

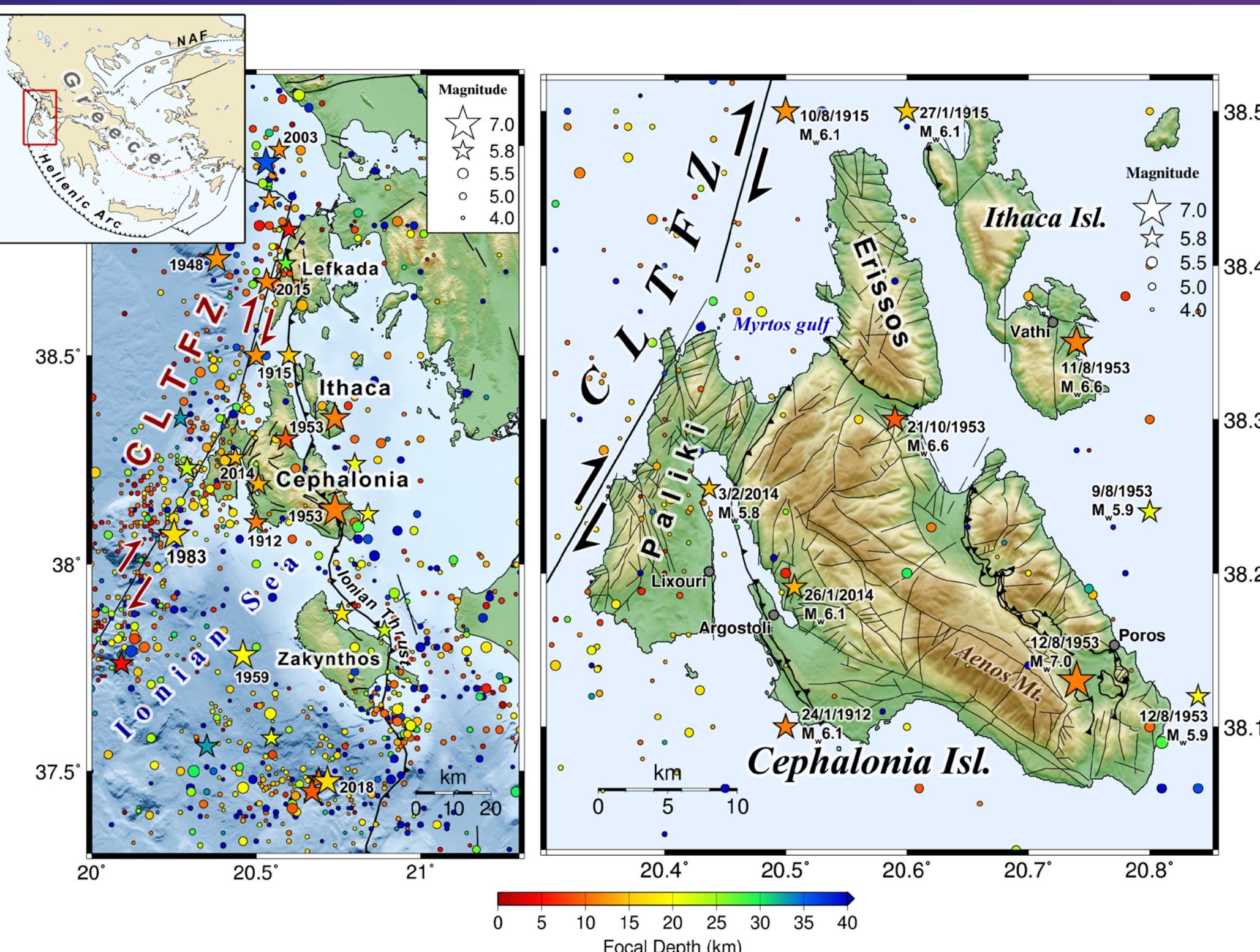
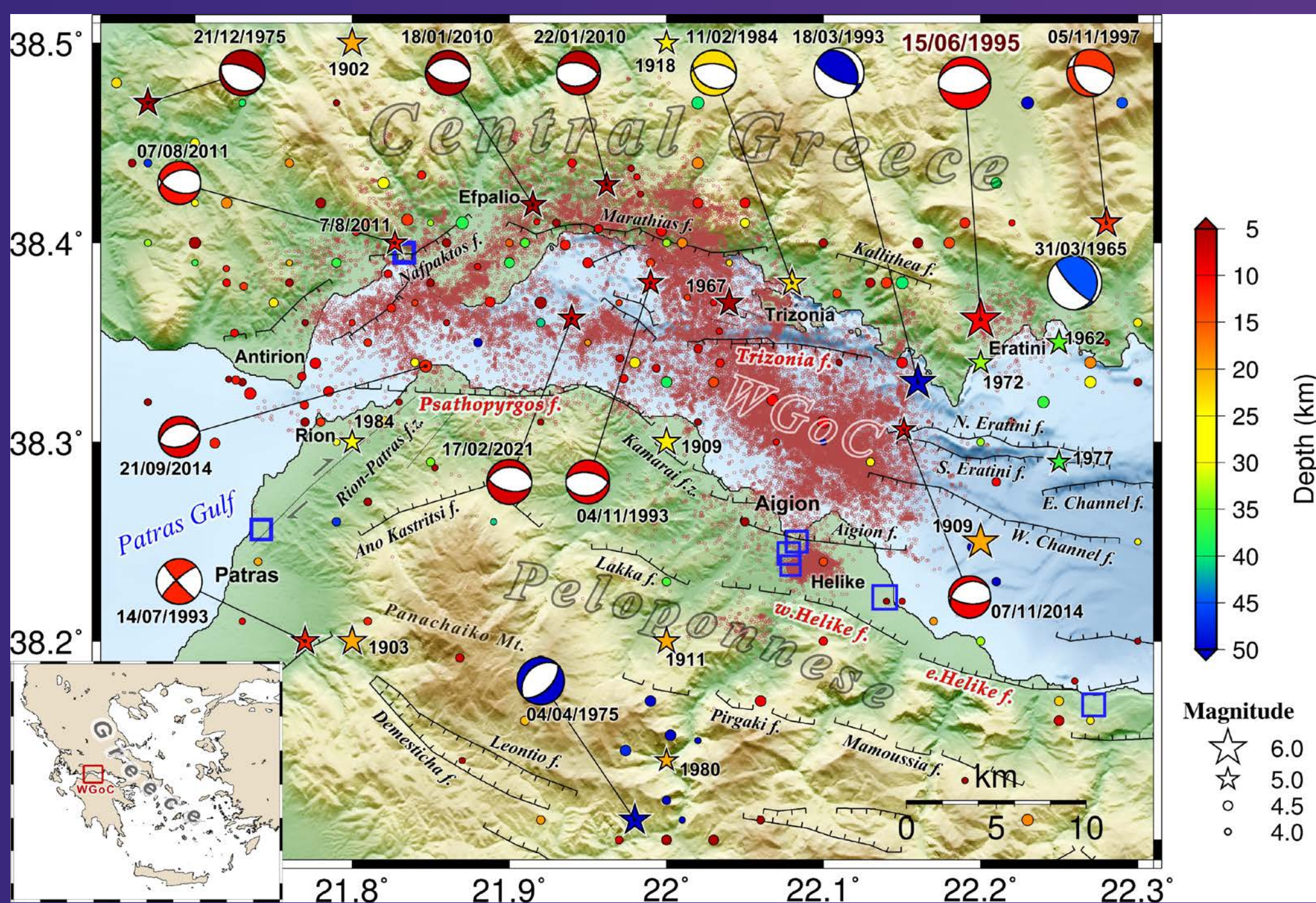
# The OSCARS seismic hazard database for the Western Gulf of Corinth and the Central Ionian Islands, Greece

Kaviris George<sup>\*1</sup>, Spingos Ioannis<sup>1</sup>, Zymvragakis Angelos<sup>1</sup>, Adamaki Angeliki<sup>2</sup>, Anagnostou Vasilis<sup>3</sup>, Andriopoulou Stefania-Alexandra<sup>4</sup>, Bathrellos George<sup>4</sup>, Bitharis Stylianos<sup>5</sup>, Bonatis Pavlos<sup>3</sup>, Foumelis Michael<sup>6</sup>, Karakostas Vasileios<sup>3</sup>, Karolos Ion-Anastasios<sup>5</sup>, Kourouklas Christos<sup>3</sup>, Papadimitriou Eleftheria<sup>3</sup>, Papageorgiou Elena<sup>6</sup>, Pikridas Christos<sup>5</sup>, Sakkas Vassilis<sup>1</sup>, Skilodimou Hariklia<sup>4</sup>

1-Section of Geophysics-Geothermics, Department of Geology and Geoenvironment, School of Sciences, National and Kapodistrian University of Athens, Panepistimiopolis Zografou, 15784 Athens, Greece  
2-Department of Physical Geography and Ecosystem Science, Lund University, Lund, Sweden  
3-Geophysics Department, Aristotle University of Thessaloniki, GR54124 Thessaloniki, Greece  
4-Department of Geology, University of Patras, 26500 Patras, Greece  
5-Department of Geodesy and Surveying, Aristotle University of Thessaloniki, GR54124 Thessaloniki, Greece  
6-Department of Physical and Environmental Geography, Aristotle University of Thessaloniki, GR54124 Thessaloniki, Greece

## 1. Our goals

- OSCARS** (Open Science Clusters Action for Research and Society) is a Horizon Europe initiative promoting open science through integrated European Research Infrastructure achievements into sustainable, interdisciplinary FAIR data and services.
- This study creates a **seismic hazard database** for Greece's high-activity regions: **Western Gulf of Corinth and Central Ionian Islands**. The database contains **simulated PGA/PGV data** for dense regional grids, plus **hazard curves** and **UHS** for major population centers using the Cornell-McGuire probabilistic methodology (**475/950-year return periods**).



- The **Gulf of Corinth** is a continental rift in Central Greece with exceptional extension rates (**6-16 mm/yr**), among the highest globally (Kaviris et al., 2021; Papadimitriou et al., 2022; Serpetsidaki et al., 2023). The **Western Gulf of Corinth (WGoC)** exhibits the **highest activity** (~10.8 mm/yr near Aigion).
- Historical Activity:** Notable events include the 373 B.C. earthquake ( $M \geq 6.6$ ) that destroyed ancient Helike, the 1861 tsunami-generating event ( $M_w = 6.5$ ), and regional earthquakes affecting Aigion (1748, 1817, 1888), Patras (1785, 1804, 1806), and Nafpaktos (1462-1831). The last major earthquake was the June 15, 1995 ( $M_s = 6.2$ ), located near Aigion.
- Significance:** Patras (Greece's third-largest city), critical infrastructure including the Rion-Antirion bridge, and major towns like **Aigion** and **Nafpaktos** necessitate comprehensive seismic hazard assessment for risk mitigation planning.
- The **Central Ionian Islands** are among Europe's most seismically active regions and **Greece's highest hazard area** (Karakostas et al., 2014; Papadimitriou et al., 2017; Sakkas et al., 2022). Cephalonia experienced two  $M_w = 6.1$  and  $M_w = 6.0$  earthquakes in 2014, with PGA values (**560-735 cm/s<sup>2</sup>**) exceeding the **National Building Code regulations** (360 cm/s<sup>2</sup> for 475-year return period).
- Seismotectonics:** High activity stems from the Cephalonia-Lefkada Transform Fault Zone (CLTFZ), a dextral SSW-NNE trending plate boundary linking the Hellenic Arc with the Apulian-Hellenic collision front.
- Seismicity:** Major events include the **1953 sequence** ( $M_w = 5.9, 6.6, 7.0$ ) destroying 83% of the building stock with 455 fatalities, prompting Greece's first building code in 1959. The 1983  $M_w = 6.7$  offshore event caused moderate damage, while the **2014 "doublet"** ( $M_w = 6.1, 6.0$ ) in Paliki was related to dextral strike-slip faulting and may have triggered the 2015 Lefkada earthquake.

## 2. Methodology

- Source area models – Western Gulf of Corinth:** ESHM13 (Woessner et al., 2015), ESHM20 (Danciu et al., 2021) and VAM16 (Vamvakaris et al., 2016).
- Source area models – Central Ionian Islands:** ESHM13 (Woessner et al., 2015), ESHM20 (Danciu et al., 2021) and BON20 (Bonatis, 2020).
- Earthquake catalogue:** Makropoulos et al. (2012),  $M_w > 4.0$ , updated.
- Focal mechanism catalogue:** Kapetanidis and Kassaras (2019).
- GMMs – PGA:** Skarlatoudis et al. (2003) – SKA03, Danciu and Tselentis (2007) – DAT07, Sakkas (2016) – SAK16, Chousianitis et al. (2018) – CHO18.
- GMMs – PGV:** Skarlatoudis et al. (2007) – SKA07, Danciu and Tselentis (2007) – DAT07, Chousianitis et al. (2018) – CHO18.
- GMMs – Sa:** Danciu and Tselentis (2007).
- Statistical analysis of EQ-catalogue:** b-value of Gutenberg – Richter FMD and Magnitude of completeness ( $M_c$ ) was computed using the Maximum Curvature method. The maximum expected magnitude was computed using three methods (observed maximum magnitude, R-W-C equation, maximum+0.5).
- Logic tree scheme:** We applied all source models with three  $M_u$  values,  $M_c/b$ -value pairs, and corresponding GMMs per source area. Sub-logic trees for each GMM incorporated normal/non-normal focal mechanism percentages. Equal weights were assigned throughout.

### Lead Partner

### Collaborating Partners



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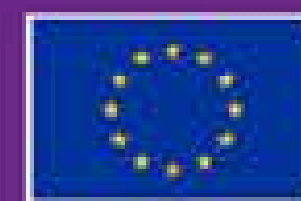
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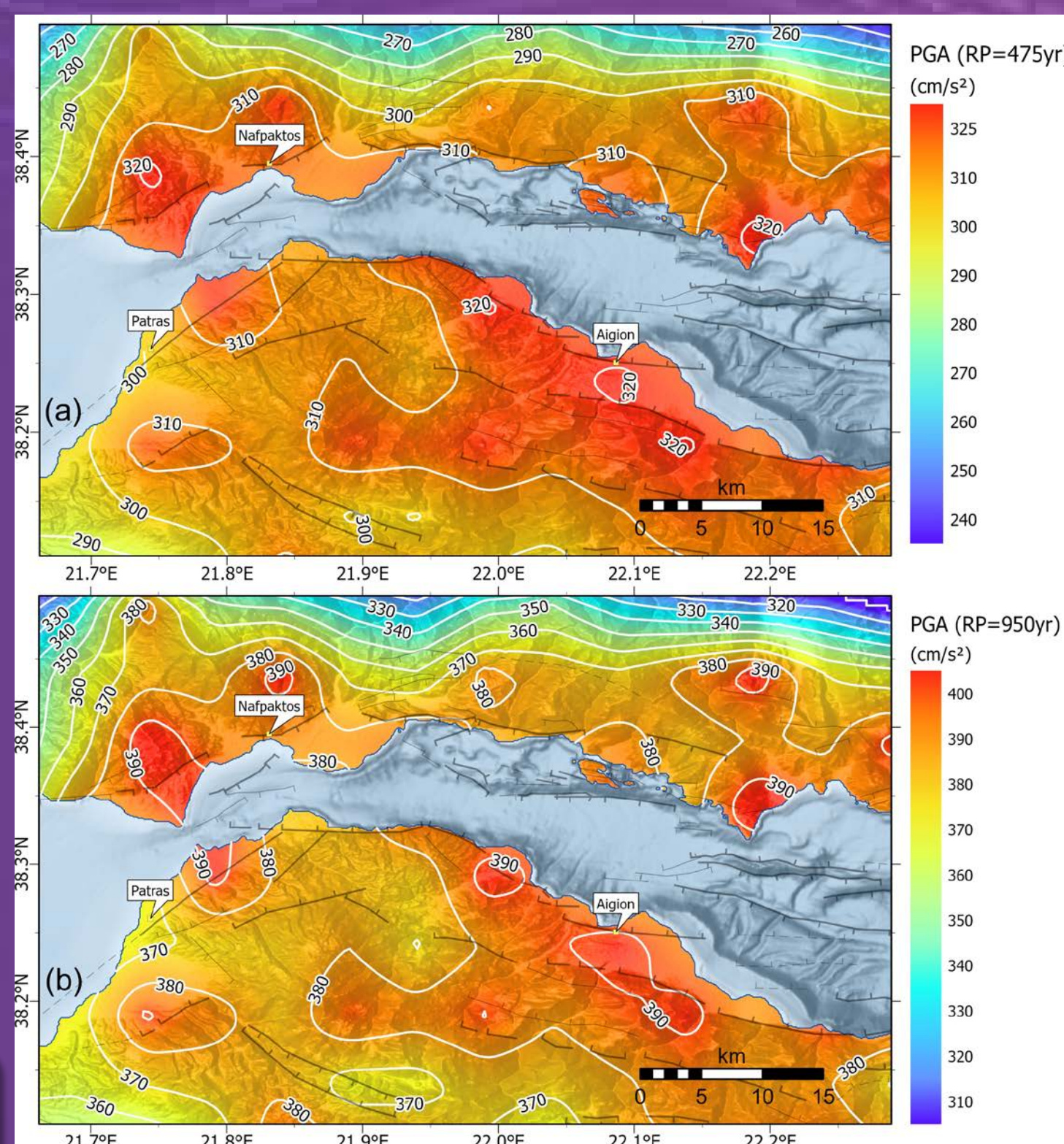
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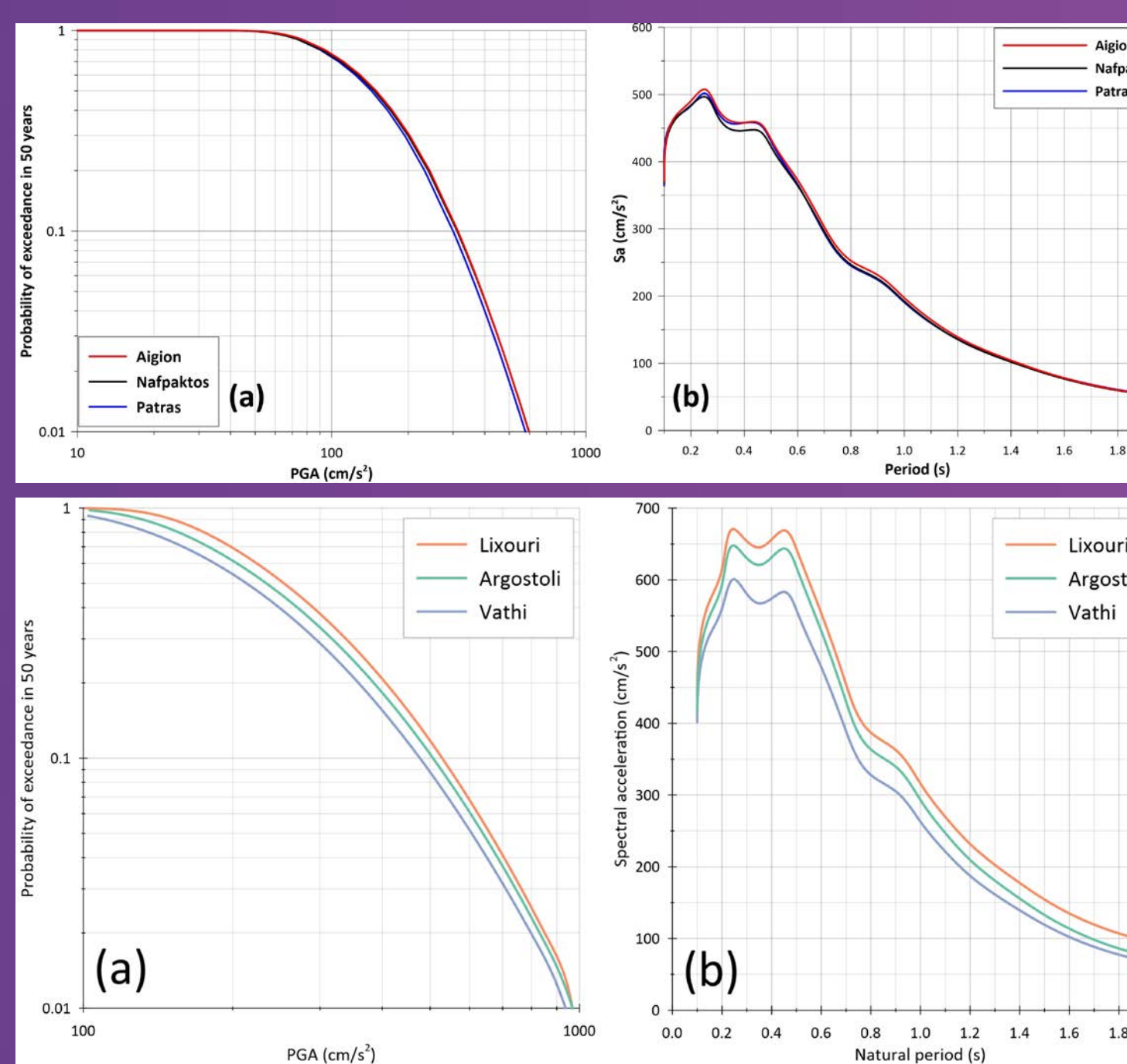
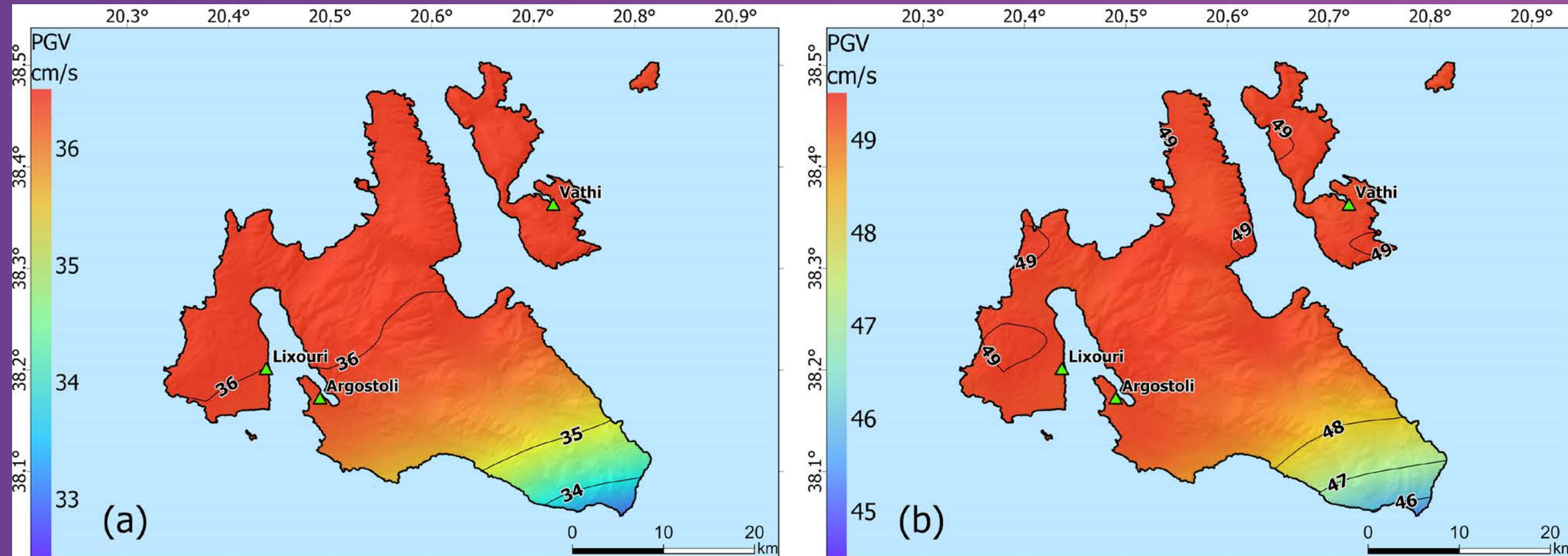
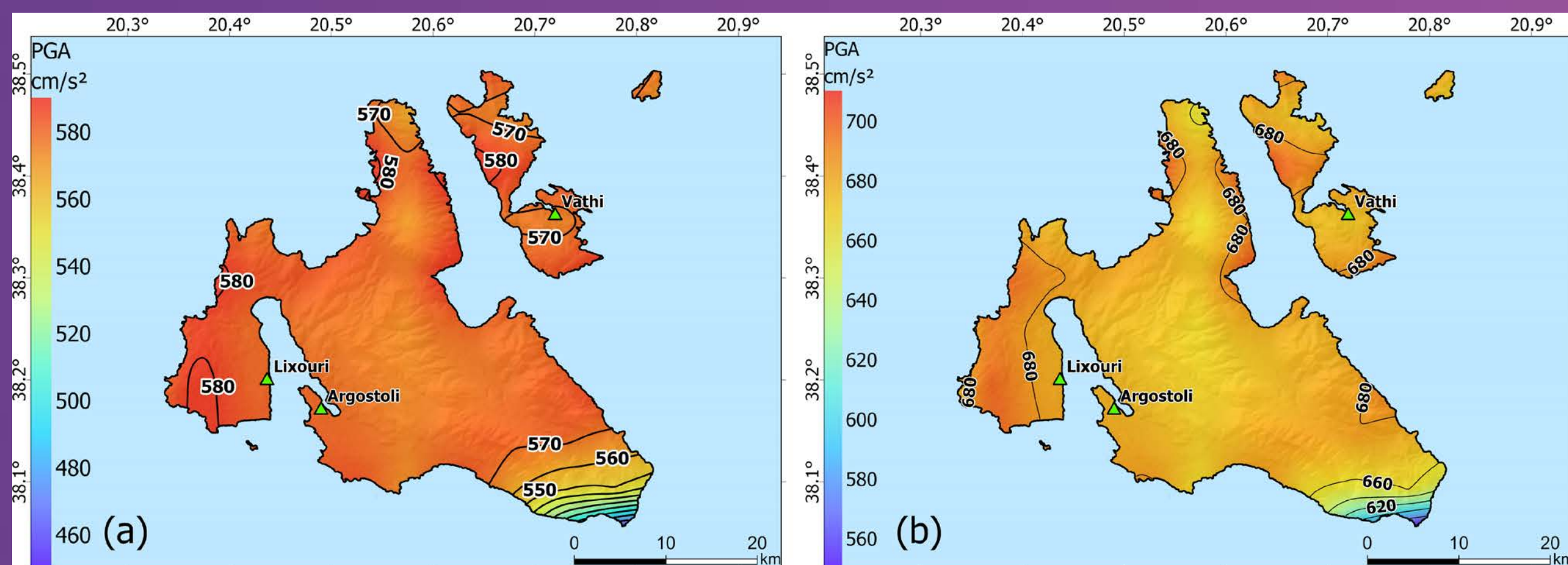


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### WGoC

- PGA Spatial Distribution:** Highest values occur near the coastlines around Nafpaktos and Aigion, decreasing to the north to ~250 cm/s<sup>2</sup> minimum (NE edge). For RP=475yr, the maximum PGA reaches ~325 cm/s<sup>2</sup> (5 km SSE of Aigion) with 75 cm/s<sup>2</sup> variation range. RP=950 yr shows identical patterns with ~400 cm/s<sup>2</sup> maximum (+75 cm/s<sup>2</sup>) and ~300 cm/s<sup>2</sup> minimum (+50 cm/s<sup>2</sup>).
- PGV Spatial Distribution:** Similar pattern to PGA with maximum ~18.5 cm/s near Aigion (RP=475 yr) and minimum 14 cm/s at the NE edge. Small variation (4 cm/s range) with Nafpaktos having intermediate hazard values, between Aigion and Patras. For RP=950yr, the maximum increases to ~24 cm/s (+5 cm/s) and minimum to 18 cm/s (+4 cm/s).
- Hazard Curves:** Patras, Nafpaktos, and Aigion show similar seismic hazard levels with similar curves. Patras exhibits slightly lower PGA, while Nafpaktos and Aigion are nearly identical. Sa curves peak at ~500 cm/s<sup>2</sup> (0.25 s period) and converge above periods of ~0.9 s. Minor deviations occur at 0.3-0.5 s, where Nafpaktos shows slightly lower Sa values than Patras and Aigion.

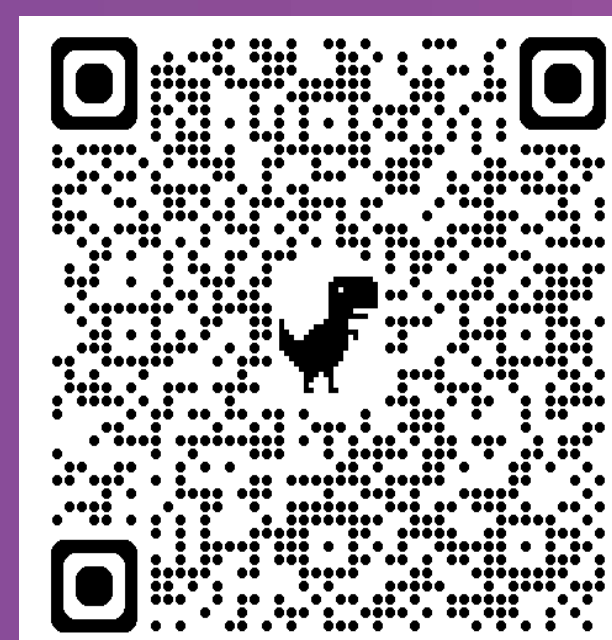


### Central Ionian Islands

- Spatial Distribution of PGA and PGV:** Lowest values in the southeastern part of the study area for both 475 and 950-year return periods; values increase northward and westward. **Peak locations:** Paliki peninsula and small area east of Myrto Gulf.
- Causes:** Proximity to high-seismicity Cephalonia segment of CLTFZ and onshore faulting system (2014 Cephalonia earthquakes). **PGA values (RP=475 yr):** maximum 580 cm/s<sup>2</sup>, for **RP=950 yr** maximum ~700 cm/s<sup>2</sup>. **PGV values (RP=475 yr):** maximum 37 cm/s, for **RP=950 yr** maximum ~50 cm/s.
- Hazard curves:** Lixouri vs Argostoli: Similar PGA levels; Lixouri ~10 cm/s<sup>2</sup> higher across all exceedance probabilities due to closer proximity to CLTFZ. Vathi: Lowest hazard curve, consistent with intermediate PGA values in spatial distribution. **Uniform Hazard Spectra (UHS):** Spectral acceleration ranking: Lixouri > Argostoli > Vathi across all natural periods.
- Future work:** Transform the dataset in order to adhere to FAIR principles.

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