Tomography with surface waves from ambient noise

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Introduction

Cross section through the western Alps



Modified from Schmid et al. (2017). Vp isolines from Diehl et al. (2009).

Geologic cross section and Vp velocities from local earthquake tomography

Introduction

Geodynamic interpretations of Alpine subduction zone



Hua et al. (2017). From teleseismic P-wave tomography.



Zhao et al. (2016). From teleseismic P-wave tomography.

Understanding the differences in tomographic models



The result of a tomographic model depends on many parameters/user choices

- Data type
- Data coverage
- Data preparation
- Data error
- Parameterization
- Inversion method
- Smoothing/damping
- Methodological approximations
- Physical properties
- ...

- Introduction
- Surface-wave tomography
 - Ambient noise measurements
 - Creation of a tomographic model
 - Depth-sensitivity kernels
- Application example
- Conclusion

Ambient Noise

Noise source intensity in northern summer



Noise source intensity in northern winter







 \rightarrow Surface waves in the Earth are generated permanently by ocean waves and are part of the ambient noise wavefield.

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Stochastic model search (Monte Carlo methods)





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150

100

CIFALPS profile



→ Very good agreement of the Moho depth between receiver functions and the surface-wave model.

VS CUS WOIST

V5 mante 1001

ENE

350

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50

80

0

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200

250

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300



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Alpine mantle structures



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Alpine mantle structures



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- Surface waves are best suited to get the volume averaged shear-velocity structure.
- Data from ambient noise helps to constrain shallow (crustal) structures.
- Sensitivity kernels explain how well the medium can be resolved.
- The resolution of surface-wave models decreases with depth.
- The resolution changes also considerably with the complexity of the structures.

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- Presentation shear velocity model
 - How is the model created what kind of data?
 - Resolution checkerboard
 - Resolution vs. ray coverage
 - Uncertainty of data
 - Ray propagation model
 - •
 - Resolution 1D depth
 - Comparison between model and likelihood plot
 - Resolution below strong velocity contrast
 - Comparison between mantle structures
 - Why can we see different depth extent?
 - What is the difference in resolution at different depth?

Lateral resolution

- 3.6

3.4

3.2

3.0

2.8



Input model: 0.2° cells (~20 km)



Recovered phase-velocity map at 8s 29 (shallow crust)