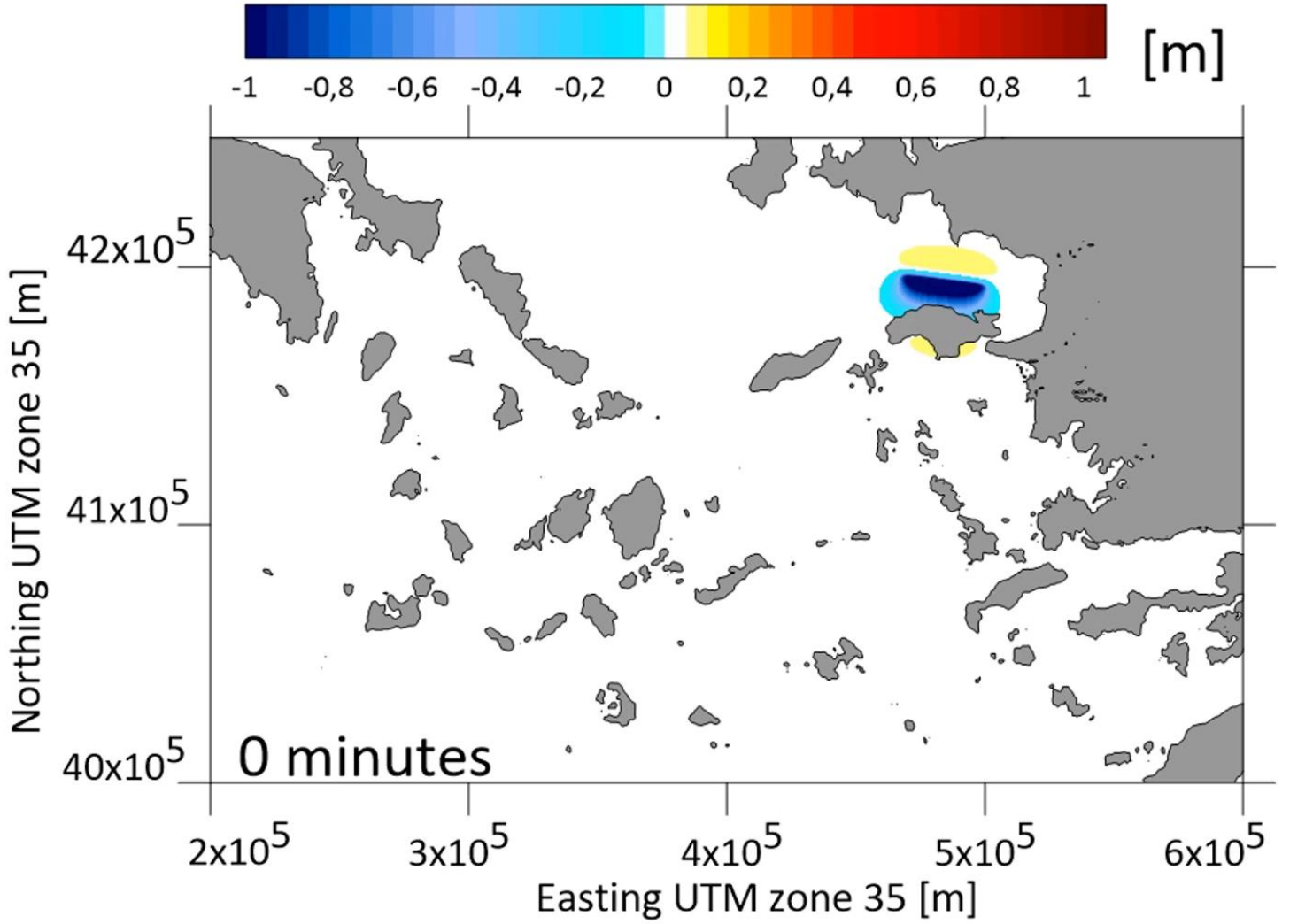
Measured tsunami heights

Karlovassi h~1.7 m, receding

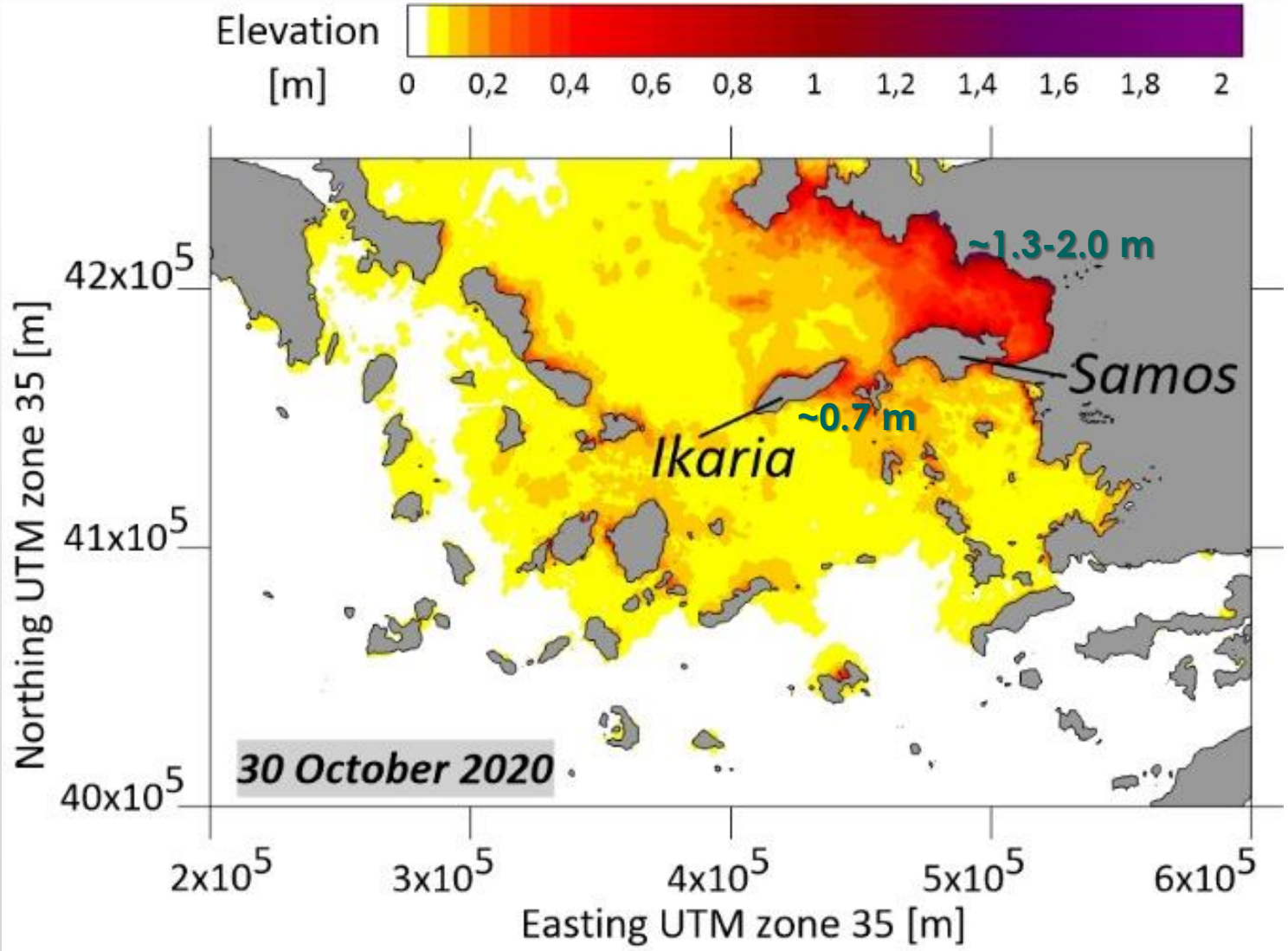
Vathy, 2 strong waves T~20 min

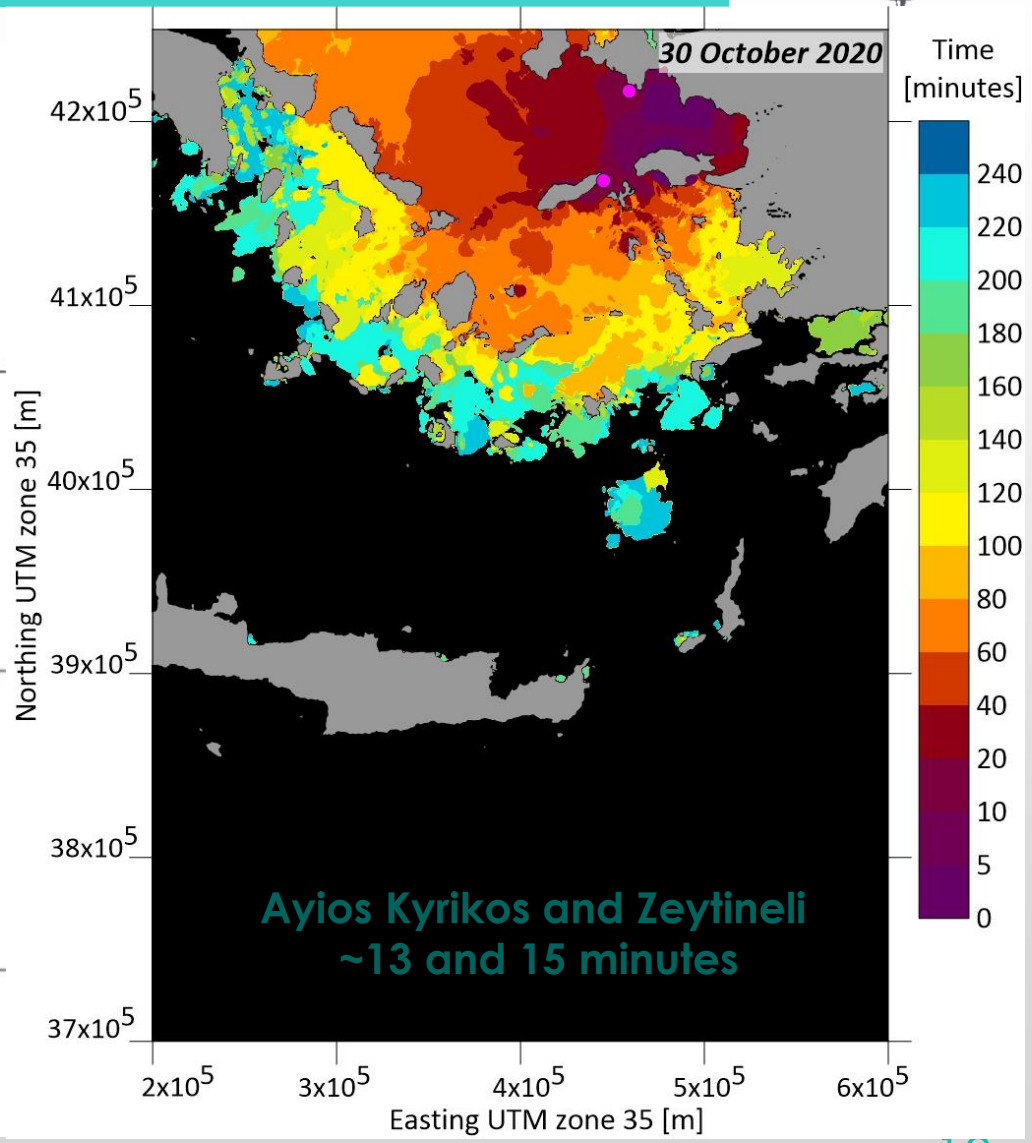


TSUNAMI PROPAGATION FIELD | 30.10.2020

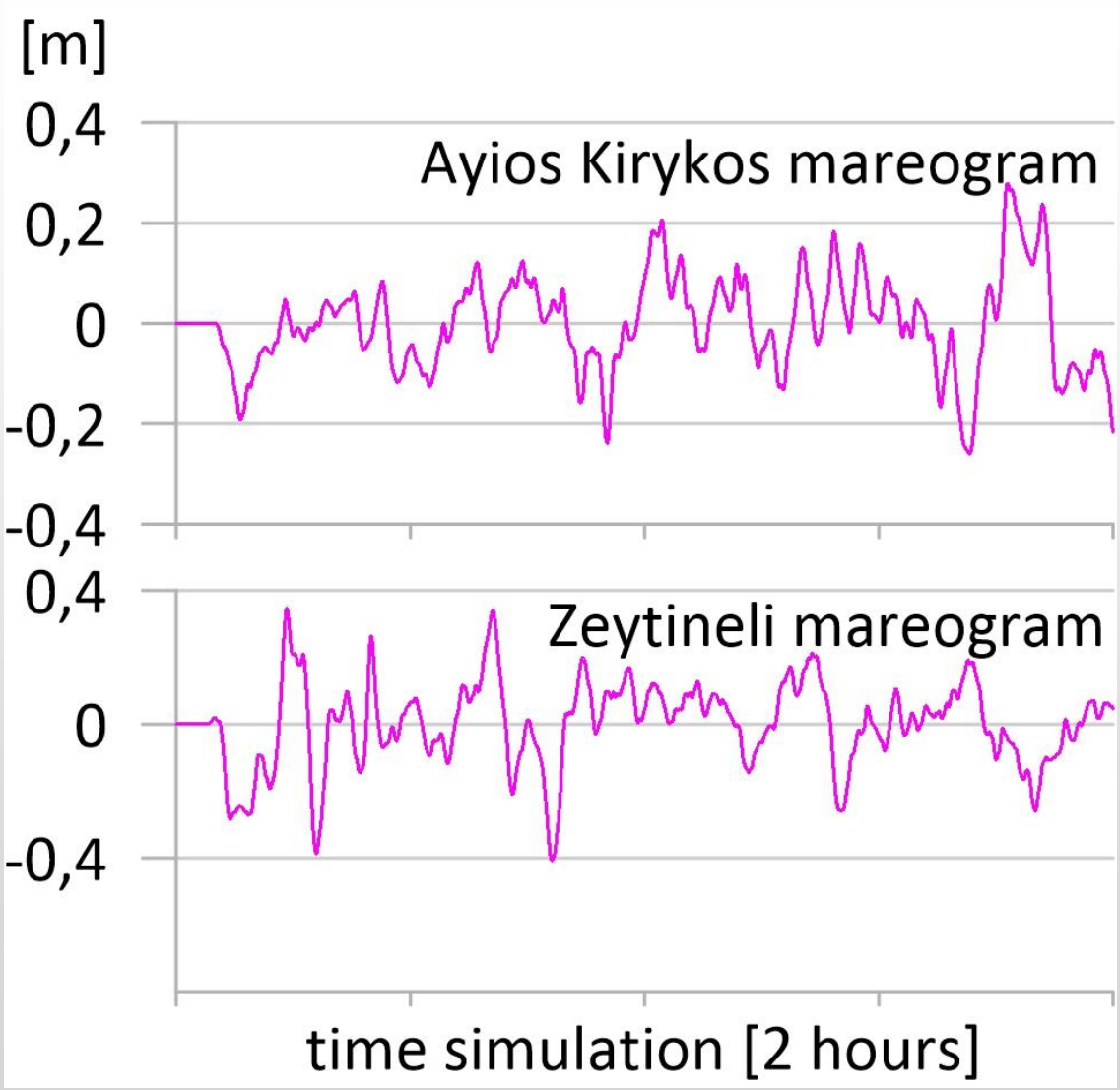


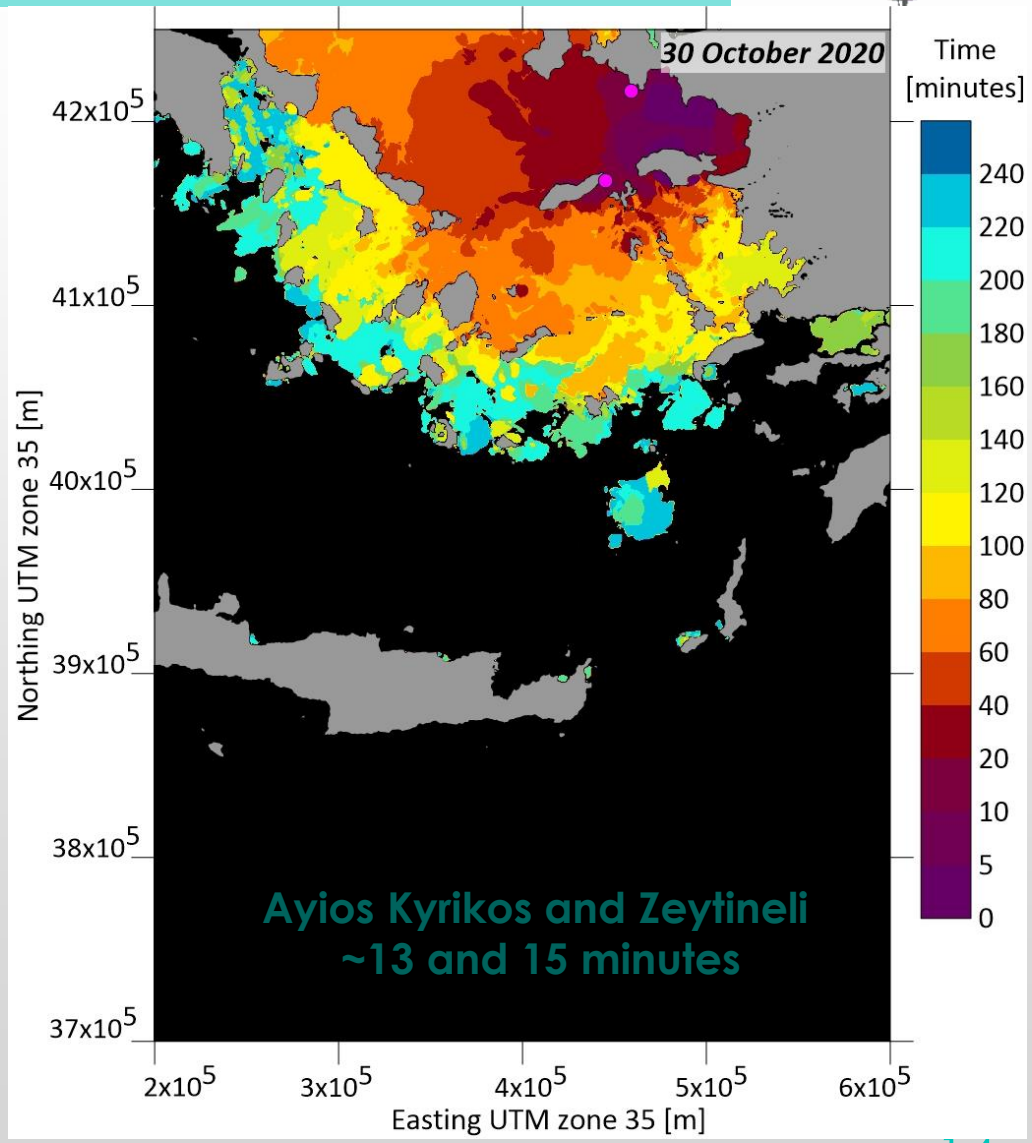
MAXIMUM ELEVATIONS TSUNAMI TIME TRAVEL



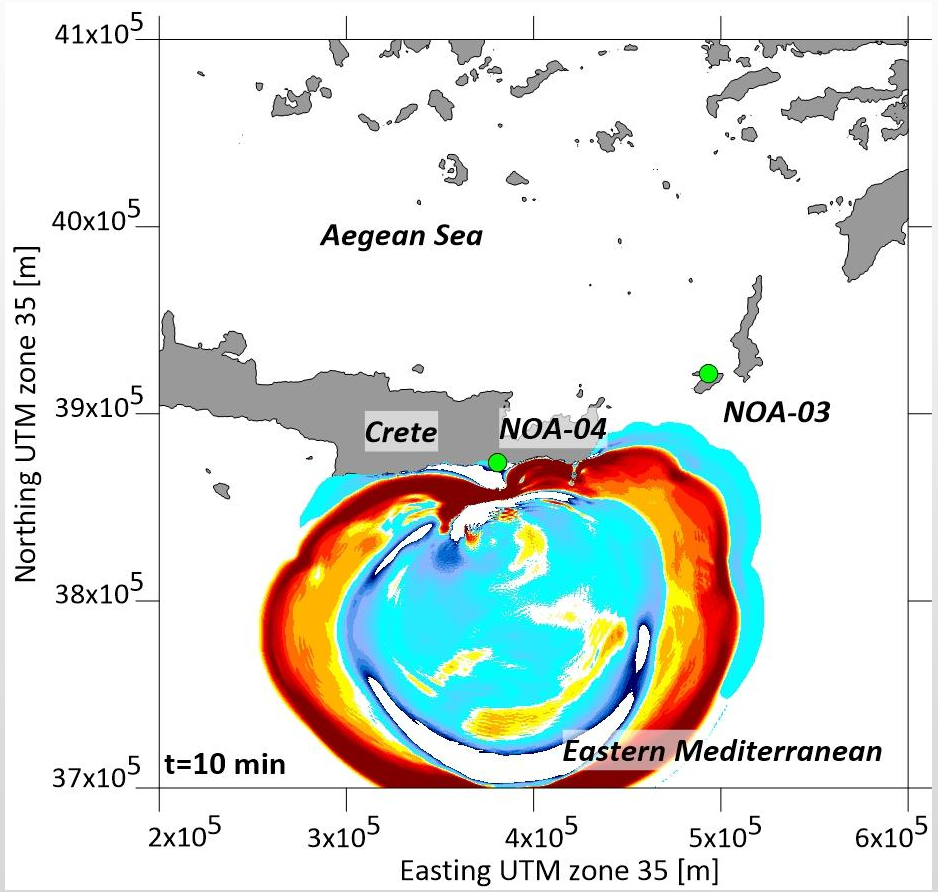


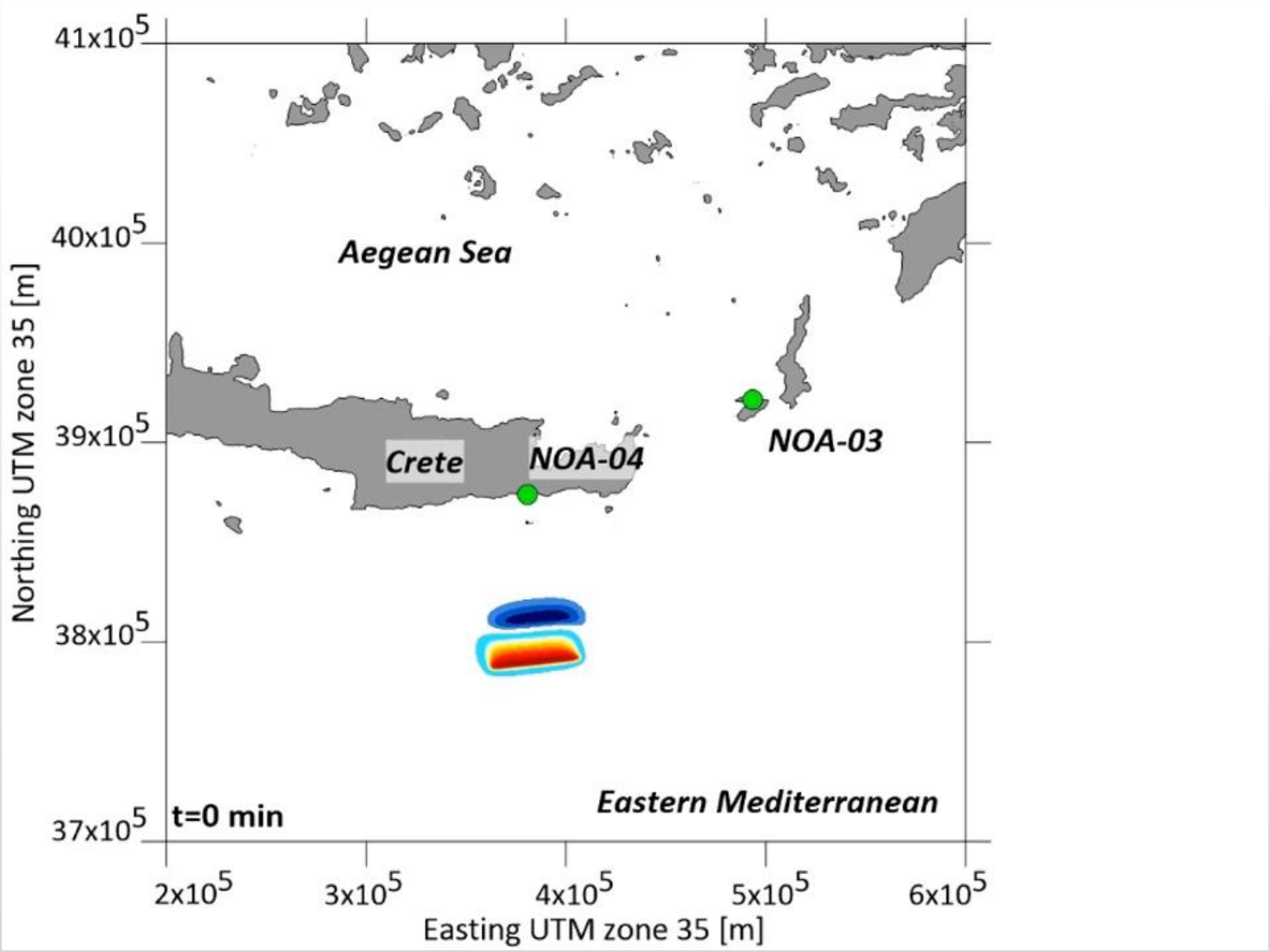
SYNTHETIC MAREOGRAMS | 30.10.2020



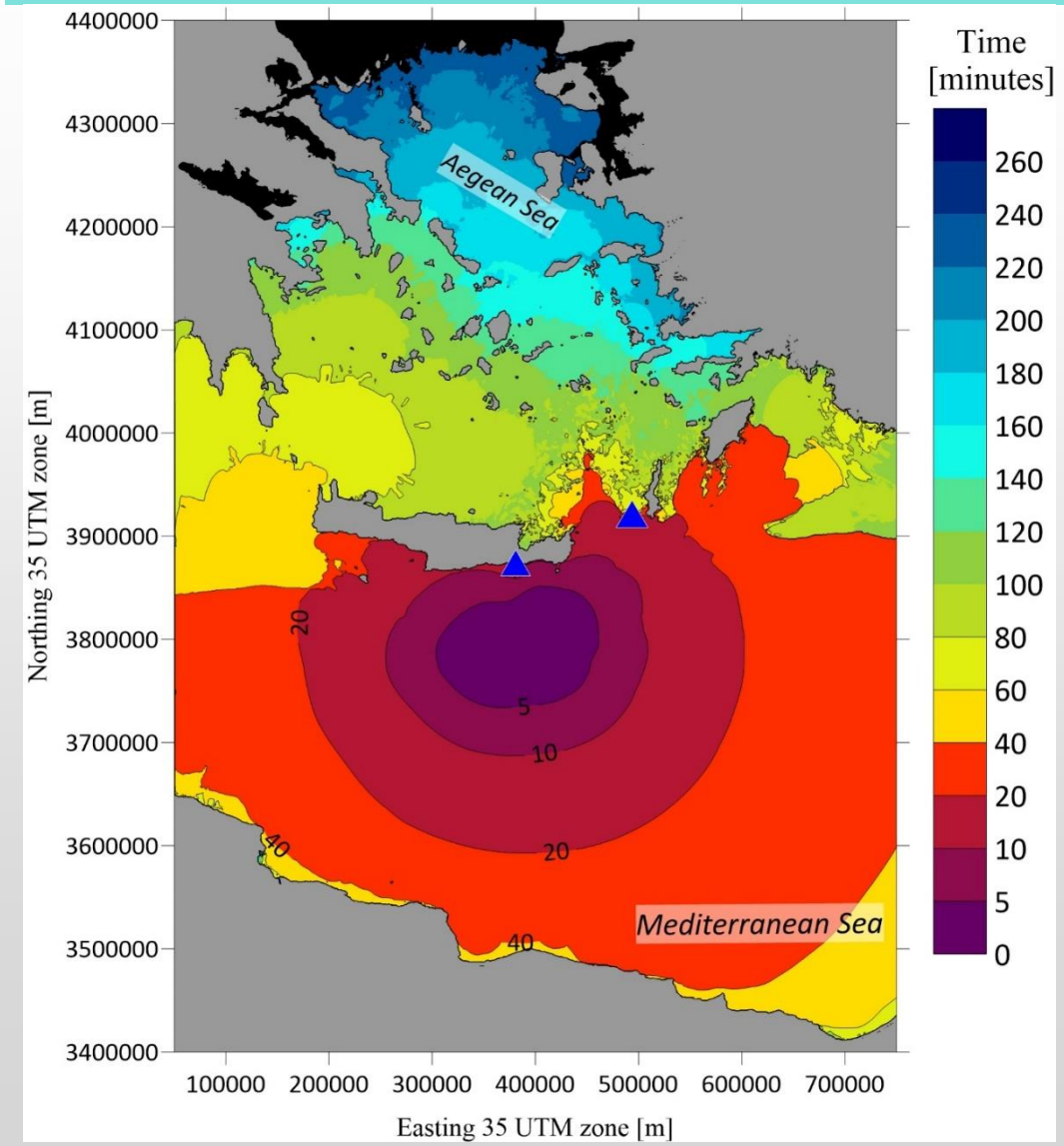


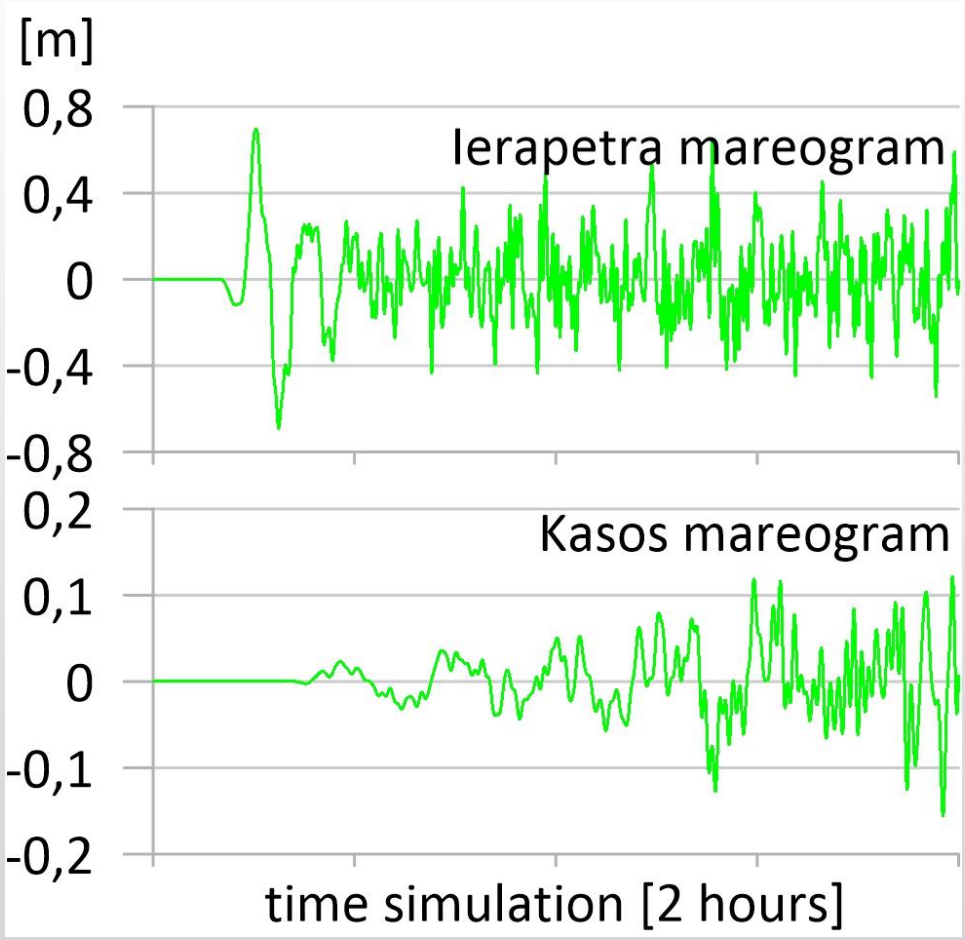
TSUNAMI PROPAGATION FIELD | 2 MAY 2020



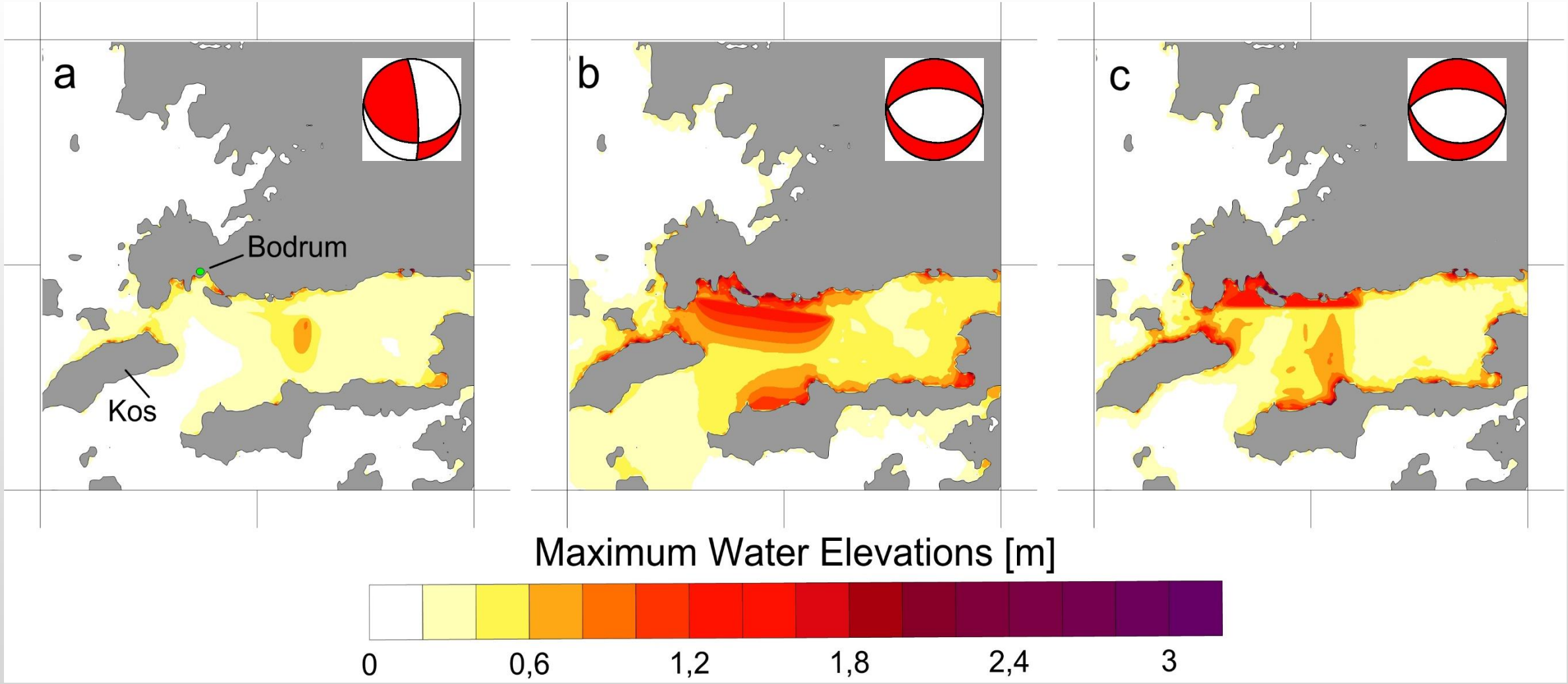


TSUNAMI TIME TRAVEL | 2 MAY 2020





MAXIMUM TSUNAMI ELEVATIONS | 20.07.2017



CONCLUSIONS

- Review of the tsunami waves, seismic activity and tectonic structures in the broad Eastern Mediterranean;

- Tsunami numerical simulations have been performed for three recently registered tsunami: 30 October 2020, 2 May 2020 and 20 July 2017;

- Tsunami maximum elevation fields and tsunami time travel maps were build and compared to the observations;

- Better resolution of the computational grid would contribute to estimate the inundation line and the run-up.

- The October, 2020 Samos-Izmir earthquake and tsunami, together with the July 2017 Bodrum-Kos and May 2020 Crete tsunamis, once more reminded us about the considerable tsunami potential in the Eastern Mediterranean.

REFERENCES

Dimova, L., and Raykova, R., 2021 Tsunami waves in the region of Southeast Europe: Analysis and Modeling, Extended abstract In: Proceedings of 11th Congress of Balkan Geophysical Society, 10-14 October 2021, virtual edition, 4p. (accepted).

Dimova, L., Dragomirov, D. and Raykova, R., 2020 Strong offshore earthquakes in the past 10 years for the Southern Europe as an input for tsunami modelling, REVIEW OF THE BULGARIAN GEOLOGICAL SOCIETY, vol. 81, part 3, p. 244–246.

Dimova, L., and Raykova, R., 2018 Numerical simulations of the earthquake-induced tsunami of July 20, 2017 (Mw=6.6) in Bodrum-Kos, Aegean Sea, REVIEW OF THE BULGARIAN GEOLOGICAL SOCIETY, vol. 79, part 1-2, p. 5-12.

Okada, Y., 1985 Surface deformation due to shear and tensile faults in a half-space. Bulletin of the seismological society of America, 75(4), pp.1135-1154.

Papadopoulos, G.A., et al., 2020 Tsunami Alert Efficiency in the Eastern Mediterranean Sea: The 2 May 2020 Earthquake (Mw6.6) and Near-Field Tsunami South of Crete (Greece), GeoHazards 2020, 1(1), 44-60; https://doi.org/10.3390/geohazards1010005

Tinti, S. and Tonini R., 2013 The UBO-TSUFD tsunami inundation model: Validation and application to a tsunami case study focused on the city of Catania, Italy, Natural Hazards and Earth System Sciences 13(7):1795-1816, DOI:10.5194/nhess-13-1795-2013

Triantafyllou, I. Et al., 2021 The Tsunami Caused by the 30 October 2020 Samos (Aegean Sea) Mw7.0 Earthquake: Hydrodynamic Features, Source Properties and Impact Assessment from Post-Event Field Survey and Video Records?. J. Mar. Sci. Eng. 2021, 9, 68.

GEBCO, ISC, GFZ, IOC, NCEI/WDS

ACKNOWLEDGEMENTS

The first author would like to thank the Tsunami Research Team from University of Bologna for the opportunity to work with ***UBO-TSUFD***. This presentation was supported by the project ***CP-06-COST-7/24.09.2020 "Tsunami Hazard Assessment in the Southeastern European region"***, funded by BNSF . The author contributed to the European Cooperation in Science and Technology COST project ***"AGITHAR-Accelerating Global science In Tsunami HAzard and Risk analysis"***. This study is supported by the Bulgarian National Program **"Young Scientists and Postdoctoral Students"** of Ministry of Education and Science of Bulgaria, 2021.

THANK YOU FOR YOUR ATTENTION!

"The Great Wave off Kanagawa" By artist Hokusai (1830-1833)

lyuba_dimova@phys.uni-sofia.bg