Structure of The Continental and Permo-Triassic Oceanic Lithosphere Beneath The Eastern Mediterranean Sea, from Stochastic Surface-wave Inversion With Wide-angle Data Constraints

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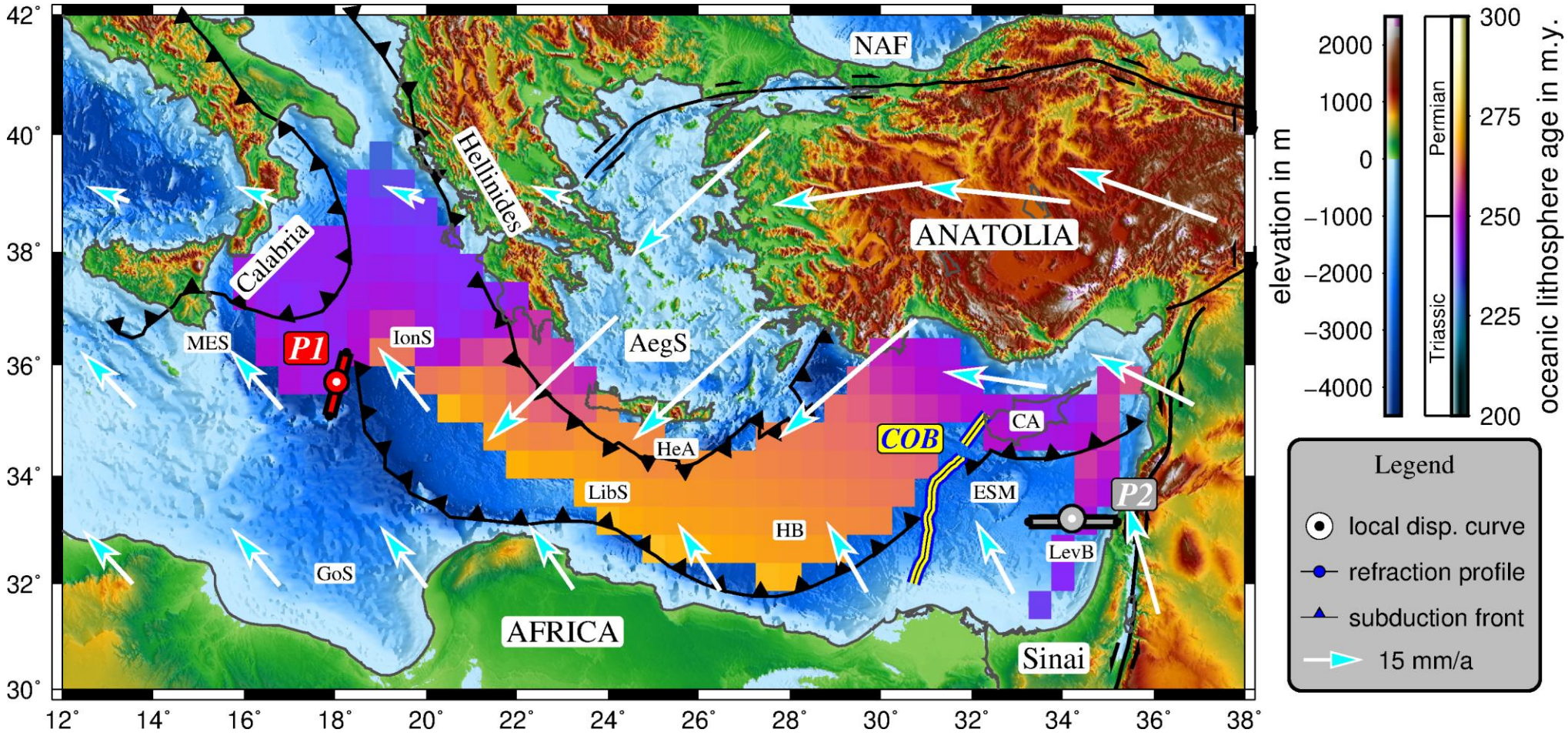
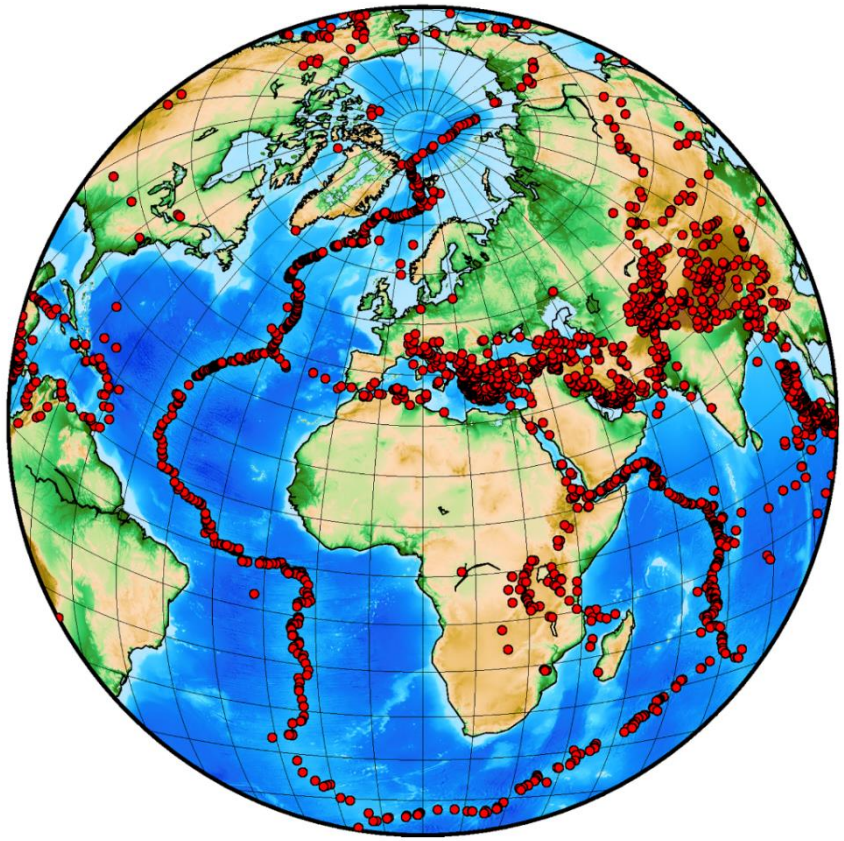
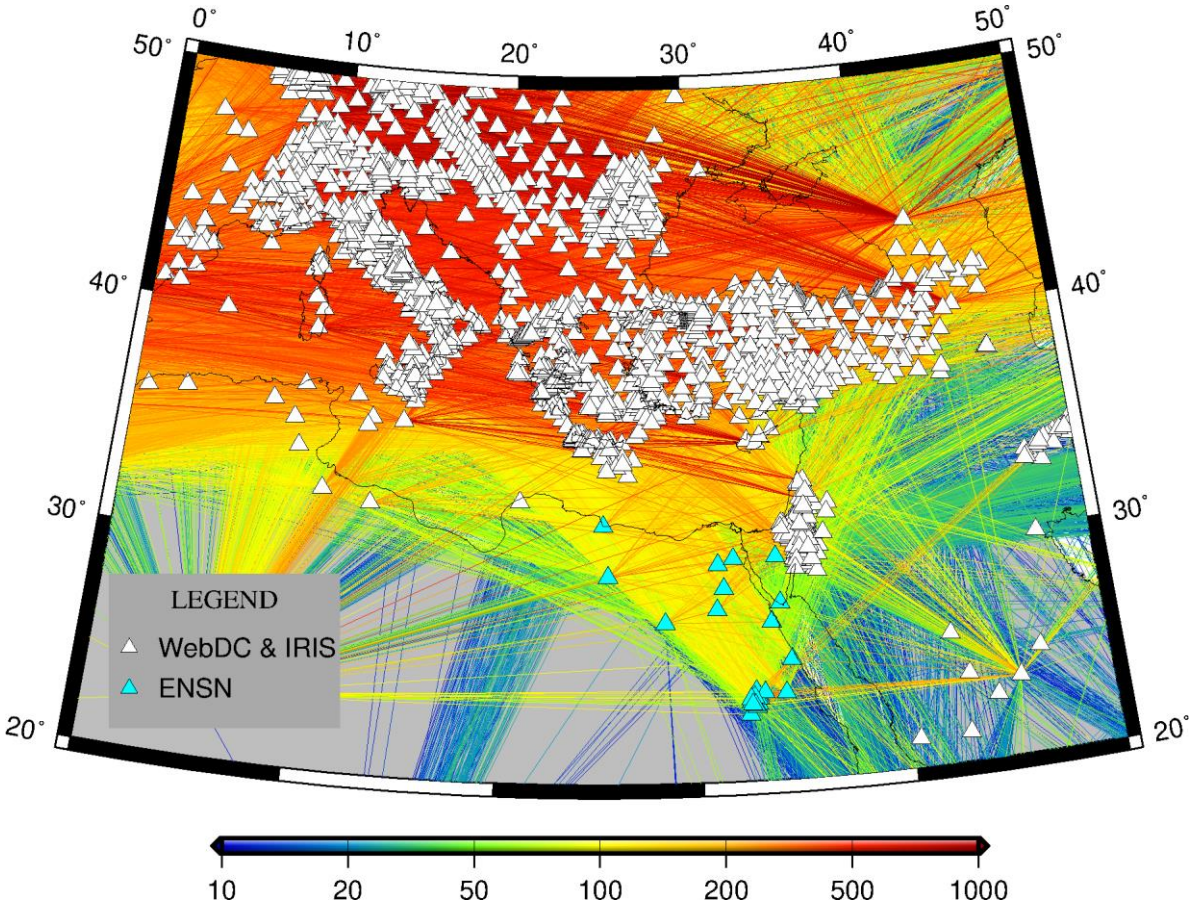


Topographic map of the eastern Mediterranean region with the age distribution of the oceanic lithosphere

Faccenna et al., 2014
Becker et al., 2015
Müller et al., 2008



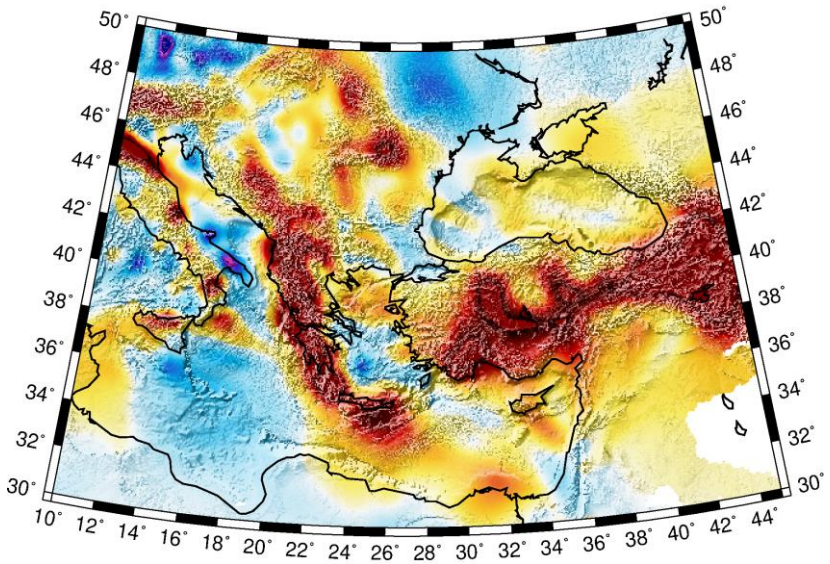
Distribution of the teleseismic earthquakes

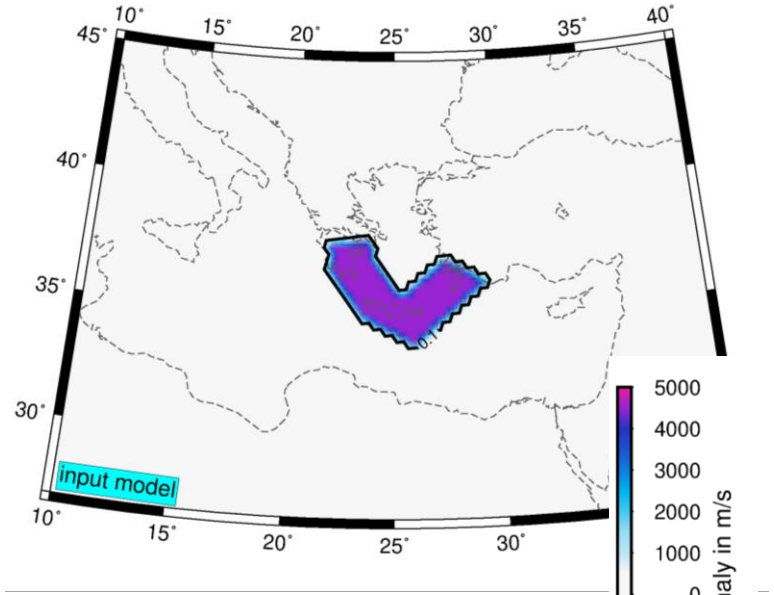


Colour coded ray path coverage. Colours indicate the number of processed events per path. Triangles indicate the location of the seismic stations.

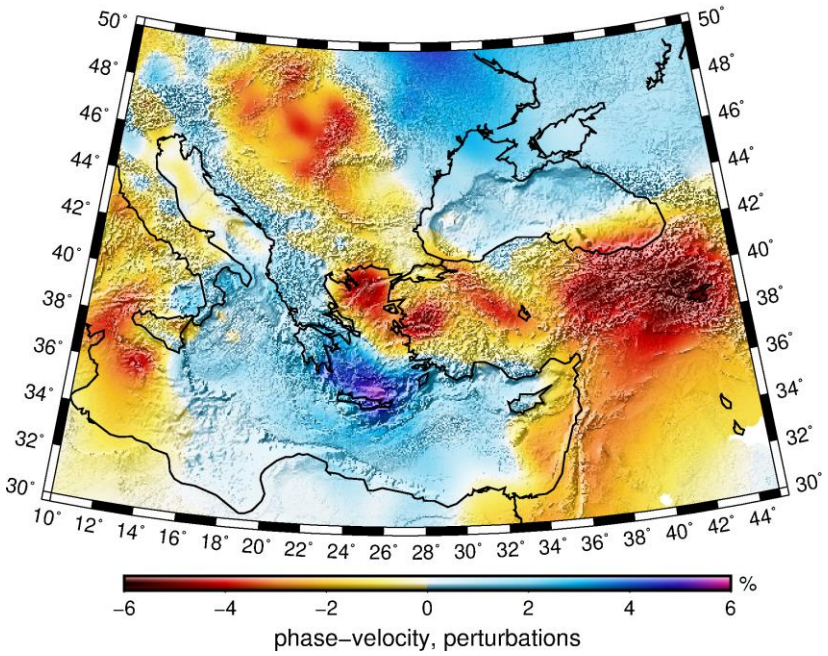
Phase velocity tomography and the model resolution test

Period = 30 s, average velocity 3.788 Km/s

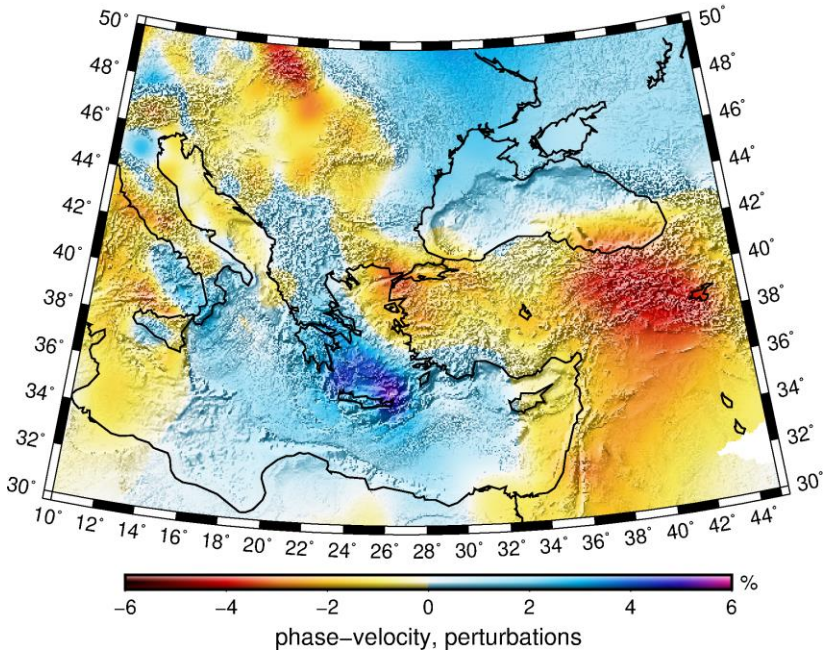


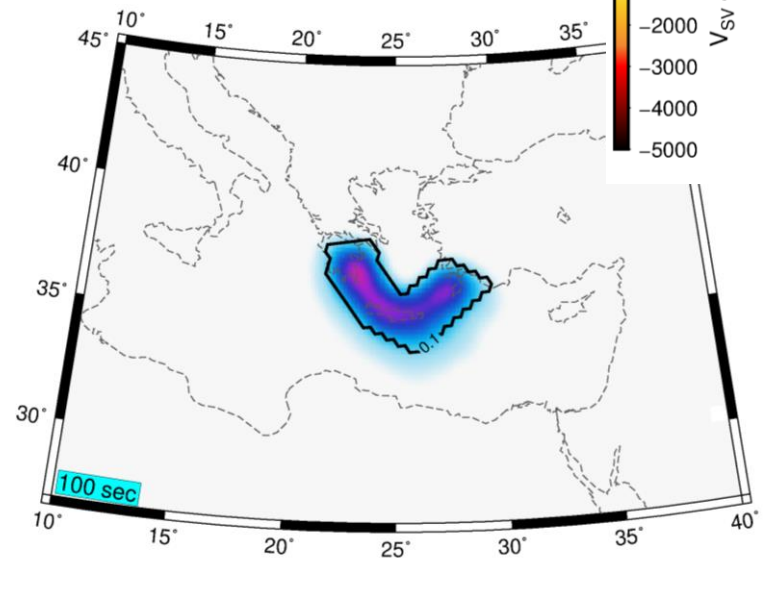


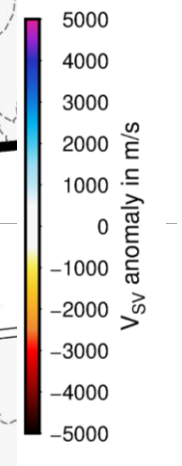
Period = 60 s, average velocity 3.983 Km/s



Period = 100 s, average velocity 4.105 Km/s







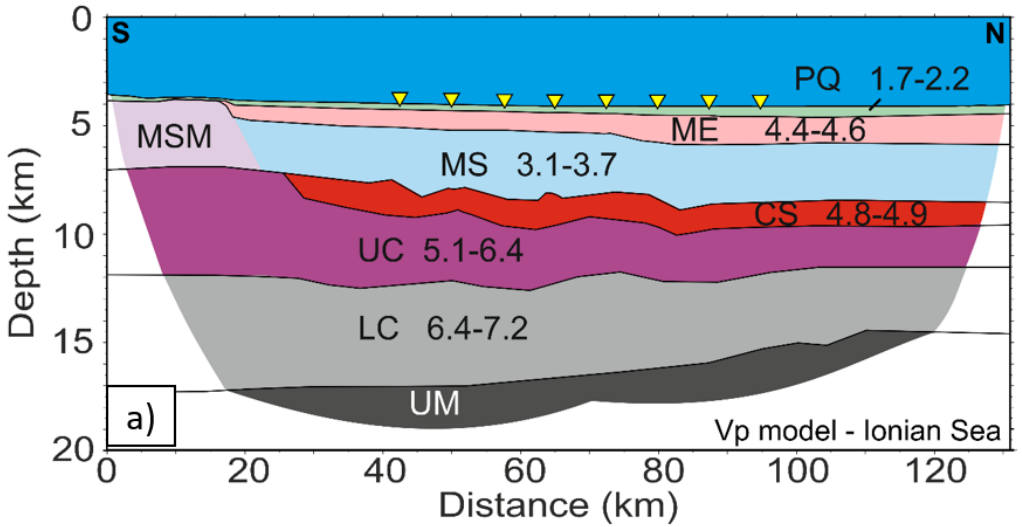
Vp models

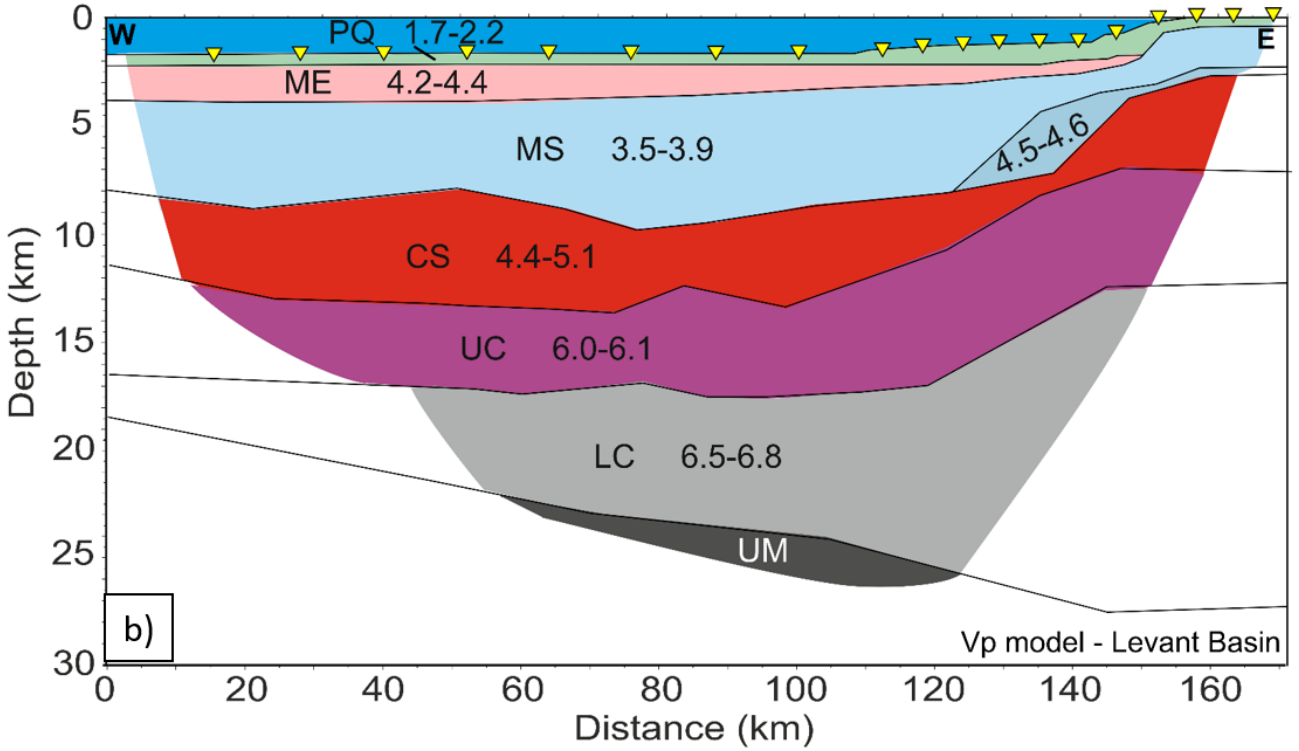
(from seismic refraction)

Ionian Sea (Dannowski et al., 2019)
Levant Basin (Netzeband et al., 2006)

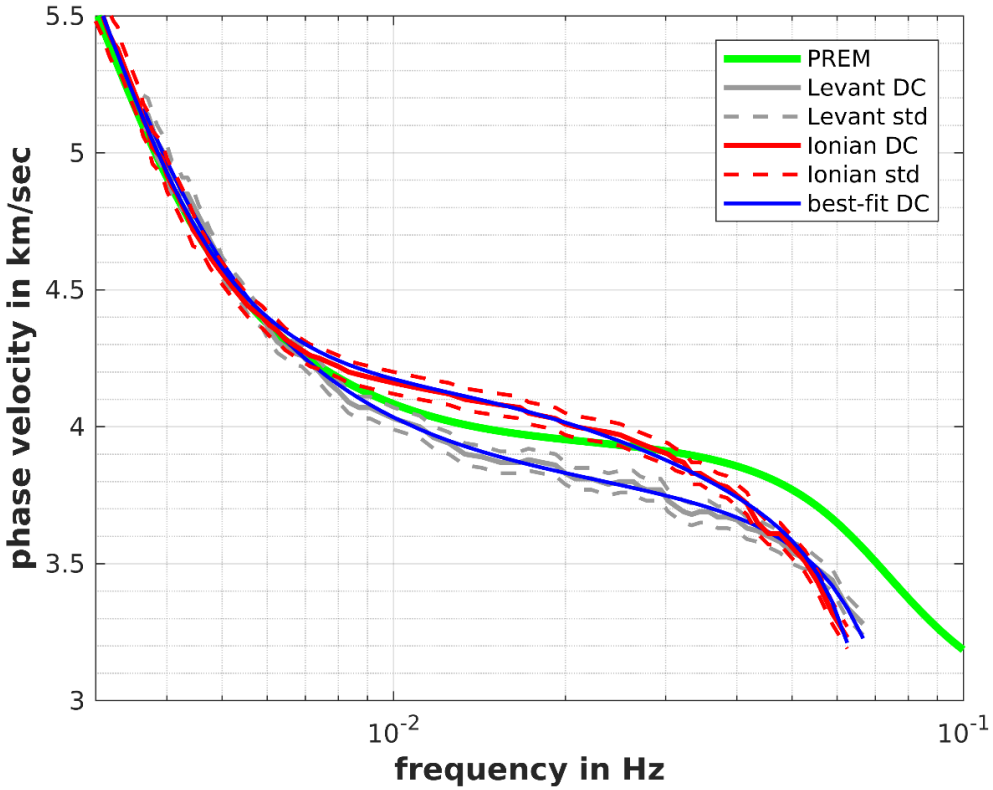
Velocities are given in km/s

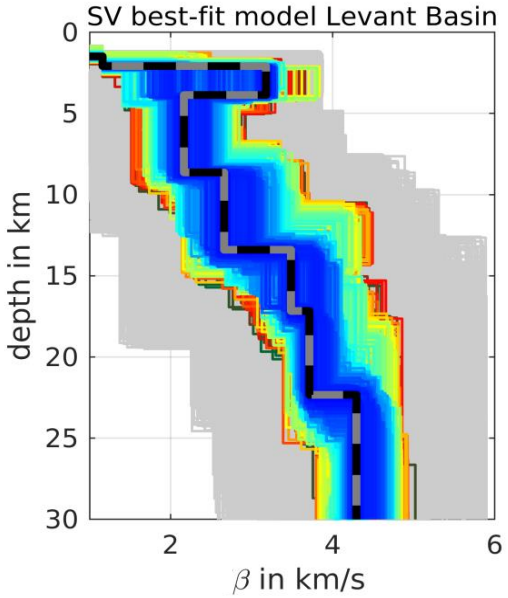
CS: Carbonate Sediments,
LC: Lower Crust,
ME: Messinian Evaporites,
MS: Mesozoic Sediments,
MSM: Medina Seamount,
PQ: Plio-Quaternary Sediments,
UC: Upper Crust,
UM: Upper Mantle.

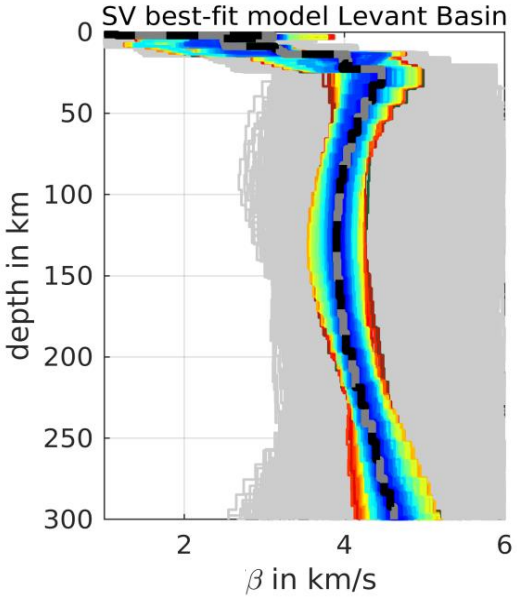


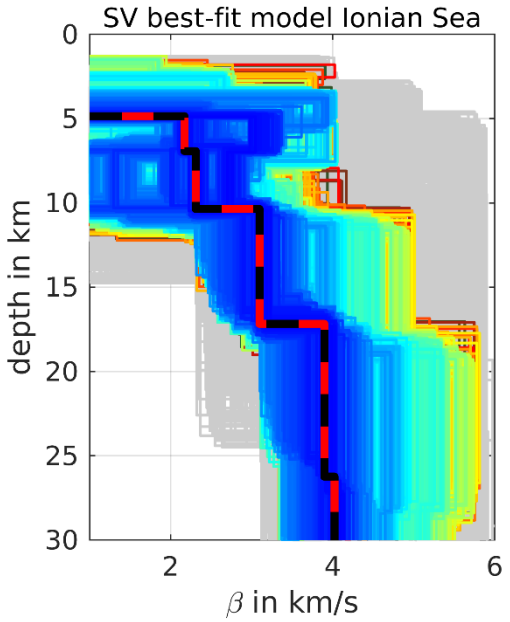


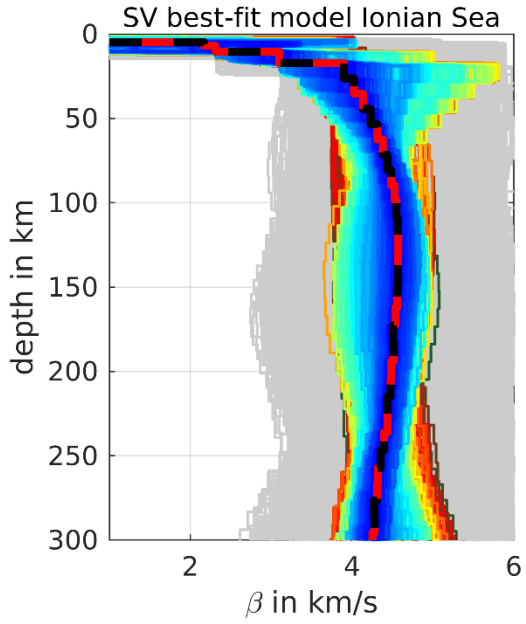
1D shear wave models from the inversion of the dispersion curves using the Particle Swarm Optimization (PSO) algorithm



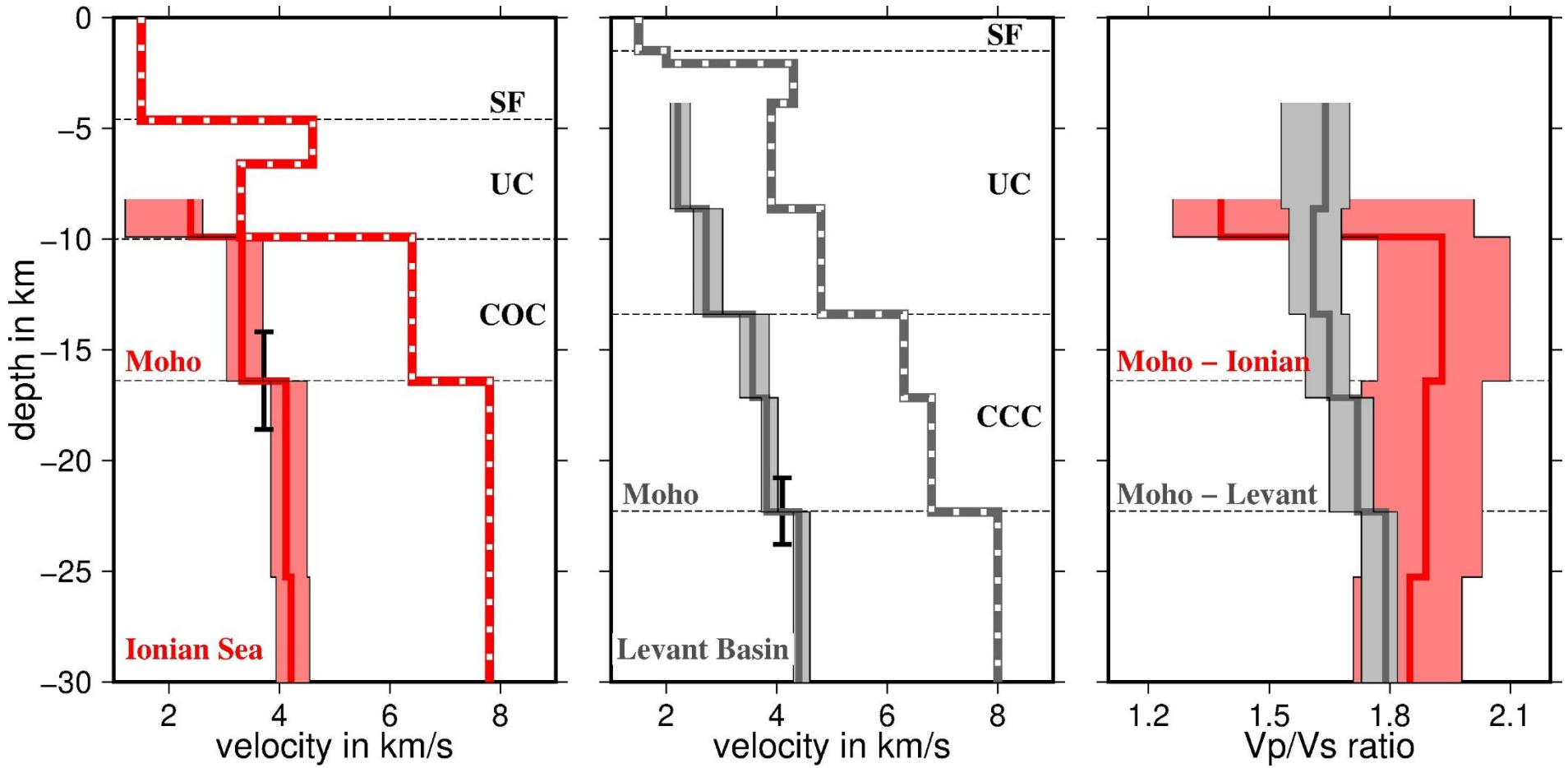








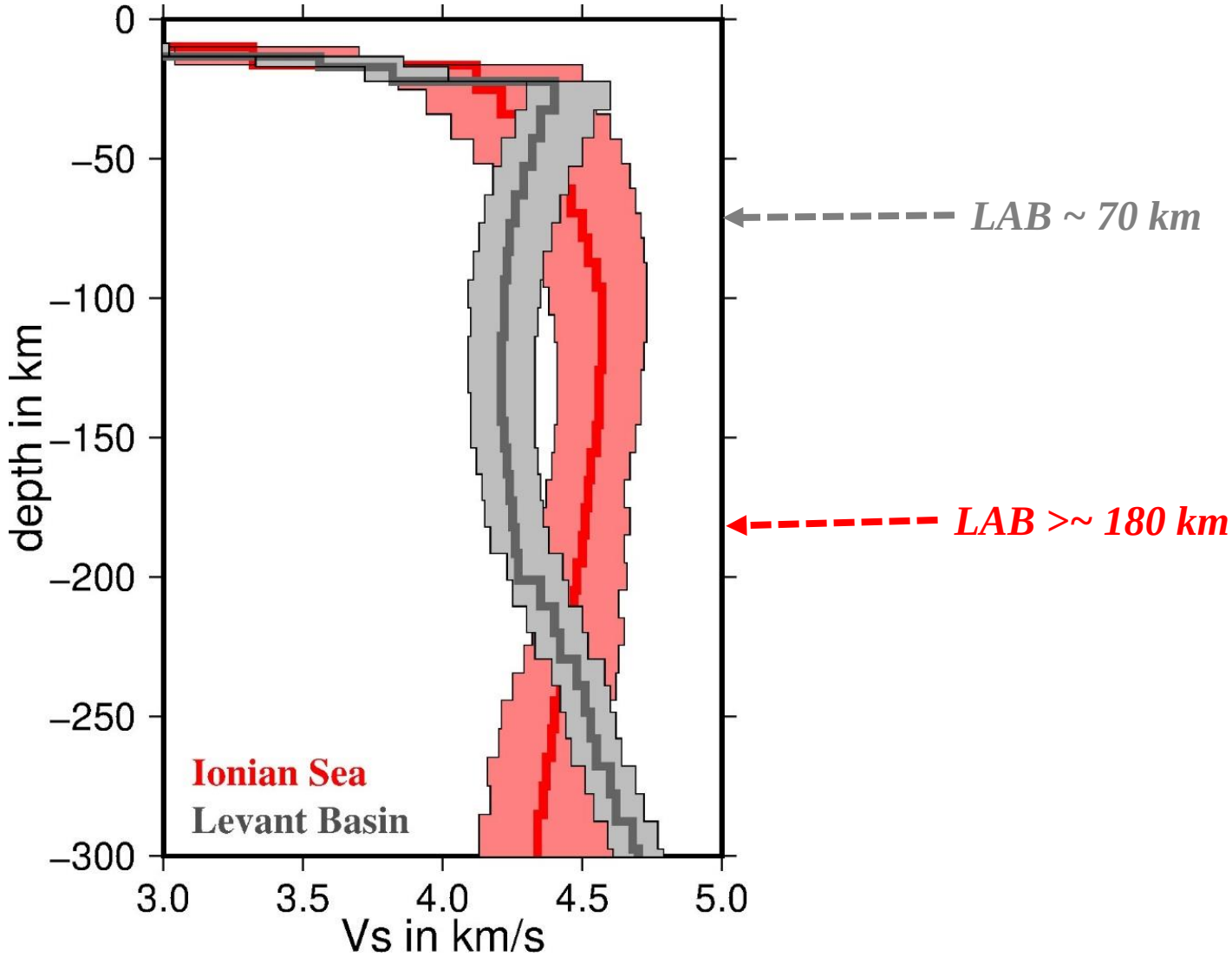
Vp **(from seismic refraction),** ***Vs*** **(from surface wave inversion) and** ***Vp/Vs crustal models***



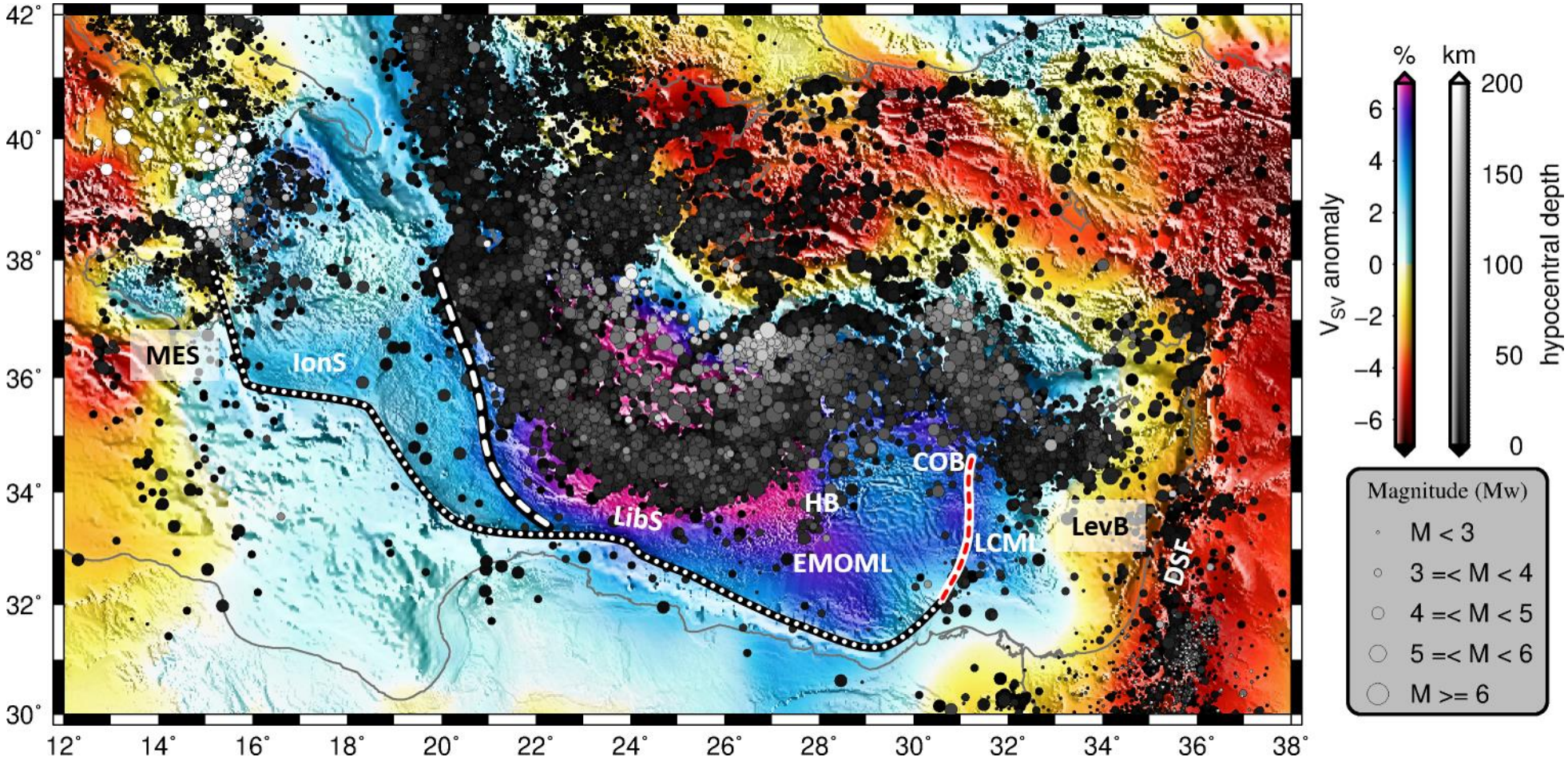
CCC: Crystalline Continental Crust
SF: Sea Floor
UC: Upper Crust
COS: Crystalline Oceanic Crust
UM: Upper Mantle

Vs models of the upper mantle

(from surface wave inversion)



3D Vs model of the Mediterranean "MeRE2020", (map view at 100 km depth)

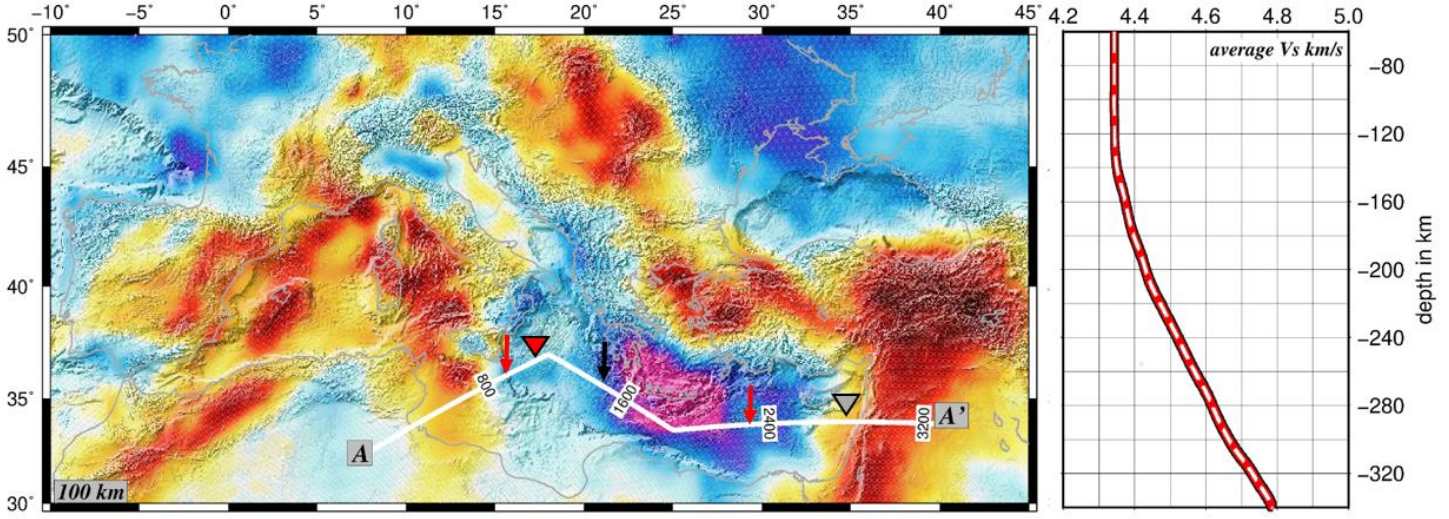


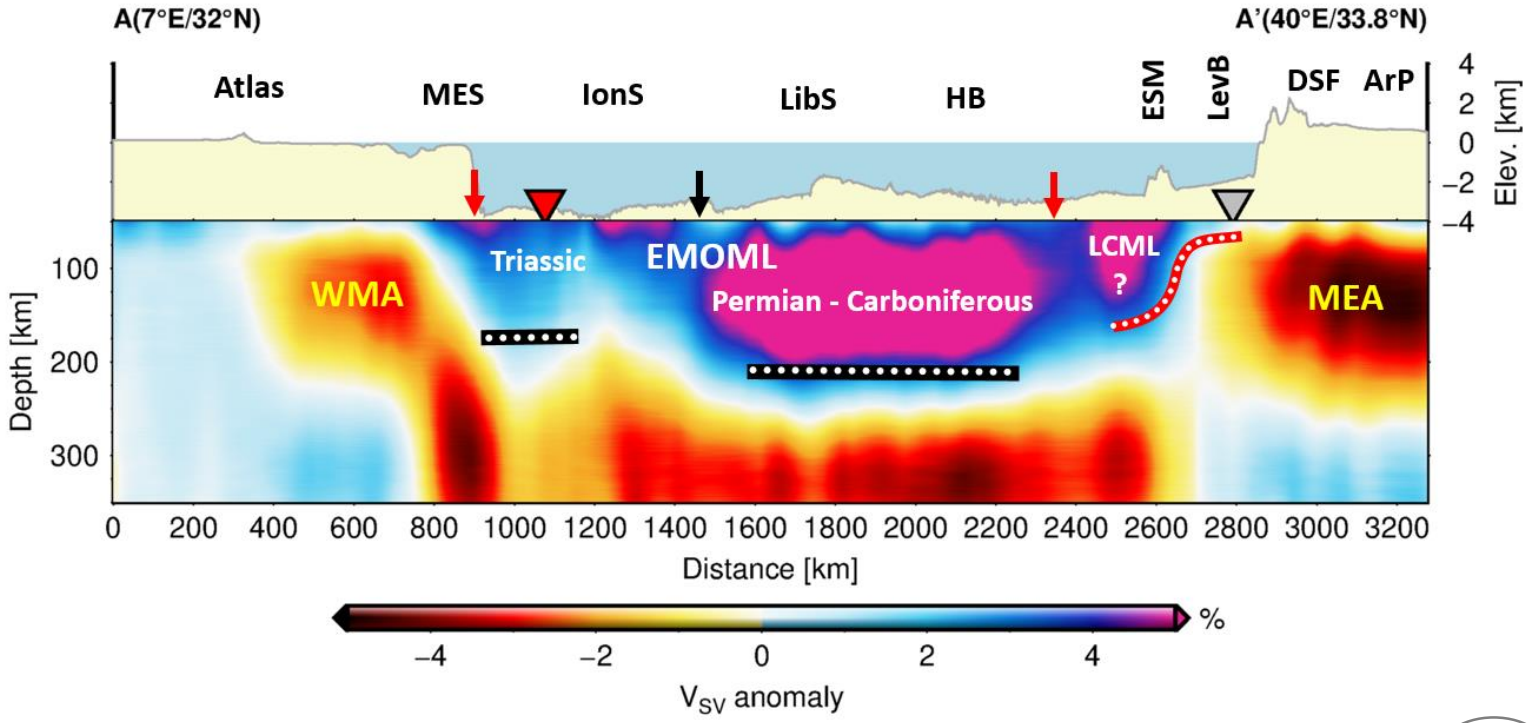
COB: Continent-Ocean Boundary
EMOML: Eastern Mediterranean Oceanic Mantle Lithosphere
IonS: Ionian Sea
LevB: Levant Basin
LibS: Libyan Sea
DSF: Dead Sea Fault
HB: Herodotus Basin
LCML: Levant Continetal Mantle Lithosphere
MES: Malta Escarpment

El-Sharkawy et al. (2020)

3D Vs model of the Mediterranean "MeRE2020"

Lateral resolution locally < 100 km





ArP: Arabian Plate
COB: Continent-Ocean Boundary
DSF: Dead Sea Fault
EMOML: Eastern Mediterranean Oceanic Mantle Lithosphere
ESM: Eratosthenes Seamount
HB: Herodotus Basin
IonS: Ionian Sea
LCML: Levant Continetal Mantle Lithosphere
LevB: Levant Basin
LibS: Libyan Sea
MEA: Middle East Asthenosphere
MES: Malta Escarpment
WMA: Western Medietrranean Asthenosphere

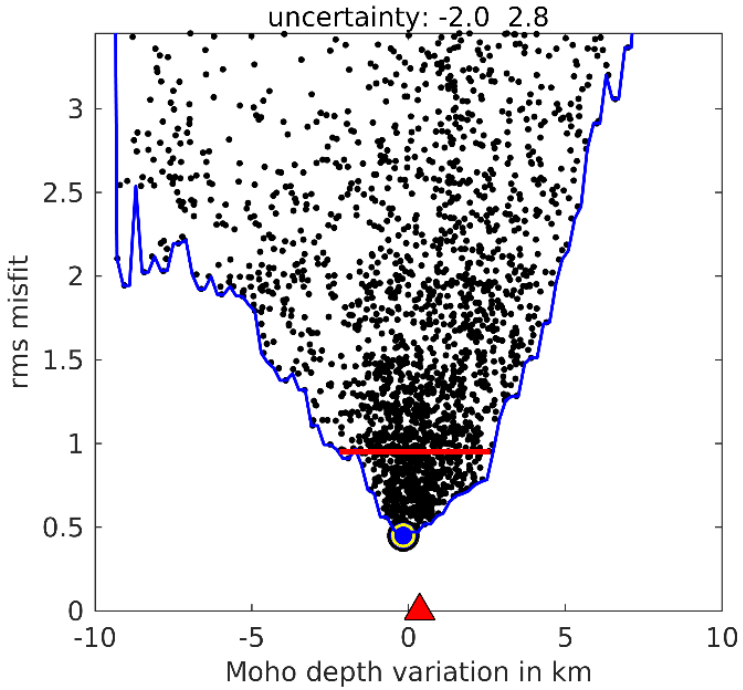
El-Sharkawy et al. (2020)

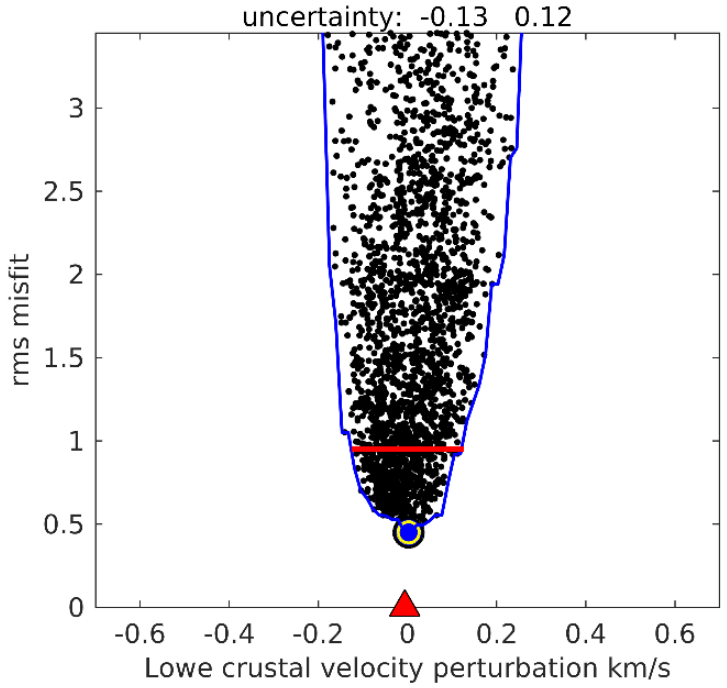
Conclusions

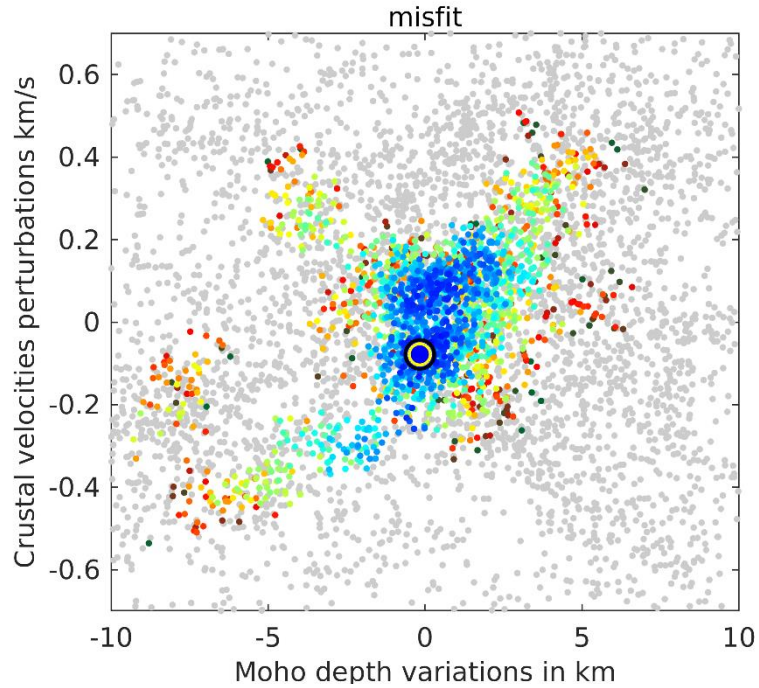
- Well resolved 1-D Vs models of the Levant Basin and the Ionian Sea down to 300 km depth
- Constraining the Vp/Vs ratios in the crust and the Moho depth by combining surface wave inversion with seismic refraction data
- The Vp/Vs ratios point to oceanic Ionian (>1.8) and continental Levant (<1.8) crystalline crust, respectively
- Lithospheric thickness is ~70 km beneath the Levant Basin and about 180 km beneath the Ionian Sea
- The EMOML shows an eastward increase of its thickness with maximum (~200 km) at the Libyan-Herodotus Basin
- Triassic (Ionian) vs Permian and Carboniferous oceanic lithosphere (Libyan Sea and the Herodotus Basin) in the EM
- The EMOML was subject to a continuous cooling and thickening in contrast to prediction by the thermal plate model
- The oceanic lithosphere does not extend further to the east of the Herodotus Basin.
- A transition to continental lithosphere is clearly outlined from high pass filtered gravity anomalies in agreement with the magnetic anomalies (Granot, 2016)
- The continent-ocean boundary (COB) in the eastern Mediterranean Sea is therefore outlined roughly at about 31° E
- In the area from the COB to the Eratosthenes Seamount, shear wave tomography and long wavelength gravity anomalies indicate about 150 km thick continental lithosphere beneath the westernmost parts of the Levant Basin
- Only about 70 km thick lithosphere beneath the eastern part of the Levant Basin
- Focusing of lithospheric deformation and crustal seismicity along the prominent Dead Sea Fault occurs in thinned and weak continental lithosphere above an area of asthenospheric upwelling

Supplementary materials

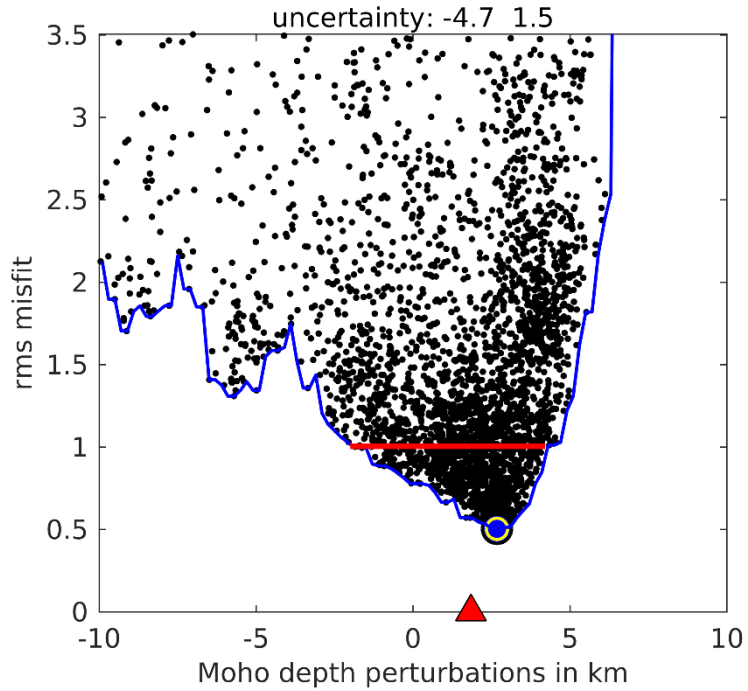
Levant Basin

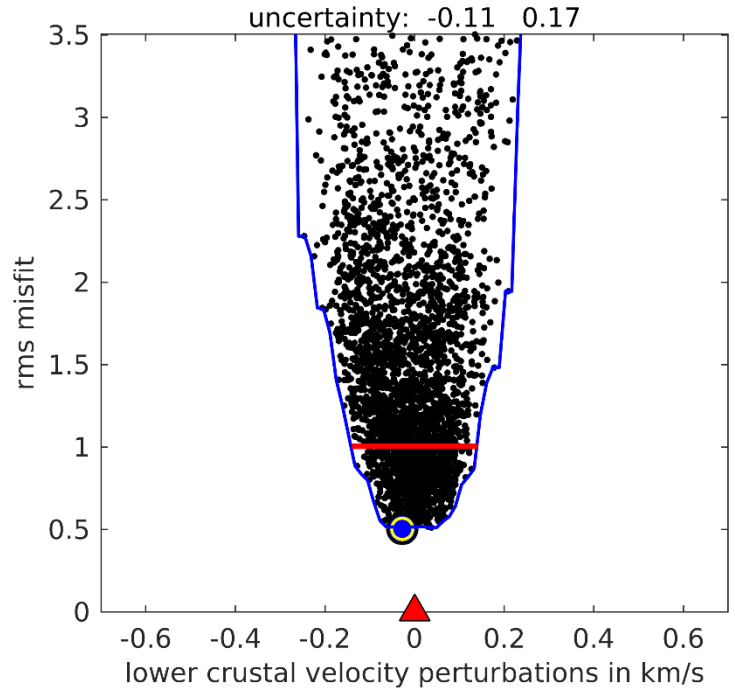


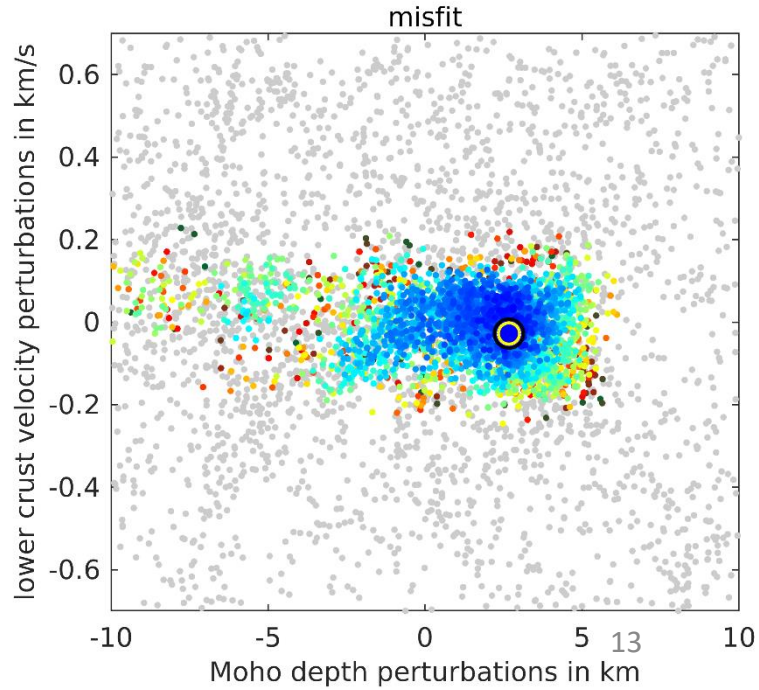


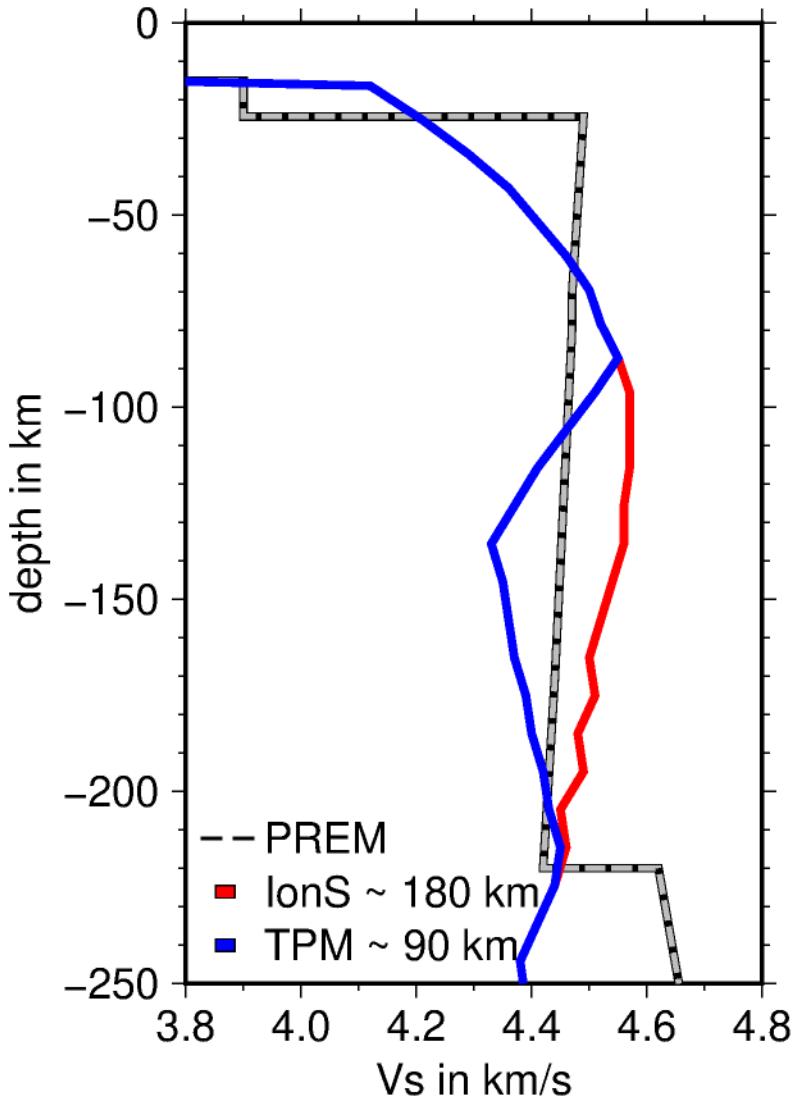


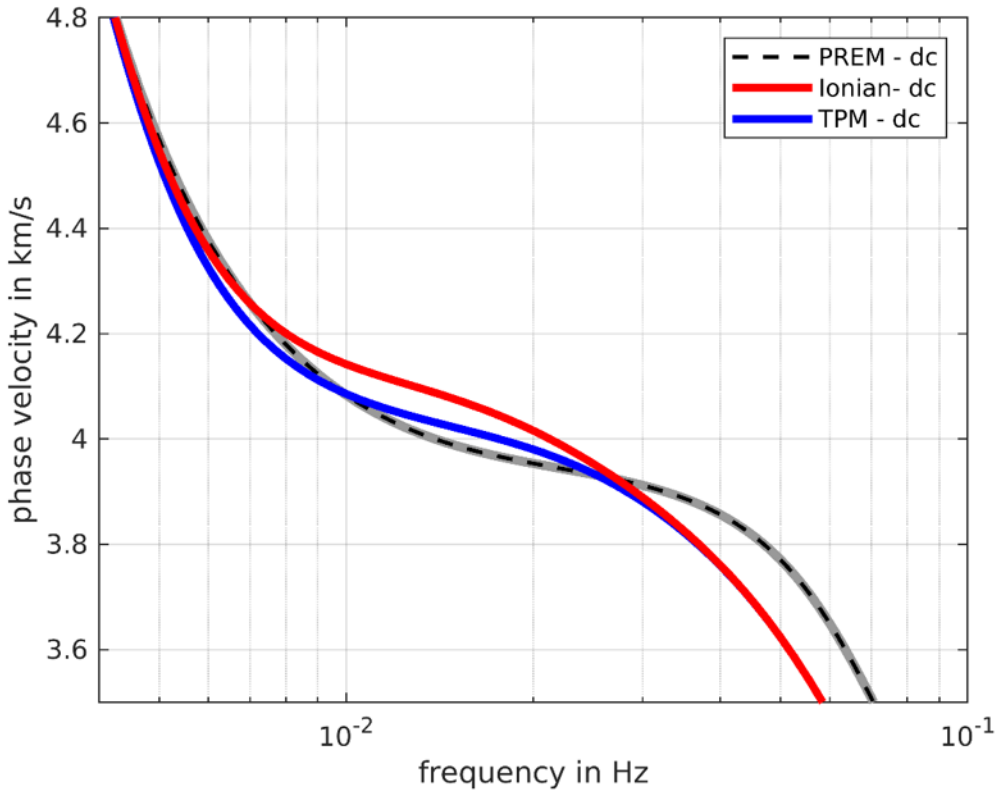
Ionian Basin

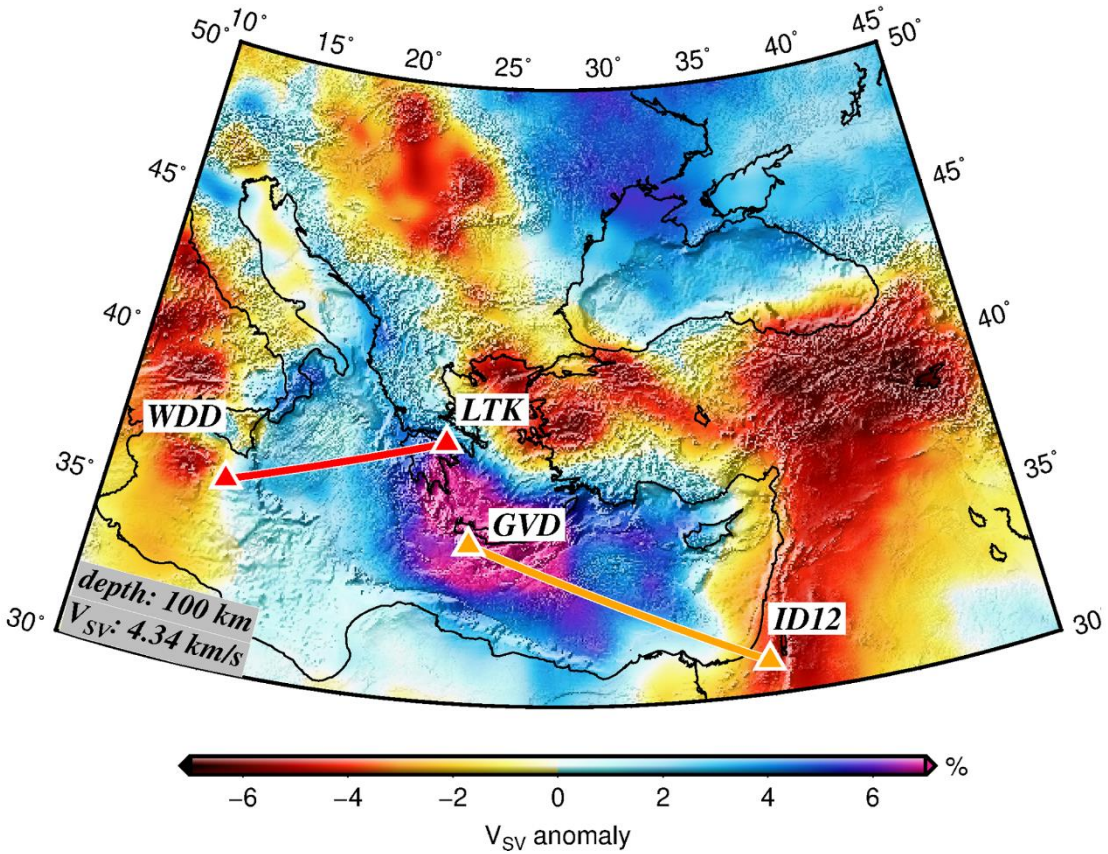


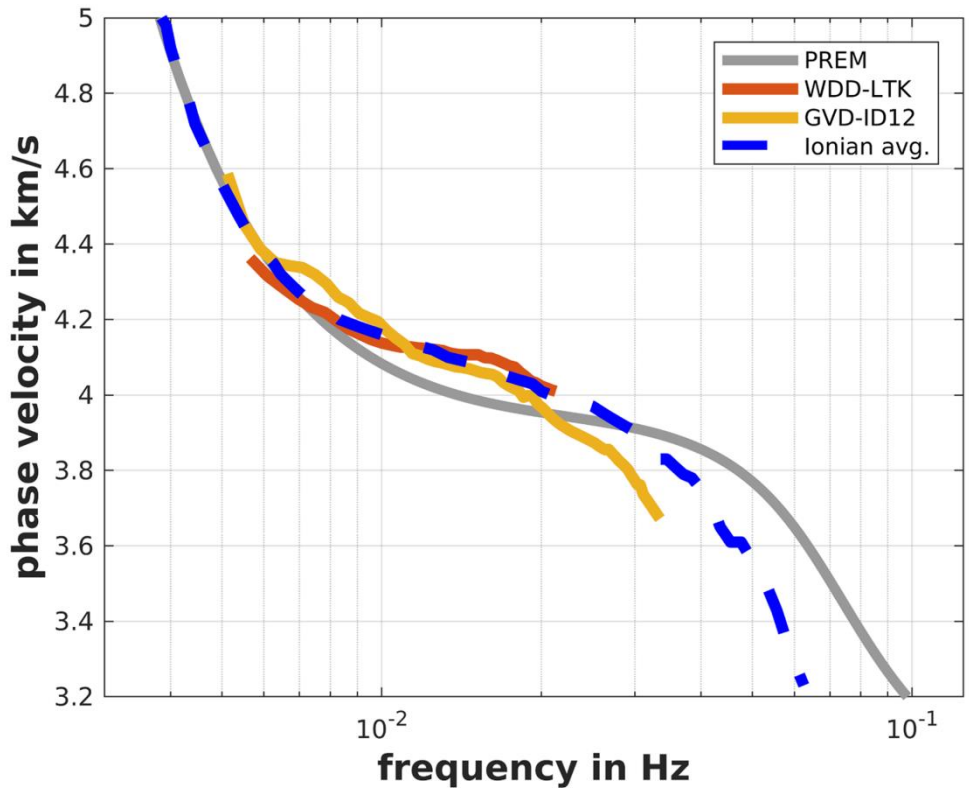





0
−50
−100
−150
−200
−250
depth in km
3.8
4.0
4.2
4.4
4.6
4.8
Vs in km/s
PREM
IonS ~ 180 km
TPM ~ 90 km


4.8
4.6
4.4
4.2
4
3.8
3.6
phase velocity in km/s
10^{-2}
10^{-1}
frequency in Hz
PREM - dc
Ionian- dc
TPM - dc


WDD
LTK
GVD
ID12
depth: 100 km
V_{SV}: 4.34 km/s
%
−6
−4
−2
0
2
4
6
V_{SV} anomaly


PREM
WDD-LTK
GVD-ID12
Ionian avg.
phase velocity in km/s
frequency in Hz