A 3-D shear-wave velocity model across the Alpine-Mediterranean mobile belt from high-resolution Rayleigh wave tomography

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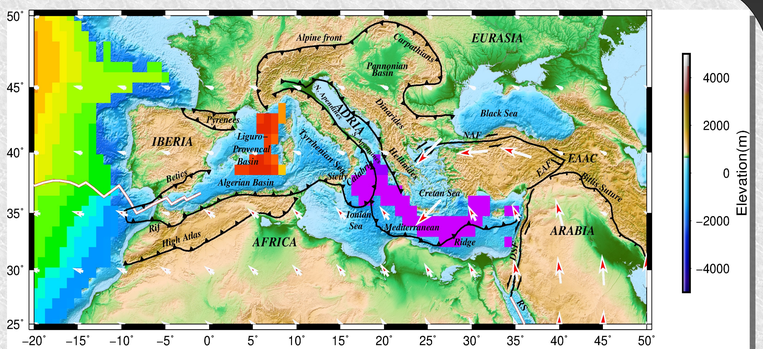
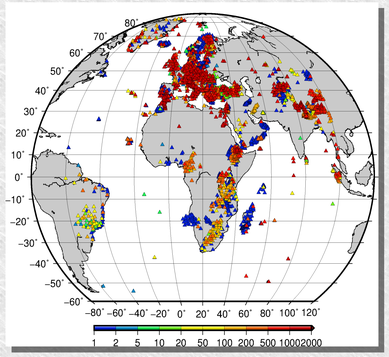
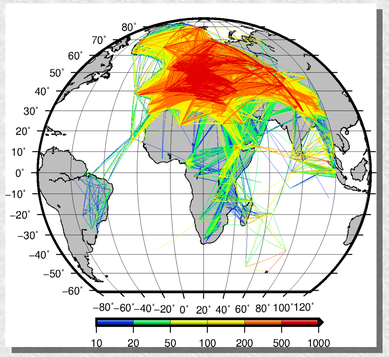


Tectonic/Topographic map of the Mediterranean, modified after Faccenna et al., 2014
The spreading-aligned reference frame plate motion of Becker et al., 2015 (white arrows) as well as the age of the oceanic lithosphere (Müller et al. 2008) are also shown on the map

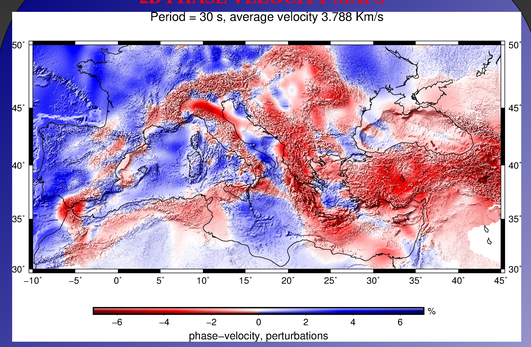


Seismic stations distribution within and around the study region. The color of each station represent the number of available waveforms for each single station



The ray path coverage. The color represents the number of events recorded by each station pair located on the same great circle path

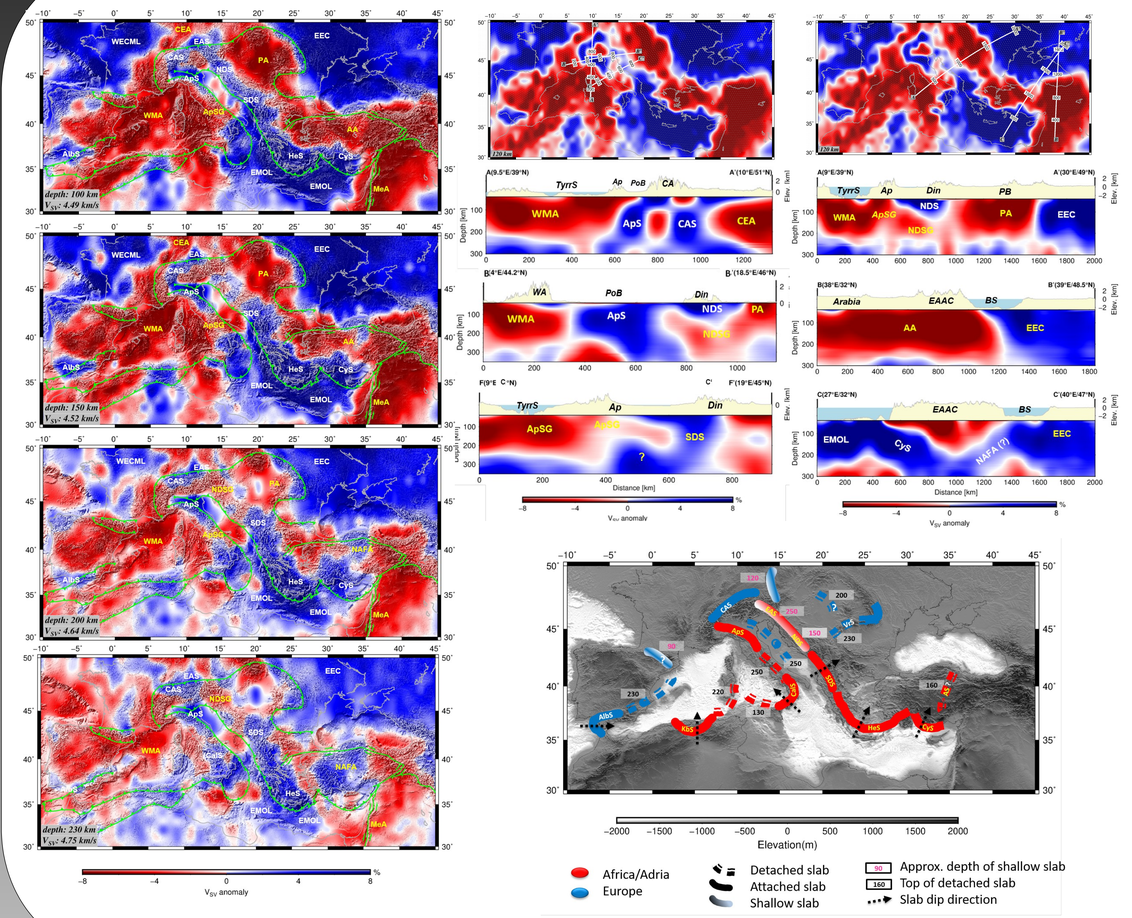
2D PHASE VELOCITY MAPS



2D isotropic Rayleigh wave phase velocity maps at two different periods 30 and 100 seconds sampling the lower crust, the mantle lithosphere and the asthenosphere. All velocity anomalies are plotted relative to the regional average phase velocity at each period, which is indicated on each plot.

On the right hand corner, may views and vertical depth slices through the 3D shear model underneath the Mediterranean are shown. The topography along each profile is plotted on top of the vertical velocity cross sections. AA: Anatolia asthenosphere, Ap: Apennines, ApSG: Apennine slab gap, AS: Anatolian slab, BS: Black Sea, CEA: central Europe asthenosphere, CyS: Cyprus slab, DiS: Dinarides, EAAC: East Anatolian Accretionary complex, EEC: East European craton, NDS: north Dinaridic slab, NDSG: north Dinaridic slab gap, PA: Pannonian asthenosphere, PB: Pannonian basin, TyrrS: Tyrrhenian Sea, WMA: western Mediterranean asthenosphere. The location of the profiles are shown on the map view of 120 km.

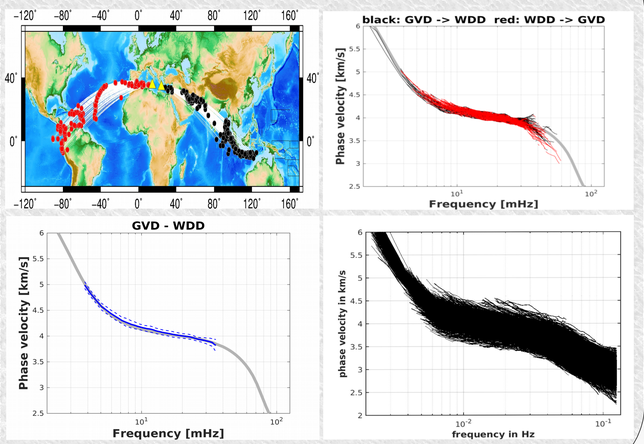
3-D SHEAR WAVE VELOCITY MODEL



PHASE VELOCITY MEASUREMENTS

Figure 2: Automated inter-station phase velocity measurements: **A)** Map showing the processed events (red and black circles representing events recorded by the station pair GVD-WDD from the two propagation directions, **B)** The single event dispersion curves for all the considered events from both propagation directions plotted on top of each other. **C)** The path-averaged inter-station dispersion curve and its standard deviation. **G)** All the averaged inter-station phase velocity curves are plotted on top of each other as function of frequency.

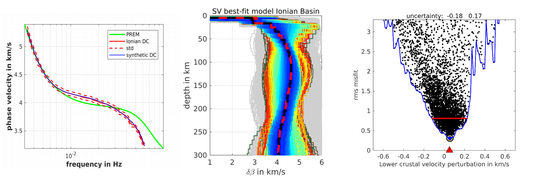
Unprecedent number of the inter-station dispersion measurements"~200,000 dispersion curves". The measurements were obtained in the frequency range from ~8 – 350 seconds.



PSO INVERSION 1D MODELS

Figure 4: TOP) Example of a local phase velocity dispersion curve at the Ionian sea in a comparison to PREM. **Bottom)** The inversion results for the selected point. For each 1D model, a range of possible models were constructed. The accepted models are shown in blue color and the rejected onesare shown in gray. The course dashed lines is used to highlight the lowest misfit model from this range of this possible models. Trade-off between the Moho depth and crustal velocities are shown. In addition to the uncertainties in the Moho depth Estimation.

1-D depth-velocity models from dispersion measurements
Particle swarm optimization algorithm (PSO)



- Stochastic inversion: particle swarm optimization
- Flexible parametrization of model perturbations (velocities + depth of discontinuities)
- Flexible regularization
- Estimation of uncertainties

NEW to our PSO implementation:
- random local search to speed up the convergence
- random excursion to best position of the other particles to ensure the exploration of the entire model space.

CONCLUSIONS

Surface wave tomography (*earthquake data*):

- ✓applicable to obtain regional 3D Vs model down to about 300 km depth
- ✓slab segments + slab gaps are detectable if resolution is better than ~100 km
- ✓resolution limit has not been reached yet

Hypotheses:

- ✓ Very thick oceanic lithosphere in the Ionian Sea & Herodotus basin
- ✓ support for slab break-off in the Western Alps
- ✓ complicated wedge (?) structure in the Eastern Alps
- ✓ slab in the Northern Dinarides down to about 150 km
- ✓ slab in the northern Apenines and slab gap beneath the central Apennines
- ✓ Continuous slabs underneath Alboran-Betics, Calabria, Hellenic and Cyprus arcs.

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